When gold turns to sand

A review of the challenges for fossil fuel rich states posed by climate policy

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When gold turns to sand - A review of the challenges for fossil fuel rich states posed by climate policy

Abstrakt/Abstract
Petrostates face an unprecedented crisis as oil and gas revenues, on which their economies and states are built upon, are set to diminish rapidly the coming 20 years. The decline in revenues is an effect of the adopted climate policies in the major oil consuming countries that, together with a strong development of renewable energy, reduces the future demand for oil and gas. The challenges that this change create are not only the financial losses but equally important are political and institutional challenges. The dependence on oil and gas have formed both the goverance and the economic structures and thus neglected alternative developments that could have fostered a diverse and competitvie economy.

Petrostates need quickly to adopt green industrial polices to diversify their economies. A few petrostates have started to prepare for a future beyond oil and gas. These diversification strategies can be grouped into either diversification of existing industrial structures, or a developmental strategy to diversify the whole economy to become more robust and innovative. The effectiveness of these diversification ambitions is still unclear. The political changes needed are first to reduce the abundant consumption subsides to fossil energy. This is not easy as this is part of the social contract of a petrostate. In the longer-term, an institutional upgrading is needed to create the right domestic incentives for developing a diverse and competitive economy.

Several areas needs more and deeper understanding in order to formulate effective responses. More in-depth knowledge of the main petrostates, and how the political economy and state model is evolving, is needed. The geopolitical dimension of this transition cannot be understated and requires further efforts.

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Preface

This publication is a deliverable of MISTRA GEOPOLITICS, which is funded by the MISTRA – The Swedish Foundation for Strategic Environmental Research

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“We are an oil country, not a rich country”

Crown Prince Mohammad bin Salman - Interview in Arab News, 28 April 2021

Executive summary

The global ambition to limit the greenhouse effect to between 1.5 and 2 C restricts how much of the remaining oil and gas reserves that can be used. The amount of oil and gas reserves that the world can consume without jeopardizing the climate targets compared to the reserves held by petrostates implies that they need to leave a large portion of these reserves in the ground.

The countries dependent on revenues from oil and gas exports – *petrostates* - are facing severe problems if oil and gas demand declines in accordance to climate change targets. For petrostates, this is just not about the financial losses but equally important is the fact the extraction and distribution of oil and gas rents have formed the governance structures in these states. Petrostates have thus neglected the institutional and societal development needed for building a competitive, open and resilient economy. This makes petrostates especially vulnerable to loss of oil income and the effects of global climate policy could challenge how their economies function and how political power is distributed. The oil market is already starting to experience the effect of global climate policy with the anticipation of a peak oil and gas demand that is driven by the adoption of stricter climate policies around the world, especially in the major oil consuming countries of the OECD. A weaker demand for oil and gas will result in permanently lower oil and gas prices compared to what oil producers have been used to and built their economies on so far.

The question of who has the right to exploit their remaining domestic reserves needs to be answered. Available global projections on how the extraction of the remaining oil and gas reserves will be geographically distributed are based on a global cost-efficiency criterion. This runs contrary to the notion of fairness, a principle deeply embedded in the global framework for dealing with climate change (the UNFCCC). An allocation considering global fairness would take into consideration the level of development of that country, the alternatives available for poorer countries, but also the potential negative or positive effects of an oil- or gas-led development. Calls for a fair allocation could force the current petrostates to reduce their oil exports even faster in order to accommodate states with so far unexploited oil and gas reserves. The international community could help this transition by establishing a complementary negotiation track within the UNFCCC to specifically deal with the phase out of fossil fuels. This track should include an agreement on how to deal with the social implications of a phase out.

Petrostates can prepare for a future less dependent on high oil and gas rents by diversifying their economies. These strategies can be group in either industrial development that diversifies the existing industrial structures or domestic developmental strategies with the ambition to diversify the economy in a broader sense. The first strategy includes investments in downstream production of petrochemicals and refineries, both domestically and overseas, to enable secure a future market for the limited remaining reserves that can be used, the use of carbon capture and storage (CCS) to prolong the use of fossil assets. Another option in this category is to developed new industries, but still linked to the energy sector, by using the competitive advantage of low cost renewables production to foster industrialization to becoming a renewable goods exporter. Several petrostates have huge renewable potentials that so far has remaining relatively underexploited.

The long-term strategy to diversify the whole economy is a challenging step that most likely requires an institutional upgrading from a rentier state logic to a production state logic. The first step in this direction is to address the political challenges of reducing the abundant consumption subsides to fossil energy that typically prevails in oil and gas producing countries. Subsides and low energy costs for citizens is seen as a part of the social contract in a petrostate and thus difficult to change. However, several petrostates have made progress on reducing subsidies for the past seven years. A few countries (Saudi Arabia and UAE) with vast economic resources are also embarking on a diversification strategy for the whole economy that includes huge investments in industry, research and education. Whether this is possible to develop within the existing limited democratic governance structures in Saudi Arabia and UAE remains to be seen.

The effectiveness of these diversification strategies are still very unclear. Several areas needs more and deeper understanding in order to formulate effective responses to this major challenge. More in-depth knowledge is also needed on how the political economy and state model is evolving for the main petrostates. A new area worthy of investigation is also the role of natural gas and the potential prolongation of fossil resources with CCS and if and how this will influence this transition. The geopolitical dimension of this transition cannot be understated and requires further efforts as developments unfold.

1 Introduction

The world energy supply needs to undergo an unprecedented energy transition away from a dominating reliance on fossil energy towards renewable energy if we are to fulfil the ambitions of the recently adopted Paris Agreement. The global emissions need to peak and then to rapidly decrease down to zero and below by 2050 to 2070 (at latest) if we are to fulfil the stated target of keeping global warming "*well below 2 C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 C*" (UNFCCC 2015, Rogeij et al 2019).

On the renewable energy supply side, this energy transition is already ongoing and has been for the past 10 years. The growth of renewable energy, driven by technical development and a rapid decrease in costs, has been impressive (REN 21 2019, IRENA 2020). In the power sector, investments in renewable electricity has surpassed fossil electricity. In the transport sector, a shift away from petrol and diesel is emerging as biofuels and electric vehicles are becoming increasingly competitive. Even the fossil dependent energy intensive industry has the past 7 to 8 years seen a rapid increase in R&D activities and demonstration projects to move away from fossil energy and feedstock in steel, petrochemicals, and ammonia (Bataille et al 2018).

However, it is not sufficient for the global community to focus only on deploying zero-emitting technologies and renewable energy. The global community also need to ensure that the production and use of fossil energy from oil, gas and coal, is phased out with acceptable consequences. Climate policy creates winners such as renewable producers and countries with access to vast amount of renewable energy, but will also create losers such as oil, coal and gas producers and the countries that rely heavily on them. The large and historically so important fossil economy has created a strong "carbon lock-in" (Seto et al 2016) for the nations dependent on the extraction of fossil energy. How petrostates, i.e. nations whose economy is dependent on incomes from the exports of oil, can manage a decline in global oil demand remain perhaps the most difficult part in a global transformation process towards a renewable and low-carbon world.

The aim of this report is to analyze the challenges that face petrostates under the assumption that the global community will adopt climate policies in line with meeting the Paris Agreement.

The report begins with examining the maximum amount of unmitigated fossil energy that can be exploited in Section 2. In Section 3, we review the political dynamics that an abundance of fossil energy resources can have on a country and Section 4 analyses the changing oil market. The principles of climate justice when allocation the rights to exploit the remaining fossil reserves are discussed in Section 5 and the potential responses and strategies for diversification are explored in Section 6. Section 7 concludes.

2 Fossil reserves, carbon budgets and climate targets

2.1 How much fossil reserves are left to exploit

The earth crusts is littered with fossil resources that could be turned into usable energy carriers. The perception of much of these resources that are available for exploitation has historically been determined by economics and technology. Energy analysts distinguishes between "proven reserves" and "available resources". A proven reserve denotes what is economically, legally and technically possible to extract and transform into usable forms of energy today. Available resources are those occurrences of fossil material that are identified but not possible (economically, legally or technically) to extract under current market conditions. Thus, the amount of reserves is not fixed in time but dynamic and changes as resources become available as reserves due to either technical development or higher prices (or most commonly both). BP (British Petroleum) has published stated proven reserves in oil by oil, coal and gas since 1951 and the current reserves are given in Table 1 below together with an estimate of the corresponding CO_2 emissions if these reserves where combusted. The classic *reserves to current yearly production ration* (R/P) that has been used and published since early 1970s as an indicator of available reserves is presented as "years" left with current production.

Table 1 Proven fossil reserves and corresponding CO_2 emissions

Global proven reserves	Reserves to production ratio (R/P)	Approximate CO_2 emissions if combusted
Oil 1734 000 Mbarrels	49.9 years	745 Gton CO_2
Gas 7019 MtCf	49.8 years	385 Gton CO_2
Coal 1 069 636 MTonnes	132 years	2139 Gton CO_2
Total reserves		3269 GtonCO_2

Source: Fossil reserves BP (2020). CO2-emissions are own estimated based on heating values.
https://ourworldindata.org/grapher/carbon-dioxide-emissions-factor

As a curiosity, the "reserve-to-production" ratio (R/P) was for a long time period always around 40 years based on what oil companies financially thought reasonable to secure for the future. This ratio has grown for the past 5 years due to the changing oil market (see Section

4) and is today 49 years on a global average (BP 2020)[1]. Extensions of the current reserves and new discoveries, driven by higher oil prices and technical development, have grown more than the global consumption[2]. The oil price crunch in 2007/2008 started the development of "unconventional oil and gas" and this development contradicts the earlier warnings that we were approaching a "peak" in oil production after which we would see a steep decline in production with major economic and geopolitical consequences (Campbell and Lahere 1998). A large part of the latest expansion in gas/oil reserves are due to the fracking revolution that started in the US between 2000 and 2010[3].

On top of these reserves given in Table 1, there are also large amounts of resources that could become available in the future with higher prices or technical development. IEA estimated in 2013 the available *oil resources* to be in excess of 6000 billion barrels corresponding to more than 2 600 Gton CO_2 (IEA 2013). McGlade and Ekins (2015) estimated all the ultimately recoverable *fossil resources* (including coal and gas also) to approximately correspond to 11 000 Gton CO_2. Taking into account not only proven reserves but also the resources that potentially could become available the coming decades, there are plenty of fossil resources to keep fuelling the global energy system for centuries and thus to exceed the climate targets several times.

