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Untapped ambition: addressing fossil fuel production through NDCs and LEDS

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Cleo Verkuijl

Natalie Jones

Michael Lazarus

Stockholm Environment Institute
Linnégatan 87D 115 23 Stockholm, Sweden
Tel: +46 8 30 80 44
www.sei.org
Author contact: Cleo Verkuijl
cleo.verkuijl@sei.org
Editing: Emily Yehle
Layout: Richard Clay
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Contents

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A climate change mitigation strategy should be holistic. It should incorporate both measures to curb fossil fuel demand and to wind down fossil fuel extraction.

1. Introduction

Barring unexpected advances in carbon capture and storage (CCS) technology, keeping Paris Agreement goals within reach will require the vast majority of proven fossil fuel reserves to be left unburned (McGlade and Ekins 2015). For decades, policy-makers have primarily sought to reduce fossil fuel combustion by pursuing measures to reduce fossil fuel demand, such as those related to renewable energy and energy efficiency. However, global fossil fuel combustion is at an all-time high (Ritchie and Roser 2017), despite the proliferation of climate change policies and regulations adopted over the past two decades (Nachmany and Setzer 2018). In addition to extreme climate risks, the economic and social risks posed by our continued reliance on fossil fuels are becoming increasingly apparent. Financial advisors and regulators have warned that a failure to take this "unburnable carbon" into consideration in economic and development planning will lead to a drastic, costly and socially disruptive transition from the fossil fuel economy once fossil fuel resources, infrastructure and investments inevitably strand (Carbon Tracker and Grantham Institute 2013; Clark 2015).

There is growing recognition that to be credible, a climate change mitigation strategy should be holistic. It should incorporate both measures to curb fossil fuel demand *and* to wind down fossil fuel extraction and delivery, as well as mitigate the impacts on affected workers and communities (Fæhn et al. 2017; Green and Denniss 2018; Lazarus and van Asselt 2018). Combining measures to constrain fossil fuel demand with those that constrain supply could allow for greater emission reductions at the same cost, or lower, than demand-side policies alone (Lazarus, Erickson, et al. 2015), and send a critical message to investors and society about the progression towards a decarbonized economy. "Supply-side" policies are also associated with a range of co-benefits for human health and the environment (Watts et al. 2018), and recent evidence suggests they may better mobilize public support than policies focused solely on reducing fossil fuel demand (Green and Denniss 2018).

National policy-making is gradually awakening to the advantages of "cutting with both arms of the scissors" (Green and Denniss 2018) – or addressing both fossil fuel demand and supply simultaneously. However, the topic of fossil fuel production commands limited attention in the UN climate process. Indeed, the Paris Agreement contains no reference to fossil fuels at all (Piggot et al. 2018). By no means accidental, this omission can be understood in the context of major fossil fuel producing nations' concerns about the impacts of climate change mitigation measures on their economies (Chan 2016). Given the UN climate regime's consensus rules, these dynamics have historically presented a challenging political economy for incorporating supply-side action into the international climate change regime (van Asselt 2014).

Nevertheless, the call for countries to take supply-side action – both within and outside the UN climate change process – is growing. Five hundred and thirty-five non-governmental organizations (NGOs) have signed the Lofoten Declaration,[1] which highlights the need to put an end to fossil fuel development and manage the decline of existing production. This call was echoed by Climate Action Network International, which represents more than 1,300 NGOs (Climate Action Network International 2018). In addition, the Suva Declaration – signed by leaders from Pacific Island governments, the private sector and civil society – called for dialogue on an "international moratorium on the development and expansion of fossil fuel extracting industries".[2]

Phasing out fossil fuels also repeatedly emerged as a topic in the 2018 Talanoa Dialogue. During the process, which was designed to enhance climate ambition, the world's 47 least developed countries requested a discussion on "managing a phase out of fossil fuels" (Gerasimchuk et al. 2017). In a summary of Party and non-Party stakeholder submissions to the Dialogue, the UN Framework Convention on Climate Change (UNFCCC) Secretariat highlighted "fossil fuel phase-out, fossil fuel subsidy reform, [and] divestment from fossil fuels" as being among the recurring demands (UNFCCC Secretariat 2018). It also recognized that phasing out fossil fuel production requires "significantly more international cooperation, and wider and deeper engagement of key stakeholders" (UNFCCC Secretariat 2018).

1 See the Lofoten Declaration: http://www.lofotendeclaration.org/

2 See the Suva Declaration on Climate Change: http://pacificidf.org/wp-content/uploads/2013/06/PACIFIC-ISLAND-DEVELOPMENT-FORUM-SUVA-DECLARATION-ON-CLIMATE-CHANGE.v2.pdf

Importantly, even though the Paris Agreement does not mention fossil fuels, its architecture creates various new opportunities to address fossil fuel supply through the international climate process (Piggot et al. 2018). One particularly promising avenue is the possibility for countries to incorporate supply-side approaches into their national climate change planning documents communicated under the UN climate regime – in particular, through their shorter-term nationally determined contributions (NDCs) and their long-term low greenhouse gas emission development strategies (LEDS). Due to the bottom-up nature of these plans, inclusion of supply-side approaches in NDCs and LEDS is not reliant on agreement among all Parties. In the near term, this makes it a more politically feasible strategy than supply-side measures that require international consensus. It also represents an important means of socializing supply-side action at the UN level, and could generate a virtuous cycle that encourages countries to take more ambitious supply-side action.

The introduction of NDCs, and, to a lesser extent, LEDS, has sparked a wave of new research into their (suggested) scope and contents (Mills-Novoa and Liverman 2019; Pauw et al. 2018; Piggot et al. 2018; Ross and Fransen 2017). While various contributions highlight the value of including supply-side information in such plans (Piggot et al. 2018; Scott et al. 2016), little research has systematically examined the extent to which NDCs and LEDS have addressed fossil fuel supply to date. A notable exception is a 2017 working paper from the Stockholm Environment Institute (Piggot et al. 2017). That paper found that the 10 largest fossil fuel producing countries had NDCs with "significant scope… to more explicitly and comprehensively address fossil fuel production and the steps needed to prepare for its ultimate decline" (Piggot et al. 2017, p.11).

This paper takes that finding as a starting point. It elaborates on the type of supply-side information that fossil fuel producing countries could include in their international climate communications, and assesses the extent to which countries have included such information or other references to fossil fuel production in their submissions to date. In doing so, it significantly expands the scope of NDCs examined, and extends this analysis to LEDS.

The paper proceeds as follows. Following a description of the methodology applied (Section 2), it briefly details the role of NDCs and LEDS in countries' communications on national climate ambition (Section 3). Section 4 considers the type of supply-side information and commitments countries could include in their NDCs and LEDS in order to help align fossil fuel production with the Paris Agreement's goals. In Section 5, the paper examines 57 NDCs and 8 LEDS to assess whether and how they integrate supply-side approaches. Section 6 concludes.

We find that countries are only making limited use of the potential of NDCs and LEDS to align fossil fuel production with Paris goals. Indeed, various plans foresee continued or scaled up fossil fuel extraction in the future. In doing so, they include insufficient reflection on the climate and equity implications of continued fossil fuel production – omissions that can be addressed as countries submit their LEDS and new or updated NDCs in the 2019-2020 period.

2. Methodology

The approach taken in this analysis is as follows.

First, Section 4 identifies six supply-side elements that countries could incorporate into their NDCs and LEDS to begin to align their plans with the Paris Agreement's goals. These are: background information about their fossil fuel reserves, and current and projected production; pathways and targets for aligning fossil fuel production with Paris Agreement goals; policy measures to manage a wind-down of fossil fuel production; just transition and economic diversification plans and measures; interventions to reduce production-related emissions; and relevant equity considerations.

Next, we searched the content of 57 NDCs and 8 LEDS for references to fossil fuel production or related terms. The following search terms were used: "coal", "extract", "fossil", "fuel", "gas", "hydrocarbon", "oil", "petroleum", "producer", "production", "subsidy", "subsidies", "supply", "just transition", and "economic diversification".

The 57 NDCs examined comprise the named fossil fuel producers in the 2018 BP Statistical Review of World Energy, which summarizes 2017 production data (BP 2018). Calculated according to the BP Review, these nations account for 98.5% of coal production, 98.6% of oil production, and 97.6% of gas production globally. The LEDS analysed are the 8 (out of the 11 submitted) that belong to fossil fuel producing states, as reflected in the same 2018 BP Statistical Review. The relevant country plans examined are summarized in Table 1. All documents were sourced from the UNFCCC website on 13 April 2019. Any later updates are omitted from the analysis.

