Implementing coal transitions

Insights from case studies of major coal-consuming economies

A Summary Report of the Coal Transitions project

Based on inputs developed under the Coal Transitions Research Project (see inside cover for contributing researchers and institutions).

September 2018

Authors

Author: O. Sartor, IDDRI

Climate Strategies

IDDRI

COAL TRANSITIONS
www.coaltransitions.org

Implementing coal transitions

Insights from case studies of major coal-consuming economies

A Summary Report of the Coal Transitions project

A project funded by the KR Foundation

Author
O. Sartor, *IDDRI (France)*

Cite this report as
Sartor O. (2018). Implementing coal transitions: Insights from case studies of major coal-consuming economies. IDDRI and Climate Strategies.

Contact information

Oliver Sartor, IDDRI, oliver.sartor@iddri.org
Andrzej Błachowicz, Climate Strategies, andrzej.blachowicz@climatestrategies.org

Publishers: IDDRI and Climate Strategies
Editors: Pierre Barthélemy, Andrzej Błachowicz, Oliver Sartor
Graphic design: Alain Chevallier, Ivan Pharabod

A Summary Report of the Coal Transitions project

This report brings together the main insights from the research consortium "Coal Transitions: Research and Dialogue on the Future of Coal". The report summarises key findings from case studies in six countries (China, India, Poland, Germany, Australia and South Africa). These explore pathways to implement coal transitions . The study also draws from findings in earlier phases of the project, including global analysis of the impact of coal transitions on steam coal trade (cf. Coal Transitions, 2018a) and analysis of past coal and industrial transitions in over 10 countries (Coal Transitions, 2017), as well as political economy aspects of coal. The publications are available on www.coaltransitions.org

Acknowledgments

The Coal Transitions project secretariat is grateful to the many people who provided valuable input on the project that have contributed to this report, either directly or indirectly. In particular, Dave Collins, Herve Casterman, Samantha Smith, Grzegorz Peszko, Steve Fothergill, Subodh Sharma, Zou Ji, Henri Waisman, Thomas Spencer, Lola Vallejo, Michel Colombier, Nicolas Berghmans, Germana Canzi, Alexandra Carr, Diana Quezada, Roxana Mastor, Matt Philipps, and Keith Allott. The project partners gratefully acknowledge funding by the KR Foundation, with additional support from the European Climate Foundation (ECF). We are also very grateful to the numerous researchers that have contributed new insights in the national reports and case studies (see below).

Contributing national researchers and institutions to the Coal Transitions project:

T. Fei *(Tsinghua University, China)*

A. Garg, S. Vishwanathan *(Indian Institute of Management Ahmedabad, India);*

V. Tiwari, *(Indian Institute of Information Technology, Allahabad)*

J. Burton, T. Caetano, B. McCall *(Energy Research Center, University of Cape Town, South Africa)*

F. Jotzo, S. Mazouz *(Crawford School of Public Policy, Australian National University, Australia),*

J. Wiseman, S. Margaret-Campbell, L. Coenen, F. Green
(Melbourne Sustainable Society Institute, University of Melbourne, Australia)

P. Lewandowski, A. Szpor, J. Witajewski, J. Baran *(Institute for Structural Research (IBS), Poland)*

J. Richstein, I. Jürgens, P.Y. Oei, H. Brauer, P. Herpich, C. von Hirschhausen, F. Holz,
I. Kafemann, T. Scherwath, K. Neuhoff *(German Institute for Economic Analysis (DIW Berlin), Germany)*

Implementing coal transitions

Insights from case studies of major coal-consuming economies

A Summary Report of the Coal Transitions project

Executive Summary

This report brings together the main insights from the Coal Transitions project. Coal Transitions was an international research consortium seeking to support fact-based dialogue on the future of coal. The research side of the project included three work streams:

- Analysis of past coal and industrial transitions
- Case studies on pathways to implement coal transitions compatible with the "well below 2°C" objective in six major coal-using economies, i.e. China, India, South Africa, Poland, Germany, and Australia
- Analysis of the impacts of coal transitions on the global coal trade.

The national case studies cited in this report were developed by national experts on the coal sector, as well as on energy systems, labour markets and industrial policy in the respective countries. The case studies aim to suggest concrete options for implementing national coal transitions that are consistent with the "well below 2°C" aim of the Paris Agreement, while being fair and just, and respecting national differences. However, they are not necessarily compatible with the Paris Agreement aspirational goal to limit temperature increases to 1.5°C. Further information on the methodology used for the research can be found in the introduction to the report and in the specific reports this study draws from.

Key findings

1. Coal transitions are already happening. Due to both climate and non-climate policy factors, global coal consumption could go into reverse by the early 2020s, if it has not done so already. In this context, it is incumbent upon governments and responsible stakeholders to prepare for a managed coal transition. 36 governments and 28 companies around the world have already committed to phasing out coal from the power sector by 2030. Governments are beginning to put in place new exploratory initiatives, just transition task forces, coal transition commissions and stakeholder consultation platforms to explore options for the end of coal use.

Momentum is also building in major coal-consuming economies. In large developing economies like China, India and South Africa, policies have been introduced recently or are being discussed to curb and/or reduce coal consumption over the coming decade. A debate is now emerging on when coal use should begin to either peak (India) or decline (China, South Africa). This is generating discussion on when and how to manage coal transitions in these countries, a process that is both demonstrated and supported by the Coal Transitions project.

2. Coal transitions are technically feasible and affordable. The analysis of the techno-economic scenario required to stay below 2°C for all six countries showed that by 2040-2050 coal can be replaced with a portfolio of alternative energy sources, including solar, wind, hydro, biomass, nuclear, and natural gas. Even in scenarios with CCS, coal remains a minor part of the power mix in 2050, due to its cost and feasibility challenges.

Because of the growing competitiveness of renewable energy, the transition to these alternatives can occur without significantly higher costs for the electricity system. In some cases, such as South Africa, costs for consumers could be reduced diversifying the power mix. A lower reliance on new coal plants and a greater focus on promoting off-grid solar-plus-battery solutions was also found to provide cheaper and more effective access to electricity for off-grid communities in places like India. Governments can avoid stranded assets in the coal sector by avoiding overbuilding new plants, retiring old amortised ones, and ensuring maximum operational lifetime policies for remaining coal plants.

3. A "just transition" for coal workers and communities is possible. While there is no universal blueprint for implementing a just transition, the Coal Transitions project identified a large number of specific policy solutions. Many of them have been tried and tested during past coal transitions. The design of such programmes matters greatly to their effectiveness, as does the meaningful consultation and participation of stakeholders early on in the decision-making process. However, early anticipation and preparation of the transition is vital to achieve the best results. Tailored workforce transition programmes and the building of local economic resilience require time, preparation and learning by doing.

4. Coal transitions can strengthen global climate action and deliver other social and economic objectives. The project found, for instance, that in India a lower reliance on coal-fired power plants (which require water for cooling) would help reduce conflicts between water and electricity access in water-stressed regions. In China and India, reducing coal use would help eliminate one of the major contributors of SO2, NOx and PM2.5 particles that adversely affect human health. In Africa and India, energy access could be cheaper and more effective with micro-grids than new coal plants.

In South Africa, diversification from coal in the power sector would help reduce the cost of supplying electricity, while limiting the risk of cross-subsidisation of the power sector by the coal export sector. In Poland, implementing a managed transition for lignite mining would help prepare for the exhaustion of lignite mines expected within the next 10-20 years. In Australia, coal transitions are also about prudent planning for the decline of export markets.

In many cases, coal mining regions are already facing significant social and economic challenges. In these communities, coal transitions can become a useful "excuse" to create an inclusive dialogue and strategy for the future generation. "Just transition" therefore needs to be not only about mitigating the unwanted impacts of phasing down coal.

In the countries examined in this report, stakeholders in the coal sector often acknowledge that the days of coal are numbered and there is a need to prepare the transition. Doing so, however, requires governments to take ownership of the problem. This means establishing a dedicated policy framework to support a fair and managed transition for all affected parties. This report and the research upon which it is based provide a number of options that policy makers may wish to consider for coal transitions. It also highlights areas where further research on coal transitions is needed.

1. Introduction

The international context surrounding coal as an energy source is changing quickly. Coal accounts for just under 30% of the world's primary energy mix, where it is used primarily for power and heating (2/3) and in industry (1/3) (IEA, 2017). However, the sector will need to transition to a minimal share of global energy production by 2050, if global climate objectives under the Paris Agreement are to be met (McGlade and Ekins, 2015; IEO WEO 2017). Moreover, air and water constraints, declining costs of alternative technologies, small-scale storage solutions, and economic rebalancing in China, will increasingly put pressure on global thermal coal consumption.

Together, these factors are generating a discussion on how to transition from coal to alternative energy sources. Coal transitions are complex because they raise a number of issues. How can policy makers ensure a fair transition for affected workers? How to support economic resilience for local economies and their communities? How to prevent large scale stranding of existing assets? How to ensure universal access to affordable electricity while phasing down coal? These are only some of the questions.

The Coal Transitions research project was set up in this context. "Coal Transitions: Research and Dialogue on the Future of Coal" is an international research consortium seeking to support fact-based dialogue on the future of coal through innovative research. The project's three analytical work streams included:

- Analysis of past coal and industrial transitions[1]
- Case studies on pathways to implement coal transitions compatible with the "well below 2°C" objective in six major coal-using economies, i.e. China, India, South Africa, Poland, Germany, and Australia[2]
- Analysis of the impacts of coal transitions on global coal trade[3].

