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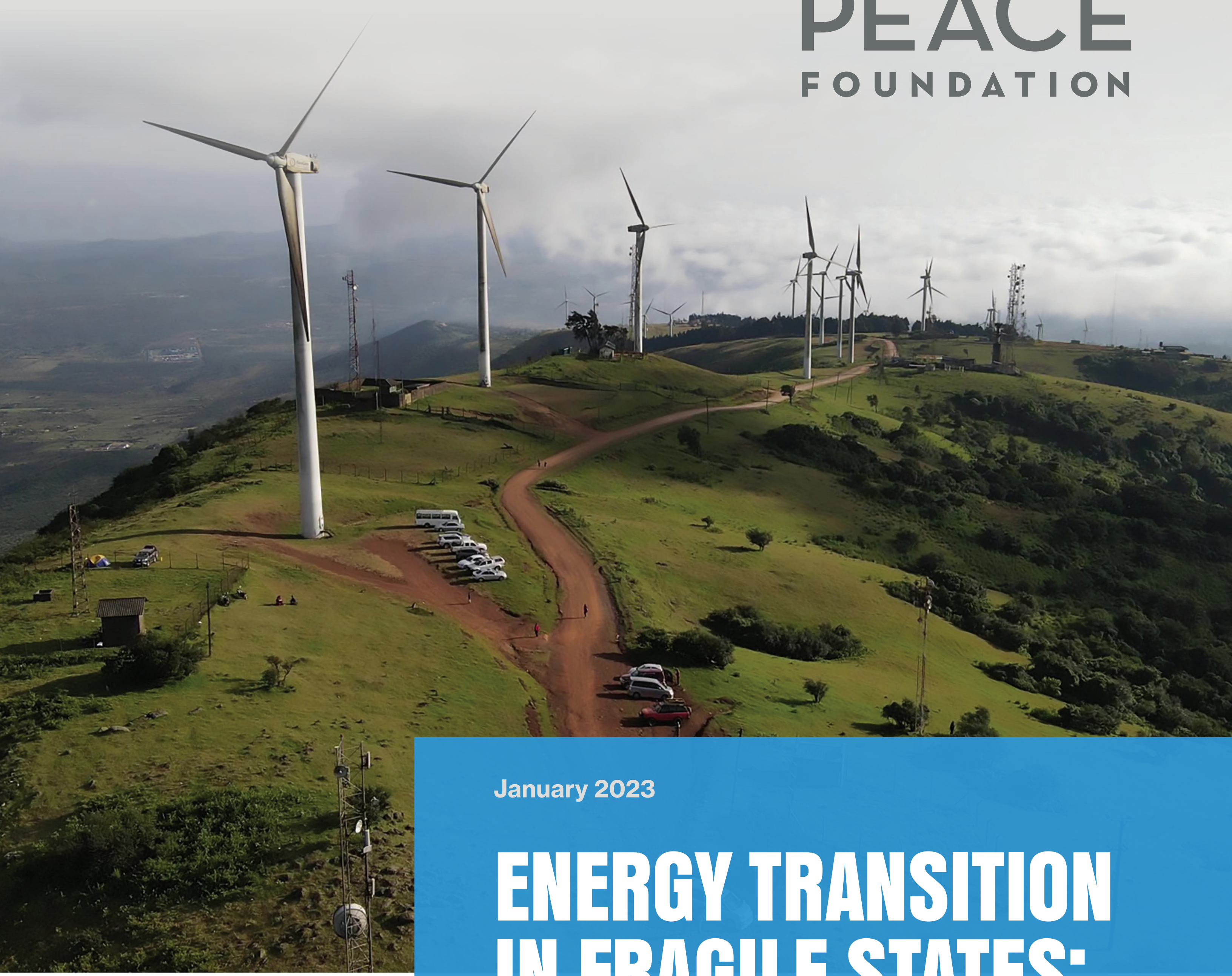

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ENERGY TRANSITION IN FRAGILE STATES: A CRITICAL PRIMER

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FLETCHER

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About Carbon Compacts, Decarbonization, and Peace in Fragile States in Africa and the Middle East Project

The Carbon Compacts, Decarbonization, and Peace in Fragile States in Africa and the Middle East project was a 21-month research project led by the World Peace Foundation at Tufts University and funded by the United States Institute for Peace. Our goal within the project was to analyze how traumatic decarbonization – a rapid loss of oil rents – would affect peace processes and political settlements in fragile oil-producing states in Africa and the Middle East. Under this project, a series of cross-cutting analyses and case studies (Iraq, Nigeria, South Sudan, Sudan, and Venezuela/Ecuador) were produced and are available at The World Peace Foundation website (**https://sites.tufts.edu/wpf/carbon-compacts-decarbonization-and-peace-in-fragile-states-in-africa-and-the-middle-east/**).

About the World Peace Foundation

The World Peace Foundation, an operating foundation affiliated with The Fletcher School at Tufts University, aims to provide intellectual leadership on issues of peace, justice, and security. We believe that innovative research and teaching are critical to the challenges of making peace around the world and should go hand-in-hand with advocacy and practical engagement with the toughest issues. To respond to organized violence today, we not only need new instruments and tools – we need a new vision of peace. Our challenge is to reinvent peace.

About the Authors

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ACRONYMS

EDA	Enhancing Direct Access
IEA	International Energy Association
GCF	Global Climate Fund
INOC	International National Owned Company (NOC with significant domestic and international operations)
GW	Gigawatt
I/NOC	Refers to both INOCs and national oil companies
IRENA	The International Renewable Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LNG	Liquified Natural Gas
LPG	Liquified Petroleum Gas
MDB	Multinational Development Bank
MFS	Mobilizing Funding at Scale
MSME	Micro-, Small-, and Medium-Sized Enterprises
NDC	Nationally-determined Contributions (as part of the Paris Climate Accord)
NOC	National Oil Company
RBCF	Results-Based Climate Finance
RBF	Results-based Finance
REDD+	Reducing Emissions from Deforestation and Forest Degradation

EXECUTIVE SUMMARY

> "The era of fossil fuels is not yet over . . . however, its time has certainly come."
>
> **– Harro Van Asselt[1]**

There is increasing global recognition of the need to move away from carbon-based fuels towards renewable energy sources in order to mitigate the worst effects of climate change. What are the distributional implications of this transition? While there are numerous analyses focused on Western and developed countries, how will it impact fragile states, especially those which produce fossil fuels? This is the driving question we seek to answer in this paper.

This literature review examines the state of research on the implications of a global energy transition for fragile states, with a specific focus on the implications for fossil fuel producing states that operate as political marketplaces.[2] By political marketplaces, we mean countries in which monetized transactional politics, often violent, dominate formal institutions (de Waal 2015). Countries such as the Democratic Republic of Congo, Iraq, Nigeria, and South Sudan epitomize these dynamics.[3] Within these countries, oil or other resource rents (e.g. critical earth minerals) are vital components of how the political systems operate.

While we find the beginnings of research agendas focusing on this topic, overall, we find that the implications of decarbonizing the energy sector and economy for fragile states are largely underexplored. Although some research attempts to analyze these dynamics, few articles meaningfully interrogate the political economy of the states in question and therefore arrive at incomplete or misleading conclusions. More often than not, so-called fragile states and rentier states are inappropriately treated as synonymous and monolithic categories leading to inappropriate recommendations and misleading conclusions that fail to grasp the nuance of each individual state. This literature review attempts to highlight these gaps as well as key opportunities for future research.

In this literature review, we use the fragile states terminology in part because this is how it is used in the literature. By fragile states, we mean states that have significant vulnerabilities across dimensions of violence, justice, institutions, economic foundations and resilience (OECD 2020). While we use the fragile

1 Harro Van Asselt in Wood and Baker 2020, xi.

2 For more on the political marketplace framework, see de Waal 2015; and de Waal, Sarkar, Detzner, and Spatz 2020.

3 For other examples of countries that operate as political marketplaces, see https://sites.tufts.edu/wpf/.

states terminology, we by no means assume all fragile states are the same, and as previously noted, a point we attempt to emphasize throughout this literature review is that while much of the literature acknowledges that states will have different experiences in transforming the energy sector, fragile states and rentier states are often inappropriately lumped together in a single category without analyzing the differences within and among them.

This critical primer should be treated as a living document, one which we hope will be a useful foundation for those working on these issues, but more importantly, one we hope others will build on, challenge, and improve going forward. This paper covers research published prior to September 2021 when the paper was completed. While it does not include reports published in 2022, we believe the trends we have identified here within still largely hold, and we look forward to learning from those who continue to publish on these topics.

METHODOLOGY

Our approach to the literature review has been two-part: a survey of some of the most high-profile reports and a snowball approach to identifying additional relevant academic articles published prior to September 2021.[4] High-level reports included those published between 2011 and September 2021 by the Intergovernmental Panel on Climate Change (IPCC), International Energy Association (IEA), International Renewable Energy Agency (IRENA), Climate Policy Initiative (CPI), as well as select reports from the World Bank and the United Nations Environmental Programme (UNEP). This focus on gray literature is consistent with the state of the field. A 2014 study on energy politics found that gray literature is the most referenced source in energy studies, accounting for more than 60 percent of all citations in three top energy journals[5] between 1999 and 2013 (Sovacool 2014; Van de Graaf et al. 2016, 6). In our review of more recent articles, this trend seems to have continued. We supplemented our survey of gray literature with a snowball approach to academic publications drawing on underlying sources within the high-level reports, top climate journals (e.g. Climate Policy and Global Policy) as well as a review of recent edited volumes on aspects of the energy transition: *The Palgrave Handbook of Managing Fossil Fuels and Energy Transitions* (Wood and Baker 2021); *The Geopolitics of the Global Energy Transition (Hafner and Tagliapietra 2021); and The Palgrave Handbook of International Political Economy of Energy* (Van de Graaf et al. 2016). The literature review is not exhaustive but presents a survey of the major debates in the reviewed literature which we believe is illustrative of the broader field.

4 September 2021 was the date the draft of the paper was first finished. We note that since then, in part driven by the global attention to climate change and the need to invest in renewable sources of energy, new research continues to emerge.

5 These journals included Energy Policy, The Energy Journal, and Electricity Journals.

KEY TAKEAWAYS FROM THE ENERGY TRANSITION LITERATURE[6]

1 Fragile and rentier states are treated as wholly overlapping, monolithic, and homogenous categories.

Across the studies reviewed, rentier states (of which gulf states are taken as exemplars) and fragile states (e.g. Angola, Iraq, and Venezuela) are often treated as similar even though they are key differences both between the broad categories as well as within each. A key distinction between the two categories is whether or not the government legitimizes itself in part through the provision of oil-funded public goods (rentier states) or whether the government uses the funds to acquire and manage political power. This lack of distinction leads to applying underlying assumptions based on rentier states to fragile states, assumptions that do not necessarily hold. Key examples include assumptions on length of political horizons, why fossil fuel rents are important, strategies to incentivize not developing fossil fuels, as well as an overreliance on technical reforms that do not take into account the differing political realities of each state.

For example, one of the most cited studies on the geopolitical implications of the energy transition, IRENA's *A New World: The Geopolitics of Energy Transformation* (2019), quantifies vulnerability to negative consequences of the energy transition as level of oil rents as a percentage of GDP. By that metric, countries such as Venezuela, Nigeria, and Yemen have low exposure to the negative consequences of decarbonizing the energy sector. This fails to take into account that each of these governments is heavily dependent on the fossil fuel industry for significant portions of their government revenues. Such revenues are vital not only for maintaining bloated civil service payrolls but are also fundamental for how each country's political system operates.

Fragile and rentier states are similar in many ways, but the ways they are different – both across and within each category – shapes how these states will be affected by and respond to an energy transition.

2 Global benefits, differentiated costs.

At a global level, a low-carbon economy is capable of delivering on energy access better than a fossil fuel one, especially when considering the lifetime financial costs of both types of technology. This is significant progress from the debate a decade ago when renewable energy was widely agreed to be more expensive, and only justifiable on a climactic basis.

However, this narrative is over-extended in the reviewed high-level literature, with a papering over of differentiated impacts and consistent attempts to paint the transition as a net-benefit for all regions and income groups. This takes a variety of forms. One is the inclusion of dubious 'renewables' such as large hydropower and industrial-scale bio-energy, playing up the benefits of these technologies for energy access, minimizing their extensively reported environmental and social negatives,

6 Note that additional emerging themes and takeaways are included in Sections Six and Seven.

and projecting ambitious export markets for electricity which are highly contingent on a variety of political stars aligning.

To a lesser extent, the 'sector-wise' estimates for jobs gained and revenues for minerals perform the same function, although the regional estimates make clear that job gains are far from universal. Nevertheless, these are caveated with suggestions that job-losing economies could mitigate these losses through structural changes, while leaving unspecified where the resources to make such changes will come from.

Secondly, the scale of investment required – even with cheaper renewable technologies – to assure universal energy access is massive. Much of this investment will have to come out of what is traditionally defined as 'public' or 'government' expenditure, because that is how most mature energy markets developed. The tendency to project a leading role for private investment results in energy market reform proposals which elides the cost of private investment to public budgets and discounts the political economy effects of decades of 'market-forming' interventions in developing economies.

3 Extractive economics treated as a technical problem.

The reports acknowledge that the decarbonization economy will involve extraction. The increasing demand for certain minerals is now a widely reported fact, highly salient even in developed contexts. The scale of land needed to grow energy crops and build universal renewables capacity at scale is also acknowledged, albeit more obliquely.

However, when discussing political/conflict risks from these factors, the discussion is of economics/politics-gone-wrong, rather than fundamental ways in which energy economies have historically worked. The fixes suggested are similarly technocratic – regulations in importing countries, and social and economic safeguards tending toward self-regulation by industry. In some still-nascent sectors, such as waste-to-energy, the discussion plays up the transformative potential ("all this wasted waste"), while almost entirely omitting that the 'energy' will be derived from a sector which has an existing complex political economy.

The 'de-coupling' of energy consumption from economic growth cited in some reports could present a non-traumatic pathway to decarbonization. However, this de-coupling is heavily contested and is partly a result of developed economies offshoring their manufacturing, while continuing to consume increasing amounts of 'embodied energy' in the form of imports. This type of decarbonization engages minimally with the structure of the global economy, where low-income economies commit to energy-intensive export-driven manufacturing while consumption levels in developed economies progress beyond aspirational levels. It hence misses the potential for decarbonization to preserve or worsen this structure and the potential for this structure to drive conflict.

Finally, the discussion of innovation in these reports sits uncomfortably with the reality of the innovation economy. Apart from the equity concerns with patent-based models of innovation, the power centers of innovation are shifting, which is likely to shift the norms around intellectual property. In addition, the distinction drawn between an advantage in natural resources and an advantage in technology is an artificial one – while the latter is more 'policy-driven' than the former, both operate on extractive logic that may increase conflict risk.

4 Vague or theorized benefits.

Beyond the numbers – gigawatts, dollars etc. – these high-level reports offer anecdotes and theories of socio-economic benefits. Among these are the idea that renewable energy can reduce marginalization along gender or social markers, that it can promote autonomy and democracy, and that it can make nations more energy independent in production while making them more inclined to cooperate in energy distribution.

Academic literature on the same topics paints a highly complicated and caveated picture. The most robust evaluation of such claims comes from the literature on cookstove distribution in Africa and India. While these were theorized to overwhelmingly benefit women, the health benefits (from avoided stove smoke) are clear, while the social benefits – such as in terms of household division of labour – are less so. In this context, as well as in the context of claims to energy democracy etc., there is evidence of the desired socio-economic improvement sparking conflict.

As for the geopolitics of cross-border energy, there is overwhelming evidence of its vulnerability to and potential for sparking conflict. This is often true of the examples cited by reports themselves as evidence of cooperation. Analysis of this conflict potential is limited to generalities such as "trust", which sets up the tautology about the role of such undertakings in "building trust".

5 Political and social aspects of energy studies are underexplored.

In fact, social science journals accounted for less than 4.3 percent of total citations, and of the articles published between 1999 and 2013, less than 20 percent of authors reported social science training (Sovacool 2014; Van de Graaf et al. 2016, 6). Our review of more recent research suggests that while political and social analyses of energy studies have increased, these areas remain underexamined.

6 Time is key.

A cross-cutting theme on questions of the likely impact of an energy transition on fragile states and how they will react is the factor of timing, notably timing of decarbonization policy conception to implementation and time-length of political horizons in the country in question. The more gradual decarbonization processes are and the longer political horizons are, the less destabilizing decarbonization of the energy sector is likely to be. However, in many fragile states, political horizons are often short, and immediate benefits can often outweigh long-term benefits making incentivizing long-term projects like transforming an energy sector extremely difficult.

KEY TAKEAWAYS RELEVANT FOR THE POLITICAL MARKETPLACE FRAMEWORK

The Political Marketplace Framework (PMF) is a lens for understanding political systems in which transactional politics and bargaining dominate institutions (de Waal 2015). It focuses on analyzing the goals of politicians in fragile and conflict-affected political systems, the political rules that influence their behavior, and based on that, the tactics they use to achieve their goals (Spatz et al. 2021). Examples of countries that operate as political marketplaces include Somalia (Jaspars, Adan, and Majid 2020), Democratic Republic of the Congo (Maxwell and Fitzpatrick 2021), Liberia (Spatz 2020), South Sudan (Thomas and de Waal 2022), and Syria (Kanfash 2021) among others.[7] PMF analyses help to separate the political façade from the real politics and serve as a basis to inform actors who are attempting to resolve violent conflict, provide humanitarian relief, and/or build positive peace in these contexts (de Waal et al. 2020).[8] This paper offers four key takeaways on the utility of the PMF as a lens of analysis for understanding the impact of an energy transition in these countries.

1 The world as it is.

Many high-level reports highlight benefits of decarbonization, some offer caveats, and other academic literature highlights the negative potential and re-emphasizes the need to balance transition and equity. The PMF frames both types of potential as a reality to be acknowledged and is capable of identifying conditions under which decarbonization enables and/or hinders equity (and vice versa). In other words, the PMF focuses on the world as it is, acknowledging both the potential barriers and enablers of an equitable energy transition that will shape how any idealized plan actually happens.

2 The resilience of political power.

High-level reports often lack a theory of politics when considering the implications of energy transitions. The reports ignore the role of political power or attempt to frame the transition as a dilution/redistribution of political power. Academic literature shows how renewable expansion often operates on political power dynamics, which generally operates as an implied criticism. By its framing of political power as “a commodity that is produced, bought and sold”, the PMF can specify how the transition changes/can change the actors and incentives around political power, while not changing the fact of political power.

7 For additional PMF analyses, see World Peace Foundation at https://sites.tufts.edu/wpf/ and The Conflict Research Programme at the London School of Economics at https://www.lse.ac.uk/ideas/projects/conflict-research-programme.

8 For more on the Political Marketplace Framework, see World Peace Foundation at https://sites.tufts.edu/wpf/.

3 Money and violence as political capital.

High-level reports frame investment as an opportunity and the lack of investment as a missed opportunity. Academic literature identifies the absence of money as a barrier to transition, and occasionally highlights the role of capital in driving conflict. By framing money and violence as currencies in a political marketplace, the PMF is capable of contextually explaining how/why/to what extent the supply of low-carbon capital can mitigate or exacerbate conflict. New forms of rentierism may emerge that seek to capitalize on opportunities presented by the variety of climate finance mechanisms. How these agreements are negotiated, the oversight mechanisms put in place, as well as the negotiating power of each actor will be key.

4 Breaking down the distinction between private and public.

High-level reports emphasize the potential of the private sector while eliding the reality of public investment. Some reports and academic literature are more critical of privatization. The PMF can move past this “institutionalized façade” to clarify that allocation of decarbonization capital/risk etc. between public and private is simply a negotiation/allocation of power.

LITERATURE REVIEW STRUCTURE

The literature review is structured in eight major sections. The first section analyzes existing research on why global warming has led to a climate crisis as well as the socio-economic and conflict implications. Section Two focuses on the scientific consensus that has emerged on how the energy sector must change in order to avert the worst consequences of climate change. A key focus of this section is the gap between the back-casted energy transition plans and current policy trajectories.

Sections Three and Four focus on the trauma of decarbonization to the current carbon economy as well as potential benefits and traumas arising from the future green economy. Section Three analyzes estimations of when and where fossil fuel production will occur as well as the impact it will have on fragile fossil fuel producing states along with the strategies these states are employing in order to mitigate the impact on the economy and government revenues. Section Four analyzes the potential benefits and trauma of a green economy.

Section Five analyzes international and national efforts to finance transitioning the energy sector from fossil fuels to renewables. The section takes a specific focus on areas of climate finance that have been, or are susceptible, to efforts by political entrepreneurs to divert climate finance into political budgets.

Section Six highlights themes that emerged during the course of our review that were not included in any depth in the other sections along with some illustrative sources. Section Seven highlights key gaps and unanswered questions in the literature. These are additional findings to the ones highlighted in the previous sub-sections of the Executive Summary. Together, they begin to outline a future research agenda.

I CLIMATE CRISIS AND IMPLICATIONS

DEFINING CLIMATE CHANGE

The IPCC defines climate change scientifically as measurable changes in the mean and/or the variability of the climate's properties (such as global average surface temperature), which persist "for an extended period, typically decades or longer." In this definition, climate change may be due to natural internal processes or "external forcings", the latter of which include "persistent anthropogenic changes in the composition of the atmosphere or in land use" (IPCC 2018).

The legal (UNFCCC) definition is focused on human-caused (anthropogenic) climate change. It specifies a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Between the years 1850-1900 and 2010-2019, global average surface temperature has increased by slightly over 1°C, driven mainly by greenhouse gas concentrations in the atmosphere.[9] The increase in atmospheric greenhouse gas concentration since around 1750 is "unequivocally caused by human activities" (IPCC 2021).

To project global warming over the rest of the century, the IPCC uses integrated assessment modelling (IAM), which integrates modelling of the global energy system with models of the climate. Modelling of the climate is based on Representative Concentration Pathways (RCPs) – scenarios for 'radiative forcing', i.e. the change in energy flux in the atmosphere, measured in watts-per-square-metre (W/m^2). These include RCP 1.9, RCP 2.6, RCP 4.5, RCP 7.0, and RCP 8.5, where the numbers correspond to a radiative forcing value in the year 2100 (Hausfather 2019).

Modelling of the global energy system is based on 'Shared Socio-economic Pathways' (SSPs) – five socio-economic 'narratives' for the global economy detailed in the table below (Riahi et al. 2017).

9 Human greenhouse emissions alone have likely increased global average surface temperatures by between 1°C and 2°C. The complicating factor is human aerosol use/emissions, which had a global cooling effect of between 0.0°C to 0.8°C between 1979 and the mid-1990s. This is why the IPCC's estimate of 'net' human-caused warming is slightly over 1°C. Other swing factors are "natural drivers", which changed global surface temperature by between –0.1°C to 0.1°C, and "internal variability", which changed it by –0.2°C to 0.2°C.