Table 1: Overview of country documents examined

Note: When a party ratifies the Paris Agreement, its previously submitted intended nationally determined contribution (INDC) under the UN climate change process automatically turns into an NDC, unless a new NDC is submitted. As the distinction between the two types of plans is not strictly relevant for the purposes of this working paper – which is primarily concerned with the content of these plans – the remainder of this paper refers to both the INDCs and NDCs examined as "NDCs" for simplicity.

Document type	Countries examined	Comments
Nationally determined contribution	Algeria, Argentina, Australia, Azerbaijan, Bahrain, Bangladesh, Bolivia, Brazil, Canada, Chad, China, Colombia, Ecuador, Egypt, Equatorial Guinea, the European Union (EU), Gabon, India, Indonesia, Japan, Kazakhstan, Kuwait, Malaysia, Mexico, Mongolia, Myanmar, New Zealand, Nigeria, Norway, Pakistan, Peru, Qatar, Republic of the Congo, Saudi Arabia, South Africa, South Korea, Sudan, Syria, Thailand, Trinidad and Tobago, Tunisia, Turkmenistan, Ukraine, the United Arab Emirates (UAE), the United States (US), Uzbekistan, Venezuela, Vietnam, and Zimbabwe.	Libya was mentioned in the BP Review, but has not submitted an (I)NDC. Iraq's NDC could not be translated.
Intended nationally determined contribution	Angola, Brunei Darussalam, Iran, Oman, Russia, South Sudan, Turkey, and Yemen.	
Long-term low greenhouse gas emission development strategy	Canada, the Czech Republic, France, Germany, Mexico, Ukraine, the United Kingdom (UK), and the US.	

The resulting extracts were examined to verify that they concerned fossil fuel supply, and were then analysed for context. On this basis, we determined, firstly, to what extent any of the recommended supply-side elements identified in Section 4 have been included in the NDCs and LEDS submitted to date; and secondly, whether countries have included any other references to fossil fuel production in these plans. These findings are detailed in Section 5.

3. NDCs and LEDS: key vehicles for enhanced climate action

Nationally determined contributions and long-term low greenhouse gas emission development strategies are complementary documents through which countries can communicate and enhance mitigation ambition over time.

Under the Paris Agreement, Parties are required to prepare and communicate NDCs every five years (UNFCCC 2015a, Article 4(9)). Broadly speaking, NDCs tend to include a country's targets, policies and actions to reduce emissions over a five- or ten-year period. Some NDCs also include information on adaptation, and many developing countries have made their contributions partially or wholly conditional on receiving support for implementation (Pauw et al. 2018). Information on the overall effect of NDCs, as well as on Parties' overall progress towards achieving their NDCs, will feed into the global stocktake. In the stocktake, which will take place in 2023 and every five years thereafter (UNFCCC 2018a, para.36(b)), countries will take stock of the Paris Agreement's implementation and assess collective progress

towards its long-term goals (UNFCCC 2015a, Article 14(1), 14(2)). The outcomes of each global stocktake, in turn, will inform countries as they update and enhance their next round of NDCs (UNFCCC 2015a, Article 14(3); UNFCCC 2018a, para.3(c) and 34(a)). To date, 183 countries have submitted NDCs to the UNFCCC Secretariat, while several additional countries have submitted intended nationally determined contributions (INDCs) that may be converted into NDCs in the future (UNFCCC n.d.).

The Paris Agreement also calls for Parties to "strive to formulate and communicate long-term low greenhouse gas emission development strategies" (UNFCCC 2015a, Article 14(19)). Parties are invited to communicate these LEDS by 2020 (UNFCCC 2015b, para.35). The idea is that these strategies will inform short- and medium-term action and planning, provide political certainty, and enable countries to make economic transformations while also meeting development and poverty eradication goals (Espinosa 2018). They may also inform the global stocktake: the stocktake's inputs include reports and communications from Parties submitted under the Paris Agreement, which includes LEDS (UNFCCC 2018a, para.37(a)). Only 11 Parties have submitted LEDS to date, but many more are expected to submit their LEDS as the 2020 communication deadline draws near (UNFCCC 2016).

Although many Parties are making strides in their short- and long-term climate planning, it is widely recognized that the gap between expected global emissions levels and global climate goals is far too wide (Rogelj et al. 2016; UNEP 2018). Projections suggest that under current national emissions ambitions, the world will see global warming of about 3°C by the end of the century (UNEP 2018).

Closely related to the emissions gap identified by the UN Environment Programme (UNEP 2018), there exists a "production gap" between the limits of a 1.5°C or 2°C carbon budget and countries' plans and actions to expand the extraction of coal, oil and gas. Global investment in fossil fuel extraction and delivery more than tripled between 2000 and 2014, and continues to be the largest share of world energy investment (IEA 2016). The world's major economies continue to subsidize fossil fuel exploration and extraction on the order of USD 18-70 billion per year (Bast et al. 2015; OECD 2017), resulting in economic, political, social and cultural lock-in of fossil-fuelled development pathways (Erickson et al. 2015).

The 2019-2020 period represents a key opportunity for countries to bridge this production gap. Countries have been invited to submit "new or updated" NDCs, as well as their LEDS, by 2020. Moreover, in recognition of the fact that climate action thus far has fallen far short of what is needed to avert dangerous climate change, countries are expected to "demonstrate a leap in collective national political ambition" at the UN Secretary-General's Climate Action Summit in September 2019 (Climate Action Summit Team 2019). Incorporating supply-side approaches into NDCs and LEDS is a key step in bringing this bold – but necessary – vision within reach. The next section identifies several ways through which countries can introduce such approaches into their medium- and long-term climate planning.

4. Planning for a managed decline of fossil fuel production in NDCs and LEDS

The Paris Agreement provides limited guidance on the scope and contents of both NDCs and LEDS, despite their central role in the Paris architecture.

The development of LEDS is voluntary, and no formal guidance from the UNFCCC as yet exists, although several organizations have released guidance on their development and content (Levin et al. 2018; Ross and Fransen 2017; Waisman et al. 2016).

When it comes to NDCs, Decision 1/CP.21 adopting the Paris Agreement lists the following information Parties "may" include alongside their NDCs "as appropriate" (UNFCCC 2015b, para.27):

- quantifiable information on the reference point (including, as appropriate, a base year);
- time frames and/or periods for implementation;
- scope and coverage;
- planning processes;
- assumptions and methodological approaches, including those for estimating and accounting for anthropogenic greenhouse gas (GHG) emissions and, as appropriate, removals;
- how the Party considers that its NDC is fair and ambitious, in the light of its national circumstances; and
- how the NDC contributes to the objective of stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

At the 2018 UN Climate Change Conference (COP 24) in Katowice, Poland, Parties further fleshed out these elements and agreed that, starting from 2025, such information "shall" be provided by Parties in order to facilitate clarity, transparency and understanding of their NDCs (UNFCCC 2018b), thereby giving the strongest possible direction to include such information. Countries are also "strongly encouraged" to provide such information in any earlier update of their NDCs (UNFCCC 2018b). However, in both cases, they are only required to provide such information "as applicable" to their NDCs (UNFCCC 2018b). The overall scope and content of these plans thus remains largely up to countries' own discretion.[3]

While this flexibility has raised concerns about NDCs' comparability and transparency (Pauw et al. 2018), it also represents an opportunity for countries to highlight and prioritize measures that are particularly relevant to their national circumstances (Atteridge et al. 2019). Fossil fuel producing nations have various opportunities in NDCs and LEDS to signal their intent to take supply-side action, alongside action to address fossil fuel demand (Piggot et al. 2018; Scott et al. 2016).

In a recent paper, Pigott et al. identify various ways in which supply-side approaches can be given greater prominence through the UNFCCC process, including in NDCs and LEDS (Piggot et al. 2018). Building on this work, the more general low-carbon transitions literature, and the official guidance described above, we suggest that countries that produce fossil fuels (or those that may become producers in the future) should seek to include the following supply-side elements in their NDCs and LEDS:

1. **Background information about national fossil fuel reserves and current and projected extraction:** Many countries include background information in their NDCs regarding their national circumstances, such as their current levels and sources of emissions. Similarly, LEDS commonly include general information about a country's emissions. Alongside this information, Parties could include details of their current and projected fossil fuel production, and the carbon content of such production. Acknowledging the present state of affairs represents a first step towards fully addressing supply-side considerations in NDCs and LEDS, and would give useful context to elements identified under Points 2-6 below.