This report brings together the main insights from the three workstreams. It also draws on relevant literature and includes observations from dialogues with stakeholders held throughout the project. he main focus of this work was on thermal coal (i.e. coal used for electricity and heat production). Transitions for coking coal are more specific and require a separate focus exploring linkages between the steel sector and the coal sector.

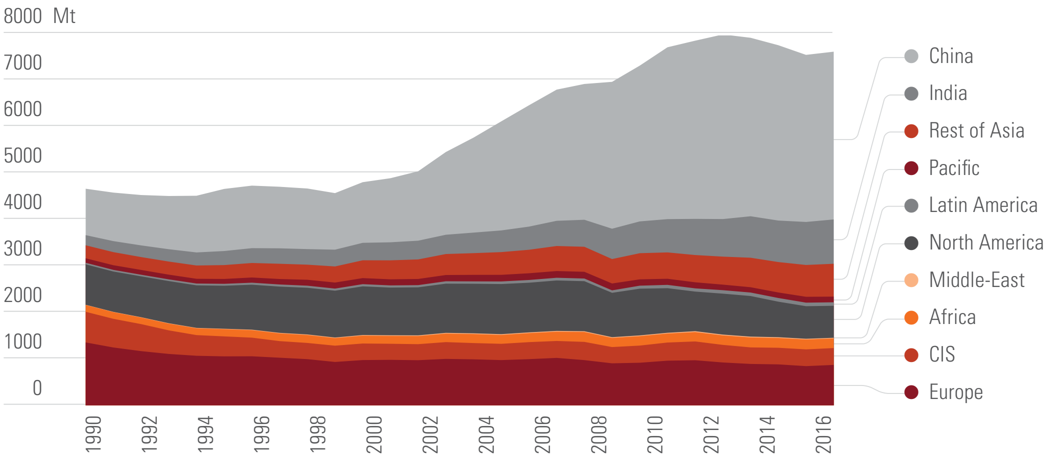
The six countries chosen for the case studies are among the 11 largest coal consumers in the world. Together they accounted for 68.6% of global coal consumption

1 Cf. Coal Transitions, 2017; Campbell et al, 2017; Herpich et al, 2018; Green, 2018 in the Annex.

2 Cf. Coal Transitions 2018b, 2018c, 2018d, 2018e, 2018f, 2018g, 2018h; Spencer et al, 2017.

3 Cf. Coal Transitions, 2018a.

Figure 1. Global coal and lignite consumption (includes thermal and metallurgical coal)



Source: Enerdata.

in 2017 (Enerdata, n.d.). They were selected to reflect different levels of economic development, a diversity of geographical regions, and a balance between major importers (China, India) and exporters (South Africa, Australia).

The case studies were developed by national experts on the coal sector, as well as on energy systems, labour markets and industrial policy in the respective countries. The case studies for these countries explore concrete pathways for national coal transitions that are consistent with the "well below 2°C" aim of the Paris Agreement (cf. Section 3). Each team explored first the transformation scenarios for the energy system consistent with its carbon budget. This was done using techno-economic modelling.

Secondly, teams were asked to develop assessments of options to tackle the socio-economic or political economy elements of the transition. Thus, teams explored implications for access to electricity for poorer households, labour market issues for coal workers, economic options for affected regions, and stranded assets. This was done to varying degrees of detail, depending on the competencies and preferences of the national teams. Selected insights on the national pathways are included throughout the report and in the annex.

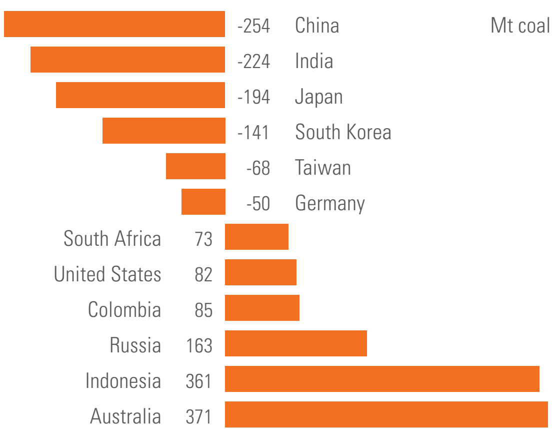
This report is structured as follows. Section 2 presents a non-exhaustive survey of current coal transitions around the world. Section 3 discusses the economic aspects of coal transitions, with a focus on the costs and economic feasibility of shifting to alternative energy sources. Section 4 focuses on options for implementing a fair transition for workers and affected coal- or power-producing communities. Section 5 highlights issues related to the governance and financing of the transition. Section 6 concludes the study with a focus on overarching policy implications and issues for further research.

Table 1. Countries ranked by national coal consumption

Rank	Country	Coal & lignite consumption (Mtpa) *
1	China	3607
2	India	953
3	United States	649
4	Russia	232
5	Germany	222
6	Japan	196
7	South Africa	192
8	South Korea	136
9	Turkey	134
10	Poland	129
11	Australia	119
12	Indonesia	100
13	Kazakhstan	78
14	Taiwan	68
15	Czech Rep.	45

Source: Enerdata. **Includes metallurgic and thermal coal*

Figure 2. World's major coal importers and exporters in 2017 (all coal types)



Note: negative numbers represent net importers, positive numbers represent exporters

Source: Enerdata.

2. Coal Transitions are already happening

Coal transitions are happening now because demand for thermal coal is slowing down and, in some regions, already in decline. They are therefore gathering momentum as an issue that calls for dedicated policy intervention by governments. "Managed" coal transition initiatives are now being implemented or are actively discussed and explored in a growing number of countries. It has been argued by some that coal transition initiatives are only occurring in a small group of OECD countries (e.g. New York Times, 16/11/2017). However, this is no longer true. The idea of the need for an actively managed "coal transition" is gaining momentum as an issue both in developed and developing countries. This is happening – albeit to varying degrees – in countries with small amounts of coal use, like France, and in larger coal-consuming countries such as China, India, Mexico and South Africa.

2.1 The different drivers of coal transitions

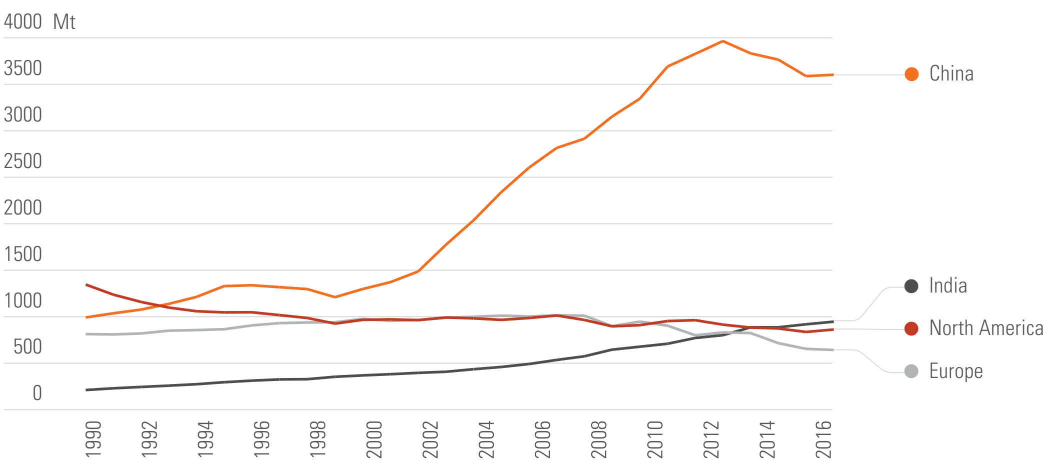
Coal transitions are not just about climate policy. On the contrary, climate policy is one of the many factors that are already (and will increasingly be) diminishing the role of coal in the global energy system. To be sure, part of this transition is driven by active climate and coal transition policies, and this is necessary to achieve the goals of the Paris Agreement (see Section 2.3 below). However, urgency is added by the fact that the demand for thermal coal has stopped growing and is already declining in some regions.

As shown in **Figure 1** above, global coal demand declined in three of the past four years. Coal is in secular decline in major economies, such as Europe and the United States. Most recently in China, as a process of rebalancing and closing down of inefficient production capacity has begun, demand has fallen, despite a small bump upwards in 2017 (**Figure 3**).

Figure 4 and **Figure 5** also show that recent projections on global coal demand have consistently been revised downwards in the past five years. Indeed, in 2017, for the first time, coal demand was projected to remain flat until 2020. A major shift occurred in the 4 years to 2017, as demand in 2020 is now estimated to be 1 billion tonnes of coal equivalent lower than what was projected in 2013. This highlights not only how quickly short term forecasts can change, but it also suggests that the fundamentals of the global coal market are changing in ways that are not necessarily well captured even by high quality projections such as those of the International Energy Agency (IEA).

What is driving these shifts and what do they mean for the future of coal demand? The Coal Transitions project identifies four key factors are play, and climate policy is just one of them.

Figure 3. Recent coal consumption trends in four major economies (all coal types)



Source: Enerdata.