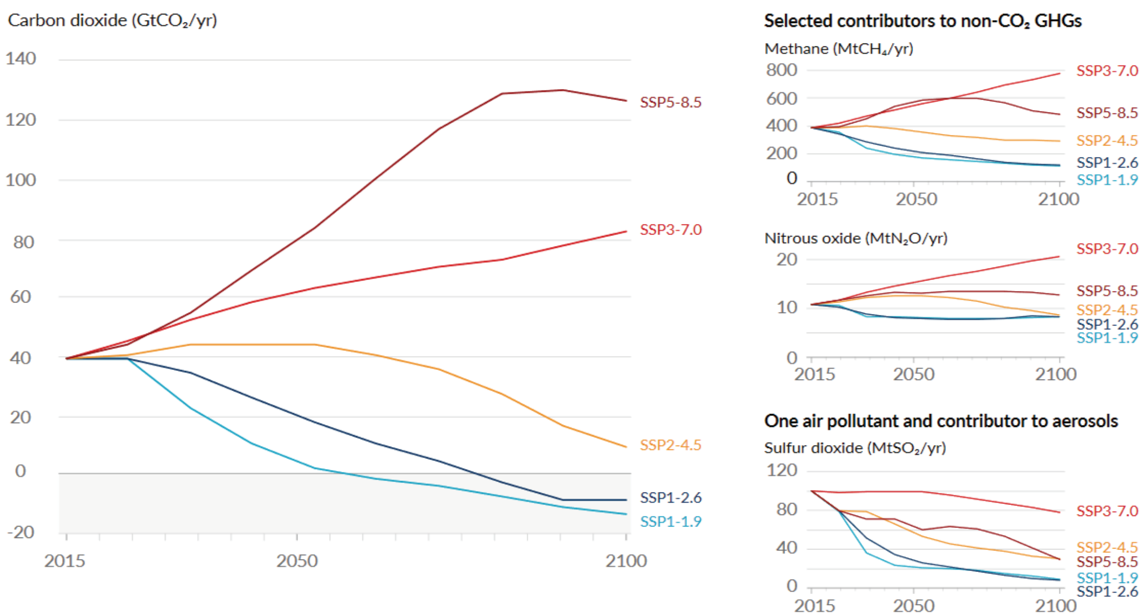
TABLE 1: THE SHARED SOCIO-ECONOMIC PATHWAYS

Socio-economic Pathway	Explanation
SSP1: Sustainability – Taking the Green Road (Low challenges to mitigation and adaptation)	The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries. Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity.
SSP2: Middle of the Road (Medium challenges to mitigation and adaptation)	The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while others fall short of expectations. Global and national institutions work toward but make slow progress in achieving sustainable development goals. Environmental systems experience degradation, although there are some improvements and overall the intensity of resource and energy use declines. Global population growth is moderate and levels off in the second half of the century. Income inequality persists or improves only slowly and challenges to reducing vulnerability to societal and environmental changes remain.
SSP3: Regional Rivalry – A Rocky Road (High challenges to mitigation and adaptation)	A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues. Policies shift over time to become increasingly oriented toward national and regional security issues. Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. Investments in education and technological development decline. Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time. Population growth is low in industrialized and high in developing countries. A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions.
SSP4: Inequality – A Road Divided (Low challenges to mitigation, high challenges to adaptation)	Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. Over time, a gap widens between an internationally-connected society that contributes to knowledge- and capital-intensive sectors of the global economy, and a fragmented collection of lower-income, poorly educated societies that work in a labor intensive, low-tech economy. Social cohesion degrades and conflict and unrest become increasingly common. Technology development is high in the high-tech economy and sectors. The globally connected energy sector diversifies, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. Environmental policies focus on local issues around middle- and high-income areas.

SSP5: Fossil-fueled Development – Taking the Highway (High challenges to mitigation, low challenges to adaptation)	This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary.

Combining these SSPs with the RCPs produces the climate-economy projections used by the most recent IPCC report to assess the ongoing and future impacts of climate change. The IPCC highlights five illustrative scenarios – SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5. The resulting projection of greenhouse emissions across the scenarios is in the figure below (IPCC 2021).

FIGURE 1: FUTURE ANNUAL EMISSIONS OF CO2 (LEFT) AND OF A SUBSET OF KEY NON-CO2 DRIVERS (RIGHT), ACROSS FIVE ILLUSTRATIVE SCENARIOS.



Source: Riahi et al. 2017

The IPCC projects that global surface temperature will continue to increase until at least the mid-century under all the above emissions scenarios. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide and other greenhouse gas emissions occur in the coming decades (IPCC 2021). These reductions are explored further in section II.

BRAD IMPACT TRENDS: EXTREMES, UNPREDICTABILITY, AND SLOW-ONSET PRESSURE

This increase in global surface temperature impacts human beings in measurable but not necessarily intuitive ways. Rather than a uniform increase in temperatures, climate change is causing an exacerbation of extremes – extreme heat and cold, extreme rainfall and drought, and an increase in the frequency and severity of storms (cyclones, typhoons etc.).

For example, every additional 0.5°C of global warming causes "clearly discernible increases" in the intensity and frequency of hot extremes, including heatwaves, and heavy precipitation, as well as agricultural and ecological droughts in some regions. Globally, extreme daily precipitation events are projected to intensify by about 7% for each 1°C of global warming. Global warming will increase the proportion of intense tropical cyclones and the peak wind speeds of the most intense tropical cyclones (IPCC 2021).

The extremes are coupled with increasing unpredictability – for example, over the coming decades, monsoon rainfall will increase over South and Southeast Asia, East Asia and West Africa and the far-west Sahel, but "rainfall variability related to the El Niño–Southern Oscillation is projected to be amplified by the second half of the 21st century" (IPCC 2021). The relative predictability of the monsoon, which has under-pinned agriculture in these regions for centuries, is no longer a given.

In addition, planetary warming has "slow-onset" consequences, particularly the thawing of the polar permafrost and ocean warming, which increase sea-levels, coastal erosion and the frequency and severity of coastal flooding events (IPCC 2021). The most direct short-term effect is the uninhabitability of smaller lower-lying islands, apart from longer-term pressures on coastal communities worldwide.

RELATING GLOBAL CLIMATE TO REGIONAL/LOCAL CLIMATE

These drivers interact with local/regional climate and environmental factors to produce socio-economic impacts. However, the ways in which they do so are varied and not quite describable in the language of causation, especially with particular weather events or patterns. For example, regarding the Cape Town drought, the IPCC cautions that "although a clear association appears" between increasing greenhouse gas concentrations, drying in the Cape Town region, and the behaviour of the Antarctic oscillation, not all models show this association and the association is weaker when looking at earlier time periods in the data record. Thus, it considers that "there is only medium confidence in the expectation of a future drier climate for Cape Town" (IPCC 2021).

For India, there is high confidence that high greenhouse emissions scenarios will see an increase in monsoon rainfall by the end of the century. However, this is complicated in the near term by "internal variability" in climactic factors/trends, i.e. the variable year-to-year manifestations and interactions of oceanic and atmospheric currents such as the El Nino (IPCC 2021).

The capacity to relate global climate change to regional climate change is improving, and illustrates the difficulty of telling a simple story about impacts. For example, while "some mid-latitude and semi-arid regions, and the South American Monsoon region, are projected to see the highest increase in the temperature of the hottest days", the Arctic is projected to experience the "highest increase in the temperature of the coldest days" (IPCC 2021). The IPCC offers a breakdown for each continent; for illustrative purposes, this review focuses on the IPCC's findings for Africa.

In terms of extreme heat and cold, a substantial increase in heatwave magnitude and frequency over most of the Africa domain is projected at even the relatively low level of 2°C of global warming, with potential effects on health and agriculture. At higher warming levels, mortality-related heat stress levels and deadly temperatures are very likely to become more frequent. Heat stress is higher in equatorial humid regions like North Africa, the Sahel and Southern Africa. On the other hand, cold spells and frost days are projected to occur less frequently in all scenarios.

In terms of rainfall, total precipitation is projected to decrease in the northernmost and southernmost regions of Africa. Most African regions will undergo an increase in heavy precipitation that can lead to pluvial floods, while increasing aridity, hydrological, agricultural and ecological droughts, and fire weather are projected for North Africa, the Southern African regions and western portions of West Africa.

Regarding storms, mean wind speed and wind energy potential are expected to decrease in North Africa while increasing in South and West Africa. Across the continent, a *decrease* in the frequency of cyclones is projected, while an increase in wind storms in most African regions located southward of Sahel. The evolution of dust storms remains largely uncertain.

African snow and glaciers have very significantly decreased in the last decades; this trend will continue over the 21st century, as will the increase in most coastal and ocean related hazards in Africa. Relative sea-level rise is "virtually certain" to continue around Africa, contributing to "increased coastal flooding in low-lying areas and shoreline retreat along most sandy coasts". Marine heatwaves are also expected to increase around the region.

SOCIO-ECONOMIC IMPACTS

The IPCC also projects socio-economic impacts based on these climate-energy scenarios. The most recent comprehensive assessment (Fifth Assessment Report or AR5) was in 2014, followed by a special report in 2018 focusing on the differing socio-economic impacts of 1.5°C of warming versus 2°C of warming. The 'impacts and vulnerability' portion of the Sixth Assessment Report is scheduled to be published in 2022.

In 2014, the IPCC found that, while climate change was an important driver of socio-economics, the impacts of traditional/well-known socio-economic drivers such as changes in population, age structure, income, technology, relative prices, lifestyle, regulation, and governance would remain larger than climate impacts and that "global economic impacts from climate change are difficult to estimate" (IPCC 2014).

Nevertheless, it outlined some broad socio-economic impacts of climate change. Throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions and especially in developing countries with low income. This includes increased likelihood of under-nutrition resulting from diminished food production in poor regions; risks from lost work capacity and reduced labour productivity in vulnerable populations; and increased risks from food- and water-borne diseases. There may be modest reductions in cold-related mortality and morbidity in some areas due to fewer cold extremes, geographical shifts in food production (medium confidence), and reduced capacity of vectors to transmit some diseases, but globally, the magnitude and severity of negative impacts are projected to increasingly outweigh positive impacts (IPCC 2014).

Climate impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security, and prolong existing and create new poverty traps, particularly in urban areas and emerging hotspots of hunger. They are expected to exacerbate poverty in most developing countries and create new poverty pockets in countries with increasing inequality. The IPCC particularly highlights that poor households dependent on wage-labor that are net buyers of food (across rural and urban areas, but particularly in Africa) will be hit by food price increases. The caveats are that the agricultural self-employed could benefit, and that equitable social protection policies could mitigate these impacts (IPCC 2014).

Climate change will create new poor between now and 2100, in developing and developed countries, and jeopardize sustainable development, particularly in urban areas and some rural regions in sub-Saharan Africa and Southeast Asia. Significantly, the IPCC highlights that "current policy responses for climate change mitigation or adaptation will result in mixed, and in some cases even detrimental, outcomes for poor and marginalized people, despite numerous potential synergies between climate policies and poverty reduction", highlighting the possibility of (bad) climate policy exacerbating the vulnerability it seeks to reduce (IPCC 2014). It highlights four instances of policy claiming to combine climate responsibility with positive socio-economic outcomes:

- The Clean Development Mechanism (internationally tradable carbon credits) and Reduction of Emissions from Deforestation and Forest Degradation (international forest protection scheme), have had **limited or no effect in terms of poverty alleviation and sustainable development.**
- Land acquisition for **biofuel production** shows preliminary **negative impacts** on the lives of poor people, such as dispossession of farmland and forests, in many developing countries, particularly for indigenous peoples and (women) smallholders.
- Insurance schemes, social protection programs, and disaster risk reduction may enhance long-term livelihood resilience among poor and marginalized people, **if policies address multidimensional poverty.**

It concludes that "climate-resilient development pathways will have only marginal effects on poverty reduction, unless structural inequalities are addressed and needs for equity among poor and non-poor people are met." The IPCC breaks down socio-economic climate impacts by region; for illustration, the tabulation of impacts for Africa, Asia and Central & South America is included below.

FIGURE 2: SOCIO-ECONOMIC CLIMATE IMPACTS/RISKS IN AFRICA

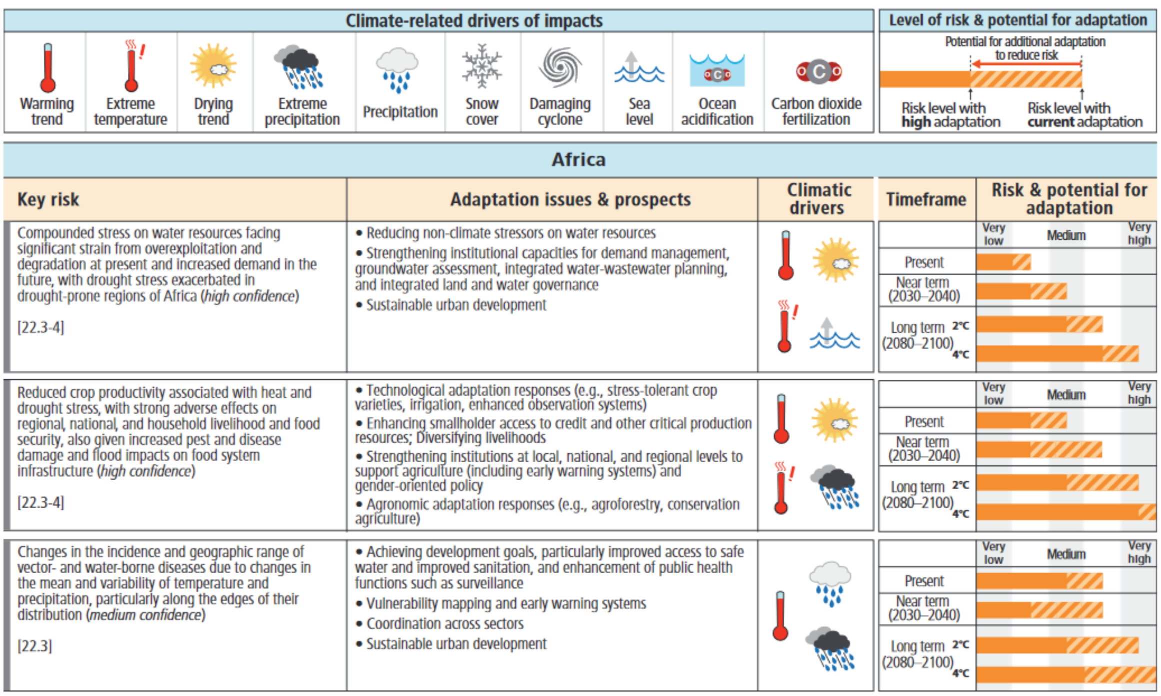


FIGURE 3: SOCIO-ECONOMIC CLIMATE IMPACTS/RISKS IN ASIA

Asia				
Key risk	**Adaptation issues & prospects**	**Climatic drivers**	**Timeframe**	**Risk & potential for adaptation** (Very low – Medium – Very high)
Increased riverine, coastal, and urban flooding leading to widespread damage to infrastructure, livelihoods, and settlements in Asia (*medium confidence*) [24.4]	• Exposure reduction via structural and non-structural measures, effective land-use planning, and selective relocation • Reduction in the vulnerability of lifeline infrastructure and services (e.g., water, energy, waste management, food, biomass, mobility, local ecosystems, telecommunications) • Construction of monitoring and early warning systems; Measures to identify exposed areas, assist vulnerable areas and households, and diversify livelihoods • Economic diversification		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	
Increased risk of heat-related mortality (*high confidence*) [24.4]	• Heat health warning systems • Urban planning to reduce heat islands; Improvement of the built environment; Development of sustainable cities • New work practices to avoid heat stress among outdoor workers		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	
Increased risk of drought-related water and food shortage causing malnutrition (*high confidence*) [24.4]	• Disaster preparedness including early-warning systems and local coping strategies • Adaptive/integrated water resource management • Water infrastructure and reservoir development • Diversification of water sources including water re-use • More efficient use of water (e.g., improved agricultural practices, irrigation management, and resilient agriculture)		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	

FIGURE 4: SOCIO-ECONOMIC CLIMATE IMPACTS/RISKS IN CENTRAL AND SOUTH AMERICA

Central and South America				
Key risk	**Adaptation issues & prospects**	**Climatic drivers**	**Timeframe**	**Risk & potential for adaptation** (Very low – Medium – Very high)
Water availability in semi-arid and glacier-melt-dependent regions and Central America; flooding and landslides in urban and rural areas due to extreme precipitation (*high confidence*) [27.3]	• Integrated water resource management • Urban and rural flood management (including infrastructure), early warning systems, better weather and runoff forecasts, and infectious disease control		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	
Decreased food production and food quality (*medium confidence*) [27.3]	• Development of new crop varieties more adapted to climate change (temperature and drought) • Offsetting of human and animal health impacts of reduced food quality • Offsetting of economic impacts of land-use change • Strengthening traditional indigenous knowledge systems and practices		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	
Spread of vector-borne diseases in altitude and latitude (*high confidence*) [27.3]	• Development of early warning systems for disease control and mitigation based on climatic and other relevant inputs. Many factors augment vulnerability. • Establishing programs to extend basic public health services		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	 2°C: not available 4°C: not available

Source Figures 2, 3 & 4: for Figures 2&3 is IPCC (2014) i.e. IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability,* Fifth Assessment Report of the Intergovernmental Panel on Climate Change

These socio-economic impacts are seen across all warming scenarios, but less warming is better. Limiting warming to 1.5°C compared with 2°C will result in smaller net reductions in yields of maize, rice, wheat, and potentially other cereal crops, particularly in sub-Saharan Africa, Southeast Asia, and Central and South America. Reductions in projected food availability are larger at 2°C than at 1.5°C of global warming in the Sahel, southern Africa, the Mediterranean, central Europe, and the Amazon. Similarly, limiting warming to 1.5°C may reduce the proportion of the world population exposed to climate change-induced increase in water stress by up to 50%, although there is "considerable variability between regions" (IPCC 2018).

DISPLACEMENT AND CONFLICT

Climate change is projected to increase displacement of people; however, there is "low confidence in quantitative projections of changes in mobility, due to its complex, multi-causal nature." The IPCC finds that some migration flows are sensitive to changes in resource availability and ecosystem services, noting that major extreme weather events have in the past led to significant population displacement, and changes in the incidence of extreme events will amplify the challenges and risks of such displacement. Many vulnerable groups do not have the resources to be able to migrate to avoid the impacts of floods, storms, and droughts, which is particularly concerning considering that "mobility is a widely used strategy to maintain livelihoods in response to social and environmental changes" (IPCC 2014).

Climate change "can indirectly increase risks of violent conflicts in the form of civil war and inter-group violence by amplifying well-documented drivers of these conflicts such as poverty and economic shocks", especially when these drivers coincide with inconsistent state institutions. This conclusion on violent conflict is significantly more measured/conservative than other projections, especially in the use of the words "can" and "indirectly". In the context of Africa, while climate change and climate variability have the potential to exacerbate or multiply known drivers of conflict including food, health, and economic insecurity, causality between climate change and violent conflict is difficult to establish owing to "interconnected causes, including country-specific sociopolitical, economic, and cultural factors" (IPCC 2014).

The finding that "some transboundary impacts of climate change, such as changes in sea ice, shared water resources, and pelagic fish stocks, have the potential to increase rivalry among states" is relatively unsurprising, as is the caveat that these rivalries can be managed through national and intergovernmental institutions. Similar to the finding for poverty, the IPCC considers that "poorly designed adaptation and mitigation strategies can increase the risk of violent conflict" (IPCC 2014).

Other high-level reports similarly acknowledge that the link between climate and conflict is indirect and contingent, but are less reticent about projecting security threats from climate change. In 2009, the UN Secretary General identified climate change as a "threat multiplier".[10] Apart from the IPCC's linkages, the UNSG report offered two additional climate-conflict links – the threat posed by climate change to the viability/survival of sovereign states, particularly small island states, and competition and disputes resulting from changes in natural resource availability or access, including "the sudden expansion of shared or un-demarcated resources" such as in the Arctic (UNSG 2009).

Similarly, in relation to the Sahel, the UNEP acknowledges climate change as one of several drivers, but is more categoric in linking it to specific impacts or socio-economic trends. For example, "traditional migration patterns are increasingly being replaced by a more permanent southward shift" and that "northern pastoralists

10 Note that the U.S. Defense Department has also adopted this perspective. For an explanation of this, see Klare 2019.

[...] have pushed further southwards into regions used by sedentary farmers, while increasing demand for food has meant that farmers have expanded cultivation into lands used primarily by pastoralists" (UNEP 2011).

Recent high-level reports are more careful to caveat the climate-conflict link. The ICRC considers that "scientists generally agree that climate change does not directly cause armed conflict, but that it may indirectly increase the risk of conflict by exacerbating factors that can, in a complex interplay, ultimately lead to conflict." In countries affected by conflict, "while climate change may not cause conflict, it may contribute to exacerbating and prolonging conflict and instability by further weakening institutions, systems, and people's coping mechanisms. It may also aggravate communal violence" (ICRC 2020).

Farmer-herder conflict and altered transhumance patterns due to desertification in the Central African Republic, Sahel and the Lake Chad region are cited as examples of climate exacerbating existing/ongoing armed conflict. In Mali, people initially displaced within the country by the conflict lost further due to the harsh climate; some ended up moving again. In the interior of the Central African Republic, people who had fled the violence and settled temporarily around urban areas endured heavy rains. This is caveated by the observation that while tensions are often described schematically – farmers and herders, local and foreign herders, northern and southern populations, Christians and Muslims – interactions between these groups and their role in the violence are intricate and nuanced (ICRC 2020).

A much stronger caution on the climate-conflict link is offered by the ODI, which is based on a systematic review of review academic and grey literature, blogs and social media coverage from April 2018–March 2019. It notes that despite "weak and contradictory evidence attesting to any simple, causal chain between climate change and conflict" (and/or migration), policy debates have "forged ahead of the evidence and leapt to conclusions about the possible role of climate change in driving natural resource-based conflicts in the future." The verifiable effects of climate-exacerbated resource scarcity and extreme weather are usually "localized skirmishes" and "depressed development outcomes, rather than overt violent conflict". Besides, climate drivers/pressures "can promote cooperation and collaboration and enhance social cohesion" rather than conflict (ODI 2020).

The broad issues ODI identifies with the climate-conflict literature are that it (i) focuses on establishing quantitative causal links rather than describing dynamics; (ii) uses narrow regional lenses such as the Sahel and East Africa because of their donor-relevance, ignoring broader vulnerability in the MENA region; (iii) is principally post-disaster, failing to trace decadal changes in vulnerability and exposure to a range of threats and hazards, and (iv) under-explores the role of politics, governance mechanisms and parallel governance structures specifically in contexts of violence and armed conflict (ODI 2020).

These concerns are echoed in recent academic work, along with suggestions for better integration of climate and conflict studies (Ide 2018; Nordas & Gleditsch 2015; Buhaug 2015; Mach et al. 2019; Adams et al. 2018). New academic work claiming evidence of climate-conflict links is more careful in its caveats, e.g.: "disasters do not enhance conflict risks per se, but only in certain contexts", or that the paper establishes a "causal relationship between climate, conflict and asylum-seeking only in the recent period." (Abel et al. 2018; Ide et al. 2020).

CONCLUSION

The fact that human activities cause global warming is clear, as are the broad global trends associated with climate change – increasing weather extremes, unpredictability and building stresses from slow-onset events. Qualitatively, the links between these trends and socio-economic vulnerability and risk is well established. However, there are still significant gaps in the details of how global climate trends will downscale regionally and interact with local demographics, politics, and environment.

In terms of conflict-afflicted states, climate change can exacerbate conflict *indirectly,* by increasing stresses on natural resources and human habitation and migration patterns. However, the climate-conflict link is far from statistically established; at best, climate change can be qualitatively considered alongside other contextual factors, many of which exhibit far clearer qualitative and quantitative links with conflict. In isolation, climate change is a highly contingent factor, capable of increasing conflict and/or cooperation.

In terms of rentier states, the literature reviewed here rarely refers directly to them. However, it does reference the role of “poorly designed” climate mitigation and adaptation policies in exacerbating poverty and conflict. In principle, this would include hasty and ill-considered decarbonization policies, especially in states which are unable to replace carbon rents.

II THE ENERGY TRANSITION IN THEORY VS. PRACTICE

DECARBONIZATION TRAJECTORIES: THE SCIENTIFIC BASIS

Over the period 1850–2019, a total of 2390 (± 240) gigatonnes of anthropogenic carbon dioxide was emitted. The IPCC has re-affirmed that there is a “near-linear relationship” between cumulative anthropogenic carbon dioxide emissions and global warming – each 1000 gigatonnes of carbon dioxide accumulated in the atmosphere adds approximately 0.45°C to global average surface temperature. Accordingly, it estimates a global carbon dioxide budget, which is actually multiple budget estimates, based on a range of temperature thresholds (IPCC 2021).

TABLE 2: ESTIMATES OF HISTORICAL CO2 EMISSIONS AND REMAINING CARBON BUDGETS.

Estimated remaining carbon budgets are calculated from the beginning of 2020 and extend until global net zero CO2 emissions are reached. They refer to CO2 emissions, while accounting for the global warming effect of non-CO2 emissions. Global warming in this table refers to human-induced global surface temperature increase, which excludes the impact of natural variability on global temperatures in individual years.