3 The Paris Agreement (Article 4.4) only prescribes that developed nations should submit "economy-wide absolute emissions reduction targets", while developing nations should continue enhancing their mitigation efforts, with a goal of moving over time "towards economy-wide emissions reduction or limitation targets."

2. **Pathways and targets for aligning fossil fuel production with Paris Agreement goals:** Alongside emissions reduction targets in NDCs (Pauw et al. 2016), nations could include pathways for fossil fuel production that aim for consistency with Paris goals (Piggot et al. 2018). LEDS, similarly, could include several targets or milestones over the longer time period to plan the transition away from fossil fuel production (Piggot et al. 2018). As part of such pathways, countries could include commitments to no longer finance fossil fuel production. In accordance with UNFCCC guidance, such information should incorporate quantifiable information on the reference point for any quantitative targets, such as: a base year; timeframes for implementation; scope and coverage; and relevant assumptions and methodological approaches.

   In LEDS – alongside scenario planning and modelling to reduce territorial emissions in various sectors and/or the economy as a whole – countries could model how fossil fuel production could be aligned with Paris goals. Countries could establish quantitative models, supported by qualitative roadmaps, to give a clear picture of various scenarios. The effects of supply-side policy measures taken in the short term (and, ideally, included in NDCs as detailed in Point 3) could be modelled over the longer term. Similarly, nations' LEDS could consider what types of fossil fuel infrastructure developments, if any, are consistent with Paris goals (Piggot et al. 2018).

3. **Policy measures to manage a wind-down of fossil fuel production:** In addition to targets, many current NDCs include specific policies and measures that will enable Parties to achieve their mitigation targets. Parties could thus identify, in their NDCs and LEDS, specific supply-side policies and measures that they intend to pursue. There is a wide range of measures this could include (for a more comprehensive list of policy approaches see Lazarus and van Asselt 2018). Countries could include regulatory approaches such as enacting moratoria on new fossil fuel infrastructure; prohibiting the development of specific resources, infrastructure, or technologies; and restricting the leasing of state-owned land and waters for fossil fuel development. Nations could also include economic instruments, such as removing subsidies for fossil fuel producers, or implementing production and export taxes on fossil fuels. In addition, countries could divest public funds from fossil fuel holdings, or restrict export credit agencies and multilateral development banks from financing fossil fuel infrastructure. Some countries are already pursuing such measures (Verkuijl et al. 2018), and could include them in their NDCs and LEDS. By highlighting such measures in their climate plans, countries would signal that they are not only considering the end goal of aligning fossil fuel supply with the Paris Agreement, but also the necessary policies to achieve it.

4. **Just transition and economic diversification plans and measures:** Ensuring a "just transition" to a low-carbon economy entails securing the future and livelihoods of the workers and communities affected by the transition, including through creating decent work and quality jobs. There is increasing recognition that a just transition is important for ensuring an effective and inclusive shift to a low-carbon economy (UNFCCC 2018c). For instance, the International Labour Organization has developed guidelines for a just transition (ILO 2015), and the Just Transition Centre of the International Trade Union Confederation has undertaken work to map just transition policies and develop guidelines for businesses (ITUC 2017; Just Transition Centre and The B Team 2018). Economic diversification is complementary to a just transition, and equally important for an effective shift to a low-carbon economy (UNCTAD 2018; UNFCCC 2018d). Nations economically reliant on fossil fuel production are increasingly taking action to restructure their economies (Al-Sahiri 2018; Ulrichsen 2016). In their NDCs, countries with workforces engaged in fossil fuel production could outline policies and measures to provide for a just transition for these workers and their communities, including policies for the participation and inclusion of affected workforces in decision-making. Similarly, nations could incorporate policies and measures to foster economic diversification away from fossil fuel production to other sectors. This would be in line with the information that Parties are required to provide to facilitate understanding of their NDCs. This includes information on the mitigation co-benefits resulting from economic diversification plans, including descriptions of the specific projects, measures and initiatives related to such plans (UNFCCC 2018b). In LEDS, nations could include modelling, scenario planning, and road mapping for economic diversification and a just transition of workers and their communities over the longer term.

5. **Interventions to reduce production-related emissions:** Due to the energy requirement as well as the associated release of methane and carbon dioxide (CO_2) from flaring and venting, extracting and delivering fossil fuels can be highly emissions-intensive, adding another 5% to 10% to the emissions from using coal, oil, and gas, according to Intergovernmental Panel on Climate Change (IPCC) estimates (Bruckner et al. 2014). Therefore, as overall fossil fuel production needs to be wound down, any remaining production that does occur needs to be done with as few emissions as possible. To this end, fossil fuel producing Parties could include, in their NDCs and LEDS, targets and policies aimed at reducing emissions from extracting sectors. These targets should be included alongside ones to align fossil fuel supply with Paris goals, as overall production can still increase even if production-related emissions decrease. Such efforts would be in line with the sector-specific targets, measures and policies that many countries already include in their NDCs.

6. **Equity considerations:** Winding down fossil fuel production has significant equity ramifications, notably when it comes to allocating the remaining "extraction budget" and to ensuring developing countries have sufficient support for a just transition (Kartha et al. 2018). NDC guidance requires countries to indicate how their NDC is fair and ambitious, in light of their national circumstances (UNFCCC 2018b, Annex I). This provides an important opportunity for countries to communicate to the international community why they consider their supply-side climate contributions to be equitable. In addition, developing countries could make the achievement of supply-side targets and policies – outlined above in Points 2 and 3 – (partially) conditional on international support or leadership by wealthier nations. In their LEDS, developing countries could also outline the support needed to meet longer-term production phase-down goals.

5. How have countries' NDCs and LEDS addressed fossil fuel production to date?

Of the 57 NDCs analysed, 38 mention fossil fuel production. This means that one-third of fossil fuel producers do not reference this activity at all in their NDCs. Notably, this includes seven countries that are in the top 10 for oil, coal and/or gas production (Australia, Brazil, Indonesia, Kazakhstan, Norway, Russia, and South Africa) (BP 2018). Out of the eight LEDS examined, six mention fossil fuel production in some way (Canada, France, Germany, Mexico, Ukraine, and the US), while two do not (the Czech Republic and the UK).

Importantly, this tally includes both references to the fossil fuel supply-side elements suggested in Section 4, as well as additional references to fossil fuel supply that countries have made. Disaggregating this information is crucial, as some references may help to further climate and equity goals, while others may not, or their effects may be ambiguous. Further discussion of these findings is therefore organized in two parts: Section 5.1 discusses the extent to which countries have incorporated the supply-side elements proposed in Section 4 in their climate plans, while Section 5.2 discusses any other references to fossil fuel supply contained in countries' NDCs and LEDS. Overall, our findings suggest that there is much scope for countries to strengthen supply-side approaches in their climate change plans.

5.1. Suggested supply-side elements

Table 2 discusses to what extent the NDCs and LEDS incorporate the supply-side elements identified in Section 4. None provide clear information on countries' fossil fuel reserves and current and/or projected extraction levels. In addition, none include targets or pathways to align fossil fuel production with the Paris Agreement, and only two highlight measures to financially disincentivize, or address public support for, fossil fuel production. Various countries highlight the need for economic diversification and a just transition away from fossil fuels; however, with a few exceptions, they do not include concrete measures for achieving these goals. Many countries highlight plans to pursue cleaner fossil fuel production methods; this suggests the need for more awareness of the potential and limitations of such approaches for achieving climate goals. Finally, no countries explicitly discuss equity considerations in the context of their fossil fuel production plans and pathways. These findings are discussed in more detail below.

Table 2. Inclusion of suggested fossil fuel supply-side elements in countries' NDCs and LEDS

Extraction-based CO_2 emissions represent the "downstream" (combustion) emissions associated with the ultimate use of fuels extracted (Davis et al 2011). They are estimated here based on primary coal, oil, and gas production data for 2016 from IEA World Energy Balances (2018 Edition) and Statistics, converted to CO_2 using default energy and carbon contents per physical unit of fuel from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (https://www.ipcc-nggip.iges.or.jp/public/2006gl/).

