2019 Report

The Production Gap

The discrepancy between countries' planned fossil fuel production and global production levels consistent with limiting warming to 1.5°C or 2°C

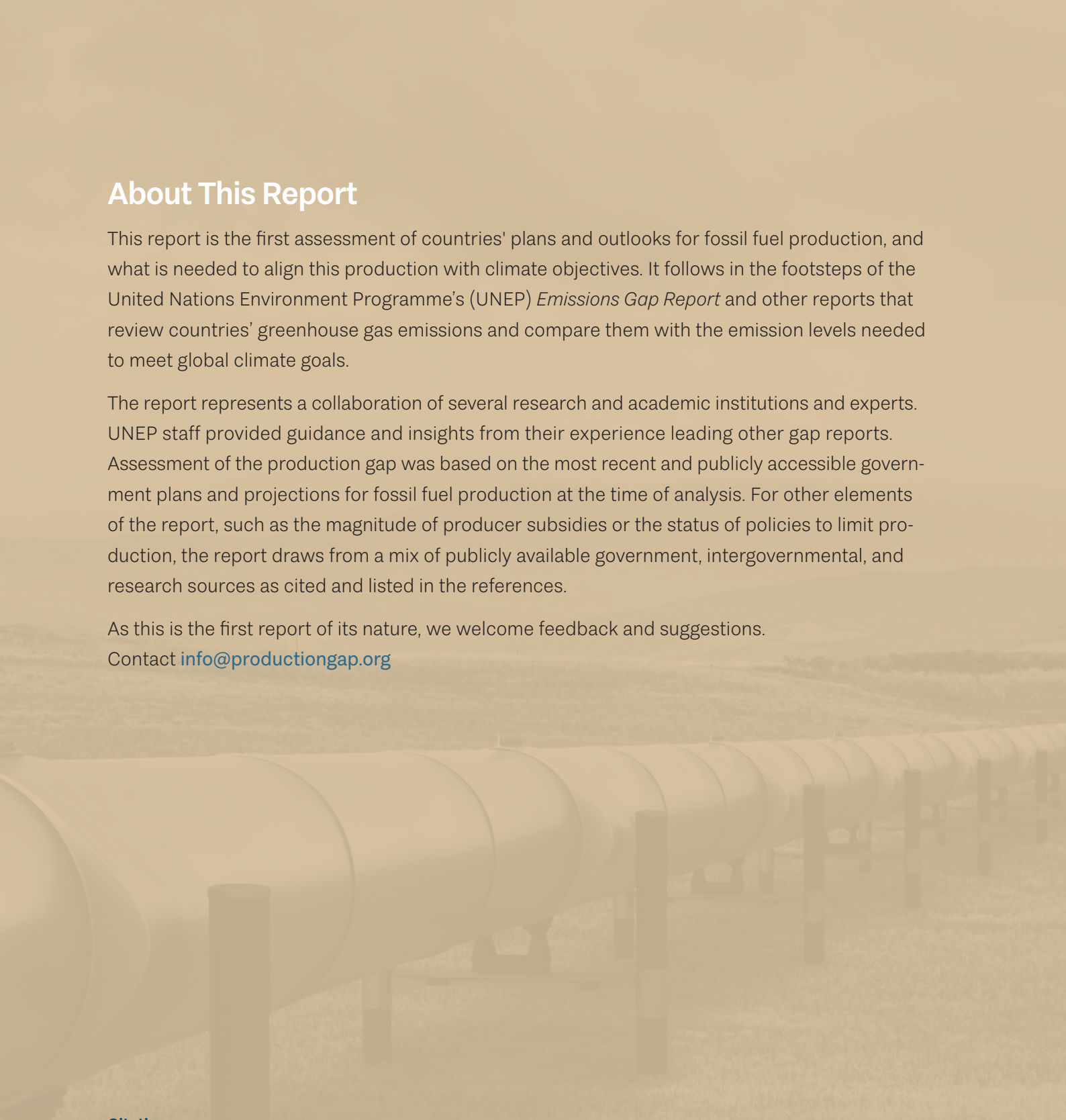
SEI Stockholm Environment Institute
IISD
ODI
CLIMATE ANALYTICS
CICERO Center for International Climate Research
UN environment programme

About This Report

This report is the first assessment of countries' plans and outlooks for fossil fuel production, and what is needed to align this production with climate objectives. It follows in the footsteps of the United Nations Environment Programme's (UNEP) *Emissions Gap Report* and other reports that review countries' greenhouse gas emissions and compare them with the emission levels needed to meet global climate goals.

The report represents a collaboration of several research and academic institutions and experts. UNEP staff provided guidance and insights from their experience leading other gap reports. Assessment of the production gap was based on the most recent and publicly accessible government plans and projections for fossil fuel production at the time of analysis. For other elements of the report, such as the magnitude of producer subsidies or the status of policies to limit production, the report draws from a mix of publicly available government, intergovernmental, and research sources as cited and listed in the references.

As this is the first report of its nature, we welcome feedback and suggestions.
Contact info@productiongap.org



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Acknowledgements

We would like to thank the following contributors for their input.

Authors and Research Contributors

Asterisk (*) connotes corresponding author.

Chapter 1

Authors: Harro van Asselt (University of Eastern Finland (UEF)), Peter Erickson (Stockholm Environment Institute (SEI)), Ivetta Gerasimchuk (International Institute for Sustainable Development (IISD)), Sivan Kartha (SEI), Michael Lazarus (SEI), Cleo Verkuijl (SEI)

Chapter 2

Authors: Ploy Achakulwisut (SEI), Peter Erickson* (SEI), Sivan Kartha (SEI), Michael Lazarus (SEI)
Research Contributors: Bill Hare (Climate Analytics), Paola Yanguas Parra (Climate Analytics), Steve Pye (University College London), Roberto Schaeffer (Universidade Federal do Rio de Janeiro), Michiel Schaeffer (Climate Analytics)

Chapter 3

Authors: Ploy Achakulwisut (SEI), Harro van Asselt (UEF), Ivetta Gerasimchuk (IISD), Ipek Gençsü (Overseas Development Institute (ODI)), Michael Lazarus* (SEI), Cleo Verkuijl (SEI)
Research Contributors: Peter Wooders (IISD)

Chapter 4

Authors: Ploy Achakulwisut (SEI), Anna Chapman (Climate Analytics), Peter Erickson (SEI), Vibhuti Garg (IISD), Philip Gass (IISD), Ivetta Gerasimchuk (IISD), Bård Lahn (CICERO), Hongyou Lu (Lawrence Berkeley National Laboratory (LBNL)), Michael Lazarus* (SEI), Paola Yanguas Parra (Climate Analytics), Leo Roberts (ODI), Anissa Suharsono (IISD)
Research Contributors: Peter Wooders (IISD)

Chapter 5

Authors: Ploy Achakulwisut (SEI), Harro van Asselt (UEF), Peter Christoff (University of Melbourne), Richard Denniss (Australia Institute), Fergus Green (Department of Philosophy, Utrecht University), Natalie Jones (Trinity College, University of Cambridge and Centre for the Study of Existential Risk (CSER)), Georgia Piggot* (SEI), Oliver Sartor (IDDRI), Fernando Tudela (Centro del Cambio Global y la Sustentabilidad A.C), Cleo Verkuijl (SEI), Oscar Widerberg (Vrije Universiteit Amsterdam)

Research Contributors: Kathryn Harrison (University of British Columbia), Bert de Wel (International Trade Union Confederation (ITUC))

Chapter 6

Authors: Harro van Asselt (UEF), Peter Christoff (University of Melbourne), Joanna Depledge (Centre for Environment, Energy and Natural Resource Governance, University of Cambridge), Sivan Kartha (SEI), Michael Lazarus (SEI), Greg Muttitt (Oil Change International (OCI)), Anju Sharma (Oxford Climate Policy), Cleo Verkuijl* (SEI), Harald Winkler (University of Cape Town)
Research Contributors: Fergus Green (Utrecht University), Natalie Jones (Trinity College, University of Cambridge and CSER), Bert de Wel (ITUC)

Reviewers

Chapter 2

Steven J. Davis (University of California Irvine), Andrew Grant (Carbon Tracker Initiative (CTI)), Fergus Green (Department of Philosophy, Utrecht University), Kathy Mulvey (Union of Concerned Scientists (UCS)), Greg Muttitt (OCI), Adrien Vogt-Schilb (Inter-American Development Bank (IADB))

Chapter 3

Andrew Grant (CTI), Fergus Green (Utrecht University), Kathy Mulvey (UCS), Greg Muttitt (OCI), Adrien Vogt-Schilb (IADB), Peter Wooders (IISD)

Chapter 4

Anders Bjartnes (Energi og Klima), Richard Denniss (Australia Institute), Shantanu Dixit (Prayas (Energy Group)), Fergus Green (Department of Philosophy, Utrecht University), Li Shuo (Greenpeace East Asia), Marc Lee (Canadian Centre for Policy Alternatives), Tatiana Mitrova (Energy Centre, Moscow School of Management, SKOLKOVO), Greg Muttitt (OCI), Rebekka Popp (E3G), Ashok Sreeniva (Prayas (Energy Group)), Kelly Trout (OCI), Peter Wooders (IISD)

Chapter 5

Siân Bradley (Chatham House), Ipek Gençsü (ODI), Joyeeta Gupta (University of Amsterdam), Christian Holz (Carleton University and Climate Equity Reference Project (CERP)), Bård Lahn (CICERO), Glada Lahn (Chatham House), Nathan Lemphers (OCI), Hongyou Lu (LBNL), Greg Muttitt (OCI), Thomas Spencer (The Energy and Resources Institute (TERI), Kelly Trout (OCI)

Chapter 6

Siân Bradley (Chatham House), Alex Doukas (OCI), Ipek Gençsü (ODI), Joyeeta Gupta (University of Amsterdam), Christian Holz (Carleton University and CERP), Glada Lahn (Chatham House), Nathan Lemphers (OCI), Thomas Spencer (TERI)

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Foreword

In 2009, the UN Environment Programme released the first *Emissions Gap Report,* an assessment of the global community's plans for mitigating climate change. In the decade since, countries have made new rounds of commitments through the Paris Agreement. However, carbon emissions have remained exactly at the levels projected a decade ago, under the business-as-usual scenarios used in Emissions Gap Reports.

This calls for a sharpened, and long overdue, focus on fossil fuels. The world's energy supply remains dominated by coal, oil and gas, driving emission levels that are inconsistent with climate goals. To that end, this report introduces the fossil fuel production gap, a new metric that clearly shows the gap between increasing fossil fuel production and the decline needed to limit global warming.

By bringing coal, oil, and gas outlooks in line with climate goals, governments can round out their climate plans and better position themselves to achieve emission reductions. This report helps start that conversation, with a set of tools for assessing and closing this important gap in climate policy.

Inger Andersen
Executive Director
United Nations Environment Programme

The Stockholm Environment Institute is entering its 30th year of informing science-based climate action. In that time, we've seen important strides to improve energy efficiency, deploy renewables, and price carbon. But in recent years, we've also helped sound the alarm about how those successes have not translated into lower global emissions.

A key reason for this paradox is that major coal, oil, and gas projects have simultaneously continued to attract investment, receive public permits, or otherwise enjoy government support. This undercuts efforts, sometimes by these same governments, to reduce emissions.

There is a need to quantify, track, and address this disconnect. The fossil fuel production gap introduced in this report demonstrates clearly that governments' collective plans and projections for future fossil fuel production are incompatible with a safe climate.

The good news is that a host of policy solutions are available. Some countries — as well as subnational governments, businesses, investors, and trade union and civil society organizations — are already beginning a just transition away from fossil fuel production. Others must now follow their lead.

Måns Nilsson
Executive Director
Stockholm Environment Institute

Glossary

Carbon entanglement
The process by which government dependence on fossil fuel extraction creates heavily vested interests in bringing fossil fuels to market that stand in the way of progress in climate policy (Gurría 2013).

Carbon lock-in
The tendency for certain carbon-intensive technological systems to persist over time, 'locking out' lower-carbon alternatives, owing to a combination of linked technical, economic, and institutional factors. These technologies may be costly to build, but relatively inexpensive to operate (Erickson et al. 2015).

Emissions gap
The difference between the greenhouse gas (GHG) emission levels consistent with a specific probability of limiting the mean global temperature rise to below 2°C or 1.5°C in 2100 above pre-industrial levels and the GHG emission levels consistent with the global effect of the nationally determined contributions, assuming full implementation from 2020 (UNEP 2018).

Extraction-based emissions accounting
An accounting framework that attributes GHG emissions from the burning of fossil fuels to the location of fuel extraction.

Fossil fuel production
A collective term used in this report to represent processes along the fossil fuel supply chain, which includes locating, extracting, and processing, and delivering coal, oil, and gas to consumers.

Green paradox
The phenomenon whereby fossil fuel producers may be incentivized to accelerate production in the near-term under the expectation of increasingly stringent demand-side policies (Hoel 2013; Sinn 2012).

Greenhouse gases
Atmospheric gases that absorb and emit infrared radiation, trap heat, contribute to the greenhouse effect, and cause global warming. The principal GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), as well as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

Integrated assessment models (IAMs)
Models that combine knowledge from multiple disciplines and are used to explore how social and economic factors and choices interact with the natural environment.

Just transition
In the context of climate policy, this refers to a shift to a low-carbon economy that ensures disruptions are minimised, and benefits maximised, for workers, communities and consumers who may be disproportionately affected (ITUC 2017; UNFCCC 2016).

Long-term low GHG emission development strategies (LEDS)
Under the Paris Agreement and its accompanying decision, all countries are invited to communicate LEDS, taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances, by 2020.

Multilateral development bank (MDB)
An international financial institution chartered by multiple countries to support economic and social development in lower-income countries.

Nationally determined contributions (NDCs)
Submissions by Parties to the Paris Agreement that contain their stated ambitions to take climate change action towards achievement of the Agreement's long-term goal of limiting global temperature increase to well below 2°C, while pursuing efforts to limit the increase to 1.5°C. Parties are requested to communicate new or updated NDCs by 2020 and every five years thereafter.

National fossil fuel production plans and projections
Fossil fuel production targets, plans, and projections drawn from national plans, strategy documents, and outlooks published by governments and affiliated institutions.

New Policies Scenario (NPS)
A widely-used scenario from the International Energy Agency's 2018 World Energy Outlook that reflects countries' climate policies and ambitions announced as of August 2018 towards the achievement of their NDCs. The NPS is nearly identical to the IEA's estimate for full implementation of NDCs (as submitted in 2015) in terms of future global CO_2 emissions from fossil fuels (IEA 2018a).

Non-state and subnational actors
Regions, cities, investors, companies, civil society, individuals, and other actors, beyond national governments, that may play a role in taking climate action.

Production gap
The discrepancy between countries' planned fossil fuel production and global production levels consistent with limiting warming to 1.5°C or 2°C.

Resource curse
Refers to the fact that many resource-rich countries do not fully benefit from their natural resource wealth, and may in fact experience worse development and economic growth outcomes than countries with fewer natural resources (Sachs and Warner 1995).

Stranded assets
Assets that suffer from unanticipated or premature write-offs, downward revaluations or are converted to liabilities, as the result of a low-carbon transition or other environment-related risks (Ansar et al. 2013).

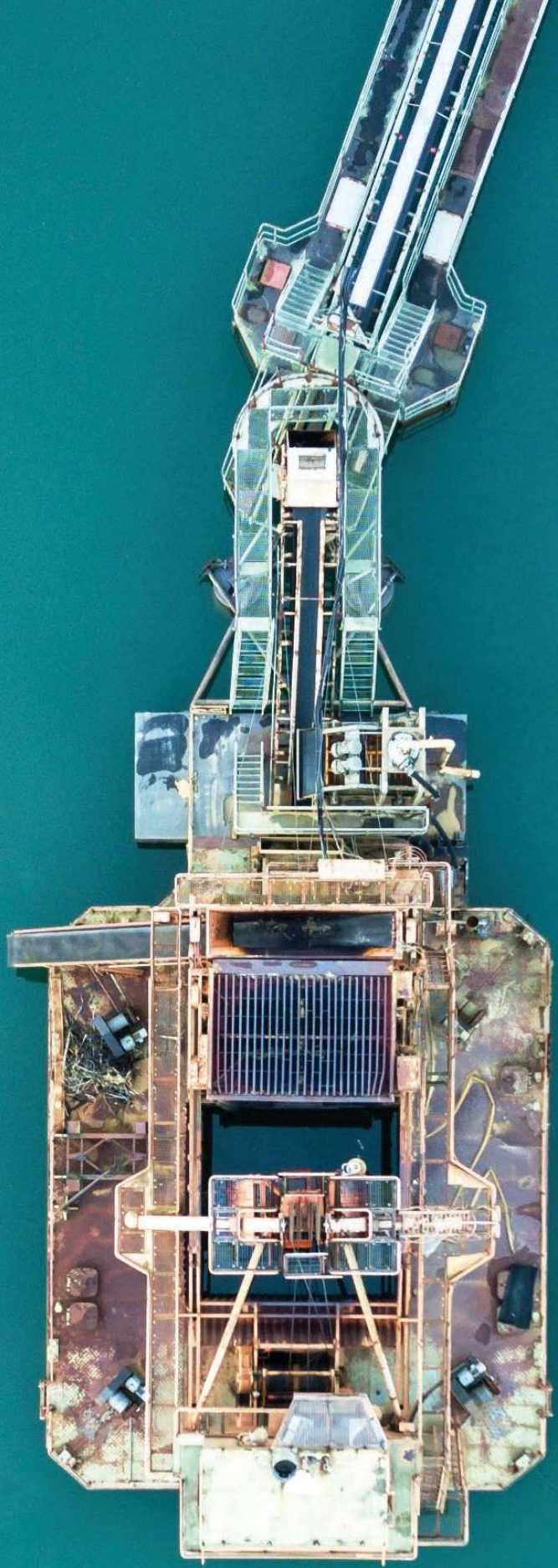
Subsidy
A financial benefit accorded to a specific interest (e.g. an individual, organization, company, or sector) by a government or public body.

Supply-side climate policy
Policies and measures aimed at regulating or managing the wind-down of, or transition away from, fossil fuel production.

Territorial emissions accounting
The standard accounting framework that attributes GHG emissions from the burning of fossil fuels to the entity or location where the fuels are burned.

Abbreviations

Bcm	Billion cubic meters
BECCS	Bioenergy with carbon capture and storage
CDR	Carbon dioxide removal
CO_2	Carbon dioxide
COP	Conference of the Parties to the UNFCCC
°C	Degree Celsius
EJ	Exajoule
ETS	Emissions Trading System
G20	Group of Twenty
GHG	Greenhouse gas
Gt	Gigatonne (Billion tonnes)
IAM	Integrated assessment model
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LEDS	Long-term low greenhouse gas emission development strategies
Mb/d	Million barrels per day
MMBtu	Million British Thermal Units
Mt	Million tonnes
NDC	Nationally determined contribution
NPS	New Policies Scenario
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PPCA	Powering Past Coal Alliance
SDG	Sustainable Development Goal
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
WTO	World Trade Organization



Contents

Executive Summary

Key Findings

Governments are planning to produce about 50% more fossil fuels by 2030 than would be consistent with a 2°C pathway and 120% more than would be consistent with a 1.5°C pathway.

This global production gap is even larger than the already-significant global emissions gap, due to minimal policy attention on curbing fossil fuel production.

The continued expansion of fossil fuel production — and the widening of the global production gap — is underpinned by a combination of ambitious national plans, government subsidies to producers, and other forms of public finance.

Several governments have already adopted policies to restrict fossil fuel production, providing momentum and important lessons for broader adoption.

International cooperation plays a central role in winding down fossil fuel production.

Executive Summary

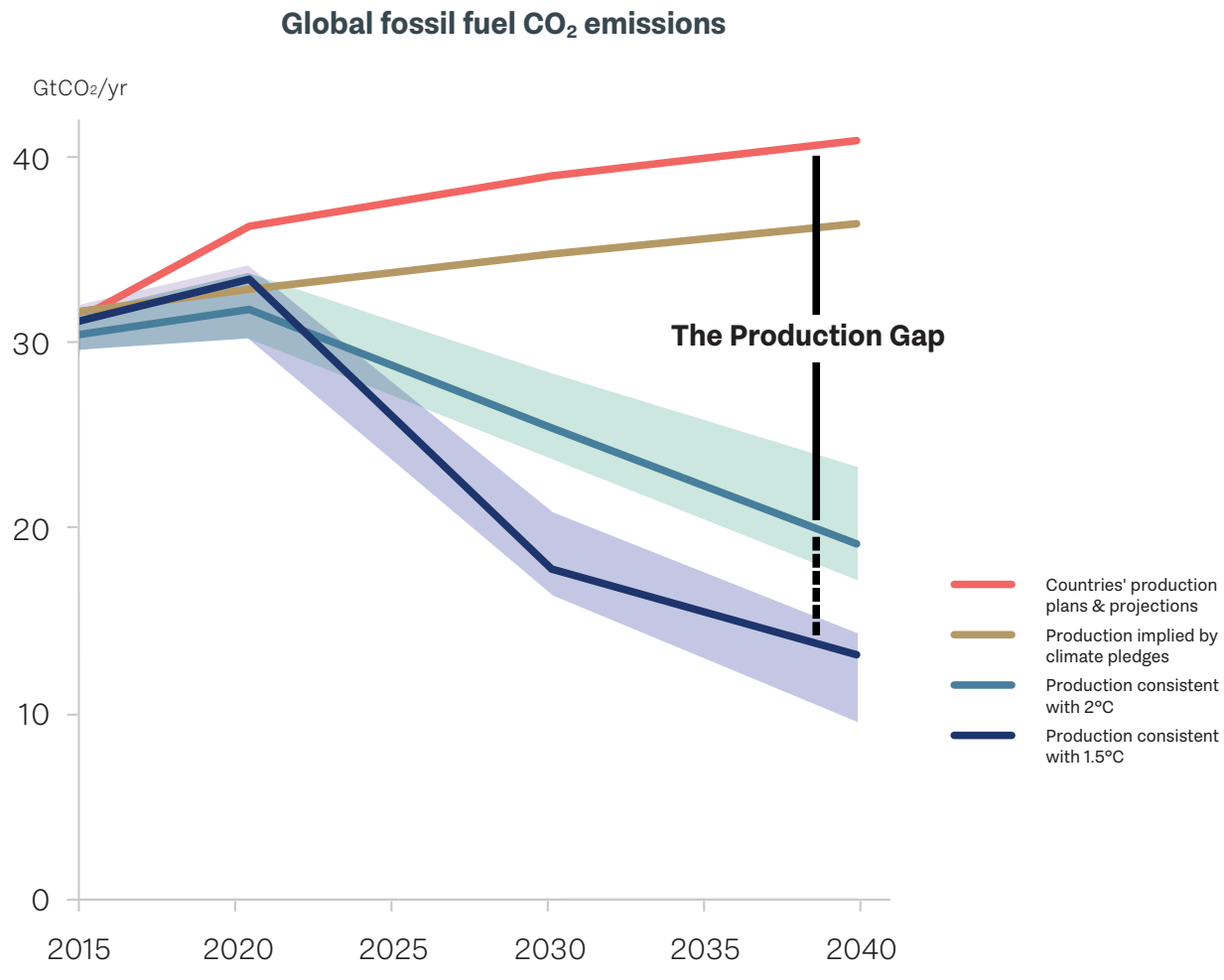
This report addresses the necessary winding down of the world's production of fossil fuels in order to meet climate goals. Though coal, oil, and gas are the central drivers of climate change, they are rarely the subject of international climate policy and negotiations. This report aims to expand that discourse and provide a metric for assessing how far the world is from production levels that are consistent with global climate goals.