2.2 Carbon budgets, climate targets and uncertainties

The temperature target in the Paris Agreement can be translated into an accumulated carbon budget left and from this we can estimate how much of the remaining fossil assets that are "burnable".

In 2015, McGlade and Ekins (2015) used integrated assessment models (IAMs) to estimate how much of the fossil fuels reserves that where "burnable". Their method included all fossil energy (coal, gas and oil) and made a globally cost-efficient allocation of the remaining carbon budgets in relation to stated reserves. McGlade and Ekins (2015) assumed a remaining carbon budget of 1100 Gton CO_2 (ibid)[4] and estimated the amount of fossil fuel reserves that thus were deemed "unburnable" (they estimated that reserves were roughly three times

[1] See BP 2020 page 15 for R/P ratio for different regions

[2] McGlade and Ekins (2015) estimated reserves to correspond to 2900 Gton CO_2 but the amount of reserves have grown since 2013-2015 due to continued exploration.

[3] The first modern peak oil prediction in 1998 (Campbell and Lahere 1998) set the peak production to around 40 to 50 Mbarrels/day of conventional oil and another potentially 30 Mbarrels/day for unconventional oil and that the peak would occur around year 2000 to 2005. This can be compared to the actual oil production today that has steadily grown to around 95 Mbarrel/day

[4] Based on the IPCC (2014) assessment that the remaining carbon budget between 2011 and 2050 is somewhere between 870 to 1240 Gton CO_2 with a 50% chance of reaching the 2 C target.

the remaining budget) and allocated *whose* reserves (geographically) and *which* reserves (oil, gas or coal) that are unburnable.

In Figure 1, the remaining global carbon budget based on the latest IPCC report (IPCC 2018) under different climate targets and the identified fossil reserves from Table 1 are given.

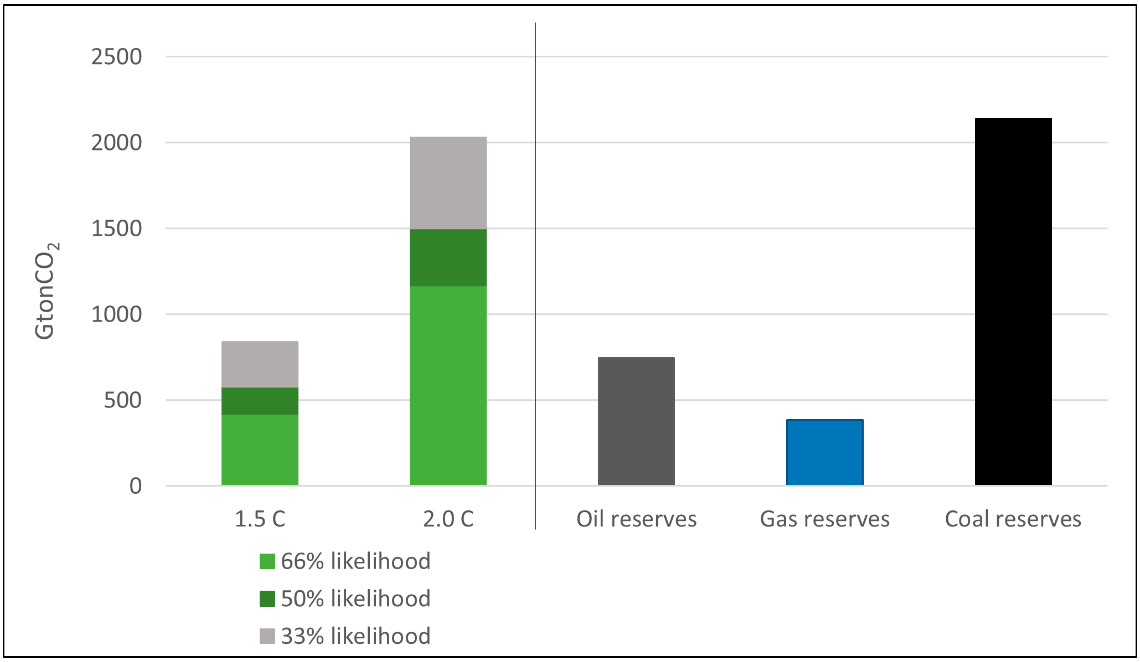

Figure 1 Remaining carbon budget (2018 to 2100) under different targets and likelihood compared to the CO_2 emissions from burning of proven oil/gas/coal reserves. Carbon budget from IPCC (2018)

For reaching the stricter 1.5 C target in the Paris Agreement the IPCC 1.5C report (IPCC 2018) allows a carbon budget of a total of 420 to 840 $GtonCO_2$ for the 1.5 C target from 2018 and onwards and 1170 to 2030 $GtonCO_2$ for the 2 C target. The link between the carbon budget and the resulting temperature increase is uncertain and the variation in Figure 1 reflects the estimated likelihood of reaching the temperature target with a 66%, 50%, and down to 33% chance based on IPCC (2018). However, including a more cautious view on the uncertainties such as the risk of feedback loops in the climate system (thawing of permafrost etc.), Kartha et al (2018) argues for an even lesser remaining carbon budget of only 200 Gton CO_2 for reaching the 1.5 C target and 800 Gton CO_2 for the 2 C target with a 66% likelihood.

The carbon budget given in Figure 1 uses the traditional carbon budget logic to estimate the total accumulated carbon budget up to 2100. However, with the limited time for acting on the Paris Agreement, focusing only on the long-term accumulated carbon budget neglects both the risk of overstepping tipping points in the climate system and the socio-economic inertia in changing energy systems and thus undervalues the benefits of reducing emissions as a faster pace in the beginning. How climate scenarios allocates the remaining carbon budget over time depends on many factors such as assumptions on the availability of negative emissions, risk assessment, and the speed of mitigation. Rogeij et al (2019) present a new and more relevant logic that focuses on three main metrics determine the emission trends needed to reach the Paris targets : (i) peak warming e.g. the accumulated emissions, (ii) timing of peak warming, e.g. the point in time when we reach carbon neutrality, and (ii) post-peak temperature decline e.g. the amount of sustained negative emissions needed. This logic introduces a stronger emphasis on *the timing* of both when we reach zero emissions and when global emission peak.

3 Petrostates and dependence on rents

3.1 Which countries are petrostates?

Several states have huge incomes from oil and gas but only some of them qualifies as being a petrostate. What is typical for a petrostate is the high dependence on the rents[5] from oil and gas in relation to their overall economy or state budget. This dependency can be expressed as share of oil rents or revenues per GDP, or per total export income, or per total government income. The available domestic oil reserves also matters. The word "petrostate" has a negative connotation and the IEA uses the more neutral term "producer economy".

The IEA (2018a) defines countries with over 33% state revenue and 33% export income from petrol and gas as being producer economies. The IEA definition includes Angola, Azerbaijan, Iran, Kuwait, Nigeria, Oman, Russia, Saudi Arabia, Turkmenistan, United Arab Emirates and Venezuela (IEA 2018a). van der Graaf and Verbruggen (2015) use the name petrostates and defines this as countries with more than 10% of GDP coming from oil rents. In Figure 2 below, we use this definition for illustration and list countries with oil rents above 10% of their GDP in 2018.

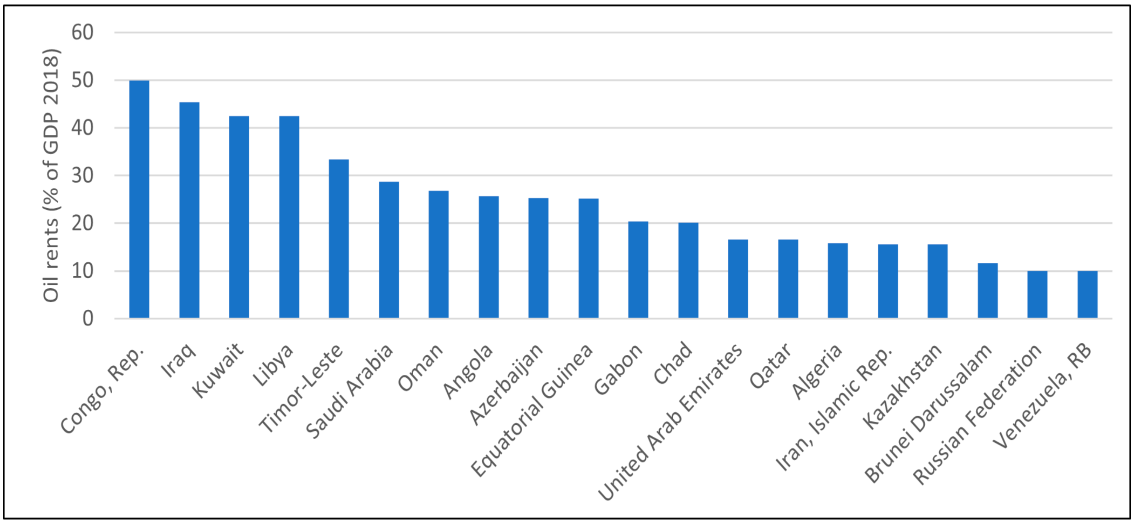

Figure 2. Countries with the highest dependence on oil rents to their GDP in 2018.
Oil rents are the difference between the value of crude oil production at world prices and total costs of production. Source: data from World Bank (2021) https://data.worldbank.org/indicator/

[5] Rents are here defined as the difference between the oil price/revenues and the domestic production costs.

In Figure 2, we find several of the big oil producers in the world such as Saudi Arabia, Libya, UAE but also several small countries such as Timor-Leste, Gabon and Oman. Some countries with a large oil production, such as Norway or USA, is not on the list in Figure 2 or any other list of petrostates as their share of oil rents or revenues per GDP or any other indicator is low.

Almost all of the definitions of petrostates include only oil producing countries and seldom natural gas and almost never coal producing countries. The focus on oil is motivated by the fact that the properties of gas and coal differs substantially compared to oil which have an impact on the influence on the political and economic development. The aspects that matters most are the market value of the resource in relation to the cost of extraction (e.g. “the rents”), the trade intensity and the cost of transport, the industrial organization and knowledge for developing this resource, and the geographic concentration of the resource.

