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CGIAR FOCUS Climate Security Position Paper Series

The Climate Security and Energy (Transition) Nexus: Winds of Change

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Acknowledgements

The authors want to thank the following people for their support. Their colleagues from the wider CGIAR/CIAT network, the engaged experts whose interview insights helped to enrich this paper greatly as well as the reviewers who provided valuable comments, particularly Timothy Suljada from the Stockholm Environment Institute (SEI) and David Mozersky from Energy Peace Partners.

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Executive Summary

Global climate change will likely add pressure to international, national and sub-national security due to its nature as a threat multiplier. The energy system is at the heart of this challenge. On the one hand, two thirds of global emissions come from burning fossil fuels. On the other hand, energy – in particular fossil fuels – have been in the past highly geopolitically influential. But global energy systems are changing. Will this global transition away from fossil fuels to renewables present an opportunity to build peace, or will it instead work to further undermine peace and security worldwide?

In order to meet the targets of the Paris Agreement and the wider sustainability agenda, countries and local communities have started to decarbonize their economies and the ways they consume energy by transitioning to renewable energies. Fossil fuel production, particularly oil, is geographically very concentrated – with the US, Russia and the Middle East accounting for more than 60% of global oil production. Renewable energies, however, are more decentralized. This means, theoretically, each country could harness the power of the wind, sun or water to create energy. Despite this, for many countries, fossil fuels remain important economically, generating revenues, jobs and foreign currency reserves. How the energy transition will affect those fossil fuel-dependent countries is still not fully clear, but it does illustrate what potential future security challenges could lay ahead as we transition globally to mitigate this global climate crisis.

Many scholars and practitioners argue renewable energies have the potential to increase global stability and security. Their decentralized nature means benefits can be more evenly distributed – reducing the risk of conflict outbreaks. Moreover, renewable energies are thought to foster regional cooperation as countries will need to work together to balance out intermittent coverage (the sun is always shining somewhere in the world). Due to their communal nature, renewables are thought to facilitate the emergence of practices conducive to peace and stability such as building trust, transparency and good governance.

While there is evidence beginning to emerge to back up these claims, much of this thinking is based on assumptions. Moreover, in order for renewables to deliver on their potential, pitfalls should be avoided and potentially negative impacts on security and stability should be acknowledged. For instance, while the sources of renewable power (sun, wind) are abundant, the raw materials needed as part of renewable technologies (metals, metalloids and rare earths) might not be – thus harboring conflict potential. This risk is compounded if stakeholders fail to be consulted on renewable energy developments that might happen in their proximity. An increased interdependency is only conducive to stability when broad solutions are sought involving all parties, rather than short sighted, nationalistic solutions.

It's important also to avoid lumping renewables together, as each one is different in terms of its conflict potential. However, these differences are not well understood. And while lowering emissions and being more democratic is laudable, massive renewable deployment might have negative, unintended consequences such as increasing land-use change or negatively affecting food security, particularly when it comes to biomass-based energy. Renewable energies have huge potential, not only to lower emissions but also to contribute to a more equitable, democratic and secure world. However, for that to materialize, several good practices are necessary to deploy at scale.

Cooperation is needed on all levels (from the international to the sub-national), to address potential bottlenecks in mining and refining materials necessary to produce renewable energies. Adopting new environmental standards on how raw materials are produced may also be key to maintaining peace during this global energy transition. To make renewable energies affordable, the right financing mechanisms should be in place, adapted to long-term project viability both internationally (allowing finance flows from richer to poorer nations) and locally. From a policy perspective, more financial support to renewable energies is needed, so they can better challenge the fossil fuel-based energy system which itself benefitted from decades of monetary and government support. However, such support should be flexible and mindful of socially regressive impacts or environmentally harmful incentives.

On a more local level, renewable energies must meet the needs of local communities. Wide and extensive stakeholder consultations should be prioritized over top down, 'one-size-fits-all' approaches. Investment into education and training are also necessary, not only to build and maintain renewable energy installations, but to provide those dependent on fossil fuel jobs with the skills and opportunities needed to earn a living when jobs disappear during the transition away from fossil fuels.

Energy transitions present a formidable opportunity not only to decarbonize our economies, but also to build a more equitable and decentralized energy system. However, if deployed improperly, and without consideration of the needs of communities, renewable energies might end up repeating past mistakes of the fossil fuel energy regime. Energy transitions harbor both risks and uncertainties when it comes to peace and stability, but with the proper policies in place and research, renewable energies can be made a global success, both in mitigating the worst impacts of the climate crisis and in contributing to peace and stability worldwide.

1. Introduction

Today, there is a scientific consensus that climate change is man-made and that it has some significant impact on our world: rising temperatures, rising sea levels, ocean acidification, biodiversity loss, increased likelihood of natural disasters and stresses on freshwater availability and food production are only a few of the expected impacts (IPCC 2014). However, not all regions of the globe are expected to be impacted equally (IPCC 2014) and countries are thought of having different capacities and resources to deal with the impacts, e.g. their resilience and vulnerabilities differ (Byers et al. 2018).

In recent years, this diverging resilience and vulnerability has been viewed through the prism of international security which has led to the emergence of the research field "climate security", i.e. the analysis of how climate change affects conflict and political stability (Scheffran and Battaglini 2011; Boas and Rothe 2016; Dalby 2014). Although the "securitisation" of the issue has been criticised (see (McDonald 2013) for a good overview of the different discourses about climate security), it has been high on the policy agenda. The issue has been discussed in the UN Security Council (2007 and 2011), the EU and NATO recognise climate change as threat to international security (European Commission 2021; Birnbaum and Ryan 2021) as does the African Union (African Union 2021) and the G7 commissioned a comprehensive report on the topic (Rüttinger et al. 2015) to name just a few occasions. And while Academia still debates how much and to what extent climate change impacts international and national security – with some arguing for a strong link (Hsiang and Burke 2014; Hsiang, Meng, and Cane 2011; Hendrix and Salehyan 2012) and some arguing for a weak link (Mach et al. 2019; Selby et al. 2017; Buhaug et al. 2014), there seems to be a consensus, that climate change does play a role in conflict (Detges et al. 2020; Mach et al. 2019) by negatively affecting people's livelihoods (Gemenne et al. 2014) and by putting additional strains on already burdened societies who suffer from poor economic development, weak institutions and a general history of armed conflict. It is therefore useful to think of climate change as "threat multiplier" a term used by the European Commission and the U.S. Department of Defense (European Commission 2021; Department of Defense 2014). Furthermore, even if the link between climate change impacts and conflict is less robust today, the IPCC expects extreme weather events such as droughts, heat waves, heavy rainfall, sea level rise to increase in frequency and scale over the 21st century (IPCC 2014). In other words, a risk amongst many today could become one of the most important risks in the future.

In order to mitigate climate change and to adapt to its impacts, a significant number of strategies and pathways exist, across all sectors of society many of them trying to replace our most polluting activities with low carbon ones. One of the most prominent sectors is certainly the energy sector, where mitigation efforts are well advanced (particularly in the power sector) and most needed. According to the International Energy Agency (IEA), global GHG emissions from electricity and heat generation accounted for over 2/3 of all global emissions in 2018 (IEA 2021b). And while the exact relationship between energy consumption and GDP growth is not settled in academic debate – although a bidirectional link between economic growth and energy consumption has been postulated (Belke, Dobnik, and Dreger 2011) - almost all of the products we consume and all of the activities we pursue require energy in some form or another.

Due to this centrality, energy is therefore doubly important for our societies. On the one hand, as one of the most important tools to mitigate climate change by decarbonising the energy sector, a term often referred to as energy transition or low-carbon transition. On the other hand, energy politics and policies, particularly the ones based on fossil fuels like oil, gas and coal, have in the past been linked to foreign policy developments, conflict and international security, particularly in popular literature (J. Colgan 2013; Price-Smith 2015), the media (Klare 2014) and some journal articles (J. D. Colgan 2014; 2013). For instance, the Council of Foreign Relations (CFR) has an entire website dedicated to the perceived influence of oil dependency on US Foreign Policy (CFR 2017). And while some scholar dispute the claim that fossil fuels, especially oil, play a prominent role in international conflicts (Meierding 2016), it is safe to assume that fossil fuels and the quest to assure the steady flow of energy on international markets have shaped the foreign policies of many countries (IRENA 2019; J. D. Colgan 2014): The US alliance with Saudi Arabia is often scrutinised under an energy prism (Bronson 2008) and the quest of the EU for energy independence from Russia after multiple gas disputes led to turned off pipelines and unheated homes (Siddi 2018; Newnham 2011) has led to a whole new set of energy security and foreign policies under the umbrella term "Southern Gas Corridor", expected to bring gas to Europe from Azerbaijan instead of Russia (Verda 2016). Moreover, scholars like Ross claim that oil would increase the likelihood of armed conflict (Ross 2004) particularly the duration of conflict between a state and rebel groups present on its territory (Lujala 2010). We can see that all three issue areas (climate change, energy (transitions) and security) seem to be interlinked.

However, while there are academic as well as non-academic publications discussing the impact of fossil fuel dependency on global affairs, there is, quite interestingly, very little research on the geopolitical impacts of energy transitions or research has been rather dispersed and ad-hoc (Vakulchuk, Overland, and Scholten 2020).
Moreover, while publications about "energy security" – narrowly defined as the "[…] uninterrupted availability of energy sources at an affordable price." (IEA 2019) – are quite omnipresent[4], the linkages between energy transitions and international security seem to be rather underexplored. Indeed, the parameters of a "new energy paradigm" - the changing ways humanity will be producing, using and living with energy and its geographies (i.e. the space energy is used and connection between the spaces) - are not well defined (Bridge et al. 2013).

This paper tries to shed some light on the linkages between a more sustainable energy system and its implications for peace and stability. To our knowledge, not many sources in academic or grey literature discuss this and other, related issues. There are several sources which investigate the implications of the energy transition from a geopolitical perspective (IRENA 2019; Vakulchuk, Overland, and Scholten 2020; Scholten et al. 2020; Scholten and Bosman 2016). Others apply a security and conflict lens to energy transitions in specific, localised contexts such as in Palestine (Khaldi and Sunikka-Blank 2020) or China (Eisen 2011) or look at it from an international relations and diplomacy angle (Griffiths 2019). But a comprehensive synthesis on the most salient issues is largely lacking. This paper tries therefore to synthesise existing knowledge about the relationship between a changing energy system necessary due to climate change concerns and the impact these transitions have on local, national and global stability.

[4] The term "energy security" yields almost 400,000 entries on google scholar

2. Methodology

The findings in this paper are based on several rounds of research. In a first round during the summer of 2021, an extensive literature review was carried out, digesting a large amount of academic as well as non-academic sources. Papers were grouped under different themes and read using a set of overarching research questions:

Q1: What are the potential impacts of energy transitions at the global, national- and sub-national level?
Q2: What kind of issues and challenges might emerge on these levels when it comes to inter-state and human security?
Q3: What are the risks of global energy transitions to global, national- and subnational stability?
Q4: What are the opportunities of global energy transitions to global, national- and sub-national stability?
Q5: What kind of impacts do renewable energy sources have on local communities, particularly in conflict prone regions?

Based on this initial literature review, a first draft of the paper was written up, describing the issue- and thematic aeras emerging from the literature. In order to buttress these initial findings, a series of semi-structured interviews was carried out to shed some light on some blind spots and to investigate the impact of energy transitions and renewable energy deployment particularly on the local level. A total of 14 experts were kind enough to provide their expertise during interviews in October and November of 2021, each interview lasting around 30-40 minutes.[5] A list of anonymised interviewees can be found in Annex 1.
Besides these procedural methodologies, reflections in this paper have been guided by the Multi-Level-Perspective theory (MLP) as developed by (F. Geels and Schot 2007; F. W. Geels 2011; 2014). According to MLP theory, innovation and new paradigms don't emerge in a vacuum but are embedded in socio-economic and socio-political contexts, also referred to as the *landscape* in MLP where change happens rather slowly (F. Geels and Schot 2007). International energy markets based on free trade and the principle of a liberal market economy would be the landscape in the context of this paper. Below the landscape sits the *socio-technological regime* which sets the rules, norms and behaviours for the current use of a specific technology system (F. W. Geels 2011). Our current, centralised energy system based still to a large extent on fossil fuels with all the supporting infrastructure (power plants, pipelines, gas stations etc.) would be an example of such a regime, where actors are well connected and form strong networks and where rules and regulations favour stability and even lock-in of this regime (Smith, Voß, and Grin 2010). The last level is the *niche* where innovation is pursued but where actors, networks and rules don't enjoy the same amount of stability as in the regime (F. W. Geels 2011). Think of solar PV a couple of years ago, which definitely did not enjoy the same stable networks, the same infrastructure and the same strong support as fossil fuel power stakeholders.

4. A lot of perspectives to take into consideration

Before discussing potential risk pathways and scenarios, it is useful to sketch out the complexities of analysing the potential linkages between energy systems and conflict.

Firstly, it might be useful to consider the **framing** of the debate. Based on sociologist Erving Goffman's book "Frame Analysis" (Goffman 1986), framing can be described as the act of interpreting the world around by focusing the attention on certain aspects of a problem or an issue (Snow 2013) which is often done by making reference to cultural, social and other norms. The interesting aspect here is that each frame might not only structure the debate around an issue but also somehow predefine what solutions are acceptable (Bößner 2020) and what policies might be adopted to tackle a certain problem. For instance, energy could be framed as a security issue (energy security) or a climate change mitigation issue or an economic issue. Depending on the frame chosen, discussions about the issue might look rather different and framing energy transitions as a thread to geopolitical stability or as a chance might lead to diverging impact pathways and future scenarios.

[5] One additional stakeholder's opinions were integrated into this paper using insights gathered during a webinar on the nexus between climate security and energy transitions, thus raising the total number of experts to 15, 14 of them were interviewed.

In the same vein, conceptual definitions might be brought into the analysis. Terms like "security" or "conflict" are multi-dimensional concepts. For instance, one can speak of "**state security**" i.e. the capacity of states to guarantee sovereignty and stability or "**human security**", the latter concept often mentioned when discussing climate change impacts on the safe and wellbeing of humans (Dellmuth et al. 2018). More recently, even the term "ecological security", has gained currency amongst the research community (McDonald 2018). Moreover, some scholars have deplored the "securitization" of the climate change debate, echoing points made above that depending on the frame used (in this case (state) security), suggested solutions might be predefined and not correspond to the complex context of climate change (Brzoska 2009; Scott 2012). Also, depending on scale (see below), security could be sub-national, national or global in nature (Haftendorn 1991). Similarly, conflict might refer to inter-state conflict, intra-state conflict, violent conflict, diplomatic conflict etc.