Specifically, this first *Production Gap Report* assesses the discrepancy between government plans for fossil fuel production and global production levels consistent with 1.5°C and 2°C pathways. This *production gap* tells us the magnitude of the challenge.

The report reviews, across 10 fossil-fuel-producing countries, the policies and actions that expand fossil fuel production and, in turn, widen the gap. It also provides policy options that can help countries better align production with climate goals. This is especially relevant over the next year, as countries prepare new or updated nationally determined contributions (NDCs), which set out their new emission reduction plans and climate pledges under the Paris Agreement.

Figure ES.1

The fossil fuel production gap — the difference between national production plans and low-carbon pathways (1.5°C and 2°C), as expressed in fossil fuel carbon dioxide (CO_2) emissions — widens between 2015 and 2040.



The report's main findings are as follows.

Governments are planning to produce about 50% more fossil fuels by 2030 than would be consistent with a 2°C pathway and 120% more than would be consistent with a 1.5°C pathway.

To estimate the production gap, this report puts forward a method analogous to that used in the *Emissions Gap Report*. It uses publicly available data to estimate the difference between what countries are planning and what would be consistent with 1.5°C and 2°C pathways, based on scenarios from the recent Intergovernmental Panel on Climate Change (IPCC) Special Report on *Global Warming of 1.5°C*.

This analysis shows that:

- In aggregate, countries' planned fossil fuel production by 2030 will lead to the emission of 39 billion tonnes (gigatonnes) of carbon dioxide ($GtCO_2$). That is 13 $GtCO_2$, or 53%, more than would be consistent with a 2°C pathway, and 21 $GtCO_2$ (120%) more than would be consistent with a 1.5°C pathway. This gap widens significantly by 2040.
- This production gap is largest for coal. By 2030, countries plan to produce 150% (5.2 billion tonnes) more coal than would be consistent with a 2°C pathway, and 280% (6.4 billion tonnes) more than would be consistent with a 1.5°C pathway.
- Oil and gas are also on track to exceed carbon budgets, as countries continue to invest in fossil fuel infrastructure that "locks in" oil and gas use. The effects of this lock-in widen the production gap over time, until countries are producing 43% (36 million barrels per day) more oil and 47% (1,800 billion cubic meters) more gas by 2040 than would be consistent with a 2°C pathway.

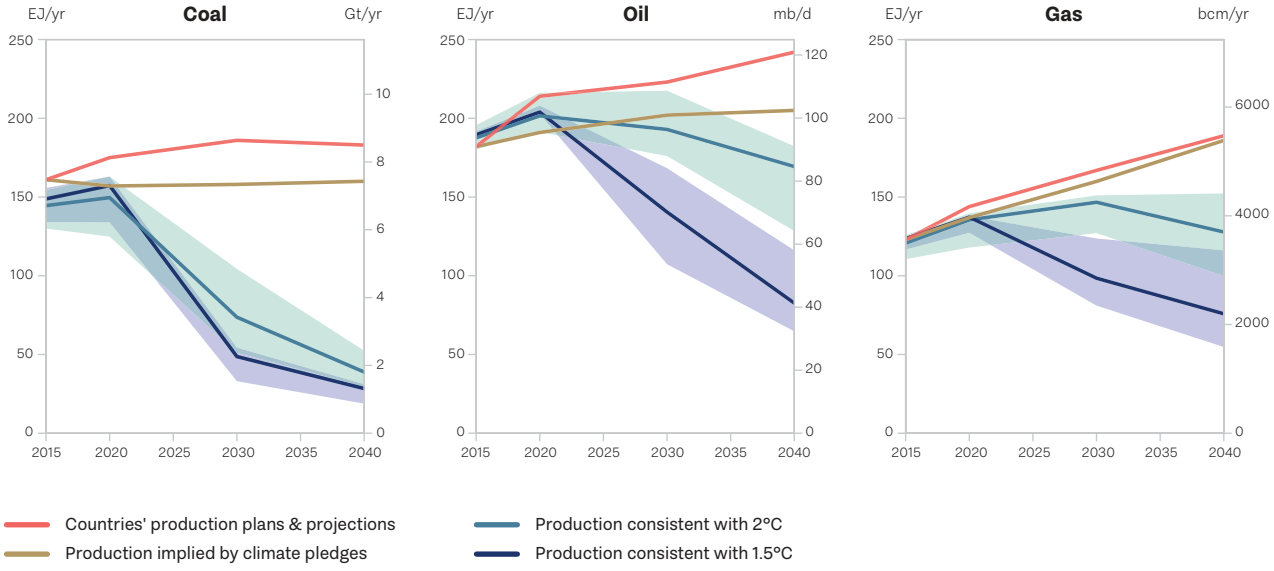
This global production gap is even larger than the already-significant global emissions gap, due to minimal policy attention on curbing fossil fuel production.

Collectively, countries' planned fossil fuel production not only exceeds 1.5°C and 2°C pathways, it also surpasses production levels consistent with the implementation of the national climate policies and ambitions in countries' NDCs. As a consequence, the production gap is wider than the emissions gap.[1]

Indeed, though many governments plan to decrease their emissions, they are signalling the opposite when it comes to fossil fuel production, with plans and projections for expansion. This hinders the collective ability of countries to meet global climate goals, and it further widens not just the production gap, but the emissions gap as well.

Figure ES.2

The production gap is widest for coal but grows rapidly for oil and gas. By 2040 the production gap, in energy terms, is as large for oil as it is for coal. Physical units are displayed as secondary axes: billion tonnes per year for coal, million barrels per day for oil, and billion cubic meters per year for gas.



[1] Since the emissions gap is the difference between the implementation of NDCs and Paris Agreement goals, an exceedance of planned fossil fuel production above the level consistent with NDCs implies that the production gap is larger than the emissions gap, at least for CO_2 emissions from fossil fuel combustion

The continued expansion of fossil fuel production — and the widening of the global production gap — is underpinned by a combination of ambitious national plans, government subsidies to producers, and other forms of public finance.

Governments support production in numerous ways. They not only play central roles in the permitting of exploration and production; they also support the fossil fuel industry through direct investments, research and development funding, tax expenditures, and assumed liability and risk. Fossil fuel subsidies span all stages of the fossil fuel production process, from research, development, and exploration, to operations, transport, processing, marketing, decommissioning, and site remediation.

This report reviews specific production plans, outlooks, and support mechanisms in 10 key countries: seven top fossil fuel producers (China, the United States, Russia, India, Australia, Indonesia, and Canada) and three significant producers with strongly stated climate ambitions (Germany, Norway, and the United Kingdom). It finds that:

- The production of coal, oil, and gas in nearly every national plan or outlook exceeds the 2030 levels projected in the International Energy Agency's New Policies Scenario, a scenario roughly consistent with global implementation of the NDCs.
- Many countries appear to be banking on export markets to justify major increases in production (e.g., the United States, Russia, and Canada) while others are seeking to limit or largely end imports through scaled-up production (e.g., India and China). The net result could be significant over-investment, increasing the risk of stranded assets, workers, and communities, as well as locking in a higher emissions trajectory.

Several governments have already adopted policies to restrict fossil fuel production, providing momentum and important lessons for broader adoption.

To help close the production gap, countries would benefit from new models of addressing fossil fuel supply. Though most countries focus exclusively on the "demand side" — with policies that aim to boost renewable energy, energy efficiency, and other low-carbon technologies — some governments have also begun to enact "supply-side" measures that aim to limit fossil fuel production. A range of policy options can help governments align their fossil fuel development plans and policies with climate goals, including: economic instruments (such as subsidy reform); regulatory approaches (such as banning new extraction permits); government provision of goods and services (such as just transition plans); and measures to enhance information and transparency (such as national reporting of fossil fuel production and targets).

The governments of Belize, Costa Rica, France, Denmark, and New Zealand have all enacted partial or total bans or moratoria on oil and gas exploration and extraction, while Germany and Spain are phasing out coal extraction. Local governments, companies, investors, trade unions, and civil society organizations can also accelerate a transition away from fossil fuels, by mobilizing constituencies and shifting investment to lower-carbon options. For example, individuals and institutions have already pledged to divest over USD 11 trillion from fossil fuel holdings.

International cooperation plays a central role in winding down fossil fuel production.

The UN climate process and other international institutions and initiatives can help catalyse supply-side ambition and action. Measures to move away from fossil fuel production are more effective when countries adopt them together, and international cooperation can send a clear signal to policymakers, investors, consumers, and civil society that the world is shifting towards a low-carbon future.

The Paris Agreement provides key opportunities for countries to report their fossil fuel production and their plans and strategies to align future production with climate goals, including through the global stocktake, NDCs, long-term low greenhouse gas emission development strategies, and financing. Countries that have already begun to wind down fossil fuel production can help other countries learn from their experiences. International financing institutions can accelerate the transition by shifting financial support away from fossil fuel production and towards low-carbon solutions. And, drawing inspiration from models such as the Powering Past Coal Alliance, coalitions of leading actors can work together to raise ambition through joint targets and actions that align future fossil fuel production with global climate goals.

1

Introduction

Key Messages

This report puts forward a new metric called the fossil fuel production gap: the discrepancy between countries' planned fossil fuel production and the global production levels necessary to limit warming to 1.5°C and 2°C.

Fossil fuels are, by far, the largest contributor to global climate change, accounting for over 75% of global greenhouse gas emissions and nearly 90% of all carbon dioxide emissions.

Moving away from fossil fuel production poses both economic and political challenges, but doing so is possible and increasingly necessary to avoid dangerous climate change.

Countries that limit the production of coal, oil, and gas can avoid carbon lock-in, limit financial risks, improve the effectiveness of climate policies, and achieve sustainable development benefits.

Now is the moment to address the fossil fuel production gap, as countries submit new and updated nationally determined contributions, and long-term low greenhouse gas emission development strategies.

1. Introduction

The world is awash in fossil fuels. From the vast reservoirs of oil and gas in North America to the sweeping coal fields of Australia, there is no shortage of fossilized carbon to burn. Coal, oil, and gas have a long history of providing exceptionally concentrated, ready-made energy, often at low and subsidized prices that do not reflect their full societal and environmental costs; it is no wonder they have powered the planet for more than a century.

But citizens, businesses, and political leaders are now starting to turn elsewhere for their energy needs. Energy from the wind and sun is becoming ever easier and cheaper to gather and store, providing the first real threat to fossil fuel dominance. This trend is emerging not a moment too soon, given the mounting climate change crisis, borne mostly from decades of burning fossil fuels.

As fast as renewable and other climate-compatible energy technologies are rising, however, there is no guarantee that fossil fuels and their greenhouse gas (GHG) emissions will decline — let alone at the pace needed to avoid dangerous climate change. The continued drive to increase fossil fuel production throughout the world only makes that harder.

This report is about how governments can work towards aligning fossil fuel production with the globally agreed climate goals of the Paris Agreement. It begins by posing the question: how far off track is the world's current pace of fossil fuel extraction? It puts forward a new metric called the fossil fuel *production gap:* the discrepancy between, on the one hand, countries' planned levels of fossil fuel production and, on the other hand, global levels of production consistent with low-carbon pathways capable of limiting global warming to 1.5° or 2°C.

Measures of climate-related "gaps" are not new. The most well-known and analogous is the longstanding emissions gap, measured in an annual report by the United Nations Environment Programme. That gap — critical for global climate policy — is the gap between countries' emission reduction pledges and the levels of emissions consistent with limiting global warming to 1.5°C or 2°C. In fact, the *Emissions Gap Report* provides the template for our work.

Like other gap reports, this report brings greater transparency and awareness to a key issue — in this case, to countries' fossil fuel development plans and policies. It also offers solutions that can help close the gap; in particular, it presents policies to support countries' transitions away from dependence on coal, oil, and gas production, and new ways to work together internationally.

Developing more coherent, climate-consistent plans for fossil fuel production is a tall task. Many governments rely heavily on revenues generated by oil, gas, and coal. The interests of fossil fuel producers are powerful and difficult to align with greater climate ambition. Unless these challenges are addressed, however, it will be more difficult to make rapid climate progress.

No single document can provide a full roadmap for the winding down of fossil fuel production. This report offers a starting point. As the first *Fossil Fuel Production Gap Report,* it widens the climate discourse to include fossil fuel supply and provides a resource for policymakers aiming to wind down coal, oil, and gas production in line with the Paris Agreement's goals.

Fossil fuels: the heart of the climate challenge

In 2019, as climate impacts intensified, global fossil fuel combustion was at an all-time high. Coal, oil, and natural gas remain the world's dominant sources of energy, accounting for 81% of total primary energy supply (IEA 2019a). These fuels are, by far, the largest contributor to global climate change, accounting for over 75% of global GHG emissions — as shown in Figure 1.1 — and close to 90% of all carbon dioxide (CO_2) emissions.

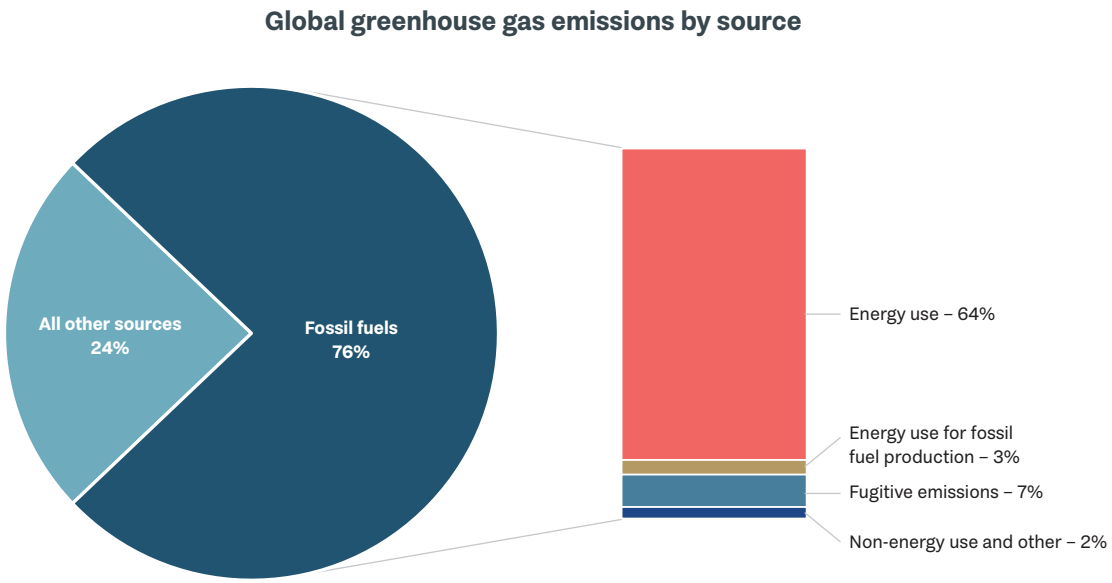
Last year, the Intergovernmental Panel on Climate Change (IPCC) put new numbers to what has long been known: CO_2 emissions from fossil fuels will need to decline rapidly, by approximately 6% per year to remain on a 1.5°C-compatible pathway, and by roughly 2% per year to remain on a 2°C-compatible one (see Chapter 2). Barring dramatic, unexpected advances in carbon capture and storage (CCS) technology, these declines mean that most of the world's proven fossil fuel reserves must be left unburned (Leaton 2011; McGlade and Ekins 2015; Meinshausen et al. 2009; Muttitt et al. 2016).

Ongoing expansion of fossil fuel infrastructure points in the opposite direction, however. Major infrastructure projects in coal, oil, and gas continue to attract investors, receive public permits, or otherwise enjoy government support. Energy analysts predict that investment in fossil fuel exploration, extraction, and delivery infrastructure could remain at about USD 1 trillion annually through 2040 (IEA 2018a).

There are some positive signs of change. Civil society and many in the business and finance community have begun to consider what climate constraints mean for future fossil fuel production plans and investments (Carney 2016; TCFD 2016). And, as described in Chapter 5, some governments are beginning to reckon with this question as well.

Figure 1.1

Global greenhouse gas emissions by source, 2015. All emissions data were drawn from IEA (2019b) except for land use and land use change, which are from the Food and Agriculture Organization of the United Nations (FAOSTAT 2019). The fraction of emissions attributed to fossil fuels within each IEA source category — fuel combustion, fugitive, industrial processes and product use, and other — were estimated using data and information from the IEA (2019b) and the Emissions Database for Global Atmospheric Research v4.3.2 (Janssens-Maenhout, G. et al. 2019). All non-CO_2 gases were reported using 100-year Global Warming Potentials (GWPs) from the IPCC's Fourth Assessment Report (IPCC 2007).



Why focus on fossil fuel production?

For decades, efforts to reduce fossil fuel CO_2 emissions have focused almost solely on decreasing demand for fossil fuels, through measures to improve energy efficiency, deploy renewable energy technologies, and shift markets through carbon pricing (see, for example, Grantham Research Institute and Sabin Center for Climate Change Law n.d.).

The focus on demand is important. One could even say that if policies and actions to reduce the use of fossil fuels were sufficiently ambitious and well-designed, it would be unnecessary to focus on supply. Indeed, strong, harmonized, and widespread carbon prices could, in principle, put fossil fuel CO_2 emissions on a sufficiently steep downward path (Rogelj et al. 2018). But such policies and actions have not materialized (Rogelj et al. 2016; UNEP 2018).

The continual shortfall in ambition of demand-side policy has led some policymakers to add supply-side measures to their climate policy mix (Erickson et al. 2018). These policymakers have realized that limiting production of coal, oil, and gas can bring countries several benefits, among them:

- **Avoiding carbon lock-in.** The more fossil fuel infrastructure that is built, the harder it is to shift away from fossil-based energy, for reasons both financial and political (Gurría 2013; Seto et al. 2016). Limiting fossil fuel production therefore has tangible emission reduction benefits by helping non-fossil alternatives compete (Erickson and Lazarus 2014).
- **Limiting financial risks.** Investors in fossil fuel extraction and processing expect certain returns on their expended capital, but a low-carbon transition could well lead to asset devaluation and "stranding", even if assets are not physically retired (Carbon Tracker Initiative and Grantham Institute 2013). Making fewer investments in fossil fuel infrastructure in the first place limits these risks for investors, and for governments and communities that depend on associated royalty and tax revenue.
- **Improving effectiveness of climate action.** Combining policies to limit fossil fuel supply with policies to limit demand reduces the overall cost of achieving emission reduction goals (Asheim et al. 2019; Green and Denniss 2018). For instance, Norway could halve the cost of achieving its 2020 emission reduction target by reducing investment and production in its oil fields and accounting for the global impact (Fæhn et al. 2017).
- **Achieving sustainable development benefits.** Addressing fossil fuel supply can also bring a range of additional sustainable development benefits, such as: decreased air and water pollution and reduced habitat degradation (Harfoot et al., 2018); improved health outcomes for those in close proximity to fossil fuel development (Epstein et al., 2011, Epstein 2017); and greater economic and democratic stability as a result of diversification away from hydrocarbon revenues (Ross, 2013).
- **Promoting policy coherence.** Policies to limit fossil fuel production can align energy policies with climate goals, sending a more coherent and consistent signal that a government intends to wind down dependence on both fossil fuel supply and use.

Reflecting such benefits, policies to constrain fossil fuel production have recently begun to gain ground. The governments of Belize, Costa Rica, Denmark, France, and New Zealand, for instance, have set limits on the exploration and future extraction of oil and gas. Likewise, Spain has committed to phasing out coal production and Germany may soon follow, and several national and international finance institutions are ceasing to invest in upstream coal, oil, and gas.

Such actions demonstrate the feasibility of "supply-side" measures as part of a broader policy response and send an important signal about the overall direction towards a low-carbon economy. However, measures to limit production continue to be underrepresented in many governments' overall climate change portfolios. And important obstacles to the transition away from fossil fuels will need to be addressed.

Barriers exist — but also opportunities

Moving away from fossil fuel production poses both economic and political challenges. For some developing countries with newly discovered fossil fuel reserves, major investments in new production facilities are viewed as a way out of dependency on energy imports and development assistance (Lahn and Bradley 2016). And in many long-standing producer countries, fiscal revenues can remain highly dependent on resource extraction; this is especially true for major exporters of oil and gas. For many members of the Organization of the Petroleum Exporting Countries (OPEC), for example, oil and gas payments represent well over half of all fiscal revenues (IEA 2018b). While some countries have made advances in diversifying their economies, this goal remains elusive for many others (Global Commission on the Geopolitics of Energy Transformation 2019; Ross 2019; van der Ploeg 2016).

Politically, fossil fuel producers represent a large and concentrated force, in contrast to the often dispersed proponents of low-carbon energy transitions (Lazarus and van Asselt 2018; Newell and Johnstone 2018; Victor 2009). Fossil fuel interests can be closely aligned with governments, particularly when state-owned enterprises (SOEs) are involved and where royalty and tax revenues are significant. And the authority of political leaders may depend on delivering jobs and services financed by oil, gas, or coal revenues, while the loss of revenues can pose a risk to the state's legitimacy (Cust and Mihalyi 2017; Global Commission on the Geopolitics of Energy Transformation 2019; Moerenhout et al. 2017).