Firstly, **structural economic factors** suggest that the strong link between economic growth, employment and coal use in developing countries (and especially in China) is now weakening if not breaking down. These factors include: the rebalancing of the Chinese economy and the rationalisation of some excess industrial capacity (Grubb et al, 2015); the rise in other developing economies of growth models that are service-led rather than based on the export of industrial products (Rodrik, 2015); the existing overcapacity for power production in China and India. To illustrate the latter, the average load factor of coal-fired power plant has recently been around 45-55% in China and 60% in India (Spencer et al, 2017; Coal Transitions, 2018b & 2018c).

In addition to these macro-economic trends, there are micro-economic ones specific of the sector. For example, employment in coal mining has been declining for decades in most regions due to greater mechanisation and new mining techniques. In the US, mechanisation together with shale gas contributed to a fall of the mining workforce: in 1980, 220 000 workers were needed and each worker produced just 4 short tons per day, while in 2016 only 60 000 workers were each producing 14 short tonnes (Kok, 2017).

Developing countries are not immune to these issues. It has been estimated, for instance, that Chinese mining over-capacity is in the order of a billion tonnes per annum and that, as a consequence, 2.3 million of the country's circa 5.3 million coal mining workers will need to find alternative employment by 2020 (China Dialogue, 07/08/2017). This also poses challenging questions for the future of China's coal mining regions, especially given that large SOEs do much of the extraction and, in turn, pay for crucial public services to local communities, such as schools, hospitals, and infrastructure (China Dialogue, 14/01/2016). Coal transitions are therefore happening irrespective of climate policy and need to be managed.

Secondly, the **growth of alternative energy technologies** is gathering momentum on its own. This is true in the United States, where shale gas and renewables are causing a drastic reduction of coal use in the power sector (**Figure 3**). Renewable energy and related technology solutions in particular, despite various challenges, are emerging faster than expected. Thus, India has recently revised its renewable energy target from 100GW to 175GW by the mid-2020s.

Renewables are supported by the fact that they are becoming competitive with, if not cheaper than, coal in certain key markets (cf. **Figure 6**). Various solutions are also emerging to solve intermittency problems, including small scale storage, more stable offshore wind, demand response systems, market design reforms, improved infrastructure connections, and in the medium to long term, durable storage (IRENA, 2017; RAP, 2014; Agora Energiewende, 2015 & 2018; IEA, 2017b; Martinez et al, 2014; McKinsey, 2018).

Micro-grids (which combine small scale storage and renewable power) also increasingly appear as a superior solution for electricity access of energy poor or stranded populations, compared to new coal plants (IEA, 2017a; The Economist, 2017; Medium, 2017; Coal Transitions, 2018c). This point is illustrated in **Figure 7** below, which

Figure 4. IEA WEO global coal demand forecasts evolution (Current Policies Scenarios)

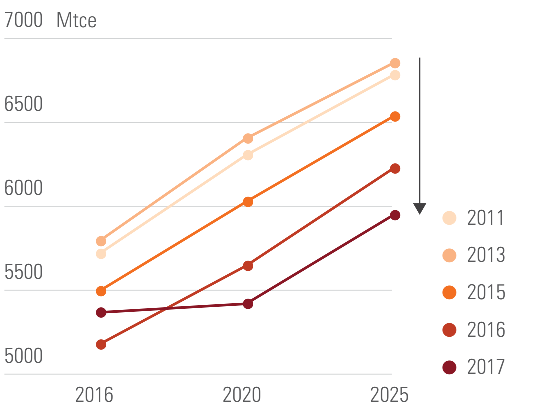
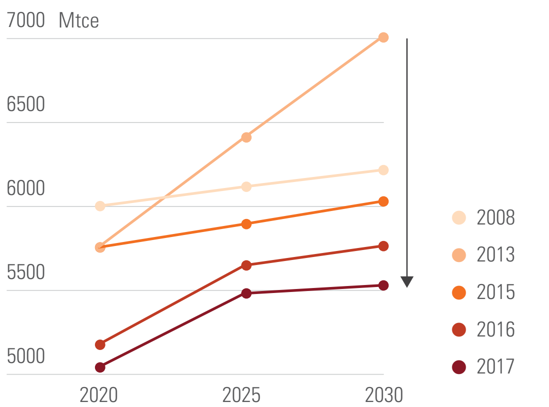


Figure 5. IEA WEO global coal demand forecasts evolution (New Policies Scenarios)



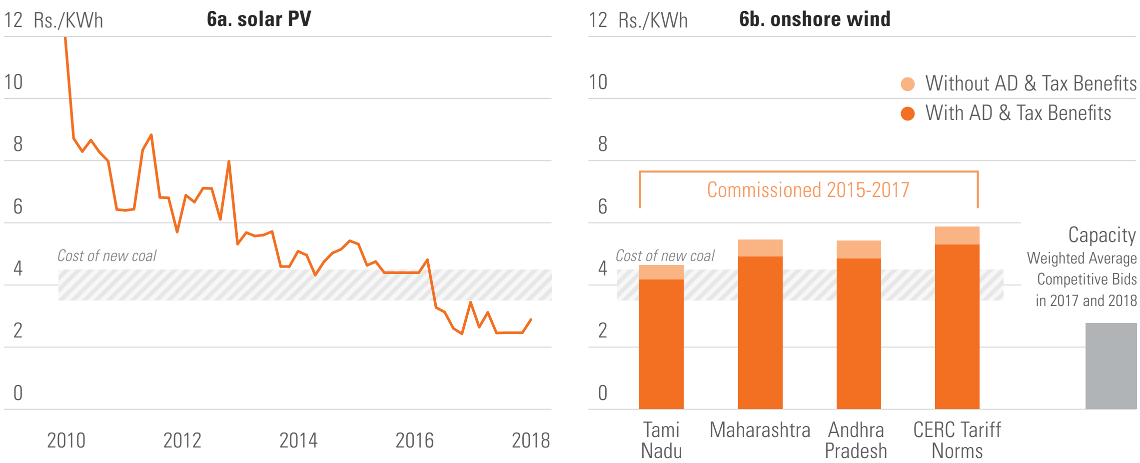
Source: IDDRI, based on forecast data from IEA WEO reports.

Note: Figures here are in Mtce rather than Mtpa as above.

compares the global average cost of grid-scale solar farms and wind parks with firming by Li-ion batteries to the median cost of new state-of-the-art Ultra-super-critical coal plants (literature estimates). It shows that the three options, and especially solar PV with battery storage, are becoming competitive[4]. The argument that, due to its low cost, coal is a necessity for economic development and universal energy access for the poor is therefore weakening.

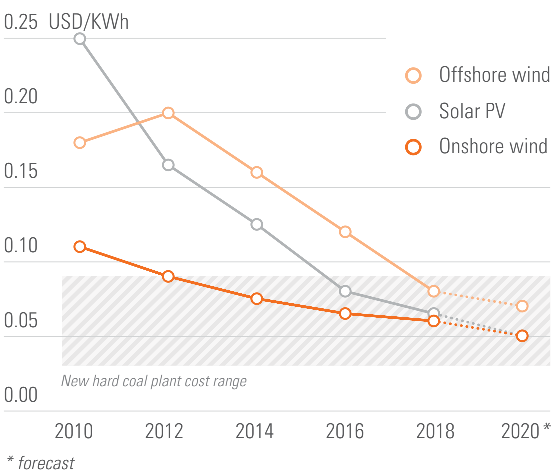
Thirdly, the **local environmental impacts of coal** are increasingly showing the lack of compatibility between sustainable development and large scale and locally concentrated deployment of thermal coal plant. For example, air pollution has become a major economic and social issue across China, and especially in the Beijing-Tianjin-Hebei area and the Yangtze River Delta. Coal combustion contributed 91.18% of total SO2 emission, 68.56% of NOx emission, and 52.74% of

Figure 6. Renewables costs versus new coal in India (Levelised cost, Rs/Kwh)



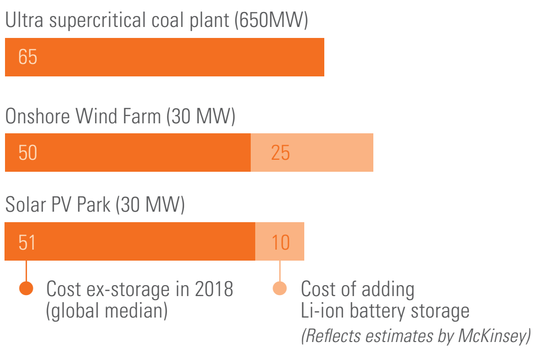
Source: Coal Transitons, based on tariff orders from CERC and SERCs and results of competitive bidding

Figure 7. The increasing competitiveness of renewable energy with hard coal technologies (global median auction results)



Source: IDDRI, based on data from IRENA, World Coal Association.

Figure 8. Current cost estimates of supercritical coal *vs* cost of onshore wind and solar PV with Li-ion battery use as capacity firming



NB. Figures reflect global averages for auctions for different installation sizes and not necessarily represent local costs in all locations, which can be significantly lower (or higher).

Source: IDDRI based on data from IRENA, 2018; McKinsey, 2018.