Oil is easily transported over vast distances at a low cost and has a high value compared to the average cost of production. The historical development of oil and global trade goes hand in hand, oil being both an enabler of global trade as the dominating shipping fuel after World War II. Oil is also one of the most traded commodities on the global market today. In several regions of the world, the cost of production of “easy accessible oil” is substantially lower compared to the market value with average production costs below 25 USD/barrel as compared to average prices between 40 to 90 USD/barrel.

Natural gas has only recently begun to develop a global market with international trade. For a long time, natural gas was traded in three separate regional markets with differentiated prices (the North American, the European and the East Asian market) due to the high cost and the lack of flexibility of transporting natural gas via pipelines. The natural gas market via pipelines market is mostly based on long-term fixing the price of natural gas to the price of oil as these resources is seen as complementary[6] to oil. However, since the introduction of vessel-ships for transporting liquefied natural gas (LNG) in early 2000s, the global trade of LNG has grown substantially. This trade was further strengthened after the shale gas revolution in the US in 2005 to 2010 that made US an exporter of LNG instead of an importer. Today, the value of LNG and it´s strategic role has grown tremendously and LNG is developing into a global commodity (Sakmar and Kelmar 2009). Qatar has taken a big role in the LNG trade with early investments in LNG infrastructure, which has made Qatar very rich the past 10 years (Krane 2020). The rents from natural gas is generally lower compared to oil but some countries such as Timor-Leste with 30%, Turkmenistan with 17% , Brunei with 14% and Uzbekistan with 10% gas rents/GDP would qualify in our definition. Recent

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[6] The fixed long-term contracts agreements can be a financial necessity for constructing the pipelines. As an example, the price of natural gas could be determined in a contract to be 80% per unit of energy compared to the market price of oil, thus following the price of oil.

large producers of gas such as Qatar and Russia also collects substantial rents from gas exports with 4.7% and 3.7% of rents/GDP respectively (World Bank 2021).

Coal is also exported but with a substantially less value and mostly at regional markets (metallurgical coal is exported on a global scale). Another important difference is that coal extraction is more evenly available across different regions in the world and requires much more labor and less technology compared to oil and gas. The coal rents thus become substantially less with no countries over our 10% threshold. Mongolia has the largest share of coal rents/GDP with 8%, followed by Mozambique with 4% and South Africa with 2.4% (World Bank 2021)

3.2 The economic and political dynamics of a petrostate

The negative meaning of the word petrostates comes from the observation that several petrostates historically have suffered from a poor economic and democratic development. There are several identified problems with an oil-led development. Here, we focus first on economic problems and then on the broader political/institutional development.

First, the economy of a country with huge oil/gas exports can suffer from a "Dutch disease" meaning that the export revenues pushes up the exchange rate and thus makes other domestic sectors in the country uncompetitive on the international market. The name Dutch disease comes from the observations of the declining manufacturing industries in the Netherlands during the gas boom after the discovery of the Groening field in 1959.

Second, the global oil market is characterized by "bust and boom cycles" that are typically for commodities. The highly fluctuating revenues from oil creates problems for a state budget is highly dependent on oil and a further problem is that these bust and boom cycles causes state revenues to be "procyclical" (Ross 2013). This means that if fiscal revenues are not handled well by the state (by e.g. large savings during good times) the state revenues will shrink during economic downturns when fiscal stimuli is needed the most. In conclusion, with weak fiscal discipline, bust and boom cycles of oil will further exacerbate economic cycles (Krane 2019, Ross 2013)[7].

Third, from an industrialization perspective, an oil-led development creates few domestic jobs and industries. The oil extraction industry has an enclave nature with few linkages to other sectors in the economy or job creation (Karl 2004). Oil exploration is a high capital

[7] Establishing a Sovereign Wealth Fund (SWF) is one way to deal with this but has so far had mixed results (IEA 2018). Russia has partly solved the problem of fluctuating oil/gas prices by depreciating the Rubel (and with a SWF) whereas MENA countries typically has their currency pegged towards either the US dollar or a basket of international currencies making them more vulnerable in times of low oil/gas prices.

intensive and high-risk business that depend on international expertise[8]. Once an oil field is operational, it employs a fairly small amount of people in relation to the generated revenues. A development based on oil/gas exploration will thus not automatically create more downstream jobs or adjoining development paths but will work mainly as an "economic enclave" within the surrounding society.

Easy access to a valuable and exportable commodity also influences the development of political institutions. This process have been explained by the rentier state theory that were first coined by Mahadavy (1970) in economic terms and later by Beblawi and Luciani (1987) and in a seminal paper by Karl (1999) in political terms. Rentier state theory is rooted in political science and international relations studies and examines how resource-rich states generate rents externally and redistribute this wealth internally. What defines the institutional development of a rentier state is the economic dependence on external rents from oil exports (but can also be applied to e.g. toll charges, gold exports or payments for pipelines) that do not require or induce a domestic industrial development of the economy for gaining wealth. This has been applied to oil-led development where "petrodollars" molds institutions and political power, especially when it coincides with state building in the early stages of industrialization and modernization. This mechanism is also associated to the enclave character of the oil industry where a weak and autocratic government focuses on gaining rents for exports industries rather than developing the population and domestic industries (Karl 2004). The social contract between the state and the population in a typical rentier states are that the sovereign/elites do not tax the population but uses the revenues from oil and other resources to provide the basic needs and social welfare for society. With this social contract follows a limited demand on political representation (and a limited capacity) and a lack of incentives for good governance[9]. Oil-led development in weak states often introduces an overly state-centric and centralized structure with strong networks between elites and the "rent business" making the economy susceptible to corruption.

The mechanisms of rentier states described above can explain the devastating long-term effects that oil-led development has had on several oil exporting countries, the so called "resource curse" (Karl 1999, Ross 2015). Venezuela is a prime example of this (Karl 1999) but the lack of social

[8] Oil fields in the MENA regions were developed by the British (Iran/Iraq), US companies developed Saudi Arabia, Kuwait, and Venezuelan oil fields, and Italians developed oil fields in Libya. During the 1970s, these assets were nationalized. The history in Russia is a bit different with Swedish /Dutch/British companies and later revolution that early on nationalized these assets but with cooperation continued (Yergin 1990). Russian oil has since then been privatized after perestroika and then nationalized with "rule by law" by Putin (Goldman 2010).

[9] Mitchell (2011) also argues that coal requires a larger state and bureaucracies to manage the extraction that has fostered democracy as opposed to oil and lately gas that relies on international expertize and capital and not on local capacities and work force. Coal was in the beginning much more work intensive and gave coal miners agency to demand political rights and organization, and thus played a critical role in forging democracy (Mitchell 2011). This can partly explain the growth of democracy in coal countries such as UK, Germany etc. whereas "oil countries" have not seen this development (labour required negotiation that required political reform etc.).

and democratic development can also be seen in e.g. the MENA region, in Russia and elsewhere. Ross (2015) makes three claims in relation to oil led development: (i) petroleum makes authoritarianism more durable, (ii) under certain circumstances oil increases corruption and (iii) oil can help trigger violence in low to idle income countries[10]. However, poor development need not always be the case of an oil-led development. Haber and Menaldo (2011) analyzed longitudinal time series and came to the opposite conclusion that an abundance of resources do not automatically fuel authoritarianism but instead find varying outcomes, especially considering the poor development from which of several of these countries started from. This conclusion has criticized as Haber and Menaldo base their analysis on very long time series (Andersen and Roos 2014). The trends of a resource curse have been especially visible after the 1970s when oil revenues were nationalized and created wealth for the countries that had the resource instead of being siphoned out to global and foreign oil companies (Ross 2015, Yergin 1990). Further to this, Elbadawi and Makdisi (2021) argues that the resource curse could be linked to the amount of rents versus GDP. If the rents are very high/GDP then the state does not need to be very authoritarian. There exist a threshold and above which the state/elite can afford a more lenient approach towards the population and develop other sectors and civil society as seen in several gulf countries (Elbadawi and Makdisi 2021). In the Gulf region, several states allow for a state with "limited access order" as opposed to "autocratic state" or "open access order" (full democracy)[11]. However, there are also petrostates in Figure 2 with higher rents/GDP ratio and less positive development compared to the Gulf.

The concepts discussed here, resource curse and the rentier or petrostate, are intertwined and include several mechanisms and preconditions that need to be in place in order to have the negative effects described above. One of these preconditions is that the rent economy develops early on in the modernization process when the state is weak, autocratic and with no domestic industry. When this is the case, collecting huge rents from a natural resources oil solidify power to the ruler (often non-democratic) and put a country on a development path that relies heavily on collecting and distribution rents. Oil rents typically strengthens the incumbent regime and it´s way of doing business, with no pressure to solve actual problems and long as one can "throw money on all issues and conflicts" (Karl 1999).

[10] The resource curse can partly also be found in coal rich regions as well but at a more limited scale and more to do with limited development rather than a completely "failed state" due to abundance of resources. Studies on resource curse in e.g. eastern US focusses on the local/regional effects on coal dependence and reveals slower growth (Betz et al 2015).

[11] In the varieties of capitalism literature (Hall and Soskice 2001), several different ways of organizing the state and economy relationships are outlined focusing on mainly OECD type of economies (liberal market economies and coordinated market economies etc.). Buhr and Frankenberger (2014) extends this literature by also including autocratic states and brands a new "incorporated capitalism" where they divided this into two different types, patrimonial market economies and bureaucratic market economies. Most rentier states fall into patrimonial market economies (e.g. Russia and Saudi Arabia) where the main coordinating principle is trust and personal linkages and where e.g. ownership and financial strength is determined or influence strongly by these networks. This theoretical understanding gives some more clues of how to understand the functions of the state and market in many fossil fuels dependent states

4 The changing market for oil – from a seller´s to a buyer´s market

The oil market is changing and there has been in general a shift in perceptions from a scarcity market (a "seller´s market"), that supports the logic to save oil reserves for future generations, to a new perception based on a future abundance of oil (a "buyer´s market") where significant amounts of the reserves may never be used (Fattouh and Sen 2021).

The oil market has always had to deal with the risk of a potential abundance of oil as the *potential* supply has normally been greater compared to the demand. Historically, the main actors on the oil market have been successful in controlling the output to the market, all the way from Rockefeller and the opaque "transport monopoly" of the Texas Railway Commission, via the Achnacarry Castle Agreement in 1928, to the formation of OPEC (Yergin 2001).