Global warming between 1850–1900 and 2010–2019 *(°C)*	Historical cumulative CO_2 emissions from 1850 to 2019 *($GtCO_2$)*
1.07 (0.8–1.3; *likely* range)	2390 (± 240; *likely* range)

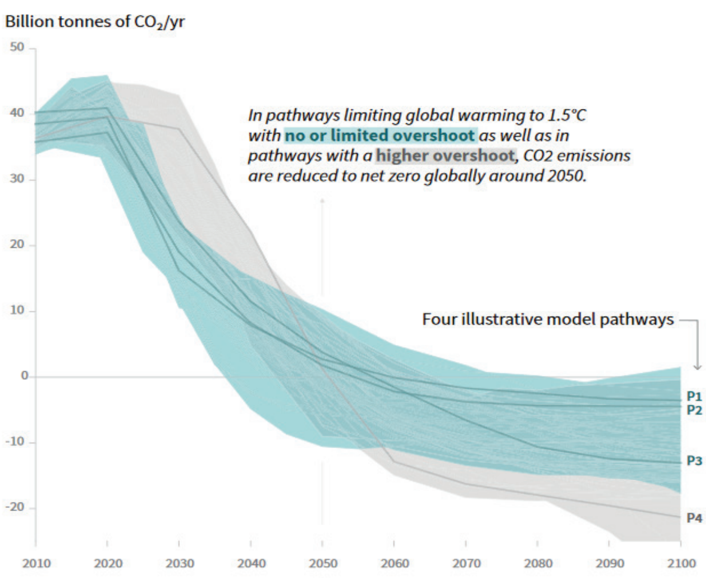
Approximate global warming relative to 1850–1900 until temperature limit *(°C)**(1)	Additional global warming relative to 2010–2019 until temperature limit *(°C)*	Estimated remaining carbon budgets from the beginning of 2020 *($GtCO_2$)* *Likelihood of limiting global warming to temperature limit*(2)*					Variations in reductions in non-CO_2 emissions*(3)
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

These budget estimates are the basis for headlines that the world has x number of years to solve climate change. For a decent likelihood (60 to 80%) of staying under the 1.5°C warming threshold, the global economy can emit 300 to 400 more gigatons of carbon dioxide.[11] In 2019-20, global carbon dioxide emissions (excluding land use change) totaled 38 gigatons. At that level of annual emissions, the budget for 1.5°C is exhausted in 10 years or less.

There are ways of removing carbon from the atmosphere – established ones such as restoring forests and reversing desertification and soil degradation, and less established carbon capture and storage technology. This raises the possibility of net negative emissions, if the sources of emissions can be controlled or eliminated. In addition, 1.5°C is not the only relevant temperature threshold; for a long time, 2°C was widely the implicitly accepted global target. The Paris Agreement refers to both thresholds.[12] The appropriate threshold is partially a question of what level and pace of change human societies can adapt to, which is itself influenced by what resources (financial and otherwise) are available for adaptation and how they are distributed.

With all this considered, the IPCC's trajectories to avoid catastrophic climate change emphasize reducing carbon dioxide emissions to zero by around the middle of this century. Depending on how quickly emissions can be reduced, the global economy would have to be a net carbon sink/net negative emitter, absorbing carbon from the atmosphere through the rest of the century. This is commonly referred to as the net-zero-by-2050 target. Prioritizing the 2°C threshold delays the net zero deadline to around 2065 (IPCC 2018).

FIGURE 5: GLOBAL TOTAL NET CO_2 EMISSIONS



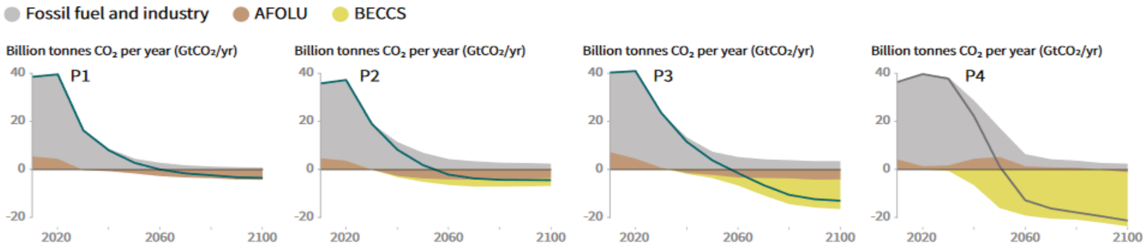
Source: IPCC 2018

11 Carbon and carbon dioxide are often used interchangeably, but one ton of carbon equals 3.67 tons of carbon dioxide. In addition, there are greenhouse gases other than carbon dioxide (such as methane), which warm the atmosphere at a different rate. Cumulative greenhouse budgets which include all gases use the unit 'tons of carbon dioxide equivalent' ('CO2e'); the table above is for carbon dioxide only. The exact warming potential of other gases is a source of some uncertainty, which is why the IPCC's carbon dioxide budget table includes the orange column to the right.

12 Article 2 establishes its objective as "[h]olding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change". The inclusion of the 1.5°C target is partially owed to highly vulnerable states, particularly small island states, who suffer the earliest catastrophic consequences of warming.

TABLE 3: BREAKDOWN OF CONTRIBUTIONS TO GLOBAL NET CO_2 EMISSIONS IN FOUR ILLUSTRATIVE MODEL PATHWAYS

Breakdown of contributions to global net CO_2 emissions in four illustrative model pathways



P1: A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

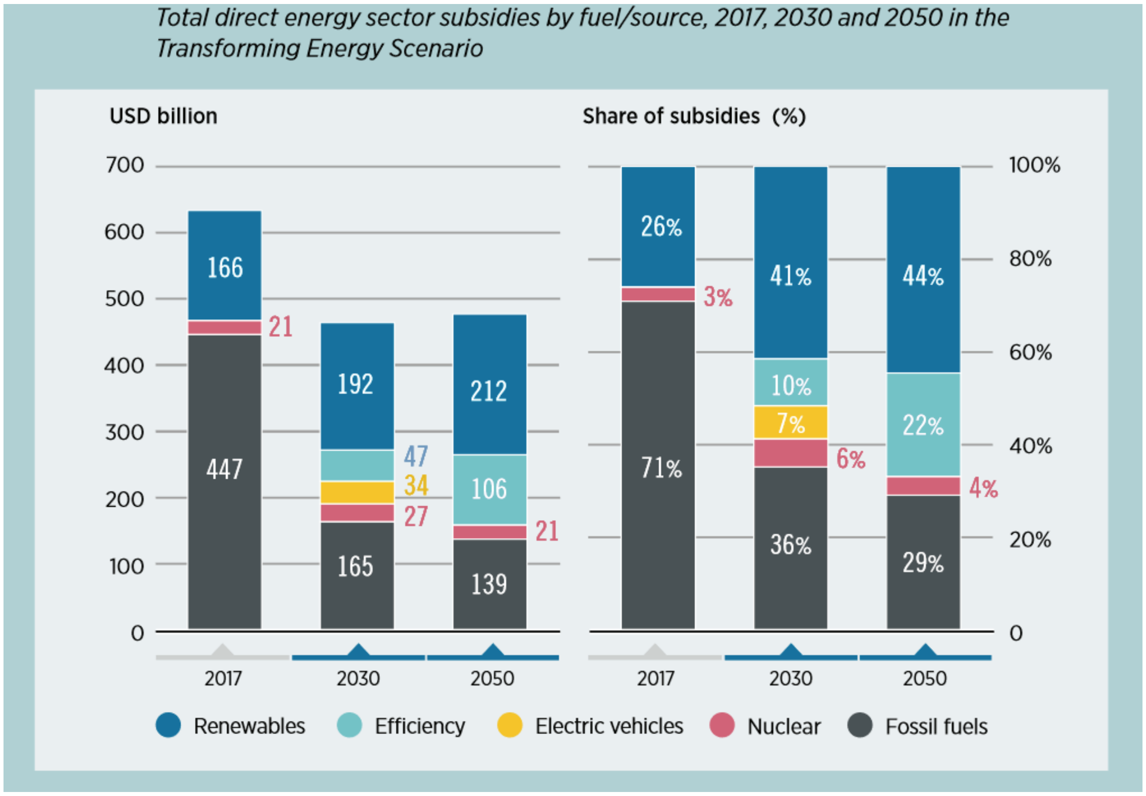
Global indicators	P1	P2	P3	P4	**Interquartile range**
Pathway classification	No or limited overshoot	No or limited overshoot	No or limited overshoot	Higher overshoot	No or limited overshoot
CO_2 emission change in 2030 (% rel to 2010)	-58	-47	-41	4	(-58,-40)
└ in 2050 (% rel to 2010)	-93	-95	-91	-97	(-107,-94)
Kyoto-GHG emissions in 2030 (% rel to 2010)*	-50	-49	-35	-2	(-51,-39)
└ in 2050 (% rel to 2010)	-82	-89	-78	-80	(-93,-81)
*Final energy demand** in 2030 (% rel to 2010)*	-15	-5	17	39	(-12,7)
└ in 2050 (% rel to 2010)	-32	2	21	44	(-11,22)
Renewable share in electricity in 2030 (%)	60	58	48	25	(47,65)
└ in 2050 (%)	77	81	63	70	(69,86)
Primary energy from coal in 2030 (% rel to 2010)	-78	-61	-75	-59	(-78, -59)
└ in 2050 (% rel to 2010)	-97	-77	-73	-97	(-95, -74)
from oil in 2030 (% rel to 2010)	-37	-13	-3	86	(-34,3)
└ in 2050 (% rel to 2010)	-87	-50	-81	-32	(-78,-31)
from gas in 2030 (% rel to 2010)	-25	-20	33	37	(-26,21)
└ in 2050 (% rel to 2010)	-74	-53	21	-48	(-56,6)
from nuclear in 2030 (% rel to 2010)	59	83	98	106	(44,102)
└ in 2050 (% rel to 2010)	150	98	501	468	(91,190)
from biomass in 2030 (% rel to 2010)	-11	0	36	-1	(29,80)
└ in 2050 (% rel to 2010)	-16	49	121	418	(123,261)
from non-biomass renewables in 2030 (% rel to 2010)	430	470	315	110	(245,436)
└ in 2050 (% rel to 2010)	833	1327	878	1137	(576,1299)
Cumulative CCS until 2100 ($GtCO_2$)	0	348	687	1218	(550,1017)
└ of which BECCS ($GtCO_2$)	0	151	414	1191	(364,662)
Land area of bioenergy crops in 2050 (million km^2)	0.2	0.9	2.8	7.2	(1.5,3.2)
Agricultural CH_4 emissions in 2030 (% rel to 2010)	-24	-48	1	14	(-30,-11)
in 2050 (% rel to 2010)	-33	-69	-23	2	(-47,-24)
Agricultural N_2O emissions in 2030 (% rel to 2010)	5	-26	15	3	(-21,3)
in 2050 (% rel to 2010)	6	-26	0	39	(-26,1)

NOTE: Indicators have been selected to show global trends identified by the Chapter 2 assessment. National and sectoral characteristics can differ substantially from the global trends shown above.

** Kyoto-gas emissions are based on IPCC Second Assessment Report GWP-100*
*** Changes in energy demand are associated with improvements in energy efficiency and behaviour change*

Source: IPCC 2018

FIGURE 6: ENERGY SUBSIDIES: OVERALL REDUCTION IN THE TRANSFORMING ENERGY SCENARIO



Source: IRENA 2020

For trajectories which do not rely heavily on carbon capture and storage technology (P1 and P2), primary energy generated from coal reduces by 77-97% by 2050 (measured against a 2010 baseline). Primary energy from oil reduces by 50-87%. With more reliance on CCS (scenarios P3 and P4), the reduction in oil-fired energy by 2050 is less steep (32-81%). While most fossil fuels in most scenarios see steady declines, the highest-CCS-reliance scenario sees primary energy from oil increase by 86% by 2030 (partially replacing coal in some applications), before declining sharply by 2050 (IPCC 2018).

Primary energy from natural gas declines in low-CCS-reliance scenarios, but somewhat less rapidly than coal or oil, and increases over some time periods in some higher CCS-reliance scenarios (IPCC 2018). Renewables are projected to supply 70–85% of electricity in 2050. In transportation, the share of "low-emission final energy" (including electric vehicles and biofuels) would rise from less than 5% in 2020 to between 35–65% in 2050 (25–45% for the 2°C threshold) (IPCC 2018).

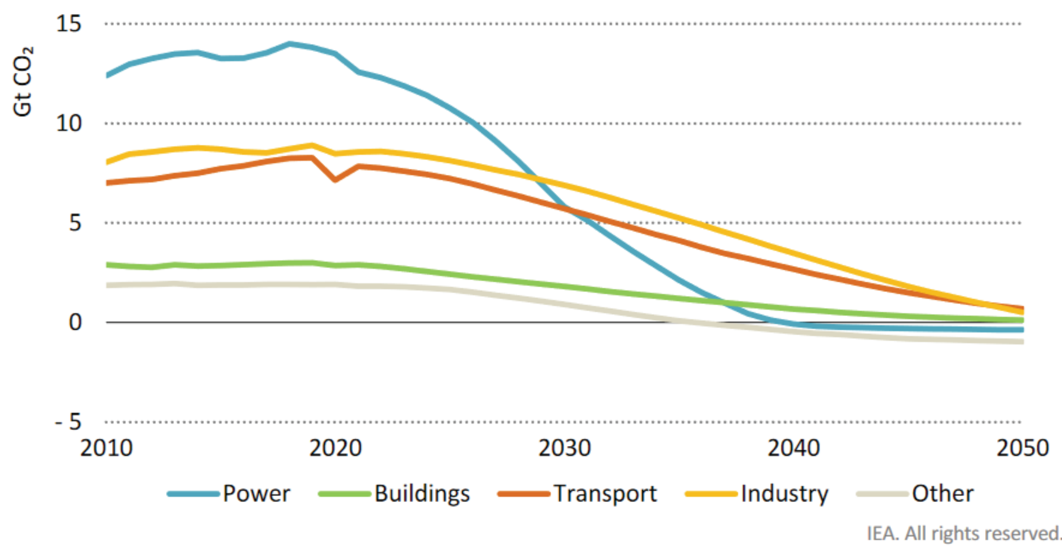
The required change in land use (between 2010 and 2050) is much less certain – even in low-CCS-reliance trajectories, non-pastureland for food and feed crops worldwide could decrease by as much as 4 million square kilometers or increase by as much as 2.5 million square kilometers. Pastureland would have to reduce between 0.5 and 11 million square kilometers, partially replaced by energy crops, which could take up to 6 million square kilometres. Forested land could reduce by 2 million square kilometres or increase by up to 9.5 million square kilometres (IPCC

2018). This results from the different ways in which land can be used, all nominally in accordance with decarbonization objectives – to produce crops for biofuels, to plant forests to absorb carbon, to integrate crops and forests[13], or through industrial-scale installations to produce renewable energy and capture carbon.[14]

Reaching net zero requires USD 830 billion in additional average energy-related investments in each year between 2016 and 2050.[15] Much of this investment is direction toward electrification of economies, and replacement of fossil-fired electricity with renewables. Annual investments in low-carbon energy technologies and energy efficiency need to be scaled up six times between 2015 and 2050. Wind power capacity needs to be expanded by 6000 GW between 2017 and 2050, solar capacity needs to be expanded by around 8500 GW.[16] This would require a significant shift in energy subsidies – fossil fuels accounted for 71% of subsidies in 2017; by 2050, they would account for under 30%.

Accordingly, even as electricity demand grows rapidly, rising by 40% from today to 2030 and more than two-and-a-half-times to 2050, emissions from electricity generation fall to net-zero in aggregate in advanced economies by 2035 and globally by 2040. The least-efficient coal plants are phased out by 2030 and all

FIGURE 7: CO2 EMISSIONS BY SECTOR IN THE NEZ



Emissions fall fastest in the power sector, with transport, buildings and industry seeing steady declines to 2050. Reductions are aided by the increased availability of low-emissions fuels

Source: IEA 2021

13 Agroforestry, which theoretically combines food production and carbon absorption, but has problems in practice, and is difficult to categorize in terms of land-use.

14 Technological solutions to capture carbon include solutions which are integrated into existing emissions sources such as power plants or industrial units, and 'Direct Air Capture' solutions which are standalone units requiring new land. Both solutions require new land to store captured carbon dioxide.

15 This is over and above the USD 95 trillion of investment already planned by governments in energy systems over the coming three decades (IRENA 2020).

16 For context, non-hydro renewable power capacity is currently around 1600 GW globally (IRENA 2021).

unabated coal by 2040. Investment in electricity grids triples to 2030 and remains high until 2050. In the buildings sector, there are no new fossil fuel boilers sold from 2025, except where they are compatible with hydrogen, and sales of heat pumps soar. By 2050, electricity provides 66% of energy use in buildings (up from 33% in 2020). Natural gas use for heating drops by 98% in the period to 2050 (IEA 2021).

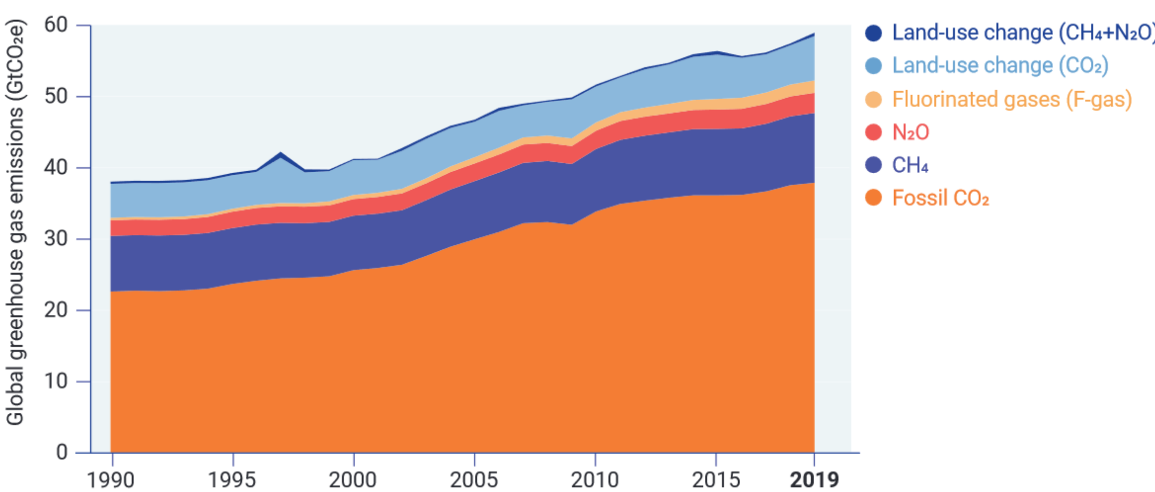
In the industry sector, emissions reductions need to be driven primarily by technologies that are not ready for market today, including hydrogen and carbon capture and storage. These require research and development investments, which are difficult to estimate. Each month from 2030, the world will have to equip 10 new and existing heavy industry plants with CCUS, add 3 new hydrogen-based industrial plants and 2 GW of electrolyser capacity at industrial sites (IEA 2021).

In the transport sector, by 2030, electric cars need to account for over 60% of car sales (up from 4.6% in 2020) and fuel cell or electric vehicles are 30% of heavy truck sales (up from less than 0.1% in 2020). By 2035, nearly all cars sold globally need to be electric, and by 2050 nearly all heavy trucks sold need to be fuel cell or electric. Low-emissions fuels and behavioural changes can help to reduce emissions in long-distance transport, but aviation and shipping are likely to remain challenging and account for 330 Mt CO2 emissions in 2050 (IEA 2021).

GAP BETWEEN SCIENCE AND POLICY

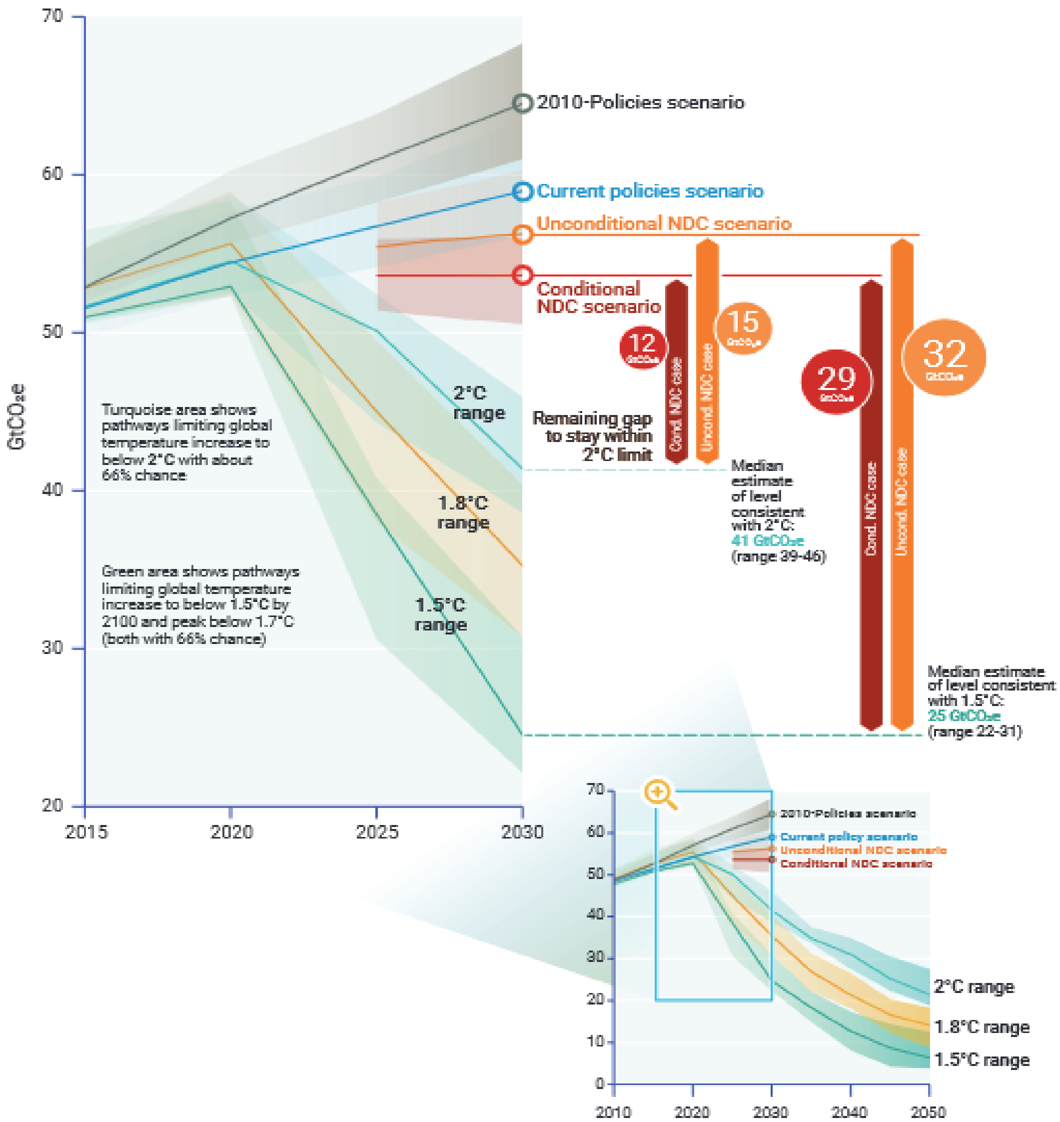
Global emissions are currently on a rising trajectory. Since 2010, greenhouse emissions excluding land use change have grown at 1.3 per cent per year on average. This includes an increase in carbon dioxide emissions from around 30 gigatons in 2010 to around 38 gigatons in 2019. Emissions are expected to dip sharply in 2020 due to the pandemic but are likely to quickly recover unless climate policy substantially changes (UNEP 2020).

FIGURE 8: GLOBAL GHG EMISSIONS FROM ALL SOURCES



Source: UNEP 2020

FIGURE 9: GLOBAL GHG EMISSIONS UNDER DIFFERENT SCENARIOS AND THE EMISSIONS GAP IN 2030 (median and 10th to percentile range; based on the pre-COVID-19 current policies scenario)



Source: UNEP 2020

Temperature thresholds and the IPCC's indicated trajectories are supposed to be translated into national emission targets and accompanying policies. At the international level, an earlier attempt to set such national targets for developed high-emitting economies – the Kyoto Protocol – failed because of a lack of political will in developed countries to accept such targets. This problem substantially remains, although political will has and continues to gradually shift.