Country	Extraction-based emissions ($MtCO_2/y$)	Largest source of extraction-based emissions	Background information on reserves; current and projected extraction	Pathways/ targets to align production with Paris Agreement goals	Policy measures to manage a wind-down of fossil fuel production	Just transition and economic diversification plans and measures	Interventions to reduce production-related emissions	Equity considerations
NDCs								
Algeria	356	Oil					Y	
Angola	228	Oil						
Argentina	156	Gas						
Australia	860	Coal						
Azerbaijan	125	Gas					Y	
Bahrain	54	Oil				Y	Y	
Bangladesh	54	Gas						
Bolivia	46	Gas						
Brazil	402	Oil						
Brunei	36	Gas					Y	
Canada	839	Oil					Y	
Chad	No data					Y		
China	6808	Coal						
Colombia	350	Coal						
Congo	34	Oil				Y	Y	
Ecuador	76	Oil					Y	
Egypt	156	Oil					Y	
Equatorial Guinea	No data							
EU	938	Coal					Y	
Gabon	31	Oil					Y	
India	1659	Coal			Y			
Indonesia	1154	Coal						
Iran	933	Oil				Y	Y	
Japan	10	Gas						
Kazakhstan	490	Oil						
Kuwait	447	Oil					Y	
Malaysia	221	Gas						
Mexico	398	Oil					Y	
Mongolia	24	Coal						
Myanmar	38	Gas						
New Zealand	17	Gas						
Nigeria	312	Oil			Y		Y	
Norway	464	Oil						
Oman	195	Oil					Y	
Pakistan	77	Gas						
Peru	47	Gas						
Qatar	518	Gas				Y		
Russia	3222	Oil						
Saudi Arabia	1695	Oil				Y	Y	
South Africa	607	Coal						
South Korea	5	Coal						
South Sudan	16	Oil						
Sudan	14	Oil						
Syria	10	Gas						
Thailand	125	Gas						
Trinidad and Tobago	76	Gas						
Tunisia	11	Oil						
Turkey	95	Coal						
Turkmenistan	175	Gas						
Ukraine	100	Coal						
UAE	589	Oil					Y	
US	3984	Oil					Y	
Uzbekistan	113	Gas					Y	
Venezuela	395	Oil					Y	
Vietnam	163	Coal					Y	
Yemen	3	Oil						
Zimbabwe	3	Coal						
Total			**0**	**0**	**2**	**6**	**21**	**0**
LEDS								
Canada	839	Oil				Y	Y	
Czech Republic	54	Coal						
France	2	Oil						
Germany	228	Coal				Y		
Mexico	398	Oil					Y	
Ukraine	100	Coal					Y	
UK	214	Oil						
US	3984	Oil				Y	Y	
Total			**0**	**0**	**0**	**3**	**4**	**0**

Background information about national fossil fuel reserves and current and projected extraction

As noted above, none of the NDCs or LEDS examined provides clear information on countries' fossil fuel reserves and current and/or projected extraction levels. There is the opportunity and need to do so, since the transparency of future production plans is key to ensuring the alignment of fossil fuel production with Paris goals.

Pathways and targets to align fossil fuel production with Paris Agreement goals

None of the NDCs or LEDS examined contain specific targets or pathways to restrict or wind down fossil fuel production. Given the importance of target-setting and scenario planning in guiding climate policy, this represents a missed opportunity for aligning fossil fuel production with the Paris Agreement. Countries have the chance to remedy this when they update or communicate their NDCs and LEDS.

Policy measures to manage a wind-down of fossil fuel production

As highlighted in Section 4, there is a wide range of national supply-side policies that countries can adopt. Moreover, some countries have already begun to do so.

However, our analysis reveals that only one country, India, has chosen to communicate a measure to constrain or disincentivize fossil fuel production: its NDC highlights a tax ("cess") on imported and extracted coal, which stood at INR 200 (USD 3.2) per tonne of coal at the time of submission (India 2016, pp.7, 27, 37).[4] In an illustration of how supply-side policy can positively reinforce demand-side approaches, the NDC indicates that the revenues raised through this policy will be used to finance clean energy projects and the rejuvenation of the Ganges River (India 2016).

Government support for fossil fuel extraction and delivery continues to be a major barrier towards a low-carbon transition, and a few countries highlight plans to reform such subsidies. Nigeria mentions policies to address current government incentivisation of fossil fuel production, as well as consumption (Nigeria 2017, p.15). India, Iran, Kuwait and Vietnam also include references to fossil fuel subsidy reform in their NDCs; however, from the language used, it is unclear whether this refers to subsidies for fossil fuel production, consumption, or both (India 2016, p.7; Iran 2015, p.6; Kuwait 2015, p.6; Viet Nam 2016, p.6).

These findings suggest that there is significant potential for countries to strengthen their NDCs and LEDS in the 2019-2020 window, by incorporating both existing and new supply-side measures.

Just transition and economic diversification plans and measures

Three of the eight LEDS examined – but none of the NDCs – mention fossil fuel supply in the context of ensuring a just transition. Germany's LEDS, noting the need to reduce coal-fired electricity production, states that "it is necessary to open up tangible prospects for [affected] regions before definite decisions about gradually pulling out of the lignite industry can be taken". It specifies that the German government may use public funding to encourage investment and attract companies to former lignite mining areas and highlights that the affected workers need "new employment prospects and an opportunity for economic success and social security" (Germany 2016, pp.31–32). Similarly, the US, in its LEDS, mentions the need for "ensuring a just transition for Americans whose livelihoods are connected to fossil fuel production and use", and specifically cites measures targeted to coal mining communities (US 2016a, p.6). Canada's LEDS notes the need for regional cooperation and progressive mitigation policies "to ensure that decarbonisation efforts do not disproportionately affect" regions where its oil and gas industry is concentrated (Canada 2016, p.46). These efforts are important, and LEDS are well-suited to merging climate goals with socio-economic and development objectives, in which just transitions play a key role. However, while these statements imply that the countries plan to reduce fossil fuel production in the future, they do not explicitly say so, nor do they include plans for how a decline would occur. Therefore, although we have reflected countries' references to just transition in their LEDS in Table 2, these references could be strengthened to more fully reflect how nations intend to ensure just futures for their workers and communities as they wind down fossil fuel production.

In terms of economic diversification, six NDCs (Bahrain, Chad, Congo, Iran, Qatar, and Saudi Arabia), but no LEDS, mention fossil fuel supply in the context of the nation's need to diversify its economy. Saudi

4 Although not explicitly stated in the NDC, the tax applies to extracted as well as imported coal.

Arabia, for instance, mentions policies to diversify the economy to reduce dependence on oil revenues; it specifies that it aims to increase the share of other sectors such as "the manufacturing industries, energy and related derivatives, mining, tourism and information technology industries" (Saudi Arabia 2015). Qatar, too, "seeks to enhance the diversification of its economy away from hydrocarbon" (Qatar 2015, p.2). These NDCs, however, do not identify concrete plans in this regard. While recognition of the need to diversify countries' economies is an important first step, and this recognition has therefore been reflected in Table 2, ideally future NDCs would also set out the policies through which Parties will seek to achieve this goal.

Interventions to reduce production-related emissions

The majority of references to fossil fuel production in the NDCs and LEDS are about cleaner production processes. Twenty-one of the NDCs[5] and four of the LEDS[6] discuss plans and policies to improve the efficiency and reduce the emissions of fossil fuel production. For 12 of the NDCs, this was the only context in which fossil fuel production is mentioned. Measures listed include: reducing emissions from venting and flaring; improving heater efficiency; maximising condensate recovery; electrifying oil extraction; and constructing new extraction infrastructure using the best available technology.

Canada's NDC states that it is developing regulations to reduce methane emissions from the oil and gas sector by 40% to 45% by 2025, and that federal, provincial and local governments will work together to help the industry improve its energy efficiency and invest in new technologies to reduce emissions (Canada 2017, p.3). In its LEDS, Canada further elaborates on how the oil sands sector could be decarbonized, including through the further electrification of processes including heat, the adoption of electric steam generators to replace those fired by natural gas, and the use of hydropower (Canada 2016). It also details energy efficiency improvements that could be made in the oil and gas sector, and prospects for the sector to implement carbon capture, utilization, and storage (CCUS) and fuel-switching options (Canada 2016, pp.6, 48, 49). The US, in its NDC, similarly highlights the development of standards to address methane emissions from the oil and gas sector (US 2016b, p.5); in its LEDS, it also envisages enhancing investments to improve methane emissions measurement, capture, and repair technology (US 2016a, pp.13, 52, 89). The EU, in its NDC, lists "fugitive emissions from fuels", including "solid fuels" and "oil and natural gas and other emissions from energy production", in the sectors and source categories that contribute to its overall GHG emissions reduction target (EU 2015, p.4). The NDCs of Iran, Saudi Arabia and Algeria reference reducing emissions from gas flaring (Algeria 2015, p.5; Iran 2015, p.4; Saudi Arabia 2015, p.3), while Kuwait's NDC notes its plans to improve petroleum products through producing cleaner fuels which would reduce GHG emissions from power plants (Kuwait 2015, p.5).