This paper will focus on "state security" in the landscape and regime level and on "human security" when investigating impacts on the more localised level. We will ignore the risks that the private sector might incur due to climate change and energy transition impacts, despite the importance of the "stranded assets" debate which has gained traction amongst private sector and policy stakeholders (see box 1). Moreover, it uses the term conflict to describe both violent and non-violent disputes which initially fail to settle, impacting individuals, group of individuals or even states (Hsiang and Burke 2014). Lastly the paper will use the terms "stability" and "instability", to signify a progression or degression of a current observed socio-economic state between nations, within nations and between and within stakeholder groups.

Box 1 – Stranded Assets

> If we want to limit global warming to 2°C or even 1.5°C, most of the fossil fuels currently owned by national and international oil, gas and coal producers must remain underground (Carbon Tracker 2017). Indeed, research shows that current fossil fuel developments are already exceeding the remaining "carbon budget" (i.e. the fossil fuels which humanity can consume in order to stay well below 2°C (McGlade and Ekins 2015)). However, if fossil fuel companies were slow to react to a changing energy system, much of their oil and gas fields and the surrounding infrastructure might become "stranded assets" i.e. costly, unusable investments. Banks such as Citigroup calculated already in 2015 that those stranded assets could amount to $ 100 trillion (!) (Parkinson 2015). Those stranded assets could be especially tricky for fossil fuel producers of the MENA region (Ansari and Holz 2020) which in turn might have negative implications political stability. Moreover, it is important to note that when large infrastructure investments become stranded, social consequences are often a collateral. For instance, regions formerly dependent on fossil fuel developments (such as coal regions) might become "stranded" as well, when people are bereft of their livelihoods thus putting additional pressure on those communities.

Apart from framing and from the different security aspects, analysing the impact pathways of energy transitions also depend on the **scale** one is willing to consider. Potential conflicts and issues around energy systems and energy transitions are likely to look rather different if one considers them from an international perspective or a local perspective, with all the levels in between. For instance, fossil fuels and their markets have been investigated under the prism of inter-state conflict such as the gas dispute between Ukraine and Russia in 2009 (Stern, Pirani, and Yafimava 2009). Going up a level, the Ukrainian-Russia gas crises of 2008, 2009 and 2012 have spurred the European Union into action to seek, rather unsuccessfully (Rodríguez-Fernández, Fernández Carvajal, and Ruiz-Gómez 2020), to diversify their gas imports away from Russia while global energy markets usually interact with and are impacted by wars and terror attacks (Kollias, Kyrtsou, and Papadamou 2013). However, on a much more local, sub-national scale, the impacts of energy system developments might be different. Here, conflict might arise due to unresolved questions of ownership of the unequal distribution of benefits, perceived by stakeholders to be unfair.[6] Furthermore, all these observations assume that when looking at energy transitions, that there is an energy system in place to begin with. However, according to the UN led

[6] Interview_Stakeholder_No1; Interview_Stakeholder_No4

Sustainable Energy For All (SEforAll) initiative, more than 750 million people around the world still lack electricity access and more than 2.3 billion people don't have access to clean cooking fuels.[7] Here, the question is not about energy transitions, but to provide those communities, mainly found in the Global South with energy in the first place, particularly on the sub-national, local scale.

Besides scale, another important factor when considering energy transitions is **geography**. As it is shown below, fossil fuel resources are rather concentrated in a few world regions. Also, energy systems are more or less interconnected depending on the region, with the EU internal energy market as being one of the most interconnected with its neighbours. Moreover, while renewable energy potential might be more evenly spread out compared to fossil fuel resources, geographical specificities do play a role. For instance, in mountainous regions such as the Alpine space, hydro power might be a more viable option than in arid or semi-arid climates without the necessary elevations. This uneven geography is important to consider, since not all countries will benefit equally from the energy transitions. Indeed, the question of who is going to benefit and who is going to see their status diminished (or their livelihood negatively impacted on a more local, human scale) is an interesting one to consider when talking about changes in the energy system.

But the analysis does not only have geographical connotation, but also a **temporal** one, and is highly dependent on what kind of boundaries one draws analytically. When considering energy transitions, depending on *where* an energy system is on the journey from fossil fuels to renewables and low carbon technologies, impacts and ramifications might look different and relatively few scholars have paid attention to this transitional phase (Vakulchuk, Overland, and Scholten 2020). In addition, and besides deciding on the time frame of the analysis, the **end point** of the analysis and the scenarios to achieve this end point are likely to influence the assessment. Consider the difference between the objectives of limiting global warming to 2°C or to 1.5°C, each of the two objectives enshrined in the Paris Agreement. While emissions compared to 2010 should decrease between -72 and -41% in a scenario "likely" to meet the 2°C target by 2050 (IPCC 2014), emissions would need to decline by almost 100% by 2050 if humanity wanted to limit global warming to 1.5C (IPCC 2018). This necessity, often called "net zero emissions" by 2050 was recently corroborated by the IEA in its landmark report on the energy sector, where it called for an immediate (!) stop to new fossil fuel developments (IEA 2021c).

Another factor influencing the analysis of the interlinkages between energy systems and stability is the **choice of technology** one is analysing. For instance, not all renewable energy sources are the same. Large scale hydro power projects have been observed to contribute to conflict between states (Zeitoun and Warner 2006; Beck et al. 2014; Ito, Khatib, and Nakayama 2016) while bioenergy development might have negative impacts on land-use and emissions via land-use change (Berndes et al. 2013) particularly impacting local communities. Other RES sources such as solar PV or wind power are likely to have other risk and impact profiles still. In a quite general manner, scholars observe that without catering to the specifics of each energy source in the analysis, one might run the risks of simply replacing one commodity or technology (oil) with another (renewables), thus applying old analytical prisms to new circumstances which might not yield the best results (Vakulchuk, Overland, and Scholten 2020). It is also important to note, that this paper will investigate only renewable energy options on the low carbon-spectrum and will not analyse the prospects of nuclear energy further. While some see nuclear energy as proved, reliable and efficient low carbon option, its construction is costly, often stymied by delays (Khatib and Difiglio 2016) and overall declining across the globe (Schneider and Froggatt 2021). Moreover, nuclear energy is often seen as lacking the capacity to ramp production up and down quickly in order to balance and support intermittent renewable energies which would make nuclear energy in theory much more part of the fossil fuel based, centralised energy regime than part of the renewable energy niche (Morris 2018).

But not only the technology choice, also the **sector** is important when considering impacts of energy transitions on peace and security. Compare to centralised fossil fuel based electricity systems, power supply based on renewable energy sources is expected to be more distributed, less centralised, more small scale and more

[7] https://www.seforall.org/goal-7-targets/access

localised (Vezzoli et al. 2018). Also, citizens and cooperatives are expected to gain more importance as drivers of the energy transition particularly in developed countries (J. Lowitzsch, Hoicka, and van Tulder 2020), thus potentially diminishing the market dominance of large utilities in the energy sector who are slow to adapt to the energy transition (Alova 2020). In the agricultural sector, increased renewable uptake might increase productivity as observed in selected countries (Ben Jebli and Ben Youssef 2017), while negative emission technologies and practices such as applying biochar to agricultural lands is expected to increase soil fertility (El-Naggar et al. 2019) thus pointing to a positive relationship between renewable energies, soil yield (Kätterer et al. 2019) and potential income growth for farmers (Bößner et al. 2019).

Lastly, it might be useful to take into consideration that energy systems and the technologies it deploys can not only be the *cause* for conflict but also a *means* and an *objective* in conflict (Månsson 2014). For instance, because states have traditionally tried to control resources for power and influence (Månsson 2014) some scholars warned in the past of new resource wars because of dwindling resources (Peters 2004; Caselli, Morelli, and Rohner 2015). Here, energy would be the objective of conflict. However, energy systems can also be a *means* of conflict, when energy is used as coercive tool as we saw above when Russia cut off gas flows through Europe via Ukraine. Interestingly, those discussions and distinctions also play a role when analysing the impact of a changing energy system towards a renewable one.

To sum up, this paper will employ several analytical lenses. It will focus on state security on the international level, why human security will be the focus on the local level while for each scale, we will investigate the impacts of energy transitions and renewables deployment. We will consider geography particularly when it comes to the distribution of resources, and we will try to take the temporal aspects of change into account. Moreover, where available we will distinguish the diverging impacts of different energy sources while trying to shed some light on sectors other than the energy sector such as the agricultural sector, particularly in section 6 where we focus on localised impacts of energy transitions and renewables deployment.

5. Energy Transitions, their impact on stability and Business as Usual (BAU)

Based on the theoretical reflections above and the criteria (scale, choice of technology, geography etc.) we will use to guide our analysis, several observations from the literature as well as from expert consultations can be made on how energy transitions and the deployment of renewable energies might impact global, national and local stability.

5.1 Clean energy as a source of conflict

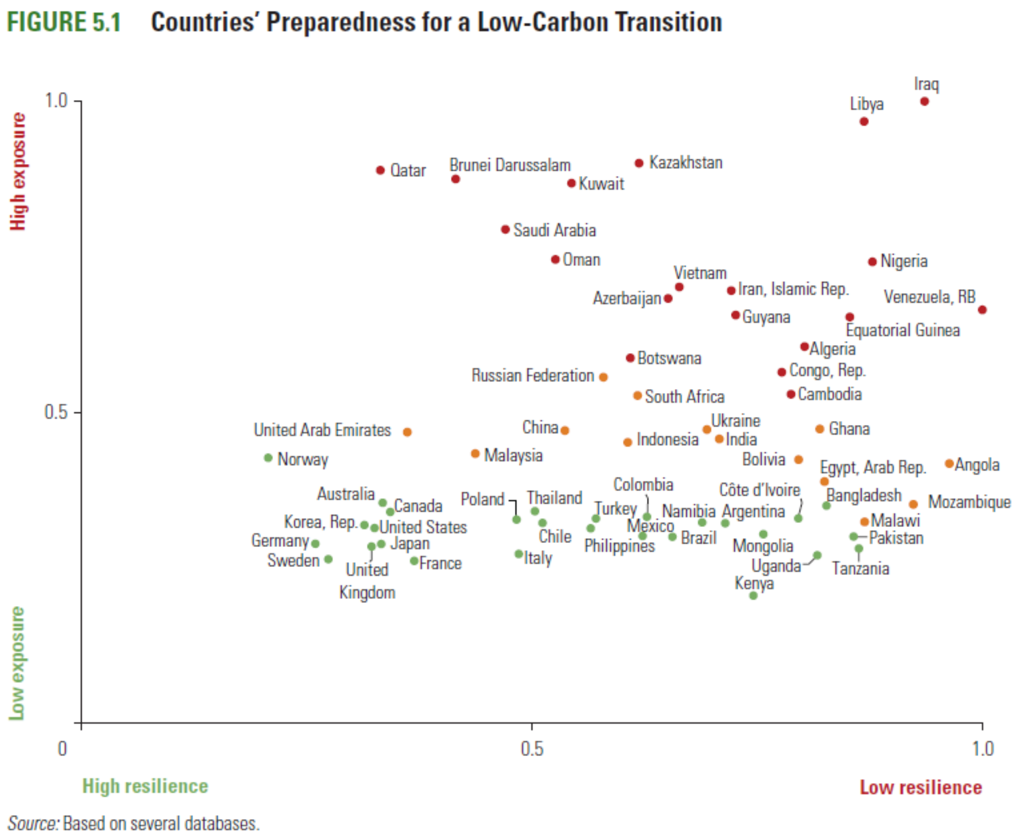
Based on the reflections above, renewables are sometimes framed as being not much “safer” in terms of conflict potential than fossil fuel based energy forms, although engagement on that topic has been mostly in grey literature and journalism (Laird 2013; Hache 2016; Rothkopf 2009). The following paragraphs describe the debates in literature where energy transitions and renewable energies are expected to be the source of instability and conflict. Moreover, it is important to note, that renewables can either influence stability and peace directly or indirectly, that is when raw materials to produce them cause conflict.

Indeed, conflict might arise on the landscape level when it comes to materials which are necessary to produce clean energy technologies and their markets. While the source for renewable power (sun, wind, water) are much more evenly distributed than for example oil (Scholten et al. 2020), minerals such as lithium, cobalt or nickel (necessary for battery production) and so called rare earths (like neodymium which is needed for magnets in electrical motors and wind turbines) are highly concentrated according to some (Hache 2016; Smith Stegen 2015; Månberger and Johansson 2019). Indeed, the IEA estimates that China and the Democratic Republic of Congo were responsible for about 60-70% of cobalt and rare earth production respectively (IEA 2021d). Quite interestingly, some researchers even argue that the transition away from fossil fuels would make certain metals and metalloids less available on global markets because certain elements would be a by-product of fossil fuel developments. For instance, Germanium is largely produced from coal fly ash and reducing coal production might also reduce the availability of this metal (Månberger 2021). This concentration of metals, rare earths and metalloids might create conflict on international mineral markets and reports of export limitations of rare earths by China have been received with worry by stakeholders such as the US Defence Department (Yu and Sevastopulo 2021) and recent souring of relations between NATO and China might bode ill for rare earths and mineral markets (Peel and Fedor 2021). Also, it should not be forgotten that mining minerals and rare earths generates some significant amount of emissions which are expected to grow in the future because of their important role in energy transitions (IEA 2021d). Similarly, trade conflicts in renewable technologies have been observed at the WTO (Hajdukiewicz and Pera 2020) although a spiralling out of control of those conflicts are unlikely as they are much more economic than political.