4 Note also that these calculations are based on global averages from 2018, so they do not account for places where renewables projects are significantly cheaper, nor for the further expected decline in technology costs for battery or other storage solutions.

primary PM2.5 emissions in 2012 (Coal Transitions, 2018c). According to a study of the World Health Organization, air pollution accounts for more than one quarter of premature death and is a significant cause of health problems in China.

Such concerns are increasingly important as a policy driver for the phase down of coal in China. For example, an estimated 63 million households would be shifted away from coal by 2021 under a new 5-year heating plan, replacing demand for approximately 140 Mt of coal per annum (Reuters, 2017).

In India, 10.4 GW of coal plant capacity was temporarily shut-down in 2017 to save water used for plant cooling in water-stressed regions. Air quality and fly ash handling disposal, as well as land degradation due to mining activities, also remain major concerns. **Figure 9** shows the number of coal plants reportedly shut down in India between 2001 and April 2017, as water stress is of growing concern. Government officials are requiring that coal plants be retrofitted with "dry-cooling technology", which is possible, but contributes to an energy-loss of around 10% that does not go into producing electricity, making the operating costs of the coal plants significantly higher.

In this context, **climate policy** is only increasing pressure on the demand and the future prospects of coal reinforcing the above trends. This is discussed further in Section 2.3.

Table 2. Generation losses for power plants shut down due to water scarcity during 2013 to 2017 in India

Year	Number of Units	Loss of generation in million units*
2013-14	16	5253
2014-15	9	1,258
2015-16	15	4,989
2016-up to Feb 2017	21	5,870

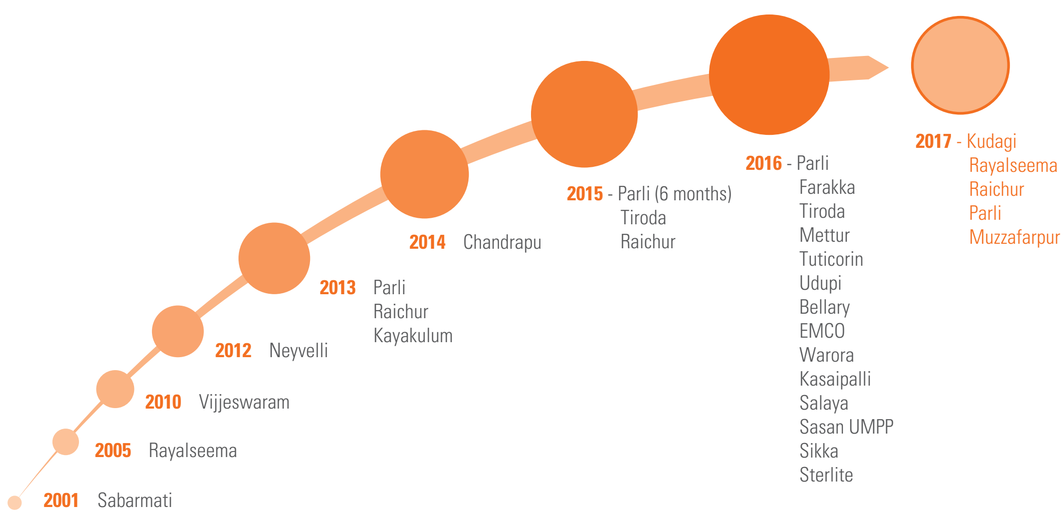
Source: GoI (2018d) *Note: * One unit = kilo watt-hour*

Action is not yet consistent with the Paris Agreement

To be clear, these four factors are not sufficient to drive an immediate abandonment of thermal coal, nor to achieve a coal transition compatible with the Paris objective of 2°C temperature increases. More ambitious and more comprehensive policies for a faster transition are therefore urgently needed. The upcoming 5-year revisions of countries' Nationally Determined Contributions (NDCs) under the Paris Agreement, in 2020, 2025 and so forth, must reinforce these transition.

Nonetheless, these factors are already having a meaningful impact on the demand for coal. Together they suggest that the outlook for coal is bleak and requires an active management strategy to help stakeholders and governments with the fall-out. This is increasingly

Figure 9. Temporal power plant shut down (2001- March2017)



Source: IIMA, Coal Transitions.

urgent. The analysis of coal demand drivers by experts in China, India, the United States, Australia, South Africa, Germany, conducted under the Coal Transitions project, suggests that the *most likely* scenario is that global thermal coal demand will be in decline during the 2020s, if it is not already occurring (Coal Transitions, 2018a). These scenarios are illustrated in **Figure 10**.

2.2 Are major coal exporters prepared for the decline in global demand?

The combination of mutually reinforcing drivers of coal transitions suggests that when it comes, change may be non-linear, and may occur more abruptly than stakeholders expect (Coal Transitions, 2018a). This raises significant risks for major coal exporters.

Analysis by the COALMOD Global Steam Coal Market Model, conducted for the Coal Transitions Project, suggested that even small shifts, such as the ones depicted below, could potentially have strong impacts on major exporters (Coal Transitions, 2018a). This is partly because thermal coal export demand represents a small share of global consumption (see **Figure 11**), and partly because large importers, such as China and to a lesser extent India, could meet large part of a sudden decline in domestic demand with domestic production. Even a 5-10% decline in Chinese coal demand could easily eliminate roughly one third of the global export market.

An important finding of the Coal Transitions project was that, if old "business as usual" scenarios are re-evaluated taking into account the factors now driving the future coal demand, of this magnitude could easily occur. **Figure 10** and **Figure 11** shows the results from the project's global modelling work and breaks down total global thermal coal supply into different sources. Old scenarios (represented in the top left corner) should arguably now be replaced by more conservative and pessimistic aggregate coal use and coal trade forecasts. This is particularly true in order to achieve the goals of the Paris Agreement (top right figure). However, *even if* the Paris Agreement is not fully implemented, the analysis of other drivers of the coal transition shows an emerging trend of decline for both coal use and imports post-2025 (bottom left and right).

Thus, even in the case of partial or fragmented climate policy, exporters could face negative outcomes.

These scenarios are arguably conservative as regards impacts on seaborne trade. As the modelling is based on market economics, they do not factor in political economy considerations. In the latter case, the consequences for major exporters could be more severe. This is because in some cases high domestic overcapacity could create the political demand to privilege domestic coal over cheaper or higher quality imports.

It remains to be seen how future iterations of NDCs will affect coal use. Significant revisions could lead to stronger reductions driven by climate policy.

2.3 An international overview of coal transition initiatives, policies and stakeholder views

This section presents an overview of coal transition initiatives, related policies and national discourse in selected countries around the world. It is not an exhaustive survey. However, it goes beyond the six countries for which case studies were produced under the Coal Transitions project. Its purpose is to highlight that in a diverse and growing number of countries and regions, coal transitions are either happening or being actively discussed and explored by stakeholders and policy makers.

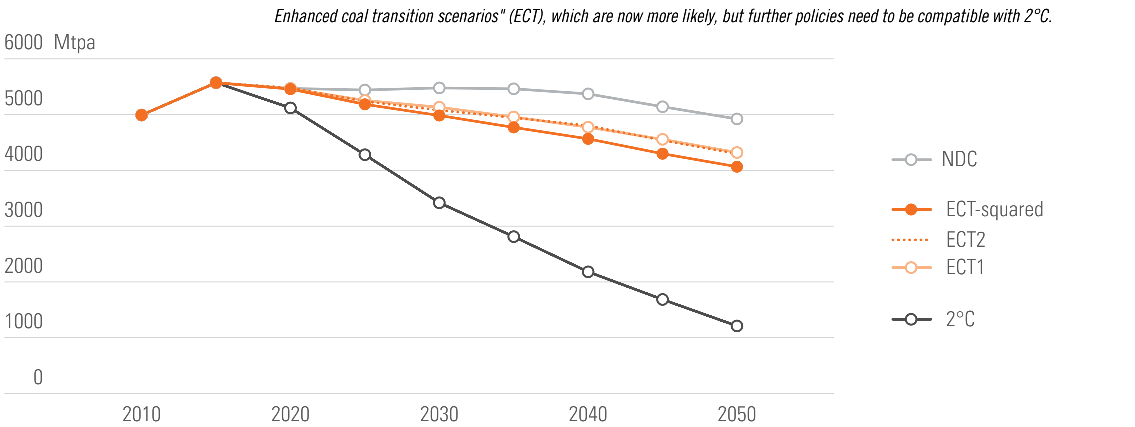
Governments and companies with full coal phase-out policies

As of mid-2018, 36 governments and 54 companies have pledged to phase out thermal coal use by 2030 at the latest, under the Powering Past Coal Alliance (PPCA) launched in 2017. These include OECD members like Canada, Austria, France, the UK and the Netherlands, middle-income countries such as Mexico, as well non-OECD countries such as Fiji, El Salvador, and Ethiopia. Both sub-national governments, such as California, Alberta and Ontario, and national governments are represented.[5]

A criticism of the PPCA is that participating countries do not account for a large share of global coal use. Collectively, they represent only 3-4% of global coal demand. However, the importance of the PPCA is that it is forcing these countries to develop policy frameworks and international dialogue on experiences that are of relevance and can be used as good practice elsewhere.

