Leaving fossil fuels underground in South Africa

From a climate debt to an unsettled stranded asset debt

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LFFU
Leave Fossil Fuels Underground
For sustainable and inclusive development: co-creating alternative pathways in Africa and Latin America

INCLUSIVELY LEAVING FOSSIL FUELS UNDERGROUND IN SOUTH AFRICA

FROM A CLIMATE DEBT TO AN UNSETTLED *STRANDED ASSET DEBT*

Final PhD Thesis

Arthur Martorelli Rempel
University of Amsterdam

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Leaving Fossil Fuels Underground in South Africa
From a Climate Debt to an Unsettled Stranded Asset Debt

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List of Abbreviations

AfDB	African Development Bank
Bcf	Billions of cubic feet
Bcm	Billions of cubic meters
bpd	barrels per day
BECCS	Bioenergy with Carbon Capture and Storage
CapEx	Capital Expenditures
CBDR-RC	Common But Differentiated Responsibilities and Respective Capabilities
CBM	Coal Based Methane
CCGT	Closed Cycle Gas Turbine
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilisation and Storage
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CoI	Coalition of the Indebted
COP	Conference of the Parties
CoS	Coalition of Stranders
CTL	Coal-To-Liquids
DBSA	Development Bank of Southern Africa
DFFE	Department of Forestry, Fisheries and Environment
DMRE	Department of Mineral resources & Energy
E&Ps	Fossil Fuel Exploration & Production Firm
EbI	Established but Incomplete
EcR	Ecological Recovery
EEA	Exclusive Energy Addition
EIB	European Investment Bank
EIUG	Energy-Intensive Users Group
ESIA	Environmental & Social Impact Assessment
ERR	Exclusive & Reformist Recovery
FGD	Flue Gas Desulphurisation
FIRR	Financial Internal Rate of Return
FMO	Netherlands Development Bank
FPIT	Finance Package for an Inclusive Transition
Gbbl	Billions of Barrels
GEM	Global Energy Monitor
GHG	Greenhouse Gases
GSADD	Great Stranded Asset Debt Dump
Gt	Billions of Tonnes
HPE	Hitachi Power Europe
IB	Investment Bank
IBRD	International Bank for Reconstruction and Development
ID	Inclusive Development
IDC	Industrial Development Corporation
IEP	Integrated Energy Plan
IMF	International Monetary Fund
Inc	Incomplete
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRP	Integrated Resource Plan
ITR	Inclusive & Transformative Recovery

JSE	Johannesburg Stock Exchange
LCOE	Levelised Cost of Electricity
LFFU	Leave Fossil Fuels Underground
LIBOR	London Inter-Bank Offered Rate
LNG	Liquified Natural Gas
MDB	Multilateral Development Bank
MEC	Mineral-Energy Complex
MHPSA	Mitsubishi Hitachi Power Systems Africa
MPRDA	Minerals and Petroleum Resources Development Act (Act No. 28 of 2002)
Mt	Millions of metric Tonnes
Mtpa	Millions of metric Tonnes per annum
NATREF	National Petroleum Refinery of South Africa
NBS	Nature Based Solutions
NDB	New Development Bank
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Act
NERSA	National Energy Regulator of South Africa
NMPP	New Multi-Purpose Pipeline
NOMBS	Not On My Balance Sheet
NUM	Nation Union of Mineworkers
N_2O	Nitrous Oxide
OCGT	Open Cycle Gas Turbine
OECD	Organisation for Economic Co-Operation and Development
OPEC	Organisation for the Petroleum Exporting Countries
OpEx	Operating Expenditures
PA 2015	Paris Agreement on Climate Change
PetroSA	Petroleum Agency of South Africa
PIIB	Principles for Inclusive Investing and Banking
PPP	Polluters Pay Principle
PRB	Principles for Responsible Banking
PRI	Principles for Responsible Investment
PtS	Pay-to-Strand
RCP	Representative Concentration Pathway of the IPCC
REI4P	Renewable Energy Independent Power Producer Procurement Programme
RMI4P	Risk Mitigation Independent Power Producer Procurement Programme
RtD	Right to Development
RtSD	Right to Sustainable Development
SAFTU	South African Federation of Trade Union
SAP	Structural Adjustment Program
SAPREF	Shell and BP South Africa Petroleum Refinery Company
SBM	Single Buoy Mooring
SDGs	Sustainable Development Goals
SEZ	Special Economic Zone
SO_2	Sulphur Dioxide
SOE	State-Owned Enterprise
SR	Social Recovery
SU4	OECD Arrangement Sectoral Understanding IV: Renewable energy, climate change mitigation and adaptation, and water projects
SU6	OECD Arrangement Sectoral Understanding VI: Coal-fired electricity generation projects
Tcf	Trillions of cubic feet
The Arrangement	The Arrangement on Officially Supported Export Credits (OECD)
UBI	Universal Basic Income

UNEP FI	United Nations Environment Programme Finance Initiative
UNFCCC	United Nations Framework Convention on Climate Change
Un	Unresolved
WE	Well Established

Publications Based On, And Relevant To, This Manuscript

This manuscript was prepared in tandem with six supplemental articles and one shorter research perspective, all submitted for peer review, in a bid to both reaffirm the theoretical and methodological approaches that have been employed and to test key and innovative working ideas that underpin the monograph's findings and conclusions. Of these six papers, four have been published/accepted, one has undergone major revisions, and one was recently sent for review, as summarised in the table below.

Title	Journal	Status	Relevant Thesis Chapters	Authors (in order)
Effective, equitable and feasible approaches to LFFU	*Wiley Interdisciplinary Reviews Climate Change* (Impact Factor: 7.9)	Published December 2021	4	Rempel, Arthur Gupta, Joyeeta
Fossil Fuels, Stranded Assets and COVID-19: Imagining an Inclusive & Transformative Recovery	*World Development* (Impact Factor 8.4)	Published June 2021	2, 8 & 9	Rempel, Arthur Gupta, Joyeeta
An Unsettled Stranded Asset Debt: Unpacking South Africa's Fossil Fuel Regime in the Context of the International Finance Landscape	*Antipode* (Impact Factor: 5.0)	Accepted June 2022	5 & 6	Rempel, Arthur
Access & Allocation: The Role of Big Shareholders and Investors in LFFU	*International Environmental Agreements: Politics, Law & Economics* (Impact Factor: 3.4)	Published July 2020	6	Gupta, Joyeeta Rempel, Arthur Verrest. Hebe
Public Finance & African Fossil Fuels: Export Credits, Development Banks and the Paris Agreement	*Environment, Development and Sustainability* (Impact Factor: 3.2)	Major Revisions June 2022	5 & 6	Rempel, Arthur Gupta, Joyeeta
Provocative Alternatives to Key Climate & Development Terminology: A Reflection on the equitability and justice implications of internationally-adopted climate and development lingo	*Energy Research & Social Science* (Impact Factor: 6.8)	Submitted May 2022	3 & 9	Rempel, Arthur

Executive Summary

Background, Gaps & Research Question

There is a scientific consensus that the bulk of global fossil fuel reserves (i.e. 90% of coal, 60% of natural gas and oil) must be left underground in order to combat the 'climate emergency' and comply with the temperature objective of the Paris Agreement on Climate Change (Article 2.1a). Leaving Fossil Fuels Underground (LFFU) is arguably *the* most pressing and existential need of the century, and yet, current macroeconomic trends suggest that unabated fossil fuel production and consumption rates are 120% of that required to meet the 1.5°C goal.

LFFU poses both an economic and financial conundrum; on a global level, some $200 trillion in (measurable, quantitative) costs may be incurred as lucrative fossil resources are left untouched, and their accompanying physical and financial assets are *stranded*. However, these 'costs' extend beyond the financial dimension; millions of coal miners will become unemployed, farmers dependent on diesel-powered vehicles will see their livelihoods upended, knowledge and skills will be deemed useless (stranded *human assets*), communities built around and dependent on fossil production may be left abandoned (stranded *social assets*) and access to reliable and affordable energy may be threatened (stranded *energy*) if adequate alternatives are not pursued. As such, it does not suffice to pursue a fossil phase-out, but rather an *inclusive phase-out*; namely, a mix of LFFU approaches that explicitly takes into account the socioecological implications of phasing out fossil fuels, and simultaneously allocates the inevitable *stranded asset burden* onto the most capable shoulders. Note that this inclusive approach challenges and rejects the sustainable development paradigm's economic dimension (integral to Agenda 2030, the international development policy environment about which this research is situated), and opts to reconceptualise economic trade-offs from LFFU through social, ecological and relational perspectives.

Four key knowledge gaps are addressed based on a scoping review of recent LFFU scholarship: studies on economic, regulatory and 'other' LFFU approaches have been empirically concentrated in European, North American and Chinese contexts – African studies have received comparatively little attention, particularly with a focus on *inclusiveness* (gap K1); the bulk of the literature refrains from grappling with the 'North-South' backdrop, particularly by studying North-South finance flows vis-à-vis South African fossil production (K2); a strong emphasis is placed on phasing *in* green fossil-alternatives (e.g., solar PV, wind, battery storage) or taking measures to govern GHG emissions (and therefore fossil fuel *consumption*) rather than curtailing unabated *fossil fuel supply* (K3); and most studies isolate and examine the effects of one single regulatory or market-based approach on one region rather than how various actors and LFFU approaches intermesh to paint 'the bigger picture' (K4).

Given these gaps, this research tackles the overarching question:

What do the key trade-offs from Leaving Fossil Fuels Underground (LFFU) imply for an inclusive fossil phaseout in South Africa (paying special attention to the risks posed by prospective multidimensional stranded assets), how do these trade-offs influence and subsequently sculpt post-pandemic fossil fuel phase-out scenarios, and under what conditions will an inclusive, post-pandemic fossil fuel phase-out unfold in South Africa?

Theoretical Framework

This thesis draws on two key overarching theoretical approaches: stranded assets and inclusive development. The former posits that physical, financial, natural, social and human assets are an inevitable consequence of an effective fossil phaseout, and the latter aspires to protect the wellbeing of the most under-resourced and under-privileged fossil-dependents in such a phaseout by scrutinising the implications of these multidimensional stranded assets across social, ecological and relational dimensions.

There is a 'North-South' dimension to this; as of 2020, some 82% of proven oil & gas reserves reside outside of Europe and North America, and as such, LFFU compatible with a 1.5°C temperature rise implicitly violates the 'South's' Right to Development (RtD). Moreover, some nations in the 'South' are already tenaciously reliant on fossil production and consumption, so that phasing out said production poses a slew of existential risks; South Africa (the geographical focus of this research) relied on coal to meet an estimated 90% of primary energy and 25% of liquid fuel demands in 2018.

Historically, climate justice advocates have shed light on this 'North-South' dimension by arguing that the 'global North' have accumulated a *climate debt*. However, these debates have explicitly focused on both *nation states* (i.e., from the 'global North') and *fossil-based emissions* rather than *actors* and *fossil supply*; this implicitly absolves key actors (like fossil fuel E&Ps and their shareholders & debt financiers) of responsibility and accountability, and deflects attention away from the critical question about *curtailing fossil fuel supply*. To expand this, this dissertation develops a new concept: the Stranded Asset Debt (SAD). The SAD presents a useful supply-side counterpart to the demand-oriented 'climate debt'; this thesis therefore focuses on empirically and theoretically unpacking the relationship between this SAD and an inclusive fossil phaseout, drawing on a South African case study.

Methods

A multi- and mixed method design was employed consisting of six unique phases, inspired by a critical realist ontology and pragmatic epistemological approach. The former refers to a sort of post-positivist approach to research, positing that 'reality' is composed of 'observable' events on an empirical level (e.g., fossil fuel production, finance flows) and 'unobservable' events and causal structures on an actual or real level (e.g., the newly proposed Stranded Asset Debt), aspiring to use the former to shed light on the latter. Moreover, a pragmatic-epistemological approach speaks to the empirically driven nature of the research, combining and compiling data from several publicly available and original sources (discussed below).

The research was inaugurated by a scoping and ad hoc review of the scholarship on stranded fossil fuel assets, inclusive development and climate debt to construct the theoretical framework briefly outlined above, and a scoping literature review on *fossil fuel phase-outs* and *stranded (fossil fuel) assets* to build an operational framework of readily proposed LFFU approaches.

It then diverged into two parallel phases; first a 'South African Stranded Asset Stocktake', which inventories and evaluates the implications of the prospective natural, physical, human, social and financial stranded assets scattered across South Africa. The second sought to 'follow the fossil money' and 'expose the finance flows' between multinational fossil fuel E&Ps, their major shareholders, commercial banks, & public finance institutes and South African fossil fuel operations. These two chapters were centred around empirically unpacking the SAD. A content analysis of stakeholder annual reports, news item mining, financial analysis of existing datasets, the generation of an original equity dataset, and semi-structured interviews (among other methods) were utilised.

The research then converged and explored the policy context within which these South Africa-borne prospective stranded fossil fuel assets and finance flows have and continue to originate. To do so, the framework developed in the literature review was applied in a content analysis to survey the LFFU approaches being adopted by the key finance institutions that have hoisted South African coal, oil and gas production. This phase predominantly relied on the annual and sustainability reports pertaining to the 74 key actors that were earlier identified to in some way driving South African fossil production, in addition to 28 expert interviews with representatives from *either* the financial institutions that were identified as key stakeholders, *or* NGOs, CSOs or academia working on fossil finance related issues with second-hand expert knowledge on the investor behaviour. The purpose of this module was to discern the extent to which an 'inclusive fossil phaseout' was likely to unfold in South Africa given the existing approach mix.

The research then zoomed out to the 'big picture', first by exploring how the COVID-19 pandemic has influenced the fossil fuel asset stranding and fossil phaseout process, and subsequently the extent to which it provides any opportunities for LFFU in South Africa and beyond; this was deemed relevant since the research has been conducted during the pandemic, and all future attempts to LFFU will by default take place in the 'post-pandemic' aftermath. Finally, the concluding phase integrated the findings from chapters 3-9 to identify the array of multidimensional trade-offs from LFFU in South Africa, developing post-pandemic LFFU scenarios based on these trade-offs, and identifying the conditions necessary for an inclusive phaseout in South Africa, paying special attention to the SAD conceptual narrative.

Several limitations persist from this research design. For instance, the research: refrains from addressing the legality behind the SAD narrative in relation to international climate policy; does not adequately cover the 'social' dimension of stranded assets due to the desk-study format; relies on existing datasets for scrutinising the 'financial' stranded asset dimension, which themselves may be incomplete; and is limited to unpacking South Africa's SAD case in detail, though by contextualising the findings vis-à-vis broader African fossil finance flows, it begins to address the generalisability of the research.

Findings

Chapter 4 posed the question: What is the array of available approaches for LFFU, to what extent are they socially, ecologically and relationally inclusive (paying particular attention to the extent to which they govern inevitable stranded assets), and which types of approaches are favoured over others?

It concluded that:

Twenty-nine unique approaches for LFFU are at the disposal of policymakers, financial regulators, financiers, investors and civil society organisations – some of which are mainstream & ubiquitously adopted (e.g., carbon emissions taxes or divestment), while others are much more unorthodox and are yet to gain traction (e.g., extraction taxes or asset write-offs). These approaches are equally distributed across three types: economic (10), regulatory (10) and 'other' (9), though the vast majority of the scholarship has favoured studying economic rather than regulatory or 'other' approaches.

Of these 29 approaches: only 12 are likely to effectively LFFU (ecologically inclusive); only 5 allocate implementation costs AND accompanying stranded asset to rich and capable actors (relationally inclusive); and NONE simultaneously account for both fossil-depends AND access to basic needs (e.g., affordable and reliable energy access) more broadly (socially exclusive). *As a result, social and relational challenges to LFFU have been almost entirely neglected in recent scholarship, while even coverage of ecologically inclusive LFFU approaches has been sparse*. This speaks to a larger tendency in the recent scholarship to favour researching fossil fuel *consumption* vs. *production* (gap K3).

Chapter 5 posed the question: What is the extent of the monetary & non-monetary stranded fossil fuel asset risks borne by South Africa and the African continent more broadly, and what implications do these risks bear on both inclusive development and sustainable development agendas?

It concluded that:

South Africa's fossil reserves pose a prospective **monetary** stranded asset risk of approximately $1 trillion, and a **non-monetary** stranded asset risk existentially threatening the livelihoods of at least 10-15% of the South Africa's population, spanning all five dimensions of the stranded asset typology.

Accordingly, due to its prospective stranded asset exposure, the existing state of the South African fossil-economy is entirely exclusive across all dimensions and indicators, and two key and fundamental challenges occlude an inclusive fossil fuel phaseout in South Africa: stranded labour and stranded energy. *Stranded labour in the form of coal-related unemployment (direct, indirect and induced), among other fossil-sectors – and to a lesser extent stranded energy – are the key social hurdles for an inclusive fossil fuel phaseout in South Africa*.

Moreover, adopting a sustainable development framework to promote LFFU in South Africa will likely result in paralysis and an accompanying failure to adequately phaseout its existing and forthcoming coal, oil and gas production, due to the severity of the economic implications of prospective stranded financial assets and the trade-offs that they pose for economically-geared SDGs.

Chapter 6 posed the question: What fraction of South Africa's stranded asset risk has been generated by financial & economic institutions from the 'North', what is the extent of the stranded financial asset risk borne by these institutions, and hence, what does a preliminary estimation suggest about the magnitude of the Stranded Asset Debt owed by the 'North' to South Africa?
It concluded that:

Given that multinational E&Ps (mainly from the 'North'): currently control 50-75% of coal production, 66% of offshore exploration blocks, and at least 85% of crude oil imports into South Africa; drive 30-60% of oil and gas production and 60-80% of coal production in Africa more broadly; are governed by shareholders who are 94-98% non-African; and acquire hundreds of billions in financing from commercial banks in addition to tens of billions from PFIs from the 'North' to drive their global (including African) businesses, it seems reasonable to conclude that at least 50-75% of South Africa's and 30-80% of Africa's monetary & non-monetary stranded asset risk exposure (purely based on the fraction of fossil production accounted for by the E&Ps) has been driven and exacerbated by financial and economic institutions predominantly from the 'North'.

While generating these prospective stranded assets across South Africa and the African continent, financial and economic institutions from the 'North' (and partially the 'South') have themselves accrued an exposure to prospective stranded financial asset worth some $4 trillion, decomposed as: on average $2 trillion in forgone annual gross revenue streams; $1.3 trillion in prospective stranded liquid equity; $50+ billion in forgone annual dividends; and at least $400 billion and $50 billion in prospective stranded commercial debt and public debt issued post-Paris, respectively.

Moreover, South Africa faces a quantifiable stranded asset risk of at least $300 billion in addition to $2.2 billion in annual payments to support fossil-dependent workers with a universal income, and by investing in and driving the bulk of both South African and African coal, oil and gas production (see conclusions 1 & 2), E&Ps and financiers predominantly from the 'North' have arguably and implicitly accumulated a Stranded Asset Debt (SAD) owed to South African citizens complementarily to having simultaneously accrued a 'climate debt.' As such, these 'Northern' actors may be responsible for 'settling' this SAD and covering a (substantial) fraction of South Africa's $300+ billion stranded asset monetary risk.

Chapter 7 **posed the question:** What does the composition of the LFFU approach mix that South Africa's stranded asset debtors are adopting imply for the allocation of their Stranded Asset Debt (SAD), to what extent are international finance policy frameworks likely to drive an inclusive fossil transition in South Africa, and hence, how can these frameworks be revamped to better align with inclusive development agendas?
It concluded that:

By preferring ecologically exclusive approaches & divestment of their assets, failing to acknowledge their South African SAD, and explicitly denoting plans to expand their global fossil operations and implicitly balloon their SAD, actors from the 'North' are in the midst of orchestrating what may become the **Great Stranded Asset Debt Dump (GSADD)** – reallocating the (non-)financial burden and accountability for phasing out existing South African fossil fuel infrastructure to other 'Northern' or 'Southern' balance sheets, or directly to the citizens of the South Africa and the 'South' more broadly. The vast majority of the studied actors abide by non-binding and multilateral policy frameworks, like the UNEP FI's PRI & PRB and the OECD Arrangement, and as of 2021, these existing frameworks yield a **policy landscape and LFFU approach mix that is at most 15% inclusive with respect to South African fossil fuel investments** (meeting only 1/7 inclusiveness conditions); the status-quo invites continuous fossil investments in non-OECD member states (e.g., South Africa) through 2040, thereby exacerbating global stranded asset risks (see 5.3.4), ballooning already massive stranded asset debts (see 6.4), and fuelling (rather than combatting) the 'climate emergency'. As a result, it seems there is an **85% likelihood (violating 6/7 inclusiveness conditions) that an exclusive energy addition will unfold in South Africa through 2030-2040, failing to LFFU altogether**.

Hence, an inclusive fossil fuel phaseout in South Africa is only possible if existing multilateral policy frameworks like the PRI, PRB and OECD Arrangement are reimagined to more strictly curtail the financial capital available for both coal- and oil & gas-intensive projects while simultaneously allocating capital to govern stranded (non-)financial assets. One possible alternative is the proposed Principles for Inclusive Investing and Banking (PIIB), which goes beyond questioning whether investors and financiers are 'aligning with the Paris Agreement' and ascertains the extent to which they are prepared to allocate resources to effectively drive an inclusive fossil phase-out.

Chapter 8 **posed the question:** How has the COVID-19 pandemic impacted prospective stranded fossil fuel assets globally and in both Africa and South Africa more specifically, and how does this influence prospects of inclusively phasing out fossil fuels in South Africa and beyond?
It concluded that:

COVID has catalysed the inevitable asset stranding process both globally and across the African continent, dealing a monetary blow to the tune of at least $1 trillion in fossil fuel E&P shareholder equity and some $300 billion in forgone revenue streams, and a non-monetary blow stranding 17 million African jobs (including at least 85,000 mining jobs in South Africa alone) and shutting down dozens of refineries, coal plants and LNG terminals, upending the livelihoods of millions of Africans. Altogether, the pandemic has materialised a fraction of the monetary and non-monetary risks that African citizens were deemed susceptible to.

By doing so, the pandemic presents a unique opportunity to drive an inclusive fossil phase-out in South Africa and beyond by unprecedentedly 'pushing' against the growing fossil sector. However, this will only be possible with an accompanying 'pulling' force in the form of an inclusive LFFU approach mix that prioritises governing the outstanding and unsettled SAD.

The concluding chapter addressed the overarching question:

What do the key trade-offs from Leaving Fossil Fuels Underground (LFFU) imply for an inclusive fossil phaseout in South Africa (paying special attention to the risks posed by prospective multidimensional stranded assets), how do these trade-offs influence and subsequently sculpt post-pandemic fossil fuel phase-out scenarios, and under what conditions will an inclusive, post-pandemic fossil fuel phase-out unfold in South Africa?

And drew three overarching conclusions:

Given the dialectical nature of the relational, social, ecological and economic trade-offs from LFFU in South Africa, an *inclusive* fossil fuel phase-out in South Africa is only possible through simultaneously top-down and bottom-up LFFU approaches (linking to knowledge gap K3), the former accounting for and governing relational implications of the several trillions of dollars' worth of stranded revenue streams, debt and equity inherent to such a phaseout (linking to knowledge gap K2), and the latter allocating resources to govern the hundreds of thousands of stranded labourers, their stranded communities, and the stranded fossil-based energy inevitable in such a phase-out (linking to knowledge gap K1). Moving forward, this duality will be central to crafting an LFFU approach mix that maximises the likelihood of a post-pandemic inclusive fossil fuel phase-out.

Four ideal-typical post-pandemic LFFU scenarios are possible, of which only one encapsulates a truly inclusive fossil fuel phaseout in South Africa on relational, social and ecological levels (linking to knowledge gap K1, K4), and this scenario is dependent on the institutions from the 'North' with an SAD to South Africa to withhold the responsibility they have implicitly obtained, subsequently allocating several hundreds of billions of dollars in to minimise South Africa's stranded asset risk exposure.

Moving forward, an inclusive post-pandemic fossil phaseout can be crafted under eight conditions:

1. *Short-term growth prospects are side-lined* in favour of greater wellbeing for people now and in the future;
2. *Articles 4.5 and 9-11 of the Paris Agreement (see 1.4.1) are not only respected but prioritised, seeing finance, technology and knowledge flows from the 'North' to South Africa, thereby settling the SAD bill (in addition and complementarily to settling demand-oriented climate debts);*
3. *Multilateral policy frameworks like the PRI, PRB and OECD Arrangement are overhauled and replaced with inclusive alternatives;*
4. *South Africa's IRP is overhauled*, drastically reducing its predicted installed coal capacity from 33GW by 2030 to at least 9.6GW (if not lower)*;*
5. *Policymakers, activists, investors and financiers break free from their conventional habits vis-à-vis LFFU approaches*, replacing ineffective and exclusive with inclusive alternatives;
6. Internalising 'green finance' for fossil alternatives *as a means of upholding universal rights to basic services – and therefore promoting social inclusiveness* – rather than effectively fettering fossil fuel production;
7. Using the COVID-19 pandemic *as an opportunity for effective climate action rather than a crisis that necessitates urgent nursing to revert to fossil-intensive normalcy*; and
8. *Juxtaposing ecologically effective approaches with socially and relationally inclusive ones.*

However, the evidence suggests that all but condition 8 above will likely be violated, and several elements of the Social Recovery scenario will unravel in South Africa, in which 'green' energy is added to the fossil-intensive grid, potentially ameliorating energy accessibility challenges in the short term, but exacerbating stranded asset exposure and resulting in 'climate' calamity in the mid-to-long term (addressing knowledge gaps K1, K3 and K4).

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PART 1

INTRODUCTION, METHODOLOGY, THEORY AND LITERATURE

Justifying the Need to Inclusively Leave Fossil Fuels Underground,
Presenting the Study Methodology,

Identifying Key Gaps in Knowledge and Constructing a Framework for an Inclusive Fossil Fuel Phaseout

1. Introduction: Why Leave Fossil Fuels Underground?

1.1. Opening & Structure

"Speaking of the 'Anthropic origin' of climate change/global warming is meaningless, in fact, if by 'anthropic' we mean something like 'human species'. Who can claim to speak for the human in general?"

Bruno Latour (2015: 121)

"Capitalism… represents the socio-historical driver of climate change, and the core institutionalized [sic] dynamic that must be dismantled in order to stop it. Capitalism drives global warming non-accidentally, by virtue of its very structure."

Nancy Fraser (2021: 96-8)

*"*Environmental economics and broader neoliberal policies now seemingly dominate attempts *to give the invisible hand a 'green thumb'"*

Noel Castreé (2015: 288-9)

Global warming arguably presents the most pressing and cataclysmic event that humanity has ever endured, and a scientific consensus points to unabated fossil fuel (i.e. coal, oil and natural gas) combustion as *a* (if not *the*) leading cause (e.g., Welsby et al., 2021; McGlade & Ekins, 2015). The Paris Agreement on Climate Change (UN, 2015) pledged to limit average global warming to "well below 2°C above pre-industrial levels and pursuing efforts to limit temperature increase to 1.5°C" (Article 2.1a) (see 1.4.1), and a recent study (Welsby et al., 2021) concluded (using a lowest-cost modelling technique) that 60% of oil, 60% of natural gas and 90% of coal proven reserves (using 2018 as a baseline) must remain underground in order to limit average global warming to 1.5°C above pre-industrial levels. These findings tighten earlier estimates that 33% of oil, 50% of gas and 80% of coal reserves were unextractable to comply with a 2°C temperature rise (McGlade & Ekins, 2015),[1] the tightening of which implies that the urgency to Leave Fossil Fuels Underground (LFFU) has intensified. However, since the Paris Agreement entered into force in 2016, the global response to drastically reduce greenhouse gasses has been minimal at best: an estimated 84% of global primary energy demands were met using fossil fuels in 2020 (BP, 2021); energy forecasts by Shell, ExxonMobil and OPEC member states indicate that fossil fuels are expected to meet 60-80% of primary energy demands in 2040 (Curtin et al., 2019); and fossil production rates compatible with a 1.5-2°C

[1] In their *Nature* article, McGlade & Ekins (2015: 187) concluded that "a third of oil reserves, half of gas reserves and over 80 per cent of current coal reserves should remain unused from 2010 to 2050 in order to meet the target of 2°C". Although these metrics are useful, they might be misleading and should be handled extremely cautiously for at least four reasons. First, the piece "found that 94% of remaining oil reserves could be extracted in the USA, but only 61% of those in Central and South America" (Kartha, 2018: 119) and "73% of the coal found in Central and South America, and 90% of African supplies, must go unburned", and "African countries… may have to leave their entire unconventional gas reserves underground" (Armstrong, 2019: 672) in order to reach a cost-optimising route to LFFU – which omits any trace of social & political context and consideration for equitability, justice and inclusiveness. Second, global temperature goals (like the 2°C target) are based on climate models that are themselves riddled with assumptions and uncertainties (particularly with unrealistically optimistic expectations of bioenergy and carbon capture & storage (BECCS) technologies), meaning that their proposed coal, oil and gas 'caps' are themselves fraught with uncertainty. Third, recent research is now questioning whether even the looser 2°C target will produce catastrophic human harm (Xu et al., 2020). Fourth, McGlade & Ekins' (2015) results strictly apply to *current* reserves as of 2015, and since new proven reserves have been discovered and developed since, their findings are inapplicable to current proven global reserves – like those published in BP (2020).

temperature rise are expected to be overshot by 50-120% (SEI et al., 2020). Hence, strategies and actions to immediately and extensively LFFU are of the utmost necessity.

There is a second face to this coin, however. This somewhat logical narrative is yet to introduce a pertinent underlying political dimension; for instance, the drivers of global warming (unabated fossil fuel combustion) and adverse climate impacts are unevenly distributed across space, time, class, gender, race and ethnicity (Fraser, 2021). As an obvious example, the bulk of the adverse impacts of a changing climate (see 1.2.1) have, and will be, predominantly felt by the citizens of the 'global South' (IPCC, 2014; 2019; 2021), despite the bulk of historical greenhouse gas (GHG) emissions (from e.g., combusting fossil fuels) originating from the 'global North', sparking debates regarding the North-South dimension (Gupta, 1997) including the *climate debt* that the latter owes the former (e.g., Martinez-Alier, 2002a; see 2.2.1.3). And as global temperatures continue to rise beyond the scientifically-deemed 'safe' levels of 1.5-2°C (see 1.4.1), these existential threats will both continue to intensify and unevenly impact members of the 'global South' (IPCC, 2021; 2022), while financial institutions from the 'global North' continue to invest trillions of dollars to develop and commercialise fossil resources today (see RAN et al., 2021).[2]

In the context of the African continent – and more specifically, South Africa (the geographical scope of this research, see 1.3.2.1) – this unevenly distributed responsibility and vulnerability could be read against the background of centuries of colonially-driven exploitation and (ap/ex)propriation of human and non-human resources (Rodney, 2018), which eventually culminated in the *Scramble for Africa* (or perhaps better suited is the *Rape of Africa,* ibid), in which the European powers quite literally partitioned the African continent amongst themselves in the Berlin Conference of 1884 as if it were a 'cake' – to paraphrase King Leopold II of Belgium (Pakenham, 1992).[3] Centuries later, our African comrades face a new, neo-colonial existential crisis.

This thesis is driven by a twofold ambition: 1) to explore strategies to *inclusively* Leave Fossil Fuels Underground (LFFU) within the context of Agenda 2030 (see 1.4.2), holding the 'North-South' discrepancies that have driven the 'climate emergency' or 'crisis' to account.[4] This is particularly urgent in the midst of the COVID-19 pandemic (during which this research has been conducted), which has not only virtually erased progress towards meeting wellbeing and development goals (see 1.4.2) and deepened existing inequalities, but has also seemingly presented an opportunity to take action (see 8); and 2) to simultaneously address the predominantly North-centric, Euro-centric and Capital-centric knowledge centred around 'solving the climate crisis' and contribute to the lacuna in scholarship on LFFU in the context of the 'global South' (see 1.2.2).

This dissertation is part of the project titled *Leaving fossil fuels underground for sustainable and inclusive development: Co-creating alternative pathways in Africa and Latin America – SDG 13, 15 and 16*, which is financed by the Dutch Research Council (Nederlandse Organisatie voor Wetenschappelijk Onderzoek, NWO-WOTRO, project number W07.303.104) following a call for proposals titled *Tackling Global Challenges through Use-Inspired Research* in 2017. This broader project investigates actors, arguments and approaches used in Africa (South Africa) and Latin America (Ecuador) that can be scaled up to address the challenge of leaving fossil fuels underground in the context of the broader Sustainable Development Goals. While the Latin America segment focuses on the role of social

[2] I purposely place the terms 'global South', 'global North' and 'climate emergency' inside single quotations throughout this manuscript, because I later argue (see 9.6.2) that these terms are arguably misrepresentative of the intricacies at hand

[3] This was also known as the Congo Conference. King Leopold's Belgium lacked a foothold in the colonised African continent, while neighbours Germany, France, England, Italy and Portugal had already effectively asserted their dominance. Through years of political savvy, King Leopold II successfully stole (and eventually ravaged) what is now the Democratic Republic of the Congo (DRC) for the Belgian empire

[4] See footnote 2

movements in shaping arguments and approaches to leave fossil fuel underground, the African component focused more on the role that stranded resources and assets will play in this narrative. This was inaugurated with an initial qualitative analysis on stranded assets in the North-South and African context (Bos & Gupta, 2016; 2018; 2019), which was subsequently expanded to the hybrid quantitative-qualitative manifestation in this manuscript. Given the 2+ year-long pandemic within which the bulk of this research has been undertaken, this thesis has adopted a desk-based approach to accommodate these circumstances, and I hope that a follow-up fieldwork period by myself or another researcher can both corroborate and complement this research's analysis and key findings.

This chapter first discusses the key societal and academic problems (i.e. knowledge gaps) that underpin and justify the research (see 1.2), then presents the overarching research question and sub questions, scope and limitations (see 1.3), the international policy context about which the research is situated (see 1.4), and finally presents the structure of the manuscript (see 1.5).

1.2. Problem Statement

1.2.1. Societal Problem

'Effectively' Addressing the Climate Emergency

The most obvious societal problem addressed in – and point of departure for – this thesis is combatting the 'climate emergency' explicitly via LFFU. As noted, numerous studies agree that the bulk of fossil fuel reserves must be left underground in order to minimise the adverse impacts of the changing climate (e.g., McGlade & Ekins, 2015), and the severity and urgency of doing so is only intensifying (Welsby et al., 2021);[5] allowing global temperatures to unabatedly rise *has already yielded a slew of catastrophic ramifications*, including, inter alia, severe and more frequent droughts & flooding and depleted crop yields and accompanying famine (for which poorer regions like sub Saharan Africa are exponentially more vulnerable) (IPCC, 2014; 2019; 2021; 2022), and will continue to do so if fossil fuel production is not fettered urgently and substantially. Adverse impacts have already begun to materialise, including in the 'global North'; "in the US the number of severe storms causing at least $1 billion in economic losses and damages has increased more than 4-fold compared to the 1980s" (Hubacek & Baiocchi, 2018: 1408). Addressing the systemic drivers of the climate emergency – unabated fossil fuel production and consumption – should therefore play a central role in all (inclusive) development agendas (see 2.2.1), as failing to do so will pose an existential crisis across the globe as the IPCC's most dire scenarios (Representative Concentration Pathways [RCPs] 4.5, 6.0, and most extremely 8.5) become more likely to manifest (IPCC, 2019), in which droughts and floods intensify, famines become more severe and mass involuntary migration ensues.

However, research finds that at current annual consumption rates, at most 30 years remain until the 2°C target is overshot with 33% risk tolerance, though "[f]or the 1.5°C target… if the risk tolerance is tightened to 5% the [point of no return] is brought forward to 2020" (Aengenheyster et al., 2018: 1085). Bioenergy with Carbon Capture and Storage (BECCS) technologies have in the past been speculated to offer flexibility to these emissions caps by sequestering GHG emissions from the atmosphere, but a plethora of recent studies conclude that BECCS is "fraught with huge uncertainty, technically, economically and politically" (van de Graaf & Verbruggen, 2015: 458 – see 2.1.2.1). *It is safe to assume that BECCS is an unreliable means to address the climate emergency, and the only way to effectively do so is by substantially LFFU*.

'Equitably' & 'Inclusively' Addressing the Climate Emergency

There is a second (and comparatively seldom discussed – see 1.2.2) dimension to the problem at hand – namely, the *equitability and inclusiveness of LFFU*. LFFU to the extent suggested to combat the

[5] The same critiques as those of the McGlade & Ekins (2015) paper apply to this piece – see footnote 1 on page 25.

climate emergency implies gargantuan financial losses – potentially as much as *$200 trillion* (Linquiti & Cogswell, 2016) – as the majority of fossil fuels reserves become *stranded***,** and their accompanying assets (e.g., infrastructure, equipment, jobs, machinery, shares, debt, communities, jobs) follow suit and are converted into stranded assets (Caldecott, Howarth & McSharry, 2013 – see 2.1). The European Investment Bank (2019) has warned of the risks that investors face by having prospective stranded financial assets on their balance sheets if (or when) they abruptly devalue; some estimates suggest that this devaluation could catalyse a global recession by sparking a $1-4 trillion loss of discounted global wealth (Mercure et al., 2018), threatening the financial health of pension funds, commercial banks, public finance institutes (PFIs) and a slew of other financiers that have and continue to bank on fossil fuels (Semieniuk et al., 2022; Gunningham, 2020; Christophers, 2019; Rempel & Gupta, 2020; RAN et al., 2021; OCI & FoE, 2019).

But the repercussions from these prospective and *multidimensional* stranded assets extend far beyond the financial and economic domain (see 2.1.1). Millions of mining jobs will vanish, threatening the livelihoods of mining-dependent families and communities (Abraham, 2017), and fossil-intensive power sectors will need to be completely revamped to accommodate fossil-alternatives, potentially jeopardising access to affordable and reliable energy (Carley & Konisky, 2020). That is, "concerns of achieving energy efficiency in the long term" should not "compromis[e] individual well-being or community cohesion" and should "seek fairness and equity with regards to… ethnicity, income, gender" (McCauley & Heffron, 2018: 1-2), among other factors; South Africa's society is particularly prone to both of these aforementioned risks (see 1.3.2, 5.2.2.6 and 5.2.3.3). Hence, it would be remiss (and inappropriate) to limit the scope and focus of this research to merely *effectively* LFFU. Given the mass socioecological repercussions that accompany LFFU, we must explore the extent to which different approaches to LFFU promote *inclusive and equitable* or *exclusive and inequitable fossil phase-outs*. It should not suffice to position this research about the linear objective of simply *addressing* the 'climate emergency', as the very act of doing so may counterintuitively and existentially jeopardise the livelihoods of the most vulnerable, under-resourced and under-privileged citizens that are most susceptible to the 'climate emergency' from the get-go. As such, an *inclusive* means of addressing the climate emergency via LFFU underpins the key relevant societal problem driving this research, unpacked in 2.2.

1.2.2. Academic Problem: Knowledge Gaps

Recent scholarship on phasing out fossil fuels has focused on, inter alia (see Table 4.1 in 4.2 for more): **governing *emissions*** and evaluating the implications of e.g., **carbon emissions taxes** (e.g., van der Ploeg & Rezai, 2020; Kopytin, 2020; Rozenberg, Vogt-Schilb & Hollegate, 2020; Kalkhul, Steckel & Edenhofer, 2020); exploring the role that ***'green finance'* and *'clean fossil-alternatives'*** play in LFFU (e.g., Baldwin, Cai & Kuralbayeva, 2020; Mutezo & Mulopo, 2021; Ediger, 2019; Asheim et al., 2019; Green & Denniss, 2018); the role of **reforming fossil fuel subsidies** (e.g., Johnsson, Kjärstad & Rootzén, 2019; Yuan et al., 2019; Coady et al., 2019; Lin & Xu, 2019; Piggot et al., 2018); specific **types of regulatory approaches** to LFFU, like **bans & moratoria** (e.g., Johnsson, Kjärstad & Rootzén, 2019; Asheim et al., 2019; Lazarus & van Asselt, 2018; Piggot et al., 2018)**,** and **divestment** (e.g., Le Billon & Kristoffersen, 2019; Rempel & Gupta, 2020; Ayling & Gunningham, 2017; Healy & Barry, 2017). These topics have been predominantly unpacked through empirical studies situated in the 'global North', for example (inter alia), in the **UK** (e.g., Johnston, Stirling & Sovacool, 2017; Caldecott & Derricks, 2018; Bebbington et al., 2020), **Norway** (Kopytin et al., 2020; Marsden, Moragues Faus & Sonnino, 2019; Bang & Lahn, 2019), and the **US** (e.g., van der Ploeg & Rezai, 2020; Hubacek & Baiocchi, 2018; Kefford et al., 2018; van de Graaf, 2018).

However, four key knowledge gaps persist that merit attention:

K1. **Geographical and Thematic Gap 1**: **Africa and Inclusiveness, Forgotten**

As mentioned, the scholarship is skewed towards discussing prospective fossil fuel phase-out trajectories and approaches in European, North American and (to a slightly less degree) Asian and Latin American contexts, though empirical research covering the 'global South' is steadily growing, with Muldoon-Smith and Greenhalgh (2019: 60) calling for a move "beyond the mostly Western European and North American perspectives" and others corroborating (Ansari & Holz, 2020; Bos & Gupta, 2018). *African* fossil fuel phase-outs have received comparatively little attention; some recent studies have adopted explicit and contextualised focuses on Africa's fossil fuel political economy (e.g., Mutezo & Mulopo, 2021; Nalule, 2020), and certain approaches have been extensively studied in 'Southern' contexts – like blockades (e.g., Temper et al., 2018; Bond, 2018), finance regulation (e.g., Baker, 2015b) and fossil-alternatives (e.g., Baker, 2015a), though these are sparse compared to their 'Northern' counterparts.

Moreover, many of these North-centric studies have focused on, inter alia, **optimising investment portfolios** (e.g., Monasterolo & de Angelis, 2020), **optimising carbon prices** (e.g., Rozenberg, Vogt-SChilb & Hallegate, 2020; Kalhul, Steckel & Edenhofer, 2020; van der Ploeg & Rezai, 2020; Caldecott & Derricks, 2018), **optimising the time to cease fossil fuel investments** (e.g., Baldwin, Cai & Kuralbayeva, 2020; van der Ploeg & Rezai, 2018; Rezai & van der Ploeg, 2016; Rezai & van der Ploeg, 2015) and **optimising indices & accounting techniques** (e.g., Overland et al., 2019). Even many of the African case studies specifically discuss carbon taxation schemes (e.g., Mutezo & Mulopo, 2021) and the financial implications of a South African fossil fuel phase-out (e.g., Winkler, Seem & Marquard, 2020). Although there is a growing and prominent scholarly body deploying justice-based research vis-à-vis LFFU (e.g., Kashwan, 2021; Healy & Barry, 2017; Abraham, 2017; McCauley & Heffron, 2018), comparatively limited scholarship has explored the socioecological implications of a fossil phase-out and multidimensional stranded assets, particularly in the 'global South' (and even more so in the African fossil fuel context), and in general has favoured economic and financial implications pertaining to the 'global North'. Indeed, there is some consensus that "neglect[ing] the equity ramifications of curbing emissions and extraction comes with serious risks" (Kartha et al., 2018: 118; Mutezo & Mulopo, 2021; Nalule, 2020; Le Billon & Kiristoffersen, 2019; Lenferna, 2018; Healy & Barry, 2017; Newell & Mulvaney, 2013; Armstrong, 2019), feeding into broader debates about climate justice and climate & ecological debt (see 2.2.1.3). Given that the costs of transitioning away from fossil fuels

> are incurred for common good—for the purpose of preserving the global atmospheric commons… they should be shared fairly, rather than allowed to fall on whoever is unfortunate enough bear them directly in the form of compromised energy access or other socio-economic sacrifices of curbing their own extraction (Kartha et al., 2018: 122).

Theoretically speaking, the majority of the studies that *have* expanded this economic focus and subsequently explored the socioecological implications of a fossil fuel phase-out have predominantly done so by adopting either a ***sustainable development*** (e.g., Bos & Gupta, 2019; Udemba & Tosun, 2022; Solarin, 2020; Faisal et al., 2021) or ***justice*** perspective (e.g., Muttitt & Kartha, 2020; Healy & Barry, 2017; Chapman et al., 2018; Evans & Phelan, 2016; Temper et al., 2018; Le Billon & Kristoffersen, 2019; Lenferna, 2018); the former employs a social, environmental and economic typology to scrutinise developmental issues, aligned with the Sustainable Development Goal (SDG) framework (see 1.4.2), while the latter aims to address the inequalities and uneven distribution of burdens associated with LFFU on the basis of one or multiple dimensions of justice (distributive, procedural, retributive and restorative) (Le Billon & Kristoffersen, 2019). To date, only two studies have deployed an ***inclusive development*** approach to scrutinising LFFU issues (Gupta & Chu, 2018; Bos & Gupta, 2016), despite the inclusive development approach offering a promising framework to unpack LFFU and prospective stranded asset threats across social, ecological and *relational* rather than economic dimensions (see 2.2).

K2. **Thematic Gap 2: North-South & Finance Flows**

Building on K1, the bulk of the literature (with the exception of studies covering Finance Swaps – see 4.2.3) refrains from grappling with the international, 'North-South' backdrop around which 'climate emergency' and its fossil fuel finance flows are situated; in fact, scholarship covering the North-South fossil-related finance flows that influence African fossil fuel phase-outs is virtually non-existent. Although ample research has scrutinised South Africa's fossil fuel regime in recent years (e.g., Baker, 2015a; 2015b; Baker, Newell & Phillips, 2014; Martin & Croukamp, 2021; Swilling, Musango & Wakeford, 2015; Cock, 2019), *none* have done so while focusing on the international finance flows and non-South African actors that have played a role in its creation. Some articles (e.g., Baker, 2015a; Swilling, Musango & Wakeford, 2015) allude to the importance of doing so, but none have systematically unpacked these linkages and have restricted their scope to the domestic level. This is both peculiar and alarming given that the Paris Agreement calls on making "finance flows consistent with pathways towards low greenhouse gas emissions" (Article 2.1c – see 1.4.1).

Moreover, a subset of the scholarship has focused on unpacking the role of financial regulation and innovation more broadly (e.g., Gunningham, 2020; Christophers, 2019; Best, 2017), but this has been scarce compared to studies on more common approaches, like emissions taxation (see K1). This is also surprising given that transnational commercial banks (RAN, 2021) and bilateral and multilateral Public Finance Institutions (PFIs) (OCI, 2021) have allocated several trillions of dollars in both public and private finance for fossil production since the Paris Agreement entered into force (see 1.4.1). Christophers (2019: 759) corroborates this gap:

> Indeed, there is a dearth of knowledge about how the finance sector at large approaches climate change issues more generally, in significant part because those academics with the best access to finance professionals—scholars of finance—have shown extraordinarily little interest in the topic…of more than 20,000 articles published in the leading twenty-one finance journals between 1998 and June 2015, only twelve (0.06 percent) were related substantively to climate change.

The IEA's updated World Energy Outlook report following COP-26 in Glasgow (IEA, 2021: 18, **emphasis added**) concludes that "**[f]inance is the missing link to accelerate clean energy deployment in developing economies**", and although it admittedly refrains from acknowledging the necessary finance to phase *out* fossil fuels, it does reinforce the importance of addressing this gap.

As a result, *this knowledge gap is perhaps the most central to this research*, driving the 'North-South' and finance flow oriented methodology (see 3.5.3 & 3.5.4) and theoretical approach (see 2.2.1.3& 2.2.1.4).

K3. **Thematic Gap 3: 'Green' Alternatives & Emissions Take Centre Stage**

As discussed above, the majority of recent scholarship places a strong emphasis on phasing *in* green fossil-alternatives (e.g., solar PV, wind – see 4.3.1.8) or taking measures to govern GHG emissions (and therefore fossil fuel *consumption*, and ergo, *demand* – see 4.3.1.3) when discussing effective climate action. Other than few recent studies (e.g., Gaulin & Le Billon, 2020; Le Billon & Kristoffersen, 2019; Lazarus & van Asselt, 2018), comparatively miniscule attention has been allocated to tackle the root cause of the climate emergency: unabated *fossil fuel production and, ergo, supply*. Although fossil fuel supply cuts are gaining traction in the literature (e.g., Gaulin & Le Billon, 2020; Lazarus & van Asselt, 2018), they still represent a lacuna.

This 'emissions' and 'green' focus has propelled numerous governments to recently pledge to 'achieve net-zero emissions' by 2045-50, including, inter alia, those of the US (2021), China (2021), Germany (2021), Japan (2021) and South Korea (2021); many firms have followed suit, including (but not limited to) fossil fuel Exploration & Production firms (E&Ps) like Shell (2021), BP (2021), Total (2020), Equinor (2021) and BHP Billiton (2021). These pledges were lauded at COP-26 in Glasgow (Duggal, 2021), and imply that an assortment of LFFU approaches (see 4.2) will be employed to reduce (*or offset*) fossil fuel *consumption* at the national or company level, though this is as if to suggest that *fossil fuel extraction and production* (i.e. supply, the root cause of emissions) is negligible. These 'net-zero' pledges have been debunked for being business-as-usual supportive ploys (Dyke, Watson & Knorr, 2020 – see 2.2.4), and a looming concern that persists is the extent to which said pledges account for the global and international scope of fossil fuel ***supply*** markets and accompanying financial flows that continue to hoist them.

Moreover, and building on K2, debates and discussions concerning climate justice at the macro-level have frequently attempted to assign responsibility for settling a 'climate debt' – a debate originating in the 1990s and conceptualising the "disproportionate contribution to the causes of climate change" by "developed countries… denying developing countries their fair share of atmospheric space" (Bond, 2010: 26, see 2.2.1.3). Not only have these debates stagnated (and been rebuked in the Paris Agreement itself, see 1.4.1), but they themselves have seemingly been incomplete for two reasons. First, they similarly focus on equitable *emissions sharing* rather than equitably *phasing out fossil fuels,* and hence are demand- rather than supply-side oriented; and second, they assign responsibility to high-emitting *nations and 'geobodies'* (Lohman, 2012) rather than *high-fossil-producing actors*. A paradigmatic shift in conceptualisation from demand- to supply-side and nation to actor is absent apart from a few recent studies (e.g., Newell & Simms, 2019), which is developed in this thesis (see 2.2.1.4).

K4. **Scope Gap**: **Big vs. Small Picture**
Finally, the bulk of the scholarship focuses on 'the small picture'; namely, studying the isolated effects of one single regulatory or market-based LFFU approach on one region (e.g., Lin & Xu, 2019; van der Ploeg & Rezai, 2020; La Rovere 2020). Fewer studies aim to paint 'the bigger picture', that is, how various actors and LFFU approaches intermesh to drive a nation-wide, intra-continental, and inter-continental fossil fuel phaseout (cf. Lazarus & van Asselt, 2018; Le Billon & Kristoffersen, 2019; Gaulin & Le Billon, 2020; Mutezo & Mulopo, 2021), particularly in the South African, and more broadly, African contexts (linking to gap K1).

1.3. Focus

1.3.1. Research Questions

The following overarching question drives this research, which covers all four identified gaps in knowledge (see 1.2.2),:

What do the key trade-offs from Leaving Fossil Fuels Underground (LFFU) imply for an inclusive fossil phaseout in South Africa (paying special attention to the risks posed by prospective multidimensional stranded assets), how do these trade-offs influence and subsequently sculpt post-pandemic fossil fuel phase-out scenarios, and under what conditions will an inclusive, post-pandemic fossil fuel phase-out unfold in South Africa?

Six sub questions were tackled to guide this study, each corresponding to one chapter and linking to one or more knowledge gaps (see Table 1.1, and see Appendix A for complete list of operational questions, variables and indicators).

Table 1.1. Sub questions addressed in the thesis, including the respective chapters in which they are answered and key knowledge gaps that they cover

	Sub Question	Chapter Addressed	Main Gap in Knowledge
S.1	What are the key components of an 'inclusive fossil fuel phase-out', unpacked using a stranded fossil fuel asset conceptualisation?	2	K1, K4
S.2	What is the array of available approaches for LFFU, to what extent are they socially, ecologically and relationally inclusive (paying particular attention to the extent to which they govern inevitable stranded assets), and hence, what does this imply for an inclusive fossil fuel phaseout?	4	K1, K3
S.3	What is the extent of the monetary & non-monetary stranded fossil fuel asset risks borne by South Africa and the African continent more broadly, and what implications do these risks bear on both inclusive development and sustainable development agendas?	5	K1, K3
S.4	What fraction of South Africa's stranded asset risk has been generated by financial & economic institutions from the 'North', what is the extent of the stranded financial asset risk borne by these institutions, and hence, what does a preliminary estimation suggest about the magnitude of the Stranded Asset Debt owed by the 'North' to South Africa?	6	K2
S.5	What does the composition of the LFFU approach mix that South Africa's stranded asset debtors are adopting imply for the allocation of their Stranded Asset Debt (SAD), to what extent are international finance policy frameworks likely to drive an inclusive fossil transition in South Africa, and hence, how can these frameworks be revamped to better align with inclusive development agendas?	7	K3, K4
S.6	How has the COVID-19 pandemic impacted prospective stranded fossil fuel assets globally and in both Africa and South Africa more specifically, and how does this influence prospects of inclusively phasing out fossil fuels in South Africa and beyond?	8	K1, K3

1.3.2. Scope & Limitations

1.3.2.1. Geographical Scope: South Africa Background and Justification

Although there is a clear gap in literature with respect to LFFU broadly in the 'global South', this research employs a geographical focus on both Africa and South Africa more specifically. South Africa was selected as a case study, first and foremost, because *its economy is tenaciously fossil-dependent* (e.g., Baker, 2015a; 2015b; Baker, Newell & Phillips, 2014; Martin & Croukamp, 2021; Swilling, Musango & Wakeford, 2015; Cock, 2019), relying on coal to generate some 90% of energy (e.g., Cock, 2019; Spencer et al., 2017), including 25% of national *liquid* fuel (Spencer et al., 2017) after it undergoes the toxic, World War II-era coal-to-liquid (CTL) process ('Fischer-Tropsch'), which "gasifies coal and then liquefies syngas to produce synthetic fuel" (Winkler & Marquand, 2011: 51). This CTL process was adopted in the 20th century due to South Africa's "miniscule proven oil reserves, estimated at 15 million barrels"; accordingly, crude oil and petroleum products are imported to meet roughly 70% of national fuel demand (Swilling, Musango & Wakeford, 2015).

This political and economic interdependence on coal has yielded what is coined the *Mineral-Energy Complex* (MEC) (originally coined by Fine & Rustomjee, 1996), which describes "a regime of accumulation based on low-cost state-owned electricity production… and cheap labour…tightly bound to energy and mining capital" (Baker, Newell & Phillips, 2014: 797). Within this complex is an enmeshed interest in the coal export industry (Baker, 2015a), and more broadly, "a coalition of interests that have a firm grip on energy production and extractive industries and their up- and downstream partners in the manufacturing sector" (Swilling, Musango & Wakeford, 2015: 660).

Eskom, the state-owned power utility, is a key player in the MEC; it is a "vertically integrated monopoly" and generates roughly 95% of South Africa's electricity[6] (mostly from coal),[7] transmits 90% of all power, distributes 60% (Baker, 2015a: 249; Swilling, Musango & Wakeford, 2015), and is *responsible for over 45% of South African greenhouse gas emissions* (Walwyn, 2020), making it the "*the continent's* largest" polluter (Baker, Newell & Phillips, 2014: 792, *emphasis added*). Eskom single-handedly accounts for 70% of domestic coal consumption, with Sasol (the homegrown oil & gas conglomerate) representing an additional 20% through the aforementioned CTL business model. Note that a group of 26 (domestic and international) industrial firms – referred to as the Energy Intensive Users Group (EIUG) – consumes over 40% of South Africa's electricity, and are therefore Eskom's main customers (Baker, 2015a).

DMRE and South Africa's Integrated Resource Plan (IRP)

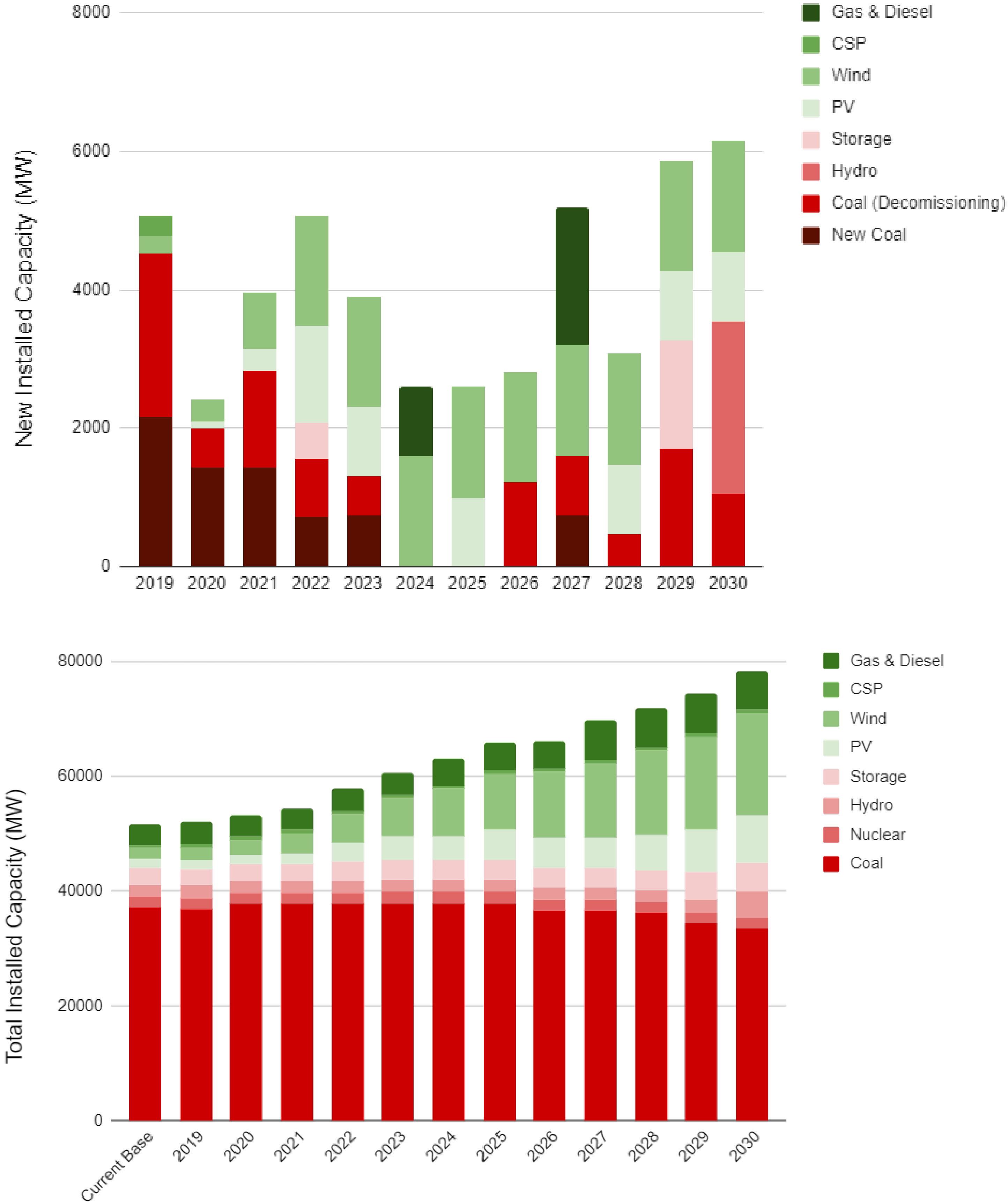
The *Department of Mineral Resources & Energy (DMRE)*[8] envisions the future of South Africa's energy infrastructure through its Integrated Energy Plan (IEP), a key policy document last published in 2017 (DMRE, 2017). One critical component of the IEP is the Integrated Resource Plan (IRP), which discerns the electricity supply and generation mix strategy for South Africa in the coming decades. The IRP establishes the schedule by which South Africa will install new power capacity through 2030 to meet growing energy demands and address existing energy poverty and insecurity, visualised in Figure 1.1. As of 2018, South Africa's installed capacity stood at roughly 51.6GW, of which 37GW (72%) was coal-based and 4GW (8%) was gas & diesel-based. According to the IRP, the DMRE plans to decommission a total of 11GW of coal capacity by 2030 but simultaneously procure and install 7.2GW of new coal, yielding an installed coal capacity of 33.3GW by 2030 – decreasing South Africa's total coal capacity by slightly over 10%. Total installed capacity across all energy types is projected to increase by 27GW (over 50%) to 78.2GW, which will be met by investments in new solar (7GW), wind (16GW), gas & diesel (3GW) and hydro (2.5GW) power. Although these projections do indicate a diversification in South Africa's energy mix – namely by decreasing coal installed capacity from 72% to 43% and increasing solar PV and wind power shares to 11% and 23%, respectively – *the aggregate installed coal capacity will exceed 33GW over the next decade, and by 2030, South Africa's grid is expected to rely on fossil fuels for at least 51% of its installed capacity* (40GW fossil power of 78GW total power).

[6] Municipalities owned 2% and private firms the remaining 3% (Orthofer, Huppman & Krey, 2019)

[7] In 2019, 42% of Eskom's electricity sales went to various South African municipalities for further distribution, while the bulk (over 50%) was sold for industrial, mining and commercial purposes (Winkler, 2020)

[8] The Department of Minerals and Department of Energy were two separate entities until 2019, when President Cyril Ramaphosa merged the two and formed the DMRE (n.d.)

Figure 1.1. Projections for new (top chart) and total (bottom chart) installed capacity in South Africa through 2030 by energy type according to the IRP (2019)



Source: Author, using data from IRP (DMRE, 2019: Table 5, p. 42)

DFFE and South Africa's Nationally Determined Contribution (NDC)

The *Department of Forestry, Fisheries & Environment* (DFFE) has "overall responsibility for environmental management" (Walwyn, 2020: 5) including mitigating against local and national environmental risks and ensuring compliance with Environmental Impact Assessments (EIAs) under the National Environmental Management Act (NEMA) of 1998 (RSA, 1998). Moreover, the DFFE is also responsible for communicating and ensuring South Africa's compliance with its NDC targets and its broader climate commitments made under the Paris Agreement (DFFE, 2021). South Africa's NDC follows a 'Peak-Plateau-Decline' (PPD) logic, proposing to peak greenhouse gas emissions between 2020-2025, "plateau for approximately a decade and decline in absolute terms thereafter" (NDC, 2016: 7). The initial draft proposed that its emissions would fluctuate between 398-614Mt CO_2e between 2025-2030 before declining, but after critiques of this being a 'Highly Insufficient' target and aligning with a 4°C warming scenario (Climate Tracker, 2021), the updated NDC has lowered this upper-limit by 28%, so now, by 2030, South Africa proposes lowering is annual emissions to the 398-440Mt CO_2e range. Upon a preliminary analysis, the Climate Action Tracker (ibid) classifies this new target as 'Insufficient' as it likely aligns with 3°C warming, and therefore is still incompatible with the Paris Agreement objectives.

In both the original and updated versions, South Africa's NDC repeatedly stresses that "South Africa is not listed in Annex I of the UNFCCC, and is a developing country in terms of the Paris Agreement" (DFFE, 2021: 3 – see 1.4.1), and as such, it constantly reaffirms the principle of equity and Common But Differentiated Responsibilities and Respective Capabilities (CBDRRC); its NDC targets

> have been set on the assumption that support will be provided to South Africa as a developing country as set out in the Paris Agreement's Articles 9,10,11 and 13 for implementation of the targets, the required just transition policies and measures, and for both developing capacity to report on implementation and achievement of the targets and for reporting (DFFE, 2021: 13).

The NDC also acknowledges that the "key challenge for South Africa is to catalyse, at an economy-wide scale, *financing of and investment in the transition to a low carbon and climate resilient economy and society*" (NDC, 2016: 8, *emphasis added*), and it is explicitly noted that "international support will be required… and will be provided for the implementation of the targets and goals… for mitigation, adaptation and loss and damage" (DFFE, 2021: 27). This could include

> concessional finance for low carbon projects; debt restructuring; support by the international climate and development and finance community for non-fossil-fuel development in Mpumalanga, and infrastructure to support energy efficiency, transmission and green hydrogen in support of electric vehicles, and public transport (DFFE, 2021: 28).

Moreover, according to the World Bank (2020: 1, *emphasis added*), "South Africa … *is the most unequal country in the world*, ranking first among 164 countries in the World Bank's global poverty database", suggesting that LFFU in South Africa may bear massive *equitability* and *inclusiveness* implications for under-resourced and under-privileged fossil-dependents in the nation. Interestingly, a substantial amount of research – both grey (e.g., Steyn et al., 2021; GroundWork, 2019; Phalatse, 2020) and academic (see e.g., Baker, 2015a; 2015b; Cock, 2018; Bond, 2010; Swilling, Musango & Wakeford, 2015) – has spurred on the implications of a South African transition away from fossil fuels, but *none* of these have positioned this research in relation to finance flows from the 'global North' (directly linking to knowledge gap K2, see 1.2.2).

This North-South focus is not to suggest that domestic actors – particularly the South African state and national banks – do not play a role in a prospective South African fossil fuel phaseout; to the contrary, South Africa's recent history of state capture – exemplified through former president Zuma's close and corrupt ties to the Gupta family (Martin & Solomon, 2016) – paired with the current Ramaphosa administration's policies hoisting the parastatal and fossil-intensive MEC – evident through, for instance, the IRP's coal-intensive forecasts (see Figure 1.1) – clearly underscore how influential domestic players are in managing (or resisting) South Africa's fossil transition. Moreover, ample green finance has arguably prompted a reconfiguration of the MEC, primarily through the Renewable Energy Independent Power Producer Procurement Programme (REI4P), established in 2011 in an attempt to procure 17GW of renewable power for South Africa's national grid (Müller & Claar, 2021); in the REI4P's first three bidding windows, almost 4GW of renewable power had been procured across 60 unique projects (Baker, 2015a), and by the end of round 3, "the weighted cost of energy has reached a 23% discount to the cost of new coal-based generation" and "falling costs of power from wind and solar" have made South African renewable energy tariffs some 80% cheaper than those from Eskom's largest coal-fired power stations" (Walwyn & Brent, 2015: 391). The MEC is immensely complex, and it would be remiss to frame it as one monolithic fossil bloc entirely at the mercy of international climate policy. Bearing in mind these intricacies, this research explores the extent to which the overlooked international fossil fuel finance flows add a new layer of complexity to South Africa's fossil transition.

South Africa within the broader African context

The South African case findings from this research are contextualised within the broader African context, but this is not to suggest a homogenisation of the African continent. To the contrary; this research aspires to learn valuable lessons from the South African case, and subsequently explore the extent to which (and conditions within which) these lessons are generalisable to other African nations and beyond, acknowledging that the key actors, approaches, arguments, challenges and intricacies identified throughout may not be transposable to the broader 'global South' context.

In some ways the South African case is unique, given, for example, that no other African nation is as dependent on coal for energy generation (IEA, 2021), particularly none with an economy as large as that of South Africa. South Africa's economy is the third largest in Africa in terms of nominal GDP ($335 billion in 2020), only trailing those of Nigeria ($432 billion in 2020) and Egypt ($365 billion in 2020), with fourth-ranking Algeria's economy being substantially smaller ($145 billion in 2020) (World Bank, 2022). In 2020, Nigeria generated less than 1TWh of coal-fired electricity, though gas-fired electricity did account for 80% of total electricity production (51/64TWh) (IEA, 2022); similarly, oil & gas jointly accounted for roughly 93TWh (54%) of Egyptian electricity generation in 2019, while coal accounted for only 25% (44TWh) (Ritchie & Rosen, 2021). This is largely because at least 70% of Africa's proven coal reserves reside in South Africa (10 out of 14Gt), with the remainder mainly dispersed in neighbouring (and much smaller) nations like Mozambique (2Gt), Botswana (0.5Gt) and Zimbabwe (0.5Gt) – see 5.3.2; this unmatched coal-dependence puts South Africa in a unique position in Africa, particularly given the vulnerabilities and exploitation prompted by coal mining & extractivism that vary across other sectors, like oil & gas extraction (see Cock, 2019).

That all being said, financial and economic actors from the 'North' very likely have played an influential role in driving fossil production throughout the African continent; this is particularly true in the cases of Nigeria, Angola, Egypt, Algeria and Libya – nations with documented linkages to E&Ps and finance institutions from the 'North' (e.g., Idemudia, 2009). As such, even though the type of fuel may differ between South Africa and other African fossil powerhouses, the findings from this study may be entirely adaptable and translatable to other African contexts based on the unpacked North-South linkages (see 5.3).

1.3.2.2. Temporal Scope

The relevant temporal scope for this research broadly spans the years 1990-2050 – 1990 being the year climate negotiations formally began and led to the adoption of the UN Framework Convention on Climate Change (UNFCCC) in 1992, and 2050 being the year adopted by the Climate Convention Regime (see 1.4.1) by which most governments have pledged to reach their 'net-zero' statuses, indicating that the results and conclusions drawn in the study are in theory applicable for the coming 30 or so years. Within this 60-year period, however, several key milestones persist that trim this temporality, namely the adoption of the Kyoto Protocol, the Doha Amendment in 2012, and the Paris Agreement on Climate Change in 2015 (see 1.4.1). With the signing of the Doha Amendment, nations from 'developed' countries (i.e., Annex B of the Kyoto Protocol, UN, 1997, and some others) pledged to both take action domestically to align with international climate goals, *in addition to* helping less-equipped non-Annex B nations to do so, therefore, post-2012 involvement by the 'global North' in fossil fuel production, financing and extraction is of particular relevance to this research. Moreover, 2030 earmarks an important moment, given the Paris Agreement's 'expiration' date of 2030 by which ratifying nations have pledged to employ their Nationally Determined Contributions (NDCs, see 1.4.1) to align with the 1.5-2°C temperature rise goal. Hence, within the broad 1990-2050 range, the sub-range of 2012-2030 categorises the more specific focus.

1.3.2.3. Actor Scope

This research focuses on identifying and mapping the role of pertinent financial, economic and political actors play in LFFU in the South African context, including: multinational fossil fuel E&Ps (see 6.2.1 & 6.3.1), commercial banks (see 6.2.3 & 6.3.4), Public Finance Institutions (PFIs) like (bi/multi)lateral development banks (BDBs and MDBs, respectively) and Export Credit Agencies (ECAs) (see 6.2.4 & 0), and institutional shareholders like pension funds, hedge funds and private equity (see 6.2.2 and 6.3.3). This scope does not account for all relevant actors; smaller & privately-owned E&Ps, for instance, who may play a significant role in a South African phase-out are excluded from this analysis. Similarly, many other types of PFIs (e.g., Tax & Revenue Services) and institutional shareholders (e.g., insurance companies) may also play a pertinent role but are not accounted for. The selection of the group of actors for this study was inspired by the severity with which these financial institutes are being scrutinised by 'grey' literature in terms of their fossil fuel finance (see e.g., RAN et al., 2021; OCI & FoE, 2019) paired with the simultaneous paucity of such scrutiny in the academic space (see 1.2.2).

1.3.2.4. Thematic Scope

Finally, an explicit focus is placed on a *fossil fuel* transition, not an *energy transition* more broadly (knowledge gap K3, also see York & Bell, 2018); that is, it is beyond the scope of this manuscript to speak to the range of economic, political, financial and social challenges and opportunities to introduce fossil-alternative energy sources (e.g., solar PV, wind) into the South African power sector or to electrify its transportation sector. Although renewable energy, particularly from a finance and policy perspective, is inevitably discussed on some occasions throughout the manuscript (see e.g., 4.3.1.8, 5.2.3.1 & 7.3.1) given its intimate relationship with LFFU, this is situated in relation to its implications for LFFU and phasing *out* fossil fuels.

1.4. International Policy Context

1.4.1. The Climate Convention Regime & the Paris Agreement

International climate discussions have been taking place since 1979 at the first World Climate Conference in Geneva (WMP, 1979). Such scientific meetings led to the adoption of a Resolution by the UN General Assembly to establish the Intergovernmental Panel on Climate Change (IPCC) to assess the latest science on climate change and come up with five yearly assessments in 1988. In 1989, the UN General Assembly initiated negotiations on the United Nations Framework Convention on Climate

Change (UNFCCC), which was adopted in 1992 (UNFCCC, 1992). The UNFCCC provided an umbrella agreement including an objective, principles, measures that countries ought to take, and established a number of bodies for its execution. However, the UNFCCC set “ambiguously worded” climate targets, which “called for tougher measures…to promote legally binding reduction commitments”, which were first discussed at the first Conference of the Parties (COP) in Berlin, and later adopted at COP-3 in the 1997 Kyoto Protocol (Gupta, 2010: 639). After years of geopolitical tension – including the withdrawal of the United States in 2001 – the Kyoto Protocol entered into full force in 2005, setting ambitious international climate targets for parties from the ‘developed’ world.

In the early climate negotiations, it was first understood that ‘industrialised countries’ (first clustered as Annex 1 of the Climate Change Agreement of 1992 (UN, 1992), and then in Annex B of the Kyoto Protocol (UN, 1997), from here on ‘Annex 1/B’) would spearhead curtailing their own greenhouse gas emissions in order to enable ‘developing economies’ (non-Annex 1/B parties) to continue to industrialise through emitting greenhouse gases. This could be interpreted to imply that the Annex 1/B countries (i.e. the ‘North’) would need to reduce their fossil fuel use to make space for the developing countries (i.e. the ‘South’) to use their own fossil resources (Gupta, 1997). The Doha Amendment of 2012 (UN, 2012) tightened the emissions reduction requirements of Annex 1/B parties for the follow-up period 2012-2022, indicating that time is of the essence and global emissions must be drastically and immediately reduced to minimise the adverse impacts of ‘climate change’. The Doha Amendment unfortunately only entered into force on December 31, 2020 (UN, 2021) and it is unclear if the targets for the period 2012-2020 have been met.

In 2015, the parties to the Convention adopted the Paris Agreement on Climate Change (PA 2015) (UN, 2015); the Paris Agreement, as a follow-up Agreement to the Climate Change Convention, should also be read in light of the umbrella provisions provided in the UNFCCC. This Paris Agreement has been ratified by 189 countries (UNFCCC, 2020); it consists of 29 Articles that cover a variety of relevant issues, including, but not limited to: long-term climate mitigation and adaptation goals; the communication of Nationally Determined Contributions (NDCs); and addressing Loss & Damage associated with adverse climate impacts. This research focuses on: (a) the long-term clauses of the Agreement; (b) financial coherence, particularly from a North-South perspective; and (c) fossil fuel embeddedness within the Agreement.

The PA “aims to strengthen the global response to the threat of climate change” (PA, 2015: Article 2.1) by adopting three overarching objectives:

1. Limiting average global warming to “well below 2°C above pre-industrial levels and pursuing efforts to limit temperature increase to 1.5°C” (Article 2.1a)
2. “Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience” (Article 2.1b)
3. “Making financial flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development” (Article 2.1c)

In essence, objective (1) focuses on climate change *mitigation*, (2) on *adaptation* given that even if Article 2.1a is met, adverse impacts have already and will continue to unfold, and (3) alludes to one of the *structural obstacles* that must be overcome to meet objectives (1) and (2). Meeting the first objective requires countries to set their own legally-binding emissions targets (i.e., NDCs) aiming “to reach global peaking of greenhouse emissions as soon as possible”, though it is recognised that such peaking will take longer and be more challenging for ‘developing countries’ (Article 4.1), and that the “least developed countries and small island States may prepare and communicate strategies… reflecting their special circumstances” (Article 4.6). As such, the PA 2015 agrees that “[d]eveloped country Parties should continue taking the lead by undertaking economy-wide absolute emissions reduction targets" (Article 4.4).

It should be noted that Article 2.1c implies that financial actors and institutions from ratifying nations are legally obliged to pursue investments that comply with climate adaptation and mitigation; it is unclear whether failure to do so (i.e. continuing to finance fossil fuel projects) will expose them to legal penalties and leave them potentially susceptible to legal challenges (see 9.5).

In addition to Article 2.1c, Article 4.5 pledges that "[s]upport shall be provided to developing country Parties… allow[ing] for higher ambitions in their actions", which is expanded in Articles 9-11:

- "Developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation" (Article 9.1), and will also "take the lead in mobilizing climate finance from a variety of sources, instruments and channels… represent[ing] a progression beyond previous efforts" (Article 9.3);
- "aim to ensure efficient access to financial resources through simplified approval procedures and enhanced readiness support for developing country Parties" (Article 9.9);
- "Support, including financial support, shall be provided to developing country Parties… for strengthening cooperative action on technology development and transfer at different stages of the technology cycle" (Article 10.6);
- "enhance the capacity and ability of developing country Parties… to take effective climate action, including, inter alia, to implement adaptation and mitigation actions" (Article 11.1), which should be "country-driven, based on and responsive to national needs" (Article 11.2).

These clauses altogether indicate that different financial players play different roles in meeting Article 2.1c by paving financial pathways towards a fossil phase-out; namely, that the 'global North' should allocate resources (financial or otherwise) to catalyse and support fossil phase-outs in the 'South'. However, the Paris Agreement itself rejects the notion of liability, stating that "that Article 8 [covering loss and damage] does not involve or provide a basis for any liability or compensation" (UN, 2015b: Article 52), which poses a threat to movements calling for climate justice through acknowledgement of a climate and ecological debt (see 2.2.1.3).

To some extent, climate adaptation (Article 2.1b) is necessary; according to the most recent IPCC (2022: 11) *Impacts, Adaptation and Vulnerability* report, "human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people", and even "global warming reaching 1.5°C in the near-term, would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans" (ibid: 15), "with the largest impacts observed in many locations and/or communities in Africa, Asia, Central and South America, Small Island Islands and the Arctic" (ibid: 11). Adaptation to these adverse impacts is both inevitable and urgently merited; however, a focus solely on adaptation runs the risk of distracting from the structural retransformation required to adequately *mitigate* the 'climate emergency'. In fact, adaptation has been accused of being "more than a keyword: it resembles a hegemonic discourse" (Watts, 2015: 21, emphasis added); while *mitigation* is about reconfiguring supply chains, behaviours and entire economies, 'adaptation' has been adopted "as the lodestar of public and development policy" – implying that a mutating climate is beyond 'our' control, relinquishing those in the 'global North' and 'South' of responsibility – "coincident with the realization [sic] that mitigation has receded into a distant future" (Watts, 2015: 20). To ensure that mitigation via LFFU remains central, Article 2.1b of the Paris Agreement is not relevant for this manuscript; rather, I address Article 2.1a by interrogating the financial structures alluded to in Article 2.1c.

Article 2.1a is therefore central to this research. It is laudable that 25 years of climate negotiations culminated to a quantified temperature goal in the UNFCCC, which was established on the basis of available science at the time, most notably synthesised via the IPCC (2014) report. This temperature target presents a major milestone for progress towards combatting the 'climate emergency', for the absence of such a goal would most certainly render a coordinated global effort to mitigate against adverse climate impacts near impossible. The IPCC (2014) *Synthesis Report* originally emphasised limiting the global average temperature rise strictly to 2°C, though after adamant negotiation efforts by Small Island States, the target was fine-tuned to "pursue efforts towards a 1.5°C rise" (Article 2.1a); this eventually gave rise to the IPCC (2018: 4) *Special Report on Global Warming of 1.5°C*, which argues that "global warming is *likely* to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate", and that "an additional 0.5°C of warming compared to present is associated with further detectable changes in… extremes" (ibid: 7); for instance, "[b]y 2100, global mean sea level rise is projected to be around 0.1metre lower with global warming of 1.5°C compared to 2°C" (ibid).

As such, a focus specifically on the 2°C target (as stated in Article 21a) is problematic, as the "precise 2°Celsius threshold to preventing dangerous anthropogenic interference [sic] in the climate system o*bscures how many communities hit limits to adaptation well before this supposed safe threshold*" (Wijsman & Faegan, 2019: 73, *emphasis added*). Article 2.1a should not be interpreted to suggest that capping average global warming at 2°C would constitute a heroic victory and 'solving' the 'climate problem', as this neglects the vast populations (mostly concentrated in the 'global South') who will suffer under this global 'accomplishment' (IPCC, 2014; 2019; 2021; 2022). In fact, the 2°C target is based on a logic that is "nearly 20 years old and is framed too narrowly" (Lenton, 2011: np), and arguably only serves as a "threshold between dangerous and extremely dangerous climate change" (Ringsmuth, Landsberg & Hankamer, 2016: 141). Like Article 2.1b, Article 2.1a should more appropriately be internalised as a long-term pledge to take substantial and urgent action to minimise the average global temperature rise to the absolute extreme possible by *drastically restructuring political and economic trends to eradicate fossil fuel production from the global political economy*.

Concerningly, the PA 2015 ***does not at any point mention the terms 'fossil fuel', 'coal', 'oil', 'natural gas'*** or any permutation thereof. At best, the it *implicitly calls for LFFU,* but the explicit omission of these terms demonstrates that tackling the fossil fuel industry is a politically sensitive 'hot potato'. This sentiment is mirrored in studies that have sought to interview 'experts' (i.e. stock brokers, bankers, shareholders, fossil fuel employees, academics), as told by Bebbington et al. (2020: 4):

> *A larger number of individuals (n= 43) were approached for an interview by name… Some responded but declined to be interviewed with the reason that they viewed unburnable carbon to be a politically sensitive issue that they did not feel happy to engage with. The larger number of our potential interview list, however, never responded to our initial and follow up requests for a conversation. Moreover, a number of those who did consent to speak with us wished to stress they were speaking in their personal (rather than their professional) capacity. The majority of interviewees were reluctant for the conversations to be taped.*

1.4.2. Sustainable Development Goals & Agenda 2030

The PA 2015 sets its objectives "on the basis of equity and in the context of sustainable development and efforts to eradicate poverty" (PA, 2015: Article 4.1), affirming that efforts to combat the 'climate emergency' should not come at the expense of social wellbeing and generate trade-offs with other Sustainable Development Goals (SDGs) (UN, 2015a). These objectives should be seen in the light of the Principles in the Climate Change Convention, namely that, inter alia:

- "Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities" (UNFCCC, Article 1);
- "specific needs and special circumstances of developing country Parties… should be given full consideration" (UNFCCC, Article 2);
- "Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects" (UNFCCC, Article 3).

As the Paris Agreement was being negotiated, parallel negotiations were ongoing on the 2030 Agenda within the UN General Assembly (Seth, 2019). Within these negotiations, there were discussions about whether climate change should be excluded from the SDGs – given the Paris Agreement's explicit focus on climate. However, negotiators felt that it would be a mistake to exclude climate as one of the top priorities of the global community, and rather framed the SDGs in such a manner complementarily to the Paris negotiations (ibid).

The 2030 Agenda was adopted in 2015 by all UN member states; it contains 17 SDGs which prioritise 17 issues that are common for the global community. It aims to 'leave no one behind'[9] in a global effort to drive 'peace and prosperity' around the globe (UN, 2015a). The 2030 Agenda calls on all nations to address the goals in an integrated manner; one goal should not be achieved at the cost of other goals. In other words, trade-offs between distinct goals should be minimised.

From an LFFU perspective, there are clearly potential *synergies* with the 2030 Agenda– see Figure 1.2. For instance, SDG 13 ('climate action') pledges to "take urgent action to combat climate change" (UN, 2015a: 14), synergising with the central societal problem addressed by and point of departure for this thesis (see 1.2.1) given that effective climate action is only possible with drastic and significant LFFU; similarly, effectively LFFU and curbing the average global temperature rise may avoid (severe) crop yield losses (IPCC, 2019; 2021), synergising with SDG 2 ('zero hunger'). Conversely, other SDGs may experience friction and *trade-offs* with LFFU (see Figure 1.2), particularly due to the inevitable and multidimensional stranded assets that may (or will) be generated (see 2.1). For instance, progress towards SDG 7 ('affordable and clean energy'), which strives to "ensure access to affordable, reliable, sustainable and modern energy" (ibid), may be compromised given the cheap and abundant coal-intensive power generation infrastructure that many economies depend on (conceptualised as stranded physical assets and de facto *stranded energy*, see 2.1.1). Moreover, Paris-compliant LFFU implies financial losses of as much as $200 trillion (Linquiti et al., 2016) as debts and equity are prematurely devalued and opportunity costs from forgoing coal, oil and gas commercialisation are incurred (stranded financial assets) in addition to rendering millions of fossil-dependents unemployed (stranded human assets), potentially contradicting SDGs 1 ('no poverty'), 8 ('decent work and economic growth')[10] and 10 ('reducing inequalities').

[9] Agenda 2030's central mantra
[10] Though the nature of the 'decency' of fossil-intensive jobs is often heavily contested, see 5.2.3.3

This altogether (implicitly) suggests that a fossil fuel phaseout may very well be resisted at local, national and international stages given the slew of ramifications that it implies. Accordingly, approaches to LFFU (see 4.2) may directly or indirectly yield these (among other) synergies and trade-offs; sculpting mixes of approaches to comply with the Paris Agreement and effectively combat the climate emergency must not go without considering the trade-offs that they will inadvertently bring forth. Many UN Agencies, including the International Labour Organization, have thus adopted a series of principles regarding a just transition for such employees who may lose their jobs. Hence, to evaluate and compare the unique trade-offs that may arise from LFFU, a selection of SDG targets has been made (see Table 1.2), which are later unpacked and operationalized (see 2.2.2).

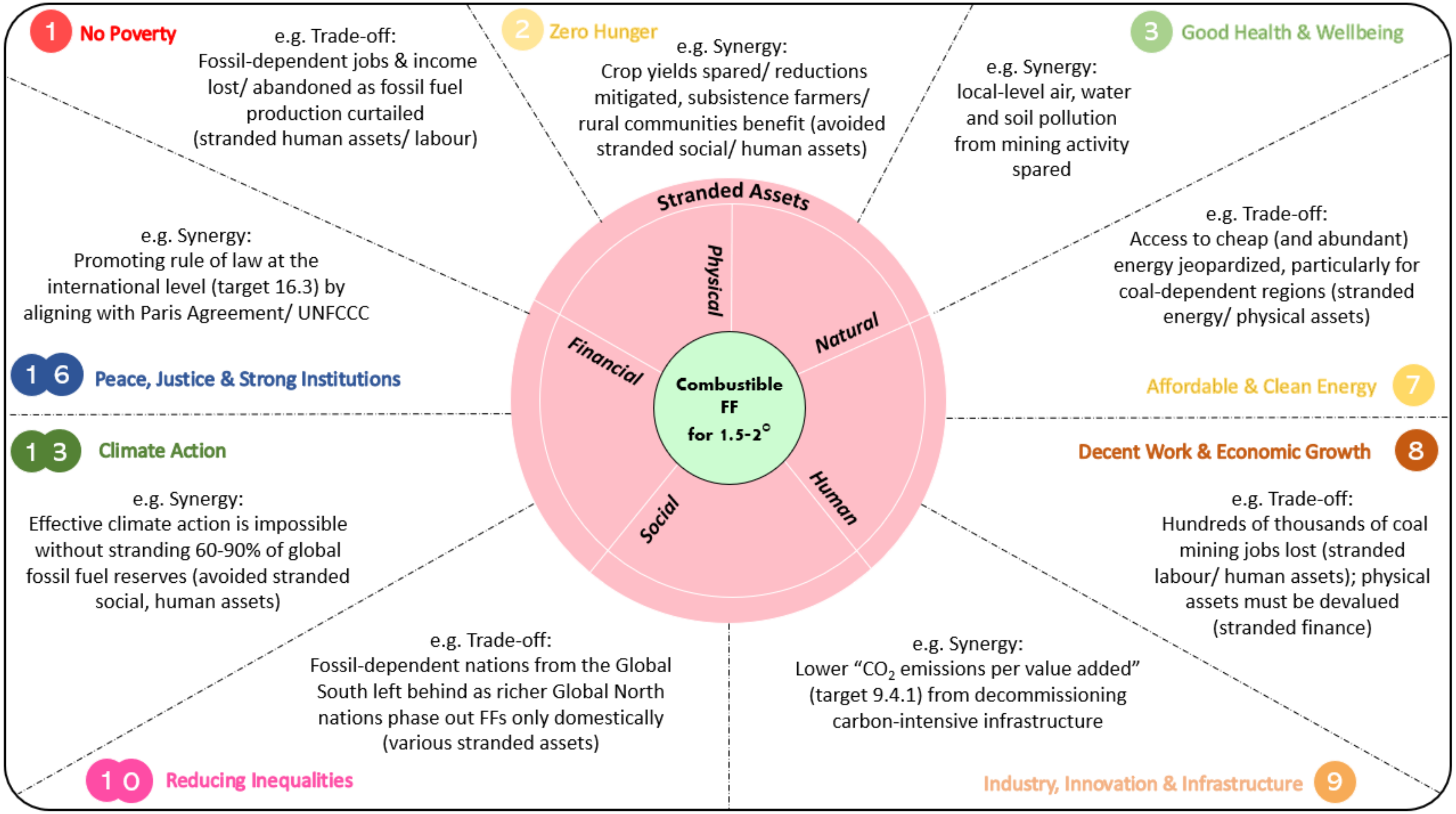
However, given the profit-driven nature of businesses in the global economy (see 2.1.3 & 2.2.3), there is reason to suspect that the *economic* trade-offs from LFFU and prospective stranded assets (e.g., exemplified by SDG 8, target 8.1) may outweigh the *socioecological* synergies. As such, the selected targets from Table 1.2 have been reconceptualized and incorporated into the Inclusive Development (ID) framework that drives my analysis (see 2.2); the ID perspective presents a more level playing field to contrast LFFU trade-offs by challenging the economic dimension and positing the stranded asset problem as a political rather than an economic one (see 2.2.2).

Table 1.2. Selected SDG targets used as an analytical framework to evaluate the implications of various African prospective stranded assets

Target	Target Description
1.2	By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.
2.1	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.
3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
7.1	By 2030, ensure universal access to affordable, reliable and modern energy services.
8.1	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries.
9.4	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
10.1	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.
13.2	Integrate climate change measures into national policies, strategies and planning.
16.6	Develop effective, accountable and transparent institutions at all levels.

Source: Author

Figure 1.2. Conceptualising the SDGs and their prospective synergies & trade-offs with LFFU using a Stranded Asset perspective



Source: Author

1.5. Structure of Chapters

This thesis is organised into four parts. Part 1 sets the stage for the manuscript; it consists of this introduction followed by the theoretical framework that drives the analysis (see 2). It then delves into the data collection and analysis methodology, which also unpacks the ontological, epistemological and axiological approach (see 3), and ends with a scoping literature review, which surveys recent scholarship to identify and evaluate key LFFU approaches on the basis of their inclusiveness, and subsequently identifies the knowledge gaps driving the empirical components of this thesis (see 4).

Part 2 focuses on exploring the prospective stranded fossil fuel assets scattered across both South Africa and the African continent more broadly (see 5) and the pertinent finance flows that have and continue to hoist South African fossil fuel production (see 6).

Part 3 explores the policy landscape of LFFU approaches proposed by the identified actors from Part 2 who have contributed to the generation of prospective and multidimensional stranded assets in South Africa through several finance flows. The section applies the analytical framework that evolved from the literature review for assessing an inventory of LFFU approaches (see 4), to evaluate the LFFU approach mix being adopted by key actors with leverage over prospective South African stranded assets, and identifies implications for an inclusive fossil phaseout (see 7).

Finally, Part 4 speculates over the future of South African fossil fuels, first by exploring the extent to which the COVID-19 pandemic has influenced fossil fuel phase-outs both globally and across Africa between 2020-22 (see 8). Subsequently, the final chapter looks beyond 2022, and by integrating the findings from chapters 4-8, it answers the overarching question (see 1.3.1) by: identifying trade-offs with LFFU in South Africa; developing four post-pandemic LFFU phase-out scenarios; and evaluating the conditions for an inclusive LFFU scenario in South Africa (see 9). The conclusion also discusses limitations and reflects on the deployed theoretical and conceptual approaches, aspiring to provoke debate and stimulate future research on inclusive fossil phaseouts.

2. Theory: Unpacking an Inclusive Fossil Fuel Phaseout[11]

This chapter tackles sub question S1, which focuses on knowledge gaps K1 and K4 (see 1.2.2):

What are the key elements of an 'inclusive fossil fuel phase-out', unpacked using a stranded fossil fuel asset conceptualisation?

It does so by combining two key theoretical and conceptual approaches: multidimensional stranded fossil fuel assets (see 2.1) and Inclusive Development (ID) (see 2.2). This chapter first defines and historicises stranded assets (see 2.1.1), identifies three key debates in the recent stranded asset scholarship, covering uncertainties (see 2.1.2.1), risks (see 2.1.2.2) and 'winners and losers' (see 2.1.2.3), then contextualises stranded fossil assets in the neoliberal fossil economy (see 2.1.3) and finally, identifies units of analysis concerning stranded assets (see 2.1.4). The chapter then repeats a similar structure for ID, first defining and historicising ID and 'Development' (see 2.2.1), in which it unpacks the North-South component of ID using scholarship on 'climate debt' (see 2.2.1.3) and subsequently develops a new concept to further substantiate this North-South component in the context of curtailing fossil fuel supply, namely the 'Stranded Asset Debt' (SAD) (see 2.2.1.4); it then unpacks the debate between ID and Sustainable Development (SD) and operationalises key SDG targets through an ID lens (see 2.2.2), proceeds to contextualise the ID framework within the bounds of the neoliberal and capitalist economy (see 2.2.3), and then builds on the unit of analysis list (see 2.2.4). Finally, it draws conclusions (see 2.3).

2.1. Stranded Fossil Fuel Assets

2.1.1. Defining and Historicising Stranded Assets

Discussions on *stranded assets* implicitly gained traction in the 19th century through explorations of early obsolescence in industrial processes (Krause, Bach & Koomey, 1989) and the Schumpeterian element of 'creative destruction', the latter denoting that old, outdated assets become stranded as newer models take over the market segment, posited as an "essential facet about capitalism" (Schumpeter, 1942: 83 – see 2.1.2.3). Neo-Schumpeterians expanded this idea in the late 20th and early 21st century, arguing that technological revolutions (i.e. "the Industrial Revolution (1771–1829)… the Age of Steel, Electricity, and Heavy Engineering (1875–1908); the Age of Oil, the Automobile, and Mass Production (1908–1971)" (Caldecott, 2017: 1) resulted in new industries replacing and effectively 'stranding' older ones through 'Techno-Economic Paradigms' (e.g., Perez, 1985; 2002).

Crew (1999: 64) proposed a first-pass definition for stranded assets, namely assets that "have lost economic value as a direct result of an unforeseeable regulatory or legislative change specific to the industry in question". This economically-geared interpretation began attracting attention in 2011 in the climate domain due to "environment-related risk factors" (Caldecott, 2017: 1), and was deemed useful for, inter ala, "measuring and managing exposure of *investments* to environment-related risks across sectors, geographies or asset classes". Since 2011, "the concept has been endorsed by a range of significant international figures", like Barack Obama, Mark Carney (Governor of the Bank of England), and Christiana Figueres, former executive secretary of the UNFCCC (ibid).

Several subdisciplines (e.g., economics, accounting, regulation, investing) have interpreted 'stranded assets' within their own contexts, which "makes it difficult for different disciplines and professions to communicate between each other about very similar and overlapping concepts" (Caldecott, 2017: 3).

[11] This chapter was written in tandem with and draws on the following publications:
Rempel, A. (Accepted 2022). An Unsettled Stranded Asset Debt?. *Antipode*
Rempel, A., Gupta, J. (2021). Fossil fuels, stranded assets and COVID-19: Imagining an inclusive and transformative recovery. *World Development, 146.* doi: 10.1016/j.worlddev.2021.105608

Moreover, researchers soon found that: a) the relevance of 'stranded assets' extends beyond merely 'economy value', and b) assets can be left 'stranded' through more mechanisms than unforeseen regulatory and legislative change (see 2.1.2.3), and hence, a broader definition surfaced some 15 years later, defining stranded assets as *"assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities"* (Caldecott, Howarth & McSharry, 2013: 7). This is "the definition most widely used in the literature" today (Caldecott, 2017: 4).

For this research, stranded assets span a five-dimensional typology, classified as either physical, financial, natural, human and social assets (see Table 2.1). In the fossil context, *physical assets* include the equipment and machinery used both directly for fossil fuel production (e.g., coal-fired power stations) and indirectly (e.g., trucks for coal transport); *financial assets* include debt issued to finance fossil fuel projects in addition to equity investments (i.e. common shares) in fossil fuel E&Ps; *natural assets* are the natural resources themselves used in producing fossil fuels (e.g., coal, oil and gas themselves); *human assets* are the jobs, knowledge and skills that drive fossil fuel production, in addition to the uses of the fossil fuels themselves (for e.g., electricity generation, transport); and *social assets* include the communities and networks built around fossil fuel production (e.g., coal mining communities). Note that some researchers propose differentiating the natural asset dimension as *stranded resources*, in which (un)conventional coal, oil and gas resources "are considered uneconomic or cannot be developed or extracted as a result of technological, spatial, regulatory, political or market limitations, or changes in social or environmental norms" (Bos & Gupta, 2019: 3). 'Stranded resources' and 'stranded natural assets' are interchangeable, and for the sake of simplicity, this research will adopt the 'stranded natural asset' terminology within the aforementioned typology.

Table 2.1. Stranded fossil fuel asset typology

Type	Description
Physical	equipment, machinery or infrastructure that (in)directly contributes to or enables fossil fuel production or consumption, such as exploration equipment, pipelines, and petrol-based vehicles
Financial	equity and debt instruments (in)directly tied to fossil fuel investments, such as shares (stocks), loans, rent, interest, profits, and revenues
Natural	resources pertinent to fossil fuel production and consumption, such as fossil fuels themselves, land, and water
Human	expertise and 'know-how' accrued over decades of fossil fuel commercialisation, such as knowledge on refining processes, unconventional 'fracking' techniques, and natural gas-based residential heating. Notably both direct and indirect *unemployment* also fall under this category, like coal mining (direct) and jobs dependent on fossil fuel for transport, like farmers using petrol-based vehicles to access local markets (indirect). Also includes stranded *uses* of fossil fuels, like energy.
Social	networks built around or enabled by fossil fuel markets, such as worker unions and communities formed around concentrated fossil fuel production, like coal mining towns

Source: Author, adapted from Caldecott, Howarth & McSharry (2013)

Stranded fossil fuel assets are an inevitable outcome of LFFU, particularly given that at least 60-90% of fossil resources must remain underground (and thereby stranded) to strive towards a 1.5°C temperature rise (Welsby et al., 2021 – see 1.2.1). There is no guarantee that fossil assets will truly be stranded, since it is very possible that no substantial actions to LFFU are taken (which is not farfetched given climbing fossil fuel production rates in recent years, see SEI et al., 2019; 2020), but *in the event that effective approaches are employed to LFFU (see 4.4), stranded assets are an inevitable by-product.*

According to this typology, stranded assets have varying degrees of 'liquidity' (Curtin et al., 2019), which often describes "the degree to which an asset can be quickly bought or sold in the market at a price reflecting its intrinsic value" (Chen & Scott, 2020). Stranded assets under the physical and natural dimension are mostly illiquid (a coal-power generator cannot be sold or exchanged for another asset very easily), whereas human and financial assets are generally (slightly) more liquid (shares can be sold on a stock exchange for cash, and some skills from fossil fuel jobs may be transferable to jobs in e.g., renewable energy). Physical assets therefore run higher risks of becoming stranded largely due to the illiquid and long-term basis in which they are constructed; fossil fuel power generators are built and financed with life expectancies of 35-40 years (Davis & Socolow, 2014) and fossil fuel production plants may have expected lifetimes of up to 75 years (Rode, Fischbeck & Páez,2017). Pfeiffer et al. (2018: 1) note, however, that "[t]hese lifetimes probably represent only economic rather than technical lifetimes…since many power generators operate long beyond their expected end of life".

2.1.2. Debates in Stranded Asset Scholarship

A scoping review of 59 recent (from 2016-21) papers on stranded fossil fuel assets identifies three key debates: uncertainties revolving around stranded assets (see 2.1.2.1); monetary and non-monetary risks associated with stranded assets (see 2.1.2.2); and 'winners' and 'losers' from governing said risks (see 2.1.2.3).

2.1.2.1. Uncertainty

There is an element of uncertainty inherent to the stranded fossil fuel asset debate, namely, the extent to which assets will be stranded in general, when this stranding may happen, and which assets will be stranded. "Stranded assets [in the financial sense] occur if investors naively believe in the government's announced tax policy and if the government deviates from its policy after investments had been made" (Kallhul, Steckel & Edenhofer, 2020: 2). This governmental indecisiveness and lack of commitment is of particular importance; van der Ploeg & Rezai (2020) discuss the notion of 'policy tipping', notably when politicians 'wake up' to stranded asset risks in the future and alter original policy decisions. This temporal delay may have adverse effects on how investors and fossil producers perceive climate policies in the present; if a ban or moratorium on extraction is implemented today, but there is a likelihood that it will be revisited and potentially lifted in the future (as has just occurred in Costa Rica, see 4.3.2.4), then investors may refrain from decommissioning (i.e., stranding) their assets today in the hopes that they can continue production in the future. Karp & Rezai (2018: 3) note that "exploration… reacts to expectations about future changes in climate policy", and if the expectations suggest that fossil markets will remain intact in the coming years, exploration for more fossil will ensue, and the stranding process will be delayed – or ignored altogether.

Uncertainty also prevails around Bio-Engineering and Carbon Capture and Storage (BECCS). At its core, BECCS aspires to generate clean, fossil-free energy while simultaneously sequestering carbon from the atmosphere – the latter of which would in theory reduce the need for LFFU and diminish the severity of the stranded asset problem (Harper et al., 2018). The coal industry has jumped on the BECCS wagon, "tout[ing] the idea of 'clean coal' and the innovation promise of carbon capture and storage (CCS)" (van de Graaf, 2018: 97). Byrd & Cooperman (2018: 2) note that the forecasting models of both the IEA (2016) and IPCC (2014; 2019; 2021) rely heavily on advancements in CCS technologies for emissions scenarios, "with widespread retrofitting of existing coal power plants crucial to fossil fuel energy generation as part of the energy mix".

The scholarship deems this BECCS-reliance problematic for multiple reasons. First, BECCS "has been deployed at a much slower rate than expected" with "less than one sixth of the planned $28 billion investment in CCS" spent from 2007-2017 (Hubacek & Baiocchi, 2018: 1408). BECCS technology is nowhere near the scale and efficiency necessary to truly outweigh the need to take climate action through LFFU, nor is it likely to improve to such a scale in the short-term (Rodriguez, Drummond, & Ekins, 2017). Second, Mo, Schleich & Fan (2018: 454) argue that BECCS "is profitable only if carbon costs are sufficiently high, e.g. because a carbon tax or an emissions trading scheme is in place" (see 4.3.1.3 & 4.3.1.6). However, BECCS requires "huge capital investments" (van der Ploeg & Rezai, 2018: 635), and due to its slow rate of progress, the carbon budget has dwindled, "so if we assume that the most economical emissions reductions will be pursued… the investment case for CCS becomes increasingly challenging" (Kefford et al., 2018: 304). Hickey et al. (2019: 481) agree that there is no clear business case for BECCS, including "robust economic incentives to support the additional high capital and operating costs of the whole CCS process".

Issues with BECCS extend beyond economics, however; it poses "environmental hazards", "ugly [not-in-my-backyard] politics", "requires a lot of space", and is "difficult to scale up as costs rise as space is used" (van der Ploeg & Rezai, 2018: 635). BECCS is also subject to "logistical and regulatory constraints" (Kefford et al., 2018: 304) because there are limited reservoirs apt for BECCS technology (Bataille et al., 2018). Finally, some argue that using BECCS as a 'bridge' technology in the energy transition may ***generate new stranded assets*** and intensify carbon lock-ins (Vergragt, Markusson & Karlssonm, 2011). BECCS is therefore "fraught with huge uncertainty, technically, economically and politically" (van de Graaf & Verbruggen, 2015: 458), and given this slew of hurdles, scholars posit that forecasting scenarios dependent on widespread BECCS adoption (like those of the IEA and IPCC) will likely not be met (Byrd & Cooperman, 2018). Despite its promising theoretical potential to minimise the extent to which LFFU is necessary, in its current state, BECCS is prone to exacerbate the socioeconomic and ecological challenges associated with addressing the climate emergency by allowing (and promoting) fossil investments in the present that will likely result in stranded assets in the future.

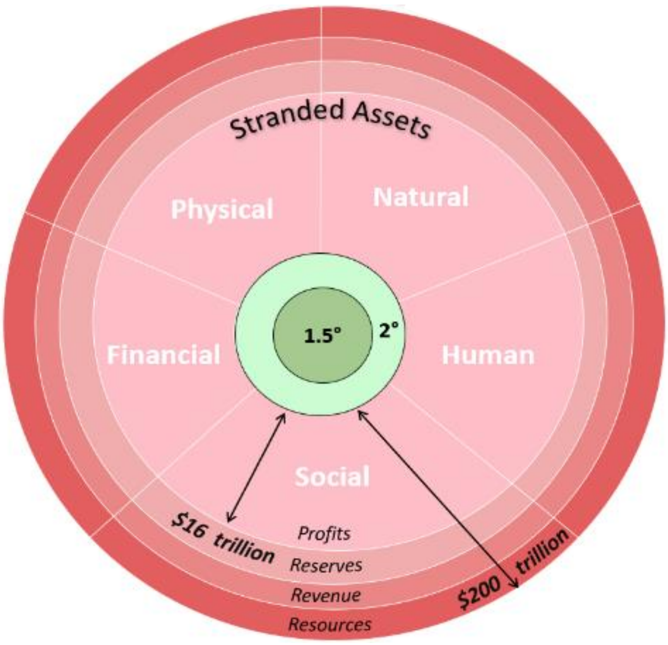
2.1.2.2. Risks

Financially, some research estimates that sufficiently phasing out fossil fuels to align with a 2°C future may cost (i.e., implicitly require stranding) between **$16 trillion** (Bauer et al., 2013) and **$200 trillion** (Linquiti & Cogswell, 2016); logically, significantly more must be stranded to comply with a 1.5°C rise. Note that the discrepancy between these lower- and upper-estimates stems from assumptions in the computational methods used to 'value' global fossil fuel markets. Some methods only account for *reserves* – which are already commercially extractable sources of fossil fuel – whereas others account for *resources* – which are estimates of total existing fossil fuel resources, with varying likelihoods of extractability in the near to long term (resources are much greater than reserves, particularly in the case of coal – Johnsson, Kjärstad, & Rootzén, 2019; Linquiti & Cogswell, 2016). Additionally, some methods consider mainly the *profits* generated in the fossil fuel sector, while others account for the much greater *revenue streams* generated (ibid) – these are denoted in Figure 2.1. These financial costs, of course, only account for the quantifiable & measurable monetary components of the stranded asset typology, which is largely misleading. LFFU in accordance with addressing the climate emergency implies leaving millions of people unemployed, upending livelihoods and stranding entire communities, particularly those entirely dependent on fossil fuels for their. As such, the aggregate 'costs' implicit in a fossil phase-out vis-à-vis unquantifiable stranded assets are much greater and merit careful attention, which are unpacked later using the Inclusive Development framework (see 2.2).

Many argue that markets do not sufficiently account for the risks (financial or otherwise) posed by stranded assets (Ansari & Holz, 2020; Monasterolo & de Angelis, 2020) and that "the issue of unburnable carbon is not currently considered a material item" for market actors (Bebbington et al., 2020: 13). As a result, fossil fuel markets are susceptible to devaluation if new regulation is introduced to curtail fossil production or if technological advances in fossil-alternatives 'creatively destroy' (Schumpeter, 1942) fossil fuel demand (Byrd & Cooperman, 2018). A stock broker told Bebbington et al. (2020: 6) that "markets will wake up late" because some "factors are completely outside of analysts' frames of reference", and Marsden & Rucinska (2019: 2) exclaim that "not only is the concept [of stranded assets] being contested, it is almost invisible in the current sustainability research and literature", suggesting that stranded asset risks are misunderstood and misconceptualised altogether.

Others disagree, however, claiming that there "is no reason to suppose that the market is not adequately pricing the risk of climatic action" (Cairns, 2018: 251). Byrd & Cooperman (2018: 1) find that "investors have embedded expectations of stranded asset risk into their valuations, but also recognize the significance of successful CCS technology development" (see 2.1.2.1). Further, "Marianne Kah, the chief economist for Conoco Phillips, points out that oil companies are not valued on the fossil fuels left in the ground, but only on proven reserves that will likely at most be used during the next 6 or 7 years" (ibid: 4), therefore the long-term risks may be purposely neglected given the short-term mentality of relevant actors (Christophers, 2019); Mark Carney (2015), governor of the Bank of England, coined this discrepancy between short-term trade and long-term climate risk as the 'tragedy of the horizon'. Conversely, it is possible that stranded asset risks are incorporated into market valuation, but investors may "expect financial compensation for their [anticipated] stranded assets" (Sen & Von Schickfus, 2020: 1).

Figure 2.1. Conceptualising stranded fossil fuel assets



Source: Author, inspired by Linquiti & Cogswell (2016), Carbon Tracker (2011) and Caldecott, Howarth & McSharry (2013)

Non-financial, non-market risks posed by stranded assets are essentially non-existent from the most recent literature, apart from recent attempts by Bos & Gupta (2018) and Gupta & Chu (2018) to expand the risk agenda. They propose that stranded risks span multiple dimension, including: economic (e.g. loss of revenue); ecological (e.g. local air, water and soil pollution); social (e.g. health risks, unemployment); legal (breached contracts); and political (bi/multilateral pressure). Shimbar & Ebrahimi (2020: 1326) begin evolving this perception, arguing that classical market methods to evaluate risk (like risk adjusted discount rates, RADR) inadequately account for political risks: "RADR may not be able to show the true commercial potential of renewable energy in developing countries".

2.1.2.3. Winners & Losers

There is a quasi-unanimous consensus among scholars that stranding fossil assets will yield 'winners' and 'losers', though debates persist on who falls under which category. van de Graaf (2018: 98) notes that "[o]il abundance creates winners (most notably the United States and import-dependent countries) but also losers (especially petrostates that are heavily dependent on oil revenues and have few competitive industries beyond fossil fuels)", positing that Saudi Arabia and Russia run the highest risk as they are "heavily dependent on oil revenues and have few competitive industries beyond fossil fuels". Major oil exporters from the 'global South' – like Venezuela, Brazil and Nigeria – have already begun to suffer since oil prices began to drop in 2014 (ibid), and the likes of Iran will likely follow suit given that it is also a net oil & gas exporter (Shimbar & Ebrahimi, 2020). Overland et al. (2019: 9) add that "major fossil fuel importers, such as Chile, New Zealand, and Sweden, are likely to experience major geo-political gains", but they disagree with van de Graaf (2018) claiming that United States is inherently a 'loser', due to both its expansive unconventional oil and gas production (van der Ploeg & Rezai, 2020) and exports (Guo & Hawkes, 2019), and its steadily growing coal exports, which increased by 61% from 2017-18 (Hubacek & Baiocchi, 2018). One other study estimates that the US economy may shrink by at least $3 trillion by 2035 due to stranded fossil assets (Mercure et al., 2018).

Saygin et al. (2019) estimate that $935 billion in cumulative *savings* (i.e., avoided stranded financial costs) from 2016-2050 can be saved if nations take action today to LFFU vs. delay action to a future date, with net importing nations like Japan saving some $20 billion. *Some carbon-intensive economies are expected to benefit from immediate action*, like the US ($436 billion savings), India ($155 billion savings), Russia ($54 billion savings), Brazil ($12 billion savings) and South Africa ($16 billion savings). That said, other net exporters financially suffer from immediate climate action, like China ($154 billion loss), Saudi Arabia ($7 billion loss) and Turkey ($5 billion loss), indicating that their economies are so committed to fossil production that it is in their best (financial) interest to continue with the status quo. In spite of these potential savings, the suspected 'losers' may refrain from cutting their losses in the near future and perhaps wait for greater certainty in (international) climate policy (see 2.1.2.1); this is problematic given that over 85% of proven coal, oil and gas reserves is concentrated in net exporter deomains (and therefore potential losers) like the Middle East, US, Russia, China, Austria, India and Venezuela (Johnsson, Kjärstad, & Rootzén, 2019)**,** meaning that delayed climate action by these states due to their vested interests would render the 1.5-2°C goal unattainable.

'Winners' and 'losers' are discussed almost entirely at the national level in the literature. This is quite purposeful given that "the vast majority of fossil fuel reserves are not held by publicly traded companies, with 74% of fossil fuel reserves either owned by state or private-owned companies not registered on the stock market" (Lenferna, 2018: 218). van de Graaf (2018) notes that state-owned oil accounts for 90% of global reserves, altogether justifying the decision to centralise the win-lose conversation around "losses of revenue for state and private fossil fuel companies and countries reliant on fossil fuel rents and exports" (Lenferna, 2018: 218). However, "the historical delineation of winners and losers becomes blurred as the supranational connective nature of wins and losses shifts across space and time… a winner today could well be a loser tomorrow" (Keys et al., 2019: 6).

2.1.3. Contextualising Stranded Assets in the Neoliberal Fossil Economy

It is important to understand these prospective stranded assets (and LFFU approaches more broadly) in the context of the capitalist system and neoliberal economy within which unabated fossil fuel production has and continues to take place (Schumpeter, 1942; Fraser, 2021); drawing on neo-Marxist critiques offers an invaluable lens with which to do so. A central concept of the capitalist mode of production is *production* itself, often linked to a *production function* that theorises a relationship between outputs (i.e. goods and services) and inputs. In its generalised form:

$$Q = f(X_1 + X_2 + X_3 + \cdots + X_n) \qquad \textit{Equation 2-1}$$

Where Q represents an amount of output, and $X_1 \ldots X_n$ represents amounts of inputs necessary to produce Q, like labour, raw materials, physical capital, and so forth. Neoclassical economists have proposed more functional forms, like the Cobb-Douglas production function (Cobb & Douglas, 1928) or the Solow-Swan model (Solow, 1957), Equations 2-2 and 2-3, respectively:

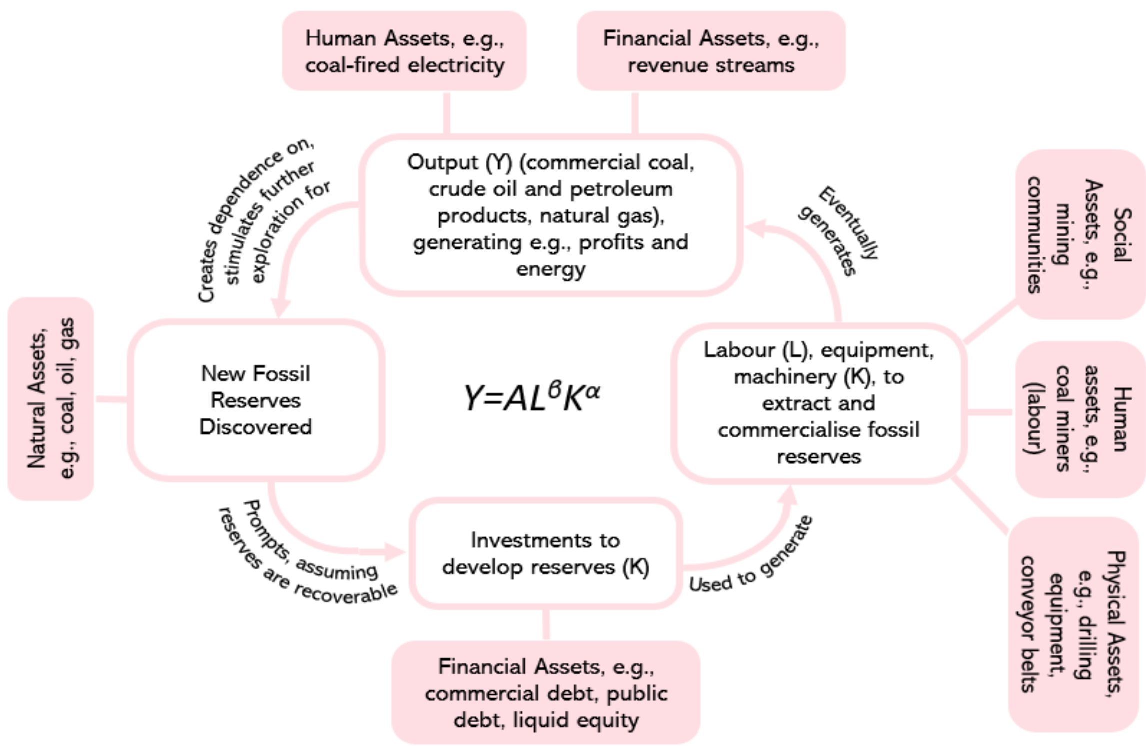
$$Y = AL^{\beta}K^{\alpha} \qquad \text{Equation 2-2}$$

$$Y(t) = (A(t)L(t))^{1-\alpha}K(t)^{\alpha} \qquad \text{Equation 2-3}$$

With Y = amount of output, L = labour input, K = capital input, A = productivity scalar (i.e. knowledge and efficiency), t = time, and α & β are elasticity constants, which measure output sensitivity to a particular input (i.e. labour or capital in this case). In less technical terms: outputs are directly and entirely dependent on both the amount of labour and physical capital as inputs. To illustrate, imagine that the crude oil refinement process producing petroleum products requires equipment like distillation columns and catalytic crackers (i.e. capital) in addition to engineers and technicians to run the refinery (i.e. labour). According to these models, doubling the number of distillation columns and personnel (i.e. doubling both K and L) would in theory double the amount of output (i.e. Y) – in this case, refined petroleum products. "Virtually all of modern economic growth theory assumes that GDP growth per capita is driven by technological progress and capital investment" (Ayres et al., 2013: 79), implying that the logic in these models is far from outdated.

Multidimensional *prospective* stranded fossil fuel assets are generated during this production process – illustrated in Figure 2.2. For instance, the discovery of new fossil proven reserves (natural assets) prompts *capital* investments (K) to develop said reserves (Cairns, 2018; Best, 2017), generating e.g., debt issued by syndicated loans (financial assets); equipment and infrastructure (i.e., physical capital) are built to commercialise the reserves, in the form of e.g., pipelines and coal-fired power generators (physical assets), which rely on labour (human assets) to function (Marx, 1867; Moore, 2017; 2018). The resulting outputs (e.g. combustible coal, oil and gas resources) then yield revenues and profits (financial assets) and are simultaneously used to meet energy needs (human assets).

Figure 2.2. Neoclassical production cycle in relation to prospective stranded fossil fuel asset generation



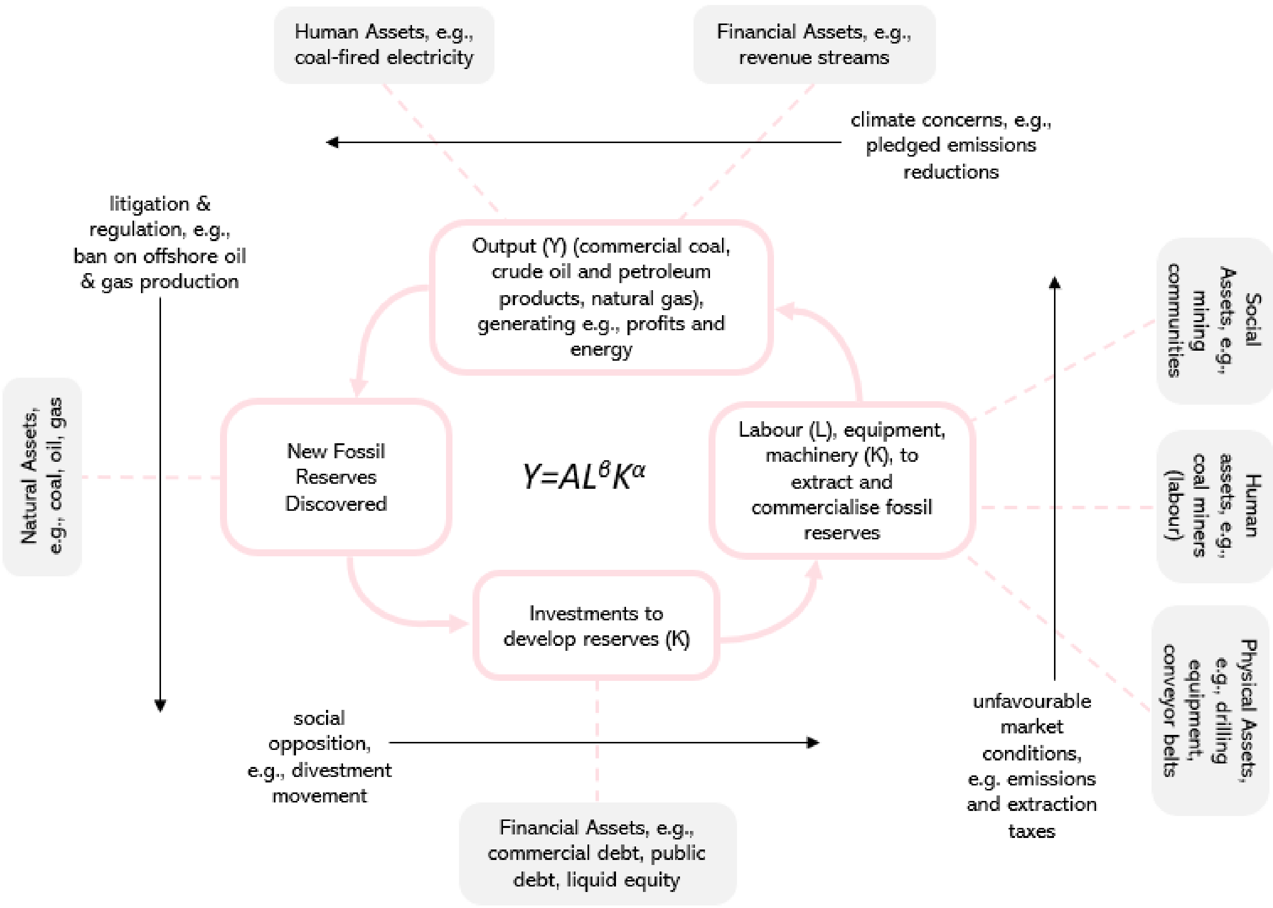
Source: Author

These generated assets can *become stranded* by six types of drivers (drawing on Bos & Gupta, 2019), of which five (#1-5 below) are of particular relevance to this research:

1. introduction or removal of **litigation & regulation** (e.g., Crew, 1999; Dong, Wei & Zhang, 2008; Cairns, 2018; Lazarus, 2019), which can prohibit the sale or production of a fossil commodity and includes approaches like, but not limited to: ***bans & moratoria*** on producing fossil fuels from a specific reserve or using a specific technology (e.g., Le Billon & Kristoffersen, 2019 – see 4.3.2.4); ***suspending licenses or permits*** for extracting or producing fossil resources (e.g., Erickson, Lazarus & Piggot, 2018 – see 4.3.2.5); and ***regulating financial capital*** for fossil projects and infrastructure (e.g., Best, 2017; Gunningham, 2020 – see 4.3.2.1);
2. unfavourable **market conditions** making fossil fuel commercialisation uncompetitive (e.g., Khalipour & Karimi, 2011; Johnson, et al., 2015; Attansi & Freeman 2013; Bergbauer & Maerten 2015), resulting from, for example, ***emissions taxes*** (e.g., Sinn, 2012; van der Ploeg & Rezai, 2020 – see 4.3.1.3), ***fossil extraction taxes*** (e.g., Sinn, 2012; Le Billon & Kristoffersen, 2019 – see 4.3.1.1) or ***fossil fuel subsidy removal and reform*** (e.g., Coady, 2019; Piggot, 2018 – see 4.3.1.10);
3. **social opposition** to fossil fuel asset and resource production (Broad & Fischer-Mackey, 2017), manifested through CSO-driven approaches to LFFU, including ***divestment*** (e.g., Rempel & Gupta, 2020; Ayling & Gunningham, 2017; Healy & Barry, 2017 – see 4.3.3.2), ***blockades*** (e.g., Klein, 2015; Gaulin & Le Billon, 2020 – see 4.3.3.6) and ***court cases/ litigation*** (e.g., Gaulin & Le Billon, 2020; Burger & Wentz, 2018 – see 4.3.3.5);
4. adverse **ecological and environmental impacts** from producing a fossil-intensive commodity (i.e. unsustainable GHG emissions from unabated fossil production resulting in climate calamity, IPCC, 2014; 2019; 2021; 2022) (e.g., Rautner, Tomlinson, & Hoare, 2016), manifesting in, for example, ***regulations mandating higher emissions and efficiency standards*** for buildings and infrastructure more broadly (e.g., Lazarus, Ericksen & Tempest, 2015 – see 4.3.2.2);
5. a lack of or advancements in **available technology** (e.g., Economides and Wood, 2009); in the case of oil and gas, this was evident through the development of unconventional hydraulic fracturing (i.e., '***fracking***') technologies to recover previously inaccessible oil and gas reserves (e.g., Geels, 2017); this also includes significant advancements in fossil-alternative technologies (e.g., solar PV, wind and storage) from ample '***green investments***' rendering our ability to harness renewable power both more affordable and efficient (e.g., Baldwin, Cai & Kuralbaveva, 2020; Collier & Venables, 2015; Winkler, 2020 – see 4.3.1.8);
6. and a lack of **geographical or spatial inaccessibility** of a particular fossil reserve (Desai, et al., 2016).

Note that drivers #1-5 above all link to one or multiple LFFU approaches, which I elaborate upon through the scoping literature review in chapter 4. These drivers can strand fossil related assets anywhere along the aforementioned production process, depicted via black arrows in Figure 2.3; for example, Costa Rica's government's moratoria on offshore gas extraction (Erickson, Lazarus & Piggot, 2018) effectively stranded those natural assets through the 'litigation and regulation' driver. Moreover, 57 well-document blockades across all continents either successfully cancelled, suspended or prevented fossil-projects from continuing (Gaulin & Le Billon, 2020 – see 4.3.3.6), potentially yielding stranded finance in the form of e.g., equity, or stranded physical assets like machinery and equipment depending on the stage at which the 'social opposition' intervened with the project.

Figure 2.3. Drivers generating stranded assets during the fossil fuel production process



Source: Author

2.1.4. Units of Analysis & Observation: Stranded Assets

Several key units of analysis and observation arise from this discussion, which are used to drive the subsequent analysis; these are presented in Table 2.2 and unpacked in more detail in the methodology section 3.2.

Table 2.2. Units of Analysis and Observation arising from the stranded asset scoping literature review

Dimension	Unit of Analysis	Unit of Observation
Natural Assets	Fossil Fuel-Related Artefacts	Proven Coal/ Oil/ Gas Reserves Net Present Value of Reserves Coal/ Oil/ Gas Production Rates Coal/ Oil/ Gas Consumption Rates Coal/ Oil/ Gas Export Rates Coal/ Oil/ Gas Import Rates Emissions (GHG) from Proven & Prospective Stranded Reserves

Dimension	Unit of Analysis	Unit of Observation
Physical Assets	Fossil Fuel-Related Capital	Coal Mine Coal-fired Power Plant Crude Oil/ Gas Pipeline Liquid Natural Gas (LNG) Terminal Crude Oil Refinery Offshore Oil & Gas Exploration Infrastructure
Social Assets	Community Level	Communities Built Around e.g., Mining Communities Impacted by Fossil Projects Through e.g., Displacement/ Land Grab or Local Pollution/ Contamination
Human Assets	Fossil-Dependents (e.g., Labour) and Users (Individual and Household Level)	Fossil Sector Jobs (e.g., mining) Fossil-Alternative Sector Jobs (e.g., solar) Skillset Required for Employment in Fossil & Alterative Sector Access to Electrical Grid Affordability of Electrical Grid
	National (Infrastructural) Level	Installed Fossil-Based Power Capacity Fossil-Intensiveness of Grid Reliability of Electrical Grid Affordability and Reliability of Fossil-Alternative Capacity
Financial Assets	Finance Institutions & Fossil Producers (Organisation Level)	Common share value under management Debt issued Type and Terms of Debt Issued Revenue Streams Dividend Payments to Shareholders Capital Expenditure (CapEx) on Fossil Projects
Stranding Drivers	Governments, Finance Institutions, Civil Society Organisations (CSOs) (Organisational Level)	Regulatory Approaches for LFFU Economic/ Market-Based Approaches for LFFU Socially-Oppositional Approaches to LFFU Technological Approaches to LFFU Environmentally-Driven Approaches to LFFU Conventionality of Approaches Economism of Approaches Temporal Considerations of Approaches Subjectivity of Approaches
Uncertainty	Financial Institutions (Organisational Level)	Perception of Fossil Investments (Dis)Belief in Stranded Financial Assets Temporality of Fossil Investments
Risk and Winners & Losers	Financial Institutions (Organisational Level)	Exposure to Prospective Stranded Financial Assets (see above)
	Governments (National Level)	Exposure to Prospective Stranded Financial Assets (see above) Exposure to Prospective Stranded Natural/ Human/ Physical/ Social Assets (see above)
	Individual and Household-Level (Intra-National)	Exposure to Prospective Stranded Human/ Physical/ Social Assets (see above)

Source: Author

2.2. Inclusive Development (ID)

2.2.1. Defining and Historicising ID and 'Development'

2.2.1.1. Overview

An ID perspective reconceptualises the challenges associated with LFFU and stranded assets through three dimensions: social, ecological and relational (elaborated below and visualised in Figure 2.4), while focusing on the wellbeing of the poorest, most under-resourced and marginalised members of society (Pouw & Gupta, 2017; Gupta & Vegelin, 2016; Gupta & Thompson, 2010). As a concept, ID is in a relatively nascent stage of being developed (particularly compared to the stranded asset concept, see 2.1.1), with Gupta, Pouw & Ros-Tonen (2015) arguably spearheading its deeper theorization. Although it is true that "the concept of inclusive development is gaining momentum in both the academic and policymaking arenas" (Rytova, Gutam & Sousa, 2021: 1), this is not the case in terms of it being applied to fossil fuel-related research. As of May 2022, only two studies have deployed an ID approach to scrutinise LFFU issues (Gupta & Chu, 2018; Bos & Gupta, 2016), though the ID framework has been adapted for studying various topics, including: urban water services (Schwarz, Gupta & Tutusaus, 2018), military expenditure and terrorism (Asongu, Le Roux & Singh, 2021) and mass poverty (Chimakonam, 2019).

Rather, fossil fuel studies focusing on well-being of 'the poorest' often adopt either a *sustainable development (SD)* (e.g., Bos & Gupta, 2019; Udemba & Tosun, 2022; Solarin, 2020; Faisal et al., 2021) or *justice* perspective (e.g., Muttitt & Kartha, 2020; Healy & Barry, 2017; Chapman et al., 2018; Evans & Phelan, 2016; Temper et al., 2018; Le Billon & Kristoffersen, 2019; Lenferna, 2018); the former employs a social, environmental and *economic* typology to scrutinise developmental issues (see 2.2.2), while the latter aims to address the inequalities and uneven distribution of burdens associated with the 'climate emergency' on the basis of one or multiple dimensions of justice (distributive, procedural, retributive and restorative). Both of these approaches have limitations; "[s]ustainable development often leads to strong trade-offs, mostly in favour of economic growth" (Gupta, Pouw & Ros-Tonen, 2015: 1) – elaborated upon in section 2.2.2 – while justice approaches are often overly critical of the status-quo and as a result are not constructive, embodying characteristics of a "hatchet" in identifying flaws in existing policy environments and systems, but omitting elements of a much-needed "seed" to generate growth and propose new pathways forward (Benjaminsen & Svarstad, 2019: 392). An ID approach departs from this prioritisation on economic growth and simultaneously allows for a more positive-constructive approach to implementing and driving development agendas while holding the world's most under-resourced and under-privileged members at the nucleus.

For the purposes of this manuscript, Development ('big D') is seen as intentional and instrumental rather than development ('little d') as an imminent aftermath of the capitalist status-quo (Corbridge, 2007); in this case, Development is the act of taking deliberate action at local, national and multilateral levels to LFFU, govern the 'climate emergency', and improve the 'capacity' of the under-resourced and under-privileged citizens (mainly in the 'global South') in "dealing with the environment" (Rodney, 2018: 3). Post-development thinkers inspired by e.g., Escobar (2008) will disagree and critique "development as a discourse of modernization" (Ulloa, 2015: 323), arguing that "the very idea of development… is corrupt beyond reform" (Cooper, 2009: 502), and that "it is not the failure of development which has to be feared, but its success'' (Sachs, 1992: 3, quoted in Cooper, 2019: 502). Although they may have a point – particularly considering the slew of catastrophic neoliberal Structural Adjustment Programs (SAPs) resulting in the 'lost developmental decades' of the 1980s and 90s (Easterly, 2001; 2005) – it would be counterproductive to take an extremist position and reject the role of government-led Development altogether in light of the 'climate emergency'. That is, "in the face of the climate crisis, [leftist movements] must come up with strategies that engage and attempt to transform the state" (Parenti, 2014: 844).

Rather, the challenge will be to embed post-developmental critiques – not just as symbolic metaphors (Tuck & Yang, 2012), but on the same ontological plane – into the core of an ID agenda to LFFU (which some researchers have already begun doing, see e.g., Rammelt & Gupta, 2021), manage the 'climate emergency', and "explicitly question and alter structures of power" (Wijsman & Faegan, 2019: 70). Such a counter-hegemonic approach (see Fraser, 2021) may at its core be "contrary to the existing system of free market, production and the relationship with nature" (Eschenhangen & Maldonado, 2014: X, quoted in Ulloa, 2015: 323). Inclusive 'Development' thus, for this research, implies departing from its modernist and colonial roots, and focusing on interventions that challenge the drivers and root causes of the 'climate emergency' (see 2.2.3), redistribute agency and the 'capacity to deal with environment' more broadly across humanity, and making "efforts at re-humanizing the world" (Álvarez & Coolsaet, 2018: 4) through the aforementioned social, ecological and relational dimensions of inclusiveness.

2.2.1.2. Social, Ecological and Relational Dimensions

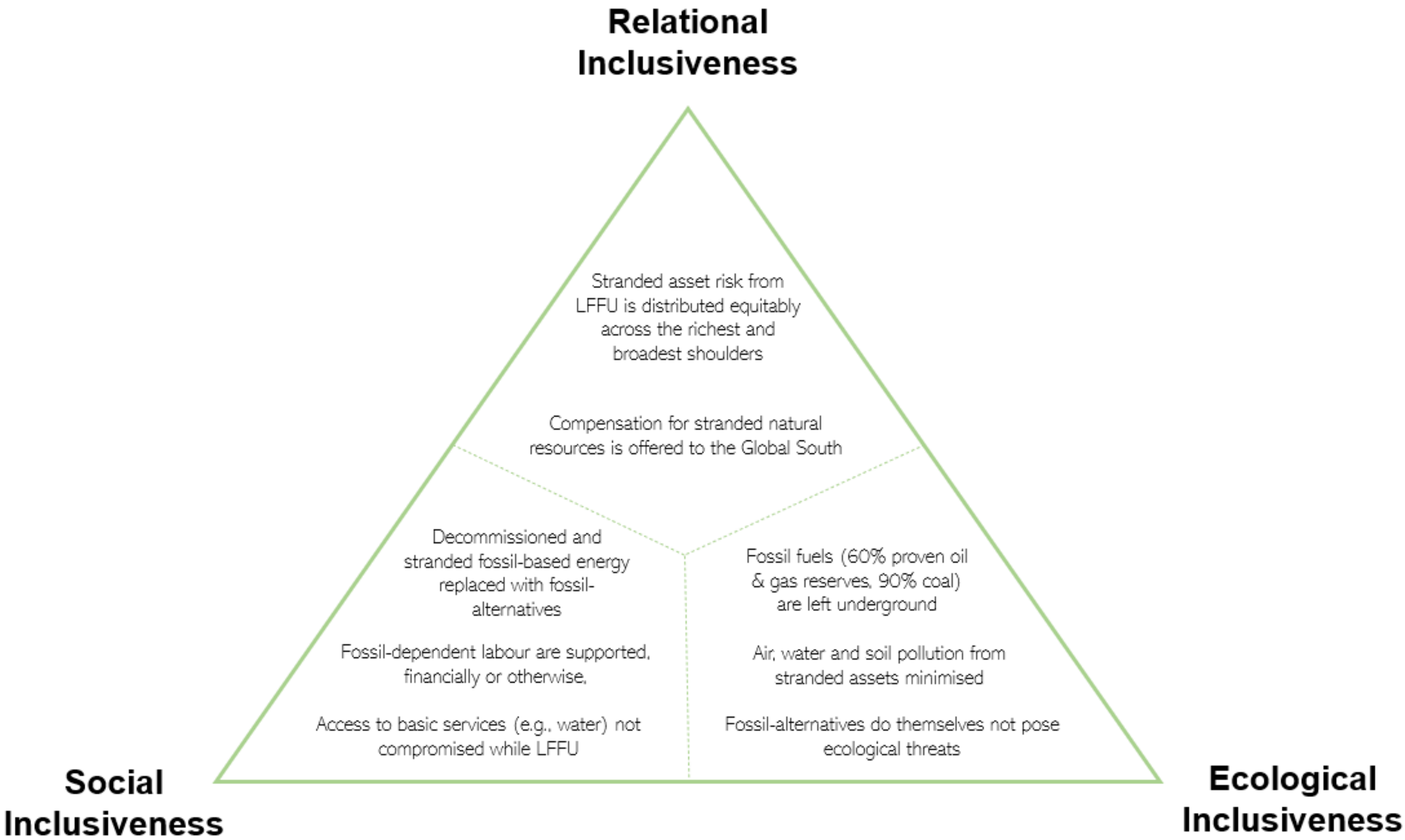
Social inclusiveness is concerned with upholding human rights, ensuring access to basic provisions and services, and addressing inequalities (Gupta & Vegelin, 2016; Gupta & Thompson, 2010); in the context of LFFU, how are both unabated fossil fuel combustion and the ramifications from LFFU vis-à-vis stranded assets affecting the wellbeing of particularly the most under-resourced and under-privileged fossil-dependents, labourers, users, and communities? 'Human rights' here refers to an expansive and multidisciplinary term that "aim[s] to guarantee not only basic political rights but also access to water, food, health services, housing, justice" by "empower[ing] people with a rights-based approach" (Pouw & Gupta, 2017: 97). It is critical that this rights-based approach enhances human wellbeing "according to people's own priorities" (ibid: 97), indicating that social inclusiveness (and ID more generally) understands context-specific wellbeing and *fundamentally rejects* traditional and institutional approaches to 'development' that aspire to alleviate 'poverty'[12] through blind GDP growth. However, social inclusiveness does not reject the idea of finance altogether; it also focuses on "access to finance, insurance and markets calling for fair, and not adverse, inclusion… [i]nclusive finance analyses access to finance (banking, debit card, account, cheques) and credit (loans, mortgages) for the poorest, as such access increases wellbeing, innovation, productivity and resilience to shocks" (Pouw & Gupta, 2017: 98). Some efforts are gaining momentum in proposing inclusive finance (e.g., Corrado & Corrado, 2017) and inclusive business frameworks (e.g., Likoko & Kini, 2017), but they fail to challenge the growth paradigm inherent to the capitalist mode of production (see 2.2.3). In sum, social inclusiveness goes beyond the traditional poverty indicators (e.g., income) and prioritises multidimensional wellbeing for the world's most under-resourced and under-represented members.

Ecological inclusiveness finds its roots in respect for planetary boundaries and the maintenance of and access to biodiversity and ecosystem services (Gupta & Vegelin, 2016). In this case, this concerns how LFFU (or failing to do so and perpetuating unabated fossil production and combustion) affects natural systems, who this impacts, and in what ways. It embeds a particular focus on "reducing resource extraction and pollution" (Pouw & Gupta, 2017: 98), which de facto resonates with calls to reduce fossil fuel extraction and combustion to protect human rights to ecosystem services. Note that in this context, *ecosystem services* "include provisioning services like food and minerals, supporting services like circulating nutrients, regulating services like maintaining climate and cleaning water, and cultural services" (Pouw & Gupta, 2017: 98). Ecological inclusiveness thus "implies the continued

[12] Poverty usually understood in a linear, monetary sense (i.e. the $1.25 poverty line), which this research rejects

access to and allocation of resources by and for the poorest… ensuring that affected [ecosystem services] do not exacerbate the vulnerability of the poorest" (Pouw & Gupta, 2017: 99). In the context of LFFU, it is important to note that three central considerations concern this dimension: 1) the extent to which fossil fuels are left underground; 2) the extent to which existing and polluting fossil-infrastructures (stranded physical assets) are fully decommissioned; and 3) the extent to which fossil-alternatives are not detrimental to and hamper access to biodiversity and ecosystem services at local, national or international levels – see Figure 2.4.

Figure 2.4. Conceptualising LFFU and stranded assets through an inclusive development lens



Source: Author, inspired by Gupta & Pouw (2017), Gupta & Vegelin (2016)

Relational inclusiveness introduces a political dimension to understanding social and ecological development, recognising "that poverty and ecological degradation are often the result of actions taken by others" (Gupta & Vegelin, 2016: 439). This dimension is concerned with the political organisation of LFFU, questioning who the powerful actors are (the State, legal bodies, fossil fuel E&Ps, investors, debt financiers), how merit and public goods (like the environment/climate, health, water) are managed (and whether they are privatised), how can power dynamics be shifted, and, of most concern to this research, how are burdens distributed and resources shared in driving development agendas (Gupta & Pouw, 2017)? An integral facet of the relational dimension of inclusive development is its call for a "stable institutional actor to provide public and merit goods… as neither NGOs nor markets can sustainably provide these" (Pouw & Gupta, 2017: 99). That is, relational inclusiveness calls for a coherent and representative government that can address local issues while simultaneously grappling with problems posed at the (inter)national scale – namely, an institution that employs "multiple instruments within a comprehensive re-distributive [relational inclusiveness] approach", acknowledging that instruments "are never politically neutral" (Pouw & Gupta, 2017: 99). In the context of LFFU and stranded assets, this is predominantly concerned with how the fossil fuel phase-out (Linquiti & Cogswell, 2016; Mercure et al., 2018 – see 1.2.1) and stranded asset 'bill' is 'settled' (see 2.1.1 and 2.2.1.4). That is, if, on a global level, tens – if not hundreds – of trillions of dollars in costs are expected to strand natural fossil assets, decommission physical assets, account for stranded labour and energy, and strand financial assets like outstanding debts, the critical two-pronged concern for an inclusive development scholar is: whether these costs are distributed across the richest and broadest shoulders of society (commercial banks, institutional shareholders, PFIs, E&Ps); and the extent to which the most under-resourced and under-privileged members of society are *compensated* for forgoing their *Right to Develop (RtD)* their fossil resources (Gupta & Chu, 2018).[13]

Regarding the latter, the countries from the 'global North' have enjoyed centuries of unabated fossil fuel production, particularly throughout the various historic regimes of the capitalist mode of production, which has seen their economies rapidly industrialise and 'develop' (Fraser, 2021). Now, however, in the face of the 'climate emergency', citizens of the 'global South' are being asked to forgo their opportunity to follow similar paths of industrialisation and 'development' (given that 85% of remaining proven fossil reserves lay outside of Europe and North America – BP, 2020; 2021), so their RtD is "potentially jeopardised when some fossil fuel assets must go unexploited, and this triggers a duty of those who are more advantaged to assist in opening up alternative paths towards development" (Armstrong, 2019: 673; Gupta & Chu, 2018). Given the gap in knowledge on 'North-South finance flows' (gap K2 – see 1.2.2), I unpack this North-South dimension of the ID framework more extensively below.

2.2.1.3. North-South Considerations and Climate Debt

Parallel to the RtD, climate activists and justice advocates have adopted a *climate debt* line of argumentation in relation to this North-South component, arguing that by overconsuming its fair share of emissions over centuries of unabated coal and oil & gas consumption (and subsequently enjoying the benefits of doing so, Fraser, 2021; Moore, 2018), the 'global North' has accrued a climate debt to the 'global South', the latter of whom has not yet been able to develop their resources and is now being told they cannot, given the need to strand the bulk of their fossil reserves to cap average global warming (e.g., Pickering & Barry, 2012; Warlenius, 2017; Matthews, 2016). *Climate debt* contains two components: an *emissions debt*, embodying a recognition of the "disproportionate contribution to the causes of climate change" by "developed countries… denying developing countries their fair share of atmospheric space" (Bond, 2010: 26); and an *adaptation debt*, accounting for the "disproportionate contributions to the effects of climate change" resulting in amplified adaptation costs mainly borne by the 'global South' (Bond, 2010: 26). By evading proactive climate action (Martinez-Allier, 2002a) continuing to invest in dirty, high-emissions infrastructure, "the Global North (including the elites of the poorer G20 countries such as South Africa) are digging themselves further into climate debt" (Bond, 2018: 450).

Although "it is important to quantify the [climate] debt in monetary terms" (Mayer & Hass, 2016: 353), it "must never be reduced to demands for monetary compensation alone" (Dillon, 2001: 27, quoted in Mayer & Hass, 2016: 353) though it is notably paid through a combination of "restoration or compensation" (Warlenius, 2017: 140). Here, 'restoration' indicates the "obligation of the creditor to cut current emissions to below its per capita share of sustainable emissions to free up space for debtor emissions", while 'compensation' denotes the "transfer [of] finance or technology that enables the

[13] Note that relational inclusiveness is also concerned with participatory approaches to policymaking (Pouw & Gupta, 2017), though this is beyond the scope this this research.

same degree of ''development'' that the restorative debt repayment would amount to, but without the emissions normally attached to it ('leap frog development' in UNFCCC lingo)" (Warlenius, 2017: 143). Climate debt is therefore concerned with an equitable distribution of "the benefits of engaging in emissions-generating activities… very roughly but more intuitively, we could say that by distributing emission rights we are distributing economic progress" (Meyer & Roser, 2010: 232; Warlenius, 2017; Bond, 2018; Bond, 2010). Moreover, climate debts have also been framed intergenerationally – a depiction of stripping the rights and abilities of future generations from using natural sinks and resources (e.g., Pickering & Barry, 2012; Matthews et al., 2020) – though the emphasis has swayed towards the aforementioned international disparities (Armstrong, 2019; Bond, 2018).