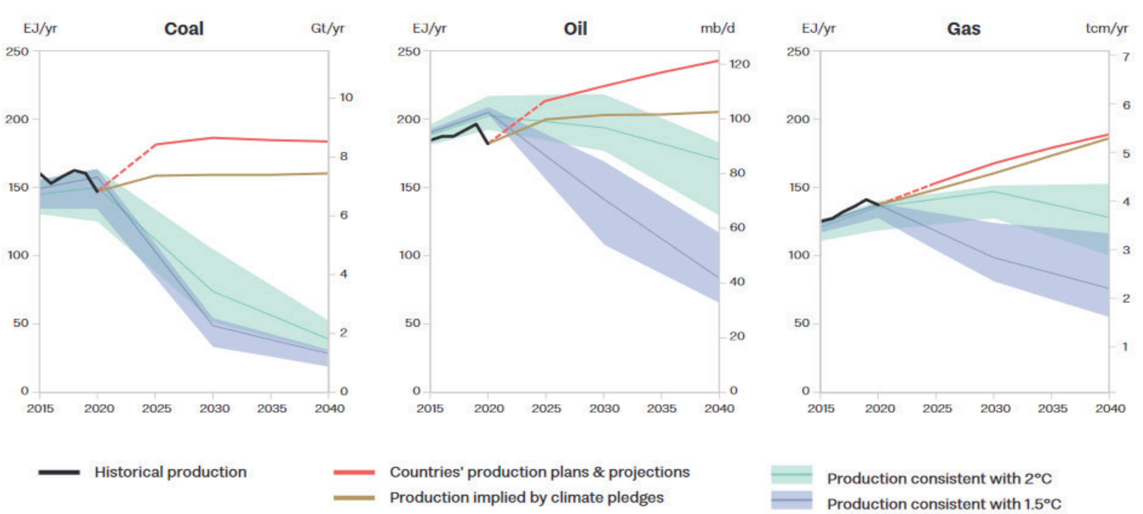
The Paris Agreement of 2015 takes a different approach to the problem by (1) requiring all countries to set emissions targets, (2) leaving it to countries to determine the content of their own targets. This removed a key objection of developed countries to the Kyoto Protocol – i.e. that large developing countries did not have targets. It also removed an objection of large developing countries to accepting targets – that their emissions, though large in annualized terms, far lagged developed countries' when framed in per capita and temporal cumulative terms (China and India were not insignificant emitters between the 1850s and the 1990s). The Paris system allows for self-determined, self-differentiated targets (known as Nationally Determined Contributions).

Countries are supposed to submit NDCs to the UNFCCC secretariat every five years, starting in 2015. The theory behind mandating a target-setting process without specifying targets is that the process could (1) expand technical capacity at the national level to discover what is actually possible, and (2) create and strengthen domestic constituencies for decarbonization, such as climate-vulnerable-community advocacy groups, climate think tanks and renewable energy industry groups. In practice, this creates (albeit partly by design) a messy global landscape of climate targets and policies.

At present, this landscape does not match the IPCC's indicated decarbonization trajectory. The NDCs cumulatively have the world on track for around 3C of warming (UNEP 2020). The worst offenders are the US and China, whose NDCs are out of sync with their contribution to the problem and their capacity to act (Climate Action Tracker 2021). Apart from NDCs, which set targets for 10 years, countries are increasingly announcing net zero pledges, with deadlines starting in 2045 (eg: Germany) and going up to 2060 (eg: China) (Net Zero Tracker 2021).

FIGURE 10: GLOBAL COAL, OIL, AND GAS PRODUCTION (EXAJOULE OR EJ PER YEAR) UNDER FOUR PATHWAYS, 2015-2040.

Global coal, oil, and gas production (exajoule or EJ per year) under four pathways, 2015–2040. This figure is adapted from the 2019 Report, updated to show actual and estimated 2015–2020 values (black lines). For the 1.5°C and 2°C pathways, the median (purple and green lines) and 25th to 75th percentile range (shaded areas) are shown. Note that the modelled pathways for production consistent with 1.5°C and 2°C have not been harmonized to recent actual data (black lines); consequently, the median values for the 1.5°C- and 2°C-consistent pathways appear above the estimated actual production for coal and oil in 2020. Physical units are displayed as secondary axes: billion tonnes per year (Gt/yr) for coal, million barrels per day (mb/d) for oil, and trillion cubic meters per year (tcm/yr) for gas.

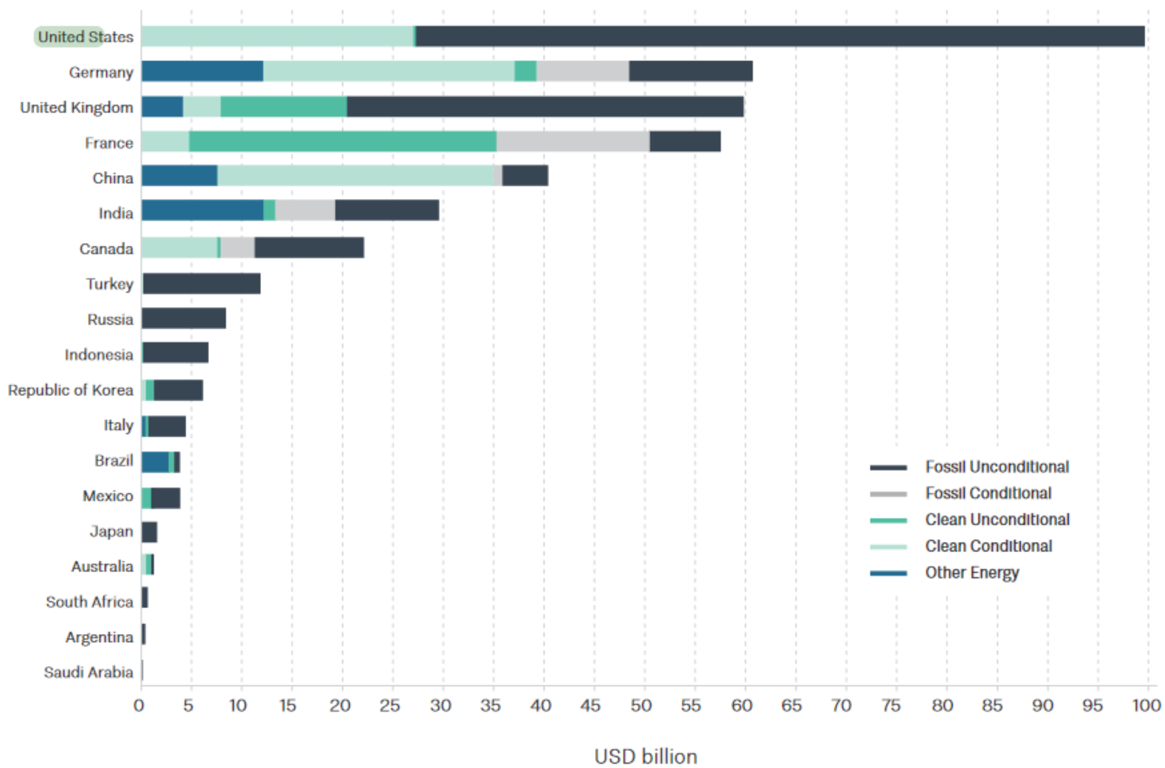


Source: UNEP 2020b

However, less than 25 percent of pledges are actually integrated into law or policy. As a result, apart from targets being inadequate, national performance lags the targets (IEA 2021). This is nowhere more evident than current fossil fuel investment policies, which are 120% in excess of the level of investment consistent with 1.5°C and/or 50% in excess of a 2°C-consistent trajectory (UNEP 2020b).

This is because "many governments in countries endowed with large stores of coal, oil, and gas have adhered to the belief that the exploitation of these resources is essential for economic development and energy security and have thus "issued optimistic outlooks for fossil fuel production, complemented by fiscal, regulatory, and other forms of government support" (UNEP 2020b). The leading providers of fossil fuel production subsidies are Canada, the US and China, who either have ambitious NDCs or net zero targets, revealing a lack of joined-up thinking on energy policy (which is sometimes presented as an "all-of-the-above" strategy).

FIGURE 11: PUBLIC MONEY COMMITMENTS TO FOSSIL FUELS, AND CLEAN AND OTHER ENERGY, IN RECOVERY PACKAGES



Source: UNEP 2020b

In low-emitting countries, where the challenge is to lay out an intended trajectory for renewables expansion and climate change adaptation, NDCs are currently (in general) poorly linked with national development plans, laws or policies, and hence lack finance, political/institutional will, and monitoring & review. This extends to the issue of replacing the economic, political and social benefits of fossil fuels – while some African countries identify the need to balance decarbonization with wide economic priorities, very few identify how to do so (ADB 2018).

Limited exceptions are South Africa and Kenya, which acknowledge the need for just transition in their NDCs. The EU, Costa Rica and, more recently, Chile consider just transition in their NDCs and have set up institutions for the purpose, but only the former has dedicated finance for it (WRI 2020; ITUC 2021). Developing countries in general have, thus far, not incorporated just transition principles in their NDCs and domestic strategies (Climate Strategies 2020).

III TRAUMA OF DECARBONIZATION TO THE CURRENT CARBON ECONOMY

The decline of fossil fuel rents is no longer a question of if, but when, and fragile fossil fuel-producing states are likely to be among the first to feel the negative consequences. However, 'peak demand' is likely to remain an OECD-centered phenomenon for the foreseeable future with petrostates continuing to accrue rents though eventually, oil will cease to play a role in a low-carbon energy system (Goldthau and Westphal 2019, 282).

This section surveys research on when and where the decline of fossil fuel rents will happen, the predicted impact on fossil fuel economies and government budgets, and emerging strategies on how these countries are attempting to manage the transition.

FUTURE OF THE FOSSIL FUEL INDUSTRY AND OIL RENTS

Decline in Fossil Fuel Rents

We are now in a moment (2022) when peak demand for fossil fuels has likely already occurred or is likely to occur in the next few years. In order to achieve net zero emissions by 2020, the IEA (2021) says that as of 2021, no new oil and gas fields should be approved for development and estimates that between 2020 and 2030, tax revenues from oil and gas will decline by approximately 40 percent (IEA 2021, 24). There is no exact roadmap to where and when fossil fuel rents will decline, but there are estimates and indicators based on current production statistics.

McGlade and Ekins (2015) estimate that globally, 35 percent of oil will need to remain in the ground. Of this, Africa will need to leave 38 percent of its oil reserves (28 billion) unextracted, and the Middle East will need to leave 38 percent of its oil reserves in the ground (approximately 264 billion barrels). Their estimates were based on 2015 available data on known reserves and projections for production costs, demand, and technological advancement.

The cost of producing a barrel of oil is likely to be one of the leading indicators of where oil rents will decrease the fastest. As demand for oil declines and the global price of oil also drops, high-cost producers will eventually be priced out of the market. Cost of production is determined by the taxes, capital expenditure required for extraction, and administrative/transportation costs. So, the costs are in part determined by the type of oil reserve and how difficult it is to extract and in part by the regulatory environment of the country. Data on production costs is notoriously difficult to come by as it is proprietary and closely guarded by companies. Table 4 shows 2016 estimates.[17] Globally, more well-established oil and gas producers more often have lower costs of production than new entrants to the market, especially as investors and businesses now have a narrower window to recuperate their investments before their assets become stranded. Indeed, investors are already anticipating this and offloading their oil-producing assets before they become stranded. For example, by 2021 investors had already paused major projects in Angola, Chad, Gabon, Nigeria[18], Uganda and other states with high-cost production (Gillies 2021, 28).

TABLE 4: TOP OIL PRODUCERS IN 2020

Country	Fragile State Ranking (2020)	Million Barrels per day (2020)	Share of World Total (2020)	Estimated Production Cost of Barrel of Oil[19] (2016)	Estimated Oil Rents as Percentage of GDP (2019)
United States	143rd	18.60	20%	$23.35 (shale) $20.99 (non-shale)	0.4%
Saudi Arabia	93rd	10.82	11%	$8.98	24.2%
Russia	74th	10.50	11%	$19.21	9.2%
Canada	171st	5.26	6%	$26.64	1.6%
China	95th	4.93	5%	N/A	0.4%
Iraq	20th	4.16	4%	$10.57	39.6%
Brazil	70th	3.79	4%	$24.99	2%
United Arab Emirate	151st	3.79	4%	N/A	16.2%
Iran	43rd	3.01	3%	$9.08	20.4%
Kuwait	129th	2.75	3%	N/A	42%
Total Top 10		67.60	72%		
World Total		94.20			

Sources: EIA, Wall Street Journal, World Bank N/A: Data not available

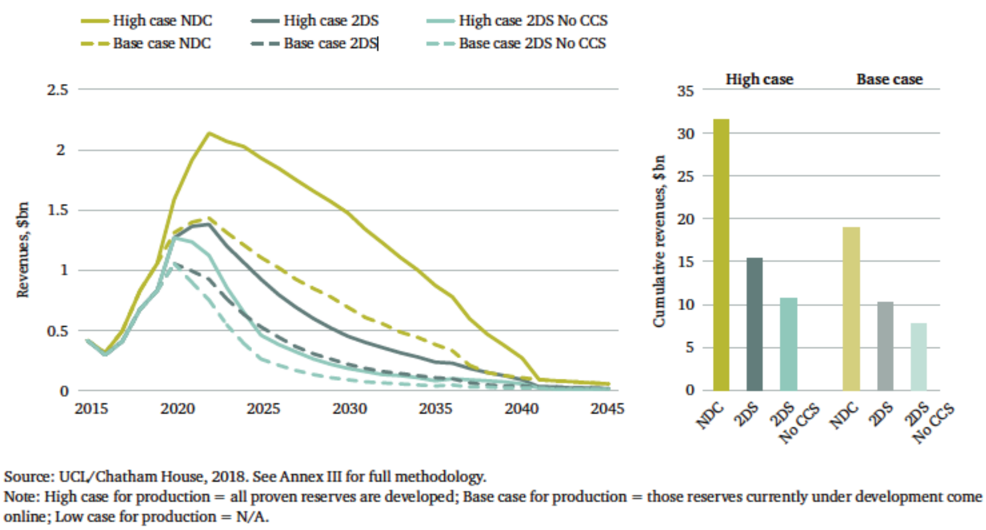
17 Note that Rystad Energy is the underlying source of these statistics as well as the most common source cited across studies on the cost of production. Rystad Energy is a private company that maintains what some believe are some of the most extensive datasets on the petroleum industry. For example, the Natural Resource Governance Institute uses Rystad Energy as the provider of the raw data for NGRI's National Oil Company Database.

18 As of 12 August 2021, Shell is seeking to divest from all joint venture licenses in Nigeria, which accounts for approximately 39 percent of Nigeria's oil production. These are wells in the Niger Delt and adjacent shallow-water areas, valued at $2.32 billion (not including the pipelines). See https://www.offshore-mag.com/regional-reports/africa/article/14208549/shell-seeking-to-sell-niger-delta-licenses.

19 Includes gross taxes, production, capital, and administrative/transportation costs. See WSJ http://graphics.wsj.com/oil-barrel-breakdown/.

Using different climate scenarios, Bradley et al. (2018) approximated the decline in oil export revenues for Ghana from 2015 – 2045. As can be seen in the graph below, the difference between Ghana's current NDCs and actually aligning with the most conservative climate scenario (Base case 2DS, No CCS)[20] is significant – a difference of $16.1 billion over the next 25 years.

FIGURE 12: GHANA NET OIL EXPORT REVENUES, NET PRODUCTION COSTS, UNDER DIFFERENT CLIMATE SCENARIOS, 2015-2045



Source: Bradley et al. 2018.

Oil rents account for less than 5 percent of Ghana's GDP and less than 10 percent of government revenues but nonetheless are an important source of revenue for the state. However, Ghana represents one of the better case scenarios. Its national oil company is highly transparent, and overall, it is considered a well-governed industry (Malden and Gyeyir 2020). The implications and potential losses for countries with higher levels of fossil fuel production where oil accounts for a larger percentage of government revenues and/or GDP are much more significant. The following sections dive deeper into these issues.

Understanding Breakeven Prices: On Paper vs. Practice

Some studies (e.g. Hertog 2019) include what's called a 'breakeven' price, meaning the price that oil would need to be at in order for a government to balance its budget. This is one metric used to estimate how vulnerable government revenues are to oil price shocks as well as an indicator of when a government is likely to need other sources of funding in order to balance its budget. A breakeven price has the connotation that oil-dependent states will be destabilized if oil drops below that price because it will either need to cut public spending or seek other sources of revenue. In practice, the relationship is not so straightforward and oil-dependent governments are adept in supplementing drops in oil rents with domestic and international loans. For example, in

20 Here 2DS refers to a 2ºC limit scenario based on a central carbon budget of 910 GtC02; CCS is carbon capture and storage.

2016, Nigeria's breakeven cost was estimated at $139/barrel (Bentley, Minczeski, and Juan 2017) but it operated on budget based on the average price of $38/barrel (Udoma 2016). At the time, Nigeria was experiencing an economic recession, in part due to the global drop in price of oil, and government spending was far outpacing its revenue, so it borrowed heavily to fill the gap. In sum, it replaced one source of revenue with another, even if that revenue would someday need to be repaid. While the government may be able to supplement the official budget with loans, drops in the price of oil have significant implications for the patronage networks and flow of oil rents that never enter the governments books at all. Tracing the impact on patronage networks can shed light on the changing nature of political alliances, rise and fall of specific political or business elite, and who has the financial capital to gain or maintain power in transactional political systems. In sum, a breakeven price can indicate how an oil-dependent state may officially respond to fluctuations in the price of oil, but the unofficial shifts are likely to be more significant and telling for who has power and influence. This is further explained on pages 45-6.

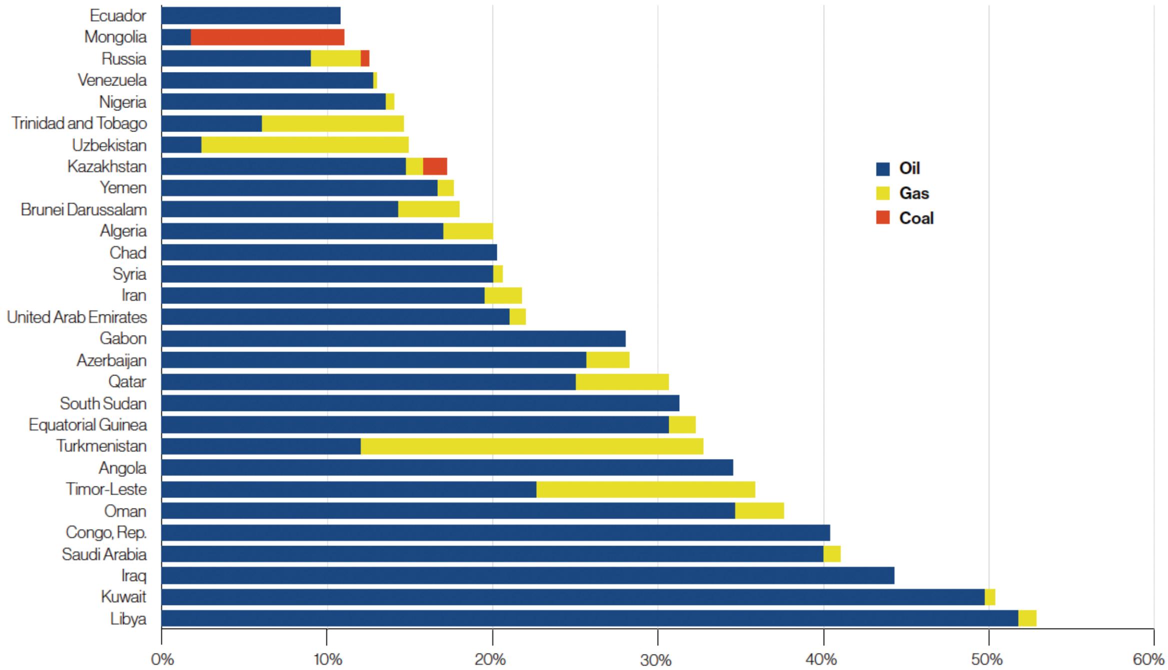
PREDICTED IMPACT: ECONOMIC SHOCKS AND DECLINING GOVERNMENT REVENUES

Not all fossil fuel producers are dependent on fossil fuels in the same way: some are economically dependent while others are dependent on them for government revenues. These are not mutually exclusive and in fact are often related, but they are different. For example, in Nigeria, oil rents account for between 65-85 percent of government revenues, less than 10 percent of GDP, but do account for the majority of foreign earnings. Shocks to the price of oil reverberate through the sector to government spending and then to businesses engaged in international transactions. In this sense, the economy does feel negative consequences, but the government is far more vulnerable to shocks to oil rents than the economy is. The distinction between economic dependence and government dependence is not always made in the literature (e.g. IRENA 2019), but the difference is important both for understanding the impact and how policy prescriptions are likely to play out in various contexts. A key challenge across the literature is a lack of robust comparable data on fossil fuel rents as a percentage of government revenues. This section analyzes the predicted impact of a loss of fossil fuels to government revenues and then the predicted impact of a loss of fossil fuels to economies to draw out the implications of each. While there is some research on these questions, overall, there is a lack of understanding on the economic and political impact an energy transition will have for governments dependent on fossil fuels (Bradley et al. 2018, 70).

Shocks to the Economy

It is widely accepted that countries in which fossil fuel rents account for a significant portion of GDP (usually meaning more than 20%) are vulnerable to negative consequences of an energy transition, these remain "poorly understood and largely unprepared for" (Bradley et al. 2018, 70).

FIGURE 13: FOSSIL FUEL RENTS AS A PERCENTAGE OF GDP (AVERAGE 2007-16)



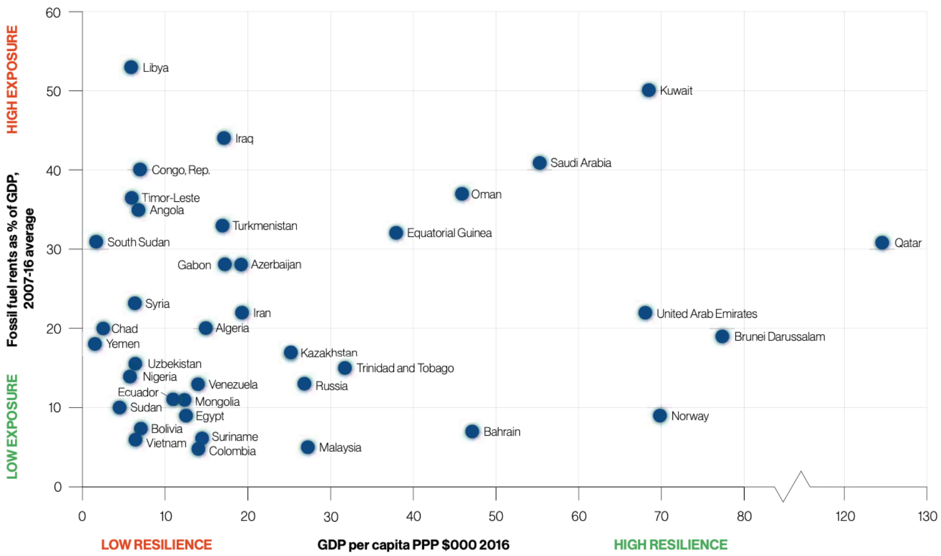
Source: IRENA 2019.

IRENA has provided what has become one of the most commonly cited reference points on the geopolitical and economic implications of the energy transition on fossil fuel producers. Their analysis attempts to quantify a fossil fuel producer's resilience and exposure to the changes in the global demand for fossil fuels. IRENA uses GDP per capita in PPP in 2016 as a measure of resilience and average fossil fuel rents as a percentage of GDP from 2007 – 2016 as a measure of exposure. These measures are problematic in of themselves but may provide at least a signal of each country's preparedness for the energy transition if not a signal of how IRENA is starting to think about the transition. IRENA (2019, 31-36) categorizes the countries as following:

1. **Highly exposed, low resilience countries.** Countries in which more than 20% of GDP comes from fossil fuel rents. Examples include Libya, Angola, Republic of Congo, Timor-Leste, and South Sudan.
2. **Highly exposed, highly resilient countries.** "These countries are highly dependent on fossil fuel rents but have sufficient income and capacity to be able to reinvent themselves and adapt to the energy transition" (IRENA 2019, 33). Examples include the Gulf States (Saudi Arabia, Qatar, Kuwait, the UAE).
3. **Moderately exposed, moderately resilient countries.** "These countries are quite exposed, but their economies are moderately resilient" (IRENA 2019, 33). IRENA argues that these countries should be able to manage the energy transition if they implement effective policies to diversify their economies. Examples include Russia, Iran, Algeria, and Azerbaijan.