Despite the barriers, it is also increasingly necessary to forge new energy pathways — not only to avoid dangerous climate change, but also to address the increasing competition fossil fuels face from renewable energy, energy efficiency, and electrification (Global Commission on the Geopolitics of Energy Transformation 2019), as well as the downsides of overreliance on revenues from volatile energy commodities (Bjorvatn et al. 2012; Bradley et al. 2018; Cust and Mihalyi 2017). As the IEA recently noted in its Outlook for Producer Economies, "more than at any other point in recent history, fundamental changes to the development model in resource-rich countries look unavoidable" (IEA 2018b, p. 12).

Alternatives to high-carbon development are now more abundant. In two thirds of the world, wind or solar technologies are now the least expensive option for adding new power-generating capacity. Combined with battery storage, they are poised to outcompete even existing gas and coal in most of the world by 2030 (Bloomberg New Energy Finance 2019). More broadly, as emphasized by past Emissions Gap Reports, "technologies and institutional innovations are available to bridge the emissions gap, and at reasonable cost", while simultaneously providing many benefits for other important environmental, social, and economic goals (UNEP 2017, p. 9).

The move to a low-carbon economy also comes with jobs. The International Labour Organization estimates that 24 million jobs could be created through changes in energy production and use that limit warming to 2°C (ILO 2018). At the same time, six million jobs will be lost, including two million in the mining and extraction of fossil fuels (ILO 2018). Careful and inclusive planning, as well as international cooperation and support, will be key to ensure a transition away from fossil fuels that leaves no one behind (Chapters 5 and 6).

Now is a timely moment to address the fossil fuel production gap. Countries are in the process of submitting new or updated nationally determined contributions (NDCs) and long-term low greenhouse gas emission development strategies, which set out their emission reduction plans and climate pledges under the Paris Agreement. The UN Secretary-General's Climate Action Summit in September has underscored the importance of increasing ambition and broadening the scope of action. And civil society's calls for bold and decisive climate action are stronger than ever. Acknowledging and reckoning with the production gap can play a key role in bringing this vision within reach.


41
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39
38
37
36
35
34
33

2

The Production Gap

Key Messages

The world is on track to produce about 50% more fossil fuels by 2030 than would be consistent with a 2°C pathway and 120% more than would be consistent with a 1.5°C pathway.

These planned levels of fossil fuel production are also inconsistent with the collective climate pledges under the Paris Agreement. As a consequence, the global production gap is even larger than the already-significant global emissions gap.

This production gap is largest for coal. Countries plan to produce 150% more coal by 2030 than would be consistent with a 2°C pathway, and 280% more than would be consistent with a 1.5°C pathway.

Oil and gas are also on track to exceed carbon budgets, with the effects of lock-in increasing over time, until countries are producing between 40% and 50% more oil and gas by 2040 than would be consistent with a 2°C pathway.

2. The Production Gap

Countries need to triple their emission reduction pledges to limit global warming to 2°C — and quintuple them to reach a 1.5°C goal (UNEP 2018). This emissions gap is well known. Less recognized is the closely related gap between the level of planned fossil fuel production and the much-lower level of production consistent with climate goals. This chapter assesses the magnitude of that fossil fuel production gap.

Every year, the United Nations Environment Programme (UNEP) releases its *Emissions Gap Report,* which measures the gap between national plans and policies to reduce greenhouse gas (GHG) emissions, and the levels required to limit warming to below 1.5°C or 2°C. Those reports draw the world's attention to the nature and scale of the efforts needed to close this gap.

This chapter assesses the magnitude of the related fossil fuel production gap, which stymies climate ambitions by locking in fossil fuel infrastructure that will make emission reductions harder to achieve. This gap is the discrepancy between national plans and projections for fossil fuel production and global production levels consistent with 1.5°C or 2°C pathways.

National plans and projections for fossil fuel production have consequences. Governments set expectations for future production through policies, incentives, and regulations that create a supportive environment for new investments in the production of coal, oil, and gas.

But when such government plans and projections do not align with climate ambitions, too much fossil fuel infrastructure — too many platforms, pipelines, ports, and mines — gets built. Once built, this infrastructure is difficult to turn away from; it decreases fossil fuel prices, hooks consumers on fossil fuels, and deeply entangles many parts of society — including workers and communities — in a fossil fuel economy. In short, overbuilding fossil fuel infrastructure makes a low-carbon transition less likely. And from another perspective, it renders a low-carbon transition even more disruptive to those dependent on fossil fuels.

Many countries already publish national fossil fuel production plans and projections that are used to inform and guide policy and investment. However, few — if any — countries have indicated how those plans align with international climate goals or their own domestic

climate ambitions, including those outlined in nationally determined contributions (NDCs). This report seeks to support countries with this alignment process, first by assessing the nature and size of the global production gap.

2.1. Estimating the production gap

To estimate the production gap, we developed a method analogous to the one used in the *Emissions Gap Report* (UNEP 2018). In brief, our calculation uses publicly available data to estimate the difference between what countries are currently planning and what the Intergovernmental Panel on Climate Change (IPCC) estimates would be consistent with 1.5°C or 2°C pathways.

To develop the global "plans and projections" trajectory, we reviewed plans and projections of major fossil-fuel-producing countries that currently account for around 60% of global production (see Section 3.2 for a more in-depth description).

For the low-carbon trajectory, we used the least-cost mitigation scenarios compiled by the IPCC for their landmark Special Report on *Global Warming of 1.5°C* (Rogelj et al. 2018). For an indicative 1.5°C pathway, we took the median of scenarios that have at least a 66% probability of limiting global warming to 1.5°C throughout the 21st

century (with overshoot limited to <0.1°C). For the 2°C pathway, we took the median of scenarios that exceed the 1.5°C limit but have at least a 66% probability of limiting global warming to below 2°C.[2]

Finally, we excluded scenarios that rely heavily on negative emissions or "carbon dioxide removal" (CDR) technologies to meet temperature limits, given their "multiple feasibility and sustainability constraints" (IPCC 2018, p. 19, see Box 2.1). As described in further detail in Appendix A (available online), this scenario methodology closely follows the approach outlined in the 2018 Climate Action Tracker *Warming Projections Global Update* report (Climate Action Tracker et al. 2018) and leads to results similar to the scenario groupings used in the UNEP 2018 *Emissions Gap Report* (UNEP 2018).

Figure 2.1

Global fossil fuel supply under four pathways, 2015-2040. For the 1.5°C and 2°C pathways, the median and 25th to 75th percentile range (shaded) are shown. See Chapter 3 and online Appendix B for discussion of how fossil fuel CO_2 emissions are calculated from fossil fuel supply.[4]

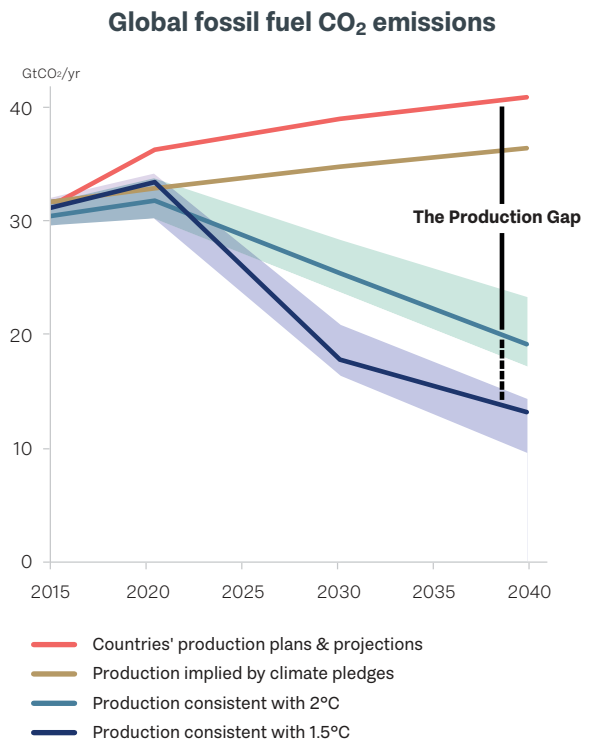


Figure 2.1 presents the overall results, comparing global fossil fuel production under national plans and projections with those under the 1.5°C and 2°C mitigation pathways. It shows that the fossil fuel production gap is large: the world is currently on track to produce far more fossil fuels in 2030 than would be compatible with a 2°C pathway and, especially, with a 1.5°C pathway. Specifically, countries' current plans and projections for fossil fuel production would lead, in 2030, to the emission of 39 billion tonnes (gigatonnes) of carbon dioxide ($GtCO_2$). That is 13 $GtCO_2$, or 53%, more than would be consistent with a 2°C pathway (with an interquartile range of 11–15 $GtCO_2$). It is 120% or 21 $GtCO_2$ (with a range of 18–23 $GtCO_2$) greater than fossil fuel production levels consistent with a 1.5°C pathway.

This gap grows even wider by 2040, when production levels reach 110% (22 $GtCO_2$, with a range of 18–24) and 210% (28 $GtCO_2$, with a range of 27–31) higher than those consistent with the 2°C and 1.5°C pathways.[3]

A production gap of this magnitude implies a risk of substantial over-investment in fossil fuel exploration, development, and infrastructure. Indeed, researchers have found that Paris Agreement goals imply major drops in planned and expected capital investment in fossil fuel production, including for oil and gas in the near term (Grant 2018; McCollum et al. 2018; Muttitt et al. 2016).

Our analysis also suggests another important finding: with respect to fossil fuels, the production gap is even larger than the emissions gap.[5] Collectively, countries are planning to increase production to levels that exceed those consistent with fulfilment of their NDCs, the metric typically used for measuring the emissions gap.[6] This is evident in Figure 2.1, which shows the world on track to produce more fossil fuels (red line) than under a scenario that reflects countries' NDC pledges (brown line, representing

[2] It is important to note that the Paris Agreement refers to holding warming "well below 2°C", whereas we included pathways with as little as 66% probability of success. This 1-in-3 chance of failing is not itself Paris-consistent, but defines an upper bound, which any outcome must be "well below".

[3] This report presents the production gap in terms of total CO_2 emissions from all fuels (coal, oil, and gas) for comparability with other emissions-based analyses, and in energy and physical units for individual fuels for comparability with other common sources. Estimates of fossil fuel CO_2 emissions from 2015-2040 were calculated using the methods described in online Appendix B.

[4] Due to differences in historical data sets for fossil fuels and the fact that most Integrated Assessment Models (IAMs) report only at decadal intervals, values for 2015 do not match precisely.

[5] The emissions gap covers all emissions sources and gases. Figure 2.1 shows only the portion of that gap (by far, the largest) that is attributable to CO_2 emissions from fossil fuels.

[6] Since the emissions gap is the difference between implementation of NDCs and Paris Agreement goals, an exceedance of planned fossil fuel production above the level consistent with NDCs implies that the production gap is larger than the emissions gap, at least for CO_2 emissions from fossil fuel combustion.

the New Policies Scenario (NPS) of the International Energy Agency's 2018 *World Energy Outlook*) (IEA 2018).[7]

The production gap is denominated in CO_2 emissions, as it provides a single metric to tally up the gap across coal, oil, and gas, and convey their primary impact on the global climate. At the same time, it is more common to think about the production of coal, oil, or gas in terms of physical units (e.g., tonnes of coal) or energy units (e.g., exajoules).

Breaking the production gap down by fuel, Figure 2.2 compares national plans and projections for coal, oil, and gas production, in both primary energy and physical units, with production levels under the 1.5°C and 2°C pathways. All three fossil fuels are on a path to be produced well in excess of Paris-compatible levels.

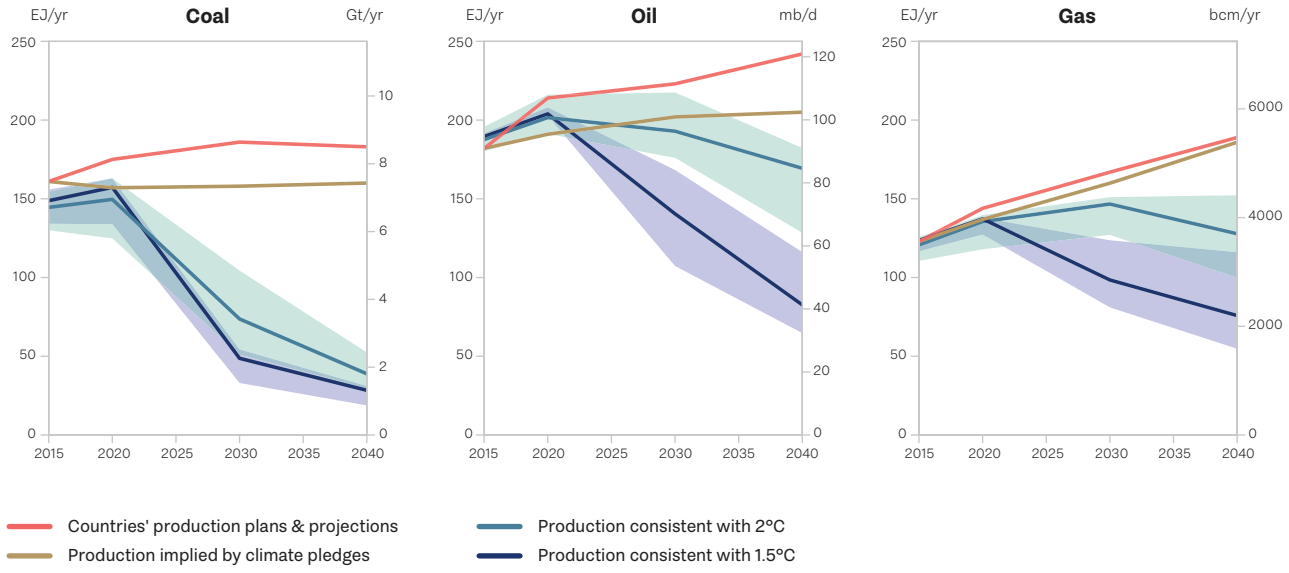
The production gap is greatest for coal, despite efforts in some countries in recent years to move away from it. Countries are on track to produce 150% — or 5.2 billion tonnes (with a range of 3.8–6.3 billion tonnes) — more in 2030 than would be consistent with the median 2°C pathway. Oil and gas production are also set to overshoot this pathway. Countries are on track to produce 16% more oil — or 15 million barrels per day (with a range of 3–24 million barrels) — more than the median 2°C pathway; for gas, that overshoot is 14%, or 590 billion cubic meters in total (with a range of 470–1,200 bcm).

The gaps in 2030 are much larger relative to the median 1.5°C pathway: coal production exceeds this pathway by 280% or 6.4 billion tonnes (with a range 6.1–7.1 billion tonnes); oil exceeds it by 59% or 42 million barrels per day (with a range of 28–58 million barrels); and gas exceeds it by 70% or 2,000 billion cubic meters (with a range of 1,300–2,500 bcm).[8]

Though near-term production gaps for oil and gas are less pronounced than for coal, ongoing investments in oil and gas infrastructure widen the production gap over time. These gaps thus grow far bigger by 2040. Countries are planning to produce 43% more oil and 47% more gas than would be consistent with a 2°C pathway by 2040.

Figure 2.2

Global coal, oil, and gas production (exajoule or EJ) under four pathways, 2015-2040. Physical units are displayed as secondary axes: billion tonnes per year for coal, million barrels per day for oil, and billion cubic meters per year for gas. The 2015 global fossil fuel production values derived from model ensembles of 1.5°C and 2°C mitigation pathways differ from historical estimates from IEA and national plans and projections and have not been harmonized.



[7] The NPS reflects countries' climate policies and ambitions announced as of August 2018 to ensure the achievement of their NDCs. It thus provides a proxy for the level of total fossil fuel production implied by a scenario in which nations meet the emission reduction goals corresponding to their unconditional NDCs. As shown in Figure 2.11 of the 2018 World Energy Outlook, the New Policies Scenario is nearly identical to IEA's estimate for full implementation of NDCs (as submitted in 2015) for future global CO_2 emissions from fossil fuels. Climate Action Tracker models an NDC-only pathway, but results are not available for fossil fuel CO_2 (https://climateactiontracker.org/).

[8] In terms of extraction-based emissions, these values translate to gaps of 11 $GtCO_2$ for coal, 1 $GtCO_2$ for oil, and 1 $GtCO_2$ for gas, relative to the median 2°C pathway by 2030. Relative to the median 1.5°C pathway, the values translate to 13 $GtCO_2$ for coal, 4 $GtCO_2$ for oil, and 3 $GtCO_2$ for gas.

Box 2.1. The potential role of negative emissions technologies

Carbon dioxide removal (CDR) refers to various approaches to reducing atmospheric concentrations of carbon dioxide by removing it from the air. In addition to land-use changes such as afforestation, reforestation, and ecological restoration, technological methods currently under investigation include using bioenergy with carbon capture and storage (BECCS) and direct air capture (DAC).

Using CDR can make it possible to exceed the carbon budget in the near-term and make up for it by later removing CO_2 from the atmosphere. It can allow for a slower and more orderly winding down of fossil fuel production, while taking pressure off sectors, such as aviation, where mitigation is particularly costly or otherwise challenging (Creutzig et al. 2015).

Reflecting these potential benefits, Integrated Assessment Models (IAMs) have introduced CDR technologies as mitigation options, along with assumptions about future cost competitiveness. Practically all IAMs rely heavily upon carbon dioxide removal to achieve net negative CO_2 emissions in the second half of the century (van Vuuren et al. 2017).

Nonetheless, the IPCC Special Report on *Global Warming of 1.5°C* underscores that "CDR deployed at scale is unproven, and reliance on such technology is a major risk in the ability to limit warming to 1.5°C" owing to "multiple feasibility and sustainability concerns" (Rogelj et al. 2018, p. 96). Risks include:

- Negative emission options may not ultimately prove technically or biophysically achievable or affordable. Scenarios rely most heavily on BECCS for power plants, which has not yet been demonstrated (Fuss et al. 2018; van Vuuren et al. 2013).
- The large-scale deployment of CDR may involve unacceptable ecological and social impacts. CDR could, for example, compete with food production or habitat areas for available land, with the potential for adverse impacts on biodiversity, food security, water resources, and human rights (Dooley et al. 2018). BECCS is inherently land-intensive: IAM scenarios assembled for the IPCC Fifth Assessment Report assumed that between 245 million hectares and about 1.5 billion hectares of agricultural land would be dedicated to bioenergy crops, compared to the approximately 1.5 billion hectares currently devoted to agriculture (Popp et al. 2017).
- Negative emissions activities could prove less effective than hoped. Land-based carbon stocks are vulnerable to release through human action or natural forces. And as noted in the Special Report, "carbon cycle and climate system understanding is still limited about the effectiveness of net negative emissions to reduce temperatures after they peak" (IPCC 2018, p. 19).

If CDR proves feasible and sustainable at large scale, then it could prove an important tool for limiting climate change. Scenarios that use CDR have been included here, but none that exceed the upper end of the range of estimates by Fuss et al. (2018) (as cited in the IPCC 1.5°C Special Report) for sustainable global potentials for BECCS (5 $GtCO_2$/year) and afforestation and reforestation (3.6 $GtCO_2$/year). That said, it is a relatively modest constraint, as even such limits are subject to "a heavy caveat of uncertainty" and hence do pose significant risks (Fuss et al. 2018).

Gas occupies a unique situation. It is the least carbon-intensive fossil fuel, and so as illustrated in Figure 2.2, IPCC scenarios show its production declining less rapidly than that of other fuels. But it must still decline, whether that downward path starts soon (under a 1.5°C pathway) or around 2030 (under a 2°C pathway). Looking a decade out or less, the production gap for gas is already substantial. With average lifetimes of 20 years or longer for pipelines, terminals, wells, and platforms, the time to begin planning for a wind-down of gas production is, as with other fossil fuels, already upon us. As shown in Figure 2.2, the gaps between planned oil and gas production and 1.5°C and 2°C pathways grow much wider starting in 2030. It has been argued that increased reliance on natural gas may lead to climate benefits and serve as a bridge fuel to a low-carbon energy system consistent with climate goals. As discussed in Box 2.2, it is unclear to what extent such a bridge still exists.

Regardless of the particular distribution of decline rates among fossil fuels — which vary considerably depending on modelling assumptions[9] — the overall modelling results indicate that the production of coal, oil, and gas will need to decline substantially compared to existing government plans in the near- to medium-term to meet the climate goals of the Paris Agreement.

2.2. Implications

Drawing on a review of coal, oil, and gas extraction policies and plans in key producing countries (Chapter 3), we find that planned production greatly exceeds global 1.5°C and 2°C mitigation pathways. In aggregate, countries' plans and projections also significantly surpass production levels that are consistent with their climate ambitions, as represented in NDCs and related policies (and modelled in the IEA NPS) — and which are themselves inadequate to meet the goals of the Paris Agreement.

In other words, with respect to fossil fuels, the global production gap is even larger than the already significant global *emissions* gap**.** This is a consequence of the minimal policy attention governments have thus far given to curbing fossil fuel production. Indeed, many governments and businesses continue to signal their intentions to expand or maximize the exploration and development of new resources, which further hinders the collective ability of countries to stabilize the climate system, including closing the emissions gap.

The global production gap is even larger than the already significant global emissions gap.

Estimating and tracking the production gap serves as an important tool in directing attention to the inadequate effort at transitioning away from fossil fuels. It complements other approaches that have defined the limits to overall fossil fuel production (Leaton 2011; McGlade and Ekins 2015; Muttitt et al. 2016) and assessed whether individual investments are inconsistent with Paris goals (Grant 2018; TCFD 2016). As such, the production gap provides a reference point for the international community and government decision makers, highlighting the disconnect between climate policies and support for increased fossil fuel production. As discussed in subsequent chapters, countries can take concrete steps to connect the dots between fossil fuel production and emissions by reporting their levels of production and communicating their plans to align future production with climate goals.

Scaling down fossil fuel production provides countries with many potential benefits, including: supporting global action to achieve climate goals; reducing the risk of stranding assets and communities; reducing the potential for the "resource curse" (the tendency of resource-rich developing countries to have lower economic performance) (Venables 2016); and decreasing other adverse social, environmental, and economic impacts. However, as noted in Chapter 1, there are also major challenges. Policymakers can anticipate political opposition from powerful interests when taking action to constrain fossil fuel production. They will also need to pay careful attention to the distributional impacts of scaling down production, and to ensuring that transitions are just and equitable.

But these challenges are not insurmountable. Though the production gap is wide, the opportunities to narrow it are abundant. As described in Chapters 5 and 6, a growing body of literature and experience shows that national and subnational governments can use a number of policies and tools to help them align their fossil fuel supply and investment strategies with Paris Agreement goals.