Although the UNFCCC "is full of language of justice" (Gardiner, 2011: 3) and (indirectly) endorses climate debt by acknowledging that "Loss and Damage require recognition and calculation" (Bond, 2018: 446; Garcia Portela, 2020), climate negotiators have met calls for repayments or reparations with objection, notoriously by US chief climate negotiator Todd Stern in 2009 (Pickering & Barry, 2012: 672). These objections have materialised in an amendment to the Paris Agreement on Climate Change, which "refused to countenance standard 'polluters pay' principles" and specifies that the agreement does "involve or provide a basis for any liability or compensation" (Article 8, quoted in Bond, 2018: 448; also in Bond & Basu, 2022 – see 1.4.1).

Even if negotiators and policymakers were to unanimously agree that a climate debt had truly been accrued and needed 'settling, it is still unclear and contested who should pay this debt, to whom, how much, and how. The most common proposal follows the Polluters (or Emitters) Pay Principle (PPP) (Bond, 2010; Bond, 2018; Garcia Portela, 2020; Heede, 2013; Baer, 2012; Meyer & Roser, 2010), which proposes holding historical GHG emitters (usually entire nations, Warlenius, 2017) to account based on the proportion of atmospheric GHGs that they were responsible for emitting; for instance, the US may have "contributed nearly 35% of the total cumulative global CO_2 emissions since 1750" (Kashwan, 2021: 1-2). In fact, in "many countries, including Brazil and the United States, laws exist embracing the legal principle of "objective responsibility" by which a polluter cannot escape responsibility by claiming ignorance of environmental damages" (Heede, 2013: 230-1). Despite this, the PPP is often met with an *excusable ignorance objection* (Garcia Portela, 2020; Pickering & Barry, 2012; Heede, 2013), which uses the 1990 IPCC report as a marker to absolve responsibility for pre-1990 emissions, in spite of evidence of "the potential effects of GHG emissions dat[ing] back to at least 1896 when Svante Arrhenius published the first scientific study describing the GHG effect" (Garcia Portela, 2020: 13).

Another argument against the PPP is one of *contractual objection*, namely that "the earth's absorptive capacity was [not] the subject of a contractual resource-sharing arrangement", and since debts are typically acquired through formal contractual obligations through a financial institution, there cannot be reasonable claim to a climate debt since no contract has been signed (Pickering & Barry, 2012: 673). Numerous historical instances of contract-less debt repayments suggest otherwise – like Germany's "obligation to pay reparations… after the first world war" and to "pay… indemnities for infringements to human rights… after the second" (Martinez-Allier, 2002a: 11). Bolivia's president used this line of argumentation in 2009 to hold the US (and industrialised countries more widely) to account for its climate debt, mocking the infamous US idiom: "[as] they say in the US, if you break it, you buy it" (Pickering & Barry, 2012: 673).

There is a temporal lag with the PPP framework, namely that historical emitters and "potential payers might be dead" (Meyer & Roser, 2020: 240), giving rise to the *intergenerational objection* to the PPP, which "claims that it is implausible to hold countries responsible now for conduct that was undertaken before anyone living in them was alive" (Pickering & Barry, 2012: 675). Others, however, argue that "while individuals *generally* do not inherit personal debts from one generation to the next, this is not the case for sovereign debt, which can remain owed by a country over successive generations… [this] is the basic norm that underlies the present treatment of sovereign debt contracts" (Pickering & Barry, 2012: 675, *emphasis added*).

An alternative is to expand the scope beyond 'polluters' and take into account a "combination of responsibility (contribution to the problem) and capacity (ability to pay)" (Baer, 2012: 61), or more formally, under the UNFCCC (1992) the 'common but differentiated responsibilities and respective capabilities' (CBDR-RC). Under this framework, "those who pollute more should pay more, those who are wealthier should pay more, and those with the greatest need should be exempted or even compensated" (Baer, 2012: 62). Moreover, "[t]o improve their chances of success", proposals have arisen to have climate debts paid "in part by 'leaving the coal in the hole'"—i.e. a financial swap (see 4.2.3) – "and in part by compensating the victims of climate change in [an] area" (Bond, 2018: 453).

2.2.1.4. Stranded Asset Debt (SAD) and Inclusive Development

An ID approach is therefore not only concerned with how the stranded asset burden is allocated, but also with the extent to which monetary and non-monetary resources are allocated to compensate citizens (particularly the most under-resourced and under-privileged members of their societies) from the 'global South' for forgoing this opportunity (which, they must, if the 'climate emergency' is to be adequately tamed – Welsby et al., 2021). Arguments circa the 'South's' RtD and the *climate debt* that it is owed by the 'North' affirm this call for compensation, though as of now, the climate debt narrative fails to account for *fossil fuel supply indebtedness* as it focuses only on fossil-borne *emissions*. To expand this, I propose developing a new concept: the Stranded Asset Debt (SAD).[14]

The SAD presents a useful supply-side counterpart to the demand-oriented 'climate debt'; as a first pass, it could be *defined as* ***the debt owed by financial, economic and political institutions from the 'global North' to the citizens of the 'global South' arising from investments in coal, oil and gas projects and infrastructure by the 'North' in the 'South', thereby having generated and exacerbated the 'South's' exposure to multidimensional stranded assets and their accompanying risks***.

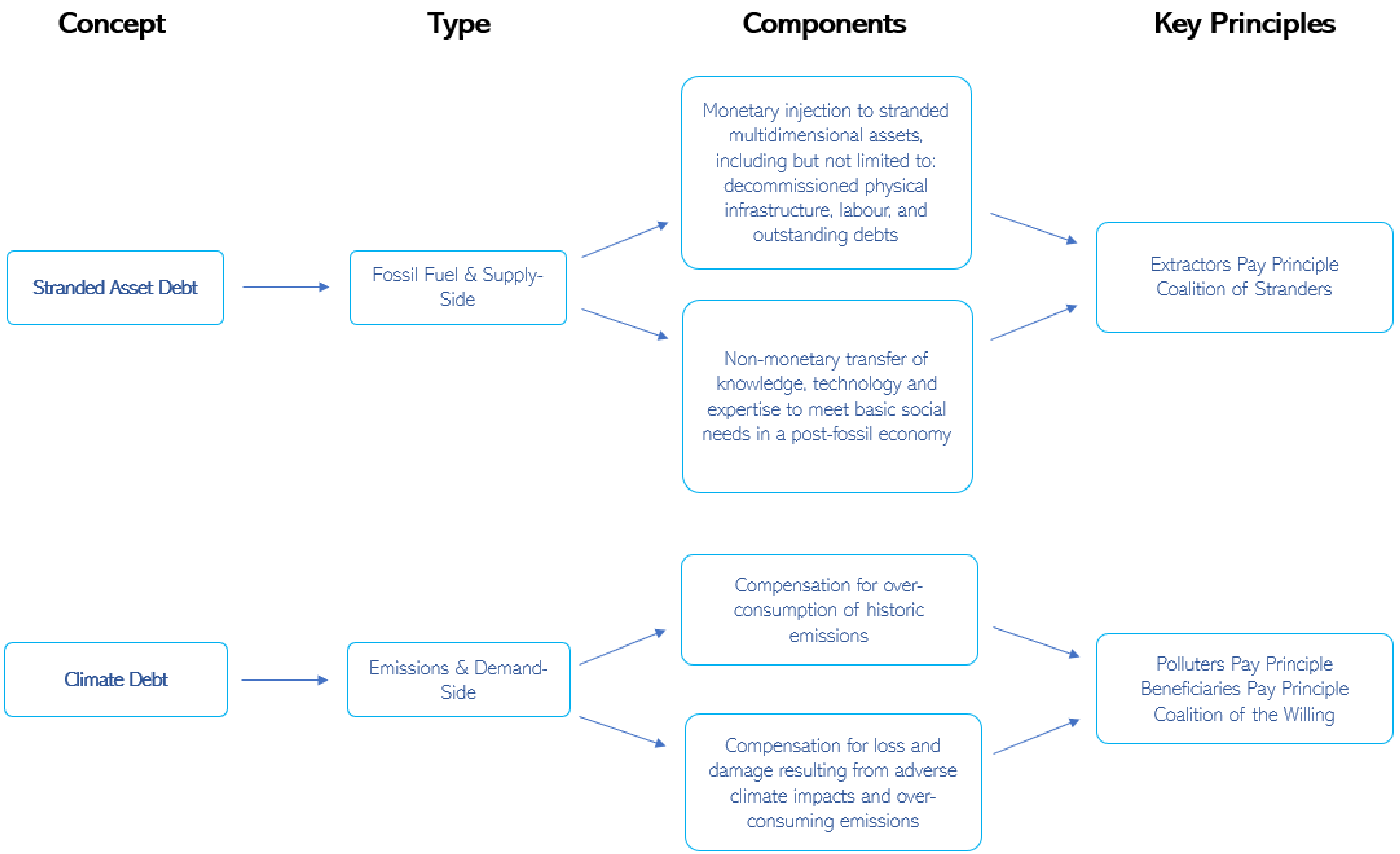
The SAD can be conceptualised *both as the monetary and non-monetary costs and resources required to strand existing fossil fuel assets in order to adequately curb the average global temperature rise and combat the emergency*; non-monetary costs can include, among others, the retraining and relocation that mining communities will have to undergo, while the monetary component includes, inter alia, the costs associated with decommissioning coal-fired power fleet, or providing a universal basic income (UBI) to stranded coal miners as new jobs (in potentially new sectors) are phased in (Bond, 2018). Generally, the monetary component of the SAD (SAD_M) is composed of the costs of governing the five stranded asset dimensions:

$$SAD_M = P + H + N + F + S \qquad \textit{Equation 4}$$

Where *P, H, N, F* and *S* correspond to the monetary costs necessary to stranded physical, human, natural, financial and social assets, respectively.

[14] Note that the SAD is complementary to a conceptual tool currently being developed in an ERC advanced grant project, namely the Stranded Asset Index (SAI) (see Gupta, 2020). The SAI aims to evaluate the relative exposure of a certain region, country, organisation or coalition to multidimensional stranded assets – which will likely take a normalised and dimensionless form, and will therefore serve the purpose of comparison rather than absolute stranded asset measure (ibid).

Figure 2.5. Visualising the complementarity of the Stranded Asset Debt and Climate Debt concepts



Source: Author

This dual monetary/non-monetary conceptualisation is aligned with the notion that ecological and climate debts ought not be reduced to purely monetary terms, but should be quantified and 'paid' by compensatory means (Mayer & Hass, 2016, see 2.2.1.3). That is, 'footing the stranded asset debt bill' is not be synonymised with writing a cheque; it envisions a power rebalancing to hold economic, financial and political institutions accountable for adequately and equitably evolving the global economy into a low-carbon form. Hence, inclusive and effective approaches to *LFFU* on a global level must account for and adequately allocate this SAD to actors both responsible for and able to internalise it – building on the 'extractors pay' and 'capacity principles' (Kartha et al., 2018).

SAD should be seen *complementarily to* the concept climate debt (see Figure 2.5). That is, a review of climate debt scholarship (see 2.2.1.3) suggests that its debates and arguments have neglected a critical focus on fossil fuels and stranded assets directly. 'Climate debt' dodges LFFU's critical supply-side component, namely an equitable sharing of fossil fuel *production*, and simultaneously, an *equitable sharing of the costs associated with stranding existing and forthcoming multidimensional stranded fossil fuel assets*; the SAD fills this void and integrates the root cause of the 'climate emergency' into North-South equity debates. **Accordingly, an ID approach to LFFU is concerned with equitably 'settling' the SAD bill *in addition to* curtailing fossil fuel production and accounting for the socioecological ramifications from doing so**.

Moreover, the proposed SAD may be very well within the Paris Agreement's bounds as the SAD is explicitly *not* concerned with reparations for *past consumption*, but rather *present and future production*. The Paris Agreement is awash with language that implicitly mandates the acknowledgement and adequate governance of the SAD; Article 2.1(c) requires ratifying states to "mak[e] finance flows consistent with a pathways towards low greenhouse gas emissions and climate-resilient development", which is virtually impossible without first establishing an upper-limit on global aggregate fossil fuel production (a 'fossil fuel budget'), then *allocating financial resources* to e.g., decommission existing coal facilities, oil & gas refineries and exploration sites that are incompatible with this budget – that is, direct finance flows to strand existing and forthcoming fossil assets, implying that a SAD is implicitly embedded in Article 2.1(c).

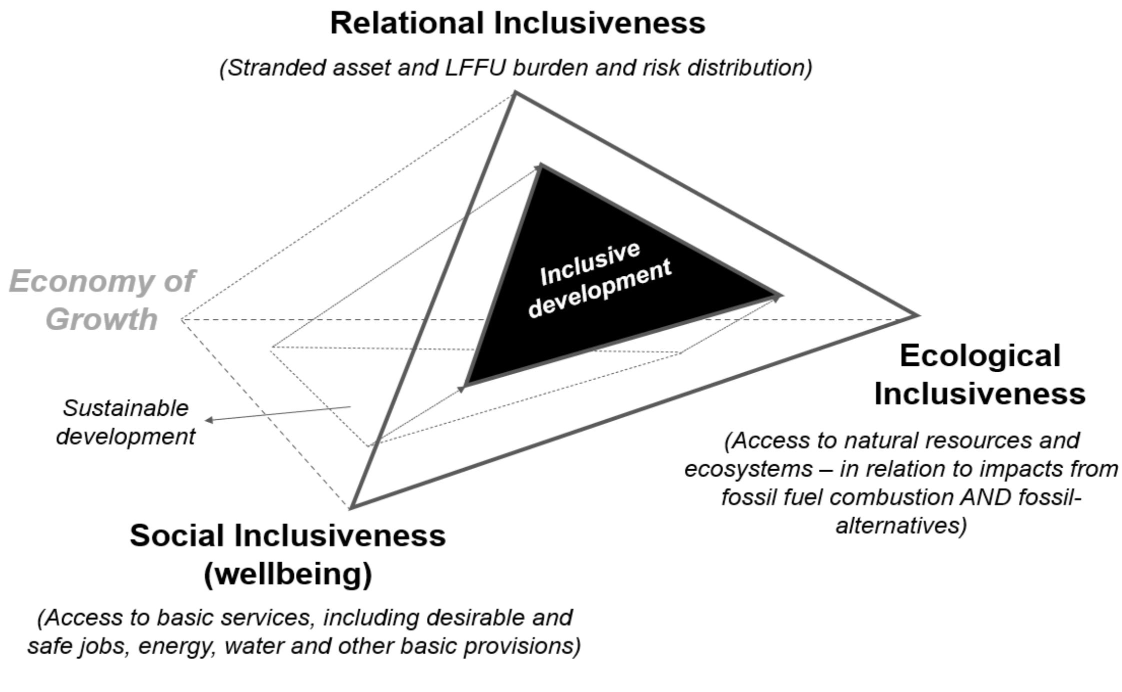
Furthermore, Articles 4.5 and 9-11 together establish financial and non-financial means to account for the SAD between the 'North' and 'South' by calling on 'developed´ countries to provide 'support' for 'developing' countries to attain 'higher ambitions in their actions' (see 1.4.1). This suggests that each nation should not be held fully responsible for the stranding costs within their own domain, and that there is a CBDRRC to foot the SAD bill on the basis of who is both *responsible* of generating the fossil assets destined for stranding (i.e., who has accumulated the SAD), and *capable* of equitably (or inclusively) stranding said fossil assets. Hence, although the PA is imperfect (see 1.4.1), it can nevertheless be leveraged as a framework to address the North-South dimension to the *fossil fuel phaseout* component that is so central to taming the 'climate emergency', encapsulated through the new 'SAD' concept.

2.2.2. Key Debate: Inclusive vs. Sustainable Development

An ID approach allows for an analysis of development issues without assigning a nucleic role for economic growth, as "[i]nclusive development questions the continuous linear quest for growth" (Gupta & Chu, 2018: 95-6) – this differs from approaches that adopt a *sustainable* development (SD) framework. From the SD perspective, development issues are scrutinised through three dimensions: environmental, social, and *economic* (e.g., Weitz, Carsen & Trimmer, 2019; ICSU, 2017; Bos & Gupta, 2018), which manifests in the 17 unique SDGs (see 1.4.2). According to SD, environmental, social and economic considerations are equally weighed and compared to one another to evaluate synergies and trade-offs resulting from a particular policy, project, decision, approach, or movement (Weitz, Carsen & Trimmer, 2019). In the LFFU context, this could be problematic given the gargantuan financial and economic losses associated with adequately phasing out fossil fuels and tackling the climate emergency (Linquiti & Cogswell, 2016); that is, tackling the climate emergency through LFFU *by definition* requires halting the growth of the fossil fuel sector in addition to redistributing resources and phasing in fossil-alternatives. Therefore, through a SD approach, mammoth economic trade-offs from LFFU may outweigh and overshadow the myriad of social and ecological benefits from doing so (Gupta, Pouw & Ros-Tonen. 2015), potentially yielding stagnation and inaction on the fossil phase-out front, which is simply not an option in light of the 'climate emergency'.

Rather, an ID lens accepts that financial losses will be incurred with LFFU (i.e. there will be 'winners' and 'losers' as stranded assets are inevitably generated and incurred, see 2.1) and explores how these monetary losses manifest across its three dimensions (Gupta, Pouw, & Ros-Tonen, 2015; Gupta & Pouw, 2017); Figure 2.6 juxtaposes the ID and SD approaches. The ID framework internalises the notion that a transition from fossil-intensive to low-fossil, climate-resilient societies cannot be achieved through a 'win-win' mechanism, and opts to study these economic and financial trade-offs from a non-economic, non-financial and political perspective. Accordingly, the key SDG targets identified in 1.4.2 (see Table 1.2) can be reconceptualised with the ID framework – see Table 2.3. For instance, target 1.2 ('reduce at least by half the proportion of men, women and children… in poverty') directly maps to the social inclusiveness dimension through the ID's aspiration to grant access to basic needs and services (including financial resources, like a stable and fair wage) to the world's most under-resourced and under-privileged (in this case) fossil-dependents.

Figure 2.6. Illustration of the relationship between inclusive development and sustainable development



Source: Adapted from Gupta (2020)

Table 2.3. Reconceptualising key SDG targets with an Inclusive Development Framework

SDG Target	Key LFFU-related ID Considerations (key ID dimension)
1.2	Access to basic services and financial resources by the world's most under-resourced and under-privileged (Social)
2.1	Access to sufficient food and nutrition by the world's most under-resourced and under-privileged (Social)
3.9	Access to a safe environment and ecosystem services (Ecological)
7.1	Access to basic provisions like reliable and affordable energy (Social)
8.1	Extent to which natural resource exploitation and economic activity synergizes with or poses trade-offs to access to basic services (Social) or ecosystem services (Ecological) AND Extent to which economic growth generates, allocates and distributes the stranded asset burden (i.e. SAD bill) inter- and intranationally (Relational)
9.4	Access to reliable infrastructure and services like electricity, transport and housing (Social)
10.1	Access to basic services and financial resources by the world's most under-resourced and under-privileged (Social)
13.2	Access to a safe environment and ecosystem services (Ecological)
16.6	Inclusive distribution of stranded asset and fossil fuel phase-out burden (i.e. SAD bill) (Relational)

Source: Author

Finally, stranded assets, ID and the SDGs all coalesce into one framework, depicted by Table 2.4 . Table 2.4 builds on section 2.2.1 (particularly Figure 2.4) by conceptualising inclusive development as a function of fossil fuels and stranded assets and proposing seven conditions (two social, three ecological, two relational) for an inclusive fossil fuel phaseout, pinning each condition in relation to the most relevant and applicable SDG targets. Most important is condition E1, which maintains that any efforts to support existing or create new fossil fuel projects and/or infrastructure is ecologically exclusive; phasing out fossil fuels is a pre-requisite to ecological inclusiveness, directly mapping to SDG targets 3.9 and 13.2.

Conditions E2, S1 and R1-2 focus on inclusive stranded asset governance. An inclusive agenda is one in which: existing infrastructure is fully and adequately decommissioned to avoid further ecosystem disruption (Condition E2); stranded fossil-dependent jobs are replaced by desirable and safe alternatives designed for the poorest and most vulnerable people (Condition S1); the financial burden of phasing out fossil fuels falls is allocated to Northern commercial banks, fossil fuel firms and institutional shareholders (Condition R1); countries from the Global South are financially compensated by richer actors from the North for leaving their coal, oil and gas reserves underground (Condition R2).

Finally, Conditions E3 and S2 account for inclusively substituting fossil fuels; that is, ensuring that fossil-alternative technologies do not disrupt ecosystems (Condition E3) or violate human rights (Condition S2) through e.g., exploitative and unsustainable metals mining. Note that all conditions build on E1 except S1. In theory, condition S1 can be met by offering safe, desirable and adequately-compensating jobs within or dependent on the fossil fuel industry, but in practice evidence points to the socially exclusive nature of the fossil industry's status-quo (see 1.2.1).

In summary, inclusive development via stranded assets should be approached through three considerations: 1) Are fossil fuels left underground? (E1); 2) Are the inevitable stranded assets governed inclusively? (S1, E2, R1-2); and 3) Are the alternatives to fossil fuels themselves inclusive? (E3, S2). And within these conditions, nine SDGs may directly experience synergies or trade-offs.

Table 2.4. Conceptualising stranded assets and the SDGs via inclusive development

Dimension	Inclusiveness Condition	Key SDG Target(s)
Ecological	E1. Investments in new fossil fuel assets are terminated immediately, and existing coal, oil and gas facilities are stranded/phased out;	3.9, 13.2
	E2. Physical assets (like coal-fired power stations) are adequately and fully retired/decommissioned so that they do not threaten local air, water and soil resources;	3.9, 13.2
	E3. Fossil fuel alternatives (e.g., grid-scale solar PV) do not themselves disrupt ecosystems and are respectful of water, land and other planetary boundaries	3.9, 13.2
Social	S1. Safe, high quality and desirable jobs are for the poorest, most under-resourced and vulnerable unemployed people, and their livelihoods and wellbeing are both sustained and prioritized;	1.2, 2.1, 8.4, 10.1
	S2. Investments in fossil-alternative assets do not hamper universal access to basic needs and services, like energy, healthcare, water, food, housing, and justice	7.1, 9.4
Relational	R1. Financial & non-financial costs (stranded assets) of phasing out fossil fuels are allocated to large (fossil fuel) multinational firms and capable financial institutions, hence allocating the SAD bill to these actors;	8.4, 16.6
	R2. Compensation (monetary and otherwise) for stranded natural resources (e.g., recoverable coal, oil and gas reserves) is paid from richer governments, firms and investors from the 'global North' to citizens of poorer nations with ample reserves and dependence on developing said reserves ('global South')	8.4, 16.6

Source: Author

2.2.3. Contextualising Inclusive Development in the Neoliberal Fossil Economy

Like with stranded assets (see 2.1.3), it is important to contextualise the ID framework in the context of the neoliberal fossil economy, particularly since the ID framework itself reprimands the 'growth' element that is so central to the capitalist mode of production (Marx, 1867).

The limitations of the central neoliberal production model (see 2.1.3) are both evident and critical for an inclusive agenda; the model is entirely reliant on serial and unequal 'free-riding' on several fronts (Georgescu-Rogen, 1971; Fraser, 2016; 2021; Martinez Alier, 2002; 2004; submitted; Costanza, 2008; Agrawal & Narain, 2011; Moore, 2017; 2018). Natural resources are assigned no value in these production models, and environmental degradation and resource depletion are taken for granted (e.g., Fraser, 2021; Moore, 2017; 2018); production and growth could theoretically perpetually grow, even as carbon sinks are saturated, rivers are polluted, the climate irreversibly mutates and raw materials vanish. Clearly this is not true; for instance, "fresh water may account for a very small fraction of the GDP, but without it the food production system would fail" (Ayres et al., 2013: 82). The end result is an "overarching political economy of emissions… exploiting forest and then fossil fuels across the globe for accumulation" (Liverman, 2015: 304) without assigning Nature any value, thereby perpetuating the 'climate emergency'.

Altogether, capitalist models are arguably "**constitutively dependent—one could say, parasitic—on a host of social activities, political capacities, and natural processes that are defined in capitalist societies as non-economic.** Accorded no 'value' and positioned outside it, these constitute the economy's indispensable presuppositions" (Fraser, 2021: 99, **emphasis added**). Economies are clearly "subordinated to politics, religion and social relations" (Polanyi, 2001: xxiii), and yet these key features are omitted from the very foundations of neoclassical models. This negligence, hardwired into the core of neoclassical models, yields what Moore (2017; 2018) calls the Law of Cheap Nature and the 'four Cheaps' that the capitalist economy presupposes but assigns no value to: labour, energy, food and raw materials. This yields a "contradictory and crisis-prone" mode of production "positioning 'nature' as a realm of stuff, devoid of value, but infinitely self-replenishing and generally available to be processed in commodity production… capitalism is a cannibal that devours its own vital organs, like a serpent that eats its own tail" (ibid: 100-1).

Capitalism historically evolved through *four separate "regimes of accumulation*": first, mercantile capitalism in the 16-18th centuries, largely characterised as a "*somatic regime*" reliant on "the conversion of chemical into mechanical energy inside the body", hence relying on human labour as the primary source (the 'primitive accumulation' regime); second, the "*exosomatic* regime", marked by the invention of the steam engine in the 19th century and reliant on converting cheap fossilized solar energy (in the form of coal) "into mechanical energy outside of living bodies";[15] third, the "state-managed phase," which saw oil replace coal in the "age of the automobile"; and finally the "current regime of financialised capitalism," in which globalisation has "scrambled the previous energic geography" with "somatic and exosomatic formations now coexist[ing] side-by-side throughout Asia, Latin America and some regions of Africa" (Fraser, 2021: 110-7). *Evidently, the exploitation of fossil fuels is deeply engrained in the core fabric that constitutes the capitalist mode of production*.

Capital was (and is) able to flow and accumulate not because of an "invisible hand" or a "free market" (Smith, 1776), but rather due to 'extraeconomic means' (Glassman, 2006), 'regulatory environments' (Peet & Watts, 1996) and 'legal codes' that enable such capital circulation and accumulation to persist; "only government can secure and police private property, legal contracts, money and credit" (Røpke, 2019: 8, referencing Polanyi, 1944). Pistor (2019: 2) notes that "with the right legal coding, any… asset can be turned into capital and thereby increase its propensity to create wealth for its holders." Pistor (ibid: 8, **emphasis added**) continues:

> Realizing [sic] the centrality and power of law for coding capital has important implications for understanding the political economy of capitalism. It shifts the attention from class identity and class struggle to the question of **who has access and controls over the legal code and its masters**: the land **elites**; the long-distance **traders** and **merchant banks**; the **shareholders** of corporations that own production facilities or simply hold assets behind a corporate veil; the **banks** who grant loans, issue credit cards and student loans; the **non-bank financial intermediaries** that issue complex financial assets, including asset-backed securities and derivates.

On the one hand, this leaves us fairly optimistic, as it indicates that sculpting a new legal code (i.e. imposing regulations on capital accumulation) holds the key to managing the 'climate emergency'; on

[15] The somatic/exosomatic bifurcation separating the first and second regimes, in which the coal-fired steam engine create the façade that animal (i.e. human) muscle was "liberated" is misleading; rather, "[e]xosomatic industrialization in Europe, North America and Japan rested on a hidden abode of somatic-based extractivism in the periphery," as Fraser (2021: 114) explains: "What made Manchester's factories hum was the massive import of 'cheap natures' wrested from colonized lands by masses of unfree and dependent labour: cheap cotton to feed the mills; cheap sugar, tobacco, coffee and tea to stimulate the 'hands'; cheap bird shit to feed the soil that fed the workers."

the other hand, “states themselves have more to gain than to lose from privileging capital by backing the private coding efforts to create it” (Pistor, 2019: 20).

Beyond states, multinational corporations, commercial & investment banks, pension funds (among other financial institutions) have pumped tens of trillions of dollars into the fossil fuel industry (see 1.2.1), and thus “have skin in the game” (Fraser, 2021: 95) – the ‘game’ referring to the ‘climate problem’. “They are”, Fraser (ibid: 95, **emphasis added**) notes, “invested not just economically but also politically in **ensuring the global climate regime remains market-centred and capital-friendly**.” Through ‘carbon offsets’, ‘trading schemes’, ‘green bonds’ – which are “set to create a new Southern debt to the North, backed by Southern land and Southern public funds” (Lohman, 2012: 88) – and through smarmy ‘net-zero’ declarations (see 1.2), “environmental economics and broader neoliberal policies[16] now seemingly dominate attempts ***to give the invisible hand a ‘green thumb’***” (Castree, 2015: 288-9, ***emphasis added***), producing a ‘neoliberalisation of nature’, a “greenwashing appropriation of resources and the environmental commons for private profit” (Baker, 2015a: 446). According to some, the root cause of the ‘climate emergency’ is a “crisis of hegemony” driven by the flaws in the capitalist model,” and thus, “safeguarding the planet requires **building a counterhegemony**” (Fraser, 2021: 95-6, **emphasis added**).

This altogether indicates that the capitalist mode of production is not only negligent of the adverse environmental & climate impacts of its production process, but has historically between entirely *dependent* on unabated coal and oil & gas consumption in its exosomatic and state-managed phases, respectively (Fraser, 2021), for perpetuating its growth, and hence has directly contributed to exacerbating (if not single-handedly birthing) the ‘climate emergency’. Moreover, as discussed earlier, this production mode has itself generated a slew of multidimensional (prospective) stranded fossil assets (see 2.1.3), the socioecological and relational impacts of which are not accounted for in the production model and therefore risk being dumped onto under-resourced fossil-dependents. The point here is that an ID-centred analysis of LFFU approaches, policies and instruments should be wary of market-based LFFU approaches (see 4.4), if not reject them altogether, given the lessons learned from studying capitalist markets over the last centuries.

2.2.4. Units of Analysis: Inclusive Development

The ID discussion has surfaced several additional units of analysis and observation, complementing those from the stranded asset narrative (see 2.1.4). Again, these are presented in Table 2.5 and elaborated upon in section 3.2.

Table 2.5. Units of analysis and observation surfacing from the ID narrative

Dimension	Unit of Analysis	Unit of Observation [relevant SDG targets]
Social Inclusiveness	Fossil Fuel-Dependents (Individual & Household Level)	Fossil sector jobs [1,2, 8.4, 10.1] Fossil-alternative sector jobs [1,2, 8.4, 10.1] Desirability of jobs [1,2, 8.4, 10.1] Safety of jobs [1,2, 8.4, 10.1] Energy access [7.1, 9.4] Energy affordability [7.1, 9.4]

[16] Not to mention fallacious claims of an ‘Environmental Kuznets Curve’, positiing that economic growth will after a certain point “actually reduce negative environmental impacts”, which clearly holds no grounds given the limitations of economic growth models and the fact that it “has fit poorly with empirical evidence since it was proposed in the 1950s” (Paulson, 2017: 429)

Dimension	Unit of Analysis	Unit of Observation [relevant SDG targets]
Ecological Inclusiveness	Fossil Fuel-Related Finance	Debt issued to new fossil projects [3.9, 13.2] Equity investments in fossil E&Ps [3.9, 13.2] Divestments from fossil-intensive (liquid and illiquid) assets [3.9, 13.2] Finance allocated to decommission existing fossil resources [3.9, 13.2]
	Fossil-Related Policies (Organisational Level)	'Green' finance for fossil-alternatives [3.9, 13.2] Plans and strategies to decommission existing fossil infrastructure [3.9, 13.2]
Relational Inclusiveness	Stranded Asset Debt (SAD)	(Financial) resources allocated for decommissioning existing physical assets [8.4, 16.6] (Financial) resources allocated for governing stranded social, human and financial assets [8.4, 16.6] (Financial) resources allocated for compensating stranded natural assets [8.4, 16.6]

Source: Author

2.3. Conclusion

This chapter addressed the question:

What are the key elements of an 'inclusive fossil fuel phase-out', unpacked using a stranded fossil fuel asset conceptualisation?

And draws three conclusions:

Conclusion 1

An inclusive development perspective allows for a unique unpacking of LFFU via stranded assets, and the scoping (see 2.1) and ad hoc (see 2.2) reviews in this chapter indicate that an *inclusive fossil fuel phase-out is inextricably tied to an inclusive governance of stranded assets* (see Table 2.4) due to the multidimensional ramifications borne by stranded assets that are all too central to the ID framework (*Element #1)*. Stranded labour, energy, communities, debt & equity, infrastructure and natural resources, among others (see 2.1.1) link to the social, ecological and relational dimensions of inclusiveness, and therefore, accounting for and mitigating against these stranded asset-borne implications is central to ID practice and scholarly research.

Moving forward, it is imperative that LFFU approaches (i.e., stranded asset drivers, see 4.2) are adopted that take into account the social, ecological and relational ramifications of the physical, natural, social, human and financial assets that they may strand in the process of capping coal, oil and gas production in combatting the 'climate emergency'. Accordingly, an inclusive approach is not satisfied with simply aligning with climate goals – like those set forth in the Paris Agreement (see 1.4.1) – and rather prioritises the wellbeing of all fossil-dependents, particularly those who are under-resourced and under-privileged. That is, social inclusiveness today must not be compromised for 'the greater good of the climate', and an adequate distribution of the stranded asset burden that will accompany any fossil phase-out plays an integral role in upholding this mantra.

Conclusion 2

Complementarily to a 'climate debt', an inclusive approach to LFFU also concerns a supply-side component, as a first pass conceptualised as a Stranded Asset Debt (SAD) (*Element #2)*; here, financial, economic and political actors from the 'global North' are held responsible for not merely overconsuming their fair share of emissions, but also exporting their fossil-intensive businesses abroad and earning the (financial) benefits of doing so while generating and exacerbating multidimensional stranded assets in the process (see 2.2.1.4). Hence, an integral component of an *inclusive* fossil phaseout (particularly the relational dimension) is equitably settling this SAD bill and allocating stranded asset burden to rich and capable extractors and financiers from the 'North'. Discerning the intricacies of this SAD bill in the context of North-South flows into South Africa's fossil fuel industry will hold a central focus of this research's analysis (see 5.3.4 and 6.4).

Conclusion 3

Both (prospective) stranded fossil fuel assets and ID agendas more broadly are situated within the context of the neoliberal fossil economy, which embodies a mode of production that historically has neglected and devalued the social, natural, environmental, ecological, and energetic systems that hoist its production models (Fraser, 2021; Moore, 2017; 2018; see 2.1.3 and 2.2.3). This neglect has itself yielded a global economy entirely dependent on fossil fuels for meeting at least 85% of primary global energy demands (BP, 2020; 2021), promoting unabated fossil production at the expense of climate impacts and perpetuating the 'climate emergency'. As such, the capitalist mode of production may be incompatible with an inclusive fossil fuel phaseout at face value, and moving forward, market-based approaches to LFFU should be taken with a grain of salt, extensively scrutinised, and critiqued, as *inclusive* LFFU approach mixes are developed at the (inter)national stage (*Element #3)*.

3. Methodology: Exploring the Stranded Asset Debt[17]

3.1. Purpose and Structure

This chapter discusses the methodological considerations and research design through which this research was conducted. It first presents the key units of analysis and observation (see 3.2) and conceptual scheme (see 3.3) that have arisen from the stranded asset and inclusive development scholarship. It then presents an overview of the research design, including an overview of all data collection and analysis methods employed (see 3.4), which is followed by a chapter-by-chapter breakdown that delves deeper into the data acquisition and analysis techniques per chapter (see 3.5). The chapter then discusses the ontological and epistemological positionality (see 3.6), study limitations (see 3.7), and concludes with ethical considerations (see 3.8).

3.2. Units of Analysis & Observation

Table 3.1 compiles the units of analysis and observation that arose from the theoretical unpacking of an 'inclusive fossil fuel phaseout' from sections 2.1.4 on stranded assets and 2.2.4 covering inclusive development, respectively; the centre-right column specifies the linkage between each unit of analysis/observation and at least one theoretical concept. Moreover, the rightmost column denotes the empirical sub-chapter in which each unit of analysis/observation is studied. For instance, the theoretical review revealed that stranded natural assets (e.g., fossil fuels themselves, see 2.1.1) play a key role in LFFU given that 60-90% of proven fossil reserves should remain underground to comply with a 1.5°C average temperature rise, which bears direct implications for ecological inclusiveness (see 2.2.1) and environmental SDGs, exemplified through, for instance, SDG target 13.2 (see 1.4.2). However, a review of the scholarship (see 1.3.2 & 4.2) showed that thus far a gap persists (see 1.2.2) in the state of South African – and African, more broadly) potential stranded natural assets and fossil fuel production (broadly categorised as 'fossil fuel-related artefacts'); hence, several key units of observation to fill this niche gap were identified, including: proven reserves; reserve value; production/ consumption/ export & import rates, and emission, which are subsequently tackled in sections 5.2.1, 5.3.2, 8.2.4 and 8.3.4.

Table 3.1. Units of Analysis and Observation arising from the theoretical discussion in Chapter 3 that drive the analysis in Chapters 4-10

Unit of Analysis	Unit of Observation	Key Concepts Derived From	Sub-Chapter Addressed
Fossil Fuel-Related Artefacts	Proven Coal/ Oil/ Gas Reserves	Stranded Natural Assets	5.2.1
	Net Present Value of Reserves		5.3.1
	Coal/ Oil/ Gas Production Rates	Ecological Inclusiveness	8.1.4
	Coal/ Oil/ Gas Consumption Rates		8.2.4
	Coal/ Oil/ Gas Export Rates	SDG Targets 3.9, 13.2	
	Coal/ Oil/ Gas Import Rates		
	Emissions (GHG) from Proven & Prospective Reserves	PA Article 2.1a	

[17] This chapter draws on excerpts from various publications, namely:
Rempel, A. (Accepted 2022). An Unsettled Stranded Asset Debt?. *Antipode*
Rempel, A., Gupta, J. (2021). Fossil fuels, stranded assets and COVID-19: Imagining an inclusive and transformative recovery. *World Development, 146.* doi: 10.1016/j.worlddev.2021.105608
Rempel, A., Gupta, J. (2022). Equitable, Effective & Feasible Approaches for a Prospective Fossil Fuel Transition. *Wiley Interdisciplinary Reviews: Climate Change, 13*(2). doi: 10.1002/wcc.756
Rempel A., Gupta, J. (2021). Fossil fuels, stranded assets and COVID-19: Imagining an inclusive and transformative recovery. *World Development, 146.* doi: 10.1016/j.worlddev.2021.105608

Unit of Analysis	Unit of Observation	Key Concepts Derived From	Sub-Chapter Addressed
Fossil Fuel-Related Capital & Infrastructure	Coal Mine Coal-fired Power Plant Crude Oil/ Gas Pipeline Liquid Natural Gas (LNG) Terminal Crude Oil Refinery Offshore Oil & Gas Exploration Infrastructure	Stranded Physical Assets	5.2.2 5.3.2 8.1.2 8.2.2
	Installed Fossil-Based Power Capacity Fossil-Intensiveness of Grid Affordability and Reliability of Fossil-Alternative Capacity	Stranded Human Assets	5.2.3 5.3.3 8.1.3 8.2.3
Fossil-Dependent Communities	Communities Built Around e.g., Mining Communities Impacted by Fossil Projects Through e.g., Displacement/ Land Grab or Local Pollution/ Contamination	Stranded Social Assets	5.3.3
Fossil-Dependent Individuals & Households	Fossil Sector Jobs (e.g., mining) Fossil-Alternative Sector Jobs (e.g., solar) Skillset Required for Employment in Fossil & Alterative Sector Access to Electrical Grid Affordability of Electrical Grid	Stranded Human Assets Social Inclusiveness SDG Targets 1.2, 7.1, 8.4, 10.1	5.2.3 5.3.3 7.3.2 8.1.3 8.2.3
	Exposure to Prospective Stranded Human/ Physical/ Social Assets (see above)	Risks & Winners/Losers	5.4 8.3
	Desirability of fossil and fossil-alternative jobs Safety of fossil and fossil-alternative jobs	Social Inclusiveness SDG Targets 1.2, 8.4, 10.1	5.2.3 5.3.3 8.1.3 8.2.3
Finance Institutions & Fossil Producers	Equity Investments in Fossil E&Ps Debt issued to fossil projects Type and Terms of Debt Issued Revenue Streams Dividend Payments to Shareholders Capital Expenditure (CapEx) on Fossil Projects	Stranded Financial Assets Ecological Inclusiveness SDG Targets 3.9, 13.2 Stranded Asset Debt PA Article 2.1c	6.2.1-4 6.3.1-4
	Perception of Fossil Investments (Dis)Belief in Stranded Financial Assets Temporality of Fossil Investments	Stranded Asset Uncertainty	7.3.1-6
	Exposure to Prospective Stranded Financial Assets (see above)	Risks & Winners/Losers	6.4
	Divestments from fossil-intensive (liquid and illiquid) assets Finance allocated to decommission existing fossil resources 'Green' finance for fossil-alternatives Plans, policies and strategies to decommission existing fossil infrastructure	Ecological Inclusiveness Relational Inclusiveness SDG Targets 8.4, 13.2, 16.6 Stranded Asset Debt PA Article 2.1c	5.2.2 7.4.1-7.4.4 7.5.1-2

Unit of Analysis	Unit of Observation	Key Concepts Derived From	Sub-Chapter Addressed
	(Financial) resources allocated for governing stranded social, human and financial assets (Financial) resources allocated for compensating stranded natural assets	Relational Inclusiveness SDG Target 8.4, 16.6 Stranded Asset Debt PA Article 2.1c	7.3-5
Governments, Finance Institutions, Civil Society Organisations (CSOs)	Regulatory Approaches for LFFU Economic/ Market-Based Approaches for LFFU Socially-Oppositional Approaches to LFFU Technological Approaches to LFFU Environmentally-Driven Approaches to LFFU Conventionality of Approaches Economism of Approaches Temporal Considerations of Approaches Subjectivity of Approaches	Stranding Drivers	4.2.1-3 4.3.1-3 4.4-6 7.3.1-6
	Exposure to Prospective Stranded Financial Assets Exposure to Prospective Stranded Natural/ Human/ Physical/ Social Assets	Risks & Winners/Losers	5.2.1 5.3.1 6.2.1-4 6.3.1-4 8.1.4 8.2.4

Source: Author

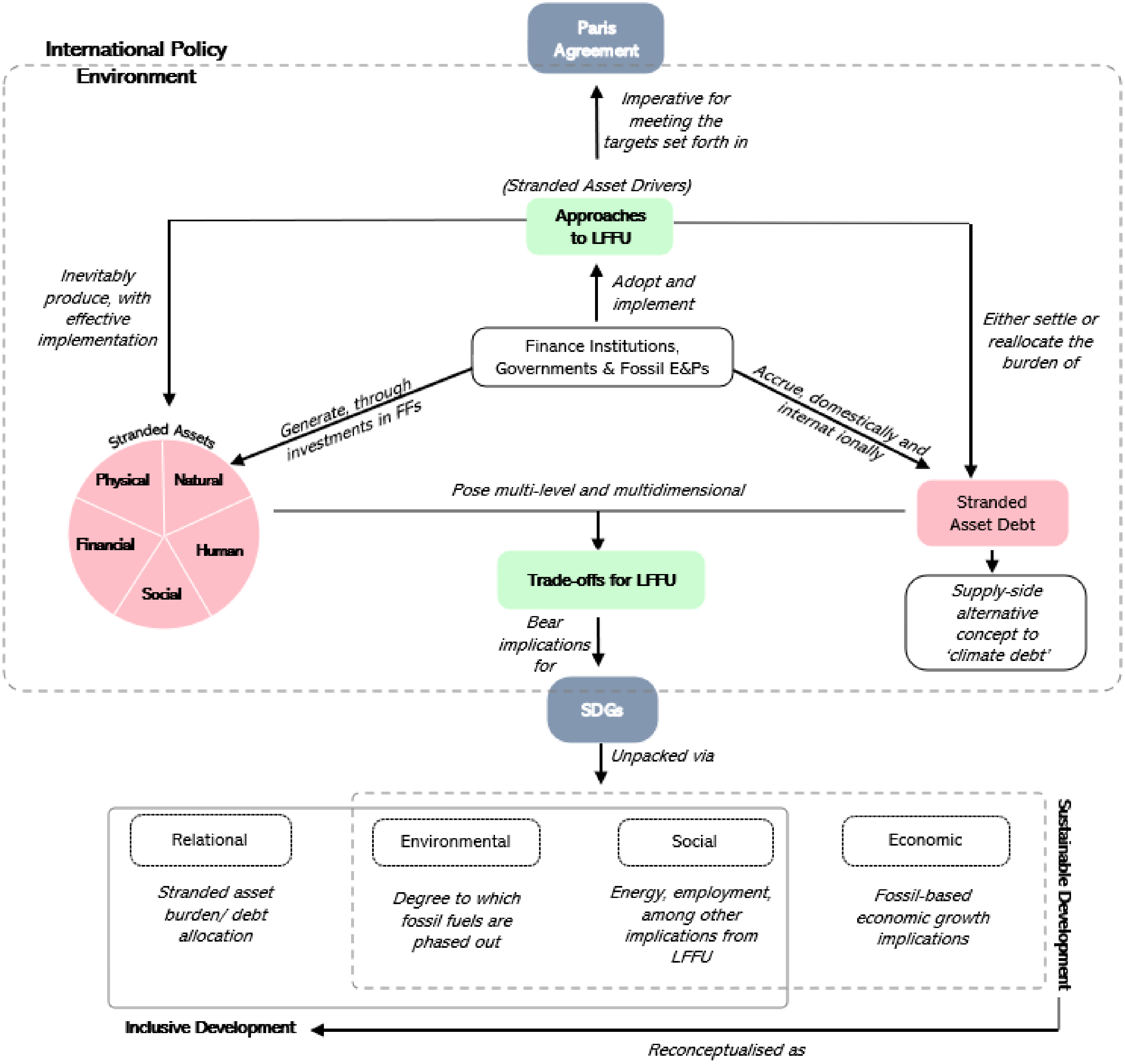
Similarly, the stranded asset review also demonstrated that 'stranded finance' (again see 2.1.1) plays a key role in LFFU given the hundreds of trillions of dollars that hoist global fossil fuel production (Linquiti & Cogswell, 2016), and yet, neither South Africa's nor (more broadly) Africa's fossil economies have been scrutinised in relation to international finance flows (see 1.2.2); hence, several units of observation related to 'finance institutions and fossil producers' were identified, including, inter alia: equity investments in E&Ps operating across the African continent; debt issued to African fossil projects; and revenue streams from African fossil fuels, which are studied sections 6.2.1-6.2.4.

These units of analysis and observation resonate with the climate change regime context driving this research. Article 2.1c of the Paris Agreement marks the fundamental point of departure for this study ("making finance flows consistent with pathways towards lower greenhouse gas emissions" – see 1.4.1) and is central to addressing all knowledge gaps, through especially K2 and K4 (see 1.2.2). This de facto corroborates the theoretical decision to study 'Finance Institutions & Fossil Producers' through the various finance-oriented and abovementioned units of observation (again, see Table 3.1 for complete list of units). Also imperative are Articles 4.5 and 9-11 of the Paris Agreement, which in various ways stress the importance of 'developed country parties' allocating (non-)financial resources to 'developing country parties' to strengthen climate mitigation plans and ambitions (see 1.4.1). These articles directly link to the relational inclusiveness indicator concerned with whether financial or non-financial resources and/or compensation are allocated by the 'global North' to the 'global South' to equitably govern various forms of stranded natural, human, physical social and financial assets, conceptualised through the 'Stranded Asset Debt' (SAD) term that I propose (see 2.2.1.4).

3.3. Conceptual Scheme

These units of analysis & observation coalesce into a broader narrative around an inclusive South African fossil fuel phaseout, depicted by the conceptual scheme in Figure 3.1; note that it should be read from inside-out, beginning with the element labelled 'Finance Institutions, Governments and Fossil E&Ps'. As was already discussed (see 1.2.1, 1.2.2, 2.1.3 and 2.2.3), these are the key actors that

Figure 3.1. Conceptual Scheme



Source: Author

themselves perpetuate fossil production globally, either by directly extracting these resources (E&Ps), crafting the 'legal codes' and policy environment within which such extraction can take place (Pistor, 2019), or allocating financial capital investments (finance institutions and governments) to drive such projects. Through these investments, these actors directly generate potential multidimensional stranded assets (see 2.1.1) in the domain of the fossil project – in the form of e.g., fossil-dependent coal mining jobs and electricity generation (explored in Chapters 5 and 8) – in addition to themselves having 'skin in the game' (Fraser, 2021) by incurring potential stranded financial assets on their own balance sheets – in the form of e.g., outstanding debts or equity investments. Complementary to discussions on a 'climate debt' owed by the 'North' to the 'South' (which denotes an over-*consumption* of fossil fuels, see 2.2.1.3), it is arguable that these actors simultaneously accrue a SAD, which depicts an over-*production* of fossil fuel assets (see 2.2.1.4); this is explored in Chapter 6.

These finance institutions, governments and E&Ps, who govern the generated fossil-intensive assets, can now adopt and implement a series of approaches to LFFU in order to align with the climate objectives set forth in the Paris Agreement and the climate change regime more broadly (see 1.4.1); these approaches are essentially stranded asset *drivers* (2.1.3), given that effective climate action is only possible by effectively curtailing fossil fuel *supply* (e.g. Le Billon & Kristoffersen, 2019; Lazarus & van Asselt, 2018) and not through techno-fixes like BECCS (see 2.1.2.1). The effectiveness and inclusiveness of these LFFU approaches is only beginning to gain traction in the scholarship (e.g., Gaulin & Le Billon, 2020), and are explored in this thesis in Chapters 4 in a general context (via a scoping literature review) and empirically in Chapter 7 specifically in the case of South Africa.

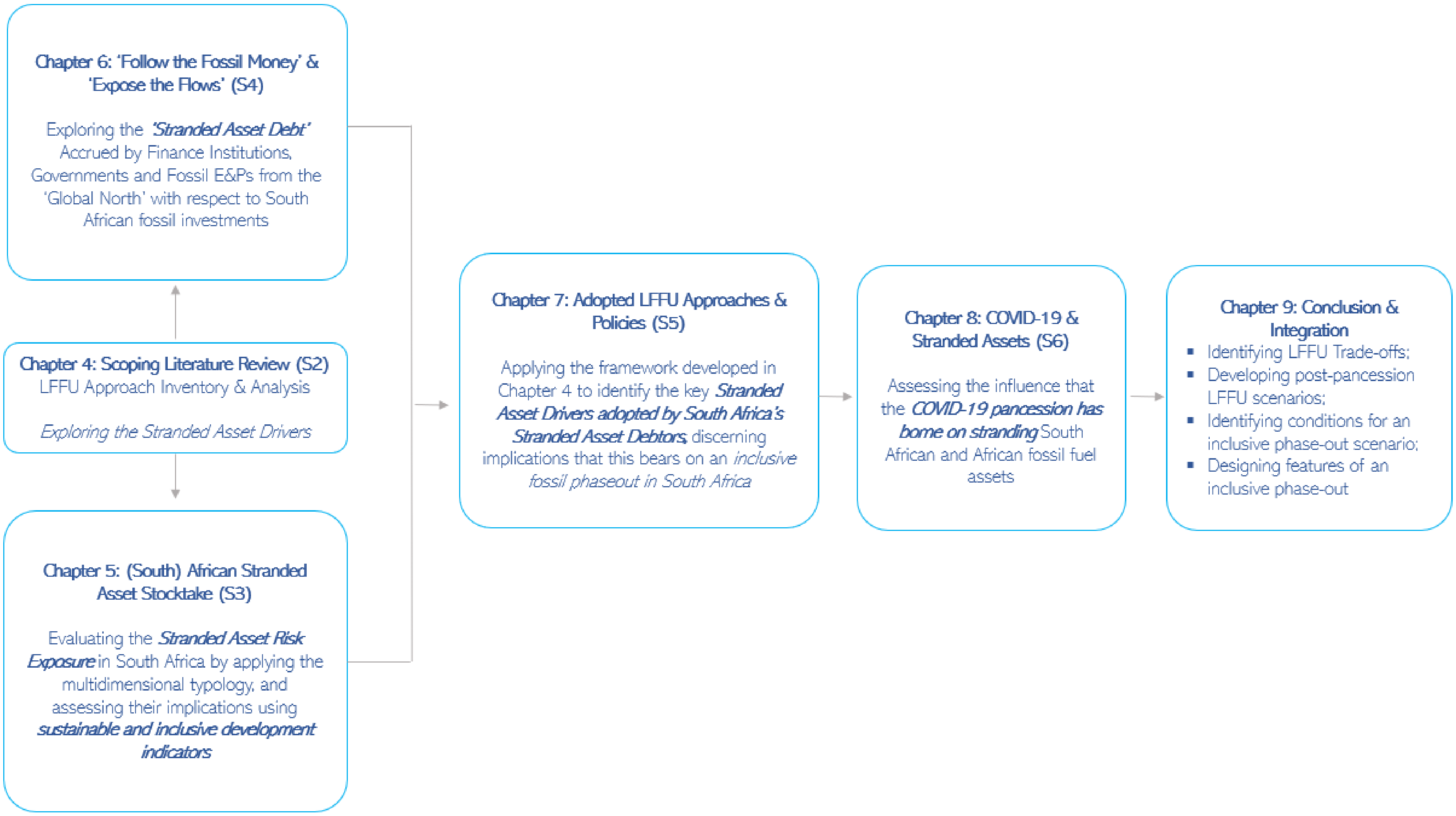
The subsequently generated stranded assets pose a series of risks, and subsequently, numerous multi-dimensional trade-offs (developed in Chapter 9) at local-, national- and international-levels of governance that yield major implications for both aligning with development agendas (i.e., the SDGs – see 1.4.2) and complying with international climate goals. These trade-offs are most readily conceptualised using the sustainable development framework, which unpacks issues across social, environmental and economic dimensions (see 2.2.3); however, given that economic trade-offs typically trump social and environmental considerations (Gupta, Pouw & Ros-Tonen, 2015), these trade-offs can be reconceptualised with an inclusive development perspective, which introduces a relational lens to scrutinise economic trade-offs (see 2.2.1). Understanding these inclusiveness trade-offs is vital, since they may incentivise or deter a South African fossil fuel phaseout altogether, or sculpt the conditions within which one may unravel. As a result, different LFFU approaches and policies may arise as a function of varying trade-offs, which may result in different potential fossil fuel phaseout *scenarios* moving forward, all with varying degrees of social, ecological and relational inclusiveness and economic sustainability. This sets-up the overarching research question of this thesis (see 1.3.1), which is addressed in sections 9.2-9.4.

3.4. Research Design Overview

Figure 3.2 outlines the overall skeletal structure of this research, which employed a multimethod approach (detailed in sections 3.5.1 -3.5.7). First, a scoping literature review was conducted to inaugurate the study (see 3.5.1), compiling and analysing an inventory of LFFU approaches (i.e. stranded asset drivers, see 2.1.3), and simultaneously identifying the key knowledge gaps (see 1.2.2) that guide the empirical phases. The research then diverged into two parallel phases; South African stranded asset stocktake (see 3.5.3) – which tackles sub question S3 and addresses knowledge gaps K1 and K3 – and the 'follow the fossil money' and 'expose the flows' phase (see 3.5.4), which is particularly inspired by knowledge gap K2 (sub question S4 – see Table 1.1 in 1.2.2). These chapters are predominantly concerned with unpacking South Africa's exposure to multidimensional prospective stranded fossil fuel assets, linkages between these assets and finance flows from the 'North' (hence establishing a case for a 'Stranded Asset Debt' (SAD) owed by the 'North' to the 'South' – see 2.2.1.4), and ascertaining implications of both these assets and the SAD for ID and SD.

These two phases converged into the 'Adopted LFFU Approaches' (see 3.5.5) phase, which addresses knowledge gaps K3 and K4 through sub questions S5. This shifts the focus to the policies and LFFU approaches that key actors pertinent to South Africa's fossil phaseout are adopting, including the national government, in addition to the various fossil E&Ps and finance institutions from the 'North' that have accrued a SAD owed to South Africa.

Figure 3.2. Research design overview



Source: Author

Table 3.2. Overview of all methods utilised in this study

Method	Purpose	Analytical Framework Used	Sub-Chapter(s)
Scoping Literature Review	Review the state-of-the-art scholarship on stranded fossil fuel assets, identify key debates and units of analysis	-	2.1
	Review the state-of-the-art scholarship on LFFU approaches (equivalent to 'stranded asset drivers') to compile an analytical inventory of proposed LFFU approaches	-	4.2
Ad Hoc Literature Review	Identify and review the key papers central to unpacking the Inclusive Development theory	-	2.2
Content Analysis	Analysing the LFFU approach inventory from the scoping literature review using an inclusive development analytical framework	Table 3.3	4.3 & 4.4
	Applying the LFFU framework devised from the scoping literature review and content analysis in sections 4.2-4.4 by reviewing the annual and sustainability reporting of key finance institutions and E&Ps with direct linkages to South African fossil fuel production, to evaluate the inclusiveness of proposed LFFU approaches by key actors from the 'global North' relative to South African fossil production	Figure 4.1	7.2-5
	Analysing the annual and sustainability reports of the key E&Ps identified with operations across the African continent to identify prospective stranded natural assets in both South Africa and across Africa more broadly, and to identify changes in CapEx spending during the pandemic compared to before to shed light on avoided stranded assets	Figure 2.1 & Table 2.4	5.2.2-3, 5.3.2-3, 5.4, 8.1.5 & 8.2.5
	Analysis of 10 grey research reports to identify key issues regarding prospective stranded energy and labour (both human assets) in South Africa and Africa	Figure 2.1 & Table 2.4	5.2.3 & 5.3.3
	Analysis of 3 key ILO reports and economic progress reports by the South African ministry of statistics to evaluate the pandemic's influence on stranded human assets (i.e. labour)	Figure 2.1	8.1.3 & 8.2.3
Publicly Available Fossil Fuel Datasets + NPV Analysis	Draw on readily available datasets on global fossil fuel reserves, production and consumption (e.g., BP, 2020; 2021; IEA, 2020) to identify prospective stranded natural assets in both South Africa and across Africa more broadly	Figure 2.1 & Table 2.4	5.2.1, 5.3.1, 8.1.4 & 8.2.4
Fossil Project Database	Draw on readily available datasets on global fossil fuel physical assets and projects (e.g., GEM, 2020a; 2020b; 2020c) to identify prospective stranded physical, human, social and financial assets in both South Africa and across Africa more broadly	Figure 2.1 & Table 2.4	5.2.2-3, 5.3.2-3, 5.4
News Item Mining	Searching online news outlets to identify prospective stranded physical, human, social and financial assets in both South Africa and across Africa more broadly	Figure 2.1 & Table 2.4	5.2.2-3, 5.3.2-3, 5.4, 8.1.2, 8.2.2
Semi-Structured Interviews	39 interviews with South African CSOs, NGOs, activists, academics, financiers and general members of civil society to identify South African and African exposure to prospective stranded human and social assets	Figure 2.1 & Table 2.4	5.2.3 & 5.3.3
	28 interviews with representatives from leading finance institutions and researchers specialising in climate-related finance to identify the key ideological environment that incentivises the adopted LFFU approach mix		7.3-5
Podcast Series, Webinars & Online Conferences	Triangulate and corroborate South African stranded asset findings from content analyses, news item mining and semi-structured interviews	-	5.2.3 & 5.3.3
E&P & Major Shareholder Original Inventory	Compile an original inventory of the leading multinational E&Ps with operations in both South Africa and Africa and their major shareholders in both 2020 and 2021 to identify stranded financial assets and stranded asset debt (SAD) accrued by the 'global North'	Figure 2.1	6.2.1-2, 6.3.1-2
	Mapping equity investments in major multinational E&Ps in three stages of the pandemic to evaluate the state of stranded financial assets during the COVID-19 pandemic		8.1.1 & 8.2.1
Public & Private Fossil Finance Datasets	Utilising two publicly disclosed datasets (OCI, 2020; RAN et al., 2020) to identify the debt finance issued by finance institutions from the 'global North' to E&Ps with operations in Africa	Figure 2.1	6.2.3-4, 6.3.3-4
Integration	Compile a comprehensive (but not exhaustive) list of the key trade-offs with LFFU in South Africa, identified through the multi-method modules in chapters 4-, to address the breadth of relational, social and ecological challenges that South Africa may face in inclusively LFFU	Figure 3.1	10.1-10.4

Source: Author

Finally, the research flows into the 'COVID-19 & Stranded Assets' phase, which contextualises the research in the midst of the pandemic (within which it took place), once more addressing knowledge gaps K1 and K2 (see 3.5.6). Finally, the conclusion wraps up the research by focusing on knowledge gap K4 (though it addresses all four knowledge gaps) and answers the overarching question (see 3.5.7).

Table 3.2 summarises the array of methods used in this study, including the purpose of utilising each method and the sub-chapter in which it was used. As shown, a multi-method study design was implemented, with several content analyses of various types of grey research and annual reports complemented by two semi-structured interview modules, an original multinational E&P and shareholder database, analysis of existing fossil fuel production and finance databases. It also specifies the analytical framework that was applied for that particular method (when applicable) in the centre-right column; for instance, the LFFU approach inventory that arose from the scoping literature review and analysis (see 3.5.2 and Figure 4.1) was applied to the content analysis in section 7.2-7.2.4, which utilised the sustainability and annual reporting of key financial institutions and E&Ps with direct linkages to South African fossil fuel production to evaluate the inclusiveness of their proposed LFFU approaches (yielding Figure 7.3).

3.5. Chapter Breakdown

3.5.1. Chapter 2: Reviewing Stranded Asset, Inclusive Development and Climate Debt Scholarship

Stranded Asset Scoping Review

A scoping review technique was employed (Munn et al., 2018; Pham et al., 2014) to evaluate the state-of-the-art on *stranded fossil fuel assets*. The following search query was input into the *Scopus* database (limiting the timeframe to 2016-2020):

TITLE-ABS-KEY ((stranded AND asset) OR (stranded AND resource) OR (stranded AND fossil AND fuel) OR (stranded AND investment)) AND PUBYEAR > 2015

Which initially yielded 458 unique hits. Publications were condensed into a more manageable list by first excluding papers from irrelevant[18] fields and subsequently selecting papers on the basis that they focused on one or all of the following:

- Stranded assets and stranded resources pertaining particularly specifically to the fossil fuel sector;
- Implications for the 'global South' and justice/equity;
- Assets, wealth, equity and investments tied to fossil fuels or climate policy
- Investors, corporations, or governments and their ties to climate policy and the fossil fuel sector

This resulted in 131 unique publications. To make this more manageable, studies that sought to contribute to directly finance or neoclassical economic *theory* (e.g., Simhauser, 2017) or deployed exclusive modelling techniques and methodologies without linkages to socioecological or climate-related context (e.g., Giannelos, Konstantelos, & Strbac, 2019) were excluded, resulting in a condensed list of 65 papers for the scoping review. These were subsequently analysed in an exploratory fashion guided by sub question S1 (see 1.3.1).

Note that one paper (Caldecott, Howarth & McSharry, 2013) was initially excluded from the search given its publication date preceding 2016, but was subsequently included after multiple others referenced this work as a seminal and central theorisation of the modern stranded asset concept.

Inclusive Development Ad Hoc Review

[18] Irrelevant fields included but were not limited to: Nuclear science and technology; Thermodynamics; Biochemistry: Biomolecular Biology; Meteorology & Atmospheric Sciences; Electrical Engineering; and Entomology

Moreover, an ad hoc review (Snyder, 2019) was subsequently conducted to unpack the *inclusive development* theory that is so central to this research. This approach was preferred over the scoping technique described above, because the inclusive development (ID) scholarship is in its nascent stages of development, and there is a dearth in scholarship developing the ID framework. Gupta, Pouw & Ros-Tonen's (2015) seminal paper was used as a foundational guide to unpacking the ID theory, which was supplemented by other studies that specifically developed the ID theory (e.g., Gupta & Vegelin, 2016) rather than those that referenced ID either passively (e.g., Asongu, Le Roux & Biepke, 2017) or loosely implying that inclusive development is a more 'equitable and just' rendition of 'sustainable development' (e.g., van Vuuren et al., 2017). It is also noteworthy that, as of May 2022, a *Scopus* search using the query: "inclusive development" AND "fossil fuel" yields 3 unique hits (Gupta & Chu, 2018; Bos & Gupta, 2019; Gupta, Rempel & Verrest, 2020), one of which includes me as a co-author.

Climate Debt Expansive Review

An expansive review (Snyder, 2019) of *climate debt* scholarship was also conducted to unpack the North-South and justice implications of an inclusive fossil phaseout, stemming from the central knowledge gap K2 that propels this research (see 1.2.2). The simple search command: "climate debt" was input into *Scopus*, which yielded 29 unique papers. 2 papers were excluded given that they focused on species extinction (Lewthwaite et al., 2018) and sub-prime mortgage lending (Asayama & Hulme, 2019), resulting in 27 papers for review. This review sought to define the *climate debt* concept, explore its utility in addressing the North-South dimension of an inclusive fossil phaseout, and identify its limitations in doing so; these limitations, particularly that the climate debt is a *demand-side and emissions-focused* concept, sparked the idea for developing a supply-side and fossil-focused counterpart, namely the Stranded Asset Debt (see 2.2.1.4).

3.5.2. Chapter 4: Scoping Literature Review of LFFU Approaches

A *scoping review* technique (Munn et al., 2018; Pham et al., 2014) was once again employed to effectively and efficiently scope the existing body of scholarship on approaches to LFFU (sub question S2) and identify critical gaps in knowledge for future research to tackle (see 1.2.2). A search was conducted on the *Scopus* database using the following query:

TITLE-ABS-KEY ("fossil fuel" AND ("transition" OR "instrument" OR "demand-side" OR "supply-side" OR "policies")) AND (LIMIT-TO (PUBYEAR, >2015),[19]

which yielded 6,826 unique hits. After limiting the search to include only relevant subject areas (e.g., social science, economics), 1,674 hits remained. The search results were then sorted by relevance and an initial screening was conducted, assessing the abstracts and conclusions of each paper in relation to the posed sub question S2 (see 1.3.1); this resulted in a preliminary selection of 121 papers, which I capped to ensure that the review remained feasible and manageable. Upon a more rigorous analysis, 22 of the papers were subsequently discarded as their focus deviated from mine.[20] Furthermore, an additional 16 papers[21] were added while analysing this filtered selection, giving rise to a final selection of 115 papers.

Five papers (Le Billon & Kristoffersen, 2019; Mutezo & Mulopo, 2021; Lazarus, Ericksen & Tempest, 2015; Lazarus & van Asselt, 2018; Gaulin & Le Billon, 2020) have also undertaken similar exercises in

[19] I limited the selection to only include publications from 2016 onward to align with the ratification of the Paris Agreement on Climate Change and assuming that these papers have built on the vast literature on instruments since 1990.

[20] For example, some papers conducted niche case studies on e.g., hydropower developments and smart-grid prospects in e.g., India, which, although interesting, only use fossil fuels as a point of departure and do not engage with the fossil fuel political economy.

[21] These additions were cited in various of the other papers in our analysis but did not make it into our selection because they were published before 2015, which we used as an initial cut-off.

reviewing instruments and approaches to LFFU, but 1) these papers almost entirely focused on supply-side instruments, arguing that demand-side discussions have overshadowed their supply-side counterparts over the last decade, and 2) they are not exhaustive and predominantly discuss common approaches to LFFU, neglecting more innovative, niche and unique alternatives. I therefore used these five papers as a basis and point of departure for the review, and supplemented their inventories by identifying other unique approaches in the remaining papers.

Furthermore, each LFFU approach was framed according to its ‘category’ (either *economic* or *regulatory*, building on the frameworks adopted by Lazarus, Ericksen & Tempest, 2015 and Le Billon & Kristofferson, 2019) and ‘type’ (either *demand or supply restrictive*, which denote tactics and instruments that strive to directly fetter fossil fuel demand and supply (respectively), or *demand or supply supportive*, which denote tactics and instruments that support fossil fuel-substitute (e.g., renewable) demand and supply, respectively, building on Green & Denniss, 2018).

29 unique LFFU approaches were identified and evaluated on the basis of their ecological, social and relational inclusiveness. *Ecological inclusiveness* purely assesses the likelihood that an approach is successful in directly LFFU; *relational inclusiveness* assesses who wins or loses from an approach and who incurs the inevitable financial, physical, natural, human and social stranded assets; finally, *social inclusiveness* assesses the extent to which fossil-dependents are accounted for and protected, and universal access to basic needs are upheld with the implementation of an approach – see Table 3.3.

Each approach was assessed in isolation according to the scoring criteria in Table 3.3, acknowledging that in practice mixes of approaches will be adopted (see 4.5). Evaluating approaches in isolation is challenging because, inter alia, the *outcome* vis-à-vis effectiveness and inclusiveness varies in different contexts (as Skovgaard & van Asselt (2017) show in terms of fossil fuel subsidy reform). However, it is useful to consider the shortcomings and possibilities that each LFFU approach *may bring* to different policy mixes. Thus, this review does not draw definitive conclusions and recommendations about LFFU approaches; rather, it: 1) sheds light on the multidimensional and implicit ramifications of LFFU approaches for policymakers, financiers, investors and civil society; and 2) allows for a comparison of various LFFU approaches across multiple categories.

Table 3.3. Scoring system used to evaluate the identified LFFU approaches

	Ecological Inclusiveness	***Social Inclusiveness***	***Relational Inclusiveness***
Scoring	*Will/can it directly LFFU at its respective level of governance?*	*To what extent are fossil-dependents (e.g., coal miners) accounted for and protected, and universal access to basic needs upheld?*	*How are implementation costs and stranded assets allocated & accounted for?*
+	Likely LFFU	Both fossil-dependents are protected AND universal access to basic needs are met	Costs are borne by governments, firms, financiers or other rich & capable actors, AND the approach directly and explicitly allocates resources to govern accompanying stranded assets
0	Potentially LFFU	Fossil-dependents are not protected, OR universal access to basic needs are not met	Costs are borne by governments, firms, financiers or other rich & capable actors, but the approach does not engage with accompanying stranded assets
-	Very unlikely LFFU	Fossil-dependents are not protected and universal access to basic needs are not met	Costs are borne by under-resourced and under-represented fossil-dependents, and stranded assets are unaccounted for

Source: Author

Finally, the UNEP GEO-6 framework was adopted for qualifying confidence (Ekins, Gupta & Boileau (eds.), 2019) in the scores assigned to each approach. More specifically, each approach's score was ranked as either (ibid: 626):

- *Inconclusive (Inc)* if there is "no or limited evidence and no clear consensus";
- *Unresolved (Un)* if "multiple independent studies exist but conclusions do not agree";
- *Established but Incomplete (EbI)* if there is "general agreement although only a limited number of studies exist but no comprehensive synthesis"; or
- *Well Established (WE)* if "multiple independent studies… agree"

Each approach hence has one of the four above qualifiers by its score depending on both the frequency with which the approach was discussed in the scholarship (see rightmost column in Table 4.1) and the general level of (dis)agreement pertaining to the social, ecological and relational inclusiveness of each particular approach across the reviewed scholarship.

3.5.3. Chapter 5: South African Stranded Asset Stocktake

BP, OPEC, IEA, & GEM Fossil Fuel Databases & NPV Analysis

This chapter employed a multi- and mixed-method approach to address sub questions S3. First, I drew on existing global fossil fuel datasets (BP, 2020; OPEC, 2020; IEA, 2021 – see Appendix B) to map the distribution of coal, oil and gas reserves across the African continent. These datasets were often incomplete; for example, BP's (2020) dataset only denotes the top 13 largest oil & gas reserves in Africa at the national level, and clumps the remaining countries under the label 'Rest of Africa'. To better dissect these reserves, I drew on national statistics bureau reports from African nations excluded from these datasets (see Appendix C), which at times included proven reserve data and at others did not. In the event of the latter, missing values were noted.

Once this inventory was completed, I estimated the Net Present Value (NPV) of the potential revenue streams that these fossil reserves could generate as a function of the price of each commodity and the discount rate for both South Africa and the continent more broadly:

$$NPV = \sum_{i=1}^{L} r \times p \times (1-d)^{i} \qquad \textit{Equation 3-1}$$

Where *r* = rate of production, *p* = price of the commodity, *d* = discount rate, *L* = remaining lifetime of the reserve, and *i* = year.

Note that the very notion of discount rates and NPVs have themselves been rebuked on the basis of intergenerational inequity (the idea is that the revenues generated by these reserves decrease over time – a standard feature of the neoliberal economy – which de facto assumes that future generations cannot enjoy as much value from these fossil resources and present generations, Bond, 2018; Bond & Basu, 2022). However, these calculations do offer a valuable indication of the potential stranded natural and financial assets (see 2.1) that may arise if South Africa and Africa more broadly adopts effective approaches to LFFU, which may generate a slew of vested interests resisting LFFU.

By fluctuating the prices of coal, oil and gas from $10-100/ton, $10-100/bbl (barrel), and $0.0005-0.01/Tcf (trillion cubic feet), respectively, and the applied discount rate from 0-10%, I generate a distribution of possible NPVs for Africa's proven fossil reserves – see 5.2.1.3 and 5.3.2.1. These calculations assume that production rates and reserve sizes remain constant over the coming decades; moreover, since South Africa does not have any annual oil and gas production rates to base these NPV calculations on (given the novelty of its recent offshore discoveries, see 5.2.2.5) for the purpose of this exercise, I use the average oil & gas production rates of Africa's leading oil and gas producers: 0.5Gbbl/year for oil and 1Tcf/year for natural gas (see 5.3.2.1).

To address the stranded physical asset risk borne across South Africa and Africa more broadly, I utilised various publicly available datasets composed and disclosed by the Global Energy Monitor (GEM), namely their: coal plant tracker (GEM, 2020a); coal mine tracker (GEM, 2020b); and their fossil infrastructure tracker (GEM, 2020c) (see Appendix B). These datasets are admittedly not exhaustive, but do contain extensive profiles for a myriad of global fossil fuel assets, including details regarding their date of construction, expected retirement, ownership, estimated annual CO_2e emissions, status (e.g., operational vs. retired vs. mothballed) and their latitude & longitude coordinates. I then wrote a script in Python using the GeoPandas package to map the geospatial distribution of these assets (for example see Figure 5.3) using these coordinates (see Appendix B for script details).

Banktrack Database & News Item Mining
11 key South African fossil fuel projects (coal fired power plants, coal mines, crude oil refineries and offshore oil and gas exploration blocks) were then selected to delve deeper into the stranded physical asset narrative; projects were selected based on the findings from the interviews and content analyses (see below). That is, Medupi & Kusile were identified as the two newest, largest, and most critical coal-fired power stations to South Africa's fossil regime, in addition to the older but almost as vast Majuba station, as were South Africa's four major (and foreign-owned) crude oil refineries: SAPREF, NATREF, the Astron refinery and the Engen refinery; informants also stressed that the recent offshore oil & gas discoveries (Brulpadda & Luiperd) may critically alter the future of South Africa's energy mix. In addition to these projects, I included the major coal mines that supply the aforementioned power stations, despite not receiving much attention by the informants and reports (see 5.2.2.2 and Appendix C).

First the Banktrack (n.d.) 'Dodgy Deals' database was used as a point of departure, which contains an extensive set of global fossil fuel project profiles with information on their commercial and public financiers in addition to date of construction, number of personnel and production rates, among others. Some entries in their inventory are quite detailed – containing data on the financier, amount issued, type of financial mechanism, and purpose of the finance flow; however, many entries were outdated and had not been updated for many years. Accordingly, I employed a news item mining technique, first conducting on a Google search (using various permutations of each project name as the search command) and then replicating this search on the *Daily Maverick*, a local South African newspaper with a dedicated climate section called *Our Burning Planet*. The news item search was conducted until results for each project's financial linkages became saturated (see Appendix B for a complete list of news items utilised).

New Actor Annual Reports
Once the full array of key actors pertaining to each selected project was identified from the Banktrack database and news item mining module, the 2020-1 annual & sustainability reports for new actors were retrieved,[22] and, combined with the E&P reports, and shareholder, commercial and PFI data from 3.5.4, a 'profile' was generated for each project, addressing sub question S3 in unpacking the slew of prospective (predominantly) stranded physical, human and financial assets that these projects pose (see Appendix B for a sample of this profile-based dataset). Moreover, the Python Scripts developed earlier were tweaked to analyse the geospatial scope of these major fossil fuel projects in the broader international financial context.

Semi-Structured Interviews
Semi-structured interviews played an integral role in contextualising and unpacking South Africa's prospective stranded human and social assets and the social, ecological and relational challenges that

[22] Reports from 2020 were used if their 2021 renditions were not yet available

will accompany a prospective fossil transition. A total of 39 informants were interviewed for this phase (note that other phases conducted additional interviews, see 3.5.5). Informants pertained to one of four stakeholder groups (Civil Society; NGOs/ Activists; Academia; and Policymakers/ Public Employees). Informants were initially recruited by reaching out to several NGOs working on fossil fuel resistance and opposition in South Africa, including several other members of the Climate Justice Coalition, a coalition of 28 NGOs/CSOs for which 350.org is the secretariat, in addition to researchers working at several key think tanks and research institutes who have published recent and relevant grey research reports, like Meridian Economics and the Economic Justice Institute. Subsequently, new potential interviewees were suggested by each interviewee (snowballing technique). All interviews took place between August-December 2020.

The privacy and pseudo-anonymity of all interviewees was prioritised during the interview process to ensure that no harm would come their way. All interviewees were asked roughly the same guiding questions; the bulk of the interviews lasted 60 minutes. Finally, all interviews were transcribed 'live' using the Microsoft Word 'dictate' feature; this negated the need to record any interviews as an added measure to ensure the safety and wellbeing of all participants. For a full (anonymised) list of participants and the general semi-structured interview template(s), see Appendix B. The names of the participants are encrypted and made available to the supervisors as part of the integrity of the research; this list will be destroyed ten years after the end of the project by the supervisors.

Podcast Series, Webinars & Online Conferences
Given that this research was conducted entirely during the COVID-19 pandemic, an extended fieldwork period was not possible for preliminary data collection. As such, virtual methods were adopted to ensure that the desk-study design was contextually sensitive; this included drawing on a ten-episode Podcast Series called *Just Us and the Climate* (Coalition, 2020), and attending eight online conferences and webinars addressing various South African fossil phaseout topics; see Appendix B for details.

Grey Literature
A sample of grey research reports by a selection of South African think tanks and research institutes were reviewed on an ad hoc basis (see Appendix B for a full list). These reports were included as per the recommendations of some informants during an interview, either because they themselves/ their institution had published the report or they were familiar with a particular report and thought it would be helpful to speak to the South African context and accompanying LFFU challenges, particularly vis-à-vis South African stranded asset exposure.

Analysis
A content analysis technique was utilised to make sense of the empirical findings from the aforementioned report podcast series, webinars/conferences, news item mining, and publicly available datasets. This technique sought to "systematically transform a large amount of text into a highly organised and concise summary of key results" (Erlingsson & Byrsiewicz, 2017: 94). This predominantly entailed converting content with low to high levels of abstraction to extract the "latent meaning" of raw data through a summarising, coding, categorising and thematising sequence (ibid: 94) – in this case, to answer the third prong of sub question S3 regarding South Africa's social, ecological and relational challenges for LFFU resulting from the identified five-dimensional prospective stranded assets (the latter using Figure 2.1 & Figure 2.4). Hence, to finally answer the sub question S3 (see 1.3.1), the inclusive development conceptualisation of stranded assets from Table 2.4 (see 2.2.3) was applied to identify the implications that the stocktake of prospective stranded South African assets borne on both inclusive development agendas and the SDGs.

3.5.4. Chapter 6: 'Follow the Fossil Money' & 'Expose the Flows'

Private & Commercial International Linkages

This chapter addresses sub question S4 (see 1.3.1), focusing on the *North-South* finance flows that have generated prospected South African stranded fossil fuel assets (see 3.5.3), unpacking and developing the conceptual *Stranded Asset Debt* that actors from the 'North' have accrued with respect to their fossil investments in both South Africa and Africa more broadly (see 2.2.1.4 & 6.4). To explore this international and multilateral finance landscape, I first identified the 20 largest coal and 20 largest oil & gas E&Ps (by reserve size) using the Fossil Free (2020) list. The most recent annual reports and/or sustainability reports (from 2019-2020) pertaining to these 40 E&Ps were collected. Evidence of any linkages to African projects and/or operations was searched for in these reports and on the websites of the 40 firms. Of them, 29 were found to have a linkage to at least one African country; these 29 E&Ps composed the sample for analysis (see Appendix B for the complete list of E&Ps). The sampled E&P reports were analysed first superficially to map out each E&P's African exposure, noting down key metrics like: country, fuel type, annual production rate(s), timeline, payments to local governments, partnerships, annual revenue, and stake in each project, then in more depth to explore the prospective stranded social and human asset implications of these South African projects (see 3.5.3).

Financial data pertinent to these E&Ps was collected in two ways. First, Yahoo! Finance was used to compile an original inventory of the major shareholders and the respective value of the equity (i.e. common shares, excluding convertible bonds) that they managed in each E&P (on July 30, 2020, and subsequently on July 15, 2021). All currencies were converted to US dollars using exchange rates from the same day. If a company was listed on multiple stock exchanges and a shareholder managed equity in both share types, then all share values were first converted to US dollars then summed together. Furthermore, the market capitalisation for each E&P was recorded, and, if necessary, values were converted to US dollars using the same exchange rates. This produced an original database of key shareholders in multinational E&Ps with direct linkages to African fossil fuel production. Second, commercial bank lending data to these 29 E&Ps was collected using the Rainforest Action Network et al.'s (2021) publicly disclosed database, which included 60 unique commercial banks spanning 11 European, North American and East Asian countries that had issued at least one loan to at least one of the 29 sampled E&Ps since the inception of the Paris Agreement. The aggregate amount loaned (in US dollars) by each bank to each E&P from 2016-2020 (the temporal scope of the available data) was retained, in addition to the bank's parent country headquarters. Together, these data allowed for an analysis of both the distribution of prospective stranded *financial* assets pertinent to an African fossil fuel phaseout, *and* the stranded asset indebtedness of key actors from the 'North'.

Public Finance Linkages

Finally, I used the *Shifting the Subsidies* dataset (OCI, 2020) to track the public finance flows hoisting the South African and African fossil fuel empires, which Oil Change International shared via e-mail on November 30, 2020. The dataset consisted of 12,334 unique financial flows between 148 PFIs (34 ECAs, 100 BDBs and 14 MDBs) from both Annex 1/B (i.e., 'North') and Non-Annex 1/B (i.e., 'South') nations and global energy projects over 2007-2019, including new coal, oil & gas projects and investments in improving existing fossil infrastructure. The comprehensive dataset has metrics including: financial mechanisms that the PFI utilised (e.g., loan, guarantee, grant, debt relief, risk management); amount financed (in original currency); amount in US dollars (paired with the exchange rate used); financing institution (name and type); and project details (i.e. country & region, institution receiving the finance, description of the project, stage of production). However, the dataset has two limitations. First, entries prior to 2012 are not comprehensive except for those pertaining to major MDBs, and entries from 2019 and (particularly) 2020 are still being updated given the lagged nature of reporting, so findings regarding financing from 2006-12 and 2019-20 likely represent lower limits. Second, some PFIs have not transparently disclosed the breadth of their energy funding, particularly from countries like South Africa, again implying that these data should be interpreted as representative of a lower-end estimate of PFI-driven energy financing.

I trimmed the main dataset to only include projects with ties to at least one African nation, resulting in a condensed dataset with 1,892 unique observations. I scrutinised the resulting dataset to identify noticeable trends in PFI lending for African fossil fuel fossil projects before the Paris Agreement was adopted (2007-2015) compared to after (2016-2019). Note that the 'pre-Paris' period spanning 2007-2015 covers nine years, whereas the 'post-Paris' period covers merely four, meaning that aggregate lending in the two periods is not entirely comparable. As such, I present both aggregate lending in addition to annual lending in both periods to better unpack PFI lending to fossil fuels in the broader context of recent global climate negotiations. Finally, these trends were explored through descriptive and visualisation techniques by writing a script to group the dataset elements into regional, temporal and actor-based subsets by utilising Python's GeoPandas package (see Appendix B).

Analysis

The stranded asset analytical framework was then deployed (see Figure 2.1 & Figure 2.4), this time paying particular attention to the stranded financial dimension given the finance flow- scope of this chapter. Moreover, these finance flows were linked back to the international policy landscape established by the Paris Agreement (see 1.4.1), and situated in the North-South context through the innovative SAD concept that has been proposed as a complementary counterpart to the *climate debt* (see 2.2.1.3, 2.2.1.4 & 6.4).

3.5.5. Chapter 7: Addressing SAD through LFFU Approaches, or a SAD Dump?

Policy Document Content Analysis

The research then scrutinised the policy environment pertinent to chapters 5-6, first by returning to the LFFU approach framework developed in the scoping literature review (see Figure 4.1 in 4.2) and tackling sub question S5 (see 1.3.1). I revisited the annual & sustainability reports pertaining to the same key actors (see 3.5.3 & 3.5.4), this time applying the framework that resulted from the literature review and identifying the key LFFU approaches being adopted by these actors to ostensibly align with the Paris Agreement and take effective climate action. In this analysis, I also included the most updated NDCs for all national governments from which public or private finance for the fossil projects in 3.5.4 had originated (7) – see Appendix B for a full list of all reports. On a theoretical level, after having already established that these key actors have generated prospective South African stranded fossil assets and simultaneously accrued a SAD, this chapter sought to explore the extent to which this SAD was being acknowledged and settled by said actors, or ignored and reallocated. After constructing the empirical LFFU approach mix adopted by these actors (see Figure 7.3), the same analytical frameworks used in chapter 5 (see 3.5.3) were applied to evaluate the implications that this approach mix bears on inclusive development and sustainable development agendas (see Table 2.4).

Semi-Structured Interviews

28 expert interviews were conducted, with representatives from either the financial institutions that were identified as key stakeholders in section 3.5.4, or NGOs, CSOs or academia working on fossil finance related issues with second-hand expert knowledge on the institutional investor behaviour. These interviews were conducted to triangulate the findings from the policy document analysis, and to subsequently complement the analysis by speaking to factors that are omitted from the policy documents themselves, including rationale behind why certain approaches are adopted or proposed over others. The same considerations from the semi-structured interviews utilised in 3.5.3 were

applied here as well; Appendix B contains anonymised interview logbook and template questions used.

3.5.6. Chapter 8: COVID-19 & Stranded Assets

To explore whether the COVID-19 pandemic provides any opportunities for phasing out fossil fuels, I employed a multi-method approach to discern how multidimensional stranded assets have been affected (see 2.1) and address the final sub question S7 (see 1.3.1). This consisted of:

1. compiling news items to scope how COVID-19 was influencing fossil-related infrastructure (***stranded physical assets***) both globally and across the African continent. I searched on Google News using permutations of the following: “fossil fuel”, “coal/oil/gas”, “close”, “shut down”, “plant”, “refinery”, “pipeline”, “reduced”, “halted”, “COVID-19”, “pandemic”, “Africa”, “South Africa/ Nigeria/ Angola/ Egypt/ Libya/ Algeria/ Mozambique/ Ghana/ Kenya”. I identified 80 relevant events for analysis that took place between February 15, 2020 and 1 February, 2022 (for a complete list see ‘References Chapter 8’);

2. surveying the market capitalizations and share prices of the E&Ps from on four dates: pre-pandemic (December 31, 2019), early-pandemic (March, 2020) and mid-pandemic (September 25, 2020) and late-pandemic (January 2022) from the Yahoo! Finance database. These fluctuating market caps and share prices were used to simulate the impact on the equity portfolio of 15 pension fund investment portfolios from 2019 by building on data I published elsewhere (Rempel & Gupta, 2020) in addition to the liquid equity investments of major shareholders pertaining to the relevant E&Ps for which historical data was available; the latter was extracted from the E&P annual reports and financial statements, in which E&Ps are legally obligated to disclose shareholders managing over 1% of outstanding shares. I assumed that the volume of shares in the 2019 portfolios remained constant into 2020-2022 and applied the changed share prices/ market caps. Although this assumption is unrealistic, it is not limiting because I am not concerned with exactly how much equity these shareholders managed during the pandemic, but rather the simulated impact that the pandemic has borne on ***financial stranded assets***;

3. analysing BP’s (2021) Statistical Review of World Energy to compare coal, oil and gas production rates both globally and across Africa from 2019 and 2020 (***contributing to stranded natural assets***);

4. reviewing 3 publications by the International Labour Organisation (ILO) (see Appendix B) to uncover fossil-related unemployment (***stranded human assets***) in the midst of the pandemic. These reports were complemented by reports published by South Africa’s National Statistics Bureau (RSA Statistics, 2020; 2021) and, when available, disclosed employment metrics by the sampled E&P annual reports from 3.5.4;

5. and finally, both evaluating announcements made by major E&Ps regarding their *forecasted* reductions in Capital Expenditure (CapEx) spending in 2020 through the same news item mining technique from (1), using search prompts: “[company name] + CapEx Reduction”, then subsequently comparing major E&P CapEx in 2019 and 2020 (disclosed in the E&P annual reports from (4) and section 3.5.4) to evaluate the *real* reductions in 2020 CapEx spending. These reductions speak to avoided prospective stranded assets from unrealised investments in new fossil fuel infrastructure (see 8.4).

These findings were then analysed and contextualised using the stranded asset (see 2.1) and Stranded Asset Debt (SAD) narratives (driven by Figure 2.1, Figure 2.5 and Figure 2.6), building on the findings from 6.4.

3.5.7. Chapter 9: Integration & Conclusion

The final conclusion chapter integrates the findings from chapters 4-9 in four stages to answering the overarching question (see 1.3.1) by employing a data merging and assimilation integration strategy (Kaur et al., 2019) and using the conceptual scheme is an analytical guide (see Figure 3.1 in 3.3).

For executing this 'merging' technique, first I produced a menu-style list of trade-offs from LFFU in South Africa by extracting key trade-offs from the lessons learned in each empirical chapter, by compiling the resulting figures and tables from applying the various analytical frameworks denoted in Table 3.2 (e.g., Figure 4.1, Figure 5.13, Figure 6.17, Figure 7.3, Table 5.3, Table 7.1, Table 7.2) and revisiting the conceptual scheme (see Figure 3.1). This resulted in Figure 9.1. Trade-offs were organised according to their key implications vis-à-vis social, ecological or relational inclusiveness, and which dimension(s) of stranded fossil fuel assets their relate to.

Second, these trade-offs feed into a scenario analysis, which uses the inclusive development & stranded asset framework (see Table 2.4 and sections 2.1 & 2.2 more generally) to construct four possible ideal-typical post-COVID-19 pandemic recovery scenarios that tend from *reformist to transformative,* building on the findings from the COVID-19 analysis (see 3.5.6 & 8.4). These recovery scenarios are speculative in nature – as are any forecasts – but by designing them as a function of social, ecological and relational *conditions*, I introduce an element of objectivity by merging these theoretical premises with the empirical findings from chapters 5-8. Moreover, each scenario explores the implications for South African stranded assets (see 5.3.4), the SAD owed by the 'North' to South African citizens (see 6.4), LFFU approach mix for stranded asset debtors (see 7.2.4), and both Sustainable and Inclusive Development (using Table 1.2 and Table 2.3).

Third, after having defined a plausible 'inclusive' phase-out scenario in the above analysis, the chapter identifies the conditions necessary for such a scenario to unravel (see 9.3.6), also by building on the trade-offs from the first stage.

3.6. Ontology & Epistemology

This research draws most of its ontological inspiration from the school of critical realism (e.g., Fletcher, 2017; Edwards, Mahoney & Vincent, 2014) and epistemological inspiration from pragmatism (e.g., Allenby, 2006; Cato, 2012; Robson & McCartan, 2016). First and foremost, this implies that "ontology… is not reducible to epistemology" (Fletcher, 2017: 182), unlike in classical renditions of positivism and constructivism. Positivism and constructivism ontologies pose a series of major limitations for researching LFFU; the former stipulates that 'reality' can only be studied objectively and deductively through empirical observation (Robson & McCartan, 2016), which de facto rejects unpacking the intangible ramifications and socioecological consequences of LFFU (see 2.1) in addition to more abstract and non-objective concepts like 'climate debts' and the newly devised SAD (see 2.2.1), while the latter posits that no such 'reality' exists and ergo 'factual' observations are quasi-meaningless (ibid), which leaves little to no room for understanding the economic and financial dimension of LFFU.

Critical realism attempts to address these shortcomings as a sort of post-positivist approach. In the critical realist school, some events are *observable* on an empirical level (in my context, for example, trends in fossil fuel employment, fossil fuel finance flows, or climate policies employing certain LFFU approaches [or lack thereof]) – resonating with the positivist belief that a fixed reality exists ready for empirical observation – whereas on an *actual* or *real* level, there are both unobservable events and underlying ‘causal structures’ that drive the aforementioned empirically observable events (e.g., vested interests in fossil fuel investments, or unwillingness to incur stranded financial assets) (ibid). These unobservable abstractions are clearly evident in some of the foundational theoretical concepts adopted in the research (e.g., climate debt, see 2.2.1.3) from which I build a new ‘unobservable’ concept, namely the Stranded Asset Debt (SAD) (see 2.2.1.4 & 6.4).

On a pragmatic-epistemological level, this research serves a twofold purpose. First, it conducts empirically-driven, practical and unbiased research in observing the complex natural and social systems that govern the South African fossil fuel empire (Cato, 2012). That is, several of the key research methods are empirically-driven and aspire to combine a myriad of data collection techniques to, for instance, map the array of South Africa’s exposure to multidimensional stranded assets (see Table 3.2). This was done ‘pragmatically’ using several data collection means to my disposal, particularly given that the research was conducted entirely via desk-study (see for 3.7 limitation).

Second, this research is “unafraid to nail political colours to [its] mast” (Cato, 2012: 1041) by incorporating an anti-capitalist perspective, situating both stranded assets and inclusive development under the problematic nature of the capitalist neoliberal economy (see 2.1.3 & 2.2.3). It also explicitly posits that development is *intentional* rather than *imminent* (Corbridge, 2007) – particularly in terms of taking action to combat the ‘climate emergency’ (see 2.2.1) – and holds that the knowledge produced in and from this thesis may be used practically to alter developmental trajectories and agendas, aligning with the pragmatic elements of “endors[ing] practical theory” and “prefer[ing] action to philosophising” (Robson & McCartan, 2016: 16).

3.7. Limitations

One key limitation of this research is that an extended period of fieldwork in South Africa was deemed both unethical[23] and infeasible given the circumstances catalysed by the COVID-19 pandemic. As a result, an entirely desk-based research was conducted, relying mainly on secondary data in the form of reports and policy documents in addition to primary data collection via virtual (Zoom-based) interviews. Given the identified units of analysis (see 3.2), this is mainly limiting in evaluating the ramifications and trade-offs that the identified fossil-related finance flows and inevitable & multidimensional stranded assets will bear on social, ecological and relational inclusiveness agendas at the *individual* or *household level*. To do this, I rely on secondary and meta-level data, which may omit some nuance and may merit additional research (see 9.5). That all being said, several key South African experts (i.e., key researchers working on climate- and fossil fuel phaseout related issues) were consulted at various moments throughout the research, which helped contextualise and co-create some of the key ideas generated for and proposed in this thesis.

Another limitation from this desk-research is that it relies extensively on publicly disclosed data, particularly when uncovering the fossil-related North-South finance flows (see 3.5.4) and assessing the climate policies and proposed LFFU approaches by key fossil producing and financing organisations (see 3.5.5). For the former, this entailed publicly available data on finance search engines like Yahoo! Finance for shareholder data, and available datasets composed by other organisations (e.g., OCI & FoE, 2019; RAN et al., 2021), which also rely on information that commercial and public financiers disclose willingly (or obligatorily). Regarding the latter, annual and sustainability reports by the same organisations composed the key data collection technique, which also contain both voluntary and legally-obligated financial disclosures. It is possible that some ‘behind the scenes’, non-disclosed

[23] Particularly when we in the ‘North’ started having vaccine access and ability to travel, while most of the ‘South’ (including South Africa) remained far behind in the vaccine race. Why should I, a privileged, white, European, and now immuno-protected researcher travel to a country without the same luxuries and consume their resources while doing so?

financial flows have been omitted from the analysis, which perhaps limits this study's ability to paint an all-encompassing picture of the 'finance flows' pertinent to addressing the Paris Agreement (see 1.4.1 & 3.2). However, this by no means compromises the study's internal or external validity, but rather, suggests that future investigative research may be merited to expand the generalisability of the findings and conclusions.

3.8. Ethical Considerations

In line with the AISSR ethical guidelines and integrity protocol (AISSR, 2019) to evaluate the widespread ethical implications of this research, two key points merit attention: the safety of and ensuring no harm to research informants & participants, and the potential misuse of the study results. First, research informants are mainly involved through the *virtual* semi-structured interviews during the desk-study period; their absolute pseudonymity and privacy was ensured throughout this research process. Their personal details are not disclosed in any way in this manuscript or any resulting document except in an encrypted document made available to the supervisors to meet integrity concerns and will be destroyed ten years after the project ends; generic codes are used pseudonymise the interview logbook and omit any personally identifiable data – see Appendix B. Interviews were recorded only if explicit verbal consent was granted by the participants, which many (particularly South African activists) did not agree to, and as such, many interviews were not recorded and rather were transcribed 'live' using the Microsoft Word 'dictate' function. Verbal consent was granted by each participant after being e-mailed a digital consent[24] form (see Appendix B), which was recorded in a log book. The import of personal data (i.e. views of experts outside of the European Union) has been in accordance with the GDPR regulations of the European Union. Furthermore, several external databases were used in the research (GEM, 2020a; 2020b; 2020c; OCI, 2020; RAN et al., 2020; BankTrack, 2020), all of which were either acquired via e-mail communication directly from the owners, or in the event that they were publicly disclosed, consent via email exchange was acquired to use them for the research.[25]

Misuse can never be fully avoided, but precautions were taken. After analysing the data and producing deliverable products (e.g., chapters of this thesis and research papers for publication in a peer-reviewed journal), they were first sent to the relevant informants (if possible, assuming secure internet access) via a secured document transferring platform (i.e. WeTransfer) – inspired by extended peer review from the Post-Normal Science domain (Funtowicz & Ravetz, 2003) as a means of an 'epistemic check' (Demerritt, 2015). Once their approval was granted, the documents were disseminated to e.g., a peer-reviewed journals and non-academic platforms, otherwise changes were made based on any recommendations by the participants to ensure that the analysis adequately encapsulated their expertise and no miscommunication arose in the collection process; this was also done to make the research accessible to a wide audience (benefit sharing) extending beyond academia, particularly given that many of the research participants are not connected to academic circles. Misuse is certainly still possible, particularly if findings are cherrypicked or taken out of context, but the purposeful selection of the ID framework attempts to minimise and safeguard against unintended consequences for the world's most under resourced and under privileged fossil fuel dependents.

[24] Adapted from the consent form used in the ERC Advance Grant Project 'CLIFF' (see Gupta, 2020), which is in line with the ethical requirements mandated by the European Research Council

[25] Again, I would like to thank the Global Energy Monitor, BankTrack, Oil Change International and Rainforest Action Network, among others, for their excellent work.

4. Literature Review: Towards a Framework for LFFU Approach Inclusiveness Evaluation[26]

4.1. Purpose and Structure

This chapter employs a scoping literature review technique (see 3.5.2) to address knowledge gaps K1 and K3 (see 1.3.1) via sub question S2:

> What is the array of available approaches for LFFU, to what extent are they socially, ecologically and relationally inclusive (paying particular attention to the extent to which they govern inevitable stranded assets), and which types of approaches are favoured over others?

by identifying debates in recent scholarship over the key approaches to LFFU. **I define an *LFFU approach* broadly as '*a policy, instrument or measure with the explicit goal of taking climate action and that may directly or indirectly diminish fossil fuel production*.'** LFFU approaches are not only crucial for taking effective climate action, but are also themselves stranded asset 'drivers' (see 2.1.3 & 3.3) and therefore bear several implications for the inclusiveness of any given fossil phaseout. This chapter first presents an inventory of identified approaches (see 4.2), then evaluates them on the basis of their ecological, social and relational inclusiveness (see 4.3) using the analytical & scoring criteria presented in Table 3.3 (see 3.5.2), analyses all approaches in tandem (see 4.4), discusses implications for approach mixes (see 4.5), and finally concludes (see 4.6).

4.2. Approach Inventory

4.2.1. Economic

Ten economic (i.e., market-based) approaches were identified; these include the renowned **Carbon Emissions Tax,** taxing the emitted CO_2 or CO_2e (carbon dioxide equivalent – see e.g., Lohman, 2012) from *consuming* (i.e., combusting) fossil fuels, also known as a Pigouvian tax (e.g., Cairns, 2018; Paterson, 2020). Such a tax assumes that a 'market failure' has externalised the "'real' costs of [greenhouse gas] emissions and thus intervention is needed to 'internalise' these costs" (Paterson, 2020: 5; Sovacool & Geels, 2016). A **Tax on Imported Fossil Fuels** raises the price of imports and hence would decrease demand for non-domestic fossil fuels (e.g., York & Bell, 2019; Lazarus & van Asselt, 2018). Note that India has a "tax on locally produced and imported coal at a rate of INR 400 [about USD 6] per tonne" (Piggot et al., 2018: 2). Import taxes expand into **Border Tax Adjustments (BTAs)**, which enables a country with a carbon pricing mechanism or abatement policy to increase tariffs on a broad range of imported goods produced in countries or regions lacking climate policies or carbon pricing (Rocchi et al., 2018: 127; Trachtman, 2017).

Alternatively, a **Fossil Fuel Production/ Extraction Tax** can tax fossil fuel extraction rather than (more commonly) consumption. Sinn (2012: 217) considers this a "tax on financial assets, or, equivalently, on the capital income earned on these assets… to make... natural capital more attractive or, alternatively, make... financial assets less enticing!.. The tax on financial assets, or, equivalently, on the capital income earned on these assets, would prompt the resource owners to leave a larger part of their wealth below ground " (Sinn, 2012: 216-7). Similarly, a **Fossil Fuel Export Tax** taxes exports rather than imports, again disincentivising fossil fuel extraction (rather than consumption) by taxing the producer (Lazarus & van Asselt, 2018; Richter, Mendelevitch, & Jotzo, 2018). Like with production/ extraction taxes, such taxes: "aim to remove distortions created by subsidies [and] to reflect the full social cost of extraction activities" (Lazarus, Ericksen & Tempest, 2015: 7).

[26] This chapter is based on the publication: Rempel, A., Gupta, J. (2022). Equitable, Effective & Feasible Approaches for a Prospective Fossil Fuel Transition. *Wiley Interdisciplinary Reviews: Climate Change, 13*(2). doi: 10.1002/wcc.756

Table 4.1. Inventory of identified approaches to LFFU, organised by type and dimension

Category	Type	Approach	Discussed in
Economic	DR	**Carbon Emissions Tax**	Cairns (2018); La Rovere (2020); Baldwin, Cai & Kuralbayeva (2020); van der Ploeg & Rezai (2020); Rozenberg, Vogt-Schilb & Hollegate (2020); Kopytin (2020); Kalkhul, Steckel & Edenhofer (2020); Le Billon & Kristoffersen (2019); Armstrong (2019); King & van den Bergh (2018); Pregger, Simon, Naegler & Teske (2019); Paterson (2020); Sinn (2012); Evans & Phelan (2016); Gunningham (2020); Mutezo & Mulopo (2021); Lazarus, Ericksen & Tempest (2015); Sovacool & Geels (2016); Gaulin & Le Billon (2020); Erickson, Lazarus & Piggot (2018); Newell & Simms (2019); Faehn et al. (2017); Green & Denniss (2018);
		Fossil Fuel Import Tax	Lazarus & van Asselt (2018); York & Bell (2019)
		Border Tax Adjustments	Rocchi et al. (2018); Trachtman (2017);
		Tradeable Emissions Permits	Caledcott & Derricks (2018); Lohman (2012); Armstrong (2019); Paterson (2020); Sinn (2012); Lazarus, Ericksen & Tempest (2015); Sovacool & Geels (2016); Gaulin & Le Billon (2020); Erickson, Lazarus & Piggot (2018); Green & Denniss (2018);
	DR + SS	**Feebate Programmes**	Rozenberg, Vogt-Schilb & Hollegate (2020); Plötz et al. (2019)
	SR	**Tradeable Production Quotas**	Le Billon & Kristoffersen (2019); Lazarus, Ericksen & Tempest (2015); Lazarus & van Asselt (2018); Green & Denniss (2018);
		Fossil Fuel Production/Extraction Tax	York & Bell (2019); Sinn (2012); Foster et al. (2017); Christophers (2019); Mutezo & Mulopo (2021); Lazarus, Ericksen & Tempest (2015); Erickson, Lazarus & Piggot (2018); Piggot et al. (2018); Faehn et al. (2017); Lazarus & van Asselt (2018); Green & Denniss (2018); Le Billon & Kristoffersen (2019); Richter, Mendelevitch & Jotzo (2018);
		Fossil Fuel Subsidy Removal	Johnsson, Kjärstad & Rootzén (2019); Yuan et al. (2019); Coady et al. (2019); Le Billon & Kristoffersen (2019); Paterson (2020); Monasterolo & Raberto (2019); Christophers (2019); Lin & Xu (2019); Mutezo & Mulopo (2021); Chepeliev & Mensbrugghe (2020); Lazarus, Ericksen & Tempest (2015); Gaulin & Le Billon (2020); Erickson, Lazarus & Piggot (2018); Newell & Simms (2019); Piggot et al. (2018); Lazarus & van Asselt (2018); Green & Denniss (2018); Collier & Venables (2015); Geels et al. (2017);
		Fossil Fuel Export Tax	Sinn (2012); York & Bell (2019); Nalule (2020); Lazarus, Ericksen & Tempest (2015); Piggot et al. (2018); Lazarus & van Asselt (2018); Richter, Mendelevitch & Jotzo, 2018);
	DS + SS	**Green Finance & Subsidies for Alternatives**	Baldwin, Cai & Kuralbayeva (2020); Rozenberg, Vogt-Schilb & Hollegate (2020); van der Ploeg & Rezai (2020); van der Ploeg (2020); Chapman et al. (2018); York & Bell (2019); Sinn (2012); Monasterolo & Raberto (2019); Ringsmuth, Landsberg & Hankamer (2016); Escobar, Neri & Silvestre (2020); Foster et al. (2017); Evans & Phelan (2016); Johnston, Stirling & Sovacool (2017); Gunningham (2020); Mutezo & Mulopo (2021); Ediger (2019); Healy & Barry (2017); Lazarus, Ericksen & Tempest (2015); Newell & Mulvaney (2013); Sovacool & Geels (2016); Erickson, Lazarus & Piggot (2018); Ashiem et al. (2019); Green & Denniss (2018); Collier & Venables (2015); Geels et al. (2017);
'Other'	SR	**Divestment**	Le Billon & Kristoffersen (2019); Rempel & Gupta (2020); Gupta, Rempel & Verrest (2020); Ayling & Gunningham (2017); Paterson (2020); Chapman et al. (2018); Christophers (2019); Healy & Barry (2017); Lazarus, Ericksen & Tempest (2015); Gaulin & Le Billon (2020); Piggot et al. (2018); Lazarus & van Asselt (2018);
		Engagement	Rempel & Gupta (2020); Gupta, Rempel & Verrest (2020); Gunningham (2020);
		Asset Write-Off	Gupta, Rempel & Verrest (2020); Rempel & Gupta (2021)
		Expanding Investor Understanding to Innovatively Regulate Investors	Christophers (2019); Gunningham (2020); Mutezo & Mulopo (2021); Healy & Barry (2017); Newell & Simms (2019); Piggot et al. (2018); Rempel & Gupta (2020);
		Blockades	Le Billon & Kristoffersen (2019); Klein (2015); Healy & Barry (2017); Gaulin & Le Billon (2020);
		Court cases/ litigation	Gaulin & Le Billon (2020); Burger & Wentz (2018)

Category	Type	Approach	Discussed in
		Finance Swap & Compensation	Le Billon & Kristoffersen (2019); Armstrong (2019); Lazarus, Ericksen & Tempest (2015); Gaulin & Le Billon (2020); Erickson, Lazarus & Piggot (2018); Newell & Simms (2019); Lenferna (2018); Piggot et al. (2018); Faehn et al. (2017); Eichner & Pethig (2019); Harstad (2012); Lazarus & van Asselt (2018); Geels et al. (2017); Kingsbury, Kramarz & Jacques (2018);
		Unionisation	Evans & Phelan (2016); Mutezo & Mulopo (2021);
		Carbon Offsets/ Net-Zero	Lohman (2012); Horowitz (2015); Dyke, Watson & Knorr (2021); Castree (2015)
Regulatory	DR	**Promoting Energy Efficiency Improvements**	Sinn (2012); Evans & Phelan (2016); Mutezo & Mulopo (2021);
		Capping Growth of Electrical Sector	York & Bell (2019); King (2012);
		High emissions/efficiency standards, building codes & regulations	Lazarus, Ericksen & Tempest (2015); Erickson, Lazarus & Piggot (2018); Green & Denniss (2018); Pollin & Callaci (2018);
	SR	**Bans & Moratoria**	Johnsson, Kjärstad & Rootzén (2019); Kalkhul, Steckel & Edenhofer (2020); Vogt-Schilb & Hallegate (2020); Le Billon & Kristoffersen (2019); York & Bell (2019); Johnston, Stirling & Sovacool (2017); Lazarus, Ericksen & Tempest (2015); Gaulin & Le Billon (2020); Erickson, Lazarus & Piggot (2018); Ashiem et al. (2019); Newell & Simms (2019); Piggot et al. (2018); Lazarus & van Asselt (2018); Green & Denniss (2018); Geels et al. (2017);
		Full climate-related information disclosure & emissions accounting	Gunningham (2020); Lazarus, Ericksen & Tempest (2015); Piggot et al. (2018); Lazarus & van Asselt (2018);
		License/ Permit Suspensions	Johnsson, Kjärstad & Rootzén (2019); Kalkhul, Steckel & Edenhofer (2020); Vogt-Schilb & Hallegate (2020); Johnston, Stirling & Sovacool (2017); Sovacool & Geels (2016); Erickson, Lazarus & Piggot (2018);
		Limiting state good provisioning	Lazarus, Ericksen & Tempest (2015); Erickson, Lazarus & Piggot (2018); Lazarus & van Asselt (2018); Bosch (working paper)
		Retire/ Phasing-out existing fossil-intensive infrastructure	Chapman et al. (2018); David (2018); Mutezo & Mulopo (2021); Sovacool & Geels (2016); Kefford et al. (2018)
	SR + DR	**Regulating Financing Capital for Fossil Fuel Projects & Infrastructure**	Best (2017); Nalule (2020); Kulagin, Grushevenko & Kapustin (2020); Johnston, Stirling & Sovacool (2017); Christophers (2019); Gunningham (2020); Mutezo & Mulopo (2021); Lazarus, Ericksen & Tempest (2015); Piggot et al. (2018); Lazarus & van Asselt (2018); Geels et al. (2017); Campigli et al. (2018);
		Environmental Impact Assessment of Forthcoming Fossil Projects	Lazarus, Ericksen & Tempest (2015); Green & Denniss (2018);

Source: Author

N.B. DR = Demand Restrictive, SR = Supply Restrictive, DS = Demand Supportive, SS = Supply Supportive

Tradeable Emissions Permits (TEPs) (a.k.a Cap-and-Trade schemes) involve commodifying and distributing tradeable *emissions* permits across fossil *consumers* through gratis allocation or auctions (Lohman, 2012), and once distributed, permit holders can buy and sell permits depending on their own targets and the marginal cost of reducing their own carbon footprint (Caldecott & Derricks, 2018; Armstrong, 2019; Paterson, 2020; Sinn, 2012). These *emissions* permits relate to fossil fuel consumption, not production, and have evidently hoisted market-based norms (see 2.2.4 & 4.3.1.6). Similarly, **Tradeable Production Quotas (TPQs)** opt to curtail fossil fuel supply by requiring a legally binding cap on fossil fuel extraction & production, and 'production permits' are allocated or auctioned among producers (e.g., Le Billon & Kristofferson, 2019; Lazarus & van Asselt, 2018).

Fossil Fuel Subsidy Reform, a popular approach (see rightmost column in Table 4.1), removes existing direct (i.e. monetary) and indirect (e.g., tax breaks) fossil fuel subsidies (e.g., Johnsson, Kjärstad & Rootzén, 2019; Coady et al., 2019; Paterson, 2020). Government subsidies make fossil fuel production competitive by externalising the socioecological and economic costs of commercialising fossil fuels; removing such subsidies would partly shift the 'true costs' of producing fossil fuels to producers (ibid).

Green Finance & Subsidies for Fossil-Alternatives, like 'green bonds', finance for research & development (e.g., Monasterolo & Raberto, 2019; Gunningham, 2020), 'green' subsidies (directly through e.g., cash transfers, indirectly through e.g., tax breaks or Feed-in-Tariffs) (Gaulin & Le Billon, 2020: 892) and allocating funds and resources to support "community-centric entrepreneurship" (Mutezeo & Mulopo, 2021: 11) can theoretically increase the competitiveness of low-carbon technologies (e.g., Gaulin & Le Billon, 2020), including fungible fuels, photosynthetic energy systems, hydrogen fuel cells (Ringsmuth, Landsberg & Hankamer, 2016) and more conventional renewables like solar PV & wind. **Feebate Programmes** are a hybrid of two instruments: an emissions tax on "energy-inefficient equipment" (a 'fee') paired with a 'rebate' (e.g., subsidy) for "new energy-efficient equipment" (Rozenberg, Vogt-Schilb & Hollegate, 2020: 2). Allegedly, feebates can "avoid stranded assets in their extreme form" (ibid: 3).

4.2.2. Regulatory

Ten regulatory approaches were also identified (see Table 4.1). One popular approach is promulgating **Stricter Emissions/ Efficiency Standards**, which includes emissions caps, prohibiting or regulating certain types of technologies, and regulations for e.g., new infrastructure projects or building codes (Lazarus, Ericksen & Piggot, 2018; Ericksen, Lazarus & Tempest, 2015). States can also pursue **Energy Efficiency Improvements** by allocating permits & licences that replace *either* high-emitting projects with lower-emitting alternatives, *or* replace projects with a low Energy Return on Investment (EROI) with one with a greater EROI (e.g., Lazarus, Ericksen & Tempest, 2015).

Permission for a new infrastructure project is often subject to an **Environmental Impact Assessment** (EIA).[27] Including GHG emission and fossil production criteria in EIAs may enable regulators to conduct "[c]omprehensive emissions assessment in environmental impact review of new fossil fuel supply projects" (Lazarus, Ericksen & Tempest, 2015: 10; Green & Denniss, 2018). Note that following an EIA, companies must prepare environment management plans to reduce their pollutants, which include GHGs, and therefore may *indirectly* target fossil fuels (ibid).

Similarly, companies and their investors & financiers could be required to provide **Full Climate-Related Information Disclosure & Accounting**, which could include financed fossil fuel projects &

[27] In the past, these did not mandate reporting on GHGs as these were not considered pollutants.

infrastructure and their carbon footprints; the latter is more commonly disclosed. With full fossil fuel-related disclosure, regulators are able to better monitor current and expected fossil fuel production at intra- and international levels (Gunningham 2020; Lazarus, Ericksen & Tempest, 2015; Piggot et al., 2018; Lazarus & van Asselt, 2018).

Fossil fuel exploration and production firms require licenses, permits or concessions before production. States could **Suspend Existing Licenses or Permits,** or explore options to revoke, terminate or forgo renewing licenses and/or permits to fossil fuel producers (e.g., Johnsson, Kjärstad & Rootzén, 2019; Kalhul, Steckel & Edenhofer, 2020; Vogt-Schilb & Hallegate, 2020). Such suspension could, for instance, reduce California's oil production by 70% over a ten-year period (Erickson, Lazarus & Piggot, 2018), though this may come with financial and legal ramifications (see 4.3.2.5). **Bans & Moratoria** prohibit producing certain kinds of fuels (e.g., from a particular reserve) or with a certain technique (e.g., unconventional fracking in Tunisia and France) (Le Billon & Kristoffersen, 2019: 1081; Geels et al., 2017: 16). Note that "certain moratoria have no legislated end date, essentially acting as de facto bans" (Gaulin & Le Billon, 2020: 891). Such approaches are being adopted in Costa Rica, Belize, France Canada, the United States, Denmark and New Zealand (Erickson, Lazarus & Piggot, 2018; Le Billon & Kristoffersen, 2019: 1081).[28]

Capping the Growth of Electrical Grid limits electricity production and "is essentially a moratorium on the growth of the energy sector" (York & Bell, 2019: 43). Since 80% of 2019 primary energy demand was met with fossil fuels (Johnsson, Kjärstad, & Rootzén, 2019), implementing an upper-limit to the energy produced can reduce demand for fossil fuel and therefore LFFU. This assumes that if "we simply add renewables to [dirty] energy mix, then we have the negative impacts of renewables in addition to the carbon emissions of the fossil-based system" (King, 2012: 2 – see Box 4.2).

Two more indirect regulatory approaches exist. States can **limit provisioning of public goods** used by fossil producers, like water & land (Lazarus, Ericksen & Piggot, 2015; Lazarus & van Asselt, 2018). Since coal-production and consumption is water-intensive (in mining and power plants) (Luo & Otto, 2014), reducing water access can constrain coal production. Moreover, **financial capital** can also be **regulated;** this is needed as central & commercial banks have heavily invested in fossil fuel projects (Gunningham, 2020: 14; Nalule, 2020; Kulagin, Grushvenko & Kapsulin, 2020; Johnston, Stirling & Sovacool, 2017). Regulating such financial capital would elevate the cost of capital for "capital-intensive energy production" (Best, 2017: 76), and establish a governance structure threatening the ability to raise funds on (inter)national markets for fossil projects (Gunningham, 2020).

4.2.3. 'Other'

'Other' approaches are those that can be taken by the state in addition to other actors, like civil society or investors & financiers; nine such approaches were identified. On the financial side, **Expanding Understanding of Investor Behaviour** (e.g. Gunningham, 2020; Mutezo & Mulopo, 2021; Healy & Barry, 2017) through four key tropes (subjectivity; economism; temporality; and convention – see Christophers, 2019) can yield innovative financial approaches to LFFU, including: a "multi-faceted approach to reducing short-termism [by] tying key management long term incentives to carbon emissions reductions" and "mandat[ing] the 'gating' (i.e., the practice of temporarily blocking withdrawals from an investment fund) of products with medium or long-term investment horizons" (Gunningham, 2020: 8); revamping fiduciary duty; and creating "substantially decarbonised" indices to accommodate conventional passive investing (Gunningham, 2020: 12).

[28] And Spain as of recently (Ioualalen, 2021)

Other options for financers include: **Divestment**, or the act of selling (often but by no means exclusively) liquid fossil fuel assets (e.g., common shares), typically by an institutional shareholder (like pension funds), so as to reduce risks, gain reputation and stigmatise the fossil fuel industry (e.g., Le Billon & Kristoffersen, 2019; Rempel & Gupta, 2020; Gupta, Rempel & Verrest, 2020; Ayling & Gunningham, 2017). One problem with divestment is that it creates new vested interests by 'sending off' stranded assets elsewhere; but in current governance systems, **Asset Write-Off** (where shareholders 'write-off' their fossil fuel-related equity and incur the devaluation costs themselves) is not yet possible (Gupta, Rempel & Verrest, 2020). Conversely, **Engagement** opposes divestment and is an approach used by investors to leverage their shareholder power to sway the behaviour of fossil fuel companies (e.g., Rempel & Gupta, 2020; Gunningham, 2020).

Civil society can employ **Blockades** to physically hamper the extraction, production and/or distribution process or anywhere along the supply chain (Gaulin & Le Billon, 2020; Klein, 2015; Healy & Barry, 2017), though mostly they "block fossil fuel extraction at its source" (Healy & Barry, 2017: 454; Le Billon & Kristoffersen, 2019: 1080). Blockades accompany other protests and are supported by public information and petitions (Le Billon & Kristoffersen, 2019: 1080). Similarly, **Labour Unions** can mobilise to pressure a company, bank, or an industry more broadly to change their business practices through: 1) *business unionism*, "which seeks mutual gains between business, workers and union interests"; 2) *social democratic/movement unionism*, "which seeks to socialise the capitalist economy to moderate market forces in order to achieve social justice and equity"; and 3) *radical unionism*, "which seeks to mobilise social political forces to promote working-class interests and an alternative non-capitalist society" (Evans & Phelan, 2016: 335; Mutezo & Mulopo, 2021).

Beyond blockades & unions, CSOs often pursue **Litigation** and demand that courts halt fossil fuel exploration and production on grounds of human rights violations, air pollution and driving climate change (Gaulin & Le Billon, 2020; Burger & Wentz, 2018). The recent verdict against Shell (Baazil & Lombrana, 2021) shows that multinationals are not immune to aggressive climate action. Litigation can also be used by companies to obstruct fossil fuel phaseouts, when companies demand compensation from governments for prematurely phasing out their contracts, permits, concessions or licenses, like nuclear power plant owners suing the German government for forced closures (Bos & Gupta, 2019).

Forgoing fossil production comes with opportunity costs (stranded natural assets – see 2.1). One approach to address this is through **Finance Swaps & Compensation,** typically where international actors can compensate citizens, companies or governments for forgoing the opportunity to develop their resources "based on the sovereign right of individual states to develop their resources, and the opportunity cost associated with renouncing this right" (Le Billon & Kristoffersen, 2019: 1079; Newell & Simms, 2019; Faehn et al., 2017; Eichner & Pettig, 2019; Harstad, 2012), or their RtD (see 2.2.1.3). Financial swaps would involve pooling international funds to compensate a host government by enacting "pay-to-preserve policies", in which "a sub-global coalition… purchases profitable fossil-fuel deposits from non-signatories to keep them in the ground" (Eichner & Pethig, 2019: 398), with the only attempted case at the international level being the Yasuni-ITT initiative of the Ecuadorian government (see Box 4.1).

BOX 4.1: THE YASUNI-ITT INITIATIVE

The only attempted (and failed) financial swap to date was the Yasuní-ITT initiative, through which the Ecuadorian government (under former president Rafael Correa) sought to mobilise $3.6 billion in funds in exchange for issuing a moratorium on extraction from a national petroleum reserve worth roughly double that amount ($7 billion) (Kingsbury, Kramarz & Jacques, 2018; Larrea & Warnars, 2009; Vallejo et al., 2015; Bond, 2018). Importantly, these contributions would be financed "as grants", as "*[loans] cannot be considered as a fulfilment of financial commitments*" (Bond, 2010: 30, *emphasis added*). Contributions from the international community would, in theory, "go to a trust fund administered by the United Nations Programme for Development" (Vallejo et al., 2015: 175) which would oversee allocating the accumulated funds to catalyse a low-carbon developmental transition in Ecuador. However, by 2013, less than 10% of the target had been met, which first prompted existing donors (e.g., the German and Spanish governments) to withdraw their contributions and subsequently the entire initiative to implode (Kingsbury, Kramarz & Jacques, 2018).

At first glance it may seem as if the Yasuni-ITT initiative failed due to insufficient international financial mobilisation; however, upon closer inspection it is better "understood as failing because Correa did not want it to succeed" (Kingsbury, Kramarz & Jacques, 2018: 6). That is, "from the very beginning of the plan and following its announcement in 2007, President Correa reminded the world that he had a backup plan, a Plan B – to drill for oil if contributions were not received" (Martin & Scholz, 2014: para 7, quoted in Kingsbury, Kramarz & Jacques, 2018: 2). Suspicions of Ecuador's petroleum affinity more broadly were alive and well since 1997 when the Yasuni-ITT initiative was first proposed by environmental groups and CSOs, only to be rejected (by Correa's predecessor) "due in large part to an existing agreement that gave Brazilian company Petrobras rights to the ITT field" (Kingsbury, Kramarz & Jacques, 2018: 8); ultimately, the "lack of guarantees from the Ecuadorian government that the oil would, in fact, stay underground" prompted the German government to pull their contribution (Martinez & Schol, 2014: para 25, quoted in Kingsbury, Kramarz & Jacques, 2018: 9-10) and eventually led to the initiative's demise.

These doubts were most certainly on justified grounds, as Kingsbury, Kramarz & Jacques (2018: 11) explain:

> Government documents have surfaced, for example, to suggest that in early 2009, at the same time that the Yasunı-ITT commission was securing its pledges from Germany, Correa was negotiating a $1 billion-dollar deal that would allow Chinese companies to drill Block 31, which is directly adjacent to the ITT block… In 10 years since the Yasunı-ITT initiative was first proposed in 2007, Ecuador's debt to China increased from $7 billion to $8.272 billion, accounting for approximately 85% of its total external debt.

Clearly suggesting that Correa's 'Plan B' was the Plan A all along, and that notwithstanding the innovation, creativity and promise that the initiative displayed on the multilateral governance front, it was rotten at its core and destined for LFFU-failure from the get-go.

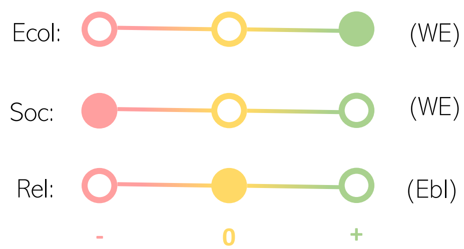
The Yasuní-ITT initiative was more than "a mere conservationist project" or a "financial mechanism" – it propelled a movement for "'yasunizing' the planet, which means to transcend the money-value paradigm present in the traditional evaluations" (Vallejo et al., 2015: 176). Transcending this paradigm – and the hegemonic and vacuumed paradigm adopted by many environmental movements (Fraser, 2021 – see 2.2.4) – is critical for inclusive approaches to LFFU; hence, the challenge is to revisit the Yasuni-ITT efforts and explore how a multilateral, financial approach to LFFU can be sculpted that "conceptualise[s] and implement[s] the Global North's repayment of the climate debt, not to elites in the Global South who could well abuse such funds, but to the people directly affected" (Bond, 2018: 452) – and transparently strives to succeed from day one.

Finally, '**carbon offsets**' are designed (in theory) to replace higher greenhouse emitting projects with lower emissions alternatives. These projects rely on CO_2e as the fixed exchange metric, through which the potency of different greenhouse gasses are set in relation to CO_2 (for instance, methane (CH_4) is 25 times more potent that CO_2 over a 100-year period, and hydrofluorocarbon-23 (HFC-23) roughly 15,000 times more potent) (IPCC, 2019). Another form of offsetting is through claiming 'avoided deforestation', "in which projects can produce carbon credits even if they allow an increase in deforestation, as long as the increase is less than what regulators agree 'would have happened' in the absence of capitalist agency" (Lohman, 2012: 96).

4.3. Evaluating Approach Inclusiveness

4.3.1. Economic

4.3.1.1. Fossil Fuel Production/ Extraction Tax

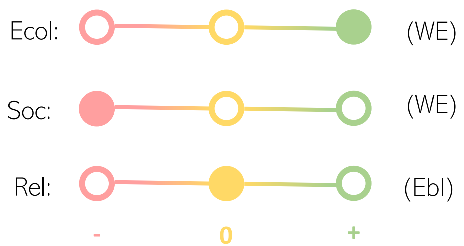


"The effect of carbon pricing is generally considered to be minor compared to the impact of oil prices on levels of new production development" (Le Billon & Kristofferson, 2019: 1078-9; York & Bell, 2019; Foster et al., 2017; Lazarus & van Asselt, 2018), indicating that a production tax can be effective for LFFU (thus ecologically inclusive) *only* if it is significant enough to financially disincentivise the fossil fuel producer. Such a competitive tax rate is dependent on nations:

> "*harmoni[sing] their tax systems* in order to avert triggering a competition that would see their tax rates engaging in a race to the bottom. Without a harmonization of tax rates, each country would have an incentive to underbid its neighbors [sic] to attract more capital at their expense, and in the end the source taxes would be eroded" (Sinn, 2012: 219, *emphasis added*).

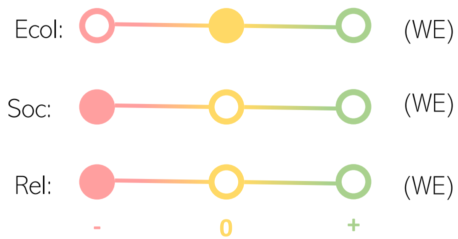
As such, a production/ extraction tax would bear with it some administrative and logistical costs. That said, the existence of unifying frameworks like those of the OECD (see 7.2.3) may leave readers sanguine of the opportunities for synchronising the aforementioned taxation systems (Sinn, 2012). Finally, since such a tax allocates costs directly to fossil fuel producers rather than consumers (see Kartha et al., 2018; Sinn, 2012; Erickson, Lazarus & Piggot, 2018), but on its own makes no effort to govern the stranded resources and infrastructure that would arise, thus it is partially relationally inclusive; it also disregards the impacts on fossil-dependents (stranded communities) and access to basic needs (like energy), rendering it socially exclusive.

4.3.1.2. Fossil Fuel Export Tax



Running in parallel with production/ extraction taxes, an export tax may be ecologically inclusive if levied "by a coalition of major exporters", while a "unilateral export tax has little impact" (Richter, Mendelevitch & Jotzo, 2018: 43). Moreover, a "nation that taxes coal exports but not domestic consumption… might reduce coal consumption and emissions globally but, by indirectly encouraging domestic consumption, increase its own" (Lazarus & van Asselt, 2018: 5), suggesting that an effective export tax must come in tandem with an effective domestic production/ extraction or consumption tax (Nalule, 2020; Lazarus, Ericksen & Tempest, 2015; Piggot et al., 2018). Moreover, an export tax resembles a production/ extraction tax as it allocates the implementation costs directly to fossil fuel exporters, which are typically multinational conglomerates or state-owned enterprises, but makes no effort to govern accompanying stranded assets, labour, lifestyles or energy (e.g., Lazarus & van Asselt, 2018).

4.3.1.3. Carbon Emissions/ Consumption Tax



The ecological inclusiveness of emissions taxes is "modest when their coverage is patchy, and when carbon-intensive industries can, therefore, shift to 'emission havens' elsewhere" (Armstrong, 2019: 672; Cairns, 2018; van der Ploeg & Rezai, 2020; Kopytin, 2020). Moreover, Sinn (2012: 221) notes that "the externality that has to be fought depends on the stock of carbon in the atmosphere, whereas the tax advocated is on the flow of carbon emitted." That is,

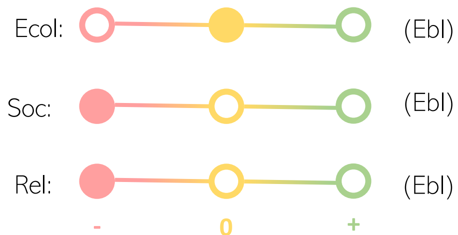
> [a] correctly designed Pigouvian tax would have to track the polluters responsible for the stock of anthropogenic carbon in the air and would have to burden their share in this stock with an annual tax whose rate should, in each year, equal the marginal damage that would be caused by a small increment to this stock… no one has ever proposed or analyzed [sic] such a carbon tax — probably because administering it would be far too demanding, since it would be necessary to trace the tax debtors over hundreds if not thousands of years after they emitted the carbon (ibid).

It is therefore generally agreed that "conventional carbon taxes might not be able to shape expectations on future climate policy" as they are unable to truly capture the social and ecological costs of carbon" (Kalkhul, Steckel & Edenhofer, 2020: 15) and are an administrative nightmare to design. Some nations have introduced emissions taxes decades ago – like Norway – though these efforts have been met largely unsuccessful in curbing domestic oil production, and some speculate that similar outcomes will be yielded as other major producers, like Canada (Kopytin et al., 2020). Nations from the 'South' are also adopting such taxes, though to a lesser degree; "South Africa is the only African country with a promulgated Carbon Tax while Ivory Coast is in the process of implementation" (Mutezo & Mulopo, 2021: 6).

Moreover, an emissions tax would exacerbate inequalities at is would (Kashwan, 2021: 8):

> affect poor and/or racial minority households very differently… Unless subsistence items, such as food, water, and energy were protected from the inflationary effects of carbon taxes, even a moderate level of the carbon tax could make these items too expensive for the poor in the United States.

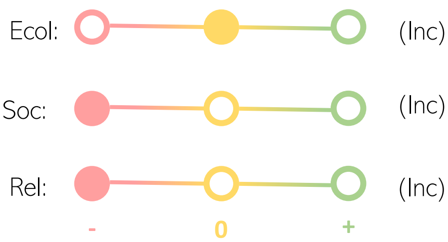
4.3.1.4. Fossil Fuel Import Tax



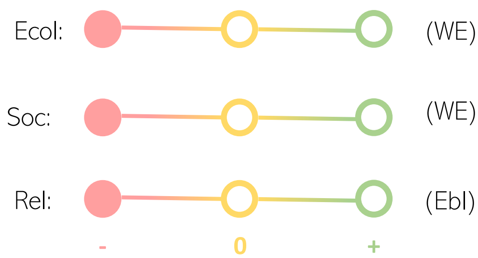
The conditions for an ecologically inclusive import tax on fossil fuels would mimic those of a consumption/ emissions tax; namely that *a coordinated and temporally-sensitive system* is necessary to tax fossil fuel imports (Lazarus & van Asselt, 2018). Generally speaking, however, demand-side policies such as this bear shortcomings, and as a result, "[i]ncreasing the price of… importing fossil fuels through a carbon fee and dividend system… may need to be implemented alongside other supply-focused approaches to increase its impact" (York & Bell, 2019: 43). Moreover, the same social and relational considerations apply as in 4.3.1.3, namely that consumers are exclusively allocated the costs of the approach and no stranded asset considerations are made for the exporting nation (Lazarus & van Asselt, 2018; York & Bell, 2019).

4.3.1.5. Border Tax Adjustments (BTAs)

Since BTAs are in essence an expansion of fossil fuel import taxes, very similar assessments apply to 4.3.1.4. However, BTAs cast a much wider net and therefore tax a more expansive group of imported, carbon-intensive consumer goods (Rocchi et al., 2018; Tachtman, 2017), which de facto allocates an even greater burden to consumers than a more simplistic tax on imported fossil fuel (ibid). As such, it is comparatively even more socially and relationally exclusive.



4.3.1.6. Tradeable Emissions Permits (TEPs)



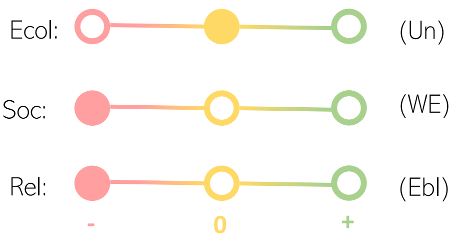
According to economists, a "cap-and-trade system indeed would be an efficient regulatory system if it were equally applied to all sectors of the economy, because it determines the one uniform price of CO_2 emissions. In fact, however, it is applied only to electric power generation and a few other sectors" (Sinn, 2012: 186; Armstrong, 2019; Paterson, 2020; Lazarus, Ericksen & Tempest, 2015). TEPs and cap-and-trade schemes will only be ecologically inclusive if they are adopted on a global level across all economic sectors, otherwise leakage issues and manipulation will persist.

However, TEPs and cap-and-trade schemes – which owe their origins to the Kyoto Protocol (UN, 1997) – have proven to be nothing more than a novel arena for capital accumulation and gargantuan profitability (Lohman, 2012) and are "used by producers to try to maintain [fossil] production and insulate it from demands about more fundamental policy reform including supply-side restrictions" (Gaulin & Le Billon, 2020: 891). Emissions permits are typically handed out gratis (often using a 'grandfathering' technique).[29] In the early phases of the EU Emissions Trading System (ETS),[30] "handouts given to only ten of Europe's intensive industrial users of fossil fuels exceed the total EU budget for environment" (Lohman, 2012: 93); moreover, "[m]any European corporations sell or charge their customers for surplus emissions rights that they receive gratis under the EU ETS, **ploughing the proceeds back into fossil-fuelled business as usual**" (Lohman, 2012: 92-3, **emphasis added**). By creating a market for carbon, states are in essence conjuring a 'new legal code' (Pistor, 2019 – see 2.2.3) for capitalists to not only continue the status-quo of unabated fossil fuel production and environmental calamity, but also sculpting a new profit-generating venues to further exacerbate the climate 'problem'. As a result, not only have TEPs failed to inclusively phase out fossil fuels, they have themselves perpetuated fossil fuel production and exacerbated the costs of phasing out fossil fuels to society as a whole (Lohman, 2012), rendering them exclusive on all fronts (cf. František, Martin & Václav, 2022; Xiongfeng et a., 2022).

[29] Grandfathering refers to handing out more permits to older and dirtier polluters and firms, based on the idea that those who already polluted have more rights to pollute than those who came later.

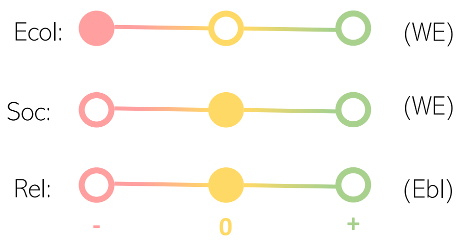
[30] The EU ETS is the only globally functioning trading scheme to date (European Union, n.d.)

4.3.1.7. Tradeable Production Quotas (TPQs)



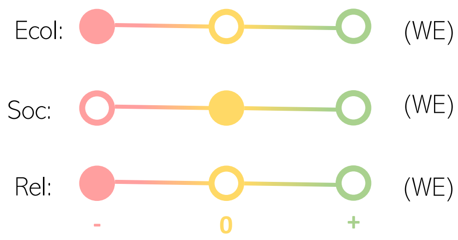
TPQs are theoretically more promising than TEPs in their environmental effectiveness since a properly devised TPQ scheme would establish a strict upper-limit on fossil fuel production and therefore directly and explicitly LFFU (Le Billon & Kristoffersen, 2019; Lazarus, Ericksen & Tempest, 2015; Green & Denniss, 2018). However, “several major hurdles need to be overcome: agreement on overall production, quasi-universal participation, a fair system of quota trading, a potential queue system for new projects, and revenue allocation consistent with the overall objective of reducing emissions *so that revenues are not reinvested in carbon-intensive projects and lifestyles*” (Le Billon & Kristofferson, 2019: 1080, *emphasis added*). Altogether these considerations would render TPQs potentially quite costly (monetarily and otherwise) (Lazarus & van Asselt, 2018) and subject to some contestation given their relational inclusiveness; moreover, TPQs may be subject to the same manipulation and exploitation as their emissions counterparts (see 4.3.1.6) given their design similarities, posing suspicions vis-à-vis the extent to which they will be inclusive to any extent.

4.3.1.8. ‘Green Finance’ & Subsidies for Fossil Fuel Alternatives



Direct (monetary) subsidies for fossil fuel alternatives stood at some $100-120 billion in 2013 (Monasterolo & Raberto, 2019), and numerous institutional investors have begun touting their ‘green bonds’ and ‘green investments’ (Baldwin, Cai & Kuralbaveva, 2020; van der Ploeg, 2020; Chapman et al., 2018), though the legitimacy of such financial mechanisms still remains in question (Rempel & Gupta, 2020). In their solitude, these tactics are “entirely useless, as the overall amount of CO_2 emissions is determined by the cap alone" (Sinn, 2012: 186; Lazarus, Ericksen & Tempest, 2015). Moreover, subsidies for “bioelectricity and feed-in tariffs supporting solar power and wind turbines”, for instance, have “become expensive flops” because “saving of fossil energy is completely neutralized by the additional use of fossil fuels triggered by this price reduction in other countries” (Sinn, 2012: 186). York & Bell (2019: 41) note that "growth in non-fossil fuel energy only had a very modest effect on curbing fossil fuel use, where it took between four and thirteen units of non-fossil energy to displace one unit of fossil energy"; *in fact, banking on fossil-alternatives alone will likely spur an “Energy Addition” rather than an “Energy Transition”, in which renewable sources are added to the existing grid and the aggregate amount of fossil fuel combustion remains virtually unscathed* (York & Bell, 2017 – see Box 4.2). Hoisting renewables may, however, directly and explicitly account for the inevitable stranded energy from LFFU (and in doing so, allocates costs to producers), rendering it partially socially and relationally inclusive.

4.3.1.9. ‘Feebates’



Given its hybridised nature, the inclusiveness of a feebate programme is dependent on those for carbon emissions taxes (see 4.3.1.3) and fossil-alternative subsidies (see 4.3.1.8), which are similar to one another (Rozenberg, Vogt-Schilb & Hollegate, 2020; Plötz et al., 2019); carbon emissions taxes are likely slightly more ecologically inclusive than green subsidies, but for the purposes of this analysis, I err on the side of caution and assign the more pessimistic score to the feebate evaluation.

BOX 4.2: CHALLENGES WITH 'GREEN ENERGY'

LFFU is often synonymised with the 'Energy Transition', justified with claims that the power sector "accounts for more than 40% of all CO_2 emissions from fossil fuel combustion" (Saygin et al., 2019: 99) and that roughly 85% of global energy demand is currently met with fossil fuels (Johnsson, Kjärstad, & Rootzén, 2019). As a result, scholarship on fossil fuels often adopts an explicit focus on the political economy of low-carbon & renewable energy; some examples include: predicting emissions reductions from phasing in renewables (Johnsson, Kjärstad, & Rootzén, 2019); and depicting the growth in renewable energy demand (Gadre & Anandarahaj, 2019; Miller & Carriveau, 2019) accompanied by the simultaneous (and alleged) decline in fossil fuel demand (Mercure et al., 2018).

Three key issues merit urgent attention. First, some studies suggest that renewables are 'disruptive' in that "new technologies… are changing [traditional power] model[s] and forcing electrical grids to become transactive and integrated" (Miller & Carriveau, 2019: 172), though as has already been argued (see 4.3.1.8), fossil-substitute supply-supportive tactics will be "useless" vis-à-vis LFFU (Sinn, 2012: 186). Moreover, the Dutch, German, Italian and British gas and coal industries alone run the risk of incurring €200 billion in stranded assets in the event that renewables are fully integrated into the power sector (Löffler et al., 2019); driven by these vested financial interests, fossil producers can deploy tactics like "flooding the market and depressing prices" to "keep out renewable energy producers" (van der Ploeg, 2020: 2).

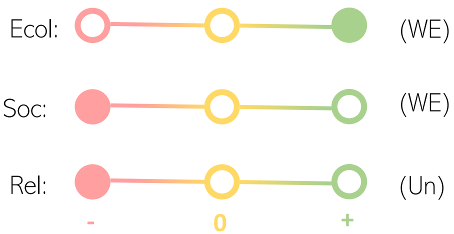
Second, even if renewables are able to penetrate power sectors, there is no guarantee that this will result in a 'transition'. York & Bell (2019) show that historically, 'transitions' from less to more efficient fuels (e.g., from biofuels to coal-power, and subsequently, from coal to oil & gas) were in fact *energy additions*, because while the *fraction* of total energy demand met with the less-efficient fuel decreased, the *total consumption* of that fuel continued to steadily increase. Accordingly, "it is misleading to characterize this growth in renewable energy as a "transition" and that doing so could inhibit the implementation of meaningful policies aimed at reducing fossil fuel use" (York & Bell, 2019: 40). *The political debate must thus shift towards "an open debate about an orderly withdrawal from coal, oil and gas extraction industries*" (Teske, 2019a: 403, *emphasis added*), justifying the thematic scope of this thesis (see 1.3.2).

Third, even if fossil-based energy is 'successfully' phased out, there is no guarantee that a low-carbon, renewable-based society will relinquish the injustices, exclusiveness and unevenness imposed by the fossil empire (Marsden & Rucinska, 2019: 12):

> The hand mill gives you society with the feudal lord, the steam-mill society with the industrial capitalist. One might therefore now ask what types of new oligarchies or panarchies the renewable revolution will encourage… a sort of post-carbonised corporate capitalism built upon new concentrated technologies and spatialities of capture, enclosure and production.

Low-carbon markets could alleviate existing geopolitical tensions and "reshape the highly uneven geopolitical economy of fossil fuel energy sectors" (Le Billon & Kristoffersen, 2019: 1075) given the "abundant and geographically dispersed nature of renewable energy sources" (i.e. sunlight and wind), which "implies a shift towards less oligopolistic global markets" (Scholten, 2020: 2); however, novel geopolitical tensions, oligarchies, and platforms for capital accumulation may very well arise given that "[r]enewable energy technologies require cobalt, lithium, neodymium, and dysprosium", and "China currently manages 90% of the share of these metals" (Scholten et al., 2020: 2); the "mining of these minerals also often contributes to gross human rights abuses, including child labour and the degradation and depletion of natural resources, such as water, forests, and pastures crucial for local livelihoods" (Kashwan, 2021: 8). Moreover, the "land-intensive nature of many renewable sources – particularly bioenergy" (Kartha et al., 2018: 121) and "reforestation, afforestation and hydroelectric dams" (Robinson & Shine, 2018: 565) may raise additional concerns given that to "maintain energy per capita at current levels, renewable energy sources would have to grow at a rate two to three times that of current projections" (King & van den Bergh, 2018: 334).