Two changes have occurred the past years that has caused a shift in perception. First, he booming shale gas market on the US changed the market dynamics and lessened OPEC´s ability to control the total output and thus manage a sensible price. Second, the oil demand might peak soon due to stronger climate change policies (van de Graff and Bradshaw 2018, IEA 2021). The problem of peak demand is not primarily that the volume of oil will diminish, but that the oil prices will decrease. This changes the position of the oil producing countries where they suddenly face a future when their revenues will shrink and eventually dry up totally.

The scenarios developed to anticipate when peak demand will occur and how much oil that eventually will be in demand are contested. Bradshaw et al (2019) gives some indication of where the major organizations and oil companies stand. Most of them see a "peak oil demand" somewhere around 2020 to 2030 but then again some organizations argues that much oil will still be needed beyond 2040 (e.g. OPEC). None of these projections is compatible with reaching the 1.5 C climate target. They also make the assumption that coal will "go first" in the decarbonization efforts and thus leave a room for continued use of oil and gas up to 2050[12]. Oil is primarily used for transport but the competition from electric vehicles and biofuels are changing the outlook. The use of petrol and diesel is slowly losing

[12] Coal has started to decline in OECD but most future coal will be serving local markets in developing countries and transitioning countries with currently weak climate policies. It is thus not sure that coal will be phased out as rapidly as energy economic models suggest based on a strict global cost-efficiency logic.

the “license to operate” in large parts of the western world and this is also slowly spreading to the policy sphere in Asia as e.g. China recently announced carbon free target for 2060 and a ban on vehicles with combustion engines by 2030. Government motivate these bans of combustion vehicles with an ambition to reduce local air pollution and to address climate change but also, and not so openly disclosed, as a part of an industrial policy to increase the production of electric vehicles.

The low and fluctuating oil prices on the oil market seen between 2015 to 2020 risks becoming permanent and will put greater pressure on the few states that can act as swing producers such as Saudi Arabia to control global output (van der Graaf and Bradshaw 2019, Fattouh and Sen 2021). Recently (May 2021), in the wake of COVID-19 recovery stimulation packages, oil prices have increased (up to 60 USD/barrel up from 20 to 40 USD/barrel). It is unclear whether this price level can be sustained in the long term but as Dale and Fattouh (2018) argues, the critical point is not *when* but *that* oil will eventually become a commodity of abundance and the consequence that the reserves stored in the ground will lose value due to “peak demand”.

4.1 Financial markets responses to climate risks

Climate change and the emerging energy transition is already affecting the risk perception for institutional “long” investors (Fattouh 2019). Renewable projects (wind and solar) require an internal rate of return (IRR) of 10 to 11 % whereas oil and coal projects require a much faster pay back with an IRR between 18 to 40% (Fattouh 2019). The IRR reveals the perceived risks by market actors including all associated risks such as technology, market, and policy uncertainty. The high IRR will also have effect on *which* investments that are being made and increases the marginal cost for new oil and gas reserves.

Looking at investment trends for fossil energy, there has been a broad shift towards projects with shorter time leads the last years (IEA 2019) which could be an effect of greater uncertainties. Fossil companies focus are thus on developing the fossil assets as short-term instead of betting on that oil, coal and gas will be viable in the long term (WEI 2019, 2020)[13]. The increasing risk perception of oil and gas markets has benefitted the development of shale oil/gas as these have a quicker return (physically) as compared to long-term oil assets (Fattouh 2019).

[13] It is unclear what effects the pandemic will have but recent data from the IEA reveals that investment in all energy sources have dramatically declined due to Covid-19 but that fossil, and especially oil, has been hardest hit and that renewables have been more resilient (WEI 2020)

Overall investments in fossil energy supply options are still higher compared to investments in renewable energy (IEA 2019, IEA 2020)[14]. The IEA still sees a need for investments in oil even in a net-zero scenario but only for maintaining oil producing capacity at existing fields (IEA 2021). In IEA´s assessment of how the world would reach net-zero emission by 2050 they clearly state that no new oil or gas fields are needed (IEA 2021).

However, despite the gloomy outlook for new oil production, this perception has not had an effect everywhere. The production gap reports (SEI et al 2019, 2020) show that future production plans for fossil energy are still based on assumptions on a continued and long-term growth of demand with few signs of a deliberate slow down. The production plans even goes beyond the submitted Nationally Determined Contributions (NDCs) to the UNFCC as several countries assume that the fossil energy will be exported and will thus not end up in their own carbon budget plans[15]. The production gap reports point to the vast problems caused by direct and foremost indirect subsidies to continued exploration via e.g. state underwrite risk with state owned enterprises (SOEs) and many more subtle subsidies. The continued plans for a production expansion plans is an indicator of the strong path dependency in producer states.

At the same time, bottom-up initiatives have been growing to get financial actors to disinvest in oil, gas and coal production. The divestment movement started in around 2010/2011 in the US and spread soon to the EU. It´s mainly based on universities/students and some NGOs. The direct effects have so far been minor in reducing investments in fossil sector (Moorman 2019) but the indirect effects and norm-building effects seem to have gained traction, at least in the western world (Bergman 2018). Green (2018) also talks about "anti-fossil fuels norms" as a growing social movement that could grow both domestically and form new international norms. "Leave it in the ground arguments" are easier to understand and to personalize as opposed to the more academic arguments discussed within the UNFCCC such as limiting to 2 C degrees (Green 2018). Practically, these movements has contributed to changing the perception of fiduciary duty within investment banking and delegitimized the fossil fuels industry (Green 2018, Bergman 2018). Divestment strategies of financial portfolios have not lead to lower returns and a divestment strategy might well be within the fiduciary duty of a financial actor (Plantinga and Scholtens 2019). The financial sector is increasingly aware of climate risks today, whether that depends on overall increased attention to climate change after the Paris Agreement, the decline in oil prices after 2014, or social movements and public pressure is irrelevant.

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[14] Investments in *renewable electricity* is now larger compared to *fossil electricity* (foremost coal and gas) (REN21 2019) It should however be noted that investment measured in USD is not equal to investment in energy capacity as investment cost for e.g. solar and wind have decrease substantially the past 10 years whereas upstream oil and gas have remained stable (IEA 2019).

[15] Preliminary data reveals that the Covid-19 pandemic has not had any major effects on these production plans yet (SEI et al 2020)

With increasing pressure to reduce fossil energy there is a substantial risk that investments in fossil infrastructures, based on expectations of a high future oil price, could become stranded and create a financial "carbon bubble" as demand declines. The NGO Carbon Tracker analyses the financial situation of the carbon bubble and points out that we are on a tipping point with decreasing renewable prices and increasing risks for fossil fuels that is further being augmented by several feedback loops such as write-downs and financial reflexivity[16] that increases the capital cost for the capital-intensive fossil industry. There is also a strong emerging break-up of the existing carbon lock-in to fossil end use technologies where new technical systems eases the transition away from fossil (CarbonTracker 2020). IEA estimates the total size of the current operating fossil energy system to be valued at over 71 trillion USD (WEI 2019). The fossil fuel *reserves* are valued somewhere between 14 and 129 trillion USD pending on future assumed value (Carbon Tracker 2020). The lower value considers the Paris Agreement whereas the higher value assumes an historical BAU development (Carbon Tracker 2020).

4.2 Future production strategies for petrostates

Petrostates are already today experiencing problems with low revenues from oil and gas. In 2019 when the average Brent oil price was above 64 USD/barrel, most MENA-oil producers were running a budget deficit (Fattouh 2021). The IEA (2018) analyzed these risk and came to the conclusion that keeping the long-term oil price at levels of 60 to 70 USD/barrel would put a lot of strain on several producer economies but that they might still survive (IEA 2018). However, the IEA projects that oil prices will decline towards 35 USD/barrel by 2030 and 25 USD/barrel by 2050 in their recent net-zero report (IEA 2021).

Producer countries have historically colluded and agreed upon output limitations (e.g.via OPEC) to manage and to keep the oil prices high. This is a potential strategy for oil producing countries to make sure that the "last drop of oil" gets as a high price as possible (Person et al. 2007, Crane 2020, Fattah and Sen 2021). The record of accomplishment of this has not been great lately for neither OPEC nor the 60% of reserves that are non-OPEC. Different views and position of how to best utilize the reserves is to blame for this (van der Graaf and Verbruggen 2015) and it is unclear how producer economies would be able to agree to collude in the future with declining demand. It is easier to agree on sharing revenues that are growing compared to sharing revenues that are shrinking.

If this is not successful, the outcome could be price wars that would be disastrous for petrostates. An uncoordinated market could lead to a "panic and pump" behavior where the

[16]Reflexivity: That capital shifts away from dying sectors to new sectors with better growth potential and thus makes capital more difficult and more expensive to access for dying sectors

holders of reserves instead maximizes short-term profits in order to invest these revenues in other sectors to build a stronger more resilient economy. The oil price would then see a downward trend towards the production cost for the lowest cost oil alternatives of 10 USD/barrels. At oil prices between 10 to 20 USD/barrel, only a few producer economies mainly located in the MENA region could sustain production (Peszko et al 2020). A "pump and panic" strategy combined with peak oil demand could increase concentration of oil production to a few states that are in for the long run whereas other states will not survive when the oil price goes below the needed price for sustaining the state, the so called "social cost of oil" (Goldthau and Westphal 2019)[17]. It would in the longer-term make it easier again, once the competition is gone, to collude among these.

[17] It is questionable if a stable oil production can be politically sustained at 10 to 20 USD/Barrel. The IEA net-zero report assumes in their modelling an "orderly transition" with oil prices moving down to 35 USD/Barrel by 2030 and to 25 USD/Barrel by 2050 (IEA 2021)

5 Climate change and the right to extract the last oil

5.1 Efficiency or ethics when allocating the remaining carbon budget

In energy-economic modelling, as presented by McGlade and Ekins (2015) and IPCC (2014), the underlying assumption is that the world will phase out the use of fossils according to a merit order based on optimizing global cost-efficiency. Based on this logic, the planned merit order is roughly to phase out coal first, then oil and last natural gas. The cost-efficiency also applies to *where* in the world the remaining fossil resources will be extracted.