[9] Various uncertainties apply here. The carbon budget could end up being larger or smaller than is assumed in the underlying model. Progress on non-CO_2 gases and land-use change could be quicker or slower than planned, leaving, respectively, more or less room for fossil carbon. The world could conceivably end up developing and effectively deploying negative emissions technologies at scales greater or smaller than the levels considered here. Additional uncertainties apply to disaggregating the production gap estimate among individual fuels. A low-carbon pathway need not be attained using the specific mix of reductions in coal, oil, and gas implied by underlying model analyses. One model may opt for a slower phase-out of coal, for example, implying a faster phase-out of oil and/or gas.

Box 2.2 Gas as transition fuel?

Over the past decade, some researchers — and many industry representatives — have suggested that natural gas could serve a valuable role as a "transition fuel." They argue that gas could replace more carbon-intensive coal and oil while lower-carbon technologies mature, and could help integrate more variable renewables into existing systems (IEA 2011; Levi 2013). Accordingly, some have seen natural gas as a potential "bridge" to a lower-carbon future.[10]

However, more recent studies have increasingly questioned the extent to which gas can play a bridging role. Research has found that increasing natural gas production and the resulting decrease in gas prices may instead lead to a net increase in global emissions and risk delaying the introduction of near-zero-emission energy systems (McGlade et al. 2018; Zhang et al. 2016). This is due to three principal factors. First, recent studies find that rates of methane leakage from natural gas systems are significantly higher than often estimated in inventories (Alvarez et al. 2018; Brandt et al. 2014; Höglund-Isaksson 2017; Schwietzke et al. 2016). For example, Alvarez et al. (2018) find overall methane leakage rates of 2.3% across the United States gas supply chain, 60% greater than official estimates and comparable in warming impact to the CO_2 emissions from gas combustion over a 20-year time horizon. Second, lower prices and greater availability of natural gas stimulate higher overall energy use and emissions (Chen et al. 2019; McJeon et al. 2014). Finally, the rapid advance of renewable energy and battery technologies has decreased the need for a potential gas bridge. Thus, the continued rapid expansion of gas supplies and systems risks locking in a much higher gas trajectory than is consistent with a 1.5°C or 2°C future. However, national plans and projections — and the current boom in liquefied natural gas (LNG) infrastructure (Nace et al. 2019) — indicate that countries are on track for this kind of rapid expansion.

[10] See McGlade et al. (2018) for a fuller discussion of the bridging roles that gas could play.

3

Government support, planning, and projections

Key Messages

Governments continue to support increased fossil fuel production through plans and targets, direct investment, R&D funding, public finance, tax expenditures and other subsidies.

Collectively, countries are aiming to produce considerably more coal, oil, and gas than would be consistent with their NDCs, suggesting a major disconnect between energy and climate plans.

Specifically, national projections suggest that countries are planning on 17% more coal, 10% more oil, and 5% more gas production by 2030 than would be needed under a scenario roughly consistent with NDC implementation.

Over-investment in production puts assets, workers, and communities at risk of stranding if efforts to reduce fossil fuel dependence accelerate.

3. Government support, planning, and projections

Despite their stated climate ambitions, many governments continue to widen the gap between fossil fuel production and climate goals. Governments support production in numerous ways. They play central roles in the sanctioning and permitting of exploration and production. They support the fossil fuel industry with direct investments, research and development funding, and tax breaks. They often assume liability and risk associated with fossil fuel production, especially where they are direct investors in state-owned enterprises (SOEs). This chapter summarizes these and other ways in which governments worldwide support fossil fuel production.

Twenty-seven countries produce the coal, oil, and gas that ultimately lead to 90% of global fossil fuel CO_2 emissions as shown in Figure 3.1. The top nine producing countries alone account for over two-thirds of global fossil fuel CO_2 emissions, when accounted from an extraction-based perspective (See Box 3.1 and online Appendix B).

We review specific examples of support mechanisms from 10 key countries: seven of the top nine producing countries (China, United States, Russia, India, Australia, Indonesia, and Canada), and three significant producers with strongly stated climate ambitions (Germany, Norway, and the United Kingdom). These reviews show how national plans and projections of fossil fuel production steer expectations, policy, investment, and ultimately infrastructure toward global production levels that significantly exceed what would be consistent with the achievement of nationally determined contributions (NDCs) — let alone what would be compatible with Paris Agreement goals to keep warming well below 2°C and pursue efforts to limit it to 1.5°C.

Government efforts to maximize extraction can be understood in light of the perceived benefits of coal, oil, and gas production. As noted in Chapter 1, for many fossil-fuel-producing countries, proceeds related to production account for a sizeable fraction of government revenues. Meanwhile, importing countries aim to ramp up domestic production to improve their "balance of payments", with the goal of importing less. Countries also associate production with increased energy security and access, and perceived geopolitical advantages. Incumbent and powerful fossil fuel interests also play an important role, applying pressure for more extraction through lobbying and influence.

But promoting increased production comes with real and serious risks. As Angel Gurría, Secretary-General of the Organisation for Economic Co-operation and Development (OECD), has noted, government dependence on fossil fuel extraction creates "carbon entanglement", whereby heavily vested fossil fuel interests stand in the way of progress in climate policy (Gurría 2013). Government support for fossil fuel production threatens climate objectives by artificially lowering the price of fossil fuels, thereby increasing global consumption and emissions. In the longer-term, dependence on future production and revenues can put economies and livelihoods at risk of stranding as stronger climate action leads to reduced demand for coal, oil, and gas. Therefore, it is critical that major coal-, oil-, and gas-producing countries pay greater attention to aligning their fossil fuel production plans and policies with what is required for a low-carbon future.

3.1. Government support mechanisms for fossil fuel production

Fossil fuel supply does not merely respond to consumer demand. Governments support and guide production in various ways. Such support is often justified on the premise that it will enhance energy security and economic development. But it also serves to lock in dependence on fossil fuels and lock out lower-carbon pathways that could provide equal or greater economic and security benefits, as well as environmental and social benefits. This section provides an overview of how governments worldwide — through planning, policies, and the provision of finance — support the production of fossil fuels.

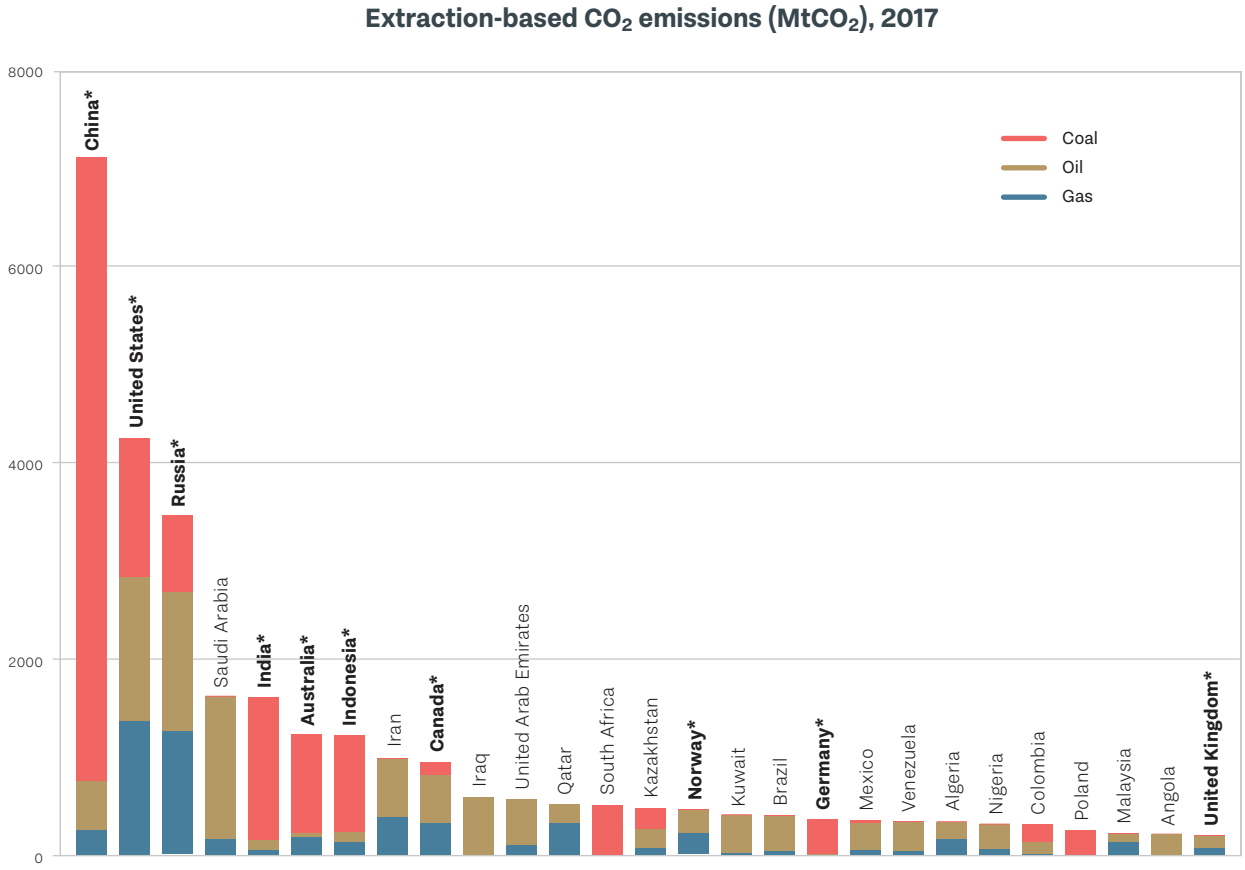
Plans, targets, and projections

Many countries issue fossil fuel production targets, plans, and projections that drive policy and investment in the exploration, extraction, and development of related infrastructure. These can signal government intentions to ramp up production, as evident among countries surveyed in Chapter 4. For example, Russia drafted an energy strategy that forecasts a 38% growth in natural gas production from 2015 to 2035 under an "optimistic" scenario (20% in a "conservative" scenario) (Ministry of Energy of the Russian Federation 2017), and India released a Draft Energy Plan that aims for a roughly three-fold increase in coal production by 2040 (NITI Aayog 2017). Countries beyond those surveyed in this report provide other examples: Argentina's 2018 Annual Energy Plan signalled the country's objective to double oil and gas production in the next five years and triple it by 2030 (Secretaría de Gobierno de Energía 2018), while Nigeria and Iraq recently announced targets that seek to roughly double their oil production within five to six years (Katsoulas 2019; Wallace and Bala-Gbogbo 2019).

Even where countries do not issue explicit plans, government projections serve as reference points that inform political, investment, and business decision-making. Published energy outlooks in the United States, Canada, and Australia, as described in Chapter 4, project large increases in fossil fuel production: between now and 2030, the United States' oil and gas production are each projected to increase by 30%, Canada's oil production is projected to increase by 30%, and Australia's coal production is projected to increase by 34%.

Figure 3.1

Top countries in terms of extraction-based CO_2 emissions (million tonnes CO_2, $MtCO_2$), 2017. The top 9 producers account for 69%, and the top 27 producers shown here account for 90%, of the global total. Countries with emissions below 200 $MtCO_2$ are not shown. Countries indicated in bold* are discussed further in Chapter 4. See online Appendix B for sources and methods.



Box 3.1 Extraction-based emissions accounting

The UN climate change process currently uses a "territorial" emissions accounting framework for national greenhouse gas emissions inventories. This framework attributes emissions from fossil fuel combustion to the country where the fuels are combusted; it also includes the "fugitive" greenhouse gases (GHGs) that are released, vented, flared, or leaked as coal, oil, and gas are located, extracted, processed, and transported. This approach tracks the consumption of fossil fuels as well as "upstream" emissions, and provides a way to track the impact of efforts to reduce emissions. However, it fails to provide a framework to track the production of fossil fuels. As a result, efforts to wind down production are not currently reflected in national accounts.

A complementary "extraction-based" accounting approach would enable countries to track the "downstream" emissions that ultimately result from the combustion of extracted fuels, helping to ensure that sufficient fossil fuel reserves are left undeveloped as required by the Paris Agreement's 1.5°C and 2°C goals (for examples of alternative emissions accounting frameworks, see Davis et al. 2011; Erickson and Lazarus 2013; Steininger et al. 2016; Piggot et al. 2018).

Extraction-based emissions accounting effectively reallocates emissions from the location of fuel combustion to the location of fuel extraction. Under the United Nations Framework Convention on Climate Change (UNFCCC), countries follow standardized guidelines — developed by the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2006) — to report inventories of territorial emissions from fuel combustion and of fugitive emissions from fuel extraction. As shown in Appendix B (available online), these inventories could be easily expanded, using readily available data, to incorporate extraction-based emissions estimates. As discussed in Chapter 6, countries can already voluntarily report their extraction-based emissions — and on their progress towards reducing these emissions — under the UN climate change process' existing modalities. Such efforts would represent an important step in enhancing transparency, and assist in tracking and managing the alignment of production with emissions targets and climate goals.

This finding is not necessarily surprising; many countries, especially (but not exclusively) those with state-owned energy enterprises, view energy production as part of their national identity and as an engine for economic development — and their plans and actions reflect these aspirations (Eckersley 2016). However, as Chapter 2 shows, these aspirations clash with the climate goals of the Paris Agreement.

Subsidies

In addition to planning and target-setting, governments support fossil fuels through direct budgetary transfers, tax expenditures, and other subsidies. In 2009, Group of Twenty (G20) leaders made a commitment to "phase out and rationalize, over the medium term, inefficient fossil fuel subsidies" (G20 2009). Ten years later — despite some reforms — many governments have kept most of their fossil fuel production subsidies, and some have even introduced new ones (Gerasimchuk et al. 2018; OECD 2018).

Fossil fuel subsidies span all stages of the fossil fuel production process, from research, development, and exploration, to operations, transport, processing, marketing, decommissioning, and site remediation (Aldy 2013; Bast et al. 2015; Koplow et al. 2010; OECD 2013). Many fossil fuel projects, such as large coal mines or oil pipelines, receive government support through several channels, including direct budgetary transfers, tax breaks, public finance, and government ownership (including on conditions better than the market) (Gençsü et al. 2019). Some governments support fossil fuel production by providing the industry with infrastructure — such as land, water, roads, rail, and ports — as well as low-cost or free exploration and production licenses, non-enforcement or exemption from various regulations, and limited corporate liability for environmental and health damage (Koplow et al. 2010).

Almost all forms of government support to fossil fuel production fall under the World Trade Organization's definition of a subsidy (ASCM Article 1.1); most of these

subsidies confer benefits to a specific industry or group of industries (ASCM Article 2) — in this case typically fossil fuel producers — and can therefore be challenged by WTO Members (WTO 2019). Differing methodologies and a lack of data transparency have led to different estimates of the size of fossil fuel subsidies, but the overall amounts are clearly large. The OECD and International Energy Agency (IEA) estimate subsidies going to fossil fuel production at USD 24 billion in 2017 (OECD/IEA 2019). However, other estimates put fossil fuel production subsidies much higher. For example, across the G20 countries, one study estimated that direct budgetary transfers and tax expenditures in favour of fossil fuel production totalled over USD 70 billion per year in 2013 and 2014 (Bast et al. 2015).

Government support reduces the capital and operational costs of extraction to fossil fuel producers, thus unlocking projects that would otherwise not be commercially viable. For instance, one study found that, at USD 50 per barrel, 45% of discovered (but not yet producing) U.S. oil would depend on subsidies to reach the minimum returns acceptable to investors (Erickson et al. 2017). Moreover, by increasing the quantity and pace of fossil fuels supplied to regional or global markets, government support to production drives down coal, oil, and gas prices, thus encouraging their consumption. One study estimated that a continuation of existing fossil fuel production subsidies globally between 2017 and 2050 would lead to CO_2 emissions equivalent to those resulting from the burning of all proven oil reserves in the United States and Norway (Gerasimchuk et al. 2017).

Other forms of public finance

Article 2.1(c) of the Paris Agreement calls for "making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development". However, in addition to the subsidies discussed above, many governments provide financing for fossil fuel production through the public finance institutions which they own and operate or in which they invest and govern multilaterally. These include development finance institutions (such as national, bilateral, and multilateral development banks) and export credit agencies.

These institutions provide domestic and international finance in the form of grants, loans, equity, insurance, and guarantees, often at a subsidized, below-market value. These investments are often backed by governments through direct investment using public funds. Even when governments do not deploy public funds, the high credit ratings of publicly owned financial institutions, and their willingness to invest in the sectors linked to government objectives, can reduce the risk to parallel private investors and drive private investment in fossil fuel production that would not otherwise occur (Bast et al. 2015).

According to one recent report, "brown" public finance flows (i.e. to upstream and downstream fossil fuel projects) continue to overshadow "green" flows (i.e. to

renewable energy); brown finance provided by the public finance institutions of G20 countries alone amounted to USD 91 billion per year during the period 2013–2015 (Climate Transparency 2018). Preliminary estimates suggest that public finance to coal, oil, and gas exploration and extraction is increasing, rising from USD 16 billion in 2015 to USD 23 billion in 2017.[11] These estimates do not account for financing provided by multilateral development banks, where G20 countries are major shareholders.

State-owned enterprises

Many countries also support fossil fuel production through their state-owned enterprises (SOEs). With majority ownership, governments maintain a degree of effective control and involvement in decision-making and financing, often on subsidized conditions that are more favourable than market terms. For example, as owners of SOEs, governments may expect lower rates of return on equity and investment than private investors, and may be more willing to bail out poorly performing SOEs than would private owners; the assumption of such bailouts lowers the risk for private sector investors. While this varies by country and institution, the impact is nonetheless significant.

The IEA (2018) estimates that SOEs accounted for 42% of global energy investment in 2017. One study found that SOEs in the G20 countries annually invested an average of USD 286 billion in oil, gas, and coal production (including fossil-fuel-based power) in 2013 and 2014 (Bast et al. 2015).

However, SOEs can also serve as a vehicle for managing extraction levels to serve wider policy goals, which could potentially include climate aims. This was demonstrated in China, where the government managed coal "decapacity" through the closure of smaller mines, industry consolidation, and a fund for worker transition (Bridle et al. 2017).

3.2. Synthesis of fossil fuel production plans and projections from major producers

This section presents a synthesis of the fossil fuel production plans and projections of countries reviewed in Chapter 4 (China, United States, Russia, India, Australia, Indonesia, Canada, Germany, Norway, and the United Kingdom), as well as those of several other top producers where documentation is publicly available (Brazil, Argentina, Mexico, and Kazakhstan). The values are drawn from

Table 3.1

Comparison of projected fossil fuel production in 2030 under national plans and projections versus IEA's New Policies Scenario in 2030, a widely used marker of how fossil fuel markets are expected to develop under policies and ambitions aimed at ensuring NDC achievement. Countries indicated in **bold*** are used to derive the global trajectory of national plans and projections shown in Figure 3.2. A dash (-) means that the country's production of that fuel is small and so is not reviewed here. See Appendix A for data sources.

	Coal (million tonnes coal equivalent/yr)		Oil (million barrels/day)		Gas (billion cubic meters/yr)	
	Plans & projections	**NPS**	**Plans & projections**	**NPS**	**Plans & projections**	**NPS**
China*	2700	2600	4.1	3.2	300	260
USA*	450	400	22.0	18.0	1100	1000
Russia*	350	310	11.0	11.0	790	770
India*	1100	710	1.1	0.9	76	58
Indonesia*	360	310	–	–	76	82
Australia*	570	430	–	–	160	180
Canada*	–	–	6.2	5.7	180	170
Norway*	–	–	1.8	2.2	100	110
Brazil	–	–	5.6	4.3	49	39
Argentina	–	–	1.5	0.7	150	77
Mexico	–	–	3.2	2.4	63	38
Kazakhstan	–	–	2.4	2.4	–	–

[11] Based on data from Oil Change International's Shift the Subsidies Database under a Creative Commons Attribution-NonCommercial 4.0 International License.

national plans, strategy documents, or projections published by governments and affiliated institutions.

As detailed in Chapter 2, these production plans and projections signal a level of global fossil fuel production that far exceeds the Paris goals. Moreover, as shown in Table 3.1, nearly every national plan reviewed aims for production levels beyond those that would meet the global fossil fuel demand implied by the NDCs — which themselves represent a level of ambition far short of the Paris goals.

In order to estimate the global production gap discussed in Chapter 2, we first derived an aggregate trajectory of global fossil fuel production between 2015 and 2040 using the national projections of the eight largest producer countries reviewed in this report (China, United States, Russia, India, Australia, Indonesia, Canada, and Norway). Together, these countries accounted for around 60% of global fossil fuel production in 2017, both in terms of energy and extraction-based CO_2 emissions.[12] Next, for other countries, production is projected assuming the same proportional share of global production for each fuel as in the NPS; this helps to account for the fact that some regions are expected to enter natural declines in production, while others ramp up — due to, for example, new discoveries and development.

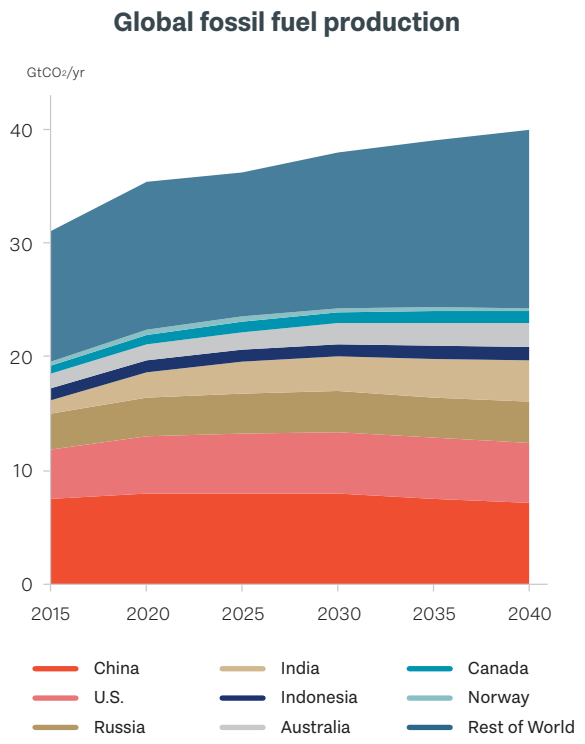
The IEA NPS, which is roughly consistent with the NDCs countries have submitted to date, would lead to global warming of around 2.7–3°C by 2100 (Abeysinghe et al. 2019), illustrating that existing policies and targets are insufficient to meet the Paris Agreement goals. As shown in Figure 3.2, fossil fuel CO_2 emissions — estimated using global fossil fuel production plans and projections — would lead to emission levels that exceed the IEA NPS by 12% in 2030; this is not only far in excess of levels consistent with 2°C and 1.5°C mitigation pathways, but exceeds even the 2.7–3°C level associated with the NPS. Taken together, the national coal, oil, and gas production plans and projections for the eight countries we analysed exceed their respective projections under the IEA NPS by 17%, 10%, and 5% in 2030 (not shown).