4.3.1.10. Fossil Fuel Subsidy Reform



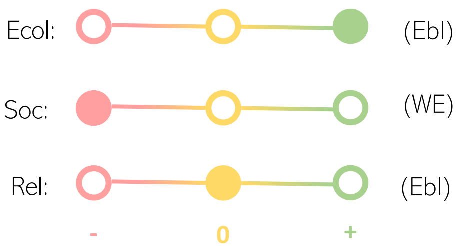
Removing fossil fuel subsidies is generally seen as an effective and feasible approach with few administrative hurdles (e.g., Lazarus & van Asselt, 2018; Johnsson, Kjärstad & Rootzén, 2019; Yuan et al., 2019; Coady et al., 2019), though the main obstacle conditioning its ecological inclusiveness is the extent to which indirect (non-monetary) subsidies – like tax credits – are accounted for, since indirect subsidies are likely several orders of magnitude larger than direct ones (Le Billon & Kristofferson, 2019; Coady et al., 2019). Monetary & direct subsidies for fossil fuel production in 2015 sat at around $50-100 billion globally, while those for consumption hit roughly $500 billion; however, "broadly defined... [they] amount[ed] to an estimated $5.13 trillion in 2015, of which 81% results from the unaccounted costs of air pollution, climate change impacts and broader vehicle externalities" (Le Billon & Kristoffersen, 2019: 1078; Coady et al., 2019). Since subsidies for fossil fuel *consumption* outweigh those for *production* by as much as tenfold, it follows that removing said subsidies will disproportionately impact consumers rather than producers (e.g., Escobar, Neri & Silvestre, 2020), following suit with the social exclusiveness narratives pertaining to e.g., emissions and import taxes (see 4.3.1.3 and 4.3.1.4) – and a neglect for the accompanying stranded assets yields a similarly relationally exclusive verdict.

4.3.2. Regulatory

4.3.2.1. Regulating Financial Capital

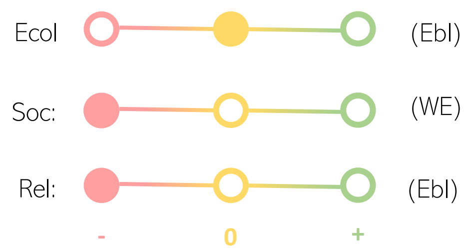
A strict cap must be set on the aggregate amount of capital available for new fossil energy if such a regulation is to be ecologically inclusive. Best (2017: 76) explains that

> [w]hen there is a larger supply of aggregate financial capital available, greater competition between capital providers helps to lower the cost of capital. This lower cost of capital benefits all borrowers in an economy, with the largest benefits accruing to capital-intensive sectors that are more sensitive to cost of capital changes, including energy producers.



Moreover, the conditions regulating the allocation of financial capital to fossil fuel projects must: be clear & cut; omit loopholes that could enable exploitation; and be internationally recognised and adopted (e.g., Johnston, Stirling & Sovacool, 2017; Gunningham, 2020). Otherwise, "high-carbon companies could bypass the tightening of prudential policy in one jurisdiction by raising funds on the international financial markets, unless such policies are implemented across all major jurisdictions" (Campigli et al., 2018: 6, quoted in Gunningham, 2020: 16). The OECD (2020), for example, has introduced (non-binding) regulations for member state Export Credit Agencies (ECAs) to abide by, but said regulations are rife with loopholes and inconsistencies (see 7.2.3). Additionally, some banks have taken the initiative to pledge a complete halt for coal-related financing (e.g., EIB, 2019), although similar measures for oil and gas are inexistent. Finally, in tandem with 'green finance' (see 4.3.1.8) key socio-relational issues (like stranded energy and labour) can be accounted for, but in its solitude, financial capital regulation will likely be socially exclusive (see Mutezo & Mulopo, 2021).

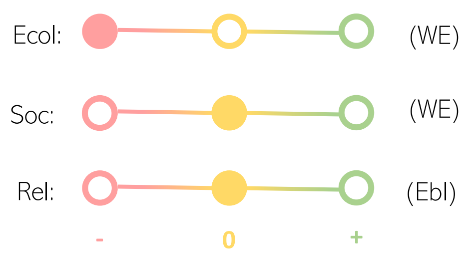
4.3.2.2. Higher Emissions Standards



Raising efficiency standards may also be lucrative for regulators, with modest estimates suggesting that the US federal government may save $1.3 billion annually by tightening such standards by some 30% (Pollin & Callaci, 2018). This demand-side approach is subject to exploitation if similarly tight emissions standards are not adopted universally; evidence suggests that "less productive jurisdictions [choose] inefficiently lax emissions standards" to "manipulate the return on capital" (Eichner & Pethig, 2018: 191) and "boost its export revenue" (ibid: 192). Accordingly, emissions standards can only be ecologically inclusive if coordinated on a global level (Lazarus, Ericksen & Tempest, 2015; Eirickson, Lazarus & Piggot, 2018). However, given its demand-side nature, raising emissions standards could allocate costs (e.g., stranded labour, energy, finance) directly to consumers, making it more expensive for civil society to afford housing or transportation and hence socio-relationally exclusive (ibid).

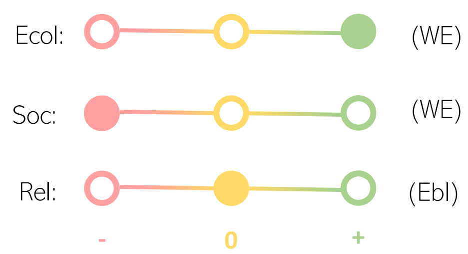
4.3.2.3. Promoting Energy Efficiency Improvements

This in theory allows for replacing higher-emitting processes (like lignite coal combustion) with lower-emitting (but nonetheless fossil-based) processes (like unconventional 'fracked' gas) (Mutezo & Mulopo, 2021). Improving energy efficiency at the intra- and international level can only LFFU under the strict condition that 'more efficient' fossil fuels cannot be used to replace 'less efficient' variants (cf. McGlade et al., 2018). Moreover, calls to improve energy efficiency with Bioenergy with Carbon Capture & Storage (BECCS) must also be rejected, given the unproven, uneconomical, and socio-ecologically hazardous state of BECCS technology (see 2.1.2.1). However, given that the explicit purpose of this approach is to replace and modernise inefficient energy infrastructure (Mutezo & Mulopo, 2021), it does in theory promote access to basic services and simultaneously allocates costs of doing so to energy producers, rendering it moderately socio-relationally inclusive.

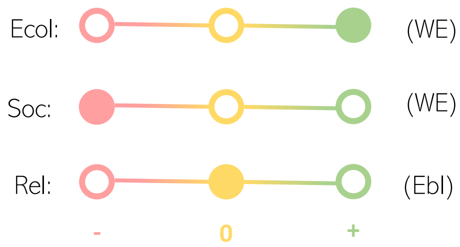


4.3.2.4. Bans & Moratoria

Bans and moratoria can be ecologically inclusive as they simplistically target fossil fuel supply at the source (e.g., Le Billon & Kristoffersen, 2019; Lazarus & van Asselt, 2018; Piggot et al., 2018). A clear obstacle to banning or establishing a moratorium on fossil fuel production, however, are accompanying opportunity costs; governments and firms could forgo billions – if not trillions – in sales, export and tax revenues (e.g., Kartha et al., 2018). Governments may resist bans on the premise that they deprive them of their RtD (e.g., Robinson & Shine, 2018; Arsel, Hogenboom & Pelligrini, 2016; Armstong, 2019; Gupta & Chu, 2018 – see 2.2.1.3). Despite this, many argue that "[m]oratoriums and bans established by governments are potentially the most effective supply-side initiatives, since they suspend or end extractive activities" (Gaulin & Le Billon, 2020: 895), though it seems that one clear condition for the social inclusiveness of a ban/moratorium is an accompanying allocation of resources to compensate (particularly the 'South') for their forgone opportunity to develop national resources (e.g., Lenferna, 2018 – see 4.3.3.8).

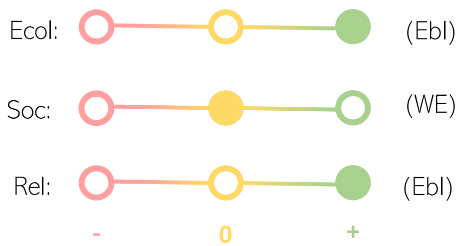


4.3.2.5. License & Permit Suspensions



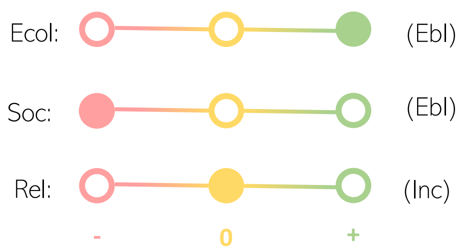
Operating somewhat analogously to bans or moratoria, suspending licenses or permits tied to fossil fuel production may directly and effectively curtail fossil fuel production (therefore deemed ecologically inclusive) (e.g., Lazarus & van Asselt, 2018; Kalkhul, Steckler & Edenhofer, 2020). However, these suspensions may violate concessions agreements and/or bilateral/multilateral investment treaties already established that previously granted firms permission to extract and commercialise coal, oil and gas resources, which could result in governments (rather than citizens) directly facing exorbitant fees to compensate firms for breached contracts or loss of revenue. However, it is generally seen that "this option is administratively feasible" (Erickson, Lazarus & Piggot, 2018: n.p.). Like bans or moratoria, however, suspending licenses or permits for fossil production entirely neglects the stranded assets that would arise by doing so, likely allocating their burden onto poorer fossil fuel dependents.

4.3.2.6. Retire/Phase-Out Fossil Fuel Infrastructure



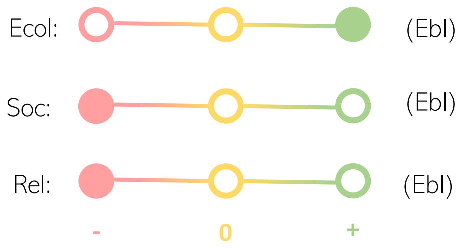
"[E]arly retirement well before [an]… investment has been recouped is unlikely to proceed without strong economic incentives, regulatory measures, and/or compensation" (Kefford et al., 2018: 295). That is, firms that have invested in coal, oil or gas projects and infrastructure with life expectancies into the mid- to long-term may demand compensation for prematurely devaluing their assets (e.g., Chapman et al., 2018; David, 2018). A recent and disconcerting revelation concerns the mammoth German utility provider, RWE, which opened a lawsuit against the Dutch government in February 2021 in response to the Dutch government introducing a coal phase-out law in 2019 (ICSID, 2021); RWE claims the Dutch government is violating the Energy Charter Treaty and is requesting €2 billion in compensation for damages and lost revenues (Verbeek, 2021). Despite these constraints, this approach is one of the few from this inventory that directly and explicitly governs stranded (physical) assets, though on its own makes no efforts to promote access to basic needs (like energy) once the fossil-assets are decommissioned.

4.3.2.7. Limiting State Good Provisioning



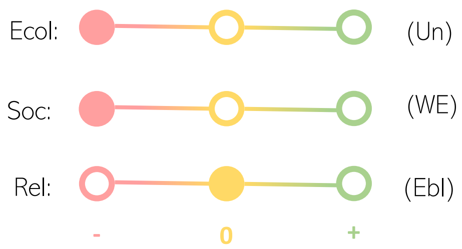
Like with bans/moratoria, licenses/permits and early retirement (see 4.3.2.4-4.3.2.6), governments should "*create funding or policy instruments designed to acquire production rights and compensate resource owners* in order to leave fossil fuel reserves undeveloped or otherwise restrict their production" (Lazarus, Erickson & Tempest, 2015: 8, *emphasis added*; Erickson, Lazarus & Piggot, 2018) while limiting state good provisioning. Moreover, states will typically have granted fossil fuel producers rights to use public land and/or water when signing concessions agreements or through bilateral investment treaties, so revoking those rights may breach those contracts and lead to arbitration and disputes at the international level (Bosch, Working Paper), like the RWE lawsuit (see 4.3.2.6). However, unlike early fossil infrastructure retirement, limiting state good provisioning does not explicitly tackle the accompanying stranded assets or address stranded labour and energy/basic needs.

4.3.2.8. Capping the Electrical Grid



Capping the electrical grid could be effective in directly limiting the demand for fossil fuel and therefore the quantity supplied (King, 2012). However, King (2012: 4) hints of the "tremendous resistance" to be expected from "embedded technocrats who have built today's grid", suggesting that, once again, economic, legal and compensatory considerations must be taken into account when states decide to establish an upper-limit on a provincial, regional or national electrical grid (e.g., Chapman 2018; Kefford et al., 2018). Furthermore, nations with currently unsustainable and growing levels of energy poverty/insecurity – like South Africa and its notorious load shedding (Memane et al., 2019, see 5.2.3.1) – may be reluctant to adopt such restrictive measures without guarantees that resources will be mobilised by the international community to ensure universal and sustainable energy access from low-carbon alternatives (York & Bell, 2019). Hence, capping the grid would unjustly and disproportionately allocate both costs and stranded assets to under-resourced and under-privileged fossil dependents.

4.3.2.9. Full Climate-Related Disclosures



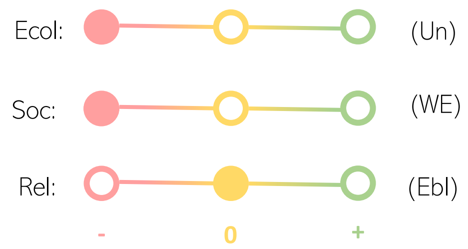
This kind of accounting has been occluded at the international stage (i.e. the Paris Agreement) because "within current international carbon accounting standards, curtailing supplies does not count as a full contribution to mitigation, since emissions are territorially accounted for at the location of consumption rather than production" (Le Billon & Kristoffersen, 2019: 1075); however, the Paris Agreement itself has "several elements through which the need to limit fossil fuel supply can be addressed" (Piggot et al., 2018: 3). These include: "embedding supply-side strategies in [national] NDCs" in complying with Article 4; developing an "alternative GHG accounting framework based on extraction-based emissions"; and a "global stocktake… tracking measures targeted at fossil fuel extraction" to help align with Article 2.1a (Piggot et al., 2018: 5-7). Even if full-disclosure of both emissions *and* fossil fuel production is mandated, such a tactic would be entirely ineffective without accompanying regulations that constrain fossil fuel supply (Gunningham, 2020; Piggot et al., 2018).

The Task Force on Climate-Related Financial Disclosures (TFCD) is a coalition of asset managers with joint assets under management summing to some $140 trillion. Its 31 respective members have pledged to improve relevant financial disclosures pertaining to climate-related investments, but these declarations have thus far been met with no substantive or meaningful action:

> it is doubtful whether the TCFD recommendations, even if mandated, will prove to be a game changer. On the contrary, it may well be that this framing has lulled policymakers… into a mistaken sense that information disclosure and risk management is all that is necessary to enable financial actors to play their part in a low carbon transition? Unfortunately, there is evidence that this is not the case (Gunningham, 2020: 7).

4.3.2.10. Environmental Impact Assessment (EIA) of Forthcoming Fossil Projects

For EIAs to be legitimate, financial, economic and environmental information must be fully, transparently and instantaneously disclosed (see 4.3.2.9) else the assessment will be both lagged and misinformed (Lazarus, Ericksen & Tempest, 2015; Green & Denniss, 2018). Second, such assessments are rendered moot unless a rigid upper cap is introduced at the (inter)national level for fossil fuel production meeting safe socio-ecological requirement (similar to 4.3.2.1 and 4.3.2.9), otherwise fossil-intensive projects can proceed in spite rigorous assessments and new fossil production will continue to be awash (ibid).

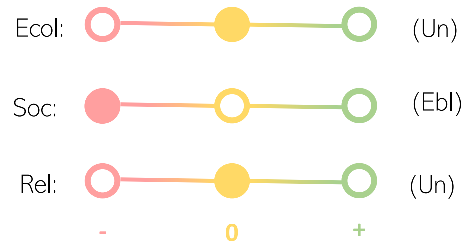


That said, EIAs are "likely to have relatively low administrative and transaction costs" because the "commodities to be accounted for (especially coal and oil)… are typically already measured by firms for existing administrative purposes such as resource tax liability assessment and compliance with local environmental license conditions" (Green & Denniss, 2018: 77), suggesting that an economic, legal and framework is already in place to enable such comprehensive assessments.

4.3.3. 'Other'

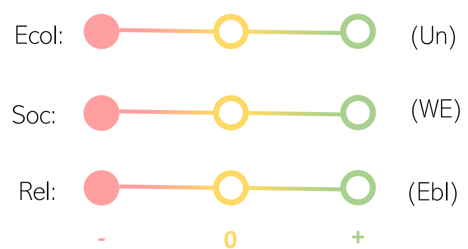
4.3.3.1. Expanding Investor Understanding to Innovatively Regulate Finance

The extent to which any innovative approach to regulating financial actors for LFFU will be ecologically inclusive rests on whether the four aforementioned tropes are understood and challenged (Christophers, 2019 – see 4.2.3). For instance, modernising the legal & fiduciary obligation that investors are bound by to include accountability and responsibility for fossil-related climate damage experienced by shareholders resulting from investments can revamp the 'economism' trope that plagues the existing investor paradigm (ibid; Gunningham, 2020; Rempel & Gupta, 2020). Reimagining financial instruments and mechanisms to this extent will most certainly be met with resistance by the investors themselves who are notoriously creatures of inefficient habit (Christophers, 2019; Piggot et al., 2018). Moreover, this does neglect the prospective stranded infrastructure, labour, lifestyles and energy that would arise (socially exclusive), despite allocating the direct administrative and logistical costs of LFFU to financiers and producers (moderately relationally inclusive).



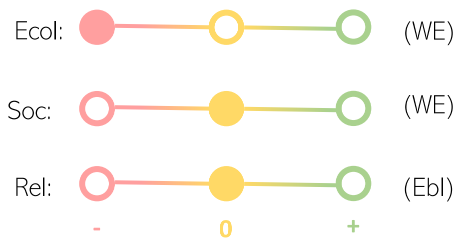
4.3.3.2. Divestment

Many have praised the fossil fuel divestment movement (FFDM) for 'successfully' accruing tens of trillions of dollars in pledged divestments from fossil firms (e.g., Healy & Barry, 2017; Paterson, 2020). The movement has successfully stigmatised the industry, questioned the legitimacy of fossil fuel investments (Healy & Barry, 2017; Piggot, 2018) and has "contributed" to climate action "through moral activism" (Gaulin & Le Billon, 2020: 895).



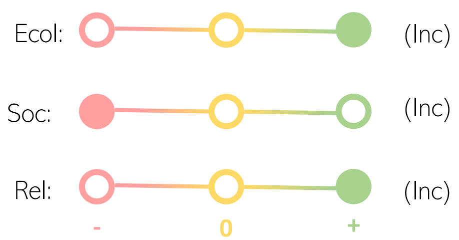
However, "divestment has had a very limited direct effect on fossil fuel production so far" (Gaulin & Le Billon, 2020: 895), because, inter alia: 1) "[m]any fossil fuel producers, especially those organized [sic] through large state-owned companies like national oil companies in the Middle East, are relatively insulated from external financial leverage, including from Western investment funds that constitute the vast majority of divesting organizations” (Le Billon & Kristoffersen, 2019: 1079); 2) although socio-political pressure may prompt investors to acknowledge the socioecological implications of their investment and subsequently divest, investors predominantly account for the *financial* risks posed by the ‘climate emergency’, and would divest if it were both the *financially sound decision* and aligned with their fiduciary duty (Christophers, 2019; Rempel & Gupta, 2020); 3) divestment very marginally (if at all) increases the cost of capital to fossil fuel producers (Gunningham, 2020); and 4) divestments imply sales to new investors, sending-off prospective stranded financial assets that may very well devalue as fossil fuels are phased out, de facto reallocating the burden of governing stranded assets elsewhere (Gupta, Rempel & Verrest, 2020; Rempel & Gupta, 2020).

4.3.3.3. Engagement



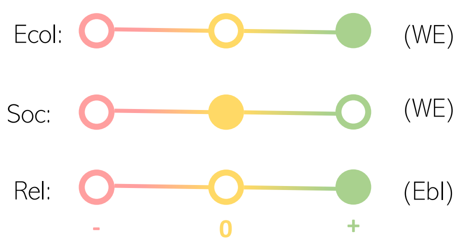
Shareholders have shown no sign of effective climate action vis-à-vis their fossil assets, particularly on the engagement front (Gunningham, 2020; Rempel & Gupta, 2020). Engagements with fossil firms have been scarce, and the few reported instances have almost entirely been reactionary in addressing e.g., oil spills rather than proactively pushing for LFFU (ibid), rendering the approach environmentally ineffective. Moreover, engagement costs the institutional shareholder (not consumers) time and resources in opening a continuous dialogue with the fossil fuel producers.

4.3.3.4. Asset Write-Off



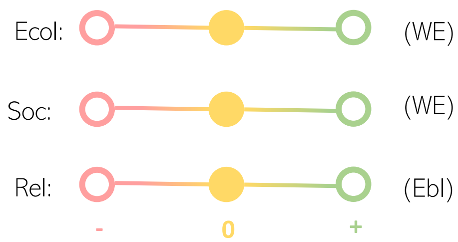
By writing-off their already existing fossil-related equity, institutional and major shareholders can stigmatise and disincentivise further investment in the fossil sector, and by doing so they could directly incur the implementation and stranded asset costs themselves (Rempel & Gupta, 2021), rendering the approach moderately inclusive. However, this would imply that relevant shareholders absorb hundreds of billions in financial costs by conducting such a write-off, which will be heavily contested under the premise that it may contradict traditional understandings of fiduciary obligations (Rempel & Gupta, 2020).

4.3.3.5. Court Cases & Litigation



Not only can the litigation process consume both time and financial resources, but also, some judges may discard climate related cases on the grounds that they “should be addressed by the executive and legislative (otherwise known as the “political”) branches of government and not the judiciary”, as some US judges have recently ruled (Burger & Wentz, 2018: 398). Plaintiffs must therefore carefully devise a legal strategy before bringing a fossil producer to court, else the litigation process may stall and actions for LFFU may excessively delay (ibid; Gaulin & Le Billon, 2020). If successful, however, favourable verdicts can demand that reparations be paid or fossil-intensive infrastructure be adequately decommissioned, in theory allocating the stranded asset burden to firms, governments and/or financiers – although the entire extent to which fossil-dependents are protected in the process remains uncertain.

4.3.3.6. Blockades

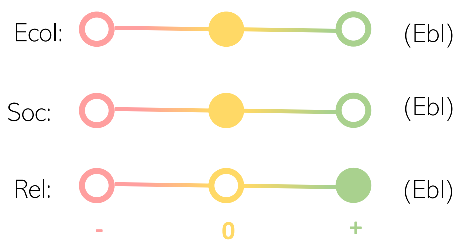


"From a sample of 57 well-documented blockades across the world, 21% led to a cancellation of the targeted project, 25% to a suspension, and 54% did not prevent the continuation of the project" (Gaulin & Le Billon, 2020: 895). Those that were successful typically targeted projects at their early stage of development "rather than… fossil fuel production already in place" (ibid: 896), suggesting that blockades may successfully prevent a fossil project from unfolding if CSOs or NGOs are able to mobilise both physical and digital movements swiftly and with urgency from the time that plans for a forthcoming project have been revealed or have leaked until the proposed projects begin materialising (Klein, 2015). Conditions for effective blockades therefore include (Gaulin & Le Billon, 2019; Healy & Barry, 2017):

- Available human resources for both organising and participating;
- Timely access to complete and transparent fossil fuel project-related information;
- Society with functioning rule of law to protect activists against powerful incumbents.

Anti-fossil fuel blockades have been ubiquitously dispersed globally, with at least 5-10 reported instances in each continent in the last 20 years – though mostly concentrated in Latin America, North America and India (Gaulin & Le Billon, 2020), suggesting that that there is no particular dearth in human resources or CSOs in any one location. However, non-disclosure and secrecy mechanisms that are built to protect financiers and investors (Gunningham, 2020) result in both lacking and lagged information that hamper the speed with which CSOs can mobilise. Furthermore, many new and forthcoming fossil fuel projects are spurring in the 'South' and in many instances in nations in which governments strongly reprimand fossil fuel opposition (Gaulin & Le Billon, 2020).

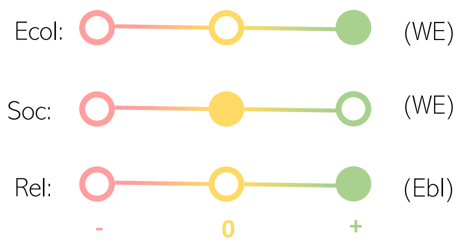
4.3.3.7. Unionisation



Unions are not environmental groups, and their predominant concern – particularly for labour unions – is that a transition away from fossil fuels will not jeopardise employment opportunities for existing direct and indirect employees of the fossil fuel industry (Evans & Phelan, 2016), echoing original calls for a 'Just Transition' that have been alive and well since the 1990s (Pollin & Callaci, 2018; Teske, 2019; Kartha et al., 2018). Therefore, the most critical condition dictating a union's success in LFFU is ensuring that more than ample resources are allocated to both generate new, low-carbon employment opportunities and retrain existing workforces to thrive in these new roles (Evans & Phelan, 2016).

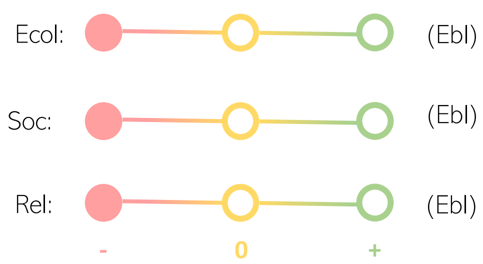
Some research indicates that "spending $1 million on clean energy investments generates about seventeen jobs across all sectors of the U.S. economy, while spending the same $1 million on maintaining the existing fossil fuel infrastructure produces only about five jobs" (Pollin & Callaci, 2018: 2). However, the general skillset of a renewable energy worker (consisting of many engineers and technicians) is different than that of e.g., a coal miner (see 5.2.3.3), which will require mobilising resources for training.

4.3.3.8. Financial Swaps



Trust in and transparency from the host government is imperative for an effective financial swap (Kingsbury, Kramarz & Jacques, 2018). The predominant factor that led to the Yasuni-ITT initiative's demise (see BOX 4.1) was the "lack of guarantees from the Ecuadorian government that the oil would, in fact, stay underground" (Martin & Scholz, 2014: para 5; quoted in Kingsbury, Kramarz & Jacques, 2018: 9-10). In order to mobilise sufficient funds, the international community must have no doubts that the intention of the host government is indeed to indefinitely ban extraction from the fossil reserve in question (e.g., Newell & Simms, 2019; Vallejo et al., 2015). If successful, however, the burden of LFFU would fall on the international community, and the accrued funds could be used to phase out existing fossil-intensive infrastructure that would have relied on the stranded fossil resources (Newell & Simms, 2019). Although monetarily expensive, this approach is socially inclusive if designed and implemented legitimately; that is, ensuring that funds are used to support current fossil-dependents and replace archaic, carbon-intensive energy sources.

4.3.3.9. Carbon Offsets & Net-Zero



Using the carbon offset CO_2e arithmetic (see 4.2.3), "by destroying a few thousand tons of HFC-23, the Mexican chemical manufacturer Quimobasicos is set to sell over 30 million tonnes of carbon dioxide pollution rights to Goldman Sachs, EcoSecurities and the Japanese electricity generator J-Power," through which they can all generate "super-profits" (Lohman, 2012: 95), hence benefiting investors and heavy emitters while simultaneously perpetuating fossil combustion, putting the ecological inclusiveness of carbon offsets into severe question (also see Dyke, Watson & Knorr, 2021). Moreover, the 'avoided deforestation' subtype of carbon offsetting "have involved the forcible displacement of communities and other abuses by corrupt governments eager for financial compensation" (Horowitz, 2015: 243). These projects may have resulted in ecological calamity by disrupting ecosystems in cases in which inefficient photosynthesising tree species are cut and replaced with more efficient ones (Chen et al., 2022; Zavala, 2021). Through these kinds of commodified ploys, "**the surplus-generating use of fossil energy by the industrial North is prolonged,** while further profits are realized through commerce in a new commodity" (Lohman, 2012: 95, **emphasis added**).

These offsets have evolved into the aforementioned pledges by governments and firms alike to become 'net zero' in a few decades (see 1.2.1) (Dyke, Watson & Knorr, 2021), birthing "new modes of *environmentality*" anchored around "the financialization of environmental governance" (Braun, 2015: 102-3). Leading climate scientists have posited that

> net zero has licensed a recklessly cavalier 'burn now, pay later' approach… perpetuat[ing] a belief in technological salvation and **diminish[ing] the sense of urgency** surrounding the need to curb emissions now… **effectively serves as a blank cheque for the continued burning of fossil fuels** and the acceleration of habitat destruction. Current net-zero policies will not keep warming to within 1.5°C because they were never intended to. **They were and still are driven by a need to protect business as usual, not the climate** (Dyke, Watson & Knorr, 2021: np, **emphasis added**).

Just as the 'climate problem' is not caused by "technology, over-consumption or over seven billion human mouths to feed… the solution is not simply clean technology" or other financial savvy (Castree, 2015: 290). As a result, carbon offsets and net-zero pledges are seemingly incapable of effective LFFU and are therefore ecologically exclusive, bear with them socioecological costs that may directly impact vulnerable fossil-dependents (socially exclusive), and not only neglect the stranded asset problem but exacerbate it by generating a new financial reliance on the fossil sector (relationally exclusive).

4.4. Approach Comparison

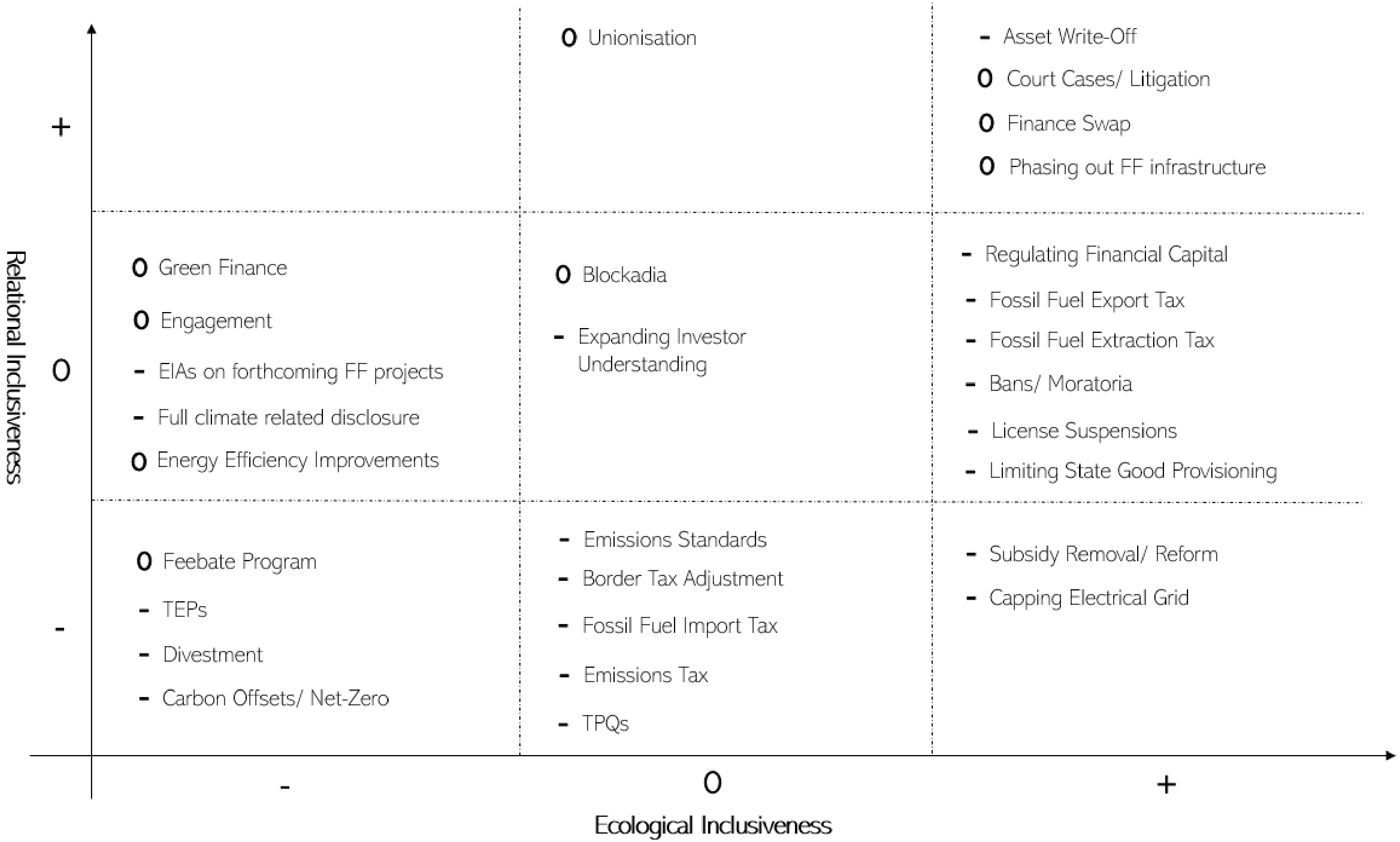
Figure 4.1 compares different scores across all 29 approaches and Figure 4.2 summarises the overall scores. Figure 4.1 is constructed so that an approach meeting all criteria (i.e. earning a '+' for all three dimensions) would be displayed in the top-right cell with a '+' marker, though no approach earned such a score.

12 of the 29 approaches are deemed ecologically inclusive (rightmost column of Figure 4.1); these are predominantly (7/12) regulatory approaches, though some (4/12) are more economic in nature, like fossil fuel production/extraction and export taxes. Conversely, 9 approaches are deemed entirely ecologically exclusive (leftmost column of Figure 4.1); these are typically demand-driven approaches subject to exploitation, like TEPs, or approaches that target promoting fossil-fuel alternatives rather than curtailing fossil fuel production at the source, like 'carbon offsetting'.

Only 5 approaches meet the criteria for relational inclusiveness (top row in Figure 4.1), of which four are simultaneously environmentally effective (top-right cell in Figure 4.1); only these five approaches acknowledge and appropriately govern the multidimensional stranded assets that inevitably accompany LFFU, even though many approaches do in fact allocate the cost of implementing a particularly approach to richer and more capable actors. Overall, however, it seems that relational considerations have generally been side-lined in favour of the pursuit for LFFU 'effectiveness'.

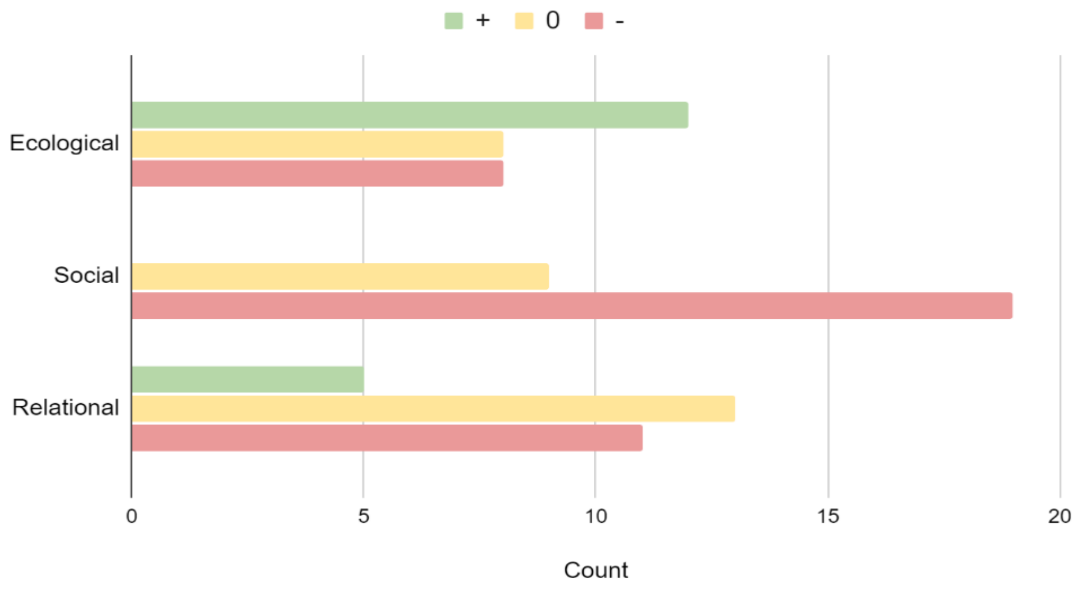
Finally, 9 approaches were rated moderately socially inclusive, while 20 were deemed entirely exclusive (and thus none met the criteria for strong social inclusiveness); that is, approaches typically *either* sought to replace fossil-intensive energy sources with non-fossil alternatives (and thereby upholding universal access to energy), like green finance, *or* protect fossil dependents, like directly phasing out fossil-intensive infrastructure, *or neither*, but never both. As was the case with relational inclusiveness, most approaches are designed with ecological effectiveness in mind, and therefore omit critical social considerations with respect to the stranded labour, energy and lifestyles that LFFU will inevitably generate. Reflecting on this finding is imperative to designing a policy and approach mix (see 4.5) that *inclusively* LFFU and combats the 'climate emergency'.

Figure 4.1. LFFU Approach Comparison



Source: Author

Figure 4.2. Summary of overall scores by category



Source: Author

It is worth highlighting that none of the five relationally inclusive approaches were market-based or abide by neoliberal and capitalist ideals (see 2.1.3 & 2.2.3). By definition, relational inclusiveness aspires to allocates the costs and burden of action to the 'richest and most capable actors', de facto critiquing any strategy in which these rich and capable actors can become richer, which has historically been the case with e.g., TEPs (see 2.2.4). In fact, of the 13 *moderately* relationally inclusive approaches (middle row in Figure 4.1), only 3 (extraction taxes, export taxes, and 'green finance') are market-based, and these are only *partially* relationally inclusive because they to some extent allocate implementation costs to producers and governments rather than civil society and fossil-dependents. Conversely, of the 11 approaches deemed entirely relationally exclusive, *seven* are market-based. Incorporating such approaches into policy mixes risks not only unsuccessfully LFFU, but simultaneously perpetuating and exacerbating inequalities as capitalist actors accrue additional resources – while the burden of climate (IN)action falls of the most under-privileged and under-resourced members of society. Market-based approaches to LFFU are therefore only inclusive IF they are embedded in a mix of other approaches and policies that are carefully designed to safeguard against their tendency to exacerbate existing inequalities (see 4.5).

4.5. Discussion: LFFU Approach Mixes

Each of the identified approaches is subject to complications vis-à-vis 'carbon leakages' and 'green paradoxes' (see Sinn, 2008; 2012; Le Billon & Kristoffersen, 2019; Foster et al., 2017; van der Ploeg & Rezai, 2020; Baldwin, Cai & Kuralbayeva, 2020; Edenhofer et al., 2020). One proposed way to mitigate against leakages and green paradoxes is through "globally coordinate[d] climate change policy" (Foster et al., 2017: 259), since climate change "cannot be successfully resolved in the absence of effective global governance" (Cole, 2011: 1, also see 2.2.1.1). A supply-side treaty is merited, which incorporate a 'coalition of the willing' (Cole, 2011; Piggot et al., 2018) to effectively restrict fossil fuel supply; the Fossil Fuel Non-Proliferation Treaty (FF-NPT) has been proposed to play this role (Newell & Simms, 2019). Altogether, a "supply-side climate treaty could notably help tackle the problem of free riders and insure against a failure of the Paris Agreement" (Gaulin & Le Billon, 2020: 889).

Individually, any approach for LFFU will be ineffective and inequitable, and therefore exclusive; considering *policy mixes* across different dimensions and levels of governance is critical. Supportive and restrictive policy mixes across various energy types can create a "policy apparatus for incumbency", which can "by counterpoint with Schumpeter's (1942) highlighted process of 'creative destruction' − be considered **'destructive re-creation'"** (Johnston, Stirling & Sovacool, 2017: 148, **emphasis added**). "Rather than the incumbent configuration being subject to destruction, it is instead re-created by destructive pressures that instead bear on emerging niche innovations (like renewable technologies and energy efficiency improvements)", which has hoisted the UK's incumbent nuclear energy and natural gas sectors while boxing out niche renewable challengers (ibid: 148). Considering mixes of approaches to LFFU is therefore imperative to sculpt an inclusive fossil fuel phaseout, and moreover, trade-offs between the multidimensional inclusiveness of various LFFU approaches within a selected mix must be taken into account. Recall that this analysis aimed to shed light on the multidimensional implications that accompany any LFFU approach, so that key actors (policymakers, investors, civil society) can sculpt mixes that mitigate against shortcomings (see 3.5.2).

4.6. Conclusions

This chapter posed the question:

> What is the array of available approaches for LFFU, to what extent are they socially, ecologically and relationally inclusive (paying particular attention to the extent to which they govern inevitable stranded assets), and which types of approaches are favoured over others?

And draws three conclusions based on the above literature review:

Conclusion 1
Twenty-nine unique approaches for LFFU are at the disposal of policymakers, financial regulators, financiers, investors and civil society organisations – some of which are mainstream & ubiquitously adopted (e.g., carbon emissions taxes or divestment), while others are much more unorthodox and are yet to gain traction (e.g., extraction taxes or asset write-offs). These approaches are equally distributed across three types: economic (10), regulatory (10) and 'other' (9), implying that the recent scholarship has covered LFFU approaches across a range of categories and has not neglected one particular type. However, of the 121 papers reviewed, 104 discussed economic LFFU approaches either in-depth or in-passing, while 60 covered regulatory approaches and 35 covered 'other' approaches to the same degree; this indicates that although all dimensions have been covered, the scholarship has significantly favoured scrutinising economic-oriented LFFU approaches.

Conclusion 2
Of these 29 approaches: only 12 are likely to effectively LFFU (ecologically inclusive); only 5 allocate implementation costs AND accompanying stranded asset to rich and capable actors (relationally inclusive); and NONE simultaneously account for both fossil-dependents AND access to basic needs (e.g., affordable and reliable energy access) more broadly (socially exclusive). *As a result, social and relational challenges to LFFU have been almost entirely neglected in recent scholarship, while even coverage of ecologically inclusive LFFU approaches has been sparse.*

Accordingly, inclusive mixes of approaches in compliance with the Paris Agreement may include (inter alia, and in no particular order): court cases/ litigation; fossil fuel subsidy reform; extraction taxes; finance swaps; infrastructure phaseout; and regulating financial capital. Notably, 6/12 of all ecologically inclusive approaches are regulatory in type, whereas only 3/12 are economic and the remaining 3/12 'other'. This is builds on Conclusion #1 above; the 6 ecologically inclusive regulatory approaches were discussed on 41 occasions across the 121 papers, the 3 economic approaches on 38 occasions, and the 3 'other' type ones only 15. Meanwhile, the 17 ecologically exclusive approaches (earning a score of ‘0’ or ‘-‘) were discussed much more often: ecologically exclusive and economic approaches 78 times (75% of all economic approach mentions), regulatory ones 29 times (48%), and ‘other’ approaches 20 times (57%). This altogether indicates that the recent scholarship has substantially favoured less effective LFFU approaches, particularly pertaining to the ‘economic’ and ‘other’ dimensions.

Conclusion 3

The two most popular approaches, ‘Green Finance’ and ‘Carbon Emissions Taxes’, were discussed on 25 and 23 separate occasions, respectively, which are entirely or partially ecologically exclusive, respectively. This speaks to a larger tendency in the recent scholarship to dodge the question on curtailing *fossil fuel supply* (cf. Le Billon & Kristoffersen, 2019; Gaulin & Le Billon, 2020; Lazarus & van Asselt, 2018), and rather tip-toe around this sensitive topic (Bebbington et al., 2020) by focusing indirectly on fossil fuels through their combustion-borne emissions and ‘cleaner’ replacements (like solar PV and wind power). An effective approach to combatting the ‘climate emergency’ is inseparable from an explicit fossil fuel phaseout (Welsby et al., 2021), and yet, the bulk of the scholarship opts to study the ‘climate emergency’ implicitly and indirectly. This reinforces one of the key gaps in knowledge that this study tackles (knowledge gap K3, see 1.2.2).

PART 2

Prospective Stranded Fossil Fuel Assets in South Africa & Africa, their Finance Flows, and the Stranded Asset Debt

An analysis of the stranded asset exposure borne by African nations based on a stocktake of potential stranded assets scattered across the continent and linkages to their key financiers

5. A Stocktake of Prospective Stranded Fossil Assets[31]

5.1. Purpose and Structure

This chapter tackles sub question S3:

What is the extent of the monetary & non-monetary stranded fossil fuel asset risks borne by South Africa and the African continent more broadly, and what implications do these risks bear on both inclusive development and sustainable development agendas?

and explores the extent to which prospective monetary and non-monetary stranded fossil fuel assets are distributed across South Africa (see 5.2.1-5.2.3). It then contextualises these South Africa-borne assets within the broader African context (see 5.3.2-5.3.4), and discerns the implications that risks from exposure to these prospective asset bear on inclusive and sustainable development agendas (see 5.4) by applying the analytical framework from Table 2.4 and Table 1.2 before drawing conclusions (see 5.5).

5.2. South Africa

5.2.1. Prospective Stranded Natural Assets

5.2.1.1. Introduction

This section evaluates the prospective stranded natural fossil assets borne by South Africa, first by presenting the key metrics concerning its proven reserves and production rates (see 5.2.1.2), and subsequently estimating the NPV of its proven reserves to speak to the potential stranded revenue streams implicit to a South African fossil phaseout (see 5.2.1.3).

5.2.1.2. Proven Reserves and Production

Table 5.1 presents the relevant metrics for South African fossil fuel production in 2019. Its 2019 coal reserves were roughly 10Gt (67% of African and 1% of global reserves),[32] which is equivalent to roughly 40 years-worth based on South Africa's 2019 coal production rate of 254Mt per annum;[33] South Africa accounted for 87% of African and roughly 3% of global coal production in 2019. Roughly half (130Mt) of the produced coal was consumed (mostly by Eskom – see 1.3.2.1), accounting for 81% of African coal consumption. Moreover, 81Mt of coal were exported (87% of African continental coal exports) whereas only 2Mt of coal were imported (almost entirely from Botswana). Accordingly, South Africa has developed a dual dependence on coal for both meeting domestic energy demands and simultaneously for export-driven revenue. Note that China, India and Indonesia jointly absorbed 61% of exported South African coal.[34]

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[31] This chapter was prepared in tandem with and is based on some elements of the following papers:
Rempel, A. (Accepted June 2022). An Unsettled Stranded Asset Debt?. *Antipode*
Rempel. A., Gupta, J. (major revisions 2022). Public Finance & African Fossil Fuels: Export Credits, Development Banks and the Paris Agreement. *Environment, Development & Sustainability*

[32] BP (2020; 2021)

[33] ibid

[34] Solar Power Africa Conference, panellist from CSIR

Table 5.1. Summary of South Africa's fossil fuel reserves, production, consumption, exports and imports using 2019 data

	South Africa			%Total Africa			%Total World			Value (B USD)		
	Coal (Bt)	Oil (Gbbl)	Gas (Tcf)	Coal	Oil	Gas	Coal	Oil	Gas	Coal	Oil	Gas
Proven Reserves	9.893	0 [9.000]	0 [60.000]	66.68%	[6.54%]	[8.49%]	0.92%	[0.52%]	[0.81%]	~300	[~370]	[~145]
Annual Production	0.254	0.001 [0.5]	0.043 [1]	86.78%	0.02% [13.3%]	0.46% [9.8%]	3.12%	0.00% [1.3%]	0.03% [0.7%]	14.99	0.04 [30.00]	0.1 [2.40]
Annual Consumption	0.130	0.250	0.150	81.41%	13.73%	2.69%	2.41%	0.69%	0.11%	7.68	14.98	0.36
Net Production (Prod-Cons)	0.124	-0.249	-0.107	-	-	-	-	-	-	7.32	-14.94	-0.26
Annual Export	0.081	0.000	0.000	86.72%	0.00%	0.00%	6.73%	0.00%	0.00%	4.78	0.00	0.00
Annual Import	0.002	0.191	0.174	20.81%	20.17%	36.27%	0.16%	0.74%	0.40%	0.12	11.46	0.42
Net Export (Ex-Im)	0.079	-0.191	-0.174	-	-	-	-	-	-	4.67	-11.46	-0.42

Source: Author

N.B. Potential oil & gas reserves from the recent Brulpadda & Luiperd offshore oil and gas discoveries (see 5.2.2.5) – along with their prospective valuation – have been included in the table in square brackets.

Mining rights are granted for firms in South Africa under the Mineral & Petroleum Resources Development Act (Act No. 28 of 2002); they are valid for 30 years and renewable for additional periods of no more than 30 years, all of which are administered and granted by the DMRE and must comply with the National Environmental Management Act (NEMA) of 1998. According to the Minerals & Petroleum Resources Royalty Act 28 of 2008, mining firms must pay the South African government royalties equivalent to 0.5-5% of all earnings before interest and taxes; all mining activity is also subject to the Income Tax Act, 1962, which specifies that the "rates of tax chargeable in respect of each year of assessment shall be fixed annually by Parliament" (Article 5(1)).

Until 2019, South Africa's oil and gas reserves were essentially non-existent, so it relied heavily on imported oil (191Mbbl, or 20% of overall African imports) and gas (0.174Tcf, 36% of African imports);[35] South Africa is therefore overwhelmingly a net-oil and gas importer. That said, its oil consumption (250Mbbl, or 14% of African consumption) was 60Mbbl greater than its oil imports due to the dirty Coal-to-Liquid (CTL) and Coal-to-Gas (CTG) processes (see 1.3.2). Conversely, its gas consumption stood at 0.150Tcf (3% of African consumption), the majority of which came from imported gas.[36] Note that South Africa's oil production was minor but not null (roughly 1Mmbbl) in spite of not having any proven oil reserves; this is because South Africa was the only African nation to import *crude oil* and subsequently refine (i.e. produce) it domestically at one of its four crude oil refineries (see 5.2.2.4).

Offshore oil & gas *exploration rights* in South Africa are granted according to Section 80 of the Mineral & Petroleum Resources Development Act (MPRDA) (Act No. 28 of 2002). Exploration rights "allow the holder to carry out the entire value chain of petroleum exploration" and are "valid for a period of 3 years, renewable for three two-year term[s]" and are transferable. In addition to the aforementioned royalties fee, exploration rights holders must pay an annual offshore exploration fee R200,000 per square degree of offshore acreage, with a minimum payment of R50,000, and pay income tax of up to 28% according to the Income Tax Act. Firms may opt to acquire *production rights* according to Section 84 of the MPRDA once exploration activities have terminated, which "allows the holder to conduct any operation, activity or matter that relates to the exploration, appraisal, development and production of petroleum"; production rights are valid for 30 years and are renewable for additional 30-year periods.

However, according to "Section 90 of the Act, the Minister is empowered to cancel or suspend this Exploration Right", and in the event that this happens, "the Holder shall not be absolved from those obligations and liabilities that have accrued up to the date of such cancellation or suspension". Section 90 specifies that "the Minister may cancel or suspend any" permit or right (ibid: 78).

5.2.1.3. Monetary Valuation

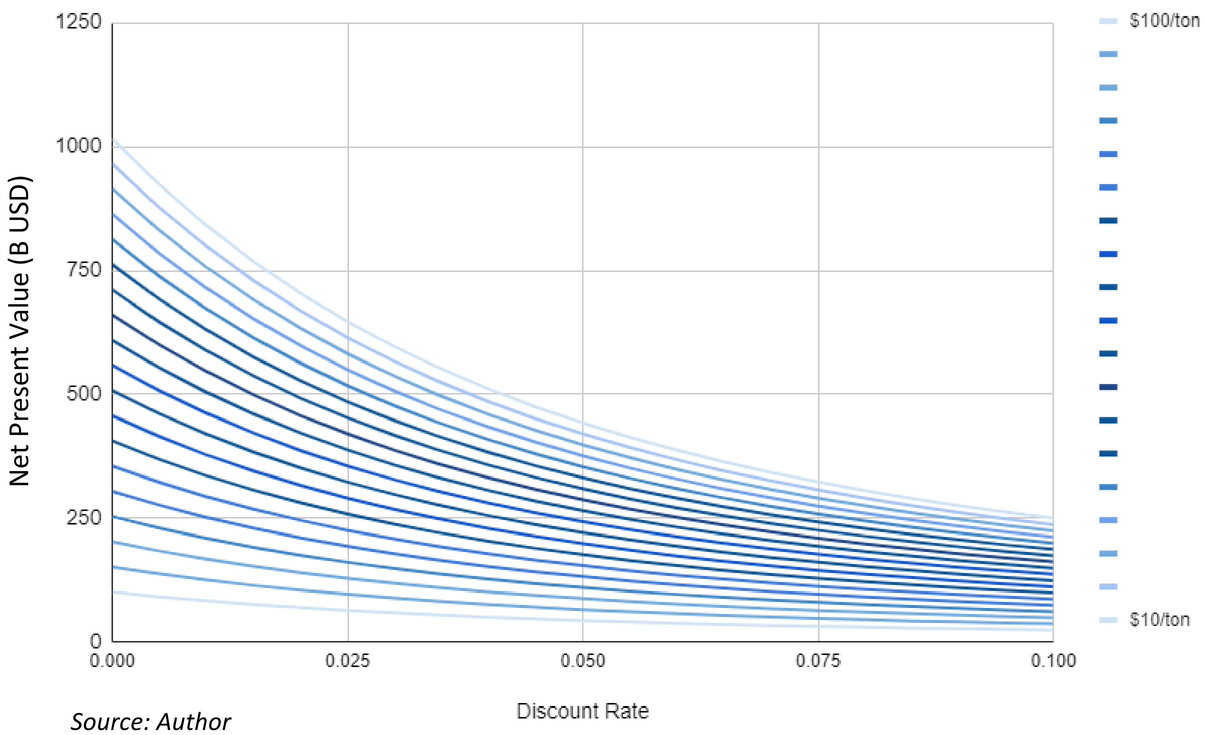
Coal Reserve Value

Assuming a realistic range for the discount rate at 1-6% based on industry average, the average NPV of South Africa's prospective coal revenues may be $303 billion, with a 95% confidence interval of $278-328 billion (computed by applying the methodology in 3.5.3, and depicted in Figure 5.1). That is*, if South Africa were to commercialise all of its proven reserves, based on the 2019/20 production rate of 254Mtpa, this would generate annual revenue streams that aggregate to roughly $300 billion over the next 40 years* (estimated lifetime remaining of its reserves – see Appendix B). This is not the monetary opportunity cost borne by the South African government, however; only a small fraction (max 5%, $15 billion) would end in government accounts given the conditions under which production rights are administered by the DMRE in South Africa (see 5.2.1.2). Moreover, since roughly half of all

[35] OPEC (2020); IEA (2020)
[36] OPEC (2020); BP (2020; 2021)

produced coal is consumed domestically by the state itself (via Eskom, see 1.3.2.1), much of which is too low in quality to export to international markets, a substantial fraction of this $300 billion would likely never result in sales revenue for South Africa's government itself (although the $300 billion figure is useful to demonstrate the magnitude of the prospective natural coal assets that reside in South Africa).

Figure 5.1. Estimating value of South Africa's proven coal reserves as a function of discount rate and price of (bituminous) coal



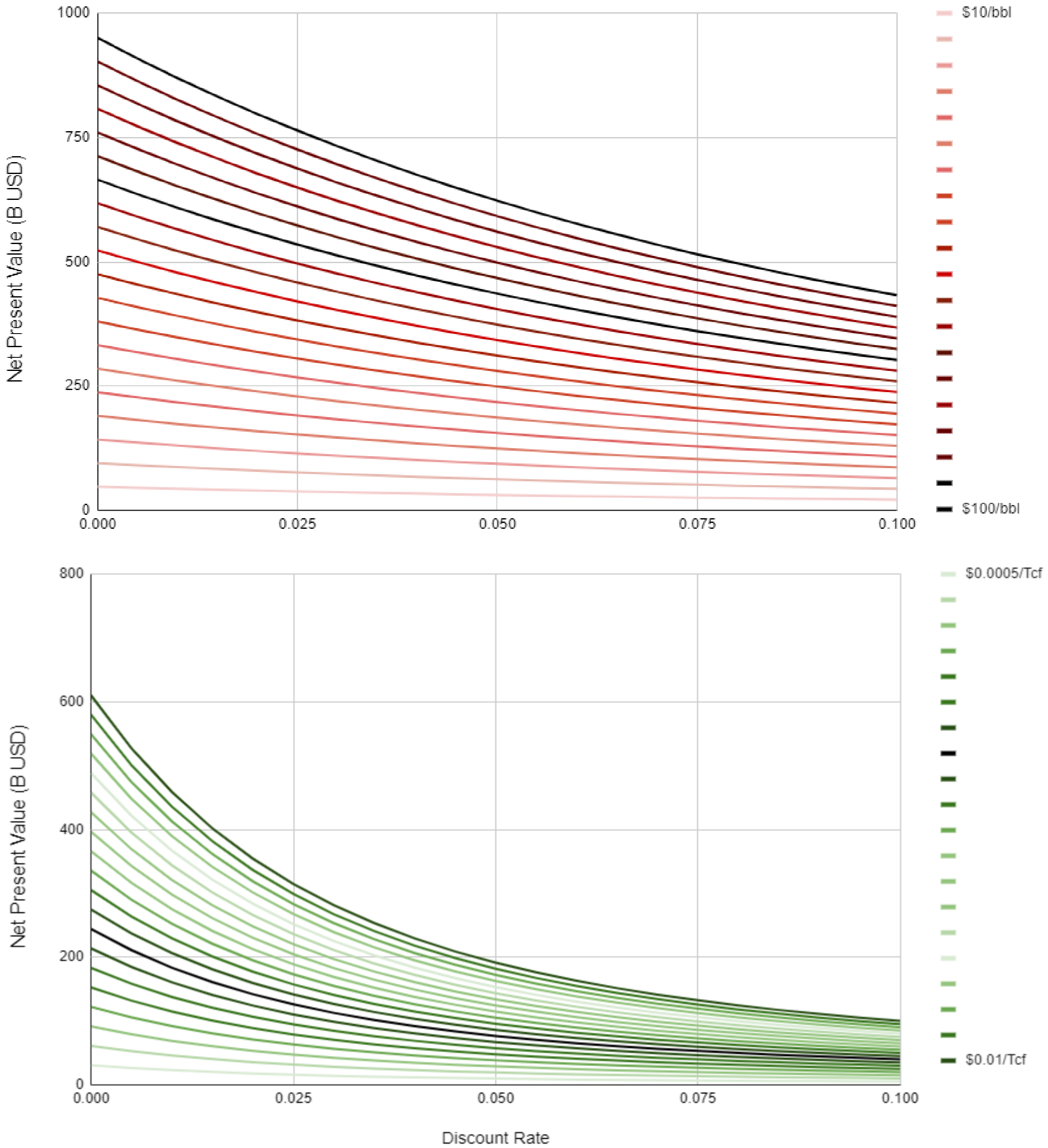
Source: Author

Oil & Gas Reserve Value

The NPV simulation was repeated for South Africa's *potential* oil and gas reserves – that is, for the recent offshore oil and gas discoveries that could add 9Gbbl of oil and 60Tcf of natural gas to South Africa's resource base (see 5.2.2.5) – using the same methods (see 3.5.3), producing Figure 5.2. (Note that the gas reserve NPV is much more sensitive to fluctuations in the discount rate than the oil NPV due to longer timeframe [roughly 60 years of gas vs. 18 years of oil], computed using average production rates for both commodities pertaining to other leading African producers – see 3.5.3). Once more limiting the discount rate to a realistic 1-6%, the average NPV of the oil reserves is $371 billion with a 95% confidence interval of $343-400 billion, while the average NPV of the gas reserves is $145 billion with a 95% confidence interval of $132-158 billion. Unlike the coal case, South Africa is not yet reliant on oil and gas production and consumption from these reserves, so in theory could opt to commercialise and export these reserves almost (if not) entirely, meaning that jointly, $516 billion in revenue streams could arise from commercialising its oil and gas reserves, of which some $26 billion (5%) could land in government accounts due to production rights contract conditions (see 5.2.1.2).

Altogether, ***South Africa's fossil reserves could therefore theoretically yield revenue streams worth $753-886 billion over the next 60 years,*** and stranding these natural assets to comply with climate goals inadvertently implies stranding the bulk of these revenue streams, suggesting that the stranded natural asset risk borne by the South African fossil regime is monetarily substantial. However, again, given that the production of these fossil resources is typically outsourced to private & public E&Ps (see 6.2) – which, according to the Minerals and Petroleum Resources Royalty Act, 2008 must pay a royalty fee between 0.5-5% on all earnings before interest and tax – the South African government could expect to obtain an estimated $4-44 billion in royalties for the development and production of these coal, oil and gas resources, while the producers pocket the lions share.

Figure 5.2. Estimating value of South Africa's potential oil (top, red) and gas (bottom, green) reserves as a function of discount rate and price of resource



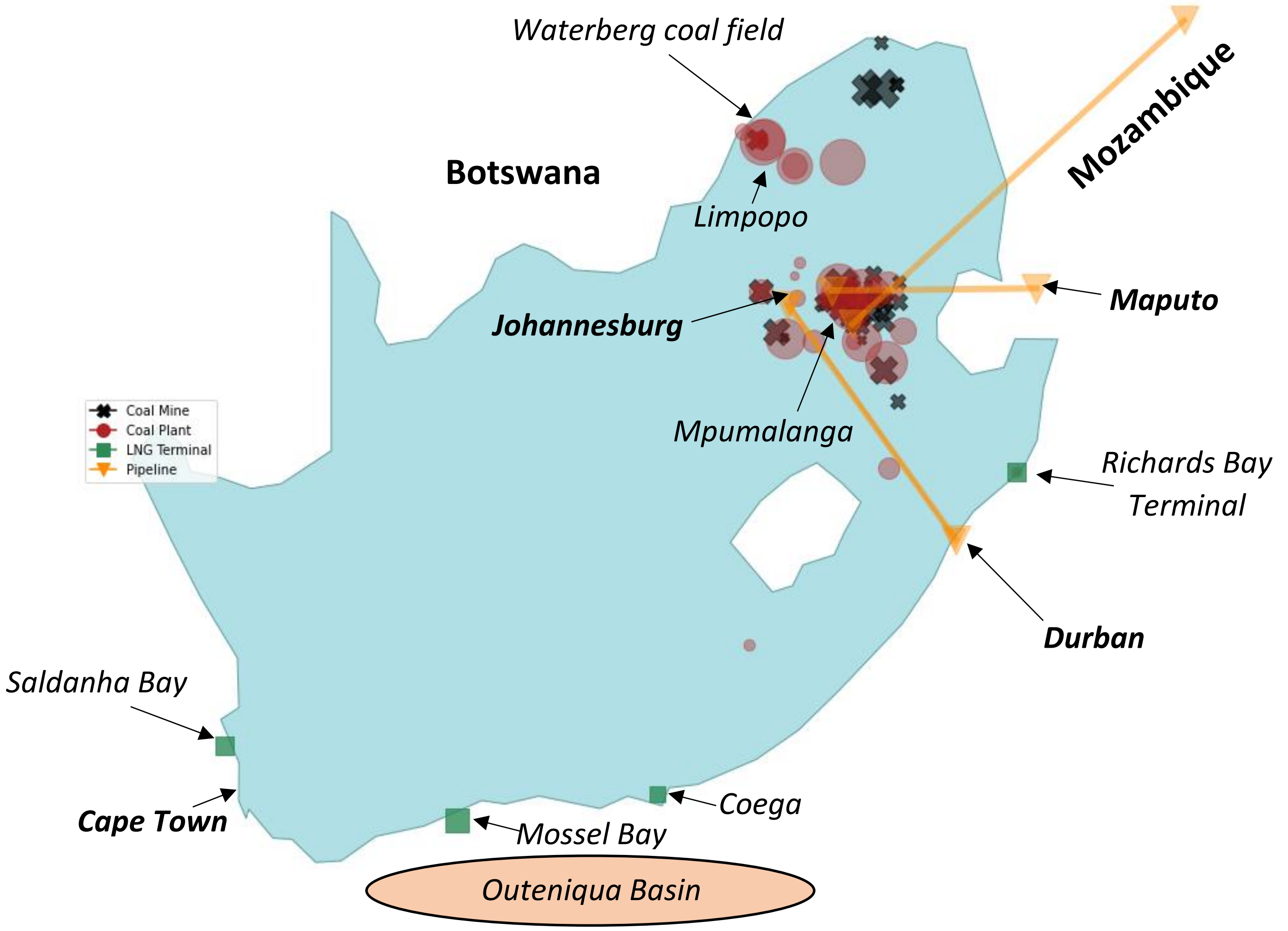
Source: Author

5.2.2. Fossil Infrastructure and Prospective Stranded Physical & Financial Assets

5.2.2.1. Introduction

Building on 5.2.1, this section sheds light on the prospective stranded physical and some accompanying financial assets that reside in South Africa; it focuses first on coal mines (see 5.2.2.2) and coal-fired power stations (see 5.2.2.3), followed by crude oil refineries (see 5.2.2.4), LNG terminals and new oil & gas discoveries (see 5.2.2.5). Figure 5.3 provides an overview of the geographical distribution of these physical assets, which are subsequently elaborated upon through selected key projects corresponding to each asset type – illustrated in Figure 5.4.

Figure 5.3. Overview of South Africa's fossil infrastructure, including coal mines (black), coal-fired power stations (red), oil & gas pipelines (orange), and LNG terminals (green).

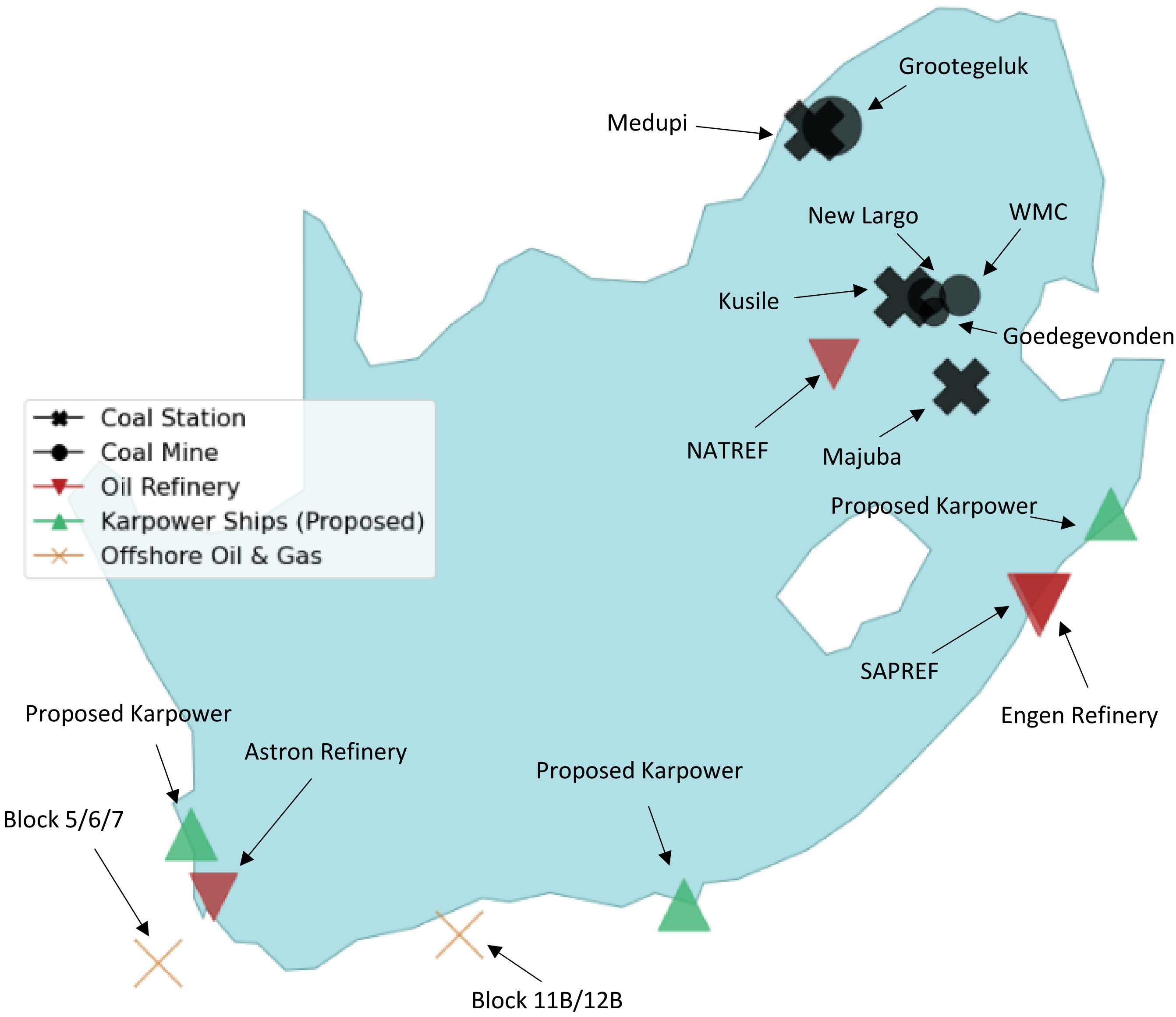


Source: Author, using data from the GEM (2020a; 2020b; 2020c)

5.2.2.2. Coal Mines

South Africa's coal-based infrastructure dominates the MEC, the bulk of which is concentrated in Mpumalanga and to a lesser extent Limpopo. At least 53 coal mines exist (denoted with black 'X's in Figure 5.3). Five domestic companies (Seriti, Canyon Coal, Exxaro Resources, Sasol and Wescoal) jointly operate 15 coal mines, while ***over half of South Africa's coal mines are operated by European or Australian multinational E&Ps*** (see Appendix C). According to the DMRE (n.d.), four multinational E&Ps (BHP [South32 subsidiary], AngloAmerican, Sasol and Exxaro) alone are responsible for producing 85% of South Africa's saleable coal. Note that Sasol and Exxaro have their headquarters in South Africa but are themselves multinationals with international shareholders (see 6.2.2).

Figure 5.4. Map visualising key sampled South African fossil fuel projects to scrutinise



Source: Author

Grootegeluk

Grootgeluk is one of South Africa's largest and oldest coal mines; located in Lephalele (see Figure 5.4), in the Waterberg coal field, it was commissioned in 1981 by ArcelorMittal and later acquired by the current owner, Exxaro Resources. In July 2021, Exxaro had a market cap of $3.04 billion and its major shareholders were predominantly South African asset managers, although US investors like Vanguard ($68 million), Blackrock ($45 million) and Dimensional Fund Advisers ($40 million) were also noteworthy. Grootgeluk allegedly employs some 3,200 direct personnel (though this metric has been disputed) and has proven coal reserves of 2.58Gt, equivalent to approximately *26% of South Africa's 2019 proven reserves*. With an annual production rate of 26Mtpa, Grootegeluk alone accounts for 55% of Exxaro Resources' overall annual 2020 coal production.

Of this 26Mtpa annual production, only 1Mtpa is exported, while the remainder is thermal coal that is consumed domestically. The mine supplies coal to Eskom's Matimba coal-fired power station, and is also the sole coal-supplier to Eskom's Medupi facility (see 5.2.2.3). Grootegeluk is being expanded by 50% (to a total capacity of 45Mtpa) to accommodate Medupi's gargantuan capacity, which will come at an estimated aggregate cost of $1.2 billion; even at this amplified production rate, Grootegeluk's reserves may last over 54 years. In 2020, Exxaro allocated R6.5 billion ($450 million) in capital expenditures for two expansions, one to increase the semi-soft coking coal capacity by 1.7Mtpa (R5.2 billion), and the other to increase the load capacity of the mine's rapid load-out station by 12Mtpa (R1.3 billion); it is quite clear that their decision to expand the mine comes after Exxaro secured the lucrative tender from Eskom in 2008 to act as Medupi's sole coal supplier (see 5.2.2.3).

Goedegevonden

The Goedegevonden mine is located in Mpumalanga, near the Ogies (see Figure 5.4). Commissioned in 2004, its 2020 recoverable reserves sat at 206Mt of coal, which, given its annual production of 7-10Mtpa, suggests the mine will operate another 20-30 years. Half of its annual coal production is used to supply the Majuba power station (currently delivered by road transport), while the remaining half is sold to Eskom for use at other undisclosed power stations. After construction, the total costs for commissioning Goedegevonden were estimated at roughly R3 billion ($375 million) in 2007. Currently, Goedegevonden employees 630 direct and permanent personnel.

Goedegevonden is owned by both Glencore's South African subsidiary (49%) and ARM Coal (51%), a joint venture between African Rainbow Minerals (ARM) (51%) – a South African-based multinational – and Glencore as well (49%), which means that Glencore effectively owns 74% interest in and is the operator of the mine. Glencore's Goedegevonden operations account for 42% of its South African production (24Mt in 2020) and 100% of its domestic coal sales. Moreover, Goedegevonden's coal production comprised 9.4% of Glencore's global 2020 operations, altogether indicating that it is a valuable asset for the Swiss multinational. Moreover, in 2020, Glencore spent a total of $175 million in capital expenditures on its South African thermal coal operations, of which $147 million were for 'sustaining' and $28 million for 'expansion'.

Wolvekrans Middelburg Complex (WMC)

WMC is a coal mining complex in Mpumalanga, near Middleburg (see Figure 5.4); the complex has 383Mt of recoverable coal reserves and produces roughly 14Mtpa, though its listed peak production capacity is 26Mtpa. Of this 14Mt, 8.5Mt of coal is supplied to Eskom's neighbouring Duvha power station, for which Eskom has signed a purchase agreement through 2024 (with the option to extend); the remaining 5.5Mt of coal is either sold to Eskom for other facilities or is transported by rail to Richard's Bay Coal Terminal for exporting. Commissioned in 1982, WMC has 23 years of expected life remaining as of 2022.

WMC was originally owned and operated by BHP Billiton, but its operating rights were eventually sold to South Africa Energy Coal, a joint venture between South32 (with 92% operating interest) and a smaller, majority black-owned shareholder called Phembani Group (8% interest). However, in July 2021, *South32 divested its operating interest in the WMC to domestic producer Seriti Resources*. Seriti is now "Eskom's second-biggest coal supplier, at 32.5% — about 39-million tonnes — of the state-owned utility's coal procurement spend" (GEM, n.d.: np), only trailing Exxaro Resources – owner of the Grootegeluk mine (see above).

5.2.2.3. Coal-fired Power Plants

South Africa's coal-fired power stations are also concentrated in Mpumalanga and Limpopo (see Figure 5.3), and 17 of its 23 coal stations are owned and operated by Eskom (see Appendix C). The average remaining lifetime of South Africa's coal-fired power plant fleet is 18 years (assuming a 40-year lifetime), with some of Eskom's plants close to retirement (as of 2022), like Duvha (2 years remaining), Hendrina (3 years) and the Richards Bay Mill power station (3 years). Moreover, South Africa's existing and forthcoming coal plants jointly emit 260 $MtCO_2e$ per year and have lifetime emissions of almost 4,000 $MtCO_2e$. Below I delve deeper into one key coal-fired power station that earmarks South Africa's prospective coal-intensive stranded assets (see Appendix C for two others).

Medupi

Medupi is one of Eskom's (and de facto South Africa's) largest coal-fired power stations. It is located in Lephalale, Limpopo province – near the Waterberg coal field (see Figure 5.4) – and is composed of six 800MW units, yielding a total of 4800MW of installed coal-fired capacity, equivalent to 14% of South Africa's projected installed coal capacity by 2030 (see 1.3.2.1). Eskom secured funding for the project in 2008/9, though 13 years have elapsed and Medupi is not yet fully functional, with units 3 and 4 connected to the grid in 2021 and units 5 and 6 projected to do so by 2022.[37] That said, Medupi's grid-connected units are only operating with Energy Availability Factors (EAFs) of 85-90%, which is "certainly not what one would expect from a properly functioning, relatively new, base-supply unit that underwent a major 10-week rework outage a year earlier" (Yelland, 2021: np). Moreover, Medupi has an expected lifetime of 50 years, and given its annual emissions of 32$MtCO_2e$ (accounting for roughly 8% of South Africa's proposed 2030 emissions targets – see 1.3.2.1), Medupi will emit over 1.6 billion tons CO_2e in its lifetime.

Exxaro Resources is the sole supplier of coal to Medupi (from the Grootgeluk mine – see 5.2.2.2); Grootgeluk is expected to increase coal production from 30Mtpa to 46Mtpa to accommodate Medupi's 4800MW capacity, which alone accounts for 17% of South Africa's coal production. That said, "Eskom's own consultants estimate that 35 new coal mines will be required to support Medupi and Kusile" (GEM, n.d.),[38] suggesting that Medupi's coal-dependence may be underestimated.

To say that Medupi was an 'internationally-influenced' project would be an understatement (depicted in Figure 5.5), notwithstanding its South African 'ownership' via Eskom. The two leading firms contracted to engineer and develop Medupi were Hitachi Power Europe (HPE),[39] the German-based subsidiary of the Japanese multinational conglomerate, who was contracted (for R20 billion, or $1.5 billion in 2008) to produce the boiling units for both Medupi and Kusile, and Alstom, the French-based manufacturer contracted (for R13.6 billion, or roughly $1 billion in 2008) to engineer Medupi & Kusile's steam turbines. In 2014, Eskom terminated its contract with Alstom due to dissatisfaction with the project's progress, at which point Siemens (the German multinational) was contracted to take over.

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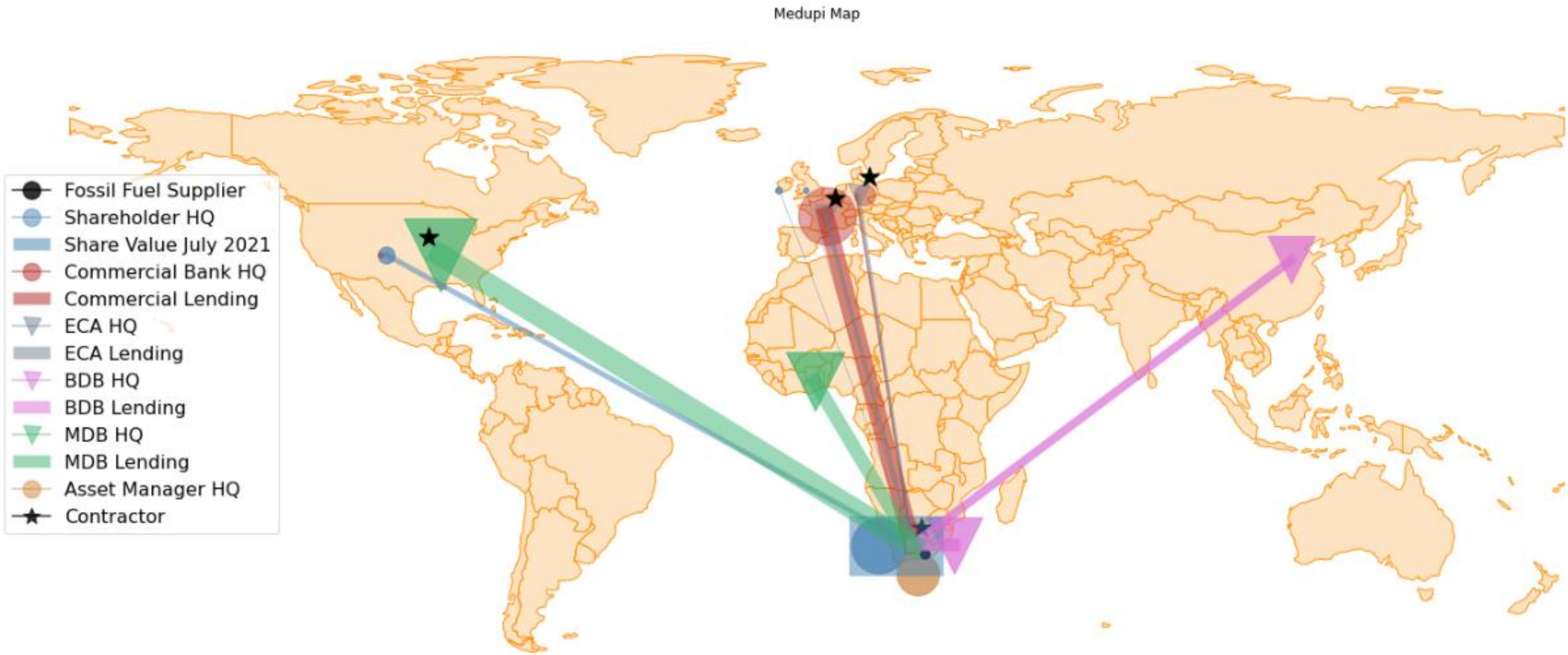
[37] On August 8, 2021, an explosion has rendered Medupi's unit 4 severely damaged and completely unable to produce power. Reparations could cost as much as R2 billion and may take as long as 2 years, one report noted (Yelland, 2021).

[38] Kusile is Medupi's sister plant, which was built and financed in tandem with Medupi and by similar investors. See Appendix C for a detailed profile and analysis.

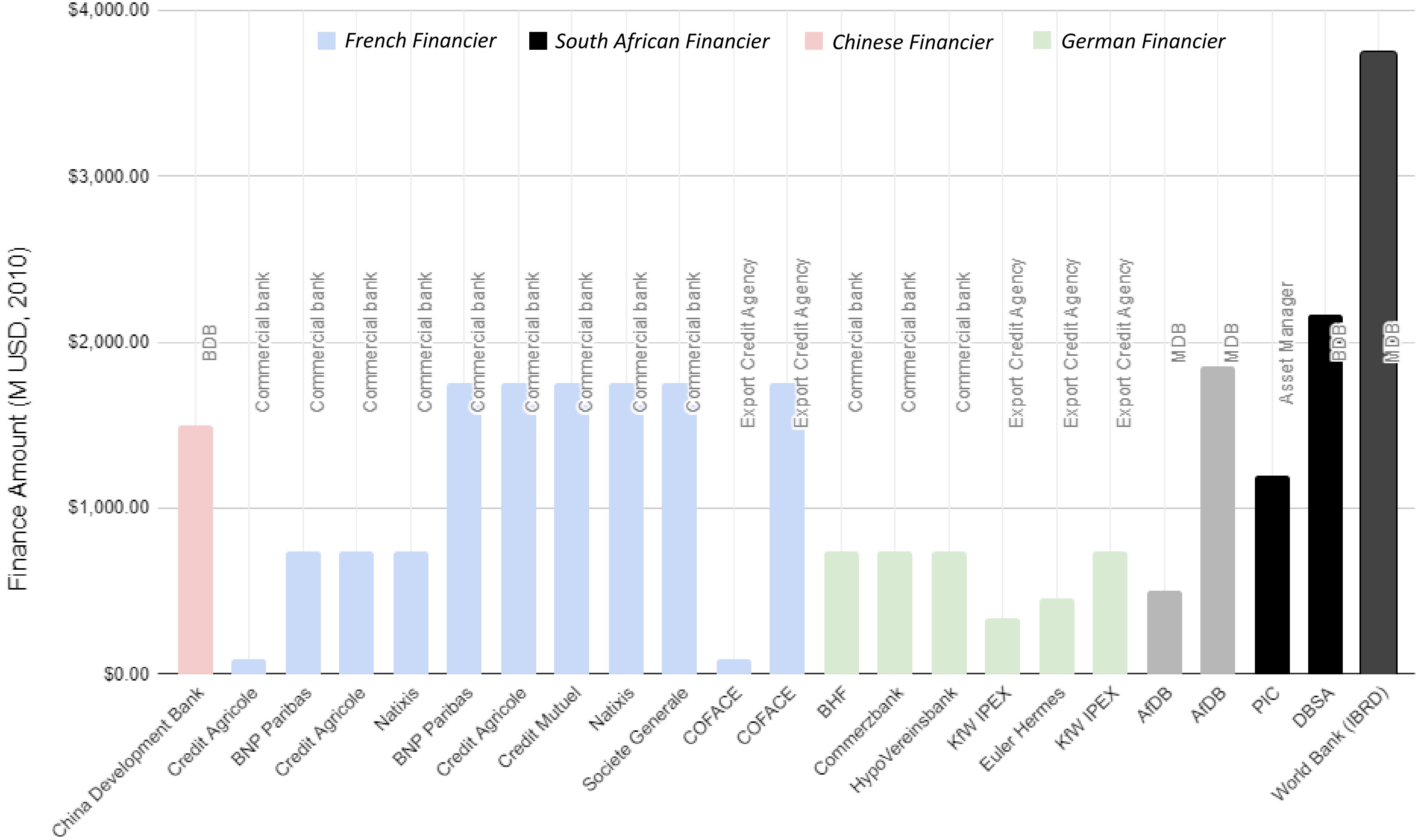
[39] In 2020, Hitachi Power Electric was merged with Mitsubishi to form Mitsubishi Hitachi Power Systems Africa (MHPSA), who took over then contract. Furthermore, in 2014, the US Security Exchange Commission (SEC) accused Hitachi of corruptly bribing the ANC in the early 2000s to acquire the Eskom tender by engaging in a lucrative deal with Chancellor House, an investment company owned by Africa's ruling political party. In response to these allegations, Hitachi agreed to pay the SEC $19 million, of which ***none*** made its way to South Africa.

Figure 5.5. Map depicting the financiers and firms that drove Medupi's development



Source: Author

Figure 5.6. Depiction of Medupi's financiers by type, country and committed project finance



Source: Author

By 2013, Medupi's total project costs were estimated at R150 billion, the bulk of which have been financed by European, North American and Asian public and private finance institutions (summarised in Figure 5.6). The World Bank (through the IBRD) and AfDB led the charge by committing \$3.75 billion and \$1.86 billion, respectively (the former to be repaid in 28.5 years with a 7 year grace period, the latter in 20 years with a 5 year grace period). Furthermore, with German ECA Euler Hermes and French ECA COFACE backing the project, nine French and three German commercial banks also issued syndicated loans worth \$2.45 billion and \$740 million, respectively; the former would fund Alstom's French-engineered steam turbines, and the latter would finance HPE's German-engineered boilers. Moreover, JP Morgan Chase – the US-based commercial bank – did not itself finance the project but did play a consultancy role by 'advising Eskom on its funding options' (BankTrack, 2016).

Bilateral investments were also ample, mainly stemming from South Africa's own BDB – the Development Bank of Southern Africa (DBSA) – who issued a \$2.17 billion corporate loan in 2010, though this loan did "not utilize guarantees from the South African Government" (BankTrack: np). Subsequently, the Chinese Development Bank (CDB) issued a \$1.5 billion corporate loan *in 2017*, once Eskom was growing short of cash and the project costs were mounting. Finally, the PIC, South Africa's largest asset manager and investment vehicle, invested \$1.2 billion in equity, denoting the only major equity investment in the Medupi project.

The World Bank loan included a floating interest rate as a function of the London Inter-Bank Offered Rate (LIBOR). Using the IBRD's publicly disclosed financials (World Bank, n.d.), the annually compounded interest rates can be reverse engineered (see Appendix B for details). For instance, in 2017, Eskom repaid the IBRD \$208 million in interest; given that the IBRD had disbursed \$3.13 billion by 2017, and therefore, \$3.13 billion was the remaining principal to be repaid on the loan in 2017:

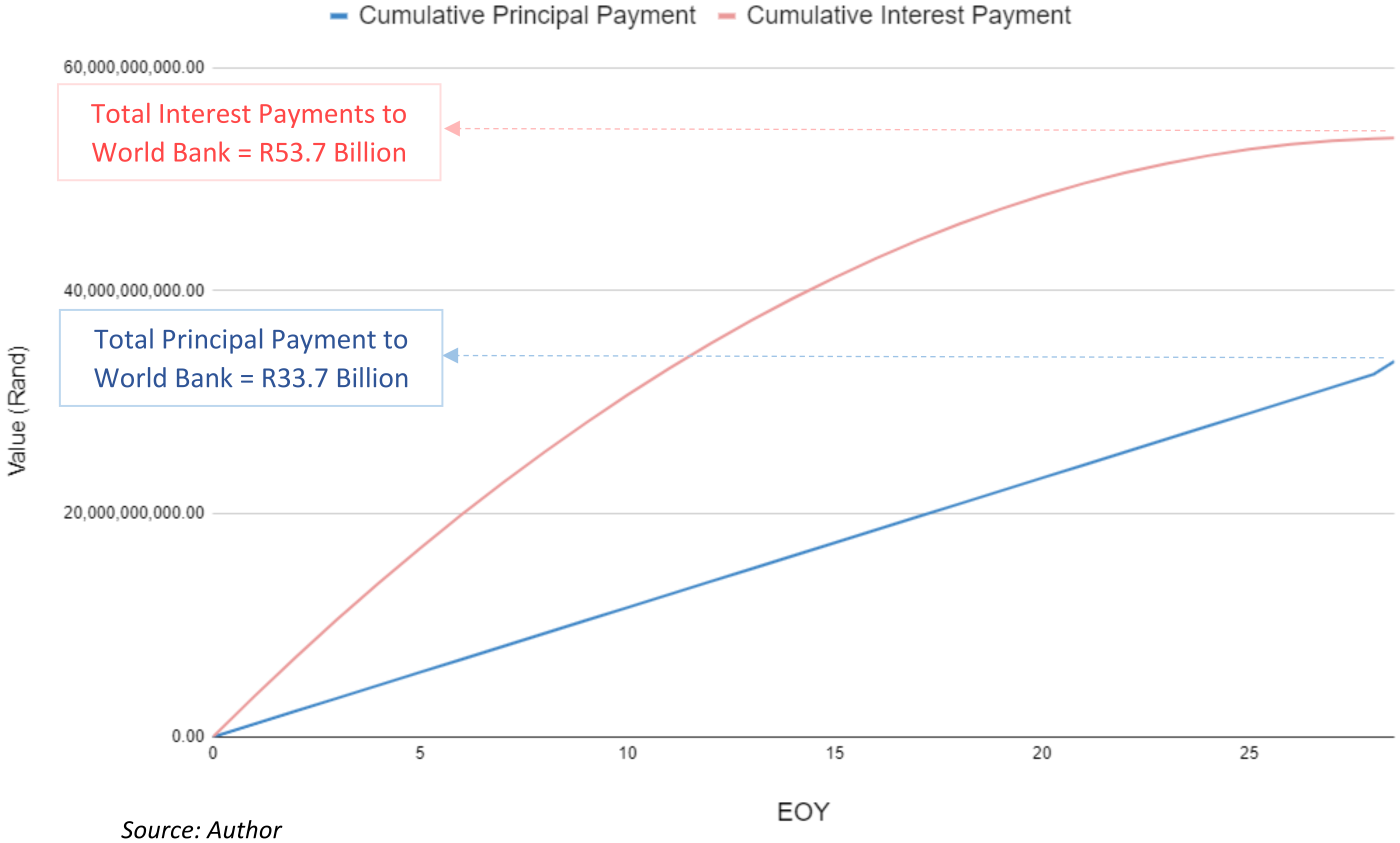
$$IR_{2017} = \frac{interest\ paid}{remaining\ principal} = \frac{\$208M}{\$3.13B} = 6.63\%$$

Repeating these calculations for years 2018-2020 reveals an average, nominal, annually compounded interest rate of 6.8%. However, the South African Rand has devalued from roughly 8 Rand/USD in 2010 to almost 15 Rand/USD by 2021, which is relevant because the World Bank loan is to be repaid in US dollars, while Eskom operates its business in South African Rands. By accounting for the deflated exchange rate, the *effective* interest rate that Eskom experiences is much higher:

$$IR_{2017,eff} = \frac{interest\ paid, rand}{remaining\ principal, rand} = \frac{R2.8B}{R29.4B} = 9.5\%$$

Repeating these inflation-adjusted calculations for 2018-2020 reveals that Eskom has in reality paid an average, effective interest rate of roughly 11%. *If this rate persists, Eskom will have paid the World Bank R53.7 billion in interest over the 28.5 year payment period, compared to the principal loan value of R33.7 billion* (see Figure 5.7). That is, from 2017 through 2046, Eskom will have paid almost R87 billion to the World Bank, of which at least ***62% is in the form of interest***. For this analysis, this translates to a substantial stranded debt that Eskom has absorbed onto its balance sheet, which the World Bank (among the other aforementioned debt financiers) expect to be repaid even if coal production or consumption is curtailed and fossil fuels are phased out in South Africa.

Figure 5.7. Cumulative interest payments (red) and principal payments (blue) that Eskom is expected to make to the World Bank for its $3.2 billion loan for financing Medupi



Source: Author

5.2.2.4. Pipelines & Crude Oil Refineries

South Africa's oil and gas infrastructure is existent but pales in comparison to that of coal – see Figure 5.3 (also see Appendix C); currently there are three operational pipelines (depicted in orange). One pumps over 90kboe/d of natural gas from Mozambique to South Africa (100% owned by Sasol and built in 2004), while the other two (both 100% owned by Transnet, the state-owned railway transport company) jointly pump over 150kbbl of oil from Durban to Johannesburg. One of these was built in 1965, while the New Multi-Purpose Pipeline (NMPP) was built more recently in 2012.

Four crude oil refineries currently contribute to South Africa's stranded asset risk, two of which are outlined below (see Appendix C for two others). [40]

SAPREF

SAPREF is South Africa's largest and oldest crude oil refinery; it is situated in Durban and is owned by a 50-50 joint venture between Shell and BP. Commissioned in 1963, SAPREF's production capacity is between 175,200-180,000 bbl/d (equivalent to 35% of South Africa's total refining capacity) and it employees 580 full time staff and 600 temporary contractors. However, recent reports indicate that Shell and BP have recently issued a tender to US firm KBR to upgrade the refinery's fluid catalytic cracker in a bid to expand the refinery capacity to an undisclosed amount.

Crude oil is imported from Saudi Arabia (38%), Nigeria (29%), Angola (16%), Iran (7%) and UAE (4%), among others, by tanker ships and is offloaded at SAPREF's 'single-buoy mooring' (SBM); this SBM is

[40] Sasol's Secunda refinery is a fifth, though it refines solid coal into liquid and gaseous hydrocarbon fuels (CTL, CTG)

responsible for importing ***80-85% of South Africa's imported crude oil***, ***implying that Shell and BP singlehandedly control 80-85% of South African oil imports***. Once imported, the crude oil is refined into 10 different products (including petrol, diesel and liquid petroleum gas, among others) and is "delivered via… underground pipelines to the Island View Tank Terminal in Durban's harbour" (Groundwork, 2001: 7).

Astron Refinery

Cape Town's 100,000bbl/d capacity crude oil refinery (formerly called 'Chevref') was owned and operated by Chevron, but in 2017/8 Swiss mining giant Glencore assumed ownership of the refinery after acquiring Chevron's South African and Botswanan assets for $973 million and $32 million, respectively; this denotes yet another instance in which a multinational firm divested its South African assets (see 5.2.2.2). "As part of the deal, [Astron Energy, Glencore's subsidiary] has undertaken to invest 6bn rand ($500mn) over five years to develop the Cape Town refinery and expand South Africa's refinery capacity" (Glencore, 2020: 55), indicating that there are no plans to retire the 55-year-old facility in the coming years. Recall that Glencore owns and operates several coal mines across South Africa, including Goedegevonden (see 5.2.2.2).

Originally commissioned in 1966, the now-renamed Astron Refinery is the smallest in South Africa – though it still accounts for 20% of South African crude oil refining capacity. Critically, however, this is the only refinery on South Africa's western coast, and thus handles all Cape Town crude oil imports. Although the refinery's annual emissions are not disclosed, Glencore (2020: 16) explicitly notes that "[e]missions resulting from customers' use of the oil products refined at the Astron refinery are excluded from our Scope 3 emissions total as we neither originate nor consume the products", adopting a 'Not-On-My-Balance-Sheet' (NOMBS)[41] approach to emissions accounting.

5.2.2.5. LNG Terminals and New Oil & Gas Discoveries

Figure 5.3 also illustrates South Africa's four LNG terminals, though the Mossel Bay terminal (proposed by Petro SA) was cancelled in 2014 due to inadequate meteorological and oceanographic conditions. Two others (Coega and Saldanha) are likely shelved, as their proposals and developments began 5-15 years ago but no developments have been noted since 2018 for either. The final terminal (Richards Bay) is in the proposal phase (operated by Transnet) and is currently procuring bidders to finance and operate a gas-fired power facility that will accompany the terminal. The Richard's bay terminal is expected to begin operation in 2024 and will have a capacity of 0.14Bcf/d – or 0.051Tcf per annum.

Brulpadda & Luiperd Discoveries

These new LNG terminal proposals are, however, currently gathering momentum in light of two recent and substantial oil & gas discoveries led by French multinational TotalSA: the 2019 Brulpadda-1AX and 2020 Luiperd-1X discoveries. Both discoveries were made in exploration Block 11B/12B, which is located roughly 175km south of Port Elizabeth in the Outeniqua Basin (see Figure 5.4). Block 11B/12B is operated by four multinationals: French giant Total SA (45%), which has operating rights; Qatar Petroleum (25%), Qatar's state-owned oil producer; Canadian Natural Resources (20%), the Canadian multinational; and Main Street (10%), a joint venture with split ownership between a private South African business man, Phuthuma Nhleko (51%) and another Canadian oil & gas producer, Africa Energy Corp (49%).

These two discoveries could add 9Gbbl of oil and 60Tcf of natural gas to South Africa's proven reserves, which, paired with hopes that similarly recoverable reserves exist elsewhere in the block, has left

[41] Originally coined by Acevedo (2012), though in the context of corporate social responsibility rather than specifically fossil fuel assets

shareholders commemorating them as "one of the most exciting oil and gas exploration plays in the world today" (Ganta, 2020: np). Africa Energy Corp. has also expressed optimism due to the discoveries' proximity to already existing infrastructure, namely the Mosel Bay Gas-to-Liquids (GTL) refinery, owned and operated by state-owned enterprise PetroSA, and an operational pipeline linking said pipeline to an exploration block adjacent to 11B/12B. According to TotalSA CEO, an application for production rights will be filed with the South African DMRE by September 2022, and first oil and gas is projected for 2025.

5.2.2.6. Analysis: will this infrastructure really be stranded?

Some preliminary calculations reinforce the assumption that the bulk of South Africa's existing fossil infrastructure may become stranded sooner rather than later:

*Scope 1 emissions (self-reported) from **three of 23** coal-fired power plants:*[42]

$$\boldsymbol{E_{cp}} = E_{medupi} + E_{kusile} + E_{majuba} = 89MtCO_2e\ pa$$

*Scope 1 emissions from **four** crude oil refineries:*[43]

$$\boldsymbol{E_{ref}} = Total\ Annual\ Capacity * Carbon\ Intensity$$

$$= \frac{425{,}000bbl}{day} \times 365\ day \times \frac{38kgCO_2e}{bbl} \cong 6MtCO_2e\ pa$$

Together, this shows that total scope 1 emissions from merely three coal plants and four[44] oil refineries $\cong \boldsymbol{95MtCO_2e\ pa}$. These scope 1 emissions already account for 22-24% of South Africa's 2030 pledged emissions reductions (see 1.3.2.1), and *27-51% of the estimated emissions necessary for South Africa to be 1.5°C compatible* (Carbon Tracker, 2021). Note that this excludes emissions from the dozens of other coal-fired power stations in South Africa (see 5.2.2.2) and the rest of the power sector, in addition to all direct emissions from other emissions-intensive sectors, transportation and agriculture.

Now consider the potential lifetime scope 3 emissions if the oil and gas resources from the Brulpadda and Luiperd discoveries are recovered: [45]

$$E_{expl} = E_{oil} + E_{gas}$$

$$= \frac{15gCO_2e}{MJ_{crude}} \times \frac{6120MJ_{crude}}{1bbl} \times 9Gbbl + \frac{0.05312kgCO_2e}{cf_{gas}} \times 60Tcf$$

$$= 827MtCO_2e + 3{,}187MtCO_2e = 4{,}014MtCO_2e$$

Assuming the average production rates from section 5.2.1.2, this would equate to, annually:

$$\frac{827MtCO_2e}{18\ years} + \frac{3{,}187MtCO_2e}{60\ years} \cong 46MtCO_2e\ pa + 53\ MtCO_2e\ pa \cong 100MtCO_2e\ pa$$

That is, the potential emissions from the newly discovered offshore oil and gas reserves alone equate to 23-25% of South Africa's pledged 2030 NDC emissions targets and 29-36% of a 1.5°C compatible scenario (280-350 $MtCO_2e$). Although this operates under the assumption that 100% of the recovered

[42] Note Kusile and Majuba coal plants are discussed in Appendix C
[43] Assuming that 1 barrel of crude oil has a carbon intensity of 38kg CO_2e (Jing et al., 2020)
[44] Including SAPREF and Astron discussed in text, and NATREF and Engen refineries in Appendix C
[45] Assuming 15g CO_2e is emitted per MJ crude oil (Masnadi et al., 2018) and 0.05312kg CO_2e is emitted per cf natural gas combusted (EIA, 2016)

oil and gas is combusted, which is likely not the case since (particularly crude oil) is refined into other non-fuel products (e.g., plastics, bitumen), it nevertheless serves as a useful indicator of the magnitude of emissions (and thus, 'climate emergency' exacerbation) that could hypothetically ensue if these reserves were to be fully commercialised.

Together, the scope 1 emissions from the four refineries and three coal-fired power plants together with the scope 3 emissions from the Brulpadda & Luiperd discoveries aggregate to an estimated 195MtCO_2e per year, equivalent to 56-70% of emissions compatible with a 1.5°C warming scenario[46] - this does not even include the emissions from any of South Africa's 50+ coal mines, CTL and CTG refineries, or other fossil-consuming sectors (like transport)!

Expanding the scope, South Africa's entire coal-fired power station fleet emits roughly 260Mt CO_2 per annum[47] with a current installed capacity of 37GW coal (see Figure 1.1) – equivalent to roughly 7Mt CO_2 per GW_{coal}. Given that the IRP proposes reducing South Africa's coal capacity to 33GW by 2030:

$$Emissions_{coal,2030} = \frac{7Mt\ CO_2}{GW_{coal}} \times 33GW_{coal} \cong 232\ Mt\ CO_2$$

South Africa's annual emissions *from coal-fired electricity production alone* will sit at around 232Mt CO_2 per year through 2030,[48] accounting for 53-58% of its NDC target. This does not even include emissions from: coal extraction (i.e. mining), the additional 3GW of natural gas set to be introduced to the grid (see 1.3.2.1), crude oil refinement (see 5.2.2.4), or other sectors.

Overall South Africa's annual emissions in 2030 would very likely surpass its own 440Mt CO_2e NDC target upper-limit, let alone levels deemed compatible with a 1.5°C rise (Carbon Tracker, 2021); altogether, it therefore seems very likely that in order for South Africa's fossil regime to align with Paris Agreement Article 2.1a, the majority of its existing fossil-intensive facilities (i.e. physical assets) may be decommissioned and therefore stranded in the coming decade(s).

5.2.2.7. Summary

Sections 5.2.2.2-5.2.2.6 show that South Africa's exposure to prospective stranded physical assets is vast, evident from the dozens of operational coal mines, 23 operational coal-fired power plants, four crude oil refineries, and three operational oil and gas pipelines that are scattered across the nation – in addition to forthcoming facilities that may rise (like new coastal LNG terminals) given the substantial oil and gas discoveries recently made in block 11B/12B. Accordingly, these infrastructural projects bring with them financial concerns, like in the case of Medupi, which has singlehandedly sent Eskom into at least R87 billion in debt to the World Bank alone – a debt that the World Bank expects to be repaid regardless of a fossil phaseout unravelling or not. An inclusive South African fossil phaseout implicitly requires adequately decommissioning these facilities and governing the accompanying unemployment and stranded energy that will arise in doing so, which are unpacked in the following section.

5.2.3. Prospective Stranded Human Assets

5.2.3.1. Introduction

This section builds on 5.2.1 & 5.2.2 by shifting the analytical focus to South Africa's exposure to prospective stranded human assets, focusing primarily on *energy* and *labour*, as these were the two

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[46] Carbon Tracker (2021)
[47] GEM (2020a)
[48] The IRP presumes that South Africa's coal fleet will become more efficient after introducing new HELE and CCUS technologies; however, the reality is that its coal fleet is aged (average of 22 years old), and based on the IRP projects, 26GW of the current (inefficient and mostly subcritical) 37GW of installed capacity will remain operational through 2030.

most ubiquitously mentioned themes within the stranded human asset dimension in the mined news items and semi-structured interviews (see 3.5.3).

5.2.3.2. Stranded Energy

According to the IRP (DMRE, 2019: 18), “South Africa still has 3-million households without access to grid-based electricity” – equivalent to 5% of the population – though this fraction is likely at least 15% based on national household survey data reported by the World Bank (n.d.). Grid connection does not guarantee energy access, however; “20 years ago, South Africa used to be the 4th cheapest energy provider in the world, now they are one of the most expensive,”[49] because Eskom steadily increased its (predominantly coal-fired) electricity tariffs, and most recently did so in April 2021 by over 15%. Average electricity prices in South Africa now sit at $0.15/kWh, which many South African’s “cannot afford”, resulting in “the majority of the working class suffer[ing] from energy poverty” (SAFTU, 2020: np).

Affording electricity prices does also not guarantee access. Eskom is notorious for its load shedding (scheduled blackouts) due to old and decrepit coal fleet; these power cuts not only affect households but also local to national businesses as essentially the entire South African economy is put on standby,[50] and even Eskom’s newest and most ‘efficient’ coal plants, like Medupi & Kusile (see 5.2.2.3 and Appendix C) have already been plagued with inefficiencies. South African economists agree that “[u]rgent steps must be taken… to bring the cheapest and most reliable energy on to the grid within the next three years. Coal, nuclear and substantial gas infrastructure cannot be brought online within that time frame” (Swilling, 2020).

Renewable electricity tariffs have “fallen sharply... to around 5USD$c/kWh” (Winkler, 2020: 48), and there “is no serious doubt… that grid-connected new wind and solar PV are now cheaper than new coal… power in South Africa” (ibid). Even accounting for “tax-incentives, feed-in tariffs and the cost of capital”, the levelised cost of electricity (LCOE) for solar PV and wind power in South Africa is projected to steadily decline from 66 and 64 Rand cents/kWh in 2020, respectively to roughly 45 Rand cents/kWh by 2040 (Meridian, 2020), altogether indicating that *there is no valid economic case for coal-fired power in South Africa*; “cost is no longer a barrier to significant mitigation in the [South African] power sector… significant climate mitigation does not increase the cost of power – it potentially even reduces cost” (Meridian, 2020: 5).

One hurdle restraining the replacement of extensive coal-fired power with large-scale renewable power in South Africa’s grid is an absence of affordable and adequate grid-scale battery storage capacity. The “prices of battery storage have plummeted over the past five years” (Swilling, 2020: np) and will play an integral role in a low-carbon grid in South Africa,[51] particularly as grid-scale storage research & development continues to unravel; some forecasts predict that investments between $600-700 billion[52] and $1.5 trillion[53] will be funnelled into energy storage procurement over the next 20 years. The latest rendition of the IRP (see 1.3.2.1) includes plans of procuring 0.5GW of storage through 2030, but this is “insufficient… 5GW of storage will be required” (Swilling, 2020: np).

Eskom and the DMRE’s historic approach to supplying power is through a ‘base load’ and ‘peak load’ model (Meridian, 2020). Coal-fired generators are run continuously and inflexibly at their maximum capacity to generate a ‘base load’; when supply exceeds demand – like in the middle of the night –

[49] Interview PRIV_AF3
[50] Interviews PRIV_AF4, NGO_AF10, POL_AF1, NGO_AF14, NGO_AF10, NGO_AF11
[51] Interviews PRIV_AF4, PRIV_AF1, NGO_AF2, NGO_AF7
[52] Solar Power Africa Conference, panellist from Bushveld Energy
[53] Solar Power Africa Conference, panellist from Lockheed Martin

pumped storage systems are charged with the excess coal generation (pumped water to a higher elevation), and when demand exceeds supply, other forms of more flexible power generation are dispatched, including the pumped water storage in addition to gas-fired generation and renewables, thereby generating the 'peak load' power (Meridian, 2020).[54] This system was designed not due to technical restraints, but rather because generating continuous and inflexible coal-fired electricity "produced the least cost power" (ibid: 5); now with renewable prices plummeting, the model could be redesigned to produce both base and peak generation with available e.g., solar PV, wind power and dispatched stored energy (see Matek & Gawell, 2015; Ueckerdt & Kempener, 2015).

Despite the clear economic case for renewables outline above, South Africa's existing power grid is still dependent on coal for 37GW (72%) of total installed *capacity*,[55] though in reality coal is used to produce 85-90% of South African electricity.[56] Accordingly, a South African fossil phaseout implies *stranding* close to 90% of the nation's power production, threatening energy poverty beyond even the 3-9 million South Africans currently without access to reliable and affordable electricity. Beyond electricity, this also implies *stranding* the CTL processes at e.g. Sasol's Secunda refinery, from which the resulting liquid petroleum is used to fuel other energetic needs like transport; although an analysis of the transport sector is beyond the scope of this research, Table 5.1 shows the of the 250Gbbl of oil consumed in South Africa in 2020, 190Gbbl was imported, implying that roughly 60Gbbl was produced domestically using coal. A substantial coal phaseout therefore also indirectly threatens South African access to other forms of energy, including petrol and diesel, among other petroleum products.

5.2.3.3. Stranded Employment

There are some 90,000 coal miners in South Africa (Meridian, 2020); these are *direct* jobs generated by the coal mining sector. *Indirect* jobs in this context encapsulate the "people employed by supplying goods and services" to coal-fired power generation (Meridian, 2020: 4), like steam turbine developers (see 5.2.2.3) – which may contain up to 180,000 South African jobs,[57] and *induced* jobs entail "those employed to provide goods and services to meet consumption demands of additional directly and indirectly employed workers" (ibid), for example, financial services offered to the aforementioned steam turbine developers. These three dimensions can be further broken down into *construction* and *operation & management* jobs (Meridian, 2020); the brunt of attention vis-à-vis a fossil phaseout has been paid to *(in)direct construction* and *(in)direct operation* employment, likely because these encapsulate the vast and vulnerable labour that the mining sector absorbs.

Some estimates suggest that up to 35,000 coal mining jobs will disappear as older coal stations are decommissioned due to "**Eskom's own build programme (Medupi & Kusile) which is stranding the older stations – not by renewable energy**" (Meridian, 2020: 2, **emphasis added**), although an additional 55,000 coal mining jobs may be created[58] if efforts to expand mining in the Waterberg coal field in Limpopo are pursued (see 5.2.2.2). Some optimistic estimates predict that over 160,000 direct and indirect solar PV jobs and 385,000 wind power jobs will be created in South Africa (Res4Africa, 2020) according to the plans embedded in the IRP (see 1.3.2.1).

[54] Interview NGO_AF2, PRIV_AF4
[55] DMRE (2019)
[56] Cock (2018)
[57] Interview PRIV_AF2
[58] Though it remains to be seen whether these jobs will ever be allocated for South African coal miners. An undisclosed Chinese mining company allegedly promised to create 500 mining jobs at a mining operation in Limpopo province, but rather than hiring locals, the firm imported Chinese personnel that were already trained and able to begin mining immediately (Milne, 2020)

Discrepancies in the temporality of coal mining vs. renewable sector jobs is often voiced as a concern,[59] namely that the former span the long-term while the latter are typically concentrated in the construction phase and are thus bound to the short-term. However, as climate expert Mark Swilling (2020: np) notes, "once you start building renewable energy, you cannot stop, because what you build this year (say 5GW), must get rebuilt in 20 years", and conversely, coal mining jobs "reduce over a long 20-year period as coal mines that service Eskom close…. [to] argue that the energy transition means less [durable] jobs is totally wrong."

A key challenge is that direct and indirect construction and operation & management jobs in coal mining and fossil-alternatives are not immediately interchangeable, and the latter typically requires a different set of skills. For example, solar PV will require structural and power systems engineers for system design (Res4Africa, 2020); similarly, wind power development necessitates meteorological technicians and civil engineers for development (ibid). Most of these require a four-year bachelor's degree, which not all coal miners have. However, "the average age of most coal miners is between 45 and 60, which means they are going to retire anyway during the 20-year transition period to a renewable energy system" (Swilling, 2020: np), meaning that retraining may not be necessary for older coal miners and rather, funds could be allocated to equitably finance their retirement in a bid to inclusively govern the stranded labour (see Pollin & Callaci, 2018). However, if decommissioning "goes too slowly, older workers will retire and newly hired (younger) ones will eventually have to be retrenched" and retrained (Swilling, 2020: np).

5.2.3.4. Summary

In addition to exposure to prospective stranded natural, physical and financial assets, South Africa is prone to incurring significant stranded human assets in a fossil phaseout, here illustrated by the 37GW of installed coal-based power capacity (prospective stranded energy) and the 270,000+ direct and indirect jobs currently bound to South African coal production, notwithstanding the hundreds of personnel currently working at South Africa's oil refineries (prospective stranded labour). An inclusive South African phaseout will have to grapple with these stranded asset considerations, particularly in order to ensure that the ideals of the social inclusiveness pillar are withheld (see 5.4).

5.3. Beyond South Africa: Mapping African Prospective Stranded Assets

5.3.1. Introduction

This section aims to contextualise the South African prospective stranded asset stocktake from 5.2 within the context of the broader African continent. It does not go into as much detail as the South African analysis in sections 5.2.1-5.2.3, for doing so for all African nations would be infeasible; rather, the section paints an overview of the prospective stranded natural and physical assets scattered across the African continent, with the purpose of drawing linkages to the South African case and beginning to shed light on the African continent's stranded asset exposure.

5.3.2. Prospective Stranded Natural Assets

5.3.2.1. Proven Reserves

Africa's 2020 proven oil reserves sat at 126Gbbl (BP, 2020; OPEC, 2020); this equates to roughly 7.3% of global proven oil reserves (1,734Gbbl). Figure 5.8 (top row, middle column) shows that these proven reserves are relatively concentrated in Libya (48Gbbl), Nigeria (37Gbbl), Algeria (12Gbbl) and Angola (8Gbbl), and another eight countries have proven oil reserves of at least 1Gbbl. Natural gas reserves (proven) are also ubiquitous across the continent, totalling to some 647Tcf as of 2020 and accounting for roughly 8.8% of global proven reserves (7,320Tcf) (BP, 2020; OPEC, 2020). Figure 5.8 (top row, right

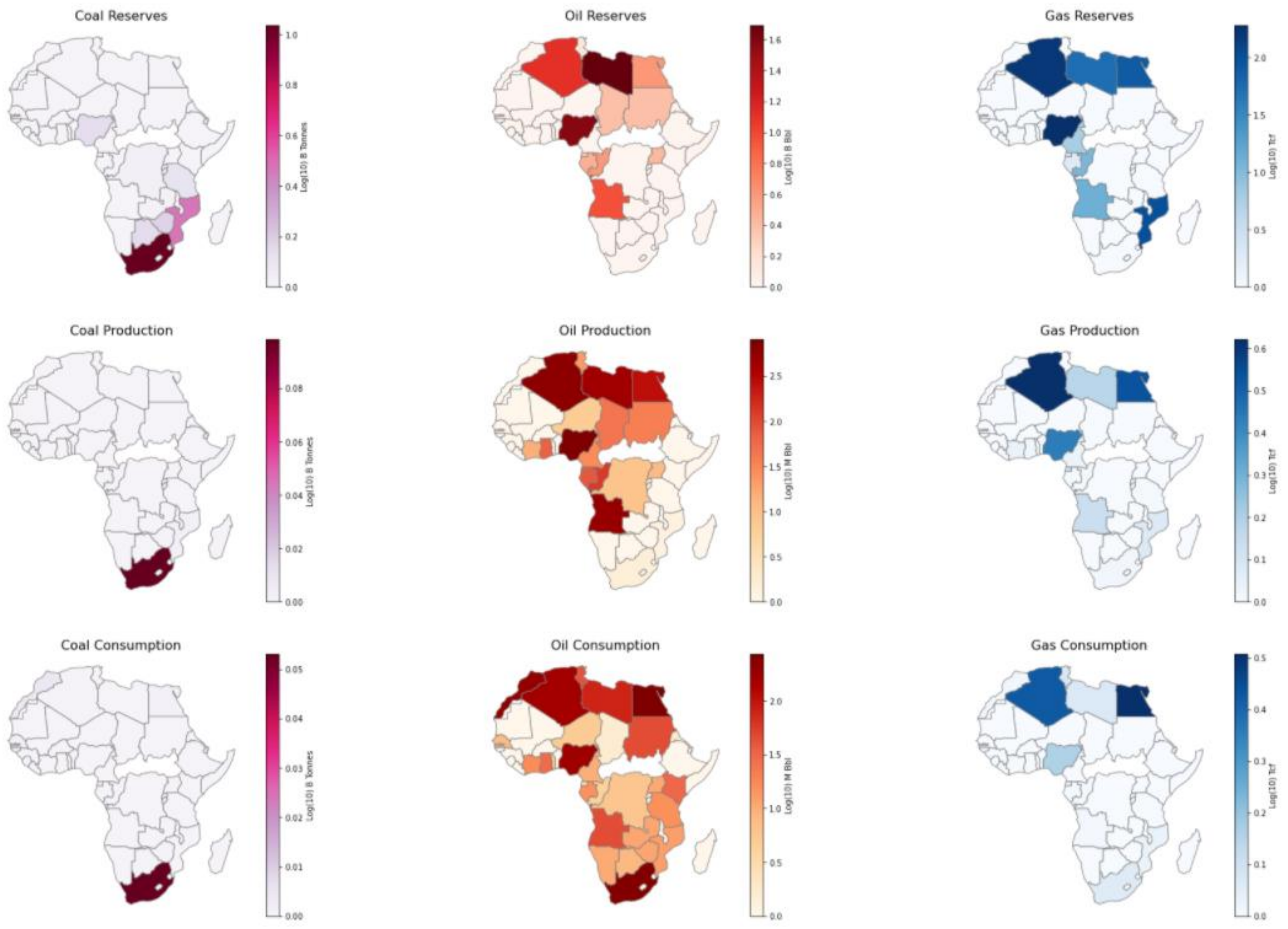
[59] Interview PRIV_AF2, PRIV_AF3

column) reveals a somewhat similar distribution of natural gas to that of oil, with Nigeria (190Tcf), Algeria (160Tcf), Egypt (79Tcf), Libya (53Tcf) and Angola (12Tcf) home to ample reserves. However, given the substantial exploration and drilling activity occurring off African shores (see 6.2), there is reason to believe these proven reserve sizes may increase in the coming years. Conversely, aggregate African coal reserves sit at roughly 15Gt, which only accounts for 1.4% of global reserves (1,070Gt) (BP, 2020; OPEC, 2020); however, as illustrated in the top row, left column of Figure 5.8, the bulk of these reserves of these reserves are heavily concentrated in southern Africa, predominantly in South Africa (10Gt), Mozambique (2Gt), Zimbabwe (0.5Gt), Botswana (0.4Gt) and Tanzania (0.3Gt).

The potential monetary value of these Africa-borne coal, oil and gas reserves are estimated by employing the same NPV methodology from 3.5.3, producing Figure 5.9. Once more, by fluctuating the discount rate to a reasonable 1-6%, the average estimated value (and confidence range) for Africa's aggregated proven fossil fuel reserves are: $392 billion ($358 - 426 billion) for coal; $3.9 trillion ($3.6 - 4.2 trillion) for oil; and $1.4 trillion ($1.3 – 1.5 trillion) for natural gas. *Altogether, these reserves could (all else being equal) generate revenue streams worth $5.3 – 6.1 trillion over the coming decades*. (See Appendix C for full African fossil fuel production metrics.)

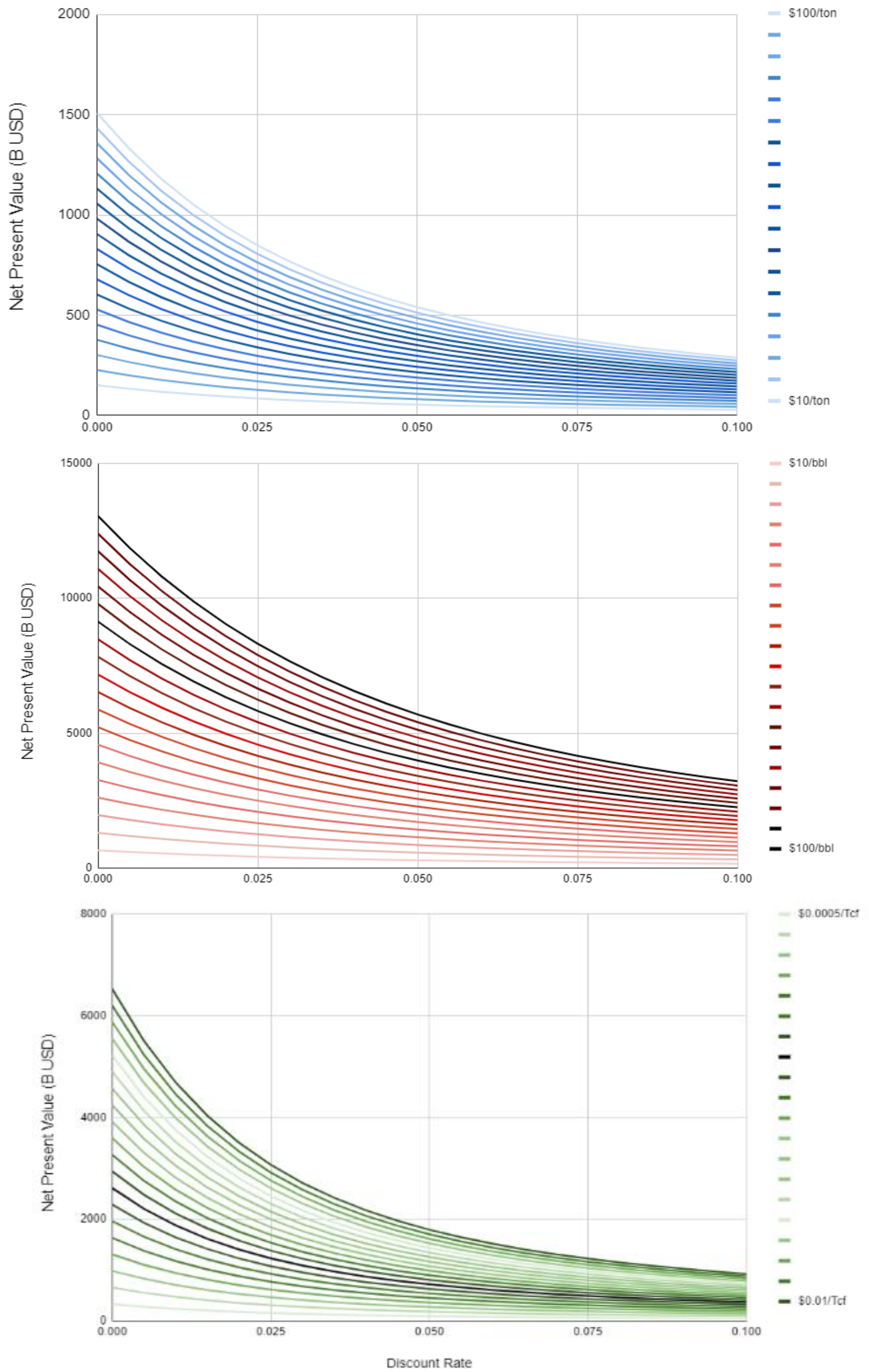
Mimicking 3.5.3, its very likely that a small fraction of these potential revenue streams end in the balances of African governments, given that the bulk of African fossil production is driven by multinationals E&Ps (see 6.3.1) who only pay a fraction of the revenue streams in royalties to the host governments. Assuming a 5% royalty rate, this would imply that African governments face approximately $265 - 305 billion in prospective stranded revenue streams from stranding coal, oil and gas reserves across the continent.

Figure 5.8 Matrix of maps showing coal (left column), oil (middle column) and natural gas (right column) proven reserves (top row), annual 2018-19 production (middle row) and consumption (bottom row), measured in: coal (GT); oil (Gbbl); gas (Tcf). The maps are scaled to the base-10 logarithm (log(10)) for visual purposes



Source: Author

Figure 5.9. Net Present Value analysis to estimate the value of Africa's coal (top, blue), oil (middle, red) and gas (bottom, green) reserves.



Source: Author

5.3.3. Prospective Stranded Physical & Human Assets

This section takes an inventory of existing fossil fuel infrastructure (oil & gas pipelines, LNG terminals, coal mines and coal-fired power plants) to briefly explore how prospective stranded physical assets are geospatially distributed across Africa, to complement 5.2.2; Figure 5.10 presents an overview.

Coal Mines

Africa has at least 66 coal mines,[60] which are concentrated in southern Africa, with 3 in Botswana, 8 in Mozambique, 1 in both Tanzania and Zimbabwe, and 53 in South Africa (see 5.2.2.2). Of these 66 mines, 24 are currently operational, with the remaining 42 either in the proposal or construction phase – see Figure 5.10. Jointly, these 66 coal have a total annual production capacity at 197Mt per annum (Mtpa), equivalent to 67% of total African coal production in 2019, indicating that 33% of coal production is beyond the scope of the data available in this analysis.

Coal Plants

Coal-fired power plants are more ubiquitously dispersed across the African continent – see the purple markers in Figure 5.10. Altogether, 133 documented coal plants (of which 45 have been cancelled, and the remaining 88 either operating, planned, announced, under construction or temporarily shelved) span 23 African countries with an aggregate total capacity of approximately 54GW;[61] this represents 54GW of potential stranded energy across 23 African nations if fossil phaseouts unravel.

Table 5.2 Average remaining coal-fired station fleet lifetimes broken down by country relative to 2020 (assuming 40 year lifetime)

Country	Average Remaining Lifetime (Yrs)
Namibia	5.0
South Africa	18.2
Mauritius	24.0
Morocco	28.8
Senegal	35.5
Madagascar	35.5
Zambia	39.0
Zimbabwe	39.8
Egypt	40.0
Botswana	40.0

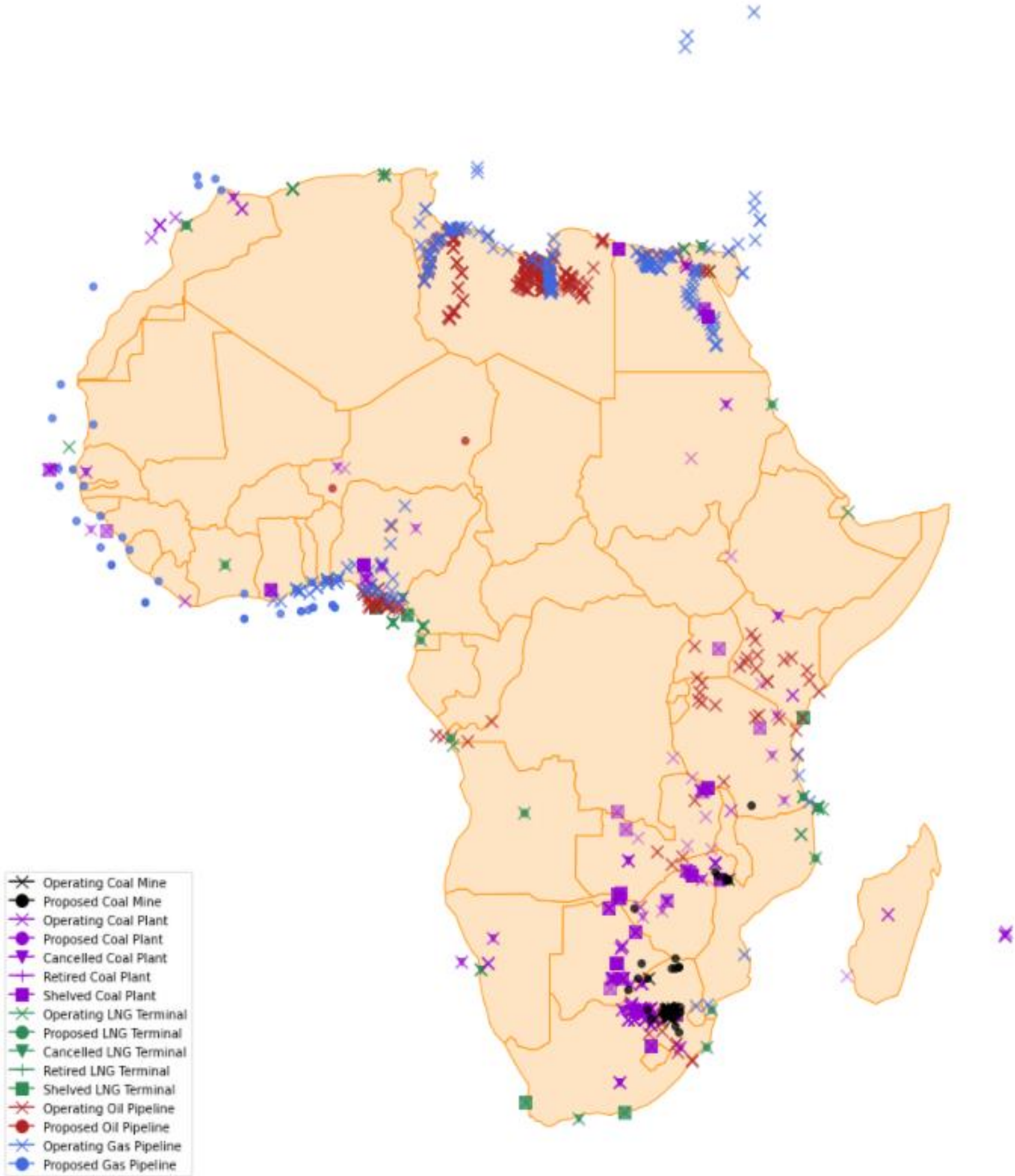
Source: Author, using data from GEM (2020a; 2020b; 2020c)

Moreover, these 88 non-cancelled plants together emit an annual 130MtCO_2; assuming a 40 year lifetime (Davis & Socolow, 2014), this translate to an aggregated lifetime emissions of 4.14GtCO_2. Even though these coal plants are more geospatially distributed across Africa than their mining counterparts, the bulk (52/88) remain concentrated in Africa's major coal producers of South Africa (26); Zimbabwe (8); Botswana (7); Tanzania (6) and Mozambique (5). Table 5.2 shows the average remaining lifetime of Africa's coal-fired power fleets at the national level. As shown, the only country with a more rapidly aging coal fleet than South Africa is Namibia, and this is due to its only coal plant set to retire in 2025.

[60] 66 are included in the GEM (2020) dataset, though many more likely persist – see 3.7 for study limitations

[61] Excluding cancelled plants

Figure 5.10 Map of oil & gas pipelines, LNG terminals, coal mines and coal-fired power plants across Africa. Note that Algeria's 20 natural gas and 12 oil pipelines are not mapped due to lack of reliable and sufficient longitudinal and latitudinal data.



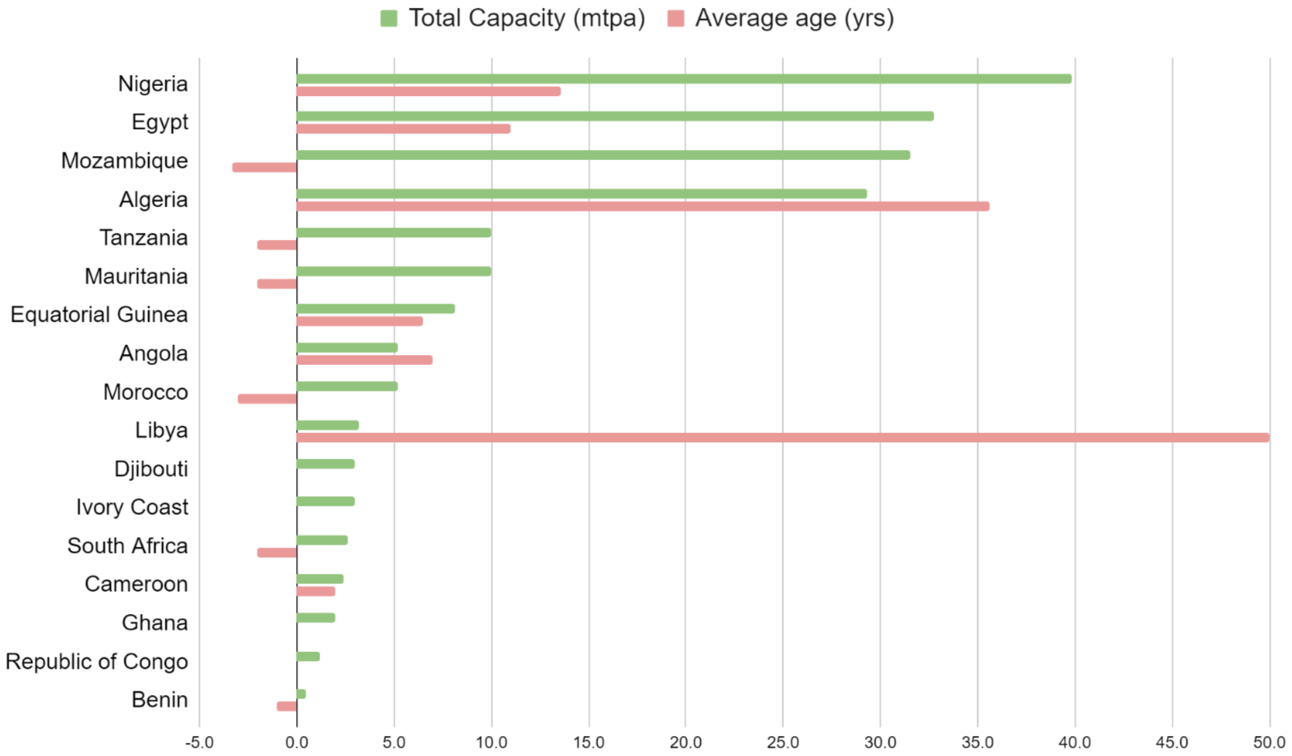
Source: Author

LNG Terminals

Africa's LNG terminals are denoted with green markers in Figure 5.10; almost all of Africa's existing, cancelled, retired or proposed LNG terminals exist along the coast to enable the transportation-driven role of the LNG terminal. Overall, at least 82 LNG terminals span 20 African countries as of 2020, 11 of which have been cancelled and 3 retired; the remaining 68 are either operational (30), proposed (20), under construction (7), mothballed (4), shelved (6) or idle (1).

The continent's LNG terminals have varying capacities and are at various stages of their lifetimes, with some much closer to retirement than others – see Figure 5.11. In Mozambique's case, production is speculative given that its 9 LNG terminals are either under construction (3) or merely proposed (6); this is denoted by Mozambique's average LNG terminal age sitting at -3.3 years, with most of its terminals set to come online between 2021-2025. If constructed and brought online, these young LNG terminals – along with those in Tanzania, Mauritania, Morocco, South Africa and Benin – could theoretically operate well passed the century's midpoint. Other nations face opposite risks, with heavily aged LNG terminal fleets today; Libya and Algeria have the oldest LNG terminals across Africa, with average start years sitting at 1970 and 1984, respectively (see Appendix C).

Figure 5.11 Summary of the total annual capacity (Mtpa) and average age (relative to 2020) of African LNG terminals, brown down by country



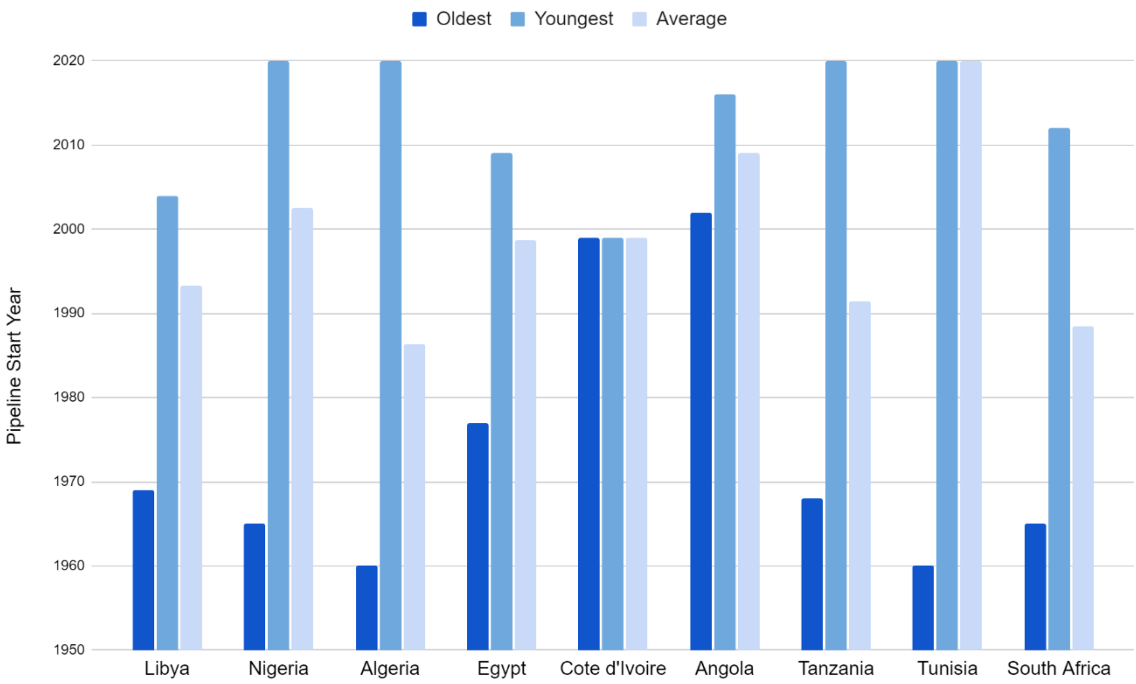
Source: Author

Oil & Gas Pipelines

Africa's array of 88 oil and 85 gas pipelines are depicted by the red and blue markers in Figure 5.10. All 88 oil pipelines start and end within the African continent, whereas six of the gas pipelines are intercontinental (i.e. they are used to transport gas from Africa to Europe or the Middle East) – hence explaining why some of the blue crosses in Figure 5.10 are outside of the Northern African coast.

Altogether these pipelines have annual capacities of 16.7 – 27.0Tcf (natural gas) and 3.5 – 5.2Mbbl (oil) per year, equivalent to 181-293% of African gas production in 2019 and 106-158% of 2019 oil production (see Figure 5.8).

Figure 5.12 African oil and gas pipeline age breakdown by country, denoting the year the oldest and youngest operational pipelines were constructed along with the average year of construction



Source: Author

Many of these pipelines are approaching retirement – see Figure 5.12. For instance, Algeria's oil and gas pipelines were built on average around 1986, with some dating their construction as far back as 1960. A similar narrative holds for Libya and Nigeria, with average construction years sitting at 1993 and 2003 and oldest pipelines dating back to 1969 and 1965, respectively. Figure 5.12 also shows that both Nigeria and Algeria (along with others) have begun constructing new pipelines in this decade, which could in theory either be used to amplify overall oil and gas production or replace older pipelines as they are decommissioned after reaching life expectancy.

5.3.4. Summary

Sections 5.3.2 & 5.3.3 clearly indicate that the distribution of prospective stranded fossil fuel assets extends far beyond South Africa's borders as far as the African continent is concerned. Although coal mines are indeed mostly concentrated in South Africa and to a lesser extent its neighbours, coal-fired power plants, crude oil refineries and LNG terminals exist all across the continent, with concentrations apparent along the West African and North African coastal nations (see Figure 5.10). This implies that several other African nations may be exposed to similar multidimensional stranded assets risks as South Africa, including prospective stranded labour, energy and finance that accompany these physical assets themselves. Although certain elements of South Africa's LFFU challenges are very much unique – not lest due to their unprecedent reliance on coal-fired electricity – it seems suitable to conclude that several African nations will eventually grapple with stranded assets of various dimensions in the event that actions are effectively taken to phase out fossil fuels within their respective domains.

5.4. Inclusiveness Analysis

Table 5.3 applies the analytical framework from Table 2.4 and evaluates the social, ecological and relational inclusiveness from exposure to these multidimensional prospective stranded assets in South Africa, while Table 5.4 evaluates these implications strictly vis-à-vis the SDGs through applying Table 1.2. Based on the inclusiveness conditions developed in Table 2.4, Table 5.3 shows that the current state of South Africa's exposure to prospective stranded assets is exclusive on all accounts. Ecologically, South Africa's existing infrastructure (i.e., physical assets) are producing some 425,000 barrels of oil per day and 254Mt of coal per annum, and new oil & gas reserves are being developed that may singlehandedly overshoot South Africa's 1.5°C-comatible emissions targets by almost 200% (failure to meet condition E1). Moreover, only one facility (the Engen refinery – see Appendix C) is allegedly being decommissioned, although the adequacy of this decommissioning is yet to be evaluated (potential failure to meet condition E2).

Socially, at least 270,000 South Africans are employed directly and indirectly by the coal production sector, and several hundreds – if not thousands – more in crude oil refinement. Although the desirability and safety of these jobs is heavily contested (particularly in the case of coal mining), a fossil phaseout nevertheless implies stranding these jobs and potentially upending the livelihoods of hundreds of thousands of South African households (failure to meet condition S1). Moreover, 37GW of installed coal-fired power capacity currently resides on the South African grid, the bulk of which will be de facto stranded in a fossil phaseout, jeopardising affordable and reliable energy access for majority of the population (failure to meet condition S2). However, this installed coal-fired capacity is *already failing to meet energy needs*, with an estimated 15-30% of the population either without access to the grid or unable to afford power in spite being grid-connected. Therefore, although stranded energy is undoubtedly socially-imperative challenge, it seems that many of South Africa's most under-resourced and under-privileged people are already energy-poor, implying that the stranded labour-related challenges pose more an existential threat to the nation's most vulnerable population.

Relationally, a substantial fraction of South Africa's coal mines and oil refineries are owned and operated by multinationals, implying that they themselves would incur part (or most) of the stranded financial assets from decommissioning these facilities on their own balance sheets. However, a few incidents of divestments from these physical assets (exemplified through Chevron's divestment of the Astron refinery and South32's divestment from the WMC mining complex, see 5.2.2.2 and Appendix C) indicate that these prospective stranded assets run a high risk of being reallocated before their stranding dates, putting the extent to which responsible and capable actors from the 'North' will in any way incur these stranded assets into serious question (likely failure to meet condition R1). Moreover, South Africa's prospective stranded natural assets (i.e. proven fossil reserves) may yield revenue streams worth some $700-900 billion today (NPV) over the coming decades, of which the government may receive $35-45 billion in royalties. Compensation for forgoing the commercialisation of these reserves is pertinent, else South African citizens' RtD is violated (see 2.2.1). However, given that no such compensatory plans have been proposed,[62] it seems likely that condition R2 will also likely not be met.