4. **Relatively low exposure countries.** In this category, fossil fuel rents account for less than 10% of GDP, which IRENA argues makes them less vulnerable to the energy transition. Examples include Malaysia, Bahrain, Colombia, and Norway.

FIGURE 14: THE RELATIVE PREPAREDNESS OF FOSSIL FUEL PRODUCING COUNTRIES FOR THE ENERGY TRANSITION



Note: The chart includes countries in which fossil fuel rents account for more than 5% of GDP. The GDP of Syria dates from 2010.

Source: IRENA 2019.

While IRENA's analysis is illustrative of likely vulnerabilities, it overstates its case in two regards. First, while fossil fuel rent rich countries (high resilience) do have significant resources to invest in diversifying their economy, only the UAE and Malaysia have made any progress in doing so, a point IRENA concedes (IRENA 2019, 33). Secondly, IRENA's analysis does not differentiate between an economy dependent on fossil fuel rents and a government dependent on them. As previously discussed, these are of course interrelated but have drastically different implications for how an energy transition will play out in the country.

Shocks to Government Revenues and Political Budgets

Oil producers are no strangers to oil boom and bust cycles. In good times, high oil prices fill government coffers with immense revenues and may even provide a buffer[21] during downturns (e.g. 2008-2014 oil boom cushioning the 2014 bust). During bust cycles, governments seek to weather the storm until the price of oil rebounds. Now, oil-producing countries are facing a bleak outlook where oil may have passed peak demand and future profits are on a downward trajectory. Oil rents serve two critical (at times mutually reinforcing) roles: as funds to manage transactional politics common in fragile states (e.g. patronage and clientelist

21 Many countries with national oil companies have stabilization funds that they fund with oil rents to help weather any unexpected drops in oil prices.

networks) and bankroll massive public spending common in rentier states. Both face instability with the sudden withdraw of oil rents without suitable replacements but do so in different ways.

In states like Venezuela, Nigeria, and South Sudan, fossil fuel rents are fundamental to leader's ability to maintain control of the government let alone the state itself (Burgess and Corrales 2022; Miller 2022; and Craze 2022). Oil rents have been used to fund payroll peace (e.g. Nigeria and South Sudan), buy elections and political coalitions (e.g. Venezuela, Nigeria, and Angola), and serve as the means for domestic and international wealth.

Rentier states are those that with large natural resource endowments which can extract rents from them so that they are not dependent on foreign aid or even domestic taxation for government revenues. These governments instead serve as distributors of the natural resource rents which in turn often fund bloated government bureaucracies and enable a lack of government accountability (Madhavy 1970; Beblawi and Luciani 1987). Many of the gulf states (e.g. Saudi Arabia, UAE, or Kuwait) fall into this category. Their governments have in part sought to legitimize their continued rule by providing massive public spending to benefit the people without significantly taxing the population. As oil revenues shrink, these states will be less able to maintain the level of public goods, services, or even public employment that they have in the past. For example, in Saudi Arabia, two-thirds of the working population is employed by the state and on average, public sector jobs have higher salaries than the private sector (Hertog 2019), dynamics also found in Iraq (Al-Kli and Miller 2022). The majority of this is paid for by oil rents.

It is important to note that each country is not in the same position leading into a future energy transition. Following the last oil boom (2008-2014), several countries have experienced fiscal and economic crises and were still in the process of recovering before the COVID-19 pandemic hit. Prior to the pandemic, Qatar, Saudi Arabia, Azerbaijan, Russia, and Kazakhstan had savings and fiscal room that could help them financially survive the COVID-19 pandemic and the unexpected downturn in oil rents (Gillies 2021). Other countries did not have that buffer. Angola, Chad, Congo-Brazzaville, and Venezuela were facing debt crises prior to the pandemic, and the pandemic and drop in oil revenues has only exacerbated their challenges. Nigeria is on track to join their ranks.[22] Against the backdrop of fiscal crises triggered by the oil prices, countries are borrowing massively and at times making sub-optimal deals with oil companies in order to keep the companies from withdrawing investments (see "Sweetening the Deal" on pg. 35). While this is a strategy that may have worked in the past on the assumption that oil prices would rebound, these stay afloat measures may simply risky bets with pessimistic forecasts for oil.[23]

22 Nigeria is currently borrowing over 40 percent of its 2021 federal budget and fiscal forecasts project that future revenues may only be sufficient to service Nigeria's ballooning debt.

23 While oil prices spiked in 2022 due in part to the war in Ukraine, this has likely provided some short-term oil revenues to oil-producing states but not changed the overall long-term pessimistic forecasts for oil.

STRATEGIES TO MANAGE THE DECLINE OF FOSSIL FUELS RENTS

Fossil fuel producing countries are not sitting idly by waiting for the energy transition. Drawing on historical and current practice, below are several strategies that fossil fuel producers are pursuing/may pursue. These strategies are not necessarily mutually exclusive and will depend on the country in question. While oil will eventually cease to have a role in a low-carbon energy system, in the interim, these strategies will help petrostates to keep filling their pockets with oil rents (Goldthau and Westphal 2019, 282). As oil rents decline, governments dependent on them for their budgets will be forced to find revenue replacements (and ones with significant discretion) or do what they have often failed or not attempted to do – collect tax from the public. This process is likely to be extremely destabilizing, especially if it happens rapidly, and as Gillies argued, may lead to some leaders being shown the door (Gillies 2021, 30).

The Green Paradox: Panic and Pump

The Green Paradox, sometimes called the panic and pump scenario, is the argument that the introduction of climate policy may incentivize oil exporters to accelerate their extraction which could then lower global oil prices bringing back customers and actually cause a rise in global carbon dioxide emissions (Sinn 2012). This is not a strategy to necessarily manage the decline of fossil fuels as much as it is a strategy to capitalize on the window for sale before it closes. This may be especially attractive to governments with short political horizons that are dependent on oil rents for a majority of their revenues (e.g. Nigeria and Venezuela). However, several scholars argue that the risk of a Green Paradox is overstated for three key reasons: 1) many oil-producers would not be able to survive the price wars that would ensure; 2) the majority of oil producers are not able to rapidly scale production;[24] and 3) divestment pressures may outweigh the Green Paradox. For the first two reasons (and as further described below), Saudi Arabia has the competitive advantage.

A panic and pump scenario would create a price war among oil-producing countries. The countries with the largest incentives to panic and pump – those with short-term political horizons or whose existence is dependent on oil-funded patronage – are also many of the same countries that would quickly lose a price war. Saudi Arabia has one of the largest oil reserves as well as one of the lowest costs of production. Historically, they have used these advantages to maintain quota discipline within OPEC as well as attempt to price out competitors who seek to challenge OPEC. Examples include Saudi Arabia's actions in 1986, their attempt to price out U.S. shale in 2015 (Van de Graaf and Verbruggen 2015, 459) and more recently, their flooding of the market to force Russia to comply with OPEC quotas (Miller 2020; Cook 2020). Countries with high costs of production, which include the majority of fragile state oil producers as well as more recent entrants to the market (e.g. Guyana), would quickly lose to Saudi Arabia and their assets would be stranded even sooner than current IEA estimates. At the same time, however, while Saudi

24 For example, from February 2022 to September 2022, the price of oil ranged from $90-126 per barrel, a potential boom time for oil-producing states. However, not all oil-producing states were able to benefit. For example, Nigeria was not only unable to scale production, but suffered production cuts due to domestic violence and attacks on pipelines meaning that it missed the benefits of the 2022 oil boom at a time when over half the federal budget was financed with debt.

Arabia may be able to win a price war in the short term, they are unlikely to survive an infinite price war because of the domestic deficit it would cause.

A second counter to the Green Paradox is driven by technical constraints. Cairns (2014) argues that the Green Paradox is overstated because oil producers cannot rapidly increase oil production because of natural and technical capacity constraints. In fact, only Saudi Arabia, along with a few other Gulf producers, has any significant spare capacity[25] in the oil market. Taken in combination with their low cost of production, Saudi Arabia is one of the few oil-producers in the world that could quickly act to maximize short-term profits and they also have the lost production cost to price almost all of their competitors out of the market.

Lastly, there is an argument that evidence from the last decade shows a low risk for a Green Paradox. Bauer et al. (2018) argue that as long as strong future climate policies are anticipated, any potential Green Paradox effect will be outweighed by divestment pressures. Their argument is based on an analysis of the coal industry over time and changes following the signing of the Paris Climate Accord. They argue that while a Green Paradox could have occurred for the coal industry, any attempt to increase extraction was outweighed by investors divesting from coal. Bauer et al. argue that the same relationship should apply to oil because oil demand is price inelastic (limiting the flexibility of producers to frontload supply as prices drop steeply – as described above), technical challenges in quickly expanding oil production (as described above), and the depletion of oil reserves without investors willing to develop new ones.

In summary, while a Green Paradox is theoretically possible, in practice, due to the inability to win a price war, technical constraints, and divestment pressures, evidence suggests it will be unlikely to occur.

Austerity Measures

Austerity measures – a combination of budget cuts and tax increases – are often the technocratic solution to a fiscal crisis, but this can be incredibly challenging within fragile and rentier states for several reasons. Take for example energy subsidies. Many oil-producing states offer heavy subsidies for domestic fuel and electricity that cut the costs below generation costs for both energy from fossil fuels as well as renewables (Sayne 2021). As regimes are increasingly unable to afford these costly subsidies, removing them may trigger massive backlash. For example, rising commodity prices and the ad-hoc removal and reinstatement of subsidies in Nigeria in 2020-2021 have triggered mass protests and strikes that forced government to reimpose the subsidies and repeatedly renegotiate the cost of energy.

A more structural challenge is austerity measures that reduce public employment. As previously explained, more than two-thirds of Saudi Arabia's workforce is employed by the state in jobs that are better paying than in the private sector. What would it take for Saudi Arabia to overcome this? Based on his calculations

25 Cairns (2014) uses the IEA's (2014) definition of spare capacity: capacity that can be reached within 30 days and be sustained for 90 days.

of the amount of growth needed for taxes and private sector employment, Hertog concludes that it is impossible for Saudi Arabia to become "post-rentier" by 2030 or even 2040 unless there are massive budget shortfalls that force austerity measures – measures which might destabilize the government. Hertog argues that Saudi Arabia's situation is exemplary for many GCC countries.

Rent Substitutes

A second strategy for governments is to find substitutes to replace the lucrative oil rents. In practice, this is likely to be extremely difficult to find something as lucrative as oil. Developing oil, gas, and coal reserves usually brings higher rents for governments than renewables, in part because the state owns the resource. Renewable energy is different because it generates electricity and in the context of states that have historically kept the cost of electricity artificially low using fossil fuel rents, this is unlikely to produce significant rents for the state (Sayne 2021). Overall, understanding rent substitutes is a major gap in the literature (outside political marketplace research[26]) and poorly understood. Potential replacements could include diverting humanitarian rents, development financing, international loans, sovereign wealth funds,[27] and climate finance (discussed in Section 5), and in practice, are likely to include a combination of all of them (see Burgess and Corrales 2022; Miller 2022; Craze 2022; Patey 2022; Al-Kli and Miller 2022).

Quota Agreements

In order to preserve higher prices, major oil producers may collectively agree on production quotas (Van de Graaf and Verbruggen 2015, 458). This could be done on a global scale, or more likely through an organization like OPEC. Quota agreements will be key to avoiding a panic and pump scenario and may also help keep high-cost producers in business longer. However, OPEC actions from the last decade – the 2014-2016 price war and 2020 price war between Saudi Arabia and Russia – indicate that this is increasingly unlikely.[28]

Economic Diversification

This has long been the call for petrostates, but historically few have managed to do so and continue to face immense diversification challenges (Van de Graaf and Verbruggen 2015, 461). This is most needed for countries like the Gulf countries (e.g. Saudi Arabia, Kuwait, and Qatar) whose economies are heavily dependent on the fossil fuel industry. Mills (2021) argues that while the outlook for MENA petrostate economies is not great, some GCC states have made progress towards diversification. However, while the UAE, Malaysia and Norway offer some lessons, there are almost no regional or global successful model of actually how to diversity. Mills argues that this transition will be further complicated if the countries

26 Research on the Political Marketplace Framework does include an analysis of rent replacements in these political systems. For example, see Patey 2022; Al-Kli and Miller 2022. Additional research available at: https://sites.tufts.edu/wpf/political-markets-justice-and-security-program/.

27 For an example of how sovereign wealth funds may be tapped for political budgets, see Jimenea 2019.

28 For more on this, see Lawler et al. 2014; and Kozhanov 2020.

experience conflict (e.g. Iraq, Syria, Libya, and Yemen), something that may become likely as petrostates are no longer able to provide the public goods and services that once sought to justify their continued rule. Mills concludes that the transition "will certainly not be easy, and not all states will achieve the transition successfully, or even survive" (Mills 2021, 145).

Double-down on Fossil Fuels: Improving Efficiency and Developing Downstream Industries

One of the strategies that may be most attractive to fossil fuel producers is not to move away from oil and gas, but to become more invested in it. As demand for fossil fuels decreases from the US and EC, GCC producers will increasingly look towards Asian markets (Mills 2021, 145). It follows that other fossil fuel producers around the globe are likely to do the same. This can play out in at least three ways: increasing efficiency, incentives to companies to continue production, and developing downstream industries.

1. Efficiency

A majority of oil-exporting countries are not efficient in their extraction processes. In 2013, the IEA estimated that a typical oil reservoir has a recovery rate of 35 percent, but new technologies could improve that (Van de Graaf and Verbruggen 2015, 460). Increasing the efficiency, however, is not the only way to cut the cost of production. Governments can also shift the regulatory environment that affects how much it costs for companies to operate.

2. Sweetening the Deal

Part of the cost of production is determined by the taxes levied against the company as well as the regulatory environment in which it operates. This includes the environmental and public safety regulations as well as commitments to communities that companies have. While these aim to protect against workplace accidents and environmental disasters, from a financial bottom-line perspective, they also increase the cost of production. As Gillies argues, "governments, desperate to keep oil companies from exiting or narrowing their investment plans, could offer deals that contain weak fiscal, environmental, or operational requirements" (Gillies 2021, 30). Indeed, this may be playing out in contexts like Nigeria where international investors are quickly withdrawing from onshore and shallow water oil wells and opaque deals are being made with domestic businesses.

3. Developing Downstream Industries

As OECD countries transition to renewables, researchers expect them to begin to offload energy-intensive sectors, such as petrochemicals and refineries, which opens up export opportunities to fill remaining global demand (Goldthau and Westphal 2019, 282). This has created incentives for current oil-producers to begin investing the development of these downstream industries to be well-placed to take up demand when OECD countries withdraw.

We already see this playing out across fossil fuel producing countries. For example, Saudi Arabia, the UAE, and Kuwait are already developing these industries. Petrochemicals are seen as one of the most promising areas for future oil demand (Mills 2021, 130). Outside of the gulf countries, we can also see these developments in SSA. Nigeria is currently building what will be Africa's largest oil refinery as well as a network of gas pipelines to power industrial centers. While these may provide short-term benefits, investments in fossil fuel downstream industries may crowd out necessary investments in renewable energy sources and create even more lock-in pressures to maintain fossil fuel use.

Increase Control of National Oil Companies

One of the potential responses is not necessarily focused on increasing the oil rents that exist but increasing control over the ones that do by tightening control over the national oil company (NOC). Research from the National Resource Governance Institute indicates that "on average, when oil prices drop, the money that NOCs transfer to the state drops even more dramatically. In other words, NOCs tend to hold onto a disproportionately large share of scare public funds" (Gillies 2021, 30). For example, in Angola, between 2012 and 2015, oil prices fell by 50 percent while NOC transfers to the public budget fell approximately 75 percent from $25 billion to $6 billion (Gillies 2021, 30). Gillies argues that this suggests that as oil revenues decrease and trigger fiscal crises, kleptocratic leaders may use NOCs as a channel to reward loyalists and maintain political control (Gillies 2021, 30). This is in part because NOC revenues often come under less scrutiny of international institutions like the IMF.

Compensation

The final strategy is that of compensation for lost compensation of the oil reserves that need to be left in the ground in order to achieve a 2ºC or 1.5ºC scenario. This is a strategy that OPEC, and notably Saudi Arabia, are pursuing. Van de Graaf and Verbruggen (2015) argue that this strategy has some backing in climate change treaties. Article 4.8 in the UNFCCC and articles 2.3 and 3.14 in the Kyoto Protocol require parties to the treaties to take measures to minimize the impacts of the emission reduction measures on energy-exporting countries (Van de Graaf and Verbruggen 2015, 460).

In 2007, this strategy was attempted. Ecuador pledged to leave 900 million barrels of oil underground in the Yasuni National Park if the international community would pay 50 percent of its value to a trust fund administered by UNDP (Van de Graaf and Verbruggen 2015, 460). At the time, this amounted to 20 percent of Ecuador's proven reserves and Ecuador then relied on oil for approximately 35 percent of its budget. However, in August 2013, Ecuador ended this commitment because the international community had not pledged enough funds. Attempts by fossil fuel producers as well as countries with significant climate assets are further discussed in Section 5: Climate Finance.

Attempts to be compensated for lost compensation of fossil fuel resources is not solely driven by the state. For example, current, a coalition of development banks and private investors is exploring the possibility of buying many of the coal production facilities across Asia in order to take control and then stop production. For more on this, see Section Five: Climate Finance (specifically *New Rentierism?* on pages p. 68–70).

NDCS, IOCS, AND NOCS: COMPETING INTERESTS AND STRATEGIC INERTIA

The Paris Climate Accord and additional country commitments to achieving Net Zero Emissions by 2050 have been landmark agreements to limiting future emissions, but there is a significant gap between nationally-determined contributions (NDCs) from the Paris Climate Accord and the actions of international oil companies (IOCs) as well as national oil companies (NOCs). Despite rhetoric of oil companies in support for an energy transition, recent studies show evidence that these companies are not only underinvesting in renewables and a low-carbon future, but that they are actively pursuing ventures (e.g. oil and gas exploration and development) and opposing climate change policies (WBA 2021; Sayne 2021). Among the least prepared (or willingly unprepared) are the national oil companies (NOCs) and international-national oil companies (INOCs) (Sayne 2021). NOCs and INOCs will be influential in the coming decades as they control 71 percent of the oil reserves of the world's 100 largest oil companies. This section discusses some of the strategic inertia as well as how nationally-owned oil companies are fighting against the energy transition.

Strategic Inertia

In the last several years, many of the world's largest oil and gas companies have announced plans and their intention to work towards a low-carbon future. As WBA (2021) reports, however, while there is a significant lack of transparency that makes it difficult to fully evaluate their efforts, available evidence indicates that these companies are actively working against an energy transition by opposing renewable policies and through a lock-in effect of using revenues to bolster public opinion (Sayne 2021)[29].

On a global level, 16 of the 100 largest oil companies have directly opposed certain climate policies. These include BP, Chevron, ConocoPhillips, ExxonMobil[30], Shell and TotalEnergies. For example, in 2021, 14 of the 20 largest oil companies headquartered in the United States were part of the American Petroleum Institute which had pledged itself to fighting the Biden administration's energy transition plans (WBA 2021, 9). One of the key challenges is the substantial financial regimes that governments have constructed to support fossil fuels (and at times subsidize them) that are now being challenged. Lenferna (2020) describes this as a battle of fossil fuel welfare versus the climate. While some fossil fuel companies are paying lip service to supporting renewables, they are also working to ensure that climate

29 Proof is in the Politics, 2021

30 Exxon has allegedly known about the dangers of climate change since 1981, but funded climate deniers until the early 2000s. See Goldenberg 2015 and Oreskes and Conway 2010.

policies have significant caveats and loopholes so that fossil fuel firms can continue to operate business as usual.[31] Strategic inertia seems to be the name of the game, and if examples from countries like the United States, Australia, Scotland, or the Netherlands[32] are any indication of how these dynamics will play out in countries where fossil fuels have even more of a hold on the economy or the government, concerted decarbonization of the energy industry will be challenging.

In addition to the fossil fuel producers, downstream industries are also fighting climate change policies. For example, in Nigeria and Lebanon where diesel generators are key to reliable electricity, the diesel generator market has intensely lobbied against the development of renewable energies out of the feat of how it will affect their own market (Sayne 2021).

International-/National Oil Companies

Nationally-owned oil companies epitomize how climate change policies clash with domestic interests (economic and patronage) and evidence shows, they are the least prepared for an energy transition. National oil companies and international oil companies currently control approximately 71 percent of the reserves of 100 countries, and over two-thirds of emissions from 2019 to 2050 are expected to come from NOCs and INCOs (WBA 2021, 17). Of the top emitting countries in 2019, six were NOCs or INOCs. These included The China Petroleum & Chemical Corporation (Sinopec), Gazprom, National Iranian Oil Company, Rosneft, and Saud Aramco (WBA 2021, 17). If NOCs follow their current course, they are set to invest more than $400 billion in oil and gas projects that will only break even if the world exceeds emission targets and temperatures rise above 2ºC (Manley and Heller 2021). Despite I/NOCs being crucial to achieving a 2ºC or 1.5ºC scenario, these companies are the least prepared compared to IOCs.

As of July 2021, none of the I/NOCs are in countries with legally binding 2050 net-zero targets. In fact, 27 I/NOCs are in countries with no planned net-zero target (WBA 2021). Nigeria provides an illustrative case. Nigeria's NDCs are unrealistic and are backed by little domestic planning on how to achieve them. While the Nigerian government continues to make speeches about climate change, their actions and those of the Nigerian National Petroleum Corporation (NNPC) show that Nigeria is not moving towards decarbonizing its energy sector, but in fact is doubling down on oil. After more than 20 years of debate, in August 2021, the Nigerian government passed one of its largest petroleum industry reform bills ever. It has the potential to increase transparency and accountability for how the Nigerian petroleum industry is run, but nowhere in it does mention climate change or provide any plans for future investments in renewables.[33] In fact, instead, it creates a new fund for oil exploration that will be funded with 30 percent of the oil revenues (Izuaka 2021). This may simply be a new slush fund for politicians or it might fill the gaps as international investors withdraw from exploration in Nigeria as many new onshore developments will likely be unprofitable after 2030. Oil is fundamental to Nigeria's political budgets

31 For example, see Hudson 2020 on strategic inertia within efforts to transition Australia's fossil fuel industry.

32 For examples of how these competing interests have played out in Australia, see Hudson 2020; in the Netherlands, see Oxenaar and Bosman 2020; in Germany, see Boßsner (2020); in Scotland, see (2020).

33 For a discussion of this missed opportunity, see Kennedy et al. 2021.

and instead of focusing on preparing for an energy transition, the elite consensus is to extract as many rents from oil before it no longer can (Miller 2022). Among fragile fossil fuel producers, Nigeria is not an outlier in its opposition to decarbonizing its energy sector.

Sayne (2021) argues that extractive sector policies and governance choices are undermining any plans to develop renewable energy sources in many fragile fossil fuel producing countries. This happens directly in firms opposing renewable policies, but it also occurs through a lock-in effect of using the revenues to bolster public opinion. This further reinforces the broad argument that while Western countries may move away from fossil fuels, oil is still likely to flow in other countries, and as Gillies reminds us, it is likely to continue to fill some individual's pockets (Gillies 2021).

RESOURCE CURSE: SHORT-TERM VS. LONG-TERM IMPLICATIONS

One of the potential traumas of a global energy transformation is the question whether new forms of a resource curse will emerge as demand for minerals vital to the production of renewable energy technologies increases. The so-called 'resource curse' is the argued relationship that an abundance of natural resources increases the likelihood of civil war (Collier and Hoeffler 2004; Collier, Hoeffler and Rohner, 2008; cf Keen 2008, 2012; Ballentine and Nitzchke 2003), poor economic performance (Sachs and Warner 1995), and low levels of democracy (Ross 2001, 2011). A survey of the literature questions the likelihood of either in the long-term, but that rent seeking behavior (perhaps aligning with hypothesized forms of the 'resource curse') caused by demand for minerals and metals may occur in the short term, something evidenced by skyrocketing demand for critical minerals in 2022.