For ensuring a globally cost-efficient phase-out of oil, the producer economies that has the lowest cost for oil (at a cost of 10 to 20 USD/barrel) should be prioritised. Several new oil fields developed in OECD-countries have a much higher production cost (IEA 2018). The currently held reserves with low-cost oil (10 USD/barrel) in the MENA region represent 200 billion barrels, which is roughly equivalent to 86 Gton CO_2, which is a major part of the remaining carbon budget for reaching the 1.5 C target with a 66% likelihood. A further argument for allocating the remaining oil exploration to the current producer economies in the MENA region is the low CO_2-emission intensity per barrel of oil compared to more difficult oil resources developed elsewhere (Jin et al 2020).

The right to extract the last fossil resource is just not a question about global cost efficiency. The guiding principles from the UNFCCC[18], that have so far been used for negotiating what "a fair share" for mitigation efforts is between countries, must be taken into consideration also for the phase out of fossil energy (Kartha et al 2018). The right to use domestic resources for development is a strong factor in the discussions on who has the right to exploit the last reserves of fossil fuels.

Several guiding principles could be applied for ensuring a *just phase out* of fossil fuels. Le Billon and Kristofferson (2019) discuss which principles that can be applied for allocation of remaining extraction space and identifies four concepts. (i) an *utilitarian concept* of justice focusing on the carbon intensity and production costs (cost-efficiency - utilitarianism), (ii) a

[18] Article 3 in the UNFCCC on "common but differentiated responsibility according to respective capabilities" established the fairness principle

distributive concept focusing either on the affordability that countries not dependent on oil and rich should reduce first or the opposite taking developmental effects into account, (a retributive argument), that countries prone to “resource curse” should reduce first, (iii) a *restorative concept* looking at past production and countries that has historically emitted most, and, (iv) a *rehabilitative concept* focusing on countries with the strongest political support for reducing production such as Norway or France for banning fracking should reduce first.

All these concepts acknowledge that there is a strong historical linkage between energy access and human development index. This link cannot be disregard for poorer countries. However, even if the track record of oil led development has been poor the last 50 years this is by no way an automatic rule, as described in previous sections. Oil can under the right conditions foster well-being, democratic rule and societal development but this requires the right governmental and institutional capacity to do so. Some producer economies can argue that their expectations for development rests upon continues exploration of domestic oil, gas and coal resources as a right to development (Armstrong 2020, Jess et al 2011).

A simpler method is proposed by Caney (2020)[19] that suggested three key dimensions to inform who has the right to exploit the remaining fossil assets; (i) the human development index of countries (ii) the historical responsibility both from the benefits of exploration and the benefits of consuming side, and (iii) availability of other resources for replacing fossil fuels. According to the principles of Caney (2020) the remaining fossil reserves should be left to the countries that have reserves but have so far not exploited them (notably Sub-Saharan Africa and South America) and wealthier oil states (the current producer economies) should instead use their financial resources to diversify and leave their oil reserves in the ground.

Drawing on the experiences so far on how to manage efficiency versus fairness in climate policy it should be noted that in the early days of the UNFCCC, the point was made that we need to separate *where* the mitigation occurs from *who bears the responsibility* to pay for that mitigation (see e.g. Tirole 2012). This logic rested upon the creation of a global trading scheme for carbon emission (AAUs[20]). The UNFCCC further developed the carbon market idea via the Clean Development Mechanism (CDM) in the Kyoto-protocol. The principle was that economic compensation via trade of carbon certificates could ease the conflict between adopting a global response based on cost-efficiency versus a global response based on fairness. The UNFCCC could develop a similar idea for phasing out oil, e.g. that producer economies continue to extract oil but pays dividends to resource rich countries that choose not to exploit their domestic resources. However, the lessons from the global carbon trading systems strongly suggest that this is not a feasible option. The ideas of a *global* carbon trading system has never materialized, despite strong support from most OECD-countries, mainly

[19] See also Muttit and Kharta (2020) with a similar idea

[20] AAU: Assigned Amount Units, equalling one ton CO_{2e}

due to the fact that it turned out too difficult to agree on what "a fair share" meant. Further to this, the idea of global carbon trading assumes that all countries participating are guided by liberal market logics.

It is clear that a cost-efficient allocation will not (and should not) be the sole guiding principle for how to allocate the remaining fossil reserves. To only look at the poorest countries and allow them to extract the remaining fossil reserves have merits form a justice perspective but taking into account the potentially negative effects from fossil development and path dependency, this can be questioned. A pragmatic approach is needed that will take into consideration also other political goals and provide all countries with a feasible and acceptable (just) way out of the fossil fuel dependence, whether it is demand dependence or supply dependence, is needed. Global climate policy has so far only focused on reducing demand via mitigation efforts.

5.2 Oil producing states and the UNFCCC

Oil-producing countries have not been at the forefront in the UNFCCC negotiations demanding strong global climate action. The interest from producer economies have foremost been in Article 4.8 in the UNFCCC which opens up for compensation of adverse effects of climate change which be interpreted as the legal right to be compensated for fossil revenues foregone.[21] Several producer economies (e.g. Nigeria, Venezuela and a number of Gulf states) requested early on in the negotiations compensation for foregone oil revenues due to response measures (i.e. climate policies in OECD) (Armstrong 2020, Depledge 2008) but this has so far not gained any traction in the negotiations.

In Table 2 below, we briefly outline the response to global climate change of a selected number of producer states as reported to the UNFCCC within their respective nationally determined contributions (NDCs). In late 2021 new and updated NDCs should be submitted

[21] The Paris Agreement (UNFCCC 2015) specifically notes "*the intrinsic relationship that climate change actions, responses and impact have on equitable access to sustainable development and eradication of poverty*" and states thus that "*take into consideration the concerns of Parties with economics most affected by the impacts of response measures*"

Table 2 Committed NDCs by a selected number of producer economies

Country	Core content of submitted NDCs
Saudi Arabia	Diversification is key. The threat of climate change and its policies are recognized, No GHG reduction targets, only actions – energy efficiency, CCU-investments and renewable investments. Investing oil revenues in diversification and "sustainable use of oil and gas". No external funding requested but targets are assessed against the future development of Saudi Arabian economy. Mentions Article 4.8 in the UNFCCC and adverse effects
Russia	Official GHG reduction target of 70 % by 2030 with 1990 as a baseline but using maximum sinks in forest/land use. No external funding requested
United Arab Emirates	No overall GHG target but targets on specific sectors such as 24% clean energy share in the total energy mix by 2021 and a shift of 25% of government vehicles fleets to compressed natural gas. Several vision for 2021 and for 2030 to diversify the economy and to drive development in renewable energies, electric vehicles and CCU (steel mill operated with CCU and EOR). No mention of compensation Article 4.8
Venezuela	GHG commitment to reduce the country's emissions by at least 20% by 2030 in relation to the baseline scenario pending provision of finance, technology transfer and capacity building pursuant to Article 4.7 of the Convention. No mention of oil
Nigeria	To keep current emission intensity of 2 tonCO_2/capita at this level until 2030 (conditional upon support). 3.4 tonCO2/capita unconditional pledge

Sources: www.UNFCCC.int and NDC partnership https://ndcpartnership.org/node/21071

This is just a snap shot of the pledges made to the UNFCCC from a select number of fossil fuels dependent states. In general, the commitments are, as expected quite weak and none of these countries explicitly mentions 1.5 or 2 C target or the need for long-term ambition to reach net-zero. The implications of a 1.5 C target compared to the current *de facto* target of 3.1 to 3.7 C, based on the ambitions in the currently submitted NDCs, is enormous for oil-producing countries. The difference between 1.5 C with high confidence compared to a 2 C target with low confidence is a difference of 1700 Gton CO_2 according to Figure 1 (the available oil reserves corresponds to 700 Gton CO_2). The future negotiations on how exactly to interpret the climate change target adopted in Paris will be sensitive.

Some oil producing states such as Saudi Arabia and the UAE have started to acknowledge that they need to prepare for a world beyond oil whereas other oil producing countries seem currently less prepared. The responses of Saudi Arabia and Russia, two of the largest petrostates, illustrates the different approaches adopted so far to deal with peak demand and the effects of climate policy.

The position of Saudi Arabia towards UNFCCC and climate change in general has historically been very negative (Depledge 2008) but this attitude has markedly shifted the last years (Krane 2021). Saudi Arabia changed their position within the UNFCCC negotiations from "blocker" (Depledge 2008) to "opportunistically constructive" (Krane 2019b). This change of mind comes from internal problems within the Kingdom with deteriorating oil revenues, high domestic emissions and excessive energy use. The need to diversify and find a replacement industry that "exceeds the loss of revenue from oil export" (Kingdom of Saudi Arabia, 2015) and to reduce their own wasteful oil consumption fits well with their targets submitted in their NDC. Saudi Arabia has launched a Vision 2030 that emphasizes economic diversification and renewables[22]. However, a reasonable oil price is needed to finance this vision and the idea is that Saudi Sovereign Wealth fund (PIF[23]) should become the largest in the world and invest in projects that eventually will provide the Saudis with revenues replacing lost oil revenues (Moshashai et al 2020). Selling 5% of Aramco was part of boosting the capital for the sovereign fund (Moshashai et al 2020). The Saudi transformation is both economic and political and still developing (Krane 2021, Fattouh and Sen 2021) and the Vision 2030 faces several challenges within the state itself (Moshashai et al 2020). The ratification of the Paris Agreement could be interpreted as a new strategy for Saudi Arabia (Krane 2021) where Saudi Arabia is focusing on selective reductions such as reducing alternative GHGs, and flaring restrictions to oil fields (reducing methane emissions) and the adoption of Carbon Capture and Storage (CCS) technologies.