[62] At COP26, the US, UK, and several EU governments pledged to allocate $8.5 billion to help South Africa phase-out its coal-dependence (Franke, 2021). Although commendable, this $8.5 billion figure: 1) pales in comparison to the potential stranded revenue streams, and 2) is specifically meant for decommissioning coal facilities and/or phasing in new alternative power sources (see 6.4.6), NOT as a compensation for stranding the coal resources themselves

Table 5.3. Applying Table 2.4 to evaluate the inclusive development implications of South Africa's prospective stranded fossil fuel assets

Dimension	LFFU & Stranded Asset Implications
Ecological	E1. Not only are existing fossil fuel facilities remaining online past their life expectancies (e.g., SAPREF), but new fossil-intensive facilities and infrastructures are arising that directly contribute to and exacerbate the 'climate emergency' by promoting additional FF production. Implication: fails to meet condition E1; ecologically exclusive; E2. The Engen Refinery is the key South African and fossil-intensive facility that is being decommissioned (and retrofit as an import and storage facility), but it is unclear whether this will occur adequately or whether the egregious local water, air and soil pollution that the refinery has already propagated will be accounted for. Implication: likely fails to meet condition E2; likely ecologically exclusive; E3. N/A (beyond the scope of this analysis)
Social	S1. At least 270,000 jobs are (in)directly linked to coal mining alone, which are notoriously unsafe and pose a slew of health risks (and are thus deemed low quality and undesirable), and given the continued reliance on coal-fired electricity (exemplified by Medupi & Kusile), these jobs are likely here to stay. Moreover, although forthcoming plans for a Just Transition are calling for a 'just' transition for coal miners, there are currently no suitable alternative industries to phase lower-skilled miners into in the even that coal mines were to shut, suggesting that they would most likely be left unemployed. Implication: failure to meet condition S1; socially exclusive S2. Coal was once a cheap source of power (especially in South Africa), but this is no longer the case now with renewable energy tariffs having plummeted; South Africa's coal-dependent grid is unable to provide electricity to at least 15% (if not circa 30%) of its population, equivalent to some 10-20 million South Africans. Moreover, given that some 40% of produced power in South Africa is consumed by the EIUG, the energy-related ramifications from phasing out coal from its grid are less imperative than other social considerations, like employment & job security. Implication: failure to meet condition S2, socially exclusive;
Relational	R1. Many of South Africa's coal mines are owned and operated by non-South African multinational conglomerates (which are almost entirely owned by European, North American and Asian asset managers), as are its four key oil refineries, implying that the brunt of the financial stranded asset risk currently does in fact lay on rich, capable & culpable balance sheets from the 'North'. However, evidenced by South32's divestment of WMC to Seriti Resources, these actors are beginning to de facto reallocate the LFFU costs beyond their balance sheets. That is, the existing distribution of prospective stranded financial assets lends itself to an inclusive fossil phaseout, but divestment measures suggest an exclusive reallocation of these assets is likely. Implication: partially failing to meet condition R1, somewhat relationally exclusive. R2. South Africa's fossil reserves may yield revenue streams over the next 60 years' worth some $900 billion today (particularly from its newly discovered offshore oil and gas fields), which could (in theory) be allocated to generate safe and high quality jobs (condition S1), provide cheap and reliable power (condition S2) or decommission older and decrepit power plants (condition E2), for instance. The government could seek compensation for these stranded financial and natural assets, but mobilising funds of even a fraction of this magnitude would prove an immense obstacle – the Yasuni-ITT initiative failed to gather just 4% of this gargantuan sum! Implication: meeting condition R2 unlikely, likely relationally exclusive

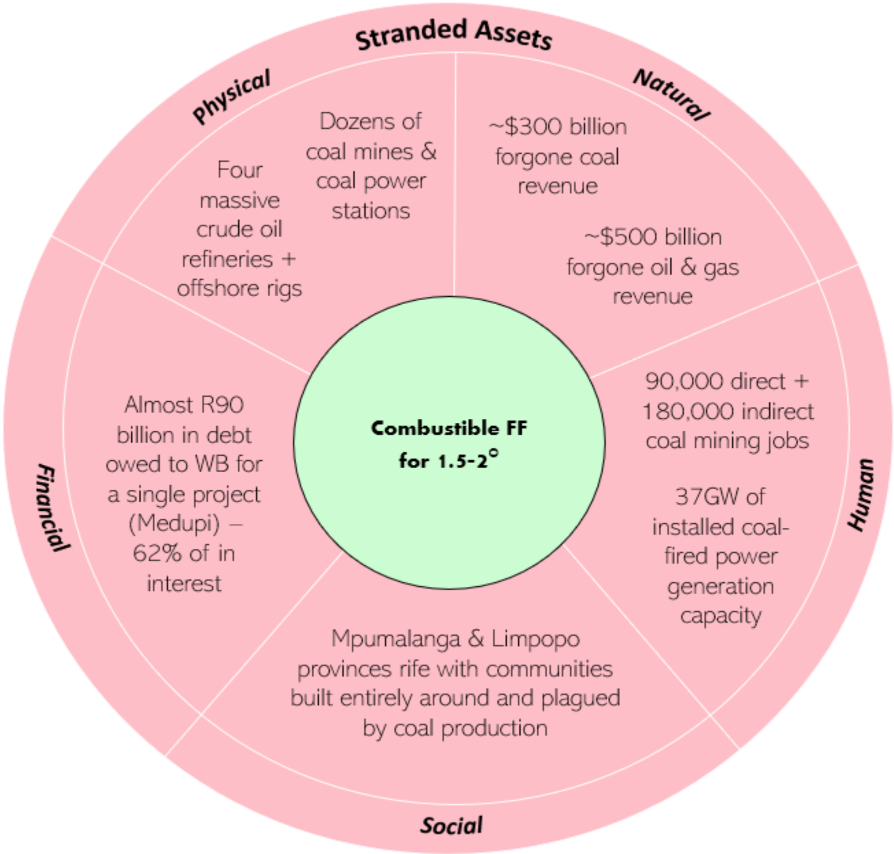
Source: Author

Table 5.4. Building on Figure 1.2 and assessing the SDG implications stemming from a South African fossil fuel phaseout

Target	LFFU & Stranded Asset Implications
1.2	At least 270,000+ coal mining jobs are at stake (prospective stranded labour) in a South African fossil fuel phaseout, threatening the livelihoods and multidimensional wellbeing of millions of fossil-dependent South Africans (prospective stranded communities, networks). Implication: likely trade-off between LFFU and SDG 1
2.1	Continued investment in and reliance on coal-fired power (through e.g., Medupi, Kusile)and oil & gas exports (through e.g., Brulpadda & Luiperd) exacerbates the 'climate emergency' and de facto threatens crop/ agricultural stability at the global level. Implication: potential synergy between LFFU and SDG 2
3.9	Coal mining in e.g., Mpumalanga and oil refining activity in e.g., Cape Town (for instance, in the Engen Refinery) have notoriously caused hundreds of thousands of deaths, spurred acute and chronic respiratory illnesses, and defiled local water and soil to the point that they are no longer consumable or usable. Implication: potential synergy between LFFU and SDG 3
7.1	South Africa is already falling short of target 7.1 with its coal-dependent grid, given that at least 15-30% of the population remains without reliable access to the grid, and those that do have access suffer from regularly scheduled blackouts (load shedding). However, abruptly phasing out coal will certainly exacerbate these already existing challenges, without adequate investment in solar, wind and grid-scale storage. Implication: likely trade-off between LFFU and SDG 7
8.1	South Africa will incur some $700-900 billion in an opportunity cost (stranded natural assets) for forgoing fossil fuel commercialisation (equivalent to 200-300% of its 2021 GDP!), IF the nation were to adequately LFFU in compliance with the PA. Moreover, Eskom (and de facto, the National Treasury & Ministry of Enterprises) would absorb the costs of prematurely decommissioning its immense and decrepit coal fleet (stranded physical assets). Implication: without support from the international community (governments or private sector), very likely a massive trade-off would yield between LFFU in SA and SDG 8
9.4	South Africa's coal-dependent MEC is notoriously archaic and environmentally deficient, with annual emissions from three coal plants (Medupi, Kusile and Majuba) alone totalling 90mtCO2e, equivalent to some ~30% of emissions estimated for South Africa to be 1.5C compatible - an alarming reality given that Medupi & Kusile are meant to be state-of-the-art, modern, and efficient as far as their OECD-approved super-critical status is concerned. Implication: likely synergy between LFFU and SDG 9
10.1	Aligned with the implications for target 1.2, particularly coal-dependent income is at stake. Implication: likely trade-off between LFFU and SDG 10
13.2	This is the key SDG entirely dependent on widespread and effective LFFU. Implication: strong synergy between LFFU and SDG 13
16.6	As it currently stands, the decision making process undertaken by the Ministry of Minerals and the Ministry of Environment is opaque and questionable, particularly in procuring new coal-fired power and approving ESIAs for offshore oil & gas exploration. However, procuring fossil alternatives will not necessarily eradicate these institutional flaws and structural limitations, as exemplified by existing issues with the REI4P. Implication: uncertain trade-off or synergy between LFFU and SDG 16

Source: Author

Figure 5.13. Depiction of South Africa's multidimensional stranded fossil fuel asset risk



Source: Author

Conversely, Table 5.4 demonstrates that using purely a sustainable development framework, the implications of stranding these multidimensional assets translate to a combination of synergies and trade-offs with various SDGs. On the one hand, phasing out coal, oil and gas production in South African will reap local-to-international-level environmental benefits, including minimised local water, soil and air pollution, and a mitigation of adverse climate impacts, thereby prompting progress towards meeting SDG targets 2.1, 3.9 and 13.2. Conversely, the economic ramifications from stranding South Africa's multidimensional assets (270,000+ jobs, $700-900 billion in revenue streams, 37GW in coal-fired power) translate into trade-offs with several key SDG targets, like 1.2, 7.1, 8.1 and 10.2 (see Table 5.4). While the inclusive development framework conceptualises these trade-offs as socio-relational issues, the explicit economic focus undertaken by the SDGs yields a scenario in which the monetary stranded asset risk borne by the South African state could potentially outweigh and undermine its non-monetary counterpart. Within the ID paradigm, the stranded natural & financial assets arising from refraining to commercialise coal, oil and gas reserves are understood as violations of South Africa's RtD (Gupta & Chu, 2018) and merit compensatory support from international governments and financiers; conversely, according to the SD framework, such stranded revenue streams directly result in economic stagnation and would detract from progress towards aligning with Agenda 2030.

5.5. Conclusion: A Gargantuan Stranded Asset Risk

This chapter posed the question:

What is the extent of the monetary & non-monetary stranded fossil fuel asset risks borne by South Africa and the African continent more broadly, and what implications do these risks bear on both inclusive development and sustainable development agendas?

And three conclusions are drawn from the stranded asset analysis from 5.2-5.4:

Conclusion 1
In pure monetary terms, African economies stand to face an opportunity cost of as much as $6 trillion stranded revenue streams over the next 60 years if they refrain from commercialising proven coal, oil and gas reserves. Specifically, South Africa's fossil reserves pose a prospective ***monetary*** *stranded asset risk of approximately $1 trillion, and a* ***non-monetary*** *stranded asset risk existentially threatening the livelihoods of at least 10-15% of the South Africa's population,*[63] *spanning all five dimensions of the stranded asset typology (highlighted in Figure 5.13).*

Conclusion 2
The existing state of the South African fossil-economy due to its prospective stranded asset exposure is entirely exclusive across all dimensions and indicators (unpacked in Table 5.3), and two key and fundamental challenges occlude an inclusive fossil fuel phaseout in South Africa: *Stranded labour in the form of coal-related unemployment (direct, indirect and induced), among other fossil-sectors – and to a lesser extent, stranded energy; these are the key social hurdles for an inclusive fossil fuel phaseout in South Africa*.

Conclusion 3
Adopting a sustainable development framework to promote LFFU in South Africa will likely result in paralysis and an accompanying failure to adequately phaseout its existing and forthcoming coal, oil and gas production, due to the severity of the economic implications of prospective stranded financial assets and the trade-offs that they pose for economically-geared SDGs.

[63] 10-15% being the fraction of the South African population that reside in Limpopo and Mpumalanga

6. Unpacking the 'Stranded Asset Debt' owed to South Africa[64]

6.1. Purpose and Structure

This chapter builds on the findings from 5.3.4 and explores 'where' the stranded asset risk borne by South Africa – and Africa more broadly – has come from. To do so, it tackles sub question S4:

> What fraction of South Africa's stranded asset risk has been generated by financial & economic institutions from the 'North', what is the extent of the stranded financial asset risk borne by these institutions, and hence, what does a preliminary estimation suggest about the magnitude of the Stranded Asset Debt owed by the 'North' to South Africa?

and traces the finance flows that have been used to generate South African fossil fuels and continue to depend on African fossil fuel production to date, specifically addressing knowledge gap K2 in addition to K1 (see 1.2.2). The chapter first maps the key fossil fuel E&Ps operating in South Africa (see 6.2.1), maps their major shareholders (see 6.2.2), and then explores the commercial (see 6.2.3) and public finance (see 6.2.4) that has hoisted South Africa's coal, oil and gas sectors. It then replicates this analysis for the broader African context (see 6.3.1-0), and subsequently applies the Stranded Asset Debt (SAD) framework (see 2.2.1.4) and roughly estimates the monetary SAD that these E&Ps and finance institutions (predominantly from the 'North') arguably owe South African citizens (see 6.4), before drawing conclusions (see 6.5).

6.2. Multinational Players in South Africa & Prospective Stranded Financial Assets

6.2.1. E&Ps

6.2.1.1. Introduction

This section maps the multinational E&Ps (predominantly from the 'North') that have and currently influence South African coal, oil and gas exploration and production. This is the first step to establishing the 'Stranded Asset Debt' that non-South African actors have inadvertently accrued by financing and hoisting South African fossil fuel production.

6.2.1.2. E&Ps Driving South African Fossil Fuel Production

Despite Eskom and Sasol dominating domestic fossil fuel *consumption* (see 5.2.2.3), South Africa's fossil fuel *production* is heavily dependent on (mostly non-South African) multinational and publicly-listed fossil fuel E&Ps. 29 E&Ps are currently active in South Africa (see Appendix B); jointly these firms' market capitalisations[65] aggregated to $968 billion in June 2020 and $1.3 trillion in July 2021 (denoting a 35% increase). Although the 'Axis of Capital' (Sasol, Exxaro, Anglo, Glencore & BHP/South32)[66] does play a prominent role, other players are also relevant – largely driven by Australian mining companies (like Terracom, MC Mining and ResGen) and European (e.g., Total SA, Shell and BP) and North American (ExxonMobil & Canadian Natural Resources) oil & gas E&Ps.

On the coal front, *these E&Ps accounted for almost 75% of South Africa's 2019 coal production* (185Mt). These firms typically operate through joint ventures; for instance, Exxaro operates its 10 coal mines jointly with AngloAmerican, of which one is solely dedicated for export production (7.2Mtpa), one for domestic production (8.5Mtpa), and the remaining 8 serving both purposes (30.6Mtpa).

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[64] This chapter was prepared in tandem with and is based on some elements of the following papers:
Rempel, A. (Accepted June 2022). An Unsettled Stranded Asset Debt? Proposing a supply-side counterpart to the 'Climate Debt' in a bid to guide a just transition from fossil fuels in South Africa and beyond. *Antipode*
Rempel. A., Gupta, J. (major revisions 2022). Public Finance & African Fossil Fuels: Export Credits, Development Banks and the Paris Agreement. *Environment, Development & Sustainability*

[65] Note that 4 of the 29 firms (Impact Oil & Gas, Azinam, Qatar Petroleum and Silver Wave Energy) are excluded from aggregated total market cap because they are privately- or state-owned, but are included in the figure due to their prominent presence in South African oil and gas exploration

[66] Baker (2015a)

Moreover, these coal E&Ps are expanding their operations: South32 disclosed a $42 million CapEx in 2020; Terracom purchased four assets from Universal Coal in June 2020, all situated in Limpopo and Mpumalanga; and MC Mining has four thermal and metallurgical coal operations currently in the planning stage or under construction.

The oil and gas story is more nascent, though a similar E&P dominance tale is told. Only 9/27 offshore oil & gas blocks and fields are under sole operation by South African petroleum firms (mainly by the state-owned petroleum company, PetroSA), ***whereas 17 unique blocks are under sole ownership of and operation by non-South African firms***, and one additional block (263ER) is operated by Sasol (South African, 60%) though Eni (Italian) has 40% interest (see Appendix C). Furthermore, four (all) of South Africa's crude oil refineries are operated by European & North American multinationals (see 5.2.2.4 and Appendix C). Unlike the coal case – in which production has been firmly underway for over a century – the offshore oil & gas interests in South Africa are in various phases, with some fields in early stages of exploration and still 'undeveloped' (e.g., PetroSA's Block 9), others recently having acquired 2D and 3D seismic surveying data (e.g., Block 224ER, owned by Total SA (40%), Shell (40%) and PetroSA (20%)), and others in more advanced stages after having made promising discoveries, like Block11B/12B (see 5.2.2.5).

6.2.2. Shareholders & Prospective Stranded Liquid Equity

6.2.2.1. Introduction

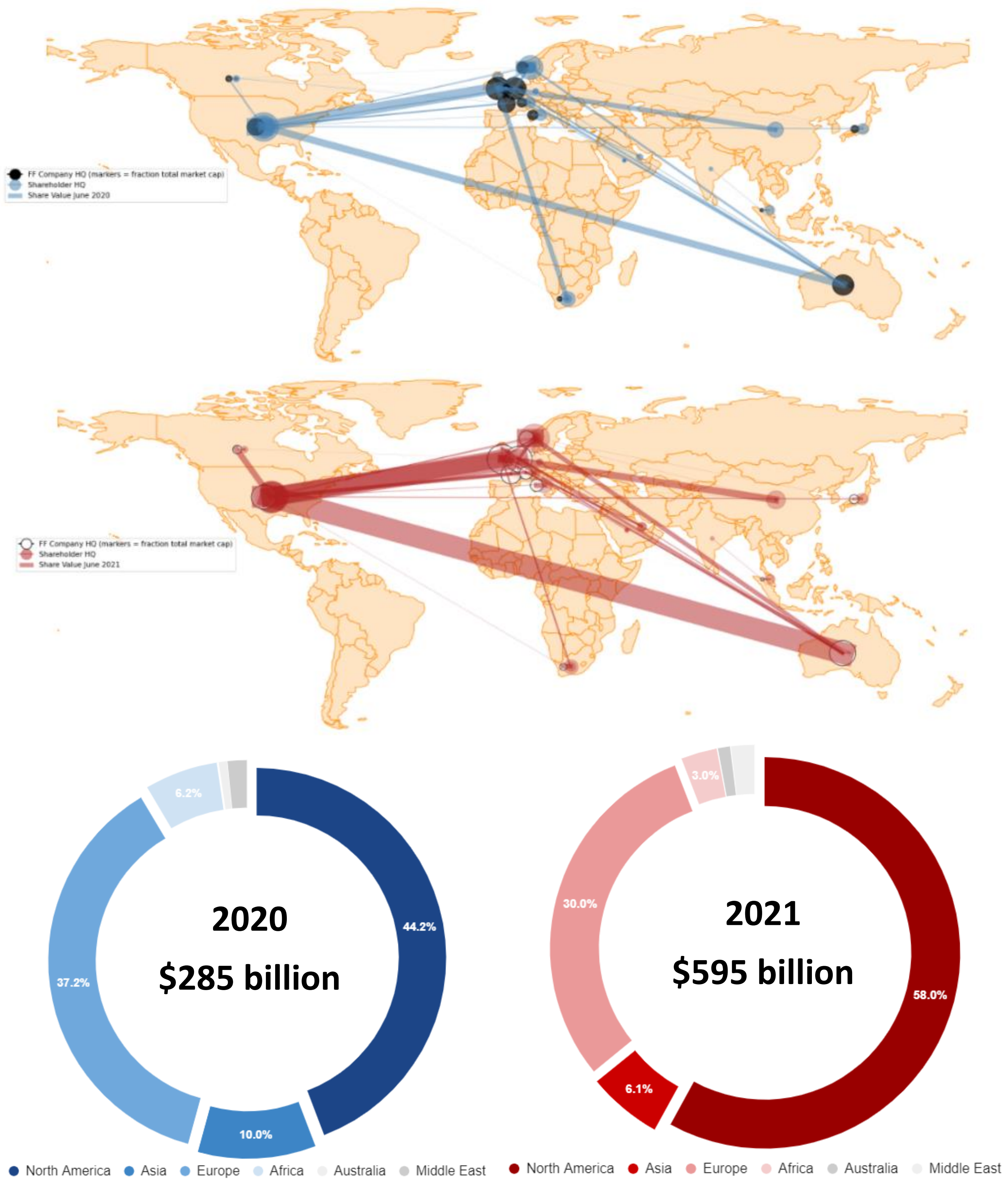
Having established that multinational & non-South African E&Ps play a prominent role in South African fossil fuel production (see 6.2.1.2), this section identifies the major shareholders of these E&Ps by tracing the liquid equity (i.e. common shares) investments in these E&Ps. These major shareholders not only have 'skin in the game'[67] by managing potential stranded equity investments in their portfolios, but also play influential roles in leveraging their shareholder influence to dictate the business agendas of the E&Ps themselves.

6.2.2.2. Equity Investments in E&Ps Linked to South African Fossil Fuel Production

Figure 6.1 maps the major shareholders pertaining to the multinational and publicly-listed E&Ps, taken both in June 2020 (top map with blue edges) and July 2021 (bottom map with red edges), and Figure 6.2 denotes the magnitude of shares held by investors in both time periods (note the base-10 logarithmic scale). A total of $285 billion in shares was tracked for 2020 (equivalent to 29% of the total 2020 market cap), of which 43% ($121 billion) was managed by shareholders from the US and an additional 22% ($63 billion) by the Norwegian Government Pension Fund alone. Overall, European (37%), North American (44%) and Asian (10%) shareholders dominated, jointly managing 91% of the total shares, *whereas African shareholders only managed $18 billion (6%)*, though this was largely concentrated in AngloAmerican's South African subsidiary ($7.5 billion), the PIC ($3.8 billion, South Africa's largest asset manager) and the IDC ($1.7 billion, a South African BDB).

[67] see Fraser (2021)

Figure 6.1. Map depicting the major shareholders of the publicly-listed fossil fuel E&Ps from Figure 5.4 in June 2020 (top map, blue) and July 2021 (bottom map, red). The two donut charts in the bottom complement the maps by breaking down the fraction of the total shares managed by regionally.

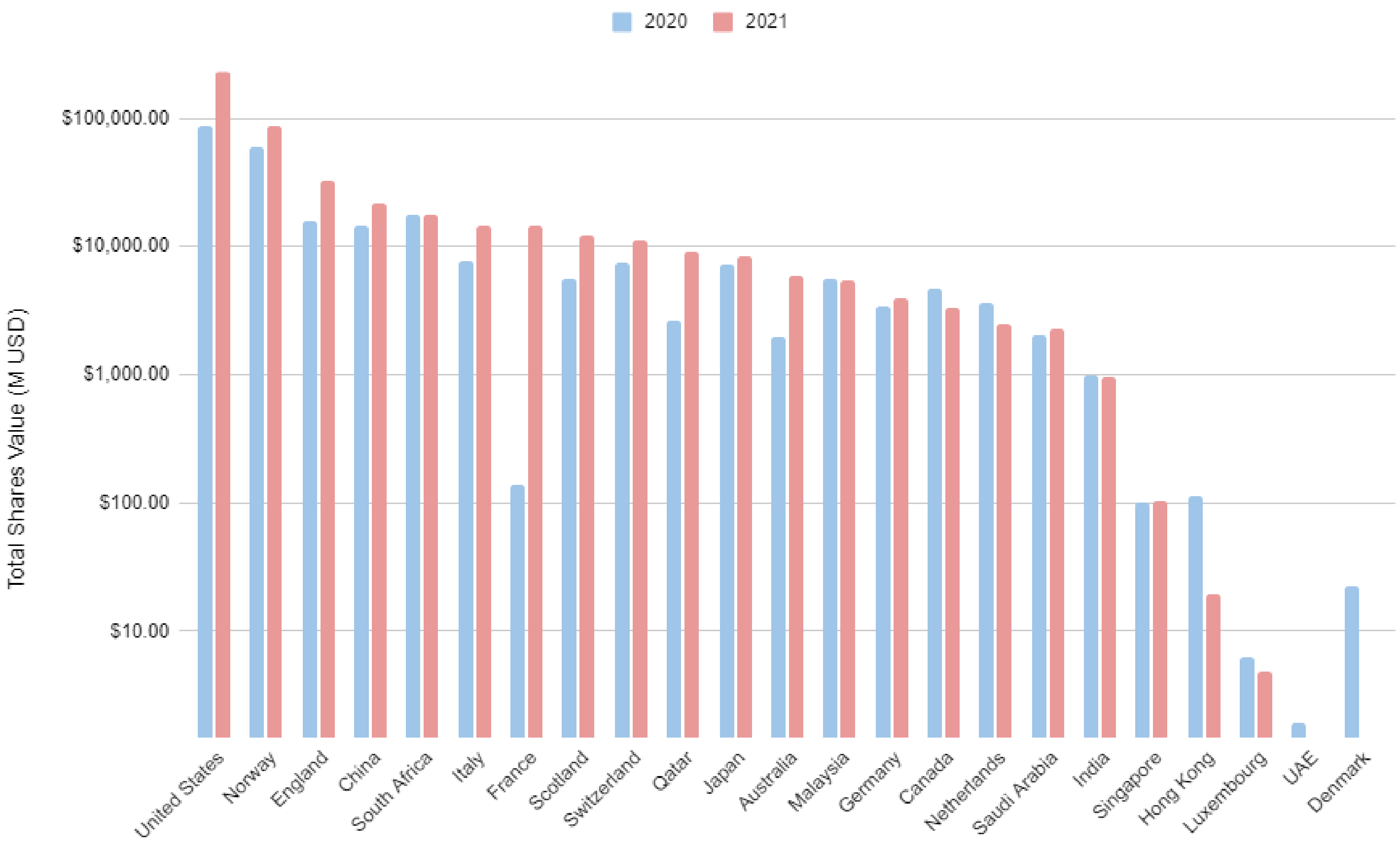


Source: Author

A greater fraction (45%, or $595 billion) of the total market capitalisation in 2021 was tracked, which indicates that the equity in the sampled E&Ps has become more concentrated in major shareholders.[68] Similarly, shareholders from North America ($344 billion, 58%), Europe ($178 billion, 30%) and Asia ($36 billion, 6%) jointly managed 94% of the total shares accounted for. African shareholders (largely the same actors as in 2020) still managed roughly $17 billion, but now accounted for less than 3% in 2021. *This could suggest that beyond this sample, the vast majority of shares could be managed by non-African major shareholders, perhaps as much as 97% of the total market capitalisation ($1.28/1.33 trillion)*.

Blackrock, Vanguard and Capital Research & Management, three mammoth US-based investment managers, jointly managed roughly $234 billion in 2021 alone, or 39% of the total sampled share value, while the Norwegian sovereign wealth fund contributed an additional $49 billion (8%) (see Appendix C). Altogether, the top 20 shareholders alone managed 80% of the aggregate share value in 2021 ($478 billion), suggesting once again that the fossil fuel E&P equity is heavily concentrated on the balance sheets of a small pool of gargantuan players; only one of these top 20 shareholders is African (South Africa's PIC), which only accounted for $5.7 billion of the 2021 shares (or 0.9%). This yields two implications: first, that the prospective stranded financial assets – in this case in the form of liquid equity – and their accompanying risks are largely borne by a subset of key gargantuan actors from the 'North'; and second, the power of leveraging the respective E&Ps (as their major shareholders) lays at present on the balance sheets of the same subset of actors, mostly from the US and Europe.

Figure 6.2. Breakdown of the amount of shares (M USD) that shareholders managed by the registered headquarter of the shareholder in 2020 (blue) and 2021 (red). Note the scale on both graphs is logarithmic (base 10).



Source: Author

[68] Since only major shareholder assets are typically disclosed on financial databases, like those used for this study (see 3.5.3)

The mapped E&Ps (again, see Appendix C for full list) issued *an average dividend yield of 5.36% in 2021*, with rates ranging from 0 – 13.04% (see Appendix C). Assuming, as an exercise, that the major shareholders included in this analysis managed the common shares in these E&Ps for the entire 2021 fiscal year, **they would have earned roughly $37 billion in dividends from these multinational coal, oil and gas producers in 2021 alone**, equivalent to over 6.2% of the total value of the equity managed in said firms.[69] These dividends issued by mature fossil fuel producers are incredibly lucrative and clearly incentivise their shareholders to passively enable status-quo production.

6.2.3. Commercial Banks & Prospective Stranded Debt

6.2.3.1. Introduction

This section tracks the loans and underwriting that a sample of 41 commercial banks have issued to a subset of 16 of the E&Ps[70] active in South Africa (from 6.2.1). Unlike equity investments (see 6.2.2.2), which as financial mechanisms themselves do not directly influence the cost or availability of capital for E&Ps, debt finance plays a direct role in granting E&Ps access to capital and subsequently executing fossil projects.

6.2.3.2. Commercial Debt Investments in E&Ps Linked to South African Fossil Production

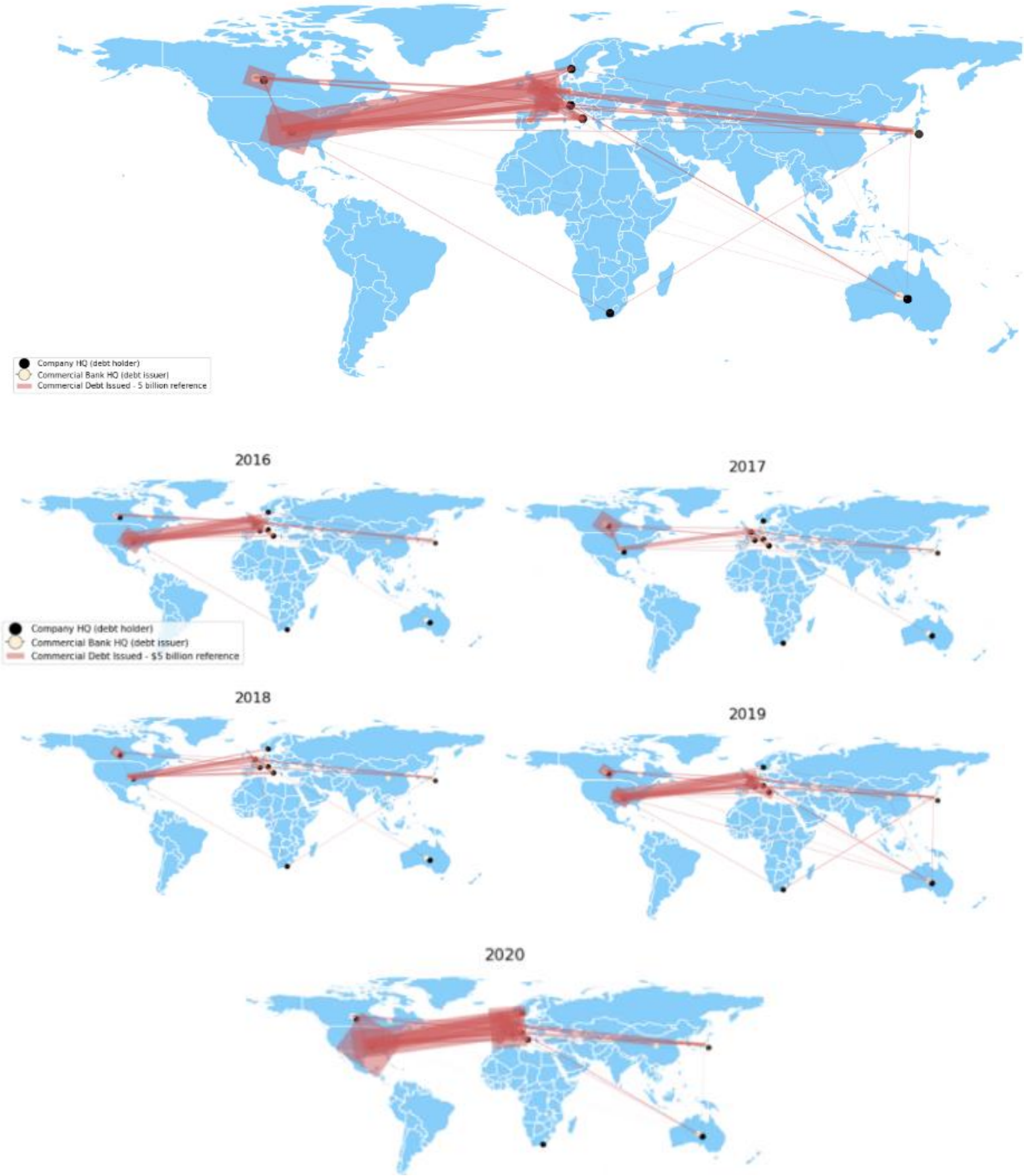
Figure 6.3 maps the financial flows between the commercial banks (red edges) and the E&P headquarters, and Figure 6.4 breaks down the magnitude of the total lending and underwriting by year, bank and country (see Appendix C). Overall, almost $333 billion in loans and underwritings were issued to the E&P subset from 2016-2020.

Not only are US-based financial institutions the most prominent shareholders in the E&Ps (see 6.2.2), but they are also the most profuse debt issuers, lending $122 billion from 2016-2020 (37%). Five US-based banks are largely accountable for this: JP Morgan ($30 billion); Bank of America ($28 billion); Citibank ($28 billion); Morgan Stanley ($23 billion); and Goldman Sachs ($12 billion). European banks were also heavy financiers, jointly allocating over $156 billion to the sampled E&Ps (47%); this was led by French ($63 billion) and English ($53 billion) commercial banks, spearhead by BNP Paribas ($39 billion) and Barclay's ($28 billion). Asian commercial banks allocated comparatively little though still substantial finance to the E&P subset ($18.5 billion), predominantly driven by Japanese banks MUFG ($6 billion), Mizuho ($6 billion) and SMBC ($5 billion).

Temporally, 39/41 banks increased their aggregate annual lending across all E&Ps in at least one year, and 25/41 commercial banks increased their lending to the fossil fuel E&Ps in 2020 compared to 2016 (see the red arrows in Figure 6.4), suggesting misalignment with Articles 2.1a and 2.1c of the Paris Agreement. Some of these increases have been dramatic; Standard Chartered's 2020 finance was 3631% greater than that in 2016 ($1.5 billion vs. $41 million), Commerzbank saw a 1240% spike ($544 million vs. $40 million), and BNP Paribas – the leading debt issuer of the sample – increased its finance by 505% over the same period ($23 billion vs. $4 billion).

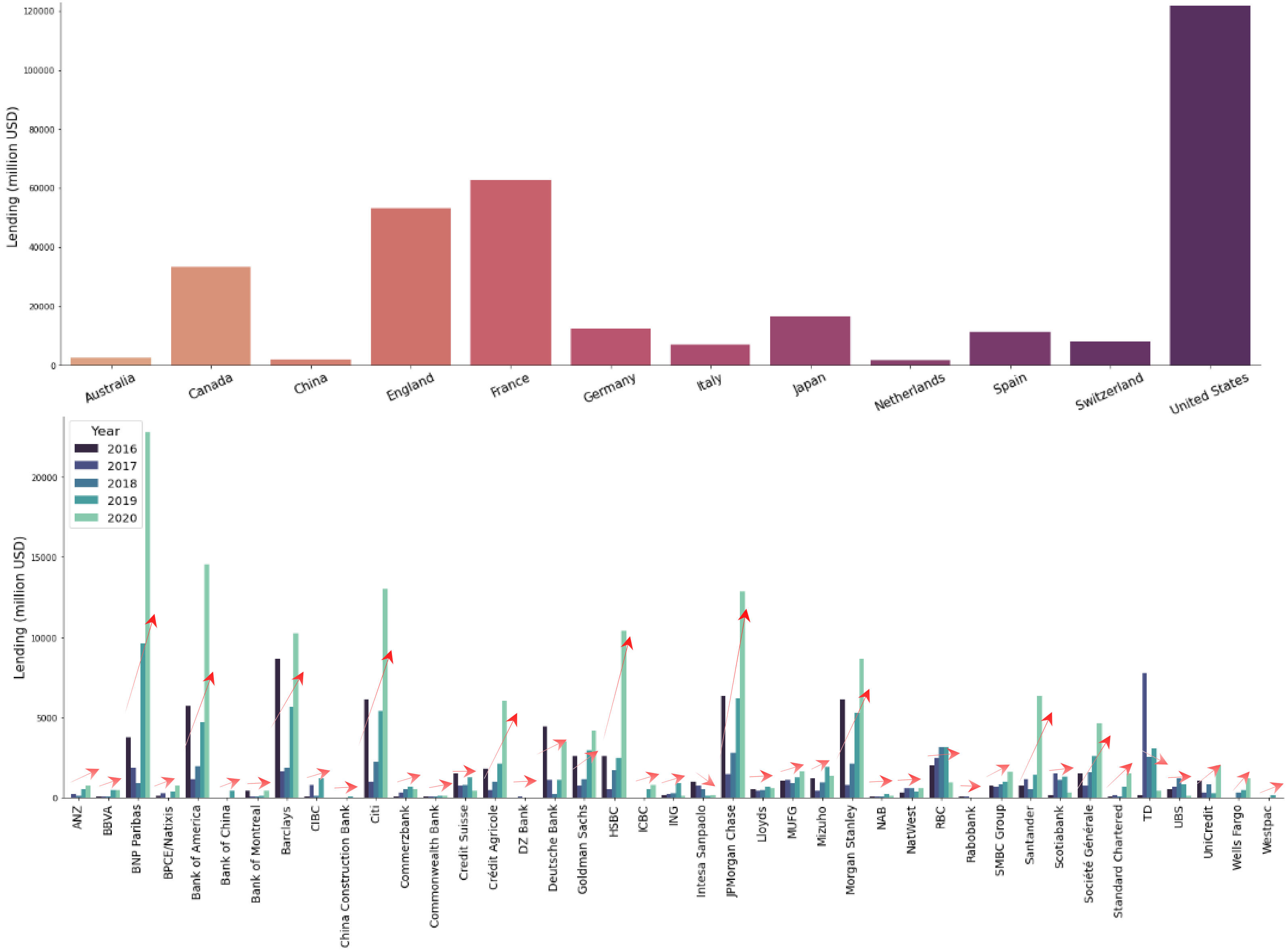
[69] This was computed by retrieving the average dividend yield for each E&P in 2021, multiplying each yield by the amount (M USD) in liquid equity managed by each shareholder in each E&P (to calculate the dividend earned per investor per E&P), then summing all such dividends together.
[70] for which there was available data.

Figure 6.3. Commercial bank lending to a subset of the E&Ps active in South Africa



Source: Author, using data from RAN et al. (2021)

Figure 6.4. Bar charts illustrating the lending (M USD) by commercial banks to a subset of the E&Ps active in South Africa by country (top chart) and by both bank and year (bottom chart)



Source: Author, using data from RAN et al. (2020)

N.B. the red arrows denote the general trends in lending and underwriting for each bank from 2016-2020

6.2.4. Public Finance Institutions (PFIs) & Prospective Stranded Debt

6.2.4.1. Introduction

Multilateral and Bilateral Development Banks (MDBs and BDBs, respectively) play a de-risking and therefore catalytic role in crowding and attracting external (private) funding for fossil fuel projects (OCI, 2020);[71] "development banks are much better at running impact assessments than any private institution,"[72] and as a result, "you don't see any (international) commercial banks invest in frontier markets without development banks involved."[73] Thus, even though the magnitude of MDB and BDB investments in fossil fuels may pale in comparison to their commercial counterparts (see 6.2.3 and 6.3.4), the very presence of MDB and BDB involvement in fossil fuel projects is significant in attracting finance that would not have arisen otherwise – catalysing (fossil) projects that may have otherwise been abandoned altogether.

Export Credit Agencies (ECAs) serve the sole purpose of *exporting* a domestic business/industry overseas "by providing either capital flows to exporters" (i.e. loaning in the same way a bank would), "or insurance to cover uncertainty" and de-risk projects for the domestic exporter.[74] ECAs play a unique role in financing fossil fuel projects for two distinct reasons. First, they drive the final investment decisions of a project. After a particular "project *has already been de-risked* by a MDB or BDB and private (commercial) banks have already secured most of the financing, *the ECA steps in to facilitate bigger project finance deals*."[75] Second, ECA support for the fossil fuel sector varies on a national basis because "different countries have different sorts of companies with different expertise that play niche roles in the coal and oil & gas sectors."[76] For instance, "Swedish and German ECAs are not investing in coal-fired power plants in South Africa, but heavily in the supporting infrastructure like coal transport – particularly the exporting the Swedish trucking industry"[77], whereas "the Dutch involvement is mainly offshore, through FPSO (Floating, Pipeline, Storage and Offloading) vessels with companies like Bernhard Schulte Offshore, and supply vessels with companies like Damen"[78] (see 5.2.2.3).

6.2.4.2. PFI Investments in South African Fossil Fuels

European, North American and Asian PFIs (ECAs, MDBs and BDBs) have financed at least $16 billion in South African fossil fuel projects in the last 15 years (see Table 6.1), mostly in the form of loans ($14.8 billion) but partially also in guarantees ($1.2 billion). Of this, $11.5 billion occurred from 2006-2015 (equivalent to roughly $1.2 billion annually, on average) and the remaining $4.5 billion occurred from 2016-2019 ($1.1 billion annually on average), again denoting misalignment with the Paris Agreement (Article 2.1c).

The nature of this PFI-based fossil finance has been both temporally and geographically variable – see Figure 6.5 and Figure 6.6. The bulk of the pre-Paris finance was allocated by the World Bank ($3 billion), the African Development Bank ($2.7 billion) and a series of ECAs, the latter predominantly driven by French ($2.3 billion), German ($1.5 billion), US ($820 million) and Japanese ($500 million) ECAs. The vast majority (roughly $11 billion) of this financing took place between 2009-2012 and was used to finance Medupi and Kusile, Eskom's two gargantuan 4,800MW coal-fired power stations (see 5.2.2.3 and Appendix C). Conversely, the post-Paris fossil financing has been spearhead by Chinese bilateral

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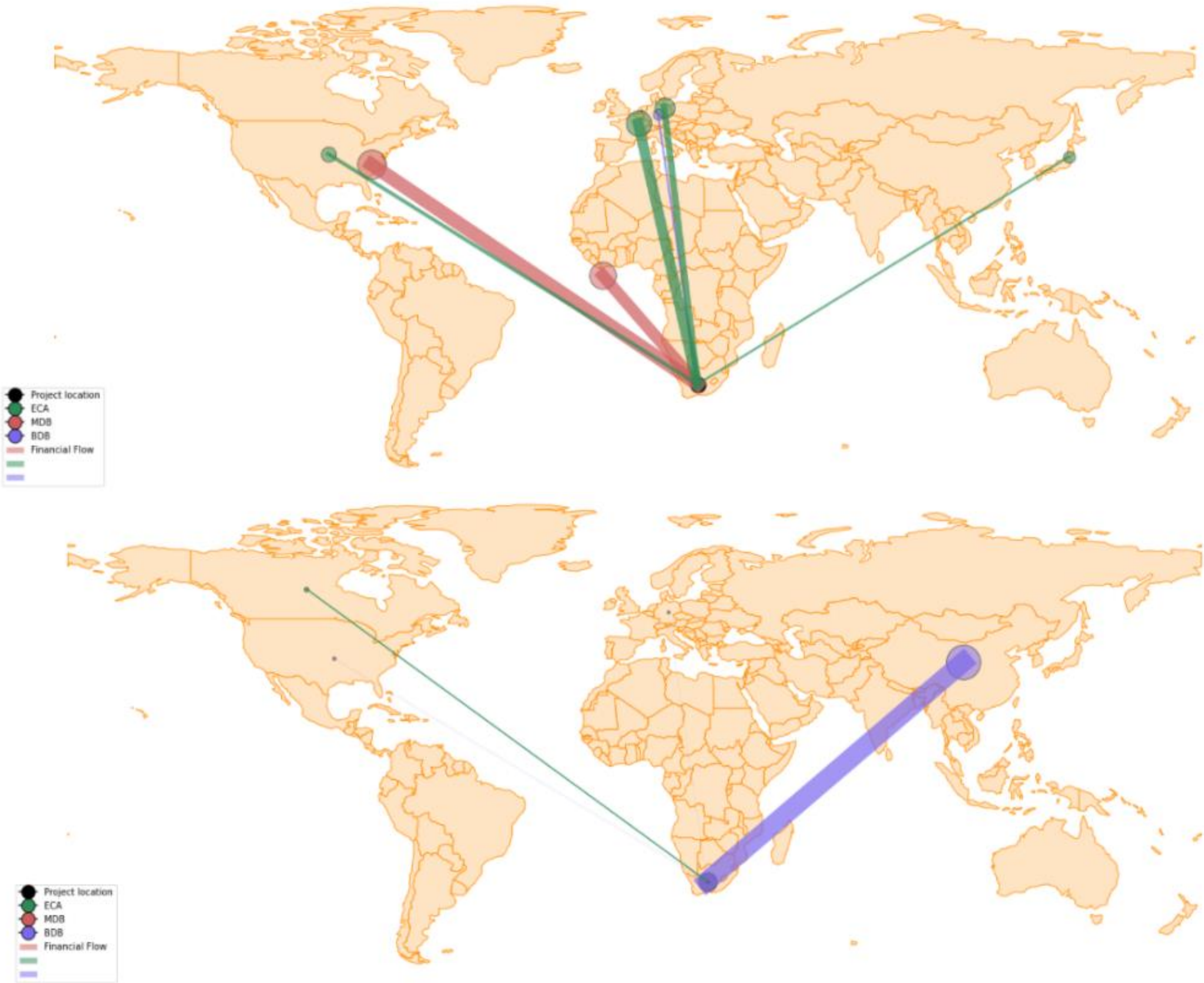
71 Interview FIN_GEN2, FIN_GEN3, FIN_GEN4, NGO_AF7, NGO_AF8
72 Interview FIN_GEN2
73 Interview FIN_GEN4
74 Gupta, Rempel & Verrest (2020: 309)
75 Interview FIN_GEN3
76 Interview FIN_GEN3
77 Interview POL_AF4
78 Interview FIN_GEN3

finance, with the Chinese Development Bank alone accounting for $4.3 billion (97%). This post-Paris finance has been gradually increasing since 2016[79] and was also mostly allocated to finance Medupi and Kusile in addition to funds allocated as working capital for Sasol ($79 million from Export Development Canada) and a $40 million loan by the World Bank (OPIC) for Tetra4 Proprietary Ltd. to finance South Africa's first commercial LNG project.

Overall, 98% ($15.7 billion) of the PFI-based finance tracked in this analysis was allocated to develop South Africa's coal sector in the last 15 years, while a much more humble $300 million (2%) were allocated to develop its oil & gas industry. This is in contrast with the commercial bank tendency to finance oil & gas E&Ps (see 6.2.3).

Figure 6.5. Maps depicting PFI financing for South African fossil fuel projects before (top map) and after (bottom map) the Paris Agreement was ratified



Source: Author, using data from OCI (2020)

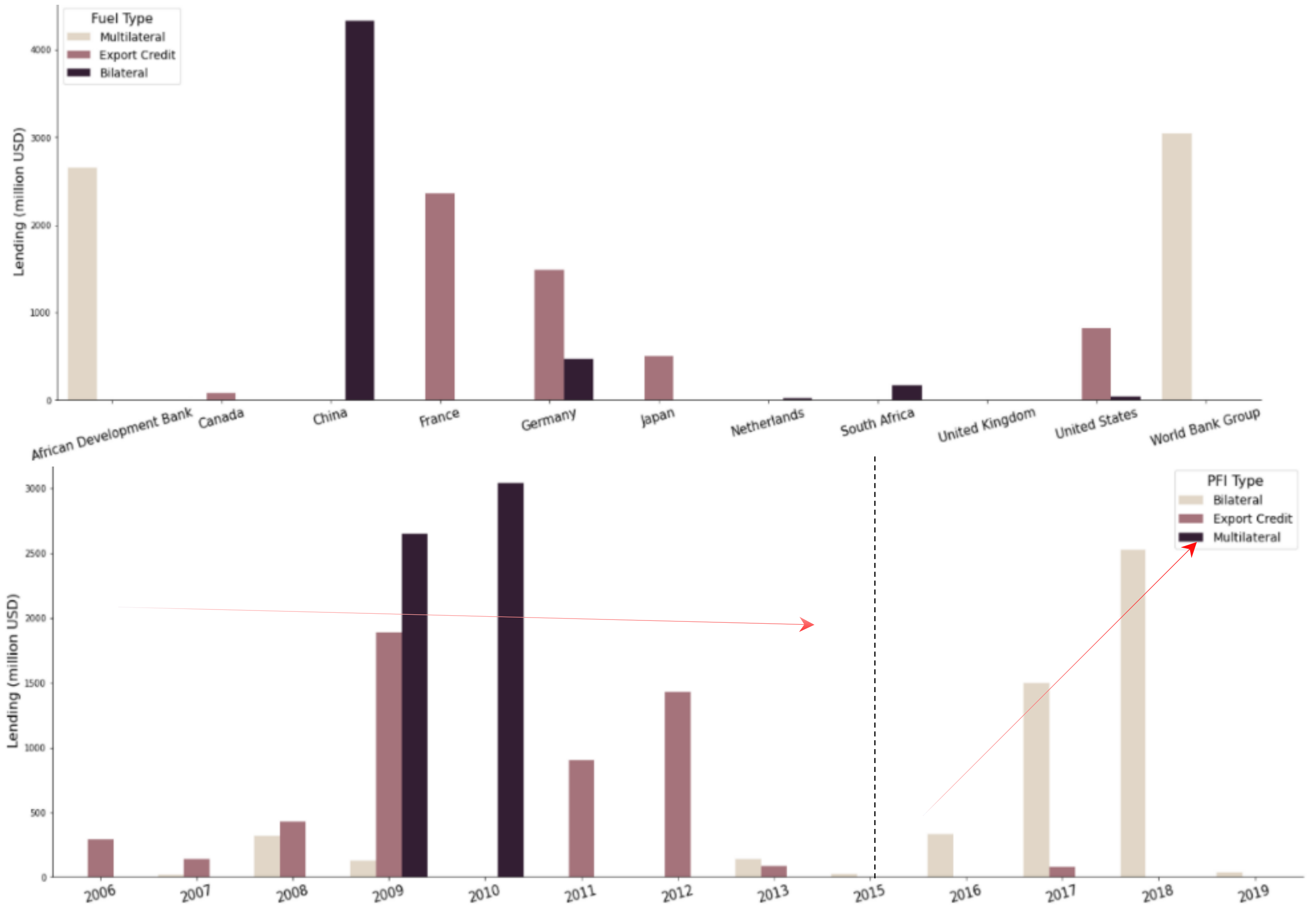
[79] Note that the 2019 data is incomplete

Table 6.1. Summary of PFI-driven financing for South African fossil fuel projects in three time periods: before the Paris Agreement was ratified (2006-2015, second column), after it was ratified (2016-2019, third column) and overall (2006-2019, rightmost column)

	Fossil Fuel Financing (M USD)		
	2006-2015	**2016-2019**	**Overall**
Bilateral	$627.78	$4,403.33	$5,031.12
Multilateral	$5,689.89	$0.00	$5,689.89
Export Credit	$5,163.48	$78.49	$5,241.97
Total	**$11,481.16**	**$4,481.82**	**$15,962.98**

Source: Author, using data from OCI (2020)

Figure 6.6. Breakdown of PFI lending to South African fossil fuel projects by institution (top chart) and by year (bottom chart)



Source: Author, using data from OCI (2020)

N.B. the red arrows denote the general trends in PFI financing before and after the Paris Agreement was ratified

6.2.5. Summary

Sections 6.2.1-6.2.4 shed light on the influence that non-South African finance and economic actors have borne on South African fossil fuel production. Not only are multinational E&Ps: responsible for some 50-75% of South African coal production; operating over half of South Africa's offshore oil and gas exploration blocks; and in control of four of the nation's crude oil refineries and de facto 80-85%

of oil imports, but the liquid equity and debt finance that supports these E&Ps directly by providing capital investments (debt) or indirectly through shareholder control (equity) almost entirely originates from non-South African finance institutes. This begins to question the extent to which these actors (largely from the 'North') should play a role in phasing out South African fossil fuels and governing the accompanying stranded assets (see 5.5). I elaborate on this point in section 6.4.

Note, however, that some actors dispute the degree to which these investments are in fact destined to generate stranded (financial) assets. "Only if the climate crisis is seriously addressed and carbon is increasingly priced over time, starting at $80-100 per tonne in 2020 to about $500 in 2035"[80] will such an overvaluation – and therefore financial risk – be relevant. Stranded (financial) asset risk denialists argue that the "valuation of [fossil fuel] reserves will gradually decline as climate policies are accordingly gradually implemented,"[81] in which case the financial risks of stranded assets is rendered moot and investors should feel free to continue di/investing as if climate-related risks were irrelevant. Others argue that "even if there is an overvaluation, it is not in the books of companies and most certainly not in the valuation of companies"[82] because the vast majority of coal, oil and gas reserves are owned by SOEs at the national level.[83] With this logic, the valuation of a particular firm and its projects is not influenced by the coal, oil or gas resources that it may extract in the future; as a result, investors need not worry about speculations about future climate policy and fossil fuel restrictions, for the firms in which they invest will remain unaffected – altogether promoting continued investment today.

6.3. Multinational Players Across Africa & Prospective Stranded Financial Assets

6.3.1. Introduction

Replicating section 5.3, this section aims to contextualise the influence that actors from the 'North' play in hoisting South African fossil production (see 6.2) within the context of the broader African continent. Like in 5.3, it does not go into as much detail as the South African analysis in sections 6.2.1-6.2.5, for doing so for all 55 African nations would also be infeasible; rather, this section maps key E&P and supporting finance linkages to continental African fossil production, though this is once again not to suggest a homogenisation of the African continent in any way (see 1.3.2).

6.3.2. E&Ps & Multidimensional Stranded Finance

Figure 6.7 maps 29 major fossil E&Ps with operations in at least one of African nation; the black markers indicate the listed headquarters of the E&Ps, which are sized according to the relative fraction of the aggregate sample market capitalisation (roughly $1.36 trillion as of December 2020 data) by country. Note that **of the 29 E&Ps, only one is African** (Sasol, with headquarters in South Africa). Moreover, the red markers in Figure 6.7 denote the African countries in which the sampled E&Ps hold coal, oil or gas operations, and the red lines link the project host countries to the E&P headquarters.

The E&Ps hold operations in at least 46 African, and most (particularly oil and gas) hold operations in multiple, like BP (11 countries), ExxonMobil (14), Shell (27) and TotalSA (40). The coal and mining E&Ps are not as proliferate (e.g., BHP Billiton, ValeSA operational in 2 countries each, Rio Tino and AngloAmerican in 4 each), although this is expected since Africa's coal reserves are concentrated in southern Africa (see Figure 5.8).

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[80] Interview ACA_GEN1
[81] Interview ACA_GEN2
[82] Interview FIN_GEN1
[83] Interviews FIN_GEN1, FIN_GEN4, ACA_GEN2

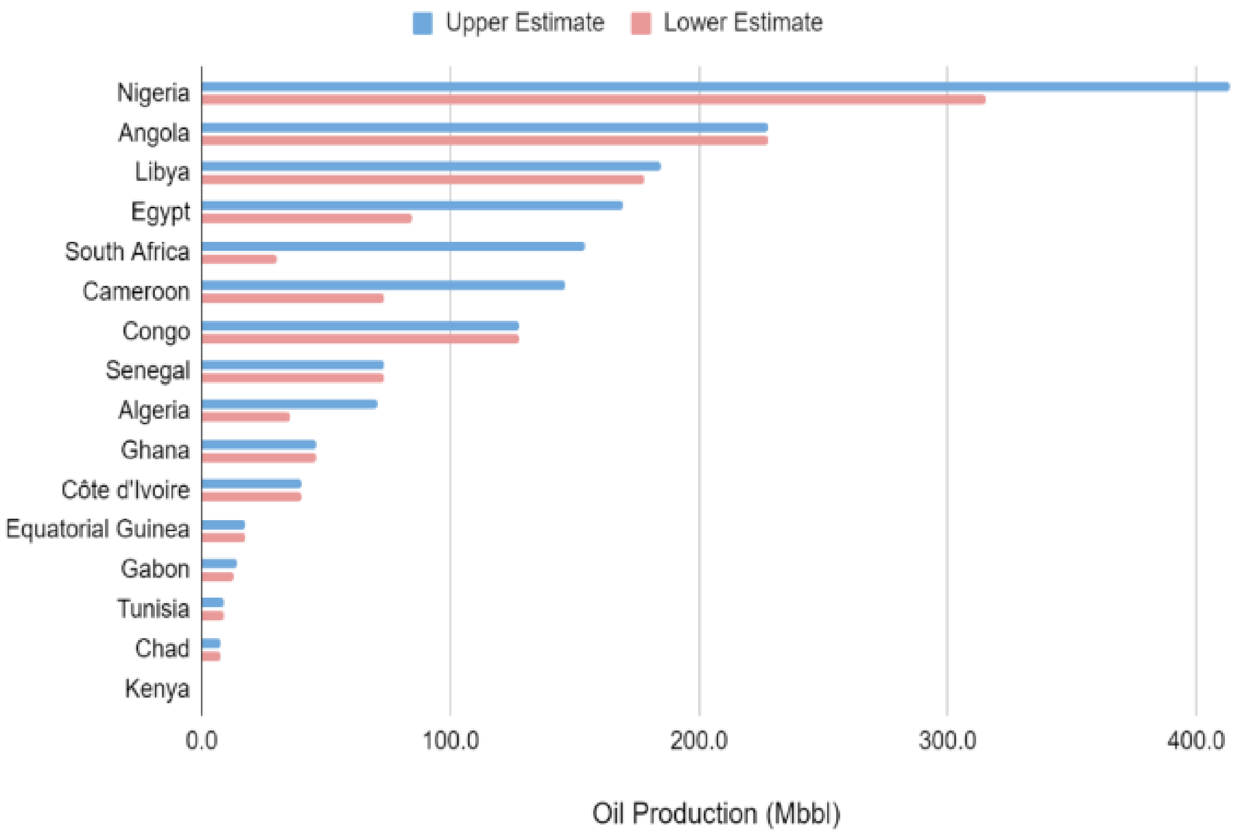
Figure 6.7 Map illustrating the linkages between 29 of the world's largest coal, oil and gas exploration & production firms (displaying their headquarters with black markers) and their African fossil fuel projects (red markers).The size of the black markers is relative to the fraction of the total market capitalisation captured by a particular country's firms.

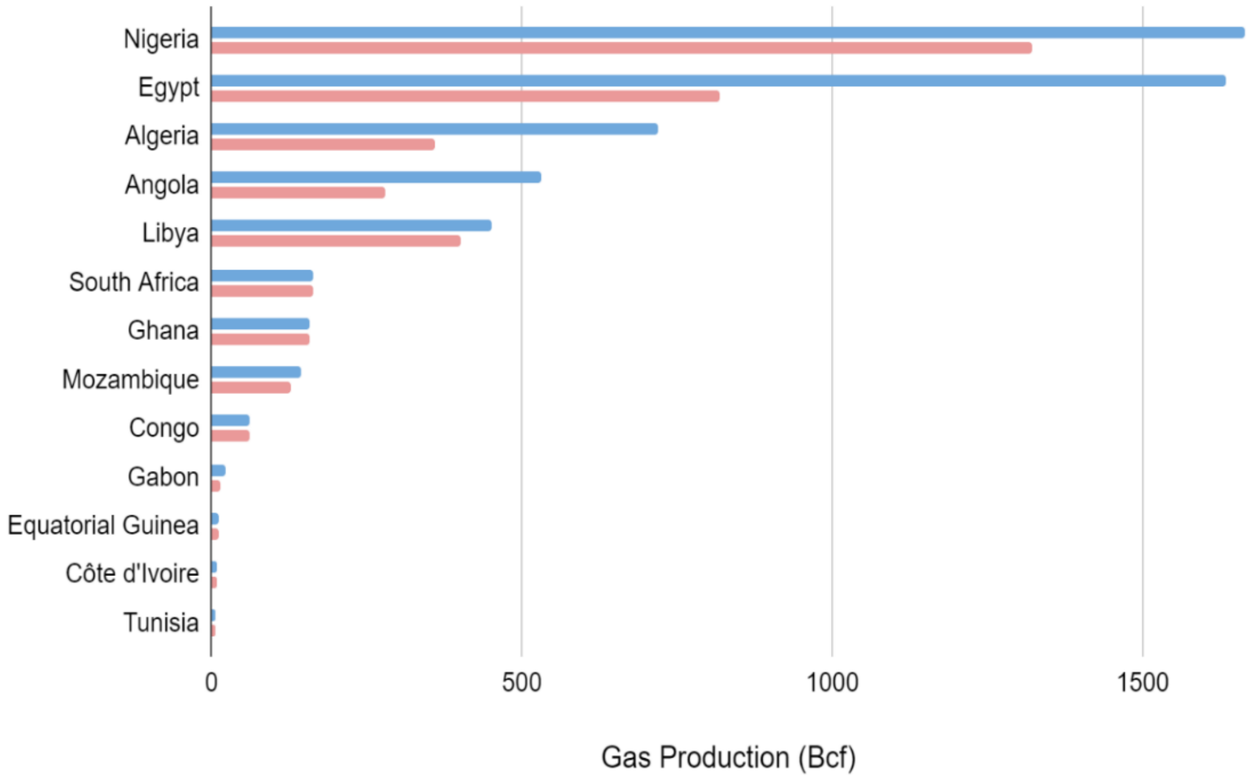
Source: Author

Figure 6.8 Geospatial breakdown of the types of operations run by the sampled E&P per country in Africa

Source: Author

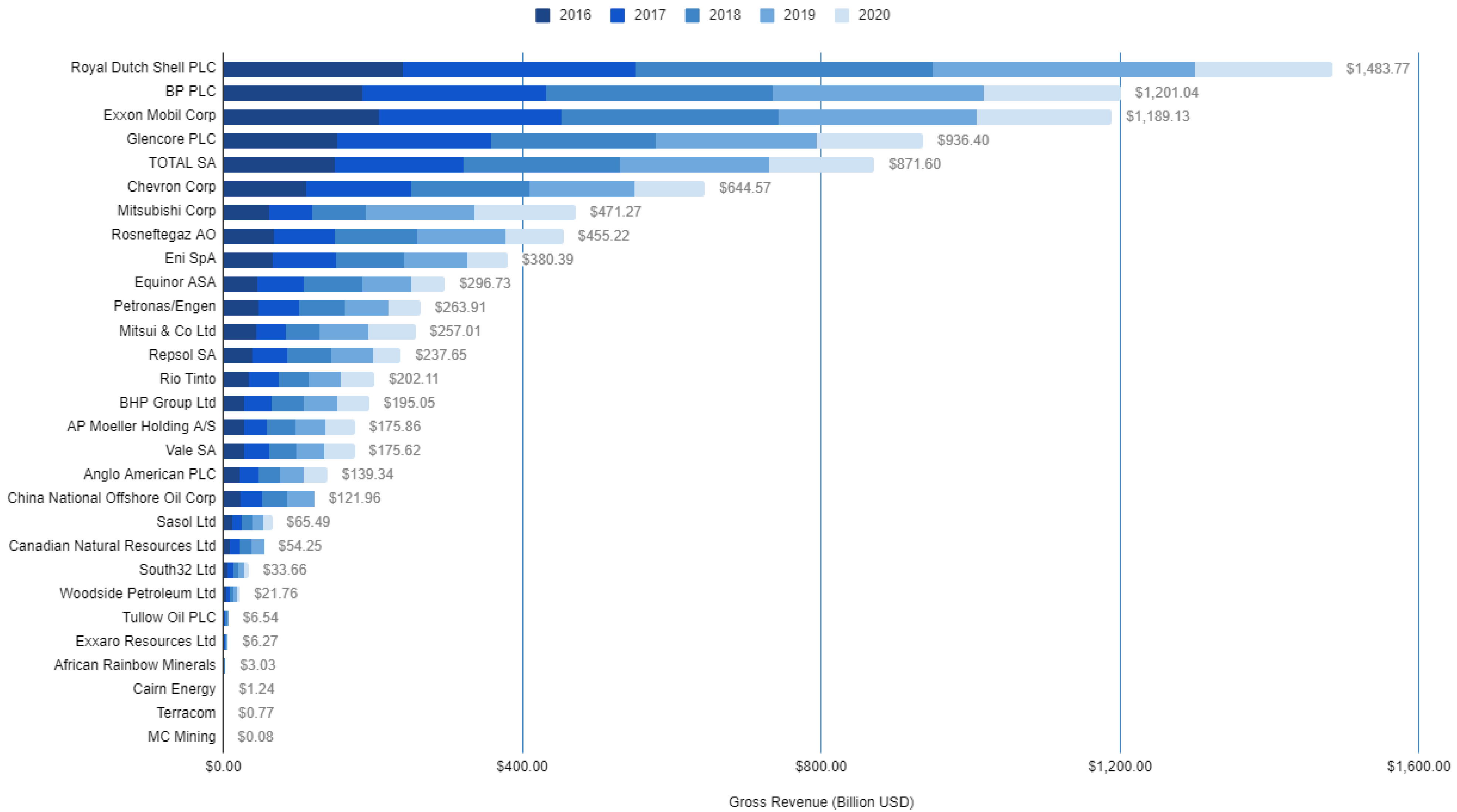
Figure 6.9 Estimated E&P oil production (Mbbl, top) and natural gas production (Bcf, bottom) by country





Source: Author

Figure 6.10. Gross revenue generated by the major E&Ps from 2016-2020 (in billion USD)



Source: Author

Figure 6.8 decompose the types of operations of the E&Ps geographically. Offshore oil and offshore gas exploration were extensively the most common operations, with approximately 60 counts of each, and these noted throughout most of the continent – depicted by the black circle and triangle markers in Figure 6.8. More mature operations in certain blocks have already begun production or continue exploration activities in parallel with production – roughly 95 and 65 instances of each were noted. For instance, Shell is the operator of two oil mining licenses for offshore oil and gas exploration and production in Nigeria (OML 118 and 135) and has a stake in two others (OML 133 and OPL 245),[84] through which it produced 15.6Mbbl of oil and 40.7 Mboe of natural gas in 2019/20 (equivalent to 2% and 13% of Nigerian oil and gas production in 2019, respectively – see Appendix C) and is continuing to explore for more recoverable resources.

Figure 6.9 displays the estimated oil (top) and gas (bottom) production[85] across the sample of E&Ps per country. These are merely estimates, because not all E&Ps readily report their annual production data, and when they do, it is at times incomplete (e.g., only Q1-Q3 production) or aggregated across multiple factors (e.g., production across 'Southern Africa', or combined oil and liquid gas production). The E&Ps likely account for 31-40% of top-5 African oil production, 39-61% of gas production, and 62-80% of coal production (see Appendix C). In some cases the disclosed E&P involvement is relatively low, like in the aforementioned Algerian case (6-11% of oil production, 11-23% of gas production); in other cases the E&P influence is substantial, like in Nigeria's case (39-52% of oil production, 76-96% of gas production). The latter is also true for South African coal, in which the E&Ps reportedly produced 160-190Mt, accounting for 63-75% of 2019 South African coal production. *These findings indicate that the multinational E&Ps very likely play a substantial role in producing most of African coal, oil and gas.*

Altogether, ***the E&Ps jointly generated $9.9 trillion in revenues*** in the last five years, with annual revenues peaking in 2018 ($2.4 trillion) and subsequently 2019 ($2.3 trillion) – see Figure 6.10. 2020 revenues surpassed $1.6 trillion, despite the COVID-19 pandemic rattling global economies. Three E&Ps alone (Shell, BP, ExxonMobil) generated over $1 trillion each over the five-year period. Naturally, these sales revenues cannot be solely attributed to the E&P's operations throughout Africa; nevertheless, it does show that these E&Ps have been immensely profitable, using their exploitation of African (among other) resources to exchange coal, oil and gas on global markets in spurring mammoth financial flows – at the expense of accelerating and exacerbating the 'climate emergency'.

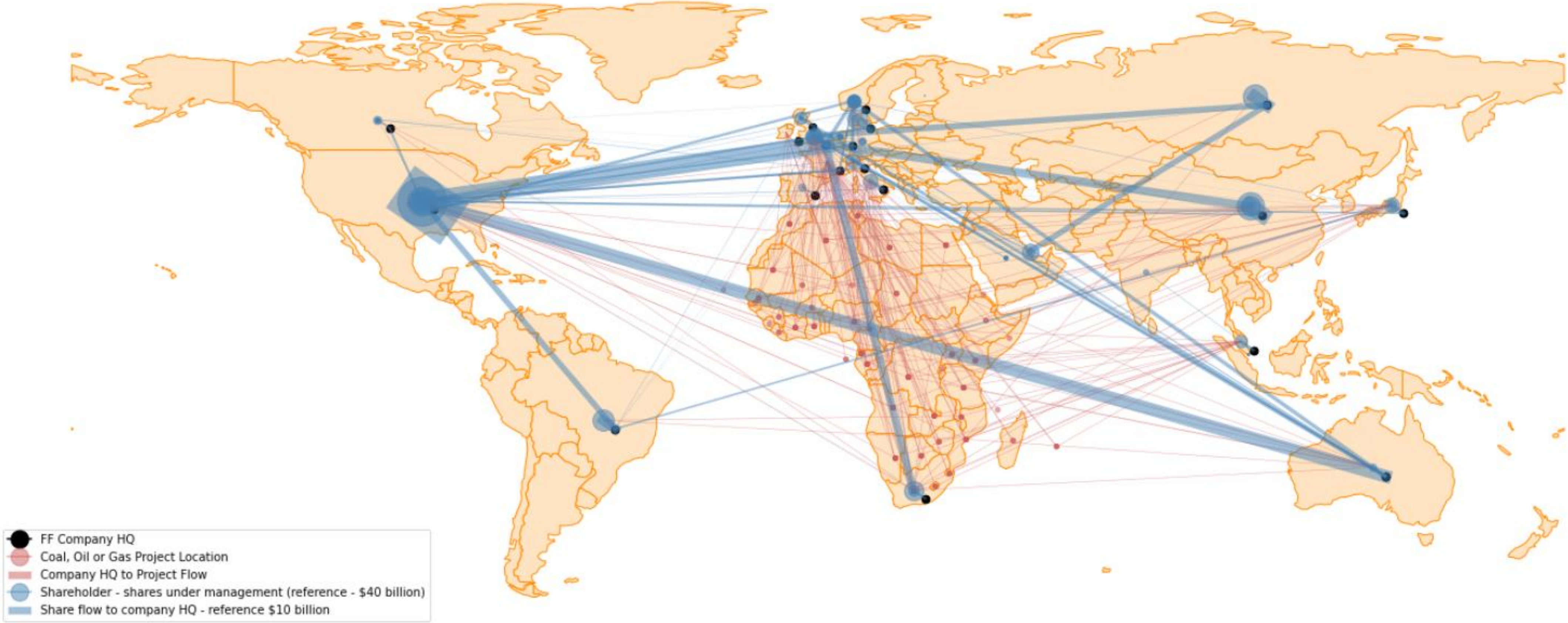
6.3.3. Equity Investments in E&Ps Linked to African Fossil Fuel Production

Figure 6.11 presents the geographical distribution of the major shareholders of the 29 sampled E&Ps, as of July 2020. The total shares tracked in this analysis sum to $422 billion (managed by 208 unique investors), capturing roughly 33% of the aggregate market capitalisation across the sample (for details see Appendix B). U.S. investors dominate; of the total $422 billion, ***roughly $177 billion belong to 76 unique U.S. shareholders***, spearheaded by BlackRock ($43 billion), Vanguard ($43 billion) and State Street ($21 billion). Chinese investors were also notable in the magnitude of their total assets (almost $42 billion), as were European investors, illustrated by the cluster of medium-sized blue markers around Europe in Figure 6.11.

[84] It is also the operator of and has a stake in 17 other onshore blocks

[85] Coal production is not graphed because it is only applicable to two countries (South Africa & Mozambique)

Figure 6.11 Shareholder data (blue markers) and magnitude of shares (blue lines) pertaining to the sampled E&Ps (black markers), and the operations that said E&Ps run in Africa (red markers & lines)



Source: Author

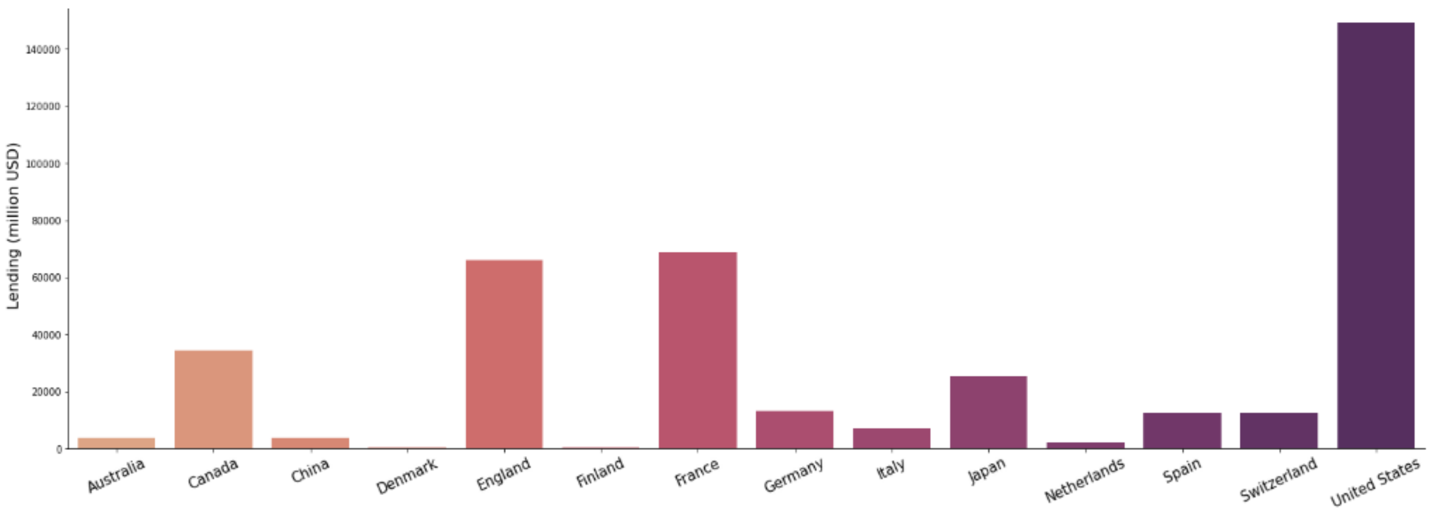
Once again (see 6.2.2), **the only African country represented within the investor sample is South Africa**, and of the $422 billion in assets, **less than $11 billion belong to 12 South African investors, with an average of $320 million per African investor.** These South African assets are not negligible, but they pale in comparison to some of the aforementioned U.S., European and Chinese counterparts, again indicating **that the vast majority of the equity tied to the E&Ps that prevail across African fossil fuel economies lays almost entirely in the 'North'**. It is quite apparent that the vested financial interests in the growth of the African fossil fuel industry lay almost entirely outside of the continent, bar the exception of a few shareholders from South Africa. Accordingly, the financial burden of phasing out African fossil fuels (as far as equity finance is concerned) currently falls on investors from the 'North', as does the responsibility and power to govern any prospect of a fossil transition across the African continent.

6.3.4. Commercial Banks & Stranded Debt

A group of 50 unique commercial banks (from 14 different countries) issued loans to 24 of the 29 sampled E&Ps from 2016-2019, with a **total amount of debt issued aggregating to $399 billion**. Figure 6.12 visualises these aggregated loans at the national level (of the commercial banks) and Figure 6.13 maps the debt flows from commercial banks to fossil fuel E&Ps.

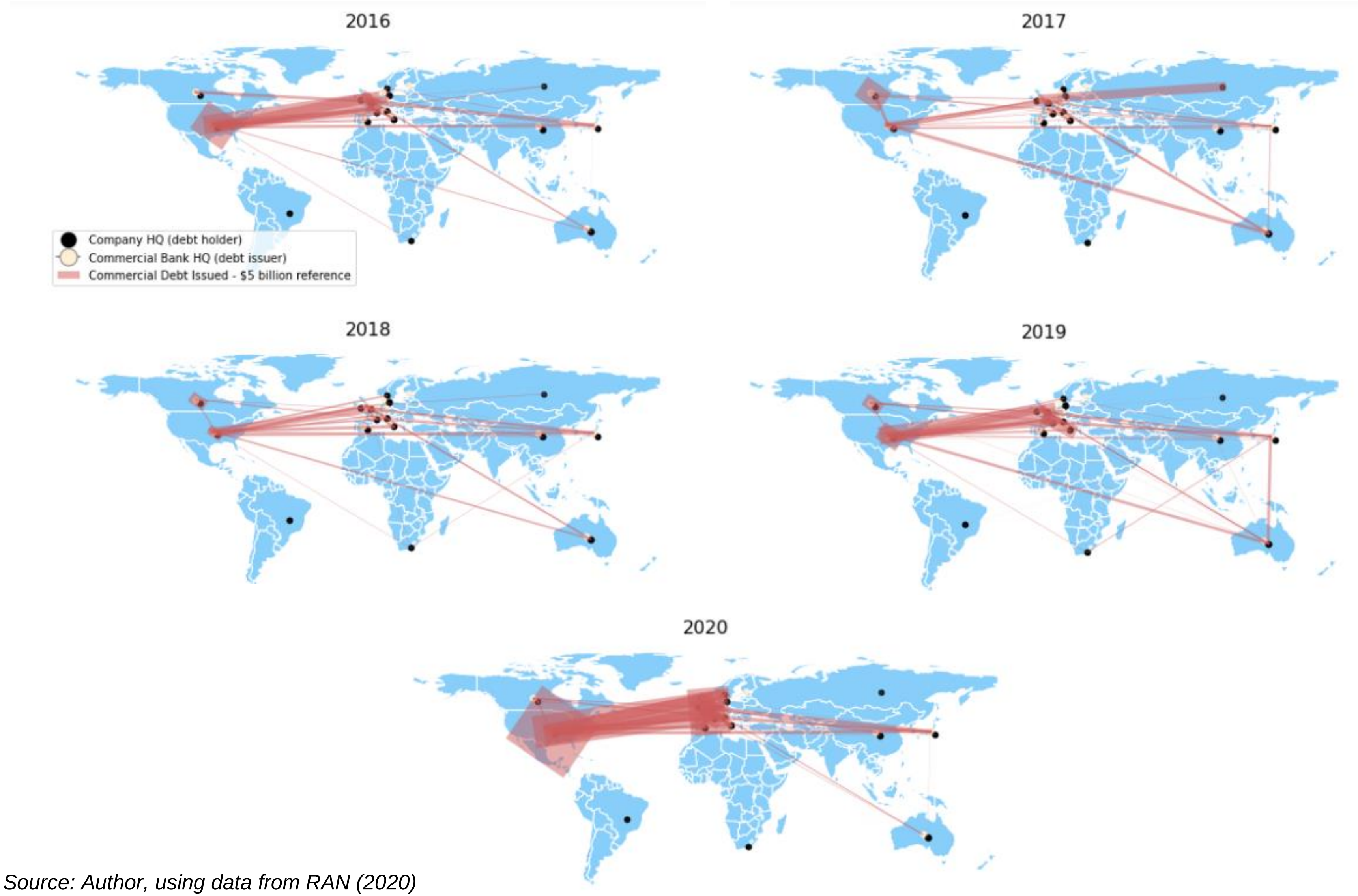
U.S. commercial banks once again lead the pack in terms of total debt issued from 2016-20, loaning almost $150 billion to the sampled fossil fuel E&Ps – accounting for over 37% of the total lending. French ($69 billion), Canadian ($34 billion) and English ($66 billion) banks follow, jointly accounting for 41% of the total debt issued; altogether **European banks issued a staggering $183 billion** to the sampled E&Ps, representing 46% of the total debt. Meanwhile, their Asian counterparts were comparatively less active, providing $29 billion in loans (7% of the total) – of which most ($25 billion) was issued by major Japanese banks, with the remaining $4 billion by Chinese banks. By lending to these E&Ps, commercial financiers from North America, Europe and Asia have not only exacerbated the 'climate emergency' by enabling continuous and unabated fossil fuel production, but have also deepened the stranded asset risk borne by African citizens by generating new prospective stranded assets across the continent (see 5.3.4), *in addition to simultaneously incurring a stranded financial asset risk on their own balance sheets in the form of this issued outstanding debt.*

Figure 6.12 Breakdown of the total amount of debt issued from 2016-20 by a sample of 50 commercial banks to 24 of the 29 sampled E&Ps, by listed headquarter of the commercial bank.



Source: Author, using data from RAN (2020)

Figure 6.13 Maps depicting the debt issued (red lines) by commercial banks (yellow markers) to the sampled fossil fuel E&Ps (black markers) over a five year period since the ratification of the Paris Agreement



Source: Author, using data from RAN (2020)

Total lending oscillated annually, from $76 billion (2016) to $49 billion (2017), $43 billion (2018) and $79 billion (2019), *only to then substantially rise to $153 billion in 2020* (see Appendix C for details). It is alarming that the downward trend in lending from 2016 to 2017 and 2018 was sharply inverted, with aggregate lending almost doubled from 2018 to 2019 and doubled again from 2019-2020, translating into violations of Articles 2.1a and 2.1c of the Paris Agreement (see 1.4.1), among others.

6.3.5. PFIs & Stranded Debt

PFIs allocated roughly $106 billion for African fossil fuel projects from 2007-2019, with $61 billion before and $45 billion after 2015 – see Table 6.2. The $61 billion of pre-Paris adoption finance was relatively evenly distributed across Non-Annex 1/B (i.e., from the 'South') party BDBs ($13 billion), Annex 1/B party (i.e., from the 'North') ECAs ($13 billion) and MDBs ($26 billion); conversely, fossil finance after 2016 was predominantly driven by Non-Annex 1/B nation BDBs ($17 billion), with both Annex 1/B and Non-Annex 1/B nation ECAs ($8 billion & $6 billion) and MDBs ($10 billion) following suit with comparable financial flows. Over the entire analysis period, Non-Annex 1/B party BDBs ($31 billion) and Annex 1/B party ECAs ($21 billion) were leading financiers of African fossil fuel projects.

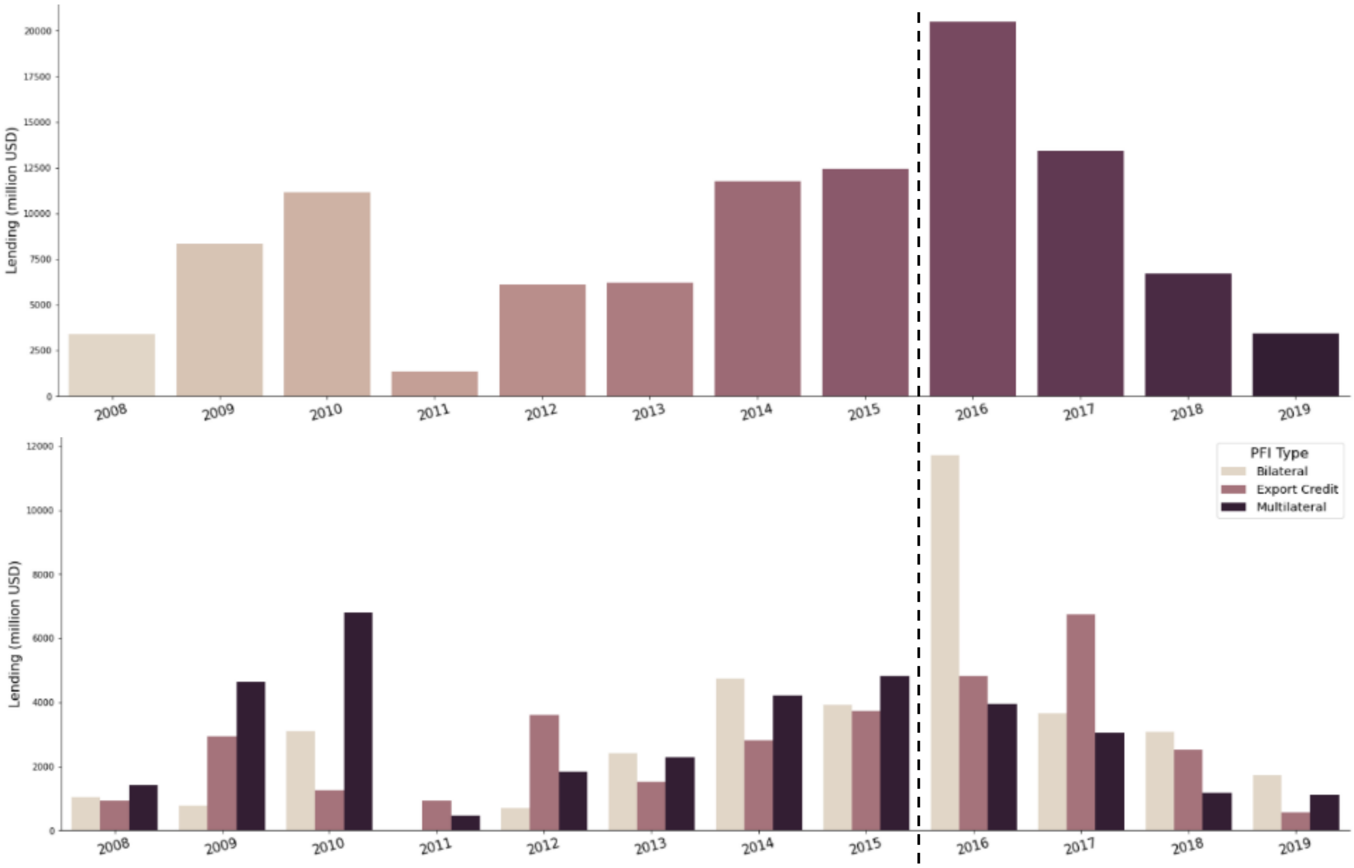
Table 6.2. African fossil financing (in USD, millions) by BDBs, MDBs and ECAs from G20 countries before and after 2015.

	Before Paris (2007-2015)		*After Paris (2016-2019)*		*Total (2007-2019)*	
	1/B	*Non-1/B*	*1/B*	*Non-1/B*	*1/B*	*Non-1/B*
Bilateral	3,695.90	13,012.36	2,875.16	17,252.75	6,571.06	30,265.11
Export Credit	12,625.31	5,500.11	8,387.64	6,275.00	21,012.95	11,775.11
Total (Non-)1/B	16,321.21	18,512.47	11,262.80	23,527.75	27,584.01	42,040.22
Total BDB/ECA	34,833.68		34,790.55		69,624.23	
Multilateral	26,448.21		9,601.55		36,049.76	
Grand Total	61,281.89		44,392.10		105,673.99	

Source: Author, using data from OCI (2020).

Figure 6.14 illustrates the trends in PFI financing for African fossil fuel projects from 2008 through 2019. African fossil financing steadily oscillated at about $5 billion annually from 2008-2013, after which annual PFI support for African fossil fuels spiked to $12 billion from 2014-2015. Immediately after 2015 fossil fuel financing peaked at over $21 billion in 2016, after which it began to gradually decline. This abrupt rise in 2016 was largely due to almost $12 billion in BDB financing, a significant increase from their pre-2015 average of roughly $2 billion. Moreover, BDB African fossil financing stood at $1.7 billion in 2019, suggesting that their pre- and post-2015 spending is quite comparable (see the second plot in Figure 6.14).

Figure 6.14 Annual ECA, MDB and BDB African fossil fuel financing



N.B. The top plot presents total financing (in USD, millions) for African fossil energy projects in total, and the bottom plot by actor; The dotted line represents the Pairs Agreement's ratification.

Source: Author, using data from OCI (2020).

The top PFIs to finance African fossil fuels are displayed by type and nationality in Table 6.3 (see Appendix C for details), complemented by Figure 6.16, which maps the financial flows between African fossil fuel projects and the PFIs both before (left) and after (right) the Paris Agreement was adopted. This depicts the African nations that received at least $1 billion in PFI financing for fossil fuel projects both before and after 2015. Financial support for African fossil fuels before the Paris Agreement was adopted was driven by Japanese ($5 billion), German ($3 billion) and French ($3 billion) ECAs (Annex 1/B), and Chinese ($8 billion) & Indian ($2 billion) BDBs and Chinese ($4 billion) & South Korean ($2 billion) ECAs (non-Annex 1/B), though MDB-driven finance overpowered all of these in the pre-Paris era ($26 billion in total). After 2015, Non-Annex 1/B member states asserted dominance, mainly driven by Chinese BDBs ($15 billion) and Chinese ($4 billion) & South Korean ($2 billion) ECAs. Annex 1/B nation PFIs also allocated substantial funds post-Paris adoption, led by German ($3 billion), Italian ($3 billion) and Japanese ($2 billion) ECAs.

Table 6.3. Types and nationalities of the top 10 PFIs to finance African fossil fuel overall (left), before 2015 (middle) and after (right).

Fossil Fuel Financing (loans, guarantees, debt relief, underwritings: M USD) [Rank]

Country	Type	Overall (2007-2019)	Before Paris (2007-2015)	After Paris (2016-2019)
Regional	Multilateral	36,049.76 [1]	26,448.21 [1]	9,601.55 [2]
China*	Bilateral	22,872.12 [2]	7,710.00 [2]	15,162.12 [1]
China*	Export Credit	7,772.18 [3]	3,672.18 [4]	4,100.00 [3]
Japan	Export Credit	6,661.41 [4]	4,571.96 [3]	2,089.45 [7]
Germany	Export Credit	5,382.78 [5]	2,803.71 [5]	2,579.07 [4]
South Korea*	Export Credit	4,002.93 [6]	1,827.93 [8]	2,175.00 [6]
Saudi Arabia	Bilateral	3,680.16 [7]	2,351.07 [7]	1,329.08 [8]
Italy	Export Credit	3,180.34 [8]	640.38 [15]	2,539.95 [5]
France	Export Credit	2,755.11 [9]	2,621.85 [6]	133.26 [17]
Japan	Bilateral	2,092.52 [10]	903.54 [12]	1,188.98 [9]

Source: Author, using data from OCI (2020)

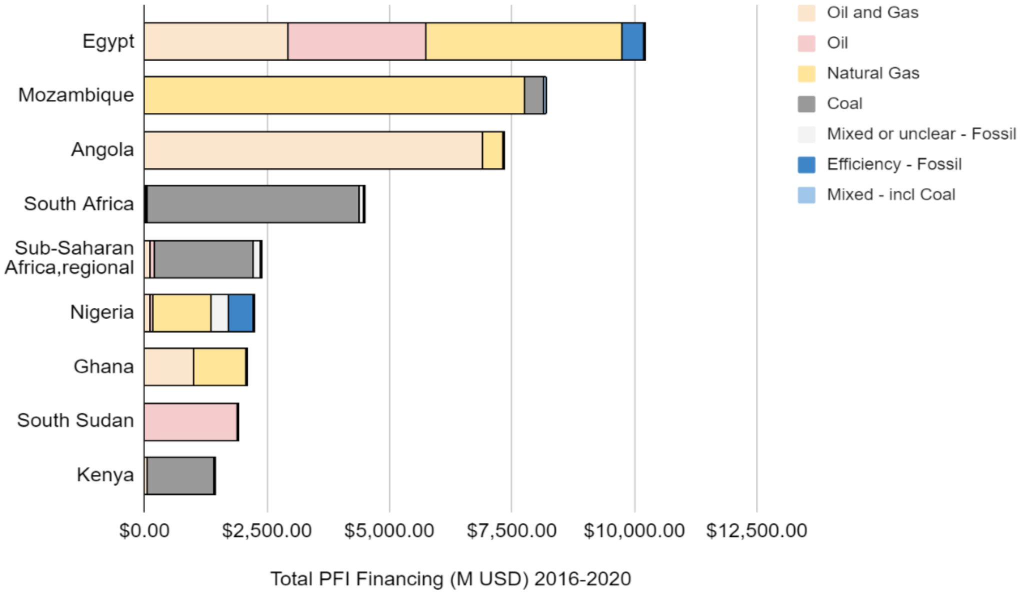
N.B. Elements marked with a "" denote Non-1/B member states. Source: Author, using data from OCI (2020).*

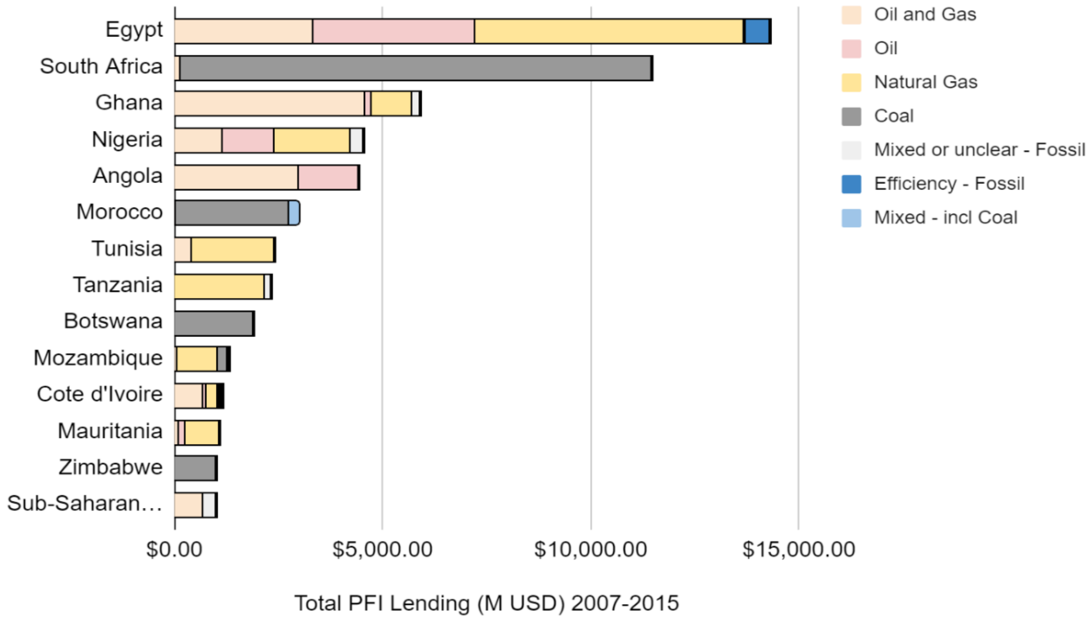
Egypt was the leading recipient both before ($14 billion) and after 2015 ($10 billion). Notably, the entirety of Egypt's PFI financing has been allocated towards oil and/or natural gas. South Africa has also been a leading recipient amongst the African nations, obtaining $11.5 billion ($11.3 billion for coal, $200 million for oil & gas) from 2007-2015 and $4.5 billion ($4.4 billion for coal, $100 million for mixed) from 2016-2019. Ghana and Angola both obtained significant oil & gas financing before ($6 billion and $4.4 billion, respectively) and after ($2 billion and $7.3 billion, respectively) 2015. Mozambique is an anomaly in that it received merely $1.3 billion in PFI financing for oil & gas ($1 billion) and coal ($280 million) projects in 2007-2015, but since 2015 Mozambique's natural gas PFI-driven financing skyrocketed to $7.7 billion, yielding a total of $8.2 billion of fossil fuel financing from PFIs since 2016.

6.3.6. Summary

Sections 6.3.2-0 clearly indicate that, as was the case in South Africa, the African fossil fuel industry has been largely shaped by non-African economic and financial actors, predominantly from the 'North'. A small sample of 29 E&Ps (of which one [Sasol] is African) hold operations in 46 African nations and were responsible for producing an estimated 31-40% of African oil, 39-61% of gas, and 62-80% of coal production in 2019/20. Moreover, less than 3% of the major shareholder liquid assets under management pertaining to these E&Ps belonged to African shareholders, and at least $400 billion in commercial debt has been allocated to finance these E&Ps from 2016-2020, though naturally not all of these funds have flowed directly to African fossil projects. PFIs mainly from Europe, Asia and North America have also issued over $44 billion in debt to drive African fossil fuel production from 2016-2020, altogether indicating that African coal, oil and gas production would not be where it is today without the financial and technical support from these non-African E&Ps and financiers. Accordingly, the gargantuan stranded asset exposure and risk accrued born by the African continent (identified in 5.3 and 5.5) can be partially or substantially attributed to intervention by actors mainly from the 'North'.

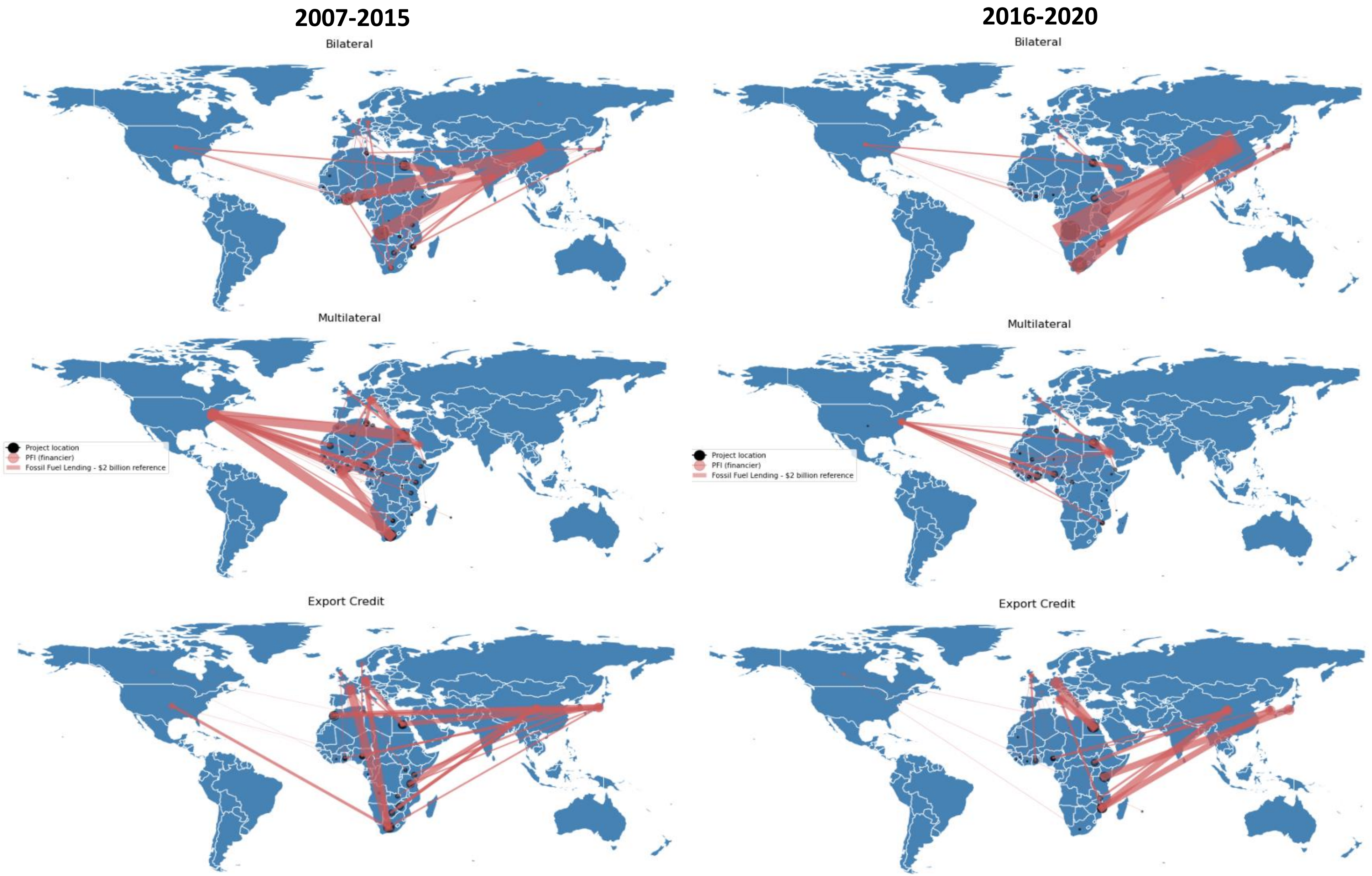
Figure 6.15. Breakdown of PFI financing (M USD) before (bottom) and after (top) the Paris Agreement was ratified for African fossil fuel projects by recipient nation. These charts only include countries that received at least $1 billion in financing. Source: Author, using data from OCI (2020).





Source: Author, using data from OCI (2020)

Figure 6.16 Maps displaying PFI financing for African fossil fuel projects before (left) and after (right) the Paris Agreement was ratified



Source: Author, using data from OCI (2020)

6.4. Analysis: A Stranded Asset Debt Owed to South Africa?

6.4.1. Introduction

This section applies the conceptual discussion in 2.2.1.4 in South African context, arguing that the empirical evidence compiled in sections 6.2 & 6.3 suggest that in addition to a 'climate debt', financial and economic actors predominantly (though not exclusively) from the 'North' have simultaneously accrued a Stranded Asset Debt (SAD) through their investments in fossil fuel production in both South Africa and the African continent more broadly. That is, *by developing fossil fuel assets across both South Africa and the African continent, the 'North' (and also the 'South') have accumulated a Stranded Asset Debt (SAD),* conceptualised as both the monetary and non-monetary costs and resources required to strand existing fossil fuel assets in order to adequately curb the average global temperature rise and combat the 'climate emergency'.

Although computing the entire costs of South Africa's prospective fossil phaseout (and indirectly the monetary component of the SAD) is well beyond the scope of this research, it is nonetheless possible to estimate its rough order of magnitude through a series of simple preliminary calculations. The following sections offer preliminary estimates for the first four terms (see Equation 4 in 2.2.1.4).[86]

6.4.2. Human Assets Stranding Costs

For this study, the costs pertaining to stranding human fossil assets are decomposed into two components, namely strand labour (*L*) (see 5.2.3.3) and stranded energy (*E*) (see 5.2.3.2):

$$H = L + E$$

To estimate the stranded labour costs, let us recall that South Africa's fossil regime contains some 270,000 direct and indirect jobs within the coal sector (see 5.2.3.2) and likely several thousand in oil & gas sector vis-à-vis oil refining (see 5.2.2.4), the bulk of which work for facilities under management by non-South African E&Ps. These labourers must be paid some sort of income (either a pension or UBI) in an inclusive fossil phaseout; we can estimate the costs of this UBI needed to support these fossil-dependents, assuming a liveable wage of ZAR7,000-10,000 for a standard family:[87]

$$L = wage \times dependents = \frac{ZAR[7000, 10000]}{month \cdot person} \times 300{,}000\, people = \frac{ZAR2 - 3\, B}{month} = \frac{\$147 - 210M}{month}$$

At an exchange rate of 1USD/14.3ZAR (Sept 2021), this equates to an estimated *monthly cost of $147-210 million per month, or $1.8-2.5 billion annually*. That is, a basic income to support all of South Africa stranded labour from coal mines in the event of a fossil phaseout sits at roughly $2.2 billion annually. This may appear significant, until we recall that Blackrock and Vanguard alone manage assets worth over 9000x this, while the gross revenue generated in 2020 alone by three mining conglomerates: AngloAmerican ($32 billion), Glencore ($142 billion) and BHP ($43 billion) (see 6.3.3) *could finance this UBI for over 85 years*. Note that this does not include the logistical and administrative costs to coordinate and implement the UBI system, which could be costly.

The stranded energy costs (*E*) could be estimated by the costs necessary to *replace* South Africa's installed coal capacity with fossil-alternatives; that is, adding installed solar PV and wind capacity to the grid *in addition to decommissioning* fossil-based capacity (the latter is accounted for in 6.4.3). South Africa's current grid has some 37GW of installed coal capacity and an additional 3.8GW of gas and diesel, yielding a total of roughly 41GW of installed fossil-based power capacity. Meanwhile, the most recent bidding window (4) of the REI4P procured solar PV and wind power projects with average

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[86] Stranded social assets, like stranded communities, are beyond the scope of this analysis

[87] WageIndicator (2019)

total costs of roughly ZAR21 million per MW (including construction costs, working capital, development costs, fees, etc.).[88] Using this as a baseline, the costs for stranding and replacing South Africa's 41GW of fossil-based energy can be sketched:

$$E = \frac{ZAR\ 21\ M}{MW_R} \times 41GW_R = ZAR\ 861B = \$60B$$

That is, adding 41GW of solar PV and wind installed capacity to the grid could cost an estimated ZAR 861 billion, or $60 billion assuming the same exchange rate of 1USD/14.3ZAR (Sept 2021). Hence, the stranded human asset debt costs amount to roughly:

$$H = L + E = \frac{\$2.2\ billion}{year} + \$60\ billion$$

6.4.3. Physical Assets Stranding Costs

Other substantial costs pertinent to the SAD include those associated with decommissioning and repurposing existing fossil-intensive facilities. This includes costs to decommission existing coal-fired power stations (C_P) and mines (C_M), among others:[89]

$$P = C_P + C_M$$

A 2017 study[90] estimated the average costs of decommissioning and dismantling coal-fired power stations at $117,000 per MW capacity (in the US), with a range of $21,000-466,000 (in 2016 USD). Assuming that these costs apply to South Africa's coal regime, this would imply an estimated (average) decommissioning cost of $4.5 billion, with lower and upper estimates of $800 million and $18 billion, respectively:

$$C_{P,min} = \frac{\$21000}{MW} \times 38GW \cong \$800\ million \qquad C_{P,avg} = \frac{\$117000}{MW} \times 38GW \cong \$4.5\ billion$$

$$C_{P,max} = \frac{\$466000}{MW} \times 38GW \cong \$18\ billion$$

This is in the same order of magnitude as the estimated UBI costs, which again, is overwhelmingly within the bounds of the financial capital at the disposal of the stranded asset debtors; *this upper limit could be financed solely by the gross revenue that Glencore generated in 2020 ($142 billion) roughly 8 times over*.

Estimates suggest that it will cost $7.5-9.8 billion[91] to decommission the coal mines in the US Appalachian region, which account for 26%[92] (73Gt) of total US proven coal reserves (278Gt),[93] equating to $103-135 million per Gt of coal. For South Africa's 10Gt proven coal reserves, this could imply decommissioning costs of $1-1.4 billion for closing the nation's coal mines:

$$C_{M,max} = \frac{\$135million}{Gt_{coal}} \times 10Gt \cong \$1.4\ billion$$

$$C_{M,min} = \frac{\$103million}{Gt_{coal}} \times 10Gt \cong \$1.0\ billion$$

[88] Eberhard & Naude (n.d.)
[89] Decommissioning costs for crude oil refineries and LNG terminals are excluded from this analysis due to a lack of reliable estimates to extrapolate from
[90] Raimi (2017)
[91] Savage (2021)
[92] EIA (2020)
[93] EIA (2021)

Hence, the estimated costs for stranded South Africa's physical assets stand between roughly $2-19 billion:

$$P_{min} = C_P + C_M = \$800\ million + \$1\ billion = \$1.8\ billion$$

$$P_{avg} = C_P + C_M = \$4.5\ billion + \$1.2\ billion = \$5.7\ billion$$

$$P_{max} = C_P + C_M = \$18\ billion + \$1.4\ billion = \$19.4\ billion$$

6.4.4. Natural Assets Stranding Costs

The natural asset stranding costs (*N*) have already been computed with the NPV calculations in 5.2.1.3; that is, South Africa's proven coal reserves and newly discovered & prospective oil and gas reserves may generate revenue streams worth $753-886 billion if they are commercialised over the coming decades, of which an estimated $4-44 billion (0.5-5%) would be funnelled to the South African government as royalties (based on conditions from production rights contracts established by the DMRE, see 5.2.1.2). Following these existing contractual parameters, a pragmatic approach would equate the stranded natural asset cost for the South African government as simply the forgone royalties from commercialising its reserves, so:

$$N = \$4 - 44\ billion$$

However, clime justice advocates will take issue with this assumption, likely arguing that by exporting 95-99.5% of the reserves' values to the 'North', producers from the 'North' will be inequitably deepening the ecological debt that they already owe the 'South',[94] and that it is the right of South Africa's citizens to extract the value of these stranded reserves,[95] not multinational E&Ps and their financiers. In the Yasuni-ITT initiative (see Box 4.1), former President Correa sought to mobilise funds to cover *half* of the oil reserve's NPV at the time. Using a similar logic:

$$N' = \frac{\$753 - 886\ billion}{2} = \$377 - \$443\ billion\ \cong \$400\ billion$$

Yielding a stranded natural asset 'cost' an order of magnitude greater than the pragmatic approach. This seems more justified as a relationally inclusive estimate of the compensation merited by the South African population for stranding its fossil resources (see condition R2, Table 2.4). It is, however, not the place of this thesis to speak to which value is more 'just' or recommend which amount 'ought to' be pursued as compensation, as this debate belongs to environmental justice scholars. For this analysis, I will simply adopt the midpoint and propose that, for the sake of argument:

$$N^* = \frac{[N, N']_{min} + [N, N']_{max}}{2} = \frac{\$4 +\ 443\ billion}{2} \cong \$224\ billion$$

6.4.5. Financial Assets Stranding Costs

Finally, we must account for the prospective stranded financial assets that may arise in a South African fossil phase out. As was revealed, the vast majority of prospective stranded liquid equity (i.e., shares) and debt already resides on the balance sheets of institutional shareholders, commercial banks and PFIs predominantly from the 'North' (see 6.2 & 6.3). The equity dimension does not necessarily translate into any costs directly owed to the South African population, since this merely implies that the 'Northern' institutional shareholders incur the stranded shares on their own balance sheets *and refrain from divestment from these assets* (see 4.3.3.2). Conversely, the debt narrative is somewhat different, as payments on debt principal and interest are expected to be paid by the debtor (e.g., Eskom) even in the event that the fossil-intensive facilities that they have financed are

[94] See e.g., Martinez-Allier (2002a; 2002b) and Bond (2010)
[95] See Gupta & Chu (2018)

decommissioned. Hence, a relationally inclusive approach would propose relieving South African debtors of this debt, allocating the implicit stranded debt 'costs' onto the balance sheets of the creditors from the 'North'.

Let us take the two projects that attracted the most commercial and public debt recently as an illustrative example: the Medupi and Kusile coal-fired power stations (see 5.2.2.3 and Appendix C), temporarily equating:

$$F = D_{Med} + D_{Kus}$$

As was shown, Eskom has been caged into ZAR87 billion ($6 billion) in debt issued by the World Bank alone for one single coal-fired power plant (Medupi, see 5.2.2.3); this does not even include the $3.2 billion in syndicated loans issued by German & French ECAs and commercial banks, though details on the interest rates and other conditions for these loans are not available. Eskom's indebtedness from the Medupi project is therefore at least $9.2 billion:

$$D_{Med} \geq \$6\ billion + \$3.2\ billion = \ \$9.2\ billion$$

Eskom's indebtedness from Kusile runs parallel to Medupi's; syndicated loans issued by ECAs and commercial banks from France ($1.8 billion) and Germany ($1 billion) in addition to injections by the AfDB ($500 million), DBSA ($2.2 billion) and the Chinese Development Bank ($2.5 billion) yield a total indebtedness of at least $8 billion:

$$D_{Kus} \geq (\$1.8\ + \$1\ +\ \$0.5 + 2.2 + 2.5)billion = \ \$8\ billion$$

Again, this only includes the principal debt owed and not interest conditions (information which is not available), which would only amplify this debt perhaps quite substantially (see Figure 5.7). As such, the stranded financial asset costs owed by the 'North' taking the form of debt relief amount to at least $17 billion:

$$F = D_{Med} + D_{Kus} \geq \$9.2\ billion + \$8\ billion = \$17.2\ billion$$

6.4.6. Discussion

Based on these individual components, we can very roughly estimate the SAD owed to South Africa's citizens by actors from the 'North':

$$SAD_M = P + \ H + N + F$$

$$= \$5.7\ billion + \left(\frac{\$2.2\ billion}{year} + \$60\ billion\right) + \ \$224\ billion + \$17.2\ billion$$

$$\cong \$290\ billion + \frac{\$2.2\ billion}{year} = \ SAD_M$$

That is, the monetary SAD costs in South Africa's case may amount to at least $290 billion plus $2.2 billion per year to provide a basic income for stranded coal mining households; note that these estimates are overly simplified and omit key administrative & logistical costs, among other considerations, but are helpful to evaluate the order of magnitude of the quantifiable stranded asset risk born by South African citizens. Furthermore, these calculations also suggest that the €8.5 billion that several 'Northern' governments pledged to support a South African coal phase-out as a key outcome of COP26 – namely the Just Energy Transition Partnership[96] – is likely insufficient by several orders of magnitude (discussed further in 9.3.6).

It is worth reiterating that this value may seem substantial at first, but a further analysis suggests otherwise. Recall that the 29 E&Ps with active African operations generated $9.9 trillion in gross sales revenue between 2016-2020 (see Figure 6.10), enough funds to finance this SAD 341 times over. In fact, Shell alone generated $352 billion in gross sales revenue in only 2019, which could singlehandedly finance these costs with $60 billion to spare. Or take ***BlackRock and Vanguard***, the two most profuse major shareholders of the sampled E&Ps, whose ***total assets under management are equivalent to 314,100% this SAD***!

This exercise was helpful to roughly estimate the order of magnitude of the monetary risk borne by South Africa from exposure to its multidimensional prospective stranded assets (see 5.5), but it still remains subject to debate what fraction of this ~$300 billion stranded asset 'bill' ought to be paid by finance institutions, governments and E&Ps from the 'North'. It is beyond the scope of this research to speak definitively on this matter,[97] but what is certainly evident from analysing the fossil finance flows into South Africa (see 6.2) is that this monetary stranded asset risk was partially or majority driven by investments from these 'Northern' actors, given the grasp that multinational E&Ps have on South African coal, oil and gas production, and given the hundreds of billions of dollars in equity and debt financing that these E&Ps have attracted from non-African financiers. Abiding by the 'extractors pay principle' (Kartha et al., 2018 – see Figure 2.5), this suggests that a 'coalition' of key E&Ps (e.g., South32, TotalSA), their major shareholders (e.g., BlackRock, Vanguard) and their commercial (e.g., BNP Paribas, Société Générale) and public debt financiers (e.g., COFACE, Euler Hermes, World Bank) could play a role in settling this SAD, particularly under Articles 4.5 and 9-11 of the Paris Agreement (see 2.2.1.4).

A brief note is merited on the role that Chinese institutions have played in driving this African stranded asset exposure. According to the UNFCCC framework (see 1.4.1), China is technically a non-Annex 1/B nation, and could therefore loosely find itself clumped under the 'global South' banner. Accordingly, traditional climate debt debates (see 2.2.1.3) could conclude that the Chinese government and people are themselves owed financial and technical resources & compensation for decarbonisation, despite Chinese PFIs having invested at least $30 billion in African fossil fuel production alone from 2007-2019. As such, Chinese institutions have been equally as influential in exacerbating African stranded asset exposure as E&Ps and financiers from 'North', which leads to one of two ways forward: either China is considered a member of the 'North' vis-à-vis discussions on LFFU; or, the 'North' and 'South' labels are scrapped altogether and more adequate alternatives are adopted (see 9.6.2.2).

Finally, although this exercise focused merely on estimating South Africa's monetary SAD risk, the complementary finance flow analysis covering the African continent more broadly (see 6.3) indicates that a similar calculation is applicable beyond the South African context, given that multinational E&Ps control 30-80% of African fossil fuel production, 97.4% of their major shareholder value resides outside of Africa, and $400 billion & $44 billion in non-African commercial and public debt issued to develop African fossil fuel production from 2016-2020. Therefore, it is likely that a similar SAD narrative persists in other major African fossil producers, like Nigeria, Angola, Egypt, Libya and Algeria in addition to less prominent African fossil producers, like Uganda, Kenya and Ghana (see 5.3.2.1) with varying degrees of prospective multidimensional stranded assets.

[96] EU (2021)
[97] Other climate justice experts are much better suited to do so, see e.g. Basu & Bond (2022)

6.5. Conclusion

This chapter posed the question:

What fraction of South Africa's stranded asset risk has been generated by financial & economic institutions from the 'North', what is the extent of the stranded financial asset risk borne by these institutions, and hence, what does a preliminary estimation suggest about the magnitude of the Stranded Asset Debt owed by the 'North' to South Africa?

And three conclusions arise from the analysis in 6.2-6.4, discussed below and visualised in Figure 6.17.

Conclusion 1

Given that multinational E&Ps (mainly from the 'North'): currently control 50-75% of coal production, 66% of offshore exploration blocks, and at least 85% of crude oil imports into South Africa; drive 30-60% of oil and gas production and 60-80% of coal production in Africa more broadly; are governed by shareholders who are 94-98% non-African; and acquire hundreds of billions in financing from commercial banks in addition to tens of billions from PFIs from the 'North' to drive their global (including African) businesses, it seems reasonable to conclude that at least 50-75% of South Africa's and 30-80% of Africa's monetary & non-monetary stranded asset risk exposure (see 5.3.4) has been driven and exacerbated by financial and economic institutions predominantly from the 'North'.[98]

Conclusion 2

While generating these prospective stranded assets across South Africa and the African continent, financial and economic institutions from the 'North' (and partially the 'South') have themselves accrued an exposure to prospective stranded financial asset worth some $4 trillion, decomposed as: on average $2 trillion in forgone annual gross revenue streams; $1.3 trillion in prospective stranded liquid equity; $50+ billion in forgone annual dividends; and at least $400 billion and $50 billion in prospective stranded commercial debt and public debt, respectively, issued post-Paris.

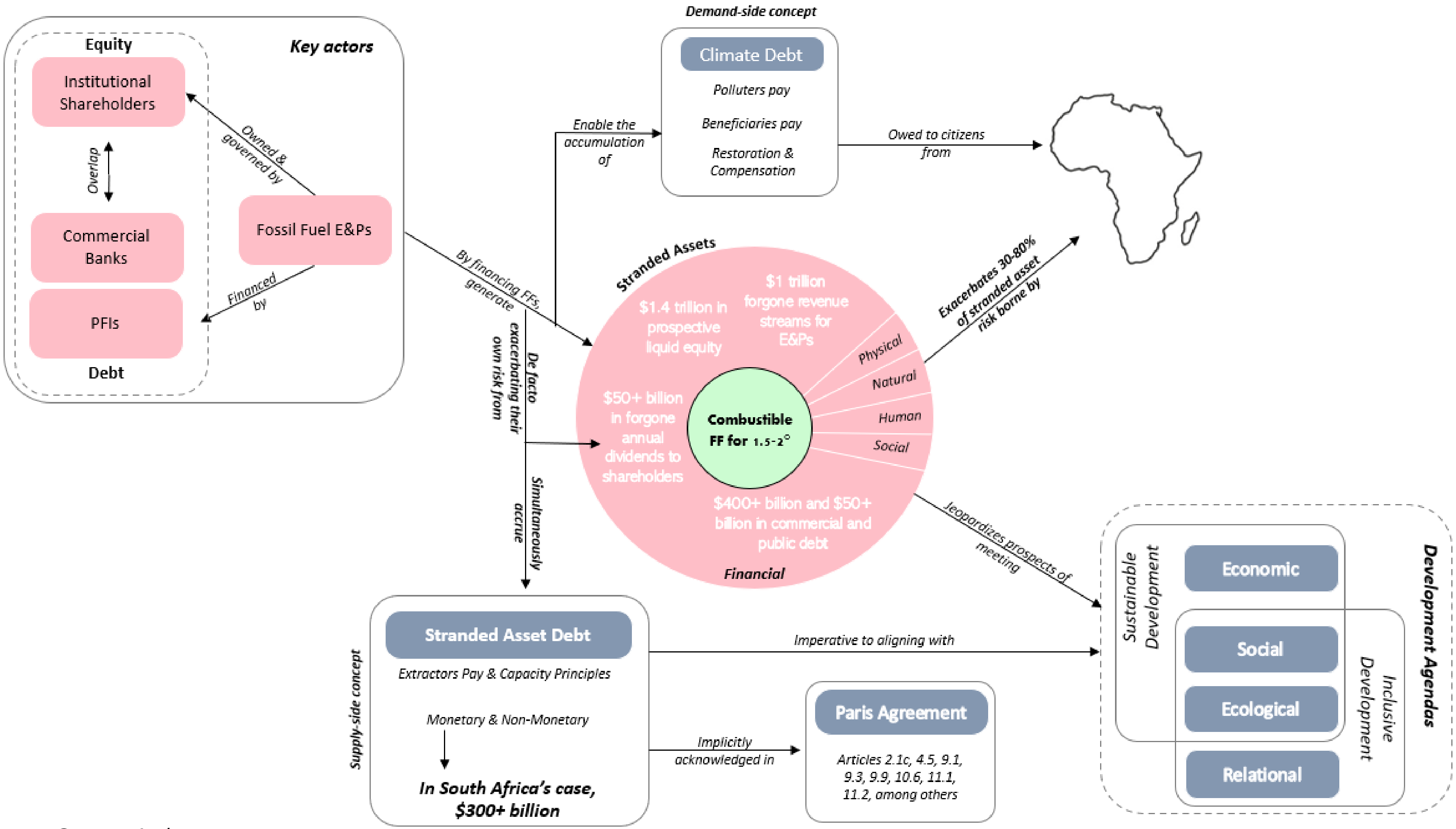
As various monetary and non-monetary stranded assets are accumulated in one pole (in this case, South Africa's fossil fuel industry), strictly prospective stranded financial assets accumulate in another (in this case, the balance sheets of the financial & economic institutions mainly from the 'North'). This bipolar reality bears major ramifications for aligning with international climate goals, as from the perspective of the financial & economic institutions, it is in the best interest of their financial wellbeing to *either prolong a fossil fuel phaseout* in South Africa so as to refrain from stranding their own financial assets, *or divest these assets* before their devaluation so as to salvage their financial health, reallocating the burden of stranding these assets elsewhere.

Conclusion 3

South Africa faces a quantifiable stranded asset risk of at least $300 billion in addition to $2.2 billion in annual payments to support fossil-dependent workers with a universal income, and by investing in and driving the bulk of both South African and African coal, oil and gas production (see conclusions 1 & 2), E&Ps and financiers predominantly from the 'North' have arguably and implicitly accumulated a Stranded Asset Debt (SAD) owed to South African and, more broadly, African citizens, complementarily to having simultaneously accrued a 'climate debt.' As such, these 'Northern' actors may be responsible for 'settling' this SAD and covering a (substantial) fraction of South Africa's $300+ billion stranded asset monetary risk.

[98] Purely based on the fraction of overall fossil fuel production that these actors allegedly account for. These percentage values are merely to stress the substantial control that the 'Northern' actors have over African and South African fossil fuel production, though a more rigorous and detailed analysis is merited to more accurately compute this (see Limitations in section 9.5)

Figure 6.17. Visualising the key stranded asset debt-related conclusions from this chapter



Source: Author

PART 3

LFFU Approaches Taming – or Ballooning – South Africa's Stranded Asset Exposure and the North's Stranded Asset Debt

Scrutinising the policies that influence the stranded asset implications of a South Africa fossil fuel phaseout in relation to international climate policy frameworks

7. LFFU Approach Mix of South Africa's Stranded Asset Debtors

7.1. Purpose and Structure

Now having established both that South Africa's stranded asset risk exposure is vast (see 5.3.4) and that financial institutions largely from the 'North' have exacerbated this risk and de facto accumulated a Stranded Asset Debt (SAD) (see 6.4), this chapter explores how this South Africa-borne risk and SAD are being acknowledged and governed. To do so, it tackles sub question S5 (see 1.3.1):

> What does the composition of the LFFU approach mix that South Africa's stranded asset debtors are adopting imply for the allocation of their Stranded Asset Debt (SAD), to what extent are international finance policy frameworks likely to drive an inclusive fossil transition in South Africa, and hence, how can these frameworks be revamped to better align with inclusive development agendas?

by applying the analytical framework developed in the literature review to study the policies and LFFU approaches that 74 unique E&Ps, shareholders, commercial banks and PFIs that have accumulated a SAD through their South African fossil-intensive investments are proposing and adopting. The chapter first discusses the general breakdown of the studied reports and the international policy frameworks that many of them abide by (see 7.2), then proceeds to populate the analytical framework and generate the LFFU approach mix adopted by these South African stranded asset debtors (see 7.3). Subsequently, it explores the extent to which the SAD is acknowledged and governed (see 7.4), evaluates the implications that this generated approach mix bears on social, ecological and relational inclusiveness and sustainable development agendas (see 7.5), and finally draws conclusions (see 7.6).

7.2. Key Actor Reports & International Policy Context

7.2.1. Actor Clusters

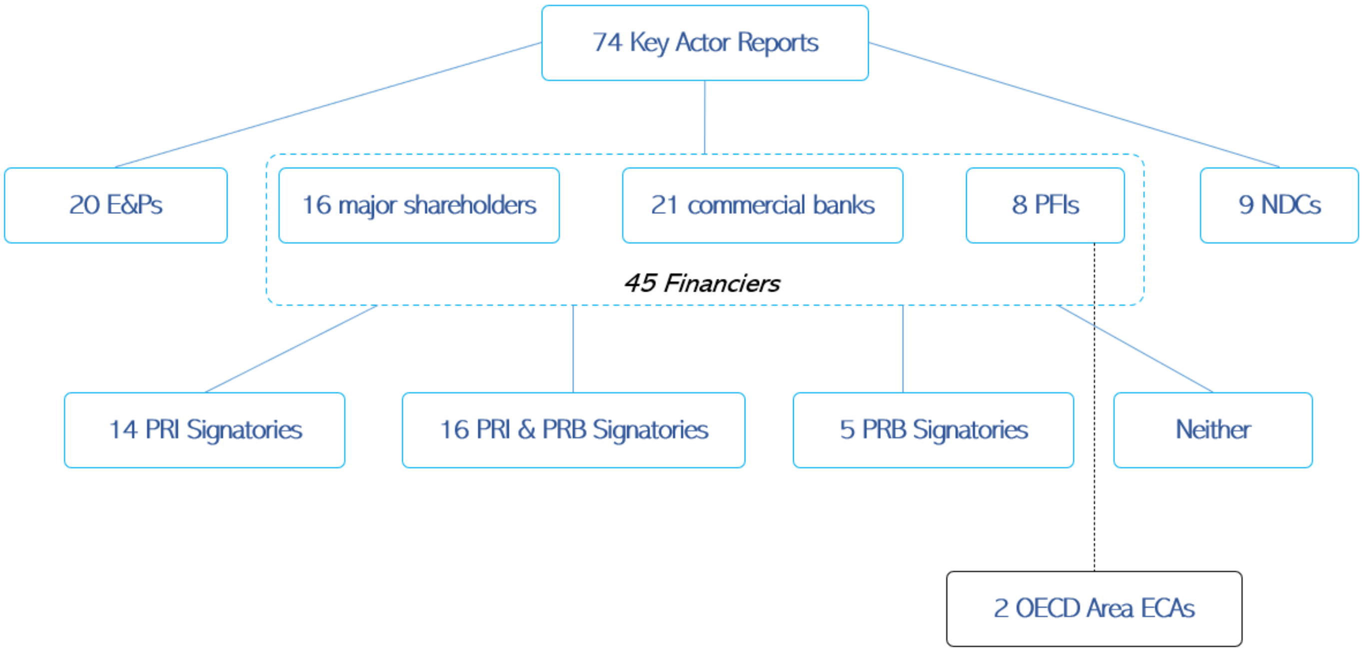
The 74 analysed reports include the annual and sustainability reports published in 2020 pertaining to the key actors that have contributed to generating South Africa's multidimensional prospective stranded assets (see 5.2 and Appendix C), which can be clustered into four groups (illustrated in Figure 7.1): a subset of **20 E&Ps** that presently control fossil operations in South Africa based on the analysed coal mines (see 5.2.2.2), coal-fired power stations (see 5.2.2.3), crude oil refineries (see 5.2.2.4) and offshore oil & gas exploration and production sites (see 5.2.2.5);[99] **financiers of these E&Ps (45)**, subdivided into the top **16 major shareholders** of those E&Ps as of July 2021 (see 6.2.2.2); the **21 commercial banks** and **8 PFIs** with explicit linkages to South African fossil fuel projects (see 5.2.2.3, 6.2.4.2 and Appendix C);[100] and the **9 NDCs** of the nations in which the key E&Ps, shareholders and debt financiers are headquartered. Through these sustainability and annual reports, actors disclose the policies they are adopting and actions that they are taking to align with the Paris Agreement, and thus implicitly communicate the LFFU approaches they are proposing (see definition in 4.1).

These actors play a key role in LFFU in South Africa due to their current ownership of the prospective multidimensional stranded assets that span South Africa's fossil economy (see 5.2.1-5.2.3) and the SAD that they have de facto accrued through their fossil investments in South Africa (see 6.4). These E&Ps operate several fossil-intensive physical assets that produce a substantial fraction of South African coal, oil and gas (natural assets, see 6.2.1) and employ thousands of fossil-dependents (human assets) in South Africa (see 5.2.3.3); moreover, their major shareholders are by definition owners of

[99] Note that three additional producer reports were included, namely those of Siemens (2020), Evonik (2020) and Hitachi Power Electric (2020) due to their pivotal roles in constructing the boiler and steam turbine units for Medupi and Kusile

[100] The bulk of the commercial financiers from the analysis in section 6.2.3 were excluded, because it is impossible to determine the extent to which those commercial finance flows were ***directly*** allocated for specifically South African fossil production. Rather, the commercial financiers from the Medupi and Kusile projects, which are documented (see 5.2.2.3 and Appendix C) were included in this sample

Figure 7.1. Clustering the 74 analysed reports by actor type and international policy framework relevance



Source: Author

and can influence the business agendas of said E&Ps, while the public and private commercial financiers control the financial capital that enables these E&Ps to execute maintenance and expansions to existing projects – or pursue new (fossil) projects altogether. Since these E&Ps have established such a stronghold on South African fossil production (estimated 50-75%, see 6.5), and since their shareholders and debt financiers are influential in controlling their agendas, the climate policies (and de facto LFFU approaches) adopted by these actor groups both implicitly and explicitly influence the degree to which South African fossil fuels may be phased out.

7.2.2. Financier Clusters: UNEP FI and the PRI & PRB

The 45 financiers from the sampled reports can be further categorised as signatories to the Principles for Responsible Investment (PRI, for shareholders, 14/45), Principles for Responsible Banking (PRB, for debt financiers, 5/45) (both of which under the UNEP Finance Initiative, UNEP FI and are explained below), both (16/45), or neither (10/45). Based on the 28 stakeholder interviews (see 3.5.5), the PRI and PRB frameworks were almost unanimously deemed the most influential policy frameworks for (implicitly) regulating Paris-related finance flows.

Through the PRI & PRB, the UNEP FI provides a preliminary basis for a universal framework to regulate finance in accordance with Article 2.1c of the Paris Agreement (see 1.4.1); it "is a partnership between UNEP and the global financial sector to mobilize private sector finance for sustainable development" (UNEPFI, nd: np). UNEP FI has accumulated over 350 members spanning all financial disciplines – banks, investors and insurers – with the objective of creating "a financial sector that serves people and planet while delivering positive impacts" (UNEPFI, nd); to do so it has founded three[101] frameworks that embody the broader objective of ensuring that "private finance fulfils its potential

[101] Only the PRI and PRB are discussed in this research and the Principles for Sustainable Insurance (PSI) is omitted due to the scope of the research

role in contributing to achieving the 2030 Agenda for Sustainable Development and Paris Agreement on Climate Change" (UNEPFI, nd: np).

The PRI is "a voluntary and aspirational set of investment principles that offer a menu of possible actions for incorporating [Environmental, Social & Corporate Governance (ESG)] issues into investment practice… [they] were developed *by investors, for investors*." (UN PRI, nd: np). It must be explicitly stressed that the PRI does not serve the primary purpose of addressing environmental and social impacts **of** investments, but rather it recognises that "ESG issues can affect the performance of investment portfolios… to varying degrees across companies, sectors, regions, asset classes and through time"; signatories "believe [the PRI] will improve [the] ability *to meet the commitments to beneficiaries*", and subsequently, that in addition to these portfolio benefits it will "better align [their] investment activities with the broader interests of society" (UN PRI, nd: np). Signatories to the PRI jointly managed assets worth roughly *$83 trillion* in 2021 and account for half of all global institutional investors (UN PRI, nd).

BOX 7.1: UNEP FI GLOBAL ROUND TABLE

At the UNEP FI Global Round Table in 2020 (hosted virtually due to the COVID-19 pandemic), the PRI and PRB were both ubiquitously idolised; a representative from South Africa's Standard Bank explained that "we not only need to incorporate the SDGs in every decision, but we need to rely on Paris Agreement alliance… reaching a 1.5°C future with existing CCS technology will require massive land repurposing and deforestation… to achieve this, Standard Bank has a very strong alignment with the PRB". Standard Bank is, coincidentally, one of the leading banks supporting the financing for the East African Crude Oil Pipeline (EACOP), which, at the time of writing, is reaching its final phase of finance procurement; when asked by two audience members about Standard Bank's financing of the pipeline in relation to the PRBs, the bank's representative declined to answer.

In fact, negligence was a recurring motif at the UNEP FI round table, particularly vis-à-vis fossil fuels. After attending 3 keynotes and 11 panel sessions over two days, the single reference to fossil fuels was made by Inger Andersen – executive director of UNEP – who "urge[d] global financial institutions to commit to science", "fully align portfolios with the SDGs and the Paris Agreement", and "stop financing coal". Other than this, no other mentions explicitly targeting the fossil fuel sector were noted. Christine Lagarde, President of the European Central Bank, remarked that "not enough finance is going in the green direction", though she applauded European financial efforts by noting that "40% of green bond issuances is in Euros and only 20% in US dollars", nudging North American financial institutions. She did not, however, acknowledge European (or any kind of) fossil fuel financing, nor did she encourage financial flows to deviate from coal (or oil and gas).

The PRB mirrors the PRI and applies to the realm of bankers and debt financiers; it is "a unique framework for ensuring that signatory banks' strategy and practice align with the vision society has set out for its future in the Sustainable Development Goals and the Paris Climate Agreement" (UNEP FI, nd: np). Like the PRI, the PRB is also composed of six distinct principles, which focus on, inter alia: alignment with the SDGs and Paris Agreement; transparency and accountability; and effective governance (UNEP FI, nd). The signatories to the PRB together managed over $47 trillion in assets as of September 2019.

7.2.3. ECAs: OECD Arrangement

ECAs specifically from OECD member states can abide by the '*Arrangement on Officially Supported Export Credits*' (OECD, 2020a) (from here on 'The Arrangement'), which is the only existing multilateral mechanism for ECA regulation. Of the sampled financiers, two of 45 were ECAs (COFACE from France and Euler Hermes from Germany), both of which reside in OECD member states.

The Arrangement is a "gentlemen's agreement" with "the main purpose… to provide a framework for the orderly use of officially supported export credits" (OECD, 2020a: 10). It lays out niche rules and regulations pertaining to six different 'Sectoral Understandings', of which two are relevant to this study: Sectoral Understanding IV) ('SU4'); and Sectoral VI) ('SU6'). SU4 aims to "provide adequate financial terms and conditions to projects… contributing to climate change mitigation, including renewable energies, greenhouse gas emissions' reductions and high energy efficiency projects, climate change adaptation as well as water projects" (OECD, 2020a: 93). Projects must meet two criteria:

1) "[L]ow to zero carbon emissions, or CO_2 equivalent, **and/or** in high energy efficiency" (OECD, 2020a: 94 – **emphasis added**);
2) A (pre-determined) lower-threshold performance standard

SU4 notes that "[p]articipants agree to examine the… **[c]onditions for low emission/high energy efficiency fossil fuel power plants including definition of CCS-readiness**" (OECD, 2020a: 98, **emphasis added**); hence, ECA-backed fossil fuel projects are fully within the bounds of SU4 so long as they *either* lower net-CO_2 emissions *or* improve energy efficiency (the latter of which was, from 4.3.2.2, discerned as ineffective for LFFU). The Arrangement labels these projects "Project Class A", which consist of removing "CO_2 stream from the emissions produced by fossil fuel generation sources, transport to a storage site, for the purpose of environmentally safe and permanent geological storage of CO_2" (OECD, 2020a: 101). Moreover, SU4 does not explicitly mention nor place any restrictions on ECA-backed projects supporting oil and natural gas production and combustion.

SU6 more explicitly places regulations fossil fuel investments by "[setting] out the financial terms and conditions that apply to officially supported export credits… for coal-fired electricity generation projects" (OCED, 2020a: 112), which are applicable to *either* (OECD, 2020a: 112) the:

1) "export of new coal-fired electricity generation plants of parts thereof… comprising all components, equipment, materials and services (including the training of personnel) directly required for… construction and commission"; or
2) "modernisation of, or supply of equipment to, existing coal-fired electricity generation plants"

According to SU6, *all ultra-supercritical coal-fired power plants are eligible*,[102] with *no upper-limit on the number of units* (and thus the total installed capacity) of the coal-fired project. Moreover, *any supercritical plants with unit capacities smaller than 500MW* is eligible for financing, so long as the support is limited "to two units, not to exceed an aggregate gross installed capacity of 600MW" (OECD, 2020: 114). *Even subcritical plants can be financed* so long as their units are smaller than 300MW and also do not exceed two total units or a total capacity of 500MW.

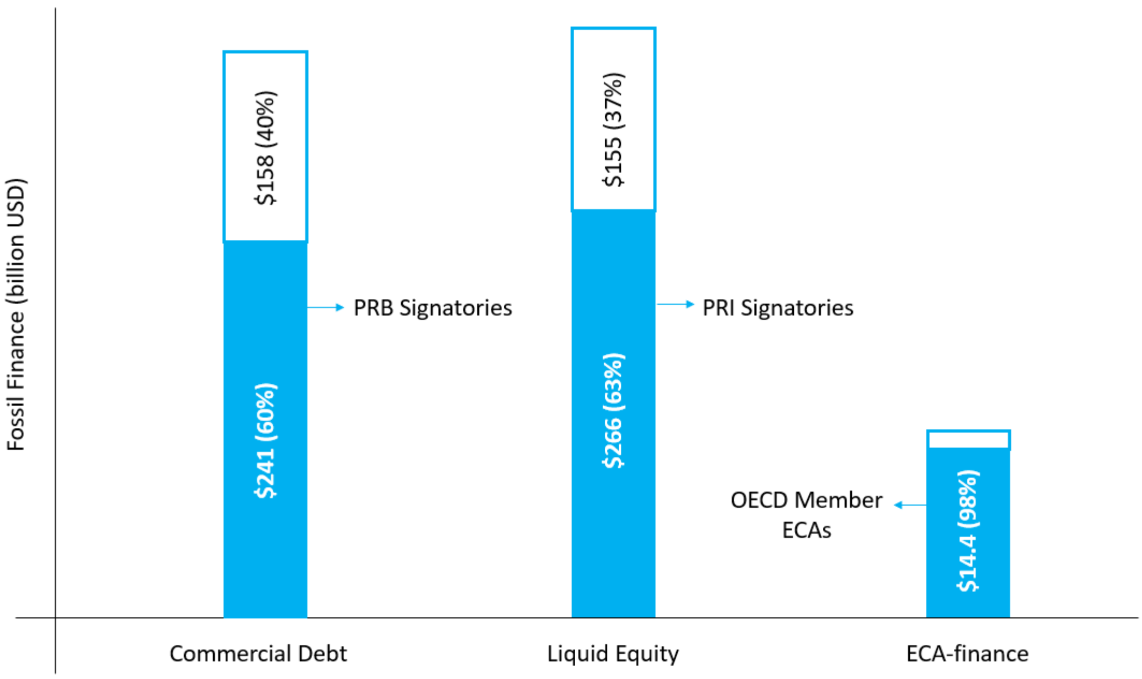
One interviewee[103] defined the "practical difference between ultra-supercritical and supercritical" units to be "almost entirely trivial in the global climate change context", and identified these conditions as "massive loopholes that… give investors the green light to continue financing coal as if nothing were different". Another loophole pertains to projects that were already in the pipeline (i.e. had already been approved) before SU6 was implemented in 2016, which are exempt from these size and criticality conditions; Korean ECAs (and to a lesser extent Japanese ECAs) have been utilizing this second loophole[104] to push through a slew of subcritical coal-fired projects since 2016 (OCI, 2020).

[102] 'sub', 'super', and 'ultra-supercritical' describe temperature and pressure conditions with which the power plant operates, and accordingly, its 'efficiency', in ascending order.
[103] Interview FIN_GEN10
[104] Interview FIN_GEN10, POL_AF4, FIN_GEN3, FIN_GEN10, POL_AF5

7.2.4. Summary

At face value, it is unlikely that the PRI/PRB and OECD Arrangement frameworks are effective in regulating finance for LFFU, particularly given the former does not explicitly mention 'fossil fuels' and the latter allows ECA-based finance for most coal projects and makes no reference to their oil & gas counterparts. In fact, half (103/206) of the major 2020 shareholders of the sampled E&Ps (see 6.3.3) are signatories to the PRI, and **of the $421 billion that they jointly manage in the sampled fossil fuel liquid equity, $266 billion (63%) belonged to signatories to the PRI, and of the $399 billion in commercial finance allocated to Africa-operational E&Ps (see 6.2.3), $241 billion (60%) were from signatories to the PRB**. Moreover, **$14.4 billion of the $14.6 billion (99%) in post-Paris fossil fuel financing (see 0) was allocated by ECAs from OECD-member states, and therefore, subject to *The Arrangement*** – see Figure 7.2. This suggests that thus far, these policy frameworks have not been effective for regulating finance for fossil projects.

Figure 7.2. Visualising the extent to which the fossil fuel finance flows from chapter 6 were driven by actors regulated by the PRI, PRB or OECD Arrangement



Source: Author

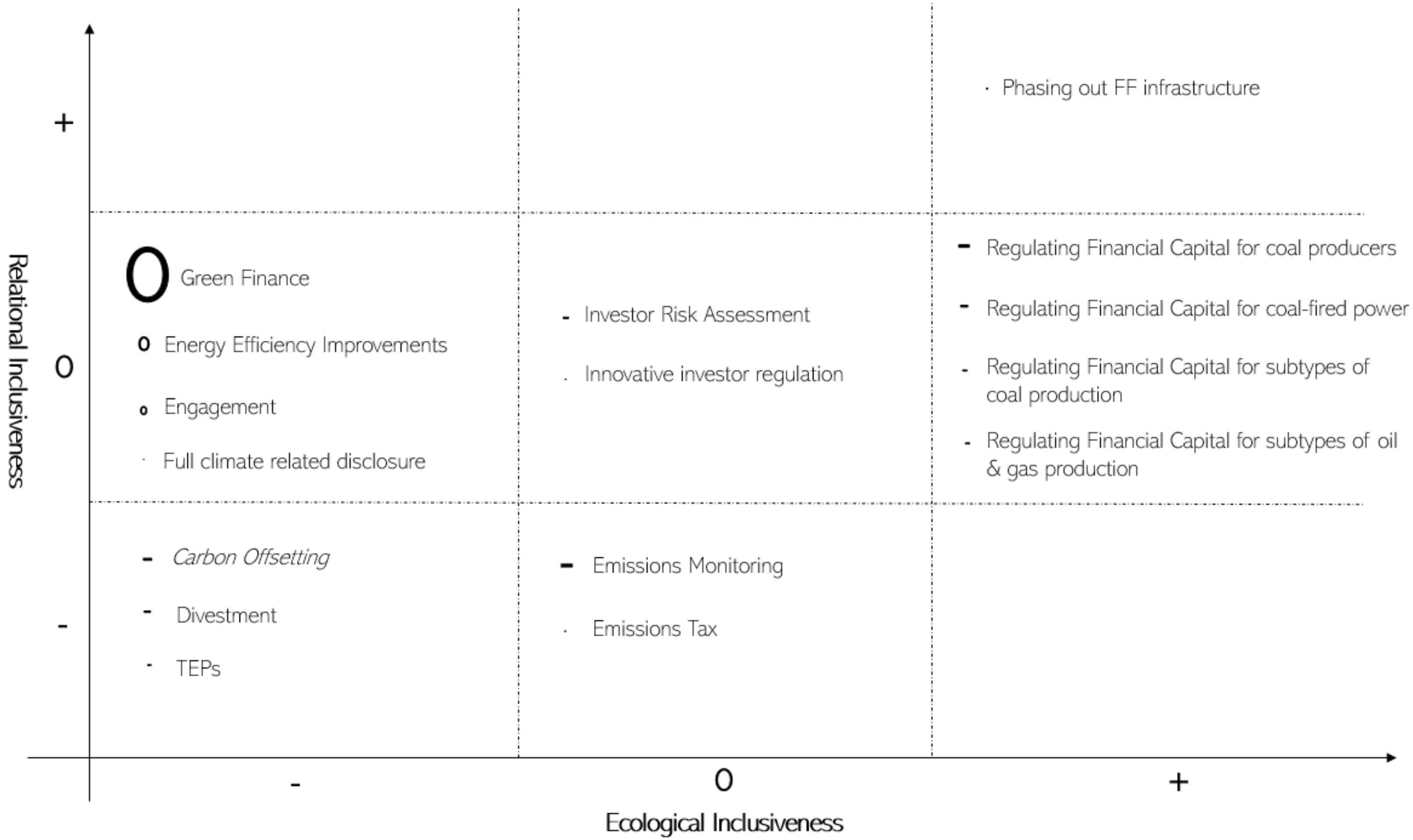
7.3. LFFU Approach Mix

7.3.1. Introduction

This section now explores the LFFU approaches that these key E&Ps, financiers and governments are adopting to discern implications for LFFU in South Africa; it does so by applying the framework developed in Figure 4.1 to generate Figure 7.3, which presents the LFFU approaches pledged and disclosed in the 74 reviewed reports.[105] The two most prominent approaches are discussed first (see 7.3.2), followed by other ecologically exclusive approaches (see 7.3.3), partially ecologically exclusive approaches (see 7.3.4) and ecologically inclusive approaches (see 7.3.5).

[105] Note that the markers are sized based on the relative frequency with which an approach was mentioned.

Figure 7.3. LFFU approaches utilised by actors that have exacerbated South Africa's stranded asset risk and accrued a SAD



Source: Author

N.B. the markers are sized as a function of the frequency of their usage. 'Green Finance' was the most popular approach (adopted by 38 actors) and is therefore the largest marker; all other markers are scaled accordingly.

7.3.2. Main Ecologically Exclusive Approaches: Green Finance & Emissions Monitoring

Plans to allocate finance for and invest in renewable energy & fossil fuel alternatives (‘**Green Finance**’) and pledges to set emissions targets and reduce portfolio emissions (‘**Emissions Monitoring**’) were the two most popular approaches, adopted by 38 and 34 actors, respectively, denoted by the largest markers in Figure 7.3. Notably, these were also the two approaches that were most often discussed in the scholarship (see 4.2).

Some instances of Green Finance:

- Bank of America (2021: 54) allocated “approximately $55 billion… to climate finance” in a bid to help “shift clients’ electricity footprints from fossil fuels to renewable energy by providing debt financing, tax equity, and leasing capital for wind and solar power generation” (ibid: 34);
- Glencore (2020: 34) touted their plans of *potentially* installing “approximately 400MW of renewable power [in South Africa], with the potential to reduce Scope 2 emissions by approximately 1.17 [Mtpa]”, which is negligible if we recall that Glencore’s Goedegevonden mine (see 5.2.2.2) supplies coal to Majuba, Eskom’s 4134MW coal-fired power plant, which emits at least 19MtCO_2e annually (see Appendix C);
- Nedbank (2020: 11) “disbursed R31bn [sic] renewable energy deals, adding >3500MW to the national grid”, even though Kusile, Eskom’s gargantuan coal plant that they helped finance (see Appendix C) singlehandedly overshadows these renewable efforts with its 4800MW installed coal capacity; and
- Total SA (2020: 4) envisions “renewable power surging to 15% of… sales versus 35% for oil products and 50% for natural gas” to “achieve a 15% reduction in… carbon intensity,” through which the prominent role of oil and natural gas in their business strategy is laid bare.

Total SA refers to plans to reduce their ‘carbon intensity’, defined as the carbon equivalent emissions per unit of energy produced or consumed; BP (2020: 26) follows suit by aiming to “halve carbon intensity of [their] products… by 50%.” Note that because it is a *ratio*, carbon intensity can be reduced by simply adding installed renewable capacity to the energy mix without reducing neither fossil fuel usage nor GHG emissions. Pledges to reduce carbon intensity (and blindly pursue renewable energy generation) are ecologically exclusive LFFU approaches and contribute to an Energy Addition (see York & Bell, 2018 and Box 4.2), deflecting attention away from a fossil phase-out.