While these and other efforts to reduce emissions from production are important, they do not obviate the need to scale down overall production. At their fullest potential, these efforts could contribute a few percent to global emissions reductions – and these reductions may be offset by added fossil fuel production and use. The countries that have included cleaner production in their NDCs and LEDS could therefore take the next step and incorporate targets and measures to limit expansion, as outlined in Section 4.

Equity considerations

The NDCs and LEDS examined do not give explicit consideration to equity in the context of fossil fuel production. Nevertheless, equity assumptions are implicit in various countries' discussion of current and future extraction (Section 5.2).

5.2. Other supply-side elements that appear in climate plans

Table 3 shows the ways NDCs and LEDS highlight fossil fuel production beyond the supply-side elements identified in Section 4. Several countries express their intention to continue or increase fossil fuel extraction, or to shift to the production of natural gas as a mitigation strategy. Some countries also reference the potential negative impacts of climate change measures – known as "response measures" – on their economies. These findings suggest insufficient reflection on the climate and equity implications of continued fossil fuel production in many countries' climate plans, and are discussed in more detail below.

5 Algeria, Azerbaijan, Bahrain, Brunei, Canada, Congo, Ecuador, Egypt, the EU, Gabon, Iran, Kuwait, Mexico, Nigeria, Oman, Saudi Arabia, the UAE, the US, Uzbekistan, Venezuela, and Vietnam

6 Canada, Mexico, Ukraine, and the US

Table 3. Other supply-side elements that appear in countries' NDCs and LEDSs

Extraction-based CO_2 emissions represent the "downstream" (combustion) emissions associated with the ultimate use of fuels extracted (Davis et al 2011). They are estimated here based on primary coal, oil, and gas production data for 2016 from IEA World Energy Balances (2018 Edition) and Statistics, converted to CO_2 using default energy and carbon contents per physical unit of fuel from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (https://www.ipcc-nggip.iges.or.jp/public/2006gl/).

Country	Extraction-based emissions ($MtCO_2/y$)	Largest source of extraction-based emissions	General context (e.g. fossil fuel production's importance to the economy)	Use of carbon capture and storage for enhanced oil recovery	Shifting to natural gas	Other references to continued production	Response measures
NDCs							
Algeria	356	Oil			Y		Y
Angola	228	Oil	Y				
Argentina	156	Gas					
Australia	860	Coal					
Azerbaijan	125	Gas					
Bahrain	54	Oil					
Bangladesh	54	Gas				Y	
Bolivia	46	Gas				Y	
Brazil	402	Oil					
Brunei	36	Gas					
Canada	839	Oil					
Chad	No data		Y				
China	6808	Coal		Y	Y		
Colombia	350	Coal	Y				
Congo	34	Oil					
Ecuador	76	Oil					
Egypt	156	Oil					
Equatorial Guinea	No data						
EU	938	Coal					
Gabon	31	Oil				Y	
India	1659	Coal					
Indonesia	1154	Coal					
Iran	933	Oil	Y				Y
Japan	10	Gas					
Kazakhstan	490	Oil					
Kuwait	447	Oil	Y				Y
Malaysia	221	Gas					
Mexico	398	Oil					
Mongolia	24	Coal					
Myanmar	38	Gas					
New Zealand	17	Gas					
Nigeria	312	Oil					
Norway	464	Oil					
Oman	195	Oil					
Pakistan	77	Gas				Y	
Peru	47	Gas	Y				
Qatar	518	Gas			Y		Y
Russia	3222	Oil					
Saudi Arabia	1695	Oil		Y	Y		Y
South Africa	607	Coal					
South Korea	5	Coal					
South Sudan	16	Oil	Y				
Sudan	14	Oil					
Syria	10	Gas	Y			Y	
Thailand	125	Gas					
Trinidad and Tobago	76	Gas	Y				
Tunisia	11	Oil					
Turkey	95	Coal				Y	
Turkmenistan	175	Gas				Y	
Ukraine	100	Coal					
UAE	589	Oil	Y	Y			
US	3984	Oil					
Uzbekistan	113	Gas					
Venezuela	395	Oil					
Vietnam	163	Coal					
Yemen	3	Oil	Y				
Zimbabwe	3	Coal			Y		
Total			11	3	5	7	5
LEDS							
Canada	839	Oil	Y				
Czech Republic	54	Coal					
France	2	Oil	Y				
Germany	228	Coal					
Mexico	398	Oil	Y				
Ukraine	100	Coal					
UK	214	Oil					
US	3984	Oil		Y			
Total			3	1	0	0	0

General context

Eleven of the NDCs[7] and three of the LEDS[8] that mention fossil fuel production do so in a general sense, by noting, for instance, their country's economic dependence on the oil and gas sector, or describing recent increases in fossil fuel extraction. Iran's NDC, for example, states that the "availability of hydrocarbon resources" combined with its young population and national development requirements have led development to "rely on energy-intensive industries" (Iran 2015, p.2). Kuwait's NDC notes that it is considered a country with a "single source of income", relying mainly on oil (Kuwait 2015, p.2). Canada and Mexico, in their LEDS, both highlight the importance of the oil and gas sector to their respective countries (Canada 2016, p.46; Mexico 2016, p.61). In future submissions, countries could build on such information by providing, for instance, more insight into the scale of their fossil fuel reserves and current and projected extraction levels.

Use of carbon capture and storage for enhanced oil recovery

Three NDCs and one LEDS outline plans to use carbon capture and storage for enhanced oil recovery. China's NDC says it will "promote the technologies of utilizing carbon dioxide to enhance oil recovery" (China 2016, p.13). Saudi Arabia in its NDC says it will operate an enhanced oil recovery demonstration project on a pilot testing basis to "assess the viability" of CO_2 sequestration in oil reservoirs (Saudi Arabia 2015, p.3). The UAE's NDC highlights that it is developing the region's "first commercial-scale network" for carbon capture, utilization, and storage (CCUS); this effort would capture emissions at a steel manufacturing plant and transport them to oil fields for use in enhanced oil recovery, "providing one of the first viable mechanisms to decarbonize essential energy intensive industries" (UAE 2015, p.2). The US, in its LEDS, also envisages using CCUS for enhanced oil recovery (US 2016a, pp.13, 52, 89). It is important to note that the use of CO_2 for the purposes of enhanced oil recovery may in many cases enable or increase output. Therefore, these countries' NDCs and LEDS could be strengthened by adding targets, pathways and measures to align oil production with Paris goals.

Shifting to natural gas

Three NDCs highlight the production of natural gas as a mitigation strategy. In this way, Qatar states that it "has been contributing indirectly" to mitigation efforts "by exporting Liquefied Natural Gas as a clean energy" (Qatar 2015, p.2). Saudi Arabia states that it will encourage investments towards exploration for and production of natural gas "to significantly increase its contribution to the national energy mix" (Saudi Arabia 2015, p.3). Algeria's NDC states that its "proven and possible natural gas resources" can advance the use of this source of energy (Algeria 2015, p.5). And China's NDC includes a statement that it aims to reach 30 billion cubic meters of coal-bed methane production (an unconventional form of natural gas extracted from coal deposits or coal seams) (China 2016, p.7).

LEDS are a space where countries could explore the long-term implications of a shift towards natural gas, including considering its potential risks and limitations as a transition fuel (see e.g., Lazarus, Tempest, et al. 2015). For instance, methane emissions from gas production, transport, and use can reduce or eliminate the benefits of gas relative to oil or coal, depending on the context (Bradley et al. 2018). Even more fundamentally, research suggests that replacing coal plants with new gas infrastructure would not cut emissions by enough to meet Paris targets – and instead could lock in emissions for decades to come (Stockman 2019).