Remaining at the international level, it is important to note that not all countries will benefit equally from energy transitions and some countries might lose revenues, economic- or political clout or pay steeper prices for energy. This issue has been investigated in Europe, where some countries might carry more of the cost of transformation than others (Sasse and Trutnevyte 2020) but also globally (Overland et al. 2019). Indeed, Overland et al. (2019) argue, that while power and influence might be more evenly distributed in a low carbon world, current fossil fuel exporters might lose share of their political clout in international affairs (Overland et al. 2019). Quite interestingly (and maybe worryingly), many of those countries expected to lose out because of their high dependency on fossil fuel related revenues have been known in the past for the instability of their political system. For instance, revenues from oil represent more than 90% of Iraq's governmental revenues (IMF 2019) while the country has consistently scored low on indicators like quality of governance.[8] Quite generally, the MENA region is quite dependent on revenues from fossil fuels especially from oil and gas which account often for more than 40% of government resources in many of the region's countries (IRENA 2019). The same can be said about countries in Latin America, particularly Venezuela where economic, political and civil unrest have been plaguing the country for the past years (see section 6 of this paper). Pertaining to this dilemma, researchers at the World Bank have prepared a report, investigating how exposed some countries are to low-carbon transitions and how resilient those countries are to deal with these changes. The following graph illustrates this effort.

[8] https://qog01-p.gu.gu.se/shiny/users/xalvna/qog/map2/

Figure 1 - Fossil Fuel producing/depending countries' exposure to energy transition and their resilience
(Peszko et al. 2020)



Legend
The researchers used a set of indicators such as “macroeconomic stability” or “institutional quality and governance” to assess the countries’ exposure to the energy transition and the countries’ resilience to its negative impacts. On the right upper corner are countries which are highly exposed to low carbon transitions and, due to low scores on those indicators have a low resilience (i.e. low capacity to recover from adversity) to mitigate the negative consequences of this exposure. These countries such as Iraq or Venezula are highly exposed but are thought of having low capacities to deal with the changes brought by low carbon transitions thus potentially worsening their internal security situation.

Here, it is important to consider the temporal scale since energy transitions don’t happen overnight and much of debate who will win and who will lose will hinge on the question of whether countries will be able to diversify their economy in time along global energy transformation pathways. Moreover, it might be possible that some countries might be impacted negatively in the beginning of their transformation but later seize their renewable energy and/or technological potential since renewable energy technologies depend much more on technical know-how and innovation than on resources found underground (Vakulchuk, Overland, and Scholten 2020; Scholten and Bosman 2016). And in a sense, innovation, know-how and technical expertise can be learnt and do not depend on geographical assets such as fossil fuels.

Going down the scale, energy transitions are expected to be more regional (than global) in outlook and impact, since one of the main resources will be electricity which, while theoretically tradeable globally, is expected to be traded much more nationally or regionally (Scholten and Bosman 2016; IRENA 2019). Here, power systems might become more interlinked transnationally (Guler, Çelebi, and Nathwani 2018) and the EU internal energy market already offers an example of this regionalisation (Chen et al. 2020). However, this regionalisation might also harbour conflict potential when countries which are part of a more or less fully integrated markets start favouring national solutions to regional problems (Glachant and Ruester 2014) or when grid control is used to exert political power (Scholten et al. 2020). While anecdotal evidence is most readily available for the EU, there is no reason to think that similar developments can't take place in other regions. Indeed, the ASEAN region already has plans to integrate the whole region into a meshed power grid (Aris and Jørgensen 2020) which might harbour conflict potential should national strategies jeopardise regional solutions.

Nationally and sub-nationally, the impact of increasing renewable energy production could be prone to conflict as well, depending on the technology used.

Conflict potential might be relatively benign but obstructive like the famous "NIMBY" (not in my back yard) attitude which has been investigated particularly when it comes to wind power developments in the EU where local communities often fought local wind power installations (Botetzagias et al. 2015). Or, conflict might lead to violence and even death when for example large hydro power projects are concerned and grievances of local populations are not taken into consideration (The Third Pole 2016). Indeed, when it comes to larger scale renewable energy sources like hydro (although small-scale hydro power technologies exist), investigations have usually taken the lens of inter-state conflict or conflict between national stakeholder groups and energy companies and/or the government (Suhardiman, Rutherford, and Bright 2017; Chowdhury and Kipgen 2013; Ito, Khatib, and Nakayama 2016). But as mentioned above, those conflicts might become more widespread in the future, especially when mining for raw materials is taken into consideration, where mines (lithium for example) might be opposed by local populations.[9] While these impacts are, for the time being, anecdotal and localised, this issue could also become a problem when renewable energy sources compete for land. The debate how land factors into the equation of stability and conflict has been focused on bioenergy. There has been a long debate on how biomass based renewables interact with land systems and their change (Berndes et al. 2013; Miyake et al. 2012), or on food security (Kline et al. 2017).

Quite interestingly, those interactions sometimes can be rather global. Banse et al. for instance argue, that EU biofuel legislation has driven land-use change in Latin America (Banse et al. 2011). From a security perspective, there are scholars who argue that bioenergy and the plantation of crops for their production might drive conflict between local communities and renewable companies (Arevalo et al. 2014). Moreover, if crops are grown for energy usage, the competition for land (and water) (Rulli et al. 2016) might impact food prices (Baffes 2013) which in turn lead to violent conflict and riots (Messer 2009).

Box 2 – Land used for Renewable Energies vs. for Fossil Fuels

Studies on the comparison between land needed for renewable energy installations compared to land needed for fossil fuels are scarce and a multitude of factors further render the issue complex. For instance, geographical conditions such as solar irradiation impact the ratio of MWhs produced per m^2 used for solar PV (van de Ven et al. 2021) while including or excluding infrastructure to produce and distribute fossil fuel energy such as coal mines or gas pipelines change the results of the comparative land use calculations. As a study by Fthenakis and Kim shows, using the USA as an example, even the time frame considered might change the results (Fthenakis and Kim 2009). They come to the conclusion that while solar PV would have a comparable land footprint (~300m^2/GWh) as coal (250-1000m^2/GWh) and gas (~300m^2/GWh) wind (1000-2000m^2/GWh), hydro power ~4000m^2/GWh) and especially biomass (+4500m^2/GWh) would have significantly higher land demand than coal and gas (Fthenakis and Kim 2009) thus potentially being able to increase conflict around land-use and land use change. However, more recent studies nuance this picture. Contrary to fossil fuels, which need constant drilling and mining, surfaces dedicated to renewable energy production stay roughly the same over decades. Once this factor is taken into consideration, renewable energy installations (with the likely exception of bioenergy) might not be more land intensive than fossil fuel energies (Trainor, McDonald, and Fargione 2016).

[9] Interview_Stakeholder_No9

The conflict potential of solar PV is less well-researched and studies investigating the socio-economic conflict potential or the potential to create conflict in local communities are virtually non-existent although there are studies showing the political conflict potential (Fischhendler, Herman, and David 2021). Nevertheless, anecdotal and journalistic sources report that solar PV might be the cause of conflict when it comes to neighbourly relations (L. Johnson 2012) and it could be envisioned that the distribution of costs and benefits in rural communities or the land need for solar PV could play a role in community conflict. Indeed, interviewed experts opined that inter- and intracommunity conflict has been occasionally observed at the local level.[10] For instance, if one village/community would benefit from a donor-based new renewable energy system and another village/community doesn't, that could generate envy and animosity between villages/community.[11] Another example given was the dynamic of first- and later adopters within a community, where first movers were able to benefit from renewable installations but late adopters were often left out of the circles of beneficiaries.[12] Another quite interesting phenomenon in relation to solar PV has been observed by one interviewee in India, where the deployment of solar powered water pumps lead to the depletion of ground water levels since the low cost of solar power incentivised the users to pump water more frequently.[13] This anecdotal evidence illustrates how unsustainable resource use (and potential conflicts that this practice creates) are not limited to fossil fuels but can materialise when using renewables as well.

As far as the **sectorial** impacts on (in)stability are concerned, scholars expect the energy transition to shift attention from the control over resources to control over technology and patents (Overland et al. 2019; Scholten et al. 2020; Vakulchuk, Overland, and Scholten 2020). Quite interestingly, a study by the World Intellectual Property Organisation (WIPO) showed, that the top 10 patent holders for renewable energy technologies come from the countries (from number one to number ten): Japan, US, Germany, S Korea, China, Denmark, France, UK, Spain and Italy[14] which might suggest that those nations might become more influential compared to their status now as mainly energy importers.

Another sector which might grow in importance compared to now might be the cyber security sector. While fossil fuel based infrastructure was also subject to cybercriminal activities recently (Sanger, Krauss, and Perlroth 2021), scholars generally expect cyber security issues to become more important when it comes to new, low carbon energy systems because of the importance of electricity grid and their interconnectivity between them but also with other things necessary for a smart grid such as car charging stations and the active participation of households and companies in electricity markets (Vakulchuk, Overland, and Scholten 2020; Månsson 2015; Scholten et al. 2020; Hawk and Kaushiva 2014; Overland 2019). Although cyber security concerns do depend more on innovation and skills than on pure military might, the increased exposure of vital infrastructure to this new form of distributed online thread might be a factor of instability.

This section has outlined, how energy transitions could impact stability in a negative way and how renewable energies could be the source of conflict. However, reasons to believe that renewables would be a source of stability and that energy transitions could play a contributing factor to peace and stability can also be found in the literature, although these investigations have not yet received the same attention in the literature as the "renewables and conflict" nexus (Gemenne et al. 2014).

[10] Interview_Stakeholder_No1; Interview_Stakeholder_No4; Interview_Stakeholder_No5
[11] Interview_Stakeholder_No4
[12] Interview_Stakeholder_No1
[13] Interview_Stakeholder_No5
[14] https://www.wipo.int/wipo_magazine/en/2020/01/article_0008.html

5.2 Clean energy as a source of stability

Starting like the previous section from the landscape and international level, scholars argue that the fact that the source of renewable energy (sun, wind, water) are less geographically and that the skills to make them (innovation, know-how) are also less concentrated would make a low carbon energy system less prone to international conflict (Smith Stegen 2018; Vakulchuk, Overland, and Scholten 2020; Lacher and Kumetat 2011; Scholten and Bosman 2016). Each country, theoretically, has the potential to exploit its renewable energy sources and despite the fact that huge innovation challenges remain, particularly in lesser developed countries (Lema, Iizuka, and Walz 2015), renewable energies have become the cheapest energy option in many places and are expected to become even cheaper compared to fossil fuel generation in the future (Ram et al. 2018). This might reduce dependencies on other countries for energy thus providing for a more symmetric and stable global energy market also because recourse control is much more complicated with renewables compared to with fossil fuels (Scholten and Bosman 2016; Månsson 2015).

Moreover, there is no reason to believe that international trade in renewable technologies will decline. While there remain barriers to trade in renewables (Nie 2014), modelling international trade flows for the Nordic countries, (Khan et al. 2020) find that trade increased with increasing renewable uptake. This in turn might have positive impact on global stability since the beneficial relationship between international trade and peace has been suggested in the literature (Hegre, Oneal, and Russett 2010; Polachek and Seiglie 2007) although this nexus is debated (Barbieri and Schneider 1999).

When it comes to minerals and rare earths, the IRENA argues in a report, that those minerals and materials aren't actually that rare (IRENA 2019). Instead, rare earths bottlenecks would be more a question of refining capacities.[15] Also, many of the minerals and rare earths importance for the renewables industries might be exaggerated. For instance, only 2% of wind turbines would use cobalt (IRENA 2019). What is, however, true is that the market of minerals and rare earths are highly concentrated and that mining them is difficult and expensive which has led to the market concentration and dominance of China and DRC (Smith Stegen 2018). However, while these dependencies and market concentration might be a factor for instability, the economic and geopolitical impact of rare earth and minerals mining should not be exaggerated either.

On the regional and national scale, renewable energy grids are expected to become more interconnected, also across borders. While this might be a source of conflict (see above), regional integration and cooperation are often thought in the literature to increase trade and prosperity (Balassa 1994; Mattli 1999) or strengthening security (Slocum-Bradley and Felicio 2006). Indeed, renewable energies could be seen as a facilitator or even reason to cooperate where there was no reason before thus giving even competing parties incentives to work together instead of competing.[16] This could happen across scales (sub-nationally, nationally, bilaterally, internationally) but it is important to note that one of the most successful cooperation and integration mechanisms is regional in nature and started with the cooperation and mutualisation of energy and its markets: the European Union which evolved from the European Coal And Steel Community after the Second World War (Marks and Steenbergen 2002). Following this logic based on liberal intergovernmentalism (Moravcsik 1995) a truly integrated European electricity market and grid is not only efficient for decarbonisation and security of supply (Murshed 2021) but could also for promoting stability and cooperation. Indeed, some scholars even argue that in order to integrate more renewable energy sources into the system, a pan-European approach would be the most cost-effective and the most stable (Neuhoff et al. 2013; Newbery, Strbac, and Viehoff 2016). And while European integration is surely more advanced than integration and cooperation arrangements in other regions like ASEAN or MERCOSUR, there is no reason to believe that cooperation on renewable energy integration cannot work as a catalysator for stability in those regions as well. In this vein, engaged experts opined that regional integration and the emergence of some sort of regionalism would be one of the consequences of energy transitions.[17]

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[15] Interview_Stakeholder_No13
[16] Interview_Stakeholder_No8
[17] Interview_Stakeholder_No13

In the light of the importance of skills, know-how and innovation when it comes to energy transitions (see above), it is also interesting to note that according to the WIPO, the global top 10 patent holders for renewable energy technologies are all found in the OECD group except for China.[18] If one compares this ranking with the Global Peace Index (GPI)[19], a ranking developed by the Institute for Economics and Peace, one might argue that if (geo)political power should indeed shift from oil producing countries to RES patent holders, the impact on global stability might be positive since the RES "champions" score better on the peace index than current large oil producers. The following table shows the top 10 RES patent holders and the top oil producers of 2019 compared to their GPI scores.

Table 1 – countries' RES patents and oil production compared to their Global Peace Index score

Top RES patent holders 2010 -2019	**GPI score 2020 (position in ranking)**	**Top oil producers 2019**[20]	**GPI Score 2020 (position in ranking)**
1.Japan	1.36 (9)	1.USA	2.307 (121)
2.USA	2.307 (121)	2.Saudi Arabia	2.442 (128)
3.Germany	1.494 (16)	3.Russia	3.049 (154)
4.Korea	1.829 (48)	4.Canada	1.298 (6)
5.China	2.166 (104)	5.Iraq	3.487 (161)
6.Denmark	1.283 (5)	6.China	2.166 (104)
7.France	1.93 (66)	7.UAE	1.752 (41)
8.UK	1.77 (42)	8.Iran	2.672 (142)
9.Spain	1.712 (38)	9.Brazil	2.413 (126)
10.Italy	1.69 (31)	10.Kuwait	1.723 (39)
Total Score	17.541	**Total Score**	23,309

Legend
The GPI score is composed of 23 qualitative and quantitative indicators such as "number of deaths from organised internal conflict" or "ease of access to small arms". The higher the score, the less peaceful a country is perceived. The figure in parentheses is the ranking out of 163 countries. For example: Japan is the top patent holder in the world for renewable energies and the 9th most peaceful country in the world. The USA are the largest oil producer in the world but rank only at position 121 when it comes to peacefulness.