The IEA reports that in order to produce the renewable technologies needed to achieve Net Zero emissions by 2050, the market size of critical minerals such as copper, cobalt, manganese, lithium, and various rare earth metals will need to grow almost sevenfold between 2020 and 2030 (IEA 2021a). The IEA estimates that revenues from these critical materials may outpace coal well before 2030 (IEA 2021a, 23) though notably these will not get anywhere close to the revenues generated from oil and gas sales (IEA 2021b).

Currently known and developed deposits of many of these minerals and metals are located in fragile and conflict-affected states (e.g. the Democratic Republic of the Congo) and countries that have significant political and economic challenges (e.g. Argentina, Chile) (USGS 2021). For example, the largest copper mines, a mineral that will be vital for the energy transition, are located in Chile and the DRC (USGS 2021), and mining of minerals such as cobalt in the DRC has been linked to violence (Church and Crawford 2020). On a broader level, both the IEA and IRENA note concerns that the concentration of mineral production and processing operations in a small number of weak states with poor governance records makes supplies "vulnerable to political instability, geopolitical risks and possible export restrictions", raising concerns "about land-use changes, competition for scarce water resources, corruption and misuse of government resources, fatalities and injuries to workers, and human rights abuses, including the use of child labour." (IEA 2021; IRENA 2019: 59).

This has led to a debate among researchers and market analysts on whether the energy transition could spur rent-seeking behavior and lead to a resource curse. The debate is mixed, but many scholars agree that there is a chance for rent-seeking behavior in the short-term, but a resource curse is not inevitable and market adaptations may discourage rent-seeking behavior in the long-term.

Hafner and Talgliapietra summarize this argument writing that since argue that since access to critical minerals and rare earth metals will be crucial, it is likely to replicate both rent-seeking behaviors and dependency relationships between international actors as has been typical of oil and gas (2021, 161). Sachs (2021) goes as far to suggest that the energy transition may lead to wars over controlling the key minerals needed for renewable technologies.

Other scholars, including Overland (2019), Mills (2021), Pistelli (2021), and O'Sullivan et al (2017) argue that mineral scarcity is not linear or static and that the market will adjust and prevent rent-seeking behavior. They argue that as demand for these critical minerals and rare metals grows, the market will adjust spurring the development of new deposits, greater recycling of existing minerals[34], and that technological advances will likely identify substitutes for these currently critical minerals and metals (Toledano et al. 2020). In sum, they believe that the uncertainty of the market in the long-run will disincentivize rent-seeking behavior. World Bank reports provide an example of how early reports forecasting massive demand for minerals are now being replaced by less optimistic outlooks. In 2020, the World Bank estimated that demand for minerals would increase by up to 500% by 2020 (Hund et al. 2020). Notably, this is significantly lower than the World Bank's own estimates using the same formula in a 2017 report (Arrobas et al. 2017). The difference is largely due to recycling not being a significant factor in 2017 (Toledano et al. 2020). While demand for minerals and metals needed to produce renewable energy technologies will increase, it is less likely to experience the boom analysts once predicted due to technological advances and market adaptations.

There is also a middle-ground in the debate, one that many scholars concede and that markets may be bearing evidence to support – a short-term spike in demand for critical minerals and rare earth metals that could fuel rent-seeking behavior and act as a multiplier for many well-known resource curse risks (Bradley et al. 2018, 4). For example, in 2018 the DRC government declared cobalt to be a strategic mineral and increased taxes on it from 3.5 percent to 10 percent. (Reuters 2018; Toledano et al. 2020). In the immediate-term, market analysts are seeing some changes in demand. For example, Jeff Currie, head of commodities research at Goldman Sachs, argues that copper is likely to be as strategically important as oil has been and that this is fueling a new super cycle of growth (Hume and Sanderson 2021).

Two key determining factors emerge on whether demand for minerals will lead to new resource curses: how quickly demand grows and the governance of

34 This historically has not been very cost-effective, but as demand grows for certain minerals, it may make this practice cost-competitive.

extractive industries. Church and Crawford argue that recent evidence of these mining operations in countries like the DRC and Guatemala have been linked to violence and may continue to cause violence if governance of these operations does not improve (2020: 289-291, 294-297). It is important to note that while some minerals needed to produce renewable energy technologies have been linked to conflict, they have not officially been declared conflict minerals by the international community or individual governments and therefore outside many efforts to ensure ethical sourcing. For example, cobalt is not included in the U.S. Dodd Frank Act or the European Union's Conflict Mineral legislation (Church and Crawford 2020, 291). The UNSC has called for OECD due diligence guidelines for companies that mine or trade in minerals to be applied in Cote d'Ivoire, the DRC, Sudan, and other conflict-affected states, but to date this has not fully happened (IRENA 2019).

While the potential for new forms of the resource curse are widely debated and show some evidence of risks in the short- and medium-term, the economy-wide implications remain poorly understood and are largely unprepared for (Bradley et al. 2018, 4).

IV THE FUTURE GREEN ECONOMY: CLAIMED BENEFITS AND POTENTIAL TRAUMA

This section examines the promises of the “new climate economy”, with a focus on the claimed benefits of the low-carbon energy transition. While the climactic positives are assumed/accepted, three popularly claimed types of socio-economic benefits are evaluated: that the transition will deliver affordable universal energy access, ensure more sustainable use of resources, and that it will generate decent employment.

The section focuses on high-level reports and gray literature advocating a climate transition, for two reasons. Firstly, such literature seeks to *back-cast* (rather than forecast) the energy transition, by assuming that some climate goals are achieved and attempting to evaluate the socio-economic costs and benefits that accrue in the process. Back-casting effectively creates a “best-case scenario” for the low-carbon energy transition, though as we discuss in Section III, this is not necessarily the most likely scenario. Evaluating this best-case literature using the Political Marketplace Framework challenges fundamental patterns of thinking about benign decarbonization that are gaining currency amongst key policymakers.

Secondly, high-level reports review a cross-section of literature (including academic literature) to draw their own conclusions about the “way forward”. The review-of-reviews in this section builds a picture of generally agreed-upon technical/technological facts, while questioning the interpretation of these facts. The questions sometimes arise because contrary conclusions are reached by different high-level reports. More often, technocratic interpretations/recommendations echoed across multiple high-level reports are contradicted by academic literature.

The section concludes by critically reviewing certain patterns in claims about the socio-economic benefits of decarbonization in high-level reports. It offers some possibilities for how the Political Marketplace Framework can address these patterns.

EQUITABLE ACCESS TO ENERGY AND ENERGY GOODS

Promises of Universal Energy Access

High level reports emphasize the potential of renewable energy to meet global energy access goals. Africa receives particular attention as the continent which has the least grid connected population. In this view, renewable energy enables ‘human security’, but this glosses over the differentiated benefits and costs of the transition.

The IEA projects that a net-zero-by-2050 oriented global economy delivers universal energy access by 2030, covering 790 million people currently without access to electricity and 2.6 billion without access to clean cooking. This is achieved at a global cost of USD 40 billion each year over the next decade, and with stability in the proportion of household income spent on energy (including modern energy services). However, it notes that the upfront capital cost of carbon-free technology – eg: electric cookstoves, efficient heating or lighting, or electric vehicles – could be unaffordable to low-income households and small and medium enterprises (IEA 2021: 154).

The IRENA's analysis of Africa's renewable energy potential draws similar links to energy access, arguing that "with modernizing economies and rising standards of living in Africa in the next 15 years, electricity demand is expected to grow *more than threefold*." By 2030, "almost half of all modern renewable energy use [in Africa] could come from the power sector" (IRENA 2015: 32). Between 2013 and 2030, the continent's generation capacity is expected to nearly quintuple, from 130 GW to 610 GW, requiring an investment of USD 45 billion each year, plus USD 25 billion annually for transmission and distribution lines (see Section VI for more on climate finance). Renewables are expected to account for around half (310 GW) of this expanded capacity (IRENA 2015: 38).

Energy poverty is generally a 'development' concern, but the IRENA offers that it also compromises security because of the threat of injury and violence to women and children when they gather fuel. It is also considered a threat multiplier, because it causes or exacerbates poverty, marginalization, social unrest, population displacement, and environmental fragility (IRENA 2019: 68).

In the most general terms, this point is not controversial. Fossil fuels have enabled energy access for large numbers of people, but even more are yet to be connected, which contributes to socio-economic stress. Renewables could be part of the solution here; the more difficult question asked of decarbonization discourses is whether renewables can be the whole solution.

Difficulties linking Renewables and Universal Energy Access

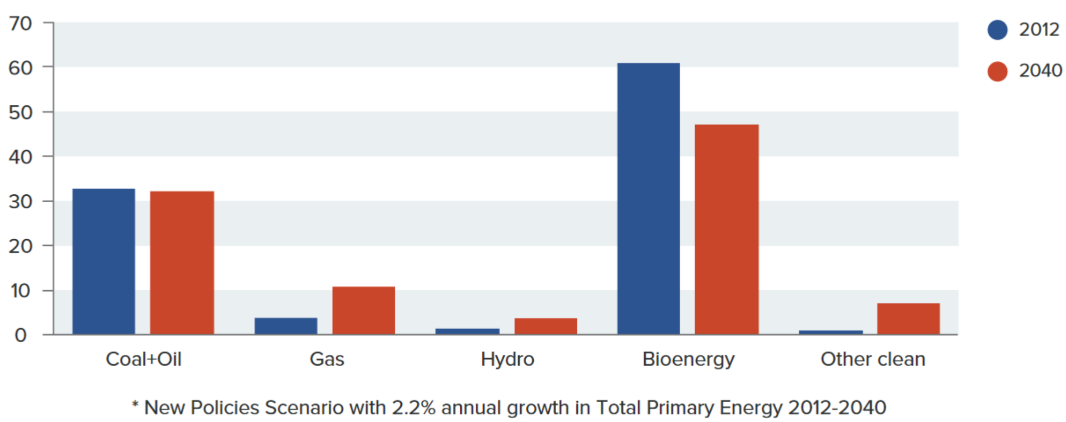
While renewables are generally presented as a solution to the energy access problem, high-level assessments themselves acknowledge that, when considering the future energy mix in currently energy poor regions/segments, renewables do not quite replace fossil fuels such as oil and natural gas. They are more likely to replace the burning of legacy fuels such as charcoal.

For example, in Africa, while hydropower has dominated non-fossil electricity (14% of generation in 2013), IRENA projects wind and solar to expand significantly, making up 30% of total electricity generated by 2030 (with hydropower projected at 20%). On this strength, industrial energy demand would triple between 2013 and 2030 (despite improvements in efficiency), and total electricity demand would grow by 270% (IRENA 2015: 35-37).

Much of the expansion of 'modern' renewables in Africa is projected to replace older 'dirtier' renewable energy such as charcoal wood-fuel, the majority of which is traditionally, sustainably gathered and used.[35] IRENA projects that, by 2030, efficient cookstoves could account for nearly three quarters of the total cookstove stock in Africa, and that the population relying on traditional cookstoves could decline by more than 60%. This replacement of 'legacy' renewables with 'modern' renewables is expected to save USD 20-30 billion annually by reducing/eliminating health problems caused by poor indoor air quality (IRENA 2015: 35).

However, charcoal for cooking is a cheap fuel and will continue to remain important for cooking because, despite its manufacturing and trade being illegal in many countries, it is convenient and an income opportunity for many rural households (IRENA 2015: 38). The Global Commission on Economy and Climate offers another caveat for sub-Saharan Africa – legacy biomass burning will only partially be replaced by renewables, while around half of biomass' share in the energy mix in 2040 will be replaced by fossil fuels (particularly natural gas). This means that even as sub-Saharan Africa's energy consumption climbs by around 2.2% annually until 2040, coal and oil's share in energy generation stays steady and natural gas' share expands significantly (GCEC 2016: 109).

FIGURE 15: SUB-SAHARAN AFRICA – IEA SCENARIO FOR PRIMARY ENERGY FUEL MIX – 2012 AND 2040 (% OF TOTAL)



Source: GCEC 2016, IEA 2014.

This echoes another high-level assessment that the global priority of satisfying the basic energy needs of the poor includes an important role for renewables but will likely also include solutions such as LPG. This is because, for the poor, "electricity is not synonymous with energy". Basic cooking, heating, and lighting needs are often satisfiable through burning fuels such as fuelwood, kerosene or – as a less lung-polluting alternative – subsidized LPG. Electricity only becomes the economical alternative at higher levels of electricity consumption – all-day lighting or temperature control. The assessment hence emphasizes "homegrown"

35 Wood/charcoal burning does not by itself release significant greenhouse gases. Its potential for climate impact lies in deforestation, but even this is an exaggerated threat, because the poor do not cut down forests at scale to use as household fuel. They largely use dead/fallen wood, generally at a pace/scale commensurate with forest re-growth (e.g. Bailis et al. 2015). However, wood/charcoal burning does cause air pollution, which results in health problems, especially among women and children.

solutions, but also recognizes that "energy systems in developing countries need transformational change in order to have a pro-poor orientation." (Karekezi et al. 2012: 185-186). It cites the success of this approach in accelerating progress towards the Millennium Development Goals.[36]

From these, the strongest argument that emerges for renewables is that they can displace fossil fuels in developed countries, the upper-and-middle-income segments of developing countries and *some* of the energy needs of the poor. However, energy access has not been de-linked from fossil fuels in the short and medium term.

Differentiated Costs of the Transition to Households

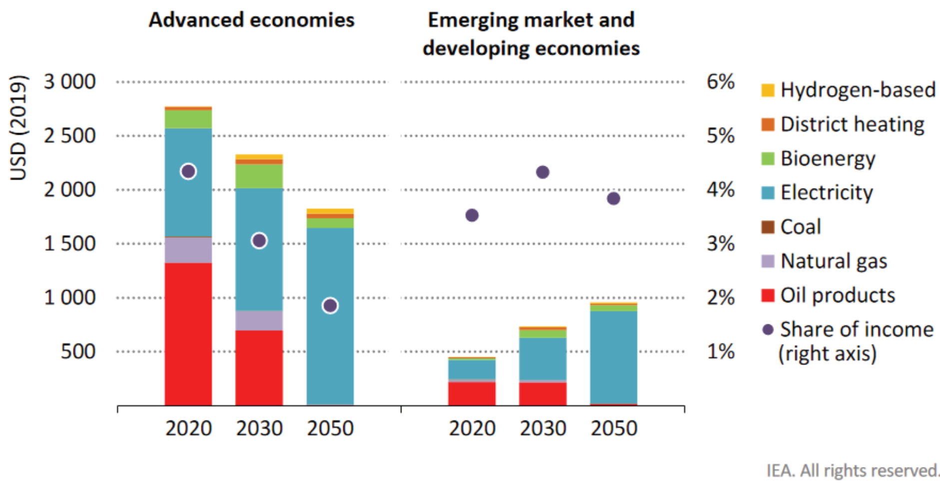
The cost of renewables has fallen drastically in the past decade, to the point where new renewables are cheaper to build than new fossil fuel electricity generation, including in developing contexts (IRENA 2020). In the transportation sector, falling battery costs (89% over the last decade) will likely make electric vehicles cost competitive over the coming decade (Bloomberg NEF 2020).

This means that households which are switching over from fossil to renewables should be saving over the long term. However, the cost structure of renewables is different – more upfront costs, less fuel and operating costs – so there will be an initial spike. In addition, while households with already high energy use (broadly, in developed countries) save money, households which are expected to increase their energy use over the coming decades (broadly, in developing countries) will end up spending more.

The IEA projects that the *total* fuel bills paid by all end users, which totaled USD 6.3 trillion in 2020, increases by 45% to 2030 and 75% to 2050, mostly driven by population and GDP growth. However, as a *share* of global GDP, total direct spending on energy holds steady at around 8% out to 2030 (similar to the average over the last five years), but then declines to 6% in 2050. This decline offsets a significant share of the higher cost of buying new, more efficient energy-consuming equipment." (IEA 2021: 170).

36 The utility of the MDGs, especially for Africa, is contested (Easterly 2009).

FIGURE 16: AVERAGE ANNUAL HOUSEHOLD ENERGY BILL IN THE NZE



The proportion of disposable household income spent on energy is stable in emerging market and developing economies, and drops substantially in advanced economies

Note: Hydrogen-based includes hydrogen, ammonia and synthetic fuels.

Source: IEA 2020

The rapid transformation of the electricity industry globally is projected by the IEA to triple the total cost of electricity supply between 2020 to 2050, but only modestly affect the average cost per unit supplied. This is because renewables make electricity supply much more capital intensive (share of capital in total cost goes from 60% to 80%), given the need for more network capacity and sources of flexibility, including battery storage. The rising capital costs are somewhat offset by reduced fossil fuel costs, which fall from a quarter of total cost in 2020 to 5% in 2050 (IEA 2021: 163).

In advanced economies, energy bills as a percentage of household expenditure halved (4% today to 2% in 2050). The cost of additional investment in electrification, energy efficiency and renewable energy is “fully offset” by reduction of energy use (through energy efficiency), and reduction in expenditure on oil (30% of household energy bills in 2030, 0% in 2050) and natural gas (10% today, 0% in 2050).

In emerging market and developing economies, energy expenditure per household doubles in absolute terms by 2050, while increasing modestly as a percentage of household expenditure (because total household income is expected to increase significantly, in part due to improving energy access) (IEA 2021: 171-173). For Africa, IRENA estimates that this renewables-intensive pathway would result in a (modest-to-significant, depending on country) savings of approximately USD 3 cents per electricity unit (IRENA 2015: 39-41).

The impact on developing economy household bills should ideally be sub-differentiated to reflect costs in least developed countries and fragile economies. Owing to the pandemic, recent successes on energy access in Africa are being reversed, while the number of people without access to electricity rose in 2020 after falling the previous six years. 30 million people who could previously afford access are now unable to afford basic electricity services (IEA et al. 2021). The assessments which remain optimistic on renewables for these economies emphasize the role of government support backed by international finance.

Cost of the Transition to National Economies

Government support for energy development is not a new phenomenon; arguably, modern power sectors would not exist without it. Especially in developing economies which are prioritizing energy access, the power sector is rarely solvent without regular public finance infusions. Fixing 'ailing' power sectors, especially through market solutions and 'leveraging' private finance, is a discourse that pre-dates decarbonization. The merits of these market solutions are highly debatable. However, the falling cost of renewables is now allowing decarbonization/energy transition to operate as a new vehicle for these market solutions.

The capital-intensity of renewables necessitates limiting risk for new investment and ensuring sufficient revenues for grid operators to fund rising investment needs (IEA 2021: 163). For Africa, IRENA projects that fully utilizing renewable potential by 2030 would require an investment of up to USD 32 billion per year (IRENA 2015: 39-41). It considers that this investment will be attracted by competitive business models and the profit motive, which requires "regulatory solutions to ensure stability and profitability" (IRENA 2019: 18, 23).

The 'Africa's New Climate Economy' report expands on such regulatory solutions – power sector 'utility reform' and unbundling/privatization of electricity market sub-sectors will link power project development with "actual demands, rather than other political objectives" and ensure that "commercial, industrial or residential users in sub-Saharan Africa pay the full cost of electricity." This reform still requires government guarantees – because many sub-Saharan countries lack robust domestic financial sectors, transactions will require credit enhancement mechanisms from government, bilaterals or multilaterals" (GCEC 2016: 114-115).

This is echoed by the Global Commission to End Energy Poverty, which remains convinced of the "need for substantial private sector participation, given the sizable investments needed to achieve full electrification, which can run into the billions of dollars even for small countries and into the tens of billions of dollars for larger countries with significant underserved populations" (GCEP 2020). Its "Integrated Distribution Framework" is an attempt to reconcile the need for universal access with the fact that people cannot afford to pay the full cost of electricity. Using examples from Rwanda, Colombia and Uganda, it offers the idea that "universality entails permanence". This is to be achieved by "utility-like" structures – essentially a government providing a minimum level of supply, atop which private entities can provide premium-tariff services. Consumer electricity subsidies are acceptable, as long as private distributors are paid the full cost (GCEP 2020).

Effectively, if revenues do not match investment, or if the private sector leaves consumers under-serviced, governments will have to make up the deficit, either through *ad hoc* bailouts or continuing deficit spending (Trimble et al. 2016; Financial Express 2021). They will have to do so while giving up the more profitable segments of electricity demand. This is an old dynamic – market-led reforms are primarily designed to improve the financial health of private electricity companies. Previous experiences with this model show that newly privatized or reformed electricity companies tend to 'cherry pick' the most lucrative markets (i.e., non-poor urban areas), raise their tariffs, and fail to widen their networks to poorer consumers (Karekezi et al. 2012).

If allowed to take root, these decarbonization-as-privatization discourses will sacrifice energy access and affordability in the name of climate responsibility. This is particularly concerning since energy use is strongly correlated with economic growth. While some high-level reports attempt to suggest that this energy-GDP link is weakening, global assessments mask a more prosaic reality in developing economies and among the energy poor. For example, the IRENA considers that investing in energy efficiency (efficient appliances, reducing power wastage on the grid etc.) will lead to economic growth with lower energy inputs. It cites a 2018 IEA projection that energy demand will only grow at 1% per year until 2040 while global GDP grows at 3%, contrasting this with the historic trend where the rate of energy demand growth has matched the rate of GDP growth (IRENA 2019).

These projections rely on data from developed economies, but such economies have not successfully 'decoupled' growth from energy demand. There is evidence that a significant portion of 'efficiency' improvements are from offshoring energy-intensive production to developing countries, a model unsustainable on a global scale (Herring et al. 2006; Brockway et al. 2021). The Global Commission on Energy and Climate considers that for regions such as sub-Saharan Africa whose energy-intensity-of-GDP is already low, decoupling energy consumption from GDP growth is unlikely, even if their growth path is more moderate on industrialization and urbanization than currently developed economies (GCEC 2016: 104).

A further concern is that the IEA's global projection assumes rising carbon prices and the removal of consumption subsidies for fossil fuels. Shifting these subsidies away from fossil fuels and towards climate-responsible or welfare spending is presented as a double positive – the 'saved' revenue of $ 700 billion per year "could be recycled into economies or otherwise used to improve consumer welfare, particularly for low-income households" (IEA 2021: 170). However, this is likely to operate as a double-cost in fossil fuel producer economies – falling national revenue from exports could result in governments raising energy prices for their own citizens (who currently benefit from significant subsidies) to make up the deficit (Abdul Kader 2014; Oxford Institute for Energy Studies 2017). This carries inherent challenges with it (see "Subsidies" on p. 30, 48).

In sum, the national economics of decarbonization will operate on a similar logic as carbon-based energy development – public finance to create a public good, topped up or replaced in certain segments with private investments. The issue is that the additional public investment to develop low-carbon energy is justified in some contexts, and more difficult to justify in others. It will require financial transfers, especially to least developed countries and fragile economies (as well as within economies), which is a source of political disagreement. Hence the push to present decarbonization as a market inevitability or as part of a package of overdue market reforms, which it is not.

GEOPOLITICAL CONSIDERATIONS

The question of how renewables will affect energy geopolitics is an open one. At a global level, the geopolitical complications of fossil fuel trade are well-established. Domestically, energy infrastructure has been a site of conflict, non-violent and violent, and its potential to shape the geography of political control is recognized. It seems reasonable to assume that trade in renewable technology and electricity will involve some mix of competition and conflict, and that its impact on national political economy and local/household socioeconomics will be contextual and contingent. However, high-level reports tend to emphasize the role of renewables in promoting cooperation, democratization, and socio-economic goods.