Other references to continued production

Notably, seven NDCs[9] explicitly mention plans to continue or expand fossil fuel production (not including those, discussed above, that imply continued fossil fuel production through cleaner techniques or shifts to other fuels). For instance, Bangladesh lists under its mitigation objectives the development of coal mines and coal-fired power stations to maximize coal output and manage coal-fired power stations in a carbon-neutral way (Bangladesh 2015, p.5). Similarly, Bolivia writes of "boosting the oil and mining sectors" (Bolivia 2016, p.5) and Pakistan anticipates that "all domestic sources of energy, including coal" will be "fully harnessed" (Pakistan 2016, p.10).

7 Angola, Chad, Colombia, Iran, Kuwait, Peru, South Sudan, Syria, Trinidad and Tobago, the United Arab Emirates (UAE), and Yemen
8 Canada, France and Mexico
9 Bangladesh, Bolivia, Gabon, Pakistan, Syria, Turkey, and Turkmenistan

While global fossil fuel production needs to decrease drastically to meet climate goals, this does not mean that every country needs to curb extraction at the same pace, and at the same time. In line with the UN climate regime's equity principles, it seems reasonable to propose, for example, that a greater responsibility to curb extraction should fall to countries and other actors who have been responsible for extraction of fossil fuels in the past, and who have more capacity (Kartha et al. 2018). Per UNFCCC guidance, it is therefore critical that countries include, in their references to fossil fuel production, information on their assumptions and approaches to equity to enable assessment of whether these are indeed fair and ambitious. Rather than planning only for continued fossil fuel extraction, developing countries could also consider including supply-side measures in their NDCs and LEDS that are (partially) conditional on international support.

Response measures

A controversial aspect of the equity debate is the reference, by some countries, to the negative impacts of climate change measures on their economies. Five NDCs[10] — four of which also discuss the need for economic diversification — mention fossil fuel production in the context of such climate change "response measures". For instance, Algeria states that its national economy is "highly dependent on petroleum export revenues…[which] makes Algeria vulnerable to climate change adverse effects, as well as to the negative impacts of response measures" (Algeria 2015, p.8). Iran states that its dependence on oil revenues and the impact of response measures make the country a "suitable candidate" for finance, technology transfer, and capacity-building support (Iran 2015, p.2).

The Paris Agreement calls on Parties to take into consideration, in the implementation of the Agreement, the concerns of Parties with economies most affected by the impacts of response measures, in particular those of developing countries (UNFCCC 2015a, Article 4.15). At the same time, many UNFCCC Parties and observers may find it objectionable if limited climate finance were allocated to relatively wealthy fossil fuel exporting nations instead of the most vulnerable or those with the least capacity (Depledge 2008; Kartha et al. 2018). While certainly not easy to resolve, this tension again illustrates the need for countries to make their assumptions and approaches to equity more explicit in the context of fossil fuel extraction. Inclusion of such information in NDCs and LEDS is an important step in promoting transparency and debate on the question of whose fossil fuel assets can fairly be extracted in light of the limited remaining extraction budget, and which countries should be supported in the process.

6. Discussion and Conclusion

Meeting the goals of the Paris Agreement will require a rapid decline in global fossil fuel production and related investment. As the key international documents for countries to communicate and enhance their ambition on climate action, nationally determined contributions (NDCs) and long-term low greenhouse gas emission development strategies (LEDS) have significant potential to be used by countries to communicate plans to phase out or restrict fossil fuel production. This paper proposes six key elements for inclusion in this regard: background information on national fossil fuel reserves, and current and projected production; pathways and targets for aligning fossil fuel production with Paris Agreement goals; policy measures to manage a wind-down of fossil fuel production; just transition and economic diversification plans and measures; interventions to reduce production-related emissions; and equity considerations.

The bottom-up nature of these plans gives countries the flexibility to incorporate supply-side approaches into their NDCs and LEDS. Despite that, our analysis shows that one-third of fossil fuel producing countries do not refer to fossil fuel supply in their NDCs at all. Although six out of the eight LEDS submitted by fossil fuel producers mention fossil fuel production in some way, none detail pathways or targets to align production with Paris goals, or policy measures to wind down production.

Many countries highlight plans to pursue cleaner fossil fuel production, but the other recommended elements cited above go largely unaddressed. The exceptions are two NDCs, which highlight measures to financially disincentivize, or address public support for, fossil fuel production. Some NDCs explicitly mention plans to continue fossil fuel production, or reference the potential negative impacts of response

10 Algeria, Iran, Kuwait, Qatar, and Saudi Arabia

measures. Planning for a managed decline in fossil fuel production is thus a key omission from most countries' climate change plans, one with severe climate and equity implications.

The analysis in this paper has focused on the NDCs and LEDS of the current main fossil fuel producers. Since additional countries may become producers in future, it is important for such Parties to also include supply-side information in their NDCs and LEDS. A future study on this topic could examine the extent to which this subset of countries is doing so.

It is also important to interrogate why fossil fuel supply-side approaches have been largely overlooked in countries' NDCs and LEDS. Most fundamentally, this reflects a broader trend in countries' climate policy-making, which has long focused almost exclusively on demand-side approaches. As highlighted in this paper, however, policy-makers are increasingly being called on to acknowledge and address the climate risks associated with untempered fossil fuel extraction. In this regard, the adoption of an extraction-based accounting system – in parallel with existing territorial GHG accounting approaches – could play a role in socializing the need for countries to take into account their fossil fuel production levels and associated emissions in their climate change planning and action (Steininger et al. 2016).

The lack of supply-side references in countries' NDCs and LEDS also may relate to the way these plans have been developed. Many plans provide relatively little detail beyond headline GHG emission mitigation targets. With new guidance for NDCs in place, however, countries are expected to provide further transparency into various aspects of these plans in the next submission round. This provides an opportunity to enhance transparency on both the demand- and the supply-side.

Finally, the importance of timing must be emphasized. Given the 2020 deadline for communication of LEDS and new or updated NDCs, the 2019-2020 period offers a narrow window of opportunity for countries to more fully harness the policy approaches outlined in this paper. As a key milestone for enhanced climate action, the UN Secretary-General's Climate Action Summit in September 2019 represents an opportune moment for countries to begin to align fossil fuel production with Paris goals.

7. References

Algeria (2015). *Intended Nationally Determined Contribution INDC - Algeria*. People's Democratic Republic of Algeria. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Algeria%20First/Algeria%20-%20INDC%20(English%20unofficial%20translation)%20September%2003,2015.pdf

Al-Sahiri, A. (2018). *Prospects for Climate Change Integration into the GCC Economic Diversification Strategies*. LSE Middle East Centre, London. http://eprints.lse.ac.uk/86873/1/Al-Sarihi_Prospects for climate change_2018.pdf

Atteridge, A., Verkuijl, C. and Dzebo, A. (2019). Nationally determined contributions (NDCs) as instruments for promoting national development agendas? An analysis of small island developing states (SIDS). *Climate Policy*. 1–14. DOI: 10.1080/14693062.2019.1605331

Bangladesh (2015). *Intended Nationally Determined Contributions (INDC)*. People's Republic of Bangladesh. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Bangladesh%20First/INDC_2015_of_Bangladesh.pdf

Bast, E., Doukas, A., Pickard, S., Van der Burg, L. and Whitley, S. (2015). *Empty Promises: G20 Subsidies to Oil, Gas and Coal Production*. Overseas Development Institute and Oil Change International, London and Washington, DC. https://www.odi.org/publications/10058-empty-promises-g20-subsidies-oil-gas-and-coal-production

Bolivia (2016). *Intended Nationally Determined Contribution from the Plurinational State of Bolivia*. Plurinational State of Bolivia. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Bolivia%20(Plurinational%20State%20of)%20First/INDC-Bolivia-english

BP (2018). *BP Statistical Review of World Energy*. BP. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf

Bradley, S., Lahn, G. and Pye, S. (2018). *Carbon Risk and Resilience: How Energy Transition Is Changing the Prospects for Developing Countries with Fossil Fuels*. Chatham House, London. https://www.chathamhouse.org/sites/default/files/publications/research/2018-07-12-carbon-risk-resilience-bradley-lahn-pye-final.pdf

Bruckner, T., Bashmakov, I. A. and Mulugetta, Y. (2014). Energy systems. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., et al. (eds). Cambridge University Press, Cambridge, UK, and New York. https://www.ipcc.ch/report/ar5/wg3/

Canada (2016). *Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy*. Government of Canada. https://unfccc.int/files/focus/long-term_strategies/application/pdf/canadas_mid-century_long-term_strategy.pdf