On the national scale, particularly in the OECD context, renewables are expected to lead to a more decentralised energy and electricity system, to a significant extent owned by citizens. Indeed, an often repeated figure is that in Germany, roughly 41% of all renewable capacity was owned by farmers, cooperatives and individuals (Yildiz et al. 2019). Here, concepts of "energy democracy" (Stephens 2019) and localised "(clean) energy communities" (Gui and MacGill 2018) are contributing to localised sustainable development and a more democratic energy system which in turn could contribute to a more stable and equitable society. Moreover, it is noteworthy that localised innovation systems around niche technologies such as renewable energies often cluster regionally, thus contributing to regional innovation systems and regional innovation clusters (Cooke 2010) thus utilising the common culture, norms, skills and know how often found in specific geographical, sub-national regions (Asheim and Gertler 2006; Cooke 2001). Quite interestingly, those renewable regional innovation clusters are already implemented in a targeted manner in regions, which were in the past dependent on fossil fuel developments such as coal (Scarlat et al. 2019), often also across borders.[21] Here, the transition towards a new low carbon energy system clearly has the potential of creating sustainable growth, jobs and therefore stability and prosperity.

[18] https://www.wipo.int/wipo_magazine/en/2020/01/article_0008.html
[19] https://www.visionofhumanity.org/
[20] According to (BP p.l.c. 2020)
[21] https://www.bigc-initiative.eu/

When it comes to energy sources, scholarly debate has not investigated the potential of renewable energy sources for peace and stability, let alone investigate each technology separately on that matter. However, it is worth pointing out that while some scholars claim that large hydropower projects would generate conflict (see above) other argue that, on the contrary, hydro power usually would foster cooperation and collaboration instead of conflict (Wolf 1998). In the same vein, localised renewable solutions like mini grids are often seen as viable approach to bring electricity to the more than 750 million people[22] who lack electricity access globally (Bahaj et al. 2019) even though the economics of those solutions are not always a clear win (Azimoh et al. 2016). Nevertheless, many engaged experts were carefully optimistic about the potential of renewable energies to bring stability and prosperity to local communities in general and conflict prone environments in particular (see impact pathways and local perspective).[23] This might be particularly true in communities currently lacking access to modern forms of energy where renewables deployment might not only reduce stressors on communities but might also allow them – although challenges remain - to "leapfrog" to a clean energy system right away without going through fossil fuel based energy systems first (Zerriffi and Wilson 2010).

5.3 Business as Usual (BAU): risks and uncertainties

The nexus between climate change impacts and energy systems is complex (Bloomfield et al. 2021). On the one hand, there are climate change impacts on the energy system. An international workshop convened on this topic identified several key security threads like the impact storms and heat waves might have on electricity demand (thus straining the grid) or how natural phenomena like cyclones or storms might impact wind electricity production (Bloomfield et al. 2021).[24] On the other hand, there are impacts the energy system has on the climate and, by extent, on international and national security. This section investigates what a business-as-usual scenario, where climate action is delayed and fossil fuels continued to play an overly prominent role in the energy system, would mean for international and national security.

There is surprisingly little literature on the impacts of continuing or fossil fuel-based energy system on conflict and stability with oil being the exception (Ross 2004; J. D. Colgan 2014). As shown above, oil has at least some impact on conflicts due to its centrality for the global economy. This is rather different for coal which might be too easily transportable and too abundant to cause direct conflict. However, pollution engendered by coal mining might lead to conflict (Olufemi, Bello, and Mji 2018) and many engaged stakeholders were under the impression that mining activities would at least often put stress on local communities thus adding to conflict potential.[25] It is however gas which seems to hold some significant conflict potential if business continues as usual in the years to come. Indeed, gas has been seen as a "bridging fuel" to replace more polluting coal (Zhang et al. 2016) during low carbon transitions even though this notion has been criticised because gas remains a source of significant emissions and its value for decarbonisation goals might therefore be limited (Levi 2013). But while oil markets are fairly global in nature (due to its transportability on oil tankers), gas markets remain regionalised (EIA 2020) and to a certain extent more bound to locked-in infrastructure such as pipelines which has led some observers to term gas even as a geopolitical "weapon" (Hafner 2020; Jopson 2014) even though the advent of (expensive) Liquified Natural Gas (LNG) has change the picture somewhat (Grigas 2018).

Nevertheless, a continuous dependence on gas could pose some security risks. For instance, gas has been found to be correlated with a states' support for rebel groups in a rival gas rich state, but the exact causal relationship between gas resources and a countries' conflict potential remain to be investigated (San-Akca, Sever, and Yilmaz 2020). In the same vein, gas (but also oil) infrastructure could cause conflict on the national

[22] https://www.seforall.org/goal-7-targets/access
[23] Interview_Stakeholder_No8
[24] However, the energy system is likely to be impacted regardless of its design (although a fossil fuel-based system might have a different risk profile than a renewable one but studies on that matter have been scarce).
[25] Interview_Stakeholders_No5, 6 & 11

and sub-national level as the controversy around the proposed Keystone XL pipeline between the US and Canada has shown (Erickson and Lazarus 2014; Parrish and Levin 2018). Moreover, the continuous craving of the world's economy for fossil fuel resources might open up new geopolitical fronts of conflict such as the resource rich Arctic, even though scholars argue that the conflict potential might be exaggerated (Keil 2014).

However, it might be argued, that it is the climatic impact of the continuous use of fossil fuels which pose the biggest threat to international, regional, national and sub-national security. The UN Environment Programme estimates that with the current Nationally Determined Contributions (NDC) pledges[26], countries are most likely to increase global temperatures by at least 3 degrees (UNEP 2020) due the insufficiency of their actions. Although the exact impacts of such temperature increase remain object of significant uncertainty and speculation, the website of NASA illustrates how a difference of even 0.5 degrees can already have a huge impact.

Table 2 - Impacts of Global Warming of 1.5 and 2 degrees *(NASA 2019)*

Impact	1.5 °C warming	2°C warming
Exposure to severe heat waves	14% of global population	37% of global population
Exposure to severe drought	1.5°C is reference	61 million more people
Water Scarcity/stress	1.5°C is reference	184 – 270 million more people
Loss of insects	6%	18%
Water level	Reference	+0.1m
Coral Reefs	-70-90%	Completely wiped out

These impacts are just a selection of a few indicators and don't even take into consideration negative feedback loops and "tipping points" from which there is no return and which can have even more extreme consequences for life on earth (Lenton 2011; Lenton et al. 2019).

[26] According to the Paris Agreement (PA), countries regularly submit their NDCs to indicate how they plan to achieve their emission reduction goals in line with the IPCC and the PA.

6. Drivers, impacts, risks and uncertainties of energy transitions on the international and national level

As we have shown, on the international and regional level, energy transitions harbour risks as well as opportunities for stability and security. Using insights from scenario building methodologies such as identifying key drivers, forces and uncertainties (Lindorfer and Velo 2016), this section No6 will illustrate the main points of the previous chapters. However, it is important to note that this table presents some possible future developments and not exact predictions. Indeed, one common factor of predictions (be it in the energy sector, the financial sector or in other sectors) was that they were either wrong or never saw “it” coming. Few people predicted the financial crisis of 2008, the cost reduction of renewable energies surprised even the experts at the IEA (who often underestimated their contributions and potential to the global energy systems (Metayer, Breyer, and Fell 2015)) and few people foresaw the collapse of the Soviet Union (Cox 1998). Nevertheless, pointing out developments, drivers, risks and uncertainties might help policy makers to at least think of different consequences and potential impacts. The following table gives an overview of previously discussed points when it comes to energy transitions, while section 6.1. will do the same for a Business as Usual (BAU) scenario.

Table 3 – Impacts of energy transitions on the international and regional (national) level

	International	Regional & National
Drivers	International Climate & Sustainability Agreements & Treaties	Regional & national transformation of energy systems
	Covid-19 recovery plans	Regional & National bottom-up demand of more sustainable development
	Innovation “Maker” instead of innovation “Taker”	Regional Climate and Environmental Agreements, Strategies and Plans
Developments	Rare earth and mineral endowments become important than fossil fuel endowments	Regional cooperation for trading and balancing RES
		Import dependency on fuels declines since RES are more equally distributed
	Shift from oligopolistic energy markets to more competitive energy markets	Cyber Security and “Smart” energy become more important
	Shift of power from fossil fuel producers to renewable innovators	Innovation, technology and control thereof grows in importance
Forces of Stability	More decentralised and more democratic energy system	More regional cooperation & integration made necessary by RES deployment
	Competitive markets	Less competition for resources, more independence
	Shift of power from autocratic to more democratic countries	Regional Innovation Clusters (i.e. more regional cooperation)
		Giving energy and electricity access to communities with no prior access
Forces of Instability	Dependency on minerals and rare earths	National solutions to regional problems which exacerbate instability
	Cyber security issues of meshed electricity grids	Cyber attacks destabilise energy systems
	Control of technologies instead of control of resources	Regional Competition instead of regional cooperation
Risks & Uncertainties	Covid-19 recovery efforts perpetuate fossil fuel energy system	Governance & institutions don’t follow regional economic integration
	Rare earth and mineral production/export bottle necks	Unnecessary infrastructure is built
		Consumer & User habits go back to BaU

Key drivers on the international, regional and national level are international climate and sustainability agreements but also demand from the bottom up, i.e. consumer demand. Indeed, first anecdotal evidence from the EU shows, that tackling climate change has climbed up the agenda of citizens' priorities (Eurobarometer 2019) and there are first insights that point to an increased awareness of and spending on more sustainably sourced products after the pandemic (Degli Esposti, Mortara, and Roberti 2021).[27] A shift from a more decentralised energy system, where resources are distributed more evenly on a more competitive market might contribute to a more stable world along the lines of the "capitalist peace" idea (Gartzke 2007) while it is also possible that one resource dependency (fossil fuels) is exchanged with another (minerals, rare earths).

On the regional and national level, it is important to note, that regional integration might not be pursued on "ideological" grounds, but out of necessity. Studies taking the EU as an example have shown, that the increasing share of renewable energies is best managed by integrating grids and leveraging the EU internal energy market to its full force to achieve the EU low carbon electricity and energy system in a more efficient and less costly way (Neuhoff et al. 2013; Newbery, Strbac, and Viehoff 2016; Newbery et al. 2017). There is no reason that this integration dynamic can't be replicated elsewhere (of course by taking in to consideration local specificities) and regions such as the ASEAN are already integrating their electricity systems (ERIA 2018) and more regional integration and cooperation is usually beneficial for stability and peace.

Another force of stability, as shown above, could be regional innovation clusters which are already forming in regionally integrated blocks like the EU to leverage the skills, infrastructures and cultural norms often found regionally to foster green innovation. Quite interestingly, if those clusters would form in regions and places which tend to lose out during the energy transition like former coal regions, those regional innovation clusters could have a beneficial impact on social cohesion and regional econmomic development, provided that those people loosing out during the transition will find jobs in these nascent renewable industries (Caldecott, Sartor, and Spencer 2017).

However, developments on the regional and national level when it comes to energy transitions can also be a factor for instability. For instance, integrated energy systems do require more cooperation than strictly national ones and experiences from the EU have shown, that sometimes, national solutions are sought for regional and transnational problems. When it comes to the increased electrification expected in several energy transition scenarios, cyber attacks could destabiliye vital energy infrastructure. Here, a main risk should be adressed, namely that governance of energy issues doesn't follow the increasingly interconnected and complex energy systems. This is particulalry true when it comes to energy planning where infrastructure is often built at great expense when better utilising existing infrastructure in cooperation might be the cheaper and more stable option (Neuhoff et al. 2013; Newbery, Strbac, and Viehoff 2016).

6.1 Business as Usual (BAU): risks and uncertainties of continuing the fossil fuel regime

Before investigating the impact of energy transitions on the local level more in detail, with a special focus on Latin America, it is necessary to sketch out at least some of the potential drivers of Business as Usual.

One of the key drivers of this business as usual (BAU) impact pathway is of course the lack of ambition of the international community to tackle global climate change. Here, it is worth considering the issue of "carbon lock-in" since the lack of ambition might not only be constraint by political will. Over decades, our cultural norms, practices and behaviours have facilitated the emergence of a fossil fuel-based regime which might be rather difficult to change (Unruh 2000; Seto et al. 2016). Moreover, fossil fuel infrastructure is expensive and up front investments often have to be paid back over decades (Seto et al. 2016) and once pipelines and oil rigs are built, stakeholders will have an incentive to produce and transport fossil fuels as long as they are

[27] Whether this trend will last is another question and still to be seen

profitable. Combined with an insufficient price on carbon pollution[28], where it is less expensive to pollute than to reduce emissions, the energy sector might fail to decarbonise in line with the international climate and sustainability agenda.

For the sake of the intellectual argument, looking at a problem from different perspectives, some might claim that this locked in fossil-fuel system is a factor of stability, particularly on the international level. The argument could be made that conventional politics are well adapted to the fossil fuel-based energy regime and that it might be better to deal with known knowns and unknows knowns than with unknown unknowns to paraphrase former US Secretary of Defense, Donald Rumsfeld (Graham 2014). In the same vein, some might prefer to have “unstable” countries like Iraq or Venezuela to continue to depend on fossil fuel revenues instead of the risk of those countries managing the transition badly and becoming even more unstable. However, this assessment of current energy BAU scenarios would not only be extremely short sighted but would only conjure a false sense of stability given the dire consequences of continuous burning of fossil fuels.