The IRENA suggests that there is potential for large non-fossil investments to recoup their investments by accessing untapped regional energy markets across national borders, even though in practice, this has been difficult to achieve. For example, IRENA notes that electricity exports from the Grand Inga project in the Democratic Republic of the Congo will significantly reduce regional power costs, saving the region some USD 2 billion (IRENA 2015: 40), but it omits that the Grand Inga hydropower project has long been mired in controversy. The project has since lost support from the World Bank (Oyewo et al. 2018).[37]

The IRENA cites the similarly controversial Manantali dam project shared by Mali, Mauritania and Senegal as an example of the potential for cross-border cooperation and interconnection, especially in small and fragmented markets (IRENA 2015: 52). This is echoed in its identification of electricity exporters such as Brazil (hydropower), Norway and Bhutan (hydropower) as “renewable energy leaders” (IRENA 2019: 40).

It acknowledges (in sanitized terms) some difficulty with regional electricity trading, recounting that the proposal made during the Oslo peace process to construct grid connections between Israel and its Arab neighbors collapsed because “there was insufficient trust between the parties” and that hence “Israel remains an ‘electricity island’”. Similarly, while acknowledging the risk of electricity cut-offs as a tool of economic coercion, the IRENA believes that because “electricity trading tends to be more reciprocal than trade in oil and gas”, it will result in a “complex web of interdependencies between importers and exporters that would tend to curtail the potential to use renewable electricity as a geopolitical weapon” (IRENA 2019: 52).[38]

Others are less sanguine about the “geopolitical Janus face” of regional grids. Even within a region, the diversity of interests involved, including different natural resources, and national political contexts, makes strong alignment of interests very difficult. The criticality of energy generation could result in increased interest from exporters and importers in bolstering security arrangements in a region. This is not a substantive departure from (the fraught history of) pipeline politics – the inter-state politics of building, maintaining and running a supergrid depends to a large extent on the geopolitical weight of the various participants (O’ Sullivan et al. 2017: 21).

37 While this IRENA report seems to be comfortable categorizing large hydropower as renewable energy, it is a controversial choice, considering the history of large dams and displacement.

38 For more on this argument, see Overland 2019 and Van de Graaf et al. 2016.

There are risks acknowledged with putting electricity "even more at the heart of energy security across the world than it already is"; "the increased importance of electricity means that any electricity system disruption would have larger impacts" (IEA 2021: 176). The disruptions considered by the IEA are mostly natural, such as extreme weather, but (as we discuss in the section on land and resource pressures) generation and transmission infrastructure could become sites of conflict. In this context, the IRENA's assessment of the geopolitical implications of renewable energy – that "fewer economies will be at risk from vulnerable energy supply lines and volatile prices" (IRENA 2019: 15) – is debatable.

The IEA considers that the green energy economy is less locationally bound than the fossil fuel economy – the "rapid increase in demand for clean energy technologies [...] requires new production capacity to come online that could be located in any region" (IEA 2021: 159). At the global level, the IRENA believes that this "reduces the importance of current energy choke points, such as the narrow channels on widely used sea routes that are critical to the global supply of oil." It offers the caveat that "energy independence does not imply complete self-sufficiency or autarchy", because "even when a country's energy needs are supplied entirely from home-grown sources, it will still benefit from international value chains and trade in technologies, goods and services." However, it still considers that "countries that achieve energy independence will also be less vulnerable or beholden to their suppliers and will therefore be able to pursue their strategic and foreign policy goals more independently" (IRENA 2019: 23). The Global Commission on Economy and Climate points out that renewable generation potential in sub-Saharan Africa is much more geographically distributed than coal supply, 95% of which is concentrated in South Africa, Botswana and Mozambique (GCEC 2016: 113).

Renewable generation could be less locationally limited than when the fossil fuel economy matured, but this conclusion may be under-playing the importance of proximity to mined raw materials, over-playing the sustainability of globalized integrated value chains, and ignoring developing trade wars over critical minerals (Schmid 2019). It also side-steps emerging conflicts over renewable energy siting in developed and developing economies (O'Neil 2021; Ryser 2019).

At the national level, the IRENA ties this locational argument to energy democratization, suggesting that "many developing economies will have the possibility to leapfrog fossil fuel-based systems and centralized grids", "just as they jumped straight to mobile phones and obviated the need to lay expensive copper-wired telephone networks." In this telling, renewables are "a powerful vehicle of democratization" because they decentralize the energy supply, empowering citizens, local communities, and cities. Some potential for de-stabilization is recognized – since "the modern nation state and the fossil fuel economy have evolved alongside one another", the transition "may have profound implications for the role of the nation state" (IRENA 2019: 15, 42, 68).

IRENA's Africa-focused report echoes this theme – because renewable energy is more modular and widely distributed than fossil-based generation, it "is a source of autonomy for local areas and villages", who can "increasingly plan for and meet their energy needs on their own, as localization gives isolated communities a chance to participate in the process." Noting that approximately 40% of Africans reside in rural areas, it considers that the continent has "a great potential to benefit from inclusive approaches to energy development.” In West Africa, mini-hydro options could provide up to 70% of rural electricity; in Southern Africa, mini-hydro and solar rooftop systems using batteries would meet half of rural demand, with the rest coming from the grid (IRENA 2015: 45).[39]

Distributed renewables are a growing worldwide market with some success in ensuring energy access – they serve an estimated 26 million households (or 100 million people) worldwide, including 20 million households through solar home systems, 5 million households through renewables-based mini-grids (usually powered by micro-hydro), and 0.8 million households through small-scale wind turbines. Significant progress is visible in vulnerable economies – Bangladesh’s home solar system market has grown at an average of 60% annually over the past decade, with 60,000 households being connected to a SHS every month. India, China and Nepal have installed over 2 million systems collectively. Installed systems in Africa and Latin America are still in the thousands rather than millions, but targets in the millions are being set and will likely be met. In addition, hundreds of megawatts of small-scale solar, wind and hydro have been installed in developing economies (REN21 2016).

However, distributed renewables are more expensive per unit of power generated than large grid-scale solar and wind farms, especially for urban markets. They have hence thus far been an under-performing segment of the broader renewables market; large ‘grid-scale’ installations are the norm. The linkage of decentralized renewables to “autonomy”, “energy democracy” etc. is currently theorized, but far from settled (Burke & Stephens 2017; Ambole et al. 2021). In the context of conflict, evidence exists that distributed/decentralized generation can provide energy access to vulnerable communities amidst conflict, but also that it can generate or exacerbate political disagreement (Brisbois 2018; Bazilian & Chattopadhyay 2016).

Decentralized renewables “have significant disruptive potential for geopolitics, by significantly weakening the control of centralized government in several ways”. They could challenge the revenue models of many governments, and newly ‘energy independent’ citizens “may feel emboldened to ask for more political participation or in some extreme cases, even promote secessionist tendencies.” Control over insurgencies through manipulating energy prices is more difficult – an example cited is Yemen in 2014, “when a surge in off-grid energy sources allowed many individuals and communities to keep power supply stable even as the capital descended into political chaos” (O’ Sullivan et al. 2017: 23).

The IRENA notes that “a growing body of evidence demonstrates that renewable energy solutions can contribute to the economic empowerment of marginalized social groups”; it recaps a case study of the ‘Solar Sister’ initiative that retails portable solar lights in rural sub-Saharan Africa through female solar entrepreneurs (IRENA 2015: 63). There is a large body of literature on the socially transformative power of such interventions. There is also an emerging body of anthropologically-oriented literature on their failure to fully account for social context, the possibility of un-intended regressive impacts such as increasing household conflict, or entrenching social hierarchies (e.g.: Iessa et al. 2016; Ojong 2021; Cross 2019).

39 Also see Pistelli 2021.

The Role of 'Innovation'

While renewable technology is now widely available, it is not affordable in all contexts, and there is significant work still to be done in adapting technology and business models to serve the energy poor. This will require technology and knowledge sharing, ideally based on the paradigm of decarbonization as a global public good. However, high-level reports continue to use narrow, potentially counter-productive definitions of innovation.

In evaluating the economies "best positioned" to take advantage of the energy transition, the IRENA uses a combination of two metrics – fossil fuel imports, and renewable energy patents. Hence, "the US is well positioned in the clean energy race: U.S. companies hold strong positions in new technologies, including robotics, artificial intelligence, and electric vehicles", and China "has a leading position in manufacturing, but also in innovation and deployment of renewable energy technologies." Neither the Middle East and North Africa, nor Sub-Saharan economies are expected to be innovation leaders. The former needs to diversify their economies away from fossil fuels, and the latter will benefit from lower fossil fuel bills (IRENA 2019: 30).

However, it argues that this renewables innovation leadership is unlikely to result in monopolization – "apart from the risk of technology dominance in specific areas, renewable energy leaders are unlikely to gain the degree of market dominance that fossil fuel leaders have enjoyed, due to the ubiquitous nature of renewable energy sources" (IRENA 2019: 42). Besides, "unlike trade in fossil fuels, trade in renewable energy technologies would be shaped by 'normal' rather than 'natural' comparative advantages." The distinction being made is between rents from natural resources and "advantages in technology, relative price, and cost of transport" (IRENA 2019: 47).

A more sober assessment identifies the possibility for 'innovation' as a site of geopolitical friction – both in terms of a refusal by innovators to share critical technologies, as well as innovators trying to build markets for their technologies in regions/contexts which have little interest in their solutions. It also complexifies the idea that innovation originates in small, disruptive start-up-type contexts, identifying large fossil companies such as Total and Statoil who are investing in renewables innovation, and highlighting the potential for these "deeper capital pools [to] affect country positions toward cooperation or competition" (O'Sullivan et al. 2017: 17).

LAND AND NATURAL RESOURCE PRESSURES[40]

New Sites of Conflict

High-level reports play up the potential for the energy transition to stimulate infrastructure development. Apart from wind and solar farms, the transition requires huge amounts of electricity storage capacity and advanced electricity distribution systems. While historically considered a cost, new infrastructure is now framed

40 Note that resource curse dynamics are discussed in Section 3 on pages 43-45.

as an economic good which can stimulate employment and incomes (discussed further in the section on job gains). However, this amount of new renewable energy infrastructure will create socio-political pressures that are not consistently recognized.

The IEA projects that electrifying the economy (particularly switching transport and industry to electricity) will increase the need for "flexibility, adequacy and reliability" in the grid. This refers to the fact that since electricity from the sun and wind is not available at all times of the day (the 'intermittency problem'), the green grid will rely on a lot of excess/redundant generation capacity, electricity storage, and information technology solutions ('smart grids', 'demand response' etc.) (IEA 2021: 176).

Renewable electricity capacity is expected to expand by more than 57,000 gigawatts by 2030, doubling current capacity globally. To provide flexibility and reliability, global storage capacity will need to increase from less than 200 gigawatt today to 3100 gigawatts by 2050. Significant infrastructure expansions are anticipated for long-distance transmission, local distribution, electric vehicle charging, as well as pipelines to transport low-carbon fuels (such as hydrogen) and carbon captured from the atmosphere (which will also require carbon storage infrastructure) (IEA 2021: 177-179).

The IEA sees this as an opportunity to "develop infrastructure from scratch in a way that is compatible with the net-zero goal." Rapidly urbanizing countries "can design and steer new infrastructure development towards higher urban density and high-capacity mass transit in tandem with EV charging and low-emissions fueling systems", with governments playing "a central role in planning, financing and regulating the development of infrastructure" (IEA 2021: 180-182).

Less acknowledged is that this additional infrastructure creates additional sites of (either causes of or vulnerability to) conflict. The Oxford Institute for Energy Studies points out that major renewable energy assets could draw protests and domestic opposition for reasons ranging from appearing as foreign investment associated with an unpopular ruling party or those central to the government's economic policy, to being seen as violating traditional lands. While historically targeting fossil fuel assets, renewables are not immune. Maasai opposition derailed the Kinangop wind project in Kenya, and investors tried to reclaim their investment from the government at the International Chamber of Commerce. A similar dispute is developing with the Kenwind project in Lamu (Gordon 2018: 12, 24).

The IEA projects that municipal solid waste will be a significant source of low-carbon bioenergy – particularly in the production of clean cooking fuel. "The technical potential of bio-LPG production from municipal solid waste in 2050 in Africa could be enough to satisfy the cooking needs of more than 750 million people." The IRENA similarly projects that, in Africa by 2030, electricity generation from waste could meet a significant portion of industrial energy needs, noting that "the use of bagasse (waste from sugar cane processing) for process-heat generation is already a common practice [on the continent]" (IRENA 2015: 36). However, municipal waste systems are existing political economies, often involving conflict and violence (e.g. Schnaiberg et al. 2001; Muindi et al. 2020). Without accounting for this reality, super-imposing an energy production system onto these is counter-productive.

Rising Demand for 'Productive' Land

The move toward renewable energy sources – ethanol, biodiesel, wood biomass-- could also increase competition over productive land. The role of energy crops and biomass in the energy transition is one of the most contentious academic debates underway, which is not reflected and often misrepresented in high-level reports. The most prosaic summary of this debate is offered by the IPCC, which notes that "there are limits to the deployment of land-based mitigation measures such as bioenergy crops" and that widespread use of such solutions "at the scale of several millions of km2 globally" increases the risk of desertification and land degradation, and risks to food security and sustainable development (IPCC 2019).

IRENA identifies liquid biofuels for the transport sector as a growth sector. The projected quadrupling of demand for motor fuel between 2013 and 2030 could be met by regionally-produced ethanol and biodiesel, benefiting parts of Africa where the potential for sustainable local production of biofuel is high (IRENA 2015: 44). It is unclear whether/how these projections account for municipal waste management systems as political marketplaces and "the contentious political economy of biofuels" (Neville 2015).

A more concerning proposition is the 'modernization' of biomass – "converting various indigenous sources of biomass into energy sources suited to end users", which the IRENA considers "presents both a great need and an opportunity for entrepreneurs." This involves creating large plantation forests in order to produce wood pellets powering 8 GW of installed capacity in 2030, requiring 10 million tons of feedstock, and creating an USD-30-billion-per-year export market (IRENA 2015: 46).

The theory behind wood pellets is to process "waste wood" such as sawdust into compressed pellets that burn more efficiently than fossil fuels. This requires forests to be regularly grown and harvested, which could continuously trap or sequester carbon from the atmosphere. In practice, this amounts to simply burning trees – often pristine, mature forests which have tangible biosphere and climate benefits while standing. The sector has failed to create verifiable carbon savings, is reported to worsen local air quality and raises pressure/demand for and on land (Aguilar et al. 2020; Drounin 2015; The Guardian 2018).

The IRENA acknowledges that land availability for energy crops is a concern, but frames this as essentially a problem of yield – "productivity has been low in many cases, agricultural land is fragmented and underdeveloped, and getting harvested crops to users would be a challenge in many settings. Overcoming these problems requires innovation and improved yields." It projects demand for "locally produced ethanol and biodiesel" of about 9.8 billion liters and 3 billion liters respectively by 2030 (IRENA 2015: 46-47).

It notes "some concerns" such as competition for land and water, food security and biodiversity threats, and soil erosion and that "large-scale land acquisitions by foreign companies are increasingly contentious" (IRENA 2015: 61). One paper estimates that, since 2000, biofuel production has driven 7.3 million hectares of private land 'investments' in Sub-Saharan Africa "which have little to do with the interests of local populations" (Giovanetti & Ticci 2016). The IRENA's suggestion in this regard – that biofuel policies “must be guided by globally accepted sustainability standards” – is a technocratic take on a political problem with strong potential to escalate and derail any decarbonization consensus.

JOB GAINS

Differentiated Job Gains across Regions and Sectors

The IEA projects a 14 million increase in clean energy jobs and a 5 million reduction in oil, gas, and coal jobs by 2030. These are estimates for direct employment within the energy sector, which currently directly employs 40 million people globally. It acknowledges, however, that “there are varying results for different regions, with job gains not always occurring in the same place, or matching the same skill set, as job losses” (IEA 2021: 157).

The ILO similarly estimates that “progress towards sustainability” will create around 18 million more jobs globally by 2030, including 4 million jobs in manufacturing and 9 million in renewables and construction combined. However, while this involves net job creation in the Americas, Asia and the Pacific, and Europe, there will be net job losses in the Middle East and Africa “if the economic structure of these regions does not divert from the historical trend.” Often, job gains are offsetting job losses within the same sector – this is true of electricity production (2.5 renewables million jobs gained, 400,000 fossil fuel jobs lost) and mining, where gains and losses cancel each other out. Vehicles production as a whole loses jobs (ILO 2018: 37-38).

This is most evident in the ‘circular economy’ – a proposed economy-wide recycling of waste, including metals waste – which is estimated to add 50 million jobs in services and 45 million in waste management, but lose 50 million mining and 60 million manufacturing jobs. Here, employment gains are driven by increases in Latin America, the Caribbean, and Europe, while net employment losses are expected in Asia and the Pacific (ILO 2018: 53).

In Africa, the IRENA links renewable energy expansion to industrial growth, because historically, unreliable power supplies have been a key obstacle preventing economic transformation in the region. As an example of this inadequacy, it cites the electricity struggles of the mining industry in West Africa, a significant employer. While electricity demand for mining projects in Guinea, Guinea-Bissau and Sierra Leone is three times the sum of all other demand in those countries, many mining companies are still opting to supply their own electricity with diesel generators because of unreliable energy supply from national power grids. In this context, the increasing adoption of renewable energy by miners is cited as a “positive trend”.

‘Decent’ employment and wages

The IRENA notes that sectors which create the most jobs, such as solar and wind technology manufacturing, require highly-skilled labor, necessitating significant re-training of even those currently employed within the carbon energy sector. “Even where the number of direct energy jobs lost is small, the impact on the local economy may be significant. Government support would almost certainly be needed to manage these transitions in a just, people-centred way” (IEA 2021).

In terms of downstream or macro-economic effects, the IEA estimates that clean energy investment directed at net-zero-by-2050 “creates a large number of jobs and stimulates economic output in the engineering, manufacturing and construction industries”, resulting in annual GDP growth that is nearly 0.5% higher than the current trajectory over the next ten years. Again, there are “large differences in macroeconomic impacts between regions”, with fossil fuel producer economies hit the worst (IEA 2021: 156). There do not seem to be IEA estimates for effects of the transition on other downstream activities (such as, for example, on transportation services around a mining hub) and particularly on the informal sector.

In terms of wages, the ILO argues that “green jobs have to be decent”. It notes that reliable estimates of green jobs are scarce, leading to the adoption of statistical guidelines on employment in the environmental sector and green jobs by the19th International Conference of Labour Statisticians in 2013. By these norms, an ILO estimate found 374,100 jobs in the “environmental sector” in Mongolia, but only 53% of these pay “decent wages” (defined as more than two-thirds of median earnings) (ILO 2018: 54).

One assessment of renewables job-generation potential in India found that “the majority of the jobs that are available to unskilled and semi-skilled workers are those created during the construction stage of on-grid projects [...] informal, temporary positions that lack stability and safeguards against losses” (Jairaj et al. 2017). In the US, which had around 3.6 million “clean energy jobs” in 2019, there is some evidence that clean energy and low-carbon jobs, on average (not universally), offer higher wages than the national average, and that they are accessible to workers without college degrees. But, because a “good portion of these jobs are non-union or contractor based”, there are concerns about the lack of benefits like health care and lack of contract security (Saha et al. 2020).

V CLIMATE FINANCE: CURRENT PRACTICES AND PITFALLS

Globally, there is an investment shift away from fossil fuels towards renewable energy through a variety of finance instruments. These financial instruments are similar to those used for development projects, but the dynamics of climate adaptation and mitigation efforts are different from development, and they therefore could have differed implications for fragile states. These differences center on the fact that achieving a 1.5ºC or 2ºC scenario requires collective global action and certain actors are well-placed to leverage domestic 'climate assets and liabilities' to improve their negotiating position as they seek public finance for climate adaptation and mitigation projects. This section surveys the current state of climate finance, common financial instruments, as well as an examination of two key climate funds: the Global Climate Fund and the Amazon Fund. Overall, climate finance analyses are still emerging, in part because many of the projects are from the last decade and the long-term implications are not yet clear (Bhandary et al. 2021). In this section climate finance refers to projects that seek to mitigate the effects of climate change as well as those that seek to adapt current practices to lower carbon emissions (inclusive of renewable energy investments). Renewable finance specifically refers to projects focused on renewable energy.

CURRENT STATE OF CLIMATE FINANCE

The Climate Policy Initiative estimates that through 2050, between $1.6 to $3.8 trillion in new climate investment will be required for the supply side of the global energy system (CPI 2020, 8). For renewable energy alone, IRENA estimates that investments will need to reach $800 billion by 2050, triple the 2018 rate of $322 billion (IRENA 2020-GL, 8). Investors, companies, and banks are keenly aware of the need and also the opportunities of financing climate adaptation and mitigation projects.

Globally, investors, companies, and central banks are evaluating their long-term strategies against 2ºC scenarios. "Long-term investors (including pension funds and sovereign wealth funds are responding to this, increasingly limiting or excluding fossil fuels from their portfolios and using their shareholder votes to influence company behavior." (Bradley et al. 2018, 4) In November 2020, 450 of the world's public development banks said they would "increase the pace and coverage of investments in renewable energy, energy efficiency, and clean technologies" (Abnett et al. 2020). Some banks, such as the European development banks, went further to pledge to phase out fossil fuel investments, while others (e.g. Asian development banks) did not. Collectively, these institutions represent approximately 10% of all global investments from public and private sources in a given year (Abnett et al., 2020). On a global level, this also represents financing trends among banks. "Where local banks see or predict fossil fuel consumption increasing in local markets, they increase lending. Where local banks envision a drop in demand, they curb lending" (Clifford 2021). In August 2021, the U.S. Treasury Department issued new guidance to multilateral development banks that it would no longer support their involvement in most fossil fuel projects with the exception of downstream investments in LNG in poorer countries (Lawder 2021). This has not been without pushback. Some fossil fuel dependent countries have argued that recent limits on fossil fuel investment represent a double standard by developed countries.[41]

Osinbajo, the Vice-President of Nigeria, recently argued that pressure from Western Countries (largely the UK, US and EU) along with the UN, have made it difficult for African states to raise necessary capital to invest in fossil fuels that play critical roles in powering the growth of developing economies (Osinbajo 2021). He argues that the fight against climate change must account for economic differences between countries and allow for multiple pathways to net-zero emissions. Osinbajo's argument echoes that made by other developing countries, however, it is not necessarily the full picture. While Nigeria is currently courting international investment to develop its substantial natural gas reserves, it is arguably still focused on propping up its oil industry. In a 2021 landmark reform bill, the Nigerian Government established a new provision that as much as 30 percent of oil revenues will go toward a fund for future oil exploration. Despite calls for investments in renewable energy or even its natural gas industry, this fund is exclusively for exploring and developing new oil fields.

Current Investment Trends

While there are indications that financial flows are beginning to shift, current investments fall far short of what is needed for a 1.5ºC or 2ºC scenario, and investments are uneven across the globe. Action within developing and emerging economies is critical, though to date, they represent a fraction of overall climate investments.

Climate flows in 2017/2018[42] averaged USD 574 billion per year for the first time in history (CPI 2020, 6). This was 24 percent higher than the average in 2015/2016. CPI estimates that 2019 financial flows will be between USD 608-622 billion, a 6-8 percent increase from 2017-2018 (CPI 2020, 6). The estimated increase in 2019 is predicted to be driven mostly by MDBs and members of the International Finance Club (IDFC) (CPI 2020, 1). MDBs increased their climate finance commitments from 43.1 billion in 2018 to 61.5 billion in 2019. (CPI 2020, 18). Of current flows, 93 percent were for mitigation, and only seven percent for adaptation measures such as renewable energy production (CPI 2020, 11).

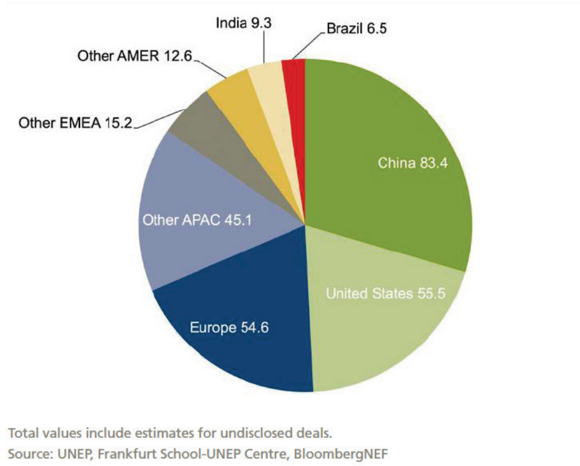
In terms of renewable energy, less than 20 percent of current investments in clean energy were in developing and emerging economies despite these economies accounting for two-thirds of the world's population (IEA 2021c). East Asia and the Pacific – mainly driven by China – accounted for 32% of global financial commitments in renewable energy (IRENA-GL 2020, 9). Western Europe accounted

41 For an example of this argument, see Osinbajo 2021.

42 Note, the Climate Policy Initiative analyzes investment data on two-year averages. Data for 2019/20 is not yet available, but estimates are provided.

for 19 percent as did OECD countries in the Americas for 19 percent (Canada, Child, Mexico and the US) (IRENA-GL 2020, 9). Regions with a majority of developing and emerging economies only attracted 15 percent of global investments in renewables between 2013-2018.