Justifications for pushing ‘green finance’ often included the employment prospects of low-carbon industries, boasting of having created over “9000 green jobs” (AfDB, 2020: 11) and supporting the EU decision to commit €1 trillion to “support job creation and sustainable development” (Fidelity, 2020: 9), though the quality of and degree of access to these jobs was entirely neglected from all policy documents. Only 9/74 documents acknowledge the inevitable stranded labour (i.e. unemployment) that a fossil transition will spur and unanimously proposed replacing this stranded labour with the aforementioned ‘green jobs’, though this might be unrealistic due to issues already discussed vis-à-vis mismatches in skillset (see 5.2.3.3).

Official government climate plans and policies are no different in pushing fossil alternatives; the most recent[106] EU NDC (2021: 6) adopts “a new target for increasing renewable energy in final energy consumption… to reach at least 32% by 2030”, Canada’s updated NDC (2021: 1) denotes a $53.6 billion budget for ‘green’ spending over the next 8 years, and in an address in September 2020, Chinese President Xi Jingping alluded to the contents of China’s forthcoming updated NDC, which would likely pledge to “increase the share of non-fossil fuels in primary energy consumption to around 25 percent” (CGTN, 2020: np). Even Qatar (2021: 3, *emphasis added*), a renowned petrostate, noted that

[106] Updated in July 2021

"[a]ttempts have been made to [utilise] clean energy and renewable sources such as solar and wind power", though this comes with a disclaimer that this is "despite the abundance of gas *which is a clean energy*."

Only three institutions acknowledged the ecological repercussions that may accompany renewable energy production. For instance, KfW (2020: 10) notes that "large-scale wind and solar power generation" are "projects that have complex impacts which partly cannot be compensated", such as "land consumption, noise pollution, biodiversity, [and] water consumption"; and Commerzbank (2020: np) acknowledge that "hydroelectric projects – especially dams – can involve risks and harm to the environment and local population" and thereby take into account "potential conflicts over competition for water resources" when engaging in energy-related finance.

Emissions Monitoring and setting higher emissions standards[107] was almost always accompanied by pledges to reach 'net-zero' (see 2.2.4) by an ascribed date – but often these emissions targets are riddled with inconsistencies. For instance, Glencore (2020: 51) acknowledges that "reducing [their] coal production" is pivotal to align with their ambition towards net zero scopes 1-3 emissions, with their 2020 scope 3 emissions (from their "customers' usage of the fossil fuels [they] produce") allegedly sitting at 253MtCO_2e (Glencore, 2020: 33). However, when disclosing their portfolio emissions *in the same document* (Glencore, 2020: 82), the only documented GHG emissions from any South African facilities are scope 2 ("purchased electricity"); any reference to direct scope 1 emissions from e.g., their Astron Refinery (see 5.2.2.4) or indirect scope 3 emissions from coal production at their Goedegevonden mine (see 5.2.2.2) are omitted.

Similarly, TotalSA (2020: 15) reports and acknowledges that its scope 3 emissions ("emissions connected with customers' end use of the products it sells, i.e. combustion to produce energy") account for 85% of its portfolio emissions, implying that reducing its oil & gas production is imperative to curbing its own emissions; though they "defined a number of interim milestones… [o]bviously,.. Scopes 1 and 2 [emissions]… are first on the list", with pledges to do so by "improving… energy efficiency, eliminating routine flaring, electrifying [their] processes and reducing methane emissions" (TotalSA, 2020: 3).

Other actors miscommunicated their emissions altogether. ARM (2020) reported a carbon footprint (scopes 1-3 combined) of 1.1MtCO_2e in 2020, and yet, the emissions from Eskom's Majuba plant (see Appendix C), for which ARM supplies roughly half of the coal, alone sits at 19MtCO_2e. That is, *the indirect emissions from a single project that ARM supplies (and therefore enables) outweighs their reported emissions by 1900%*. JP Morgan (2020: 52) follows suit, proposing a meagre 15% reduction in scope 3 emissions compared to 2019 levels – though this only consists of "air travel", "hotel stays" and the like, omitting indirect financed emissions from e.g., coal-fired power stations like Medupi, which emits 32MtCO_2e annually and for which JP Morgan provided Eskom with financial advisory in 2008-9 (see 5.2.2.3).

7.3.3. Other Ecologically Exclusive Approaches

A slew of other ecologically exclusive approaches were disclosed, illustrated in the leftmost column of Figure 7.3. Most notable is **divestment**; 37 of the 45 finance institutions and 10/20 E&Ps freely divest from their fossil assets, many aspiring to employ "divestment to fully exit the financing of the thermal coal industry by 2030" (Credit Agricole, 2020: 27), though three institutional shareholders (M&G Investment, Capital Research, and Schroder Investment) adopted stricter policies and pledge to divest only as a last resort. South32 (2020: 32) boasted that "the divestment of South Africa Energy Coal

[107] This includes an organisation's direct (scope 1) emissions from fuel consumption, indirect emissions from electricity generation (scope 2) and other indirect emissions along the supply chain (scope 3)

would reduce [their] scope 3 emissions by around 50 per cent", and Shell (2020: 36) flaunted that they had divested 3.5MtCO_2e between 2019-2020. BP (2020: 30, ***emphasis added***) elaborates:

> Divestments are... an important part of our strategy… Going forward, *divestments will help bp to create a resilient, lower cost and lower carbon oil, gas and refining portfolio that is smaller but higher quality*... ***while these divestments may not directly lead to a reduction in absolute global emissions, they accelerate the pace bp can grow low carbon businesses*** and underpin our aim to reduce our oil and gas production by around 40% by 2030.

Meanwhile, others more subtly communicated their divestment prospects, like Credit Suisse (2020: 104) revamping their "corporate oil & gas and coal business by reducing exposure to traditional business", and Nedbank (2020: 65) aspiring to have "zero exposure to fossil fuel related activities" by 2045.

Proponents of divestment operate under the well-researched premise that "pension funds could do a lot more,"[108] and "engagement with fossil firms is not very effective"[109] – perhaps because "engagement is always very polite and civilised, we never tell a company to 'do it completely differently'."[110] As one interviewee[111] described:

> Pension funds and other institutional investors invest in companies, not projects really. ***You can try to use your leverage and all that sort of bullshit, but it hasn't worked for at least 20 years and it won't work now***. These companies cannot reform – we don't have time to reform them. They need to close up shop now. Yes they have green components, often times much bigger than green components of small renewable players, but compared to their fossil fuels this is miniscule. ***There is a bill to be paid, it is a fair question to raise, but it is not a reason not to go in the direction of divestment***.

Others echoed these sentiments, noting that "right now the engagement argument is based on the assumption that fossil fuel companies can reinvent themselves, which is a bit too rosy if you ask me. Institutional investors don't have this agenda; they just want to make a quick buck in the interim, so they hold onto the dirty shares until they sell for profit."[112] One European pension fund asset manager[113] noted: "we could divest fully from our fossil fuel equity and it wouldn't be a disaster for us or anyone, but why would we? The sector still has a promising risk-return", while others noted that top financiers are literally banking on the utopian possibility of companies like Shell to completely reinvent themselves as renewable energy firms.[114]

[108] Interview FIN_GEN7
[109] Interview ACA-GEN1
[110] Interview FIN_GEN8
[111] Interview FIN_GEN3
[112] Interview FIN_AF4
[113] Interview FIN_GEN1
[114] Interview FIN_GEN1, FIN_GEN4, FIN_GEN8

BOX 7.2: COULD DIVESTMENT BENEFIT RICH ASSET OWNERS?

Not only is divestment ecologically and socially exclusive, but we must also speculate the extent to which it in fact may *benefit the institutional investor* (and this therefore relationally exclusive). Assume that hypothetical institutional investor 'A' decided to invest €1billion evenly across two major fossil fuel multinationals in December 2015 (right as the Paris Agreement was being signed): BHP Billiton (coal mining) and Equinor (oil & gas E&P). At the time, their share prices were $22.61 and $13.96, respectively, meaning investor A could have purchased 22.1 million BHP shares and 35.8 million Equinor shares:

$$S_{bhp} = \frac{\$500\ million}{\$22.61\ per\ share} = 22.1\ million\ shares\ BHP$$

$$S_{equi} = \frac{\$500\ million}{\$13.96\ per\ share} = 35.8\ million\ shares\ Equinor$$

Assume for the sake of argument that Investor A withholds these shares for 6 years – until present. As of September 2021, BHP shares and Equinor shares had appreciated to $61.95 and $22.95 per share, respectively (even during the pandemic!). If Investor A were to divest these shares, they would earn a total of $2.2 billion, or a 120% profit in 6 years:

$$V_{bhp} = 22.1\ million\ shares\ BHP\ \times \$61.95\ per\ share = 1.4\ billion$$

$$V_{equi} = 35.8\ million\ shares\ BHP\ \times \$22.95\ per\ share = \$822\ million$$

And this excludes the dividends that fossil fuel industry investments are renowned for; BHP for instance, pays a forward dividend rate of roughly 10% as of September 2021 (Yahoo!, 2020), while Equinor's currently sits at a lower 3% (ibid). If asked to divest, Investor A would not only absolve themselves of any responsibility and accountability for the unabated fossil exploration and production that took place *under their watch* over the last 6 years, but they would leave with over $1.2 billion in profit!

Conversely, many financiers "believe much more in **engagement** and in active ownership than divestment,"[115] arguing that "if you believe in environmental sustainability you must heavily engage with leading energy companies" due to the "massive growing inertia that the fossil fuel sector has accumulated in the last 100 or so years."[116] As active shareholders, financiers argue they can engage with investees and sway their behaviour; "our investor community is largely in favour of a move towards sustainability and fossil fuel industry reform towards carbon neutrality by 2050."[117] Divestment is "the easy way out,"[118] absolves them of this power and risks sending the assets to 'neutral investors' – i.e. shareholders who have no fossil-related agenda and are happy sitting idle as their assets accrue interest.[119] One interviewee[120] remarked, "I've been in finance for 40 years. The fossil fuel guys will always find investment to back them – ALWAYS – at least for another 30 years. *Whether it's the US, the Chinese, the Koreans, the Indians. Divesting won't ever make a difference – they will always find the money*. You know where the most Chinese billionaires are from? Shanxi, the coal province!"

Fossil fuel E&Ps will very likely be financially unscathed by divestment campaigns "as long as there remain many unscrupulous financiers willing to buy up their stocks and loan them money" (TNI, 2020:

[115] Interview FIN_GEN1
[116] Interview FIN_GEN6
[117] Interview FIN_GEN7
[118] Interview FIN_GEN8
[119] Interviews FIN_GEN1, FIN_GEN4, ACA_GEN1, ACA_GEN2, FIN_GEN6, FIN_GEN7, FIN_GEN8, FIN_AF1, FIN_GEN9
[120] Interview FIN_GEN6

7). In fact, one of the early leaders of the fossil fuel divestment movement[121] admitted that "the divestment movement gathered lots of momentum, but it looks like the global scene is shifting… *the divestment framework needs to be revisited from its aspirational origin to something more constructive*," one that "expands our neoliberally bound imagination, more rigidly disciplines and regulates capital"[122] and that tackles the critical question of "who gets left with the stranded investments."[123]

Only two institutions showed promising signs of *proactive* engagement with the explicit purpose of LFFU. Fidelity (2020: 5) "discourage[ed] Asian banks from financing new thermal coal projects", and M&G (2020: 15) "engage[ed] with investee companies with high thermal coal exposure to understand their plans to phase out coal by 2030/40". Other instances of fossil-related engagement were detected, but these were largely reactive and irrelevant for LFFU: Vanguard (2020: 23), for instance, "engaged with Rio Tinto… to discuss a climate-related shareholder proposal", but not only did the engagement result in "monitoring the company's progress", the proposal itself focused on "destruction of an Aboriginal heritage site in Australia" rather than Rio Tinto's unabated coal mining.

Another approach frequently adopted was **energy & emissions efficiency improvements**. For example, Shell and TotalSA both noted their plans to improve the energy efficiency *at their crude oil refineries*, by "choosing more energy-efficient electrical motors rather than older steam turbine technology" (Shell, 2020: 66) and investing "nearly $450 million to maximize energy efficiency in the Refining & Chemicals business segment" through various solar PV projects (Total SA, 2020: 30). Ironically, these energy improvements are used to hoist their oil & gas operations, which, of course, continue to perpetuate unabated fossil fuel production.

One final ineffective approach was investment in **carbon offsets**, particularly nature-based solutions. These include investments in projects that "either removes CO_2 or avoids emissions that would otherwise have occurred" (Shell, 2020: 42-3). TotalSA (2020: 3), for instance, is "developing carbon sinks, such as nature-based solutions, by investing in forests" using "an annual budget of $100 million as of 2020 and targets sustainable storage capacity of 5MtCO_2 per year by 2030" (ibid: 8); similarly, Hitachi (2021: 25) – one of the lead contractors for the Medupi & Kusile coal plants (see 5.2.2) – also openly adjusts its reported emissions based on "the amount of renewable energy purchased" and "using non-fossil fuel energy certificates." National governments are also entertaining this narrative: Canada's updated NDC (2021: 6) pledges to "[i]nvest more than $3 billion over 10 years to plant two billion trees"; Japan's climate policy (NDC, 2021: np, *emphasis added)* discloses plans to pursue offsets and nature based solutions "*in developing countries*… to use them to achieve Japan's emission reduction target"; and the EU NDC (2021: 4) broadly claim that "nature-based solutions play an important role to solve global challenges such as… climate change."

7.3.4. Partially Ecologically Exclusive Approaches

Seven unique actors mentioned **carbon emissions taxes**. This included national governments, who unanimously agreed that "[p]ricing carbon pollution is the most efficient way to reduce GHG emissions while also driving clean innovation. Putting a price on carbon pollution sends a broad signal across the economy that encourages individuals and businesses to take climate action" (Canada NDC, 2021: 5), and pledged to "implement preferential taxation policies for promoting the development of new energy and to improve mechanisms of pricing, grid access and procurement mechanisms for solar, wind and hydro power" (China NDC, 2016: 15). This also included fossil fuel producers, who communicate their sensitivity to "regulatory schemes… [like] the South African carbon tax" (South32,

[121] Interview FIN_GEN9
[122] Interview FIN_AF1
[123] Interview ACA_AF2

2020: 35) and account for long-term carbon pricing, in Sasol's (2020: 6) case "for [their] South African assets… ranging from R19-76ton/year until 2030", which is equivalent to $1-5/ton CO_2e. Investors are also allegedly pushing for the implementation of an emissions tax; one noted that "*it's not my job to manage these fossil fuels* – I am not the government. *Just put a tax on carbon and make it easy for us* – that will incentivise investments in green technology. If you don't tax us, the timing will be all off and the problem will never be resolved." Various interviewees[124] supported this demand.

BOX 7.3: PASSIVE AND AUTOMATED INVESTING

Various interviewees[1] stressed that the bulk of investment is passive – coined the 'buy-and-hold strategy', through which investors attempt to minimise the frequency of transactions (e.g., buying and selling shares) while maximising profits. Vanguard, Blackrock, State Street are all passive asset managers (ERIN Conference, 2020) (which jointly managed $106 billion in the sampled E&Ps), as are "almost all institutional investors except for a few, like ABP/APG."[1] Passive investors "just follow indices, like the S&P500", and compare the return on an index to their own returns; this "is why so many institutional investors invest in Shell or BP shares – because they are included in these indices that measure baseline profits."[1] Accordingly, it was "a huge deal that ExxonMobil was kicked out of the Dow Jones Industrial Average Index"[1] in August 2020. It should be stressed that these types of investors have made the *active choice* to be passive – it does not excuse them from accountability or responsibility (ERIN conference, 2020).

One such responsibility is participating in and voting at Annual General (Shareholder) Meetings (AGMs) on e.g., the makeup of a company's board of directors or changes to a firm's corporate structure. A recent study (Bebchuk & Hirst, 2019) found that Blackrock, Vanguard and State Street – who jointly manage roughly $14 trillion in assets – casted roughly *25% of all votes at AGMs in 2018 across the S&P500*. These votes dictate the future of not only fossil fuel E&Ps in which they hold assets, but also many of the commercial banks that finance the said E&Ps. Blackrock, Vanguard and State Street are all major shareholders in JP Morgan – which again, loaned almost $20 billion to only the sampled E&Ps (see 6.3.4) and $270 billion overall to fossil fuel firms (RAN, 2020); in 2020, these three passive investors (among many others) voted to reintroduce Lee Raymond – the former chairman and CEO of ExxonMobil and notorious climate denialist – to JP Morgan's board of directors. Additionally, Blackrock and Vanguard both voted against over 80% of Climate Action 100+'s proposed resolutions in 2020, despite joining and supporting the coalition in January that year (Erin Conference, 2020).

On the opposite end of the spectrum, automation plays a central role in enabling exponentially more deals to be struck by detaching the investor from the investment, even for active investors. A senior investment specialist at APG[1] explained that "we are still an active asset manager, but we have quantified and automated a lot of things and rely on algorithms." ABP even "determines which companies to engage with based on automated, preestablished criteria," and since their "individual investments do not align with a 1.5°C future,"[1] it is not particularly surprising that their engagements with fossil fuel firms have been so unsuccessful.

The "computerisation of global financial markets" means that "over 50% of all trading on any US market"[1] has been High-Frequency Trading (HFT), which unlike passive investment, executes thousands of orders within milliseconds using sophisticated algorithms. Thus, the "architecture of trading markets do not lend themselves to fossil fuel divestment – or incorporating any environmental costs, for that matter."[1] Social and environmental issues "cannot be quantified so easily, and ABP has an appetite for measuring impact of our investments. We need to be able to show that we are doing something – and not losing money. The blessing with money is that you can quantify it."[1] Naturally, then, social and environmental issues slip through the cracks as both the passive and HFT markets continue with their day-to-day routines.

Note that President Cyril Ramaphosa signed the Carbon Tax Act No. 15 of 2019 into law in June 2019, which established a very modest emissions tax on South African polluters, ranging from R6 (USD 0.4) to R48 (USD 3.2) per ton CO_2 (only scope 1 emissions), though by 2021 it was raised to R134 (USD 8.6) per ton CO_2e (KPMG, 2021); note that in its first phase (2019-2023), the act allows for "tax-free

[124] Interviews FIN_GEN1, FIN_GEN4, FIN_GEN8, FIN_GEN9

emissions allowances ranging from 60-95%" (IEA, 2020: np; 2021), though it is unclear whether and in what form these allowances will exist in the second phase (2023-2030). For instance, the "electricity sector… currently receives an exemption from the carbon tax… due to there being an environmental levy in place on all power generated from fossil fuels" (Tyler et al., 2020: 5). And given that over 45% of South Africa's emissions derive from Eskom's coal-fired power generation (see 1.3.2), roughly half of all scope 1 South African emissions are currently untaxed, while the other half may be subject to a price as low as USD 0.4/tCO_2; this carbon price would need to increase by at least 2500% to become effective (see 4.3.1.3).

Some instances of **innovative investor understanding and regulation** were noted, depicted in the middle row and middle column of Figure 7.3. Eight actors extensively discussed their exposure to fossil fuel assets, and accordingly, the risk accompanying said exposure, like Credit Suisse (2020: 104) denoting their "total exposure to carbon-related sectors [as] approximately 4.5%... [c]orporate lending to climate-sensitive sectors [as] approximately 17.6% of the total exposure." These metrics incentivise the firms to "progressively eliminate exposure to the thermal coal sector" or fossil fuels more broadly (Societe Generale, 2020: 5), hence resonating with the divestment approach also frequently utilised (see 7.3.3). Perhaps more interestingly, two instances were identified in attempting to address the 'myopia' that plagues the financial world, another of Christophers' (2019) proposed tropes (again see 4.3.3.1). Shell (2020: 35) has "linked the pay of more than 16,500 staff to our targets to reduce the carbon intensity of our energy products by 6-8% by 2023", and BP (2020: 25) similarly "allocate[s] a percentage of remuneration linked to emissions reductions for leadership and around 28000 employees"; these are admittedly excellent first passes at incentivising long-term climate action, but they still remain ineffective as they are tied to 'emissions reductions' and 'carbon intensity', which I have already argued are lacklustre at best (see 7.3.3).

7.3.5. Ecologically Inclusive Approaches

The dominant ecologically inclusive approach deployed is **regulating financial capital for forthcoming fossil fuel projects**. However, these pledged regulations bear conditions that span three dimensions:

1. *Finance for coal producers/production*
   17 financiers pledged to "not provide lending, capital markets or advisory services to companies deriving the ***majority*** of their revenues from the extraction of coal" (JP Morgan, 2020: 4), "screen out companies that have significant carbon-intensive operations, such as coal mining" (Aberdeen, 2020: 25), and "end all new thermal coal financing" (Fidelity, 2020: 47). Nedbank (2020: 65) has adopted a policy that pledges "no provision[ing] of project financing for new thermal-coal mines, regardless of jurisdiction" by 2020. Some are more ambiguous, disclosing "exclusion of investments in the fossil fuel industry" (Barclays, 2021: 26), while others specify that all finance for coal production will be withdrawn by 2030 for OECD member states ***and by 2040 for non-OECD member states*** (e.g., Credit Agricole, 2020; BNP Paribas, 2020).

2. *Finance specifically for new coal-fired power stations*
   13 financiers disclosed plans to "not provide project financing or other forms of asset-specific financing where the proceeds will be used to develop a new coal-fired power plant or refinance an existing coal-fired power plant" (JP Morgan, 2020: 5); some were less assertive and pledged to "[restrict] cover of coal-fired power plants" (Euler Hermes, 2021: 29) and "facilitate the gradual phase-out of… coal-fired power generation" (Deutsche, 2020: 37). Others were more aggressive, like HSCB (2019: 43), who agree "not [to] finance any new coal-fired power plants" but noted that this was accompanied by the "limited exceptions of Bangladesh, Indonesia and Vietnam to appropriately balance local humanitarian needs"; similarly, JP Morgan (2020: 5) also noted that "[c]oal-fired power plants [utilising] carbon capture and sequestration technology

will be considered on a case-by-case basis." Finally, some pledges to reduce financing for coal-fired power generation panned well into the future, like MUFG (2020: 54) aspiring to reduce such financing "by 50% from FY2019 by FY2030 and reduced to zero… by FY2040."

3. *Finance for subsets of coal, oil & gas production*
   7 reports denoted plans to limit the amount of financial capital available for subsets of coal and oil & gas production. For coal, this typically included prohibiting finance for mountaintop mining[125] or greenfield coal mining. For oil & gas, these unanimously covered finance for "[n]on-conventional prospection, exploration and extraction of oil from bituminous shale, tar sands or oil sands" (KfW, 2020: 2) and "projects related to Arctic drilling" (Commerzbank, 2020: np). As stated, many banks and institutional shareholders pledged to "end thermal coal-related investments by 2030 across OECD and EU member states and by 2040 in developing countries" (M&G, 2020: 11), but few have made such pledges for oil and gas more broadly, like Nedbank (2020: 65) who vouch for "no new finance for oil production" by 2035, and "zero exposure to fossil fuel-related activities (thermal-coal; upstream oil and gas; power generation)" by 2045.

Although likely effective in LFFU and therefore ecologically inclusive, these three tropes of regulatory fossil fuel finance are by themselves incomplete and thus inadequate for four reasons. First, oil & gas production is almost entirely neglected apart from unique and unconventional circumstances, implying that conventional on- and offshore oil & gas exploration can continue to expand. Second, given the lethargic timelines, coal finance will, in many cases, continue to be available through 2030 and even 2040 for non-OECD countries, which will continue to misalign with climate goals and see SADs balloon. Third, apart from Natixis (2020: 503), no policies prohibited indirect finance for coal production – e.g., accompanying manufacturing and infrastructure, like the French and German commercial finance & ECA finance that produced Medupi & Kusile's steam turbines and generators (see 5.2.2.2) – implying that finance that indirectly drives coal production remains well within possibility. Fourth, exceptions are made to circumvent these regulations, often justified by a certain country's 'humanitarian' needs, such as employment, economic development or energy access. These pledged regulations demonstrate a step in the right direction for existing fossil-policy landscape, though this must be accelerated and intensified to prompt meaningful action against the 'climate emergency'.

It is possible that some banks are refraining from fully exiting all coal finance in the immediate future due to vested interests "in other exploitative industries which are needed to keep fossil fuel projects alive."[126] For instance, the "government of South Africa has huge vested interests in coal production via transport or equipment manufacturing," which is why "it was such a huge struggle to persuade the Development Bank of Southern Africa not to finance Thabemetsi"[127] – a now-abandoned coal-fired power station formerly in South Africa's pipeline. Commercial banks also own "deep, massive brown assets like you wouldn't believe." One of the top 20 largest global commercial banks (anonymised as per the interviewee's[128] request) managed "loads of assets that made the coal sector work – platforms, machinery, pipelines, trains, you name it. They were getting nervous that all of these assets would tank – ***they were worried they were not going to be able to shift those assets***, so they are trying to configure new products to blend renewables with coal." Such vested interests may explain why there is no explicit regulation banning *all* coal financing in the OECD (see 7.2.3).[129] The indirect

[125] This is "a method of removing all or a portion of a mountain or ridge to access coal seams near the surface" (JP Morgan, 2020: 5)
[126] Interview FIN_AF4
[127] Interview NGO_AF7
[128] Interview FIN_GEN6
[129] Interview FIN_GEN3

businesses that are currently intertwined with oil, gas and (especially) coal – and the widespread extent to which investors and financiers are exposed to these sectors in addition to direct exposure to fossil fuel assets – both may drive investment in fossil fuel assets and demotivate financial alignment to phase out fossil fuels, though the exact nature of these vested interests is beyond the scope of this research.

Only two actors demonstrated use of a simultaneously effective and equitable approach, namely prematurely **decommissioning existing fossil fuel facilities**. CNR (2020: 4) noted that they are "an industry leader for abandonment and facility [decommissioning] in Canada and UK offshore operations", but it seems unlikely that such a premature decommissioning will unravel for their offshore oil & gas assets in South Africa, like Block 11B/12B (see 5.2.2.5). KfW (2020: 6) noted that in special circumstances, "outstanding need for action is laid down in concrete terms… including demolition and decommissioning, if necessary", but the likelihood that investors are able to sway E&Ps to prematurely decommission existing facilities is itself questionable; an institutional asset manager[130] noted that "it's hard to ask us to destroy shareholder value," elaborating that "influencing decisions on forthcoming CapEx is doable, but if a coal plant is up and running, we are never going to talk to the company about closing it down. The government should make that decision." Asset managers will only interject in existing investments if "there is a financial problem,"[131] otherwise it is beyond their structural jurisdiction, rendering this approach solely to the discretion of the E&Ps themselves.

7.3.6. Summary

By comparing the empirically-driven Figure 7.3 to the theoretically driven framework from Figure 4.1, it is clear that, apart from regulating financial capital *under certain conditions* for fossil fuel production (see 7.3.5), the vast majority of the likely ecologically, socially and relationally inclusive approaches to LFFU are omitted from the existing policies of the actors who have exacerbated South Africa's stranded asset risk (see 5.3.4) and de facto accrued a SAD (see 6.4). There is little to no evidence to suggest that the financiers and governments that have allocated tens of billions into sculpting South Africa's fossil fuel regime are taking effective climate action and addressing the 'climate emergency' by phasing out fossil fuels from the global economy. With this existing menu of LFFU approaches, South Africa's fossil fuel regime (and beyond) will likely continue to grow, and the existing fossil infrastructure will remain fully intact and operational. At best, an exclusive Energy Addition (York & Bell, 2019) may unravel in South Africa as firms and financiers aggressively pursue investments in renewable technologies while (in)conspicuously both maintaining and aggrandizing their fossil operations.

7.4. Stranded Asset Debt

7.4.1. Introduction

This sections explores the extent to which the reviewed reports acknowledge the SAD that their respective actors have de facto accrued with respect to investments in and control over South Africa coal, oil and gas exploration and production (see 6.4 & 6.5).

7.4.2. Negligence

Of the 74 policy and sustainability documents reviewed, only 19 made an explicit reference to 'South Africa' in any sense, seven of which were by South African banks or fossil firms; these domestic actors predominantly: described their most recent coal, oil or gas production (e.g., Exxaro, 2020; Seriti, 2020; Sasol, 2021; ARM, 2020); discussed their broad roles in financing South Africa's energy sector (e.g., FirstRand, 2021; NedBank, 2021); or the importance of the fossil sector for South Africa's economic

[130] Interview FIN_GEN8
[131] ibid

development. For instance, the "PIC has invested in five downstream oil and gas assets, which sustain 3,604 jobs, 2,956 of which are permanent" (PIC, 2021: 103). The remaining 12 references were mainly broad and either: regarded renewable energy projects in South Africa (e.g., Total, 2020; AfDB, 2020); passively presented company global operations (e.g., Qatar Petrol, 2020; CNR, 2020; Shell, 2021); or related to 'sustainability' projects like "environmentally-friendly… food and beverage packaging" (Evonik, 2021: 59).

Only 6 of the 74 documents explicitly mentioned their respectively financed or operated fossil project from the earlier analysis (see section 5.2 and Appendix C). Exxaro & ARM both discussed the Grootegeluk and Goedegevonden mine metrics (production rates, reserve sizes, location, etc.) and *plans for their respective expansions*; Engen (2020) elaborated on their plans to convert their refinery to an import terminal; Sasol (2020: 32) noted that the NATREF refinery was both "unique" and had been shut-down due to the pandemic; Glencore (2020) noted that their scope 3 emissions calculations emitted all emissions from its Astron refinery; and South32 (2020) discussed both the water usage considerations of WMC mine and subsequently their decision to divest its South African assets. Not a single policy & sustainability document has embedded any of the fossil fuel projects that they have generated and currently operate into their climate action plans, suggesting that the fate of South Africa's coal-fired power stations, coal mines, refineries, and offshore oil and gas exploration remains uncertain as approaches are adopted to LFFU.

7.4.3. Expansion

At least 11 of the actors have expressed explicit plans to not only maintain but also *expand* their existing fossil fuel operations. For instance:

- Shell (2020: 35) "expect[s] the percentage of total gas production in [their] portfolio to gradually rise to 55% or more by 2030" since they consider natural gas a low-carbon fuel as it "emits 45-55% fewer GHG emissions than coal when used to generate electricity";
- Qatar Petroleum (2020: 32) also "firmly supports the view that natural gas is a destination fuel and not only a transitional energy… it is a crucial building block of what will be the optimal energy mix in decades to come";
- Sasol (2020: 10) plans to make "limited investment to maintain" its coal operations, has "forecasted limited growth" for its liquid fuels operations, and will make "investments to grow its natural gas value chain "because the role of gas as a transition fuel to a low-carbon economy is expected to create opportunity for growth in all sectors";
- CNR (2020: 29) claims that "[a]ccess to affordable, reliable, and abundant crude oil and natural gas unlocks human potential and raises quality of life", justified by claiming that the "United Nations (UN) relates general social and health outcomes directly to greater energy consumption"; and
- BP (2021: 32, *emphasis added*) notes that their "[decarbonisation] options… are dependent on regional and national energy markets and demand profiles. These include *developing countries that need to meet rising energy demand and are on different emissions trajectories* to developed countries."

National governments have also interwoven fossil fuel expansion plans directly into their climate policies. Japan's updated NDC (2021: np, *emphasis added*) pledges to "actively contribute internationally towards… diffusion of technologies relating to emission reductions in developing countries" including "[*p]ursuit of high efficiency in thermal power generation*", indicating that new 'high efficiency' coal projects resembling Medupi & Kusile are likely to continue appearing. Moreover, Malaysia's NDC (2021: 4) complains that fossil fuel production cannot be hampered due to "the cost and suitability of appropriate technologies. Generation cost of renewable energy is still higher than conventional energies."

Investors and lenders often attribute their perpetual fossil flows to a lack of suitable alternatives; "failure to invest in fossil fuels today produces energy shortages later. We know that BAU will overshoot 1.5°C and even 2°C, but where do we draw the line?"[132], hinting at the lack of opportunity to invest in fossil-alternatives compared to their coal, oil and gas. A former senior member of the UNEP FI[133] corroborated: "the ability to secure any finance from mainstream banks for small renewable projects is pitiful – it literally doesn't exist." There is a growing recognition that "if governments in Africa- like in Tanzania – have the opportunity to invest in renewable energy, they would – but the access to finance is not there."[134]

A senior manager at a European BDB[135] explained that "we know there is always a trade-off, but for some of these poorer countries there is no other economically viable way to invest in energy projects and achieve SDG 7 other than investing in fossil fuels." The World Bank Group provided an almost identical justification for their $12 billion lent to fossil fuel projects from 2016-2020, quoting their "mandate to help around 789 million people living without access to electricity, mostly in rural Africa and Asia" (quoted in Urgewald, 2020: 26). This fallacy has been debunked, by noting that: "[n]one of the fossil fuel projects included in the [World Bank's] $12.1 billion… provide new electricity connections to people living without access ($2.3 billion went to oil and gas exports)" – almost half of it "went to countries that already have 100% electrification rates (e.g., Brazil, Mexico, Turkey, El Salvador)",[136] and the "vast majority of households living without energy access are located in rural communities which electricity grids do not reach…the best solution… is distributed renewable energy, specifically not large fossil fuel power plants" (Urgewald, 2020: 26).

7.4.4. Summary

It is evident that the stranded asset debtors not only show no signs for acknowledging or governing their South African SAD (see 7.4.2), but also hint at the prospects of expanding their existing SAD by pursuing new fossil projects both in South Africa and beyond in the coming decade (see 7.4.3). This, paired with the ecologically and socially exclusive approaches adopted by these actors (see 7.2.4), raises serious questions about whether fossil fuels will be phased out altogether from the South African economy, let alone inclusively – see 7.5.

7.5. Analysis: Inclusiveness and Sustainability

7.5.1. Inclusiveness

Building on the analysis from 5.4, this section evaluates the implications that this LFFU approach mix (see 7.2.4) and SAD negligence (se 7.3.6) bear on an inclusive fossil phaseout in South Africa by applying the analytical framework from Table 2.4, yielding Table 7.1.

Ecologically, the dearth of effective approaches suggests that: 1) it is unlikely that existing fossil-infrastructure (e.g., coal-fired power stations like Medupi & Kusile, or coal mines like WMC) is decommissioned/ retired within the next decade, given that only 2/74 actors even acknowledged the possibility of employing such an approach (see 7.3.5); and 2) given the lack of regulation on financial capital for forthcoming oil & gas production – along with the paramount loopholes plaguing

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[132] Interview FIN_GEN1
[133] Interview FIN_GEN6
[134] Interview NGO_GEN1
[135] Interview FIN_GEN4
[136] It should be stated that it is somewhat unclear what is meant by 'electrification rate' in the Urgewald (2020) report. Speaking anecdotally and as a Brazilian national, Brazilians are certainly not living with universal access to electricity – neither within the household nor in some communities more broadly.

regulations for coal-intensive financial capital, it seems likely that South Africa's carbon economy will experience a continuous influx of oil & gas investment in addition to coal financing. Regarding the latter, South Africa is *not* a member of the OECD, which means that according to the bulk of the financial institutions analysed here (see 7.3.5), *South African coal projects are eligible for financing through 2040*, which aligns with the IRP's plans to procure 7GW of new coal-fired power through 2030 (see 1.3.2.1); all this considered, we should expect to see the coal-intensity of South Africa's MEC increase *in addition to* its oil & gas-intensity, which currently is low but barrelling forward with momentum due to the Brulpadda & Luiperd discoveries (see 5.2.2.5) – altogether violating condition E1. Moreover, since 73/74 and 71/74 actors both refrained from proposing infrastructural decommissioning plans and neglected the ecological challenges with fossil-alternative power procurement (e.g., land- and water-intensity of solar PV power generation), respectively, there is little to no evidence to suggest that conditions E2 and E3 will be complied with. As such, the LFFU approach mix is, it its current form, entirely ecologically exclusive.

Socially, the compiled LFFU approach mix dodges the critical issue vis-à-vis inevitable stranded labour and allocates all attention to stranded energy due to the profuse focus on 'green finance' (see 7.3.1). As was argued (see 5.5), stranded labour presents an arguably greater trade-off for LFFU in South Africa than stranded energy due to the inadequacies of the existing fossil-dependent grid; accordingly, neglecting the stranded labour dimension today exacerbates the vulnerability that coal miners and other coal-dependent South Africans face, delaying these concerns well into the future. Moreover, the forecasted expansion of South African fossil production based on the policies being adopted (see 7.4.3) suggests that the number of prospective stranded labourers in South Africa could increase in the coming decade (potentially through 2040), not only delaying but also exacerbating the stranded human asset risks borne by South African citizens, hence, violating condition S1. However, South Africa's power grid may experience improvements in the event that the newly financed solar PV, wind and other renewable projects provide more affordable and reliable power than the incumbent coal grid, which could align with condition S2 by promoting access to basic needs like energy – which are currently not being met by the exiting fossil-intensive grid.

Relationally, a complete negligence for (implicitly) acknowledging the SAD (see 7.4.2), in addition to a preference for adopting approaches that export stranded asset-related costs (like divestment, emissions monitoring and green finance, see 7.3.2 & 7.3.3), suggests that the costs of settling the inevitable SAD 'bill' are currently not accounted for to any extent, violating condition R1. Moreover, no actors mention any type of financial compensation for forgoing fossil fuel production in any context, subsequently violating condition R2. As a result, the LFFU approach mix is likely to 'dump' the eventual phaseout and stranded asset costs (i.e., SAD) to South African organisations, financial institutions and citizens. As South Africa's economy expands its coal- and oil & gas dependence, the burden of the Stranded Asset Debt will likely be reallocated to domestic commercial banks like Nedbank, institutional shareholders like the PIC, governmental institutions like Eskom & the National Treasury, and its citizens more broadly.

Table 7.1. Evaluating the implications of the LFFU approach mix adopted by South Africa's stranded asset debtors on inclusive development

Dimension	Condition	Implications for ID via Stranded Assets
Ecological	E1. Investments in new fossil fuel assets are terminated immediately, and existing coal, oil and gas facilities are stranded/phased out; E2. Physical assets (like coal-fired power stations) are adequately and fully retired/decommissioned so that they do not threaten local air, water and soil resources; E3. Fossil fuel alternatives (e.g., grid-scale solar PV) do not themselves disrupt ecosystems and are respectful of water, land and other planetary boundaries	E1. Investments in a minor subset of fossil fuel assets (predominantly coal) are regulated, the bulk are unregulated and often encouraged, particularly for oil & gas; stranding of existing facilities and assets neglected. *Net implication: Ecologically exclusive* E2. The decommissioning and/or retiring of physical assets is not yet being pursued, and given that 73/74 actors did not disclose the possibility of decommissioning existing assets, this seems like it is very likely off key actor agendas. *Net implication: Likely ecologically exclusive* E3. Only 3/74 actors acknowledged the ecological ramifications from fossil-alternative projects, despite the majority (38/74) actors push for 'green finance' as a centrepiece for their climate policies, indicating that these ecological issues may be entirely overlooked. *Net implication: Likely ecologically exclusive*
Social	S1. Safe, high quality and desirable jobs are for the poorest, most under-resourced and vulnerable unemployed people, and their livelihoods and wellbeing are both sustained and prioritized; S2. Investments in fossil-alternative assets do not hamper universal access to basic needs and services, like energy, healthcare, water, food, housing, and justice	S1. Forecasted expansion of coal, oil and gas production in South Africa (see 7.4.3) suggests that additional fossil-intensive direct and indirect jobs will be introduced and maintained, many of which (e.g., coal mining) are unsafe and undesirable. *Net implication: Socially exclusive* S2. The growing momentum for 'green finance' suggests that South Africa's decrepit coal-dependent grid may see general improvements in terms of both reliability and availability of power. Other basic needs (healthcare, food, water, etc.) are beyond the scope of the analysis. *Net implication: Socially inclusive*
Relational	R1. Financial costs (stranded assets) of phasing out fossil fuels are allocated to large (fossil fuel) multinational firms and capable financial institutions; R2. Compensation for stranded natural resources (e.g., recoverable coal, oil and gas reserves) is paid from richer governments, firms and investors from the 'North' to citizens of poorer nations with ample reserves and dependence on developing said reserves ('South')	R1. Unabated investments in additional fossil fuel infrastructure paired with ineffective approaches to LFFU and tactics to divest existing & dirty assets suggests that the Stranded Asset Debt 'bill' is both ballooning and being dumped onto South African citizens by debtors mainly from the 'North'. *Net implication: Relationally exclusive* R2. No acknowledgement of possible financial compensation/ swaps by financial, economic or political institutions from the 'North', despite requests by the 'South' through their NDCs. *Net implication: Relationally exclusive*

Source: Author

7.5.2. Sustainability

Table 7.2 complementarily evaluates the SDG trade-offs that this approach mix will yield. Despite the likelihood that coal, oil and gas production may continue to grow in South Africa in the coming decade – leading to exacerbated agricultural and health risks (trade-offs with SDGs 2 and 3), perpetuated human rights violations from e.g., coal mining (trade-off with SDGs 1 and 10), and continuing to fuel the 'climate emergency' (trade-off with SDG 13) – neglecting to LFFU and flooding the South African economy with 'green' power will likely improve access to affordable and reliable energy (synergy with SDG 7) and improve prospects of supporting domestic economic growth (synergy with SDG 8). However, the aforementioned synergies only apply in the short-term (i.e., perhaps through the expiration date of the SDGs in 2030). Continuing to finance coal and oil & gas production today may spur short-term economic growth, but this will simultaneously amplify the monetary & non-monetary stranded asset risks that South Africa already faces (see 5.3.4) – a risk that implicitly threatens any long-term growth prospects. It is plausible that in the decades succeeding Agenda 2030, South Africa's coal- and oil & gas-dependent economy will suffer when the inevitable moment to strand its fossil assets arises, which may inevitably hamper growth, amplify unemployment and reduce the availability of reliable energy on the grid – directly *countering* SDGs 7 and 8 in the longer-term.

Hence, the identified LFFU approach mix may produce trade-offs with (and therefore counter progress towards) 6/9 SDGs included in the analysis (SDGs 1, 2, 3, 9, 10 & 13), whereas synergies are likely to arise with only 2/9 SDGs (SDGs 7 & 8).[137] This paints a seemingly more optimistic picture than from an inclusive development perspective, suggesting that a sustainable development approach is more likely to justify the exclusive features of the existing LFFU approach mix and promote fossil production.

7.5.3. Beyond the PRI/PRB and OECD Policy Frameworks: Proposing the PIIB

The joint LFFU approach mix by the stranded asset debtors – again, who are predominantly from the 'North' (see 6.2) and many of whom abide by international policy frameworks like the PRI, PRB and OECD Arrangement (see 7.2.2) – as it stands (see 7.3.2), both relies on ineffective approaches and makes no effort to address the SAD that must be inevitably settled in any fossil phaseout (see 7.4.2). Moreover, the existing multilateral policy frameworks for regulating fossil fuel-related finance flows – namely the PRI/PRB and OECD Arrangement – themselves continue to permit hundreds of billions in public and private financial support for global fossil fuel projects (see 7.2.2-7.2.3) while simultaneously breeding the aforementioned ineffective and inequitable LFFU approach mix (see 7.3.2). It is apparent that if nothing changes, South Africa is very unlikely to experience any semblance of a fossil phaseout in the coming decades, let alone an inclusive one. Ergo, either external pressure is required to encourage or mandate changes, taking the form of e.g., the South African government suspending production licenses (which may prompt a slew of legal challenges (see 4.3.2.5) and is beyond the scope of this analysis), or an overhaul of these policy frameworks to drive change internally.

A revamped *framework for inclusive fossil finance* can be constructed manipulating the analytical framework (see Table 2.4) that has been used to evaluate inclusiveness various times in this research (see 5.4 & 7.5.1), tentatively taking on the name: *Principles for Inclusive Investing and Banking (PIIB)*. The PIIB is predominantly an interpretation of stranded fossil fuel assets (see 2.1) from an inclusive development perspective (see 2.2) and strives to go beyond questioning whether investors and financiers are 'aligning with the Paris Agreement' (Principle 1 of the PRB, see UNEP FI, nd) and ascertain the extent to which they are prepared to allocate resources to effectively drive an inclusive fossil phase-out. In this first pass, the PIIB altogether has 10 pillars spanning the ecological, social and relational dimensions – see Figure 7.4.

[137] Synergies and trade-offs with SDG16 were rendered beyond the scope of the analysis

Table 7.2. Evaluating the implications that the identified LFFU approach mix will yield on prospects of meeting Agenda 2030 in South Africa

Target	Implications for Trade-offs and Synergies from existing LFFU Approach Mix
1.2	Continued investment in coal-intensive power and infrastructure will likely either maintain or increase the magnitude of coal-dependent employees and communities in South Africa. These jobs are predominantly unsafe and underpaid, and by continuously investing in them, vulnerabilities and risk of stranding will continue to deepen, counteracting any progress towards target 1.2. Implication: likely trade-off between existing approach mix and SDG 1
2.1	The ecologically exclusive LFFU approach mix implies that at the local level, profuse coal mining and oil refinement will likely continue to pollute local water & soil resources and natural ecosystems more broadly, continuing to threaten domestic agricultural production. At the international level, these approaches will exacerbate the 4C, synergistically worsening current and future crop yield prospects throughout South Africa. Implication: very likely a massive trade-off between existing LFFU approach mix and SDG 2
3.9	Building on the implications from target 2.1, continuing the deleterious coal mining and oil refinement activities will certainly maintain - if not exacerbate - water, air and soil contamination and the already well-documented resulting health violations associated with both industries. Implication: very likely and massive trade-off between existing LFFU approach mix and SDG 3
7.1	Ample pledges to finance 'green' fossil alternatives - in addition to the readily accessible finance for coal-production in South Africa - suggests that South Africa's grid should expect to see improvements to its decrepit and unstable coal-intensive grid. Implication: likely synergy between existing LFFU approach mix and SDG 7
8.1	Neglecting to LFFU and welcoming an influx of 'green' projects will likely both spur 'green growth' in South Africa through newly financed green projects, and also hoist other sectors that have been constrained by the nation's unreliable coal grid (the latter of which - exemplified by Eskom's continuous load shedding schedule - has historically been associated with fettering South Africa's economic growth). Implication: very likely synergy between existing LFFU approach mix and SDG 8 by 2030.
9.4	Despite the abundance of pledged green finance for South Arica's grid, the aforementioned propensity by stranded asset debtors to divest fossil-intensive assets rather than decommission/ retire them suggests that the inefficient and unsustainable infrastructure (predominantly South Africa's archaic coal mines and power facilities) will remain online and operational through 2030. Implication: very likely trade-off between existing LFFU approach mix and SDG 6
10.1	South Africa's coal industry's track record suggests that 'the bottom 40 percent of the population' (i.e., the most under-resourced and under-privileged South Africans) have not benefited from unabated fossil production, but rather have been fixated as 'the bottom 40 percent' due to said production; maintaining the status quo will certainly perpetuate this trend. Implication: likely trade-off between existing LFFU approach mix and SDG 10
13.2	Given the dearth of ecologically inclusive approaches, progress towards SDG 13 is entirely contradicted. Implication: indisputable and massive trade-off between existing LFFU approach mix and SDG 13
16.6	Beyond the scope of the analysis

Source: Author

Figure 7.4. Proposed framework for the Principles for Inclusive Investing & Banking (PIIB) as an alternative to the PRI, PRB and OECD Arrangement

Principles for Inclusive Investing & Banking

ECOLOGICAL

E1 No financial capital or services (e.g. loans, guarantees, underwritings, equity) will be, from now onwards, allocated to support new coal, oil or gas exploration and production

E2 No financial capital or services (e.g. loans, guarantees, underwritings, equity) will be, from now onwards, allocated to support the development of new infrastructure that serves the explicit purpose of supporting or combusting fossil fuels – e.g. coal-fired power plants, crude oil pipelines, LNG power generators

E3 All finance supporting low-carbon, fossil alternative projects (e.g. solar PV, wind, battery storage) will undergo a strenuous impact assessment process (conducted by a coalition of CSOs & regulatory agencies) to ensure that land, water, air, and biodiversity disruptions are minimised or omitted altogether.

E4 Financial capital (in the form of grants, debt relief, and concessionary loans) will be allocated to adequately and entirely decommission and repurpose existing fossil fuel infrastructure so that ecological disruptions to land/soil, water and local air are eradicated.

SOCIAL

S1 Financial capital to generate safe, high quality and desirable jobs is prioritised over profitability. Projects that generate unsafe, undesirable or inadequate jobs that do not sustain the livelihoods and wellbeing of the most under-resourced, under-privileged and vulnerable people will not be financed under any conditions.

S2 Ecologically-inclusive investments in fossil-alternatives should not hamper universal access to basic needs and services, like energy, healthcare, water, food, housing and justice. Finance for projects hampering such access will not be made available.

RELATIONAL

R1 Action is taken by indebted (vis-à-vis a SAD) financial institutions to voluntarily allocated ample funds (grants and debt relief) to meet all ecological and social principles above as part of the FPIT mechanism. This will inevitably imply incurring hundreds of billions of dollars in losses spread across thousands of institutions, and all those with accumulated SAD will comply.

R2 No financier or investor will seek to earn profits through fossil fuel exploitation. This includes investment in fossil fuel producer equity in addition to debt-financing for fossil and fossil-related infrastructure, like railways for the explicit purpose of transporting coal from a mine to a power generating facility.

R3 Asset managers and other institutional investors will write-off any and all liquid assets (in the form of e.g. shares) pertaining to firms that derive any of their revenue from fossil fuel production, and will subsequently allocate ample (non-)financial resources to shut down these fossil operations in compliance with the other ecological and social principles

R4 Asset managers and other institutional investors will identify firms that derive any of their revenue indirectly from fossil fuel production (through e.g. infrastructure construction), and will subsequently allocate ample (non-)financial resources to terminate all forthcoming projects of this nature and recraft their business in compliance with the other ecological and social principles

Source: Author

Ecologically, the PIIB regulates and bans any and all forthcoming financial capital allocation (in the form of commercial or concessionary loans, guarantees, underwritings, equity, etc.) for new fossil fuel exploration and production and new projects directly supporting fossil exploration and production (pillars E1 & E2) – building on condition E1 from Table 2.4. Green finance is permitted as long as projects are vetted and undergo a strenuous impact assessment (by CSOs or other organisations well-embedded in local contexts) to ensure no further ecological disruption (pillar E3), adapted from condition E3 in Table 2.4. Finally, financial capital (in the form of grants, debt relief and highly-competitive concessional loans) are allocated to *decommission and repurpose existing fossil infrastructure* (pillar E4) – building on condition E2 in Table 2.4; this may require breaching contracts/concessions and suspending existing fossil exploration and production licenses (see 4.3.2.5), potentially sparking lawsuits and compensation requests, which PIIB-abiding financiers may help cover partially or entirely.

Socially, the PIIB ensures that new investments prioritise creating safe, high quality and desirable jobs for a society's most under-resourced and under-privileged citizens, particularly those who will inevitably become unemployed as a result of e.g., coal mine and oil refinery closures (pillar S1) – building on S1 from Table 2.4. Furthermore, building on the ecological principles, financial capital for new, low-carbon projects must not in any way come at the expense of hampering universal access to basic needs, like housing through e.g., land grabbing & involuntary dispossession, or water & sanitation through unsustainable metals mining practices (pillar S2) – building on S2 from Table 2.4.

Finally, the PIIB stresses that an immense financial (SAD) bill will be afoot assuming compliance with the abovementioned ecological and social principles. As such, the PIIB mandates that financiers accept that these losses are inevitable, and that financial capital in the form of debt relief and grants be made readily available (according to the SAD that the respective financier has accrued) (pillar R1) – building on R1 from Table 2.4. Moreover, the PIIB explicitly denotes that financiers and investors shall refrain from earning any profits from fossil or fossil-related investments (pillar R2). In the event that an asset manager or institutional investor is already managing equity in a fossil or fossil-supporting firm, then rather than divesting, the PIIB obliges signatories to first allocate financial and non-financial resources to leverage their shareholder power and engage the respective firm to terminate all fossil-related business, then subsequently write-off the assets on their own balance sheets (thereby incurring the losses themselves rather than reallocating them elsewhere via divestment) (pillars R3 & R4) – altogether building on both R1 and R2 from Table 2.4.

From the perspective of international financial institutions, there is no real incentive to urgently revamp existing policy frameworks like the PRI/PRB/OECD Arrangement, adopt the PIIB, and subsequently to, for instance, cease all available financing for fossil fuel projects to 'non-OECD members' or 'least developed and developing economies' *before* 2040 (see 7.3.5), given that nations like South Africa pledge to continue introducing fossil power into their grids through at least 2030 (see 1.3.2.1) and will therefore require financing to do so. Hence, incentivising the adoption of and alignment with the PIIB may require either 'carrot' or 'stick'-type LFFU approaches – the 'carrot' potentially manifesting as government subsidies or tax breaks for terminating fossil financing (see 4.3.1.8), while the 'stick' could take the form of amplified taxes for financed *extraction* (see 4.3.1.1) or strict bans/ moratoria on such financing (see 4.3.2.4). Although both the carrot and the stick may 'effectively' lead to compliance with the PIIB, the equitability and, ergo, inclusiveness of the 'carrot' approach is questionable since it seemingly benefits the rich & capable fossil fuel financiers and de facto ignores and reallocates that Stranded Asset Debt (SAD) burden elsewhere. Further research should explore these carrot- and stick-type approaches to promote PIIB alignment in both the South African case, and more broadly in the African continent and the 'South'.

7.6. Conclusion: The Great Stranded Asset Debt Dump?

This chapter posed the question:

What does the composition of the LFFU approach mix that South Africa's stranded asset debtors are adopting imply for the allocation of their Stranded Asset Debt (SAD), to what extent are international finance policy frameworks likely to drive an inclusive fossil transition in South Africa, and hence, how can these frameworks be revamped to better align with inclusive development agendas?

And three conclusions are drawn from the analysis in 7.2-7.5:

Conclusion 1

By preferring ecologically exclusive approaches & divestment of their assets, failing to acknowledge their South African SAD, and explicitly denoting plans to expand their global fossil operations and implicitly balloon their SAD, actors from the 'North' are in the midst of orchestrating what may become the ***Great Stranded Asset Debt Dump (GSADD)*** *– reallocating the (non-)financial burden and accountability for phasing out existing South African fossil fuel infrastructure to other 'Northern' or 'Southern' balance sheets, or directly to the citizens of the South Africa and the 'South' more broadly.*

Conclusion 2

As of 2021, existing international policy frameworks like the PRI/PRB and OECD Arrangements yield a ***policy landscape and LFFU approach mix that is at most 15% inclusive with respect to South African fossil fuel investments*** *(given that only 1/7 inclusiveness conditions are met, or 15%); the status-quo invites continuous fossil investments in non-OECD member states (e.g., South Africa) through 2040, thereby exacerbating global stranded asset risks (see 5.3.4), ballooning already massive stranded asset debts (see 6.4), and fuelling (rather than combatting) the 'climate emergency'. As a result, it seems there is an* ***85% likelihood that an exclusive energy addition will unfold in South Africa through 2030-2040, failing to LFFU altogether.***[138]

Conclusion 3

Hence, an inclusive fossil fuel phaseout in South Africa is only possible if ***existing multilateral policy frameworks like the PRI, PRB and OECD Arrangement are reimagined to more strictly curtail the financial capital*** *available for both coal- and oil & gas-intensive projects while simultaneously allocating capital to govern stranded (non-)financial assets. One possible alternative is the proposed Principles for Inclusive Investing and Banking (PIIB).*

[138] I would like to stress that these percentages are simply communicating that 1 of the 7 inclusiveness conditions from Table 7.1 is met, which translates to (roughly) a 15% inclusive LFFU approach mix.

PART 4

WHERE DO WE GO FROM HERE?

Unpacking the trade-offs and potential LFFU scenarios in the midst of the COVID-19 induced pandemic and their implications for inclusive and sustainable development agendas

8. COVID-19 & Stranded Fossil Fuel Assets[139]

8.1. Introduction

At the time of writing (May 2022), over two years have elapsed since the beginning of the COVID-19 pandemic, and no true end is in sight. A fifth wave of infections driven by several more contagious subvariants have prompted abrupt and unexpected lockdowns in Europe and beyond; international travel remains chaotic, 'working from home' is the official norm, and supply chain shortages still render access to certain goods like laptops delayed or even impossible. It would therefore be remiss to neglect this context when speculating over the *future prospects* of phasing out fossil fuels. COVID is the new norm, and presents the global context within which any attempts to combat the 'climate emergency' and LFFU will be situated, at least through the end of the decade (and therefore, the expiration date of the Paris Agreement and Agenda 2030).

In order to assess the influence that the pandemic has had on both global and South African prospective stranded assets – and the potential opportunity that COVID-19 presents to 'push' against the fossil fuel sector – I address sub question S6 (see 1.3.1):

How has the COVID-19 pandemic impacted prospective stranded fossil fuel assets globally and in both Africa and South Africa more specifically, and how does this influence prospects of inclusively phasing out fossil fuels in South Africa and beyond?

and explore the impacts of the pandemic on global and African (respectively) fossil fuel financial (see 8.2.1 and 8.3.1), physical (see 8.2.2 and 8.3.2), human (see 8.2.3 and 0) and natural (see 8.2.4 and 8.3.4) assets, and speculate over avoided fossil fuel assets (see 8.2.5 and 8.3.5). This predominantly targets knowledge gaps K1 and K4 (see 1.2.2). Note that data for this chapter was collected intermittently between March 2020 – February 2022 (see 3.5.6).

8.2. Global Stranded Assets

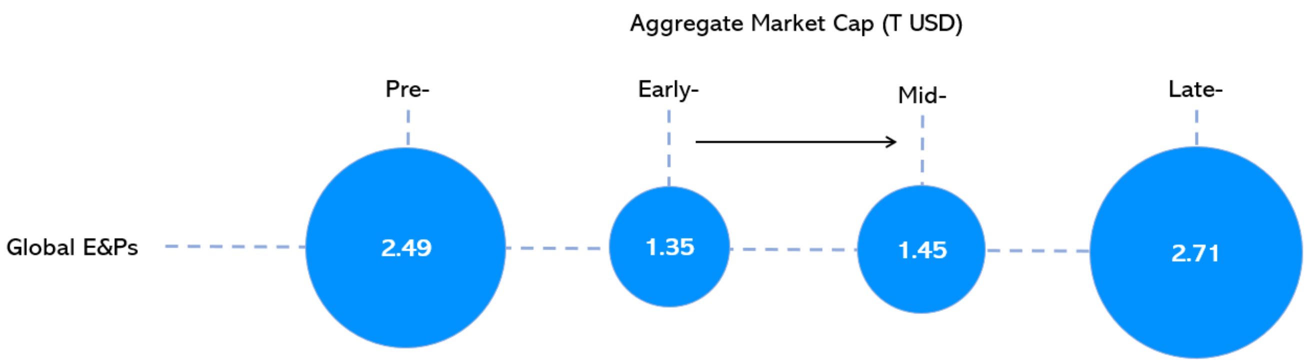
8.2.1. Financial: Market Cap and Equity Investments

First I compare the market capitalisations of 42 major coal, oil and gas E&Ps[140] at four moments: pre-pandemic (31/12/19); early-pandemic (31/3/20) and mid-pandemic (25/9/20) and late-pandemic (31/1/22). Figure 8.1 presents the aggregated and summarised results – for more, see Appendix C.

The total market cap of the sample decreased from roughly \$2.50 trillion to \$1.35 trillion at the beginning of the pandemic (46% decrease) and sat at \$1.45 trillion mid-pandemic (42% drop compared to pre-pandemic levels). Such a drop occurred as a result of plummeting share prices (compared to pre-pandemic levels) for some notable multinationals, like Anglo American (18%), BP (52%), Chevron (43%), ExxonMobil (54%), and Shell (62%). Furthermore, mid-pandemic market caps only marginally increased compared to early-pandemic levels (by about \$100 billion), suggesting that COVID-19 has stunned global fossil fuel markets for months, abruptly devaluing *trillions* of dollars' worth of fossil fuel financial assets.

[139] This chapter was prepared in tandem with and is based on the following publication:
Rempel A., Gupta, J. (2021). Fossil fuels, stranded assets and COVID-19: Imagining an inclusive and transformative recovery. *World Development, 146.* doi: 10.1016/j.worlddev.2021.105608
[140] Building on research I had published elsewhere – see Rempel & Gupta (2020)

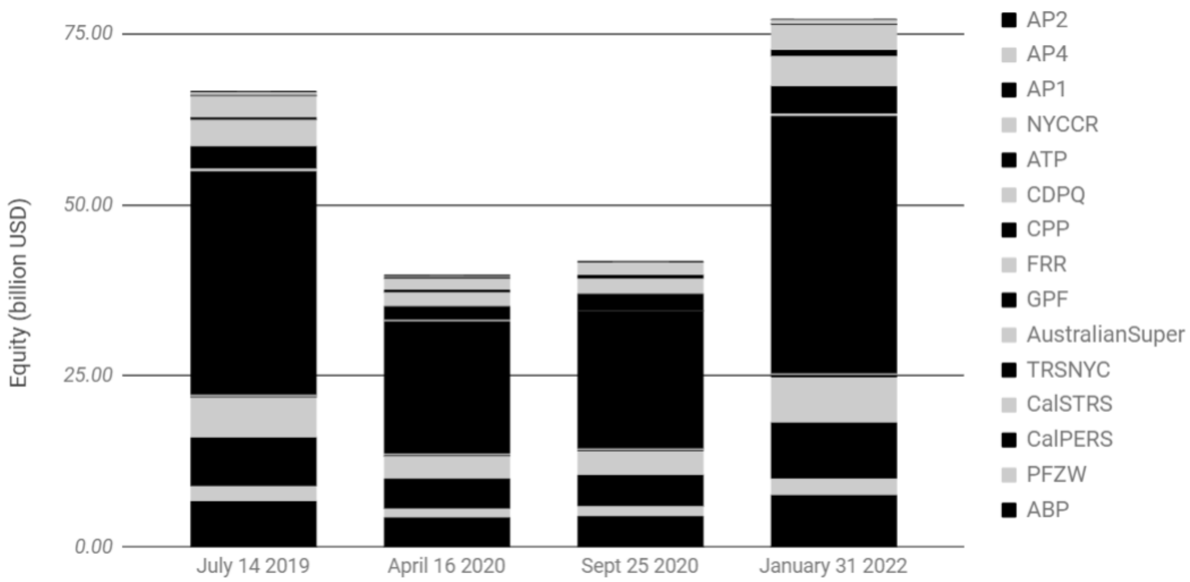
Figure 8.1 Aggregate market capitalisation for major coal, and oil & gas producing companies pre-, early-, mid-and late-pandemic.



Source: Author

However, late-pandemic market caps have ballooned, with the sample aggregate sitting at $2.7 trillion (denoting a 8.6% increase from its pre-pandemic state and an 86% increase from mid-pandemic levels). This is explained by sharp rises in late-pandemic market caps of key multinationals like AngloAmerican ($64 billion, 169% spike from pre-pandemic levels), Canadian Natural Resources ($63 billion, 68% increase) and Glencore ($74 billion, 144% increase). Although some E&P market caps remain wounded (e.g., Sasol's market cap shrunk from $174 billion (pre-) to $14 billion (late-), a 92% decline), the general trend suggests that after roughly two years, the pandemic's rattling of the fossil fuel financial domain has been largely reverted.

Figure 8.2 Simulated equity loss in the portfolios of 15 leading pension funds as a result of decreased share values.



Source: Author

Decreased share prices and market caps impact shareholder equity portfolios, and hence stranded financial assets; to explore this, I *simulate*[141] the equity loss that the investment portfolios of 15 leading pension funds endured as a result of the denoted stock market fluctuations – see Figure 8.2. Pre-pandemic, these pension funds managed roughly $66 billion in equity of the 42 sampled fossil fuel firms – approximately $53 billion in oil & gas and $15 billion in coal.[142] However, the simulated value of this equity decreased to approximately $40 billion by early-pandemic (40% decrease) and remained fairly constant at $42 billion mid-pandemic (37% decrease compared to pre-pandemic levels). Expectedly, this indicates that the pandemic prominently left tens of billions in fossil fuel financial assets from this small sample alone temporarily stranded.

However, also like the market cap narrative, simulated late-pandemic equity investments ($77 billion aggregate) spiked past their pre-pandemic levels by roughly 16%, or an $11 billion gain. Apart from one pension fund,[143] almost all sampled 2019 equity investments experienced simulated rises between 11-25%, with one fund's (ATP) simulated fossil investments ballooning by 98% (from $433 million to $858 million, pre- and late-pandemic). Altogether, this indicates that the initial stranding potential of pandemic was undermined, and these fossil fuel financial assets were substantially 'un-stranded' as the pandemic unravelled.

8.2.2. Physical: Fossil-Intensive Infrastructure

I now explore the degree to which physical fossil fuel assets were affected globally; Table 8.1 summarises the key findings (see Appendix B for details).

Table 8.1 Summary of key events denoting decreases (top) or increases (bottom) in the usage of physical fossil fuel assets Globally

	Event	Frequency	Country
Decreased physical asset usage	Coal-fired power plant closures	5	USA, UK, Austria
	Net earnings drops in coal sector	5	Indonesia, Germany, USA, China
	Oil & gas exploration and drilling paused	2	New Zealand, Australia
	Oil refineries shut down or reduce production	11	Canada, Italy, Pakistan, USA, Brazil, South Africa, Russia, Thailand, South Korea Global (OPEC)
Increased physical asset usage	Forthcoming oil projects continued or oil investments increased	5	Uganda & Tanzania, USA & Canada, Indonesia, Mozambique

Source: Author

Table 8.1 shows that at least 5 coal-fired power plant were closed during the pandemic, while some others discuss first quarter profit drops ranging from 37% (BASF) to as high as 97% (PT Bumi Resources). Similarly, there were two instances of halted offshore exploration and drilling, multiple

[141] Note that these pre-, early- mid- and late-pandemic dates differ slightly than those from Figure 8.1 due to data availability
[142] Building on research I have done elsewhere - see Rempel & Gupta (2020)
[143] AustralianSuper, who's pre-pandemic equity investments experienced a simulated loss of roughly 5% through the late-pandemic

refinery closures and reduced production at operational refineries, suggesting reduced oil and gas activity and stagnated infrastructure at a global level. Conversely, five instances of increased oil and gas activity were noted (mainly in Africa and Asia), including plans for continuing the East Africa Crude Oil Pipeline (EACOP) from Uganda to the Tanzanian reaching their final stage of financial negotiations in June 2020.

8.2.3. Human: Employment

Unemployment across global economies has been a recurring topic in the midst of the pandemic. Roughly 435 million (formal) jobs were lost (globally) in the first half of 2020,[144] and the fossil fuel industry is no exception. Multiple reports indicate that mining, construction, operation and maintenance jobs around the globe for coal, oil and gas projects have reduced, stalled or vanished altogether. For instance, by December 2020, the US mining industry "exhibited the second highest [unemployment] rate… across industries (13.1%)",[145] with at least 6,000 US coalminers becoming unemployed in March and April 2020 alone.[146] Some nations (like South Africa) curbed underground mine operations by 50% while others (like Poland) temporarily shut down underground mines altogether for fears of expedited virus spreading in compact mineshaft elevators.[147] Moreover, South Africa's mining industry relies partly on migrant workers from neighbours Mozambique and Lesotho, and "closed borders are halting the temporary use of cross-border migrant workers," and since many mining companies operate on a 'no work, no pay' principle, it seems likely that many of these workers are left without income.[148]

The pandemic has also taken a toll on oil and gas jobs; by September 2020, the US had lost over an estimated 100,000 oilfield services jobs, with Texan oil unemployment numbers almost hitting 60,000.[149] Russian unemployment almost doubled from February to May 2020, largely explained by tanking crude oil exports,[150] and Saudi Arabian national unemployment rose to 15% by September 2020 after its oil sector production dipped by roughly 6%.[151]

8.2.4. Natural

This section gauges the degree to which coal, oil and gas reserves have been impacted by the pandemic by comparing 2020 and 2019 production rates, summarised in Figure 8.3.

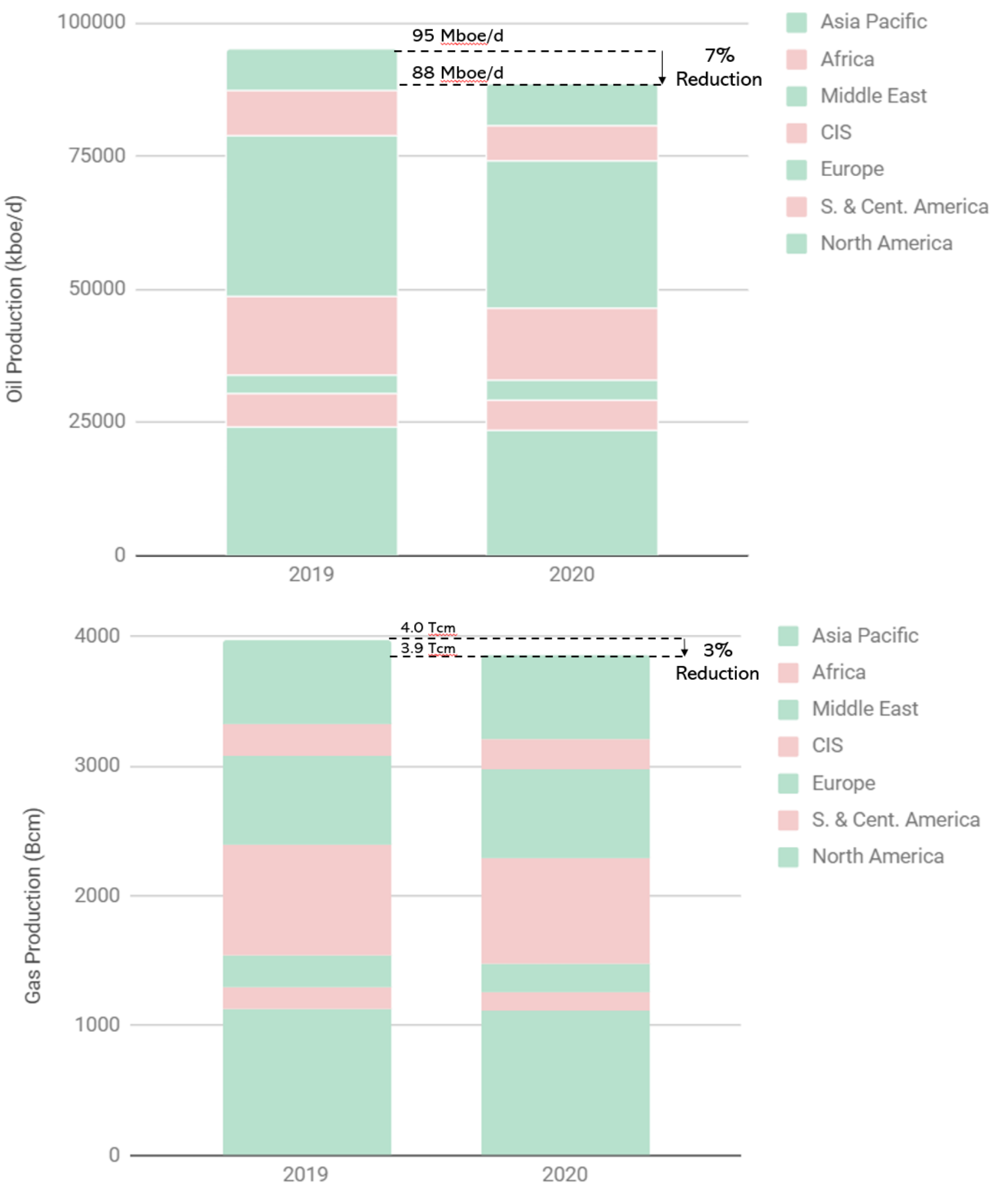
Production across all fossil types decreased between 2019 and 2020. Global oil production dipped by roughly 7% (from 95 Mboe/d to 88 Mboe/d), largely due to declined production in the Middle East (-2.5Mboe/d, 8% decline), Africa (-1.6 Mboe/d, 19% decline) and the Commonwealth of Independent States (CIS) (-1.2 Mboe/d, 9% decline). (Interestingly, European oil production increased by almost 5% (155 kboe/d) in the timeframe.) Global gas production more mildly declined by 3% (119 Bcm), also largely attributed to decreased production in the CIS (-56 Bcm, 7%) in addition to North America (-20 Bcm, 2%) and Latin America (-19 Bcm, 11%). Coal production, meanwhile, decreased by 5% (roughly 400 Mt) from 2019 to 2020, predominantly driven by decreases in North America (-170Mt, 25%), Latin America (-33Mt, 36%), Europe (-90Mt, 16%) and CIS (-43 Mt, 8%). Note that coal production in Asia

[144] ILO (2020)
[145] US Congressional Research Service (2020: 5)
[146] Sainato (2020)
[147] Ramdoo (2020)
[148] Ramdoo (2020: 6)
[149] WorldOil (2020)
[150] Gofman (2020)
[151] Nereim (2020)

Pacific (by far the most producing region due to China's dominance) declined by a miniscule 40Mt, or 0.7%. As a simple exercise, assuming coal, oil and gas prices were held constant at $100/ton, $100/barrel, and $0.0005/cf, respectively, these **production reductions translate into $288 billion in forgone revenue on a global level**.

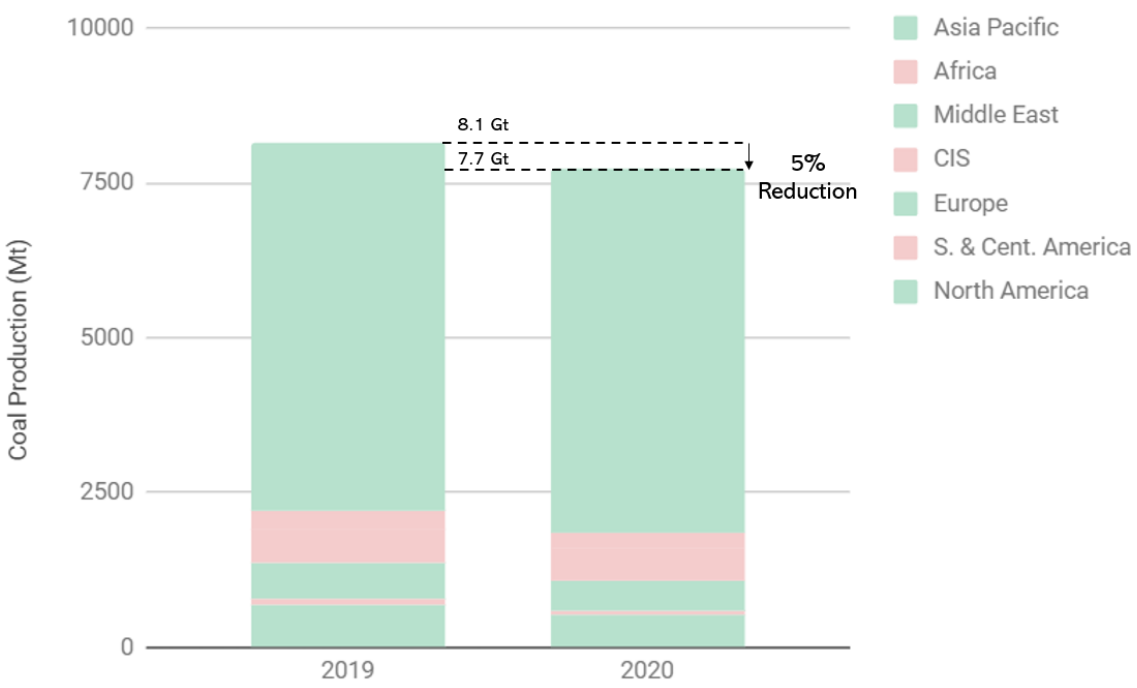
Decreased coal, oil and gas production during the pandemic correlates to an increase in fossil fuel resources that were not extracted, produced and commercialised. This *in theory* suggests that reserves did not decrease by as much as they would have if production had not dipped in 2020, which means that fossil resources (i.e. natural assets) remained underground for the time being. These assets are not stranded yet, but remain susceptible to becoming stranded in the future, though the revenue streams they would have generated – worth almost $300 billion – have been stranded, at least temporarily.

Figure 8.3. Global 2019 and 2020 oil (top), gas (middle) and coal (bottom) production rates



Source: Author, using data from BP (2021)

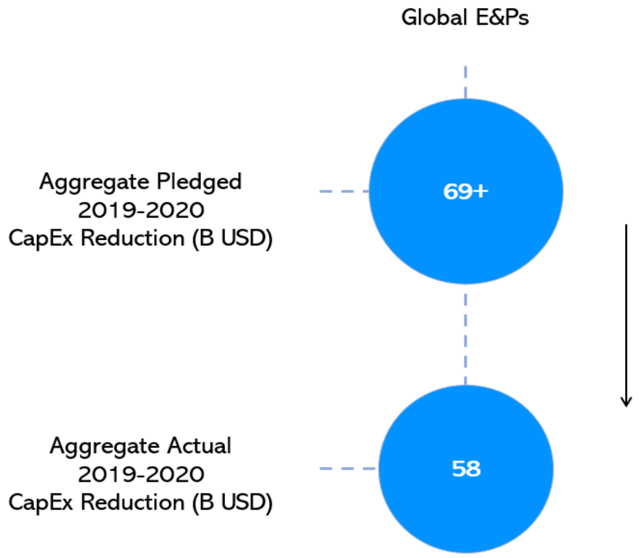
Figure 8.3 continued



8.2.5. Avoided Stranded Assets?

Finally, I surveyed changes in fossil industry Capital Expenditure (CapEx) (i.e. annual expenses for, inter alia, new infrastructure and projects) to assess potential changes to expansions, exploration and production. Decreases in CapEx on fossil fuels can indicate potentially avoided stranded assets; if a firm decides not to invest in e.g., a pipeline, then that *physical asset* and its accompanying *human assets* (e.g., jobs), *financial assets* (e.g., debt) and *social assets* (e.g., communities built around the pipeline) are avoided.

Figure 8.4. Visualisation of the pledged vs. actual CapEx reductions from 2019-2020 by the major E&Ps



Source: Author

30 major E&Ps made announcements regarding pledged reductions to their 2020 CapEx – summarised in Figure 8.4 (see Appendix B and C). Of the 30, only one firm (Gazprom) declared no changes to their 2020 CapEx. Most (15/29) firms announced CapEx reductions between $1-4.9 billion, and four firms announced larger CapEx reductions, including Shell ($5 billion), ExxonMobil ($10 billion) and Saudi Aramco ($25-

30 billion). Based on these announcements, total pledged reductions of at least[152] $69 billion were estimated.

In actuality, these 30 E&Ps jointly reduced the aggregated 2020 CapEx by a $58 billion. Many firms respected and even surpassed their earlier pledged reductions, like Chevron ($2 billion pledged, $7 billion actual), Eni Spa ($2.3 billion pledged, $4 billion actual) and Shell ($5 billion pledged, $6 billion actual). Conversely, some firms failed to meet their pledges (e.g., Saudi Aramco, $25-30 billion pledged, $6 billion actual), whereas others marginally *increased* their 2020 CapEx compared to 2019 values, like BHP Billiton ($300 million increase) and Lukoil ($700 million increase), even after announcing forecasted reductions months earlier (by $1.4 billion and $2.5 billion, respectively). Nevertheless, this general decrease in spending in the order of tens of billions of dollars hints at a slew of potential fossil fuel stranded assets that have been avoided due to the pandemic – again, at least temporarily.

8.3. South African and African Stranded Assets During the Pandemic

8.3.1. Financial: Share Value and Equity Investments

Mimicking section 8.2, I now analyse the extent to which the pandemic has catalysed the fossil fuel asset stranding process for African (and South African) specific assets, beginning with the financial dimension. Figure 8.5 tracks the share prices of the 29 publicly-listed E&Ps with major African fossil fuel operations (see 6.3.1) at four key moments: 'pre-pandemic' (July 2019); 'early-pandemic' (April 2020); 'mid-pandemic' (September 2020); and 'late-pandemic' (January 2022).[153] Compared to their pre-pandemic values, share prices fell by a sample average of 45% by the 'early' pandemic; this consisted of many drastic drops in share value, like in the cases of Tullow ($231 to $21, 91% decrease), Sasol ($2195 to $309, 86%) and Terracom ($0.38 to $0.06, 85%), but also some milder decreases, like in the cases of Petronas ($4.12 to $3.53, 14% decrease) and BHP Billiton ($58 to $39, 34%).

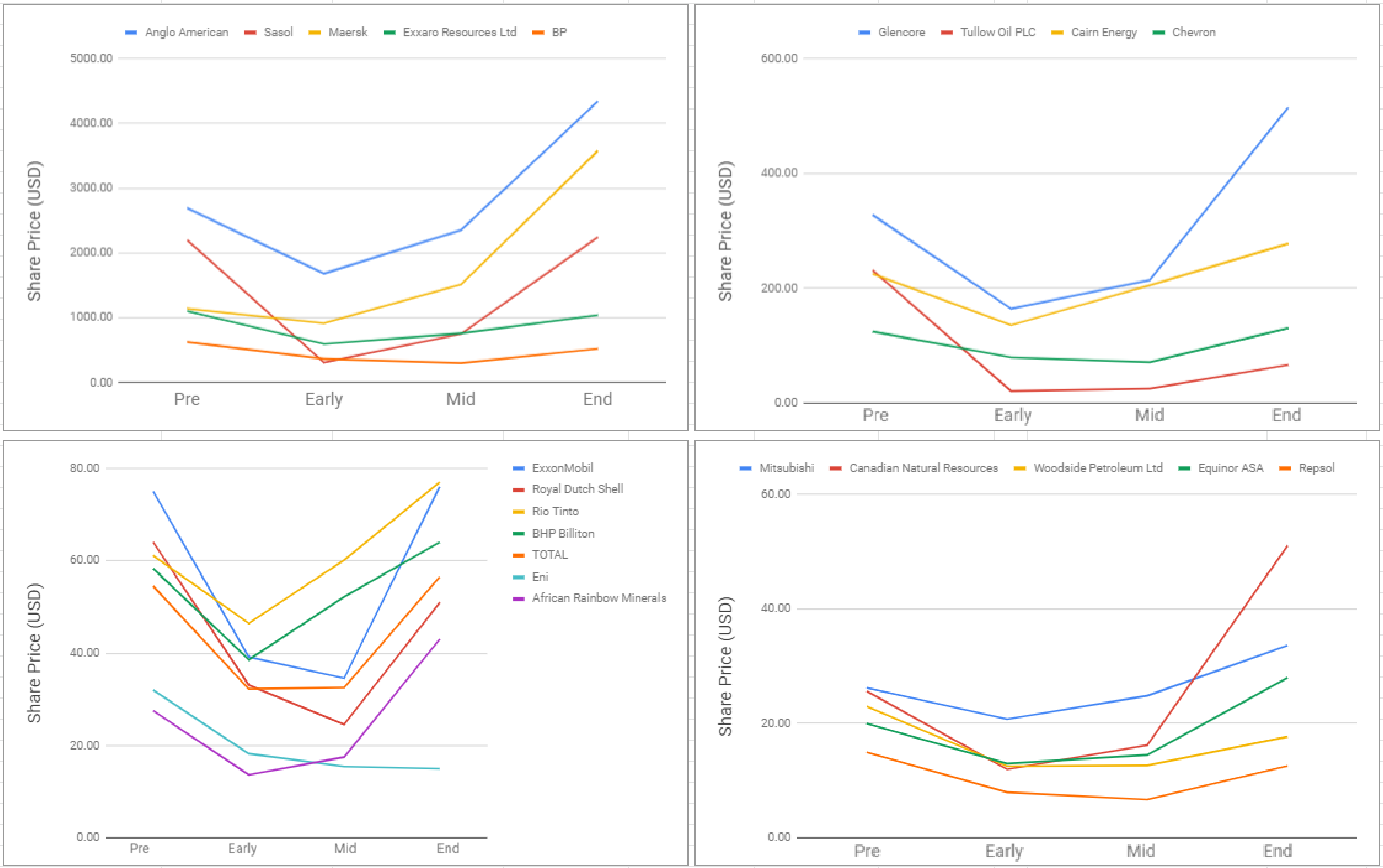
Through the 'mid-pandemic', share prices remained deflated, depicted by a sample average decrease of 36%. Once again, this included substantial drops compared to their pre-pandemic values, such as in the case of Tullow ($231 to $26, 89% drop) and Shell ($64 to $25, 62%), but also slightly milder drops, like in the case of BHP Billiton ($58 to $52, 11% drop) and Rio Tinto ($61 to $60, 2%); AP Moller Maersk presents an anomaly in which the share price 'mid-pandemic' increased by 33% compared to its 'pre-pandemic' value, from $1139 to $1513. Otherwise, all other prices remained minorly or majorly deflated.

Conversely, by the 'late-pandemic' milestone, share prices had *risen* by an average of 8.4% compared to pre-pandemic values, with some shares experiencing drastic increases, like in the case of AP Moller Maersk ($1139 to $3576, 214% increase), Canadian Natural Resources ($26 to $51, 99%) and Glencore ($328 to $515, 57%). These upward trends certainly did not apply to all E&Ps, though; decreases were still evident for, among others, MC Mining ($0.47 to $0.07, 85% drop), South32 ($11 to $3, 75%), Eni SPA ($32 to $15, 53%) and Shell ($64 to $51, 20%). Altogether, this indicates that although most share prices have begun recovering, some still remain crippled.

[152] Seven firms announced CapEx reductions but did not specify an amount, implying that this is very likely an underestimate.

[153] Note that this differs from section 8.2.1, which tracked market cap rather than share prices across these four timeframes, due to data availability at the time of data collection. For more, see methods section 3.5.6.

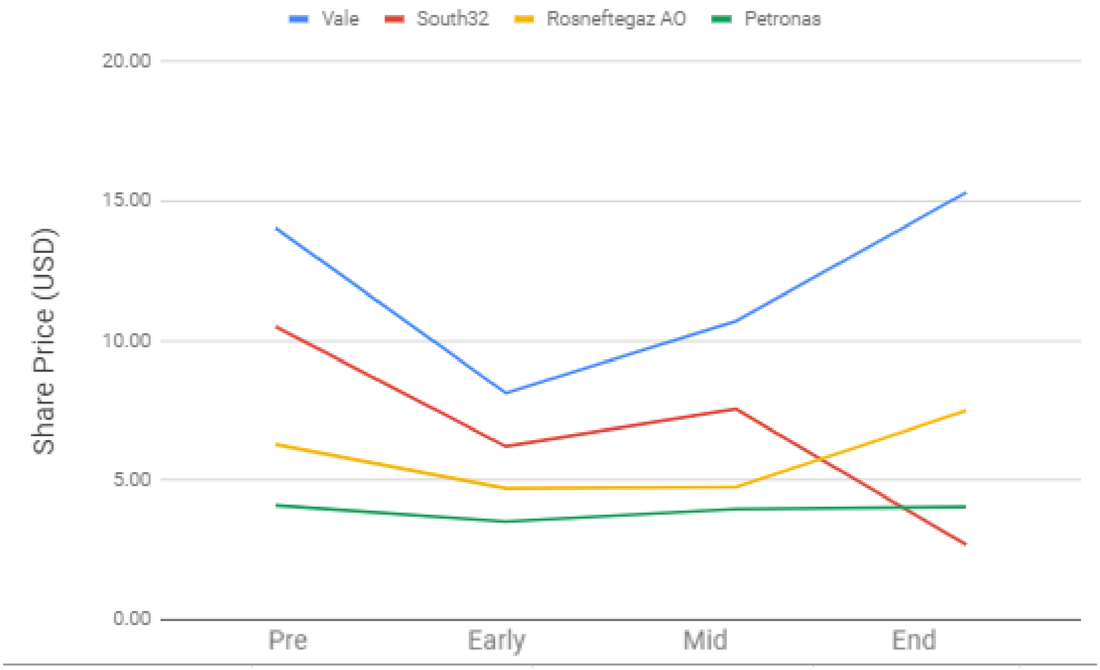
Figure 8.5. Grid tracking the share prices of the 29 publicly-listed major E&Ps with active African fossil fuel operations (as denoted in 6.3.1) throughout the pandemic.

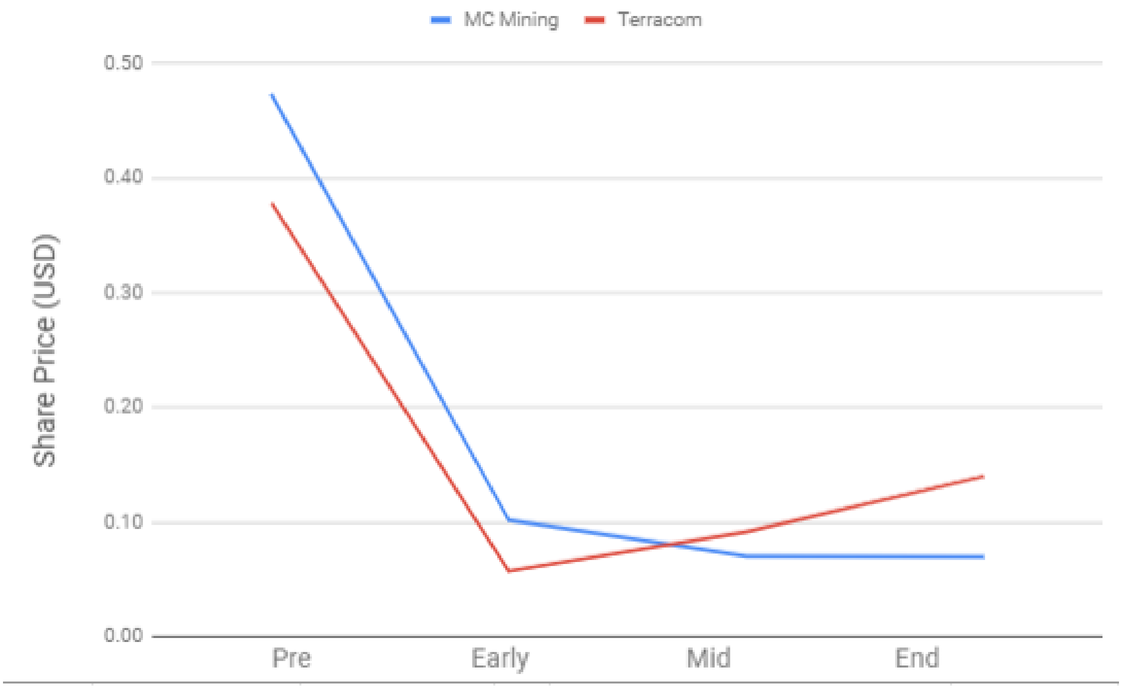


Source: Author.

N.B. share prices were identified at four key moments: 'pre-pandemic' (July 2019); 'early-pandemic' (April 2020); 'mid-pandemic' (September 2020); and 'late-pandemic' (January 2022).

Figure 8.5 continued





Source: Author

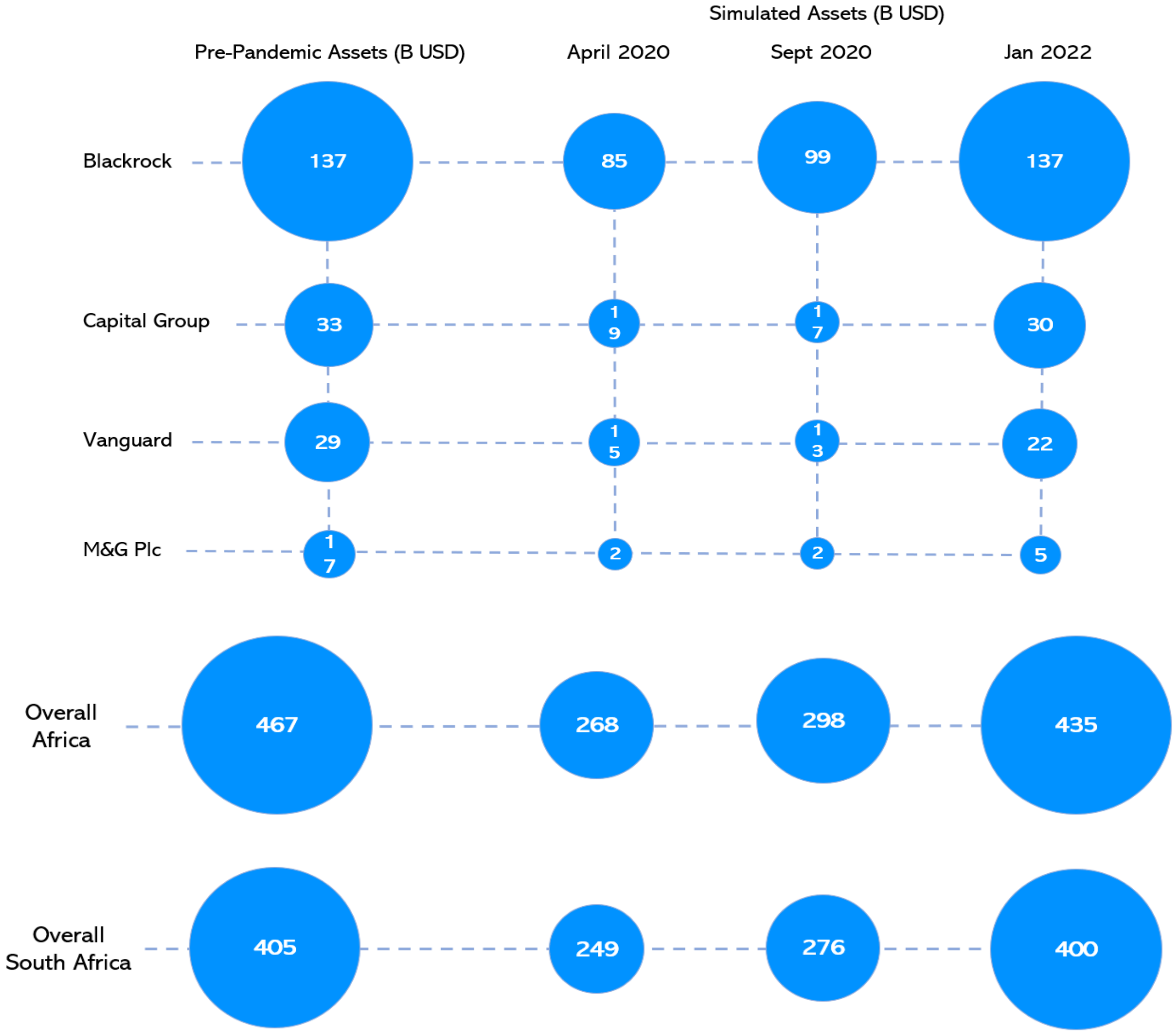
These share price fluctuations are somewhat meaningless unless they are interpreted in terms of their impact on shareholder investments and, ergo, prospective stranded financial assets. Figure 8.6 and Table 8.2 simulates the impact that the price fluctuations from Figure 8.5 would have borne on the liquid equity investments of some of the major shareholders of the 29 sampled E&Ps (for methods see 3.5.6).

Jointly, the 18 top major shareholders managed *at least* $467 billion[154] in the shares pertaining to the 29 E&Ps before the pandemic (of which $405 billion pertained to the E&Ps specifically operational in South Africa); by April 2020, the value of these assets would have been slashed by almost $200 billion (43%), which in the case of some shareholders translates to massive losses, like for Blackrock ($52 billion loss, 38%), JP Morgan ($30 billion loss, 39%), and the Capital Group ($14 billion loss, 42%). By the mid-pandemic, these losses were marginally recovered, and the overall simulated equity deflation still stood at $169 billion (36% average decrease). This translates to substantial losses for major shareholders, like Blackrock ($37 billion loss, 27% decrease), M&G Plc ($15 billion loss, 89%) and Vanguard ($15 billion loss, 55%).

Interestingly, the 'late-pandemic' milestone did not experience as strong a recovery in shareholder equity value; by January 2022, the simulated investments would have still *decreased* by an overall value of $32 billion (average loss of 7%). Some shareholders would have marginally recovered their 2019 investments, like Blackrock ($190 million increase, or 0.1%) and HSBC ($3 billion increase, 6%), while others would still have experienced major losses, like the Capital Group ($3 billion loss, 9%), Vanguard ($6 billion, 22%) and M&G Plc ($12 billion, 71%). Altogether, this shows that the pandemic played a substantial role in abruptly devaluing (and de facto, stranding) financial assets pertaining to the major shareholders of Africa-operational multinational E&Ps, and even two years later, the stranding influence of the pandemic on these financial assets is still evident.

[154] This is very much a lower-estimate, see methods section 3.5.6

Figure 8.6. Simulated impact of share price fluctuations from Figure 8.5 on subset of major shareholder equity investments



Source: Author

Table 8.2 Simulated impact of share price fluctuations from Figure 8.5 on all major shareholder equity investments

	Assets (M USD)				Delta (M USD)			%Delta		
Major Shareholders	Pre-Pandemic	Apr 2020	Sept 2020	Jan 2022	Apr 2020	Sept 2020	Jan 2022	Apr 2020	Sept 2020	Jan 2022
Blackrock	137,305.48	85,014.16	99,954.24	137,495.80	-52,291.32	-37,351.24	190.32	-38.08%	-27.20%	0.14%
JP Morgan Chase	77,710.91	47,587.85	49,774.86	72,456.96	-30,123.06	-27,936.05	-5,253.94	-38.76%	-35.95%	-6.76%
Norges Bank	58,340.00	38,088.04	44,609.91	77,559.63	-20,251.96	-13,730.09	19,219.63	-34.71%	-23.53%	32.94%
HSBC	46,676.99	30,211.23	39,696.29	49,263.10	-16,465.76	-6,980.70	2,586.11	-35.28%	-14.96%	5.54%
Capital Group	32,894.97	18,919.62	17,338.64	29,858.60	-13,975.35	-15,556.33	-3,036.37	-42.48%	-47.29%	-9.23%
Cassa Depositi e Prestiti SpA	29,970.72	17,082.00	14,489.28	14,040.00	-12,888.72	-15,481.44	-15,930.72	-43.00%	-51.66%	-53.15%
Vanguard	28,600.83	15,485.68	13,157.67	22,279.12	-13,115.15	-15,443.16	-6,321.70	-45.86%	-54.00%	-22.10%
M&G Plc	17,118.07	1,572.50	1,897.44	4,958.00	-15,545.57	-15,220.64	-12,160.07	-90.81%	-88.92%	-71.04%
RWC	16,424.10	1,508.75	1,820.51	4,757.00	-14,915.35	-14,603.58	-11,667.10	-90.81%	-88.92%	-71.04%
Italian Ministry of Economy and Finance	5,059.16	2,883.50	2,445.84	2,370.00	-2,175.66	-2,613.32	-2,689.16	-43.00%	-51.66%	-53.15%
Previ	4,731.48	2,739.81	3,605.90	5,156.10	-1,991.67	-1,125.58	424.62	-42.09%	-23.79%	8.97%
BNDES	4,548.96	2,634.12	3,466.80	4,957.20	-1,914.84	-1,082.16	408.24	-42.09%	-23.79%	8.97%
Citicorp	2,483.38	1,356.41	1,370.28	1,913.37	-1,126.96	-1,113.10	-570.01	-45.38%	-44.82%	-22.95%
PIC	2,162.71	1,349.50	1,888.88	3,488.86	-813.21	-273.84	1,326.15	-37.60%	-12.66%	61.32%
Silchester International	983.05	613.41	858.58	1,585.85	-369.64	-124.47	602.79	-37.60%	-12.66%	61.32%
Genesis Asset Managers	786.44	490.73	686.87	1,268.68	-295.71	-99.58	482.24	-37.60%	-12.66%	61.32%
Tarl Investment	668.48	417.12	583.84	1,078.38	-251.36	-84.64	409.90	-37.60%	-12.66%	61.32%
Epoch Two Investment	589.83	368.05	515.15	951.51	-221.78	-74.68	361.68	-37.60%	-12.66%	61.32%
Total	467,055.55	268,322.48	298,160.98	435,438.16	-198,733.08	-168,894.57	-31,617.39	-42.55%	-36.16%	-6.77%

Source: Author

8.3.2. Physical: Fossil-Intensive Infrastructure

This section mimics 8.2.2 and explores the pandemic's influence on stranding physical fossil fuel assets in Africa; Table 8.3 summarises the key events on physical fossil fuel assets across Africa, and Figure 8.7 maps their geographical locations.

Table 8.3. Summary of key events denoting decreases (top) or increases (bottom) in the usage of physical fossil fuel assets throughout Africa

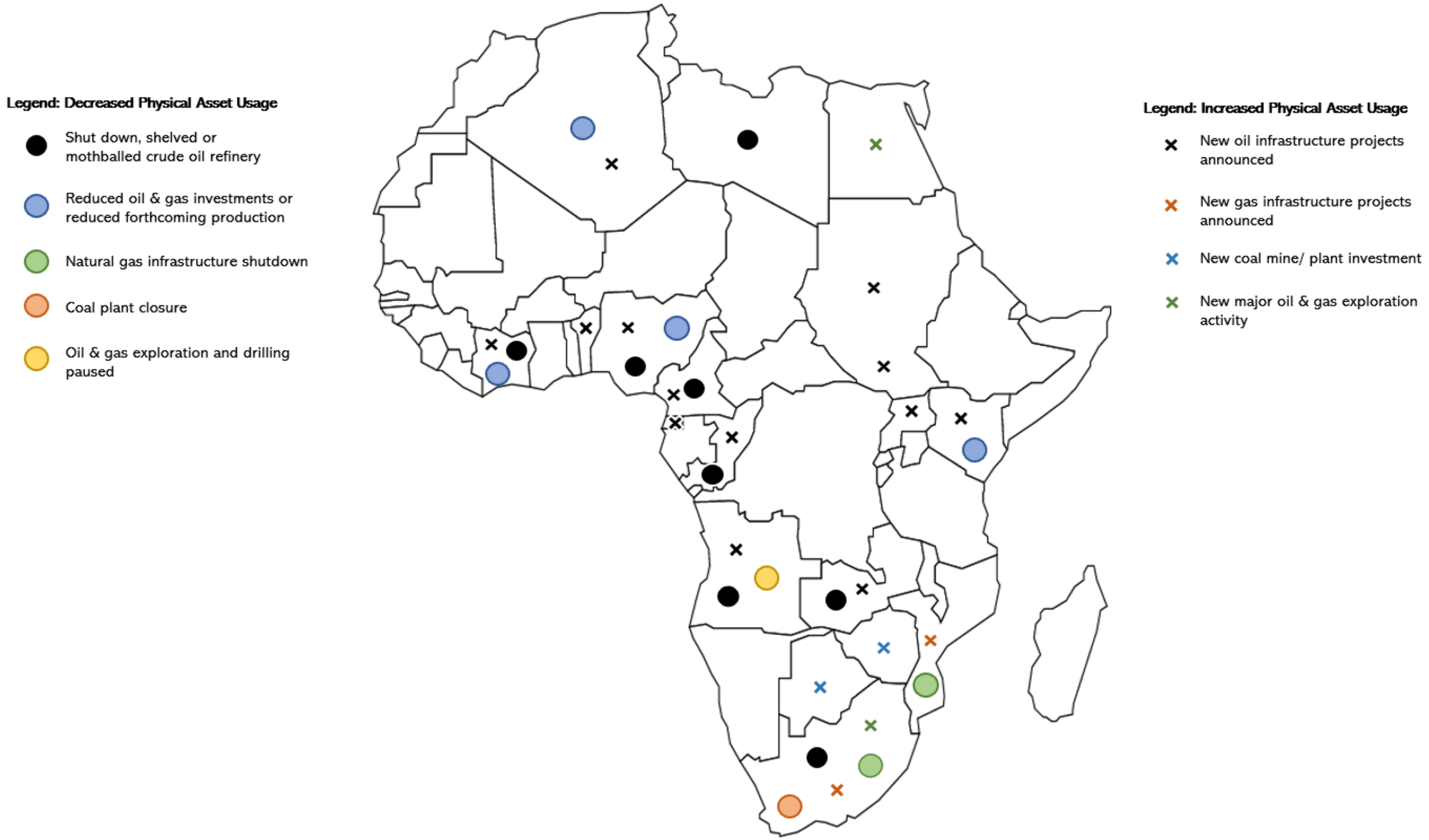
	Event	Frequency	Country
Decreased physical asset usage	Crude oil refineries shut down, shelved or mothballed (May 2021)	12	South Africa, Nigeria, Angola, Libya, Ghana, Congo, Cameroon, Zambia,
	Reduced oil & gas financing/ investments or forthcoming production	5	Algeria, Kenya, Ghana, Nigeria
	Natural gas infrastructure shutdown	2	Mozambique, Algeria
	Coal-fired power plant closures	1	South Africa
	Oil & gas exploration and drilling paused	1	Angola
Increased physical asset usage	New oil infrastructure projects announced (October 2021)	14	Nigeria, Algeria, Kenya, Ghana, Angola, Uganda, Sudan, Zambia, Guinea, Benin, South Sudan, Cameroon, Congo
	New gas infrastructure projects announced	3	Mozambique, South Africa
	New coal mine/ plant investments	2	Botswana, Zimbabwe
	New major oil and gas exploration activity	2	South Africa, Egypt

Source: Author

Throughout the continent, at least 12 instances of temporary or semi-permanent crude oil refinery shut-downs were denoted. For instance, all four of Nigeria's refineries were shut down in September 2020 due to a combination of both damaged feed-in pipelines and plummeting oil prices, though by January 2022 these refineries were back online; moreover, South Africa's Engen refinery was permanently shut-down in April 2021 due to its unprofitability, with plans disclosed to convert it into a storage facility (see Appendix C). Production at several other refineries were temporarily paused, including in Ghana, the Congo, Libya, Cameroon and Zambia.

Five instances of forecasted reductions in either oil & gas investments or production were also detected; for instance, Algeria's state-owned oil company (Sonatrach) announced plans to cut its spending by 50% in April 2020 (by $7 billion), and the Nigerian state-owned oil company (NNPC) expects 'unplanned crude production outages in 2022' and potentially beyond. Moreover, Total SA abandoned its exploration and drilling activities in Angola 'due to the coronavirus crisis', and Tullow Oil suspended its Kenyan oil-export program altogether in June 2020 due to forecasted unprofitability. In the case of coal, plans for a forthcoming coal-fired power plant in South Africa (Thabemetsi) were scrapped in November 2020, as Eskom was not able to secure financing for the project.

Figure 8.7. Geographical distribution of the key fossil fuel physical asset events from Table 8.3



Source: Author

Conversely, several instances of increased physical fossil fuel asset usage were also denoted. New oil & gas infrastructure projects in at least 14 African nations were announced by May 2021, including new crude oil refineries in Angola, Nigeria, Ghana, Sudan, Zambia, Uganda and the Congo, among others; moreover, Nigeria's NNPC approved a $1.5 billion investment to repair and upgrade an existing refinery in May 2021. New (potential, planned) gas infrastructural projects were also announced, including the Karpowership project in South Africa and Total SA's revived plans to finance as much as $15 billion in Mozambican gas. Finally, new coal-fired projects were announced in Botswana and Zimbabwe in November 2021 and May 2020, respectively, the former spearheaded by Indian firm Jindal and the latter by the Chinese government.

Note that the announcements pertaining to increased physical asset usage *generally* came deeper into the pandemic (in 2021 onwards), whereas the announcements indicating decreased usage generally came earlier (in the early months of the pandemic in 2020). Altogether, this suggests that that the pandemic had an immediate impact on catalysing the stranding process of several physical fossil fuel assets in Africa (as was the case with the financial assets, see 8.3.1), and as it progressed, the pandemic's catalytic stranding influence was partially undone as new prospective stranded assets were pursued.

8.3.3. Human: Employment

Fossil fuel human assets (in this case operationalised as employment) were also substantially influenced by the pandemic across Africa. The ILO estimates a "crisis-induced jobs gap of nearly 17 million [jobs]… for Africa in 2020", disaggregated into 4 million lost jobs and 13 million "forgone jobs that, in the absence of the pandemic, the region would have added". [155]

For the African mining and quarrying sector, this translates to a decrease of over 3% in employment from 2019 to 2020.[156] In South Africa's case more specifically, mining employment decreased from some 430,000 in 2019[157] to 345,000 by September 2021,[158] **denoting a 20% increase in mining unemployment in South Africa in merely 10 months**! (Note that this trend was largely evident across South Africa's entire economy, with overall employment dipping from 16.4 million to 14.3 million (13% drop) in the same timeframe.)[159] Furthermore, South Africa's economy also experienced an estimated increase in unemployment by some 409,000 jobs, of which 74,000 (18%) were in the mining sector.[160]

Table 8.4 unpacks these African fossil fuel unemployment trends at the company level, using publicly disclosed employment metrics from E&P annual reports (see 3.5.6). Rio Tinto and AngloAmerican jointly laid-off at least 962 employees across the African continent, while Glencore and Chevron laid-off an additional 3,321 employees worldwide; Shell allegedly experienced no change in its African staff from 2019-2020, and Sasol hired an additional 31 employees worldwide. Overall, these E&Ps were responsible for laying-off 4,252 people in the fossil fuel industry, of which at least 962 reside in Africa.

As a result, the pandemic also catalysed the stranding process for fossil-intensive human assets (i.e. employment) across Africa, though unlike the financial and physical asset dimensions (see 8.3.1 and 8.3.2), it is unclear whether these stranded human assets have to any extent recovered at the time of writing.

155 ILO (2020: 43)
156 ibid
157 RSA (2020)
158 RSA (2021)
159 ibid
160 RSA (2021: 4)

Table 8.4. Disclosed employment data by a small subset of the 29 E&Ps with African operations

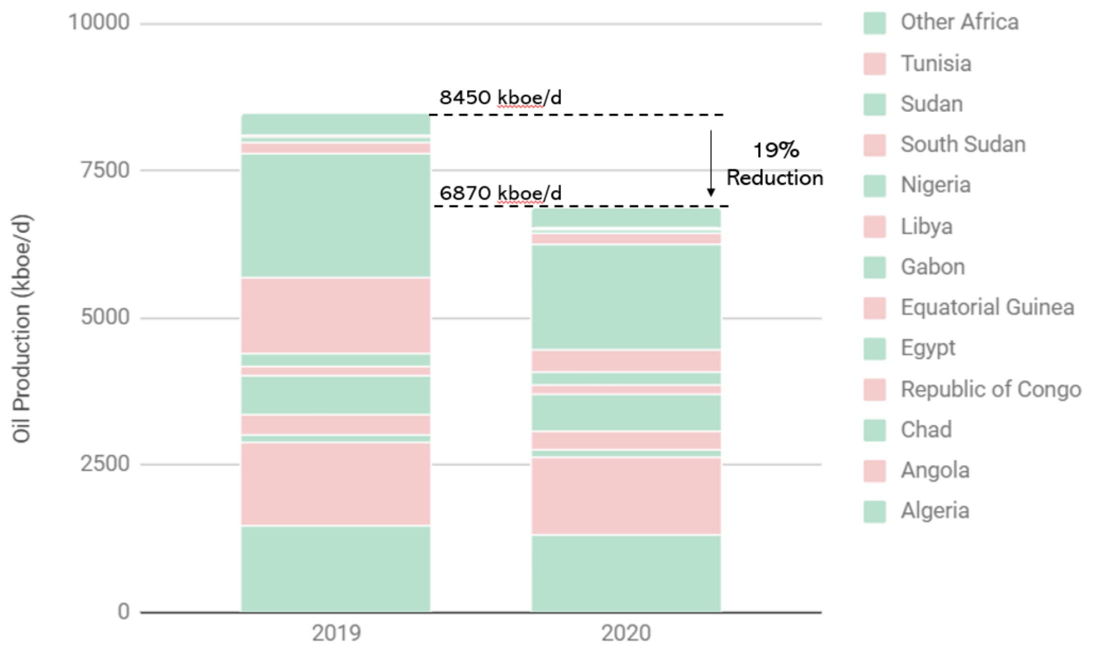
	Employees in Africa (unless otherwise specified)		
Company	2019	2020	Change
Rio Tinto	2,559	3,121	-562
AngloAmerican	4,600	5,000	-400
Glencore (global)	87,822	89,092	-1,270
Shell	4,000	4,000	~0
Sasol (only mining, global)	7,433	7,402	+31
Chevron (global)	42,628	44,679	-2,051
Sample Total	149,042	153,294	-4252

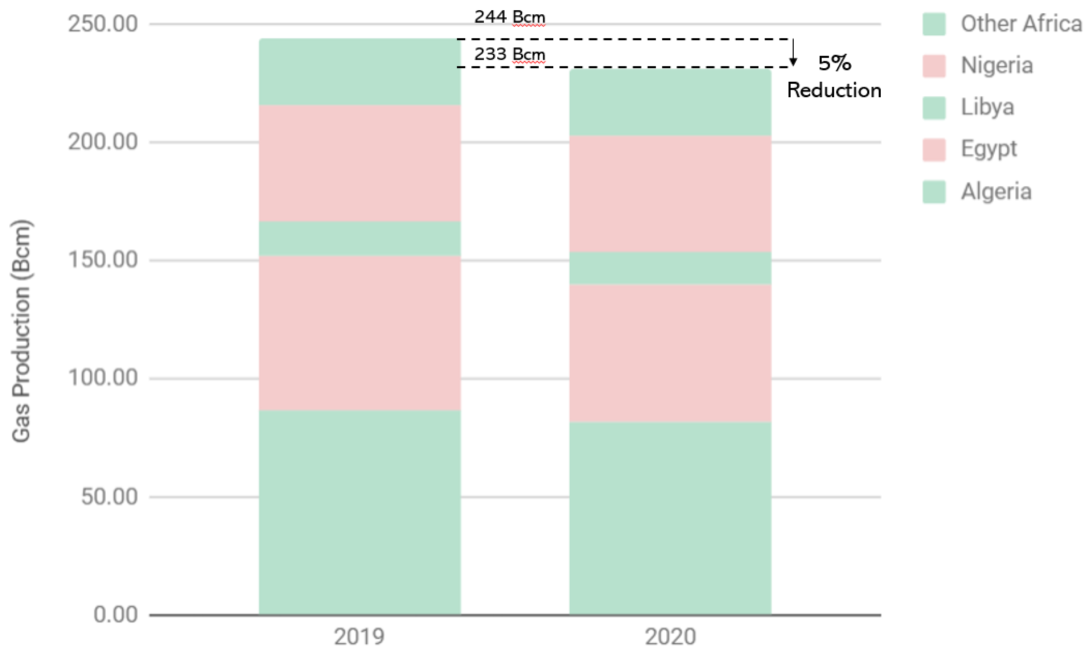
Source: Author

8.3.4. Natural

As was the case with global production (see 8.2.4), African coal, oil and gas production has also declined due to the pandemic – summarised in Figure 8.8. Net African oil production decreased by some 19% in 2020 (8450 kboe/d) compared to 2019 (6865 kboe/d), driven by declined production by key producers like Nigeria (2102 kboe/d to 1798, 15% drop), Algeria (1487 kboe/d to 1332, 10% drop) and Angola (1420 kboe/d to 1324, 7% drop). (Libyan oil production declined heavily by 70% from 2019 to 2020, but this may have been due to political instability over the last years.) Net African gas production more mildly but nevertheless declined by 5% from 2019 (244 Bcm) to 2020 (231 Bcm), mainly driven by declined production rates by the continent’s leading producers, like Egypt (65 Bcm to 59 Bcm, 10% decline) and Algeria (87 Bcm to 82 Bcm, 7% decline). Finally, net African coal production also declined by some 6% from 2019 (282 Mt) to 2020 (268 Mt), comprised of humble declined coal production in South Africa (258Mt to 248, 4% decline) and relatively major declined production in neighbouring countries like Botswana, Mozambique and Tanzania (jointly from 21Mt to 16, 26% decline). These various decreases in production can be understood as a greater magnitude of proven African fossil fuel reserves that have forgone production and thus remained underground, potentially taking the form of stranded natural assets in the forthcoming future. Once again assuming, for the sake of argument, that coal, oil and gas prices were held constant at $100/ton, $100/barrel and $0.0005/cf in 2020 (see 3.5.3), this **reduced production in Africa translates to circa $60 billion in forgone revenue streams**.

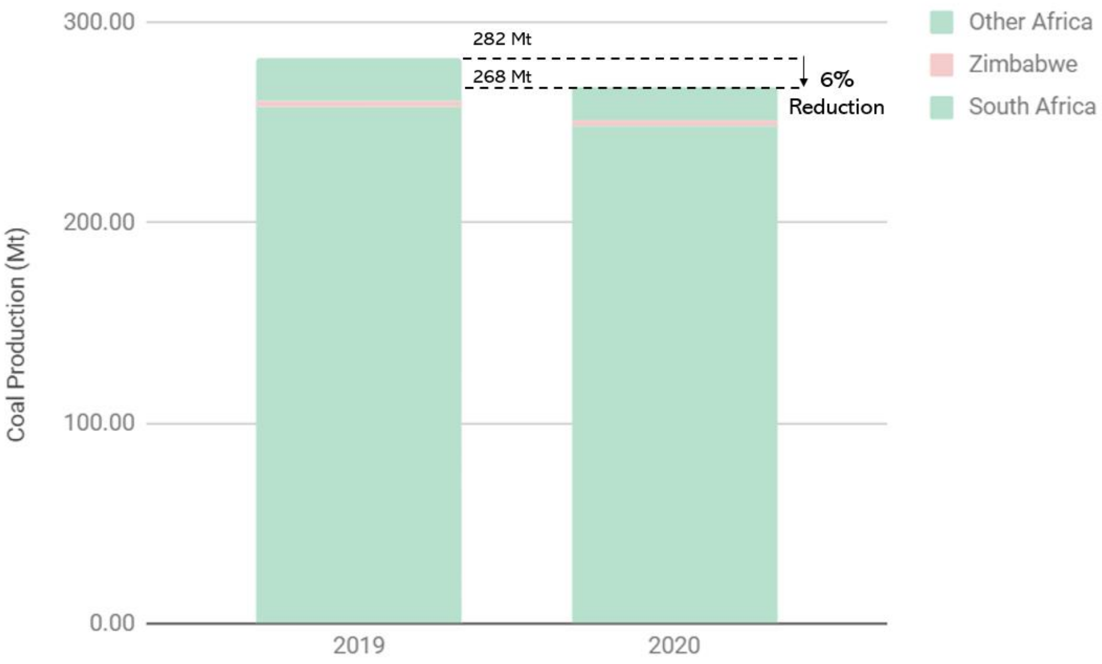
Figure 8.8. Depiction of the change in African oil (top), gas (middle) and coal (bottom) production from 2019 to 2020





Source: Author, using data from BP (2021)

Figure 8.8 continued



8.3.5. Avoided Stranded Assets?

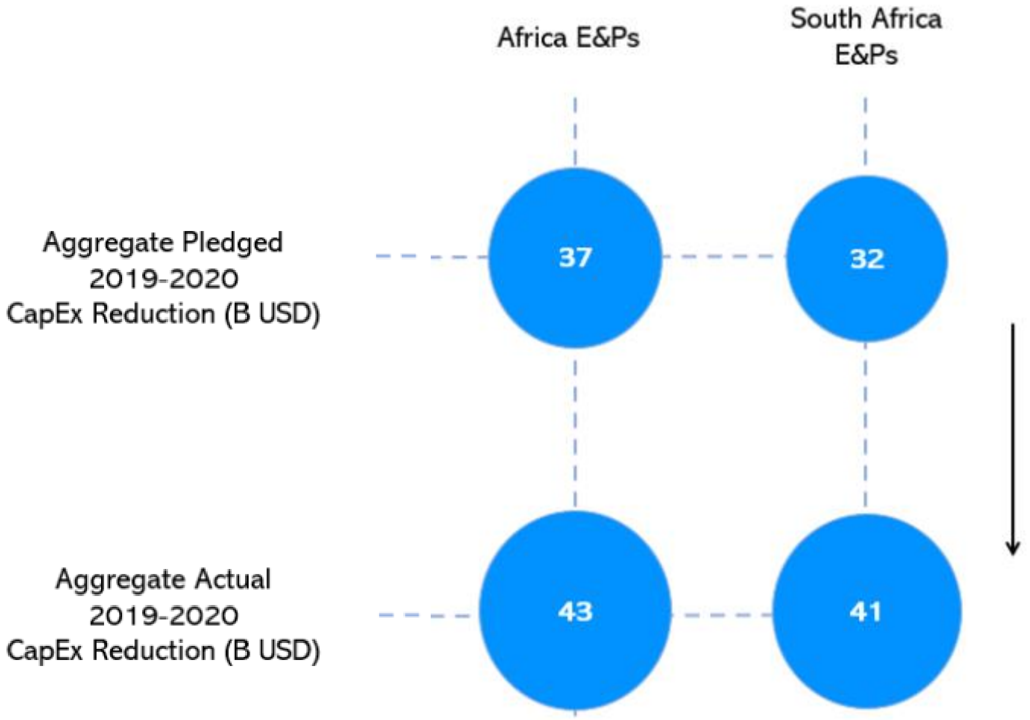
Finally, I evaluate the pledged *and* actual CapEx reductions between 2019 and 2020 by the sampled major E&Ps with prominent African operations, summarised in Figure 8.9 (see Appendix C). In the early stages of the pandemic, the E&Ps declared potential reductions to their CapEx of at least $37 billion,[161] with at least $32 billion pertaining to E&Ps with operations in South Africa. However, by the end of 2020, the aggregate *actual* CapEx reduction by the sampled E&Ps surpassed these pledges and reached some $43 billion, with some $41 billion linked to E&Ps with South African operations. This comprised both substantial spending cuts by the likes of Shell ($6 billion), Chevron ($7 billion) and Equinor ($5 billion) and milder spending cuts by E&Ps like Glencore ($1.3 billion), AngloAmerican ($200 million) and ExxonMobil ($200 million). In four cases, 2020 CapEx saw an increase from 2019 values, as in the case of BHP Billiton ($300 million increase), South32 ($40 million increase), Vale SA and Woodside Petroleum (both $70 million increase), though these were minor and rare in comparison to the much larger aforementioned reductions. These CapEx cuts can be understood as avoided forthcoming stranded physical, financial, human and social assets, as investments further intensifying fossil production and dependence were forgone.

Given the multinational nature of these E&Ps, not all of this $40+ billion CapEx reduction can be attributed to avoided *African* stranded assets per se, but certainly some evidence suggests that a (substantial) fraction of the slashed CapEx was in fact Africa-bound:

- Total SA's CapEx in Africa specifically decreased from $7.7B in 2019 to $3.8B in 2020. Moreover,[162] other than their major exploration discovery in South Africa (see 5.2.2.5), their main exploration activity (worth $1 billion) mainly took place in "Suriname, the United States,

[161] Four E&Ps announced forecasted CapEx reductions in early 2020 but did not specify an amount
[162] Total (2021: 332)

Figure 8.9. Visualisation of the pledged vs. actual CapEx reductions from 2019-2020 by the major E&Ps in Africa



Source: Author

the United Kingdom, Bolivia, Lebanon, Mexico, compared to $1.55 billion in 2019 and $1.2 billion in 2018";[163]

- Shell's joint revenue from its operations in Asia, Oceania and Africa decreased from $140B in 2019 to $65B in 2020; moreover, its subsidiaries' crude oil and natural gas production in Africa decreased from 64.4 Mboe in 2019 to 57.1 Mboe in 2020 (over 10% reduction);[164]
- Rio Tino "announced that as a result of separate actions by the Premier of Quebec and the President of South Africa to contain the spread of COVID-19, some of its operations would be slowed down."[165] Similarly, Glencore admitted that "impacts were most notable in Peru, South Africa and Colombia, while Australia and Canada were relatively unaffected", and its thermal coal revenue from South African operations subsequently declined by 25% ($1.3 billion to $970 million from 2019 to 2020);[166]
- AngloAmerican also admitted that "[o]perational disruptions as a result of the pandemic due to national lockdowns in South Africa and Botswana in the first half of the year, resulted in production levels decreasing to 60% of total capacity in April", leading to an underlying EBITDA loss of $15 million in 2020 compared to a loss of $5 million in 2019. [167]

Some evidence does, however, point to increased capital investments by the E&Ps in African operations in 2020:

[163] Total (2021: 66)
[164] Shell (2020: 17)
[165] Rio Tinto (2020: 186)
[166] Glencore (2020: 2)
[167] AngloAmerican (2020: 86)

- Total SA "finalized its acquisition of 100% of Tullow's interests in both the Lake Albert development project in Uganda and the East African Crude Oil Pipeline (EACOP) pipeline project during 2020, and also acquired interests in Blocks 20 and 21 in Angola";[168]
- Shell "acquire[d] seven exploration licences in four countries from Kosmos Energy", including in São Tomé and Príncipe, South Africa and Namibia;[169]
- And Rio Tinto invested $500M in CapEx in the "[d]evelopment of the Zulti South project at Richards Bay Minerals (RBM) in South Africa (Rio Tinto 74%), to sustain current capacity and extend mine life."[170]

We can therefore attribute a relevant though not all-encompassing fraction of the CapEx reductions to African fossil fuel operations, and therefore, the pandemic was successful in fettering the creation of new and forthcoming prospective fossil fuel stranded assets in Africa (and South Africa in particular) by forgoing investments in new fossil-intensive capital and infrastructure.

8.4. Discussion: COVID-19 and Stranded Asset Debts

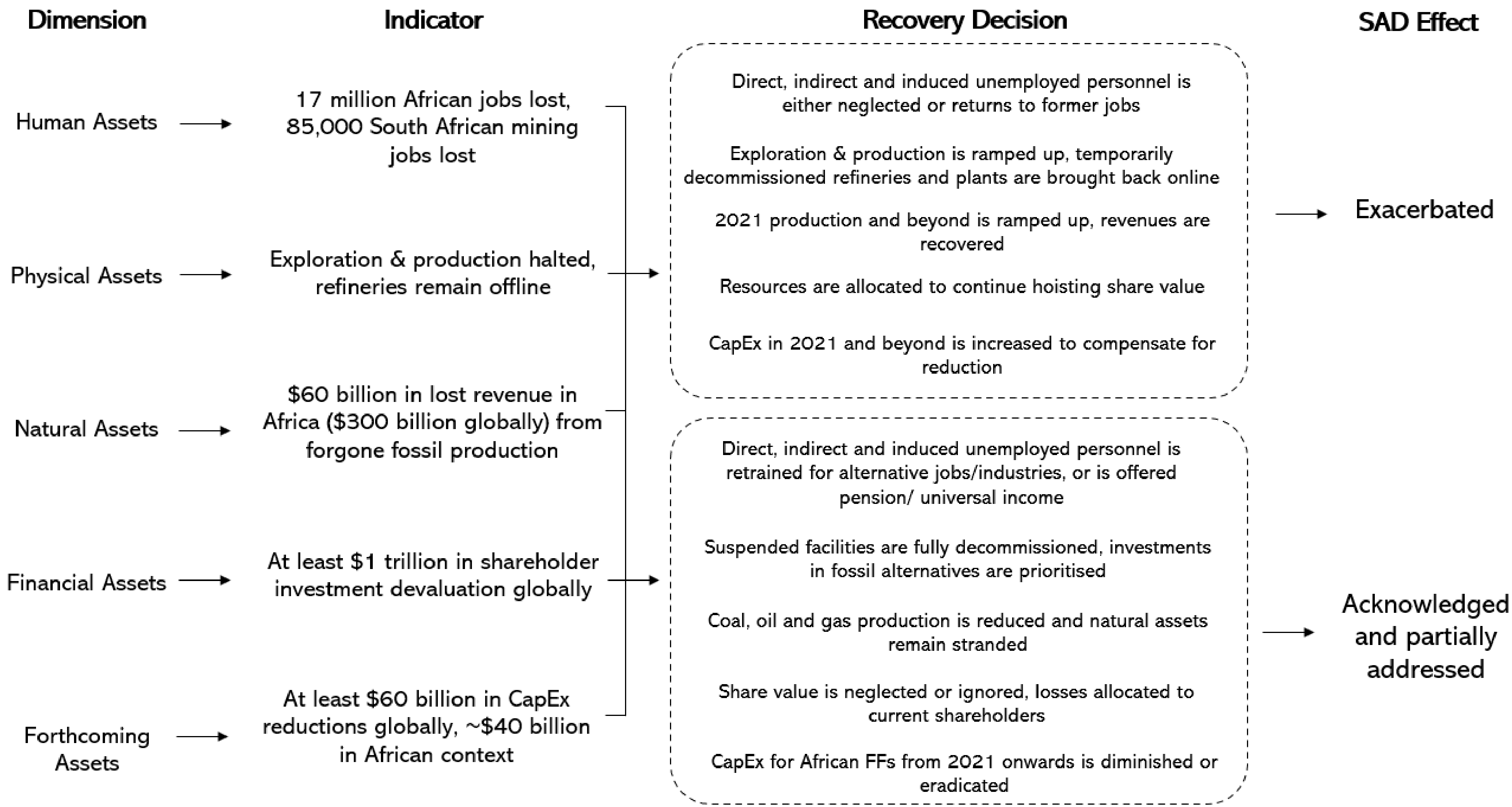
Stranded assets across all five dimensions are inevitable for any fossil fuel phaseout, and due to the gargantuan monetary and non-monetary risks that they pose to fossil-dependent societies, investors, financiers and governments, the 'stranding process' needs a catalyst to overcome the friction presented by these vested interest. As is evident, the COVID-19 pandemic has catalytically initiated this process by forcibly stranding global fossil assets spanning all five dimensions, despite clear pre-pandemic trends suggesting that no such stranding was expected;[171] this was evident both on a global level (see 8.2) and simultaneously both across Africa and specifically in South Africa (see 8.3), with fossil unemployment, reduced fossil production, reduced CapEx spending, fossil-intensive facility shutdowns, and financial asset devaluations evidenced in all cases.

There is no guarantee that any of the aforementioned assets above have been or will remain stranded; in fact, some share prices have already mostly recovered and mended the wounds of investor portfolios, some coal plants and oil refineries have been mothballed and subsequently reinstituted, and forthcoming CapEx spending may skyrocket given the slew of oil refineries forecasted to spur across the African continent from 2022 onwards. However, the very fact that some: financial assets have and remain devalued; physical assets, like refineries and power plants, have been and remain offline; millions of Africans have been and remain unemployed; tens of billions of dollars' worth of prospective stranded assets have been avoided due to forgone CapEx spending in 2020; and natural assets worth several hundred billion dollars have remained underground *presents an opportunity to shape recovery strategies in alignment with an inclusive governance of these prospective assets*. The COVID-19 pandemic has seemingly granted us a socio-ecological lifeline by *pushing against and decreasing the growing momentum of the fossil sector*.

Accordingly, the pandemic has presented an opportunity for the stranded asset debtors from the 'North' to partially settle (or exacerbate) the skyrocketing Stranded Asset Debt (SAD) that they arguably owe to South Africa and beyond (see 6.4). With millions of Africans still unemployed, several fossil-intensive facilities temporarily shelved and production paused, and tens of billions in forgone fossil-intensive CapEx, decisions can be made today to either effectively, permanently and inclusively stranded these multidimensional assets (thereby beginning to settle the multi-billion dollar SAD bill), or revert to the status-quo and reinvest in African fossil fuels (de facto adding to the SAD bill).

168 Total (2020: 19)
169 Shell (2020: 54)
170 Rio Tinto (2020: 39)
171 see e.g., SEI et al. (2019; 2020)

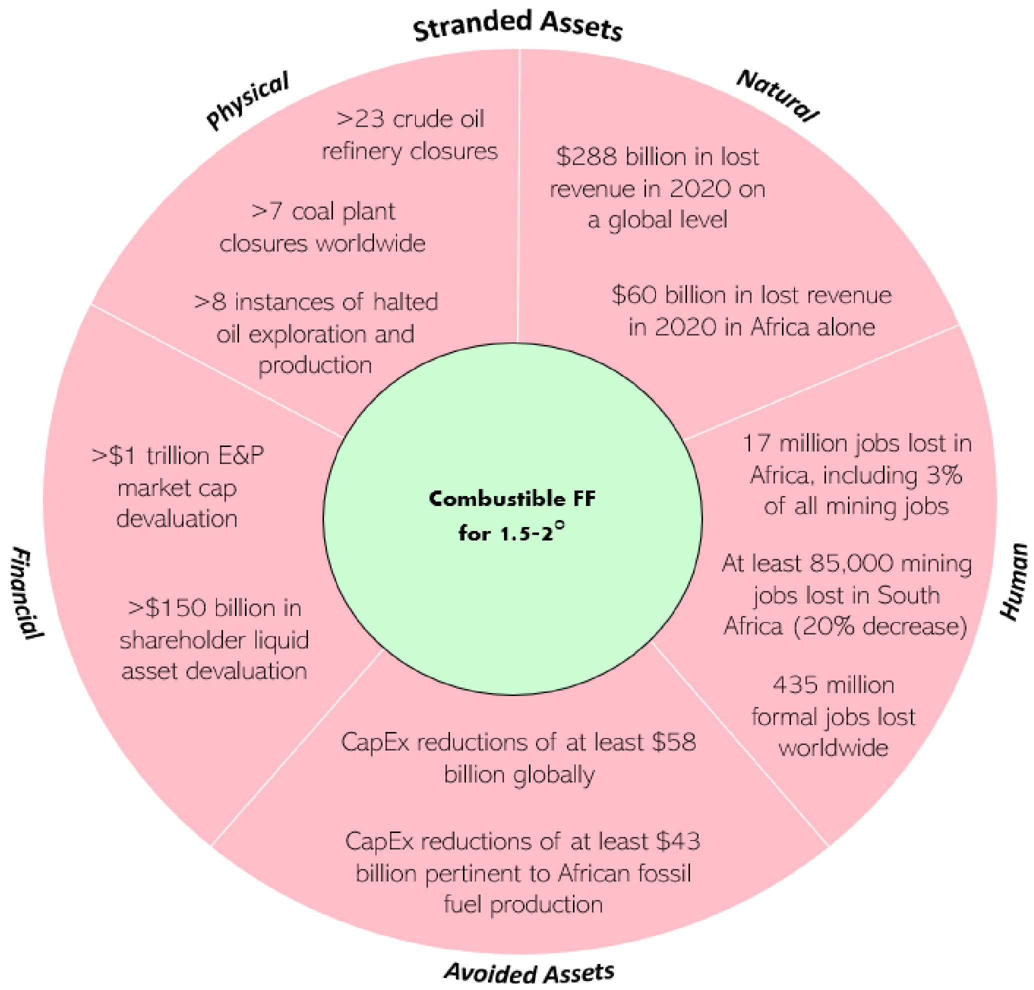
Figure 8.10. Flowchart of an illustrative example of key pandemic recovery decisions in relation to prospective stranded fossil assets



Source: Author

Several key considerations therefore arise for pandemic recovery scenarios that directly influence the SAD, summarised in Figure 8.10. Namely, will unemployed coal miners and refinery operators be herded back to their former jobs (SAD exacerbated), or will they be either retrained for alternative industries or offered a universal income or pension (SAD acknowledged)? Will suspended exploration facilities and temporarily shut-down refineries be brought back online (exacerbated), or will resources be allocated to fully decommission these fossil-intensive facilities (acknowledged)? Will decisions be made to ensure that shareholder investments (which have already seemingly recovered, see 8.2.1 & 8.3.1) are protected (exacerbated), or will such investments be ignored or sacrificed in pursuit of effective climate action (acknowledged)? Finally, will fossil production and forthcoming capital spending ramp up to compensate for 2020's dip (exacerbated), or will the pandemic pivot these trends downward from 2021 onwards (acknowledged)? These considerations are key to uncovering inclusive fossil fuel phaseout scenarios in the midst of the pandemic, which is the focus of the final chapter of this thesis (see 9).

Figure 8.11. Summary of the pandemic's influence on generating stranded assets both in Africa and worldwide



Source: Author

8.5. Conclusion: COVID-19 as an opportunity?

This chapter posed the question:

How has the COVID-19 pandemic impacted prospective stranded fossil fuel assets globally and in both Africa and South Africa more specifically, and how does this influence prospects of inclusively phasing out fossil fuels in South Africa and beyond?

And based on the analysis in sections 8.2-8.4, two conclusions are warranted:

Conclusion 1

COVID has catalysed the inevitable asset stranding process both globally and across the African continent, dealing **a monetary blow to the tune of at least $1 trillion** in fossil fuel E&P shareholder equity globally and some **$300 billion in forgone revenue streams**, and a **non-monetary blow stranding 17 million African jobs** (including at least 85,000 mining jobs in South Africa alone) and **shutting down dozens of refineries, coal plants and LNG terminals**, upending the livelihoods of millions of African households (see Figure 8.11). Altogether, the pandemic has materialised a fraction of the monetary and non-monetary risks that African citizens were deemed susceptible to (see 5.3.4).

Conclusion 2

The pandemic presents a unique opportunity to drive an inclusive fossil phase-out in South Africa and beyond by unprecedentedly 'pushing' against the growing fossil sector. However, this will only be possible with an accompanying 'pulling' force in the form of an inclusive LFFU approach mix that prioritises governing the outstanding and unsettled SAD.

9. Conclusion: Trade-offs, Post-Pandemic Scenarios, and Conditions for an Inclusive Fossil Phase-Out in South Africa[172]

9.1. Introduction

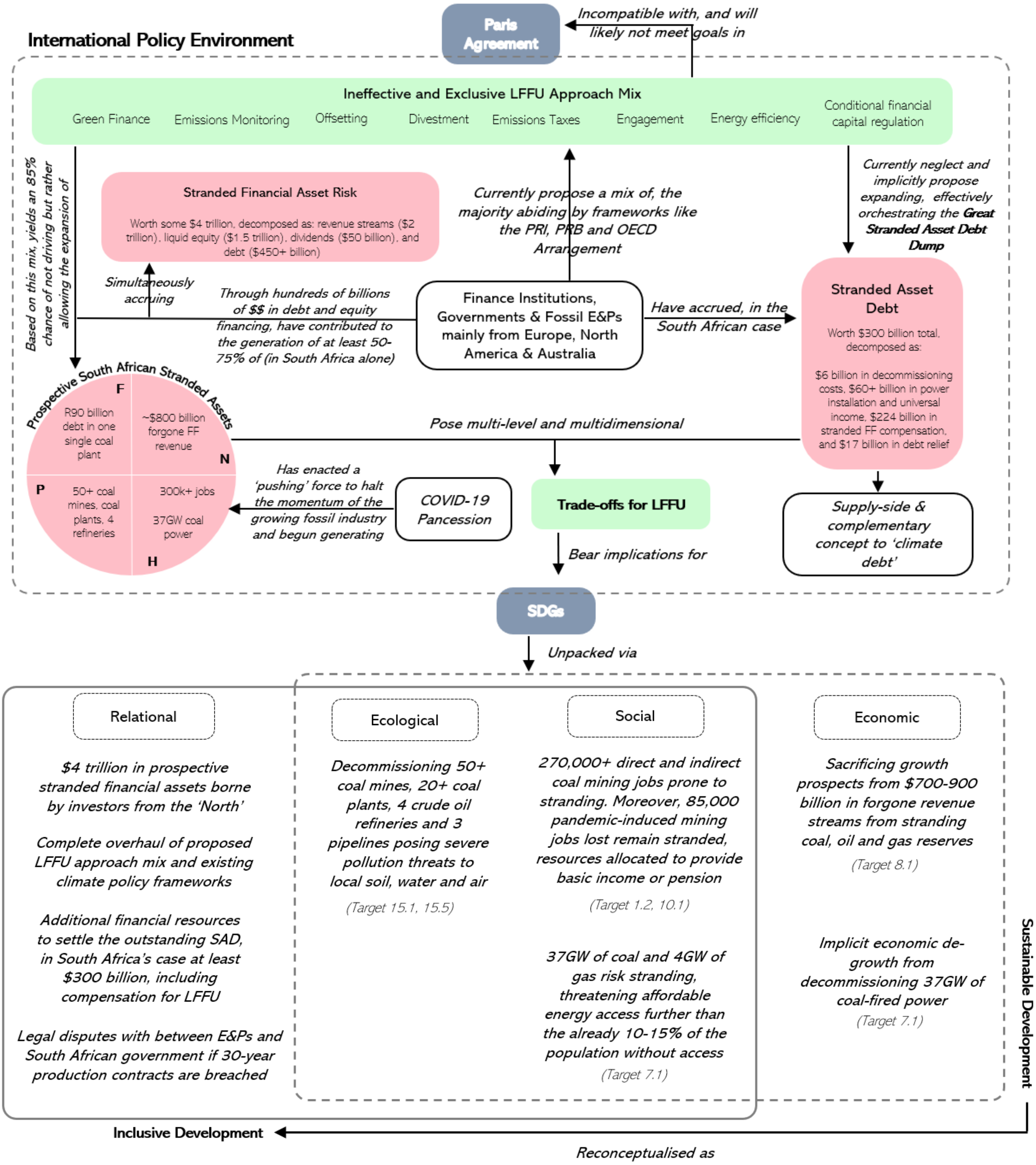
This thesis set out to understand the role that finance and economic institutions from the 'North' (knowledge gap K2) play in driving an inclusive fossil phaseout (knowledge gap K3) in South Africa (knowledge gap K1 and K4) (see 1.2.2) by merging inclusive development (see 2.2) and stranded asset (see 2.1) literature to develop a new supply-side concept – the Stranded Asset Debt (SAD) (see 2.2.1.4) – to complement the demand-side and well-research 'climate debt' (see 2.2.1.3); the SAD first and foremost contributes to plugging knowledge gap K2 given both its explicit focus on the North-South implications of a fossil phaseout, and its intimate relationship with Articles 2.1c, 4.5, and 9-11 of the Paris Agreement (see 1.4.1). Moreover, it subsequently addresses knowledge gaps K1 and K3, the former through the understanding that an *inclusive* fossil phaseout de facto entails 'settling' the SAD, and the latter by imparting an explicit focus on fossil fuel supply cuts (see e.g. Lazarus & van Asselt, 2018) for climate action rather than the procurement of fossil-alternative power. Finally, the SAD conceptual tool can plug knowledge gap K4 if it is applied to study regional or national level fossil fuel phaseouts from an inclusiveness and North-South perspective.

Seventeen key findings have arisen that address the multidimensional stranded asset implications of a prospective South African fossil fuel phaseout; Figure 9.1 applies and populates the conceptual scheme (see Figure 3.1) to compile the key findings from chapters 2-8, which I summarise below.

Finance institutions, E&Ps and governments predominantly from Europe, North America and Australia (i.e. the 'North') have funnelled hundreds of billions in debt and equity investments that have partially or substantially developed South Africa's fossil fuel sector (see 6.2.2 & 6.2.4), resulting in these 'Northern' actors controlling some 50-75% of South African coal, oil and gas production (see 6.2.1). In doing so, they have themselves incurred a stranded financial asset risk worth some $4 trillion in prospective forgone revenue streams, stranded liquid equity, dividends and debt (see 6.5), while simultaneously having driven and exacerbated South Africa's exposure to multidimensional stranded assets, including 300,000+ prospective stranded mining jobs, 37GW of prospective stranded energy, and hundreds of billions in prospective stranded debt (see 5.5). Complementarily to the climate debt, we can conceptualise this exacerbation of stranded asset risk as the 'North' having accumulated a Stranded Asset Debt (SAD) with respect to their South African fossil investments, which, after a first-pass estimation, may be to the tune of at least $300 billion (see 6.4) – a bill that the 'North' owes South Africans in an inclusive transition away from fossil dependence; although this amount may seem excessive, it is worth reiterating that the: gross sales revenue generated by one single E&P (Shell) in 2019 could singlehandedly finance this with $60 billion to spare; aggregate sales revenue generated by the 29 E&Ps from 2016-2020 ($9.9 trillion) could finance this 341 times over; and the assets under management pertaining to BlackRock and Vanguard alone are equivalent to 314,000% of this sum.

[172] Some elements of this chapter were written in tandem with and are based on the following publications:
Rempel A., Gupta, J. (2021). Fossil fuels, stranded assets and COVID-19: Imagining an inclusive and transformative recovery. *World Development, 146.* doi: 10.1016/j.worlddev.2021.105608
Rempel, A. (submitted 2022). Provocative alternatives to climate terminology. *Energy Research and Social Science*.

Figure 9.1. Applying the conceptual scheme from Figure 3.1 to stitch together the key findings from chapters 2-8



Source: Author

However, an analysis of the climate policies pertaining to these indebted actors (who largely abide by international policy frameworks like the UNEP FI's PRI and PRB, or the OECD's 'Arrangement') reveals that their proposed LFFU approaches prioritise ineffective and generally ecologically, socially and relationally exclusive approaches, relying mostly on 'green finance' and 'emissions monitoring' (among others) to ostensibly align their investments with the Paris Agreement (see 7.3). Additionally, they also neglect to either implicitly or explicitly acknowledge the SAD that they have de facto accrued, and explicitly disclose plans of expanding their fossil operations in the coming decade (see 7.4). This altogether indicates that, rather than an inclusive fossil fuel phaseout, these actors are likely orchestrating a 'Great Stranded Asset Debt Dump' (GSADD), in which South Africa's society continues to expand its stranded asset exposure while the 'North' attempts to absolve its responsibility to settle the SAD bill and allocate the burden onto South African shoulders (see 7.6). The COVID-19 pandemic has marginally halted the SAD from ballooning and effectively stunned both the growing South African and global fossil empire (see 0), but without overhauling the policy mix, South Africa seems most likely to experience an 'Exclusive Energy Addition' (EEA) (in which fossil-alternative power is procured while fossil production continues to expand) rather than any semblance of an inclusive fossil ***phaseout***.

This altogether yields a series of trade-offs for LFFU that may influence post-pandemic fossil phaseout scenarios, which are yet to be explored. Hence, this concluding chapter addresses the overarching question:

What do the key trade-offs from Leaving Fossil Fuels Underground (LFFU) imply for an inclusive fossil phaseout in South Africa (paying special attention to the risks posed by prospective multidimensional stranded assets), how do these trade-offs influence and subsequently sculpt post-pandemic fossil fuel phase-out scenarios, and under what conditions will an inclusive, post-pandemic fossil fuel phase-out unfold in South Africa?