While many countries publish national fossil fuel production plans and projections, few, if any, have provided assessments of how their projected production plans align with domestic and international climate goals. In fact, as shown in Chapter 4, governments continue to actively promote, support, and invest in expanded fossil fuel extraction and trade, using subsidies, public finance, and other means. Expected future production levels are considerably higher than what would be consistent with the achievement of NDCs, not to mention the Paris goals. These measures, taken together, risk undermining both the stated climate ambitions of individual countries, as well as the globally agreed climate objectives.

Many countries appear to be banking on export markets to justify major increases in production (e.g. the United States, Russia, and Canada) while others are seeking to limit or largely end imports (e.g. India and China). The net result could be significant over-investment, increasing the risk of stranded assets, workers, and communities, as well as locking in a higher emissions trajectory.

Figure 3.2

Global estimate of fossil fuel production from national plans and projections, in terms of extraction-based CO_2 emissions. Values shown are compiled from sources and figures cited in the country reviews in Chapter 4. The rest of the world is scaled by the relative share of production by fuel in IEA NPS for the years shown.



[12] The government projections of Russia and India included two scenarios of fossil fuel production, and we use the average of these values in our analysis. For Russia, where available projections do not extend to 2040, values are extrapolated from 2035 onward, based on rates of growth in IEA NPS. The 2015 and 2017 global fossil fuel production values derived from the national plans and projections differ slightly from estimates under the IEA NPS, and have not been harmonized.

But there are also some potentially promising signs and opportunities. A number of smaller producing countries are already taking steps to limit further fossil fuel development, while leading international finance institutions are increasingly limiting or ending their lending to fossil fuel production.

Countries seeking to align fossil fuel production with climate goals can pursue a range of policy approaches to do so. From limits on new extraction to the removal of subsidies and the adoption of just transition plans, meeting the Paris goals may require that such "supply-side" policies become an increasing part of countries' planning for climate change and broader sustainable development. International forums — such as the UN climate change process — and non-state actors can also play a valuable role in catalysing the winding down of fossil fuel production in line with climate goals.

These opportunities to accelerate climate action are discussed in the final two chapters.

4

Support for fossil fuel production in key producer countries

Key Messages

This chapter reviews government support, planning, and projections for fossil fuel production in 10 key countries: seven top fossil fuel producers (China, United States, Russia, India, Australia, Indonesia, and Canada) and three significant producers with strongly stated climate ambitions (Germany, Norway, and the United Kingdom).

Together, these surveys illustrate how a combination of ambitious plans for expanding production, subsidies to producers, direct investment in infrastructure, and other government supports underpin the continued expansion of fossil fuel production, widening the global production gap.

4. Support for fossil fuel production in key producer countries

This chapter surveys fossil fuel production plans and support mechanisms across 10 key countries. The first seven — China, the United States, Russia, India, Australia, Indonesia, and Canada — are among the nine top global producers in terms of extraction-based CO_2 emissions, as shown in Figure 3.1.[13] The final three — Germany, Norway, and the United Kingdom — represent significant producers with strongly stated climate ambitions.

The country surveys in this chapter draw on national plans and strategy documents, projections published by government and affiliated institutions, and studies by government, research, and intergovernmental institutions. Together, they illustrate how a combination of ambitious plans and targets, subsidies, and other support policies underpin the continued expansion of fossil fuel production, which in turn widens the global production gap, making the emissions gap harder to close.

This chapter shows trajectories of fossil fuel production from the most recently available national plans and projections. Most countries foresee increases, while a few expect overall declines despite active government support for maximizing production (e.g. the United Kingdom for oil and gas). Differences in trajectories reflect a variety of factors beyond government support, including: reserves and resources; extent of depletion; levels of infrastructure investment for extraction and transport; relative costs of extraction; changes in domestic demand; and access to international markets, among others.

Consequently, it is challenging to assess what 1.5°C- and 2°C-compatible pathways for fossil fuel production might look like at a national level. While some studies have estimated future coal, oil, and gas production by country or region under climate constraints (IEA 2018a; McGlade and Ekins 2015; Solano-Rodriguez et al. 2019), the underlying models rely exclusively on the relative costs of production to determine the national or regional distribution of production, and their results differ in quantitatively non-negligible ways. Arguably, other important factors also come into play in determining the pace at which countries need to wind down production to be in accordance with the Paris Agreement (Article 4.3) — in particular, each country's unique capabilities, responsibilities, and circumstances.

Further research could take these factors into account in identifying equitable, effective, and cost-efficient production pathways at national scales, much as research has illuminated similar pathways for emissions (Climate Action Tracker 2019; Holz et al. 2019; Kartha et al. 2018). Such production pathways would provide guideposts for governments seeking alignment with Paris goals, and for civil society organizations seeking to encourage action and track progress.

Most countries foresee increases, while a few expect overall declines despite active government support for maximizing production.

[13] The other two top producers, Saudi Arabia and Iran, were not included due to limitations in data availability.

China

China is the world's largest coal producer, accounting for nearly half (43%) of global production in 2017 (3159 of 7320 million tonnes, or Mt) (IEA 2019a). Coal production more than doubled from 2000 to 2013, dropping briefly from 2013 to 2016 before resuming growth (IEA 2019a). While China is the world's seventh leading oil producer, it imports around two-thirds of its consumption (IEA 2019a). Its latest Five-Year Plan encourages the expansion of domestic oil exploration and extraction, and it continues to subsidize domestic coal production (The People's Republic of China 2016a). China is also a top natural gas producer, ranking sixth in 2017. The country's gas production increased by over 400% (from 1.0 to 5.0 exajoules (EJ)/year) from 2000 to 2017, though it remains a net importer (IEA 2019a).

Chinese government support for fossil fuel supply takes many forms:

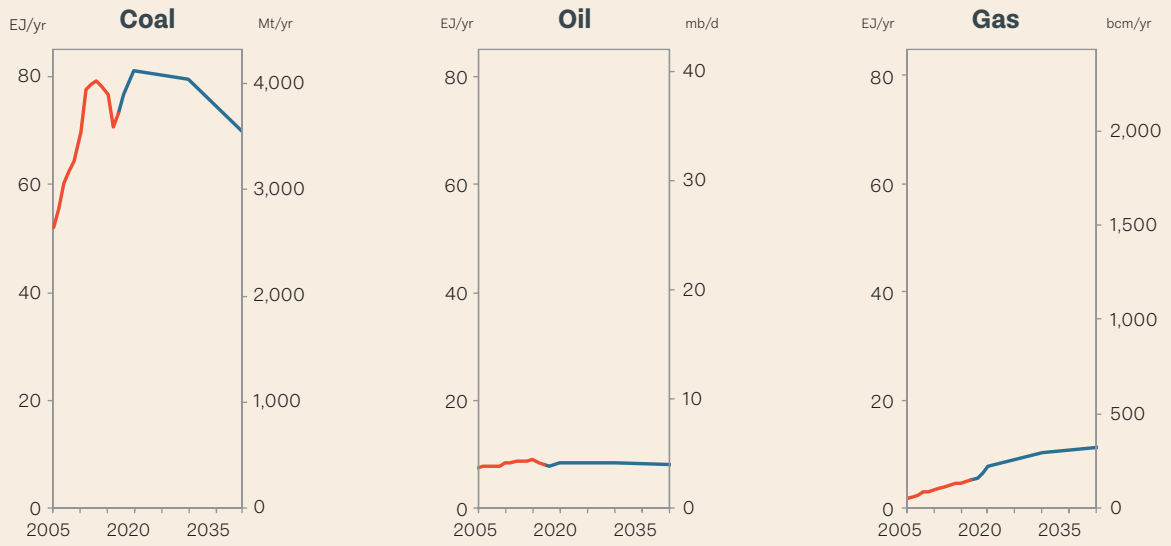
- The central and provincial governments provide over a dozen subsidies to coal and coal-bed methane production — including tax relief, direct investment, research and development support, and compensation for mine shutdowns — totalling over CNY 35.7 billion (USD 5.8 billion) in 2013 (Xue et al. 2015). Oil and gas production also benefits from tax breaks, refunds, and exemptions estimated at USD 669 million in 2013 (Denjean et al. 2015).
- The central government currently provides a direct subsidy of CNY 0.2 to 0.3 per cubic metre (m^3) (USD 0.8 to 1.2/MMBtu (million British Thermal Units)) for shale gas and coal-bed methane extraction, with provincial and local governments providing matching funds, and is considering its extension for the upcoming 14th Five-Year Plan (China Ministry of Finance 2012, 2016; NEA 2016; State Council 2018). Shale gas extraction also receives tax abatement and refunds, as well as exemptions on mineral rights taxation (Xinhua Net 2019).
- State-owned enterprises (SOEs) in the oil and gas industry, such as Sinopec, China National Petroleum Corporation (CNPC), and the China National Offshore Oil Corporation (CNOOC), invested an average of USD 22 billion per year in upstream exploration and capital expenditure in 2013 and 2014 (Denjean et al. 2015). SOEs receive preferential loan rates and terms to finance their production.
- CNOOC and CNPC are exempted from land-use tax in cities and towns, reducing costs and "leading to excessive production of fossil fuels" (G20 Peer-review Team 2016).

Government plans and projections suggest that coal production could increase to 3,900 Mt in 2020 and then drop slowly thereafter, as shown in Figure 4.1. This is in line with government intentions to cap domestic coal use. However, since China accounts for nearly half of global coal production today, its leadership in planning for a more rapid coal phase-out remains central to the goals of the Paris Agreement.

Sinopec expects China's oil production to remain at roughly 4 million barrels per day. On expectations of increased demand, Sinopec projects natural gas production to continue its rapid growth, more than doubling current levels by 2040, although still leaving the country as a major importer.

Figure 4.1

Chinese government outlooks for coal, oil, and gas production. For coal, production levels beyond 2020 are estimated from consumption projections, assuming imports account for 7% of consumption based on the 2010-2018 average. Sources: China Energy Group and LBNL 0The People's Republic of China 2016b



United States

The United States produces more oil and gas than any other country, surpassing Saudi Arabia for oil in 2015 and Russia for gas in 2012 (IEA 2019a). After China, the United States is the second largest producer of coal (IEA 2019a).

For decades, the United States has encouraged fossil fuel production through tax incentives, regulatory reform, undervalued leases of federal lands, low royalty rates, and research and development support (Vietor 1984; Wang and Krupnick 2015; Warner and Shapiro 2013). In recent years, U.S. presidents have supported increased production through strategies termed "all of the above" energy development (Obama 2014) and, most recently, "energy dominance" (The White House 2017). This has included the lifting of the four-decade-old ban on crude exports in 2015, which has played an instrumental role in the continuing boom in U.S. oil production (Blas 2019).

The United States supports fossil fuel production in numerous ways, for example:

- The federal government reports 16 subsidies to coal, oil, and gas production, such as immediate depreciation of many capital expenses and a "percentage depletion" allowance that reduces taxable income (U.S. Government 2015).
- Research indicates that federal and state subsidies boost investor returns enough to be a decisive factor for development on up to half of all new oil fields, depending on prevailing oil prices. Gas development may be similarly subsidy-dependent (Erickson et al. 2017).
- Significant federal support of oil and gas research and development contributed to the hydraulic fracturing technology that enables the current expansion of unconventional oil and gas extraction in the United States and beyond (National Research Council 2001; Wang and Krupnick 2015).
- Companies can lease public, government lands and waters for fossil fuel extraction, often paying below-market rates. About 40% of all coal, 17% of all oil, and 14% of all gas produced in the United States is from federal lands and waters (Merrill et al. 2018; U.S. EIA 2015).

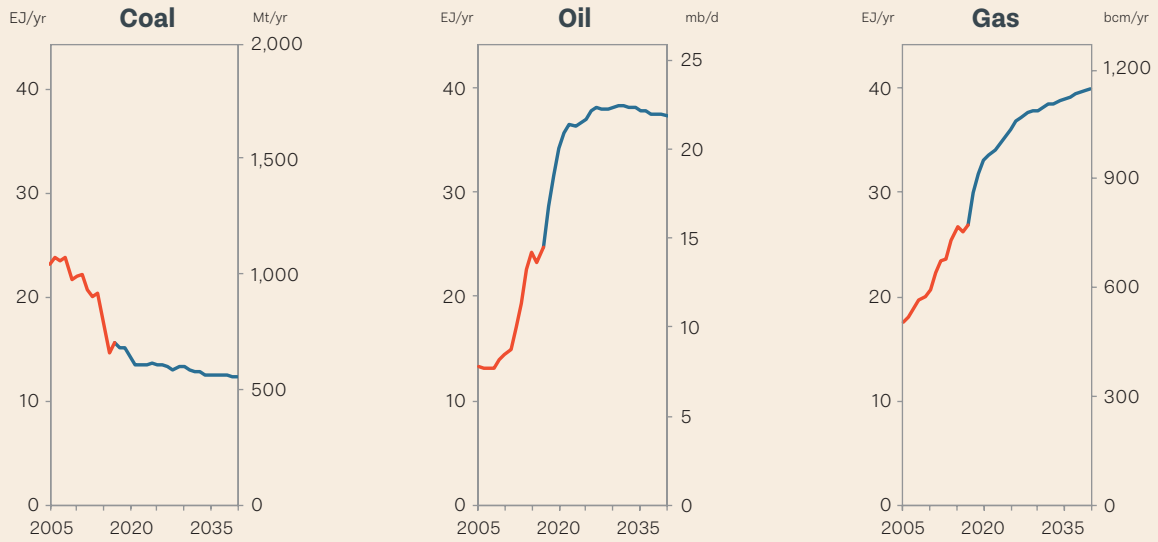
As shown in Figure 4.2, without policy change, the current boom in U.S. oil and gas production is expected to continue. The U.S. Energy Information Administration projects that oil and gas production will increase to 30% above current levels by 2030 (U.S. EIA 2019). While coal production is expected to continue its decline, the rapid rise in oil and gas production will push total U.S. extraction-based CO_2 emissions 40% above 2005 levels by 2025, in contrast with the 26–28% decline in territorial emissions targeted in the country's NDC (U.S. EIA 2019).

The United States expects to become a net exporter of fossil fuels in 2020 and increase net exports throughout the next decade. In fact, the IEA expects the United States to account for 70% of the rise in global oil production and 75% of the expansion in liquefied natural gas (LNG) trade over the next five years (IEA 2019b).

In recent years, the U.S. government has taken some national policy actions to restrict fossil fuel supply, though these have not been supported by the current administration. The U.S. Department of the Interior has discussed using a carbon budget to set a "declining schedule" of coal permits on federal lands (BLM 2017), the Obama administration removed offshore waters from oil and gas development citing climate risks (The White House 2016), and ongoing Congressional proposals provide templates for future action (Huffman et al. 2016; Merkley et al. 2015).

Figure 4.2

U.S. government outlooks for coal, oil, and gas production. Sources: IEA 2019a; U.S. EIA 2018, 2019



Russia

Russia is the world's second largest producer of natural gas, third largest producer of oil, and sixth largest producer of coal (IEA 2019a). The country exports about half of its oil and coal, as well as about a third of its natural gas (IEA 2019a). The oil and gas sector is estimated to contribute between 10% and 20% of Russia's GDP and almost half of federal government revenues (IEA 2014; Ministry of Energy of the Russian Federation 2017; Economic Expert Group 2019).

Russia's energy policy aims to retain its fossil fuel export shares in global markets through trade with Europe and expanding flows to the Asia-Pacific region, especially China (President of the Russian Federation 2019). To support these goals, the Russian government uses direct budgetary transfers, funds from government-owned financial institutions and state-owned enterprises, tax preferences, and various regulations (Gerasimchuk 2012; Ogarenko et al. 2015). For example:

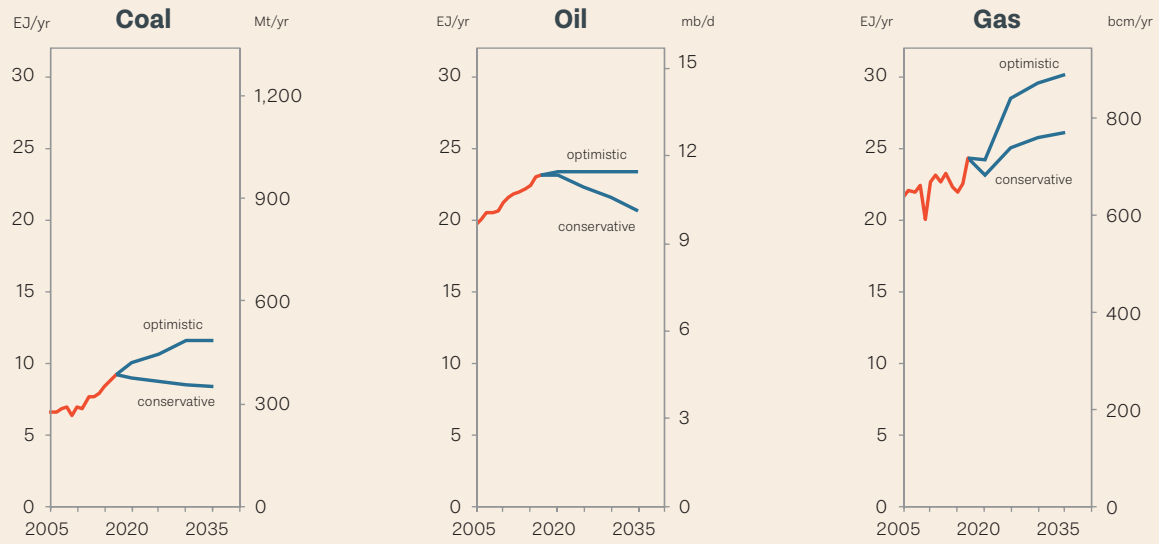
- Federal subsidies to fossil fuel production totalled RUB 440 billion (USD 7.5 billion) in 2017, a conservative estimate based on an analysis from the Organisation for Economic Co-operation and Development (OECD) of budgetary support and tax expenditures (OECD 2019). The vast majority (98%) of these subsidies were through tax breaks, especially through a reduced rate of the extraction tax on new and mature higher-cost fields (OECD 2019).
- Through price regulations, Russia provided subsidies worth another USD 12.1 billion to domestic gas consumption in 2017 and an unquantified amount of support to the consumption of Russian gas abroad (Gerasimchuk 2012; IEA 2018b), spurring investments in gas production and trade infrastructure.
- Majority state-owned Russian financial institutions provided at least USD 10.1 billion in finance for the fossil fuel industry between 2013 and 2015, partially at subsidized rates (Doukas et al. 2017).
- Oil, gas, and coal companies benefit from subsidized access to transport infrastructure, such as through preferential railroad tariffs for coal (Khusainov 2018), as well as through ports, icebreakers and pipelines (Gerasimchuk 2012; Lunden and Fjaertoft 2014).
- Russia is piloting a tax regime switch for oil fields (one based on profit rather than outputs and exports) aimed at reducing tax burdens and stimulating oil output (by 0.9 million tonnes per year), which may be expanded (Reuters 2018; Yepryntseva and Palees 2019).

The Russian government recognizes its production plans face challenges from increasing competition in energy export markets and decarbonisation trends (Ministry of Energy of the Russian Federation 2017; President of the Russian Federation 2019). Accordingly, the Ministry of Energy's draft energy strategy developed both an "optimistic" and a "conservative" scenario for future production. As illustrated in Figure 4.3, Russia expects to sustain oil production close to current levels by 2035 in both cases. Under its optimistic scenario, by 2035, coal and natural gas production would increase from 2015 levels by 32% and 38%, respectively; under its conservative one, coal production would drop 5% and natural gas would rise 20%. Russia's largest oil and gas companies also have their own plans to increase production; Gazprom plans to increase gas production by as much as 40% between 2017 and 2020 (Gazprom 2018a, 2018b).

Russia's total extraction-based CO_2 emissions would rise by 6% and 24% above 1990 levels by 2030 under the conservative and optimistic scenarios, respectively. This is in contrast with Russia's NDC target of reducing territorial emissions by 25–30% during that same period (Russian Federation 2015).

Figure 4.3

Russian government outlooks for coal, oil, and gas production. Sources: IEA 2019a; Ministry of Energy of the Russian Federation 2017.



India

India is the world's fourth largest coal producer, and also the world's second largest coal importer, reflecting the country's significant level of coal consumption (IEA 2019a). The country's coal production has more than doubled in the last two decades, totalling 724 million tonnes in 2017 (IEA 2019a). With over 75% government ownership, Coal India is the world's largest coal mining company, producing 84% of India's thermal coal, and is a major employer in many parts of the country (Tongia and Gross 2019).

India produces far less oil and gas than coal, on an energy basis (EJ). While it seeks to increase production of both, it is expected to remain a major importer in coming decades, especially for oil.