FIGURE 17: INVESTMENT IN RENEWABLE ENERGY CAPACITY BY REGION, 2019



Source: UNEP, Frankfurt-School-UNEP Centre, BloombergNEF 2020, 24.

FIGURE 18: INVESTMENT IN RENEWABLES CAPACITY BY TOP 30 COUNTRY OR TERRITORY IN 2019, AND GROWTH ON 2018, SBN

		% growth on 2018
China	83.4	-8%
United States	55.5	28%
Japan	16.5	-10%
India	9.3	-14%
Taiwan	8.8	390%
Spain	8.4	25%
Brazil	6.5	74%
Australia	5.6	-40%
Netherlands	5.5	25%
United Kingdom	5.3	-40%
Chile	4.9	302%
United Arab Emirates	4.5	1223%
Germany	4.4	-30%
France	4.4	3%
Mexico	4.3	17%
Sweden	3.7	-19%
Ukraine	3.4	56%
Vietnam	2.6	-64%
Korea (Republic)	2.4	31%
Russian Federation	2.3	76%
Argentina	2.0	-18%
Turkey	1.9	-16%
Poland	1.8	349%
Finland	1.5	41%
Italy	1.3	-35%
Norway	1.0	-8%
South Africa	1.0	-76%
Kazakhstan	0.8	58%
Greece	0.7	11%
Israel	0.7	113%

Source, UNEP, Frankfurt-School-UNEP Centre, BloombergNEF 2020, 24.

Climate Finance Instruments

Climate finance policies have largely emerged in the last ten years and are still developing. Below is a table presenting an overview of nine key climate finance instruments and the countries that have experience using them. No instrument is effective in every context but has strengths and weaknesses (Bhandary et al. 2021). These instruments are often used in combination with each other and are context dependent. Bhandary et al. argue that "academic literature on climate finance policies is limited, however, and where it exists, the focus is on policies to address the North-South climate finance gap or policy analysis based on economic modeling" (2021, 530). They encourage future research to focus on the effectiveness of different financial instruments across developing and developed economies to better understand the conditions under which each instrument is most effective.

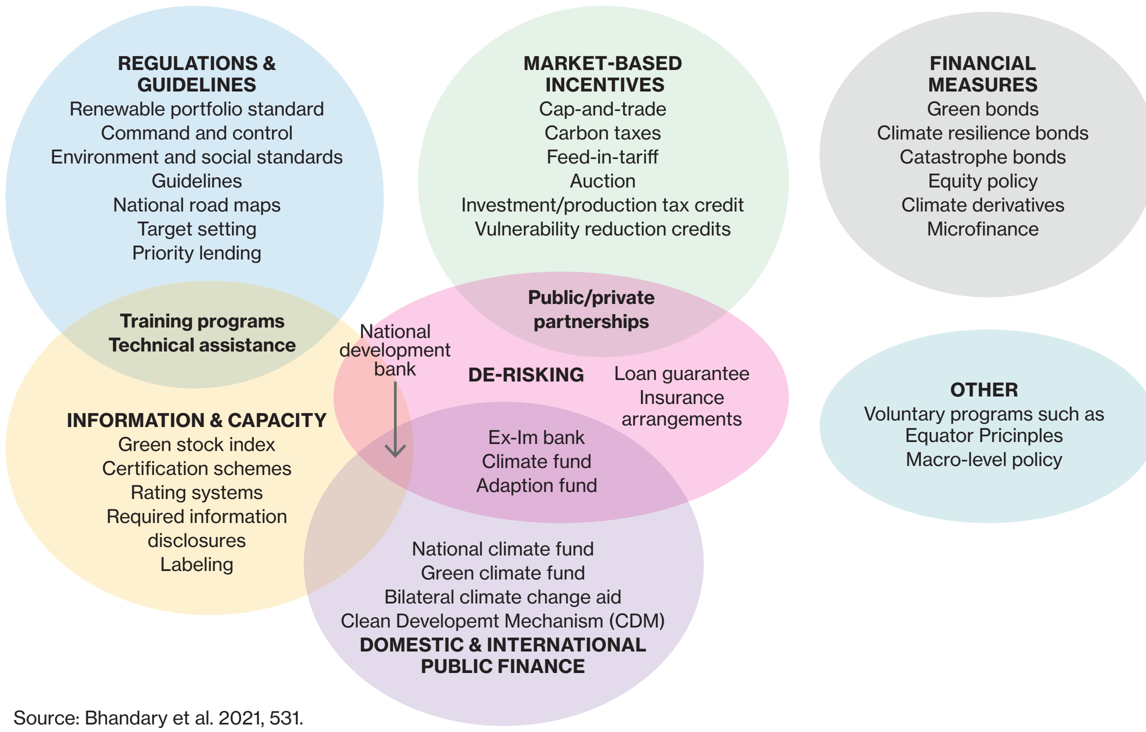
TABLE 5: SELECTED POLICIES AND COUNTRY EXPERIENCE

Table 1. Selected policies and country experience.

Policy Instrument	Policy definition	Country experience
Targeted lending	Requiring banks to lend a certain portion of their credit or deposits towards certain policy priorities, such as agriculture or clean energy.	India, China
Green bonds	Bonds earmarked for projects with environmental and/or climate benefits	China, Indonesia, India, the US
Loan guarantees	Governments commit to cover the borrower's debt obligation in the event that the borrower defaults on climate change projects.	the US, International Finance Corporation (IFC)
Weather indexed insurance	Index-based insurance provides payouts based on a measurable condition that is related to agricultural production loss, such as drought.	India, Mongolia, and Ethiopia
Tax credits	Permitting taxpayers to subtract, dollar for dollar, from taxes that they owe in return for new investments in climate friendly projects.	the US, Netherlands, Japan
Feed-in-tariffs (FiT)	Providing either a fixed total electricity price per kWh or a fixed premium on top of the wholesale rates of electricity for fixed periods for low-carbon electricity providers.	Spain, Germany, China
National development banks (NDBs)	Government-backed, sponsored, or supported financial institutions that have a specific public policy mandate to promote low-carbon development in a specific country. The NDBs in this study do not include those at multi-lateral, regional or local levels.	KfW in Germany, China Development Bank in China, and Indian Renewable Energy Development Agency in India
National climate fund	Funding vehicles designed by governments to mobilize, access, and channel climate finance.	Brazil, Ethiopia, Bangladesh, Indonesia
Disclosure	Requiring companies to report climate change information	the US

Source: Bhandary et al, 2021, 531.

FIGURE 19: CLASSIFICATION OF CLIMATE FINANCE POLICIES BASED ON FUNCTION.



Source: Bhandary et al. 2021, 531.

TABLE 6: STRENGTHS AND WEAKNESSES OF CLIMATE FINANCE POLICY INSTRUMENTS

Policy instrument	Strengths	Weaknesses
FiT	Mobilization of finance, environmental integrity,* transparency	Economic cost
Tax credits	Mobilization of finance, environmental integrity,* transparency, equal access,	Instability, economic cost, can benefit bigger/wealthier firms
Loan guarantee	Mobilization of finance, environmental integrity*, can be inexpensive	Vulnerable to political influence, can benefit bigger/ wealthier firms
NDBs	Mobilization of finance, environmental integrity,* can benefit SMEs or neglected sectors	Vulnerable to political influence
Targeted lending	Mobilization of finance, environmental integrity,* can benefit SMEs or neglected sectors	Vulnerable to political influence
Disclosure	Transparency	Mobilization of finance, environmental integrity is unclear
Green bonds	Mobilization of finance, can be inexpensive	Environmental integrity unclear due to lack of standardization
Weather indexed insurance	Administrative ease, addressing adaptation need	Mobilization of finance unclear
National climate fund	Gives country a degree of autonomy and credibility, mobilization of finance, environmental integrity	Mobilization of finance, vulnerable to political influence unless insulated or autonomous

*If climate-friendly sectors or technologies are targeted

Source: Bhandary et al. 2021, 539.

TABLE 7: MDBS CLIMATE FINANCE TARGETS

MDB	Pre-2020 Target	Post-2020 Target
afDB	**40%** of approved finance per year by **2020**	**At least $25 billion** for **2020-2025**
ADB	**$6 billion** by **2020**; $4 billion for mitigation and $2 billion for adaptation	**$80 billion** for **2019-2030**, and 75% of projects (by number of projects rather than amount of financing) by 2030
AIIB	None	**50%** of annual loan volume by **2025** (aiming to reach $10 billion in total annual loan volume by 2025)
EBRD	**40%** of annual commitments support environment/climate financing by **2020**, providing **$20 billion for 2016-2020**	**More than 50%** of commitments support green finance by **2025**
EIB	Global: **$20 billion** per year for **2016-2020**, equal to **at least 25%** of overall lending Developing countries: **35%** of total lending in those countries by **2020**	Global: **50%** of operations support climate action and environmental sustainability by **2025**; €1 trillion (around $1.18 trillion) of investments in climate action and sustainability from **2021-2030** No developing country specific target yet
IsDB	None	**35%** of overall annual lending by **2025**
IDBG	**25-30%** of commitments by **2020**	**At least 30%** of finance from IDB, IDB Invest and IDB Lab (the three components of the IDB Group) for **2021-2024**
NDB	None	None
WBG	**28%** of annual commitments by **2020**	**35%** of overall financing from **2021-2025**; **50%** of IDA and IBRD climate finance to support adaptation and resilience

Source: Neunuebel et al. 2021.

MAJOR CLIMATE FUNDS

There are several key multilateral climate funds that seek to provide financing to support economic and societal transformations needed to address climate change. Below is a table highlighting seven key funds that have existed from 1991 to 2017.

TABLE 8: MAJOR CLIMATE FUNDS FROM 1991 TO 2017

Fund	Global Environment Facility -5ºC and 6[43]	Least Developed Countries Fund	Special Climate Change Fund	Adaptation Fund	Clean Technology Fund	Forest Investment Program	Pilot Program for Climate Resilience	Scaling-Up Renewable Energy Program	Green Climate Fund
Founded	1991	2001	2001	2001	2008	2008	2008	2008	2010
Cumulative pledged funding (time period)[44]	$3.03bn (2010-18)	$1.19bn (2001-16)	$351m (2001-16)	$541m (2009-16)	$5.57bn (2008-16)	$768m (2008-16)	$1.19bn (2008-16)	$777m (2008-16)	$10.3bn (2014-c2018)
Contributor Countries with number of developing countries in parentheses	39 (13)	25	15	14	9	8	9	11 (1)	43 (9)
Funding Approved	$2.54bn	$1.04bn	$347m	$337m	$4.5bn	$315	$950m	$197m	$1.48bn
Projects approved	379	231	76	52	91	22	60	21	35
Countries with projects approved	137	51	79	48	25	8	18	11	52

Source: Amerasinghe et al. 2017.

Update on the Green Climate Fund

The Green Climate Fund (GCF) was established by the Paris Agreement in an effort to raise funds to support countries to achieve their NDCs. The GCF distributes funds to a network of over 200 accredited entities and delivery partners who work directly with countries to design and implement climate adaptation and mitigation projects. Accredited organizations include international and national commercial banks, multilateral, regional and national development finance institutions, equity funds, UN agencies, and civil society organizations (GCF n.d.). GCF has a four-pronged approach: 1) transformational planning and programming; 2) catalyzing climate innovation; 3) mobilizing finance at scale; and 4) aligning finance with sustainable development (GCF 2021). They provide funds through grants (42%), loans (44%), results-based payments (6%), equity instruments (6%), and guarantees (2%) in an attempt to crowd-in private investment. As of September 2021, $33.2 billion has been approved for projects (including co-financing), $8.8 billion directly funded by the GCF. However, as of September 2021, only $1.9 billion had actually

43 Data covers only Global Environment Fund (GEF)-5 and GEF-6 climate change activities. GEF-5 ran from July 2010 to June 2014 and GEF-6 runs from July 2014 to June 2018. For pledged funding, rather than including the total amount of donor pledges to the GEF Trust Fund for the GEF-5 and GEF-6 periods, we count only the amounts allocated toclimate change activities

44 Based on pledges, not disbursed money.

been dispersed (GCF 2021). In addition, the majority projects that are currently being implemented have been targeted at mitigation efforts, though approved projects are equally split between adaptation and mitigation (GCF 2021, 9).

NEW CLIMATE RENTIERISM?

Reducing Emissions from Deforestation and Forest Degradation (REDD+)[45] is a mechanism to govern carbon emissions, though most countries targeted by REDD+ programs have weak governance structures (Korhonen-Kurki et al. 2014, 168). A major challenge is fighting illegal deforestation, smuggling, and the networks of corruption that stem from each.[46]

One of the largest REDD+ efforts has been Norway's International Climate and Forest Initiative (NICFI). NICFI is mainly a results-based program in which the Norwegian Government disburses payments (largely funds derived from Norway's own petroleum industry) to countries with the mutually agreed goal of reducing forest destruction (NICFI n.d.). One of the main ways it has done this is by creating partnerships with governments in which it provides funds in exchange for the target country decreasing its rate of deforestation. The process is monitored and verified by satellite imagery. NICFI currently has partnerships with Brazil, Colombia, the Congo Basin countries (Cameroon, CAR, DRC, Equatorial Guinea, Gabon, and RoC), Ecuador, Ethiopia, Guyana, Indonesia, Liberia, and Peru. Each country partnership is unique, but often include capacity-building efforts to increase monitoring and verification capacity, as well as broader efforts to strengthen governance of relevant sectors. For example, given that one of the drivers of deforestation in Indonesia is illegal activity, NICFI's partnership with the Indonesian Government includes a significant focus on collaborative anti-corruption efforts (Vaillant et al. 2020). This is seen as a cost-effective way to reduce carbon emissions, though it has shown to be challenging in contexts with weak governance.

One of NICFI's most high-profile partnerships has been with the Brazilian Government in efforts to protect the Amazon. The Brazilian Amazon is approximately 5 million square kilometers, or approximately 1.5 times the size of India (NICFI n.d.-b). Historically, the Amazon rainforest has absorbed approximately 5 percent of annual global carbon dioxide emissions leading some to call the Amazon Earth's carbon sink. NICFI's partnership is a results-based program in which the Norwegian government makes contributions to the Amazon Fund, which is managed by the Brazil Development Bank, in exchange for progress limiting deforestation (NICFI n.d.-b). The Amazon Fund is intended to fund Brazil's climate action plan. This partnership began in 2008.[47] From 2006 to 2012, Amazon deforestation was cut by 80 percent, much of this was government action to cut down on illegal deforestation and what Human Rights Watch calls "Rainforest Mafias" (Change and Tollefson 2019; HRW 2019). However, in 2012, the rate of

45 It is worth noting that a 2021 UN study found that in almost every Latin America country, indigenous and tribal territories have lower deforestation and degradation rates than other territory. See FAO and FILAC 2021.

46 Wildlife and forest crime, including illegal timber, is the fourth largest illegal trade in the world after arms, drugs, and human trafficking. See UNODC n.d.

47 See the Memorandum of Understanding: https://www.regjeringen.no/contentassets/2ecbe3693ac04a85bf4d8ddb5d78d858/mou_norway_brazil.16.09.08.pdf.

deforestation began to increase, dramatically increasing after Javi Bolsonaro, a staunch anti-conservationist, was elected in 2019. In August 2019, Norway suspended payments to the Brazilian Government after Bolsonaro unilaterally shut down the steering committees overseeing the Amazon Fund (Reuters 2019). From when the partnership began to August 2019, Norway had contributed approximately $1.2 billion to the Amazon Fund. Part of the increase in deforestation is driven by illegal gold mining in the Amazon. Illegal gold mining is now estimated to account for as much as a third of all gold production in the country and many of the illegal mines are in the Amazon (Economist 2021). In addition, in July 2021, for the first time in recorded history, the Amazon was a net producer of CO2 due to fires set to clear land for soy and beef production (Carrington 2021; Gatti et al. 2021).

The Amazon Fund is intended to support Brazil's efforts to adapt and mitigate climate change, but it is unclear whether all the funds are used for that purpose. In an evaluation of NICFI, Norway's own government noted that there was a substantial risk of fraud within the program and that full monitoring and verification of how the funds would be used was difficult (Gaworecki 2018). Bolsonaro's Minister of the Environment, Ricardo Salles, actually gave corruption within the Fund as the reason for the committees' suspension. However, Salles himself is now the subject of an illegal timber operation investigation in the Amazon and has since resigned from his post (Marcello and Spring 2021). Salles is recorded to have encouraged the cabinet to roll back environment regulations while the public was distracted by Covid. The current investigation focuses on him, but Marcio Astrini, head of the environmental group Climate Observatory says Salles, and whoever serves as environment minister, is following Bolsonaro's orders and will likely continue a policy of environmental destruction (Marcello and Spring 2021).

Shifting Negotiation Power

Historically, Norway and Germany's contributions to the Amazon Fund have been results-based payments made only after extensive monitoring and verification. As pressure mounts for climate change response and more attention is paid to Amazon deforestation, former President Bolsonaro seemed to have tried a new approach – negotiating payment with limited strings. In advance of U.S. President Biden's virtual climate summit in April 2021, Bolsonaro's government announced that it would cut deforestation by 40 percent in exchange for $1 billion from the international community. At the same time, it rebuffed the inclusion of accountability mechanisms over how the money would be spent (Trevisani and Puko 2021; Pagliarini 2021; Coleman and Grunwald 2021). Many were skeptical of whether Bolsonaro would actually commit to a deal on those terms. The New Republic described this writing that "no amount of money will compel Bolsonaro to confront the illicit logging interests and rapacious cattle ranchers that drive deforestation today" (Pagliarini 2021).

Bolsonaro's proposal gained little traction with the US or with the international community. However, given the importance of preserving the Amazon in achieving a 2°C scenario and that a majority of the Amazon is within Brazil, there was pressure for international actors to negotiate with Bolsonaro. Similarly, Bolsonaro's administration was in severe need of funds and willing to negotiate.

At the time, Bolsonaro's government was facing court-ordered debt payments of approximately $17 billion in 2022, approximately 94 percent of the government's discretionary budget, and it was scrambling to come up with the necessary funds (Ayres and Mcgeever 2021). The debts comprised compensation, benefits, and tax refunds mandated by Brazil's courts. Between 2019 and 2021, Brazil's government debts had almost doubled under Bolsonaro's leadership. When asked how it happened, Brazilian Economic Minister Paulo Guedes said that "maybe we fell asleep at the wheel," and that the government may have "failed" (Ayers and Mcgeever 2021). While Bolsonaro's offer did not gain significant traction with the international community and few saw him or his government as a credible climate change partner, the US and other nations still engaged in talks with his government because of the simple fact that the Brazilian government controls one of the largest sections of the Amazon (Colman and Grunwald 2021).

The example of Bolsonaro and the Amazon is an extreme example of a negotiating the monetary value of a climate asset, but examining it shows an important point: the potential of authoritarian leaders to demand payouts with little strings in order to preserve environmental assets or leave certain resources (e.g. oil or coal) undeveloped. Put another way, this is the risk that climate assets could be held for ransom by authoritarian leaders demanding payments they could exploit for their own benefit.

More broadly, there are a growing number of examples around the globe of states monetizing behavior changes related to climate change. For example, the Asian Development Bank in collaboration with financial firms like Prudential and lenders like Citi, HSBC and BlackRock Real Assets, are putting together a plan to buy out coal plants across Asia and then phase them out of use in the next fifteen years (Denina and Burton 2021). The goal is to inject finance that is willing to accept a lower return in order to speed the closure of the plants and as Nick Robins argues, the goal is not to pay the polluter, but pay for an accelerated transition (Denina and Burton 2021). But what if accomplishing that goal requires paying the polluter to stop?

As the window closes for action against climate change, countries may be forced to make concessions to leaders like Bolsonaro or to major polluters, knowing that the funds are essentially buyouts and may be used to bolster authoritarian regimes. This is not a deal many countries are ready to make, but time may shift what world powers are willing to do in order to prevent climate harm.

VI OTHER THEMES IN THE LITERATURE

- **Energy transitions are not necessarily a transition everywhere.** Energy transition implies an evolution from one form of energy to another, but in countries with energy deficits, a future energy transition will simply be the development of energy sources.[48]
- **Climate Change as a Threat Multiplier.** In 2013, the National Research Council found that climate change, in combination with globally integrated systems, could global system shocks that could have devastating consequences on human well-being (NRC 2013, 73). This argument is perhaps best exemplified by Klare's (2019) book on how the U.S. Department of Defense sees climate change as a potential multiplier of existing threats, especially those related to fragile states and humanitarian crises. While looking systemically, these arguments focus on first-order effects of climate change (e.g. rising sea levels, droughts, etc.) and leaves second order effects stemming from climate change responses (e.g. decarbonizing the energy sector) unexplored.
- **Renewables as Energy Security Strategy.** While a transition to renewable energy is a threat to fossil fuel producers, it is also an opportunity for energy import-dependent countries to develop their own domestic energy supply to ensure their own energy security.
- **Regional Cooperation/Integration of Energy Grids.** Countries will transition to renewables at different rates and those that are more advanced may be well-positioned to export renewable energy to neighboring countries. However, while IRENA has shown the increasing cost competitiveness of renewable energy, the production cost increases steadily once transportation is involved. Regional cooperation also requires well-developed electrical grids.
- **Decentralization of Energy Production.** Fossil fuel energy production is often centralized into production facilities and then transmitted across electrical grids and other means. Renewable infrastructure has the potential to be different. For example, creating small solar or wind farms in rural areas.

48 For a discussion of the intersection of international political economy analysis and historical transitions within the energy sector, see Kern and Markard (2016). For a discussion of why the concept of transition does not necessarily apply to many African states, see Pistelli (2021).

VII ADDITIONAL UNANSWERED QUESTIONS & GAPS IN CURRENT RESEARCH

The following are unanswered questions and gaps in current research we noted when conducting the review. These questions and gaps are in addition to those outlined in the executive summary of this paper.

- **Need for country-specific studies of fossil fuel dependent fragile states.** Surface level data is available on this, but country-specific studies are largely not yet available leading all fragile fossil fuel producing states to be lumped together despite importance differences among them.
- **Gap between state and corporate commitments.** States are setting climate change goals, but many businesses and corporations within the petroleum sector, despite rhetoric and broad plans in support of these goals, are not acting in line with these plans or are actively opposing them. This is not new, but it is likely to be a major challenge for a successful transformation of the energy sector. As detailed above, although IOCs and NOCs have made public commitments to a net zero future, their actions leading up to the Paris Climate Accord, immediately following, and likely trajectory in the short-term is to maximize petroleum profits as long as possible.
- **Lack of comparative data on oil rents as percentage of government revenues.** Not all fossil fuel producers are dependent on fossil fuels in the same way: some are economically dependent while others are dependent on them for government revenues. These are not mutually exclusive and in fact are often related, but they are different. While individual country data on oil rents as a percentage of government revenues does exist in some cases, there is no comprehensive dataset. Oil rents (or petroleum rents more broadly) as a percentage of government revenues is an indicator of a government's dependence on oil rents, a key factor in determining the ways in which and to what extent a country is vulnerable to a global energy transition. Current analyses typically rely on oil rents as a percentage of GDP, a generally available measure, but one more appropriate for understanding the impact oil booms and busts have on an economy than directly on a government.
- **Will governments plug finance gaps to keep the oil flowing?** High-cost producers will be the first priced out of the market and in anticipation of this, international investors are already withdrawing investments and selling off assets. In order to keep the oil pumps running for a little longer, will governments attempt to sweeten the deal by funneling some of their own money into the deals? At what point will it no longer be feasible?

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