The chapter first identifies the key trade-offs with LFFU in South Africa and speaks to the implications of these multi-level trade-offs for an inclusive fossil fuel phase-out in South Africa (see 9.2); it then develops four post-pandemic LFFU scenarios (of which only one is inclusive on all accounts), using the inclusive development framework as a skeletal basis (see 9.3), and subsequently identifies the conditions necessary for the inclusive phase-out scenario to materialise (see 9.4). To conclude, the chapter includes opportunities for future research (see 9.5) and both a theoretical (see 9.6.1) and conceptual reflection (see 9.6.2).

9.2. Trade-Offs

The bottom section of Figure 9.1 presents the nine key trade-offs have arisen from a prospective fossil phaseout in South Africa, which are clustered in relational (see 9.2.1), ecological (see 9.2.2), social (see 9.2.3) and economic (see 9.2.4) dimensions.

9.2.1. Relational Trade-Offs (RTO)

Four unique relational inclusiveness trade-offs arise from LFFU in South Africa:

RTO1: Stranded Asset Bill

An effective fossil phaseout in South Africa may translate into costs for South Africa's citizens to the tune of several hundreds of billions of dollars – the 'Stranded Asset Bill'. This includes: circa $1 trillion in forgone revenue streams from not commercialising South Africa's proven coal, oil and gas reserves (see 5.2.1.3) – and as much as $6 trillion across the continent (see 5.3.2.1); several tens of billions in outstanding debt from key fossil projects, like Medupi & Kusile; roughly $60 billion to replace the 41GW of installed fossil power capacity on the grid with fossil-alternatives; $6-20 billion to decommission the existing coal power station fleet and the nation's operational coal mines, with additional costs for other fossil infrastructure like its various crude oil refineries and pipelines; and roughly $2 billion in annual payments to support coal mining households via either a universal income or pension (see 6.4.6). Although the exact value of this 'bill' is uncertain (these were merely estimates), what is more certain is that someone must 'foot this bill' eventually in the event of an effective and inclusive fossil phaseout in South Africa.

RTO2: Stranded Financial Asset Risk
Moreover, investors and financers globally (though predominantly from Europe, North America and Australia (i.e. the 'North') – and to a slightly lesser degree China) have themselves accrued a potential stranded financial asset risk worth some $4 trillion. Leaving South African fossil fuels underground risks devaluing and 'stranding' fractions of these financial assets, effectively 'destroying shareholder value' (see 7.3.5).

RTO3: LFFU Approach Mix and Policy Framework Overhaul
LFFU in South Africa implies a complete overhaul of the climate agendas and LFFU approach mixes currently proposed and adopted by key financiers, investors and governments (see 7.3.6) who have accumulated a South African Stranded Asset Debt (see 6.4), since these actors own, govern and operate the majority of South African coal, oil and gas producing infrastructure. The approach mix they propose (see 7.3.2) is not only ineffective (as they, like the scholarship [see 4.2], impart a dual focus on 'emissions' and 'fossil-alternatives', deflecting attention away from effective fossil fuel supply cuts) but is also exclusive in that it, among other reasons, 'dumps' the 'stranded asset bill' to other balance sheets. Moreover, since many of these actors are signatories to, have ratified, or abide by several key international policy frameworks, like the PRI, PRB and OECD Arrangement (see 7.2.4), this subsequently suggests that an effective fossil phaseout in South Africa is only possible by drastically revamping these existing policy frameworks into more inclusive renditions, perhaps in the form of the PIIB (see 7.5.3).

RTO4: Legal Disputes
Finally, a series of legal disputes between the DMRE (or the South African state more broadly) and multinational fossil fuel producers and their financiers may arise, since these producers have been granted 30-year mining and production rights (see 1.3.2.1), learning from lessons by the German utility RWE suing the Dutch government from announcing a coal phase-out from its grid (see 4.3.2.5).

9.2.2. Ecological Trade-Offs (ETO)

One key ecological trade-off may arise from a South African fossil phaseout:

ETO1: Stranded Physical Asset Local Pollution
The only central concern with LFFU in South Africa is that its substantial fossil infrastructure (i.e. coal mines, coal-fired power stations, crude oil refineries, and offshore oil & gas exploration and production machinery – see 5.2.2.2-5.2.2.5) is adequately and fully decommissioned (and not abandoned altogether) so as not to pose any local soil, water and air pollution threats. This fossil-infrastructure has already yielded a series of well-documented local air, soil and water pollution violations (see e.g., GroundWork, 2001; SwedWatch, 2020), and given the exorbitant costs associated with decommissioning some of these facilities (to the tune of several billions of dollars, see 6.4.3), it remains a concern whether an adequate decommissioning will arise, the absence of which would hamper progress towards SDG targets 15.1 and 15.5.

9.2.3. Social Trade-Offs (STO)

Two key social inclusiveness trade-offs persist:

STO1: Stranded Labour
Hundreds of thousands of coal mining jobs will be lost, jeopardizing the livelihoods of millions of South Africans living in and reliant on the fossil production in the coal-dense regions of Mpumalanga and Limpopo (see 5.2.3.3), among other parts of the country, and posing direct threats towards reaching several SDGs, including targets 1.2 and 10.1. The COVID-19 pandemic has already temporarily stranded some 85,000 South African mining jobs (see 0); an effective and inclusive fossil phaseout implies accepting this stranded labour and allocating ample resources to retrain stranded miners and provide a universal income (or pension) to their communities and families.

STO2: Stranded Energy
Exacerbated energy poverty poses an existential threat to the millions of South Africans who currently depend on coal for electricity or coal/oil/gas as transport fuel, in addition to the millions of South Africans who *already* cannot afford or gain access to reliable electricity (see 5.2.3.1). Energy poverty in South Africa (which is already profuse given the 15-30% of the population without reliable and affordable access to electricity) may be exacerbated given the 37GW of existing coal-fired installed capacity, the bulk (or entirety) of which needs to be decommissioned in an inclusive fossil phase-out (see 5.2.2.6). This may translate to a potential degression in SDG target 7.1.

9.2.4. Economic Trade-Offs (EcTO)
Finally, two economic trade-offs are evident, which are in essence a reinterpretation of other social and relational trade-offs through a sustainable development lens:

EcTO1: Sacrificed Revenue and Economic Growth
Mimicking RTO1 and RTO2 (see 9.2.1), a South African fossil phaseout implies stranding circa $1 trillion in prospective revenue streams and potentially destroying shareholder value by stranding e.g., liquid equity and multi-billion dollar revenue and dividend streams. Loosely, this could be understood as scarified and forgone economic growth and progress (see e.g., Meyer & Roser, 2010: 232; Warlenius, 2017; Bond, 2018; Bond, 2010; Arsel, Hogenboom & Pellegrini, 2017), yielding potentially degressions towards meeting SDG target 8.1.

EcTO2: Electrical Grid Capping and Implicit De-Growth
Moreover, building on STO2 (see 9.2.3), LFFU in South Africa implies decommissioning most or all of the existing 37GW of coal-based and 4GW of gas- and diesel-based installed power capacity from the grid (see 1.3.2.1), which may not only hamper affordable and reliable access to energy (SDG target 7.1), but also implies that some fossil- and energy-intensive businesses must halt or reduce their activities, like those of the Energy Intensive Users Group (see 5.2.3.2), prospectively further hampering economic progress prospects (SDG target 8.1) in addition to a degression towards SDG target 7.1.

9.2.5. Multi-Level Implications
The various and multi-dimensional trade-offs identified in 9.2.1-9.2.4 bear differing implications for different stakeholder groups. From a relational perspective, the bulk of the monetary costs associated with the ‘stranded asset bill’ predominantly rest on the shoulders of finance institutions and E&Ps from ‘the North’, implying that a South African fossil phaseout may directly and indirectly cost these players hundreds of billions – if not trillions – of dollars. Meanwhile, the bulk of the social and ecological trade-offs bear implications at the local-level and directly threaten the livelihoods and wellbeing of fossil-dependents in South Africa, particularly the most under-privileged and under-resourced South Africans. That is, it is the households that depend on e.g., coal mining and coal-fired electricity who may experience the ramifications from decommissioning the nation’s coal-intensive infrastructure, particularly if they are not compensated for forgoing their right to develop and commercialise their fossil reserves. Here, unlike the relational and economic dimensions, it is the

stranded human, physical and natural assets that bear the most drastic implications for an inclusive fossil phaseout, rather than the financial assets.

Accordingly, decisions made at the international-level (by e.g., major shareholders, commercial banks, PFIs) regarding LFFU may be predominantly influenced by prospects of the trillions of stranded financial assets that they risk incurring, potentially disregarding the trade-offs that their decisions may spur on social, natural and physical stranded assets absorbed at the local-level. As a result, forthcoming LFFU approach mixes for an *inclusive* South African fossil fuel phase-out must carefully account for both forces of this dialectic (see 9.3.5), otherwise perpetual fossil production seems all the more likely.

This surfaces the first key conclusion of this dissertation:

Overarching Conclusion 1:
Given the dialectical nature of the relational, social, ecological and economic trade-offs from LFFU in South Africa, **an *inclusive* fossil fuel phase-out in South Africa is only possible through simultaneously top-down and bottom-up LFFU approaches, the former accounting for and governing relational implications of the several trillions of dollars' worth of stranded revenue streams, debt and equity inherent to such a phaseout, and the latter allocating resources to govern the hundreds of thousands of stranded labourers, their stranded communities, and the stranded fossil-based energy inevitable in such a phase-out.** Moving forward, this duality will be central to crafting an LFFU approach mix that maximises the likelihood of a post-pandemic inclusive fossil fuel phase-out. Note that this broad conclusion most closely begins to plug knowledge gaps K1, K2 and K3.

9.3. Post-Pandemic LFFU Scenarios

9.3.1. Intro

This section speculates over the composition of different post-pandemic South African LFFU scenarios (driven by the operationalised inclusive development framework, see Table 2.4), integrating the nine LFFU trade-offs with the key findings pertaining to South Africa's prospective stranded asset exposure (see 5.5), the 'North's' SAD (see 6.5) and the LFFU approach mix framework (see 4.4 & 7.3.2). Four post-pandemic fossil fuel phase-out scenarios are unpacked, pivoting from a reformist tendency towards a transformative alternative: 1) Exclusive & Reformist Recovery (ERR); 2) Social Recovery (SR); 3) Ecological Recovery (ER); and 4) an Inclusive & Transformative Recovery (ITR) (see Figure 9.2), all of which embody varying degrees of social, ecological and relational inclusiveness and bear implications for inclusively combatting the 'climate emergency'. Although these scenarios are extremes, and 'in reality' several elements from multiple scenarios may manifest, they are nevertheless presented in sections 9.3.2-9.3.5 as if they were mutually exclusive for the sake of argument and concision. Of the four scenarios, the ITR is unpacked in the most detail given that it is the driving motivation behind this research (knowledge gap K1, see 1.2.2).

9.3.2. Exclusive & Reformist Recovery (ERR)

The ERR scenario (top-left quadrant of Figure 9.2) runs parallel to reformist pandemic recoveries that prioritise the return to 'normal', driven and measured by neoclassical economic indicators like GDP growth. Here, the South African government and beyond props-up existing (fossil fuel-dependent) infrastructure, businesses and markets for short-term economic growth, prioritising the retrenchment of the some 85,000 miners unemployed due to the pandemic (see 0). Ecologically (and socially & relationally) exclusive LFFU approaches (if any) are adopted, potentially according to the devised mix in Figure 9.3; this could include domestic emissions taxes, intensified divestment campaigns, and inadequate climate-related disclosures. Key major shareholders like Blackrock, Vanguard and Capital

Research & Management (among many others) discretely (or publicly) divest part or the bulk of the $595 billion in 2021 liquid equity managed in South Africa-operational E&Ps (see 6.2.2) as pressure mounts to 'green' their balance sheets in a misguided alignment with the Paris Agreement (see 1.4.1). Similarly, key South Africa-operational E&Ps like Glencore, Shell and BP follow in South32's footsteps and divest their stake in physical fossil assets, like Glencore's Goedgevonden mine (see 5.2.2.2) and Shell & BP's monumental SAPREF refinery (see 5.2.2.4), in a bid to rid themselves of their most polluting assets and subsequently comply with forthcoming court mandates (for instance, like Shell's recent court ruling mandating that they slash the emissions intensiveness of their portfolio – see 4.3.3.5). In fact, in February 2022, Shell and BP announced that they are considering to sell (read: divest) the SAPREF refinery (potentially to the South African government) (Reed, 2022).

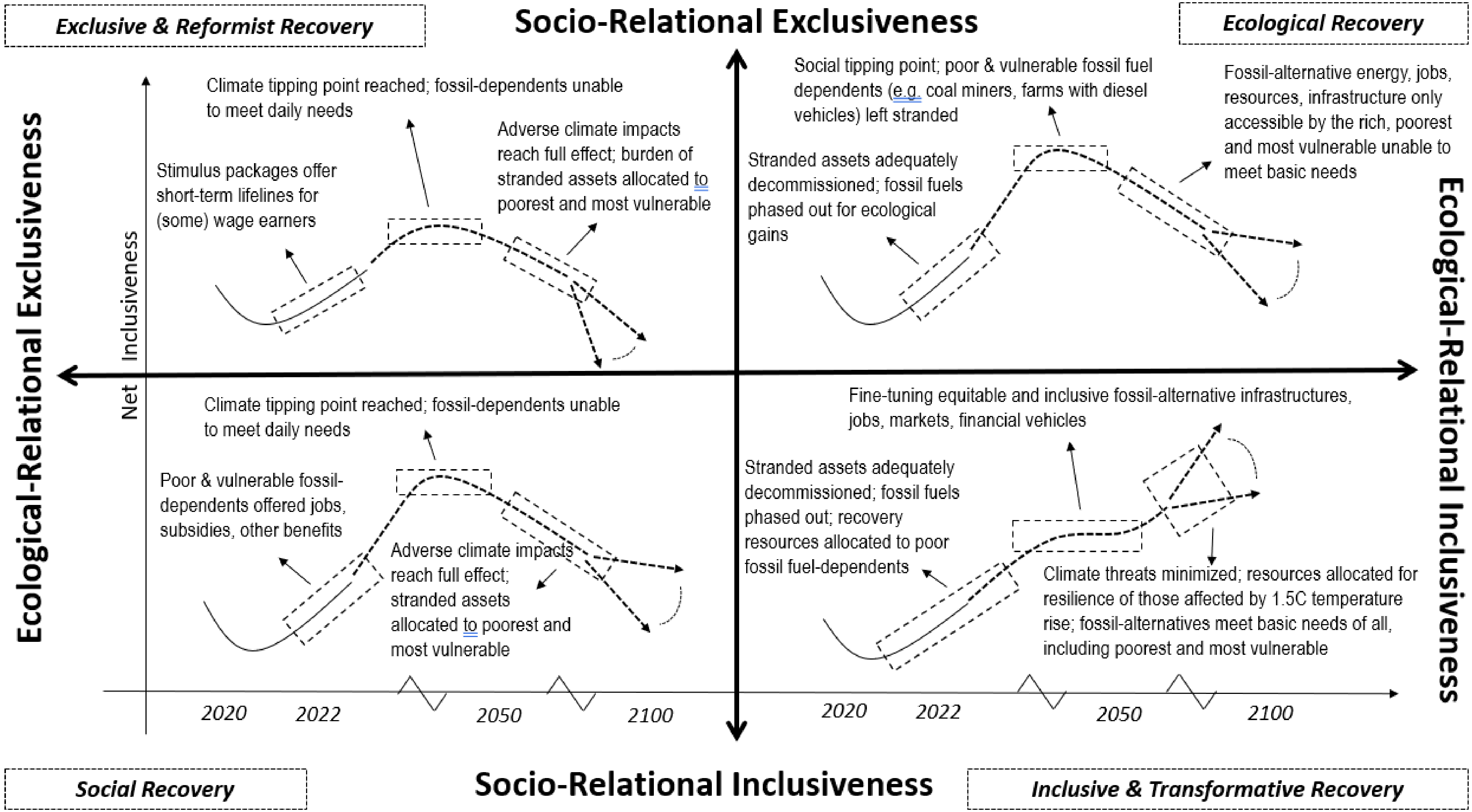
This altogether sustains coal production at circa 250Mtpa and introduces new oil and gas production from the Block 11B/12B discoveries (see 5.2.1.2), and as a result, ***inclusiveness condition E1 is immediately violated***, rendering the recovery exclusive on all ecological accounts (see Table 9.1) as it supports the survival and/or growth of the fossil fuel sector and inherently threatens the stability of the global climate system with impacts on humans and nature at glocal (global + local) levels. Furthermore, the wellbeing and livelihoods of vulnerable fossil-dependent South Africans are side-lined given the socially exclusive nature of the LFFU approaches, and thus they are by and large excluded from the recovery process. ***Condition S1 is also not met***, and since all other conditions rely on fossil fuels being phased out, ***no conditions are met in this scenario*** and it is exclusive on all accounts (see Table 9.1).

Table 9.1. Inclusive development implications of the ERR Scenario

Dimension	Implications for ID via Stranded Assets
Ecological	E1. Investments in coal and particularly oil & gas run rampant in the ERR; condition violated E2. The bulk of physical assets remain online; some of Eskom's oldest power stations are decommissioned (in line with the IRP trajectory), and this occurs carelessly and incompletely; condition violated E3. New solar PV (7GW), wind (16GW), and hydro (2.5GW) power capacity is procured (in line with the IRP) through the REI4P, bypassing stringent EIAs; condition violated
Social	S1. Coal mining jobs still remain in the order of hundreds of thousands, which are by definition unsafe, low-paying and undesirable; condition violated S2. Investments in alternatives are minor compared to their fossil counterparts, and those that do ensue pose social risks through e.g., land grabbing for solar farms. Moreover, these investments do not suffice to grant energy access to the 15-30% of South Africans who currently reside without; condition violated
Relational	R1. Eskom (and de facto the South African taxpayer) is allocated the costs to decommission a select few of power plants (rather than the gargantuan multinationals like Glencore, BHP Billiton/ South32, AngloAmerican) that have been mining coal for their facilities for decades; condition violated R2. Given that fossil fuel production remains amass, no compensation is granted; condition violated

Source: Author

Figure 9.2. Depiction of the four post-pandemic fossil fuel phaseout scenarios, conceptualised through an inclusive development and stranded asset lens



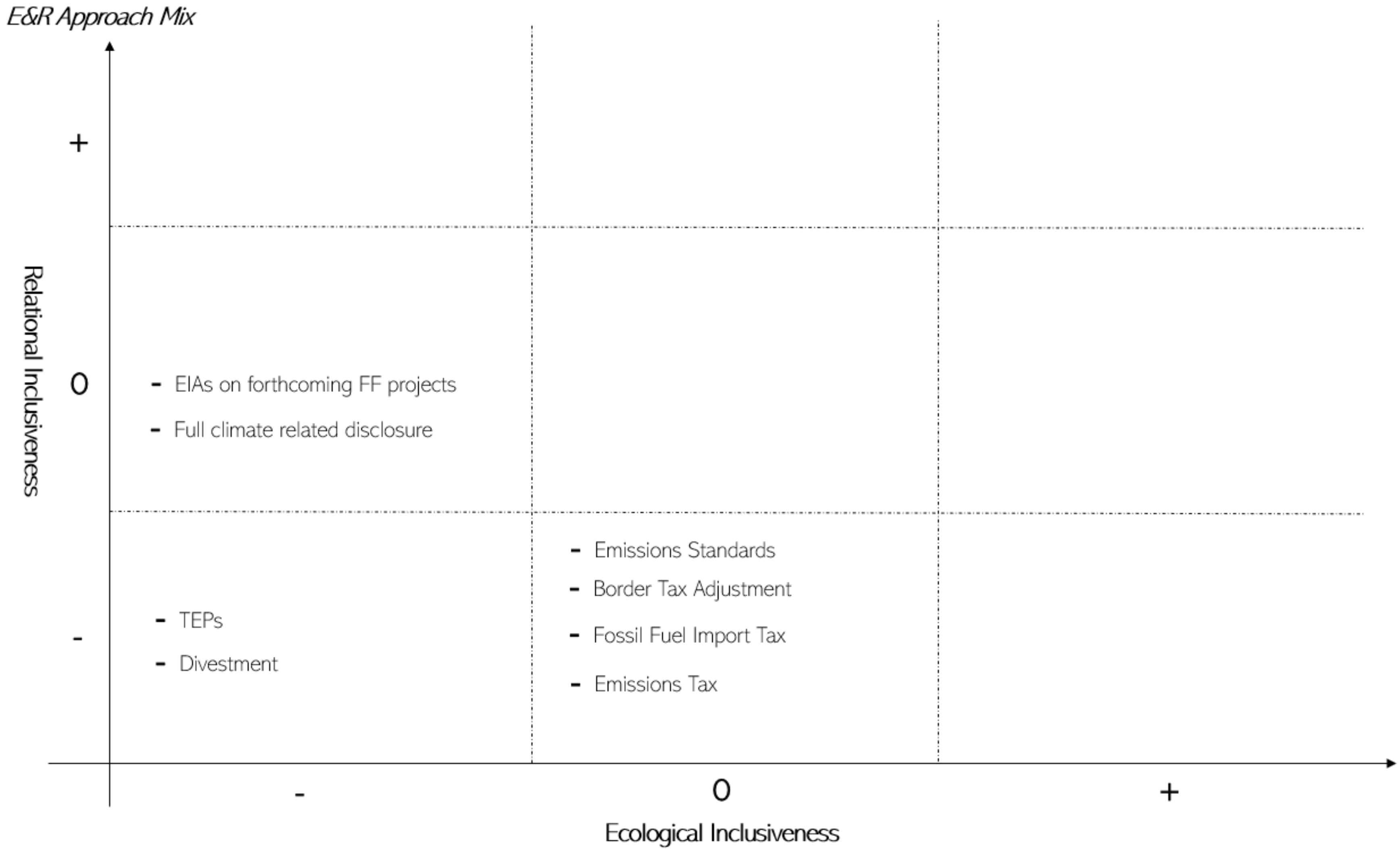
Source: Author

Efforts in the ERR scenario are predominantly geared towards rescuing 'the economy' and its accompanying financial assets (e.g., shareholder portfolios, see 8.2.1 & 8.3.1); accordingly, forecasted investments in forthcoming fossil fuel projects are realised (see 7.4.3), and as a result new pipelines, refineries, power plants arise that require new personnel (human assets), deepening dependencies on archaic and decrepit fossil-technologies. Moreover, Operational Expenditure (OpEx) spending is funnelled to keep Medupi & Kusile online (see 5.2.2.2), an additional 7.2GW and 3GW of new coal and gas & diesel, respectively, are added to South Africa's grid by 2030 (as pledged in the IRP – see 1.3.2.1), and oil & gas extraction from the Brulpadda & Luiperd discoveries (see 5.2.2.5) is ramped up. (This latter point generates minor 5% royalties for South Africa's PetroSA according to typical production contracts (see 1.3.2.1), indicating that the lion's share of the oil & gas resource value is exported beyond South African borders, exacerbating the *ecological debt* owed by the 'North' to South Africans, see 2.2.1.3). Altogether, *in the ER scenario, the stranded asset exposure and risk borne by South Africans is exacerbated (see 5.3.4), while the Stranded Asset Debt (SAD) owed by the 'North' balloons* (see 6.4). Meanwhile, the indebted actors mainly from the 'North' orchestrate the already-in-motion Great Stranded Asset Debt Dump (GSADD) (see 7.3.6).

Investments in existing and new fossil fuel assets will increase the likelihood of the Intergovernmental Panel on Climate Change's (IPCC, 2014) most dire RCP 8.5 scenario taking place, thus moving into dangerous upper-estimates (Vuuren, et al., 2011; Pedersen, et al., 2020). This scenario may spur *minor* short-term developmental progress as jobs are generated in the quest for GDP points. However, ignoring ecological issues will exacerbate 'climate change' impacts, eventually reaching a tipping point and sending net inclusiveness spiralling down in the long term.

Table 9.2 conceptualises the ERR scenario's key implications through the SDGs. Not only is progress towards climate goals (SDG target 13.2) non-existent, but the socioeconomic ramifications of the ER scenario ooze into all corners of Agenda 2030; for instance, unsafe and underpaid coal mining not only persists but expands (regression on targets 1.2 and 10.1), the existing unreliability of South Africa's decrepit coal-intensive grid remains (regression on targets 7.1 and 9.4), and unabated fossil production intensifies the adverse impacts of the 'climate emergency' (regression on targets 2.1 and 3.9). As was alluded to, the ERR scenario *may* spur *temporary* economic growth as carbon-intensive sectors are hoisted, but given that South Africa's fossil-based growth has stagnated over the years due to the grid's unreliability (see 5.2.3.1), meeting SDG target 8.1 remains possible but extremely unlikely, particularly as the adverse impacts of the 'climate emergency' continue to intensify. All in all, the *ERR scenario is both exclusive and unsustainable on virtually all accounts*.

Figure 9.3. Potential LFFU Approach Mix in the ERR Scenario



Source: Author

Table 9.2. SDG implications of the ERR Scenario

Target	ERR Scenario
1.2	Unsafe and underpaid coal-intensive labour continues in South Africa and neighbouring producers like Botswana, Zimbabwe and Mozambique. Moreover, socially exclusive LFFU approaches (like emissions taxes, border tax adjustments, and tradeable emissions permits) unjustly allocate costs of implementation to fossil consumers who already struggle to afford power access; Regression, SDG 1 is not met
2.1	Unabated FF production leads to an exacerbation of the 'climate emergency' and its adverse impacts; Regression, SDG 2 is not met
3.9	Mining and other fossil-intensive activities with proven, documented harm to humanity are continued indefinitely; Regression, SDG 3 is not met
7.1	A continued reliance on coal-fired power for 33GW of installed capacity by 2030 (43% of total) indicates that both affordable and reliable energy access remain a mirage in the distant future, particularly given South Africa's decrepit and dysfunctional coal track record; Regression, SDG 7 not met
8.1	Massive capital injections to propel South Africa's fossil industry may generate jobs and spur growth in the short term, but the unreliable coal-intensive grid has proven to be counterproductive for GDP growth prospects, and may very well continue to do so given the fragility of South Africa's newest and most 'modern' plants, like Medupi and Kusile; potential regression OR progression, meeting SDG 8 possible but unlikely
9.4	Learning from Medupi & Kusile, which are allegedly emblematic of South Africa's 'new and modern' wave of coal-fired power, this 43% projected reliance on coal by 2030 essentially guarantees that archaic, outdated and resource-inefficient facilities will plague South Africa's power grid far beyond 2030; Regression, SDG 9 not met
10.1	Maintaining the status-quo of coal-dependence and the human rights violations that accompany it will stagnate any growth prospects of South Africa's poorest coal-dependent communities (like those in Mpumalanga and Limpopo); Regression, SDG 10 not met
13.2	Most obviously, continued unabated fossil production renders effective climate action unattainable; Regression, SDG 13 is not met

Source: Author

9.3.3. Social Recovery (SR)

The SR scenario (bottom-left quadrant of Figure 9.2) mimics the ERR scenario in terms of its ecological narrative (see 9.3.2); socio-economic pressures lead to greater investment in fossil fuel as resources are tight and actors are traumatized by the forced degrowth during the COVID-19 pandemic, once again ***violating inclusiveness condition EI*** (***de facto violating all other conditions bar S1*** – see Table 9.3). The need for: protecting jobs in fossil-related sectors (see 5.2.3.3, 8.2.3 & 0); keeping fuel costs low for the middle class; and ensuring access to energy for the poorest (see 5.2.3.1) in South Africa and beyond, puts climate concerns into the background; continued exploration and production of the Brulpadda & Luiperd offshore discoveries is justified using the RtD argument (Gupta & Chu, 2018 – see 2.2.1.3). As a result, analogous to the ERR scenario, forecasted investments in forthcoming fossil fuels are realised (see 7.4.3) as new pipelines, refineries, power plants arise that require new personnel (human assets), deepening dependencies on archaic and decrepit fossil-technologies. Once again, an array of ecologically exclusive LFFU approaches are pursued (see Figure 9.4) as e.g., major shareholders divest hundreds of billions in relevant liquid equity (see 6.2.2), major E&Ps divest physical assets to the balance sheets of financial institutions from the 'South' (see 5.2.2.2), and inadequately regulated financial capital according to lacklustre frameworks like the OECD Arrangement, PRI and PRB (see 7.2.4) prompt both public and private finance to intensify South

Africa's fossil-intensiveness (see 6.3.4 & 0). Once again, the stranded asset exposure and risk borne by South Africans is exacerbated (see 5.3.4), the SAD owed by the 'North' balloons (see 6.4), and the indebted institutions orchestrate the GSADD (see 7.3.6).

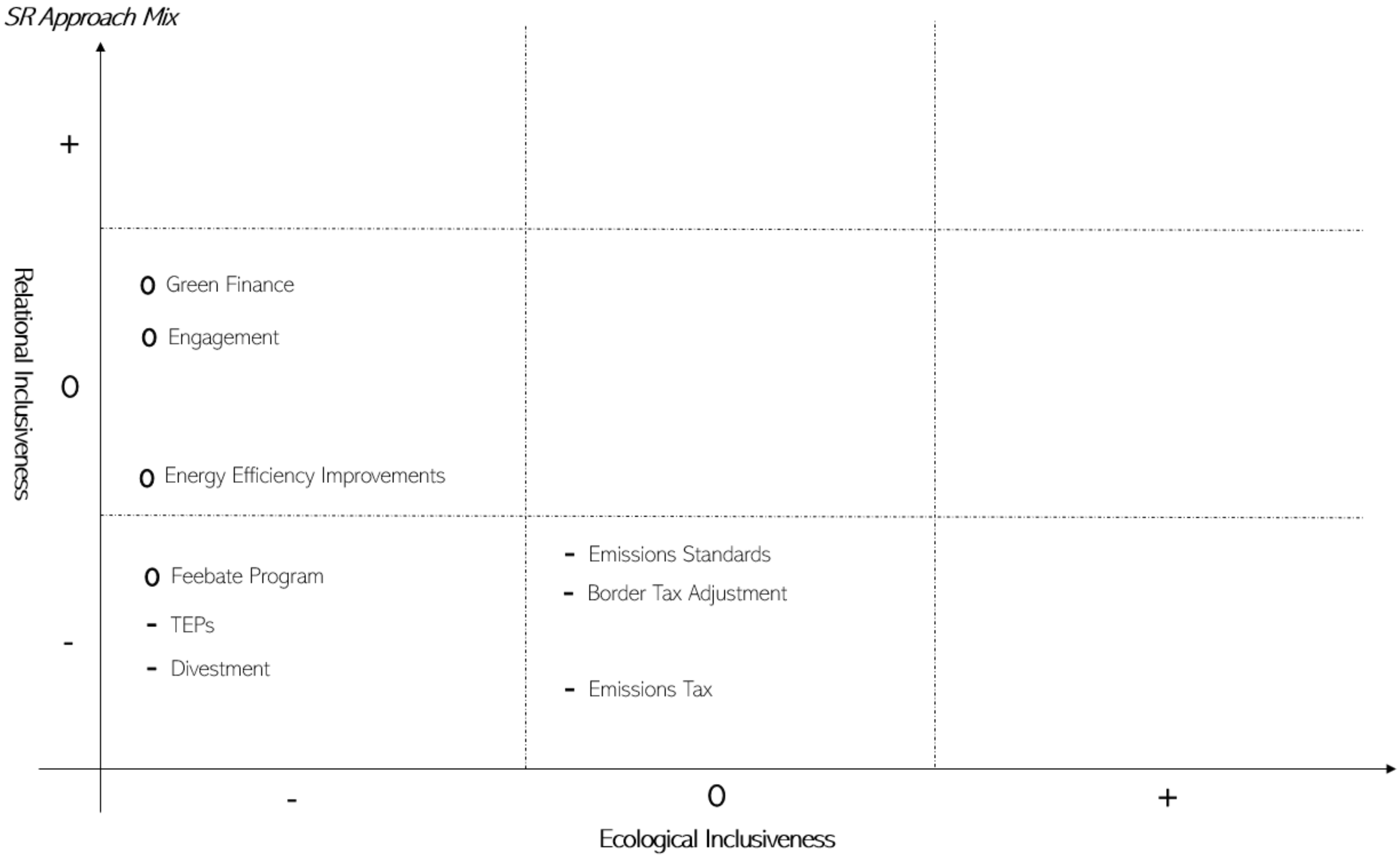
Table 9.3. Inclusive development implications of the SR Scenario

Dimension	Implications for ID via Stranded Assets
Ecological	E1. Same as ERR; condition violated E2. Same as ERR; condition violated E3. Same as ERR; condition violated
Social	S1. Resources are allocated to improve the working conditions for fossil employees, e.g., increasing pay and improving safety conditions; condition is partially or fully met; S2. Resources are also allocated to procure 'green' energy and other fossil alternatives in a bid to grant more affordable and reliable energy access to fossil-dependent consumers in South Africa; condition is partially or fully met
Relational	R1. Same as ERR; condition violated R2. Same as ERR; condition violated

Source: Author

However, the key difference between ERR and SR is that some socially inclusive progress is ostensibly made in the short term as fossil-based employment and energy is invested in and improved, as ecologically ineffective approaches are paired with more socially inclusive ones, like engagement, green finance and feebate programs (see Figure 9.4). (***Notice that this approach mix most closely resembles the identified mix from section 7.2.4, suggesting that the SR scenario is the most likely of the four to unravel – see conclusion #3 in 9.4).*** This may also manifest in wage-increases and improved working conditions for coal miners, refinery operators and other fossil employees in addition to increasing access cheaper and reliable energy, ***partially or substantially meeting inclusiveness conditions S1 and S2 in the short term*** (see Table 9.3) and making progress towards key SDG targets, like 1.2, 7.1 and 10.1 (see Table 9.4). However, the unsustainability of unabated fossil production takes its toll and leads to a gargantuan stranded asset bill in the mid- to long-term, and the accruing pressure on planetary boundaries renders these efforts moot in the long-term as the climate reaches its tipping point. Social inclusiveness in the short-term therefore compromises inclusive and sustainable development prospects in the long-term, as the adverse impacts of the 'climate emergency' render the bulk of the SDGs unattainable in the mid- to long-term.

Figure 9.4. Potential LFFU Approach Mix in the SR Scenario



Source: Author

Table 9.4. SDG implications of the SR Scenario

Target	SR Scenario
1.2	Investments are made to improve working conditions and/or pay for coal miners, refinery & plant operators and transport services; Progress towards meeting SDG 1
2.1	Same as ERR; SDG 2 is not met
3.9	Same as ERR; SDG 3 is not met
7.1	Investments in fossil-alternatives, like solar PV & wind, are made to provide additional non-fossil installed capacity and improve access to affordable and reliable energy; Progress towards meeting SDG 7
8.1	Unlike in the ERR scenario, investments in reliable and cheaper fossil-alternatives safeguard against the shortcoming of South Africa's decrepit coal power facilities, paired with profuse investments in new coal, oil and gas improve prospects of GDP growth; Progress towards meeting SDG 8
9.4	Same as ERR; SDG 9 is not met
10.1	Building on target 1.2, allocating resources to improve the working conditions for miners and other fossil-dependent wage earners improves income of the bottom 40 per cent; Progress towards meeting SDG 10
13.2	Same as ERR; SDG 13 is not met

Source: Author

9.3.4. Ecological Recovery (EcR)

The EcR Scenario (top-right quadrant of Figure 9.2) deviates from its ERR and SR counterparts; here, an aggressive 'green' recovery is pursued that capitalises on the opportunity to permanently shut-down coal plants and oil refineries, retire coal mines and catalyse a fossil transition, thereby ***meeting inclusiveness condition E1*** (see Table 9.5) and making progress towards meeting SDG target 2.1, 3.9 and 13.2 (see Table 9.6). Accordingly, a series of ecologically inclusive LFFU approaches are pursued and implemented, depicted in Figure 9.5; these could include export and extraction taxes for forthcoming South African coal, oil and gas production, bans & moratoria on the production itself (particularly from oil & gas reserves in which production is yet to commence, like Block 11B/12B – see 5.2.2.5) and financial capital regulation for spending on existing and forthcoming projects, like Majuba and Karpowerships (see Appendix C). Furthermore, approaches are adopted to explicitly decommission existing fossil-intensive facilities, Eskom's oldest and most dysfunctional power plants (again see 5.2.2.2), thereby ***partially or substantially meeting inclusiveness condition E2*** (see Table 9.5) and also making strides toward meeting SDG target 9.4 (see Table 9.6). Here, the multi-hundred-billion dollar stranded asset bill is partially or substantially addressed purely to decommission this physical infrastructure. (***Notice that the speculative approach mix in Figure 9.5 deviates most extremely from the empirically identified mix in section 7.2.4, suggesting that the EcR scenario is the least likely to unfold in its extreme***). Unlike previous scenarios, the EcR scenario aspires to minimise (or at the very least, stun the growth of) the stranded asset risk borne by South Africans (see 5.3.4); that is, this scenario acknowledges that the stranded asset dilemma (see 2.1) and 'climate emergency' will result in winners and losers, and is fixated on minimizing the net losses by restraining further carbon lock-in and continued investments in inevitable stranded assets (Overland, et al., 2019; Mercure, et al., 2018; van de Graaf, 2018).

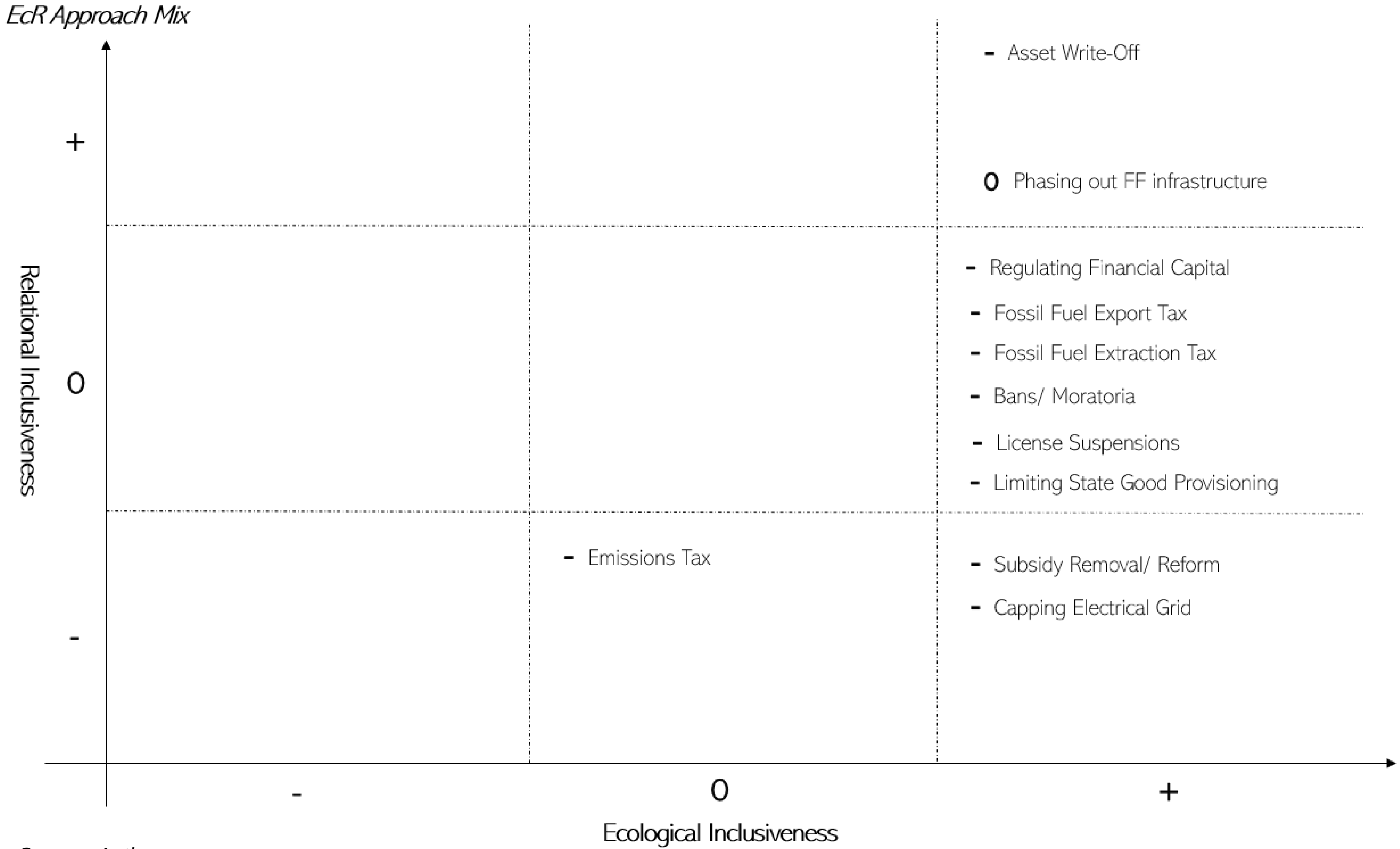
Although this ecologically-inclusive mentality minimises the adverse impacts of the 'climate emergency', the EcR scenario fails to inclusively govern accompanying stranded assets and/or guarantee that (energy) demands are sustainably and affordably met beyond fossil fuels in South Africa and beyond, particularly the latter given the lack of reliability that has plagued South Africa's grid for decades (see 5.2.3.1). That is: safe and desirable replacement jobs are not explored (see 5.2.3.3 & 8.2.3); devalued equity and debt (partially or entirely) remain on the balance sheets of governments and institutions from 'South' as the 'North' continues to divest its prospective stranded assets (see e.g., 5.2.2.2); no compensation is paid for stranding fossil fuel resources; and investments in solar PV, wind power and grid-scale storage is exploitative (e.g., through metal mining) and ecologically detrimental (e.g., through land use degradation). As a result, ***one or all of conditions S1-2, E3 and R1-2 are violated*** (see Table 9.5), and regressions toward a number of socially- and economically-oriented SDGs unfold, e.g., targets 1.2, 7.1, 8.1 and 10.1 (see Table 9.6). Although commendable efforts are made by the South African state and other African governments to fetter domestic fossil production, similar efforts are neglected by the international community to equitably distribute the burden of the stranded asset 'bill', and as a result, the 'North's' Stranded Asset Debt (see 6.4) is inappropriately allocated the South African finance institutions and organisations. Unlike earlier scenarios, this recovery builds on the devaluing and destabilising fossil fuel asset 'push' by the COVID-19 pandemic; however, like in previous cases, long-term inclusive development is compromised in spite of radical ecological inclusiveness.

Table 9.5. Inclusive development implications of the EcR Scenario

Dimension	Implications for ID via Stranded Assets
Ecological	E1. South Africa's power grid is revamped, the bulk of the existing coal-fired installed capacity is decommissioned, and investments in forthcoming coal, oil and gas are limited (if not eradicated altogether); condition is partially or fully met E2. Polluting, fossil-intensive facilities (like coal-fired power stations, oil refineries) are fully decommissioned in accordance with strict regulations (assessed through an ESIA); condition partially or fully met E3. Fossil-alternatives are procured to a greater extent than as spelled out in the IRP, but socioecological implications are not considered; condition violated
Social	S1. Mining jobs and other fossil-dependent employment is phased out, but resources are not allocated to transition employees to different sectors, pay a universal income/ pension, or offer any other support in the process. Over 200,000 coal miners are left unemployed in South Africa, and millions of South African communities in coal-dependent regions of Mpumalanga and Limpopo are stranded; condition violated S2. Same as condition E3 – socioecological implications of fossil-alternative investments is neglected; condition violated
Relational	R1. Eskom absorbs the stranded asset bill to decommission its facilities, along with other major E&Ps currently operating South Africa's coal mines and oil & gas exploration blocks. However, divestment of liquid assets (and physical assets to a lesser extent) is awash, exclusively reallocating the financial stranded asset debt burden globally; condition is partially met R2. South Africa is left fully responsible to finance their own fossil phaseout as Articles 4.5, 9-11 are ignored – no international compensation is offered for forgoing coal, oil or gas production; condition is violated

Source: Author

Figure 9.5. Potential LFFU Approach Mix in the EcR Scenario



Source: Author

Table 9.6. SDG implications of the EcR Scenario

Target	EcR Scenario
1.2	A narrow focus on climate issues and phasing out fossil production fails to account for the inevitable stranded labour; Regression, SDG 1 is not met
2.1	Effective measures to phase out fossil fuels and combat the 'climate emergency' will curtail its adverse impacts, improving prospects of flourishing harvest; Progress towards meeting SDG 2
3.9	Coal mining & production is phased out, as are the ecologically deleterious impacts of doing so on water, air and soil and surrounding ecosystems; Progress towards meeting SDG 3
7.1	Similar to the EcR trade-off with SDG 1, focusing on aggressively phase-out South Africa's coal-fired power while neglecting to establish affordable and reliable alternatives jeopardizes energy security, particularly for under-resourced and under-privileged South Africans with limited or no grid access currently; Regression, SDG 7 is not met
8.1	Drastic LFFU de facto implies forgoing roughly $1 trillion in fossil-based revenue streams from commercialising coal, oil and gas over the coming decades, leading to a likely stagnation in economic (GDP) growth in the short term; Regression, SDG 8 is not met
9.4	Decommissioning existing, archaic & inefficient coal-fired power stations (like Medupi, Kusile, Majuba) and crude oil refineries (like SAPREF, NATREF) will make room for adopting 'clean and environmentally sound' technologies in the future; Progress towards meeting SDG 9
10.1	Same rationale as EcR trade-off with SDG target 1.2; Regression, SDG 10 is not met
13.2	An intensive fossil fuel phase-out by definition is effective climate action; Progress towards meeting SDG 13

Source: Author

9.3.5. Inclusive & Transformative Recovery (ITR)

An *Inclusive and Transformative Recovery* (bottom-right quadrant of Figure 9.2) builds on earlier scenarios by phasing out South African fossil fuels (thereby generating trillions of dollars in stranded natural assets, see 5.2.1 and 5.3.2), catalysing the asset stranding process (thereby ***meeting condition E1***, see Table 9.7) and directing recovery resources to fossil-alternatives to comply with a 1.5℃ future, simultaneously making progress towards meeting SDG targets 2.1, 3.9 and 13.2 (see Table 9.8). Figure 9.7 speculatively envisions how this could unravel.

Building on the EcR scenario, ecologically inclusive LFFU approaches are adopted (see Figure 9.6), the bulk of which are *regulatory* rather than *market-based* (e.g., bans & moratoria, finance capital regulation and export/extraction taxes rather than emissions taxes or TEPs) so as to promote a relationally-inclusive fossil phaseout and ensure that the 'invisible hand's green thumb' does not capitalise on the 'climate emergency' as an opportunity for additional accumulation of capital for the world's elites (see Castree, 2015 and section 2.2.4). In doing so, indebted 'North' institutions are incentivised (if not obligated) to settle the Stranded Asset Debt bill, and allocate several hundreds of billions of dollars themselves to decommission South Africa's decrepit fossil infrastructure (see 5.2.2.2) and govern the stranded labour and energy (among others) that inevitably arise (see 5.2.3.1 & 5.2.3.3) (***thereby meeting condition R1***, see Table 9.7).

Table 9.7. Inclusive development implications of the ITR Scenario

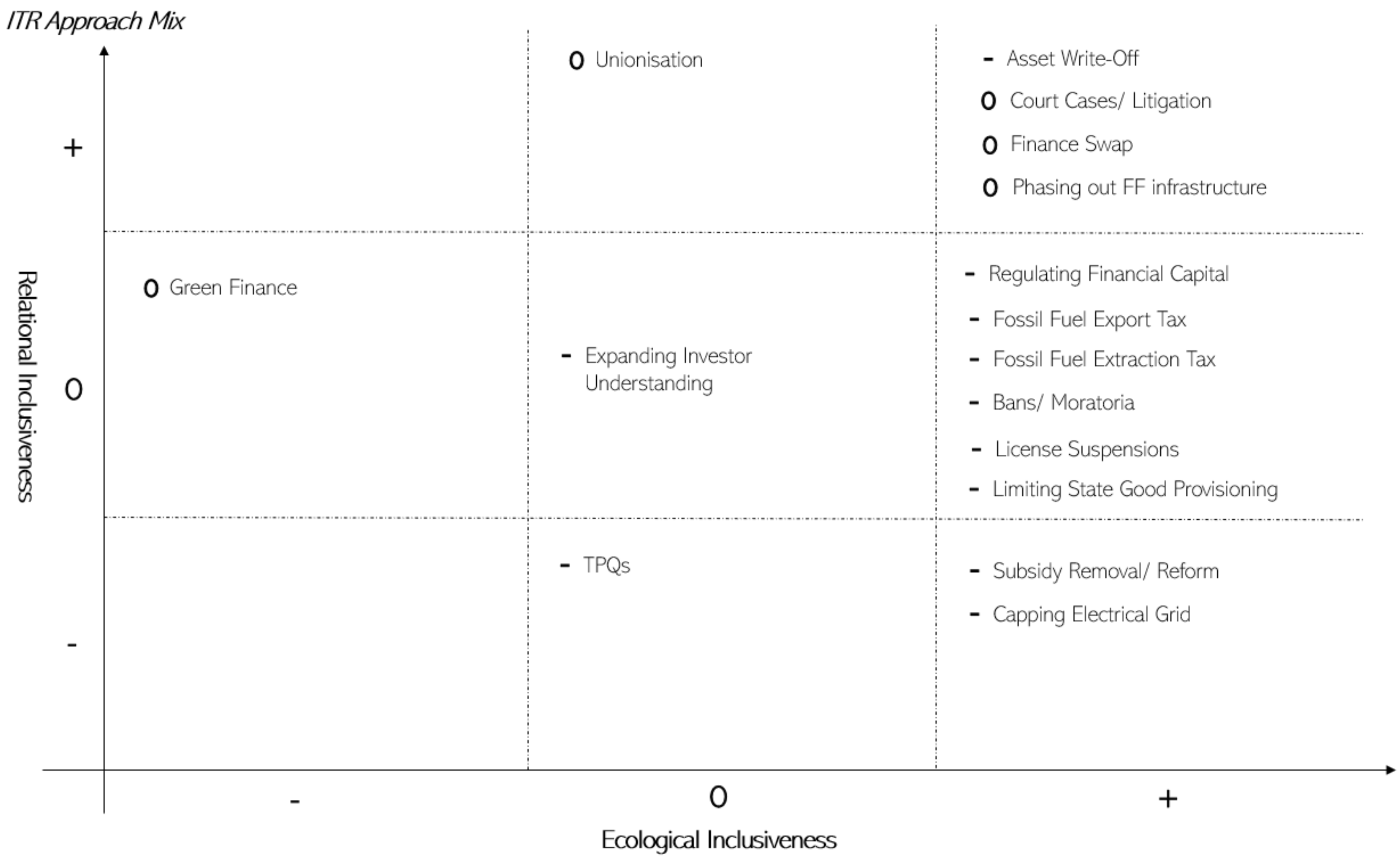
Dimension	Implications for ID via Stranded Assets
Ecological	E1. Same as EcR Scenario; condition partially or fully met E2. Same as EcR Scenario; condition partially or fully met E3. Fossil-alternatives are procured to a greater extent than as spelled out in the IRP, and socioecological impacts are mitigated; condition partially or fully met
Social	S1. Mining jobs and other fossil-dependent employment is phased out, and resources are allocated to transition employees to different sectors, pay a universal income/ pension, or offer other support in the process. condition partially or fully met S2. Same as condition E3 – socioecological impacts of fossil-alternative investments is mitigated; condition partially or fully met
Relational	R1. Key major shareholders, commercial banks, and the E&Ps that they own and finance are allocated majority or full responsibility to finance South Africa's coal (and oil & gas) phase out, settling the Stranded Asset Debt that they have de facto accumulated over the decades; condition partially or fully met R2. Building on R1, key investors and financiers adopt the PIIB in place of the PRI/PRB and pool together a financial package to compensate South Africans for forgoing their fossil investments; condition partially or fully met

Source: Author

Moreover, the stranded asset debtors allocate additional resources to compensate South Africans for forgoing the opportunity of developing and commercialising hundreds of billions of dollars' worth of coal, oil and gas and thereby sacrificing their Right to Development (**meeting condition R2**, see Table 9.7); this could take the form of an innovative Finance Swap (see 4.3.3.8), learning from the shortcomings of the Yasuni-ITT initiative (see Box 4.1) – for now, call it a Finance Package for an Inclusive Transition (FPIT). Here, rather than a 'coalition of the willing' (Cole, 2011; Piggot et al., 2018), which is all too passive and voluntary, it seems fitting that a '**Coalition of the Indebted**' (CoI) is established to bank the FPIT – that is, a coalition of various capitalist institutions predominantly from the 'North' that have deepened South Africa's dependency on fossil fuels and accumulated a SAD (again see 6.4). The CoI is thus a conglomeration of rich, capable and responsible actors that have promulgated the 'climate emergency' through their South African fossil investments.

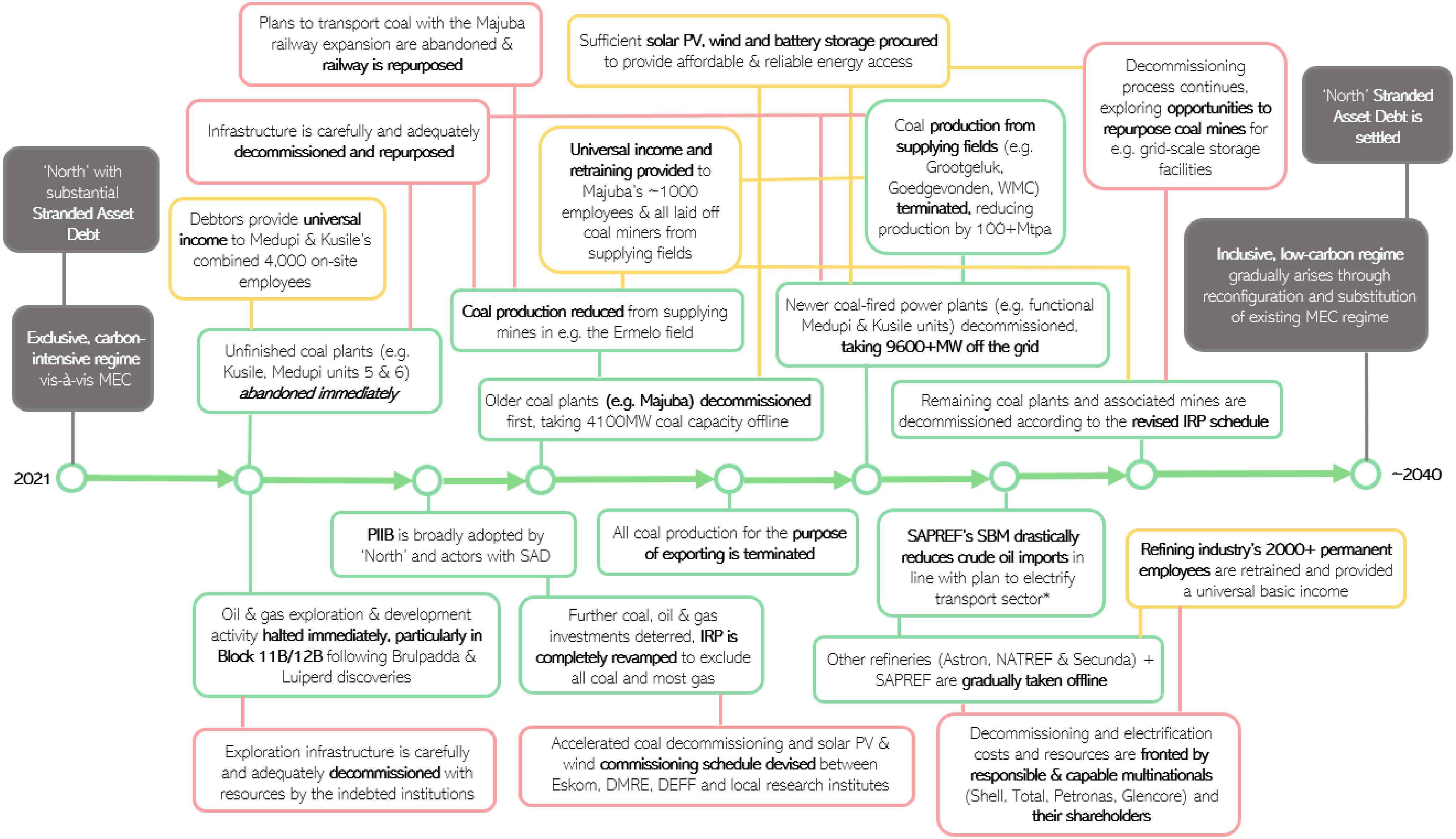
Once the CoI is established, the 'pay to preserve' principle (attempted at Yasuni – see Box 4.1) could be reimagined as the '***Pay to Strand*´** (PtS) principle, or rather, an allocation of financial and non-financial resources to South Africans in exchange for *not only* forgoing the opportunity to explore for and exploit existing coal, oil and gas resources & reserves, but also to immediately begin decommissioning coal-fired power generators, crude oil refineries, coal mines, and oil & gas rigs, and the accompanying multidimensional assets that accompany this infrastructure (i.e., settle the SAD – see 6.4.6). This is the 'package' of the FPIT (which takes the form of mostly (if not entirely) *interest-free grants, not commercial loans* – or at worst, *highly competitive concessional loans*), and could be financed either voluntarily *or by means of a (retroactive) extraction and/or export tax on fossil fuel E&Ps in addition to taxing shareholders and debt issuers for the trillions of dollars in dividends and interest earned on their fossil investment (see 6.2.2)*. Notably, the FPIT is likely welcomed by Eskom, which, in August 2021, publicly requested R33 billion from DFIs to finance its 'exit from coal-fired power generation' (Bloomberg, 2021).

Figure 9.6. Potential LFFU Approach Mix in the ITR Scenario



Source: Author

Figure 9.7. Speculative timeline contextualising a prospective ITR in South Africa



Source: Author

N.B. the flowchart is color-coded according to the three dimensions (ecological, social and relational) of the PIIB for which each milestone most closely associates with – see 7.5.3

Table 9.8. SDG implications of the ITR Scenario

Target	ITR Scenario
1.2	Building on the SR scenario, resources are allocated to retrain South Africa's mining labour force for other sectors, in addition to allocating financial capital for universal income and pension during and after the transition; Progress towards meeting SDG 1
2.1	Same as EcR; Progress towards meeting SDG 2
3.9	Same as EcR; Progress towards meeting SDG 3
7.1	Same as SR; Progress towards meeting SDG 7
8.1	Same as EcR. Circa $1 trillion in forgone revenue streams from commercialising South Africa's fossil reserves (and as much as $6 trillion across Africa more broadly) implies that near-term growth prospects (within the decade, i.e. by 2030) may be hampered; Regression, SDG 8 is not met
9.4	Same as EcR; Progress towards meeting SDG 9
10.1	Same rationale as ITR synergy with SDG target 1.2; Progress towards meeting SDG 10
13.2	Same as EcR; Progress towards meeting SDG 13

Source: Author

It is crucial that these FPIT payments are *not directly funnelled to potentially corrupt institutions in the 'South'* – i.e. directly to the pockets of South Africa ministerial branches, like the DMRE or DEFF, or finance institutes, like PIC (see 1.3.2.1), which have promulgated several instances of state-capture in the past decade(s) (Martin & Solomon, 2016). One of the major shortcomings of the Yasuni-ITT initiative was the lack of transparency from and trust in the Ecuadorian government as to whether or not they would, in fact, 'leave the oil in the soil' as was promised as part of the proposed finance swap, and the extent to which the pledged donations would reach and benefit Ecuadorian citizens (see Box 4.1). To refrain from repeating past mistakes, a '***Coalition of Stranders***' (CoS) could be formed on the receiving end of the FPIT to coordinate the fossil transition, including: groups of leading CSOs, existing trade unions and union federations, leading local research institutes, representation from local and national government in addition to Eskom, other SOEs and other financial and international organisations.[173]

In the ITR scenario, FPIT support also cushions the impact for both the unemployed by investing in safe, desirable and high quality jobs in other economic sectors (***meeting condition S1,*** see Table 9.7) and fossil users by investing affordable, reliable and non-exploitative solar PV, wind power and grid-scale storage (***meeting conditions R2 and E3,*** see Table 9.7), altogether making progress towards key SDG targets 1.2, 7.1 and 9.4 (see Table 9.8).

Furthermore, the ITR scenario oversees that existing physical stranded assets are fully decommissioned to protect ecosystems disruption (***meeting condition E2,*** see Table 9.7); unfinished and non-operational coal-fired power stations, like Medupi's units 5 & 6 and Kusile's units 4-6, are

[173] Some financial institutions have already begun adopting more progressive fossil fuel stranding approaches, which may speak to the legitimacy and feasibility of the FPIT proposal. For instance: the Asian Development Bank, Citibank, HSBC and Blackrock announced plans to purchase and prematurely decommission coal-fired power stations across Asia (at undisclosed locations) using debt and concessional finance (Denina & Burton, 2021); and also in August 2021, APG, asset manager to ABP, the largest Dutch pension fund, publicly scolded the South Korean government for maintaining its coal sector burning (Son, 2021). Though the FPIT proposal would take these two instances to new extremes, they nonetheless serve as a promising indicator that perhaps the broader landscape is ready to entertain a truly progressive and inclusive fossil agenda.

abandoned and the FPIT provides a UBI for laid-off personnel, their families and communities, in addition to fully and adequately decommissioning the physical stranded assets and absorbing the financial stranded assets (i.e. the World Bank, among the other PFIs (see 6.4), relieves Eskom of its relevant debt). Since these units are not commercial yet, abandoning their development does not exacerbate South Africa's energy poverty any more than its current state. Moreover, ITR promotes the immediate termination of offshore oil and gas exploration & production, first and foremost targeting the Block 11B/12B discoveries (see 5.2.2.5), which also does not jeopardise the livelihoods of South African citizens but does imply a (stranded) financial burden for the exploration firms in accordance with the SAD that they have accrued (see 6.4). (Suspending the existing exploration rights to these blocks may be possible under Section 90 of the MPRDA (Act No. 28 of 2002) – see 1.3.2.1).

Eventually, older operational power plants (e.g., Majuba, see 5.2.2.2) begin to shut down (removing 4100MW of installed coal capacity from the grid) and their supplying mines taper off production. This inevitably begins to lay-off staff, like Majuba's ~1000 permanent employees and the thousands of miners employed at the dozens of supplying fields, who will receive both income (or pension) and retraining (aligned with SDG target 1.2 and 10.1 and inclusiveness condition S1). This certainly risks breaching mining rights contracts still within their 30-year period (trade-off RTO4, see 9.2.1), although there is room to terminate these contracts prematurely on the grounds of incompliance with Section 90 of the MPRDA (see 1.3.2.1). Eventually, younger coal plants (like Medupi & Kusile's commercial units) are also decommissioned and repurposed, their ~4000 combined employees are provided with a basic income and retraining, and additional solar PV and wind power is procured to account for 9000+MW of decommissioned installed capacity. More broadly, South Africa's IRP is reimagined, drastically reducing the forecasted 33GW of installed coal capacity by 2030, forthcoming spending on South African fossil fuels is eradicated (see 7.4.3), and the LFFU approach mix currently proposed by Stranded Asset Debtors is completely upended (see 7.2.4).

There may be a period of transition (denoted by the slight plateau in the bottom-right curve of Figure 9.2) in the short- to mid-term as equitable and inclusive approaches to replacing fossil fuels are 'fine-tuned' – for example, as South Africa's MEC reconfigures itself, overhauling the incumbent coal-dependent regime, introducing a new fossil-alternative approach to energy, labour and the economy, and safeguarding against the rise of new oligopolies and extreme wealth concentration in these fossil-alternative energy markets (Scholten et al., 2020). In the ITR, COVID-19 is used as an opportunity to move towards short- and long-term inclusive development by building on its momentum of already having devalued some fossil fuel assets and paralysed the growth and activity of others.

9.3.6. Implications

The second key conclusion from this thesis arises:

Overarching Conclusion 2:

The scenario analysis in sections 9.3.2-9.3.5 demonstrates that in their extremes, only one scenario (ITR) encapsulates a truly inclusive fossil fuel phaseout in South Africa on relational, social and ecological levels, and this scenario is dependent on the institutions from the 'North' with a SAD to South Africa to withhold the responsibility they have implicitly obtained, subsequently allocating several hundreds of billions of dollars to minimise South Africa's stranded asset risk exposure. Note that this scenario analysis especially holds knowledge gap K4 to heart, though of course it also addresses knowledge gaps K1 and K2 given the focus on South African fossil fuel supply phaseout in relation to a multilateral SAD.

9.4. Conditions for an Inclusive & Transformative Phase-out

Overarching Conclusion 3:

Based on the trade-offs from 9.2 and the scenarios from 9.3.2-9.3.5, eight key conditions for an inclusive and transformative South African fossil fuel phaseout seem necessary:

1. *Short-term growth prospects are side-lined*, particularly due to hundreds of billions in forgone annual fossil-based revenue streams from commercialising South African coal, oil and gas reserves (see 5.2.1 & 5.3.2.1);

2. Given the gargantuan opportunity cost that condition (1) poses, and given the reliance that South Africa's economy have evolved on commercialising their fossil reserves (see 1.3.2.1, 5.2), internalising this opportunity cost is only possible if *Articles 4.5 and 9-11 of the Paris Agreement (see 1.4.1) are not only respected but prioritised, seeing finance, technology and knowledge flows from the capitalist institutions from the 'North' that have perpetuated the 'climate emergency' and generated the bulk of South African prospective stranded assets (i.e., the Coalition of the Indebted – see 9.3.5) to the 'South', thereby settling the SAD bill.* Again, this should be seen complementarily to the demand-oriented climate debt debate (see 2.2.1.3) for it is possible that some nations who have not acted as 'stranded asset creditors' in the past have nonetheless been barred from their fair share of the emissions budget and are owed a climate debt, such as Tuvalu or other small island states with both limited fossil consumption and production;

3. *Multilateral policy frameworks like the PRI, PRB and OECD Arrangement are abandoned*, and financiers and investors alike *adopt inclusive alternatives (like the PIIB, see 7.5.3*) that explicitly allocate phase-out costs to indebted producers & investors, and reject and omit any loopholes that allow capitalist institutions to capitalise on the 'climate emergency' as an opportunity for profitable accumulation of wealth (see 2.2.4);

4. *At the national level, South Africa's IRP is overhauled*, drastically reducing its predicted installed coal capacity from 33GW by 2030 to at least 9.6GW (if not lower), allowing Medupi & Kusile 's commissioned units to remain online while decommissioning older plants and refraining from investing in new ones (see 5.2.2.2);

5. *Policymakers, activists, investors and financiers break free from their conventional habits vis-à-vis LFFU approaches*, replacing ineffective and exclusive approaches (e.g., emissions taxes emissions monitoring, carbon offsetting, divestment, and lacklustre finance regulation for a subset of coal production – see 7.3.1) with inclusive alternatives (e.g., finance swaps, broader finance capital regulation, bans & moratoria, and export taxes – see Figure 9.6). Notably, ***market-based approaches must be severely scrutinised or rejected altogether***;

6. Meeting condition (5) will simultaneously require a paradigm shift regarding 'green finance' (see 4.3.1.8), which will most certainly be necessary to replenish fossil-intensive grids (like South Africa's), but *such financing must be understood as a means of upholding universal rights to basic services – and therefore promoting social inclusiveness* – rather than effectively fettering fossil fuel production (and hence promoting ecological inclusiveness), and broader calls for adopting 'net-zero' portfolios and balance sheets by offsetting dirty fossil assets with 'cleaner' and 'greener' assets must be deunked for the misleading ploys that they are (see 1.2.2);

7. *The COVID-19 pandemic is used as an opportunity for effective climate action rather than a crisis that necessitates urgent nursing to revert to fossil-intensive normalcy* (see 8.4); and

8. Finally, *the importance of juxtaposing ecologically effective LFFU approaches with socially and relationally inclusive ones cannot be sufficiently stressed*. Not only do fossil-rich African nations depend on coal, oil and gas production, but also their Right to Development (RtD) (Gupta & Arts, 2018) implies that blindly succumbing to global pressure to 'fight climate change' is far beyond a priority. Wellbeing cannot be compromised for 'the greater good of the climate' – South Africans will simply not play ball.

However, given: 1) the failures of previous finance swaps, like the Yasuni-ITT (see 4.3.3.8); 2) the low funds that rich 'Northern' governments are currently pledging to South Africa to support a just transition (evident through the Just Energy Transition Partnership resulting from COP-26 in October 2021, through which governments from France, Germany, the UK, US and EU pledged to allocate $8.5 billion in financing to decarbonise South Africa's economy [Franke, 2021; EU, 2021], [174] which accounts for less than 3% of the roughly estimated SAD – see 6.4.6); 3) the ecologically exclusive makeup of the current proposed LFFU mix by the indebted (see 7.3.2); 4) the inadequate existing policy frameworks that guide climate- and fossil-related financial decision making (see 7.5.3); and 5) the detected trends in late-pandemic increased fossil spending and production (see 8.3.2), it seems unlikely that any of these conditions bar condition 8 will be met. Rather, ***it seems all but likely that several elements of the SR scenario will unravel in South Africa, in which 'green' energy is added to the fossil-intensive grid, potentially ameliorating energy accessibility challenges in the short term, but exacerbating stranded asset exposure and resulting in 'climate' calamity in the mid-to-long term***.

9.5. Limitations & Future Research

Three central limitations exist that merit further research, the first pertaining to the legal intricacies of the SAD argument. Compliance with the articles of the Paris Agreement is technically legally mandated once the agreement enters into force for ratifying countries, but it is beyond the scope of this research to discern whether the fossil-intensive finance flows (see 6.2 & 6.3) violate Article 2.1c. Moreover, the identified stranded asset debtors may themselves pursue legal action against efforts to LFFU, potentially claiming protection under applicable investment treaties. Future research should engage with these legal ramifications, by posing the question: *to what extent are inclusive approaches*

[174] On the one hand, the this seems relatively promising, particularly given that PFIs from France & Germany and shareholders from the US,UK & EU were identified as the most prominent investors in South African fossil projects (see 6.2). On the other hand, however, not only is this initial pledged $8.5 billion at least two orders of magnitude lower than the surface level SAD estimates denoted earlier (see 6.4.6), but depending on how it is allocated, it may yield new or exacerbated financial dependencies – perhaps similar to those evidenced through the World Bank's mammoth loan for developing Medupi (see 5.2.2.3) – particularly if commercial loans or even concessional loans are favoured over grants. Moreover, it is unclear whether these funds will be used explicitly to decommission existing fossil infrastructure, or rather to commission 'green' alternatives, given that the central pledge of the partnership is to "identify financing options for innovative technical developments and investments, including electric vehicles and green hydrogen, to help the creation of quality, green jobs" (EU, 2021: np). If the latter, then the partnership would predominantly be accounting for the *human asset* dimension of the SAD (though falling short by at least 85%), and would likely neglect several of the SAD's remaining dimensions, primarily fossil-intensive physical asset decommissioning costs. That is, if not carefully monitored, the Just Energy Transition Partnership may not only create new financial dependencies for South Africa, but may also do little to adequately govern the already existing prospective stranded fossil fuel assets in its economy, even though it may safeguard against the creation of new ones by disincentivising investments in *new* coal (and to a lesser extent) oil & gas infrastructure. As such, perhaps the SAD conceptualisation may prove a useful tool in guiding the financial mobilisation of the Partnership.

for LFFU legally sound, and how can the justice system be leveraged to promote an inclusive fossil transition and mandate acknowledging the SAD?

Second, this research made a first-pass attempt to unpack South Africa's stranded asset exposure and to subsequently approximate the SAD that finance institutions and E&Ps mainly from the 'North' owe to South African citizens, but this was done pragmatically (see 3.6) with methodological limitations and operating under several assumptions. Notably: identifying and unpacking prospective stranded communities (i.e., social assets) was beyond the scope of the research (see 3.7); the equity finance flows (see 6.2.2) relied on publicly disclosed data, which only pertains to major shareholders to the sampled E&Ps and thus omits smaller and private shareholders; the debt finance flows (see 6.2.3 & 6.2.4) relied on two existing datasets (RAN et al., 2021; OCI, 2020), which themselves may be incomplete; the data on which this analysis was based was temporally bound to 2010-2020 for the PFI finance, 2016-2020 for the commercial debt finance, and 2019-2021 for the equity finance, which means that this research is unable to draw more concrete conclusions regarding the historic accumulation of a SAD, particularly in the case of major shareholders; and the technique used to roughly estimate the 'SAD' bill (see 6.4) both relied on existing parameters from other contexts and omitted certain costs altogether due to lack of available and reliable estimates (e.g., crude oil refinery decommissioning costs). Forthcoming research could consider expanding this analysis by both fully encapsulating the broader array of South African prospective stranded assets, and by improving the SAD estimates so they are better suited for the South African context.

Finally, the applicability of this research design and findings beyond South Africa's fossil economy merits attention. On the one hand, the research has made an effort to contextualise South Africa's stranded asset stocktake and the respective finance flows within the context of the broader African fossil fuel empire (see 5.3 & 6.3), but as already stated (see 1.3.2.1), this is not to suggest an erroneous homogenisation of the African continent. This exercise has demonstrated, however, that multinational E&Ps very likely have played an influential role in the generation of prospective stranded fossil fuel assets elsewhere in the African continent, and therefore, similar arguments holding the 'North' accountable for settling an analogous SAD may be applicable elsewhere and merit further detailed analysis. This is particularly true in the cases of Nigeria, Angola, Egypt, Algeria and Libya – nations with well-established oil & gas production sectors (see 5.3.2) and already evident linkages to E&Ps and finance institutions from the 'North' (see 6.3.2-0). Note, however, that these cases may differ from that of South Africa, not least due to their prominent oil & gas sectors and virtually absent coal & mining sector, which may bear implications for the intricacies pertaining to prospective stranded physical assets and human assets, but nonetheless a SAD argumentation is applicable.

More broadly, the applicability beyond the African continent is also relevant. Although the South African case may be relatively unique within the African continent due to its unprecedented coal dependence, other global coal juggernauts in the 'South' may find themselves in similar positions to South Africa, like Indonesia, India, and China (though China perhaps merits special considerations – see 9.6.2). That is, other economies with certain similar characteristics may apply to the SAD narrative, those characteristics being: an established coal, oil or gas production sector with proven and recoverable reserves; engagement with international capital markets; and the presence of at least one multinational E&P. Future research could conduct similar studies to examine the stranded asset exposure and international finance linkages pertinent to these global producers, to subsequently ascertain the extent to which the 'North' is indebted to the 'South' even more broadly through the SAD. This would, in theory, run in parallel with broader calls for settling the 'North's' climate indebtedness to the 'South' (see 2.2.1.3).

9.6. Reflections

9.6.1. Theoretical Contributions

Six theoretical contributions are made from this research:

Stranded Assets and Inclusive Development Intimately Intertwined

First, the stranded asset conceptual and typological framework bears an intimate relationship with inclusive development agendas, particularly in the context of a fossil fuel phaseout. The empirical evidence presented here indicates that a slew of stranded assets are essentially inevitable in a South African fossil phaseout (see 5.2.2.6 & 5.5), which bear several implications for social, ecological and relational inclusiveness (see 5.4), and yet (at time of writing) no one has attempted to fuse the ID and stranded asset frameworks to generate an analytical framework for inclusive stranded asset governance (see Table 2.4 in 2.2.2), making strides towards addressing knowledge gap K1. This is critical given that stranded fossil fuel assets will play a central role in South Africa's fossil phaseout (and likely elsewhere around the globe); accordingly, inclusive development scholars could consider adapting the framework to study different fossil-related research topics.

'Inclusive Finance' Must Include 'Dirty' Investments

Second, the notion of *inclusive or sustainable finance* must go beyond either simply granting access to financial capital (see e.g., Likoko & Kini, 2017) or the ample availability of financial capital for 'green', fossil-alternative projects (see 4.3.1.8). As has been argued and demonstrated (see e.g., 6.4), substantial investments *in 'brown', fossil-intensive assets* will be required to strand and inclusively decommission said assets so as to improve the odds of directly curtailing fossil fuel supply; this has been conceptualised throughout this manuscript as 'settling the inevitable SAD bill' (see 2.2.1.4). Few scholars in general have addressed the role that finance plays in materialising inclusive development agendas (see 2.2.1), and it has become clear here that this must include an allocation of 'stranding' financial capital, particularly in the context of LFFU. To this, the developed Principles for Inclusive Investing and Banking (PIIB – see 7.5.3) may serve as a helpful framework to begin developing a theoretical approach for 'inclusive development finance' both in the context of cutting fossil fuel supply and beyond.

Sustainable Development Inferior to Inclusive Development for Addressing the 'Climate Emergency'

Third, the central underlying premise of the inclusive development theory – that economic challenges typically trump social and environmental concerns within the sustainable development paradigm (Gupta, Pouw & Ros-Tonen, 2017 – see 2.2.1) – is corroborated in this research. As shown, phasing out South African coal (and oil and gas) implicitly requires stranding several hundreds of billions of dollars in forgone revenue streams, in addition to decommissioning at least 40GW of fossil-intensive installed power capacity (the bulk of which (37GW) is coal based), which can be translated into both forgone opportunities for economic growth and even an implicit degrowth (see 5.4), both of which are conceptualised as major degressions towards meeting SDG target 8.1. Accordingly, there would be substantial incentive to reject a fossil phaseout in South Africa, in spite of the several socioecological synergies that would spur. Rather, the ID framework takes LFFU as a point of departure and scrutinises the challenges that will likely arise in the phaseout process, making it much more suitable for studying the climate-development nexus rather than the SD lens.

Capitalist Institutions Incapable of and Inadequate for Addressing the 'Climate Emergency'

Fourth, it has become evident that if the responsibility of and control over phasing out fossil fuels and addressing the 'climate emergency' is voluntarily left to the hands of rich capitalist institutions and governments (especially from the 'North'), then no semblance of any such phase out will take place in South Africa or likely anywhere else, particularly not an inclusive one. *Pension funds, ECAs, PFIs,* *commercial banks and E&Ps scattered across the globe have clearly demonstrated that the role that they play vis-à-vis climate issues is one purely of unabated fossil fuel exploitation and 'climate emergency' exacerbation*. These institutions show no sign of adequate and substantial consideration for the climate calamities that their investments hoist; this was empirically evident simultaneously through the hundreds of billions in investments funnelled to developing both South African and African fossil fuel sectors (see 6.2 & 6.3), their explicitly disclosed plans to continue expanding their global fossil footprint (see 7.4.3), and the ineffective and exclusive mix of LFFU approaches that these actors jointly propose to ostensibly address the 'climate emergency' (see 7.3 & 7.6). Through their smarmy pledges to reduce emissions and build a 'greener' future, these capitalist actors are deceptively constructing new markets to seek the ultimate goal of maximised profits, while inconspicuously maintaining their fossil operations pumping in the background. This aforementioned LFFU approach mix must be completely flipped on its heads if even an exclusive fossil phaseout is desired, let alone an inclusive one, but such an overhaul will certainly not come from these capitalist institutions with so much 'skin in the game' (see Fraser, 2021); perhaps more external pressure is warranted to drive this overhaul, potentially from Civil Society Organisations (CSOs) who are dedicated to adequately addressing the 'climate emergency' and unafraid to admit that significant monetary losses will be incurred in the process.

Stranded Asset Debt as a Useful Conceptual Tool to Prompt Effective Fossil Fuel Supply Cuts
This feeds into the fifth contribution, namely that the Stranded Asset Debt (SAD) may prove to be a useful conceptual tool for scholars, in addition to global activists, CSOs, NGOs, and social opposition groups to adopt and hold key actors from the 'North' responsible and accountable for perpetuating the 'climate emergency' in the 'South' (and beyond) through their reckless and unabated fossil investments. Although the SAD is in its nascent stages of development through this thesis (see 2.2.1.4 & 6.4), it nevertheless makes an important stride towards introducing a supply-side concept to complement historic and demand-oriented 'climate debt' debates (see 2.2.1.3), though unlike the climate debt approach, the SAD is constructed in a manner that is seemingly within the bounds of several articles of the Paris Agreement on Climate Change (see 1.4.1). This thesis has clearly demonstrated that there is an essential North-South component to phasing out fossil fuels, evident through the multi-billion dollar international finance flows driving and hoisting both the South African and African fossil sectors, though this North-South dimension is overlooked in the existing *fossil fuel supply-side* scholarship (see knowledge gap K2 in 1.2.2).

Pandemics and Recessions as Opportunities for Action, not Spectating
Finally, despite their detrimental impacts, major global events likely pandemics and recessions bear a 'blessing-in-disguise' quality in involuntarily stunning the perpetual growth of sectors notorious for their social and ecological violations, like the fossil industry (see 0). COVID-19 has presented a socioecological lifeline, and, at time of writing, over 2 years have elapsed since the pandemic upended global societies and its impacts are still being felt today – including in its influence in catalysing the fossil fuel asset stranding process (see 8.2– 8.4). But with this 'push' must come a 'pull' in the form of revamped and impactful LFFU approach implementation, else the window for action will dwindle and the opportunity will be squandered. In the future, if other calamitous events arise, lessons could be extrapolated to prompt similarly urgent actions to address structural socioecological issues, whatever they may be at the time.

9.6.2. Conceptual Reflection

It is finally time to reflect on the three terms that have been purposefully and exclusively placed in single quotations throughout this manuscript: the 'climate emergency' (see 9.6.2.1), '(global) North' and '(global) South' (see 9.6.2.2). This reflection recognises that knowledge and power are intricately intertwined (Foucault, 1980). For Foucault, power "is not concentrated in specific social locations and bodies… but in the material actions and re-actions of social exchanges within a particular society… [power] produces social truths, reality, and individual subjects and structures" (Valdivia, 2015: 468). If the very knowledge that such power is predicated upon is itself flawed, then the ensuing truths (i.e. ontologies and epistemologies) and actions (i.e. policies, plans, projects) will likewise reproduce and reflect these core misconceptions, resulting in the "epistemicide of non-European ways of knowing" (De Sousa Santos, 2018, quoted in Wijsman & Faegan, 2019: 73). As scientists, we have a "response-ability" (Latour, 2016) to acknowledge the political embeddedness of our research, and in this context, to challenge the common nomenclature and rhetoric that frames climate regimes and discourses. We must ask ourselves, "what forms of ontological violence are authorized [sic] when Eurocentric categories are the primary referents of analysis through which to encode and represent?" (Sundberg, 2015: 120). Wijsman & Faegan (2019: 71, **emphasis added**) summarise this nicely:

> Against a **backdrop of uneven [urban] development entrenched in patriarchal, colonial, racial, and capitalist spatial arrangements**, we maintain that knowledge systems analysis needs to engage better with critical social science theory to be able to contribute to just and equitable [urban] futures.

This 'backdrop' presents the point of departure for the following reflection.

9.6.2.1. 'Climate Emergency'

The 'climate crisis' and 'climate emergency' have both been endorsed by the UN (United Nations, n.d.; UNEP, n.d.) to stress the urgency and gravity of the climate change 'problem'; this describes a scenario in which failing to limit the average global temperature rise to 1.5-2°C above pre-industrial levels increases the likelihood of exacerbating the adverse impacts of *climate* change, including, inter alia, flooding, droughts, depleted agricultural yields, mass involuntary migration and deepened social inequalities (IPCC, 2019). The *crisis* element – or until more recently, *emergency* – arises by acknowledging that time for action is rapidly expiring (Nordhaus, 2018), and we are currently on pace to overshoot this temperature goal by 50-120% (SEI et al., 2019; 2020).

First, it is problematic that we describe the 'crisis' or 'emergency' at hand as one of the *climate*, when in reality it is not the climate that is in the state of crisis or emergency, but rather the human and non-human species, who will suffer from the aforementioned adverse impacts (IPCC, 2019). Latour (2016) argues that referring to an 'ecological' crisis distances *humans* from the problem and strips them of their agency, assigning it rather to ecosystems or Nature more broadly. By this logic, the 'human-induced emergency' marks a slight improvement in terminology.

However, claiming that human – or 'anthropogenic' – forces are driving climate change implicitly and inappropriately distributes agency to all humans across both space (i.e. geographically) and time (i.e. intergenerationally), regardless of socio-political or historical context (e.g., Paulson, 2017), thereby establishing "the human as a unified agent" (Latour, 2016: 121). As Latour (ibid) explains, "Indian nations deep in the Amazonian forest have nothing to do with the 'anthropogenic origin' of climate change." That is, "can we really equate the carbon dioxide contributions of gas guzzling automobiles in Europe and North America or, for that matter, anywhere in the Third World [sic] with the methane emissions of draught cattle and rice fields of subsistence farmers in West Bengal or Thailand?" (Agrawal & Narain, 2011: 82). This 'unification of the human agent' (Latour, 2016) is occurring now in the alleged 'Anthropocene' – 'age of the (hu)man' – which has become the unofficial,[175] ubiquitously

[175] As of May 2021, the International Geological Society is still searching for evidence of 'golden spikes' that affirm that humans have irreversibly altered physical, chemical and biological processes of the Earth, and as such it has yet to formally confirm that we live in the 'Anthropocene', and we therefore technically still reside in the Holocene (Subramanian, 2019; Stratigraph, 2021)

adopted label for this epoch, the era in which 'humans' have supposedly irreversibly altered the physical, chemical and biological makeup of the Earth (Subramanian, 2019). In this context, it has become common vernacular to discuss the '*anthropogenic drivers of climate change*,' referring to e.g., human-induced GHG emissions or deforestation (IPCC, 2019) that have driven the 'climate emergency' (see e.g., Gupta et al., 2020).

This clearly "overlook[s] equally significant processes of geographical and social differentiation" (Barca & Birdge, 2015: 366), and blindly adopting this loaded term to inform (climate) research, policies, finance and economics may crack open the ultimate epistemicidal and ontologicidal Pandora's box – a "slow violence… that both reproduces and transforms inequalities in economic and political power" (Barca & Bridge, 2015: 366; Nixon, 2011).

Several researchers have proposed reconceptualising the 'Anthropocene', which may deem helpful in this quest to reconceptualise the 'climate emergency'. Moore (2018; 2017: 594, ***emphasis added***) proposes the "***Capitalocene***, understood as a system of power, profit and re/production in the web of life," through which he ridicules the 'Anthropos' prefix (Moore, 2017: 595):

> [The Anthropocene] tells us that the origins of the modern world are to be found in Britain, right around the dawn of the nineteenth century.. The motive force behind the epochal shift? Coal and steam. The driving force behind coal and steam? Not class. Not capital. Not imperialism. Not even culture. But… you guessed it, the Anthropos: humanity as an undifferentiated whole.

Fraser (2021: 97-8) agrees, arguing that rather than "[pinning] the rap… on humanity in general," we ought to isolate the "class of profit-driven entrepreneurs who engineered the fossil-fuelled system of production and transportation that released a flood of greenhouse gases into the atmosphere." Here, "anthropogenic global warming" is denounced as a "colossal falsification… *[global] warming is capital's crowning achievement*. ***Global warming is capitalogenic***" (Moore, 2018: 237, ***emphasis added***).

Although these accusations may seem harsh, biased, or perhaps even emotionally triggered, this research has clearly provided empirical evidence to corroborate the 'Capitalogenic' arguments that Fraser (2021) and Moore (2017; 2018) propose. Namely, South Africa's fossil sector being heavily controlled by multi-trillion-dollar revenue hoarding E&Ps (see 6.2.1), who are in turn owned and governed by multi-trillion-dollar asset owning institutional shareholders (see 6.2.2) and financed by the most opulent commercial banks and PFIs (see 6.2.3 & 6.2.4), all of whom reap several hundreds of billions of dollars in profits from investing in these E&Ps all the while perpetuating the 'climate emergency' by promoting unabated South African coal, oil and gas production.

Perhaps, then, the 'capitalism/capitalogenic-driven emergency' is even better suited to describe the 'climate' calamity at hand.

Donna Haraway (2016: 3) hints at two prospective dangers of adopting charged language like the 'Capitalocene'. First is a "comic faith in technofixes, whether secular or religious", and the second is a "position that the game is over, that it's too late"; the former warns against fallaciously relying on geoengineering, BECCS or other cleverly deceitful ploys like the elusive 'net-zero' gambit (see 2.1.2.1 & 4.3.3.9), while the latter urges us to look past the cynics that have lost hope for a better tomorrow. Haraway (ibid: 51) argues that "another world is not only urgently needed, it is possible, but not if we are ensorcelled in despair, cynicism, or optimism," a world she conceptualises as the 'Chthulucene':

> Unlike the Anthropocene and the Capitalocene, the Chthulucene is made up of ongoing multispecies stories and practices of becoming-with in times that remain at stake, in precarious times, in which the world is not finished and the sky has not fallen yet (Haraway, 2016: 51).

Here, the 'Chthulu' prefix refers to a fictional and cosmic divinity with human (e.g., arms and legs) and non-human qualities (e.g., wings and tentacles), who is used to symbolise human and non-human species co-existing and co-creating reality together (a 'sym-poiesis') (ibid). Note that Haraway does not dispute Moore's (2017; 2018) *Capitalocene*; in fact, she notes (Haraway, 2016: 46, ***emphasis added***) that "every imaginable, and many unimaginable, technologies and strategic measures are being *pursued buy all the big global players to* ***extract every last calorie of fossil carbon at whatever depth and in whatever formations***." The problem for Haraway (2016: 50), however, is that the term 'Capitalocene' may be counterproductively vilifying, and such "denunciations have been singularly ineffective, [otherwise] capitalism would have long ago vanished from the Earth." Another issue with the 'Capitalocene' is that it itself reduces the "agency of humanity… to those Humans at the core of capitalist society" (Córdova & Bailey, 2019: 7), which on the one hand is arguably justified as a historical driver of global warming, but on the other relinquishes non-capitalists of their own agency. The 'Chthulu' prefix opens the door to "decolonise eco-Marxism" and "make most visible the agency of humans… lying outside the realm of capitalism and its core" (ibid: 7).

Hence, perhaps there is room for both terminologies to coexist, reconceptualising the 'capitalogenic emergency' as something to the tune of the 'Capitalist-driven, Chthulu-endured emergency'.

Calling this an 'emergency' or 'crisis' is also problematic as it embodies an expectation that – like a *financial crisis* – this climate or ecological 'crisis' will eventually 'pass' (Latour, 2016). However, a simple rebuttal need look no further than the 150,000 annual deaths that 'climate change' is already claiming, the bulk of which are heavily concentrated in the poorest nations in sub Saharan Africa (WHO, n.d.), deaths that are very permanent and by no means will 'pass'. Not to mention the various biophysical 'tipping points' that – again, quite literally – denote limits beyond which ***irreversible*** (i.e. permanent, non-temporary, non-'passable') changes to climate systems solidify (Lenton, 2011: 201). This logic also applies to the 'emergency'; when you have a medical 'emergency' and rush to an 'emergency room',[176] you hope to receive (immediate) care and eventually return to your life as though nothing had happened.

Thus, the phrase 'climate crisis/emergency' seems grossly inadequate to convey historical politics, gravity, seriousness, and permanence of the disaster that lays before us. Latour (2016: 8) suggests that rather than a crisis (or emergency), we should denote this as a "profound mutation of our relation to the world" - or perhaps more concisely, *Climate-mutating Cataclysm*.

Altogether then, it seems that the 'climate emergency' ought to be reconceptualised as the ***Capitalist-driven, Chthulu-endured, Climate-mutating Cataclysm***, or abbreviated, *4C*. Accordingly, one cannot 'solve' the 4C, for the 4C describes the *irreversible death and mutation of the world that capitalist institutions have driven* through their South African fossil investments and beyond. Efforts can be made to *manage*, *tame*, *pacify*, *combat* or *navigate* the 4C, as a few examples, but it should be stressed that definitive claims to 'resolve' the irreparable and irreversible realities of the 4C are naïve at best.

9.6.2.2. 'global North' & 'global South'

With the terms 'first, second' and 'third world' losing traction as the Soviet Union dissolved at the end of the 20th century (and due to their derogatory connotations), it became commonplace to categorise nations based on income levels (typically measured through the Gross Domestic Product (GDP) or Gross National Income (GNI)), and subsequently assign a 'developed' or 'industrialised' qualifier to those with GDP values above a certain threshold, and a corresponding 'developing' or 'industrialising' qualifier to those below it, implying that the 'developed countries' had reached some arbitrary goal

[176] Based on my own experience with emergency rooms in Europe and North America

that their 'developing' counterparts were striving towards (Rodney, 2018). These classifications were also met with friction (rightfully so), for they carried the same Eurocentric and demeaning connotations as their 'third world' predecessors (Khokhar & Serajuddin, 2015); accordingly, this vocabulary has veered towards a more objective variant, with the official UN country classifications structured around various permutations of 'high', 'middle' and 'low-income countries' (UN, 2020). Subsequently, a pseudo-geographical dimension was then introduced to group 'high income' and 'low-middle income' countries (HICs and LMICs, respectively) together, producing what we now refer to as the *Global North* and *Global South*,[177] with the former including the likes of e.g., the United States (US) and all of Europe, while the latter consists of all of Africa, Asia and most of Central and South America (Odeh, 2010). These labels were used repeatedly throughout this study, though hesitantly so, for reasons explained below.

Although not as hierarchical, the Global North-South divide is somewhat emblematic of the abandoned First-Third World labels (e.g., Horner, 2019). In a similar vein to the critique of the 'Anthropos' (see 9.6.2.1), what is perhaps most problematic is the reductionist and apolitical nature of these terms. Classifying a nation as 'low-income' or within the 'global South' homogenises it both inter- and intra-nationally. For instance, climate debt advocates often argue that the 'global North' has emitted more than its fair share of greenhouse gasses, and is now in its entirety indebted to the 'global South' (see 2.2.1.3). Is this really true, though? Is the entire population of the 'global North' in debt? Should the uninsured Philadelphian single mother working three full-time jobs who cannot pay her daughter's medical bills be assigned equal agency (and accordingly, responsibility) as powerful elites from the 'North', like the CEO of a major E&P, whose business-as-usual (BAU) has wreaked havoc on the climate front? Similarly, are all members of the 'global South' indebted to and absolved from any blame? Walter Rodney (2018: 145) speaks to the latter, noting that although White-dominated colonial Europe was responsible for the African slave trade – or the "Rape of Africans from 1445-1870" – some African leaders recognised that producing slaves (i.e. involuntarily captivating citizens) to sell to European colonisers was potentially more lucrative than mining other natural resources: "Europeans know that they carried on the slave trade, and Africans are aware that the trade would have been impossible if certain Africans did not co-operate with the slave ships" (ibid: 126).

These 'North-South' reductionist tendencies have proven problematic in this research as well. For instance, 'China' is not an Annex 1/B member (see 1.4.1) and is thus technically a member of the 'global South', and yet, it was revealed that Chinese PFIs have played a central role in hoisting and driving both South African and African fossil projects (see 6.2.4 and 0). Similarly, South Africa is also in the 'global South', and yet, its fossil regime would not have grown to its current state had it not been for lacklustre national policies that openly invited investment in its coal, oil and gas reserves, both before and after the collapse of the Apartheid regime (see 1.3.2.1). Just as not all Africans were absolved from responsibility in the slave trade (Rodney, 2018), it would follow that not all members of the 'global South' are absolved from responsibility from hoisting unabated fossil fuel production, accumulating a SAD, and perpetuating the 4C.

Hence, this generalised and overly-simplified 'North-South' terminology is misleading, particularly in the face of such an intersectional (e.g., Fraser, 2016; 2021; Buckingham, 2015; Elmhirst, 2011; 2015) arena like that of the *Capitalist-driven, Chthulu-endured, Climate-mutating Cataclysm*; policies aiming to 'hold the North accountable' run the risk of unevenly and unjustly distributing burdens across entire populations, while 'aid for the South' may very well end in the hands of corrupt elites. Inspired by Andy

[177] It is 'pseudo' geographical because the bulk of the nations considered to be in the 'global South' are in fact in the Northern hemisphere

Stirling's (2010) article in *Nature* vouching for scientists to 'keep things complex',[178] and building on the earlier Capital- and Chthulu- prefixes, perhaps in the context of the 4C, the 'global North' and 'South' ought to be disaggregated into the *Capital-North* and *Capital-South*, referring to the class of powerful elites (financiers, business leaders, politicians, etc.) that themselves have profited from funnelling capital resources to expand global fossil fuel production (and de facto accumulated a SAD), and the *Chthulu-North* and *Chthulu-South*, referring to the broader range of human and non-human species across their respective spatial domains that face several stranded asset- and climate-related calamitous repercussions from the Capital-North and Capital-South's destructive behaviour, and are owed the aforementioned SAD. It is still important to differentiate between the 'North' and 'South', particularly in the case of the 'Capital-North' and 'Capital-South', for there are certainly power politics at play in international fossil finance that place capitalist actors from different domains on unlevel playing fields (though these power politics are beyond the scope of this research). However, this disaggregation is critical to begin improving the state of knowledge, and, ergo, the ontological and epistemological premise within which an 'inclusive' approach to combatting the 4C may begin to unfold in the coming years.

9.6.3. Concluding Remarks

With these theoretical and conceptual insights, and the empirical evidence base from which they arise, I hope that this dissertation makes a small but important contribution to aiding both research and actionable agendas in mitigating against the devastating and life threatening impacts of the 4C. Or at the very least, I hope it provokes debate and stimulates reflection in both the 'Capital-North/South' and the 'Chthulu-North/South' to more concretely craft pathways towards a future that is inclusive on both interspatial and intergenerational levels. Clearly, lots must change at international, national and local levels if the present and future wellbeing of the world's most under-resourced and under-privileged citizens is to be prioritised, and although this research has several limitations (see 9.5), perhaps it can at least inspire thoughts to sculpt a better tomorrow – beyond the 4C. To reiterate Latour (2016), we as scientists have a 'response-ability' to address the political challenges of our time, and I hope above all else that this mantra is reflected in my work.

[178] Rather than 'keeping things simple', as the saying goes

References: Peer-Reviewed Articles, Books & Book Chapters

Abraham, J. (2017). Just Transitions for the Miners: Labor Environmentalism in the Ruhr and Appalachian Coalfields. *New Political Science*, *39*(2), 218-40. doi: 10.1080/07393148.2017.1301313

Acevedo, A. (2012). Responsible Profitability? Not on my Balance Sheet!. *Catholic University Law Review*, *61*(3). Retrieved May 2 2022 from: https://scholarship.law.edu/cgi/viewcontent.cgi?article=1019&context=lawreview

Aengenheyster, M., Feng, Q., van der Ploeg, F., & Dijkstra, H. (2018). The point of no return for climate action: effects of climate uncertainty and risk tolerance. *Earth Systems Dynamics*, 1085-95. doi:10.5194/esd-9-1085-2018

Agrawal, A., & Narain, S. (2011). Global warming in an unequal world: A case of environmental colonialism. *Handbook of Climate Change and India*, 10.4324/9780203153284.ch5.

AISSR. (2019). *AISSR Integrity Protocol.* Amsterdam: Amsterdam Institute for Social Science Research. Retrieved 08 05, 2020, from https://aissr.uva.nl/our-research/ethics-and-integrity/ethics-and-integrity.html#AISSR-Integrity-Protocol

Allenby, B. (2006). The ontologies of industrial ecology? *Progress in Industrial Ecology, 3*(3), 28-40. doi:10.1504/PIE.2006.010039

Álvarez, L., & Coolsaet, B. (2018). Decolonizing Environmental Justice Studies: A Latin American Perspective. *Capitalism Nature Socialism*, 1-28. doi:10.1080/10455752.2018.1558272

Ansari, D., & Holz, F. (2020). Between stranded assets and green transformation: Fossil-fuel-producing developing countries towards 2055. *World Development, 130*, 1-17. doi:10.1016/j.worlddev.2020.104947

Armstrong, C. (2019). Decarbonisation and World Poverty: A Just Transition for Fossil Fuel Exporting Countries? *Political Studies, 68*(3), 671-688. doi:10.1177/0032321719868214

Arsel, M., Hogenboom, B., & Pellegrini, L. (2016). The extractive imperative in Latin America. *The Extractice Industries and Society, 3*(4), 880-87. doi:10.1016/j.exis.2016.10.014

Asayama, S., Hulme, M. (2019). Engineering climate debt: temperature overshoot and peak-shaving as risky subprime mortgage lending. *Climate Policy, 19*(8), 937-46. doi: 10.1080/14693062.2019.1623165

Asheim, G., Faehn, T., Nyborg, K., Greaker, M., Hagem, C., Harstad, B., . . . Rosendahl, K. (2019). The case for a supply-side climate treaty. *Science, 365*(6451), 325-7. doi:10.1126/science.aax5011

Asongu, S., Le Roux, S., Biepke, N. (2017). Environmental degradation, ICT and inclusive development in Sub-Saharan Africa. *Energy Policy, 111,* 353-61. doi: 10.1016/j.enpol.2017.09.049

Asongu, S., Le Roux, S., Singh, P. (2021). Fighting terrorism in Africa: Complementarity between inclusive development, military expenditure and political stability. *Journal of Policy Modeling, 43*(5), 897-922. doi: 10.1016/j.jpolmod.2020.01.014

Attansi, E. D., & Freeman, P. A. (2013). *Role of Stranded Gas in Increasing Global Gas Supplies.* Virginia: US Geological Survey. Retrieved 05 10, 2020, from https://pubs.usgs.gov/of/2013/1044/

Ayling, J., & Gunningham, N. (2015). Non-State Governance and Climate Policy: The Fossil Fuel Divestment Movement. *SSRN Electronic Journal*. doi:10.2139/ssrn.2601176

Ayres, R., van den Bergh, J., Lindenberger, D., & Warr, B. (2013). The underestimated contribution of energyto economic growth. *Structural Change and Economic Dynamics, 27*, 79-88. doi:10.1016/j.strueco.2013.07.004

Baer, P. (2012). The greenhouse development fights framework for global burden sharing: reflection on principles and prospects. *Wiley Interdisciplinary Reviews: Climate Change, 4*(1), 61-71. doi:10.1002/wcc.201

Baker, L. (2015a). Renewable energy in South Africa's minerals-energy complex: a 'low carbon' transition? *Review of African Political Economy, 42*(144), 245-261. doi:10.1080/03056244.2014.953471

Baker, L. (2015b). The evolving role of finance in South Africa's renewable energy sector. *Geoforum, 64*, 146-156. doi:10.1016/j.geoforum.2015.06.017

Baker, L., Newell, P., & Phillips, J. (2014). The Political Economy of Energy Transitions: The Case of South Africa. *New Political Economy*, 791-818. doi:10.1080/13563467.2013.849674

Baldwin, E., Cai, Y., & Kuralbayeva, K. (2020). To build or not to build? Capital stocks and climate policy*. *Journal of Environmental Economics and Management, 100*. doi:10.1016/j.jeem.2019.05.001

Bang, G., & Lahn, B. (2019). From oil as welfare to oil as risk? Norwegian petroleum resource governance and climate policy. *Climate Policy*. doi:10.1080/14693062.2019.1692774

Banktrack. (n.d.). *Banks, Policies, Dodgy Deals, Campaigns*. Retrieved 10 22, 2021, from Banktrack: https://www.banktrack.org/

Barca, S., & Bridge, G. (2015). Industrailization and Environmental Change. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 366-77). New York: Routledge.

Bebbington, J., Schneider, T., Stevenson, L., & Fox, A. (2020). Fossil fuel reserves and resources reporting and unburnable carbon: Investigating conflicting accounts. *Critical Perspectives on Accounting, 66*. doi:10.1016/j.cpa.2019.04.004

Benjaminsen, T., & Svarstad, H. (2019). Political Ecology. *Encyclopedia of Ecology (Second Edition)*, 391-6.

Bergbauer, S., & Maerten, L. (2015). Unlocking stranded resources in naturally fractured reservoirs using a novel approach to structural reconstructions and palaeostress field modelling: an example from the Hoton field, southern North Sea. *Geological Society, 421*(1), 246-61. doi:10.1144/SP421.8

Best, R. (2017). Switching towards coal or renewable energy? The effects of financial capital on energy transitions. *Energy Economics, 63*, 75-83. doi:10.1016/j.eneco.2017.01.019

BHP Billiton. (2021). *Climate change*. Retrieved 10 22, 2021, from BHP Billiton: https://www.bhp.com/sustainability/climate-change

Bloomberg. (2021, Aug 5). *Eskom seeking R33 billion from development institutions*. Retrieved March 12, 2022, from BusinessTech: https://businesstech.co.za/news/energy/511324/eskom-seeking-r33-billion-from-development-institutions/

Bond, P. (2010). Climate Debt Owed to Africa: What do Demand and How to Collect? *African Journal of Science, Technology, Innovation and Development*.

Bond, P. (2018). Climate debt, community resistance and conservation alliances against KwaZulu-Natal coal mining at Africa's oldest nature reserve. In B. Engels, & K. Dietz, *Climate Change in Africa.* Frankfurt: Peter Lang Ltd. International Academic Publishers. doi:10.3726/b13085

Bond, P., & Basu, R. (2022). Intergenerational Equity and the Geographical Ebb and Flow of Resources: The Time and Space of Natural Capital Accounting. In M. Himley, E. Havice, & G. Valdivia, *The Routledge Handbook of Critical Resource Geography.* New York City: Routledge.

Bos, K., & Gupta, J. (2018). Climate change: the risks of stranded fossil fuel assets and resources to the developing world. *Third World Quarterly, 39*(3), 436-453. doi:10.1080/01436597.2017.1387477

Bos, K., & Gupta, J. (2019). Stranded assets and stranded resources: Implications for climate change mitigation and global sustainable development. *Energy Research & Social Science, 56*. doi:10.1016/j.erss.2019.05.025

Bosch, H. (Working Paper). Review of Mining Contracts and Water Allocation.

BP. (2020, 2 12). *BP sets ambition for net zero by 2050, fundamentally changing organisation to deliver*. Retrieved 10 22, 2021, from BP: https://www.bp.com/en/global/corporate/news-and-insights/press-releases/bernard-looney-announces-new-ambition-for-bp.html

BP. (2020). *Statistical Review of World Energy.* London: BP. Retrieved 07 22, 2020, from https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html

Braun, B. (2015). From Critique to Experiment? Rethinking political ecology for the Anthropocene. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 102-14). New York: Routledge.

Broad, R., & Fischer-Mackey, J. (2017). From extractivism towards Buen Vivir: mining policy as an indicator of a new development paradigm prioritising the environment. *Third World Quarterly, 38*(6), 1327-1349. doi:10.1080/01436597.2016.1262741

Buckingham, S. (2015). Ecofeminism. *International Encyclopedia of the Social & Behavioral Sciences (Second Edition), 9*, 845-50. doi:10.1016/B978-0-08-097086-8.91020-1

Bureau of Transportation Statistics. (2019). *Average age of Aircrafts 2019*. Retrieved 07 25, 2020, from Bureau of Transportation Statistics: https://www.bts.gov/average-age-aircraft-2019

Burger, M., & Wentz, J. (2018). Holding fossil fuel companies accountable for their contribution to climate change: Where does the law stand? *Bulletin of the Atomic Scientists, 74*(6), 397-403. doi:10.1080/00963402.2018.1533217

Cairns, R. (2018). Stranded Oil of Erewhon. *Energy Policy*, 248-251. doi:10.1016/j.enpol.2018.06.032

Caldecott, B. (2017). Introduction to special issue: stranded assets and the environment. *Journal of Sustainable Finance & Investment, 7*(1), 1-13. doi: 10.1080/20430795.2016.1266748

Caldecott, B., & Dericks, G. (2018). Empirical calibration of climate policy using corporate solvency: a case study of the UK's carbon price support. *Climate Policy, 18*(3), 776-780. doi:10.1080/14693062.2017.1382318

Caldecott, B., McSharry, N., & Howarth, P. (2013). *Stranded assets in agriculture: protecting value from environment-related risks.* Oxford: University of Oxford. Retrieved 05 10, 2020, from https://ora.ox.ac.uk/objects/uuid:4496ac03-5132-4a64-aa54-7695bfc7be9d

Campigli, E., Dafermos, Y., P, M., Ryan-Collins, J., Schotten, G., & Tanaka, M. (2018). Climate change challenges for central banks and financial regulators. *Nature Climate Change, 8*, 462-8. doi:10.1038/s41558-018-0175-0

Cardno, C. (2018). Policy Document Analysis: A Practical Educational Leadership Tool and a Qualitative Research Method. *Educational Administration: Theory and Practice, 24*(4), 623-40.

Carley, S., Konisky, D. (2020). The justice and equity implications of the clean energy transition. *Nature Energy, 5*, 569-77. doi: 10.1038/s41560-020-0641-6

Castree, N. (2015). Capitalism and the Marxist Critique of Political Ecology. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 279-92). New York: Routledge.

Cato, M. S. (2012). Green economics: putting the planet and politics back into economics. *Cambridge Journal of Economics, 36*(5), 1033-1049. doi:10.1093/cje/bes022

Chapman, A., McLellan, B., & Tezuka, T. (2018). Prioritizing mitigation efforts considering co-benefits, equity and energy justice: Fossil fuel to renewable energy transition pathways. *Applied Energy, 219*, 187-98. doi:10.1016/j.apenergy.2018.03.054

Chen, J., & Scott, G. (2020, 03 19). *Liquidity*. Retrieved 07 25, 2020, from Investopedia: https://www.investopedia.com/terms/l/liquidity.asp

Chen, P., Wang, S., Shuang, S., Wang, Y., Wang, Y., Gao, D, & Li, Z.. (2022). Ecological restoration intensifies evapotranspiration in the Kubuqi Desert. *Ecological Engineering, 175.* doi: 10.1016/j.ecoleng.2021.106504

Chepeliev, M., & Mensbrugghe, D. (2020). Global fossil-fuel subsidy reform and Paris Agreement. *Energy Economics, 85*. doi:10.1016/j.eneco.2019.104598

Chimakonam, J. (2019). Addressing the problem of mass poverty in the Subsaharan Africa: Conversational thinking as a tool for inclusive development. *Filosofia Theoretica, 8*(1), 141-61. doi: 10.4314/ft.v8i1.10

Christophers, B. (2019). Environmental Beta or How Institutional Investors Think about Climate Change and Fossil Fuel Risk. *Annals of the American Association of Geographers, 109*(3), 754-74. doi:10.1080/24694452.2018.1489213

Coady, D., Parry, N., Le, P., & Shang, B. (2019). *Global fossil fuel subsidies remain large: An update based on country-level estimates.* IMF. Retrieved 09 01, 2020, from https://www.imf.org/en/Publications/WP/Issues/2019/05/02/Global-Fossil-Fuel-Subsidies-Remain-Large-An-Update-Based-on-Country-Level-Estimates-

46509#:~:text=Globally%2C%20subsidies%20remained%20large%20at,percent%20of%20GDP)%20in%202017.

Coalition, C. J. (2020). Just Us and the Climate [Recorded by A. Lenferna, M. Nkali, & F. Nkosi]. Johannesburg, Gauteng, South Africa. Retrieved March 11, 2021, from https://pod.link/cjc

Cobb, C., & Douglas, P. (1928). A Theory of Production. *American Economic Review, 18*, 139-65. Retrieved May 12, 2021, from https://assets.aeaweb.org/asset-server/journals/aer/top20/18.1.139-165.pdf

Cock, J. (2019). Resistance to coal inequalities and the possibilities of a just transition in South Africa*. *Development of Southern Africa*, 86-873. doi:10.1080/0376835X.2019.1660859

Cole, D. (2011). FROM GLOBAL TO POLYCENTRIC CLIMATE GOVERNANCE. *SSRN Electronic Journal*, 1-27. doi:10.2139/ssrn.1858852

Collier, P., & Venables, A. (2015). Closing coal: economic and moral incentives. *Oxford Review of Economic Policy, 30*(3), 492-512. doi:10.1093/oxrep/gru024

Cooper, J. (2009). Territories of difference: place, movements life by Arturo Escobar. *International Social Science Journal, 60*(197-8), 497-508. doi:10.1111/j.1468-2451.2010.01738.x

Corbridge, S. (2007). The (im)possibility of Development Studies. *Economy and Society, 36*(2), 179-211. doi:10.1080/03085140701264869

Córdova, J., & Bailey, D. (2019). Forum introduction: Decolonising green Marxism: Capitalism, decolonialism and radical environmental politics. *Capital & Class, 45*(1), 3-9. doi:10.1177/0309816820929114

Corrado, G., & Corrado, L. (2017). Inclusive finance for inclusive growth and development. *Current Opinion in Environmental Sustainability, 24*, 19-23. doi:10.1016/j.cosust.2017.01.013

Costanza, R. (2008). Ecological Economics 1. *Encyclopedia of Ecology*, 999-1006. doi:10.1016/b978-008045405-4.00619-4

Crew, M. (1999). *Regulation Under Increasing Competition.* Springer. doi:10.1007/978-1-4615-5117-1

Curtin, J., Mcinerney, C., Ó Gallachóir, B., Hickey, C., Deane, P., & Deeney, P. (2019). Quantifying stranding risk for fossil fuel assets and implications for renewable energy investment: A review of the literature. *Renewable and Sustainable Energy Reviews, 116*. doi:10.1016/j.rser.2019.109402

da Silva, T., & Delgado, F. (2018). Leapfrogging Natural Gas in the Energy Transition: More Renewables, More Technology and More Stranded Assets. *Geopolitics of Energy, 40*(7-8), 2-6.

Daily Maverick. (2021, 10 22). *Our Burning Planet*. Retrieved https://www.dailymaverick.co.za/our-burning-planet/?utm_source=top-menu&utm_medium=link, from Daily Maverick.

David, M. (2018). The role of organized publics in articulating the exnovation of fossil-fuel technologies for intra- and intergenerational energy justice in energy transitions. *Applied Energy, 228*, 339-50. doi:10.1016/j.apenergy.2018.06.080

Davis, S., & Socolow, R. (2014). Commitment accounting of CO2 emissions. *Environmental Research Letters, 9*(8). doi:10.1088/1748-9326/9/8/084018

De Sousa Santos, B. (2014). *Epistemologies of the Global South: Justice Against Epistemicide.* New York City: Routledge.

Demerritt, D. (2015). The Promises of Participation in Science and Political Ecology. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 224-234). New York: Routledge.

Denina, C., & Burton, M. (2021, Aug 3). *ADB, Citi, HSBC, Prudential hatch plan for Asian coal-fired closures*. Retrieved March 12, 2022, from Reuters: https://www.reuters.com/world/uk/exclusive-citi-hsbc-prudential-hatch-plan-asian-coal-fired-closures-sources-2021-08-03/

Desai, S., Koryakina, I., Case, A., Toney, M., & Astumi, S. (2016). Biological conversion of gaseous alkenes to liquid chemicals. *Metabolic Engineering, 38*, 98-104. doi:10.1016/j.ymben.2016.07.002Get

DFFE (Department of Forestry, Fisheries & the Environment RSA). (2021). *South Africa's updated draft Nationally Determined Contribution (NDC) launched.* Pretoria: DFFE. Retrieved 10 22, 2021, from https://www.environment.gov.za/mediarelease/creecy_indc2021draftlaunch_climatechangecop26

Dillon, J. (2001), The History of the Ecological Debt Movement. Paper for the Conference 'Globalisation, Ecological Debt, Climate Change and Sustainability', Republic of Benin, November 27-30, 2001

DMRE (Department of Mineral Resources & Energy RSA). (2019). *Integrated Resource Plan.* Pretoria: DMRE. Retrieved 10 22, 2021, from https://www.bing.com/search?q=south+africa+irp&cvid=8fd2b1785b144d6dbdc0fa87f886ab7c&aqs=edge..69i57l2j69i65j69i60l4.1611j0j4&FORM=ANAB01&PC=HCTS

DMRE (South Africa Department of Mineral Resourcs and Energy). (n.d.). *Our Vision & Mission*. Retrieved March 10, 2022, from DMRE: https://www.dmr.gov.za/about-dmr/overview

Dong, L., Wei, S., & Zhang, H. (2008). GTL or LNG: which is the best way to monetize "stranded" natural gas? *Petroleum Science, 5*, 388-394. doi:10.1007/s12182-008-0063-8

Duggal, H. (2021, Nov 14). *Infographic: What has your country pledged at COP26?* Retrieved March 11, 2022, from AlJazeera: https://www.aljazeera.com/news/2021/11/14/infographic-what-has-your-country-pledged-at-cop26#:~:text=New%20net%2Dzero%20pledges,urged%20to%20achieve%20by%202050.

Dyke, J., Watson, R., & Knorr, W. (2021, April 27). Climate scientists: concept of net zero is a dangerous trap. *Social Europe*. Retrieved April 28, 2021, from https://www.socialeurope.eu/climate-scientists-concept-of-net-zero-is-a-dangerous-trap

Easterly, W. (2001). The lost decades: Developing countries' stagnation in spite of policy reform 1980-1998. *Journal of Economic Growth*, 135-57.

Easterly, W. (2005). What did structural adjustment adjust?: The association of policies and growth with repeated IMF and World Bank adjustment loans. *Journal of Development Economics, 76*(1), 1-22. doi:10.1016/j.jdeveco.2003.11.005

Economides, M. J., & Wood, D. A. (2009). The state of natural gas. *Journal of NAtural Gas Science and Engineering*, 1-13. doi:10.1016/j.jngse.2009.03.005

Edenhofer, O., Jakob, M., Creutzig, F., Flachsland, C., Fauss, S., Kowarsch, M., . . . Steckel, J. (2015). Closing the emission price gap. *Global Environmental Change, 31*, 132-43. doi:10.1016/j.gloenvcha.2015.01.003

Edenhofer, O., Kalkhul, M., Requate, T., & Steckel, J. C. (2020). How assets get stranded: The impact of climate policy on capital and fossil fuel owners. Introduction to the JEEM special section on climate policy and political economy. *Journal of Environental Economics and Management, 100*. doi:10.1016/j.jeem.2020.102300

Edwards, P., O'Mahoney, J., & Vincent, S. (2014). *Studying Organizations Using Critical Realism.* Oxford: Oxford University Press. doi:10.1093/acprof:oso/9780199665525.001.0001

EIB. (2019). *EIB energy lending policy: Suporting the energy transformation.* Zurich: European Investment Bank. Retrieved 07 29, 2020, from https://www.eib.org/en/publications/eib-energy-lending-policy.htm

Eichner, T., & Pethig, R. (2019). Supply-Side Climate Policy: On the Role of Exploration and Asymmetric Information. *Environmental and Resource Economics, 74*, 397-420. doi:10.1007/s10640-019-00323-0

Ekins, P., Gupta, J., & Boileau, P. (2019). *Global Environment Outlook : GEO-6 : healthy planet, healthy people.* Cambridge: Cambridge University Press.

Elmhirst, R. (2011). Introducing new feminist political ecologies. *Geoforum, 42*(2), 129-32. doi:10.1016/j.geoforum.2011.01.006

Elmhirst, R. (2015). Feminist Political Ecology. In T. Perreault, G. Bridge, & M. J, *The Routledge Handbook of Political Ecology* (pp. 519-30). New York: Routledge.

Equinor. (n.d.). *We're going for net zero, but what does that really mean?* Retrieved March 10, 2022, from Equinor: https://www.equinor.com/en/sustainability/climate.html#:~:text=Equinor%20aims%20to%20become%20a,grow%20a%20profitable%20renewables%20business.

Erickson, P., Lazarus, M., & Piggot, G. (2018). Limiting fossil fuel production as the next big step. *Nature Climate Change*. doi:10.1038/s41558-018-0337-0

Erlingsson, C., & Byrsiewicz, P. (2017). A hands-on guide to doing content analysis. *African Journal of Emergency, 7*(3), 93-9. doi:10.1016/j.afjem.2017.08.001

Eschenhangen, M., & Maldonado, C. (2014). *Un viaje por las alternativas al desarrollo: Perspectivas y propuestas teóricas.* Bogóta: Universidad del Rosario.

Escobar, A. (2008). *Territories of Difference.* Durham: Duke University Press.

European Parliament. (2019, 11 29). *The European Parliament declares climate emergency*. Retrieved March 3, 2022, from European Parliament News: https://www.europarl.europa.eu/news/en/press-room/20191121IPR67110/the-european-parliament-declares-climate-emergency

EU (European Union). (2021). *France, Germany, UK, US and EU launch ground-breaking International Just Energy Transition Partnership with South Africa*. Brussels: EU. Retrieved May 29, 2022 from: https://ec.europa.eu/commission/presscorner/detail/cs/ip_21_5768

Evans, G., & Phelan, L. (2016). Transition to a post-carbon society: Linking environmental justice and just transition discourses. *Energy Policy, 99*, 329-39. doi:10.1016/j.enpol.2016.05.003

Faehn, T., Hagem, C., Lindholt, L., Maeland, S., & Rosendahl, K. (2017). Climate policies in a fossil fuel producing country: Demand versus supply side policies. *The Energy Journal, 38*(1), 77-102. doi:10.5547/01956574.38.1.tfae

Faisal, F., Khan, M., Pervaiz, R., Muhamad, P., Rashdan, M. (2021). Exploring the role of fossil fuels, hydroelectricity consumption, and financial sector in ensuring sustainable economic development in the emerging economy. *Environmental Science and Pollution Research, 25*(5), 5953-65. doi: 10.1007/s11356-020-10608-3

Fine, B., & Rustomjee, Z. (2018). *The political economy of South Africa: From minerals-energy complex to industrialisation.* Taylor & Francis.

Fletcher, A. (2017). Applying critical realism in qualitative research: methodology meets method. *International Journal of Social Research Methodology, 20*(2). doi:10.1080/13645579.2016.1144401

Fossil Free. (2020). *The Carbon Underground 200.* Fossil Free Funds. Retrieved March 9, 2021, from https://fossilfreefunds.org/carbon-underground-200

Foster, E., Contestabile, M., Blazquez, J., Manzano, B., Workman, M., & Shah, N. (2017). The unstudied barriers to widespread renewable energy deployment: Fossil fuel price responses. *Energy Policy, 103*, 258-64. doi:10.1016/j.enpol.2016.12.050

Foucault, M. (1978). *Security, Territory, Population.* Paris: Palgrave Macmilan.

Foucault, M. (1980). *Power-Knowledge: Selected Interviews & Other Writing 1972-1977.* New York City: The Harvester Press.

Franke, A. (2021). *COP26: Western nations pledge $8.5 billion for South African coal phase-out*. S&P Global Commodity Insights. Retrieved April 29, 2022 from: https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/110321-cop26-western-nations-pledge-85-billion-for-south-african-coal-phase-out

František, Z., Martin, S., Václav, K. (2022). Multi-stage stochastic optimization of carbon risk management. *Expert Systems with Applications, 201*. doi: 10.1016/j.eswa.2022.117021

Fraser, N. (2016). CONTRADICTIONS OF CAPITAL AND CARE. *New Left Review, 100*. Retrieved May 7, 2021, from https://newleftreview.org/issues/ii100/articles/nancy-fraser-contradictions-of-capital-and-care

Fraser, N. (2021). Climates of Capital. *New Left Review, 127*(10), 94-128.

Funtowicz, S., & Ravetz, J. (2003). *Post-Normal Science.* International Society for Ecological Economics: Internet Encyclopedia of Ecological Economics. Retrieved 08 05, 2020, from http://isecoeco.org/pdf/pstnormsc.pdf

Gadre, R., & Anandarajah, G. (2019). Assessing the evolution of India's power sector to 2050 under different CO2 emissions rights allocation schemes. *Energy for Sustainable Development, 50*, 126-138. doi:10.1016/j.esd.2019.04.001

Garcia Portela, L. (2020). Moral responsibility for climate change loss and damage: A response to the excusable ignorance objection. *Teorema*, 7-24.

Gardiner, S. (2011). Climate Justice. In J. Dryzek, R. Norgaard, & D. Schlosberg, *The Oxford Handbook of Climate Change and Society.* London: Oxford University Press. doi:10.1093/oxfordhb/9780199566600.003.0021

Gaulin, N., & Le Billon, P. (2020). Climate change and fossil fuel production cuts: assessing global supply-side constraints and policy implications. *Climate Policy, 20*(8), 888-901. doi:10.1080/14693062.2020.1725409

Geels, F. (2014). Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. *Theory, Culture & Society, 31*(5), 21-40. doi:10.1177/0263276414531627

Geels, F., Sovacool, B., Schwanen, T., & Sorrell, S. (2017). Sociotechnical transitions for deep decarbonization. *Science, 357*(6357), 1242-4. doi:10.1126/science.aao3760

GEM (Global Energy Monitor). (2015a). *Global Coal Plant Tracker*. Retrieved 10 22, 2021, from GEM: https://globalenergymonitor.org/projects/global-coal-plant-tracker/

GEM. (2015b). *Global Coal Mine Tracker*. Retrieved 10 22, 2021, from GEM: https://globalenergymonitor.org/projects/global-coal-mine-tracker/

GEM. (2015c). *Global Fossil Infrastructure Tracker*. Retrieved 10 22, 2021, from GEM: https://globalenergymonitor.org/projects/global-fossil-infrastructure-tracker/

Georgescu-Rogen, N. (1971). *The Entropy Law and the Economic Process.* Boston: Harvard University Press.

Gerretsen, I. (2021, Jan 14). *South Korea 2050 net zero pledge spurs renewables investment*. Retrieved March 10, 2022, from Climate Home News: https://www.climatechangenews.com/2021/01/14/south-korea-2050-net-zero-pledge-spurs-renewables-investment/

Giannelos, S., Konstantelos, I., & Strbac, G. (2019). Investment model for cost-effective integration of solar PV capacity under uncertainty using a portfolio of energy storage and soft open points. *IEEE Milan PowerTech*, 1-6. doi:10.1109/PTC.2019.8810522

Glassman, J. (2006). Primitive accumulation, accumulation by dispossession, accumulation by ‘extra-economic’ means. *Progress in Human Geography, 30*(5), 608-25. doi:10.1177/0309132506070172

Green, F., & Denniss, R. (2018). Cutting with both arms of the scissors: the economic and political case for restrictive supply-side policies. *Climate Change, 150*, 73-87. doi:10.1007/s10584-018-2162-x

GroundWork. (2019). *Down to Zero: The politics of a just transition.* Johannesburg: GroundWork. Retrieved March 24, 2022 from: https://lifeaftercoal.org.za/wp-content/uploads/2020/05/gW_Report_2019-Down-to-Zero.pdf

GroundWork. (2018). *Boom and Bust in the Waterberg: A History of coal mega projects.* Johannesburg: Groundwork. Retrieved March 10, 2022, from https://www.groundwork.org.za/reports/gW_Report_2018_-_Boom_or_Bust_in_the_Waterberg_-_A_history_of_coal_mega-projects.pdf

Gunningham, N. (2020). A Quiet Revolution: Central Banks, Financial Regulators and Climate Finance. *Sustainability, 12*(22), 1-22.

Gupta, J. (1997). The Climate Change Convention and Developing Countries: From Conflict to Consensus?. New York City: Springer

Gupta, J. (2010). A history of international climate change policy. *Wiley Interdisciplinary Reviews: Climate Change, 5*, 636-653. doi:10.1002/wcc.67

Gupta, J. (2020). ERC Advanced Grant 2020 Part B2: Climate Change and Fossil Fuels (CLIFF).

Gupta, J., & Arts, K. (2018). Achieving the 1.5C Objective: Just Implementation Through A Right to (Sustainable) Development. *International Environmental Agreements: Politics, Law and Economics, 18*(1), 11-28.

Gupta, J., & Chu, E. (2018). Inclusive Development and Climate Change: The Geopolitics of Fossil Fuel Risks in Developing Countries. *African and Asian Studies, 17*(1-2), 90-114. doi:10.1163/15692108-12341402

Gupta, J., & Pouw, N. (2017). Towards a trans-disciplinary conceptualization of inclusive developmen. *Current Opinion in Environmental Sustainability*, 96-103. doi:10.1016/j.cosust.2017.03.004

Gupta, J., Scholtens, J., Perch, L., Dankelman, I., Seager, J., Sánder, F., Stanley-Jones, M., & Kempf, I. (2020). Re-imagining the driver–pressure–state–impact–response framework from an equity and inclusive development perspective. *Sustainability Science, 15*, 503-20. doi: 10.1007/s11625-019-00708-6

Gupta, J., & Thompson, M. (2010). Development and development cooperation theory. In J. Gupta, & N. v. Grijp, *Mainstreaming climate change in development cooperation: Theory, practice and implications for the European Union* (pp. 33-66). Cambridge: Cambridge University Press.

Gupta, J., & Vegelin, C. (2016). Sustainable development goals and inclusive development. *International Environmental Agreements: Politics, Law and Economics, 16*, 433-48. doi:10.1007/s10784-016-9323-z

Gupta, J., Pouw, N., & Ros-Tonen, M. (2015). Towards an Elaborated Theory of Inclusive Development. *European Journal of Development Research, 27*, 541-59. doi:10.1057/ejdr.2015.30

Gupta, J., Rempel, A., & Verrest, H. (2020). Access and Allocation: The role of large shareholders and investors in leaving fossil fuels underground. *International Environmental Agreements: Politics, Law and Economics, 20*, 303-22. doi:10.1007/s10784-020-09478-4

Haraway, D. (2016). *Staying with the Trouble: Making kin in the Chthulucene.* Durham & London: Duke University Press.

Healy, N., & Barry, J. (2017). Politicizing energy justice and energy system transitions: Fossil fuel divestment and a "just transition". *Energy Policy, 108*, 451-9. doi:10.1016/j.enpol.2017.06.014

Heede, R. (2013). Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010. *Climate Change, 122*, 229-41. doi:10.1007/s10584-013-0986-y

Horner, R. (2019). Towards a new paradigm of global development? Beyond the limits of international development. *Progress in Human Geography, 44*(3), 415-36. doi:10.1177/0309132519836158

Horowitz, L. (2015). Local Environmental Knowledge. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 235-248). New York: Routledge.

Hubacek, K., & Baiocchi, G. (2018). Fossil Fuel Assets May Turn Toxic. *Joule*, 1407-1409. doi:10.1016/j.joule.2018.07.014

ICSID. (2021, June 2). *RWE AG and RWE Eemshaven Holding II BV v. Kingdom of the Netherlands (ICSID Case No. ARB/21/4)*. Retrieved June 16, 2021, from ICSID World Bank Group: https://icsid.worldbank.org/cases/case-database/case-detail?CaseNo=ARB/21/4

IEA (International Energy Agency). (2021). *World Energy Outlook 2021.* IEA. Retrieved March 10, 2022, from https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf

IEA. (2019). *Nigeria Energy Outlook*. IEA. Retrieved April 30, 2022 from: https://www.iea.org/articles/nigeria-energy-outlook

Ioualalen, R. (2021, May 14). *Spain becomes latest country to ban new oil and gas exploration and production*. Retrieved June 15, 2021, from Oil Change International: http://priceofoil.org/2021/05/14/spain-becomes-latest-country-to-ban-new-oil-and-gas-exploration-and-production/

IPCC. (2014). *AR5 Synthesis Report: Climate Change 2014.* International Panel on Climate Change. Retrieved 05 10, 2020, from https://www.ipcc.ch/report/ar5/syr/

IPCC. (2018). *Special Report on Global Warminig of 1.5°C.* International Panel on Climate Change. Retrieved April 30, 2022 from: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf

IPCC. (2019). *Global warming of 1.5°C.* International Panel on Climate Change. Retrieved 05 10, 2020, from https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf

IPCC. (2021). *AR6 Climate Change 2021: The Physical Science Basis.* IPCC. Retrieved February 18, 2022, from https://www.ipcc.ch/report/ar6/wg1/

IPCC. (2022). *Climate Change 2022: Impacts Adapatation and Vulnerability.* Retrived May 30, 2022 from: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf

Japan Ministry of Economy, Trade and Industry. (n.d.). *Japan's Roadmap to Beyond-Zero Campaign*. Retrieved March 10, 2022, from METI: https://www.meti.go.jp/english/policy/energy_environment/global_warming/roadmap/index.html

Johnson, N., Krey, V., McCollum, D., Rao, S., Riahi, K., & Rogelj, J. (2015). Stranded on a low-carbon planet: Implications of climate policy for the phase-out of coal-based power plants. *Technological Forecasting and Social Change, 90 Part A*, 89-102. doi:10.1016/j.techfore.2014.02.028

Johnsson, F., Kjärstad, J., & Rootzén, J. (2019). The threat to climate change mitigation posed by the abundance of fossil fuels. *Climate Policy, 19*(2), 258-274. doi:10.1080/14693062.2018.1483885

Johnstone, P., Stirling, A., & Sovacool, B. (2017). Policy mixes for incumbency: Exploring the destructive recreation of renewable energy, shale gas 'fracking,' and nuclear power in the United Kingdom. *Energy Research & Social Science, 33*, 147-62. doi:10.1016/j.erss.2017.09.005

Kalkhul, M., Steckel, J. C., & Edenhofer, O. (2020). All or nothing: Climate policy when assets can become stranded. *Journal of Environmental Economics and Management, 100*. doi:10.1016/j.jeem.2019.01.012

Kartha, S., Caney, S., Dubash, N., & Muttitt, G. (2018). Whose carbon is burnable? Equity considerations in the allocation of a "right to extract". *Climate Change, 150*, 117-29. doi:10.1007/s10584-018-2209-z

Kashwan, P. (2021). Climate Justice in the Global North. *Case Studies in the Environment, 5*(1), 1-13. doi:10.1525/cse.2021.1125003

Kaur, N., Vedel, I., Sherif, R., Pluye, P. (2019). Practical mixed methods strategies used to integrate qualitative and quantitative methods in community-based primary health care research. *Family Practice, 36*(5), 666-71. doi: 10.1093/fampra/cmz010

Kefford, B., Ballinger, B., Schmeda-Lopez, D., Greig, C., & Smart, S. (2018). The early retirement challenge for fossil fuel power plants in deep decarbonisation scenarios. *Energy Policy, 119*, 294-306. doi:10.1016/j.enpol.2018.04.018

Khalipour, R., & Karimi, I. A. (2011). Investment portfolios under uncertainty for utilizing natural gas resources. *Computers & Chemical Engineering, 35*(9), 1827-1837. doi:10.1016/j.compchemeng.2011.04.005

Khokhar, T., & Serajuddin, U. (2015). *Should we continue to use the term "developing world"?* World Bank Group. Retrieved May 11, 2021, from https://blogs.worldbank.org/opendata/should-we-continue-use-term-developing-world

King, L., & van den Bergh, J. (2018). Implications of net energy-return-on-investment for a low-carbon energy transition. *Nature Energy, 3*, 334-340. doi:10.1038/s41560-018-0116-1

King, R. (2012). *Cap the Grid.* Santa Rosa, CA: Post Carbon Institute. Retrieved June 16, 2021, from http://energy-reality.org/wp-content/uploads/2013/10/32_Cap-the-Grid_R1_072113.pdf

Kingsbury, D., Kramarz, T., & Jacques, K. (2018). Populism or Petrostate?: The Afterlives of Ecuador's Yasuní-ITT Initiative. *Society & Natural Resources*, 1-18. doi:10.1080/08941920.2018.1530817

Kopytin, I., Maslennikov, A., Sinitsyn, M., Zhukov, S., & Zolina, S. (2020). Will carbon tax constrain oil production in canada? *Smart Technologies and Innovations in Design for Control of Technological Processes and Objects; Economy and Production, 138*, 793-803. doi:10.1007/978-3-030-15577-3_73

Krause, F., Bach, W., & Koomey, J. (1989). *Energy Policy in the Greenhouse.* El Cerrito, CA: Dutch Ministry of Environment.

Kulagin, V., Grushevenko, D., & Kapustin, N. (2020). Fossil fuels markets in the “energy transition” era. *Russian Journal of Economics, 6*(4), 424-36. doi:10.32609/j.ruje.6.55177

La Rovere, E. (2020). The potential contribution of emerging economies to stop dangerous climate change. The case of Brazil. *Wiley Interdisciplinary Reviews, 11*(1). doi:10.1002/wcc.614

Larrea, C., & Warnars, L. (2009). Ecuador's Yasuni-ITT Initiative: Avoiding emissions by keeping petroleum underground. *Energy for Sustainable Development, 13*(3), 219-23. doi:10.1016/j.esd.2009.08.003

Latour, B. (2015). *Facing Gaia: Eight Lectures on the New Climate Regime.* Cambridge: Polity.

Lazarus, M., & van Asselt, H. (2018). Fossil fuel supply and climate policy: exploring the road less taken. *Climate Change, 150*, 1-13. doi:10.1007/s10584-018-2266-3

Lazarus, M., Erickson, P., & Tempest, P. (2015). *Supply-side climate policy: the road less taken.* Stockholm: Stockholm Environment Institute. Retrieved May 25, 2021, from https://mediamanager.sei.org/documents/Publications/Climate/SEI-WP-2015-13-Supply-side-climate-policy.pdf

Le Billon, P., & Kristoffersen, B. (2019). Just cuts for fossil fuels? Supply-side carbon constraints and energy transition. *Environment and Planning A: Economy and Space, 52*(6), 1072-92. doi:10.1177/0308518X18816702

Lenferna, G. (2018). Can we equitably manage the end of the fossil fuel era? *Energy Research and Social Science, 35*, 217-223. doi:10.1016/j.erss.2017.11.007

Lenton, T. (2011). Early warning of climate tipping points. *Nature*, 201-9. doi:10.1038/nclimate1143

Lewthwaite, J., Angert, A., Kembel, S., Goring, S., Davies, T., Mooers, A., Sperling, F… Kerr, J. (2018). Canadian butterfly climate debt is significant and correlated with range size. *Ecography, 41*(12), 2005-15. doi: 10.1111/ecog.03534

Likoko, E., & Kini, J. (2017). Inclusive business—a business approach to development. *Current Opinion in Environmental Sustainability, 24*, 84-88. doi:10.1016/j.cosust.2017.03.001

Lin, B., & Xu, M. (2019). Good subsidies or bad subsidies? Evidence from low-carbon transition in China's metallurgical industry. *Energy Economics, 83*, 52-60. doi:10.1016/j.eneco.2019.06.015

Linquiti, P., & Cogswell, N. (2016). The Carbon Ask: effects of climate policy on the value of fossil fuel resources and the implications for technological innovation. *Journal of Environmental Studies and Sciences, 6*(4), 662-676. doi:10.1007/s13412-016-0397-2

Lipschutz, R. (2004). *Global environmental politics power perspective and practice.* Washington D.C.: CQ Press.

Liverman, D. (2015). Reading Climate Change and Climate Governance as Political Ecologies. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 303-). New York: Routledge.

Löffler, K., Burandt, T., Hainsch, K., & Oei, P.-Y. (2019). Modeling the low-carbon transition of the European energy system - A quantitative assessment of the stranded assets problem. *Energy Strategy Reviews, 26*. doi:10.1016/j.esr.2019.100422

Lohman, L. (2012). FINANCIALIZATION, COMMODIFICATION AND CARBON: THE CONTRADICTIONS OF NEOLIBERAL CLIMATE POLICY. *Social Register*, 85-108. Retrieved May` 4, 2021, from https://socialistregister.com/index.php/srv/article/view/15647/12771

Luo, T., & Otto, B. (2014, April 15). *Identifying the Global Coal Industry's Water Risks*. Retrieved June 16, 2021, from World Resource Institute: wri.org/insights/identifying-global-coal-industrys-water-risks

Marsden, T., & Rucinska, K. (2019). After COP21: Contested transformations in the energy/agri-food nexus. *Sustainability (Switzerland), 11*(6). doi:10.3390/su11061695

Marsden, T., Moragues Faus, A., & Sonnino, R. (2019). Reproducing vulnerabilities in agri-food systems: Tracing the links between governance, financialization, and vulnerability in Europe post 2007–2008. *Journal of Agrarian Change, 19*(1), 82-100. doi:10.1111/joac.12267

Martin, J., & Croukamp, L. (2021). Exploration into the potential for a low-enthalpy geothermal power plant in Cape fold belt. *Geothermics, 89*. doi:10.1016/j.geothermics.2020.101934

Martin, P., & Scholz, I. (2014). Policy Debate | Ecuador's Yasuní-ITT Initiative : What Can We Learn from its Failure? *International Development and Policy*. doi:10.4000/poldev.1705

Martin, M., Solomon, H. (2016). Understanding the Phenomenon of "State Capture" in South Africa. *Southern African Peace and Security Studies, 5*(1).

Martinez Alier, J. (2002b). Ecological Debt and Property Rights on Carbon Sinks and Reservoirs. *Capitalism Nature Socialism, 13*(1), 115-9. doi:10.1080/104557502101245404

Martinez-Alier, J. (2002a). The Ecological Debt. *Kurswechsel, 4*, 5-17. Retrieved 4 25, 2021, from http://www.beigewum.at/wordpress/wp-content/uploads/005_joan_martinez-alier.pdf

Martinez-Alier, J. (2004). The environmentalism of the poor. *Geoforum*, 239-41. doi:10.1016/j.geoforum.2013.04.019

Martinez-Alier, J. (Submitted). Circularity, entropy, ecological conflicts and "unburnable fuels". *Local Environment*. Retrieved April 30, 2021, from https://www.sussex.ac.uk/webteam/gateway/file.php?name=cynthia-isenhourjmarevised-19-april-2021.pdf&site=253

Marx, K. (1867). *Das Kapital*. London: Wordsworth Editions.

Matthews, H. (2016). Quantifying historical carbon and climate debts among nations. *Nature Climate Change*, 60-4. doi:10.1038/nclimate2774

Matthews, H., Tokarksa, K., Nicholls, Z., Rogelj, J., Canadell, J., Friedlingstein, P., & Zickfeld, K. (2020). Opportunities and challenges in using remaining carbon budgets to guide climate policy. *Nature Geoscience*, 769-79. doi:10.1038/s41561-020-00663-3

Mayer, A., & Hass, W. (2016). Cumulative material flows provide indicators to quantify the ecological debt. *Journal of Political Ecology, 23*(1), 350-65. doi:10.2458/v23i1.20222

McCauley, D., Heffron, R. (2018). Just transition: Integrating climate, energy and environmental jusice. *Energy Policy, 119,* 1-7. doi: 10.1016/j.enpol.2018.04.014

McGlade, C., & Ekins, P. (2015). The geographical distribution of fossil fuels unused when limiting global warming to 2 °C. *Nature, 517*, 187-190. doi:10.1038/nature14016

Memane, N., Munda, J., Popoola, O., & Hamam, Y. (2019). An Improved Load shedding technique for optimal location and profitability for contingency conditions. *IEEE*, 10.1109/RoboMech.2019.8704831.

Mercure, J., Pollitt, H., Viñuales, J., Edwards, N., Holden, P., Chewpreecha, U., . . . Knobloch, F. (2018). Macroeconomic impact of stranded fossil fuel assets. *Nature Climate Change, 8*(7), 588-593. doi:10.1038/s41558-018-0182-1

Meyer, L., & Roser, D. (2010). Climate justice and historical emissions. *Critical Review of International Social and Political Philosophy, 13*(1), 229-53. doi:10.1080/13698230903326349

Miller, L., & Carriveau, R. (2019). Energy demand curve variables – An overview of individual and systemic effects. *Sustainable Energy Technologies and Assessments, 35*, 172-179. doi:10.1016/j.seta.2019.07.006

Min, H. (2021, March 15). *China's net zero future*. Retrieved March 10, 2022, from Race to Zero: https://racetozero.unfccc.int/chinas-net-zero-future/

Mo, J., Schleich, J., & Fan, Y. (2018). Getting ready for future carbon abatement under uncertainty – Key factors driving investment with policy implications. *Energy Economics, 70*, 453-564. doi:10.1016/j.eneco.2018.01.026

Monasterolo, I., & Raberto, M. (2019). The impact of phasing out fossil fuel subsidies on the low-carbon transition. *Energy Policy, 124*, 355-70. doi:10.1016/j.enpol.2018.08.051

Moore, J. (2014). The Value of Everything? Work, Capital, and Historical Nature in the Capitalist World-Ecology. *Research Foundation of State University of New York*. Retrieved May 13, 2021, from https://www.jstor.org/stable/pdf/90011611.pdf?refreqid=excelsior%3Acd12871f85ca26c290a759edd49d586e

Moore, J. (2017). The Capitalocene, Part I: on the nature and origins of our ecological crisis. *The Journal of Peasant Studies, 44*(3), 594-630. doi:10.1080/03066150.2016.1235036

Moore, J. (2018). The Capitalocene Part II: accumulation by appropriation and the centrality of unpaid work/energy. *The Journal of Peasant Studies*, 237-79. doi:10.1080/03066150.2016.1272587

Munn, Z., Peters, M., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Medical Research Methodology, 18*(143). doi:10.1186/s12874-018-0611-x

Mutezo, G., & Mulopo, J. (2021). A review of Africa's transition from fossil fuels to renewable energy using circular economy principles. *Renewable and Sustainable Energy Reviews, 137*. doi:10.1016/j.rser.2020.110609

Muttitt, G., Kartha, S. (2020). Equity, climate justice and fossil fuel extraction: principles for a managed phase out. *Climate Policy,* 1024-42*.* doi: 10.1080/14693062.2020.1763900

Nalule, V. (2020). Transitioning to a Low Carbon Economy: Is Africa Ready to Bid Farewell to Fossil Fuel? In G. Wood, & K. Baker, *The Palgrave Handbook of Manaing Fossil Fuels and Energy Transitions* (pp. 261-86). Cham: Palgrave Macmillan.

Newell, P., & Mulvaney, D. (2013). The political economy of the 'just transition'. *The Geographical Journal, 179*(2), 132-40. doi:10.1111/geoj.12008

Newell, P., & Simms, A. (2019). Towards a fossil fuel non-proliferation treaty. *Climate Policy*, 1-12. doi:10.1080/14693062.2019.1636759

Nordhaus, W. (2018). Projections and Uncertainties about Climate Change in an Era of Minimal Climate Policies. *American Economic Journal: Economic Policy, 10*(3), 333-60.

OCI (Oil Change International). (2020). *Shifting the Subsidies Database.* Oil Change International. Retrieved March 18, 2021, from http://priceofoil.org/shift-the-subsidies/#:~:text=The%20Shift%20the%20Subsidies%20database,data%20from%202008%20to%202019.