Russia´s economy has historically not been as dependent on oil and gas as compared to Saudi Arabia. For Russia, oil has a long history and is a main revenue for the economy (10% of GDP). However, gas is also a major revenue source for Russia (3.7% in 2018) and is increasing in political importance due to the strategic reliance on infrastructure. Economically, increasing oil and gas prices helped Putin after the decline in the economy the early 2000s (Goldman 2010). Russia´s economy has a large but uncompetitive manufacturing industry (with few exports) that survives as the cash inflow of "petrodollars" are keeping demand high in Russia (Bradshaw et al 2019). Russia has not yet presented any long-term plan for a "post gas/petroleum" economy, and seems to be determined to continue with increasing oil and gas production as the base of their economy (Bradshaw et al 2019). Russia has plans to diversify the economy but this is a diversification based domestic industrial development subsidized by a strong future development of its natural resources, e.g. increasing the dependence (or maintaining) on hydrocarbon resources[24]. To this end, Russia is increasingly engaging in "gas diplomacy" and actively building pipelines for continued gas exports. The current expansion of gas pipelines to the EU (Nordstream II) is now complemented with initiatives to build pipelines to China[25] and Turkey[26]. These pipelines should be seen as a part of Russia´s energy strategy to secure a long-term market by

[22] Saudi Arabia is also pursuing major effort to move into petrochemicals with Sadara joint venture with Dow chemicals. Saudi Aramco and SABIC is expanding into petrochemicals production across the world for ensuring a new market niche of Saudi oil (Krane 2019b). Saudi Aramco is also investing downstream in foreign refineries and end uses with the aim to further "lock in" Saudi Arabian crude to the market similar strategies as the seven sisters did in the early 20th century (Krane 2021).

[23] The Public Investment Fund; (PIF) https://www.pif.gov.sa/en/Pages/default.aspx#1¨

[24]However, there are signs that Russia begins to acknowledge that oil demand might have peaked or will peak the coming 10 years: "Russia-starts-preparing-for-life-after-peak-fossil-fuels" https://www.bloomberg.com/news/articles/2020-12-05/russia-starts-preparing-for-life-after-peak-fossil-fuels

[25] https://www.washingtonpost.com/world/asia-pacific/a-huge-siberian-gas-pipeline-binds-russia-and-china-as-gas-flows-for-the-first-time/2019/12/02/35250ff8-14f7-11ea-80d6-d0ca7007273f_story.html

[26] https://www.e-ir.info/pdf/79966

diversifying the outlets and thus reduce the risk of an EU peak gas demand and locks-in China gas demand with a 30 years contract to finance the pipe line.

5.3 Regulating the oil-output instead of the demand

The global negotiations within the UNFCCC focus on limiting the *demand* for fossil fuels by asking countries to adopt mitigation policies, e.g. fuel efficiency or fuel shifts to renewables. The responsibility for mitigation thus rests upon the countries that consume the oil and where the emissions occur. A different logic would be to ask countries that *produce* oil, gas and coal to reduce the output and thus constraint the emissions in that way. The logic of "going upstream" is not new in the UNFCCC and is today applied to *avoid* the exploitation of tropical forests in the REDD[27] mechanism. In the same vein, as similar logic could be applied where oil producers could be asked to/or payed to avoid exploiting their fossil resources. Governments normally own subterranean resources, such as oil, gas and coal, and companies only lease the right to extract and pays a royalty to the state. Governments can thus have a direct control over these resources. An initiative, Yasuni-ITT in Ecuador, tried this by creating a fund to compensate that Ecuador would not exploit an oil field. The initiative started in 2007 but could not find enough donors willing to contribute to the fund. Ecuador subsequently abandoned the initiative in 2013 and oil drilling began in 2016.

Complementing the current global climate with upstream supply restriction policies (e.g. bans/moratoriums) has been neglected in the discussions until recently. Supply restrictions would have several benefits such as avoiding the "green paradox"[28], certainty, and low administrative costs (Green and Denniss 2017). A supply-side agreement can also act as an insurance if demand-side policies does not work, or does not stimulate enough R&D for low carbon technologies, and can enhance the impact of the Paris Agreement in the presence of free riders (Asheim et al 2019, Newell and Simms 2019, Piggot et al 2018).

OPEC might gain from restricting global output by increasing export prices instead of relying on that consumer states will increase national carbon taxes (Persson et al 2007). Allocating extraction rights instead of limiting demand increases oil prices and can thus gain acceptance from producer states (Asheim et al 2019). A consumer carbon tax will allow consumer states to gain the "climate rent" from oil as compared to a production tax that will keep this rent in the producer economy.

Newell and Simms (2019) suggested a fossil fuel non-proliferation treaty similar to the existing treaties for nuclear armaments and the moratorium on mining projects in Antarctica.

[27] REDD: Reduced Emissions from Deforestation and forestry Degradation

[28] Green Paradox: that climate policies by suppressing demand will lower fossil fuels prices and thus make renewables less competitive

This treaty would start with a moratorium on exploration for new fossil fuels reserves (as is needed according to IEA 2021) and also include an assessment of current reserves and a sequencing on how to phase out and which reserves to “leave in the ground” (Newell and Simms 2019).

The number of policy initiatives to reduce the amount of fossil fuels put on the market has grown substantially the past decade from the bottom-up. At the national and regional level there has already been a growth of “leave it in the ground” decisions such as France decision to ban fracking in several parts of the EU (France, Germany, Wales, Scotland etc.), Denmark´s pledge to ban new oil exploration within their waters, and Germany´s decision to phase out of coal in Germany. Gaulin and Le Billion (2020) created a first world database that covers 1302 phase-out different initiatives. Most of these have come the past decade and are typically concentrated in countries with low or no dependence on fossil fuels. None of these has so far resulted in anything more substantial as usually the big extractors are not part of the deals. The exception is Norway and Canada (ibid); two countries with fossil fuels reserves and at the same time a high profile in climate mitigation. In order to become effective, the group of countries engaging in these initiatives need to grow and include petrostates if not to result in “fossil leakage”.

6 Responding to climate policy and peak demand

The bleak outlook for the oil market with lower prices poses severe challenges for petrostates. There is a need for a long-term vision of how to escape this "carbon lock-in" and to diversify their economies. Diversifying strategies can either build on existing fossil industrial structures or aim to diversify the whole economy towards new sectors, such as information technologies, tourism, services or innovative manufacturing. Diversification of the whole economy usually comes with a need to change the institutional settings and this can have political ramifications. Below we discuss first the opportunities for diversifying the current industrial structures and then the challenges for more profound changes of institutional settings for enabling a wider diversification of the whole economy.

6.1 Diversifying the existing industrial structures

6.1.1 Extending the use fossil reserves

The remaining carbon budget in Section 2 assume that the world cannot consume fossil energy without causing CO_2-emissions. However, fossil energy resources can still supply energy with low or even close to zero emissions by utilizing carbon capture and storage (CCS) technologies where the emitted carbon is captured and permanently stored underground[29]. CCS is only feasible for coal and gas used for large power or industrial production sites and not for oil use in e.g. individual vehicles.

The claim that coal and gas reserves can be prolonged is disputed on several grounds. McGlade and Ekins (2015) include CCS for coal and gas as an option in one of their scenarios and comes to the conclusion that CCS does not extend the lifetimes of reserves very long as it will come too late, due to long lead times for planning and construction, to make a substantial contribution. It is also questionable if coal and gas power equipped with CCS will be competitive with renewable electricity such as wind and solar power. In large parts of

[29] Carbon capture and utilization (CCU) is also an option where the CO_2 is captured from flue gases but then used as feedstock for petrochemicals. For CCU, the emission will eventually come up at the end of life and needs to be stored underground there. In practice, this means that all waste combustion needs to be equipped with CCS, a fact often neglected by the proponents of that technology.

the world, wind and solar power is cheaper today compared to new coal and gas power even *without* CCS (IRENA 2019). A further limitation for using CCS is that a typically coal or gas power plant with CCS reduces CO_2-emissions only with 80 to 85% using current post-capture technologies which is not sufficient for meeting the 2050 climate target of zero emissions.

There is also a technical possibility to extend the use of natural gas, and possibly coal, by separating and storing the carbon from these feedstock and produce pure hydrogen ("pre-process capture"). Hydrogen produced from a fossil resource with CCS is commonly referred to as "blue hydrogen" (IEA 2020). Blue hydrogen is not entirely emissions free and between 50 to 90% of the embodied carbon can be captured pending on which technology is used[30]. Blue hydrogen can theoretically also be produced from coal and even from oil via gasification with CCS (Lua et al 2019). Blue hydrogen as a low-carbon option need however to compete with green hydrogen in the future. Green hydrogen is produced from electrolysis and water and will thus be inherently carbon free which is a major advantage compared to blue hydrogen that relies on effective management of CCS and residual emissions.

In Figure 3, the estimated costs of producing grey (hydrogen produced from natural gas with CO_2 emissions), blue and green hydrogen are given for today and the future anticipated cost for green and blue hydrogen as these technologies are still developing.

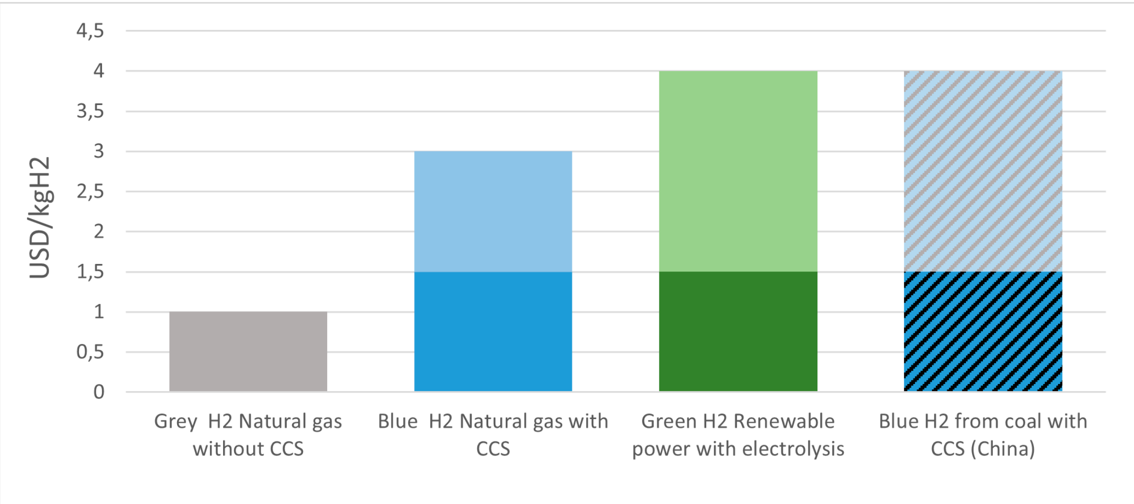

Figure 3. Costs of producing blue versus grey and green hydrogen.
Notes: Blue and green hydrogen presented with both high and low estimates. High estimate represents current cost and low estimates represent the potential future cost. Source. Based on IEA 2018, 2019, 2020, Cappellen et al 2018, Lua et al 2019.