Canada (2017). *Canada's 2017 Nationally Determined Contribution Submission to the United Nations Framework Convention on Climate Change*. Canada. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Canada%20First/Canada%20First%20NDC-Revised%20submission%202017-05-11.pdf

Carbon Tracker and Grantham Institute (2013). *Unburnable Carbon 2013: Wasted Capital and Stranded Assets*. www.carbontracker.org/report/wasted-capital-and-stranded-assets

Chan, N. (2016). The 'new' impacts of the implementation of climate change response measures. *Review of European, Comparative & International Environmental Law*, 25(2). 228–37. DOI: 10.1111/reel.12161

China (2016). *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions*. People's Republic of China. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/China%20First/China's%20First%20NDC%20Submission.pdf

Clark, P. (2015). Mark Carney warns investors face 'huge' climate change losses. *The Financial Times*, 29 September 2015. https://www.ft.com/content/622de3da-66e6-11e5-97d0-1456a776a4f5

Climate Action Network International (2018). CAN Position: The need for restrictions on Fossil Fuel Supply. September 2018. http://www.climatenetwork.org/sites/default/files/can_position_fossil_fuel_supply_restriction_september_2018.pdf

Climate Action Summit Team (2019). Information Note of 2019 Climate Summit of the Secretary-General. March 2019. https://www.documentcloud.org/documents/5780060-2019-03-20-Information-Note-of-2019-Climate.html

Davis, S. J., Peters, G. P. and Caldeira, K. (2011). The supply chain of CO2 emissions. *Proceedings of the National Academy of Sciences*, 108(45). 18554–59. DOI:10.1073/pnas.1107409108

Depledge, J. (2008). Striving for No: Saudi Arabia in the Climate Change Regime. *Global Environmental Politics*, 8(4). 9–35. DOI: 10.1162/glep.2008.8.4.9

Erickson, P., Kartha, S., Lazarus, M. and Tempest, K. (2015). Assessing carbon lock-in. *Environmental Research Letters*, 10(8). 084023. DOI: 10.1088/1748-9326/10/8/084023

Espinosa, P. (2018). We Need Long-Term Strategies to Meet the Climate Challenge. *United Nations Framework Convention on Climate Change*, 12 April 2018. https://unfccc.int/news/we-need-long-term-strategies-to-meet-the-climate-challenge

EU (2015). *Intended Nationally Determined Contribution of the EU and Its Member States*. Latvia and the European Commission on Behalf of the European Union and its Member States. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/European%20Union%20First/LV-03-06-EU%20INDC.pdf

Fæhn, T., Hagem, C., Lindholt, L., Mæland, S. and Einar Rosendahl, K. (2017). Climate policies in a fossil fuel producing country -- demand versus supply side policies. *The Energy Journal*, 38(1). DOI: 10.5547/01956574.38.1.tfae

Gerasimchuk, I., Merrill, L., Bridle, R., Gass, P., Sanchez, L., Kitsun, L. and Wooders, P. (2017). *Fossil Fuel Phase-out and a Just Transition: Learning from Stories of Coal Phase-Outs*. International Institute for Sustainable Development, Winnipeg, Canada. https://unfccc.int/sites/default/files/resource/69_IISD%20Fossil%20fuel%20phase%20out%20and%20just%20transition,%20stories%20for%20success.pdf

Germany (2016). *Climate Action Plan 2050*. Germany. https://unfccc.int/sites/default/files/resource/Klimaschutzplan_2050_eng_bf.pdf

Green, F. and Denniss, R. (2018). Cutting with both arms of the scissors: the economic and political case for restrictive supply-side climate policies. *Climatic Change*, 150(1–2). 73–87. DOI: 10.1007/s10584-018-2162-x

IEA (2016). *World Energy Investment 2016*. International Energy Agency, Organisation for Economic Cooperation and Development, Paris

IEA (2019). World energy balances (Edition 2018). DOI: 10.1787/42865fbe-en

ILO (2015). *Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for All*. International Labour Organization. https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_432859.pdf

India (2016). *India's Intended Nationally Determined Contribution: Working towards Climate Justice*. India. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf

IPCC (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. H. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Institute for Global Environmental Strategies (IGES) on behalf of the Intergovernmental Panel on Climate Change, Hayama, Japan.

Iran (2015). *Intended Nationally Determined Contribution*. Islamic Republic of Iran. https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Iran/1/INDC%20Iran%20Final%20Text.pdf

ITUC (2017). *Just Transition - Where Are We Now and What's next? A Guide to National Policies and International Climate Governance*. International Trade Union Confederation. https://www.ituc-csi.org/just-transition-where-are-we-now

Just Transition Centre and The B Team (2018). *Just Transition: A Business Guide*. https://www.ituc-csi.org/IMG/pdf/just_transition_-_a_business_guide.pdf

Kartha, S., Caney, S., Dubash, N. K. and Muttitt, G. (2018). Whose carbon is burnable? Equity considerations in the allocation of a "right to extract". *Climatic Change*, 150(1–2). 117–29. DOI: 10.1007/s10584-018-2209-z

Kuwait (2015). *Intended Nationally Determined Contributions*. State of Kuwait. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kuwait%20First/Kuwait%20First%20NDC_English.pdf

Lazarus, M., Erickson, P. and Tempest, K. (2015). *Supply-Side Climate Policy: The Road Less Taken*. Stockholm Environment Institute, Stockholm. https://www.sei.org/publications/supply-side-climate-policy-the-road-less-taken/

Lazarus, M., Tempest, K., Klevnäs, P. and Korsbakken, J. I. (2015). *Natural Gas: Guardrails for a Potential Climate Bridge*. Stockholm Environment Institute and The New Climate Economy. https://www.sei.org/publications/natural-gas-guardrails-for-a-potential-climate-bridge/

Lazarus, M. and van Asselt, H. (2018). Fossil fuel supply and climate policy: exploring the road less taken. *Climatic Change*, 150(1–2). 1–13. DOI: 10.1007/s10584-018-2266-3

Levin, K., Fransen, T., Ross, K., Elliott, C., Manion, M., Waite, R., Northrop, E. and Worker, J. (2018). *Long-Term Low Greenhouse Gas Emission Development Strategies: Input Document for the G20 Climate Sustainability Working Group*. World Resources Institute and UN Development Programme. https://www.wri.org/publication/designing-G20-long-term-strategies

McGlade, C. and Ekins, P. (2015). The geographical distribution of fossil fuels unused when limiting global warming to 2 °C. *Nature*, 517(7533). 187–90. DOI: 10.1038/nature14016

Mexico (2016). *Mexico's Climate Change Mid-Century Strategy*. Mexico. https://unfccc.int/files/focus/long-term_strategies/application/pdf/mexico_mcs_final_cop22nov16_red.pdf

Mills-Novoa, M. and Liverman, D. M. (2019). Nationally determined contributions: material climate commitments and discursive positioning in the NDCs. *Wiley Interdisciplinary Reviews: Climate Change*. e589. DOI: 10.1002/wcc.589

Nachmany, M. and Setzer, J. (2018). *Global Trends in Climate Change Legislation and Litigation: 2018 Snapshot*. Grantham Research Institute on Climate Change and the Environment, London. http://www.lse.ac.uk/GranthamInstitute/publication/global-trends-in-climate-change-legislation-and-litigation-2018-snapshot/

Nigeria (2017). *Nigeria's Intended Nationally Determined Contribution*. Nigeria. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Nigeria%20First/Approved%20Nigeria's%20INDC_271115.pdf

OECD (2017). *Investing in Climate, Investing in Growth*. Organisation for Economic Co-operation and Development, Paris. DOI: 10.1787/9789264273528-en

Pakistan (2016). *Pakistan's Intended Nationally Determined Contribution (PAK-INDC)*. Pakistan. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Pakistan%20First/Pak-INDC.pdf

Pauw, P., Cassanmagnago, D., Mbeva, K., Hein, J., Guarin, A., et al. (2016). NDC Explorer. German Development Institute (Deutsches Institut Für Entwicklungspolitik), African Centre for Technology Studies, and Stockholm Environment Institute. 2016. https://klimalog.die-gdi.de/ndc/#NDCExplorer/worldMap?NDC??income???catIncome

Pauw, W. P., Klein, R. J. T., Mbeva, K., Dzebo, A., Cassanmagnago, D. and Rudloff, A. (2018). Beyond headline mitigation numbers: we need more transparent and comparable NDCs to achieve the Paris Agreement on climate change. *Climatic Change*, 147(1–2). 23–29. DOI: 10.1007/s10584-017-2122-x