As shown above, even “small” changes in global temperatures can have catastrophic consequences which might be amplified by so called “tipping points”, when events such as the thawing of the Nordic permafrost are likely to trigger a cascade of irreversible, catastrophic changes to the global climate (McSweeney 2020), some of these are expected to be more likely under a warming scenario above 2°C (McSweeney 2020). Consequences for international, regional, national and sub-national stability would be quite severe as well, particularly if one thinks of climate change as a thread multiplier as mentioned in the introduction. Here, the continuation of business as usual would clearly have a wide array of consequences such as people moving from zones newly rendered inhabitable by climate change to other zones, often to already densely populated areas as observed prior to the Syrian civil war (Kelley et al. 2015); resource depletion and destruction of habitat and livelihood of local communities due to mining, or gas and oil exploration leading to more conflict (Isiaka 2010); exacerbation of social inequalities due to fossil fuel developments (Morrice and Colagiuri 2013) to name only three factors which might fuel conflict in the future in a business as usual scenario. Moreover, new resource conflicts might emerge also on new geopolitical hotspots such as the Arctic Sea (Lasserre and Têtu 2020) especially on the quest for more resources and political and economic reforms of rentier states might be put on hold (Bjorvatn, Farzanegan, and Schneider 2012) which might breed further instability. Similarly, the question might be asked whether the continuous importance oil rich (but unstable) countries like Iraq, Libya or Venezuela have for the global economy would not create more instability in the years to come. In addition, the concentration of wealth and resources in the hands of a few nations and/or National Energy Companies (NECs) might generate further instability, especially when contrasted with the more equitable and broader distribution of benefits when it comes to low carbon energy sources. Indeed, according to one study, nationally owned oil and gas companies controlled almost 55% of global oil and gas production with National Oil Companies (NOCs) of Venezuela[29], Saudi Arabia or Iran leading the ranking (Heller and Mihalyi 2019).

[28] Currently, the pollution caused by fossil fuel-based production practices are not priced into the final consumer goods. In order to do that, leading economist suggest putting a price on carbon, either by a tax or by a cap-and-trade certificate scheme where stakeholders can trade their permit to pollute amongst each other. The High-Level Commission on Carbon price, including Joseph E. Stiglitz and Nicholas Stern, estimate that in order to meet the Paris Agreement’s 2°C target, by 2030, a carbon price between $50 and $100 per tonne emitted would be needed (High Level Commission on Carbon Prices 2017).

[29] Data largely before the collapse of oil production in the country; see section 6 of this paper

7. Impact Pathways of energy transitions and renewable energy deployment: local perspectives

While there are some academic as well as non-academic sources on how energy transitions and the deployment of renewable energies might impact international and national energy systems and markets, energy transitions and their impact on the local level are rather under researched. This holds especially true for studies about energy transitions and renewables deployment in conflict-prone regions. While some case studies on those matters exist (Fischhendler, Herman, and David 2021), insights remain anecdotal and sometimes even normative in nature (e.g. that renewables deployment leads to social and economic benefits almost automatically) while systematic evidence is lacking.[30] Part of the problem is that causalities are difficult to establish since energy, although very important for economic and societal development, is only one factor amongst many that can contribute to stability and peace such as good governance, stable institutions, low inequality etc.[31] Moreover, renewables deployment in the emerging economies in the Global South has been relatively slow compared to the uptake in OECD countries, although in 2015, investments in renewables deployment in China and the rest of the developing world had overtaken the investments of the EU, US and other developed countries for the first time (but with China accounting for more than half of this investment (REN21 2021, p.184)). In 2020, however, both "blocks", invested roughly the same amount (ibid.). Therefore, experiences are lacking on how renewables deployment contributed to peace and stability in the longer term in regions sometimes prone to conflict and violence.

Be that as it may, the literature review carried out for this paper in combination with targeted expert consultations yielded some interesting insights and experiences in how energy transitions and renewables deployment has impacted local communities. The focus on this section of the paper will be on experiences of the Global South and in conflict prone environments. Moreover, the following section contain a level of abstractness because even though drivers and factors are highly context specific sometimes, interviews with experts from different organisations and different geographical experiences often mentioned the same factors and drivers, thus pointing to the fact that some of the described dynamics might be applicable to local contexts in general (i.e. a local experience from Malawi might share similarities of a local experience in Colombia).

7.1. Drivers of local energy transitions and renewables deployment

Besides the drivers that are at work on the international and regional level, it is noteworthy that many of the emerging economies in the Global South do not have sufficient access to clean forms of energy or any energy at all. Indeed, estimates show, that around 13% of the global population would not have access to electricity in 2019[32] a problem especially prevalent in sub-Saharan Africa.[33] Bringing electricity and (clean) energy access to those people is therefore one of the main drivers of local energy transitions and/or renewable energy deployment.

In addition, engaged experts opined that energy and electricity access should be seen in the wider development context, another driver. For instance, providing people with access to energy in general and electricity in particular can provide many co-benefits such as improved learning for children (when solar lights provide additional hours for studying)[34], increased gender parity (when women have to spend less time to collect traditional energy sources such as firewood),[35] or increased agricultural productivity (when using renewable energy sources such as solar powered water pumps).[36] While, theoretically, this could be also achieved with fossil fuel energy sources, oftentimes, the cheapest option are renewable forms of energy,

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[30] Interview_Stakeholder_No10
[31] Interview_Stakeholder_No8
[32] https://ourworldindata.org/energy-access
[33] https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity
[34] Interview_Stakeholder_No2
[35] Interview_Stakeholder_No1; Interview_Stakeholder_No2
[36] Interview_Stakeholder_No2

especially considering that fossil fuel bases solutions often necessitate infrastructure developments such as grid extension etc.[37]

Another driver identified by experts are demands by local populations for more sustainable development and for a less destructive economic system, not only in the EU (see above) but also in regions such as Latin America.[38] Interestingly, some policy makers share this vision of a more sustainable future, also in fossil fuel resource rich countries,[39] even though translating these visions into reality might run into opposition by powerful fossil fuel interests.[40]

Other drivers are conceivable as well, such as the preoccupation by policy makers to be seen as "green" or to tap into the existing and nascent carbon markets which allow companies and stakeholders to offset their emissions in one jurisdiction by financing emissions reducing projects in another jurisdiction.[41]

Those drivers of energy transitions and renewable energy deployment might then contribute to either stability and security or to instability and insecurity. Literature and experts identified both pathways and we will examine renewable energies as sources of potential conflict and instability first.

7.2. Local energy transitions and renewables: forces of instability

Like the identified drivers, the factors and impacts mentioned in this sub section are only a selection identified in the literature and by engaged experts. It is not an exhaustive list but instead serves to illustrate how energy transitions and renewables deployment could impact local communities.

Experts pointed out that renewable energies do not automatically mean more stability (or instability for that matter). From an energy systems perspective, renewable energies could destabilise local grids if insufficiently diversified[42] (i.e. only solar power, or only wind power) due to their intermittency (sun does not always shine) and or storage capacity is insufficient.[43] But also beyond the technical impacts on energy and power systems, experts identified several forces of instability.

Land-use and land use change might become a problem, if renewable energy installations are built on land used normally for agricultural activity.[44] While this is not unique to renewable forms of energy, it can still play a role in inter- or intracommunity instability. While traditional biomass was mentioned (see above), solar PV or other sources might also be built on land which was used by local communities for agricultural or husbandry activities.[45] Quite interestingly, however, renewable installations can also have another negative effect on land, namely the depletion of resources (which in turn may cause instability and conflict). This pathway is might even be indirect. Experiences in India have shown that when solar powered water pumps were given out for free to farmers (running those pumps was essentially free due to them being solar powered and not connected to the electricity grid and/or diesel generators), farmers were using them heavily which drained groundwater.[46] This could not lead to inter community conflict but also to conflict between suburban and urban areas since farmers in this case were draining water resources going into large cities.

This potential force of instability also related to an important aspect of energy transition, namely the transition part, i.e. the moving from one set of technologies, norms, rules and behaviours to another. Interviewed

[37] Interview_Stakeholder_No4
[38] Interview_Stakeholder_No9
[39] Interview_Stakeholder_No9
[40] Interview_Stakeholder_No11
[41] Interview_Stakeholder_No1
[42] Interview_Stakeholder_No5
[43] Interview_Stakeholder_No4
[44] Interview_Stakeholder_No2
[45] Interview_Stakeholder_No2
[46] Interview_Stakeholder_No5

experts opined that sometimes, renewable forms of energy would disrupt traditional forms of living and traditional practices on the very local level.[47] In South Africa, some communities provided with individual solar powered cook stoves would sometimes not use them, because it would disrupt this communities' traditional way of communal cooking.[48] While this might not necessarily lead to conflict or even instability and while solar cook stoves are rather different than solar PV applications which supply users with electricity, it is a noteworthy aspect and a reminder, that in transitions, some practices and behaviours will fade and new practices and behaviours will have to be learnt.

Another factor mentioned many times by experts which might contribute to instability was the unequal distribution of benefits, renewable energies might cause. [49] This was deemed a particular problem in donor-based deployment, where renewables installations might go first to early adopters (often free of charge). Once the rest of the community gets aware of the advantages, renewables confer on their users, they want to become part of the user community but (donor) money would often run out.[50] This in turn could exacerbate or even create inequality amongst communities but also between communities (one village gets renewable electricity, another doesn't) thus leading to potential instability within or between communities based on unequally distributed benefits. Similarly, if renewables should go to already powerful figures in the community, this would also exacerbate inequalities and, as a subsequent development, social tension.[51] Here, this inequality of access and benefits meet another important factor mentioned in the paragraph above, namely renewable projects, which are not adapted to local needs. Indeed, this was not only observed in donor related projects, but also for-profit companies would sometimes not take local specificities and user needs into consideration thus leading to project failure in the worst-case scenario.[52] However, it is worth mentioning that the need for good project management is not unique to renewable energies and that questions of unequal access and inequity might also arise when deploying fossil fuel-based forms of energy.

Quite interestingly, the change of technology, norms and behaviour could also have potential destabilising impacts on established power structures. As mentioned above (and confirmed by experts) renewable energy production usually happens in a more decentralised and localised form. This in turn might take away political power away from people and institutions who own and control the more centralised fossil fuel energy system such as government stakeholders or powerful private sector stakeholders.[53] While this could be a factor of increasing stability (see below), it could also mean that the interests of the regime[54] (i.e. the status quo) would "fight back" against their loss of influence/power thus exacerbating conflicts, especially those who pit local communities against central or even local governments and regime actors.[55]

Pertaining to this sort of conflict, which pits central government actors against local communities, one potential destabilising factor might be that due to its decentralised, localised nature, renewable energy installations might add to separatist pressure.[56] A (hypothetical) example might include a region which harbours separatist tendencies, usually dependent on energy provisions from the central government, but once energy impendence is achieved, political independence might be sought more forcefully thus contributing to conflict. While this has been a hypothetical case and no scholarly (or anecdotal) evidence exists for this impact pathway (to our knowledge), becoming more energy independent might add pressure to seek more political independence as well.

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47 Interview_Stakeholder_No2
48 Interview_Stakeholder_No2
49 Interview_Stakeholders_No1, No2, No4, No5
50 Interview_Stakeholder_No1
51 Interview_Stakeholder_No4
52 Interview_Stakeholder_No3
53 Interview_Stakeholder_No10
54 The word regime is used here in the MLP theory sense, see theories section
55 Interview_Stakeholder_No10
56 Interview_Stakeholder_No4

Before describing the positive impacts renewable energies could have on stability and conflict, there are a few risks and uncertainties which are likely not directly related to conflict and instability but which might warrant closer attention when deploying renewables.

7.3. Other risks and uncertainties

Although renewables are often the cheapest form of electricity and energy in many parts of the world, sometimes costs can be forbiddingly high in poor communities.[57] Particularly maintenance can be an issue, not only from a cost perspective but also from a capacity perspective where people are often not properly trained to look after installations once they have been adopted (Bößner et al. 2019). This skills and knowledge transfer need (and the absence of such dynamics) was identified by one expert who mentioned the need of companies to share their knowledge and know how more readily with local populations.[58] Looking more at the end of the renewable value chain and the life cycle of installations, two experts mentioned the need to start thinking already now about what would happen with old installations, especially old batteries and the recycling thereof which, if done not properly, could exacerbate environmental damages and degradation thus presenting another risk.[59] Lastly, cultural risks of some renewable installations were mentioned, namely technologies using human or animal waste to generate energy which might run counter social and cultural norms and taboos.[60]

7.4. Local energy transitions and renewables: forces of stability

At this point it might be appropriate to not only talk about "human security" but also about "individual security". Renewable forms of energy have been shown to contribute to the individual feeling of security especially for women and children, when, for instance, solar and battery powered lights were installed in communities thus making communities safer at night and deter violent crime.[61] In the same vein, and as mentioned above, renewable energies usually have an impact on learning opportunities for children[62], contribute to gender equality when housework (done traditionally by women) is rendered easier and more efficient[63], and allow local communities to develop economically, for instance when a previously unelectrified village gets electricity thanks to renewable mini-grid solutions.[64]

This also pertains to the factor of instability mentioned above, the change of land use and the depletion of resources: While this might be a real problem, experts mentioned that in the Indian water pump case mentioned above, agricultural- and economic productivity went up at the same time as water resources were depleted. Here, renewable energy powered infrastructure (water pumps) were at the same time detrimental (water depletion) and beneficial (increased productivity and revenues).[65] Also, the issue of land use change when installing renewable energies such as solar PV could be mitigated, by implementing renewables in a synergetic way with agricultural practices such as in "Agrivoltaic" installations, where solar panels allow for agricultural activities underneath them.[66]

Moreover, experts identified a rather important vector for renewable energies to contribute to stability both from a resource perspective but also from a human needs perspective when it comes to refugee communities. Anecdotal evidence describes the problem of refugee communities sourcing traditional biomass like wood from neighbouring communities to meet their energy needs, often in an unsanctioned manner. This has been

[57] Interview_Stakeholder_No2
[58] Interview_Stakeholder_No3
[59] Interview_Stakeholders_No3 & No4
[60] Interview_Stakeholder_No1
[61] Interview_Stakeholders_No2 & No8
[62] Interview_Stakeholders_No1, No2 & No8
[63] Interview_Stakeholders_No1 & No2
[64] Interview Stakeholders_No4 & No8
[65] Interview_Stakeholder_No5
[66] Interview_Stakeholder_No2

observed to create conflict, pitting refugee communities against neighbouring host communities.[67] Deploying renewable energies in these contexts might then kill two birds with one stone: On the one hand, illegal foraging and deforestation on neighbouring land is avoided (thus mitigating conflict between settlers and farmers and newly arrived migrants) and on the other hand, people are provided with cheap, clean forms of energy to meet their energy needs thus also contributing to stability and peace inside refugee communities which could grow to the size of entire cities like the Kutupalong refugee camp in Cox Bazar, Bangladesh which houses an estimated 600,000 people.[68] Renewable energies and their benefits in refugee camp contexts were mentioned several times by experts.[69]