[30] With steam reforming can have a 50 to 90 % capture rate (the higher rate if flue gas from the needed heat is also captured) whereas Auto Thermal Reforming (ATR) captures above 90% of the CO_2 (Cappellen et al 2018)

For blue hydrogen to become competitive with grey hydrogen, the cost difference will have to be compensated by a carbon price. As an example, the IEA estimates that blue hydrogen in the MENA region requires a carbon price of 50 USD/ton CO_2 in order to become competitive to grey hydrogen (IEA 2019)

The cost comparison between blue and green hydrogen favors blue hydrogen in the short-term (IEA 2020) but green hydrogen is expected to become competitive the coming 5 to 10 years due to declining cost for both electrolyzes and renewable electricity (IEA 2018b, 2020). The production of green hydrogen is projected to increase substantially the coming years with several major projects underway that will drive down costs as it enters large-scale production[31]. However, future fossil feedstock prices can also decrease in a scenario where the supply outmatches the demand (see Section 5). A mixture between gas prices, electricity price and future development of electrolyzers will determine the breakeven between blue and green hydrogen and this will differ between regions in the world.

The current global market for hydrogen is around 70 Mton/year, mostly used as feedstock for chemicals. The hydrogen market is projected to grow to at least 168 Mton/year by 2030[32] equalling a value of 170 to 500 billion USD (assuming hydrogen prices ranging from 1 to 3 USD/kgH2). Beyond 2030, the market for hydrogen could continue to grow as hydrogen becomes a major part of a deep decarbonization effort of steel industry (Vogl et al 2018), plastics industry (Palm et al 2018) and for the transport and heating sectors (IEA 2019). The markets´ trust in these projections are strong and a number of projects and initiatives are underway to developed industrial capacity for producing both blue and green hydrogen[33].

Blue hydrogen could extend the use of existing gas resources in gas rich countries such as the US, Iran, Qatar, Saudi Arabia, Russia and Norway. However, compared to the current global market of oil that amounts to approximately 5 000 billions USD/year, the future hydrogen market will still remain small in comparison. Especially as a replacement for lost oil revenue for petrostates if we account for the fact that the rents (sales value minus production costs) are substantially less for industrially produced hydrogen compared to oil.

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[31] "Gigawatt-scale-the-worlds-13-largest-green-hydrogen-projects" https://www.rechargenews.com/transition/gigawatt-scale-the-worlds-13-largest-green-hydrogen-projects/2-1-933755

[32] "Global hydrogen production market to hit massive $420 billion in 2030" https://www.powerengineeringint.com/hydrogen/global-hydrogen-production-market-to-hit-420bn-by-2030/

and Hydrogen production set to increase https://oilprice.com/Energy/Energy-General/Hydrogen-Production-Is-Set-To-Increase-5000-In-Just-5-Years.html

[33] Examples of Blue H2 projects include: Aramco export of blue ammonia to Japan, the project H-vision in Rotterdam (H-vision 2018) , the H21 Equinor hydrogen project in England (www.h21.green), the NEOM plant in Saudi Arabia (650 t/day H2 and 3000 t/day Ammonia) powered by 4GW solar/wind with Acwa power, Thyssen Krupp and Air products (US) involved.

6.1.2 Expanding to petrochemicals and downstream processing

Petrostates can also diversify their economies by investing downstream in the fossil value chain into the refinery and petrochemical industry. Petrochemicals would allow producer economies to capture a higher value and increase the number of domestic jobs, especially if the downstream investment went further and includes plastics and chemicals production (Fattouh and Sen 2021). Another key benefit is that the earnings from downstream processing are counter-cyclical to oil price cycles thereby offers a stabilizing effect. Producer economies are currently making huge investments to expand into downstream processing (IEA 2018). Saudi Arabia, via SABIC, and the Gulf States have established a number of industrial parks since 2011 to move into this direction (Fattouh and Sen 2021). Saudi Arabia is also exploring new processing techniques to go more directly from crude oil to chemical produces instead of chemical as a by-product from refineries, e.g. producing chemicals from a substantially larger share of the crude (Fattouh and Sen 2021). This is good if demand for petrol and diesel in the transport sector declines.

International projections expect the production of chemicals from the MENA-region to double between now and 2040, reaching 17 % of global production by 2040 (up from 4% today) (IEA 2018). This means that only a minor part (0.8 million barrels/year) of the expected increase in oil (6.5 million barrels/y) is expected to be sold as crude (IEA 2018).

Apart from strategies “to pull” petrochemicals production to oil regions, stronger climate policy measures within the OECD might also “push” energy intensive fossil based petrochemicals production to relocate to oil regions with lesser regulations and easier access to fossil feedstock (Goldthau and Westphal 2019). However, there is a future risk here that petrochemicals of fossil origins will be subject to border carbon adjustments for exports into the OECD because of recent trends in climate policy to include embodied emissions in trade (Åhman et al 2020).

6.1.3 Building on a competitive advantage from renewable energy

Many petrostates have a competitive advantage from producing renewable electricity at low costs. Access to low cost renewable electricity will be a key resource for deep decarbonisation in the future (Lechtenböhmer et al 2016, IRENA 2019). Renewable electricity will be the main future source of energy supply in the future due to the rapidly declining costs for wind and solar power as the potential scale-up problems for the other main decarbonisation options, such as CCS and biomass, have become apparent.

Countries with favourable conditions for developing low-cost renewable electricity are Australia, Saudi Arabia, Northern Africa, Chile (Bogdanov et al 2019, IRENA 2019). This competitive advantage could provide some of the current petrostates like Saudi Arabia, Iran and Iraq (and even Russia with wind) with a long-term lifeline. These countries might, from an industrial policy perspective, want to move up the value chain rather than just exporting renewable electricity but also to export intermediate materials or products that have a higher value.

As an industrial upgrading strategy, an export industry based on renewables would create jobs and help build industrial capacity but would generate substantially less rents compared to oil. Using this competitive advantage for producing exportable commodities like hydrogen is a first step that can be followed by further development into exporting refined commodities such as ammonia and other industrial intermediates at scale such as DRI (direct reduced iron). Gielen et al (2020) make the case for Australia to shift from exporting coke and iron ore to start exporting DRI based on solar derived hydrogen. Gidey et al (2017) and Armijo and Philibert (2019) argue for green ammonia production based on renewable hydrogen that could compete with fossil alternatives in scenarios with low electricity prices. Diversifying the whole economy and institutional change

6.1.4 Fossil fuel subsidy reforms as an immediate response

The first and immediate response to both declining oil and gas revenues is to reduce the substantial domestic use fossil fuels that has been exacerbated by large consumption subsidies. Petrostates provides some of the largest subsidies to oil and gas consumption in the world with a subsidization rate averaging around 55 to 80% of consumer prices compared to international fuel prices in 2014 (Al-Saidi 2020). These subsidies represents between a fifth to a third of total government spending, equalling or even above spending on health care and education (El-Katiria and Fattouh 2015).

Subsidies to fossil energy have many well-known negative side effects. With low or no cost for supply of electricity and heat, these countries have turned into some of the most energy intensive economies in the world and fostered a wasteful use of energy. The Gulf region now consumes on average 25% of all the oil and gas output internally, up from 5 % in the 1970s (Krane 2019). Energy subsidies, motivated for protecting the poor from energy poverty, are often inefficient in doing so as they disproportionately favors the middle class that are the major consumers of energy (Skovgaard and van Asselt 2018). Subsides to fossil energy have also long-term developmental effects so called carbon lock-in. Subsides to fossil fuels creates expectations of continued low but unsustainable energy prices among households. Industrial development developed based on access to low cost fossil energy crowds out the development of renewable energy and other sectors.

Changing the levels of subsidies in petrostates is difficult as the size and longevity of these subsides have formed society and politics for decades and is usually a part of the political “deal” in a country. Subsidies are a part of the social contract, i.e. that the state provides citizens with low cost energy in return for support (Al-Saidi 2020, Krane 2019).

Starting around 2010, and with increased attention after the oil price decline in 2014, there have been many initiatives to reform the subsidy regimes within producer economies. The results from these initiatives have been mixed but not all together negative. Iran succeeded in reducing subsidies by offering a cash handout and simultaneously making a huge information campaign (Krane 2019). Egypt succeeded to launch a subsidy reform in the aftermath of the Al-Sisi take over in 2013 (Mourenhout 2018) when there was a political momentum to do it. Saudi Arabia launched a reform program in 2016 that has managed to stepwise increase energy prices. This program linked subsidy reductions with a cash transfer of 250 USD to each household (Salehi-Isfanai et al 2015).

Subsidies reforms challenges the long held wisdom that energy subsides are a core part of the social contract in rentier states and thus cannot be changed. The common denominator is that several political factors coincided that made these changes possible, notably the oil price drop reducing fiscal budgets and also the soaring domestic energy demand showing that something had to be done in order for these states to survive (Krane 2019, Al-Saidi 2020). Several other countries (Venezuela, Nigeria, Indonesia, Mexico) have tried but with less success. Skoovgard and van Asselt (2018) and Inchauste and Victor (2017) gives several country example of these previous and ongoing attempt to reform subsidies.

6.1.5 Diversifying the whole economy and long-term development

Petrostates need also to adopt a long-term strategy to transform and break away from the institutional and economic dependence on oil and gas rents. There is an increasing awareness of this among some of these states, albeit with different ambitions. As briefly described in Section 5.2, Saudi Arabia and the rest of the Gulf countries recognize this threat and have started to develop diversification strategies beyond oil and gas. Russia seems to have the ambition to diversify its economy but based on continued oil and gas revenues in the long-term. Other petrostates in Figure 2, such as Libya, Iraq, Nigeria, and Venezuela, that all suffered from declining and volatile oil prices the past five years, have so far not managed to develop any comprehensive strategies (Peszko et al 2020).

Unlocking a strong political path dependence based on oil and gas is harder than just economic diversification linked to the existing industrial structures. In order to develop into a competitive economy with a diverse set of sectors and a high level of innovativeness, several long-term investments into human skills (education and research) linked to institutional reforms that create the right incentives for entrepreneurship is needed. A modern "production state" has the capacity to produce a variety of competitive products to the market. This capacity does not come from only traditionally analyzed production factors such as labor, energy endowments, and capital, but from the full complexity of knowledge creating and productive capacities supported by innovation and industrial policies.