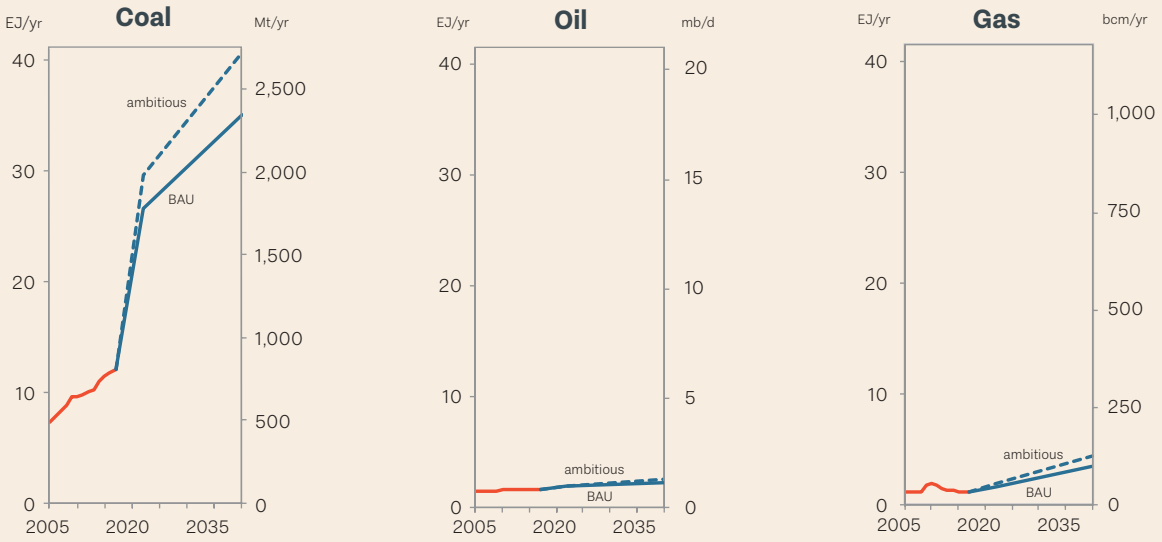
India supports fossil fuel production in various ways, including:

- The government provides subsidies across the energy value chain to increase both energy production and consumption, totalling INR 1.5 trillion (USD 23 billion) in fiscal 2017. That year, subsidies to oil and gas totalled INR 370 billion (USD 5.5 billion); those to coal were INR 160 billion (USD 2.4 billion), largely for production through concessional duties and tax breaks (Soman et al. 2018).
- India also supports coal through INR 740 billion (USD 11.3 billion) in public finance and the equivalent of INR 250 billion (USD 3.8 billion) through postponements in the implementation of environmental standards and other policies (Worrall et al. 2018).
- A number of state-owned industries are involved in the production of coal, oil and gas, as well as in the transportation and refining of oil and natural gas.
- It is important to note that these supports exist in the context of other costs and interactions faced by coal, such as the coal cess (tax) described in Chapter 5 and cross-subsidisation of passenger rail prices by coal freight.

India's Draft Energy Plan is not approved in its final form, but it is used for this overview, as it is the latest national planning document. This plan foresees coal production increasing between 2015 and 2040 by 200% under a business-as-usual scenario, and by 250% under an "ambitious" scenario that seeks to reduce imports (NITI Aayog 2017; PIB 2018), as shown in Figure 4.4. India's steep rise in coal production is predicated on the notion that not only will imports be largely displaced (under its ambitious scenario, India becomes a net coal exporter), but also that coal demand from the power sector will continue to rise steeply for the next two decades, which is uncertain given the increasing competitiveness of solar and wind (Marcacci 2018).

Figure 4.4

Indian government outlooks for coal, oil, and gas production. BAU: business-as-usual. Sources: IEA 2019a; NITI Aayog 2017



Indonesia

Indonesia is the world's fifth largest coal producer and exports over 80% of its production, making it the second leading exporter, just behind Australia (IEA 2019a). By contrast, oil production peaked in the mid-1990s, and Indonesia became a net importer of oil in 2006 (IEA 2019a). The country's natural gas production increased by around 50% between 1990 and 2017, making it the world's 12th largest producer in 2017 (IEA 2019a).

The central government has undergone a paradigm shift from viewing oil and gas as export commodities to seeing them as strategic domestic resources, a shift that is also beginning to occur with coal (Braithwaite and Gerasimchuk 2019). After a major expansion of coal production in the early 21st century (IEA 2019a), the government now aims to direct an increasing fraction of future production to domestic energy needs through a policy of Domestic Market Obligation. Under this policy, producers must deliver a specific amount to coal plants at a capped price (Braithwaite and Gerasimchuk 2019; Notonegoro 2018).

Indonesia's 2014 National Energy Policy foresees a tripling of the use of domestic coal by 2050 for electricity production (IEA 2016), while its 2018 Energy Outlook projects an increase in coal production by over 50% by 2050 (PPIPE and BPPT 2018), primarily due to growing domestic demand.

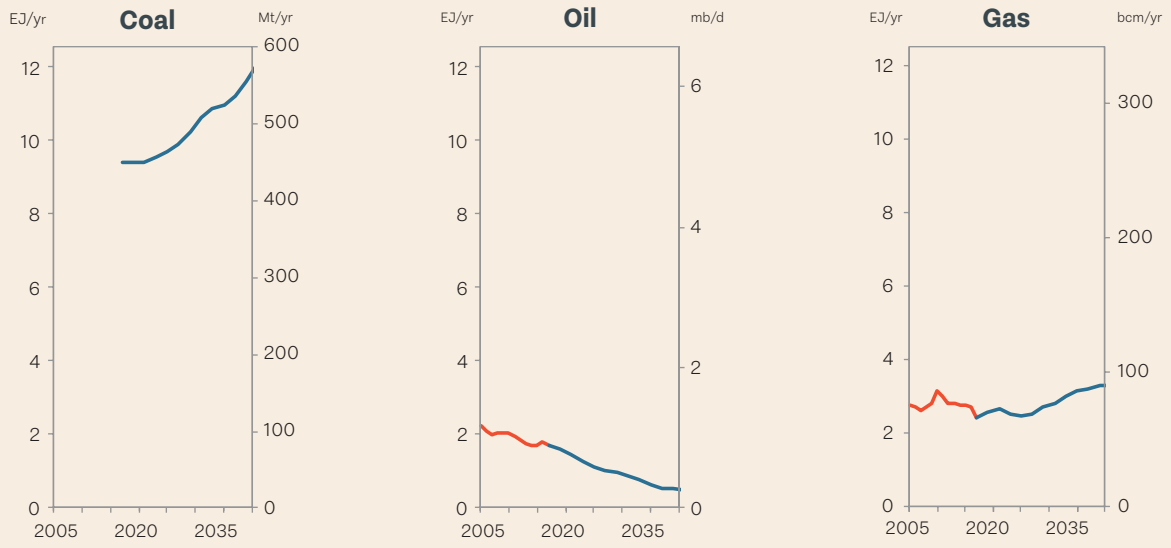
Government support for fossil fuel production includes several measures:

- Indonesia provided IDR 5 trillion (USD 400 million) or 0.05% of GDP in subsidies for fossil fuel production between 2014 and 2016 (Braithwaite and Gerasimchuk 2019).
- Subsidies for oil and gas extraction include exemptions and reductions in import duties and taxes, in income taxes on capital goods and equipment, and in land and building taxes (MEMR and MoF 2019).
- Subsidies to the coal sector averaged IDR 10.5 trillion (USD 800 million) in 2014 and 2015 (Attwood et al. 2017).
- Thermal coal was exempt from export tariffs from May 2012 to August 2015, which totalled IDR 1.2 trillion (USD 91 million) in 2015 and IDR 2.6 trillion (USD 200 million) in 2014 in forgone government revenue (Attwood et al. 2017).

Indonesia has successfully diversified its economy as its oil production has declined, maintaining constant growth and stable budget deficits (Braithwaite and Gerasimchuk 2019). Revenue from upstream oil and gas production has dropped from 7% of GDP in 2001 to 1% in 2016 (IMF 2004, 2018). However, as shown in Figure 4.5, government projections envision gas production growing by 24% between 2020 and 2040. Likewise, coal production is projected to grow by 29% during this period (PPIPE and BPPT 2018). Both increases are driven by the need to meet expected growth in national energy demand, which is partially fuelled by planned developments of household gas distribution networks and of coal-based industry (PPIPE and BPPT 2018).

Figure 4.5

Indonesian government outlooks for coal, oil, and gas production. Historical production values are not shown for coal because of a mismatch between the reported 2017 values in the Indonesia 2018 Energy Outlook (418 Mt) and IEA statistics (488 Mt). Sources: IEA 2019a; PPIPE and BPPT 2018



Australia

Australia is not only a major fossil fuel producer, but also the world's leading exporter of coal (IEA 2019a) and the second largest producer and exporter of LNG (IGU 2018). With government backing, and proposed major new investments in mines and port facilities, Australia's coal and gas outputs and exports could continue their rapid rise (Office of the Chief Economist 2019). Proposed large coal mines and ports — if fully completed — would represent one of the world's largest fossil fuel expansions (around 300 Mt per year of added coal capacity) (Buckley 2019a; Department of the Environment and Energy 2018). The rise of hydraulic fracking has also opened the door to discussions on tapping into the country's vast resources of unconventional (shale) gas (Westbrook 2018).

Australia supports increased fossil fuel production through several measures:

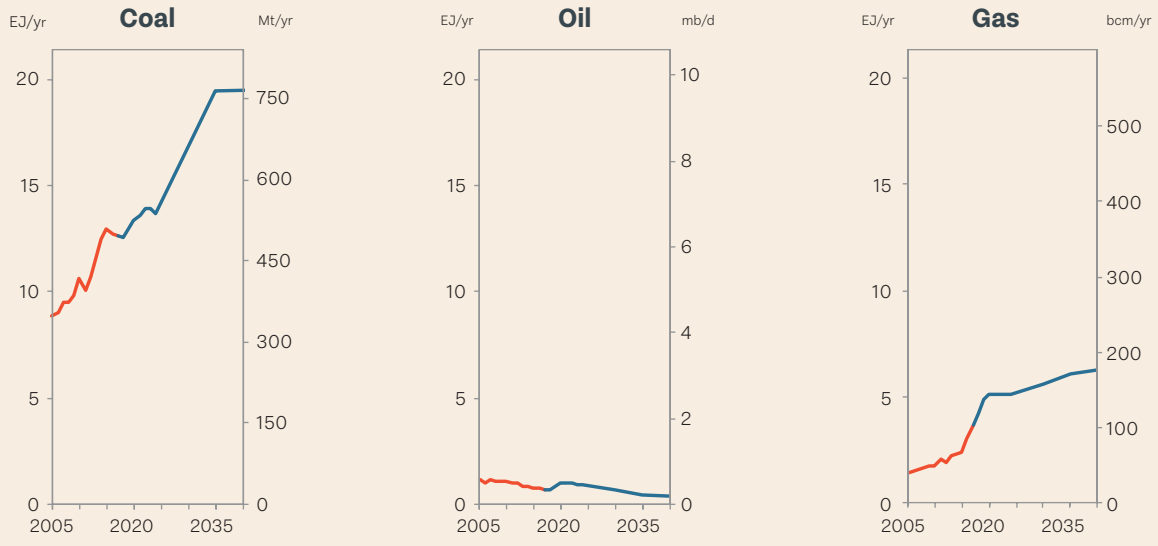
- Tax-based subsidies total more than AUD 12 billion (USD 9 billion) per year (Market Forces 2019). This includes the fuel tax credit scheme, which allows fossil fuel companies to claim tax credit on their fuel use (Australian Taxation Office 2017), and a budgeted AUD 1.7 billion (USD 1.3 billion) for accelerated depreciation for oil and gas assets (Australian Department of the Treasury 2015).
- Geoscience Australia, a government agency, absorbs sector risk by financing and conducting resource exploration, which was worth AUD 100 million (USD 75 million) in fiscal 2017 (Department of Industry, Innovation and Science 2018).
- The government takes various steps to support increased coal production, including, for example, fast-track approval, private road construction, and reduced royalty payments for Adani's recently approved Carmichael coal mine project in the Galilee Basin (Buckley 2019b).
- Recent legislation increased government support for investment in new overseas infrastructure projects from AUD 2 million to AUD 1.2 billion (USD 2 million to USD 900 million) to accommodate Australian coal and gas exports (Parliament of Australia 2019; Hasham 2019).

Government projections show coal production growing another 10% by 2024 and 34% by 2030, relative to 2018 levels (Office of the Chief Economist 2019; Syed 2014). As shown in Figure 4.6, the government also envisions gas production growing 20% by 2024 and 33% by 2030 relative to 2018 levels (Office of the Chief Economist 2019; Syed 2014).

Under these projections, Australia's extraction-based emissions from fossil fuel production would nearly double (a 95% increase) by 2030 compared to 2005 levels. However, its NDC targets a reduction in territorial GHG emissions of 26–28% over the same period (Government of Australia 2016).

Figure 4.6

Australian government outlooks for coal, oil, and gas production. Sources: Office of the Chief Economist 2019; Syed 2014



Canada

Canada is the world's sixth largest oil producer and fourth largest natural gas producer (IEA 2019a). In coal production, it ranks just outside the world's top 10 (IEA 2019a). The fossil fuel sector currently generates about 8% of Canada's GDP, though this has been in decline since 1997, when it generated 10%. Production levels, however, have risen (Hughes 2018). The government views fossil fuel exports as critical for Canada's economic growth — the current Prime Minister has stated that expanding fossil fuel export infrastructure is "of vital strategic interest to Canada" (Prime Minister of Canada 2018). Canada has encouraged the production of oil and natural gas through several government measures, including tax incentives, regulatory reform, research and development support, and, most recently, direct public investment. For example:

- Federal subsidies for fossil fuel production (including a 100% deduction for exploration expenditures) were approximately CAD 1.6 billion (USD 1.2 billion) per year from 2013 to 2015 (Touchette and Gass 2018). As they are linked to oil prices and exploration activities, a decline in both led to a significant drop in subsidies over the 2016–2018 period (Touchette and Gass 2018). While some incentive programs have ended, subsidy values are still expected to increase with oil prices.

- Subsidies at the provincial level can also be significant. Oil, gas, and coal subsidies in Alberta, for example, totalled CAD 2 billion (USD 1.5 billion) in fiscal year 2017–2018, with the vast majority coming from royalty adjustment (Environmental Defence and Gass 2019).

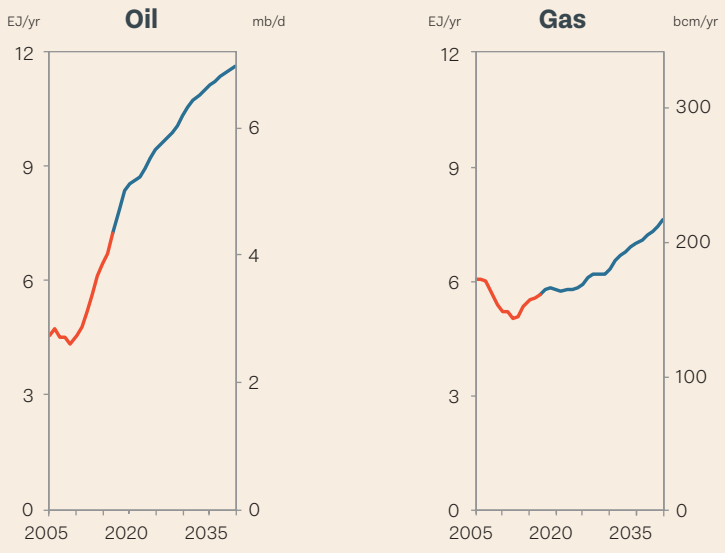
- In 2018, the national government purchased the Trans Mountain Pipeline for CAD 4.5 billion (USD 3.5 billion) and it has offered to indemnify the pipeline expansion project for a private buyer to enable increased oil sands production for international export markets (Department of Finance 2018).

Though Canada plans to address domestic emissions by putting in place a nation-wide carbon price, fossil fuel production is expected to grow progressively, largely driven by oil sands expansion. Canada's Energy Future 2018 projects oil production to increase 60% from 2017 to 2040 (National Energy Board 2018). Natural gas production is also on track to increase 34% during that time (National Energy Board 2018). In contrast, as a founding member of the Powering Past Coal Alliance, Canada has committed to a coal power phase-out by 2030, accompanied by measures to support coal workers and communities (Environment and Climate Change Canada 2017). Thermal coal production is thus expected to decline by roughly 90% from 2017 to 2040 (National Energy Board 2018).

While Canada reported a 2% reduction in 2017 emissions relative to 2005 levels (Environment and Climate Change Canada 2019), its NDC target is to reduce territorial emissions 30% below 2005 levels by 2030 (Government of Canada 2017). Ongoing fossil fuel production could create challenges for meeting this goal, as upstream oil and gas production alone accounts for 27% of Canada's territorial emissions (Environment and Climate Change Canada 2019). Furthermore, extraction-based CO_2 emissions from fossil fuel exports nearly doubled from 2000 to 2015, and now exceed Canada's domestic CO_2 emissions from all sources (Environment and Climate Change Canada 2019; Lee 2018).

Figure 4.7

Canadian government outlooks for oil and gas production. Canadian coal production is small (~1 EJ/yr) and not shown. Source: National Energy Board 2018.



Norway

Norway is the largest oil and gas producer in Europe outside Russia, with extensive offshore production. While oil production has declined since a 2001 peak, gas production has increased by almost 350% over the past three decades (IEA 2019a). Both are expected to rise in coming years, as shown in Figure 4.8, before a longer-term decline.

Norway's oil and gas policy emphasizes maximum exploitation of economically viable resources through technological innovation in existing fields, increased exploration in "mature" areas, and gradual expansion in less-explored frontier areas — primarily in the Arctic (Norwegian Ministry of Petroleum and Energy 2011). The government supports expanded oil and gas development through multiple measures:

- Norway awards new oil and gas licenses through two different processes designed to encourage increased exploration in frontier and mature areas, respectively (Lahn 2019).
- The government is a direct investor in the oil industry through passive ownership in many licenses and its controlling share in Equinor (Lahn 2019).
- A 78% tax rate on the industry is a key source of government revenue, but full deductibility of exploration and development means the public shoulders a large share of the risk in new oil and gas developments (Lahn 2019).
- The current system of deductions is characterized by the Ministry of Finance as "too generous" compared to the ideal of a neutral tax regime (Norwegian Ministry of Finance 2018). These tax breaks totalled NOK 10.7 billion (USD 1.3 billion) in 2018 (Norwegian Ministry of Finance 2018), and are categorized as subsidies by some analysts (Aarsnes and Lindgren 2012).

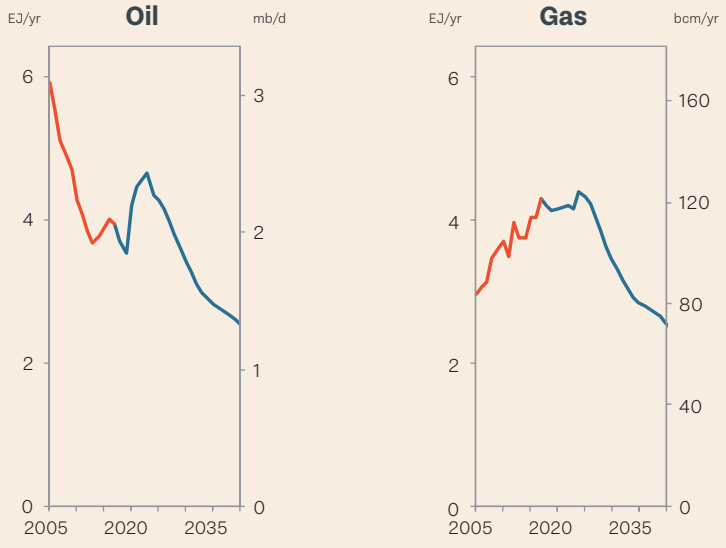
While Norway's territorial targets are to reduce emissions by 40% from 1990 levels by 2030, and by 80–95% by 2050 (Norwegian Ministry of Climate and Environment 2017), it remains to be seen whether these goals will lead to changes in oil and gas policy or production. Emissions from oil and gas production have increased since 1990 and may continue to increase despite Norway's territorial reduction targets, due to the ability to use allowances purchased from the EU Emissions Trading System (EU ETS) to offset the sector's emissions (Lahn 2019).

At the same time, there is increasing awareness that future oil and gas policy may be impacted by international climate policy developments (Lahn 2019). In response to this, some measures have been taken to minimize the economic risks associated with declining fossil fuel demand. The Norwegian government recently announced its intention to assess future oil and gas investments against an oil and gas price scenario in line with Paris Agreement goals (Norway's Climate Risk Commission 2018; Norwegian Ministry of Finance 2019a). While it is not yet clear how this will be factored into decision-making, previous analysis indicates some new oil developments may be vulnerable to lower oil demand (Down and Erickson 2017; Rystad Energy 2013).

The government has also announced the intention to divest its USD 1 trillion sovereign wealth fund, which is built on oil and gas revenues, from upstream oil and gas activities, in order to reduce Norway's oil price exposure (Norwegian Ministry of Finance 2019b). The fund divested from coal energy in 2016, based on the sector's environmental impact.

Figure 4.8

Norwegian government outlooks for oil and gas production. Publicly available government projections of production beyond 2023 only show oil and gas combined; projections beyond 2023 are split between oil and gas based on the ten-year average of the latest data (2014–2023). Norway produces almost no coal (<0.01 EJ/yr). Sources: Norwegian Ministry of Finance 2019a; Norwegian Petroleum Directorate 2019.



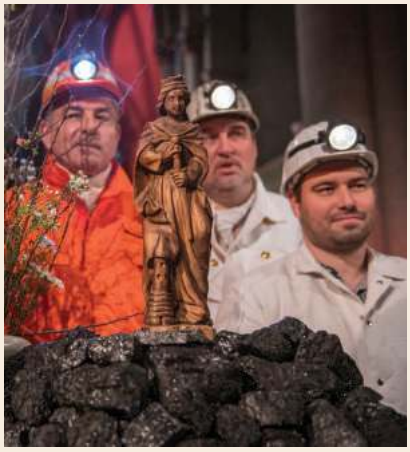
Germany

Historically one of the world's largest coal producers and exporters, Germany has now taken initial steps towards winding down coal production and use, driven by its "Energiewende" clean energy transition agenda. With its last hard coal mine closing in late 2018 (driven by EU State aid rules requiring the removal of subsidies to their operation by 2018 (European Union 2010)), the key debate is around the speed and process for moving away from brown coal (lignite) mining and use (Apunn 2019; Wynn and Coghe 2018). As of 2017, Germany remains the world's largest producer of lignite (171 Mt), the most emissions-intensive type of coal (IEA 2019a).

Germany has provided extensive government support to fossil fuel extraction to date (Whitley et al. 2017). Recently, however, it has begun shifting fossil fuel subsidies to transition support for workers and mine rehabilitation, in line with international commitments and the domestic coal phase-out discourse (Schulz 2019). Specifically:

- Between 2005 and 2016, the German government provided an average of EUR 2.4 billion (USD 2.8 billion) annually in transition support to the hard coal industry, including support for rehabilitation of mining sites and for workers and communities, following the decision to close the industry (in line with European Commission restrictions) (Whitley et al. 2017).
- The German Commission on Growth, Structural Change and Employment (referred to as the Coal Commission) has earmarked around EUR 40 billion (USD 47 billion) in government support to compensate states affected by the phase-out of lignite. It is unclear what proportion will go to mining (rather than power), as the Commission's recommendations still need to be translated into law (Gençsü 2019).