This beneficial effect is thought to be related to the empowering attributed of renewable energies, particularly if managed in a collaborative manner. Renewables are thought to increase community spirit, create a sense of ownership and responsibility[70] but can also increase accountability and transparency: while (centralised) government might be a rather distant, abstract entity for local communities (and therefore accountability is a distant concept as well, in the figurative as well as in the literal sense), being accountable towards a neighbour or a person you interact with daily might foster increased accountability especially when resources are managed together.[71] Moreover, renewable sources of energy were also mentioned as tool for education and skills learning (and sharing), particularly in community energy projects particularly with regards to learning how to manage complex systems, which, in turn, would strengthen the community and make it more resilient.[72]

In the same vein, renewable energies are often thought of generating new employment opportunities. While one has to keep in mind that not all jobs lost during an energy transition in the fossil fuel industry – for instance in coal dependent regions – might be easily replaced by renewable energies due to the different skill sets needed, research is slowly emerging that shows that overall, investments in renewable energies often generate more direct employment than the same amount of investment in the fossil fuel sector (Garrett-Peltier 2017; Fragkos and Paroussos 2018; Jaeger et al. 2021). Moreover, investment in renewables might lead to more local jobs, instead of creating jobs in other jurisdictions (Fragkos and Paroussos 2018). While these calculations are often based on model results and/or in high-income level countries such as those in the EU, engaged experts were also convinced of the positive impact, renewables could have on local job creation. For instance, one expert shared some experiences from the Democratic Republic of Congo, where each MW of renewable energy capacity had led to the creation of 800-1000 jobs, particularly amongst former rebel group members.[73]

Quite interestingly, this issue of a distant, centralised government which provides (or often doesn't provide energy) can also be seen as an advantage for renewable deployment. Indeed, the argument could be made, that renewables with their emphasis on community led development and management could fill the void, where government is absent.[74] This has been observed in the context of the Israel-Palestinian conflict in Gaza, where the difficult security situation and the curtailment of electricity provision coming from Israel and Egypt have contributed to the increase in off grid solar installations (Fischhendler, Herman, and David 2021). While this development did not help to pacify the overall conflict, renewable energy was still a factor in providing energy needs to local populations thus alleviating at least one grievance and factor of instability.[75] The same linkages (absence of government can actually spur renewable deployment) was evoked also in Europe, where the empty coffers of the Greek government after the financial crisis of 2008 as well as the remoteness (both

[67] Interview_Stakeholder_No5
[68] https://www.unhcr.org/rohingya-emergency.html
[69] Interview_Stakeholders_No5 & No4
[70] Interview_Stakeholder_No4
[71] Interview_Stakeholder_No8
[72] Interview_Stakeholder_No4
[73] Interview_Stakeholder_No7
[74] Interview_Stakeholder_No4
[75] While there is, to our knowledge, no study detailing the causal link between lack of energy or energy access interruption and conflict, several experts opined that lack of energy or intermittent energy access at least contribute to conflict; Stakeholder_Interview_No5 & No4

physically and metaphorically) of the central government in Athens from remote areas of the country, were evoked for spurring off-grid or mini grid renewable energy solutions.[76]

With regards to conflict prone environments specifically, renewables could be a force of stability and cooperation. Indeed, interviewed experts argued that traditional energy infrastructure and its products are often part of the larger conflict- or war economy in conflict environments. For instance, governments often control the fossil fuel infrastructure such as oil fields or pipelines (which can be seized by any group challenging governmental authority as seen in Syria when ISIS captured large oil fields in Northern Iraq) while other conflict parties like rebel groups or insurgents often control smuggling routes of diesel, gasoline and other fossil fuel derivate products.[77] This has been observed in places like in Somalia, South Sudan, Mali or Syria (under ISIS).[78] While one person's freedom fighter might be another person's terrorist, it is clear that traditional sources of energy such as oil and gas and derivate products such as gasoline or diesel are infrastructure "heavy" (pipelines or refineries are needed) which facilitates leveraging them as political tool. Renewable energies could therefore play a stabilising role in two ways. On the one hand, renewable energy forms are usually less infrastructure demanding and much more decentralised, thus being less likely to be leveraged in conflict situations.[79] On the other hand, giving communities access to energies they can themselves manage and use might reduce their dependencies on informal, mafia-type networks to satisfy their energy needs thus taking leverage away from those parties controlling smuggling- and shadow economy trade routes.

And while empirical evidence is lacking (or only slowly emerging), an argument can be made for how renewable energies might contribute to increase stability especially in conflict prone regions. Firstly, fossil fuel-based energy has often been observed to exacerbate conflicts or, at least, to add to pressures already piling up on communities such as environmental degradation or air pollution.[80] Secondly, energy poverty and energy insecurity stemming from the use of energy as political tool can exacerbate conflict.[81] Thirdly, zero-sum competition for resources usually exacerbates or even kindles conflict. Renewable energies are usually less polluting than traditional fossil fuels, even if one takes waste such as batteries into consideration (although this is a challenge that needs addressing). Also, renewable energies also can also provide people with reliable forms of energy where there was no or only intermittent energy before. And finally, renewable energies might provide an incentive for communities and interest groups in conflict with one another to use those decentralised forms of energy to cooperate and collaborate. That might be (or have been) the case also with traditional forms of energy such as oil and gas as well but given their mentioned appetite for heavy infrastructure and their huge up front investment needs, small-scale, off- or mini grid renewable energy solutions seem to lend themselves much more easily to inter- and intracommunity cooperation.[82]

Finally, an initial theory suggests that renewable energies might be beneficial for building capacity which is needed for sustainable peace and stability. For instance, renewable energies are thought to foster qualities such as good governance, accountability, transparency thus generating the preconditions for resilience and stability of local communities.[83] Despite the fact that these arguments remain largely theoretical and unproven at this point, investigations are currently under way to explore these linkages and their directionalities[84] and first investigations from the EU seem to point in the direction of how community led renewable energy development might offer a number of benefits to local communities such as more democratic decision processes, a more equal distribution of benefits, the building of capacity and know-how and the remaining of benefits within the communities (Caramizaru and Uihlein 2020). All of those factors might be beneficial to stability and peace in conflict prone regions.

[76] Interview_Stakeholder_No10
[77] Interview_Stakeholder_No7
[78] Interview_Stakeholder_No7
[79] Interview_Stakeholder_No7 & No8
[80] Interview_Stakeholder_No8
[81] Interview_Stakeholder_No7
[82] Interview_Stakeholders_No7, No8 & No4
[83] Interview_Stakeholder_No8
[84] Interview_Stakeholder_No8

8. Energy transitions and renewables: local perspectives in Latin America

After having described potential positive and negative contributions renewable energies and energy transitions can have on the local level mainly in general terms, the last section of this paper will investigate concrete examples in Latin America to further illustrate potential impact pathways. We chose four selected countries – Venezuela, Ecuador, Colombia and Peru – because fossil fuels are such an important factor in those countries' economies which might generate several friction points on the transition from fossil fuels to low carbon energy systems.

The following table contains a collection of indicators, showing the exposure of Venezuela, Ecuador, Colombia and Peru to the fossil fuel regime and the progress of the renewable energy niche.

Table 4 – Energy indicators for selected countries

Indicator	**Venezuela** (last available year in parenthesis)	**Ecuador** (last available year in parenthesis)	**Colombia** (last available year in parenthesis)	**Peru** (last available year in parenthesis)
Oil production (2020)[85]	27,4 mio tonnes (down from 145,8 mio in 2010)	25,8 mio tonnes	41,3 mio tonnes	5,4 mio tonnes
Gas production (2020)	18,8 bn m^3	Negligible	13,3 bn m^3	12,1 bn m^3
Coal production (2020)	0,02 Exajoules	Negligible	1,46 Exajoules	Negligible
GDP (current USD)[86]	estimated 48.6 billion in (2020)[87] (drop from 482 bn in 2014)	98.8 billion (2020)	271.3 billion (2020)	202 billion (2020)
Part of fossil fuels of GDP (approximation)	Around 12%	Around 7%	Around 4,5%	Less than 1%
Estimated Fossil Fuel Subsidies[88]	$12.8 billion, mostly electricity and petroleum products (2019)	$3 billion, essentially all petroleum products (2019)	$1.2 billion, mostly petroleum products and nat. gas	Not available
CO2 emissions per capita	4,8 tonnes (2018)	2,3 tonnes (2018)	1,6 tonnes (2018)	1,7 tonnes (2018)
Share of Renewables in Total Energy[89]	14,5% (2018), down from 16,2% in 2005	16,3% (2018), down from 16.5% in 2005	30,7% (2018) up from 29,8 % in 2005	27,9% (2018), down from 28% in 2005
Fragile States Index[90]	92.6 (2021) (Finland [1st]: 16,2)	71,2 (2021) (USA: 44,6)	79,3 (2021) (Saudi Arabia: 69,7)	71,4 (2021: Serbia: 67,4)
Renewable and climate mitigation	No specific renewables or climate mitigation	Ecuador has an energy efficiency plan up until 2035, an	Besides ratifying the Paris Agreement,	Since 2009, Peru used an auction system to build

[85] Fossil Fuel Statistics from (BP p.l.c. 2021)
[86] https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=VE-EC-CO
[87] World Bank data only goes to 2014 in the case of Venezuela. However, the Australian Ministry of Foreign Affairs and Trade estimates, that Venezuelan GDP in current USD dropped from $323.6 billion in 2015 to $48,6 billion in 2020 (DFAT 2020)
[88] https://fossilfuelsubsidytracker.org/country/
[89] https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?locations=CO-EC-VE
[90] https://fragilestatesindex.org/

support policies[91]	support policies in place or info not available although RES support policies have been in place in the past but expired (IRENA 2015).	electricity master containing provisions to increase the share of renewables as well as support instruments such as feed-in tariffs (FiTs) and tax cuts for renewable energy developments.	Colombia's Ministry of Mining and Energy adopted a 10 milestones plan, with the focus areas of increasing the share of renewable energies, increase energy security and diversify the mining sector. In addition, Colombia has some biofuel support policies in place as well as some energy efficiency policies and some tax incentives for RES development.	renewable energy installations, although, according to the IEA, the last auction dates back to 2016. The country furthermore has some biofuels mandates, provides for specialised loans for RES installations mandates quotas for RES uptake, besides having specialised off gird RES programmes (Feron and Cordero 2018).

Several observations can be made. First, all countries are significantly exposed to a fossil fuel-based energy system both in terms of revenues and in terms of energy consumption (the comparatively high share of renewables in the energy mix is mainly explained by large hydropower projects in the power sector; other sectors such as transport or industry remain almost exclusively fuelled by fossil fuels). Second, and this is true particularly for Venezuela, selected countries have been and continue to be haunted by political instability often following economic instability in the case of Venezuela. Third, while renewable energies might still be quite niche (with the exception of hydro energy), the countries still have huge untapped potential due to their geography. The following sub-section will describe the importance of the fossil fuel regime in countries, describe the recent renewable energy developments and how energy transitions might impact the country. Again, these scenarios are no predictions, but possible future pathways (amongst many).

8.1. Venezuela

Recent economic developments in Venezuela could not be more dire: A power struggle between president Maduro and Juan Guaidó (who is recognised as president by the US and the EU (Vyas 2020)) and years of sanctions and economic mismanagement (Cheatham and Labrador 2021) have plunged the country into an economic crisis, where shortages of all sort of goods, a crippling debt (Cheatham and Labrador 2021) and hyperinflation (Hanke 2020) have become the norm. Indeed, the Australian Foreign Ministry estimates, that Venezuelan GDP plunged from $323 billion in 2015 to $48,6 billion in 2020 (DFAT 2020). Moreover, institutional infighting between opposition and ruling party have led to Venezuela becoming the world's 25th most instable country, placing it firmly in the "alert" category of the Fragile State Index.

8.1.1. The Fossil Fuel Regime in Venzuela

Fossil fuels are at the heart of this crisis (Cheatham and Labrador 2021). For instance, state-owned National Oil Company (NOC) *Petroléos de Venezuela S.A.* (PDVSA), accounted for 95% of the countries' exports in 2017 and was therefore the main source of foreign currency (Seelke et al. 2021). In addition, the value chain around fossil fuel production account for roughly 12% of Venezuelan GDP (see above). For comparison, researchers estimate that the German car industry - oftentimes seen as one of the most important sectors of the German

[91] Based on the IEA Policies Database: https://www.iea.org/policies/ and (REN21 2021)

economy - is responsible for around 5% of German GDP (Krpata 2021). However, the Venezuelan fossil fuel sector has followed the path of the overall economy. A combination of mismanagement (Hanke 2020), a back and forth between market reforms and (re)-nationalisations (Pietrosemoli and Rodríguez-Monroy 2019) as well as the sanctions imposed by the US (Brown 2020) led to the tumbling of Venezuelan oil production. While in 2007, the year of the nationalisation of PDVSA, production stood at 154 million tonnes per year, in 2019, merely 49 million tonnes of crude oil were produced according to available data.[92] In addition to this decline in output, aging equipment and infrastructure as well as mismanagement has led to some severe environmental damages. Despite the fact that the Maduro government tries to keep information about oil spills or gas flaring from aging infrastructure under the cover, researchers report many accidents and subsequent environmental degradation from those accidents (Berg 2021). Moreover, and similar to the mining activities in the country, large networks of smuggling and corruption are associated with the oil and gas industry, particularly after the collapse of the national economy made people look to illegal smuggling routes (to Colombia and Ecuador) to satisfy their energy needs (Berg 2021).