5 Under the Powering Past Coal Alliance, 36 governments and 28 global energy companies have committed to phasing coal out of their operations. Governments include: Province of Alberta, Angola, Austria, Belgium, Province of British Columbia, Canada, California, Costa Rica, Denmark, El Salvador, Ethiopia, Fiji, Finland, France, Great Britain, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Marshall Islands, Mexico, Netherlands, New Zealand, Niue, Province of Ontario, State of Oregon, Portugal, Province of Québec, Sweden , Switzerland, Tuvalu, City of Vancouver, Vanuatu, State of Washington. These governments collectively represent roughly 3% of global coal demand.

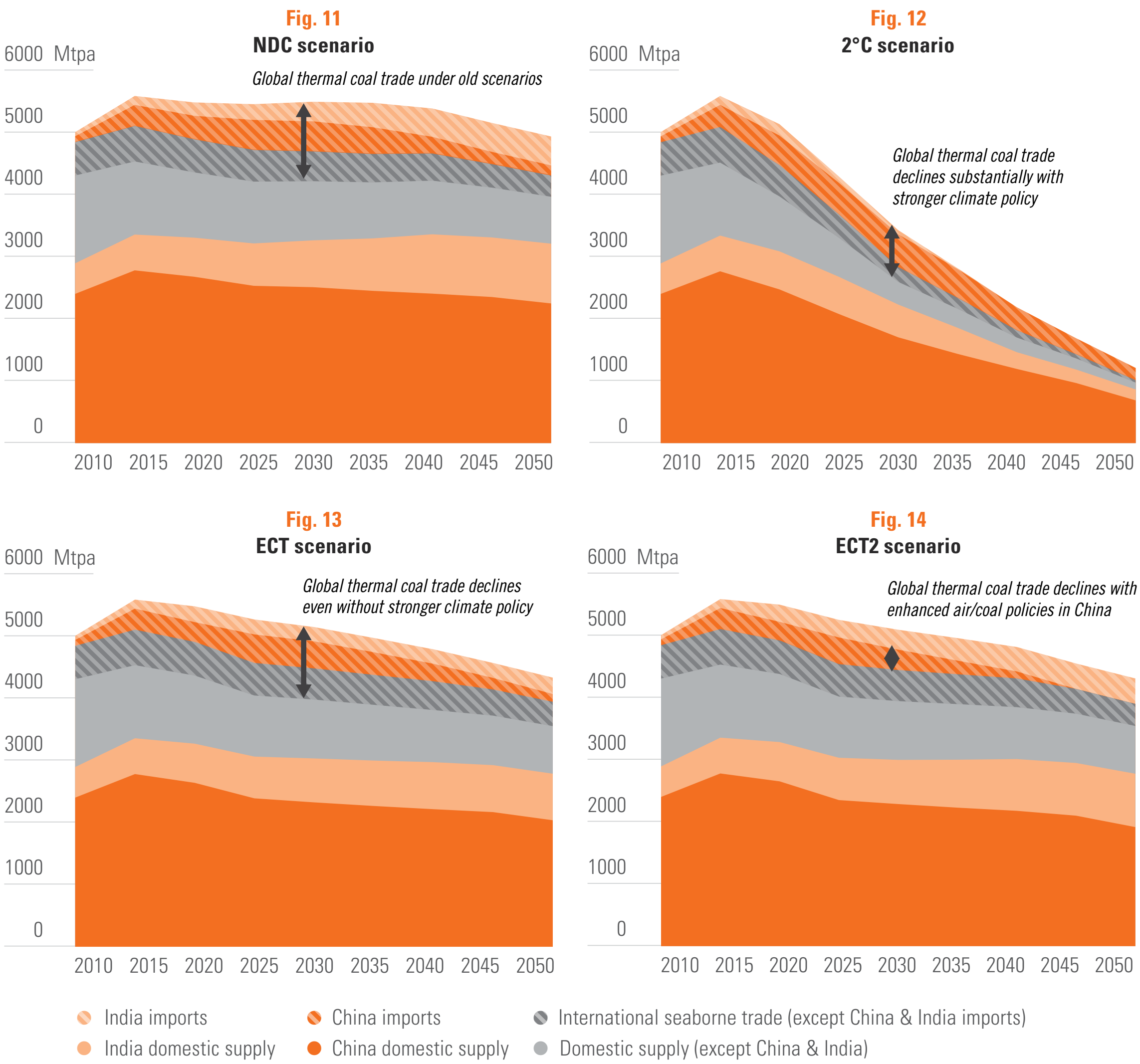
Figure 10. Global coal consumption 2010-2050 in various scenarios in Mtpa



Source: Coal Transitions project.

Note: Figures for thermal coal only

Figures 11. How thermal coal exporters are vulnerable to a decline in global demand from major coal consumers



Source: Coal Transitions and Coalmod-World results.

Note: Figures for thermal coal only

For instance, **Canada**, which has set a goal to completely phase out coal power by 2029, has established a Task Force for Just Transition for Canadian Coal Power Workers and Communities (Government of Canada, 2018). In line with this, the Canadian province of Alberta has established a Support Program for Workers affected by Coal Phase Out (Province of Alberta, 2017). These initiatives are viewed by prominent voices in the international labour movement as successfully reflecting principles of just transition that were agreed by the International Labour Organisation (ILO, 2015).

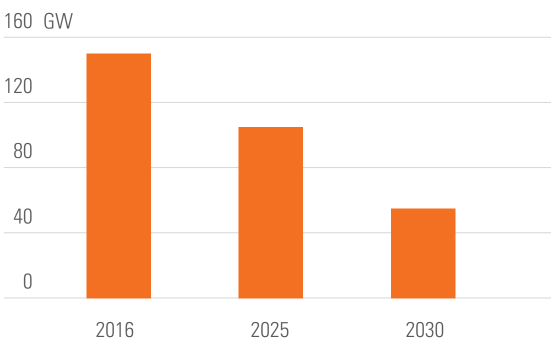
Of course, in many of these places, the design of the transition strategy is not finished and in some cases policies are imperfect. However, these examples are important as test cases and learning experiences.

Governments with emerging or partial coal transition policies

In the **European Union**, there is currently no official coal phase out policy covering the 28 member states. However, there are a number of elements that the European Commission is trying to pull together to develop a coherent coal and fossil fuels transition strategy. The European Union has already adopted targets to reduce GHG emissions by between 80-95% by 2050. Modelling shows this will require a decarbonisation of the power sector of about 99%, only a minor part of which might be achieved with coal plus CCS (Spencer et al, 2016).

To reach the target, the EU also has established a carbon market that, although imperfect, will increasingly put pressure on coal use over the coming decades. In addition, it has gradually tightened standards on local pollutants from large combustion plants, and strengthened renewable energy and energy efficiency policies. Some suggest that this, combined with their age, will lead to the closure of many coal plants throughout Europe in the coming decade (JRC, 2018) (**Figure 12**).

Figure 12. EU JRC's Forecast of Total Coal-fired power capacity in Europe to 2030



Source: IDDRI, based data from JRC, 2018.

What has been missing in the EU until now is a dedicated policy framework for assisting member states and their coal-using regions and workers to make a just and managed transition. However, this is changing. The European Commission has recently developed the EU Coal and Fossil Fuel Regions in Transition Initiative (EC, n.d.). Its purpose is to explore concrete ways by which the EU can provide support (e.g. funds, technical expertise, innovation support), to facilitate the transition of highly impacted regions.

At the member states level, many countries have committed to phase out coal under the PPCA mentioned above. The two largest coal consumers that have not yet committed to phasing out coal are Germany and Poland. However, this too may be changing. **Germany**, where thermal coal and lignite still represent 37% of the power mix, has recently established a Structural Reform Commission (informally known as the "Coal Commission"). The Coal Commission brings together a broad mix of stakeholders and experts. Their mandate is to decide on a coal phase out schedule and strategy and provide recommendations to the government by December 2018.

Beyond Europe and the OECD, a discussion on the future of coal is also emerging. It might not be transition strategies as such, but there are indications of a global momentum towards a changing policy paradigm for coal. In **China**, rising concerns about air quality are contributing to a significant rethink on the future coal. There is also concern about overcapacity and a need for economic diversification away from construction and energy intensive industries. Such concerns have led to a state-imposed cap on coal consumption at 4.2 billion tonnes per year.[6] To meet this target, 120GW of planned new coal-fired capacity have been cancelled in the past 2 years. In addition, under a new 5-year heating plan, an estimated 63 million households will be shifted away from coal by 2021, replac-

6 In 2014, the State Council issued the National Energy Development Strategy Action Plan (2014-2020), and clearly stated that, by 2020, the total annual coal consumption should be capped at 4.2 billion tons/year, and among the primary energy consumption the share of coal should be below 62%. In the National Air Pollution Control Action Plan issued by Ministry of Environmental Protection, the National Development and Reform Commission and other key ministries, the detailed coal consumption control target is further explicitly stated for key provinces and cities.

ing demand for approximately 140 Mt of coal per annum (Reuters, 17/12/2017). China also imposed a ban on new domestic coal mines in 2016 (China Dialogue, 2016).

National experts in China are now further exploring the possibility of a decline in coal use from 2020 onwards, as part of a strategy that could see China's total GHG emissions peak by 2025 (Coal Transitions, 2018b). As shown in Figures 13 and 14, this would see China's emissions peak at least 5 years earlier than currently pledged in its Nationally Determined Contribution to the Paris Climate Agreement, with coal use beginning to decline already from 2020.