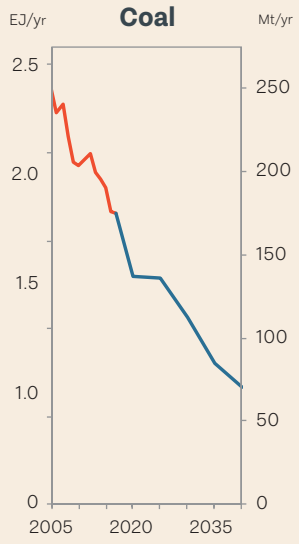
A full transition away from coal is expected to play a central role in achieving Germany's long-term goal of an 80–95% emissions reduction below 1990 levels by 2050. The draft National Energy and Climate Plan (NECP) currently envisages a 63% drop in coal production between 2015 and 2040 (BMWi 2018). However, the Coal Commission has since proposed a full phase-out of coal-fired power generation by 2038 at the latest, with measures that include social and structural development of lignite mining regions (BMWi 2019; Schulz 2019). Germany's Coal Commission has brought together actors from coal regions, industry, trade bodies, environmental NGOs, academia, and communities affected by the expansion of coal mines, in order to chart a path to ending German coal extraction and use while mitigating negative socio-economic impacts. Germany joined the Powering Past Coal Alliance in September 2019.



Miners from the Prosper-Haniel coal mine stand next to the Saint Babara sculpture a day before the mine officially closed, at a religious service at the Dom cathedral.

Figure 4.9

German government outlook for coal production. German oil and gas production is small (<1 EJ/yr each) and not shown. Source: BMWi 2018



United Kingdom

The United Kingdom's fossil fuel production lies primarily in offshore oil and gas, with estimated recoverable petroleum resources of 10 billion to 20 billion barrels of oil equivalent (OGA 2018). Under the United Kingdom's policy of "maximizing economic recovery", it has stated an intent to extract "every drop of oil and gas" (UK Parliament 2017). On the other hand, the country's coal production and use has been on a steep decline since the 1980s, including a recent commitment to phase out coal power by 2025 (Department for Business, Energy, and Industry Strategy 2018). It is one of the founding members of the Powering Past Coal Alliance, along with Canada.

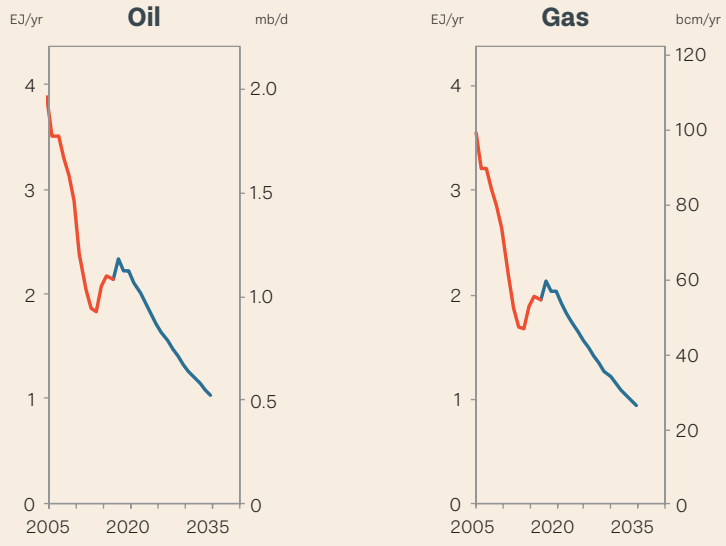
Though the UK government stated that it does not provide any subsidies for fossil fuels under its own definition, a recent report by the European Commission found that the United Kingdom has the largest fossil fuel subsidies in the European Union (European Commission 2019). A range of measures support the oil and gas industry:

- The United Kingdom issues new exploration and production licenses every year, alternating between offering mature and frontier areas. Leases generally last 30 years but are extendable (Muttitt et al. 2019).
- The United Kingdom offers investment allowances, lowered tax rates for oil and gas, and support for decommissioning (Muttitt et al. 2019; Whitley et al. 2018).
- In the tax years 2015–16 and 2016–17, the oil and gas industry received an average of GBP 176 million (USD 224 million) more per year in government support than it paid back in taxes (Muttitt et al. 2019).
- A public body, the Oil and Gas Authority, has a statutory mission of maximizing extraction. It has created a strategy to boost 2035 production revenue by around 50% compared to baselines, and promotes its achievement by, for example, coordinating among companies on their use of infrastructure, sharing information on costs, and intervening in supply chains (OGA 2019a, 2019b).
- The United Kingdom provided an annual average of GBP 432 million (USD 550 million) in international public finance for upstream oil and gas in 2013 and 2014 through UK Export Finance (UKEF). A recent report by the Environmental Audit Committee of the UK government stated that "UKEF support for fossil fuel energy projects is unacceptably high", recommending that UKEF should set a strategy for net-zero emissions by 2050, and push other export credit agencies within the OECD to do the same (UK Environmental Audit Committee 2019, p. 3).

Recently, the UK Committee on Climate Change recommended that the United Kingdom should raise its ambitions to net zero emissions by 2050, deeming such a target "necessary, feasible and cost-effective" (UK Committee on Climate Change 2019, p.8). Although the Committee's report contemplates mitigating emissions from oil and gas production, it does not discuss how fossil fuel production itself might be aligned with the net zero target.

Figure 4.10

UK government outlooks for oil and gas production. UK coal production is small (<0.1 EJ/yr) and not shown. Source: OGA 2019b



5

Policy options to close the production gap

Key Messages

Countries can begin to close the production gap by aligning their energy and climate plans.

Governments have a range of policy options to regulate fossil fuel supply, including limits on new exploration and extraction and removal of subsidies for production.

Some countries are already demonstrating leadership: Belize, Costa Rica, Denmark, France, and New Zealand have all enacted partial or total bans on oil and gas exploration and extraction. Germany and Spain are phasing out coal extraction.

Non-state actors and sub-national governments can also help facilitate a transition away from fossil fuels, by mobilizing constituencies and shifting investment to lower-carbon options. Individuals and institutions have already pledged to divest over USD 11 trillion from fossil fuel holdings.

Several governments are planning for a "just transition" that aims to minimize disruption for affected workers and communities.

5. Policy options to close the production gap

A key step toward closing the production gap is for countries to recognize the substantial discrepancy between fossil fuel production plans and global climate goals – and then to enact policies that bring production plans in line with climate efforts. Their policy toolkit can include not only "demand side" policies, such as renewable energy and energy efficiency measures, but also those that focus explicitly on reducing the supply of fossil fuels.

Accordingly, in this chapter, we outline the "supply-side" policy options available, describe the benefits they could offer, and highlight important lessons from early adopters of such policies. We discuss the importance of incorporating processes that support a just transition away from fossil fuels. We conclude by discussing the role that non-state actors can play in winding down fossil fuel production.

5.1. Supply-side climate policy

Policies to address fossil fuel supply are often missing from the climate policy toolkit. Most climate policy interventions seek to address the consumption, rather than the production, of coal, oil and/or gas, through measures such as pricing carbon, fostering alternative energy sources, and improving energy efficiency. Climate policy need not be limited to interventions on the demand side, however. In many other areas of public policy, governments recognize that tackling supply and demand for a product at the same time is the most effective way to limit its use (Green and Denniss 2018). This is true for a diverse range of policy goals, including efforts to reduce the consumption of tobacco, the selling of illicit drugs, and the trafficking of endangered species. The continued growth in fossil fuel extraction suggests that there may be value in similarly seeking to limit the upstream production of such fuels, in addition to their consumption (Green and Denniss 2018; Lazarus and van Asselt 2018).

For governments interested in restricting fossil fuel supply as part of their broader climate strategy, a range of policy options exist (Table 5.1.). These "supply-side" climate policy tools include *economic instruments*, such as fossil fuel subsidy reform and taxation on the production or export of fuels. Governments may also use their *regulatory authority* to limit extraction, for instance by banning new permits for exploration or extraction, or by limiting or rescinding

existing fossil fuel licenses. Policymakers can also turn to their *provision of goods and services*, by redirecting public finance away from the fossil fuel sector, setting long-term goals to wind down extraction, and developing strategic transition plans to support fossil-fuel-dependent workers and communities. And governments can *raise awareness and increase transparency* by requiring fossil fuel companies to report on their production plans, and by reporting on their own progress in closing the "production gap."

For governments interested in restricting fossil fuel supply as part of their broader climate strategy, a range of policy options exist.

Table 5.1: Taxonomy of supply side policy

Category	Supply-side policy
Regulatory approaches	Limit exploration, production, or export (e.g., via moratoria, bans, or quotas)
	Prohibit development or limit permits for specific resources, infrastructure (oil pipelines and terminals, coal ports, etc.), or use of certain technologies
	Ensure comprehensive (upstream and downstream) emissions assessment in environmental impact reviews of new fossil fuel supply projects
Economic instruments	Remove fossil fuel producer subsidies
	Introduce fees or taxes for fossil fuel production or export, and increase royalties
Government provision of goods and services	Assist workers and communities transitioning out of fossil fuel production
	Divest state-controlled investment funds from companies involved in fossil fuel production
	Restrict financing for fossil fuel supply projects through government-owned finance institutions (e.g. export credit agencies, and national and multilateral development banks)
Information and transparency	Require corporate disclosure of long-term climate-related risks associated with capital-intensive upstream production and exploration (Carbon Tracker Initiative 2019a)
	Set targets for reducing fossil fuel production, and report on progress alongside existing climate mitigation accounts (e.g. by using an extraction based emissions accounting framework) (Steininger et al. 2016)

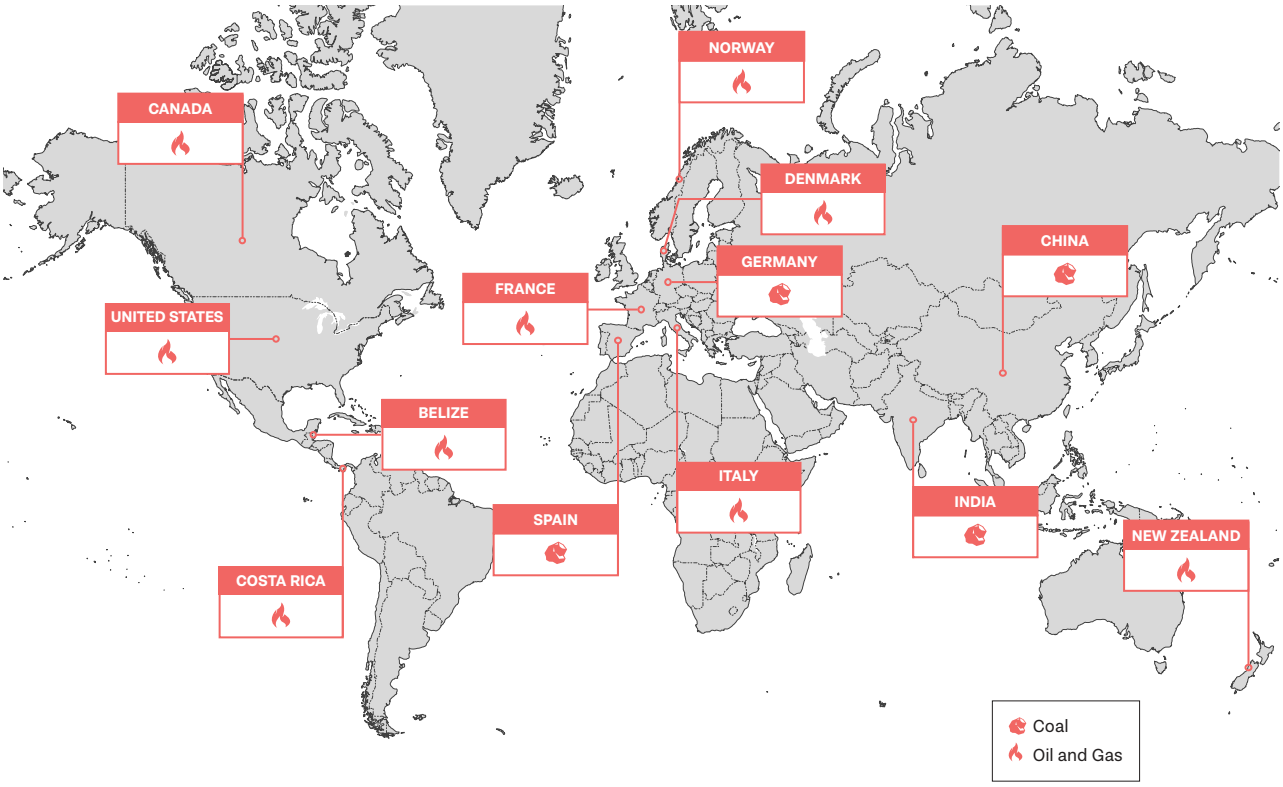
Source: Lazarus and van Asselt (2018), adapted from Somanathan et al. (2014) Table 15.2.

Some governments have already begun to enact policies such as those outlined in Table 5.1, providing models for the rest of the world to learn from and emulate (Figure 5.1). The governments of Belize, Costa Rica, France, Denmark, and New Zealand, for instance, have all enacted partial or total bans or moratoria on oil and gas exploration and extraction. Germany and Spain are phasing out coal extraction, and working with workers and communities to plan for an economic future without mining (MITEGO 2018; Wehrmann 2018). And more than 40 countries have endorsed the need to reform fossil fuel subsidies (FFFSR 2019). These actions represent a growing momentum to limit fossil fuel supply for climate and related sustainable development reasons. Most of these policies and commitments have been enacted in the last five years (see online Appendix C), signalling policymakers' new focus on fossil fuel production.

As noted in Chapter 1, policies to limit fossil fuel production can bring several benefits. Supply-focused measures broaden the climate policy toolkit, which can increase the scale of emission reductions available at a given marginal cost. They can also help avoid "carbon lock in" by limiting investment in long-lived infrastructure (i.e. entrenched fossil fuel production with long pay-back horizons). This can also decrease the risks and costs associated with stranded assets (Erickson et al. 2015) — risks that are particularly pronounced for countries that are now deciding whether to follow a fossil-fuel-driven development pathway (Bradley et al. 2018). Supply-side policies also may have administrative advantages over other forms of climate policy: they target a narrower set of actors (fossil fuel producers), and thus may be easier and less costly to administer (Green and Denniss 2018).

Finally, there may be distinct socio-political advantages to addressing fossil fuel supply, alongside other climate policy measures. Fossil fuels are more tangible than emissions, which helps to mobilize public support for climate policy; people may find it easier to attribute costs and benefits to specific, familiar energy sources, rather than the more abstract emissions created from those fuels when they are burnt (Ansolabehere and Koninsky 2014; Green and Denniss 2018). Addressing fossil fuel supply also brings added co-benefits — such as reducing pollution around extraction, processing, and transportation sites — that may appeal to affected communities (O'Rourke and Connolly 2003). That said, supply-side constraints may encounter opposition from industry, communities and regions economically dependent on fossil fuel extraction (Harrison 2015). Careful design of policies, including supporting measures for affected communities and industries, can increase the political viability of supply-side policy.

Figure 5.1 Examples of supply-side polices and actions taken by countries. Note that not all policies were adopted with a climate change rationale, though they may potentially have mitigation impacts. For more detail, see online Appendix C.



BELIZE

Moratorium on offshore oil exploration and drilling

CANADA

Phase-out of the accelerated capital cost allowance for oil sands projects and the Atlantic Investment Tax Credits for use in oil and gas activities (subsidy reform)

Moratorium on offshore oil and gas activities in Canada's Arctic waters and in designated marine protected areas

CHINA

Supply-side structural reform (closure of coal mines) and just transition support measures

COSTA RICA

National moratorium on oil exploration and exploitation

DENMARK

Ban on exploration and drilling for oil, gas, and shale gas on land and in inland waters

FRANCE

No new or renewal of exploration permits for conventional and unconventional fossil fuels; Phase-out of all oil and gas production within the country and its overseas territories by 2040

GERMANY

Phase out of subsidies for domestic hard coal industry by 2018

Just transition plan for the coal industry: compensation for coal mining provinces; compensation and training for coal miners

INDIA

Cess (tax) on coal production

ITALY

18-month moratorium on offshore oil and gas exploration permits

NEW ZEALAND

Ban on new offshore oil and gas exploration permits

Establishment of a "Just Transitions Unit" with a focus on supporting the region most dependent on the oil and gas industry

NORWAY

Certain offshore areas closed for drilling (including Lofoten archipelago and other coastal and sensitive areas and in the Arctic)

SPAIN

Closure of domestic coal mines with Just Transition plan (compensation and re-training)

UNITED STATES

Moratorium on oil and gas exploration in some areas of the Arctic and Atlantic

Box 5.1. Lessons from first movers: Limiting oil supply in Latin America and the Caribbean

Some of the earliest efforts to limit the production of oil and gas on environmental grounds originated in Latin America and the Caribbean. The most prominent moratorium effort is probably the Yasuní-ITT project, launched in 2007 in Ecuador, which sought international compensation for banning the extraction of oil in a national park (Finer et al. 2010).

While this initiative was ultimately unsuccessful (Sovacool and Scarpaci 2016), later efforts to limit oil extraction without a condition of compensation fared better. In 2011, Costa Rica announced a temporary moratorium on offshore oil exploration, which was later extended to 2050 (Government of Costa Rica 2019). In 2016, former Mexican President Enrique Peña Nieto signed decrees banning oil and gas activities in areas of high natural value, amounting to approximately 1 million square kilometres of protected area (Government of Mexico 2016). And in December 2017, the Belize government unanimously approved a moratorium on petroleum-related activities in maritime areas (Government of Belize 2017).

These governments have shown that starting with small steps — a temporary ban, or limits on extraction in a restricted area — can help build momentum for expanding constraints on production. While climate change was occasionally raised as a motivating factor, the protection of biodiversity, ecosystem services, and eco-tourism were the main rationales underpinning all of these initiatives. An emphasis on the measures' potential benefits helped increase the viability of their adoption, suggesting more attention needs to be paid to the wider sustainable development benefits of closing the production gap.

5.2. Support for just transitions

Policies that constrain fossil fuel production — either directly through supply-side policies, or indirectly by reducing fuel demand — can be coupled with transition support to aid those currently reliant on fossil fuel development for their livelihoods. All governments, as signatories to the Paris Agreement, have recognized the need to "[take] into account the imperatives of a just transition" and the impacts of response measures; this implies the need to plan to minimize disruption for workers, communities, and consumers who may be disproportionately affected by a shift to a low-carbon economy (ITUC 2017; UNFCCC 2016). Some countries have already embarked on such planning. For example, the governments of Canada (Government of Canada 2018), Germany (Wehrmann 2018), Spain (MITEGO 2018), Scotland (Scottish Government 2018), and New Zealand (MBIE 2018) are all developing or implementing new transition planning processes and support programs to help oil, gas, and/or coal workers and communities adjust as their industry declines.

While transitions away from fossil fuels will affect many across society, two groups are typically the focus of transition planning efforts in the fossil fuel production sector: workers and fossil-fuel-dependent communities and regions (Sartor 2018). Both workers and communities want to be consulted on the transition and want meaningful social dialogue to take place concerning their future. Once dialogue takes place and workers' concerns are heard, a range of solutions can be negotiated to facilitate a transition that different parties perceive as fair.

Commonly employed transition provisions include: facilitating local development planning; ensuring workers' existing legal entitlements (e.g. to pensions and healthcare) are maintained; ensuring social protection and insurance measures for workers; supplementing local government revenues; creating job training programs; restoring industrial sites; and investing in new community facilities to revitalize social and economic development (Green and Gambhir 2019). There is no "one-size-fits-all" approach to transition planning; the choice of transition support should reflect

Box 5.2. Addressing supply and demand: New Zealand's comprehensive approach to climate policy

New Zealand is a relatively small fossil fuel producer. However, the country faces similar challenges to those of most producing countries. Oil production is highly concentrated in one region, Taranaki, and forms an important part of the regional economy, accounting for 28% of the region's economic output (Make Way for Taranaki 2017). The New Zealand government has recognized the challenge that the global phase-out of fossil fuels represents for Taranaki, and the need for a managed transition that protects jobs and supports regions and local communities (New Zealand Government 2018a).

In April 2018, the New Zealand government announced that it would cease granting offshore oil and gas exploration permits, a ban that was subsequently passed into law in the Crown Minerals (Petroleum) Amendment Act 2018 (New Zealand Government 2018b). The policy protects existing jobs and exploration and extraction rights: it does not cover the country's 22 existing offshore exploration permits, and new onshore exploration permits can still be granted. As Prime Minister Jacinda Ardern highlighted, the policy aims to provide certainty for industry and communities to plan for the future, and to kick-start the managed transition (New Zealand Government 2018c).

The exploration ban fits within a wider, comprehensive climate strategy that aligns demand, supply, and transition measures. In May 2019, the government proposed legislation that would set a target of net-zero carbon emissions by 2050, and establish an independent climate change commission (New Zealand Government 2019a). Alongside this policy, the government has created a Just Transitions Unit to aid the transition process (MBIE 2018).

A key element of New Zealand's climate strategy is supporting the Taranaki region as it transitions its economy away from fossil fuels. The government is investing NZD 20 million (USD 13 million) in local infrastructure and clean energy projects to diversify the region's economy (New Zealand Government 2018d), and in 2019 it hosted a Just Transition Summit to discuss the steps needed to realize a low-emissions future (New Zealand Government 2019b). The government has also helped the Taranaki region to develop a 2050 Roadmap, co-designed with local communities and stakeholders (Venture Taranaki 2019).

the desires and opportunities that make the most sense for individual workers and communities, as well as the government capacity, institutions, and wider conditions in the relevant jurisdiction (Green and Gambhir 2019). The size and scope of these plans depends on the current footprint of the industry: countries and regions that are heavily dependent on fossil fuel production will need extensive industry transition plans, whereas more diversified economies may have relatively minimal transition needs.

Providing assistance to those impacted by a transition away from fossil fuels is almost certainly a necessary precondition for ambitious climate policy. Absent a clear plan to support those affected by a low-carbon transition, governments are likely to face social and political resistance to any efforts to limit fossil fuel production or use. Transition planning can build consensus for more ambitious climate policy, including for the types of supply-side policies outlined in this chapter.

5.3. The role of subnational and non-state actors

National governments are not acting alone to limit fossil fuel production and support a just transition. Many city and regional governments are putting in place policies to constrain fossil fuel supply, and help communities move into alternative economic development models. Dozens of municipalities, counties, and regional governments have, for example, enacted bans on hydraulic fracturing (Carter and Eaton 2016; KTWS 2018); subnational governments, such as Scotland and Alberta, were also among the first to announce just transition policies to support oil and coal workers, respectively (Government of Alberta 2017; Scottish Government 2018).