Complexity of economics is one concept of capturing all of these preconditions by measuring a basket of export products from a country[34] and can be seen as a proxy of all things that relates to a nation´s capacity to produce a variety of competitive products domestically (Hausmann and Hidalgo 2009).

Russia has not managed to diversify but relies on industrial development linked to their domestic oil and gas industry (Bradshaw et al 2019, Lyubimov 2019) whereas Saudi Arabia has a stronger focus on diversifying but this diversification is still linked to the petrostate logic and has "rentier characteristics" (Yamada 2020). The private sector in the Saudi Arabian economy rely heavily on public procurement, has historically developed around an advantage of access to low-wage, and imported work force (Yamada 2020). The recent efforts of Saudi Arabia and the Gulf states to expand renewable energy as a way to escape fossil dependence also builds on existing institutional structures of the rentier state (e.g. a strong reliance on public procurement and state coordination) and thus risks reinforcing the current rentier state model (Sim 2020).

For a petrostate to diversify, there is a need for an "institutional upgrading" from the rentier state logic, where the state is preoccupied with capturing and redistributing rents, to a production state. A production state has a state bureaucracy that is independent from vested interests (normally the ruling elites) and has the ability to tax the population and to focus on developing the innovative capacity of a nation (Yamada 2020). In general, transitioning from a rentier state to a production state that resembles OECD economies is not easy, a long-term process, and linked to institutional and political developments. The political elite in authoritarian states needs to agree to political changes and to lose some of their control, often in their self-interest, or change can come from external political changes. Historically, institutional upgrading has come when vested interests within the state accepts loss of influence and rents in order to avoid an even worse scenario with loss of legitimacy and power (Yamada 2020). Indonesia can be seen as one example where the combination of political changes together with the geostrategic position were the two factors that pushed Indonesia away from overreliance on oil into a more productive state (Rosser 2007).

[34] Complexity of Economics Atlas: https://atlas.cid.harvard.edu

7 Discussion

Global climate and energy policies have succeeded in accelerating the development of renewable energy to the level where renewables are competitive with fossil alternatives in most parts of the world. Renewable energy has been rapidly deployed around the world for the past 10 years and are set to outcompete fossil alternatives in the long-term. Now, global climate policy need to broaden the perspective and focus on the implications of phasing out the remaining use and production of fossil energy with a speed that is consistent with the climate targets set in the Paris Agreement.

The most difficult part of this global transition will undoubtedly be to address the petrostates whose whole economy and governance systems are molded around revenues from oil and gas. The awareness of what a rapid decline in fossil energy demand, as required by the Paris Agreement, would mean for petrostates is not yet fully accommodated within these states. There is, however, a growing awareness of a potential crisis stemming from the recent developments on the global oil and gas markets where the perception have changed from a future "seller´s markets" to a "buyer´s markets". The effects of climate policy and renewables development is set to make large parts of the remaining oil and gas reserves stranded and have triggered responses in several countries. The differences in both awareness and capacity to act on this knowledge between the circa 15 to 20 countries that could be labelled as petrostates is wide.

The effect that the Paris Agreement will have on the fossil fuels markets is strongly dependent on how the climate target is interpreted. The Paris Agreement target includes a substantial flexibility and the speed and ambition of future emission reductions will have a tremendous effect on fossil fuels markets. The allowable carbon budget left to year 2100 can be anything between <400 Gton to <2000 Gton. Recent science has furthermore argued for an even faster near-term response in order not to risk overstepping feedback loops in the climate system. A steeper near-term reduction target would have even more dramatic effects on the oil and gas markets and the value of the remaining fossil reserves.

The lack of preparedness can also be seen in international oil demand projections and oil and gas production expansion plans by the e.g. IEA and OPEC countries that in most case are grossly overshooting the allowable carbon budgets. If the major consuming countries (USA, EU, Japan and China) maintain and accelerate their climate policies, then a large part of the reserves and planned investments by petrostates will become stranded nonetheless.

The conflict between allocating the remaining fossil reserves according to cost-efficiency and market principles, as embedded in integrated assessment models, and an allocation based on justice principles as embedded in the UNFCCC, is not resolved. Neither cost-efficiency nor fairness will likely dominate this allocation in the real world as domestic and international geopolitics will play a part. However, the phase out would benefit from being globally coordinated and assistance offered to those least developed countries that choose not to exploit their resource for the benefit of the climate.

Petrostates can choose, or be forced to choose, different strategies for maximizing their remaining revenues and either choose to cooperate and collude or to “pump and panic”. Collusion would be a way to ensure that the producers would capture most of the value of the remaining reserves. Collusion and cooperation has been the strategy ever since the early 1930s among the big international oil companies and later, with the formation of OPEC, the strategy by the main producer economies. However, today the number of petrostates has grown and these have different agendas and positions. The tradable fossil energy carriers has also grown with the emergence of natural gas as a traded commodity that competes with oil but with a lower carbon footprint. There are also several petrostates with large and yet untapped fossil reserves such as Iran, Iraq and Venezuela with the world´s largest oil reserves. Previous successful collusion by the OPEC was orchestrated in a world when oil demand was steadily growing. The limited allowable reserves under climate change will be a major problem and cause political conflicts between these countries, which makes an orchestrated decline less probable.

Apart from colluding to gain the maximum out of the remaining fossil assets, several petrostate are today developing diversification strategies and preparing for a future with less dependence on oil and gas revenues. However, the preparedness for an economy beyond oil in the major petrostates is just emerging and is still nascent or weak. The short-term response has been to start phasing out subsidies to domestic use of fossil energy. Phasing out subsidies is always difficult but the last experience has shown some promise with reduced subsidies in the MENA-region. Several countries in the MENA-region are developing the capacity to diversify by moving down the fossil value chain by e.g. developing petrochemical clusters or building and owning overseas refinery capacity to “lock-in” future oil exports. Russia is also aiming for diversifying their economy but based on the vast gas and oil resources they have. A longer-term diversification strategy can in some cases build upon utilizing the large untapped potential for renewable energy that several of these petrostates have in e.g. solar or wind power, or even developing CCS option for extending the use of their fossil resource base. A potential diversification strategy for several petrostates would be to utilize their access to low carbon energy resources (renewables or fossils with CCS) to move downstream into the commodities market by refining and export green or blue commodities such as hydrogen, iron, ammonia, and aluminium. This would provide more jobs and domestic development but would also require a better-trained population.

Diversifying existing industrial structures is not enough. A wider diversification of the whole economy is needed and this often requires an institutional reinvention or "upgrading". Recent examples of diversification strategies by petrostates prolong the status quo and seems to be merely reinforcing the rentier state model. However, the true effect of these strategies remains to be seen the coming years. Historic examples show that in order to achieve an institutional upgrading, the incumbents need to concede part of their influence over the economy, something that normally only happens when they face an existential threat.

Several areas needs more and deeper understanding in order to formulate effective responses to this major challenge. More in-depth knowledge of the main petrostates, and how the political economy and state model is evolving, is needed. A new area worthy of investigation is also the role of natural gas and "gas diplomacy" that may act as a carbon lock in with long-term contracts. This transition will have major effects also on the geopolitical balance between petrostates and their neighbours and requires further efforts as developments unfold.

8 Conclusions

Petrostates face an unprecedented crisis as oil and gas revenues, on which their economies and states have been built upon, are set to diminish rapidly the coming 20 years. Petrostates need to transform quickly and to adopt ambitious green industrial polices to diversify their economies. Oil and gas revenues will dry up – it is not a question of *if* but of *when* and current developments suggest that this is already under way and will accelerate the coming five years. The emerging peak demand of oil and gas is a combined effect of two interconnected developments. First, the growing political momentum in the major oil consuming countries such as the US, EU, China and Japan, to implement stricter climate policies and second, the rapid technology developments of both renewable energy and of end-use technologies such as electric and fuels cell vehicles that do not use oil or gas.

Current plans for both oil and gas exploration, and thus the expectation of future revenues, in petrostates are not in line with the current rapid developments in climate policy and renewable energy. A large share of their oil and gas reserves can never be used and investments in exploration will thus become stranded. Petrostates need to diversify their economies and rapidly become less dependent on the declining revenues from oil and gas. A select number of petrostates have started to invest in downstream petrochemicals and refineries to secure a part of the future oil demand. These states have also begun to take advantage of their great potential for renewables with huge investments lately. There is also an emerging interest in further downstream investments from renewables with the production and export of commodities such as green ammonia and green hydrogen. However, the rents and future revenues from these sectors will never compensate for the loss from oil and gas exports. Thus, petrostates need also to deal with the long-term challenge of diversifying the whole economy. This means that petrostates need to instigate political and institutional reforms to create the right incentives for an inclusive and diversified economy. Phasing out consumption subsidies the oil and gas is a first and difficult step but this needs to be followed by a broader strategy for an institutional upgrading.

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When gold turns to sand

Petrostates face an unprecedented crisis as oil and gas revenues, on which their economies and states are built upon, are set to diminish rapidly the coming 20 years. The decline in revenues is an effect of the adopted climate policies in the major oil consuming countries that, together with a strong development of renewable energy, reduces the future demand for oil and gas. The challenges that this change create are not only the financial losses but equally important are political and institutional challenges. The dependence on oil and gas have formed both the goverance and the economic structures and thus neglected alternative developments that could have fostered a diverse and competitvie economy.

Petrostates need quickly to adopt green industrial polices to diversify their economies. A few petrostates have started to prepare for a future beyond oil and gas. These diversification strategies can be grouped into either diversification of existing industrial structures, or a developmental strategy to diversify the whole economy to become more robust and innovative. The effectiveness of these diversification ambitions is still unclear. The political changes needed are first to reduce the abundant consumption subsides to fossil energy. This is not easy as this is part of the social contract of a petrostate. In the longer-term, an institutional upgrading is needed to create the right domestic incentives for developing a diverse and competitive economy.

Several areas needs more and deeper understanding in order to formulate effective responses. More in-depth knowledge of the main petrostates, and how the political economy and state model is evolving, is needed. The geopolitical dimension of this transition cannot be understated and requires further efforts.

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