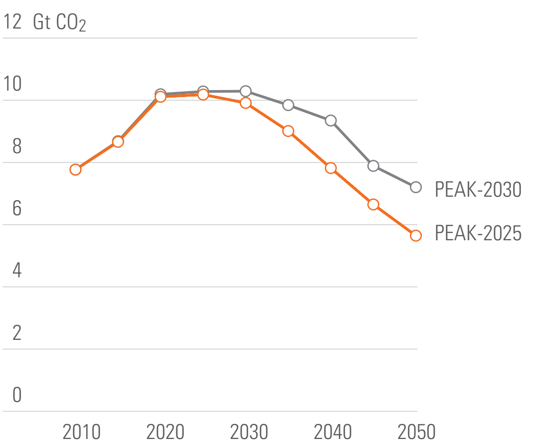
This, in turn, is leading to a focus on options for China's coal-intensive regions to diversify their economies and replace the employment and investment opportunities brought by mining SOEs (China Dialogue, 2016); on how to manage the risks of stranded assets in China's large coal-fired power and mining sector (Spencer et al, 2017); and on how to make cleaner energy options more accessible for heating in poorer households (Coal Transitions, 2018a). To date, these questions have not been fully addressed. However, the Chinese Government appears to be acutely aware of the issues and the coal transition is arguably a topic for the country's 14th 5-year plan (2021-2025).

In **Japan,** the country's new Energy Plan also proposes significant shake up to the energy sector with coal set to be squeezed out in favour of renewables, nuclear, and gas. Coal currently makes up 30.3% of the Japanese primary energy mix. However, under the government's Fifth Basic Energy Plan, which extends until 2030, the country would set strict new efficiency standards for all thermal power plant (a minimum 44.3% thermal efficiency rating would be required to be met by 2030). This would in effect lead to the retirement of a significant number of old coal plant, which currently do not come close to meeting the standard. Ultimately, investors in new plant will therefore face a choice been investing in the most efficient (but also most expensive) coal plant technologies, or pursuing alternative technologies. Coal transition for thermal power therefore looks likely to be coming to Japan, just as it has arrived already in nearby Rep. of Korea (which is a member of the PPCA mentioned above).

South Africa's Nationally Determined Contribution under the Paris Agreement implies that, conditional on action abroad, the country will reduce its emissions from coal power in the order of 80% by 2050. The government's 2010 electricity plan also envisages a reduction of the share of coal in the power mix in the order of 65% by 2030, with a strong role for renewables and support from natural gas. Although this plan was put on hold by the Jacob Zuma government, economics appears to be taking over under the new leadership of President Matamela Cyril Ramaphosa. The country's new energy minister, Jeff Radebe, has stated that he wants a transition from coal to renewables to be reflected in the country's integrated resource plan (IRP), as they are now viewed as cheaper than maintaining the ageing coal fleet (Business Day, 28/08/2018).

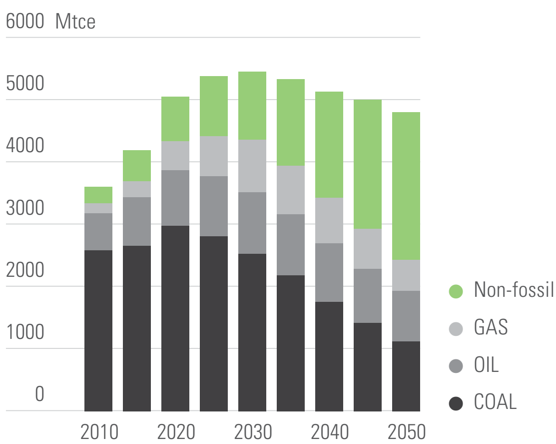
Meanwhile, total electricity demand has been declining, resulting in surplus capacity and leading to the likely stranding of recently built coal power plants. In this context, the issue of how to transition from a coal-in-

Figure 13. Chinese Emissions under NDC/2030 Peaking Scenario vs 2025 Peaking Scenarios for China



Source: Tsinghua University, Coal Transitions.

Figure 14. China's primary energy mix under a 2025 Peaking Scenario



Source: Tsinghua University, Coal Transitions.

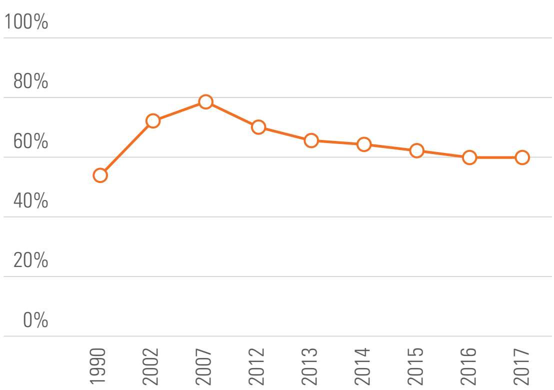
tensive to a low-carbon economy while ensuring a "just transition" is gathering attention. The South African government has therefore recently established a "Pathways to Just Transition Dialogue" that is run through the National Planning Commission to explore options. The new leadership has also re-started the nations renewable energy tender programme. A clear policy framework remains to be developed, however.

In this context, South African energy experts have been exploring feasible pathways to progressively retire coal assets while minimising stranded assets, de-linking the cross-subsidisation between coal exports and power sector, keeping energy prices affordable and ensuring industrial diversification for development (Coal Transitions, 2018f).

In **India**, where coal use has been increasing rapidly in recent years, the national debate is not focusing directly yet on its phase down. However, climate policy is high on the political agenda. India's NDC has given rise to plans to significantly diversify the country's energy mix. For instance, it has set a target for non-fossil fuel based energy production of 40% by 2030 and a CO_2 intensity target to reduce CO_2/GDP by 33-35% by 2030. India is on track to exceed these goals also thanks to additional policies, such as the increase of renewable energy goals from 100 GW to 175 GW by 2022, and growth plans for nuclear power. Indeed, the national report by the Indian research team under the Coal Transitions project proposes options for reinforcing these targets (Coal Transitions, 2018b).

Due to uncertainties on its future power demand, India has not yet set a cap on its total coal use, nor a peak date, unlike China. However, some experts argue that it could potentially do so. As part of the Coal Transition project, experts from the Indian Institute of Management in Ahmedabad argue that the Indian power system has been creating dangerous levels of excess capacity in anticipation of future demand growth that is yet to materialise (Coal Transitions, 2018b). Average coal plants are thus running at just 60% of capacity (**Figure 15**). Moreover, coal is increasingly seen as problematic for development due its growing cumulative impact on air quality, land use, and water availability in water-stressed regions. There is also increasing evidence that electricity access to the poor can be provided via small-scale solutions rather than large new power plants (IEA, 2017a).

Figure 15. Average plant load factor of Indian power plant



Source: IIMA, Coal Transitions, 2018b.

Some of these considerations have already led the government to take a number of measures to limit the role and the impact of coal. For instance, the government has been retiring large numbers of old and inefficient coal plants, delaying domestic coal production expansion plans, setting biomass co-firing objectives, requiring that new plant be super-critical and use dry cooling technologies, implementing stricter coal quality standards, increasing coal taxes, and is aggressively pursuing alternative energy technologies, such as solar, wind, hydro and nuclear. The next questions for India are about setting a time-frame for peaking coal use. This is needed to begin to reconcile the power market design to support higher integration of renewable energy, to create a commercial framework for new investments in clean coal technologies and to explore ways to limit coal use in industry as the country develops.

Emerging coal transition debates in other countries

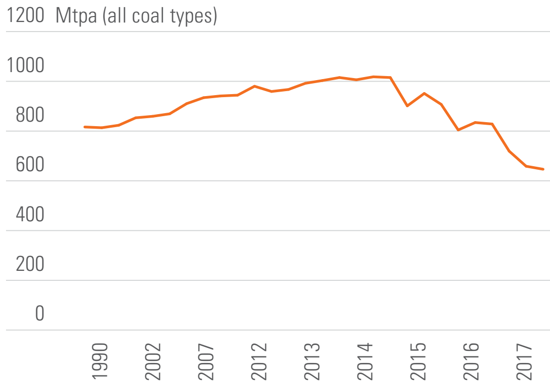
In several coal-intensive economies there is growing awareness of coal transitions as an issue amongst stakeholders. However, for different reasons, formal policy processes for governing them are not currently being taken forward by national governments. Four examples of this phenomenon are Australia, the United States, Poland and Colombia.

In **Australia**, a major global coal exporter and significant domestic user of coal, a relatively robust national debate on a coal transition has emerged. In recent years, a number of stakeholders in the coal sector have set out detailed public positions and policy proposals in favour of new governance tools for a managed and fair transition to clean energy. Among those who have publicly called for measures to implement such transition, there are: two of Australia's major labour union groups (CFMEU and ACTU), conservation groups in coal-using regions, academic experts, coal port operators, owners of coal-fired power plants, and mining companies, (CFMEU, 2016; ACTU, 2016; Environment Victoria, 2016 & 2018; Wiseman et al, 2017; ABC.net, 14/04/2018; BHP, 2018; The Guardian, 29/03/2018). A key challenge in Australia remains the strong political polarisation on the question of coal and energy transition more generally. There is an entrenched political split over the need and pace of such a transition. Nonetheless, some local experts believe that growing economic and international factors may force Australian leaders to accept the fact that coal demand is declining and it therefore needs to adapt. For instance, domestically, renewables are becoming cheaper than coal, even on an operating cost basis (Coal Transitions, 2018g). Internationally, coal demand also looks set to decline sooner or later (see above) with impacts on Australian exporters and related industries and employment.