Piggot, G., Erickson, P., Lazarus, M. and van Asselt, H. (2017). *Addressing Fossil Fuel Production under the UNFCCC: Paris and Beyond*. Stockholm Environment Insitute, Stockholm. https://www.sei.org/publications/fossil-fuel-production-unfccc/

Piggot, G., Erickson, P., van Asselt, H. and Lazarus, M. (2018). Swimming upstream: addressing fossil fuel supply under the UNFCCC. *Climate Policy*, 18(9). 1189–1202. DOI: 10.1080/14693062.2018.1494535

Qatar (2015). *Intended Nationally Determined Contributions (INDCs) Report*. State of Qatar. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Qatar%20First/Qatar%20INDCs%20Report%20-English.pdf

Ritchie, H. and Roser, M. (2017). Fossil Fuels. *Our World in Data*. https://ourworldindata.org/fossil-fuels

Rogelj, J., den Elzen, M., Höhne, N., Fransen, T., Fekete, H., et al. (2016). Paris Agreement climate proposals need a boost to keep warming well below 2 °C. *Nature*, 534(7609). 631–39. DOI: 10.1038/nature18307

Ross, K. and Fransen, T. (2017). *Early Insights on Long-Term Climate Strategies*. World Resources Institute, Washington, D.C. https://www.wri.org/publication/early-insights-long-term-climate-strategies

Saudi Arabia (2015). *The Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia under the UNFCCC*. Saudi Arabia. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saudi%20Arabia%20First/KSA-INDCs%20English.pdf

Scott, A., Van der Burg, L. and Patel, S. (2016). *Aligning Objectives: International Climate Commitments and National Energy Strategies*. Overseas Development Institute, London. https://www.odi.org/publications/10684-aligning-objectives-international-climate-commitments-and-national-energy-strategies

Steininger, K. W., Lininger, C., Meyer, L. H., Muñoz, P. and Schinko, T. (2016). Multiple carbon accounting to support just and effective climate policies. *Nature Climate Change*, 6(1). 35–41. DOI: 10.1038/nclimate2867

Stockman, L. (2019). *Burning the Gas 'bridge Fuel' Myth: Why Gas Is Not Clean, Cheap, or Necessary*. Oil Change International, Washington, D.C. http://priceofoil.org/content/uploads/2019/05/gasBridgeMyth_web-FINAL.pdf

UAE (2015). *Intended Nationally Determined Contribution of the United Arab Emirates*. United Arab Emirates. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20Arab%20Emirates%20First/UAE%20INDC%20-%2022%20October.pdf

Ulrichsen, K. C. (2016). *Economic Diversification Plans: Challenges and Opportunities for Gulf Policymakers*. The Arab Gulf States Institute in Washington, Washington, D.C. https://agsiw.org/wp-content/uploads/2016/09/Ulrichsen_ONLINE-3.pdf

UNCTAD (2018). *Climate Policies, Economic Diversification and Trade*. United Nations Conference on Trade and Development, Geneva. https://unctad.org/en/PublicationsLibrary/ditcted2018d4_en.pdf

UNEP (2018). *Emissions Gap Report 2018*. United Nations Environment Programme, Nairobi. https://www.unenvironment.org/resources/emissions-gap-report-2018

UNFCCC (2015a). Paris Agreement. FCCC/CP/2015/10/Add.1. http://unfccc.int/paris_agreement/items/9485.php

UNFCCC (2015b). Adoption of the Paris Agreement. Decision 1/CP.21. 12 December 2015.

UNFCCC (2016). *2050 Pathways Platform Announcement*. https://unfccc.int/media/791675/2050-pathway-announcement-finalclean-3.pdf

UNFCCC (2018a). Matters relating to Article 14 of the Paris Agreement and paragraphs 99–101 of decision 1/CP.21. Decision 19/CMA.1. https://unfccc.int/node/187579

UNFCCC (2018b). Further guidance in relation to the mitigation section of decision 1/CP.21. Decision 4/CMA.1. https://unfccc.int/node/184692

UNFCCC (2018c). Solidarity and Just Transition Silesia Declaration. https://cop24.gov.pl/fileadmin/user_upload/Solidarity_and_Just_Transition_Silesia_Declaration_2_.pdf

UNFCCC (2018d). *The Concept of Economic Diversification in the Context of Response Measures*. United National Framework Convention on Climate Change, Bonn, Germany. https://unfccc.int/sites/default/files/resource/Technical%20paper_Economic%20diversification.pdf

UNFCCC (n.d.). NDC Registry. https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx [Accessed 18 June, 2019.]

UNFCCC Secretariat (2018). *Overview of Inputs to the Talanoa Dialogue*. UNFCCC. https://img1.wsimg.com/blobby/go/9fc76f74-a749-4eec-9a06-5907e013dbc9/downloads/1ct8fja1t_768448.pdf

US (2016a). *United States Mid-Century Strategy for Deep Decarbonization*. United States of America. https://unfccc.int/files/focus/long-term_strategies/application/pdf/mid_century_strategy_report-final_red.pdf

US (2016b). *First NDC Submission*. United States of America. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20States%20of%20America%20First/U.S.A.%20First%20NDC%20Submission.pdf

van Asselt, H. (2014). *Governing the Transition Away from Fossil Fuels: The Role of International Institutions*. Stockholm Environment Institute, Stockholm. https://www.sei.org/publications/governing-the-transition-away-from-fossil-fuels-the-role-of-international-institutions/

Verkuijl, C., Piggot, G., Lazarus, M., van Asselt, H. and Erickson, P. (2018). *Aligning Fossil Fuel Production with the Paris Agreement: Insights for the UNFCCC Talanoa Dialogue*. Stockholm Environment Institute, Seattle, WA. https://www.sei.org/publications/aligning-fossil-fuel-production-paris-agreement/

Viet Nam (2016). *Intended Nationally Determined Contribution of Viet Nam*. Viet Nam. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Viet%20Nam%20First/VIETNAM%27S%20INDC.pdf

Waisman, H., Spencer, T. and Colombier, M. (2016). *Long-Term Low Emissions Development Strategies and the Paris Agreement – Why, What and How?* IDDRI, Paris. https://www.iddri.org/en/publications-and-events/policy-brief/long-term-low-emissions-development-strategies-and-paris

Watts, N., Amann, M., Ayeb-Karlsson, S., Belesova, K., Bouley, T., et al. (2018). The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. *The Lancet*, 391(10120). 581–630. DOI: 10.1016/S0140-6736(17)32464-9

SEI Headquarters

Linnégatan 87D Box 24218
104 51 Stockholm Sweden
Tel: +46 8 30 80 44
info@sei.org

Måns Nilsson
Executive Director

SEI Africa

World Agroforestry Centre
United Nations Avenue
Gigiri P.O. Box 30677
Nairobi 00100 Kenya
Tel: +254 20 722 4886
info-Africa@sei.org

Philip Osano
Centre Director

SEI Asia

15th Floor Witthyakit Building
254 Chulalongkorn University
Chulalongkorn Soi 64 Phyathai Road
Pathumwan Bangkok 10330 Thailand
Tel: +66 2 251 4415
info-Asia@sei.org

Niall O'Connor
Centre Director

SEI Tallinn

Arsenal Centre
Erika 14, 10416
Tallinn, Estonia
info-Tallinn@sei.org

Lauri Tammiste
Centre Director

SEI Oxford

Florence House 29 Grove Street
Summertown Oxford
OX2 7JT UK
Tel: +44 1865 42 6316
info-Oxford@sei.org

Ruth Butterfield
Centre Director

SEI US
Main Office

11 Curtis Avenue
Somerville MA 02144-1224 USA
Tel: +1 617 627 3786
info-US@sei.org

Michael Lazarus
Centre Director

SEI US
Davis Office

400 F Street
Davis CA 95616 USA
Tel: +1 530 753 3035

SEI US
Seattle Office

1402 Third Avenue Suite 900
Seattle WA 98101 USA
Tel: +1 206 547 4000

SEI York

University of York
Heslington York
YO10 5DD UK
Tel: +44 1904 32 2897
info-York@sei.org

Lisa Emberson
Centre Director

SEI Latin America

Calle 71 # 11–10
Oficina 801
Bogota Colombia
Tel: +57 1 6355319
info-LatinAmerica@sei.org

David Purkey
Centre Director

SEI Stockholm Environment Institute

sei.org

@SEIresearch @SEIclimate