8.1.2. The Renewable Niche in Venezuela

Despite this importance of fossil fuels for the Venezuelan economy, it is important to note that the country has vast renewable energy resources. For instance, in 2011, Venezuela was the 9th largest hydro power producer in the world (Pietrosemoli and Rodríguez Monroy 2013) and new studies have attested the country huge solar and wind potential (Pietrosemoli and Rodríguez-Monroy 2019). However, a weak or inexistant regulatory and policy framework as well as mismanagement which also ravaged the renewable sector, particularly hydro power[93], does not allow Venezuela to seize the potential. As shown above, Venezuela does not have any significant climate change mitigation or renewable energy regulation and past initiatives to scale renewables past like the "Smbrando Luz" programme were abandoned. Some mini grid application have been installed in the past, but larger scale projects such as the *La Gujira* wind farm are nowadays defunct and/or abandoned (Gutiérrez 2020). Similar to the oil and gas sector, the electricity sector in Venezuela is assessed by experts as facing some huge challenges such as insufficient generation capacity to meet demand, stalled or abandoned power projects (thus exacerbating the supply-demand gap) as well as lacking regulatory frameworks (Pietrosemoli and Rodríguez-Monroy 2019). Also in the policy sphere, energy transitions or renewable energies are absent from the political debate and stakeholder focus on the fossil fuel regime (and how to increase fossil fuel production).[94]

8.1.3. Potential impacts of low carbon transitions in Venezuela

Venezuela illustrates a dilemma quite common in the Latin American region, namely the "extractivist" and "rentist" nature of its economies.[95] All too often, economic models are based on extracting resources (fossil fuel ones such as coal, gas and oil) but also renewable ones such as biomass (cassava, sugar cane, maize etc.) or biomass-based consumable products such as coffee or bananas. However, this path of economic development is problematic. First of all, it does not create local industries which might transform these raw materials and resources, especially renewable, bio-based ones into higher value-added products.[96] Second, economic models based on rent are prone to be passive victims of international commodity price cycles, with the plunging of the oil price and its devastating effect on the Venezuelan economy as one example. Similarly, there is a significant amount of scholarly debate on why resource rich countries oftentimes seem to be plagued by political and economic instability, a fact often referred to as "Dutch disease" or "Resource curse" (Ross 1999; Bruno and Sachs 1982). Third, import dependency on technology, know how and skills remains high which can cause a problem when it comes to clean energy transitions as identified by interviewed experts.[97] It

[92] https://www.iea.org/countries/venezuela
[93] Interview_Stakeholder_No15
[94] Interview_Stakeholder_No14
[95] Interview_Stakeholder_No12
[96] Interview_Stakeholder_No12
[97] Interview_Stakeholder_No12 & No3

is therefore of great importance, to diversify one's economy away from this extractivist- and rent seeking business model, if the low carbon transition is to be a success. However, the situation in Venezuela is especially difficult due to the economic and political instability which makes an energy transition rather unlikely, at least as long as the current Maduro government is in place.[98] The economy is in shambles (see above), technological know-how and skills are increasingly lacking due to a brain drain particularly amongst young people[99] and many of the foreign backers of the current regime like Iran, Cuba or Russia would not be interested in Venezuela transitioning towards a low carbon system.[100] Moreover, without a significant overhaul of the local economy away from rent seeking towards a more diversified economy, there is little chance that renewable energies, despite their job creation potential and their cost advantage can contribute in the same way to the Venezuelan budget as did and does the fossil fuel regime.[101] Therefore, interviewed stakeholders opined that the energy transition would be far away in Venezuela.[102] Without the necessary revenues generated by the fossil fuel industry, the country would not even be able to care for most basic needs of its citizens such as healthcare[103] although some theoretical entry points for renewable energies were identified at least in rural areas, where they could bring more reliable electricity compared to fossil fuels.[104]

8.2. Ecuador

GDP per capita in Ecuador is comparable to its neighbours Peru and Colombia, although adjusted for purchasing power parity, the country, by a small margin, is the poorest of countries in the case study.[105]

8.2.1. The Fossil Fuel Regime in Ecuador

Overall, Ecuador's economy seems to be more dependent on fossil fuels and particularly oil compared to its neighbours since oil revenues account for almost 7% of its GDP. Moreover, according to the US Energy Information Administration (EIA), oil export earnings accounted for 21% of public sector revenues (EIA 2021). The oil sector is dominated by state owned *Petroecuador* which accounts for almost 80% of oil production (USAID 2020). The country's newly elected president recently sought to enlist international investors to invest in the country's fossil fuel industry and infrastructure (Reuters 2021b) thus pointing to the continuing importance of the fossil fuel sector for the Ecuadorian economy. However, oil as well as mining has played a central role in regional conflicts where fossil fuel interests often clashed with the interests of indigenous communities such as in 2009 (Reuters Staff 2009), 2012 (BBC 2012) or in 2018 (Collyns 2018). Moreover, Ecuador spends more on fossil fuel subsidies than its neighbours. The Inter-American Development Bank estimates, that on average, Ecuador spent $2.3 billion on fossil fuel subsidies, or roughly 7% of public spending (Schaffitzel et al. 2019). Not surprisingly, fossil fuel subsidies have been at the heart of popular unrest in 2019, when the government announced the scrapping of fossil fuel subsidies as part of an austerity package only to reinstate them 11 days later after protest turned violent, echoing the famous "gilets jaunes" protests in France (Woods 2019).

8.2.2. The Renewable Niche in Ecuador

Like its neighbours, Ecuador's renewable niche record is rather mixed. On the one hand, Ecuador's energy mix is heavily fossil fuel based (86% of total energy consumption comes from non-renewable sources). On the other hand, like it's neighbours, its electricity sector is already relatively (!) low carbon since hydropower plays

[98] Interview_Stakeholder_No14
[99] According to Stakeholder_No14, almost 5 million, mostly young and well-educated people left Venezuela during the past years
[100] Interview_Stakeholder_No14
[101] Interview_Stakeholder_N015
[102] Interview_Stakeholder_No14; Interview_Stakeholder_No15
[103] Interview_Stakeholder_No15
[104] Interview_Stakeholder_No15
[105] Reliable data on Venzuela was missing

such an important role in the region. However, river erosion have recently put a strain on the country's largest hydro power station at the *Coca Codo Sinclair* dam (Reuters 2021a). Whether in response to that or not, the ministry of energy announced in September 2021 a new auction tender for renewable energy installations despite increase in RES capacity over the past years has been tepid (Sánchez-Molina 2021). One of the past tenders for solar energy was one by Spanish company Solarpack, since, according to the database xprt-energy, Ecuador has no national renewable energy or service companies.[106] Quite interestingly, Solarpack's *El Aromo* solar project offers some insights in how RES installations do not only compete with fossil fuel installations for land, but also with other economic endeavours. (Patridge 2021) reports, that parts of the aera were *El Aromo* is supposed to be build, were reserved for a Venezuelan-Ecuadorian mega refinery project (RDP-CEM) while money from the EU is supposed to be used there to establish an agro-industrial maize and soy site, all under scrutiny of local communities who remain sceptical of how their land is going to be used. Latest news suggest that the solar park is going ahead, while using only 290 of the 1500 hectares initially foreseen for the RDP-CEM project (Patridge 2021) thus illustrating that RES installations, particularly solar PV might often be less land intensive compared to fossil fuel installations if mining and transport of resources is included in the calculations (Fthenakis and Kim 2009).

8.2.3. Potential impacts of low carbon transitions in Ecuador

Ecuador offers some interesting insights in some of the equity challenges of energy transitions. Many countries in Latin America and indeed around the world disburse fossil fuel subsidies. Although what exactly counts as fossil fuel subsidy is debated in the literature (Koplow 2018), the IEA estimates that in 2020, countries spent $180 billion on fossil fuel subsidies[107] or the difference between energy prices on free markets and the tools governments use to keep the price artificially low either for the entire country or certain income groups via tax breaks, vouchers, direct payments and other instruments (Koplow 2018). Despite their negative consequences – they are socially regressive and negatively impact public health and the environment as they incentivise fossil fuel use - (Whitley and van der Burg 2018) reform has been difficult (Schaffitzel et al. 2019) and reform tentatives have oftentimes been met with violence as the case of Ecuador illustrates. However, this doesn't mean that reform is impossible or unnecessary. Researchers identify several good practice examples such as cross-ministry collaboration when deciding on subsidy reform, careful analysis and monitoring of the impacts and results, clear and transparent communication with stakeholders about the objectives and goals and, almost most importantly, flanking measures to cushion the impacts of reform for the most vulnerable and poor strata of society (Whitley and van der Burg 2018). In the case of Ecuador, modelling efforts have shown that by using direct cash transfer to the poorest members of society or by distributing vouchers for instance for LPG use, subsidy reform could be carried out efficiently, effectively freeing up money for the government since the amount of direct payments to compensate for price increases would be largely outweighed by the money saved in spending wasteful and inefficient subsidies (Schaffitzel et al. 2019). Nevertheless, the authors point to the fact that reform of subsidies for some energy sources such as LPG or Diesel are more difficult to achieve because of the prominence of these fuels to large parts of the society (Schaffitzel et al. 2019) thus arguing for a gradual approach. Ecuador therefore illustrates nicely, how energy transitions can be a success only if the most vulnerable members of society are protected from its negative consequences and if those transitions are based on evidence-based, comprehensive and transparently enacted policies.

[106] https://www.energy-xprt.com/renewable-energy/companies/location-ecuador
[107] https://www.iea.org/topics/energy-subsidies

8.3. Peru

8.3.1. The Fossil Fuel Regime in Peru

Compared to the other countries investigated in the case study, the importance of the fossil fuel regime for Peru's economy is less pronounced. According to World Bank data, less than 1% of GDP would come from fossil fuel exploitation, mainly gas, production of which is concentrated in the *Camisea* field.[108] However, Peru relies heavily on gas as source of electricity production, around 46% of electricity coming from gas turbines (Israel and Herrera 2020). Compared to its neighbours and Venezuela, Peru has the "lowest" electricity access rate as around 1.6% of the population still lack access to electricity according to the World Bank.[109] Interestingly, scholars argue that the main driver of future electricity developments would be the energy intensive mining sector, which accounts for 61.8% of export revenues (Israel and Herrera 2020).

8.3.2. The Renewable Niche in Peru

Information about the RES sector in Peru is difficult to come by. Secondary sources claim that the country recently adopted a target of 15% renewable energy sources in the energy mix by 2030.[110] Moreover, institutions like the Intra American Development Bank (IADB) argue that Peru would be at the forefront of joining international efforts to reach carbon neutrality by mid-century with a new NDC (incorporating these yet unspecified targets) due to be presented at COP26 in Glasgow (Saavedra 2020). As a positive sign, the online sources argue that Peru's outgoing administration has left 1.2 GW of renewable energy projects in the pipeline for the new administration (Djunisic 2021b). However, as of 2019, wind, solar and other renewables (excluding hydro) presented only around 1% of total energy supply (with hydro and biomass and waste representing a further 23%)[111] and around 5% of electricity generated in March 2021 (Djunisic 2021a) which illustrates the challenge laying ahead. Moreover, scholars, based on stakeholder consultation are a bit more sceptical of Peruvian ambitions and argue that comprehensive RES policies would be lacking as would government strategies to increase their share (Israel and Herrera 2020).

8.3.3. Potential impacts of low carbon transitions in Peru

Stakeholder engagement and expert interviews revealed that current debates in Peruvian society turn around the topic of who would own the different resources such as gas, oil but also land.[112] In the past, international companies or national companies have extracted resources from the land, often without much consideration of the needs and wishes of local communities who were often left without economic benefits but with the negative externalities of fossil fuel production and extraction such as polluted environments and destroyed homes.[113] Here, renewables might pave the way for a more inclusive regional growth model by giving people access to clean forms of energy with benefits staying in the community. However, experts opined that renewables development must not repeat past mistakes of the fossil fuel system and see, that decisions are taken in cooperation with local communities and that benefits are distributed amongst community stakeholders.[114] Also, RES deployment should make economic sense for the end users.[115] Stakeholder consultations revealed, that oftentimes, RES projects are parachuted in (often by donors or aid organisations), without the necessary training for the end users to maintain and repair the installations.[116] Moreover, RES projects are often limited in terms of financing and the actual user needs are not met with the limited budget,

[108] https://www.eia.gov/international/analysis/country/PER
[109] https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?end=2019&locations=VE-PE-EC-CO&start=2011
[110] https://perutradeoffice.us/15-of-perus-energy-matrix-in-2030-to-be-generated-from-renewable-sources/
[111] https://www.iea.org/countries/peru
[112] Interview_Stakeholder_No9
[113] Interview_Stakeholder_No12
[114] Interview_Stakeholder_No9; Interview_Stakeholder_No10
[115] Interview_Stakeholder_No9
[116] Interview_Stakeholder_No2

thus potentially exacerbating injustices when some local stakeholder benefit from new RES installations and some don't as shown in the section above.

8.4. Colombia

8.4.1. The Fossil Fuel Regime in Colombia

Like in Venezuela, the fossil fuel sector plays an important role in the Colombian economy. According to the World Bank, rents from coal, gas and oil account for roughly 4,5% of GDP while the country accounts for roughly 0,9% of global coal production (BP p.l.c. 2021), a non-negligible factor, particularly if one considers that in 2017, that coal revenues represented one fifth of Colombia's international trade income and therefore foreign currency (Strambo and Atteridge 2018). Also, while coal might seem less important for the overall economy, it is noteworthy that coal production is often highly concentrated. In Colombia, only two departments (Cesar and La Guajira) produce and export 90% of the country's coal (Strambo and Atteridge 2018) and for many more regions, coal is the main source of export revenues.[117] Moreover, research has shown that even if coal contributes (comparatively) little to the overall, national economy in terms of revenues and employment, regionally, coal can have a significant importance because of being the single largest employer and because of secondary industries and employment build around the coal industry (Bößner 2020). While official statistics are lacking, researchers, through stakeholder engagement, estimate that large scale coal mining operations in the provinces *Cesar* and *La Gujira* would directly employ 30,000 people and a further 100,000 would depend on small and medium sized mines in other provinces (Strambo and Atteridge 2018). It is important to note, that some fossil fuel stakeholders such as international mining company Drummond have been linked to alleged human rights violations in the past such as targeting unions and their leaders (Reuters 2018). Moreover, experts identified the close historic relationship between the state and the fossil fuel industry, who was subsidised for a long time either directly or indirectly, by the state shouldering the financing of important fossil fuel infrastructure such as roads and train tracks to transport coal.[118] Also, the interlinkages between fossil fuel interests (private sector players as well as state owned companies) and the interests of the different governments were seen as hindering energy transitions.[119]

8.4.2. The Renewable Niche in Colombia

When it comes to renewable energies, Colombia's performance is chequered. On the one hand, installed capacity - with the exception of hydro power - is rather marginal. According to IRENA, less than 4% of installed electricity capacity is non-hydro renewable such as wind, biomass and solar PV although hydro capacity stands at 31% of overall capacity (IRENA and USAID 2021).