Public opinion polls suggest that a significant majority of Australians already support the idea of phasing out coal-fired power by 2030. Several companies, including AGL (Australia's largest coal power plant owner) and GDF Suez, have already closed the most emissions-intensive coal plant in the country and have recently announced plans for the closure of another one (The Guardian, 21/05/2018). Another scenario is that, as it happened in the past with Australia's energy policy, a change in national leadership might lead to a shift in policy positions, although bipartisan support is obviously preferable for a stable long-term policy framework.

In the **United States**, the decline of coal is a reality and is occurring fast albeit not in a particularly well managed fashion, due to increasing competition from cheap natural gas, renewable energy, regulations on power plant pollution, the ageing of the existing coal fleet and the mechanisation of mining activities (Kok, 2017). The capacity of coal-fired power plants fell from 310 to 260 GW between 2010 and 2017, and is projected to decline to below 200 GW by 2025, according to the projections of the US Energy Information Administration. This despite the intention of the Trump Administration to revive coal's fortunes (EIA, n.d.). Meanwhile, the US coal consumption has fallen from 1,150 to 800 million short tons between 2008 and 2017 (EIA, n.d.). The US coal mining workforce, having already been reduced dramatically since the 1960s due to the rise of oil and ongoing mechanisation, is meanwhile continuing to decline rapidly. Between 2012 and 2018, that the number of coal miners fell from 89,000 to 53,000, notes the US Bureau of Labour Statistics (US BLS, n.d.). Coal transitions are therefore happening in the US as well.

Figure 16. US Coal Consumption is declining rapidly



Source: Enerdata.

The Obama Administration and some US State initiatives had begun to develop policies to support a fairer transition for affected workers, such as the Power+ Plan or the Coal and Connected Initiative (Coal Transitions, 2017b). Representing the vision of the US Democratic Party, the Hillary Clinton 2016 Election Campaign wanted to take the coal transition a step further, via a 30 billion USD plan to support it and revitalize affected communities (Hillary Clinton Campaign, 2016; Vox, 21/03/2016). However, active policies on how to improve the social fairness and the climate ambition of the transition from the Federal level are being stifled by the current political climate.

In **Poland**, while no formal public-facing process currently exists, informal discussion among experts, coal producers, labour unions, and local stakeholders is beginning to emerge. Change appears to be inevitable as declining mine productivity, the high costs of subsidisation, economic and demographic decline in mining regions, and European climate and energy regulations put pressure on coal.

Finally, in **Colombia**, the world's fourth largest coal exporter, informal discussions on the future of the coal sector have recently begun to take place (SEI, 2017). At present thermal coal exports to Latin America represent a significant source of revenue for the country. However, local actors are becoming concerned that, as Latin-American demand saturates, large multinationals will potentially move investments elsewhere in order to be better positioned, from a geographical point of view, to reach other markets. Some reports also suggest local concerns about the impacts of mining on local populations and the surrounding environment (Munoz-Galeano, 2017).

3. Coal transitions are feasible and affordable

Under the Coal Transitions project, national expert teams in China, India, South Africa, Australia, Poland and Germany explored pathways for the coal transition with regard to the energy and socio-economic systems. These scenarios were required to be consistent with the respective countries' carbon budget in line with the "below 2°C" goal.

National teams were invited to determine the allocation of emissions based on their own view of a fair share for their country in the 2050 global carbon budget. However, national choices were constrained with reference to key benchmarks included in previous IPCC reports for the economy as a whole and for relevant sectors. (For instance, economy-wide emissions for all countries needed to be within 1-3tCO_2eq/capita in 2050, while power sector emissions needed to be below 0.05tCO_2/MWh in 2050). These figures are not necessarily compatible with the 1.5°C ambition.

These techno-economic scrutiny of the energy system were also supported by quantitative and qualitative analysis of social, economic and political economy challenges that countries face when implementing coal transitions. This section discusses insights with respect to technological and economic aspects of transition scenarios. Elements related to just transition, governance and finance are discussed in Sections 4 and 5.

3.1 Replacing coal in the energy system

It is sometimes argued that thermal coal is necessary for generating baseload electricity for economic development and universal access to power. However, the scenarios developed showed that this is no longer true. On the contrary, all six countries were able to build cost-efficient scenarios that lead to either a full phase out of thermal coal from the power sector by 2050 or a very close outcome.

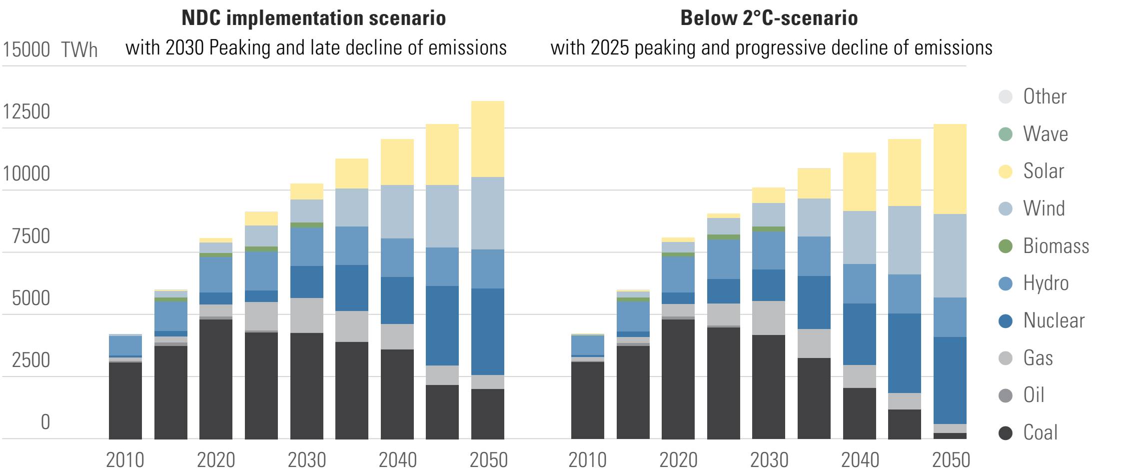
To be clear, some scenarios also explored the possible need for some residual role of coal combined with carbon capture and storage, such as India, China and Poland. However, even in these cases, the expected cost premium and other socio-technical constraints linked to the addition of CCS to coal plants meant that coal plus CCS was generally expected to deliver a relatively small contribution to the energy mix in 2050 (in the order of 5% in Poland and 4% in China). The scenario for India explored the option of 17-18% of the power mix being supplied by coal plus CCS. However, this should be seen as extreme, since it also ignores other less expensive options, such as higher shares of offshore wind and nuclear power.

The implications of coal transitions scenarios for the power sector, the main consumer of thermal coal in these countries, are presented in **Figure 17**. The left-hand column shows the upper range for coal consumption under the scenarios examined, while the right-hand column shows the lower range.

A first key observation from the energy system transformation scenarios is that (often rising) **national consumption demands can be met either with zero coal or with minimal amounts of coal**. Where coal is retained in the energy system, this typically reflects situations where very large energy consumers, such as China or India, face either technical or social limits in deploying larger amounts of low-carbon energy sources (renewables, nuclear) to meet peak demand. Alternatively, it occurs in some scenarios where it is assumed that some asset stranding might not be politically possible (e.g. South Africa's upper ambition NDC scenario).

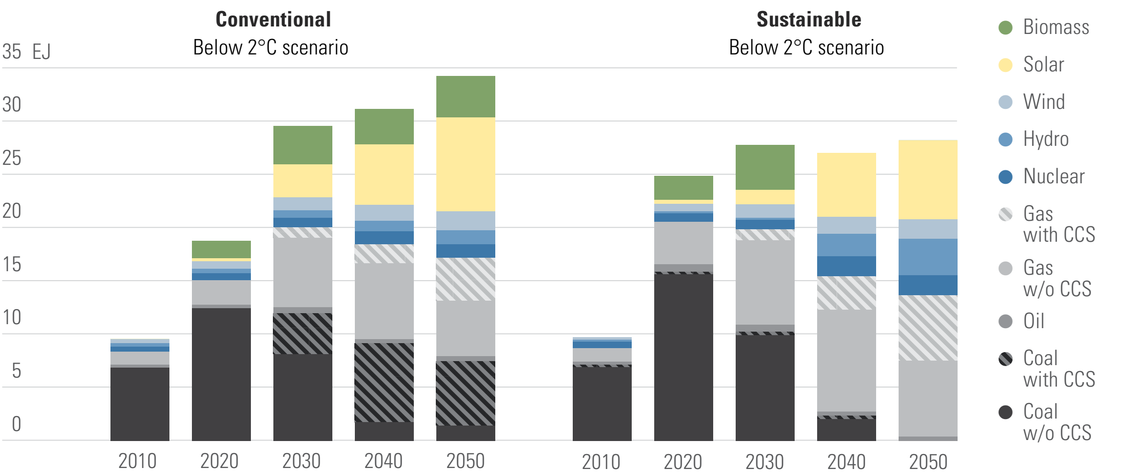
A second observation is that the incremental cost of coal transitions scenarios for the energy system were found to be likely to be **affordable for energy consumers** compared with no-action scenarios based on today's technologies. There are some caveats (see below). However, this result is essentially due to the cost of established renewable energy (onshore and offshore wind, solar PV, and some biomass solutions), which is already equivalent to or below the operating costs of the power generation mix in many of these countries. Thus, incremental costs for the energy consumer stemming from the provision of back-stop technologies that are capital intensive, such as nuclear, CCS or biomass, are largely offset by the low costs of renewable energy. Scenarios also rely to varying degrees on improving energy efficiency, which reduces costs through lower consumption. In addition, coal operations are in some cases expected to become more