Beyond governments, a range of other non-state actors are helping to facilitate the transition away from fossil fuel extraction, including companies, investors, trade unions, and civil society organizations. Through fossil fuel divestment campaigns and other efforts, civil society groups and investors have placed social, political, and economic pressure on governments and companies to move away from supporting fossil fuel production (Healy and Barry 2017). To date, more than USD 11 trillion in fossil fuel divestment pledges have been made by over 58,000 individuals and more than 1,100 institutions (Fossil Free 2019).

Civil society has also been leading the call for governments and corporations to take action on fossil fuel supply. More than 500 non-governmental organizations, for instance, have signed the "Lofoten Declaration" calling for an end to fossil fuel development and the managed decline of existing production (The Lofoten Declaration 2017). Collectively, campaigns like this are helping to change the discourse, norms, and attitudes around ongoing fossil fuel production in a climate-constrained world (Cheon and Urpelainen 2018; Green 2018; Piggot 2018).

Fossil fuel companies could also play important roles in closing the production gap. A handful of fossil fuel companies are already moving their investments towards lower-carbon options. For example, in 2017, the Danish Oil and Natural Gas company (DONG) sold off its oil and gas business, and announced a name change to Ørsted to reflect its exit from the fossil fuel business (Spector 2017). While this is a step in the right direction, the industry as a whole has not yet signalled a commitment to a long-term transition away from fossil fuels, with only 1.3% of oil and gas companies' total capital expenditures (USD 22 billion) invested in low-carbon energy since 2010 (Fletcher et al. 2018). Historically, fossil fuel industry associations aiming to reduce emissions — such as the Oil and Gas Climate Initiative and IPIECA (the oil and gas industry association for environmental and social issues) — have primarily focused on improving the reporting and the emissions intensity of production, rather than on limiting investments in projects that are incompatible with a 1.5°C or 2°C pathway (Carbon Tracker Initiative 2019b; Grant 2018). Going forward, these organizations could be instrumental in managing an orderly wind-down of fossil fuel production by helping companies align their portfolios with Paris Agreement goals and by moving away from investments that could stand in the way of meeting the world's climate change objectives.

While such actions by civil society, governments, and some businesses are promising, the shift away from fossil fuel production and use is not yet happening at the speed or magnitude needed to limit dangerous global warming (Muttitt et al. 2016). Greater ambition and coordination by state, subnational, and non-state actors will be required to align fossil fuel supply with Paris goals (Piggot et al. 2018). The next chapter details how the policies and initiatives outlined in this chapter might be scaled up internationally.

6

Increasing international ambition and action

Key Messages

International cooperation can play a central role in efforts to wind down fossil fuel production.

The Paris Agreement provides key opportunities for countries to address fossil fuel production, including through the global stocktake, nationally determined contributions, financing, and long-term low greenhouse gas emission development strategies.

Drawing inspiration from models such as the Powering Past Coal Alliance, coalitions of leading actors can work together to raise ambition through joint targets and actions that align future fossil fuel production with global climate goals.

International financial institutions can shift financial support away from fossil fuel production and towards low-carbon energy.

Ensuring an equitably managed decline in production is crucial to success.

6. Increasing international ambition and action

International cooperation plays an important role in catalysing supply-side policy. It can encourage countries to adopt more ambitious policies by offering assurances of collective action. That collective action can, in turn, increase policy effectiveness; since fossil fuels are traded internationally, supply-side measures are more effective when countries adopt them together. International cooperation can also increase momentum for domestic action by sending a clear signal to policymakers, investors, consumers, and civil society that the world is shifting towards a low-carbon future. And it can help ensure that such a transition takes place in an equitable way.

This chapter summarizes how the UN climate process and other international institutions and initiatives can help to catalyse supply-side ambition and action. We conclude by discussing the importance of ensuring an equitable transition away from fossil fuel production, and key considerations that can support this effort.

6.1. Winding down fossil fuel supply through the UN climate change process

As the foremost international forum for climate action, the UN climate change process (under the UN Framework Convention on Climate Change, UNFCCC) is arguably well placed to address the linkages between fossil fuel production and climate policy (Piggot et al. 2018). Yet its consensus-based approach to decision-making also presents a challenge. Fossil fuels have historically been kept from the UN climate regime's agenda (Depledge 2008), with the 2015 Paris Agreement omitting any reference to fossil fuels. This omission reflects the concerns of major fossil-fuel-producing and exporting nations, whose governments have argued that they would face economic challenges if stronger climate action were to be taken (Chan 2016; van Asselt 2014).

There is a clear rationale for addressing fossil fuel supply through the UN climate regime, however. As discussed in Chapter 1, meeting the Paris Agreement's goal of limiting the global average temperature to well below 2°C above pre-industrial levels — and pursuing efforts to stay below 1.5°C — will require the vast majority of proven fossil fuel reserves to remain unburned (McGlade and Ekins 2015; Muttitt et al. 2016). Moreover, the Agreement aims to make finance flows consistent with a pathway towards low greenhouse gas (GHG) emissions and climate-resilient development. This will require the redirection of the approximately USD 1 trillion that is invested annually in new fossil fuel supply infrastructure (IEA 2018), and the USD 24 billion to 70 billion that governments expend on fossil fuel production subsidies each year (Chapter 3).

Delegates gather in the Chamber Hall at the Bonn Climate Change Conference in May 2017. Photo by IISD/Kiara Worth (enb.iisd.org/climate/sb46/enb/8may.html)

Fossil fuel phase-out, fossil fuel subsidy reform, and divestment from fossil fuels also repeatedly emerged as topics in the 2018 Talanoa Dialogue, a process designed to enhance climate ambition through the UN climate regime. Inputs into the Dialogue underscore that addressing fossil fuel production "requires significantly more international cooperation, and wider and deeper engagement of key stakeholders" (UNFCCC Secretariat 2018, p.8).

The Paris Agreement creates various new opportunities to integrate supply-side considerations into the UN climate change process (Piggot et al. 2018). Seven such avenues are discussed below. Importantly, given the relatively "bottom-up" nature of the Paris architecture, many of these are not dependent on international consensus, and could thus be pioneered by one country or a group of countries.

Box 6.1. Leakage and supply-side policy

There is a popular misconception that reducing production in one location will simply lead to an equal amount being produced elsewhere — a game of "perfect substitution" that would, if true, negate the emission reductions and other benefits of supply-side actions (Roberts 2015). However, this argument of perfect substitution defies basic economics of supply and demand. If there is less available of a commodity — such as oil — its price will increase, meaning less of it will be consumed. In principle, limits to oil production in one area could be "undone" by coordinated increases elsewhere, such as by the Organization of the Petroleum Exporting Countries (OPEC). However, OPEC's ability to effectively control production and, in turn, long-term prices, is limited and declining (Baffes et al. 2015; Van de Graaf 2017).

Using elasticities of supply and demand, we can gauge the extent of leakage and demonstrate the effectiveness of supply-side climate policy. The less fossil fuel producers are able to increase extraction in response to price increases (i.e. low supply elasticity), the more effective a cut in fossil fuel supply becomes at reducing carbon dioxide emissions. For example, studies using elasticities from the economics literature have shown that for oil, each barrel left undeveloped in one region will lead to 0.2 to 0.6 barrels not consumed globally over the longer term (Erickson et al. 2018).

The same principles hold with demand-side policies as well. Energy efficiency policies, for example, can lead to lower fuel prices, somewhat diminishing their benefits. Therefore, reducing demand and supply in tandem — through linked policies and targets — offers the advantage of neutralizing the potential for leakage, and increasing the effectiveness of each type of policy. Indeed, a coalition of countries acting together to limit both demand and supply can counteract global fossil fuel price change that could otherwise undermine the effectiveness of their climate policies (Asheim et al. 2019).

Global stocktake

Starting in 2023, and every five years thereafter, the Paris Agreement's global stocktake will assess collective progress made towards the long-term goals of the treaty. The outcomes of this exercise should help Parties to the Paris Agreement strengthen their climate action and support, and increase overall ambition. Given the importance of addressing fossil fuel supply for meeting the Paris Agreement's objectives, the global stocktake could assess the extent to which countries and other actors are winding down fossil fuel production and limiting their support for extraction-related activities. This assessment could facilitate learning by highlighting Parties' best practices and successes, as well as the barriers they faced while pursuing a wind-down of fossil fuel supply. Information to support such assessments could be sourced from Parties, scientific assessments (like those of the Intergovernmental Panel on Climate Change or IPCC), international organizations (like the International Energy Agency), and submissions from non-state actors. To assist in monitoring the alignment of fossil fuel production with Paris goals, Parties could voluntarily adopt extraction-based emissions accounting — alongside the IPCC's existing territorial emissions accounting approach, which is currently used in the climate change regime (Box 3.1).

Nationally determined contributions

Central to the achievement of the Paris Agreement's long-term goals is the requirement for Parties to communicate, every five years, their nationally determined contributions (NDCs) to climate action. Countries currently include a variety of emissions reduction targets and policies in their NDCs. They could add targets and measures to align their fossil fuel production with Paris goals (Piggot et al. 2018; Verkuijl, Jones, et al. 2019). This would help enhance the climate ambition of such plans and socialize the importance of taking both demand- and supply-side action. Countries could adopt a range of supply-side policies in this regard, including: moratoria on new fossil fuel infrastructure; removal of subsidies for fossil fuel producers; fossil fuel production and export taxes; and divestment of public funds from fossil fuel holdings (See Chapter

5). However, only two countries — India and Nigeria — currently include supply-side measures in their NDCs, according to an examination of NDCs from 57 of the top fossil-fuel-producing nations (Verkuijl, Jones, et al. 2019). The upcoming 2020 deadline for Parties to communicate new or updated NDCs offers an important window of opportunity for countries to include more supply-side approaches, as part of wider efforts to boost global climate ambition through these plans.

Long-term low-emissions development strategies

Long-term low GHG emission development strategies (LEDS) are national plans for transitioning to a low-carbon economy by 2050. As part of the Paris outcome, Parties are invited to voluntarily submit such plans by 2020. These plans typically include scenario planning and modelling to reduce territorial emissions, both in specific sectors and in the economy as a whole. They thereby play an important role in informing short- and medium-term action and in helping to provide political certainty regarding countries' low-carbon development trajectories (Espinosa 2018). Alongside such information, countries could use their LEDS to map out their fossil fuel extraction and infrastructure development pathways over a longer time frame, in a way that is consistent with global climate goals, and meets the just transition needs of fossil-fuel-dependent workers and communities. The LEDS submitted so far (April 2019) by fossil-fuel producing countries do not include this information (Verkuijl, Jones, et al. 2019). However, incorporating supply-side planning into LEDS can help countries to avoid a more costly and disruptive transition away from fossil fuel extraction further down the line. It further sends a strong political signal that countries are considering the impacts of fossil fuel production in their climate change planning.

Transparency and reporting

The Paris Agreement established an enhanced transparency framework to help build confidence and improve implementation of both climate action and support (Winkler et al. 2017). At the 2018 Katowice Climate Change Conference, countries agreed to identify indicators to track progress towards the implementation of their respective NDCs. Such indicators can be qualitative or quantitative, and could include information such as the percentage of renewable energy use or production and the share of fossil fuel in primary energy consumption (UNFCCC 2018). In recognition of the importance of winding down fossil fuel production for meeting climate goals, Parties could also provide information on their current and projected fossil fuel production levels. The first such opportunity to do so under the new transparency framework will be in 2024, when the first round of national "biennial transparency reports" is due. Countries could also report such information under the existing transparency framework, under which several reporting rounds are still anticipated. Moreover, in the review process, Parties can ask each other questions about the role of fossil fuel production in implementing and achieving NDCs.

Financing and capacity-building

In Article 2.1(c), the Paris Agreement aims to make finance flows consistent with a pathway towards low GHG emissions and climate-resilient development. Discussions on how to put this objective in practice will offer a clear opportunity to discuss how to wind down support for fossil fuel production. The Paris Agreement further stipulates that developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation. Governments and other funding agencies could support developing countries with just transition funds that help to retrain workers in fossil-fuel-dependent communities (Rosemberg 2017; UNFCCC 2016). In parallel, countries' technical and institutional capacity to wind down fossil fuel extraction could be enhanced through UNFCCC Technical Expert Meetings and the Paris Committee on Capacity-building, and international coalitions such as the NDC Partnership and LEDS Global Partnership.

Forum on the impact of the implementation of response measures

Many countries are grappling domestically with the question of how to plan a just and equitable transition away from fossil fuel production. With its focus on "economic diversification and transformation" and "just transition of the workforce, and the creation of decent work and quality jobs" (UNFCCC 2015), the UNFCCC's forum on the impact of the implementation of response measures offers a platform where relevant information, experiences, and best practices can be shared internationally (Jenkins 2019).

Showcasing action by subnational and local governments, civil society, businesses, and investors

Non-state actors and subnational authorities play a vital role in promoting a transition away from fossil fuel production (Chapter 5). Parties, with the backing of the UNFCCC Secretariat, could expressly support and spotlight civil society efforts to wind down extraction. For example, Parties could ensure that supply-side efforts taken by regions and

cities inform and strengthen national transition plans, and are reflected in NDCs and LEDS. The steps that subnational governments, civil society, businesses, and investors are already taking to address fossil fuel supply could also feature more prominently in the work of the Marrakech Partnership for Global Climate Action, which currently focuses almost exclusively on demand-side approaches. They can also be shared through the Global Climate Action database and yearbook, which captures non-state and subnational climate commitments and progress.

6.2. Winding down fossil fuel supply through other institutions

The previous section details various ways in which the UN climate process can advance international cooperation on supply-side climate policies. But governments also can pursue various options to address fossil fuel production outside of the UNFCCC context.

First, international cooperation can be pursued through new coalitions. Several possible models exist in this regard. For instance, Harstad (2012) suggests that a coalition of the willing could buy up and close high-cost coal fields through a system of tradable extraction rights. Building on this proposal, Collier and Venables (2014) suggest this could be financed through redirecting the economic rents from oil production. Richter et al. (2018) show that a coordinated coal tax adopted by a coalition of major coal producers or exporters could reduce emissions and leave these countries with welfare gains. While these contributions suggest that new supply-side-orientated coalitions may yield climate and economic benefits under certain conditions, it may be difficult to attract the participation of major fossil fuel producers from the start.

However, coalitions that have emerged in recent years show that they need not necessarily start with major fossil fuel producers and exporters. Instead, international cooperation "is likely to be contingent on a coalition of early-movers taking unilateral steps to limit or reduce fossil fuel supply (i.e. 'leading by example') and then persuading or incentivising other states to adopt similar restrictions" (Green and Denniss 2018, p. 83). Several initiatives have emerged that are arguably aimed at "socializing" other states to the idea of restricting fossil fuel supply (Green 2018a). For instance, Anote Tong, then-President of the small island state Kiribati, proposed a "no new coal mines moratorium", which was supported by several Pacific island nations (Pacific Island Development Forum 2015).

Another example of a related, though demand-side-oriented, coalition is the Powering Past Coal Alliance (PPCA), which aims to phase out existing coal-fired power plants. The PPCA quickly grew from an initiative by two countries — Canada and the United Kingdom — to a coalition

Table 6.1

Commitments by multilateral development banks to end fossil-fuel-extraction-related support. Unless otherwise noted, restrictions apply to direct financing but not indirect financing (e.g., via financial intermediaries).

Year	Institution	Policy	Source
2009	Asian Development Bank	Will not finance oil and gas exploration. Will not fund oil field development projects, but will consider supporting the development of "marginal and already proven" fields if economically sound. Will not directly finance coal mine development "except for captive use by power plant."	https://www.adb.org/sites/default/files/institutional-document/32032/energy-policy-2009.pdf
2012	African Development Bank	Will not finance oil and gas exploration.	https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/Energy_Sector_Policy_of_the_AfDB_Group.pdf
2013	World Bank Group	Will only finance coal mining in "rare circumstances".	http://documents.worldbank.org/curated/en/745601468160524040/pdf/795970SST0SecM00box377380B-00PUBLIC0.pdf
2017	World Bank Group	Will not provide direct financing for upstream (exploration and production of) oil and gas after 2019. (In exceptional circumstances, consideration will be given to financing upstream gas in the poorest countries, where there is a clear benefit in terms of energy access for the poor and where the project fits within the countries' Paris Agreement commitments.)	https://www.worldbank.org/en/news/press-release/2017/12/12/world-bank-group-announcements-at-one-planet-summit
2018	European Bank for Reconstruction and Development	Will not finance thermal coal mining or coal-fired electricity generation capacity, any upstream oil exploration, or upstream oil development projects except in "rare and exceptional" circumstances, where the projects reduce GHG emissions or flaring.	https://www.ebrd.com/power-and-energy/ebrd-energy-sector-strategy.pdf
2019	European Investment Bank	Energy lending policy phases out direct and indirect financing of energy projects reliant on fossil fuels by 2021. This includes upstream oil or gas production, coal mining, and infrastructure dedicated to coal, oil, and natural gas.	https://www.eib.org/en/press/all/2019-313-eu-bank-launches-ambitious-new-climate-strategy-and-energy-lending-policy

that includes more than 30 countries, as well as subnational authorities and businesses. As noted in Chapter 4, the Alliance now counts Germany, the world's eighth largest coal producer, among its members. Its success in attracting participation is in part due to the low barriers for joining (Green 2018b; Jewell et al. 2019; Blondeel et al. forthcoming).

Ideas have also been put forward for new coalitions that would include commitments to restrict the supply of fossil fuels, such as a "fossil fuel non-proliferation treaty" (Newell and Simms 2019), "fossil fuel free zones" (Green 2018c), and "supply-side NDCs" (Asheim et al. 2019). As fossil fuel infrastructure on the ground can be relatively easily observed via satellite, a key advantage of approaches such as these, compared to those targeting more abstract emissions reductions, is the ease with which commitments to address fossil fuel production can be monitored and verified (Green 2018b).

Second, international cooperation can take place through existing international forums (van Asselt 2014). A case in point is the issue of fossil fuel subsidies. The impetus for addressing such subsidies did not come from the UN climate process, but rather from high-level commitments by the G20, as well as capacity-building and information-gathering activities by international organizations such as the International Monetary Fund, the World Bank,

and the Organisation for Economic Co-operation and Development (Van de Graaf and Blondeel 2018). Reflecting the broader sustainable development benefits of fossil fuel subsidy reform, all countries have now agreed to take action through the adoption of Sustainable Development Goal (SDG) Target 12.c (UN General Assembly 2015). Other international institutions, such as the World Trade Organization, could further contribute to supporting such reform efforts by negotiating new rules that discipline fossil fuel production subsidies that also distort international trade, or by improving transparency (Verkuijl, van Asselt, et al. 2019).

Third, nation states, acting through international financial institutions, can shift financial support away from fossil fuel production. Some development banks have already taken steps in this direction. The World Bank Group, for instance, announced in 2017 that it would end its direct financial support for upstream oil and gas, following a similar commitment for coal mining. Similar commitments have also been made by several other multilateral development banks (Table 6.1). To help developing countries meet their energy needs, this would require support for low-carbon energy to be scaled up in parallel.

6.3. Toward an equitably managed decline in fossil fuel extraction

While climate equity has long been debated with respect to fossil fuel consumption (Fleurbaey et al. 2014; Gardiner et al. 2010), the study of equity impacts is more nascent when it comes to fossil fuel production (Bradley et al. 2018; Caney 2016; Green and Gambhir 2019; Kartha et al. 2016, 2018; Le Billon and Kristoffersen 2019; Lenferna 2018). However, the equity issues raised by reducing fossil fuel production are no less consequential than those raised by reducing demand. If fossil fuel production is to decline at a rate commensurate with meeting the Paris goals (Chapter 2), millions of workers who are directly involved in extracting fossil fuels would need to shift to different jobs. Communities economically dependent on fossil fuel production-related activities would have to sustain their livelihoods in new ways. Provision of affordable, reliable, and modern energy might, in some cases, become more difficult. National economies that are fuelled by domestic fossil resources would need to shift to alternative resources. And governments that depend heavily on revenues from domestic fossil fuel extraction would need to diversify and develop alternatives for funding public services.

These equity consequences are not only compelling from a moral standpoint but are politically important as well. Climate change is a commons problem, and an effective response requires global engagement and widespread cooperation that is robust enough to support a major global transformation. This is unlikely if the path forward is not broadly seen as fair by the nations whose participation is needed.

Insights from the transitions literature can help to inform how these equity questions might be fairly addressed (Muttitt and Kartha forthcoming). A country's ability to phase out extraction while meeting the needs of workers and communities depends in part on the scale of the transition required and the capacity for support. Countries or regions where a transition would be least socially disruptive could thus be best positioned to take the lead by winding down extraction earlier and faster.

A country's ability to wind down production also depends on the resources (financial and otherwise) available to support a smooth transition, which may be limited in lower-income producing countries. Since the costs of prematurely winding down extraction are incurred partly for the global common good, an equitable approach would ensure such countries are supported internationally. Importantly, this support should not be for the purpose of compensating for foregone revenues, but rather for aiding in economic diversification and for ensuring a just transition for communities and workers.

It is important not to ignore the fact that winding down extraction can also come with significant domestic benefits. Extraction and processing can be associated with deeply inequitable impacts, often in the form of human rights violations and local ecological damage (Amnesty International 2016, 2017; Rowell et al. 2005). An approach to aligning climate and equity considerations could thus be to link the wind-down of fossil fuel extraction with human rights and environmental agreements, by prioritizing the winding down of production in the places where human rights and environmental concerns are greatest.

Political economic factors will undoubtedly result in pressure to set aside these equity considerations. However, in the words of the Intergovernmental Panel on Climate Change (IPCC 2014, p. 5), outcomes "seen as equitable can lead to more effective cooperation".

In summary, winding down fossil fuel supply is an important step towards achieving international climate change goals. International cooperation can play a key role in catalysing such efforts. Within the UN climate change process, the Paris Agreement creates various new opportunities to support supply-side efforts through enhanced transparency, ambition, and learning. Looking beyond the UN climate regime, supply-side action can also be supported through new coalitions, and existing international processes and institutions. Inspiration can be drawn from initiatives such as the Powering Past Coal Alliance, as well as international commitments to address fossil fuel subsidies. Ultimately, such efforts will be most likely to succeed if they are deemed to be fair and equitable. Internationally agreed temperature limits, insights from the transitions literature, and existing human rights and environmental agreements can offer a starting point for informing this challenging — but urgent — task.

Tung Bua Tong Mexican sunflower field in Mae Moh Coal Mine, Lampang Province, Thailand.

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Chapter 5

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