OCI (Oil Change International); FoE (Friends of the Earth US). (2020). *Still Digging: G20 Governments Continue to Finance the Climate Crisis.* Washington D.C.: Oil Change International. Retrieved March 17, 2021, from http://priceofoil.org/content/uploads/2020/05/G20-Still-Digging.pdf

OECD. (2020). *ARRANGEMENT ON OFFICIALLY SUPPORTED EXPORT CREDITS.* OECD. Retrieved March 17, 2021, from http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=tad/pg(2020)1

OPEC. (2020). *2020 OPEC Annual statstical bulletin.* Vienna: OPEC. Retrieved 08 04, 2020, from https://asb.opec.org/ASB_PDFDownload.php

Pakenham, T. (1992). *The Scrameble for Africa.* London: Little Brown Book Group.

Parenti, C. (2014). The Environment Making State: Territory, Nature, and Value. *Antipode, 47*(4), 829-48. doi:10.1111/anti.12134

Paterson, M. (2020). 'The End of the Fossil Fuel Age'? Discourse Politics and Climate Change Political Economy. *New Political Economy*. doi:10.1080/13563467.2020.1810218

Paulson, S. (2017). Degrowth: culture, power and change. *Journal of Political Ecology, 24*(1), 425-49. doi:10.2458/v24i1.20882

Peet, R., & Watts, M. (1996). Liberation Ecology: Development, sustainability and the environment in the age of market triumphalism. In R. Peet, & M. Watts, *Liberation Ecologies* (pp. 1-38). New York: Routledge.

Perez, C. (1985). Microelectronics, long waves and world structural change: New perspectives for developing countries. *World Development, 13*(3), 441-63. doi: 10.1016/0305-750X(85)90140-8

Perez, C. (2003). *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*. Northampton: Edward Elgar Publishing.

Phalatse, S. (2020). *Eskom: The Roots Of A Crisis And Avenues Forward*. Johannesburg: Institute for Economic Justice. Retrieved March 24, 2022 from: https://www.iej.org.za/eskom-the-roots-of-a-crisis-and-avenues-forward/

Pham, M., Rajic, A., Greig, J., Sargeant, J., Papadopolous, A., & McEwen, S. (2014). A scoping review of scoping reviews: advancing the approach and enhancing the consistency. *Wiley Research Synthesis Methods, 5*(4), 371-85. doi:10.1002/jrsm.1123

Pickering, J., & Barry, C. (2012). On the concept of climate debt: Its moral and political value. *Critical Review of International Social and Political Philosophy, 15*(5), 667-85. doi:10.1080/13698230.2012.727311

Piggot, G., Erickson, P., van Asselt, H., & Lazarus, M. (2018). Swimming upstream: addressing fossil fuel supply under the UNFCCC. *Climate Policy*, 11-14. doi:10.1080/14693062.2018.1494535

Pistor, K. (2019). *The Code of Capital: How the Law Creates Wealth and Inequality.* New Jersey: Princeton University Press.

Plötz, P., Axsen, J., Funke, S., & Gnann, T. (2019). Designing car bans for sustainable transportation. *Nature Sustainability*, 534-6. doi:10.1038/s41893-019-0328-9

Polanyi, K. (2001). *The Great Transformation: The political and economic origins of our time. Forward by Joseph E. Stiglitz, with a new introduction by Fred Block.* Boston: Beacon.

Pollin, R., & Callaci, B. (2018). The Economics of Just Transition: A Framework for Supporting Fossil Fuel–Dependent Workers and Communities in the United States. *Labour Studies Journal*, 1-46. doi:10.1177/0160449X18787051

Pouw, N., & Gupta, J. (2017). Towards a trans-disciplinary conceptualization of inclusive development. *Current Opinion in Environmental Sustainability, 24*, 96-103.

Pregger, T., Simon, S., Naegler, T., & Teske, S. (2019). Main Assumptions for Energy Pathways. In S. Teske, *Achieving the Paris Climate Agreement Goals: Global and Regional 100% Renewable Energy Scenarios with Non-energy GHG Pathways for +1.5C and +2C* (pp. 93-130). New York City: Springer.

Rainforest Action Network. (2020). *Banking on Climate Change.* San Francisco: RAN. Retrieved 2 22, 2021, from https://www.ran.org/bankingonclimatechange2020/

Rainforest Action Network; BankTrack; Indigenous Environmental Network; Sierra Club; Oil Change International. (2021). *Banking on Climate Chaos.* Rainforest Action Network. Retrieved May 13, 2021, from https://www.ran.org/bankingonclimatechaos2021/

Rammelt, C., Gupta, J. (2021). Inclusive is not an Adjective, it Transforms Development: A Post-Growth Interpretation of Inclusive Development, *Environmental Science and Policy*, 124: 144-155.

Rautner, M., Tomlinson, S., & Hoare, A. (2016). *Managing the Risk of Stranded Assets in Agriculture and Forestry.* London: Chatham House. Retrieved 07 25, 2020, from https://www.issuelab.org/resources/25572/25572.pdf

Reed, E. (2022). *BP, Shell to shutter South African Refinery*. Energy Voice. Retrieved April 29, 2022 from: https://www.energyvoice.com/oilandgas/africa/refining-africa/387129/bp-shell-sapref-shutting/#:~:text=BP%20and%20Shell%20are%20putting,March%2C%20while%20considerin

g%20a%20sale.&text=23%2F10%2F2018-
,BP%20and%20Shell%20are%20putting%20refinery%20operations%20at%20their%20Sapref,
March%2C%20while%20considering%20a%20sale.

Rempel, A., & Gupta, J. (2020). Conflicting commitments? pension funds, fossil fuel assets and climate policy in the Organisation for Economic Co-operation and Development (OECD). *Energy Research and Social Sciences, 69*. doi:10.1016/j.erss.2020.101736

Rempel, A., & Gupta, J. (2021). Fossil Fuels, Stranded Assets and COVID-19: Imagining an Inclusive & Transformative Recovery. *World Development, 146*. doi:10.1016/j.worlddev.2021.105608

Republic of South Africa. (1998). *National Environmental Management Act 107 of 1998.* Pretoria, South Africa. Retrieved March 10, 2022, from https://www.gov.za/documents/national-environmental-management-act

Richter, P., Mendelevitch, R., & Jotzo, F. (2018). Coal taxes as supply-side climate policy: a rationale for major exporters? *Climate Change, 150*, 43-56. doi:10.1007/s10584-018-2163-9

Ringsmuth, A., Landsberg, M., & Hankamer, B. (2016). Can photosynthesis enable a global transition from fossil fuels to solar fuels, to mitigate climate change and fuel-supply limitations? *Renewable and Sustainable Energy, 62*, 134-63. doi:10.1016/j.rser.2016.04.016

Ritchie, H., Roser, M. (2020). Energy. *OurWorldInData.org.* Retrieved April 30, 2022 from: https://ourworldindata.org/energy-mix

Robinson, M., & Shine, T. (2018). Achieving a climate justic pathway to 1.5C. *Nature Climate Change, 8*, 564-9. doi:10.1038/s41558-018-0189-7

Robson, C., & McCartan, K. (2016). Approaches to Social Research. In C. Robson, & K. McCartan, *Real World Research* (4 ed., pp. 14-42). Wiley.

Rocchi, P., Serrano, M., Roca, J., & Arto, I. (2018). Border Carbon Adjustments Based on Avoided Emissions: Addressing the Challenge of Its Design. *Ecological Economics, 145*, 126-36. doi:10.1016/j.ecolecon.2017.08.003

Rode, D., Fishbeck, P., & Paez, A. (2017). The retirement cliff: power plant lives and their policy implications. *Energy Policy, 106*, 222-32. doi:10.1016/j.enpol.2017.03.058

Rodney, W. (2018). *How Europe Underdeveloped Africa.* London, United Kingdom: Verso Books.

Rodriguez, S., Drummond, P., & Ekins, P. (2017). Decarbonizing the EU energy system by 2050: an important role for BECCS. *Climate Policy, 17*, 93-110.

Røpke, I. (2019). Econ 101—In need of a sustainability transition. *Ecological Economics, 169*, 1-12. doi:10.1016/j.ecolecon.2019.106515

Rozenberg, J., Vogt-Schilb, A., & Hallegate, S. (2020). Instrument choice and stranded assets in the transition to clean capital. *Journal of Environmental Economics and Management, 100*. doi:10.1016/j.jeem.2018.10.005

Rytova, E., Gutman, S., Sousa, C. (2021). Regional inclusive development: An assessment of Russian regions. *Sustainability (Switzerland), 13*(11). doi: 10.3390/su13115773

Sachs, W. (1992). *The Development Dictionary: A Guide to Knowledge as Power.* London: Zed Books.

Saygin, D., Rigter, J., Caldecott, B., Wagner, N., & Gielen, D. (2019). Power sector asset stranding effects of climate policies. *Energy Sources, Part B: Economics, Planning, and Policy, 4*(14), 99-124. doi:10.1080/15567249.2019.1618421

Scholten, D., Bazilian, M., Overland, I., & Westphal, K. (2020). The geopolitics of renewables: New board, new game. *Energy Policy, 138*. doi:10.1016/j.enpol.2019.111059

Schumpeter, J. (1942). *Capitalism, Socialism, and Democracy.* New York: Harper & Bros. .

Schwartz, K., Gupta, J., Tutusaus, M. (2018). Editorial - Inclusive development and urban water services. *Habitat International*, *73,* 96-100. doi: 10.1016/j.habitatint.2018.02.006

SEI, IISD, ODI, Climate Analytics, CICERO, UNEP. (2019). *The production gap: The discrepancy between countries' planned fossil fuel production and global production levels consistent with limiting warming to 1.5C or 2C.* Stockholm: Stockhold Environment Institute. Retrieved 07 29, 2020, from http://productiongap.org

SEI; IISD; ODI; E3G; UNEP. (2020). *The Production Gap: Special Report 2020.* Stockholm: SEI. Retrieved 2 20, 2021, from https://productiongap.org/wp-content/uploads/2020/12/PGR2020_FullRprt_web.pdf

Semieniuk, G., Holden, P…Viñuales, J. (2022). Fossil-fuel stranded asset risks held by individuals in OECD countries and non-OECD governments. *Nat. Clim. Chang.* doi: 10.1038/s41558-022-01373-x

Seth, N. (2019). The negotiation process of the 2030 agenda. Washington DC: United Nations. doi: 10.18356/962a893d-en

Shell. (2021). *VOLUNTARY CARBON CREDITS*. Retrieved 10 22, 2021, from Shell: https://www.shell.com/business-customers/trading-and-supply/trading/shell-energy-europe/clean-energy-solutions/voluntary-carbon-credits.html?gclid=CjwKCAjwndCKBhAkEiwAgSDKQcXvlB5__6ctRNaDC9BiLg3jrpeFqUGBoeFLHsrntH5xAleWrPpSchoCxtIQAvD_BwE

Simhauser, P. (2017). Monopoly regulation, discontinuity & stranded assets. *Energy Economics, 66*, 384-398. doi:10.1016/j.eneco.2017.06.029

Sinn, H.-W. (2008). Public policies against global warming: A supply side approach. *International Tax and Public Finance, 15*, 360-394.

Sinn, H.-W. (2012).The Green paradox: A supply-side approach to global warming. MIT University Press.

Skovgaard, J., & van Asselt, H. (2019). The politics of fossil fuel subsidies and their reform: Implications for climate change mitigation. *WIREs Climate Change, 10*(4). doi:10.1002/wcc.581

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research, 104*, 333-9. doi: 10.1016/j.jbusres.2019.07.039

Solarin, S. (2020). Towards sustainable development in developing countries: Aggregate and disaggregate analysis of energy intensity and the role of fossil fuel subsidies. *Sustainable Production and Consumption*, *24*, 254-65. doi: 10.1016/j.spc.2020.07.011

Solow, R. (1957). Technical changes and the aggregate production function. *Review of Economics and Statistics, 39*, 312-20. doi:10.2307/1926047

Son, J.-h. (2021, Aug 5). *Dutch pension fund urges Seoul to scrap domestic coal power projects*. Retrieved March 12, 2022, from The Korean Herald: http://m.koreaherald.com/view.php?ud=20210804000774

Sovacool, B., & Geels, F. (2016). Further reflections on the temporality of energy transitions: A. *Energy Research & Social Science, 22*, 232-7. doi:10.1016/j.erss.2016.08.013

Spencer, T., Colombier, M., Sartor, O., Garg, A., Tiwari, V., Burton, J., . . . Wiseman, J. (2017). The 1.5°C target and coal sector transition: at the limits of societal feasibility. *Climate Policy, 18*, 333-351. doi:10.1080/14693062.2017.1386540

Steyn, G., Tyler, E., Roff, A., Renaud, C., Mgoduso, L. (2021). *The Just Transition Transaction: A Developing Country Coal Power Retirement Mechanism*. Cape Town: Meridian Economics. Retrieved March 24, 2022 from: https://meridianeconomics.co.za/wp-content/uploads/2021/09/2021-09-28_What-is-the-JTT_Final-Report.pdf

Stirling, A. (2010). Keep it Complex. *Nature, 468*, 1029-31. doi:10.1038/4681029a

Subramanian, M. (2019). Humans versus Earth: the quest to define the Anthropocene. *Nature*.

Sundberg, J. (2015). Ethics, Entanglement and Political Ecology. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 117-26). New York: Routlege.

Swedwatch. (2020). *Up in Smoke*. Stockholm: Swedwatch, Swedish Society for Nature Conservation, & AfrikaGrupperna. Retrieved April 29, 2022 from: https://swedwatch.org/wp-content/uploads/2020/09/99_Kol-i-Sydafrika_200921.pdf

Swilling, M., Musango, J., & Wakeford, J. (2015). Developmental States and Sustainability Transitions: Prospects of a Just Transition in South Africa. *Journal of Environmental Policy and Planning*, 650-672. doi:10.1080/1523908X.2015.1107716

Temper, L., Demaria, F., Scheidel, A., Del Bene, D., & Martinez-Alier, J. (2018). The Global Environmental Justice Atlas (EJAtlas): ecological distribution conflicts as forces for sustainability. *Sustainability Science, 13*, 573-84. doi:10.1007/s11625-018-0563-4

Teske, S. (2019a). Trajectories for a Just Transition of the Fossil Fuel Industry. In S. Teske, *Achieving the Paris Climate Agreement Goals* (pp. 403-13). New York City: Springer.

Teske, S. (2019b). *Achieving the Paris Climate Agreement Goals: Global and Regional 100% Renewable Energy Scenarios with Non-energy GHG Pathways +1.5C and +2C.* New York City: Springer. doi:10.1007/978-3-030-05843-2

TotalSA. (2020, 5 5). *Total adopts a new Climate Ambition to Get to Net Zero by 2050*. Retrieved 10 22, 2021, from TotalEnergies: https://totalenergies.com/media/news/total-adopts-new-climate-ambition-get-net-zero-2050

Trachtman, J. (2017). WTO LAW CONSTRAINTS ON BORDER TAX ADJUSTMENT AND TAX CREDIT MECHANISMS TO REDUCE THE COMPETITIVE EFFECTS OF CARBON TAXES. *National Tax Journal, 70*(2). doi:10.17310/ntj.2017.2.09

Tuck, E., & Yang, K. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society, 1*(1), 1-40.

Udemba, E., Tosun, M. (2022). Are Renewable Energy and Technological Innovation Development Consistency in Achieving Climate and Sustainable Development Goals (Sdgs)? *SSRN.* doi: 10.2139/ssrn.4077016

Ulloa, A. (2015). Environment and Development. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (p. 320). New York: Routledge.

UN Environment Programme. (n.d.). *Facts about the climate emergency*. Retrieved March 3, 2022, from UNEP: https://www.unep.org/explore-topics/climate-action/facts-about-climate-emergency

UN. (1992). *United Nations Framework Convention on Climate Change.* UN. Retrieved March 29, 2021, from https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf

UN. (1997). *Kyoto Protocol FCCC/CP/1997/L.7/Add.1.* Kyoto: UNFCCC. Retrieved March 29, 2021, from https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf#page=24

UN. (2012). *Doha Ammendment to the Kyoto Protocol.* Doha: UN. Retrieved March 29, 2021, from https://unfccc.int/files/kyoto_protocol/application/pdf/kp_doha_amendment_english.pdf

UN. (2015a). *Transforming our world: The 2030 agenda for sustainable development.* New York: United Nations. Retrieved 07 30, 2020, from https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

UN. (2015b). Adoption of the Paris Agreement. Report No. FCCC/CP/2015/L.9/Rev.1. *Conference of the Parties 21st Session.* Paris. Retrieved 05 10, 2020, from https://unfccc.int/sites/default/files/english_paris_agreement.pdf

UN. (2015c). Adoption of the Paris Agreement: Proposal by the President. Report No. FCCC/CP/2015/L.9/Rev.1. *Conference of the Parties 21st Session.* Retrieved April 30, 2022 from: https://unfccc.int/sites/default/files/resource/docs/2015/cop21/eng/l09r01.pdf

UN. (2020). *Country Classification.* Retrieved March 8, 2021, from https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/WESP2020_Annex.pdf

UN. (2021). Doha ammendment to the Kyoto Protocol. Retrieved April 30, 2022 from: https://unfccc.int/files/kyoto_protocol/application/pdf/kp_doha_amendment_english.pdf

UN. (n.d.). *The Climate Crisis - A Race We Can Win*. Retrieved March 3, 2022, from UN: https://www.un.org/en/un75/climate-crisis-race-we-can-win

UNFCCC. (n.d.). *Article 3: Principles*. United Nations Framework Convention on Climate Change. Retrieved April 30, 2022 from: https://unfccc.int/resource/ccsites/tanzania/conven/text/art03.htm#:~:text=The%20Parties%20should%20protect%20the,differentiated%20responsibilities%20and%20respective%20capabilities.

UNFCCC. (2020). *Paris Agreement - Status of Ratification.* New York: UNFCCC. Retrieved 07 30, 2020, from https://unfccc.int/process/the-paris-agreement/status-of-ratification

US Department of Energy. (2021, April 19). *How We're Moving to Net-Zero by 2050*. Retrieved March 10, 2022, from US Department of Energy: https://www.energy.gov/articles/how-were-moving-net-zero-2050

Valdivia, G. (2015). Eco-governmentality. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 467-80). New York: Routledge.

Vallejo, M., Burbano, R., Falconi, F., & Larrea, C. (2015). Leaving oil underground in Ecuador: The Yasuní-ITT initiative from a multi-criteria perspective. *Ecological Economics, 109*, 175-185. doi:10.1016/j.ecolecon.2014.11.013

van de Graaf, T. (2018). Battling for a shrinking market: Oil producers, the renewables revolution, and the risk of stranded assets. *Lecture Notes in Energy, 61*, 97-121. doi:10.1007/978-3-319-67855-9_4

van de Graaf, T., & Verbruggen, A. (2015). The oil endgame: Strategies of oil exporters in carbon-constrained world. *Environmental Science & Policy, 54*, 456-462. doi:10.1016/j.envsci.2015.08.004

van der Ploeg, F. (2020). Race to burn the last ton of carbon and the risk of stranded assets. *European Journal of Political Economy, 64*. doi:10.1016/j.ejpoleco.2020.101915Get rights and content

van der Ploeg, F., & Rezai. (2018). The simple arithmetic of carbon pricing and stranded assets. *Energy Efficiency, 11*(3), 627-639. doi:10.1007/s12053-017-9592-6

van der Ploeg, F., & Rezai, A. (2020). The risk of policy tipping and stranded carbon assets. *Journal of Environmental Economics and Management, 100*. doi:10.1016/j.jeem.2019.102258

van Vuuren, D., Stehfest, E., Gernaat, D., Doelman, J., van den Verg, M., Harmsen, M., de Boer, H…Kram, T. (2017). Energy, land-use and greenhouse gas emissions trajectories under a green growth paradigm. *Global Environmental Change*, *42*, 237-50. doi: 10.1016/j.gloenvcha.2016.05.008

Verbeek, B. (2021). *Research undermines billion euro "compensation" claims by German energy companies for Dutch coal phase-out.* Den Haag: SOMO. Retrieved June 16, 2021, from somo.nl/research-undermines-billion-euro-compensation-claims-by-german-energy-companies-for-dutch-coal-phase-out/

Vogt-Schilb, A., & Hallegatte, S. (2017). Climate policies and nationally determined contributions: reconciling the needed ambition with the political economy. *Wiley Interdisciplinary Reviews: Energy and Environment, 6*(6). doi:10.1002/wene.256

Walwyn, D. (2020). Turning points for sustainability transitions: Institutional destabilization, public finance and the techno-economic dynamics of decarbonization in South Africa. *Energy Research & Social Science, 70*. doi:10.1016/j.erss.2020.101784

Warlenius, R. (2017). Decolonizing the Atmosphere: The Climate Justice Movement on Climate Debt. *The Journal of Environment & Development, 27*(2), 131-55. doi:10.1177/1070496517744593

Watts, M. (2015). Now and Then: The origins of political ecology and the rebirth of adaptation as a form of thought. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 19-50). New York: Routledge.

Wehrmann, B. (2021, Sept 10). *Germany can achieve net zero emissions by 2045 at net zero costs – consultancy*. Retrieved March 10, 2022, from Clean Energy Wire: https://www.cleanenergywire.org/news/germany-can-achieve-net-zero-emissions-2045-net-zero-costs-consultancy

Weimer, D., Vining, A. (eds.) (2017). *Policy Analysis: Concpets and Practice*. Routledge, New York, New York.

Welsby, D., Price, J., Pye, S., & Ekins, P. (2021). Unextractable fossil fuels in a 1.5 °C world. *Nature, 597*, 203-4. doi:10.1038/s41586-021-03821-8

WHO. (n.d.). *Climate Change*. Retrieved May 10, 2021, from The Health and Environment Linkages Initiative: https://www.who.int/heli/risks/climate/climatechange/en/

Wijsman, K., & Feagan, M. (2019). Rethinking knowledge systems for urban resilience: Feminist and decolonial contributions to just transformations. *Environmental Science & Policy, 98*, 70-6. doi:10.1016/j.envsci.2019.04.017

Winkler, H., & Marquard, A. (2020). *Climate finance to transform energy infrastructure as part of a just transition in South Africa.* Cape Town: University of Cape Town. Retrieved March 10, 2022, from https://open.uct.ac.za/handle/11427/32176

WMP. (1979). *WMO Proceedings of the World Climate Conference: A Conference of Experts on Climate and Mankind.* Geneva: WMO. doi:ISBN: 92-63-10537-5.

Wolford, W., & Keene, K. (2015). Social Movements. In T. Perreault, G. Bridge, & J. McCarthy, *The Routledge Handbook of Political Ecology* (pp. 573-84). New York: Routledge.

World Bank. (2020). *Inequality in Southern Africa : An Assessment of the Southern African Customs Union (English)*. Washington D.C.: World Bank. Retrieved March 24, 2022, from https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099125303072236903/p1649270c02a1f06b0a3ae02e57eadd7a82

World Bank. (2022). GDP (current US$) - Sub-Saharan Africa, Middle East & North Africa. Retrieved April 30, 2022 from: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=ZG-ZQ&most_recent_value_desc=true

Xiongfeng, P., Chenxi, P., Sai, Y., Haitao, Xu. (2022). Effect of Chinese pilots carbon emission trading scheme on enterprises' total factor productivity: The moderating role of government participation and carbon trading market efficiency. *Journal of Environmental Management, 316*. doi: 10.1016/j.jenvman.2022.115228

York, R., & Bell, S. (2019). Energy transitions or additions?: Why a transition from fossil fuels requires more than the growth of renewable energy. *Energy Research & Social Science, 51*, 40-3. doi:10.1016/j.erss.2019.01.008

Yuan, J., Guo, X., Zhang, W., Chen, S., Ai, Y., & Zhao, C. (2019). Deregulation of power generation planning and elimination of coal power subsidy in China. *Utilities Policy, 57*, 1-15. doi:10.1016/j.jup.2019.01.007

Yuan, J., Guo, X., Zhang, W., Zhou, J., & Qin, C. (2019). Stranded Coal Power Assets in China: A Case Study of Jilin Province. *Emerging Markets Finance and Trade, 55*(12), 2673-2688. doi:10.1080/1540496X.2018.1541134

Zavala, M. (2021). Excess plant growth worsens droughts. *Global Change Ecology, 5.* Retrieved 2 May 2022 from: https://www.nature.com/articles/s41559-021-01556-3.pdf?proof=t%2Btarget%3D

Appendix A. Operationalisation Table

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
Stranded Assets “Assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities” (Caldecott, Howarth & McSharry, 2013: 7)	**Physical** Physical equipment, machinery or infrastructure that (in) directly contributes to or enables fossil fuel production or consumption	Amount Age Carbon intensity Production rates	Number of operational coal mines, coal-fired power stations, crude oil refineries, oil & gas pipelines, and LNG terminals Distribution of the above physical assets across South Africa & Africa more broadly Life expectancy of the above physical assets Scopes 1-3 Annual GHG Emissions from the above physical assets Annual coal (Mtpa), oil (Mboe/d) and natural gas (Mboe/d) production from the above physical assets	S2, S6
	Natural Natural resources pertinent to fossil fuel production and consumption, such as fossil fuels themselves, land, and water	Monetary value of proven fossil reserves	NPV of proven coal, oil and gas reserves, computed using current production rates and fluctuating both commodity price & discount rate	
	Human Intangible assets that depend on fossil fuel production or consumption, including direct and indirect *labour*, knowledge & expertise, and *energy* acquired from fossil consumption	Labour/ Employment Energy production Energy poverty	Number of direct, indirect and induced employees in coal, oil and gas operations Quality of fossil-based jobs Number of available alternative employment opportunities for current fossil employees Skillsets of both fossil and fossil-alternative jobs Installed power capacity (MW) of fossil-based infrastructure Fraction of the population without any grid access Fraction of the population with grid access but cannot afford electricity tariffs	

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
			Fossil-based & fossil-alternative energy tariffs Constraints to meeting energy supply and demand with fossil- and fossil-alternative energy production	
	Financial Equity and debt instruments (in)directly tied to fossil fuel investments, such as shares (stocks), loans, rent, interest, profits, dividends and revenue streams	Liquid Equity Debt Revenues Dividends	Common shares (USD) managed by major shareholders of leading E&Ps in (South) Africa Dividends earned (USD) by major shareholders from managing shares in leading E&Ps Annual revenues (USD) generated by E&Ps holding operations in (South) Africa Private debt issued to major E&Ps and their South African projects by commercial banks Public debt issued to major E&Ps and their (South) African projects by PFIs, including MDBs, BDBs and ECAs Annual trends in public and private debt issued since the ratification of the Paris Agreement Geographical distribution of the listed HQs of major E&Ps and their shareholders, debt financiers, PFIs	S3, S6
	Social Networks built around or enabled by fossil fuel markets, such as worker unions and communities formed around concentrated fossil fuel production	Fossil-dependent communities Displaced communities	Areas with high concentration of physical and human assets (i.e. labour) Communities having been stranded and the livelihoods of its members upended *due to* fossil fuel production through land acquisition and displacement	S2
LFFU Trade-offs Social, ecological, financial, economic, legal or political compromises that are inherent and implicit to phasing out coal, oil and gas production	**Local Level** Trade-offs from LFFU experienced at the individual- or household-level directly linked to the fossil reserve(s) being left underground, conceptualised through the stranded physical, human, social, financial and natural asset framework	Stranded labour Stranded physical asset pollution Stranded energy	See 'stranded asset' operationalisation above	Overarching

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
	National Level Trade-offs from LFFU experienced by the state and government with ownership over the fossil reserves being left underground, conceptualised through the stranded physical, human, social, financial and natural asset framework	Stranded natural assets and forgone revenue streams Stranded contracts and legal disputes	See 'stranded asset' operationalisation above	
	International Level Trade-offs from LFFU experienced by the international actors with financial and economic ties to the fossil reserve(s) being left underground, conceptualised through the stranded physical, human, social, financial and natural asset framework	Stranded financial assets Additional costs for LFFU and settling the SAD Overhauled and revamped policy frameworks	See 'stranded asset' operationalisation above and 'stranded asset debt' operationalisation below	
Inclusive Development A perspective accepting that financial and economic losses (i.e. trade-offs, see above) are inevitable in LFFU, and reconceptualises these trade-offs through social, ecological and relational lenses	**Social Inclusiveness** The extent to which human rights are upheld and inequalities are addressed; in the context of LFFU, how stranded assets are (and potentially will) affect the wellbeing of (particularly) the most under-resourced and under-privileged fossil-dependents	Labour & income streams upheld Affordable and reliable energy access	Safe, high quality and desirable jobs are for the poorest, most under-resourced and vulnerable unemployed people, and their livelihoods and wellbeing are both sustained and prioritized; Investments in fossil-alternative assets do not hamper universal access to basic needs and services, like energy, healthcare, water, food, housing, and justice	S1, S2, S4, S5, Overarching
	Ecological Inclusiveness Respect for planetary boundaries and the maintenance of & access to biodiversity and ecosystem services; in the an LFFU context, this concerns how LFFU (or failing to do so) affects natural systems, and who will be impacted	Degree of LFFU Fully decommissioned fossil-intensive physical assets Adverse impacts from fossil-alternatives	Investments in new fossil fuel assets are terminated immediately, and existing coal, oil and gas facilities are stranded/phased out; Physical assets (like coal-fired power stations) are adequately and fully retired/decommissioned so that they do not threaten local air, water and soil resources; Fossil fuel alternatives (e.g., grid-scale solar PV) do not themselves disrupt ecosystems and are respectful of water, land and other planetary boundaries	

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
	Relational Inclusiveness Concerned with an equitable distribution and governance of stranded fossil fuel assets, namely, the extent to which capable and culpable power actors are absorbing or reallocating the inevitable stranded assets that they have generated	Distribution of implementation costs for LFFU Governing of stranded financial assets Governing of stranded natural assets	Financial costs (stranded assets) of phasing out fossil fuels are allocated to large (fossil fuel) multinational firms and capable financial institutions; Compensation for stranded natural resources (e.g., recoverable coal, oil and gas reserves) is paid from richer governments, firms and investors from the Capital-North to citizens of poorer nations with ample reserves and dependence on developing said reserves (Chthulu-South)	
Sustainable Development Aligned with the SDGs and Agenda 2030; development understood as progress towards social, environmental and economic goals and targets that span local, national and international levels of governance		By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions. (Target 1.2) By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round. (2.1) By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination. (3.9) By 2030, ensure universal access to affordable, reliable and modern energy services (7.1) Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries (8.1) By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and	Number of prospective stranded jobs at risk in a fossil phase-out Quality of existing fossil-intensive jobs Degree to which fossil fuel production is being curtailed Ecological impact of existing fossil-intensive infrastructure Fossil-intensity of existing electric grids (ratio of fossil installed capacity to overall installed capacity) (stranded energy) Affordability and reliability of existing fossil-intensive electrical grids Monetary value of stranded natural fossil fuel assets (NPV) Number of new fossil-intensive physical assets being introduced to an economy (coal-fired power stations, coal mines, oil refineries) Emissions-intensity of existing and forthcoming fossil-intensive infrastructure	S2, S4, Overarching

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
		greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities. (9.4) By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average. (10.1) Integrate climate change measures into national policies, strategies and planning (13.2) Develop effective, accountable and transparent institutions at all levels (16.6)		
LFFU Approach A policy, instrument or measure with the explicit goal of taking climate action and that may directly or indirectly diminish fossil fuel production or consumption	**Regulatory** Approaches implemented predominantly by governments, policymakers and financial regulators, that legally prohibit or limit fossil fuel or consumption production in a specific domain, sector, or using a specific technology (e.g., fracking) **Economic** Approaches implemented predominantly by governments or policymakers that disincentivise fossil production or consumption by internalising and increasing costs to fossil producers and consumers **Other** Approaches implemented by governments and policy makers, in addition to CSOs, NGOs, financiers and investors themselves that directly or indirectly disincentivise, obstruct or illegalise fossil production or consumption	Social Inclusiveness Ecological Inclusiveness Relational Inclusiveness	To what extent are fossil-dependents (e.g., coal miners) accounted for and protected, and universal access to basic needs upheld? Will/can the approach directly LFFU at its respective level of governance? How are implementation costs and stranded assets allocated & accounted for?	S1, S4, Overarching
Stranded Asset Risk The risks born by a population due to exposure to and dependence on prospective stranded	**Monetary**	Prospective Stranded Natural Assets	NPV of proven coal, oil and gas reserves	S2, S6, Overarching

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
financial, natural, physical, social and human fossil fuel assets (see above)	The quantifiable risks borne by a population due to exposure to and dependence on prospective multidimensional stranded assets	Prospective Stranded Financial Assets	Magnitude (USD) of outstanding debt managed by recipient public of private financiers from a fossil project hosting nation Magnitude (USD) of liquid equity (shares) stake in domestic fossil projects and firms	
	Non-Monetary The non-quantifiable and intangible risks borne by a population due to exposure to and dependence on prospective multidimensional stranded assets	Prospective Stranded Labour, Energy (Human Assets) Prospective Stranded Communities Prospective Stranded Machinery, Infrastructure (Physical Assets)	Number of operational coal mines, coal-fired power stations, crude oil refineries, oil & gas pipelines, and LNG terminals Distribution of the above physical assets across South Africa & Africa more broadly Life expectancy of the above physical assets Scopes 1-3 Annual GHG Emissions from the above physical assets Annual coal (Mtpa), oil (Mboe/d) and natural gas (Mboe/d) production from the above physical assets Number of direct, indirect and induced employees in coal, oil and gas operations Quality of fossil-based jobs Number of available alternative employment opportunities for current fossil employees Skillsets of both fossil and fossil-alternative jobs Installed power capacity (MW) of fossil-based infrastructure Fraction of the population without any grid access Fraction of the population with grid access but cannot afford electricity tariffs	

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
			Fossil-based & fossil-alternative energy tariffs Constraints to meeting energy supply and demand with fossil- and fossil-alternative energy production	
Stranded Asset Debt An abstract concept describing the extent to which an actor, organisation, or coalition of organisations have directly driven and exacerbated the stranded asset risk (see above) exposure borne the citizens of a particular region by driving and financing fossil fuel projects, thereby accruing a 'debt' repayable and merit of addressing under Articles 4.5, 6, 9-11 of the Paris Agreement. This is supplementary to and builds on traditional concepts of *climate and ecological debts*	**Monetary** The quantifiable costs associated with LFFU, including but not limited to those for: decommissioning existing physical assets, retraining and providing a basic income or pension for fossil labourers (human assets), procuring affordable and reliable fossil-alternative installed power capacity, relieving outstanding fossil-debts, and writing-off devalued liquid equity (financial assets)	Direct LFFU costs Opportunity costs	*Infrastructure decommissioning costs* *Personnel retraining costs* *Universal basic income and pension costs* *Compensation for forgone fossil production*	S3
	Non-Monetary The non-quantifiable and intangible costs necessary for stranding assets and inclusively LFFU, including but not limited to those from: transferring knowledge and expertise for redesigning fossil-intensive grids and the time investment in LFFU	Technology Administration Logistics	*Assistance with adequately decommissioning existing fossil infrastructure* *Access to cheap or free fossil-alternative technology, either through concessional loans or grants* *Full-time staff from stranded asset debtor organisations to help coordinate and manage the phase-out and stranding process*	
Inclusive Stranded Asset Debt Governance Ensuring that *culpable* and *capable* stranded asset debtors comply with the monetary and non-monetary components in settling their SAD and supporting inclusive fossil phase-outs	**Responsibility** The extent to which a key economic or financial actor (see below) has driven, invested in and hoisted fossil fuel production and thereby generated and intensified the multidimensional stranded asset risk	E&P-driven fossil production Debt financing Equity financing	Geographical distribution of the listed HQs of major E&Ps and their shareholders, debt financiers, PFIs Common shares (USD) managed by major shareholders of leading E&Ps in (South) Africa Private debt issued to major E&Ps and their South African projects by commercial banks Public debt issued to major E&Ps and their (South) African projects by PFIs, including MDBs, BDBs and ECAs Annual trends in public and private debt issued since the ratification of the Paris Agreement	S3
	Capability The extent to which key economic or financial actors (see below) have sufficient monetary	Financial health of key actors	Annual revenues (USD) generated by E&Ps holding operations in (South) Africa	

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
	and non-monetary resources to address both the monetary and non-monetary components of the stranded asset debt bill		Dividends earned (USD) by major shareholders from managing shares in leading E&Ps Total assets under managed by major shareholders Total cashflow of commercial and public financiers	
Inclusive Fossil Phase-out A scenario in which coal, oil and gas production is curtailed while the social, ecological and relational ramifications from the inevitable stranded assets that arise from doing so are prioritised, the stranded asset burden is absorbed by capable and culpable actors, and de facto, stranded asset debts are settled				
Climate policy frameworks Adopted and ratified frameworks that directly or indirectly influence and regulate fossil fuel production	**International, Non-legally binding** Frameworks that key actors and organisations (see below) become voluntary signatories to, like the UNEP FI PRI/PRB and the OECD 'Arrangement' and 'Common Approaches', that are used to shape or justify economic and financial decision-making pertinent to fossil fuel production	Social Inclusiveness of framework Ecological Inclusiveness of framework Relational Inclusiveness of framework	Financial capital to generate safe, high quality and desirable jobs is prioritised over profitability (PIIB S1) Ecologically-inclusive investments in fossil-alternatives should not hamper universal access to basic needs and services, like energy, healthcare, water, food, housing and justice (PIIB S2) No financial capital or services (e.g., loans, guarantees, underwritings, equity) will be, from now onwards, allocated to support new coal, oil or gas exploration and production (PIIB E1) No financial capital or services (e.g., loans, guarantees, underwritings, equity) will be, from now onwards, allocated to support the development of new infrastructure that serves the explicit purpose of supporting or combusting fossil fuels (PIIB E2) All finance supporting low-carbon, fossil alternative projects (e.g., solar PV, wind, battery storage) will undergo a strenuous impact assessment process (conducted by a coalition of CSOs & regulatory agencies) to ensure that land, water, air, and biodiversity disruptions are minimised or omitted altogether (PIIB E3) Financial capital (in the form of grants, debt relief, and concessionary loans) will be allocated to adequately and entirely decommission and repurpose existing fossil fuel	S5

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
			infrastructure so that ecological disruptions to land/soil, water and local air are eradicated (PIIB E4) Action is taken by indebted (vis-à-vis a SAD) financial institutions to voluntarily allocated ample funds (grants and debt relief) to meet all ecological and social principles above (PIIB R1) No financier or investor will seek to earn profits through fossil fuel exploitation (PIIB R2) Asset managers and other institutional investors will write-off any and all liquid assets (in the form of e.g., shares) pertaining to firms that derive any of their revenue from fossil fuel production, and will subsequently allocate ample (non-)financial resources to shut down these fossil operations in compliance with the other ecological and social principles (PIIB R3) Asset managers and other institutional investors will identify firms that derive any of their revenue indirectly from fossil fuel production (through e.g., infrastructure construction), and will subsequently allocate ample (non)financial resources to terminate all forthcoming projects of this nature and recraft their business in compliance with the other ecological and social principles (PIIB R4)	
	National policy frameworks Policy documents drafted and adopted by South Africa's various ministries (DMRE, DFFE) that directly or indirectly hamper (or invite) fossil fuel investment and future production, including the IRP, NDP, NDCs and Exploration and Production Contracts	Direct fossil fuel supply constraint Indirect fossil fuel supply constraint	Amount (GW) of forecasted installed coal, oil and gas-fired power capacity through 2030 and beyond Amount (GW) of planned decommissioned coal, oil and gas-fired installed capacity Annual emissions targets through 2030 and beyond Planned investments in domestic coal, oil and gas infrastructure Timespan of issued mining contracts Legal flexibility in terminating existing contracts	S5
Key Financial & Economic Actors	'North'			

Concept	Dimension	Variable(s)	Indicator(s)	Question(s)
Organisations that directly drive and continue to hoist fossil fuel production in both South Africa and Africa more broadly, including multinational Exploration & Production firms (E&Ps), their major shareholders, and the private (e.g., commercial banks) and public financiers (PFIs – MDBs, BDBs and ECAs) that issue loans and underwriting to the E&Ps	Key actors from Annex 1/B nations, as defined by the UNFCCC **'South'** Key actors from non-Annex 1/B nations, as defined by the UNFCCC	E&P foothold on (South) African fossil fuel production	Presence and active operations in (South) Africa Type of operation in (South) Africa Coal (Mtpa), oil (Mboe/d) and natural gas (Mboe/d) production rates in (South) Africa compared to national rates Taxes, royalties, and other payments made to host governments Number of (South) African mining and exploration sites under control/ operation Equity and debt finance for these E&Ps – see 'stranded financial assets' above	S3

Appendix B. Supplementary Methodological Information

Chapter 5

This chapter drew on the annual reports pertaining to the 29 E&Ps identified in the sample, in addition to several news items and supplementary reports identified in the news item mining exercise after using the Banktrack (n.d.) and GEM (2020a; 2020b; 2020c) databases as a point of departure. These reports and news items are denoted in the reference list below. Moreover, the stranded asset related findings form these reports were corroborated and triangulated with semi-structured interviews in addition to a superficial analysis of a podcast series and by attending 6 webinars, the details of which are also denoted below.

Datasets & Sample Calculations

Moreover, three unique databases (BP; 2020; 2021; OPEC, 2020; IEA, 2021) were used to build an inventory pertaining to the distribution of prospective stranded natural assets across the African continent, also disclosed in the reference list below. To compute the NPV of these reserves, I assumed production rates (R) and reserve sizes (S) remained constant and subsequently computed the remaining lifetime (L) of the reserve. For instance, in the case of coal in South Africa:

$$L_{coal} = \frac{S}{R} = \frac{10Gt}{254Mt/yr} \cong 40\ years$$

This was repeated for all fuel types both for the South African case and then for the African continent. The NPV of the revenue streams generated from these reserves could then be estimated by summing the annual cashflows using a fixed discount rate and commodity price. So for example, assuming a discount rate of 10% and prices of coal, oil and gas of $10/ton, $50/bbl, and $0.005/cf, Table B1 was generated. Finally, these calculations were repeated in a sensitivity analysis by fluctuating the discount rate from 0-10% (in 20 x 0.5% increments) and the commodity prices from $10-100/ton (coal), $10-100/Bbl (oil) and $0.005-0.1/cf (natural gas), also in 20 increments each, yielding a total of 400 NPV calculations per fuel type, or 1200 total. This process was automated by writing a simple Google Script:

```
function SensitivityAnalysis(){

  var sheet = SpreadsheetApp.getActiveSpreadsheet();
  var insheet = sheet.getSheetByName("DRV Africa");
  var outsheet = sheet.getSheetByName("Sensitivity Analysis Africa");
  var col = 3;
  var row = 57;

for(var discount = 0; discount <=0.101; discount = discount + 0.005) {

  insheet.getRange(11,1).setValue(discount);

  for(var pcoal = 0.0005; pcoal <0.0101; pcoal = pcoal + 0.0005){

    insheet.getRange(10,1).setValue(pcoal);

    var coalvalue = insheet.getRange(4,13).getValue();

    outsheet.getRange(row, col).setValue(coalvalue);

    col = col + 1;

  }

  row = row + 1;

  col = 3;

}

}
```

Which eventually produced Table B2 (in the case of goal) which was used to generate Figure 5.1.

Table B1. Sample sheet modelling the NPV of South African fossil reserves at a fixed discount rate and commodity price.

	Reserves	Production	Years Remaining	Cash Flow		NPV Cash Flow (Billions USD)			NPV Reserves (Billions USD)	
Coal (B Tonnes)	9.893	0.392	25	Year	Discount Factor	Coal	Oil	Gas	Coal	$385.91
Oil (Gbbl)	9.0	2.5	4	0	1	$39.17	$123.21	$20.92	Oil	$1,065.62
Gas (Tcf)	60.0	4.2	14	1	0.900	$35.25	$110.89	$18.82	Gas	$208.81
				2	0.810	$31.73	$99.80	$16.94	Total FF	$1,660.35
				3	0.729	$28.55	$89.82	$15.25		
Constants (Assumed)				4	0.656	$25.70	$80.84	$13.72		
$100.00	USD/metric tonne			5	0.590	$23.13	$72.75	$12.35		
$50.00	USD/Bbl			6	0.531	$20.82	$65.48	$11.12		
$0.0050	USD/cf			7	0.478	$18.73	$58.93	$10.00		
0.100	discount rate			8	0.430	$16.86	$53.04	$9.00		
				9	0.387	$15.18	$47.73	$8.10		
				10	0.349	$13.66	$42.96	$7.29		
				11	0.314	$12.29	$38.66	$6.56		
				12	0.282	$11.06	$34.80	$5.91		
				13	0.254	$9.96	$31.32	$5.32		
				14	0.229	$8.96	$28.19	$4.78		
				15	0.206	$8.06	$25.37	$4.31		
				16	0.185	$7.26	$22.83	$3.88		
				17	0.167	$6.53	$20.55	$3.49		
				18	0.150	$5.88	$18.49	$3.14		
				19	0.135	$5.29		$2.83		
				20	0.122	$4.76		$2.54		
				21	0.109	$4.29		$2.29		
				22	0.098	$3.86		$2.06		
				23	0.089	$3.47		$1.85		
				24	0.080	$3.12		$1.67		
				25	0.072	$2.81		$1.50		
				26	0.065	$2.53		$1.35		
				27	0.058	$2.28		$1.22		
				28	0.052	$2.05		$1.09		
				29	0.047	$1.84		$0.99		
				30	0.042	$1.66		$0.89		
				31	0.038	$1.49		$0.80		
				32	0.034	$1.34		$0.72		
				33	0.031	$1.21		$0.65		
				34	0.028	$1.09		$0.58		
				35	0.025	$0.98		$0.52		
				36	0.023	$0.88		$0.47		
				37	0.020	$0.79		$0.42		
				38	0.018	$0.71		$0.38		
				39	0.016	$0.64		$0.34		
				40	0.015			$0.31		
				41	0.013			$0.28		
				42	0.012			$0.25		
				43	0.011			$0.23		
				44	0.010			$0.20		
				45	0.009			$0.18		
				46	0.008			$0.16		
				47	0.007			$0.15		
				48	0.006			$0.13		
				49	0.006			$0.12		
				50	0.005			$0.11		
				51	0.005			$0.10		
				52	0.004			$0.09		
				53	0.004			$0.08		
				54	0.003			$0.07		
				55	0.003			$0.06		
				56	0.003			$0.06		
				57	0.002			$0.05		
				58	0.002			$0.05		
				59	0.002			$0.04		
				60	0.002			$0.04		
				61	0.002					
				62	0.001					
				63	0.001					
				64	0.001					
				65	0.001					
				66	0.001					
				67	0.001					
				68	0.001					
				69	0.001					
				70	0.001					

Table B2. Resulting table from sensitivity analysis estimating NPV of South Africa's coal reserves, using the Google Script denoted above.

Coal Reserve Value (B USD) -- using 10Gt Reserve

	Price Coal ($/t)																			
Discount Rate	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
0	50.80	101.60	152.40	203.20	254.00	304.80	355.60	406.40	457.20	508.00	558.80	609.60	660.40	711.20	762.00	812.80	863.60	914.40	965.20	1016.00
0.005	46.15	92.29	138.44	184.59	230.73	276.88	323.03	369.17	415.32	461.47	507.61	553.76	599.91	646.05	692.20	738.35	784.49	830.64	876.79	922.93
0.010	42.04	84.08	126.12	168.16	210.20	252.24	294.28	336.32	378.37	420.41	462.45	504.49	546.53	588.57	630.61	672.65	714.69	756.73	798.77	840.81
0.015	38.41	76.82	115.23	153.65	192.06	230.47	268.88	307.29	345.70	384.11	422.52	460.94	499.35	537.76	576.17	614.58	652.99	691.40	729.82	768.23
0.020	35.20	70.40	105.59	140.79	175.99	211.19	246.39	281.58	316.78	351.98	387.18	422.38	457.57	492.77	527.97	563.17	598.37	633.56	668.76	703.96
0.025	32.35	64.70	97.04	129.39	161.74	194.09	226.43	258.78	291.13	323.48	355.83	388.17	420.52	452.87	485.22	517.56	549.91	582.26	614.61	646.96
0.030	29.81	59.63	89.44	119.26	149.07	178.89	208.70	238.52	268.33	298.15	327.96	357.78	387.59	417.41	447.22	477.04	506.85	536.67	566.48	596.30
0.035	27.56	55.12	82.68	110.24	137.80	165.36	192.92	220.48	248.04	275.59	303.15	330.71	358.27	385.83	413.39	440.95	468.51	496.07	523.63	551.19
0.040	25.55	51.09	76.64	102.19	127.74	153.28	178.83	204.38	229.92	255.47	281.02	306.57	332.11	357.66	383.21	408.75	434.30	459.85	485.40	510.94
0.045	23.75	47.50	71.24	94.99	118.74	142.49	166.24	189.98	213.73	237.48	261.23	284.97	308.72	332.47	356.22	379.97	403.71	427.46	451.21	474.96
0.050	22.14	44.27	66.41	88.54	110.68	132.81	154.95	177.09	199.22	221.36	243.49	265.63	287.77	309.90	332.04	354.17	376.31	398.44	420.58	442.72
0.055	20.69	41.38	62.06	82.75	103.44	124.13	144.82	165.51	186.19	206.88	227.57	248.26	268.95	289.63	310.32	331.01	351.70	372.39	393.07	413.76
0.060	19.39	38.77	58.16	77.54	96.93	116.31	135.70	155.08	174.47	193.85	213.24	232.62	252.01	271.39	290.78	310.16	329.55	348.93	368.32	387.70
0.065	18.21	36.42	54.63	72.84	91.05	109.26	127.47	145.68	163.89	182.10	200.31	218.52	236.73	254.94	273.15	291.36	309.57	327.78	345.99	364.20
0.070	17.15	34.29	51.44	68.59	85.74	102.88	120.03	137.18	154.33	171.47	188.62	205.77	222.92	240.06	257.21	274.36	291.51	308.65	325.80	342.95
0.075	16.18	32.37	48.55	64.74	80.92	97.11	113.29	129.48	145.66	161.84	178.03	194.21	210.40	226.58	242.77	258.95	275.14	291.32	307.50	323.69
0.080	15.31	30.62	45.93	61.24	76.55	91.86	107.17	122.48	137.79	153.10	168.41	183.72	199.03	214.34	229.65	244.96	260.27	275.58	290.89	306.20
0.085	14.51	29.03	43.54	58.05	72.57	87.08	101.59	116.11	130.62	145.13	159.65	174.16	188.67	203.19	217.70	232.21	246.73	261.24	275.75	290.27
0.090	13.79	27.57	41.36	55.15	68.93	82.72	96.51	110.29	124.08	137.87	151.65	165.44	179.23	193.01	206.80	220.59	234.37	248.16	261.95	275.73
0.095	13.12	26.24	39.37	52.49	65.61	78.73	91.85	104.97	118.10	131.22	144.34	157.46	170.58	183.71	196.83	209.95	223.07	236.19	249.31	262.44
0.100	12.51	25.02	37.54	50.05	62.56	75.07	87.59	100.10	112.61	125.12	137.64	150.15	162.66	175.17	187.68	200.20	212.71	225.22	237.73	250.25

A modelling exercise was also used to estimate the interest payments that Eskom owed the World Bank for the issued loan to finance the Medupi power station (see 5.2.2.3). This was fairly straightforward given that the World Bank (n.d.) publishes an updated payment schedule for all outstanding project loans, including this one. The floating interest rate could then be computed in biannual increments (payments are made every 6 months) by comparing the interest payment to the outstanding principal.

Accounting for the deflating South African Rand to compute the *effective* interest rate was slightly more technical; to execute this, I download monthly USD/ZAR exchange rate data from Yahoo! Finance from April 2010 through May 2021 (time of the analysis), then converted each element in the payment schedule into ZAR using the appropriate exchange rate using a vlookup() function, denoted in the Sheet below. Finally, the biannual interest rates could then be re-computed in South African rands, shown in Table B3.

Table B3. Estimating the effective interest rate owed by Eskom to the World Bank for Medupi.

	Repayment	Interest and Charges	Principal Remaining from Commitment	Principal Remaining from Disbursed		
May 2017	$735,803,967.34	$1,403,359,663.96	$28,630,268,628.53	$32,350,922,746.14	Total Repayment	
Sep 2017	$0.00	$0.00	$28,630,268,628.53	$32,350,922,746.14	$1,416,449,361.53	
Nov 2017	$680,645,394.19	$1,382,535,293.04	$27,949,623,234.34	$31,670,277,351.95	Total Interest	IR1
Dec 2017	$0.00	$0.00	$27,949,623,234.34	$31,670,277,351.95	$2,785,894,956.99	9.49%
Mar 2018	$0.00	$0.00	$27,949,623,234.34	$31,670,277,351.95	Total Repayment	
May 2018	$884,182,269.16	$1,530,736,916.76	$27,065,440,965.19	$30,786,095,082.79	$1,677,400,531.89	
Nov 2018	$793,218,262.73	$1,427,245,319.78	$26,272,222,702.45	$29,992,876,820.06	Total Interest	IR
Dec 2018	$0.00	$0.00	$26,272,222,702.45	$29,992,876,820.06	$2,957,982,236.54	10.58%
May 2019	$855,804,563.03	$1,492,144,142.69	$25,416,418,139.42	$29,137,072,257.03	Repayment	$1,698,187,383.62
Jun 2019	$0.00	$0.00	$25,416,418,139.42	$29,137,072,257.03	Interest	$3,005,779,369.04
Nov 2019	$842,382,820.60	$1,513,635,226.35	$24,574,035,318.83	$28,294,689,436.44	IR	11.44%
Apr 2020	-$20,719,179.68	-$37,550,768.59	$24,594,754,498.51	$28,315,408,616.11	Repayment	$1,599,847,301.60
May 2020	$797,004,717.70	$1,381,155,925.04	$23,797,749,780.81	$27,518,403,898.42	Interest	$2,744,954,262.04
Jun 2020	$0.00	$0.00	$23,797,749,780.81	$27,518,403,898.42	IR	11.17%
Nov 2020	$823,561,763.59	$1,401,349,105.59	$22,974,188,017.22	$26,694,842,134.83		
Jan 2021	$0.00	$0.00	$22,974,188,017.22	$26,694,842,134.83		
May 2021	$832,197,336.26	$1,318,238,415.97	$22,141,990,680.96	$25,862,644,798.57		

Major Projects Database

E3 `=D3/vlookup(B3, 'Rand to USD XR'!$B$2:$C$137, 2, FALSE)`

Period	Transaction Type	Amount (US$)	Amount in Rand
Apr 2010	Commitment	3,750,000,000.00	27,695,716,395.86
Jun 2010	Disbursement	9,375,000.00	71,949,347.66
Jun 2010	Fees	9,375,000.00	71,949,347.66
Oct 2010	Disbursement	361,614,274.59	2,537,109,903.81
Nov 2010	Interest and Charges	30,880.21	220,336.85
May 2011	Interest and Charges	1,408,040.87	9,587,640.41
Jun 2011	Disbursement	170,490,686.92	1,159,327,396.44
Nov 2011	Disbursement	37,032,040.57	300,877,807.69
Nov 2011	Interest and Charges	1,769,948.20	14,380,469.61
Jan 2012	Disbursement	199,311,126.59	1,569,502,532.40
Apr 2012	Disbursement	101,603,213.82	790,010,215.54
May 2012	Interest and Charges	3,095,928.15	26,418,023.30
Jun 2012	Disbursement	98,556,678.17	805,201,619.04
Sep 2012	Disbursement	42,343,488.07	352,187,374.78
Nov 2012	Interest and Charges	4,940,081.07	43,939,171.66
Dec 2012	Disbursement	56,684,221.92	482,008,689.80
Mar 2013	Disbursement	66,986,416.51	619,957,579.92
May 2013	Interest and Charges	4,362,747.42	44,237,958.02
Jun 2013	Disbursement	167,131,885.74	1,659,700,950.74
Oct 2013	Disbursement	31,098,570.43	314,095,247.25
Nov 2013	Disbursement	291,080,284.11	2,967,481,742.38
Nov 2013	Disbursement	-600,000,000.00	-6,116,831,481.29
Nov 2013	Interest and Charges	4,534,879.39	46,231,821.69
Nov 2013	Disbursement	299,690,789.76	3,055,263,429.10
Dec 2013	Disbursement	28,373,876.06	299,270,921.42
Mar 2014	Disbursement	104,301,643.18	1,099,648,320.30
May 2014	Disbursement	101,285,107.28	1,071,233,286.94
May 2014	Disbursement	100,452,170.54	1,062,423,802.64
May 2014	Disbursement	100,880,538.01	1,066,954,394.61
May 2014	Disbursement	-300,000,000.00	-3,172,924,378.64
May 2014	Interest and Charges	2,396,073.35	25,341,865.15
May 2014	Interest and Charges	13,018,143.84	137,685,286.52
May 2014	Interest and Charges	12,422,289.06	131,383,279.32
Jun 2014	Disbursement	74,581,456.61	793,673,051.08
Sep 2014	Disbursement	34,388,522.75	388,219,945.25
Nov 2014	Disbursement	303,186,652.86	3,360,898,490.85
Nov 2014	Disbursement	185,028,810.40	2,051,089,794.92

Finally, the E&P report analysis for this chapter led to the creation of an original dataset that maps the E&Ps to their African operations (as of 2019/20, when the reports were published). This dataset compiled general details concerning the location (country) of operation, type of operation (exploration/ production, fuel type), status (operational, undeveloped, etc.) and operating stake, among others. A sample of this dataset is presented below and a full version is available upon request.

	Company	Country	Resource Type	Project Type	Details	Parternerships	Operator?	%Stake(s)	Status (as of 2020)
8	BP	South Africa	Offshore Oil	Refining	Downstream crude oil refinery			50.00%	Operational
9	Canadian Natural	South Africa	Offshore Oil	Exploration & Production	Block 11B/2B oil gas offshore exploration and production (Burlpadda field)	TotalSA (Operator)	Non-Operator	20%	
10	Canadian Natural	South Africa	Offshore Gas	Exploration & Production	Block 11B/2B oil gas offshore exploration and production (Burlpadda field)	TotalSA (Operator)	Non-Operator	20%	
12	Engen	South Africa	Offshore Oil	Refining	Crude oil (and finished product) sourcing --> inbound logistics to ship and store products locally --> processing in refinery (durban based)				
13	Engen	South Africa	Offshore Oil	Shipping & Transport	Crude oil (and finished product) sourcing --> inbound logistics to ship and store products locally --> processing in refinery (durban based)				
14	ENI	South Africa	Offshore Oil	Exploration	26,000 km2 of acreage operated for O&G activity - nothing reported				
15	ENI	South Africa	Offshore Gas	Exploration	26,000 km2 of acreage operated for O&G activity - nothing reported				
16	Equinor	South Africa	Offshore Oil	Exploration	Undeveloped oil and gas acreage (exploration)				Undeveloped
17	Equinor	South Africa	Offshore Gas	Exploration	Undeveloped oil and gas acreage (exploration)				Undeveloped
20	ExxonMobil	South Africa	Offshore Oil	Exploration	Deepwater Durban exploration; Tranksei-Algoa exploration; Tugela South exploration			40-50%	(Seismic) Evaluation ongoing
21	ExxonMobil	South Africa	Offshore Gas	Exploration	Deepwater Durban exploration; Tranksei-Algoa exploration; Tugela South exploration			40-50%	(Seismic) Evaluation ongoing
24	Glencore	South Africa	Offshore Oil	Exploration	Oil interest -- Acquired 75% stake in Chevron South Africa Pro	Chevron		75%	
26	Qatar Petroleum	South Africa	Offshore Oil	Exploration	Offshore block exploration license Blocks 11B/12B	Total (45%, operator), Canadian Natural (20%), Main Street (10%)	Non-Operator	25%	
27	Qatar Petroleum	South Africa	Offshore Gas	Exploration	Offshore block exploration license Blocks 11B/12B	Total (45%, operator), Canadian Natural (20%), Main Street (10%)	Non-Operator	25%	
30	Sasol	South Africa	Offshore Gas	Liquification (LNG)	Gas imports into SA from Mozambique through gas pipeline (see Mozambique) & Gas to Liquid process (Sasolburg)				
31	Sasol	South Africa	Offshore Oil	Refining	Chemicals facility & base chemicals commodity market				

Content Analysis: E&P Reports

Sampled fossil fuel E&P reports

Company	Africa? (Y/N)	Average 2021 Dividend Yield	Report(s)
African Rainbow Minerals	Y	12.52%	(ARM, 2020)
AngloAmerican	Y	3.00%	(AngloAmerican, 2020)
BHP Billiton	Y	13.04%	(BHP Billiton, 2020)
BP	Y	5.19%	(BP, 2020)
Cairn Energy	Y	0.00%	(Cairn Energy, 2019)
Canadian Natural	Y	4.40%	(CAN, 2019)
Chevron	Y	5.56%	(Chevron, 2020) (Chevron, 2019)
CNOOC	Y	7.08%	(CNOOC, 2019)
Coal of Africa (MC Mining)	Y	0.00%	(MC Mining, 2020)
Engen	Y	0.00%	(Engen, 2019)
ENI	Y	6.29%	(ENI, 2019)
Equinor	Y	2.08%	(Equinor, 2019a) (Equinor, 2019b)
Exxaro Resources	Y	8.38%	(Exxaro Resources, 2019)
ExxonMobil	Y	6.45%	(ExxonMobil, 2019a) (ExxonMobil, 2019b)
Glencore	Y	1.31%	(Glencore, 2020)
Mitsubishi Group	Y	3.80%	(Mitsubishi, 2020)
Mitsui Mining and Minerals	Y	5.97%	(Mitsui, 2020)
Repsol	Y	6.38%	(Repsol, 2020)
Rio Tinto	Y	5.52%	(Rio Tinto, 2020)
Rosneft	Y	6.41%	(Rosneft, 2019)
Sasol	Y	0.00%	(Sasol, 2019)
Shell	Y	6.42%	(Shell, 2020) (Shell, 2019a) (Shell, 2019b)
South32	Y	2.20%	(South32, 2020)
Terracom (formerly Universal Coal)	Y	5.41%	(Terracom, 2020)
TotalSA	Y	7.20%	(Total S.A., 2019)
Tullow Oil	Y	0.93%	(Tullow, 2019a) (Tullow, 2019b)
Vale SA	Y	9.21%	(Vale SA, 2020)
Woodside Petroleum	Y	2.92%	(Woodside, 2020)
Adani Enterprises	N	-	N/A
PT Bukit Asam	N	-	N/A
Coal India	N	-	N/A
EOG Resources	N	-	N/A
Foresight Energy	N	-	N/A
Gazprom	N	-	N/A
Inner Mongolia Coal	N	-	N/A
Novatek	N	-	N/A
Peabody	N	-	N/A
Petrobras	N	-	N/A
Shaanxi Coal & Chemicals	N	-	N/A

Subset of fossil fuel E&Ps identified with direct linkages to South African fossil fuel projects. Same reports as those denoted above corresponding to the respective E&P was used in this stage of the analysis.

E&P Name
ExxonMobil
Chevron
BHP Billiton
Shell
Rio Tinto
TotalSA
BP
Equinor
Glencore
AngloAmerican
ENI
Canadian Natural Resources
Mitsubishi
South32
Sasol
Petronas/Engen
African Rainbow Minerals
Exxaro Resources
Terracom
ResGen
MC Mining

References: Reports & News Items

350.org Africa. (n.d.). *#StopKarpowershipSA*. Retrieved March 11, 2022, from 350 Africa.org: https://350africa.org/stopkarpowershipsa/

A Barrel Full. (n.d.). *Sapref Durban Refinery*. Retrieved 10 22, 2021, from A Barrel Full: http://abarrelfull.wikidot.com/sapref-durban-refinery

AE (Africa Energy). (n.d.). *SOUTH AFRICA, BLOCK 11B/12B*. Retrieved March 11, 2022, from AE: https://www.africaenergycorp.com/operations/south-africa-block-11b-12b/

AE. (2021, 6 8). *Africa Energy Announces Block 11B/12B Operations Update*. Retrieved 10 22, 2021, from Africa Energy: https://news.cision.com/africa-energy/r/africa-energy-announces-block-11b-12b-operations-update,c3362730

AIDC (Alternative Information and Development Centre). (2020). *The PIC, Eskom Debt & Financing a Just Energy Transition.* Johannesburg: AIDC. Retrieved March 10, 2022, from http://aidc.org.za/download/the_public_investment_corporation_pic_and_the_government_employees_pension_fund_gepf/The-Public-Investment-Corporation-and-Financing-a-Just-Energy-Transition-Final.pdf

Aljazeera. (2020, Oct 13). *'The king of electricity': Solar outshines other power sources*. Retrieved March 10, 2022, from Aljazeera: https://www.aljazeera.com/economy/2020/10/13/the-king-of-electricity-solar-outshines-other-power-sources

Argus. (2018, Sep 28). *Glencore's BEE partner concludes Chevron purchase*. Retrieved March 11, 2022, from Argus: https://www.argusmedia.com/en/news/1763532-glencores-bee-partner-concludes-chevron-purchase

ARM (Africa Rainbow Minerals). (n.d.). *ARM COAL*. Retrieved March 11, 2022, from ARM: https://arm.co.za/arm-coal/

ARM. (2020). *Integrated Annual Report.* African Rainbow Minterals. Retrieved March 12, 2021, from https://arm.co.za/wp-content/uploads/2020/11/Integrated-Annual-Report-2020.pdf

Astron Energy. (n.d.). *About Us: The Refinery*. Retrieved March 11, 2022, from Astron Energy: https://www.astronenergy.co.za/about-us/

Baily, M. (1978). *Shell and BP in South Africa.* Johannesburg: Anti-Apartheid Movement, Haslemere Group. Retrieved 10 22, 2021, from http://psimg.jstor.org/fsi/img/pdf/t0/10.5555/al.sff.document.aam00020_final.pdf

Banktrack. (2017). *Medupi coal power plant*. Retrieved 10 24, 2021, from Banktrack: https://www.banktrack.org/project/medupi_coal_power_plant#documents

Banktrack. (2018, August). *Kusile coal power plant South Africa*. Retrieved February 18, 2022, from BankTrack Dodgy Deals: https://www.banktrack.org/project/kusile_coal_power_plant#financiers

Bloomberg. (2020, Oct 27). *South Africa's cities to switch to solar as Eskom monopoly ends*. Retrieved March 10, 2022, from Business Tech: https://businesstech.co.za/news/energy/443644/south-africas-cities-to-switch-to-solar-as-eskom-monopoly-ends/

Bloomberg. (2021, Mar 29). *Karpowership Record S. Africa Deal Estimated at $15 Billio*. Retrieved March 11, 2022, from Bloomberg: https://www.dailymaverick.co.za/article/2021-03-29-karpowership-record-s-africa-deal-estimated-at-15-billion/

BP. (2020). *Statistical Review of World Energy.* London: BP. Retrieved 07 22, 2020, from https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html

Brigham, K. (Director). (2020). *The Future of Energy Storage Beyond Lithium* [Motion Picture]. Retrieved March 10, 2022, from https://www.youtube.com/watch?v=EoTVtB-cSps&ab_channel=CNBC

Britannica. (n.d.). *Transportation and Telecommunications*. Retrieved March 11, 2022, from Britannica: https://www.britannica.com/place/South-Africa/Transportation-and-telecommunications#ref260132

Business Insider SA. (2021, Apr 15). *Total halts additional drilling in the same block as SA's Brulpadda and Luiperd gas deposits*. Retrieved March 11, 2022, from Business Insider SA: https://www.businessinsider.co.za/total-halts-additional-drilling-around-sas-brulpadda-and-luiperd-gas-deposits-2021-4

Business Tech. (2020, Nov 20). *Eskom wants to 'name and shame' residents for non-payment*. Retrieved March 11, 2022, from Business Tech: https://businesstech.co.za/news/energy/450161/eskom-wants-to-name-and-shame-residents-for-non-payment/

CAN (Canadian Natural Resources). (2020). *2020 Annual Report.* CAN. Retrieved March 11, 2022, from https://www.cnrl.com/upload/report/134/04/2020-annual-report---teams.pdf

CAN. (2019). *Annual Report.* Canadian Natural Resources. Retrieved March 12, 2021, from https://www.cnrl.com/investor-information/annual-documents#2019

Climate Action Tracker. (2021, Oct 29). *South Africa*. Retrieved March 11, 2022, from Climate Action Tracker: https://climateactiontracker.org/countries/south-africa/

Coal International. (2007). *ARM Coal And Xstrata Coal To Develop R2.9 Billion Goedgevonden Open Pit Coal Mine*. Retrieved 10 22, 2021, from Mining & Quarry World: https://mqworld.com/2007/07/11/arm-coal-and-xstrata-coal-to-develop-r2-9-billion-goedgevonden-open-pit-coal-mine/

Coalition, C. J. (2020). Just Us and the Climate [Recorded by A. Lenferna, M. Nkali, & F. Nkosi]. Johannesburg, Gauteng, South Africa. Retrieved March 11, 2021, from https://pod.link/cjc

Creamer, T. (2020, Sept 23). *Ten lessons to guide South Africa's 'just transition' from coal to renewables*. Retrieved March 10, 2022, from Mining Weekly: https://www.miningweekly.com/article/ten-lessons-to-guide-south-africas-just-transition-from-coal-to-renewables-2020-09-23

Creamer, T. (2021, Apr 23). *Engen to shut refinery and repurpose KZN site as an import terminal*. Retrieved March 11, 2022, from Engineering News: https://www.engineeringnews.co.za/article/engen-to-shut-refinery-and-repurpose-kzn-site-as-an-import-terminal-2021-04-23

Creamer, T. (2021, Jul 13). *Shell expresses concern over RMIPPPP delays as it confirms Karpowership SA partnership*. Retrieved March 11, 2022, from Engineering News: https://www.engineeringnews.co.za/article/shell-expresses-concern-over-rmipppp-delays-as-it-confirms-karpowership-sa-partnership-2021-07-13/rep_id:4136

DFFE (Department of Forestry, Fisheries & the Environment RSA). (2021). *South Africa's updated draft Nationally Determined Contribution (NDC) launched.* Pretoria: DFFE. Retrieved 10 22, 2021, from https://www.environment.gov.za/mediarelease/creecy_indc2021draftlaunch_climatechangecop26

DMRE (Department of Mineral Resources & Energy RSA). (2019). *Integrated Resource Plan.* Pretoria: DMRE. Retrieved 10 22, 2021, from https://www.bing.com/search?q=south+africa+irp&cvid=8fd2b1785b144d6dbdc0fa87f886ab7c&aqs=edge..69i57l2j69i65j69i60l4.1611j0j4&FORM=ANAB01&PC=HCTS

DMRE. (n.d.). *Aplly for a mining right*. Retrieved March 11, 2022, from DMRE: South African Government: https://www.gov.za/services/mining-and-water/apply-mining-right

DMRE. (n.d.). *Independent Power Producer Procurement Programme*. Retrieved March 11, 2022, from DMRE: IPP Projects: https://www.ipp-projects.co.za/Home/About

DMRE. (n.d.). *Structure and functions of the South African Government*. Retrieved March 11, 2022, from South African Government: DMRE: https://www.gov.za/about-government/government-system/structure-and-functions-south-african-government

Eberhard, A., & Naude, R. (2020). *THE SOUTH AFRICAN RENEWABLE ENERGY IPP PROCUREMENT PROGRAMME.* Cape Town: University of Cape Town. Retrieved March 11, 2022, from https://www.gsb.uct.ac.za/files/EberhardNaude_REIPPPPReview_2017_1_1.pdf

Energy, Oil & Gas. (n.d.). *NATREF*. Retrieved March 11, 2022, from Energy & Mining: https://energy-oil-gas.com/profiles/natref/

Engen. (2020). *Moving Forward Together: Engen Integrated Report 2020.* Engen. Retrieved March 11, 2022, from https://engen-admin.engen.co.za/storage/app/uploads/public/60f/042/353/60f0423532d29625322681.pdf

Engen. (n.d.). *Manufacturing: Refinery*. Retrieved March 11, 2022, from Engen: https://engen.co.za/about/manufacturing

Eskom. (2021, December 30). *Kusile Unit 4 synchronised to the national grid for the first time, helping to ease the capacity constraints*. Retrieved February 18, 2022, from Eskom: https://www.eskom.co.za/kusile-unit-4-synchronised-to-the-national-grid-for-the-first-time-helping-to-ease-the-capacity-constraints/

Eskom. (n.d.). *Response to NERSA's consultation paper*. Retrieved March 11, 2022, from Eskom Distribution: https://www.eskom.co.za/distribution/tariffs-and-charges/

Evans, S. (2019, Jul 23). *Sunday Read: Eskom in race against time to complete Majuba rail line*. Retrieved March 11, 2022, from Fin24: https://www.news24.com/fin24/economy/sunday-read-eskom-in-race-against-time-to-complete-majuba-rail-line-20190623

Exxaro. (2020). *Integrated Report.* Pretoria: Exxaro Resources Limited.

Exxaro Resources. (2019). *Integrated Report.* Exxaro Resources. Retrieved March 12, 2021, from https://www.exxaro.com/investors/integrated-reports

ExxaroResources. (n.d.). *Grootegeluk*. Retrieved March 11, 2022, from Exxaro: https://www.exxaro.com/operations/grootegeluk

Financial Times. (2021). *South Africa rejects power ships on environmental grounds*. Retrieved March 11, 2022, from Financial Times: https://www.ft.com/content/b0a90204-cee5-4a1c-a175-6e496fd21371

Fuels and Lubes Daily. (2021, Apr 26). *South Africa's Engen to re-purpose oil refinery to a terminal*. Retrieved March 11, 2022, from F+L Daily: https://www.fuelsandlubes.com/south-africas-engen-to-re-purpose-oil-refinery-to-a-terminal/

GEM (Global Energy Monitor). (2015a). *Global Coal Plant Tracker*. Retrieved 10 22, 2021, from GEM: https://globalenergymonitor.org/projects/global-coal-plant-tracker/

GEM. (2015b). *Global Coal Mine Tracker*. Retrieved 10 22, 2021, from GEM: https://globalenergymonitor.org/projects/global-coal-mine-tracker/

GEM. (2015c). *Global Fossil Infrastructure Tracker*. Retrieved 10 22, 2021, from GEM: https://globalenergymonitor.org/projects/global-fossil-infrastructure-tracker/

GEM. (n.d.). *Goedgevonden coal mine*. Retrieved 10 22, 2021, from GEM: https://www.gem.wiki/Goedgevonden_coal_mine

GEM. (n.d.). *Kusile Power Station*. Retrieved February 18, 2022, from Global Energy Monitor Wiki: https://www.gem.wiki/Kusile_Power_Station

GEM. (n.d.). *Majuba Power Station*. Retrieved March 11, 2022, from Global Energy Monitor Wiki: https://www.gem.wiki/Majuba_Power_Station

GEM. (n.d.). *Medupi Power Station*. Retrieved 10 24, 2021, from Global Energy Monitor: https://www.gem.wiki/Medupi_Power_Station

GEM. (n.d.). *New Largo coal mine*. Retrieved March 11, 2022, from Global Energy Monitor Wiki: https://www.gem.wiki/New_Largo_coal_mine

GEM. (n.d.). *Wolvekrans Middelburg Mine*. Retrieved 10 22, 2021, from GEM: https://www.gem.wiki/Wolvekrans_Middelburg_mine

Glencore. (2019). *Annual Report 2019.* Glencore. Retrieved March 11, 2022, from https://www.glencore.com/dam/jcr:79fd3300-ee50-4ee1-870d-6372274c71b5/glen-2019-annual-report-interactive.pdf

Glencore. (2020). *Annual Report 2020.* Glencore. Retrieved March 12, 2021, from https://www.glencore.com/investors/reports-results

Glencore. (2020). *Energy: Oil*. Retrieved March 11, 2022, from GLencore: https://www.glencore.com/what-we-do/energy/oil

Global Economy. (2020). *Coal reserves in Africa*. Retrieved March 10, 2022, from Global Economy: https://www.theglobaleconomy.com/rankings/coal_reserves/Africa/

Global Petrol Prices. (2021, June). *South Africa electricity prices*. Retrieved March 11, 2022, from Global Petrol Prices: https://www.globalpetrolprices.com/South-Africa/electricity_prices/?__cf_chl_jschl_tk__=pmd_0WtdbefznApeN.Gi0ARHDsLRJkUFIfCxEGzNLc6f_TI-1629693105-0-gqNtZGzNAfujcnBszQeR

GlobalData Energy. (2021, Jan 21). *Brulpadda and Luiperd have potential to spark an energy transformation in South Africa*. Retrieved March 11, 2022, from GlobalData Energy: https://www.offshore-technology.com/comment/south-africa-energy-brulpadda-luiperd/

Government of the Repblic of South Africa. (2018). *BROADD -BASED SOCIO- ECONOMIC EMPOWERMENT CHARTER FOR THE MINING AND MINERALS INDUSTRY, 2018.* Pretoria. Retrieved March 11, 2022, from https://www.gov.za/sites/default/files/gcis_document/201809/41934gon1002.pdf

Government of the Republic of South Africa. (1998). *National Environmental Management Act No. 107 of 1998*. Pretoria: Government of South Africa. Retrieved March 11, 2022, from https://www.gov.za/sites/default/files/gcis_document/201409/a107-98.pdf

Government of the Republic of South Africa. (2002). *Mineral and Petroleum Resources Development Act No. 28 of 2002.* Pretoria. Retrieved March 11, 2022, from https://www.gov.za/sites/default/files/gcis_document/201409/a28-020.pdf

Grey, E. (2015, May 10). *South Africa: investing in a new era of rail*. Retrieved March 11, 2022, from Railway Technology: https://www.railway-technology.com/features/featuresouth-africa-investing-in-a-new-era-of-rail-4568871/

Groundwork. (2001). *The Filthy Five.* Durban: Groundwork. Retrieved 10 22, 2021, from https://www.groundwork.org.za/publications/MD%20binnen%20Shell-VV3-Def2%20.pdf

Groundwork. (2002). *Shell International's Legacy of Pollution and Damage.* Johannesburg: Groundwork. Retrieved 10 11, 2021, from https://www.groundwork.org.za/factsheets/Shell%20International.pdf

GroundWork. (2018). *Boom and Bust in the Waterberg: A History of coal mega projects.* Johannesburg: Groundwork. Retrieved March 10, 2022, from https://www.groundwork.org.za/reports/gW_Report_2018_-_Boom_or_Bust_in_the_Waterberg_-_A_history_of_coal_mega-projects.pdf

Halsey, R., Tyler, E., & Renaud, C. (2020). *INTERNATIONAL COAL TRANSITIONS AND THEIR RELEVANCE FOR MPUMALANGA.* Cape Town: Meridian Economics. Retrieved March 10, 2022, from https://meridianeconomics.co.za/wp-content/uploads/2020/09/BN_July2020_02_International-Coal-Transitions_and_their_relevance_for_Mpumalanga.pdf

Herberd, J. (2018, July 26). *China Development Bank latest to lend to Kusile coal-fired*. Retrieved February 18, 2022, from IJ Global: https://www.ijglobal.com/articles/134458/china-development-bank-latest-to-lend-to-kusile-coal-fired

Huxham, M., Anwar, M., & Nelson, D. (2019). *Undertanding the impact of a low carbon transition on South Africa.* CPI (Climate Policy Initiative). Retrieved March 10, 2022, from https://www.climatepolicyinitiative.org/publication/understanding-the-impact-of-a-low-carbon-transition-on-south-africa/

Hydrocarbons Technology. (2021, Apr 21). *Engen to transform South African oil refinery into terminal*. Retrieved March 11, 2022, from Hydrocarbons Technology: https://www.hydrocarbons-technology.com/news/engen-to-transform-south-african-oil-refinery-into-terminal/

IAEA (International Atomic Energy Agency). (2016). *Country Nuclear Power Profiles: Egypt*. Retrieved March 10, 2022, from IAEA: https://www-pub.iaea.org/MTCD/publications/PDF/cnpp2016/countryprofiles/Egypt/Egypt.htm#:~:text=At%20present%2C%20most%20of%20Egypt's,potential%20of%2021%20million%20tonnes.&text=As%20of%202013%2C%20Egypt's%20proven,the%20third%20largest%20in%20Africa.

IEA. (2019). *Cote D'Ivoire Key Energy Statistics*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/cote-divoire

IEA. (2019). *Key Energy Statistics Cameroon*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/cameroon

IEA. (2019). *Key Energy Statistics Democratic Republic of the Congo*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/democratic-republic-of-the-congo

IEA. (2019). *Key Energy Statistics Kenya*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/kenya

IEA. (2019). *Key Energy Statistics Mauritius*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/mauritius

IEA. (2019). *Key Energy Statistics South Africa*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/zambia

IEA. (2019). *Key Energy Statistics Sudan*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/sudan

IEA. (2019). *Key Energy Statistics Sudan*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/south-sudan

IEA. (2019). *Key Energy Statistics Tanzania*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/tanzania

IEA. (2019). *Key Energy Statistics Togo*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/togo

IEa. (2019). *Zambia Key Energy Statistics*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/cote-divoire

IEA. (2021). *Total coal exports by major exporters, 1978-2020.* IEA. Retrieved March 10, 2022, from https://www.iea.org/data-and-statistics/charts/total-coal-exports-by-major-exporters-1978-2020

IEA. (n.d.). *Key Energy Statistics Mozambique*. Retrieved March 10, 2022, from IEA: https://www.iea.org/countries/mozambique

IEA. (n.d.). *IEA Atlas of Energy.* IEA. Retrieved from http://energyatlas.iea.org/#!/tellmap/2020991907/1

IJ Global. (2010, Apr 20). *Eskom base-load project signs coal supply deal*. Retrieved March 11, 2022, from IJ Global: https://www.ijglobal.com/articles/61661/eskom-base-load-project-signs-coal-supply-deal

Independent. (2019, Aug 5). *Oil exports key for Uganda to handle growing debt – BoU*. Retrieved March 10, 2022, from The Independent: https://www.independent.co.ug/oil-exports-key-for-uganda-to-handle-growing-debt-bou/#:~:text=Uganda%20has%206.5%20billion%20barrels,part%20of%20the%20country's%20debt.

Jasi, A. (2021, May 7). *Engen to convert SA refinery into terminal*. Retrieved March 11, 2022, from The Chemical Engineer: https://www.thechemicalengineer.com/news/engen-to-convert-sa-refinery-into-terminal/

Jing, L., El-Houjeiri, H. M., Masnadi, M., Gordon, D., & Bergerson, J. (2020). Carbon intensity of global crude oil refining and mitigation potential. *Nature Climate Change, 10*, 526-532. doi:0.1038/s41558-020-0775-3

Kirsten, J., & Sihlobo, W. (2021, Aug 3). *How a land reform agency could break South Africa's land redistribution deadlock*. Retrieved March 11, 2022, from The Conversation: https://theconversation.com/how-a-land-reform-agency-could-break-south-africas-land-redistribution-deadlock-165450

Makhaye, C. (2021, Jun 17). *Residents breathe easier as Engen refinery to close*. Retrieved March 11, 2022, from New Frame: https://www.newframe.com/residents-breathe-easier-as-engen-refinery-to-close/

Matek, B., Gawell, K. (2015). The Benefits of Baseload Renewables: A Misunderstood Energy Technology. *The Electricity Journal, 28*(2), 101-12. doi: 10.1016/j.tej.2015.02.001

Masnadi, M., El-Houijeri, H., Schunack, D., Li, Y., Englander, J., Badahdah, A., . . . Brandt, A. (2018). Global carbon intensity of crude oil production. *Science, 31*(6405), 851-3. doi:10.1126/science.aar6859

Meridian Economics. (2018). *An overview of the employment impications of the South African power sector transition.* Cape Town: Meridian Economics. Retrieved March 10, 2022, from https://meridianeconomics.co.za/wp-content/uploads/2020/11/SAWEA-Employment-in-SA-Power-Sector-July-2018-EMAIL-VERSION1.pdf

Meridian Economics. (2020). *Meridian's Renewable Energy Levelised Cost Tool.* Cape Town: Meridian Economics. Retrieved March 10, 2022, from https://meridianeconomics.co.za/wp-content/uploads/2020/06/Meridian-LCOE-tool-note.clean_-1.pdf

Milne, N. (Director). (2020). *South Africa's Battle Between Coal and Climate* [Motion Picture]. Retrieved March 10, 2022, from https://www.gov.za/sites/default/files/Executive%20Summary-NDP%202030%20-%20Our%20future%20-%20make%20it%20work.pdf

Mining Data Solutions. (n.d.). *Middelburg Mines Services (MMS) Mine*. Retrieved 10 24, 2021, from Mining Data Solutions: https://miningdataonline.com/property/346/Wolvekrans-Middelburg-Complex-Mine.aspx

Mundi. (n.d.). *Coal Imports by Country*. Retrieved March 10, 2022, from Index Mundi: https://www.indexmundi.com/energy/?region=af&product=coal&graph=imports&display=rank

National Petroleum Refiners of SA (Pty) Ltd (NATREF). (n.d.). Retrieved March 11, 2022, from Natref Linked In: https://www.linkedin.com/company/natref/about/

NDC (National Development Committee). (2013). *National Development Plan 2030.* Pretoria. Retrieved 10 22, 2021, from https://www.nationalplanningcommission.org.za/National_Development_Plan

Nkambule, N., & Blignaut, J. (2017). Externality costs of the coal-fuel cycle: The case of Kusile Power Station. *South African Journal of Science, 113*(9-10). doi:10.17159/sajs.2017/20160314

Offshore. (2021, Jun 8). *Offshore South Africa venture investigates early production system*. Retrieved March 11, 2022, from Offshore: https://www.offshore-mag.com/regional-reports/africa/article/14204817/offshore-south-africa-venture-investigates-early-production-system

Omarjee, L. (2020, Dec 17). *Ramaphosa appoints long-awaited climate change commission*. Retrieved March 11, 2022, from Fin24: https://www.news24.com/fin24/economy/south-africa/ramaphosa-appoints-long-awaited-climate-change-commission-20201217?fbclid=IwAR2vSjdFvhTi8WWGDmeZpDrj-qtKGyk8cIoIdLWpOnLE2KhxDYWoGEr2EyQ

OPEC. (2021). *Annual Statistics Board*. Retrieved March 10, 2022, from OPEC: https://asb.opec.org/ASB_PDFDownload.php

OPEC. (n.d.). *Angola Facts and Figures*. Retrieved March 10, 2022, from Organization of the Petroleum Exporting Countries: https://www.opec.org/opec_web/en/about_us/147.htm

Paulson, S. (2017). Degrowth: culture, power and change. *Journal of Political Ecology, 24*(1), 425-49. doi: 10.2458/v24i1.20882

Petroleum Agency SA. (2019). *OK Energy Limited Exploration License, 2019.* Pretoria: PetroSA. Retrieved March 11, 2022, from https://resourcecontracts.org/contract/ocds-591adf-7096109034/view#/pdf/page/20/tagged/31438

Petroleum Agency SA. (n.d.). *Licencing*. Retrieved March 11, 2022, from Petroleum Agency SA: South African Agency for Promotion of Petroleum Exploration and Exploitation: https://www.petroleumagencysa.com/index.php/regulations/licencing

Power Technology. (2021, July 1). *The Kusile Power Station Project, South Africa*. Retrieved February 18, 2022, from Power Technology: https://www.power-technology.com/projects/kusilepowerstation/

Reed, E. (2020, Oct 21). *Transnet tackles Umbilo River spill, blames pipeline theft*. Retrieved from Energy Voice: https://www.energyvoice.com/oilandgas/africa/pipelines-africa/273295/transnet-pipeline-spill-durban/

Res4Africa. (2020). *A Just Energy Transition in South Africa.* EGSA. Retrieved March 10, 2022, from https://www.egsa.org.za/just-energy-transition-2/a-just-energy-transition-in-south-africa-res4africa-foundation/

Reuters. (2018, June 19). *Total to start Uganda crude oil production in 2021 at the earliest*. Retrieved March 10, 2022, from Energy World: https://energy.economictimes.indiatimes.com/news/oil-and-gas/total-to-start-uganda-crude-oil-production-in-2021-at-the-earliest/64647798

Ritchie, H., & Roser, M. (2020). *Fossil Fuels.* Our World in Data.

S&P Global. (2021). *S Africa's largest refinery Sapref declares force majeure on civil unrest*. Retrieved 10 22, 2021, from S&P Global Platts: https://www.spglobal.com/platts/en/market-insights/latest-news/oil/071421-s-africas-largest-refinery-sapref-declares-force-majeure-on-civil-unrest-sources

SAFTU (South African Federation of Trade Union). (2020). *Section 77 Notice List of Demands: Extract on Environment and Climate Change and Mine Affected.* Johannesburg: SAFTU. Retrieved March 10, 2022, from https://docs.google.com/document/d/1liQlI1AGSCTzdOtBymJ78fx6oBnnOEzB_pBBdtfuc44/edit

SAPIA (South African Petroleum Industry Association). (n.d.). *South African fuel industry*. Retrieved March 11, 2022, from SAPIA: https://www.sapia.org.za/overview/south-african-fuel-industry

SAPREF. (2019). *2019 SAPREF Sustainability Report.* Durban: SAPREF. Retrieved 10 22, 2021, from https://bb0c1fac-b0b9-417f-b81f-193c1614016a.filesusr.com/ugd/322aad_63219ef40861411da4c2590e587bf29c.pdf

Sasol. (2019). *Sasol Integrated Report 2019.* Sasol. Retrieved March 12, 2021, from https://www.sasol.com/investor-centre/financial-reporting/annual-integrated-report/latest

Sasol. (2020). *Annual Financial Statements 30 June 2020.* Sasol. Retrieved March 11, 2022, from https://www.sasol.com/sites/default/files/financial_reports/Sasol%20South%20Africa%20Limited%20annual%20financial%20statements%20for%20the%20year%20ended%2030%20June%202020.pdf

Seriti Resources. (n.d.). *New Largo*. Retrieved March 11, 2022, from Seriti: https://seritiza.com/business/projects/new-largo/

Sexton, C. (2019, Oct 2). *The world's largest untouched coal reserves are set to be mined in Botswana*. Retrieved March 10, 2022, from Earth.com: https://www.earth.com/news/coal-reserves-botswana/

Shell. (2021). *Manufacturing Locations*. Retrieved 10 22, 2021, from Royal Dutch Shell: https://www.shell.com/business-customers/chemicals/manufacturing-locations.html

Solomon, J. (Director). (2020). *Becoming Visible* [Motion Picture]. Retrieved March 11, 2022, from https://becomingvisible.africa/the-movie/

South32. (2016). *South Africa Energy Coal - Klipspruit Site Tour Presentation.* Perth: South32. Retrieved 10 22, 2021, from https://www.south32.net/docs/default-source/all-financial-results/reports-and-presentations/klipspruit-site-tour-presentation-2016.pdf?sfvrsn=ebb5c1a0_6

Steyn, G. (2019). *Ensuring Reliable and Secure Electricity Supply at Least Cost.* Cape Town: Meridian Economics. Retrieved March 10, 2022, from https://meridianeconomics.co.za/wp-content/uploads/2019/11/Base-load-and-energy-security.pdf

Swilling, M. (2019, Oct 04). *Wake up, Everyone: ANC NEC's energy statement is a real New Dawn for South Africa*. Retrieved March 11, 2022, from Daily Maverick: https://www.dailymaverick.co.za/opinionista/2019-10-04-wake-up-everyone-anc-necs-energy-statement-is-a-real-new-dawn-for-south-africa/

Swilling, M. (2020, Feb 18). *Eskom is in a death spiral, so it's time to change the energy ballgame*. Retrieved March 10, 2022, from Daily Maverick: https://www.dailymaverick.co.za/opinionista/2020-02-18-eskom-is-in-a-death-spiral-so-its-time-to-change-the-energy-ballgame/

Swilling, M. (2020, Sep 30). *Load shedding will cripple our economic recovery – we must bring renewables onstream fast*. Retrieved March 10, 2022, from Daily Maverick: https://www.dailymaverick.co.za/article/2020-09-30-load-shedding-will-cripple-our-economic-recovery-we-need-to-bring-renewables-onstream-fast/

The World Bank. (2010). *Project Appraisal Document on a Proposed Loan in the Amount of US$3,750 Milllion to Eskom Holdings Limited Guaranteed by Republid of South Africa for an Eskom investment Support Project.* New York: The World Bank Group. Retrieved 10 24, 2021, from https://documents1.worldbank.org/curated/en/126361469672138599/pdf/534250R20101005914.pdf

The World Bank Group. (n.d.). *Eskom Investment Support Project*. Retrieved March 12, 2022, from The World Bank IBRD*IDA: https://projects.worldbank.org/en/projects-operations/project-detail/P116410

Theron, Ashley. (2019, Jul 23). *South Africa's IPP programme to lose its greatest Champion*. Retrieved March 11, 2022, from ESI Africa: https://www.esi-africa.com/industry-sectors/finance-and-policy/south-africas-ipp-programme-to-lose-its-greatest-champion/

TNI (Transnational Institute). (2020). *Change Finance, Not Climate.* TNI. Retrieved March 10, 2022, from https://www.tni.org/files/publication-downloads/executive_summary_financial_system_change_online_def.pdf

Total S.A. (2019). *2019 Universal Regisration Document (including the annual financial report).* Total S.A. Retrieved March 12, 2021, from https://www.total.com/investors/publications-and-regulated-information/regulated-information/annual-financial-reports

TotalEnergies. (2019, Feb 7). *Total Makes Significant Discovery And Opens A New Petroleum Province Offshore South Africa*. Retrieved March 11, 2022, from TotalEnergies: https://totalenergies.com/media/news/press-releases/total-makes-significant-discovery-and-opens-new-petroleum-province-offshore-south-africa

TotalEnergies. (n.d.). *Natref Reginery*. Retrieved March 11, 2022, from TotalEnergies: https://totalenergies.co.za/about-us/totalenergies-marketing-south-africa/natref-refinery

Toyana, M. (2020, Nov 18). *Consortium pulls plug on S.Africa's Thabametsi coal plant*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/article/climate-change-safrica-coal/rpt-exclusive-consortium-pulls-plug-on-safricas-thabametsi-coal-plant-idUSL1N2I3216

Tyler, E., Renoud, C., & Roff, A. (2020). *WHAT MIGHT A PARIS-ALIGNED EMISSIONS PROFILE LOOK LIKE FOR THE SOUTH AFRICAN POWER SECTOR?* Cape Town: Meridian Economics. Retrieved March 10, 2022, from https://meridianeconomics.co.za/wp-content/uploads/2020/08/Power-sector-carbon-budgets-2020-v1.1.pdf

Ueckerdt, F., Kempener, R. (2015). *From Baseload to Pea: Renewables Provide a Reliable Solution*. Abu Dhabi: IRENA. Retrieved May 30, 2022 from: https://www.irena.org/publications/2015/Jun/From-Baseload-to-Peak-Renewables-provide-a-reliable-solution

Urgewald; Friends of the Earth US; LINGO; Global Gas & Oil Network; Oil Change International; Global Energy Monitor; Rainforest Action Network; Les Amis de la Terre France; RE:Common. (2020). *Five Years Lost: How Finance is Blowing the Paris Carbon Budget.* Berlin: Urgewald. Retrieved March 11, 2021, from https://urgewald.org/sites/default/files/media-files/FiveYearsLostReport.pdf

US EIA (Energy Information Administration). (2019). *Chad*. Retrieved March 10, 2022, from US EIA Independent Statistics and Analysis: https://www.eia.gov/international/overview/country/TCD

US EIA. (2021, Nov 18). *Carbon Dioxide Emissions Coefficients*. Retrieved March 12, 2022, from US Energy Information Administration: https://www.eia.gov/environment/emissions/co2_vol_mass.php

US International Trade Administration. (2021, Sept 11). *South Africa - Country Commercial Guide: Rail Infrastructure*. Retrieved March 11, 2022, from US ITA: https://www.trade.gov/country-commercial-guides/south-africa-rail-infrastructure

Van Minnen, M. (2020, Jul 6). *Question NW1205 to the Minister of Trade, Industry and Competition*. Retrieved March 11, 2022, from Parliamentary Monitoring Group: https://pmg.org.za/committee-question/13969/

Winkler, H., & Marquard, A. (2020). *Climate finance to transform energy infrastructure as part of a just transition in South Africa.* Cape Town: University of Cape Town. Retrieved March 10, 2022, from https://open.uct.ac.za/bitstream/handle/11427/32176/SNAPFI.%20SA%20study%20-%20Just%20Transition%20Transaction.pdf?sequence=1&isAllowed=y

Winning, A., & Roelf, W. (2021, Jun 24). *Karpowership refused environmental approvals for S.Africa projects*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/business/environment/south-africa-refuses-karpowership-environmental-authorisations-2021-06-24/

World Bank. (2020). *Restructuring Paper on a Proposed Project Restructuring of Eskom Investment Support Project Approved on April 8, 2010 To Eskom Holdings SOC Limited Guaranteed By the Reuplic of South Africa.* New York: World Bank. Retrieved February 18, 2022, from https://documents1.worldbank.org/curated/en/945661577445675366/pdf/Disclosable-Restructuring-Paper-Eskom-Investment-Support-Project-P116410.pdf

Worldometer. (n.d.). *Cameroon Oil*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/oil/cameroon-oil/

Worldometer. (n.d.). *Central African Republic Coal*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/coal/central-african-republic-coal/#:~:text=The%20Central%20African%20Republic%20holds,inf%20times%20its%20annual%20consumption.

Worldometer. (n.d.). *DR Congo Coal*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/coal/democratic-republic-of-the-congo-coal/#:~:text=Coal%20Reserves%20in%20the%20DR%20Congo&text=The%20DR%20Congo%20holds%2097,7%2C736.7%20times%20its%20annual%20consumption.

Worldometer. (n.d.). *Eswatini Coal*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/coal/swaziland-coal/

Worldometer. (n.d.). *Morocco COal*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/coal/morocco-coal/

Worldometer. (n.d.). *Mozambique Coal*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/coal/mozambique-coal/#:~:text=Coal%20Reserves%20in%20Mozambique&text=Mozambique%20holds%201%2C975%20million%20tons,162%2C909.1%20times%20its%20annual%20consumption.

Worldometer. (n.d.). *Mozambique Natural Gas*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/gas/mozambique-natural-gas/#:~:text=Gas%20Reserves%20in%20Mozambique&text=Mozambique%20holds%20100%20trillion%20cubic,1%2C545.7%20times%20its%20annual%20consumption.

Worldometer. (n.d.). *Nigeria Coal*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/coal/nigeria-coal/#:~:text=Coal%20Reserves%20in%20Nigeria&text=Nigeria%20holds%20379%20million%20tons,1%2C961.4%20times%20its%20annual%20consumption.

Worldometer. (n.d.). *Zambia Coal*. Retrieved March 10, 2022, from Worldometer: https://www.worldometers.info/coal/zambia-coal/

World Bank. (n.d.). *Access to electricity (% of population) - South Africa*. Retrieved March 11, 2022, from The World Bank Data: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ZA

WSP. (n.d.). *Medupi Power Station*. Retrieved 10 22, 2021, from WSP: https://www.wsp.com/en-GL/projects/medupi-power-station

XMP Cosulting CC. (n.d.). *South African Coal: Annexure Q.* XMP. Retrieved 10 24, 2021, from https://cer.org.za/wp-content/uploads/2017/12/Annexure-Q.pdf

Xolo, N., & Cronjé, M. (2020). *South Africa: Mining Brings Death and Division to Kwazulu-Natal.* AllAfrica. Retrieved March 11, 2021, from https://allafrica.com/stories/202011170596.html

Yelland, C. (2020, Aug 31). Eskom's Majuba power station rail project is a debacle. Retrieved March 11, 2022, from Daily Maverick: https://www.dailymaverick.co.za/article/2020-08-31-eskoms-majuba-power-station-rail-project-is-a-debacle/

Podcast Series & Webinars

The podcase series utilised (Coalition, 2020) was organised and hosted by the Climate Justice Coalition. Each episode of the series tackles a pertinent dimension of the South African fossil regime by interviewing one or various essential stakeholders that I did not have access to from the Netherlands. For instance, Episode #06 ('*Women on the frontlines*') was composed of an interview with two women from communities severely affected by the coal mining sector, and Episode #09 ('*Transforming Africa's Biggest Polluter | A Green New Eskom*') entailed an interview with Mandy Rambharos, the Head of Eskom's Just Energy Transition Office. This podcast series was used predominantly to speak to the prospective stranded human and social assets in South Africa (see 5.2.2.6).

Additionally, eight webinars and online conferences were attended – hosted by NGOs/ activists, private firms, and policymakers/ the public sector – all of which grappled with the state-of-the-art challenges and opportunities for decarbonising South Africa's carbon-intensive regime. These included, but are not limited to: a webinar hosted by the Trade and Industrial Policy (TIPS) on the economic and political implications of a Just Transition in South Africa; and a webinar organised by a consortium of NGOs with to discuss strategies to 'Fight Sasol', South Africa's largest oil and gas producer.

List of Webinars and Virtual Conferences Attended

Event	Date	Host
Understanding the REIPPPP RfP	September 17, 2020	SAPVIA
South Africa Just Transition	September 29, 2020	TIPS
Musina-Makhado Webinar	December 3, 2020	
Fighting Sasol in South Africa	November 17, 2020	
Financing South Africa's Energy Transition	October 1, 2020	Colloquim
Climate Justice Charter Address to Parliament	October 16, 2020	Climate Justice Charter

Semi-Structured Interviews

Example Interview Template for South African Stakeholders

1. Could you tell me a little more about the work you've been doing at ***XXXX*** in regards to the fossil fuel sector?

    1. What role does and could ***civil society/ NGOs/*** in managing/limiting SA fossil fuel production -- closing down plants like Medupi or Kusile, and changing revamping Eskom's/Sasol's BAU?

2. What does a ***just transition mean to you***?

3. What are the biggest ***challenges*** that SA faces in phasing out coal (and oil/gas) from its economy? Biggest ***opportunities***?

4. What role does (and could) the ***government play*** in managing/limiting SA fossil fuel production? IRP? Gwede Mantashe?

5. What is the general ***South African public's opinion*** on domestic fossil fuel projects? Environmental hazard? Job opportunity? Energy security?

6. To what extent do ***North-South financial flows*** influence SA fossil fuel production? In other words, what role do/could/should foreign actors (investors) play in shaping SAs carbon economy?

7. What aspects of the ***legacy of apartheid*** are critical to understand when managing SA's fossil fuel sector?

8. Who should I interview next?

Anonymised Interview Log (South African Stakeholder Interviews). All interviews took virtually place via Zoom between August-December 2020

Code	Date Interviewed
ACA_AF1	18/9/20
ACA_AF2	6/10/20
ACA_AF3	22/10/20
ACA_AF4	20/10/20
ACA_AF5	22/10/20
FIN_AF1	7/10/20
FIN_AF1	3/12/20
FIN_AF2	14/10/20
FIN_AF3	11/11/20
FIN_AF4	2/12/20
FIN_GEN6	22/10/20
NGO_AF10	7/10/20
NGO_AF11	8/10/20
NGO_AF12	8/10/20
NGO_AF13	19/10/20
NGO_AF14	13/10/20
NGO_AF15	20/10/20
NGO_AF16	15/10/20
NGO_AF18	21/10/20
NGO_AF19	5/11/20
NGO_AF2	22/09/20
NGO_AF20	28/10/20
NGO_AF21	28/10/20
NGO_AF22	3/11/20
NGO_AF23	30/11/20
NGO_AF3	24/9/20
NGO_AF5	24/9/20
NGO_AF7	30/9/20
NGO_AF8	6/10/20
NGO_AF9	7/10/20
NGO_AF9	26/10/20
POL_AF1	23/09/20
POL_AF4	14/10/20
POL_AF5	16/10/20
PRIV_AF1	6/10/20
PRIV_AF2	15/10/20
PRIV_AF3	21/10/20
PRIV_AF4	28/10/20
PRIV_AF5	30/11/20
NGO_AF1	21/09/20
NGO_AF17	17/10/20
NGO_AF4	24/9/20
NGO_AF6	28/9/20
NGO_AF6	30/10/20
POL_AF2	30/9/20
POL_AF3	30/9/20

Template Consent Form

	Yes	No
I have read the information sheet and/or been orally informed about the purpose of the research and the purpose of this interview.		
I had the opportunity to ask questions about the study and am satisfied with the answers. I am aware that my interview will be imported into the EU for further analysis.		
I consent to participate in the project, but can at any time refuse to answer a specific question, and withdraw from the project without giving a reason. This can even happen after the interview has been completed, and then my information will be erased.		
I consent to my interview being recorded, but can at any time withdraw from the project without giving a reason. This can even happen after the interview has been completed, and then my information will be erased.		
I consent to my contact details being kept, but can at any time withdraw from the project without giving a reason. This can even happen after the interview has been completed, and then my information will be erased.		
I agree that I can be contacted again for follow-up questions. I understand that I can withdraw my consent to be contacted again at any time and without giving any reasons.		
I understand that the information I provide can be used in the research publications but without attribution to me. This means that no one should be able to identify me from the research.		
I understand that this form will be kept under lock and key and not shared with others.		
I would like to be contacted before publication and check the information that will be published based on my information given.		
Signature/thumbprint (NAME PRINTED) Date Place		
Signature on behalf of the interviewee (where a third party signs on behalf of the interviewee – because they cannot read or write)		
Signature by the interviewer – where the interviewee does not wish to leave a paper trail		

Chapter 6

Original & Existing Datasets

This chapter drew on two publicly disclosed datasets (OCI, 2020; RAN et al., 2020) in addition to the annual reports pertaining to the 29 identified E&Ps from Chapter 5 to answer sub question S4, denoted in the reference list below. The reports were retrieved from the online archives pertaining to each of the firms. This chapter also saw the creation of an original dataset compiling the major shareholders of the sampled E&Ps along with their equity data (share value under management) by drawing on data from Yahoo! Finance. A sample of this dataset is shown below (full version available upon request).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1							Assets (USD, mil) - as of Jun 30, 2020, unless otherwise indicated							
2						Company	BP	Exxon	TotalSA	Equinor	Sasol	Petronas/Enge	Rosneft	Repsol
3		Shareholder	Country	Type	Public/Private	Region	England	States of A	France	Norway	South Africa	Malaysia	Russia	Spain
4	1	Capital Research & Management	United States of	Private Investment Manager	Private	North America							$351.59	
5	1	Fidelity Management & Research	United States of	Private Investment Manager	Private	North America	$382.71	$3,200.50	$397.90	$417.90				
6	1	RBC Global Asset Management	Canada	Publicly Traded Financial Services	Publicly Traded	North America								
7	1	Vanguard Group	United States of	Private Financial Advisor	Private	North America	$160.14	$16,191.63				$81.79	$107.27	$341.28
8	1	1832 Asset Management LP	Canada	Private Investment Manager	Private	North America								
9	1	TD Asset Management	Canada	Publicly Traded Financial Services	Publicly Traded	North America								
10	2	Norges Bank Investment Management*	Norway	Sovereign Wealth Fund	Public	Europe	**$2,971.35**	$3,056.00	**$3,353.01**	**$0.00**	**$0.00**	**$95.80**	**$0.00**	$279.71
11	1	Canadian Pension Plan (CPP)	Canada	Public Pension Fund	Public	North America	$0.00	$4.62	$1.54	$0.00	$2.31	$0.00	$0.00	$2.31
12	1	BMO Asset Management	Canada	Publicly Traded Financial Services	Publicly Traded	North America								
13	1	Caisse de Depot et Placement du Quebec*	Canada	Public Pension Fund	Public	North America	**$57.92**	**$601.23**	**$833.54**	**$26.08**	**$21.08**	**$14.08**	**$20.46**	**$8.77**
14	2	ABP Pension Group	Netherlands	Pension Fund	Public	Europe	$257.14	$284.52	$348.81	$33.33	$8.33	$2.38	$28.57	$20.24
15	2	Fonds de Reserve Pour des Retraites (FRR) (Dec 31 20	France	Pension Fund	Public	Europe	$4.52	$13.58	$49.86	$5.60	$0.00	$0.00	$0.00	$25.48
16	2	PFZW	Netherlands	Pension Fund	Public	Europe	$164.29	$16.67	$155.95	$53.57	$0.00	$5.48	$0.00	$30.00
17	2	ATP	Denmark	Pension Fund	Public	Europe	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
18	1	Fisher Investments	United States of	Private Investment Manager	Private	North America	$232.62		$707.20	$30.30				$0.78
19	1	T Rowe Price Associates	United States of	Publicly Traded Financial Services	Publicly Traded	North America			$577.70					
20	1	Wellington Management Co.	United States of	Private Investment Manager	Private	North America	$271.93		$397.10					
21	3	Public Investment Fund	Saudi Arabia	Sovereign Wealth Fund	Public	Middle East	$803.43		$333.00	$200.00				
22	1	Wells Fargo Bank	United States of	Publicly Traded Financial Services	Publicly Traded	North America			$140.60					
23	1	Columbia Threadneedle Investments	United States of	Private Investment Manager	Private	North America			$113.90					
24	1	Boston Partners Global Investors	United States of	Private Investment Manager	Private	North America			$108.80					
25	1	Morgan Stanley	United States of	Publicly Traded Financial Services	Publicly Traded	North America			$90.60		$3.70			
26	1	Lord, Abbett & Co	United States of	Private Investment Manager	Private	North America			$88.50					
27	1	Northern Trust Investments	United States of	Publicly Traded Financial Services	Publicly Traded	North America			$85.70	$24.80	$3.90			
28	6	Computershare Limited	Australia	Publicly Traded Financial Services	Publicly Traded	Asia/Oceania								
29	6	Argo Investment Ltd	Australia	Publicly Traded Financial Services	Publicly Traded	Asia/Oceania								
30	6	Australian Foundation Investment Co. Ltd	Australia	Publicly Traded Financial Services	Publicly Traded	Asia/Oceania								
31	6	Macquarie Investment Management Business Trust	Australia	Publicly Traded Financial Services	Publicly Traded	Asia/Oceania							$79.95	

A python script was then written to map the equity flows from the dataset to generate e.g., Figure 6.1, a sample of which is presented below (full python notebook available upon request).

Sample Python Script used to map the finance flows between the key actors

```
In [72]: world_SA.plot(figsize=(25,13), edgecolor="cadetblue", color="powderblue");

legend_elements = [Line2D([0], [0], marker='X', color='black', label='Coal Mine',
                          markerfacecolor='black', markersize=10),

                   Line2D([0], [0], marker='o', color='firebrick', label='Coal Plant',
                          markerfacecolor='firebrick', markersize=10),

                   Line2D([0], [0], marker='s', color='seagreen', label='LNG Terminal',
                          markerfacecolor='seagreen', markersize=10),

                   Line2D([0], [0], marker='v', color='darkorange', label='Pipeline',
                          markerfacecolor='darkorange', markersize=10)]

for lat, lon, size in zip(df_cmine["Start_Lat"], df_cmine["Start_Long"],
                          df_cmine["Capacity"]):
        plt.scatter([lon], [lat], color="black", alpha=0.6, s=(size +1)*50, marker='X')


for lat, lon, size in zip(df_cplant["Start_Lat"], df_cplant["Start_Long"],
                          df_cplant["Capacity"]):
        plt.scatter([lon], [lat], color="firebrick", alpha=0.4, s=size/4, marker='o')

for lat, lon, size in zip(df_lng["Start_Lat"], df_lng["Start_Long"],
                          df_lng["Capacity"]):
        plt.scatter([lon], [lat], color="seagreen", alpha=0.8, s=(size +1)*100, marker='s')


for lat, lon, size, lat2, lon2 in zip(df_pipe["Start_Lat"], df_pipe["Start_Long"],
                          df_pipe["Capacity"], df_pipe["End_Lat"], df_pipe["End_Long"]):
        plt.scatter([lon], [lat], color="darkorange", alpha=0.4, s=size/200, marker='v')
        plt.scatter([lon2], [lat2], color="darkorange", alpha=0.4, s=size/200, marker='v')
        plt.plot([lon , lon2], [lat, lat2], linewidth=size/20000, color="darkorange", alpha=0.5)

plt.axis('off')

plt.title("Fossil Fuel Physical Assets in Africa")

plt.legend(handles=legend_elements, loc="center left")
```

Section 6.4 conducts some rough and preliminary calculations to estimate the monetary component of the SAD (SAD_m) that the E&Ps and their major shareholders and financiers may potentially owe the South African people. It should be again stressed that these are merely first-pass estimates, and should not be interpreted as finalised values by any means. In fact, some of the SAD_m components were estimated by extrapolating from studies disconnected from the South African context due to lack of more relevantly available studies – for instance, estimating the coal fired power station and coal mine decommissioning costs within the stranded physical assets (*P*) dimension. Since the purpose was not to conduct a systematic review of available estimates, once a sufficiently relevant study was encountered (i.e., one that presented parameters for the decommissioning costs of such physical assets in a different geographical context), then the details from said study were utilised bearing in mind the limitations this may imply. Future research should embark on a more detailed analysis of the SAD_m, particularly the elements that extrapolate from studies detached from South Africa's fossil regime; conversely, the stranded human asset dimension (*H*) utilises studies pertaining directly to South African wages (*L*) and energy procurement (*E*), which may be slightly more relevant but still merit additional scrutiny.

References: Reports

AngloAmerican. (2020). *Integrated Annual Report.* AngloAmerican. Retrieved March 12, 2020, from https://www.angloamerican.com/investors/annual-reporting

ARM. (2020). *Integrated Annual Report.* African Rainbow Minerals. Retrieved March 12, 2021, from https://arm.co.za/wp-content/uploads/2020/11/Integrated-Annual-Report-2020.pdf

BHP Billiton. (2020). *Annual Report 2020.* Sydney: BHP Billiton. Retrieved March 12, 2021, from https://www.bhp.com/investor-centre/annual-report-2020/

BP. (2020). *Annual Report.* BP. Retrieved March 12, 2021, from https://www.bp.com/en/global/corporate/investors/results-and-reporting/annual-report.html

Cairn Energy. (2019). *Annual Report 2019.* Cairn Energy. Retrieved March 12, 2021, from https://www.cairnenergy.com/investors/results-reports-and-presentations/#Tab2021=1

CAN (Canadian Natural Resources). (2020). *2020 Annual Report.* CAN. Retrieved March 11, 2022, from https://www.cnrl.com/upload/report/134/04/2020-annual-report---teams.pdf

CAN. (2019). *Annual Report.* Canadian Natural Resources. Retrieved March 12, 2021, from https://www.cnrl.com/investor-information/annual-documents#2019

Chevron. (2019). *Annual Report 2019.* Chevron Corp. Retrieved March 12, 2021, from https://www.chevron.com/-/media/chevron/annual-report/2019/documents/2019-Annual-Report.pdf

Chevron. (2020). *2020 Supplement to the Annual Report.* Chevron Corp. Retrieved March 12, 2021, from https://www.chevron.com/-/media/shared-media/documents/2020-chevron-annual-report-supplement.pdf

CNOOC. (2019). *Annual Report 2019.* China National Offshore Oil Corporation. Retrieved March 12, 2021, from https://www.cnoocltd.com/col/col7511/index.html

Engen. (2019). *Engen 2019 Integrated Report.* Engen. Retrieved March 12, 2021, from https://www.engen.co.za/media/annual-reports

Equinor. (2019a). *Annual Report 2019.* Equinor. Retrieved March 12, 2021, from https://www.equinor.com/en/investors/our-dividend/annual-reports-archive.html

Equinor. (2019b). *Sustainability Report 2019.* Equnior. Retrieved March 12, 2021, from https://www.equinor.com/en/investors/annual-reports.html

Exxaro. (2020). *Integrated Report.* Pretoria: Exxaro Resources Limited.

Exxaro Resources. (2019). *Integrated Report.* Exxaro Resources. Retrieved March 12, 2021, from https://www.exxaro.com/investors/integrated-reports

ExxonMobil. (2019a). *2019 Summary Annual Report.* ExxonMobil. Retrieved March 12, 2021, from https://corporate.exxonmobil.com/Investors/Annual-Report

ExxonMobil. (2019b). *2019 Financial and Operating Data.* ExxonMobil. Retrieved March 12, 2021, from https://corporate.exxonmobil.com/Investors/Annual-Report

Glencore. (2019). *Annual Report 2019.* Glencore. Retrieved March 11, 2022, from https://www.glencore.com/dam/jcr:79fd3300-ee50-4ee1-870d-6372274c71b5/glen-2019-annual-report-interactive.pdf

Glencore. (2020). *Annual Report 2020.* Glencore. Retrieved March 12, 2021, from https://www.glencore.com/investors/reports-results

MC Mining. (2020). *MC Mining- Annual Report 2020.* MC Mining. Retrieved March 12, 2021, from https://www.mcmining.co.za/investors-and-media/annual-reports

Mitsubishi. (2020). *Integrated Report 2020.* Mitsubishi Corp. Retrieved March 12, 2021, from https://www.mitsubishicorp.com/jp/en/ir/library/ar/

Mitsui. (2020). *Integrated Report 2020.* Mitsui & Co. Retrieved March 12, 2021, from https://www.mitsui.com/jp/en/ir/library/report/index.html

OCI (Oil Change International). (2020). Shifting the Subsidies Database. Oil Change International. Retrieved March 18, 2021, from http://priceofoil.org/shift-the-subsidies/#:~:text=The%20Shift%20the%20Subsidies%20database,data%20from%202008%20to%202019.

Rainforest Action Network (RAN). (2020). *Banking on Climate Change.* San Francisco: RAN. Retrieved 2 22, 2021, from https://www.ran.org/bankingonclimatechange2020/

Repsol. (2020). *Integrated Management Report.* Repsol Group. Retrieved March 12, 2021, from https://www.repsol.com/imagenes/global/en/2020-integrated-management-report_tcm14-209132.pdf

Rio Tinto. (2020). *Annual Report 2020.* Rio Tinto. Retrieved March 12, 2021, from https://www.riotinto.com/en/invest/reports/annual-report

Rosneft. (2019). *Rosneft Annual Report 2019.* Rosneft. Retrieved March 12, 2021, from https://www.rosneft.com/Investors/Reports_and_presentations/Annual_reports/

Sasol. (2019). *Sasol Integrated Report 2019.* Sasol. Retrieved March 12, 2021, from https://www.sasol.com/investor-centre/financial-reporting/annual-integrated-report/latest

Sasol. (2020). *Annual Financial Statements 30 June 2020.* Sasol. Retrieved March 11, 2022, from https://www.sasol.com/sites/default/files/financial_reports/Sasol%20South%20Africa%20Limited%20annual%20financial%20statements%20for%20the%20year%20ended%2030%20June%202020.pdf

Shell. (2019a). *Sustainably Report 2019.* Shell. Retrieved March 12, 2021, from https://www.shell.com/media/annual-reports-and-publications.html#iframe=L3JlcG9ydC1ob21lLzIwMjAv

Shell. (2019b). *Tax Contribution Report 2019.* Shell. Retrieved March 12, 2021, from https://www.shell.com/media/annual-reports-and-publications.html#iframe=L3JlcG9ydC1ob21lLzIwMjAv

Shell. (2020). *Annual Report and Accounts 2020.* Shell. Retrieved March 12, 2021, from https://www.shell.com/media/annual-reports-and-publications.html#iframe=L3JlcG9ydC1ob21lLzIwMjAv

South32. (2020). *Annual Report 2020.* South32. Retrieved March 12, 2021, from https://www.south32.net/investors-media/investor-centre/annual-reporting-suite

Terracom. (2020). *Financial Statements Full Year Report.* Terracom. Retrieved March 12, 2012, from http://terracomresources.listedcompany.com/download.html

Total S.A. (2019). *2019 Universal Regisration Document (including the annual financial report).* Total S.A. Retrieved March 12, 2021, from https://www.total.com/investors/publications-and-regulated-information/regulated-information/annual-financial-reports

Tullow. (2019a). *2019 Annual Report & Accounts.* Tullow Oil. Retrieved March 12, 2021, from https://www.tullowoil.com/investors/results-reports-and-presentations/

Tullow. (2019b). *2019 Sustainability Report.* Tullow Oil. Retrieved March 12, 2021, from https://www.tullowoil.com/investors/results-reports-and-presentations/

Vale SA. (2020). *Annual Report Form 20-F.* Vale SA. Retrieved March 12, 2021, from http://www.vale.com/en/investors/information-market/annual-reports/pages/default.aspx

Woodside. (2020). *Annual Report.* Woodside Petroleum. Retrieved March 12, 2021, from https://www.woodside.com.au/investors/reports-publications

Chapter 7

LFFU Approach Dataset

This chapter drew on the sustainability reporting for 74 unique finance institutes to explore the LFFU approach mix jointly proposed and adopted – these reports are denoted in the reference list below. Furthermore, findings from the reports were corroborated and triangulated with data collected from semi-structured interviews with key financiers and knowledgeable experts on fossil-related finance issues, the details of which are disclosed below. The LFFU framework developed in the literature review (see Chapter 4) was applied to drive the report content analysis (employing a deductive line of reasoning); this generated another original dataset that linked actors to the array of LFFU approaches that they discussed in their sustainability reporting – a sample is presented below, and a full version is available upon request.

	A	B	C	D
1				
2		**Approach**	**Actor**	**Notes**
3		*(Portfolio) GHG Emissions Monitoring*	JP Morgan BNP Paribas Credit Mutuel Natixis Societe Generale Alstom Siemens GEA Cooling Bank of America Barclays Deutsche Bank Exxaro ARM South32 China NDC	Deutsche Bank's inadequate goal to "disclose pathway for portfolio alignment to Paris Agreement targets" by 2023 (p. 9) Deutsche has also "started a portfolio review of our coal power clients in the United States and Europe" (p. 17) but of course not Africa or elsewhere in the South China NDC: "improve greenhouse gas emission statistics covering areas including energy activity, industrial process, agriculture, land-use change, forestry and waste treatment" and "improve the statistical indicator systems for climate change, to strengthen personnel training and to constantly improve the quality of data" (p. 14)
		Emissions Reduction Targets & 'Performance Improvements'	JP Morgan COFACE AfDB Commerzbank Natixis Societe Generale Alstom Hitachi Siemens GEA Cooling Bank of America Deutsche HSBC GE Exxaro Seriti Glencore ARM South32 Shell BP Sasol Total SA Engen Qatar CNR	JP Morgan (sust 2020: 49) calls them "financed emissions" **JP Morgan (sust 2020: 50) propose a meager 15% scope 3 emissions reduction from 2019 baseline -- but scope 3 for them does not include financed FF and rather includes air travel, hotel stays, etc.** Siemens (2021: 3) laughably boasted about "increas[ing]... efficiency in primary energy use by 99%" COMPARED TO 2014 LEVELS "GE is powering China's coal-to-gas transition" (p. 2) Exxaro discusses having "communicated our intention to attain carbon neutrality by 2050 by reducing our direct GHG emissions in the short to medium term and partnering with our suppliers and partners to reduce the indirect GHG emissions" (Sust Report p. 17) but no further elaboration, and given their main business in thermal coal mining, this appears to be an empty and negligible promise Seriti banking on retrofitting and CCUS to manage carbon emissions from their thermal coal operations (and Eskom plants they feed) **The only South African based emissions that GLENCORE accounts for are scope 2 purchased electricity emissions, not even scope 1 direct consumption or scope 3 financed included in Sust report (see page 82) --> also banking on CCUS (p. 31)** **Glencore also reports: "The most significant contributor to our Scope 3 emissions was our customers' usage of the fossil fuels we produce; this totalled 253 million tonnes CO_2e (2019: 326 million tonnes CO_2e). We exclude emissions resulting from customers' use of the oil products refined at the Astron refinery from our Scope 3 emissions total as we neither originate nor consume the products" (33)** **ARM completely ignores enabled emissions -- they disclose a carbon footprint of 1.1MtCO_2e, while just Majuba is 19MtCO_2e (for which they supply coal)** South32 acknowledges that the bulk of their scope 3 emissions comes from the coal that they SUPPLY in South Africa, but their predominant strategy to reduce these scope 3 emissions is to divest (see below) and ergo reallocate responsibility elsewhere

References: Reports

Aberdeen. (2019). *Standard Life Aberdeen Corporate Sustainability Report 2019.* Retrieved March 11, 2022, from https://www.abrdn.com/docs?documentId=GB-020820-122814-3&_ga=2.110091148.807252887.1630931727-2145933123.1630931727

AfDB (African Development Bank). (2019). *Infrastructure and Urban Development Department - Annual Report 2019.* Retrieved March 11, 2022, from https://www.afdb.org/en/documents/infrastructure-and-urban-development-department-annual-report-2019

AfDB. (2020). *AfDB-CIF Annual Report 2020.* Retrieved March 11, 2022, from https://www.afdb.org/en/documents/afdb-cif-annual-report-2020

AfDB. (n.d.). *Annual Report 2015.* Retrieved March 11, 2022, from https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Annual_Report_2015_EN_-_Full.pdf

Alstom. (2021). *Universal Registration Document 2020/21.* Retrieved March 11, 2021, from https://www.alstom.com/sites/alstom.com/files/2021/07/07/20210706_Alstom_Universal_Registration_Document__EN.pdf

Amundi. (2020). *CSR Report 2020.* Retrieved March 11, 2022, from https://about.amundi.com/index.php/layout/set/popin/Sites/Amundi-Corporate/Pages/News/Actus-Financieres/Amundi-s-key-documents2

ARM. (2019). *2019 Sustainability Report.* Retrieved March 11, 2022, from https://arm.co.za/wp-content/uploads/2020/05/2019_sustainability_report.pdf

ARM. (2020). *Integrated Annual Report.* African Rainbow Minterals. Retrieved March 12, 2021, from https://arm.co.za/wp-content/uploads/2020/11/Integrated-Annual-Report-2020.pdf

Barclays. (2015). *Annual Report 2015.* Retrieved March 11, 2022, from https://home.barclays/content/dam/home-barclays/documents/investor-relations/annualreports/ar2015/Barclays_PLC_Annual_Report_%202015.pdf

Barclays. (2020). *Barclays PLC Environmental Social Governance Report 2020.* Retrieved March 11, 2022, from https://home.barclays/content/dam/home-barclays/documents/investor-relations/reports-and-events/annual-reports/2020/Barclays-PLC-2020-ESG-Report-2020.pdf

Bebchuk, L., & Hirst, S. (2019). *THE SPECTER OF THE GIANT THREE.* Boston: Harvard Law. Retrieved March 12, 2022, from http://www.law.harvard.edu/programs/olin_center/papers/pdf/Bebchuk_1004.pdf

Berkshire Hathaway Inc. (2015). *2015 Annual Report.* Retrieved March 11, 2022, from https://www.berkshirehathaway.com/2015ar/2015ar.pdf

Berkshire Hathaway Inc. (2020). *2020 Annual Report.* Retrieved March 11, 2022, from https://www.berkshirehathaway.com/2020ar/2020ar.pdf

BlackRock. (2021). *2021 TCFD report.* Retrieved March 11, 2022, from https://www.blackrock.com/corporate/literature/continuous-disclosure-and-important-information/tcfd-report-2021-blkinc.pdf

BNP Paribas. (2015). *CSR Report 2015.* Retrieved March 11, 2022, from https://group.bnpparibas/uploads/file/2015_corporate_social_responsibility.pdf

BNP Paribas. (2020). *COAL-FIRED POWER GENERATION - SECTOR POLICY.* Retrieved March11 2022, from https://group.bnpparibas/uploads/file/csr_sector_policy_internet_pdf_cfpg_010720.pdf

BNP Paribas. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from https://www.sustainability-report.bnpparibas-am.com/

BoA (Bank of America). (2020). *Annual Report 2020.* Retrieved March 11, 2022, from https://d1io3yog0oux5.cloudfront.net/_0eb62bf63283ad7d1c7167c2f788c416/bankofamerica/db/867/9129/annual_report/BAC_2020_Annual_Report.pdf

BP. (2020). *BP Sustainability Report 2020.* Retrieved March 11, 2022, from https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/group-reports/bp-sustainability-report-2020.pdf

CAN. (2020). *Climate Governance & Risk Management.* Retrieved March 11, 2022, from https://www.cnrl.com/corporate-responsibility/sustainability-reporting/climate-governance-risk-management

Capital Group. (2020). *ESG at Capital Group.* Retrieved March 11, 2022, from https://www.capitalgroup.com/content/dam/cgc/tenants/eacg/esg/files/esg-brochure_2020(en).pdf

CDB (China Development Bank). (2019). *Sustainability Report 2019.* Retrieved March 11, 2022, from http://www.cdb.com.cn/English/bgxz/kcxfzbg1/kcx2019/

CDB. (2015). *Sustainability Report 2015.* Retrieved March 11, 2022, from https://ungc-production.s3.us-west-2.amazonaws.com/attachments/cop_2016/335091/original/CHINA_DEVELOPMENT_BANK_SUSTAINABILITY_REPORT_2015.pdf?1478253427

CDB. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from http://www.cdb.com.cn/English/bgxz/kcxfzbg1/kcx2020/

CGTN. (2020). *Full text: Xi Jingping's speech at Climate Ambition Summit 2020.* CGTN. Retrieved May 31, 2022 from: https://news.cgtn.com/news/2020-12-12/Full-text-Xi-Jinping-s-speech-at-Climate-Ambition-Summit-2020-WaztGQcuBO/index.html

COFACE. (2015). *Corporate Social Responsibility.* Retrieved March 11, 2022, from https://www.coface.com/Group/Corporate-Social-Responsibility

COFACE. (2020). *UNIVERSAL REGISTRATION DOCUMENT 2020.* Retrieved March 11, 2022, from https://www.coface.com/News-Publications/Publications/Universal-Registration-Document-2020

Commerzbank. (2015). *GRI report of Commerzbank.* Retrieved March 11, 2022, from https://www.commerzbank.de/en/nachhaltigkeit/daten___fakten/publikationen/gri_bilanz/gri_bilanz.html

Commerzbank. (2020). *Active Climate Protection.* Retrieved March 11, 2022, from https://www.commerzbank.de/en/nachhaltigkeit/gesellschaft/klimastrategie/climate_strategy_.html

Commerzbank. (2020). *Positions and Policies.* Retrieved March 11, 2022, from https://www.commerzbank.de/en/nachhaltigkeit/nachhaltigkeitsstandards/positionen_und_richtlinien/positionen_und_richtlinien.html

Credit Agricole. (2015). *CSR Report 2014-2015.* Retrieved March 11, 2022, from https://www.banktrack.org/download/corporate_social_responsibility_report_2014_2015_pdf/corporate_social_responsibility_report_20142015.pdf

Credit Agricole. (2020). *REPORTING ON THE IMPLEMENTATION OF THE PRINCIPLES FOR RESPONSIBLE BANKING (PRB) OF THE UNEP FI.* Retrieved March 11, 2022, from https://www.credit-agricole.com/en/pdfPreview/187221

Credit Agricole. (2021). *2020-2021 Integrated Report.* Retrieved March 11, 2022, from https://www.credit-agricole.com/en/pdfPreview/188402

Credit Mutuel. (2015). *Annual Report 2015.* Retrieved March 11, 2022, from https://www.creditmutuel.fr/partage/fr/CC/CMNE-2018/telechargements/institutionnel/rapport-annuel/2015/rapport-annuel-2015-en.pdf

Credit Mutuel. (2020). *Le rapport annuel du groupe Crédit Mutuel en 2020.* Retrieved March 11, 2022, from https://presse.creditmutuel.com/publications/

Credit Suisse. (2015). *Corporate Responsibility Report 2015.* Retrieved March 11, 2022, from https://www.societegenerale.com/sites/default/files/documents/Document%20RSE/2015_Group_CSR_Report.pdf

Credit Suisse. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from https://reports.credit-suisse.com/download/2020SR/en/Sustainability_Report_2020.pdf

DEPARTMENT OF CLIMATE CHANGE, NATIONAL DEVELOPMENT & REFORM COMMISSION OF CHINA. (2015). *Enhanced Actions on Climate Change.* Retrieved March 11, 2022, from https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/China%20First/China's%20First%20NDC%20Submission.pdf

Deutsche Bank. (2015). *Corporate Responsibility Report 2015.* Retrieved March 11, 2022, from https://cr-report.db.com/2015/en/servicepages/downloads/files/dbcr2015_entire.pdf

Deutsche Bank. (2020). *Annual Report 2020.* Retrieved March 11, 2022, from https://investor-relations.db.com/reports-and-events/annual-reports/index

DWS. (2020). *DWS Sustainability Reports.* Retrieved March 11, 2022, from https://group.dws.com/responsibility/sustainability-report/

Euler Hermes. (2015). *2015 Registration Document.* Retrieved March 11, 2022, from https://www.eulerhermes.com/content/dam/onemarketing/ehndbx/eulerhermes_com/en_gl/finance/documents/en/pdf/Euler-Hermes-2015-Registration-Document.pdf

Euler Hermes. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from https://www.eulerhermes.com/content/dam/onemarketing/ehndbx/eulerhermes_com/en_gl/discover-euler-hermes/euler-hermes-sustainaibility-governance-report-april-2021.pdf

Exxaro. (2020). *Climate Change Response strategy report 2020.* Retrieved March 11, 2022, from https://www.exxaro.com/assets/files/Exxaro-CCRS-2020_final.pdf

Exxaro. (2020). *Integrated Report.* Pretoria: Exxaro Resources Limited.

Exxaro Resources. (2019). *Integrated Report.* Exxaro Resources. Retrieved March 12, 2021, from https://www.exxaro.com/investors/integrated-reports

Fidelity. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from https://eumultisiteprod-live-b03cec4375574452b61bdc4e94e331e7-16cd684.s3-eu-west-1.amazonaws.com/filer_public/b2/8d/b28db59d-e3eb-4b86-8bb8-c13fff78a64c/fidelity_esg_report_2020_v15.pdf

FirstRand. (2015). *Report to Society 2015.* Retrieved March 11, 2022, from https://www.firstrand.co.za/media/1402/2015-fnb-report-to-society.pdf

FirstRand. (2020). *2020 Report to Society.* doi:https://www.firstrand.co.za/media/investors/reports/FirstRand-report-to-society-2020.pdf

FirstRand. (2020). *Annual Integrated Report 2020.* Retrieved March 11, 2022, from https://www.firstrand.co.za/media/investors/annual-reporting/firstrand-annual-integrated-report-2020.pdf

Fisher Investments. (2020). *Environmental, Social and Governance Philosophy Statement.* Retrieved March 11, 2022, from https://institutional.fisherinvestments.com/en-ie/process/esg

Folketrydgfondet. (2016). *Ownership Report 2016.* Retrieved March 11, 2022, from https://www.folketrygdfondet.no/getfile.php/132669-1495538600/Download%20centre/Ownership%20reports/Ownership%20report%202016.pdf

Folketrygdfondet. (2020). *Responsible investment.* Retrieved March 11, 2022, from https://www.folketrygdfondet.no/responsible-investment/category388.html

GE (General Electric). (2020). *Sustainability Report.* Retrieved March 11, 2022, from https://www.ge.com/sites/default/files/ge2020_sustainability_report.pdf

GEA. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from https://www.gea.com/en/binaries/sustainability-report-2020_tcm11-82534.pdf

Glencore. (2020). *Annual Report 2020.* Glencore. Retrieved March 12, 2021, from https://www.glencore.com/investors/reports-results

Glencore. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from https://www.glencore.com/dam/jcr:fa2343a3-831b-42d0-93b3-26457e111c22/Glencore_SR%202020_Interactive_Final_%20optimised.pdf

Government of Australia. (2020). *Australia's Nationally Determined Contribution.* Retrieved March 11, 2022, from https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Australia%20First/Australia%20NDC%20recommunication%20FINAL.PDF

Government of Canada. (2021). *CANADA'S 2021 NATIONALLY DETERMINED CONTRIBUTION UNDER THE PARIS AGREEMENT.* Retrieved March 11, 2022, from https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Canada%20First/Canada's%20Enhanced%20NDC%20Submission1_FINAL%20EN.pdf

Government of Malaysia. (2015). *INTENDED NATIONALLY DETERMINED CONTRIBUTION OF THE GOVERNMENT OF MALAYSIA.* Retrieved March 11, 2022, from https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Malaysia%20First/INDC%20Malaysia%20Final%2027%20November%202015%20Revised%20Final%20UNFCCC.pdf

Government of the United Kingdom. (2015). *United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution.* Retrieved March 11, 2022, from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943618/uk-2030-ndc.pdf

Government of the United States of America. (2015). *Nationally Determined Contribution: Reducing Greenhouse Gases in the United States: A 2030 Emissions Target.* Retrieved March 11, 2022, from https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20States%20of%20America%20First/United%20States%20NDC%20April%2021%202021%20Final.pdf

Hitachi. (2020). *Hitachi Sustainability Report 2020.* Retrieved March 11, 2022, from https://www.hitachi.com/sustainability/download/pdf/en_sustainability2020.pdf

HSBC Holdings. (2019). *Environmental, Social and Governance Update 2019.* Retrieved March 11, 2022, from https://www.hsbc.com/-/files/hsbc/investors/hsbc-results/2015/annual/hsbc-holdings-plc/hsbc-holdings-plc-annual-report-and-accounts-2015.pdf

HypoVereinsbank. (2015). *Annual Report 2015.* Retrieved March 11, 2022, from https://www.banktrack.org/download/corporate_social_responsibility_report_2014_2015_pdf/corporate_social_responsibility_report_20142015.pdf

HypoVereinsbank. (2020). *Annual Report HVB Group 2020.* Retrieved March 11, 2022, from https://www.banktrack.org/download/corporate_social_responsibility_report_2014_2015_pdf/corporate_social_responsibility_report_20142015.pdf

IEA (International Energy Agency). (2021). *World Energy Outlook 2021.* IEA. Retrieved March 10, 2022, from https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf

IEA. (2020). *South African Carbon Tax*. IEA. Retrieved May 30, 2022 from: https://www.iea.org/policies/3041-south-african-carbon-tax

JP Morgan. (2021). *Environmental and Social Policy Framework.* Retrieved March 11, 2022, from https://www.jpmorganchase.com/content/dam/jpmc/jpmorgan-chase-and-co/documents/environmental-and-social-policy-framework.pdf

JP Morgan Chase. (2015). *2015 Environmental Social and Governance Report.* Retrieved March 11, 2022, from https://www.jpmorganchase.com/content/dam/jpmc/jpmorgan-chase-and-co/documents/jpmc-cr-esg-report-2015.pdf

JP Morgan Chase. (2020). *Environmental Social & Governance Report 2020.* JP Morgan. Retrieved March 11, 2022, from https://www.jpmorganchase.com/content/dam/jpmc/jpmorgan-chase-and-co/documents/jpmc-esg-report-2020.pdf

KfW IPEX-Bank. (2015). *Sustainability Report 2015.* Retrieved March 11, 2022, from https://www.kfw.de/PDF/Download-Center/Konzernthemen/Nachhaltigkeit/Nachhaltigkeitsbericht-2015.pdf

KFW IPEX-Bank. (2019). *Exclusion List of KfW Group.* Retrieved March 11, 2022, from https://www.kfw.de/PDF/Download-Center/Konzernthemen/Nachhaltigkeit/Ausschlussliste_EN.pdf

KFW IPEX-Bank. (2020). *Guideline of KfW IPEX-Bank GmbH for environmentall and socially sound financing.* Retrieved March 11, 2022, from https://www.kfw-ipex-bank.de/pdf/About-KfW-IPEX-Bank/Social-responsibility/Environmental-and-social-sustainability/2020_10-Nachhaltigkeitsrichtlinie-KfW-IPEX-Bank-2020.pdf

KPMG. (2021). *South Africa: Carbon tax measures included in budget 2021*. KPMG. Retrieved May 31, 2022 from: https://home.kpmg/us/en/home/insights/2021/02/tnf-south-africa-carbon-tax-measures-included-budget-2021.html

M&G Plc. (2021). *Sustainability Report 2020/21.* Retrieved March 11, 2022, from https://www.mandgplc.com/~/media/Files/M/MandG-Plc/documents/respomsibility/sustainability-report/MGplc-SR2020-ia.pdf

MUFG. (2015). *Integrated Report 2015.* Retrieved March 11, 2022, from https://www.mufg.jp/dam/ir/report/annual_report/backnumber/pdf/ir2015_all_ja.pdf

MUFG. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from https://www.mufg.jp/dam/csr/report/2020/en_all.pdf

Natixis. (2015). *2015 Registration Document and Annual Financial Report.* Retrieved March 11, 2022, from https://natixis.groupebpce.com/natixis/en/2015-registration-document-pdf-4465-ko-rep_95262.html

Natixis. (2019). *2020 Non-Financial PERFORMANCE REPORT.* Retrieved March 11, 2022, from https://natixis.groupebpce.com/natixis/en/non-financial-performance-report-extract-from-universal-registration-document-rep_95833.html

NedBank. (2015). *2015 Sustainability Review.* Retrieved March 11, 2022, from https://www.nedbank.co.za/content/dam/nedbank/site-assets/AboutUs/Information%20Hub/Integrated%20Report/2015/2015_Nedbank_Group_Sustainability_Review.pdf

NedBank. (2020). *Integrated Report For the Year Ended 31 December 2020.* Retrieved March 11, 2022, from https://www.nedbank.co.za/content/dam/nedbank/site-assets/AboutUs/Information%20Hub/Integrated%20Report/2021/2020%20Nedbank%20Group%20Integrated%20Report%20(High%20Res%20single%20page).pdf

Norges Bank. (2015). *Respnsible Investment Report 2015.* Retrieved March 11, 2022, from https://www.nbim.no/contentassets/96608d5f04eb4a138fa88f8fdf937b70/20160211-responsible-investment-2015.pdf

Norges Bank. (2020). *Responsible Investment: Government Pension Fund Global.* Retrieved March 11, 2022, from https://www.nbim.no/contentassets/fef0e2802b3f423ba2e514cfde1277d7/government-pension-fund-global_2020_responsible-investment_web.pdf

Petronas. (2020). *1st Half 2020 Sustainability Disclosure.* Retrieved March 11, 2022, from https://www.petronas.com/sites/default/files/sustainability/1st%20Half%202020%20Sustainability%20Disclosure.pdf

Petronas. (2020). *Sustainability Disclosure.* Retrieved March 11, 2022, from https://www.petronas.com/sites/default/files/Media/2nd%20Half%202020%20Sustainability%20Disclosure.pdf

PIC. (2015). *Integrated Annual Report 215.* Retrieved March 11, 2022, from https://www.pic.gov.za/DocAnnualReports1/Integrated-Annual-Report-2015.pdf

Qatar Energy. (n.d.). *Climate Change Mitigation.* Retrieved March 11, 2022, from https://www.qatarenergy.qa/en/Sustainability/Pages/ClimateChangeMitigation.aspx

Sasol. (2020). *Climate Change Report.* Retrieved March 11, 2022, from https://www.sasol.com/sites/default/files/financial_reports/SASOL%20CCR%202020.pdf

Sasol. (2020). *Sustainability Report 2020.* Retrieved March 11, 2022, from https://www.sasol.com/sites/default/files/financial_reports/2020%20Sasol%20Sustainability%20Report%20-%2028%20August%202020%2010h30.pdf

Schroders. (2015). *Responsible Investment Report.* Retrieved March 11, 2022, from https://www.schroders.com/en/sysglobalassets/staticfiles/schroders/sites/global/pdf/2015ri.pdf

Schroders. (2020). *Sustainable Investment Report 2020.* Retrieved March 11, 2022, from https://www.schroders.com/en/insights/economics/sustainable-investment-report-2020/

Seriti Resources. (2020). *Our Safety, Health and Environmental Policy.* Retrieved March 1, 2022, from https://seritiza.com/wp-content/uploads/2021/05/she-policy-2020.pdf

Seriti Resources. (n.d.). *Towards a Just Transition*. Retrieved March 11, 2022, from Seriti: https://seritiza.com/news-media/features/just-transition/

Shell. (2020). *Responsible Energy: Sustainability Report 2020.* Retrieved March 11, 2022, from https://reports.shell.com/sustainability-report/2020/servicepages/downloads/files/shell-sustainability-report-2020.pdf

Siemens. (2020). *Sustainability information 2020.* Retrieved March 11, 2022, from https://assets.new.siemens.com/siemens/assets/api/uuid:13f56263-0d96-421c-a6a4-9c10bb9b9d28/sustainability2020-en.pdf

Societe Geenrale. (2015). *Corporate and Social Responsibility Report 2015.* Retrieved March 11, 2022, from https://www.societegenerale.com/sites/default/files/documents/Document%20RSE/2015_Group_CSR_Report.pdf

South32. (2020). *2020 Sustainable Development Report.* Retrieved March 11, 2022, from https://www.south32.net/docs/default-source/sustainability-reporting/fy20-sustainability-reporting/sustainable-development-report-2020.pdf?sfvrsn=8886afe8_12

State of Qatar: Ministry of Environment. (2015). *Intended Nationally Determined Contributions (INDCs) Report.* Retrieved March 11, 2022, from https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Qatar%20First/Qatar%20INDCs%20Report%20-English.pdf

State Street. (2015). *2015 Corporate Responsibility Report.* Retrieved March 11, 2022, from https://www.statestreet.com/content/dam/statestreet/documents/values/StateStreet_2015_CR_Report.pdf

State Street. (2020). *2020 ESG Report.* Retrieved March 11, 2022, from https://www.statestreet.com/ideas/articles/2020-esg-report.html

TNI (Transnational Institute). (2020). *Change Finance, Not Climate.* TNI. Retrieved March 10, 2022, from https://www.tni.org/files/publication-downloads/executive_summary_financial_system_change_online_def.pdf

Total Energies. (2020). *GEtting to Net Zero.* Retrieved March 11, 2022, from https://totalenergies.com/sites/g/files/nytnzq121/files/documents/2020-10/total-climate-report-2020.pdf

Tyler, E., Renoud, C., & Roff, A. (2020). *WHAT MIGHT A PARIS-ALIGNED EMISSIONS PROFILE LOOK LIKE FOR THE SOUTH AFRICAN POWER SECTOR?* Cape Town: Meridian Economics. Retrieved March 10, 2022, from https://meridianeconomics.co.za/wp-content/uploads/2020/08/Power-sector-carbon-budgets-2020-v1.1.pdf

UBS. (2015). *Sustainability Report 2015.* Retrieved March 11, 2022, from https://www.ubs.com/global/en/sustainability-impact.html#tab-780591741

UBS. (2020). *Banking on Sustainability 2020.* Retrieved March 11, 2022, from https://www.ubs.com/global/en/ubs-society/our-stories/2021/banking-on-sustainability/_jcr_content/mainpar/toplevelgrid/col2/linklist/link.1064588450.file/bGluay9wYXRoPS9jb250ZW50L2RhbS91YnMvZ2xvYmFsL3Vicy1zb2NpZXR5LzIwMjAvdWJzLXN1c3RhaW5hYmlsaXR5LXJlcG9yd

UN PRI. (n.d.). *What are the Principles for Responsible Investment?* Retrieved March 12, 2022, from PRI: https://www.unpri.org/about-us/what-are-the-principles-for-responsible-investment

UNEP FI. (n.d.). *About us*. Retrieved March 12, 2022, from UN Environment Programme Finance Initiative: https://www.unepfi.org/about/

UNEP FI. (n.d.). *Principles for Responsible Banking*. Retrieved March 12, 2022, from UNEP FI: UNEP FI. (n.d.). About us. Retrieved March 12, 2022, from UN Environment Programme Finance Initiative: https://www.unepfi.org/about/Vanguard. (2020). *Climate-related stewardship report.* Retrieved March 11, 2022, from https://corporate.vanguard.com/content/corporatesite/us/en/corp/how-we-advocate/investment-stewardship/investment-stewardship-insights.html

Urgewald; Friends of the Earth US; LINGO; Global Gas & Oil Network; Oil Change International; Global Energy Monitor; Rainforest Action Network; Les Amis de la Terre France; RE:Common. (2020).