Box 3 – Hydropower in Latin America

Hydropower in Colombia quite nicely illustrates the sometimes quite precarious link between climate change, energy and security. Overall, many countries in Latin America are highly dependent on hydropower for their electricity needs: on average 45% of electricity comes from that source (IEA 2021a). Unfortunately, hydropower is very susceptible to be impacted by global climate change such as changing rainfall patterns, droughts and soil erosion (IEA 2021a). In Colombia and other countries, this situation is rendered even more complex by El Niño and El Niña, two cyclical weather events which can both boost rainfall or, on the contrary, increase droughts (Restrepo-Trujillo, Moreno-Chuquen, and

[117] Interview_Stakeholder_No6
[118] Interview_Stakeholder_No12
[119] Interview_Stakeholder_No12

Moreover, support for renewables has been perceived as being insufficient in the past (Edsand 2017; Jimenez, Franco, and Dyner 2016) and renewables still face many barriers today (López et al. 2020). In addition, government policy foresees a more than doubling of the share of coal in the power mix to 18,5% by 2031 (López et al. 2020) and while experts argued that that the discourse in the policy sphere was indeed changing (by acknowledging the need to decarbonise), concrete steps and concrete policies (besides quite general "strategy" and "vision" documents) are often lacking.[120] Interestingly, 5% of all electricity consumption and indeed the top 6 consumers are in the mining sector, thus showing the link between the upstream and downstream fossil fuel regime (López et al. 2020) not dissimilar from Peru (see above). On the other hand, recent developments have been more positive. Expert interviews were more upbeat about the future, arguing that policy stakeholders, civil society as well as some fossil fuel producers recognise the need to decarbonise.[121] Moreover, in 2019, Colombia became the first Latin American country to carry out auctions for renewable energy sources (IRENA and USAID 2021). According to another source, Colombia secured a total of 2.2 GW of wind and solar capacity, all expected to come on stream by 2022 (Bellini 2019). Interestingly, prices per MwH ($28.5) were roughly 50% below global averages, indicating the high potential especially for wind power in Colombia (IRENA and USAID 2021). In the same vein, Resolution 40715, recently adopted by the Ministry of Energy and Mines stipulates that power distributors must source 10% of their electric from renewable sources (Pilar Sánchez 2021). According to the xprt-energy database, several companies are active in Colombia in the renewables sector, but none of them are headquartered in the country.[122]

Jiménez-García 2020) thus impacting hydropower production which already happened in 2021 (Millard and Chediak 2021). While some stakeholders might react by wanting to boost fossil fuel developments, it is important to note that researchers find that boosting the share of unconventional renewables such as solar and wind power could also achieve the desired security of supply (Parra et al. 2020).

8.4.3. Potential impacts of low carbon transitions in Colombia

Overall, stakeholders perceived energy transitions both as a factor of stability and instability in Colombia. On the one hand, Guerrilla groups have been known to attack fossil fuel installations in the past (Griffin 2021), which were seen as either a tool of foreign influence, a tool of government revenues and/or as infringing on local communities' land rights.[123] Renewables, which are much more decentralised and potentially owned by the end users themselves could make this sort of attacks unnecessary.[124] Moreover, the more decentralised nature of renewables might make them more susceptible of benefit sharing and therefore contribute to more stability in certain regions.[125] This estimate is in line with some arguments brought forward in the literature, whereupon energy partnerships would reduce complexity of renewable energy systems and projects (by bundling expertise) and mitigate the "not in my backyard (NIMBY)" attitudes by spreading the benefits amongst more stakeholders and strengthens the feeling of "ownership" (Eitan et al. 2019). Moreover, experts argued that corruption would be especially prevailing in the power sector in Colombia and that renewable energies could challenge these corrupt networks which have also been linked to paramilitary activities, drug networks and other network of violence, particularly in the vicinity of coal mines.[126]

However, the Colombian case also offers some insights in how the restructuring of certain regions (for instance away from fossil fuels), might have negative impacts on security even beyond the primarily impacted regions. Stakeholder engagement has revealed that migratory movements of people from declining (coal) regions to centres of potential employment might increase insecurity and conflict potential. This might be especially relevant in Colombia, since coal is such an important economic aspect in certain regions such as *Cesar* and *La*

[120] Interview_Stakeholder_No12
[121] Interview_Stakeholder_No6
[122] https://www.energy-xprt.com/renewable-energy/companies/location-colombia
[123] Interview_Stakeholder_No6
[124] Interview_Stakeholder_No6
[125] Interview_Stakeholder_No6
[126] Interview_Stakeholder_No12

Gujira (Strambo and Atteridge 2018). As an historic example, stakeholders have cited the decline of Colombian cotton industry in the 1990s where waves of migration from the disaffected zones to zones of expected employment had put pressure on local security and stability (Strambo and Atteridge 2018). Therefore, great importance should be placed on diversifying local economies and replacing fossil fuel based economic activities with other, more sustainable ones. One avenue to be explored was the role of eco-tourism[127] in a country often thought of being one of the most biodiverse on the planet.[128] Moreover, by geographic coincidence, the same regions which are currently heavily dependent on coal, also have a high potential for wind and solar PV due to strong local wind patterns and solar irradiation.[129] This could be an opportunity to wane the regions away from coal but at the same time give people other employment opportunities in the renewable sector.

9. Policy Recommendations

Having described and analysed the developments, dynamics, impacts of energy systems and energy transitions on different levels in different regions of the world, several recommendations can be made. This is not an exhaustive list, but a starting point to adequately frame energy transitions internationally and locally.

One of the most important aspects to keep in mind is the fact that renewable energies are, from a security perspective, no panacea against conflict, violence and instability. Indeed, if nations, developers, policy makers (and to certain extent, adopters) were to repeat the same mistakes that haunted fossil fuel developments (e.g. unequal distribution of benefits, not listening to needs of adopters and impacted communities etc.), renewable energies might not only fail to deliver on their environmental benefits but also exacerbate conflict and instability.

On the **international level** it is therefore of great importance, to seize the potential of cooperation and collaboration when it comes to renewable energies instead of engaging in zero sum competition. From a governance perspective, using international fora such as the G7, the G20 or regional organisations such as ASEAN, MERCOSUR or the African Union to steer global energy transitions might be a needed step to ensure a minimum of coordination (Rüttinger et al. 2015). Other fora such as UN agencies (UNDP, UNEP) might also work towards this goal, by establishing dedicated working groups and inter-ministerial committees in order to discuss issues of global energy transitions.

This might not only be an idealistic vision, but indeed a necessity from a security of supply perspective. Scholars argue, that in order to build sustainable and stable low carbon energy systems based on renewable energies, cooperation and the mutualisation of risks and benefits is key. The European internal energy market might serve as an (imperfect) example, where a variety of renewable energy sources – solar power in Spain, hydro power in Norway – keep the grid and therefore the economies stable. Increased cooperation might be especially warranted in the production of minerals and rare earths in order to avoid supply bottlenecks and where such governance mechanisms are currently missing (IEA 2021d). What kind of shape this cooperation should take might be a subject for legal scholars to investigate but it might be worth exploring whether historical precedents of mutualisation of raw materials and resources offer insights of how like-minded nations could cooperate on materials necessary for the energy transition. The Coal and Steel Union which led to the creation of the EU or the mutual management and acquisition of nuclear material as regulated in the EURATOM[130] treaty are two examples that could be explored further. Despite this, such a treaty would not be necessary immediately. A first step might be to use existing fora such as regional cooperation organisations (ASEAN, MERCOSUR etc.) or meetings like the G20 or the G7 to facilitate dialogue between producers and

[127] Interview_Stakeholder_No6
[128] https://www.cbd.int/countries/profile/?country=co
[129] Interview_Stakeholder_No11
[130] The Euratom treaty established EURATOM an international organisation distinct from the EU but with which it shares many institutions. The treaties regulate the cooperation of Member States when it comes to nuclear research but, most importantly, establish an agency, the Euratom Supply Agency (ESA) which sources nuclear fission materials and distributes them amongst member states.

consumers of minerals and rare earths which, together with increasingly transparent value chains, might already increase security of supply (IEA 2021d).

Another area where international cooperation could be intensified is the area of **environmental standards** especially when it comes to the production of biomass or the mining sector (of rare earths and minerals) to ensure mining of materials needed for renewables does not have the same negative impacts on the environment and people as conventional mining activities had in the past. Here, cooperation at the international level must join cooperation needs at **regional** and national levels. Indeed, it is expected that regional cooperation will become more important to balance renewable energy production. From this perspective, discussions should start now on what to do with waste from renewable energy installation and supporting infrastructure such as batteries[131]. Recycling value chains are almost inexistant today, particularly in the developing world which risks adding to existing environmental pressures. Here, circular economy initiatives and well-designed **recycling value chains** should accompany energy transitions right from the beginning.

On a more **national, and sub-national (local) level**, one of the most important preconditions for allowing renewable energies to contribute to peace and stability is adopting **inclusiveness** when developing renewables by engaging with impacted stakeholders right from the beginning. All interviewed experts argued, in one form or another, that ignoring the needs and wishes of people who will either be impacted by renewable installations (because they are in the same vicinity) or who are supposed to benefit from them, projects are bound to fail. Therefore, **stakeholder engagement** is of highest importance to make renewable deployment a success. While research on this topic is patchy, some sources claim that the more stakeholders are included in renewable energy development decisions and the more local communities' benefit from renewable energies, the better it is for stability. This seems to be particularly true in conflict prone areas where stakeholder engagement and development on equal terms is preferable to top down approaches which ignore the needs of local communities (Khaldi and Sunikka-Blank 2020; O. Johnson et al. 2016). As well as this, only if community needs are met, renewable energies can deploy their full potential as a more democratic energy source, that fosters a sense of community, trust and accountability – all factors conducive to stability and peace.

Another precondition for successful renewable implementation is an **adequate finance and business model**, particularly at the local level. As shown above, community buy-in is of utmost importance. Oftentimes, financing installations for free does not meet the objective of long term, continuous use or, on the contrary, leads to overuse. On the other hand, experts argued that sometimes, poor members of targeted communities would not be able to afford neither the installations nor the recurring costs of using them. Here, adapted business and finance models are needed, which ensure that many people can benefit for a long period of time.

This focus on community needs also extends to **educating and training** how best to use technologies – skills often lacking, particularly in the Global South. Therefore, investing in education, training and skills acquisition is particularly important, not only for comparatively low-level competencies such as maintaining and repairing small scale mini- and off-grid installations, but also for medium and high-level skills such as constructing, maintaining and improving renewable energy sources. This is particularly important for local communities, currently based mostly on fossil fuels such as coal mining regions. Only if people have the necessary skills to switch to jobs in renewable energy, can transitions can be called a success. Research has shown how regional innovation systems (Asheim and Gertler 2006) based on clean technology innovation could help to revitalise former fossil fuel-dependent regions (Campbell and Coenen 2017; Coenen, Campbell, and Wiseman 2018).It is unlikely that these local innovation systems will emerge on their own, so appropriate policies are needed to encourage and help local communities diversify their economies and to promote local skills and know-how.

Indeed, from a policy perspective, even though renewable energies have become the cheapest form of electricity and heat generation in many regions of the world, applications in some jurisdictions might still need targeted **support policies** (Azimoh et al. 2016; Bößner et al. 2019). Special attention should be placed on being flexible in the policy design so support policies can be adjusted if needed (Ben Jebli and Ben Youssef 2017) in

[131] Interview_Stakeholder_No3

order to limit costs for consumers but also mitigate pressure on national or federal budgets. Moreover, targeted innovation policies are needed especially in regions which are usually technology and innovation “takers” instead of technology and innovation “makers” to allow those regions to tap into higher value-added products in the field of renewable energies and biomass. Here, questions of **technology transfer** should be discussed particularly between technology providers and adopter governments.

Lastly, one important recommendation would be for the **research community**. There are still many things unknown when it comes to the impact of energy transitions and renewable energy deployment and oftentimes, assumptions of “renewables peace” are based on idealistic assumptions rather than empiric facts. Here, research has the task of **investigating the links between renewables deployment and security and stability further** to learn more about possible causalities and specific dynamics. This could be done by enriching our understanding about the link between security and renewables via case studies, or more formally by identifying indicators which would be able to tell stakeholders about the possible relationship between energy transitions, renewables deployment, security and peace. Moreover, research into how to avoid land-use change and negative impacts to food security is needed, with a special focus on innovative agricultural practices and who could forge a symbiotic relationship between renewable energies and agricultural development.

10. Conclusion

The energy sector is at the heart of both our economies and the effort to limit the most devastating consequences of global climate change. While the pace of uptake is slow, change in the energy sector is happening, although at different paces around the globe. Indeed, ‘Business as Usual’ might not be an option because of the negative consequences for our economies, livelihoods and international, national and local security. From that perspective, energy transitions and the deployment of renewable energies present a formidable chance not only to decarbonize our economies but also to build a more equitable and more decentralized energy system which allows more people to benefit from it and which puts innovation, know-how and skills at the center of our economies, rather than in randomly distributed resource assets.

However, renewable energies are not a panacea to all the world’s woes. If deployed improperly, without consideration of the needs of adopting communities, without flexible support policies and without adequate financing mechanisms and business models, renewable energies might repeat the same past mistakes made by the fossil fuel energy regime. Energy transitions harbor both risks and uncertainties when it comes to peace and stability, but those risks and uncertainties are manageable. With the proper cooperation, the proper research and the proper guiding policies in place, renewable energy development and energy transitions can be made a global success and contribute to peace and stability for decades to come.

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Annex 1 – Interviewed Stakeholders

Stakeholder ID	Institution/Organisation
Stakeholder_No1	South African Weather Service
Stakeholder_No2	South African Weather Service
Stakeholder_No3	Deakin University
Stakeholder_No4	Netherlands Authority for Consumer and Markets
Stakeholder_No5	CGIAR
Stakeholder_No6	University of Sussex
Stakeholder_No7	Energy Peace Partners
Stakeholder_No8	Energy Peace Partners
Stakeholder_No9	CGIAR
Stakeholder_No10	Hebrew University
Stakeholder_No11	Guidehouse
Stakeholder_No12	TU Berlin
Stakeholder_No13[132]	University of Bremen
Stakeholder_No14	Independent consultant
Stakeholder_No15	University of Madrid

[132] This stakeholder was not interviewed but part of our public engagement actions such as the webinar on energy and climate security