Five Years Lost: How Finance is Blowing the Paris Carbon Budget. Berlin: Urgewald. Retrieved March 11, 2021, from https://urgewald.org/sites/default/files/media-files/FiveYearsLostReport.pdf

World Bank. (2015). *Annual Report 2015.* Retrieved March 11, 2022, from https://www.worldbank.org/en/about/annual-report-2015

World Bank Group. (2018). *Supporting Transitions in Coal Regions.* World Bank. Retrieved March 11, 2022, from https://openknowledge.worldbank.org/bitstream/handle/10986/35323/Supporting-Transition-in-Coal-Regions-A-Compendium-of-the-World-Bank-s-Experience-and-Guidance-for-Preparing-and-Managing-Future-Transitions.pdf?sequence=1&isAllowed=y

Yahoo! Finance. (2022). *BHP Group Limited (BHP)*. Retrieved March 12, 2022, from Yahoo! Finance: https://finance.yahoo.com/quote/BHP/

Yahoo! Finance. (2022). *Equinor ASA (EQNR)*. Retrieved March 12, 2022, from Yahoo! Finance: https://finance.yahoo.com/quote/EQNR/

Semi-Structured Interviews

Example Semi-Structured Interview Template for Financial Experts

1. How does asset managing work for APG, particularly in relation to environmental and social issues?
2. What does "**Paris Alignment"** mean for you and APG?
3. How do you think financial institutions can meaningfully **account for the social (and ecological) risks** of fossil fuel investments?
4. That Climate Action 100+ has "with some **success gotten fossil fuel companies to reform**". How exactly do you believe this to be true, how could they improve?
5. At the UNEP FI round table earlier this month, **the worlds "fossil fuel, oil and gas" did not come up and "coal"** was mentioned only once. This is also true in the Paris Agreement and various other documents. Why do you think that is?
6. In the email you wrote the really interesting phrase: "But my own work—again sponsored by investors—is to ensure tha**t we don't give value, and hence declare profits on stranded assets**" -- Can you unpack this? How is this possible given that without rigorous climate policy, it is impossible to determine what is doing to be "stranded"?
7. As of today the US is officially out of PA. What does this mean for the financial coherence with climate change?
8. **Divestment vs. Engagement**? Why not engage and LFFU?
9. Does the **carbon bubble exist**? To what extent?
10. What do you think is the **role of public financial institutions** (e.g., pension funds, ECAs) in addressing the climate crisis and LFFU, and how does this differ to private financiers like commercial banks?
11. Are financial institutions and markets **realistically equipped to truly address the climate emergency**? Why/why not?
12. Who should I interview next?

Anonymised Interview Log for financial experts. All interviews took virtually place via Zoom between October-November 2020

Code	Date
ACA_GEN1	5/10/20
ACA_GEN2	9/10/20
ACA_GEN3	9/10/20
ACA_GEN4	12/10/20
ACA_GEN5	2/2/21
FIN_GEN1	18/9/20
FIN_GEN10	26/11/20
FIN_GEN11	26/11/20
FIN_GEN2	24/9/20
FIN_GEN3	25/9/20
FIN_GEN4	2/10/20
FIN_GEN5	19/10/20
FIN_GEN7	4/11/20
FIN_GEN8	6/11/20
FIN_GEN9	18/11/20
NGO_GEN1	12/10/20
NGO_GEN2	13/10/20
NGO_GEN3	13/10/20
POL_GEN	4/12/20
PRIV_GEN1	11/11/20

Chapter 8

This chapter largely relied on a news item mining technique to uncover the multidimensional stranded assets driven by the COVID-19 pandemic – these news items are disclosed in the reference list below. Annual reports published by the same E&Ps as those in the sample list in Chapter 5 were also analysed, which are also included in the reference list.

Original Dataset

Like with the other chapters, this final empirical chapter also saw the creation of an original dataset that tracked the influence of the COVID-19 pandemic on global, African and South African multidimensional stranded assets. For the financial dimension, this included a review of the share prices and market capitalisations for the major E&Ps analysed in chapters 5 and 6:

		Market Cap (B USD)				Share Price (USD)						
E&P in Africa	**SA?**	**Dec 2019**	**March 2020**	**July 2020**	**Currency**	**Pre**	**Early**	**Mid**	**End**	**%D Early**	**%D Mid**	**%D End**
Anglo American	Y	19.66	18.29	41.81	USD	2691.57	1679.50	2350.77	4342	-37.60%	-12.66%	61.32%
Sasol	Y	2,656.41	37.03	4.93	USD	2195.54	309.64	749.42	2245	-85.90%	-65.87%	2.25%
Maersk	N	187.59	115.92	38.49	USD	1138.83	914.12	1512.50	3576	-19.73%	32.81%	214.01%
Exxaro Resources Ltd	Y	#N/A	#N/A	2.83	ZAR	1101.64	592.35	758.46	1040	-46.23%	-31.15%	-5.60%
BP	Y	96.08	69.52	69.41	USD	623.73	364.94	299.10	522	-41.49%	-52.05%	-16.31%
Glencore	Y	25.45	17.94	38.90	USD	328.01	164.55	214.59	515	-49.83%	-34.58%	57.01%
Tullow Oil PLC	N	#N/A	#N/A	0.55	GBX	231.33	21.25	25.64	67	-90.81%	-88.92%	-71.04%
Cairn Energy	N	#N/A	#N/A	1.28	GBX	225.30	136.25	205.13	278	-39.53%	-8.95%	23.39%
Chevron	Y	226.82	135.28	167.83	USD	125.04	79.99	71.47	131	-36.03%	-42.84%	4.77%
ExxonMobil	Y	295.45	160.55	161.22	USD	74.99	39.15	34.58	76	-47.79%	-53.89%	1.35%
Royal Dutch Shell	Y	241.03	140.22	136.42	USD	64.00	33.08	24.55	51	-48.31%	-61.64%	-20.31%
Rio Tinto	Y	124.33	18.38	28.10	USD	61.11	46.47	60.09	77	-23.96%	-1.67%	26.00%
BHP Billiton	Y	454.00		132.78	USD	58.30	38.61	52.17	64	-33.77%	-10.51%	9.78%
TOTAL SA	Y	143.30	100.44	116.44	USD	54.50	32.25	32.53	56.5	-40.83%	-40.31%	3.67%
Eni	Y	55.41	36.33	36.46	USD	32.02	18.25	15.48	15	-43.00%	-51.66%	-53.15%
African Rainbow Minerals	Y	#N/A	#N/A	3.39	ZAR	27.54	13.68	17.50	43.00	-50.34%	-36.45%	56.13%
Mitsubishi	Y	40.07	31.48	34.97	USD	26.21	20.75	24.83	33.6	-20.83%	-5.27%	28.20%
Canadian Natural Resources	Y	49.85	22.73	26.98	USD	25.60	12.01	16.19	51	-53.10%	-36.75%	99.21%
Woodside Petroleum Ltd	N	#N/A	#N/A	15.70	AUD	22.97	12.55	12.68	17.7	-45.38%	-44.82%	-22.95%
Equinor ASA	Y	#N/A	#N/A	49.97	USD	20.00	13.00	14.50	28	-35.00%	-27.50%	40.00%
Repsol	N	21.13	13.05	16.33	USD	14.96	7.97	6.69	12.6	-46.72%	-55.29%	-15.75%
Vale	N	67.69	42.53	77.29	USD	14.04	8.13	10.70	15.3	-42.09%	-23.79%	8.97%
South32	Y	23.13	8.72	8.64	USD	10.50	6.22	7.55	2.7	-40.76%	-28.10%	-74.29%
Rosneftegaz AO	N	#N/A	#N/A	62.46	RUB	6.30	4.71	4.76	7.5	-25.21%	-24.41%	19.11%
Petronas	Y	#N/A	#N/A	8.64	MYR	4.12	3.53	3.98	4.06	-14.19%	-3.29%	-1.37%
MC Mining	Y	#N/A	#N/A	0.02	AUD	0.47	0.10	0.07	0.07	-78.45%	-85.11%	-85.20%
Terracom	Y	#N/A	#N/A	0.08	AUD	0.38	0.06	0.09	0.14	-84.85%	-75.80%	-63.00%
									average	-45.25%	-35.94%	8.38%
									min	-90.81%	-88.92%	-85.20%
									max	-14.19%	32.81%	214.01%

These price fluctuations were subsequently used to *simulate* the impacts on major shareholder liquid equity investments by applying the denoted percent difference in share price to the value of the shares under management taken pre-pandemic (December 2019). Below the April 2020 ('early-pandemic') simulation is presented (full dataset available upon request):

Simulated April 2020	**Anglo American**	**BHP Billiton**	**BP**	**Eni**	**Equinor ASA**	**Rio Tinto**	**Royal Dutch Shell**	**South32**	**TOTAL**	**Tullow Oil PLC**	**Vale**	**Woodside Petroleum Ltd**		
Major Shareholders													**Total**	**Total SA**
Capital Group	0.00	0.00	0.00	0.00	0.00	5,985.34	12,934.28	0.00	0.00	0.00	0.00	0.00	18,919.62	18,919.62
Vanguard	0.00	0.00	655.29	0.00	378.30	957.28	11,181.04	1,598.54	0.00	0.00	0.00	715.22	15,485.68	14,770.46
Blackrock	748.36	46,483.26	1,205.27	0.00	438.10	7,007.68	18,624.04	2,225.52	5,342.20	0.00	2,219.49	720.24	85,014.16	82,074.43
JP Morgan Chase	0.00	19,498.05	25,956.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,133.12	47,587.85	45,454.73
PIC	1,349.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,349.50	1,349.50
Silchester International	613.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	613.41	613.41
Genesis Asset Managers	490.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	490.73	490.73
Tarl Investment	417.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	417.12	417.12
Epoch Two Investment	368.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	368.05	368.05
HSBC	0.00	26,911.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,300.06	30,211.23	26,911.17
Norges Bank	0.00	9,020.04	0.00	0.00	29,068.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38,088.04	38,088.04
Italian Ministry of Economy a	0.00	0.00	0.00	2,883.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,883.50	2,883.50
Cassa Depositi e Prestiti SpA	0.00	0.00	0.00	17,082.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17,082.00	17,082.00
M&G Plc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,572.50	0.00	0.00	1,572.50	0.00
RWC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,508.75	0.00	0.00	1,508.75	0.00
BNDES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,634.12	0.00	2,634.12	0.00
Previ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,739.81	0.00	2,739.81	0.00
Citicorp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,356.41	1,356.41	0.00
													268,322.48	**249,422.74**

Natural asset behaviour during the pandemic was deduced from changes in coal, oil and gas production both globally and in Africa/South Africa based on data from BP (2021), the latter being presented below:

	A	B	C	D	E
1			Oil Production (kboe/d)		
2			2019	2020	%D 2019-2020
3		Algeria	1487	1332	-10,4%
4		Angola	1420	1324	-6,8%
5		Chad	127	126	-0,5%
6		Republic of Congo	336	307	-8,8%
7		Egypt	653	616	-5,7%
8		Equatorial Guinea	160	161	0,4%
9		Gabon	218	207	-5,0%
10		Libya	1306	390	-70,2%
11		Nigeria	2102	1798	-14,5%
12		South Sudan	172	170	-1,2%
13		Sudan	98	86	-12,2%
14		Tunisia	42	36	-16,2%
15		Other Africa	331	314	-5,0%
16		**Total Africa**	8452	6865	-18,8%
17					
18			Natural Gas Production (Bcm)		
19		Country	2019	2020	%D 2019-2020
20		Algeria	87.00	81.50	-0.07
21		Egypt	64.90	58.50	-0.10
22		Libya	14.50	13.30	-0.09
23		Nigeria	49.30	49.40	0.00
24		Other Africa	28.10	28.60	0.02
25		**Total Africa**	243.80	231.30	-0.05
26					
27					
28			Coal Production (MT)		
29		Country	2019	2020	%D 2019-2020
30		South Africa	258.40	248.30	-0.04
31		Zimbabwe	2.60	3.30	0.25
32		Other Africa	21.20	15.80	-0.26
33		**Total Africa**	282.20	267.50	-0.06

Physical assets were analysed via a news item mining search, surveying fossil-intensive facilities that had either temporarily/permanently shut down/ mothballed/ shelved their operations, or increased/opened new operations. These were also compiled in a dataset, a sample of which is displayed below (full version available upon request):

	A	B	C	D	E	F	G
1	Event		Fuel Type	Inc/ Dec?	Date	Location	Source
2	Total scores "significant" gas condensate find offshore South Africa	x	Oil & Gas	Inc	October 2020	South Africa	https://www.worldoil.com/news/2020/10/28/total-scores-significant-gas-condensate-find-offshore-south-africa
3	Eni wins five new exploration licences in Egypt	x	Oil & Gas	Inc	January 2022	Egypt	https://www.offshore-energy.biz/eni-wins-five-new-exploration-licences-in-egypt/
4	The Algerian state oil company, Sonatrach, is planning to halve its spending to $7 billion	x	Oil & Gas	Dec	April 2020	Algeria	https://www.nytimes.com/2020/03/31/business/energy-environment/crude-oil-companies-coronavirus.html
5	Algeria's oil and gas exports plummet Sinking energy exports threaten more financial pain for Algeria, and possibly renewed unrest.	x	Oil & Gas	Dec	May 2021	Algeria	https://www.aljazeera.com/economy/2021/2/8/algerias-oil-and-gas-exports-plummet
6	Nigeria approves R22 billion funding to repair key oil refinery	x	Oil	Inc	May 2021	Nigeria	https://www.news24.com/fin24/economy/africa/nigeria-approves-r22-billion-funding-to-repair-key-oil-refinery-20210319
7	Several forthcoming refinery launches announced	x	Oil	Inc	May 2021	Nigeria, Algeria, Kenya, Ghai	https://www.spglobal.com/platts/en/market-insights/latest-news/agriculture/052621-refinery-news-roundup-several-refineries-
8	Total's latest African deal will position Uganda among major oil exporters	x	Oil	Inc	October 2021	Uganda	https://www.worldoil.com/news/2021/4/10/total-s-latest-african-deal-will-position-uganda-among-major-oil-exporters
9	Blast-rocked South African oil refinery shut down for investigations	x	Oil	Dec	December 2020	South Africa	https://www.reuters.com/article/us-engen-refinery-idUKKBN28E0SR
10	Fuel refinery confirms shutdown amid ongoing violence in KZN and Gauteng	x	Oil	Dec	July 2021	South Africa	https://www.timeslive.co.za/news/south-africa/2021-07-13-fuel-refinery-confirms-shutdown-amid-ongoing-violence-in-kzn-anc
11	S.Africa's Engen refinery to be converted into a storage terminal	x	Oil	Dec	April 2021	South Africa	https://www.reuters.com/world/africa/safricas-engen-refinery-be-converted-into-storage-terminal-2021-04-23/
12	All four of Nigeria's refineries are currently shut down, says NNPC chief	x	Oil	Dec	September 2020	Nigeria	https://www.reuters.com/article/nigeria-oil-idUSL8N2G65VN
13	Africa's largest refinery, Nigeria's Dangote, to start operations in H2 2022: officials	x	Oil	Dec	January 2022	Nigeria	https://www.spglobal.com/platts/en/market-insights/latest-news/oil/012422-africas-largest-refinery-nigerias-dangote-to-start-c
14	Angola's oil exploration evaporates as COVID-19 overshadows historic reforms: France's Total TOTF.PA, responsible for almost half of Angola's oil output, told Reuters it would not drill for more oil for now due to the coronavirus crisis, instead focusing on current production.	x	Oil	Dec	May 2020	Angola	https://www.reuters.com/article/us-global-oil-angola-insight-idUSKBN22W0OZ
15	Nigeria — Africa's largest oil producer — is likely to continue battling unplanned crude production outages in 2022, as international investments starts to wane.	x	Oil	Dec	December 2021	Nigeria	https://www.argusmedia.com/en/news/2286627-viewpoint-west-african-crude-output-in-declinee
16	Several oil refineries offline, undergoing maintenance or lack of crude supply	x	Oil	Dec	May 2021	South Africa, Ghana, Congo,	https://www.spglobal.com/platts/en/market-insights/latest-news/agriculture/052621-refinery-news-roundup-several-refineries-
17	Total system shutdown' as Ghana hit by countrywide power blackout...The country has both hydropower and thermal plants fuelled by crude oil and natural gas, and exports power to Togo, Benin and Burkina Faso.	x	Oil	Dec	March 2021	Ghana	https://www.news24.com/fin24/Economy/Africa/total-system-shutdown-as-ghana-hit-by-countrywide-power-blackout-202103
18	Tullow has hit financial goals and is looking to farm down its Kenyan operations, as it focuses further on its Ghanaian operations.	x	Oil	Dec	September 2021	Kenya	https://www.energyvoice.com/oilandgas/africa/ep-africa/350000/tullow-ghana-kenyan-partner/
19	Tullow Oil suspends Kenyan oil-export program	x	Oil	Dec	June 2020	Kenya	https://www.worldoil.com/news/2020/6/3/tullow-oil-suspends-kenyan-oil-export-program
20	Divided Libya to restart oil production after six-month shutdown (The oilfields have been shut since January and been under the control of forces loyal to Haftar, and more recently, a group of Russian mercenaries employed by the Wagner Group.)	x	Oil	Both	July 2020	Libya	https://www.theguardian.com/world/2020/jul/10/divided-libya-to-restart-oil-production-after-six-month-shutdown
21	Sapref refinery fully back after brief halt	x	Oil	Both	August 2021	South Africa	https://www.hellenicshippingnews.com/refinery-news-roundup-south-africas-sapref-fully-back-after-brief-halt/
22	TotalEnergies CEO Patrick Pouyanne met Monday with Mozambican President Filipe Nyusi to discuss the reopening of a natural gas project shut down nearly a year ago after terrorist attacks.	x	Gas	Inc	January 2022	Mozambique	https://www.dailysabah.com/business/energy/totalenergies-seeks-to-revive-terror-hit-mozambique-gas-project
23	Total secures $14.9 bn to finance Mozambique gas project	x	Gas	Inc	July 2020	Mozambique	https://www.thecitizen.co.tz/tanzania/news/total-secures-14-9-bn-to-finance-mozambique-gas-project-2712838
24	S.Africa grants Turkey's Karpowership licences for floating power generation	x	Gas	In	September 2021	South Africa	https://www.reuters.com/business/energy/safrica-grants-turkeys-karpowership-licences-floating-power-generation-2021-09-2
25	Why the closure of an Algerian gas pipeline is bad news for Spain		Gas	Dec	October 2021	Algeria	https://english.elpais.com/economy-and-business/2021-10-28/why-the-closure-of-an-algerian-gas-pipeline-is-bad-news-for-s

Finally, the avoided generation of new stranded fossil fuel assets during the pandemic were estimated by changes in CapEx spending by the sampled E&Ps; pledged CapEx reductions (or lack thereof) were surveyed via news item announcements in the 'early-pandemic' stage (May 2020), and subsequently actual reductions in CapEx spending by the same E&Ps were obtained through their annual reports published later in 2020 and 2021 (see reference list below). This resulted in the following table:

Company	SA?	Announced CapEx Reduction *(B USD) in 2020*	CapEx Reduction (B USD) (2019-2020)	CapEx Reduction (B USD) (2020-2021)	%Total CapEx	Announcement Date (2020)	Source
African Rainbow Minerals	Y	no announcement	0.05	0.1	Not specified	n/a	https://arm.co.za/wp-content/uploads/2020
Anglo American	Y	1	0.20	n/a	Not specified	23-Apr	https://de.reuters.com/article/anglo-outlook
BHP Billiton	Y	1.4	-0.30	-0.3	Not specified	03-Apr	https://www.fnarena.com/index.php/2020/0
BP	Y	4	4	n/a	25%	02-Apr	https://finance.yahoo.com/news/bp-revises
Cairn Energy	N	0.1	0.05	n/a	Not specified	27-Mar	https://www.capricornenergy.com/media/29
Canadian Natural Resources	Y	1	4.00	n/a	Not specified	18-Mar	https://seekingalpha.com/news/3553180-ca
Chevron	Y	2	7.00	9.00	Not specified	01-May	https://oilprice.com/Latest-Energy-News/W
CNOOC	N	1.4	0.16	-0.40	Not specified	30-Apr	https://www.reuters.com/article/us-cnooc-re
ENI	Y	2.3	4.50	-0.30	30%	24-Apr	https://www.offshore-energy.biz/eni-posts-3
Equinor ASA	Y	2	5.00	n/a	20%	25-Mar	https://www.equinor.com/en/news/2020-03-
Exxaro Resources Ltd	Y	n/a	0.20	n/a	47%	n/a	https://www.exxaro.com/assets/files/EXXAI
ExxonMobil	Y	10	0.20	n/a	30%	07-Apr	https://corporate.exxonmobil.com/News/Ne
Glencore	Y	1-1.5	1.30	n/a	Not specified	30-Apr	https://seekingalpha.com/news/3567046-gl
Maersk	N	Amount not specified	0.70	n/a	65%	20-Mar	https://www.offshore-energy.biz/maersk-dr
Mitsui	N	n/a	0.04	1.10	48% (2021)		https://www.mitsui.com/jp/en/ir/library/repo
Petronas	Y	Amount not specified	2.40	n/a	42%	27-May	https://www.petronas.com/integrated-repor
Repsol	N	1	1.40	n/a	25%	25-Mar	https://seekingalpha.com/news/3555178-re
Rio Tinto	Y	7+	0.70		50%	17-Apr	https://www.mining-journal.com/bulks/news
Rosneft	N	2.7	0.90	-2.20			https://www.rosneft.com/press/releases/ite
Royal Dutch Shell	Y	5	6.00	n/a	Not specified	23-Mar	https://www.reuters.com/article/us-shell-ca
Sasol	Y	Amount not specified	1.30	1.30	Not specified	22-Apr	https://www.dailymaverick.co.za/article/202
South32	Y	0.16	-0.04	0.20	Not specified	30-Mar	https://www.mining-technology.com/news/s
Total SA	Y	3	4.00	n/a	20%	03-Apr	https://www.total.com/media/news/press-re
Tullow	N	Amount not specified	0.20	n/a	40%	23-Apr	https://www.upstreamonline.com/finance/tu
Vale	N	0.4	-0.70	n/a	15%	29-Apr	https://www.reuters.com/article/us-vale-sa-
Woodside	N	n/a	-0.70	n/a	80%	n/a	https://www.woodside.com.au/docs/default
Total		~37	***42.56***				
Total SA		~32	**40.51**				

Reports: Reports & News Items

AFP. (2020, Jul 18). *Total secures $14.9 bn to finance Mozambique gas project*. Retrieved March 11, 2022, from The Citizen: https://www.thecitizen.co.tz/tanzania/news/total-secures-14-9-bn-to-finance-mozambique-gas-project-2712838

AFP. (2021, May 19). *Nigeria approves R22 billion funding to repair key oil refinery*. Retrieved March 11, 2022, from Fin24: https://www.news24.com/fin24/economy/africa/nigeria-approves-r22-billion-funding-to-repair-key-oil-refinery-20210319

AFP. (2021, Apr 3). *Total shuts down gas plant after Mozambique jihadist attacks*. Retrieved March 11, 2022, from CGTN Africa: https://africa.cgtn.com/2021/04/03/total-shuts-down-gas-plant-after-mozambique-jihadist-attacks/

AngloAmerican. (2020). *Integreated Annual Report.* AngloAmerican. Retrieved March 12, 2020, from https://www.angloamerican.com/investors/annual-reporting

ANI. (2020, 04 01). *Local oil refineries in Pakistan close as demand slumps during COVID-19 lockdown*. Retrieved 05 20, 2020, from Energy World: https://energy.economictimes.indiatimes.com/news/oil-and-gas/local-oil-refineries-in-pakistan-close-as-demand-slumps-during-covid-19-lockdown/74928164

Argus. (2021, Dec 24). *Viewpoint: West African crude output in decline*. Retrieved March 11, 2022, from Argus: https://www.argusmedia.com/en/news/2286627-viewpoint-west-african-crude-output-in-decline

ARM. (2020). *Integrated Annual Report.* African Rainbow Minterals. Retrieved March 12, 2021, from https://arm.co.za/wp-content/uploads/2020/11/Integrated-Annual-Report-2020.pdf

Batten, K. (2020, 04 17). *Rio Tinto slashes copper, capex guidance*. Retrieved 05 15, 2020, from Mining Journal: https://www.mining-journal.com/bulks/news/1385121/rio-tinto-slashes-copper-capex-guidance

BBC News. (2020, 04 12). *US backs Opec deal with cuts to boost oil price*. Retrieved 05 20, 2020, from BBC News: https://www.bbc.com/news/business-52226236

BHP Billiton. (2020). *Annual Report 2020.* +: BHP Billiton. Retrieved March 12, 2021, from https://www.bhp.com/investor-centre/annual-report-2020/

Bousso, R. (2020, 03 23). *Shell cuts 2020 spending by $5 billion, suspends share buyback*. Retrieved 05 15, 2020, from Reuters: https://www.reuters.com/article/us-shell-capex/shell-cuts-2020-spending-by-5-billion-suspends-share-buyback-idUSKBN21A0PD

BP. (2020). *Annual Report.* BP. Retrieved March 12, 2021, from https://www.bp.com/en/global/corporate/investors/results-and-reporting/annual-report.html

BP. (2021). *Statistical Review of World Energy.* Retrieved March 11, 2022, from https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Brocklehurst, E. (2020, 04 23). *Firm Outlook For BHP Despite Restrictions*. Retrieved 05 15, 2020, from Financial Arena: https://www.fnarena.com/index.php/2020/04/23/firm-outlook-for-bhp-despite-restrictions/

Brower, D. (2020, 04 16). *ConocoPhillips slashes oil output and spending plans*. Retrieved 05 10, 2020, from Financial Times: https://www.ft.com/content/afdb5603-7176-410d-8535-1859c6585ea9

Brown, T. (2020, 05 01). *BASF throws out 2020 guidance as pandemic demand impact continues to bite*. Retrieved 05 20, 2020, from ICIS: https://www.icis.com/explore/resources/news/2020/05/01/10503528/basf-throws-out-2020-guidance-as-pandemic-demand-impact-continues-to-bite

Browning, N., Zhdannikov, D., & George, L. (2020, May 20). *Angola's oil exploration evaporates as COVID-19 overshadows historic reforms*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/article/us-global-oil-angola-insight-idUSKBN22W0OZ

Burkhardt, P., & Herbling, D. (2020, Jun 3). *Tullow Oil suspends Kenyan oil-export program*. Retrieved March 11, 2022, from WorldOil: https://www.worldoil.com/news/2020/6/3/tullow-oil-suspends-kenyan-oil-export-program

Burkhardt, P., & Khraiche, D. (2020, Oct 28). *Total scores "significant" gas condensate find offshore South Africa*. Retrieved March 11, 2022, from WorldOil: https://www.worldoil.com/news/2020/10/28/total-scores-significant-gas-condensate-find-offshore-south-africa

Business Daily. (2020, 04 23). *Tullow sells Ugandan stake to Total for $575m*. Retrieved 05 20, 2020, from The East African: https://www.theeastafrican.co.ke/business/Tullow-sells-Ugandan-stake-to-Total/2560-5532252-91ihjn/index.html

Cairn Energy. (2019). *Annual Report 2019.* Cairn Energy. Retrieved March 12, 2021, from https://www.cairnenergy.com/investors/results-reports-and-presentations/#Tab2021=1

CAN (Canadian Natural Resources). (2020). *2020 Annual Report.* CAN. Retrieved March 11, 2022, from https://www.cnrl.com/upload/report/134/04/2020-annual-report---teams.pdf

Carbon Tracker. (2020). *Political decisions, economic realities: The underlying operating cashflows of coal power during COVID-19.* Carbon Tracker. Retrieved 05 15, 2020, from https://carbontracker.org/reports/political-decisions-economic-realities/

Chevron. (2020). *2020 Supplement to the Annual Report.* Chevron Corp. Retrieved March 12, 2021, from https://www.chevron.com/-/media/shared-media/documents/2020-chevron-annual-report-supplement.pdf

Climate Action Network Europe. (2020, 04 27). *The last coal plant in Austria shuts down, leaving only seven EU member-states without plans to do the same by 2030 "deadline"*. Retrieved 05 15, 2020, from Climate Action Network Europe: http://www.caneurope.org/publications/press-releases/1907-the-last-coal-plant-in-austria-shuts-down-leaving-only-seven-eu-member-states-without-plans-to-do-the-same-by-2030-deadline

CNOOC. (2019). *Annual Report 2019.* China National Offshore Oil Corporation. Retrieved March 12, 2021, from https://www.cnoocltd.com/col/col7511/index.html

Duran, M. (2020, 05 21). *Report: Total secures $14.4 billion Mozambique LNG financing*. Retrieved 05 20, 2020, from Offshore Energy: https://www.offshore-energy.biz/report-total-secures-14-4-billion-mozambique-lng-financing/

Equinor. (2020, 02 25). *Exploration in the Great Australian Bight discontinued*. Retrieved 05 15, 2020, from Equinor: https://www.equinor.com/en/where-we-are/gabproject.html

European Commission. (2021, Nov 2). *France, Germany, UK, US and EU launch ground-breaking International Just Energy Transition Partnership with South Africa*. Retrieved March 11, 2022, from European Commission: https://ec.europa.eu/commission/presscorner/detail/en/IP_21_5768

ExxonMobil. (2020, 04 07). *ExxonMobil reduces 2020 capex by 30%, cash opex by 15%; maintains long-term outlook*. Retrieved 05 10, 2020, from ExxonMobil: https://corporate.exxonmobil.com/News/Newsroom/News-releases/2020/0407_ExxonMobil-reduces-2020-capex-by-30-percent-cash-opex-by-15-percent

Fabrizio, I. (2021, Oct 28). *Why the closure of an Algerian gas pipeline is bad news for Spain*. Retrieved March 11, 2022, from El Pais: https://english.elpais.com/economy-and-business/2021-10-28/why-the-closure-of-an-algerian-gas-pipeline-is-bad-news-for-spain.html

Fin24. (2021, Mar 8). *'Total system shutdown' as Ghana hit by countrywide power blackout*. Retrieved March 11, 2022, from Fin24: https://www.news24.com/fin24/Economy/Africa/total-system-shutdown-as-ghana-hit-by-countrywide-power-blackout-20210308

FirstEnergy. (2020, 04 23). *FirstEnergy Announces First Quarter 2020 Financial Results*. Retrieved 05 10, 2020, from FirstEnergy: https://firstenergycorp.com/newsroom/news_articles/firstenergy-announces-first-quarter-2020-financial-results.html

FitchRatings. (2020, 04 07). *Fitch Downgrades ArcelorMittal S.A. to 'BB+'; Outlook Negative*. Retrieved 05 10, 2020, from FitchRatings: https://www.fitchratings.com/research/corporate-finance/fitch-downgrades-arcelormittal-sa-to-bb-outlook-negative-07-04-2020

Fox Business. (2020, 03 24). *Kentucky coal plant closure spells doom for struggling industry*. Retrieved 05 10, 2020, from Fox Business: https://www.foxbusiness.com/lifestyle/kentucky-coal-plant-closure-struggling-industry

French Press Agency. (2022, Jan 31). *TotalEnergies seeks to revive terror-hit Mozambique gas project*. Retrieved March 11, 2022, from Daily Sabah: https://www.dailysabah.com/business/energy/totalenergies-seeks-to-revive-terror-hit-mozambique-gas-project

General Energy News. (2020, 04 15). *REFINERY NEWS ROUNDUP: Run cuts, maintenance, closures in focus in Europe*. Retrieved 05 15, 2020, from Hellenic Shipping News: https://www.hellenicshippingnews.com/refinery-news-roundup-run-cuts-maintenance-closures-in-focus-in-europe/

Gofman, K. (2020). *'Russian economy hit twice by covid and decreasing oil prices'.* Port of Rotterdam. Retrieved 2 22, 2021, from https://www.portofrotterdam.com/en/news-and-press-releases/russian-economy-hit-twice-by-covid-and-decreasing-oil-prices

Gordon, P. (2020, 04 02). *RWE, SSE close last coal plants – only four left in Britain*. Retrieved 05 15, 2020, from Smart Energy: https://www.smart-energy.com/renewable-energy/rwe-sse-close-last-coal-plants-only-four-left-in-britain/

Harsono, N. (2020, 03 31). *Coal mining giant Bumi records 97 percent plunge in profit*. Retrieved 05 15, 2020, from The Jakarta Post: https://www.thejakartapost.com/news/2020/03/31/coal-mining-giant-bumi-records-97-percent-plunge-in-profit.html

Hellenic Shipping News. (2021, Oct 8). *REFINERY NEWS ROUNDUP: South Africa's Sapref fully back after brief halt*. Retrieved March 11, 2022, from Hellenic Shipping News: https://www.hellenicshippingnews.com/refinery-news-roundup-south-africas-sapref-fully-back-after-brief-halt/

IEA. (2020a). *Annual Change in Coal Demand.* Retrieved 2 22, 2021, from https://www.iea.org/data-and-statistics/charts/annual-change-in-coal-demand-1971-2020

IEA. (2020b). *Global Energy Review 2020: Oil.* IEA. Retrieved 2 22, 2021, from https://www.iea.org/reports/global-energy-review-2020/oil

IEA. (2020c). *Global Energy Review 2020: Natural Gas.* IEA. Retrieved 2 22, 2021, from https://www.iea.org/reports/global-energy-review-2020/natural-gas

ILO (International Labour Organization). (2021). *World Employment and Social Outlook.* ILO. Retrieved March 11, 2022, from https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_795453.pdf

ILO. (2020). *COVID-19 and the world of work. Third edition.* New York: ILO. Retrieved 2 22, 2021, from https://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/documents/briefingnote/wcms_743146.pdf

Kilgore, T. (2020, 03 25). *Occidental Petroleum cuts capex plans and costs further, stock extends bounce off 20-year low*. Retrieved 05 15, 2020, from Market Watch: https://www.marketwatch.com/story/occidental-petroleum-cuts-capex-plans-and-costs-further-stock-extends-bounce-off-20-year-low-2020-03-25

Kim, D.-Y. (2020, 04 24). *LG International: Earnings Visibility Lessens amid COVID-19*. Retrieved 05 20, 2020, from Business Korea: http://www.businesskorea.co.kr/news/articleView.html?idxno=44774

Kolyako, D. (2020, 04 28). *Lukoil: A Downgrade Until Better Times*. Retrieved 05 15, 2020, from Seeking Alpha: https://seekingalpha.com/article/4340541-lukoil-downgrade-until-better-times

Kolyako, D. (2020, 04 28). *Lukoil: A Downgrade Until Better Times*. Retrieved 05 15, 2020, from Seeking Alpha: https://seekingalpha.com/article/4340541-lukoil-downgrade-until-better-times

Krauss, C. (2020, 03 31). *Oil Companies on Tumbling Prices: 'Disastrous, Devastating'*. Retrieved 05 20, 2020, from The New York Times: https://www.nytimes.com/2020/03/31/business/energy-environment/crude-oil-companies-coronavirus.html

Krauss, C. (2020, Apr 21). *Oil Companies on Tumbling Prices: 'Disastrous, Devastating'*. Retrieved March 11, 2022, from New York Times: https://www.nytimes.com/2020/03/31/business/energy-environment/crude-oil-companies-coronavirus.html

Kulovic, N. (2020, 04 24). *Eni posts $3 billion loss, lowers production target due to capex cuts*. Retrieved 05 15, 2020, from Offshore Energy: https://www.offshore-energy.biz/eni-posts-3-billion-loss-lowers-production-target-due-to-capex-cuts/

Kumar, N. (2020, 04 16). *Evraz expects declining sales in Russia on the background of weakened demand due to coronavirus*. Retrieved 05 15, 2020, from The Times Hub: https://thetimeshub.in/evraz-expects-declining-sales-in-russia-on-the-background-of-weakened-demand-due-to-coronavirus/7192/

Marino, D. (2020, 03 30). *Newfoundland refinery becomes first in North America to shut down as fuel demand tanks*. Retrieved 05 15, 2020, from Financial Post: https://business.financialpost.com/commodities/energy/first-north-american-refinery-shuts-with-fuel-demand-plunging

Mining Technology. (2020, 03 30). *Covid-19: South32 cuts capital expenditure, reduces exploration*. Retrieved from Mining Technology: https://www.mining-technology.com/news/south32-cuts-capital-expenditure/

Mohamed, T. (2020, 04 09). *Saudi Arabia plowed $1 billion into Shell and other European oil producers*. Retrieved 05 20, 2020, from Business Insider: https://www.businessinsider.nl/saudi-arabia-invested-1-billion-shell-european-oil-majors-wsj-2020-4/

Morton, A. (2020, 04 13). *Australia's booming LNG industry stalls after fall in oil prices amid coronavirus*. Retrieved 05 15, 2020, from The Guardian: https://www.theguardian.com/environment/2020/apr/13/australias-booming-lng-industry-stalls-after-fall-in-oil-prices-amid-coronavirus

Murphy, J. (2020, 03 30). *GAZPROM MAKES NO CHANGE 2020 INVESTMENT PLAN*. Retrieved 05 15, 2020, from Natural Gas World: https://www.naturalgasworld.com/gazprom-cuts-2020-investments-77621

Nereim, V. (2020). *Saudi Economy Shrank 7%, Unemployment at Record as Virus Hit.* Bloomberg. Retrieved 2 22, 2021, from https://www.bloomberg.com/news/articles/2020-09-30/saudi-economy-shrank-7-in-second-quarter-as-virus-oil-hit-hard

Offshore Technology. (2020, 04 30). *China’s CNOOC slashes 2020 capital expenditure*. Retrieved 05 15, 2020, from Offshore Technology: https://www.offshore-technology.com/news/cnooc-slashes-capital-expenditure/

Offshore Technology. (2020, 03 25). *Saudi Aramco’s capex cut may impact BPCL investment plans*. Retrieved 05 15, 2020, from Offshore Technology: https://www.offshore-technology.com/news/saudi-aramco-capex-bpcl-cut/

Ojambo, F., & Burkhadt, P. (2021, Apr 10). *Total’s latest African deal will position Uganda among major oil exporters*. Retrieved March 11, 2022, from WorldOil: https://www.worldoil.com/news/2021/4/10/total-s-latest-african-deal-will-position-uganda-among-major-oil-exporters

Otago Daily Times. (2020, 02 20). *OMV drilling off Otago comes up empty handed*. Retrieved 05 15, 2020, from Otago Daily Times: https://www.odt.co.nz/news/dunedin/omv-drilling-otago-comes-empty-handed

Paraskova, T. (2020, 05 01). *Chevron Slashes Capex Again To Protect Dividend In Oil Price Rout*. Retrieved 05 15, 2020, from Oil Price: https://oilprice.com/Latest-Energy-News/World-News/Chevron-Slashes-Capex-Again-To-Protect-Dividend-In-Oil-Price-Rout.html

Paraskova, T. (2020, 04 07). *Indonesia's Pertamina To Boost Oil Production Despite Price Crash*. Retrieved 05 20, 2020, from Oil Price: https://oilprice.com/Latest-Energy-News/World-News/Indonesias-Pertamina-To-Boost-Oil-Production-Despite-Price-Crash.html

Paraskova, T. (2020, 07 20). *Petrobras Slashes Oil Output Ahead Of Global Production Meeting*. Retrieved 05 20, 2020, from Oil Price: https://oilprice.com/Latest-Energy-News/World-News/Petrobras-Slashes-Oil-Output-Ahead-Of-Global-Production-Meeting.html

Planting, S. (2020, 04 22). *Sasol's perfect storm*. Retrieved 05 15, 2020, from Business Maverick: https://www.dailymaverick.co.za/article/2020-04-22-sasols-perfect-storm/

Praiwan, Y. (2020, 04 23). *PTT capacity cuts of 15-25% in May*. Retrieved 05 20, 2020, from The Bangkok Post: bangkokpost.com/business/1905440/ptt-capacity-cuts-of-15-25-in-may

Prohaska, T. (2020, 03 30). *New York's last coal-burning power plant closes on Lake Ontario shore*. Retrieved 05 15, 2020, from The Buffalo News: https://buffalonews.com/2020/03/30/new-yorks-last-coal-burning-power-plant-closes-on-shores-of-lake-ontario/

Ramdoo, I. (2020). *The Impact of COVID-19 on Employment in Mining.* IISD. Retrieved 2 22, 2021, from https://www.iisd.org/system/files/publications/covid-19-employment-mining-en.pdf

Ratcliffe, V., Karam, S., & El Wardany, S. (2021, Feb 8). *Algeria's oil and gas exports plummet*. Retrieved March 11, 2022, from Bloomberg: https://www.aljazeera.com/economy/2021/2/8/algerias-oil-and-gas-exports-plummet

Reed, E. (2021, Sep 15). *Tullow Oil hits goals, rethinks Kenya plan*. Retrieved March 11, 2022, from Energy Voice: https://www.energyvoice.com/oilandgas/africa/ep-africa/350000/tullow-ghana-kenyan-partner/

Reuters. (2020, Sep 9). *All four of Nigeria's refineries are currently shut down, says NNPC chief*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/article/nigeria-oil-idUSL8N2G65VN

Reuters. (2020, 04 28). *BRIEF-Inner Mongolia Yitai Coal's Q1 Net Profit Down 48.7% Y/Y*. Retrieved 05 15, 2020, from Yahoo! News: https://sg.news.yahoo.com/brief-inner-mongolia-yitai-coals-093629415.html

Reuters. (2020, 03 24). *Suncor cuts 2020 production outlook, capex amid coronavirus outbreak*. Retrieved from Financial Post: https://business.financialpost.com/pmn/business-pmn/suncor-cuts-2020-production-outlook-capex-amid-coronavirus-outbreak

Reuters. (2021, Nov 19). *India's Jindal plans to start building Botswana coal mine in 2022*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/markets/commodities/indias-jindal-plans-start-building-botswana-coal-mine-2022-2021-11-19/

Reuters. (2021, Sep 21). *S.Africa grants Turkey's Karpowership licences for floating power generation*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/business/energy/safrica-grants-turkeys-karpowership-licences-floating-power-generation-2021-09-21/

Reuters. (2021, Apr 23). *S.Africa's Engen refinery to be converted into a storage terminal*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/world/africa/safricas-engen-refinery-be-converted-into-storage-terminal-2021-04-23/

S&P Global. (2021, May 26). *REFINERY NEWS ROUNDUP: Several refineries in Africa remain offline*. Retrieved March 11, 2022, from S&P Global: https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/agriculture/052621-refinery-news-roundup-several-refineries-in-africa-remain-offline

S&P Global. (2021, May 26). *REFINERY NEWS ROUNDUP: Several refineries in Africa remain offline*. Retrieved March 11, 2022, from S&P Global: https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/agriculture/052621-refinery-news-roundup-several-refineries-in-africa-remain-offline

S&P Global. (2022, Jan 24). *Africa's largest refinery, Nigeria's Dangote, to start operations in H2 2022: officials*. Retrieved March 11, 2022, from S&P Global: https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/oil/012422-africas-largest-refinery-nigerias-dangote-to-start-operations-in-h2-2022-officials

Sainato, M. (2020). *The collapse of coal: pandemic accelerates Appalachia job losses.* The Guardian. Retrieved 2 22, 2021, from https://www.theguardian.com/us-news/2020/may/29/coal-miners-coronavirus-job-losses

Savides, M. (2022, Jul 13). *Fuel refinery confirms shutdown amid ongoing violence in KZN and Gauteng*. Retrieved March 11, 2022, from Times Live: https://www.timeslive.co.za/news/south-africa/2021-07-13-fuel-refinery-confirms-shutdown-amid-ongoing-violence-in-kzn-and-gauteng/

Sguazzin, A., & Marawanyika, G. (2020, May 7). *As others shun African coal projects, China gets $4bn Zimbabwe project under way*. Retrieved March 11, 2022, from Business Day: https://www.businesslive.co.za/bd/companies/mining/2020-05-07-as-others-shun-african-coal-projects-china-gets-4bn-zimbabwe-project-under-way/

Shabalala, Z. (2020, 04 23). *UPDATE 3-Anglo American to cut capex, costs due to coronavirus impact*. Retrieved 05 15, 2020, from Reuters: https://de.reuters.com/article/anglo-outlook/update-3-anglo-american-to-cut-capex-costs-due-to-coronavirus-impact-idUKL5N2CB24Z

Slater, D. (2020, 03 30). *Engen refinery temporarily shut amid low demand*. Retrieved 05 5, 2020, from Engineering News: https://www.engineeringnews.co.za/article/engen-refinery-temporarily-shut-amid-low-demand-2020-03-30

South African Government Department of Statistics. (2020). *Quaterly Labour Force Survey 2020.* Retrieved March 11, 2022, from http://www.statssa.gov.za/publications/P0211/P02114thQuarter2020.pdf

South African Government Department of Statistics. (2021). *Quarterly Labour Force Survey.* Retrieved March 11, 2022, from http://www.statssa.gov.za/publications/P0211/P02113rdQuarter2021.pdf

Surran, C. (2020, 03 18). *Canadian Natural Resources to cut 2020 capex by more than $1B*. Retrieved 05 10, 2020, from Seeking Alpha: https://seekingalpha.com/news/3553180-canadian-natural-resources-to-cut-2020-capex-1b

Surran, C. (2020, 04 30). *Glencore cuts full-year guidance for capex, production*. Retrieved 05 15, 2020, from Seeking Alpha: https://seekingalpha.com/news/3567046-glencore-cuts-full-year-guidance-for-capex-production

Surran, C. (2020, 03 16). *Pioneer Natural Resources cuts 2020 capex by 45%*. Retrieved 05 15, 2020, from Seeking Alpha: https://seekingalpha.com/news/3552225-pioneer-natural-resources-cuts-2020-capex-45

Surran, C. (2020, 03 25). *Repsol to cut 2020 planned capex by 26%, or more than €1B*. Retrieved 05 15, 2020, from Seeking Alpha: https://seekingalpha.com/news/3555178-repsol-to-cut-2020-planned-capex-26-1b

TC Energy. (2020, 03 31). *TC Energy to Build Keystone XL Pipeline*. Retrieved 05 20, 2020, from TC Energy: https://www.tcenergy.com/announcements/2020-03-31tc-energy-to-build-keystone-xl-pipeline/

The Canadian Press. (2020, 03 11). *Seven Generations and MEG Energy cutting capital spending plans for 2020*. Retrieved 05 15, 2020, from City News: https://www.citynews1130.com/2020/03/11/seven-generations-and-meg-energy-cutting-capital-spending-plans-for-2020/

Total SA. (2020, 03 23). *TOTAL ANNOUNCES IMMEDIATE ACTION PLAN IN CONTEXT OF SHARP DECREASE IN OIL PRICES*. Retrieved 05 15, 2020, from Total SA: https://www.total.com/media/news/press-releases/total-announces-immediate-action-plan-context-sharp-decrease-oil-prices

Toyana, M. (2020, Nov 17). *Consortium pulls plug on South Africa's Thabametsi coal plant*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/article/us-climate-change-safrica-coal-exclusive-idUSKBN27X2LC

US Congressional Research Service. (2020). *Unemployment Rates During the COVID-19 Pandemic: In Brief.* Washing DC: Congressional Research Service. Retrieved 2 22, 2021, from https://fas.org/sgp/crs/misc/R46554.pdf

Vijayraghavan, K. (2020, 04 10). *Tata companies told to conserve cash, go slow on capex*. Retrieved 05 15, 2020, from The Economic Times: https://economictimes.indiatimes.com/news/company/corporate-trends/tata-companies-told-to-conserve-cash-go-slow-on-capex/articleshow/75075115.cms

Ward, R., & Roelf, W. (2020, Dec 4). *Blast-rocked South African oil refinery shut down for investigations*. Retrieved March 11, 2022, from Reuters: https://www.reuters.com/article/us-engen-refinery-idUKKBN28E0SR

Wintour, P. (2020, Jul 10). *Divided Libya to restart oil production after six-month shutdown*. Retrieved March 11, 2022, from The Guardian: https://www.theguardian.com/world/2020/jul/10/divided-libya-to-restart-oil-production-after-six-month-shutdown

Woodall, T. (2020, 03 26). *UPDATE: Top Russian steelmaker NLMK withdraws 2020 capex guidance amid pandemic*. Retrieved 05 15, 2020, from S&P Global: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/update-top-russian-steelmaker-nlmk-withdraws-2020-capex-guidance-amid-pandemic-57775789

World Maritime News. (2020, 03 20). *Maersk Drops 2020 Guidance amid Coronavirus Uncertainties*. Retrieved 05 15, 2020, from Offshor Energy: https://www.offshore-energy.biz/maersk-drops-2020-guidance-amid-coronavirus-uncertainties/

WorldOil. (2020). *PESA says oilfield job losses exceed 100,000, but layoff rates are slowing.* Retrieved 2 22, 2021, from https://www.worldoil.com/news/2020/9/9/pesa-says-oilfield-job-losses-exceed-100-000-but-layoff-rates-are-slowing

Zacks Equity Research. (2020, 04 02). *BP Revises 2020 Capex Downward as Coronavirus Drags Oil Down*. Retrieved 05 15, 2020, from Yahoo! Finance: https://finance.yahoo.com/news/bp-revises-2020-capex-downward-114211909.html

Zacks Equity Research. (2020, 03 17). EOG Resources to Curb 2020 Capex Maintaining Flat Production. Retrieved 05 13, 2020, from Zacks Equity Research: https://www.zacks.com/stock/news/818818/eog-resources-to-curb-2020-capex-maintaining-flat-production

Appendix C: Supplementary Data

Chapter 5

Prospective Stranded Physical Assets

Kusile

Kusile is Medupi's sibling coal-fired power station, also owned by Eskom; it is located in Witbank, Mpumalanga province (see Figure 5.3) and is currently under construction (Kusile's developments have been delayed in spite securing financing in parallel with Medupi's timeline, in 2008/9), though once it is finished it will have 4800MW (6 units x 800MW) of installed capacity, making it South Africa's largest coal-fired power station jointly with Medupi. Together, Medupi and Kusile would account for 28% of South Africa's installed coal capacity in 2030, as predicted by the IRP (see 1.3.2.1). According to Eskom (2020), Kusile has a 60-year life expectancy, and with its final units expected to go fully online by 2024, Kusile will likely only be decommissioned circa 2085. With annual emissions sitting at 36.8 $MtCO_2e$ (equivalent to 9.2% of South Africa's lower-bound 2030 emissions targets, see 5.2.2.6), Kusile will emit over 2.2 billion tons of CO_2e in its lifetime; *together, Kusile and Medupi jointly consume over 17% of South Africa's 2030 lower-bound emissions budget*. Medupi & Kusile have joint peak workforces of 31,000 employees, including both permanent staff and temporary contractors.

Kusile will likely be supplied with coal by the neighbouring (and still undeveloped) New Largo coal mine; New Largo was formerly owned by the UK-based multinational AngloAmerican, who had been negotiating plans as early as 2009 with Eskom to supply Kusile with 12-15Mtpa of coal. However, these negotiations stagnated for years and eventually reached an impasse after disagreements on several key issues, one of which being the BBEE ownership requirements. As a result, AngloAmerican *divested these assets* in 2018 by selling the New Largo coal project for $65 million to a consortium of South African and black-majority shareholders, spearheaded by Seriti Resources (who have 45% operating interest). New Largo will employ some 1100 direct staff in addition to 478 contract jobs, and has an estimated lifetime of over 50 years once built given its 585Mt recoverable reserves. Critically, reports suggest that rather than calling on bank finance, ***Seriti will secure financing directly from Eskom to develop the New Largo mine*** (Davie, 2019), implying that Kusile's multilateral financiers (see below Figure C1 and Figure C2) are de facto financing Seriti's coal mine.

While Seriti Resources is privately owned by four majority black shareholders, AngloAmerican has multinational ownership. As of July 2021, Anglo's market cap stood at $51.2 billion, and although South Africa's PIC was its majority shareholder ($3.5 billion), the bulk of its shareholders resided on the balance sheets of either US (Blackrock, $2.5 billion; Vanguard Group, $1.3 billion), British (Genesis Investment, $2.1 billion; Tarl Investment, $1.8 billion; Epoch Two Investment, $1.6 billion) or Norwegian (Government Pension Fund, $1.2 billion) investors; these six shareholders (excluding PIC) account for over 20% of Anglo's listed July 2021 shares – see Figure C1. All of these shareholders were also major Anglo shareholders in July 2020. Some major shareholders in 2020 were omitted from the 2021 list, however, like South Africa's IDC (a BDB), which managed $1.4 billion in Anglo shares in July 2020, indicating that it has divested part or all of its assets by July 2021.

Recent Eskom disclosures indicate that financial constraints will fetter the capacity of the New Largo mine by about half, implying that half of Kusile's coal supply (some 7.5Mtpa) will be imported from other coal mines likely from elsewhere in Mpumalanga. However (GEM, nd: np: **emphasis added)**,

> [g]iven that Kusile was designed to be supplied by a large tied mine, the coal yard infrastructure was not designed to facilitate large-scale coal imports and will face challenges in congestion, stockpiling and blending, if 50% of its supply is imported. Procurement of many smaller, cheaper contracts will

exacerbate this problem due to the greater need for coal blending and handling. These constraints **will therefore require further capital investment should large imports be required**.

Figure C1. Map depicting the financiers and firms that drove Kusile's development

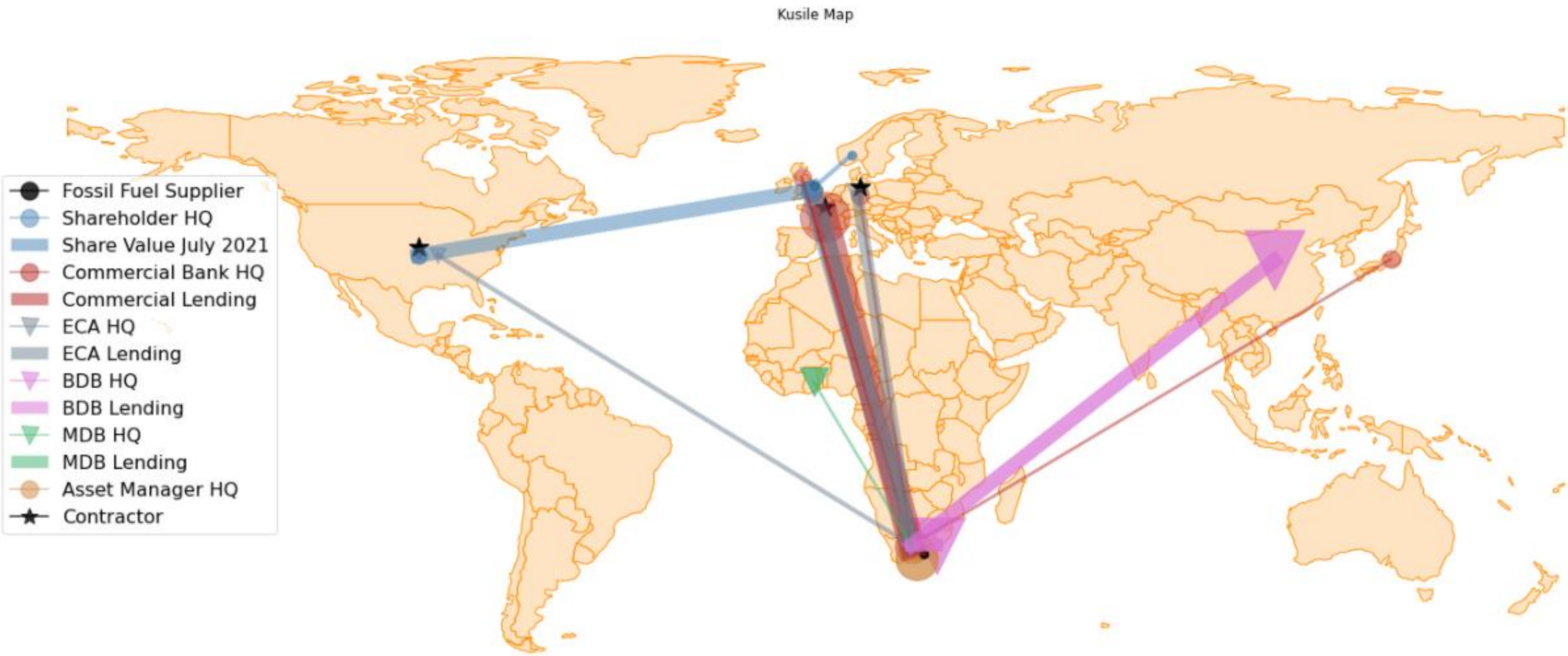
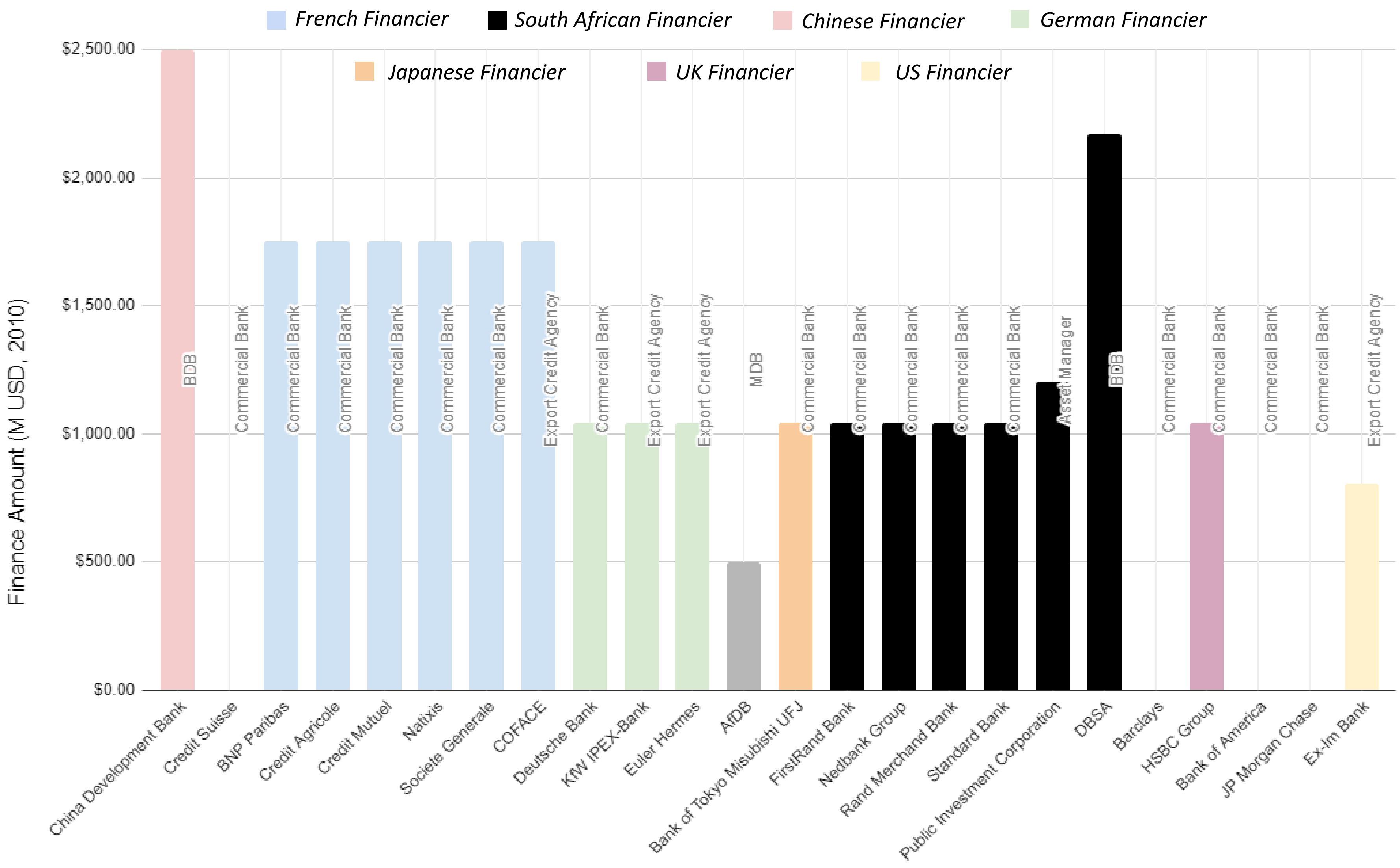


Figure C2. Depiction of Kusile's financiers by type, country and committed project finance



Kusile's economic and financial background extensively overlaps with Medupi's as both were proposed in tandem; French and German manufacturers Alstom and Hitachi Power, respectively, received tenders to build both Medupi & Kusile's turbines and boiling units. Accordingly, many of the same German and French financiers issued syndicated corporate loans to finance Kusile in 2009, backed by French ECA COFACE ($1.8 billion) and German ECAs Euler Hermes and KfW-IPEX ($1 billion), along with similar financial injections by the AfDB ($500 million) and the DBSA ($2.2 billion). Also analogous to Medupi, the Chinese Development Bank loaned an additional $2.5 billion in 2018 for financing Kusile, making the Chinese BDB Kusile's major financier to date (see Figure C2).

One notable difference between Medupi and Kusile is that the latter did not receive any World Bank financing; rather, it attracted significantly more South African commercial finance (through a syndicated loan worth $705 million issued by various major local banks, including FirstRand Bank, NedBank, Rand Merchant Bank and Standard Bank jointly with UK bank HSBC and Japanese bank MUFG). Furthermore, a slew of US manufacturers were contracted along with Alstom and Hitachi to develop Kusile, like General Electric (contracted to develop the turbine islands and condensers), Bateman Engineering Group (for developing the stockyards, conveyors, etc.) and Black & Veatch (to offer general engineering services). These US firms were backed by $805 million loan by the US ECA, the Ex-Im Bank. Altogether, as of 2018, Kusile's total expected costs stood at some R119 billion (roughly $9 billion).

Majuba

Majuba is located in Mpumalanga and is South Africa's third largest coal-fired power plant (also owned by Eskom), with an installed capacity of 4143MW, only trailing Medupi and Kusile. Unlike Medupi and Kusile, however, Majuba is much older, with its construction beginning in 1983, its first unit serviced in 1996, last unit serviced in 2001, and expected retirement set at 2050. Its annual emissions sit at 19MtCO_2e, equivalent to 5% of South Africa's lower-bound 2030 emissions targets; together with Medupi and Kusile, these three plants alone account for over 22% of South Africa's 2030 emissions targets. According to Eskom (2020), Majuba employees 1042 personnel.

Majuba does not have one designated mine for supply. Rather, it imports coal from various mines mainly linked to the neighbouring Ermelo coal field; this is due to unforeseen "geological faults were belatedly discovered in the coal seam" in developing the Majuba Colliery in 1993, a then-new coal mine that would interpedently fuel the Majuba plant (Yelland, 2020: np). As a result, a rail link was constructed in 1996 to transport coal to Majbua from Palmford along the Natal Corridor with a capacity of 8Mtpa, which at the time was more than sufficient for meeting the plant's 2.2Mtpa capacity. However, Majuba's production skyrocket by almost 700% (from 2.2Mtpa to its current 14Mtpa) in 2001, at which point the existing rail link was no longer able to meet Majuba's coal supply needs, and a fleet of hundreds of trucks began transporting coal to Majuba by road on a daily basis. Given the economic and environmental costs of relying on road transit for coal transport (particularly for a country like South Africa that is already liquid fuel-deficient, see 1.3.2.1), Eskom announced plans to build a new 68km railway to directly connect the Ermelo coal field to Majuba, by extending the existing Transnet heavy export railway that ran from Mpumalanga through to Richards Bay (Yelland, 2020).

Financing for this expansion was provided *by the World Bank in 2008*, in the same loan issued to fund Medupi; of the $3.75 billion committed by the bank, $416 million (R6 billion) were to be allocated for the Majuba Railway expansion project, although by 2021 the projects costs were estimated at some R8 billion, suggesting that additional funding will be required to complete the railway (which, according to Eskom, is now 87% completed). Note that since project falls under the same loan as that granted for Medupi, the financing conditions – including the exorbitant 11% effective interest rate Eskom is bound to – discussed earlier (see Figure 5.7) apply.

The Majuba railway expansion was financed under the premise that it would contribute to South Africa's environmental sustainability as a "low Carbon Energy Efficiency Investment" (World Bank, 2020) by significantly reducing its truck fleet emissions.[179] However, there is a flaw in this rationale given the general state of South Africa's railway system and the broader electrical grid. According to the South African International Trade Administration (Eskom, 2021), 80% of the South African railway is electrified, and since 87% of South Africa's electricity is produced through coal combustion (see 1.3.2.1), we can conclude that the rail system is indirectly (and largely) fuelled by coal-fired electricity, implying that the World Bank's 'low carbon investment' is in reality replacing liquid fuel with coal combustion and is exacerbating South Africa's dependency on coal. Moreover, the remaining 20% of the rail system uses diesel as fuel, which is supplied from one of two sources: 1) imported and refined crude oil from one of five national oil refineries; or 2) Sasol's Secunda plant, which employs the environmentally disastrous CTL Fischer-Tropsch process to convert coal to liquid fuels. Altogether, the World Bank pledge to finance 'low-carbon energy efficient' infrastructure in South Africa through both Medupi and the Majuba railway expansion have indisputably exacerbated the nation's dependence on fossil fuels, and further locked in its existing coal- and oil-based infrastructure.

[179] Due to an incident in late 2019 resulting in Majuba's conveyor catching fire, all coal deliveries to Majuba have been made by truck for the last 2 years.

Engen Refinery

The Engen Refinery is located near SAPREF (see 5.2.2) in Durban and marks South Africa's fourth and final crude oil refinery. It was commissioned in 1954 and has a throughput of 135,000bbl/d (27% of total South African capacity), making it the second largest only behind SAPREF. Roughly half of the refinery's crude oil is imported from West Africa (likely Angola and Nigeria), and the other half from the Persian Gulf (like Saudi Arabia, Iran and Qatar). Engen, the refinery's owner and operator, is a South African subsidiary owned by majority shareholder Petronas (74%), the Malaysian multinational oil and gas conglomerate, and minority shareholder Phembani (21%), a local BBEE organisation, among others. According to Engen, the refinery's scopes 1 and 2 annual emissions combined to 8.5MtCO_2e in 2020, compared to 10.5 MtCO_2e in 2019 (Engen, 2020), which is astounding given that these emissions metrics exclude indirect scope 3 emissions from consuming the refined petroleum products themselves, which would drastically increase overall emissions from the refinery.

Major shareholders Petronas announced in May 2021 that *the refinery will be shut down and converted into an import and storage terminal for petroleum products (Euro 5 fuels) by the end of 2023* (Makhaye, 2021). The refinery has allegedly "raked billions for its owners" in the last 67 years (ibid: np), but Petronas claimed that the more stringent "fuel quality and emissions regulations" (Creamer, 2021) would render the refinery economically unviable. Converting the refinery into the import and storage terminal will "involve significant capital investments" (ibid), and according to Petronas, will have the "added benefit of allowing Engen to reduce its emissions and carbon footprint" and "strengthen[ing] South Africa's long-term fuel supply security and lower road transport emissions" (Jasi, 2021). This of course completely neglects the fact that the repurposed facility will serve as a major import hub for *diesel fuel and other petroleum products*, which will further deepen South Africa's dependency on fossil fuel – particularly for the transport sector; this is completely misaligned with South Africa's NDC's (see 5.2.2.6) plans to completely electrify South Africa's transport and automotive sector by 2050. Moreover, these alleged 'emissions reductions' are laughably misleading; although the direct scopes 1 and 2 emissions from the refinery would be forgone, new & indirect emission from importing liquid fossil fuel would be introduced and displaced to the transport sector.

NATREF

The National Petroleum Refinery of South Africa (NATREF) is South Africa's only inland crude oil refining facility, located in Sasolbourg in the Free State. Owned jointly by Sasol (63.6% operating interest) and Total SA (36.4% interest), NATREF has a production capacity of 108,500bbl/d, accounting for 22% of South African crude oil refining capacity; it was commissioned in 1971 and employs 650 direct, permanent personnel in addition to 600 contractors. Notably, NATREF receives all of its input crude oil from the SBM in Durban via a 600km pipeline (Energy & Mining, nd), which is owned and operated by Shell & BP through SAPREF (see 5.2.2.4). Sasol claims that NATREF's annual emissions were approximately 1.2MtCO_2e in 2019 (Sasol, 2019), but this excludes any indirect scope 3 emissions from the products that it refines.

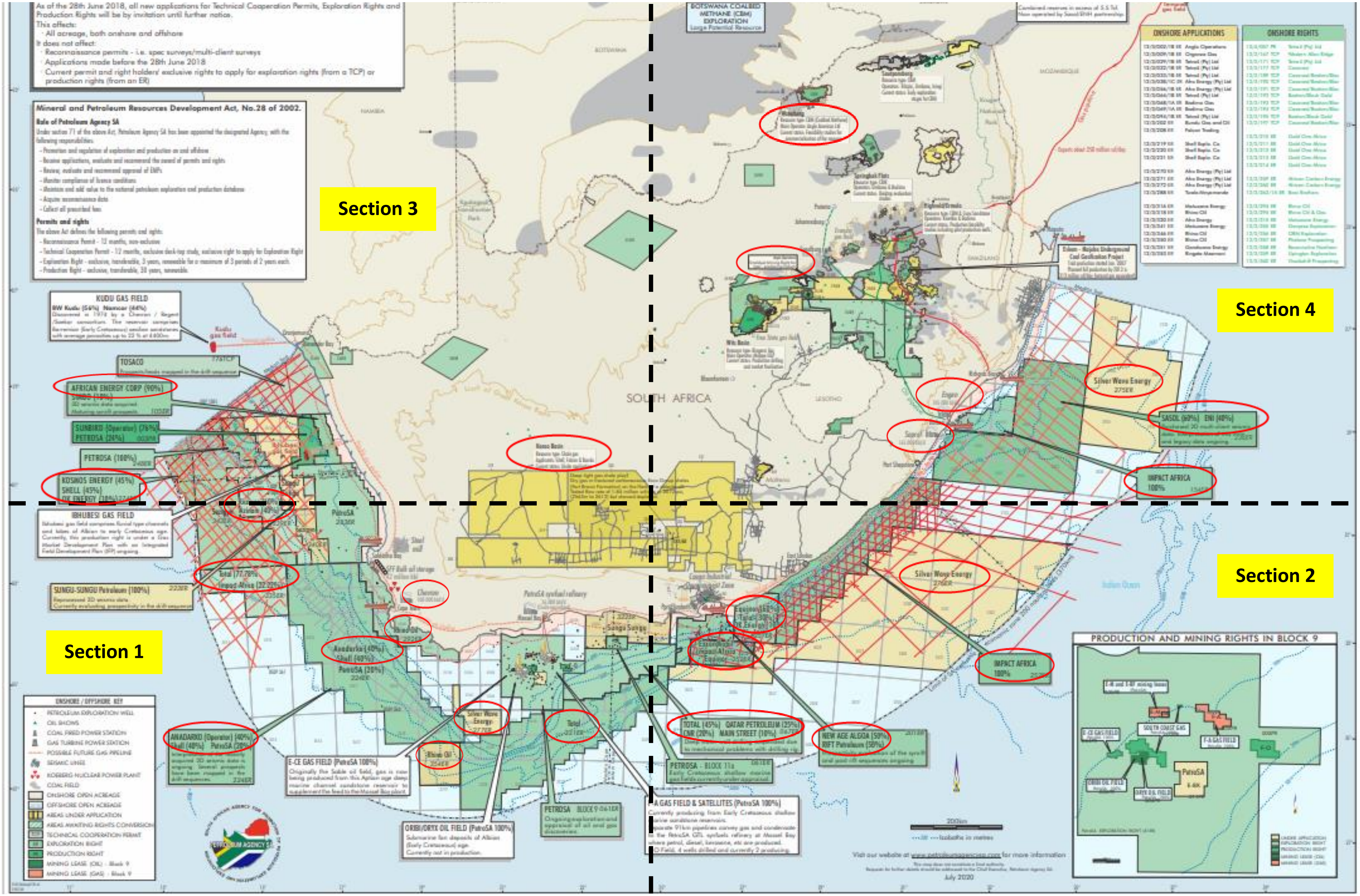
According to Sasol's 2019 balance sheet (Sasol, 2019), all NATREF-related equities and liabilities sum to R3.841 billion, or roughly $260 million. Given their 63.6% stake, this suggests that NATREF assets altogether may be valued at $409 million, with Total SA's share therefore sitting at $149 million. This could be understood as the prospective stranded assets that each respective shareholder could incur in the event that NATREF is prematurely decommissioned.

Offshore Exploration Blocks

Figure C3 displays the various onshore and offshore oil & gas E&P blocks for which the South African government has issued exploration and production permits and rights to both domestic and international firms. Note that the map was produced circa 2018 and few of the details are yet to be updated; for instance, Anadarko was acquired by Occidental Petroleum (US-based E&P), which subsequently sold its South African assets to Total SA in 2020.

I have circled the non-South African, multinational operators of South Africa's oil and gas assets to stress that South African oil and gas exploration and production is largely driven by the sampled European and North American E&Ps.

Figure C3. National map illustrating South Africa's offshore exploration and production blocks – also including onshore operations, including coal based methane (CBM) sites and gas pipelines.



Source: PetroSA (2018)

N.B. due to the map's high level of intricacy, it has been partitioned into four sections that are magnified separately in the following pages to convey its detail. Moreover, the international companies from ***Error! Reference source not found.*** *are circled in red, to denote the (non-African) multinational presence in South African oil and gas exploration*

Figure C3 continued

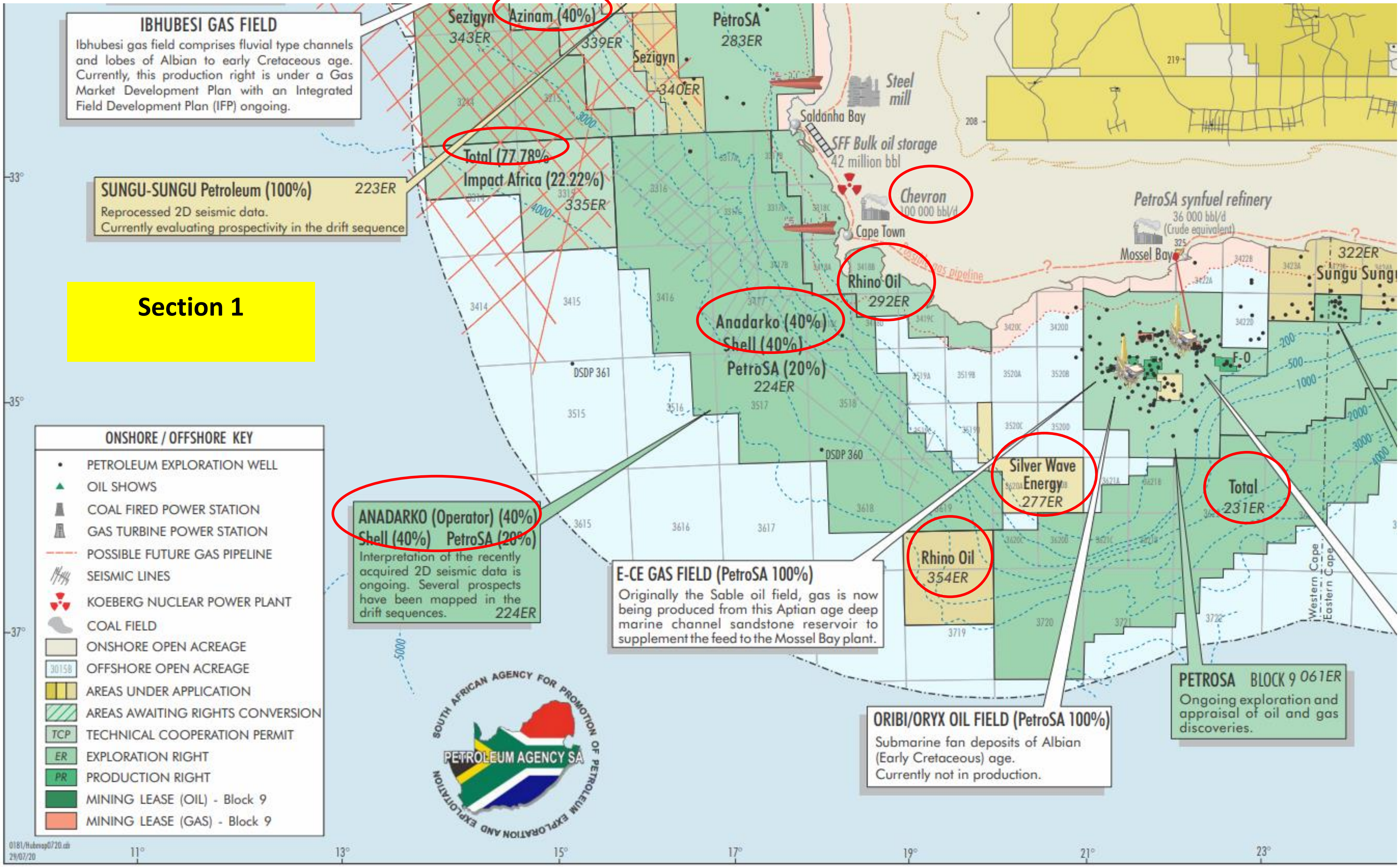


Figure C3 continued

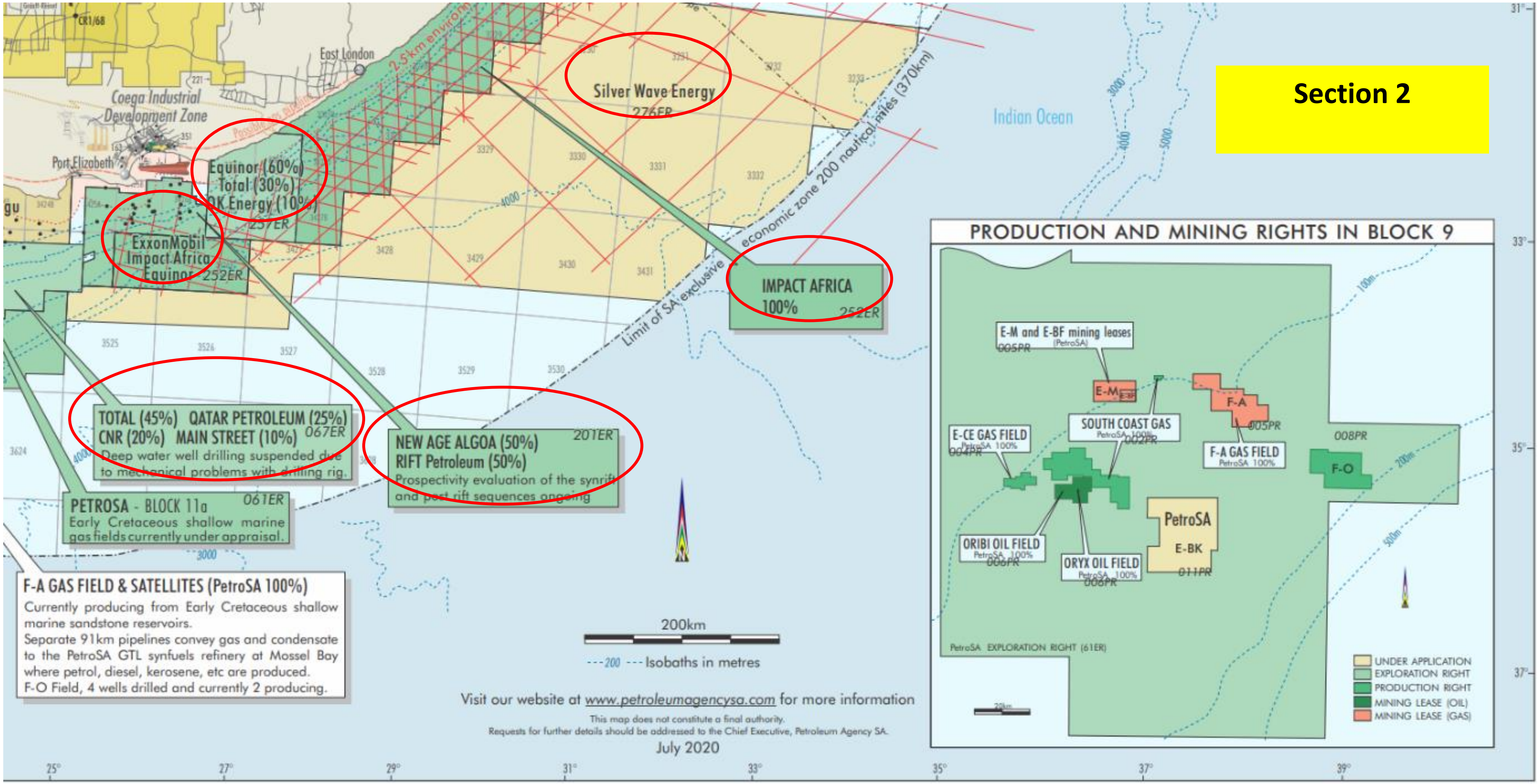


Figure C3 continued

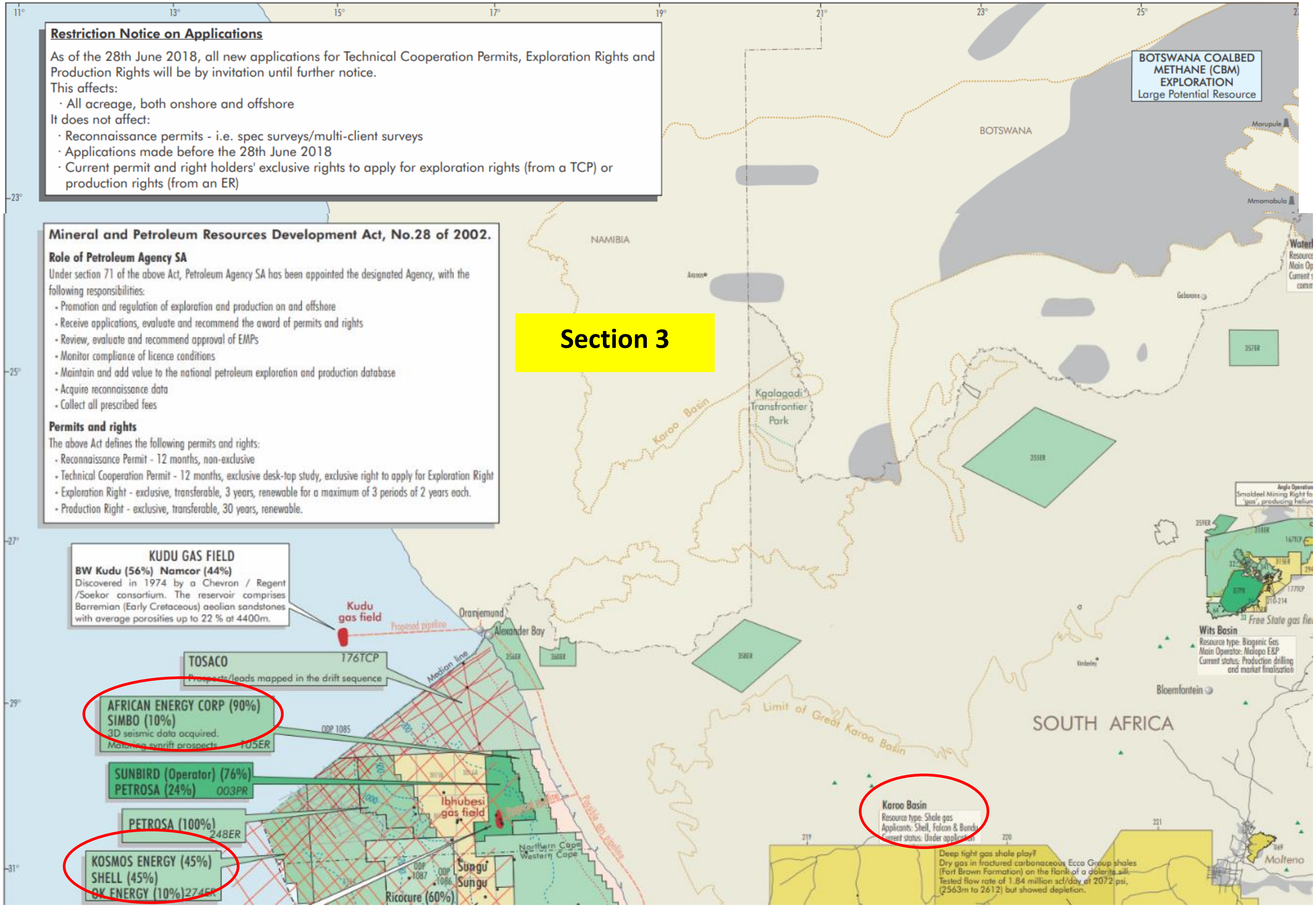
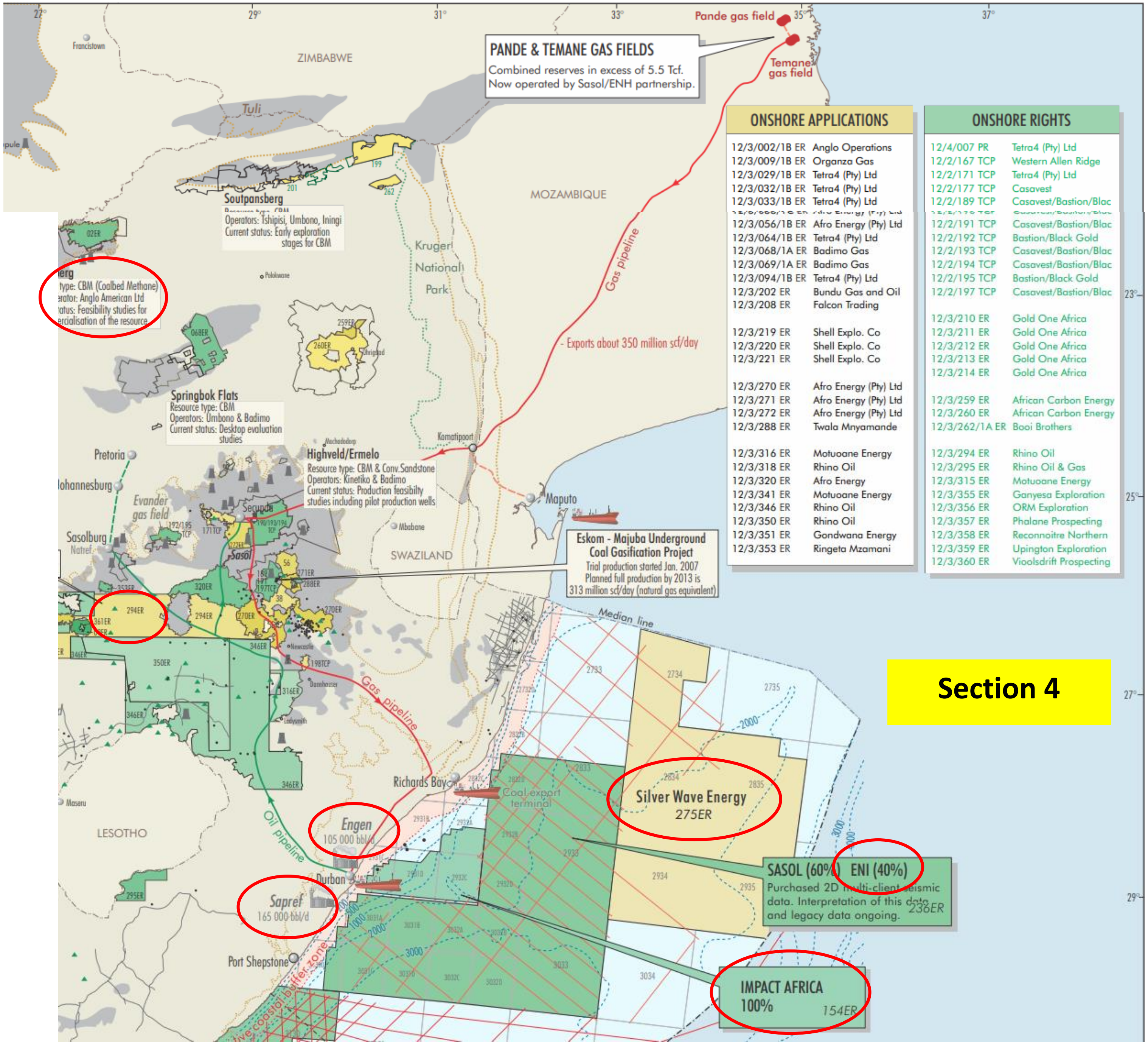


Figure C3 continued



Prospective Natural Fossil Fuel Assets

Production Metrics

Oil production is depicted in Figure 5.8 (middle column, middle row, in section 5.3.2); altogether the continent produced a reported 3.3Gbbl of crude oil and petroleum products in 2019, equating to 8.3% of global production (~39Gbbl). Overall, at least 18 African countries produced at least 10Mbbl of oil in 2019. African natural gas production in 2019 was more concentrated than oil production – see Figure 5.8 (middle row, right column). Total continent-wide production stood at roughly 9.2Tcf, or 6.3% of global natural gas production (~145Tcf). African coal production in 2019 was even more concentrated, mirroring the continent's asymmetric reserve distribution – see Figure 5.8 (middle row, left column). Overall continent production stood at roughly 300Mt, equivalent to 3.5% of global production (~8.1GT). South Africa alone accounted for 89% of total African production (~254Mt); other nations with relatively high coal reserves contributed meagre amounts comparatively, like Mozambique (~6Mt), Zimbabwe (~2Mt) and Botswana (~1Mt).

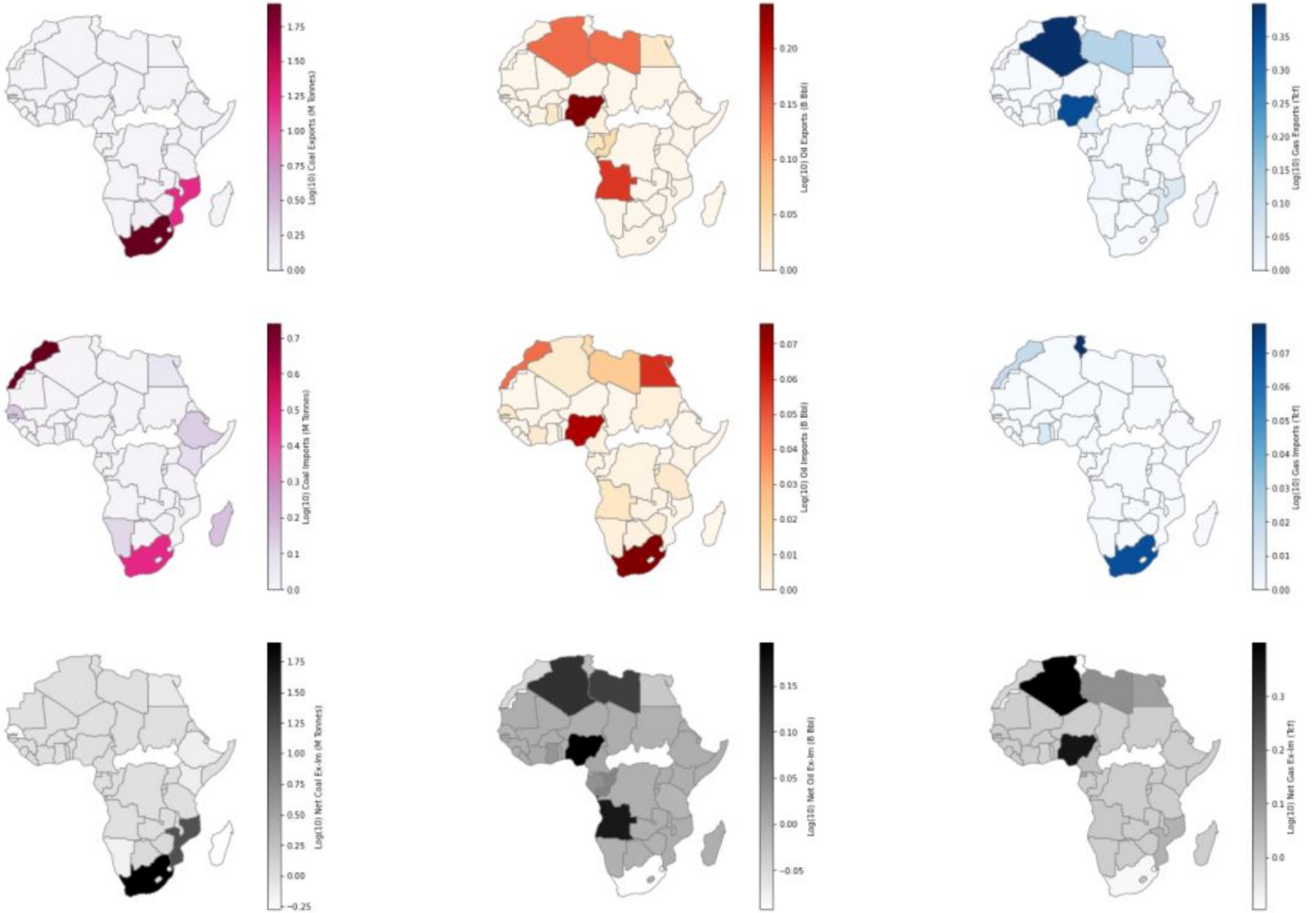
Fossil fuel consumption across Africa paints a different image. 2019 African crude oil and petroleum product consumption aggregated to roughly 1.8Gbbl, equivalent to 5% of global consumption (~36Gbbl). At least 31 countries[180] reportedly consumed oil & petroleum products, six of which consumed over 100Mbbl: Egypt (~272Mbbl), South Africa (~250Mbbl), Morocco (~208Mbbl), Nigeria (~172Mbbl) and Algeria (~166Mbbl). Oil consumption was far less than overall 2019 oil production (~3.3Gbbl), implying that ***Africa was a net oil producer* – *producing 1.5Gbbl (or 80%) more than it consumed***. Similarly, total natural gas consumption aggregated to 5.6Tcf, equivalent to 4% of total global consumption (~139Tcf). Average gas consumption sat at roughly 0.2Tcf, revealing that like in the case of oil, ***African gas production shadowed its overall consumption by roughly 3.6Tcf (or 65%), meaning that it was also an overall net producer of natural gas***.

Overall 2019 African coal consumption was roughly 160Mt, equivalent to 3% of global coal consumption (~5.4GT) –see Figure 5.8. South African coal consumption (~130Mt) alone accounted for 81% of African and 2.4% of global consumption. Since African coal production outweighed its consumption by ~130Mt (80%), ***Africa was also a net coal producer in 2019, with South Africa accounting for 124Mt (95%) of its net production***.

Figure C4 runs in parallel to Figure 5.8 and presents an overview of Africa's chief coal (left column), oil (middle column) and gas (right column) exporters (top row), importers (middle row) and net-exporters (exports – imports) (bottom row) in 2019. Note that these mapped values are very likely underestimates given the limitations in data availability (particularly for natural gas imports and oil exports – see 3.7), but nonetheless merit analysis. South Africa expectedly dominates African coal exports by exporting 81Mt of coal in 2019, equivalent to 88% of African coal exports in 2019 and roughly 32% of its 2019 coal production, the latter implying that 68% of South African produced coal is either consumed or stockpiled. Total African coal exports summed to 93.4Mt, representing roughly 7.8% of global coal exports (1.2Gt). Coal imports tell a slightly different tale, with Morocco importing 4.5Mt of coal in 2019 – accounting for 48% of continent-wide imports in 2019 (9.4Mt, or only 0.8% of global coal imports). South Africa also imported almost 2Mt of coal, mostly from Botswana, Mozambique and Zimbabwe as cheap fuel for its coal-fired power stations in Limpopo and Mpumalanga provinces (see 5.2.2.2). Altogether, South Africa (and to a lesser extent, Botswana) are blatant net coal exporters.

[180] Data was unavailable for some countries

Figure C4. Matrix of maps showing coal (left column), oil (middle column) and natural gas (right column) 2019 exports (top row), imports (middle row) and net exports (exports-imports) (bottom row), measured in: coal (GT); oil (Gbbl); gas (Tcf). Note that the colour scales are logarithmic to better illustrate discrepancies between nations. Source: Author



Africa's oil exports paint a much different picture; in 2019 they sat at roughly 2.8Gbbl, accounting for almost 11% of total global oil exports[181] (25.9Gbbl). As shown in the top-middle map in Figure C4, the continent's top oil exporters included Nigeria (740Mbbl), Angola (501Mbbl), Algeria (398Mbbl), Libya (385Mbbl) and the Republic of the Congo (115Mbbl), who jointly exported over 2.1Gbbl and account for over 77% of 2019 African oil exports. Oil imports differed slightly, with South Africa once again leading the way (191Mbbl) followed by Nigeria (168Mbbl), Egypt (140Mbbl), Morocco (110Mbbl) and Libya (53Mbbl), jointly accounting for 70% of Africa's 2019 oil imports, which sat at 950Mbbl (or 3.7% of global oil imports). Both South Africa and Morocco spearhead (net) oil consumption in 2019 without having produced any crude oil or petroleum products.

Africa's natural gas exports and imports run parallel to the oil narrative. Continent-wide 2019 gas exports totalled roughly 3.8Tcf, representing 8.2% of global exports (46.7Tcf), with Algeria, Nigeria, Libya and Egypt identified as Africa's top natural (net) natural gas producers. Similar to the oil narrative, Tunisia, South Africa and Morocco were also Africa's top 3 net gas consumers in 2019, indicating that their lack of domestic reserves and production are overcome by imports to satisfy national demand.

Table C1. Summarised table depicting top 5 African oil/gas/coal producers, consumers, net-producers and net-consumers.

		Oil			Gas			Coal	
	Top 5	**Mbbl**	**%Africa**	**Top 5**	**Tcf**	**%Africa**	**Top 5**	**Mt**	**%Africa**
Production	Nigeria	801.9	24.6%	Algeria	3.18	34.6%	South Africa	254.00	88.3%
	Algeria	632.5	19.4%	Egypt	2.45	26.6%	Mozambique	6.82	2.4%
	Angola	531.8	16.3%	Nigeria	1.74	18.9%	Zimbabwe	2.30	0.8%
	Libya	457.7	14.0%	Libya	0.50	5.5%	Botswana	1.11	0.4%
	Egypt	269.7	8.3%	Angola	0.37	4.1%	Zambia	0.69	0.2%
	Total	2693.6	82.5%	Total	8.25	89.7%	Total	264.92	92.1%
Consumption	Egypt	271.2	14.9%	Egypt	2.22	39.8%	South Africa	130.03	81.4%
	South Africa	249.7	13.7%	Algeria	1.66	29.9%	Morocco	9.56	6.0%
	Morocco	207.7	11.4%	Nigeria	0.45	8.1%	Egypt	2.73	1.7%
	Nigeria	171.6	9.4%	Tunisia	0.19	3.5%	Senegal	2.68	1.7%
	Algeria	165.7	9.1%	Libya	0.18	3.2%	Zimbabwe	1.87	1.2%
	Total	1065.8	58.6%	Total	4.70	84.4%	Total	146.87	91.9%
Net Producers	Nigeria	630.4		Algeria	1.52		South Africa	124.00	
	Angola	487.3		Nigeria	1.29		Mozambique	7.00	
	Algeria	466.8	-	Angola	0.35	-	Zambia	1.00	-
	Libya	379.6		Libya	0.33		Zimbabwe	<0.01	
	Congo	123.0		Egypt	0.23		Niger	<0.01	
	Total	2087.07	-	Total	3.71	-	Total	132.00	-
Net Consumers	South Africa	249.1		Tunisia	0.19		Morocco	10.00	
	Morocco	207.7		South Africa	0.11		Egypt	3.00	
	Kenya	31.2	-	Morocco	0.03	-	Senegal	3.00	-
	Tunisia	20.1		Gabon	0.01		Algeria	1.00	
	Tanzania	14.7		Congo	<0.01		Mauritius	<0.01	
	Total	522.712	-	Total	0.34	-	Total	17.00	-

[181] This includes exported crude oil and refined petroleum products

Source: Author, using data from reference list in Appendix B

Table C2. Breakdown of Africa's top 5 oil, gas and coal exporters, importers and subsequently the top 5 net-exporters and net-importers for each fuel type in 2019.

		Oil			Gas			Coal	
	Top 5	**Mbbl**	**%Africa**	**Top 5**	**Tcf**	**%Africa**	**Top 5**	**Mt**	**%Africa**
Exports	Nigeria	740.2	26.7%	Algeria	1.51	39.6%	South Africa	81.00	86.7%
	Angola	500.8	18.1%	Nigeria	1.28	33.5%	Mozambique	12.00	12.8%
	Algeria	397.9	14.4%	Libya	0.32	8.5%	Zimbabwe	0.14	0.2%
	Libya	385.4	13.9%	Egypt	0.24	6.2%	Botswana	0.14	0.1%
	Rep. Congo	115.0	4.2%	Eq.Guinea	0.17	4.4%	Eswatini	0.12	0.1%
	Total	***2139.3***	***77.3%***	***Total***	***3.51***	***92.1%***	***Total***	***93.40***	***100.0%***
Imports	South Africa	190.8	20.2%	Tunisia	0.20	41.5%	Morocco	4.51	47.9%
	Nigeria	167.8	17.7%	South Africa	0.17	36.3%	South Africa	1.96	20.8%
	Egypt	140.4	14.8%	Morocco	0.05	9.6%	Mauritius	0.71	7.5%
	Morocco	109.5	11.6%	Ghana	0.03	5.3%	Madagascar	0.47	4.9%
	Libya	52.6	5.6%	Egypt	0.01	1.1%	Senegal	0.43	4.6%
	Total	***661.1***	***69.8%***	***Total***	***0.45***	***93.7%***	***Total***	***8.08***	***85.8%***
Net Exports	Nigeria	572.5		Algeria	1.51		South Africa	79.04	
	Angola	477.1		Nigeria	1.28		Mozambique	12.00	
	Algeria	380.9	-	Libya	0.32	-	Botswana	0.13	-
	Libya	332.8		Egypt	0.23		Zimbabwe	0.12	
	Rep. Congo	115.0		Eq. Guinea	0.17		Zambia	0.00	
	Total	***1878.3***		***Total***	***3.51***		***Total***	***91.28***	
Net Imports	South Africa	190.8		Tunisia	0.20		Morocco	4.51	
	Morocco	109.5		South Africa	0.17		Mauritius	0.71	
	Egypt	68.5	-	Morocco	0.05	-	Madagascar	0.47	-
	Tunisia	36.1		Ghana	0.03		Senegal	0.43	
	Senegal	18.8		Togo	<0.01		Ethiopia	0.38	
	Total	***423.8***		***Total***	***0.45***		***Total***	***6.50***	

Source: Author, using data from reference list in Appendix B and methods in section 3.5.3

Table C3 below shows that E&P oil and gas production in Nigeria (315-415Mbbl; 1.3-1.7Tcf), Angola (~225Mbbl; 0.3-0.5Tcf), Libya (178-185Mbbl; 0.4-0.45Tcf) and Egypt (85-170Mbbl; 0.82-1.6Tcf) topped the charts. E&P gas production in Algeria (the fifth chief African oil and gas producer) is also high (0.36-0.72Tcf), although reported E&P oil production in Algeria was low (35-71Mbbl) comparatively, indicating that either insufficient data was disclosed by the E&Ps, or that Algerian oil production is predominantly driven by other firms/entities – likely Sonatrach, the nationally run SOE.

Table C3. Top 5 oil, gas and coal producers juxtaposed with production data by the E&Ps, depicting the (estimated) fraction of total national oil, gas and coal production that the E&Ps are responsible for.

Oil

Top 5	Total Mbbl	E&P Lower Mbbl	E&P Upper Mbbl	%Total, low	%Total, up
Nigeria	801.9	315.2	413.7	39.3%	51.6%
Algeria	632.5	35.4	70.7	5.6%	11.2%
Angola	531.8	227.8	227.8	42.8%	42.8%
Libya	457.7	177.8	184.6	38.8%	40.3%
Egypt	269.7	84.8	169.5	31.4%	62.8%
Total	***2,693.6***	***840.9***	***1,066.3***	***31.2%***	***39.6%***

Gas

Top 5	Total Tcf	E&P Lower Tcf	E&P Upper Tcf	%Total, low	%Total, up
Algeria	3.18	0.4	0.7	11.3%	22.6%
Egypt	2.45	0.8	1.6	33.4%	66.9%
Nigeria	1.74	1.3	1.7	76.0%	95.7%
Libya	0.50	0.4	0.5	79.9%	89.5%
Angola	0.37	0.3	0.5	74.8%	142.0%
Total	***8.25***	***3.2***	***5.0***	***38.6%***	***60.7%***

Coal

Top 5	Total Mt	E&P Lower Mt	E&P Upper Mt	%Total, low	%Total, up
South Africa	254.00	160.1	190.3	63.0%	74.9%
Mozambique	6.82	3.1	20.4	45.5%	299.2%
Zimbabwe	2.30	0.0	0.0	0.0%	0.0%
Botswana	1.11	0.0	0.0	0.0%	0.0%
Zambia	0.69	0.0	0.0	0.0%	0.0%
Total	***264.92***	***163.2***	***210.7***	***61.6%***	***79.5%***

Table C4. List of PFIs that have increased their gross African fossil fuel financing in 2016-2019 compared to 2007-2015.

			Gross Fossil Fuel Financing (M USD)		
Institution	**Country**	**Type**	**Before Paris (2007-2015)**	**After Paris (2016-2019)**	**%Increase**
China Development Bank	China	Bilateral	$6,320.00	$12,183.33	92.77%
Islamic Development Bank	Regional	Multilateral	$2,658.57	$3,824.19	43.84%
Export-Import Bank of China	China	Export Credit	$2,523.18	$2,550.00	1.06%
Servizi Assicurativi del Commercio Estero	Italy	Export Credit	$640.38	$2,539.95	296.63%
Industrial and Commercial Bank of China	China	Bilateral	$573.75	$2,115.00	268.63%
China Export and Credit Insurance Corporation	China	Export Credit	$1,149.00	$1,550.00	34.90%
Export-Import Bank of Korea	Korea	Export Credit	$1,207.93	$1,375.00	13.83%
Japan Oil Gas and Metals National Corporation	Japan	Bilateral	$124.83	$1,151.40	822.40%
Bank of China	China	Bilateral	$816.25	$863.79	5.82%
Korea Trade Insurance Corporation	Korea	Export Credit	$620.00	$800.00	29.03%
Cassa depositi e prestiti	Italy	Bilateral	$0.00	$515.13	N/A
CDC Group Plc	United Kingdom	Export Credit	$76.40	$416.48	445.13%
UK Export Finance	United Kingdom	Export Credit	$32.72	$401.05	1125.78%
Export Credit Insurance Corporation	South Africa	Bilateral	$213.19	$400.00	87.63%
Korea Development Bank	Korea	Bilateral	$111.90	$361.54	223.09%
Export Development Canada	Canada	Export Credit	$101.61	$228.38	124.77%
KfW IPEX-Bank	Germany	Bilateral	$60.00	$151.71	152.85%

Table C5. List of PFIs that have increased their annual African fossil fuel financing in 2016-2019 compared to 2007-2015. Source: Author, using data from OCI (2020)

			Average Annual Fossil Fuel Financing (M USD)		
Institution	**Country**	**Type**	**Before Paris (2007-2015)**	**After Paris (2016-2019)**	**Before Paris (2007-2015)**
China Development Bank	China	Bilateral	$702.22	$3,045.83	333.74%
Islamic Development Bank	Regional	Multilateral	$295.40	$956.05	223.65%
Euler Hermes	Germany	Export Credit	$311.52	$644.77	106.97%
Export-Import Bank of China	China	Export Credit	$280.35	$637.50	127.39%
Servizi Assicurativi del Commercio Estero	Italy	Export Credit	$71.15	$634.99	792.42%
Industrial and Commercial Bank of China	China	Bilateral	$63.75	$528.75	729.41%
China Export and Credit Insurance Corporation	China	Export Credit	$127.67	$387.50	203.52%
Export-Import Bank of Korea	Korea	Export Credit	$134.21	$343.75	156.12%
International Finance Corporation	Regional	Multilateral	$337.16	$343.29	1.82%
Saudi Fund for Development	Saudi Arabia	Bilateral	$261.23	$332.27	27.19%
Japan Oil Gas and Metals National Corporation	Japan	Bilateral	$13.87	$287.85	1975.39%
Multilateral Investment Guarantee Agency	Regional	Multilateral	$242.29	$274.75	13.40%
Nippon Export and Investment Insurance	Japan	Export Credit	$127.93	$250.28	95.64%
Overseas Private Investment Corporation	United States	Bilateral	$116.91	$226.59	93.80%
Bank of China	China	Bilateral	$90.69	$215.95	138.10%
Korea Trade Insurance Corporation	Korea	Export Credit	$68.89	$200.00	190.32%
European Bank for Reconstruction and Development	Regional	Multilateral	$108.96	$151.85	39.36%
Cassa depositi e prestiti	Italy	Bilateral	$0.00	$128.78	999999.00%
CDC Group Plc	United Kingdom	Export Credit	$8.49	$104.12	1126.54%
UK Export Finance	United Kingdom	Export Credit	$3.64	$100.26	2658.01%
Export Credit Insurance Corporation	South Africa	Bilateral	$23.69	$100.00	322.16%

Source: See Table C4.

Table C6. Commercial bank annual lending (in M USD) data to the E&Ps

	Lending (in Millions)					
Bank	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
BNP Paribas	$4,469.42	$2,003.82	$928.25	$9,638.29	$23,760.77	$40,800.56
JPMorgan Chase	$7,341.77	$2,778.90	$3,810.24	$6,548.46	$15,367.57	$35,846.94
Citi	$7,859.05	$2,370.37	$3,172.46	$6,501.65	$15,706.41	$35,609.94
Bank of America	$6,469.19	$2,248.05	$2,757.40	$5,284.70	$17,208.41	$33,967.74
Barclays	$9,430.17	$2,644.25	$1,985.40	$5,678.93	$12,830.31	$32,569.06
Morgan Stanley	$7,293.09	$2,497.24	$3,084.20	$5,415.27	$8,782.00	$27,071.80
HSBC	$3,343.10	$677.98	$1,904.49	$2,560.93	$11,258.44	$19,744.94
TD	$167.03	$7,759.52	$2,752.63	$3,123.09	$397.67	$14,199.94
Société Générale	$2,661.93	$884.03	$1,843.89	$2,695.48	$5,364.26	$13,449.59
Goldman Sachs	$3,569.25	$764.34	$1,279.22	$3,182.95	$4,508.89	$13,304.66
Crédit Agricole	$2,019.27	$585.81	$1,226.68	$2,369.91	$6,487.83	$12,689.50
RBC	$2,034.82	$2,506.04	$3,165.77	$3,129.42	$942.86	$11,778.91
Deutsche Bank	$4,612.28	$1,095.14	$272.96	$1,114.58	$3,747.24	$10,842.20
Santander	$714.70	$1,261.18	$545.52	$1,495.67	$6,734.95	$10,752.02
MUFG	$1,154.78	$2,270.50	$1,775.24	$1,677.26	$3,546.04	$10,423.83
Mizuho	$1,916.92	$927.64	$1,922.65	$2,325.32	$1,536.64	$8,629.17
UBS	$1,070.75	$2,204.45	$2,162.73	$1,458.29	$261.31	$7,157.54
SMBC Group	$1,352.55	$744.65	$871.78	$1,718.13	$1,622.26	$6,309.37
Sberbank	$185.43	$4,712.34	$364.81	$89.83	$0.00	$5,352.41
Credit Suisse	$1,792.75	$831.96	$925.67	$1,259.78	$443.01	$5,253.17
Scotiabank	$167.03	$1,515.81	$1,339.81	$1,386.36	$297.80	$4,706.80
UniCredit	$1,025.62	$330.11	$830.50	$376.03	$2,135.03	$4,697.30
Wells Fargo	$650.53	$766.67	$310.71	$495.69	$1,194.85	$3,418.44
Standard Chartered	$40.56	$247.77	$142.04	$664.06	$1,713.87	$2,808.30
NatWest	$327.74	$640.17	$562.76	$364.44	$860.60	$2,755.71
Lloyds	$521.01	$445.53	$526.56	$686.16	$564.23	$2,743.48
Intesa Sanpaolo	$979.74	$785.82	$500.00	$137.28	$185.58	$2,588.42
Commerzbank	$40.56	$415.86	$545.52	$669.37	$677.96	$2,349.27
CIBC	$40.56	$804.21	$131.78	$1,212.97	$23.07	$2,212.59
ICBC	$299.43	$0.00	$145.00	$654.35	$870.75	$1,969.53
BPCE/Natixis	$113.33	$273.24	$206.54	$445.51	$905.16	$1,943.79
ING	$303.61	$292.43	$302.66	$896.07	$122.39	$1,917.16
ANZ	$0.00	$213.79	$90.47	$848.35	$717.95	$1,870.56

BBVA	$372.18	$101.42	$80.50	$468.93	$784.24	$1,807.27
Bank of Montreal	$421.46	$55.47	$80.50	$413.73	$397.67	$1,368.83
Bank of China	$0.00	$0.00	$159.38	$570.99	$181.55	$911.91
Westpac	$66.67	$266.67	$24.35	$458.80	$3.89	$820.38
Bank of Communications	$299.43	$0.00	$0.00	$136.36	$66.67	$502.46
NAB	$65.31	$46.94	$66.12	$195.52	$126.29	$500.19
Commonwealth Bank	$107.22	$46.94	$66.12	$113.73	$122.39	$456.41
Nordea	$134.51	$76.56	$0.00	$0.00	$133.96	$345.03
Danske Bank	$0.00	$76.56	$74.71	$0.00	$133.96	$285.23
Agricultural Bank of China	$0.00	$0.00	$0.00	$136.36	$66.67	$203.03
Rabobank	$40.56	$46.94	$0.00	$0.00	$0.00	$87.50
China Construction Bank	$0.00	$0.00	$0.00	$81.79	$3.89	$85.69
DZ Bank	$0.00	$75.00	$0.00	$0.00	$0.00	$75.00
Industrial Bank	$0.00	$0.00	$0.00	$0.00	$66.67	$66.67
Shanghai Pudong Development Bank	$0.00	$0.00	$0.00	$0.00	$66.67	$66.67
China Minsheng Bank	$0.00	$0.00	$0.00	$0.00	$66.67	$66.67
Truist	$32.34	$0.00	$0.00	$0.00	$0.00	$32.34
Total	***$75,507.67***	***$49,292.13***	***$42,938.02***	***$78,680.82***	***$152,997.28***	***$399,415.91***
Mean	$1,258.46	$821.54	$715.63	$1,311.35	$2,549.95	$6,656.93
Median	$167.03	$269.95	$152.19	$463.86	$279.55	$1,956.66
St. Dev.	$2,256.21	$1,342.50	$1,018.19	$2,018.27	$5,050.53	$10,445.60
Max	$9,430.17	$7,759.52	$3,810.24	$9,638.29	$23,760.77	$40,800.56

Source: Retrieved from the Banking on Climate Chaos Database:

Rainforest Action Network; BankTrack; Indigenous Environmental Network; Sierra Club; Oil Change International. (2021). *Banking on Climate Chaos.* Rainforest Action Network. Retrieved May 13, 2021, from https://www.ran.org/bankingonclimatechaos2021/

Table C7. List of top shareholders pertaining to the E&Ps. Only shareholders managing at least $1 billion included here – full dataset available upon request.

Shareholder	Total Shares 2020 (M USD)
Vanguard Group	43021.96
Blackrock Inc.	42754.80
Norges Bank Investment Management*	30697.88
China State-Owned Assets Supervision & Admin Commission	27107.89
JSC ROSNEFTEGAZ	21262.92
State Street Corporation	20686.90
Capital Research & Management	17208.06
Aluminum Corporation of China	14325.08
AP Molller Holdings A/S	11139.62
BP Russian Investments Ltd	10393.34
QH Oil Investments LLC	9962.29
Anglo South Africa	7425.00
Government of Italy	7053.07
Fidelity Management & Research	6593.82
Aberdeen Asset Managers	5956.15
Litela Participações S.A.	5837.38
Elliott Investment Management LP	5787.63
Geode Capital Management	5347.35
Schroder Investment Management	3990.75
Government of Malaysia	3876.86
Legal & General Investment Management Ltd.	3770.27
Public Investment Corporation SA	3765.40
ABP Pension Group	3392.86
Bradespar SA	3298.36
Mitsui & Co. Ltd	3215.31
Fisher Investments	3138.17
Franklin Resources	3067.58
Caixa de Previdência dos Funcionários do Banco do Brasil	2954.29
Glencore PLC	2694.38
Qatar Holding LLC	2614.55
Ivan Glasenberg (Glencore CEO)	2594.59
Caisse de Depot et Placement du Quebec*	2514.98
Bank of New York Mellon Corp	2233.15
Vale SA	2117.83

Shareholder	Total Shares 2020 (M USD)
BNDES Participações SA	2117.83
Northern Trust Investments	2065.53
Silchester International Investors LLP	2062.28
Public Investment Fund	2002.43
PFZW	1925.47
Den A.P. Mollerske Stottefond	1918.67
DWS Investment GmbH	1875.83
Bank of America	1764.34
Berkshire Hathaway, Inc.	1720.30
Industrial Development Corporation of South Africa Ltd	1694.10
Genesis Investment Management LLP	1632.97
Charles Schwab Investment Management	1632.60
AP Moller Maersk A/S	1615.72
Harris Associates LP	1556.76
Clearstream Banking SA	1501.19
Meiji Yasuda Life Insurance	1488.20
JP Morgan	1482.92
Dimensional Fund Advisers	1478.02
Tokio Marine Holdings, Inc.	1409.69
Tarl Investment Holdings Ltd	1392.24
Columbia Threadneedle Investments	1372.40
Managed Account Advisers	1327.60
Nomura Asset Management Co., Ltd.	1296.13
Sumitomo Mitsui Asset Management Co., Ltd.	1281.22
Invesco Ltd.	1273.68
Coronation Asset Management (Pty) Ltd	1266.89
Epoch Two Investment Holdings Ltd	1239.77
Motsepe Family	1208.61
M&G Investment Management Ltd	1060.28
T Rowe Price Associates	1033.28
Wellington Management Co.	1001.11

Source: Author, using publicly shareholder information from Yahoo! Finance.

Table C8. Complete list of PFI financing (in millions) allocated to African fossil fuel projects

Country	Type	Fossil Fuel	Clean	Other	Total Energy
China	Bilateral	$267,619.69	$4,734.83	$38,313.19	$310,667.71
Japan	Export Credit	$132,376.44	$10,637.39	$4,112.77	$147,126.60
Regional	Multilateral	$131,775.69	$134,436.17	$196,331.53	$462,543.39
China	Export Credit	$66,321.15	$2,964.60	$34,801.33	$104,087.08
Korea	Export Credit	$60,526.69	$1,042.23	$5,919.40	$67,488.32
Russian Federation	Bilateral	$40,337.21	$1,654.01	$10,466.35	$52,457.57
United States	Export Credit	$37,150.25	$1,788.76	$2,633.60	$41,572.61
Canada	Export Credit	$27,592.47	$1,492.76	$5,377.43	$34,462.65
Japan	Bilateral	$27,163.39	$4,491.37	$7,118.95	$38,773.71
India	Bilateral	$24,791.09	$1,529.88	$4,011.72	$30,332.69
United Kingdom	Export Credit	$22,861.74	$10,590.79	$11,116.02	$44,568.55
Brazil	Bilateral	$14,016.11	$9,095.08	$14,351.20	$37,462.39
Germany	Bilateral	$12,585.15	$15,813.02	$2,101.94	$30,500.11
Saudi Arabia	Bilateral	$12,341.79	$740.66	$16,192.28	$29,274.74
Germany	Export Credit	$10,563.24	$3,309.40	$69.08	$13,941.72
Italy	Export Credit	$10,405.50	$560.18	$2,485.27	$13,450.95
Korea	Bilateral	$9,626.92	$1,424.04	$373.39	$11,424.35
France	Export Credit	$5,892.26	$2,523.56	$4,018.46	$12,434.28
United States	Bilateral	$5,342.33	$7,838.86	$11,397.02	$24,578.21
Argentina	Bilateral	$4,348.00	$230.00	$0.00	$4,578.00
Russian Federation	Export Credit	$4,237.44	$0.00	$510.22	$4,747.67
Australia	Export Credit	$4,216.81	$6.90	$16.19	$4,239.90
Netherlands	Export Credit	$3,603.40	$0.00	$0.00	$3,603.40
Canada	Bilateral	$3,576.25	$130.73	$6,617.44	$10,324.42
India	Export Credit	$3,039.11	$162.35	$2,349.45	$5,550.91
Turkey	Bilateral	$2,916.14	$65.00	$1,447.68	$4,428.82
Mexico	Bilateral	$2,778.78	$1,779.57	$125.94	$4,684.29
Indonesia	Bilateral	$2,491.63	$455.47	$2,599.19	$5,546.30
Italy	Bilateral	$2,086.16	$549.00	$1,374.08	$4,009.24
Netherlands	Bilateral	$1,842.85	$983.32	$486.69	$3,312.85
South Africa	Bilateral	$1,456.89	$1,306.19	$35.00	$2,798.08
Norway	Export Credit	$1,259.10	$0.00	$0.00	$1,259.10
Mexico	Export Credit	$1,081.69	$1,503.62	$0.00	$2,585.31
Czech Republic	Export Credit	$682.80	$0.00	$0.00	$682.80
Norway	Bilateral	$624.33	$73.60	$0.00	$697.93

Country	Type	Fossil Fuel	Clean	Other	Total Energy
France	Bilateral	$538.26	$4,893.95	$7,003.74	$12,435.95
Indonesia	Export Credit	$197.84	$0.00	$73.60	$271.44
Slovak Republic	Export Credit	$66.90	$0.00	$0.00	$66.90
China	Multilateral	$50.00	$74.70	$29.60	$154.30
Poland	Export Credit	$37.50	$0.00	$0.00	$37.50
Switzerland	Bilateral	$27.78	$0.00	$0.00	$27.78
Sweden	Bilateral	$27.22	$144.50	$69.63	$241.35
United Kingdom	Bilateral	$18.75	$3,332.66	$838.07	$4,189.48
Sweden	Export Credit	$17.70	$15.47	$755.35	$788.52
Austria	Export Credit	$13.60	$0.00	$0.00	$13.60
Australia	Bilateral	$13.45	$5,231.29	$445.93	$5,690.67
Greece	Bilateral	$13.33	$0.00	$0.00	$13.33
Denmark	Export Credit	$6.30	$0.00	$0.00	$6.30
Spain	Export Credit	$0.60	$0.00	$0.00	$0.60

Source: Retrieved from the Shifting the Subsidies Database:

OCI (Oil Change International). (2020). *Shifting the Subsidies Database.* Oil Change International. Retrieved March 18, 2021, from http://priceofoil.org/shift-the-subsidies/#:~:text=The%20Shift%20the%20Subsidies%20database,data%20from%202008%20to%202019.

Table C9. Top shareholders corresponding to the subset of E&Ps. Share values are in millions. Only shareholders with at least $1 billion included – complete dataset available upon request.

Shareholder	Country	2020	2021
Vanguard Group	United States	$28,171.62	$92,184.09
Blackrock Inc.	United States	$33,329.88	$79,456.52
Capital Research & Management	United States	$8,445.92	$62,684.03
Government of Norway	Norway	$33,479.90	$48,550.98
Norges Bank Investment Management*	Norway	$27,271.57	$35,760.68
State Street Corporation	United States	$12,045.30	$33,176.45
Aluminum Corporation of China	China	$14,325.08	$20,503.22
M&G Investment Management Ltd	England	$1,043.19	$18,472.23
Government of Italy	Italy	$7,053.07	$13,647.12
Aberdeen Asset Managers	Scotland	$5,588.34	$10,272.26
Fidelity Management & Research	United States	$5,775.58	$9,121.43
Geode Capital Management	United States	$3,324.65	$8,810.62
Elliott Investment Management LP	United States	$5,787.63	$8,636.51
Schroder Investment Management	England	$3,822.38	$8,274.27
Berkshire Hathaway, Inc.	United States	$1,720.30	$6,975.60
Northern Trust Investments	United States	$133.80	$5,812.94
Public Investment Corporation SA	South Africa	$3,765.40	$5,729.13
Qatar Holding LLC	Qatar	$2,614.55	$5,324.47
Ivan Glasenberg (Glencore CEO)	Switzerland	$2,594.59	$5,283.82
Total SA Employees Stock Ownership Plans	France	$0.00	$5,067.05
Fisher Investments	United States	$2,667.34	$4,770.20
Government of Malaysia	Malaysia	$3,876.86	$3,829.08
Sasol Khanyisa Employee Share Ownership Plan	South Africa	$0.00	$3,811.00
Qatar Investment Authority	Qatar	$0.00	$3,790.60
Northern Cross LLC	United States	$0.00	$3,720.87
T Rowe Price Associates	United States	$898.10	$3,101.89
Credit Suisse	France	$0.00	$3,054.87
Harris Associates LP	United States	$1,556.76	$2,897.97
Wellington Management Co.	United States	$921.13	$2,692.82
Dimensional Fund Advisers	United States	$1,066.10	$2,637.04
DWS Investment GmbH	Germany	$1,875.83	$2,611.43
Societe Generale Gestion	France	$0.00	$2,498.00
Folketrygdfondet	Norway	$1,748.95	$2,466.42
Amundi Asset Management SA	France	$0.00	$2,425.90

Shareholder	Country	2020	2021
Public Investment Fund	Saudi Arabia	$2,002.43	$2,297.77
State Farm Investment Management Corp	United States	$951.73	$2,209.94
Arrowstreet Capital LP	United States	$724.56	$2,204.59
Genesis Investment Management LLP	England	$1,632.97	$2,080.42
Dodge & Cox	United States	$730.48	$2,009.40
Daniel Francisco Mate Badanes	Switzerland	$972.26	$1,979.98
Aristotelis Mistakidis	Switzerland	$872.45	$1,962.56
UBS Securities LLC	Switzerland	$292.60	$1,856.03
Coronation Asset Management (Pty) Ltd	South Africa	$1,266.89	$1,831.66
RBC Global Asset Management	Canada	$744.30	$1,805.18
Baillie Gifford & Co.	Scotland	$0.00	$1,797.54
Meiji Yasuda Life Insurance	Japan	$1,488.20	$1,794.88
Tarl Investment Holdings Ltd	England	$1,392.24	$1,773.73
First Sentier Investors IM	Australia	$0.00	$1,672.68
Epoch Two Investment Holdings Ltd	England	$1,239.77	$1,579.48
Tokio Marine Holdings, Inc.	Japan	$1,409.69	$1,547.88
Canadian Pension Plan (CPP)	Canada	$588.28	$1,515.82
Computershare Limited	Australia	$833.99	$1,446.46
Nomura Asset Management Co., Ltd.	Japan	$1,201.48	$1,432.61
Aegon Asset Management	Netherlands	$0.00	$1,423.47
Motsepe Family	South Africa	$1,208.61	$1,400.80
Sumitomo Mitsui Asset Management Co., Ltd.	Japan	$1,126.39	$1,358.51
Lyxor International Asset Management	N/A	$0.00	$1,354.56
Clearstream Banking SA	Germany	$1,501.19	$1,327.51
Franklin Resources	United States	$1,990.36	$1,304.50
Commonwealth Superannuation Corp.	Australia	$0.00	$1,211.84
APG Asset Manager	Netherlands	$23.92	$1,041.57

Source: Author, using publicly disclosed shareholder data on Yahoo! Finance

Table C10. Subset denoting annual commercial lending to the subset of E&Ps. All values in millions.

Bank	2016	2017	2018	2019	2020	Total
BNP Paribas	$3,758.90	$1,872.78	$866.71	$9,638.29	$22,752.75	$38,889.43
JPMorgan Chase	$6,343.75	$1,462.51	$2,803.70	$6,179.23	$12,837.15	$29,626.34
Bank of America	$5,707.05	$1,121.49	$1,957.40	$4,684.70	$14,558.78	$28,029.41
Barclays	$8,632.14	$1,634.64	$1,849.15	$5,638.74	$10,226.42	$27,981.10
Citi	$6,108.52	$995.42	$2,227.46	$5,412.00	$13,031.72	$27,775.12
Morgan Stanley	$6,118.06	$773.73	$2,094.23	$5,310.17	$8,618.52	$22,914.71
HSBC	$2,590.41	$546.94	$1,684.78	$2,468.25	$10,385.43	$17,675.82
TD	$167.03	$7,759.52	$2,502.63	$3,023.09	$397.67	$13,849.94
RBC	$2,034.82	$2,463.29	$3,165.77	$3,129.42	$942.86	$11,736.16
Goldman Sachs	$2,601.07	$709.87	$1,134.22	$2,953.91	$4,149.90	$11,548.97
Crédit Agricole	$1,824.77	$495.64	$962.86	$2,137.10	$6,016.76	$11,437.13
Société Générale	$1,483.75	$752.99	$1,562.64	$2,559.12	$4,657.80	$11,016.30
Deutsche Bank	$4,445.43	$1,095.14	$211.42	$1,074.39	$3,478.25	$10,304.63
Santander	$714.70	$1,130.14	$545.52	$1,402.99	$6,341.25	$10,134.60
MUFG	$1,055.77	$1,077.28	$900.53	$1,256.85	$1,644.47	$5,934.89
Mizuho	$1,175.97	$395.88	$959.36	$1,922.55	$1,350.21	$5,803.97
SMBC Group	$725.76	$662.89	$810.25	$1,005.35	$1,622.26	$4,826.50
Credit Suisse	$1,503.22	$719.33	$780.67	$1,259.78	$443.01	$4,706.01
UniCredit	$1,025.62	$330.11	$830.50	$283.35	$2,010.31	$4,479.90
Scotiabank	$167.03	$1,502.20	$1,089.81	$1,286.36	$297.80	$4,343.19
UBS	$508.08	$678.37	$1,172.76	$821.93	$126.29	$3,307.42
Lloyds	$521.01	$445.53	$465.02	$686.16	$564.23	$2,681.94
Intesa Sanpaolo	$979.74	$731.34	$500.00	$137.28	$185.58	$2,533.94
Standard Chartered	$40.56	$171.21	$80.50	$664.06	$1,513.24	$2,469.57
NatWest	$327.74	$563.61	$562.76	$364.44	$557.97	$2,376.52
CIBC	$40.56	$804.21	$131.78	$1,212.97	$23.07	$2,212.59
Commerzbank	$40.56	$339.30	$545.52	$669.37	$544.00	$2,138.75
Wells Fargo	$0.00	$0.00	$310.71	$495.69	$1,194.85	$2,001.24
ING	$169.11	$215.87	$241.12	$896.07	$122.39	$1,644.56
ANZ	$0.00	$213.79	$90.47	$548.35	$717.95	$1,570.56
BPCE/Natixis	$113.33	$273.24	$0.00	$352.83	$741.69	$1,481.09
ICBC	$0.00	$0.00	$0.00	$517.99	$804.08	$1,322.08
BBVA	$40.56	$46.94	$80.50	$468.93	$481.61	$1,118.53
Bank of Montreal	$421.46	$55.47	$80.50	$113.73	$397.67	$1,068.83

Bank	2016	2017	2018	2019	2020	Total
NAB	$65.31	$46.94	$66.12	$195.52	$126.29	$500.19
Bank of China	$0.00	$0.00	$14.38	$434.62	$3.89	$452.90
Commonwealth Bank	$40.56	$46.94	$66.12	$113.73	$122.39	$389.74
Westpac	$0.00	$0.00	$24.35	$158.80	$3.89	$187.04
Rabobank	$40.56	$46.94	$0.00	$0.00	$0.00	$87.50
China Construction Bank	$0.00	$0.00	$0.00	$81.79	$3.89	$85.69
DZ Bank	$0.00	$75.00	$0.00	$0.00	$0.00	$75.00
Total	***$61,532.90***	***$32,256.49***	***$33,372.23***	***$71,559.89***	***$133,998.30***	***$332,719.81***
Mean	$1,500.80	$786.74	$813.96	$1,745.36	$3,268.25	$8,115.12
Median	$508.08	$546.94	$545.52	$896.07	$741.69	$3,307.42
St. Dev.	$2,210.74	$1,257.82	$861.80	$2,126.70	$5,147.43	$10,008.55
Max	$8,632.14	$7,759.52	$3,165.77	$9,638.29	$22,752.75	$38,889.43

Source: Retrieved from the Banking on Climate Chaos Database:

Rainforest Action Network; BankTrack; Indigenous Environmental Network; Sierra Club; Oil Change International. (2021). *Banking on Climate Chaos.* Rainforest Action Network. Retrieved May 13, 2021, from https://www.ran.org/bankingonclimatechaos2021/

Table C11. Subset denoting the PFIs that have financed South African fossil fuel projects between 2007-2020. All values in millions.

Country	Type	Fossil Fuel	Clean	Other	Total Energy
China	Bilateral	$4,333.33	$0.00	$273.89	$4,607.22
World Bank Group	Multilateral	$3,040.00	$1,235.43	$843.50	$5,118.93
African Development Bank	Multilateral	$2,649.89	$337.35	$540.88	$3,528.13
France	Export Credit	$2,353.45	$0.00	$0.00	$2,353.45
Germany	Export Credit	$1,484.45	$89.56	$0.00	$1,574.01
United States	Export Credit	$822.12	$22.58	$0.00	$844.70
Japan	Export Credit	$503.46	$2,530.00	$0.00	$3,033.46
Germany	Bilateral	$474.30	$367.95	$431.94	$1,274.19
South Africa	Bilateral	$167.03	$1,306.19	$0.00	$1,473.22
Canada	Export Credit	$78.45	$0.00	$0.00	$78.45
United States	Bilateral	$40.00	$684.00	$257.08	$981.08
Netherlands	Bilateral	$16.45	$52.01	$0.00	$68.46

Source: Retrieved from the Shifting the Subsidies Database:

OCI (Oil Change International). (2020). *Shifting the Subsidies Database.* Oil Change International. Retrieved March 18, 2021, from http://priceofoil.org/shift-the-subsidies/#:~:text=The%20Shift%20the%20Subsidies%20database,data%20from%202008%20to%202019.

Table C12. Complete list of news items denoting changes to fossil fuel production, supply and unemployment during the COVID-19 pandemic

Event	Location	Source
Indonesian coal giant announces 97% drop in profits	Jakarta, Indonesia	(Harsono, 2020)
New York State closes its last coal fired plant in Niagara County	New York, USA	(Prohaska, 2020)
Two British energy giants shut down their two final operating coal plants in the UK	United Kingdom	(Gordon, 2020)
Coal plant in Western Kentucky officially closed	Kentucky, USA	(Fox Business, 2020)
Report analyses coal cash flows in 2019, indicates that half coal plants will not be profitable in 2020	China	(Carbon Tracker, 2020)
Last coal plant shuts down in Austria	Austria	(Climate Action Network Europe, 2020)
Decisions on more than USD80bn of investments delayed in Australia's LNG industry	Australia	(Morton, 2020)
Inner Mogolia Yitai Coal Q1 2020 earnings dropped by almost 50% compared to Q1 2019	China	(Reuters, 2020a)
Oil drilling is halted in New Zealand by giant OMV	Otago, New Zealand	(Otago Daily Times, 2020)
FirstEnergy Corp Q1 2020 earnings dropped by 75% compared to Q1 2019	USA	(FirstEnergy, 2020)
Exploration drilling discontinued in Australia	Great Australian Bight, Australia	(Equinor, 2020)
Lukoil cuts oil production by 320,000bpd (18%)	Russia	(Kolyako, 2020)
Engen oil refinery in South Africa temporarily shut down	Durban, South Africa	(Slater, 2020)
First North American oil refinery shuts down amid low fuel demand	Newfoundland, Canada	(Marino, 2020)
API's oil refinery in Falconara, Italy shuts down	Falconara, Italy	(General Energy News, 2020)
US oil refineries are reducing production by as much as 30%	USA	(Krauss, 2020)
Oil company has shut down its largest refinery due to non-existent demand	Islamabad, Pakistan	(ANI, 2020)
Thai PTT cuts oil production capacity by 15-25% in May	Thailand	(Praiwan, 2020)
BASF announce net income drop by 37% in Q1 2020	Germany	(Brown T. , 2020)
LG International announces drops in energy and palm oil business by 53%	South Korea	(Kim D.-Y. , 2020)
Oil Producers agree to cut down production by a tenth	Global	(BBC News, 2020)
EACOP Pipeline in Uganda proceeds	Africa	(Business Daily, 2020)
TC Energy has officially announced that it will continue with plans to build the Keystone XL Pipeline	North America	(TC Energy, 2020)
Indonesian Oil Giant Petramina plans on increasing oil and gas production by 1.8% by end of 2020	Indonesia	(Paraskova, 2020b)
Brazilian state-owned Petrobras has slashed oil production, cutting planned investments in 2020 from USD12B to USD8B and reducing daily output by 200,000 bpd	Brazil	(Paraskova, 2020c)
Total SA lands $14.4 billion financing for natural gas project in Mozambique	Mozambique	(Duran, 2020)
Saudi Arabia bought USD1 billion worth of shares in four European Oil companies	Europe/Middle East	(Mohamed, Saudi Arabia plowed $1 billion into Shell and other European oil producers, 2020)
At least 435 million formal jobs and 1.6 billion jobs were lost or affected in H1 2020	Global	(ILO, 2020)
US mining industry exhibited second highest sectoral unemployment in the US (13%) by December 2020	US	(US Congressional Research Service, 2020)
Mining sector employment deeply affected by COVID-19, particularly underground and cross-migrant employees	Global	(Ramdoo, 2020)
At least 6000 US coalminers lost their jobs in Q1 and Q2 2020	US	(Sainato, 2020)

Over 100,000 jobs lost in the US oil and gas sector in 2020	US	(WorldOil, 2020)
Russian unemployment doubled from February to May 2020, largely attributed to declining oil exports	Russia	(Gofman, 2020)
Saudi Arabian oil production dips 6% from January to September 2020	Saudi Arabia	(Nereim, 2020)
Global coal, oil and gas production all declined dramatically in 2020 compared to 2019 rates	Global	(IEA, 2020a) (IEA, 2020b) (IEA, 2020c)

Table C13. Complete list of company announcements to reduce 2020 capital expenditure in the fossil fuel sector

Company	Country	CapEx Reduction *(billions USD)*	%Total CapEx	Source
Anglo American	UK	1	Not specified	(Shabalala, 2020)
ArcelorMittal	EUR	Reduced, amount not specified	Not specified	(FitchRatings, 2020)
BHP Billiton	UK	1.4	Not specified	(Brocklehurst, 2020)
BP	UK	4	25%	(Zacks Equity Research, 2020a)
Canadian Natural Resources	CAN	1	Not specified	(Surran, 2020a)
Chevron	USA	2	Not specified	(Paraskova, 2020a)
CNOOC	CHN	1.4	Not specified	(Offshore Technology, 2020a)
ConocoPhillips	USA	-	35%	(Brower, 2020)
ENI	EUR	2.3	30%	(Kulovic, 2020)
EOG Resources	USA	2	Not specified	(Zacks Equity Research, 2020b)
EVRAZ	UK	180-270 (million)	20-30%	(Kumar, 2020)
ExxonMobil	USA	10	30%	(ExxonMobil, 2020)
Gazprom	RUS	0	Not specified	(Murphy, 2020)
Glencore	UK	1-1.5	Not specified	(Surran, 2020b)
Lukoil	RUS	2.5	Not specified	(Kolyako, Lukoil: A Downgrade Until Better Times, 2020)
Maersk	DNK	Reduced, amount not specified	Not specified	(World Maritime News, 2020)
Novolipetsk Steel	RUS	Reduced, amount not specified	Not specified	(Woodall, 2020)
Occidental	USA	2.5-2.7	45-50%	(Kilgore, 2020)
Pioneer Natural Resources	USA	1.7-1.9	45%	(Surran, 2020c)
Repsol	EUR	1	25%	(Surran, 2020d)
Rio Tinto	AUS	7+	50%	(Batten, 2020)
Royal Dutch Shell	EUR	5	Not specified	(Bousso, 2020)
Sasol	ZAF	Reduced, amount not specified	Not specified	(Planting, 2020)
Saudi Aramco	SAU	25-30	Not specified	(Offshore Technology, 2020b)
Seven Generations Energy	CAN	200 (million)	18%	(The Canadian Press, 2020)
South32	AUS	160 (million)	Not specified	(Mining Technology, 2020)
Suncor Energy	CAN	1.1	Not specified	(Reuters, 2020b)
Tata Steel	IND	Reduced, amount not specified	Not specified	(Vijayraghavan, 2020)
Total SA	EUR	3	20%	(Total SA, 2020)

Appendix D: Unique Concepts & Definitions

Concept	Definition
LFFU Approach	A policy, instrument or measure with the explicit goal of taking climate action and that may directly or indirectly diminish fossil fuel production or consumption
Capitalist-driven, Chthulu-endured, Climate-mutating Cataclysm (4C)	An alternative and politically-charged reconceptualisation of the 'climate emergency', poised with assigning agency and culpability to the capitalist agenda that has, "by virtue of its very structure" (Fraser, 2021: 96) mutated the climate and spurred the accompanying cataclysm vis-à-vis adverse socioecological impacts
Capital-North/South & Chthulu-North/South	A disaggregation of the apolitical terms 'Global-North' and 'Global-South' into two dimensions: 'Capital-' denoting the capitalist institutions from both the 'North' and 'South' that are culpable in driving the 4C, and 'Chthulu-' denoting the human and non-human species from both the 'North' and 'South' that are vulnerable to the cataclysm driven by the Capital-North/South, namely the 4C
Inclusive Fossil Phase-out	A transition in which a fossil-intensive regime phases out its fossil fuel consumption, production, financing and commercialisation, and in doing so, allocates ample resources to ensure that the inevitable stranded asset burden – manifested as, inter alia: unemployment, devalued financial assets, and energy insecurity – falls on the most capable and culpable shoulders of the regime and broader landscape
Stranded Fossil Fuel Assets	Natural, physical, human, social and financial (fossil fuel related) assets are abruptly and prematurely devalued due to newly introduced economic, regulatory or technical restraints
Stranded Asset Debt	An abstract concept describing the extent to which an actor, organisation, or coalition of organisations have directly driven and exacerbated the stranded asset risk exposure borne the citizens of a particular region by financing fossil fuel projects, thereby accruing a 'debt' repayable under Articles 4.5, 6, 9-11 of the Paris Agreement. This is supplementary to and builds on traditional concepts of *climate and ecological debts*
Principles for Inclusive Investing & Banking (PIIB)	A set of 10 principles spanning three dimensions (social, ecological and relational) designed to build on and improve the lacklustre UNEP FI Principles for Responsible Investing & Banking (PRI and PRB); it is constructed with a theoretical interpretation of stranded fossil fuel assets from an inclusive development perspective
Finance Package for an Inclusive Transition (FPIT)	A niche LFFU approach mix proposed to drive an Inclusive Fossil Phase-out by directly and explicitly grappling with the Stranded Asset Debts that actors (predominantly from the Capital-North) have accrued in relation to their fossil financing in the 'South'
LFFU Trade-off	Social, ecological, financial, economic, legal or political compromises that are inherent and implicit to phasing out coal, oil and gas production
Local-level Trade-off	Trade-offs from LFFU experienced at the individual- or household-level directly linked to the fossil reserve(s) being left underground, conceptualised through the stranded physical, human, social, financial and natural asset framework
National-level Trade-off	Trade-offs from LFFU experienced by the state and government with ownership over the fossil reserves being left underground, conceptualised through the stranded physical, human, social, financial and natural asset framework

International-level Trade-off	Trade-offs from LFFU experienced by the international actors with financial and economic ties to the fossil reserve(s) being left underground, conceptualised through the stranded physical, human, social, financial and natural asset framework

Summary in Dutch