Figure 17a. China



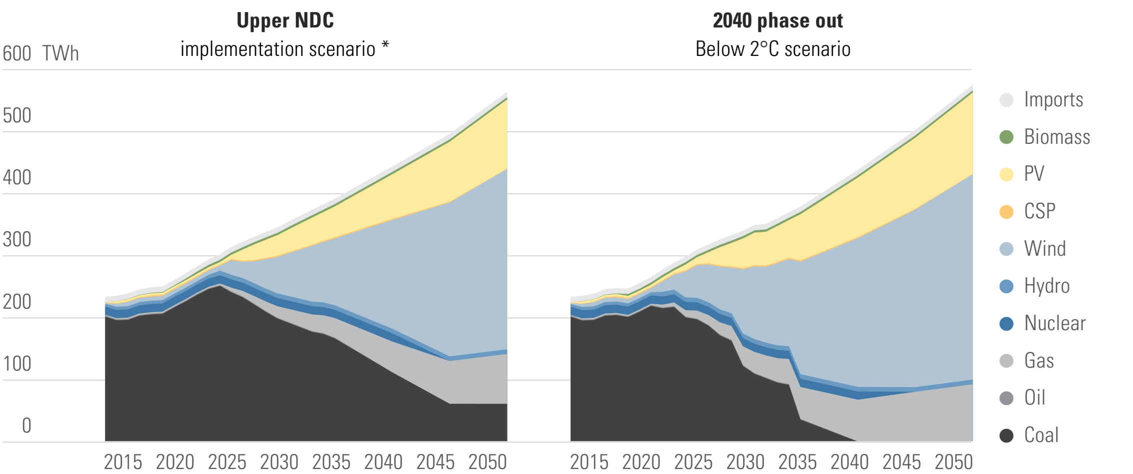
Source: Tsinghua University, China

Figure 17b. India



Source: IIMA, India.

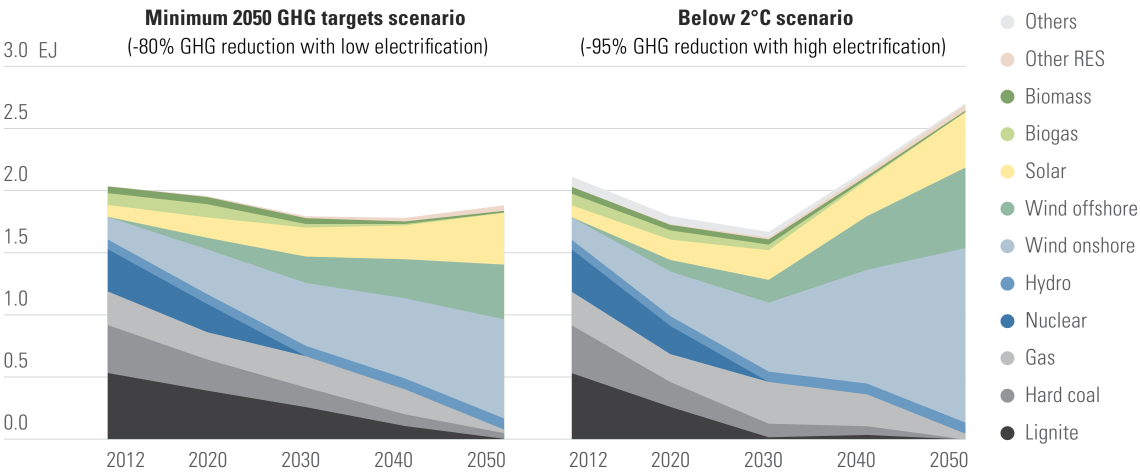
Figure 17c. South Africa



Source: UCT, South Africa

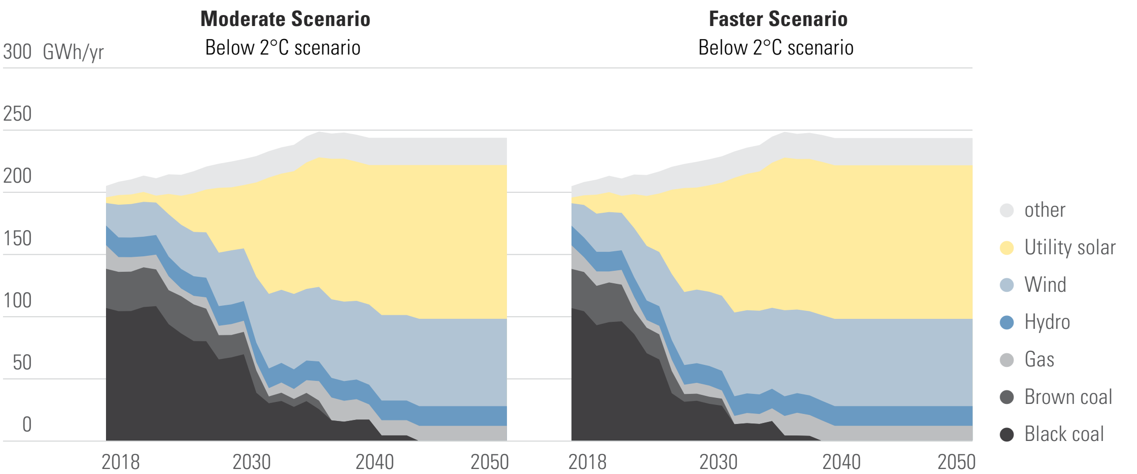
** South Africa has a range for its NDC scenario. However experts note that the upper range is more consistent with business as usual or reference case*

Figure 17d. Germany



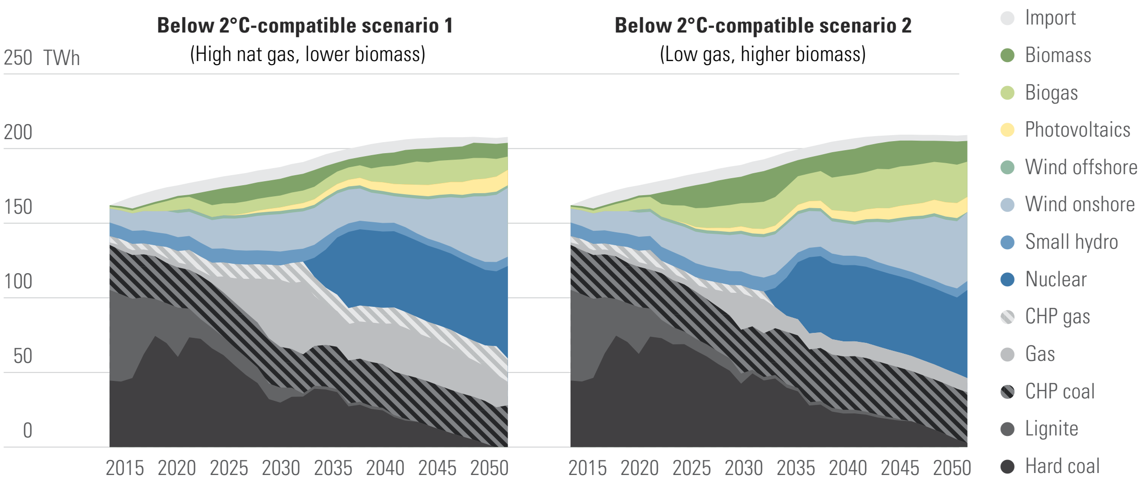
Source: DIW Berlin, based on (Öko-Institut e.V and Fraunhofer ISI 2015).

Figure 17e. Australia



Source: Crawford School of Public Policy, ANU.

Figure 17f. Poland



Source: IBS, Poland.

expensive in the long term for multiple regulatory and technological reasons.[7]

For example, South Africa's decarbonisation scenarios do not necessarily imply higher electricity prices to remunerate investors. Indeed, South Africa's "Upper NDC" scenario is found to lead to lower total power system costs for consumers than remaining with coal (Coal Transitions, 2018). Similarly, in Australia, the abundant sun, wind and coastline, lack of land use constraints and favourable capital markets, make phasing in a high share of renewables potentially cheaper than continuing with coal long term (Coal Transitions, 2018g). Furthermore, in India, evidence increasingly suggests that a large portion of population without access to electricity would be more cheaply and reliably serviced by renewable-based mini-grids or off-grid solutions than through industrial scale investments.

Therefore, even in China's or India's scenarios, the incremental costs for the energy consumer stemming from more expensive back-stop technologies such as nuclear, CCS or biomass are largely offset.

Some scenarios suggested a slightly higher cost, but even in these cases the increment did not seem high and could be debated on the basis of contextual factors. For instance, in Poland, the aggregate costs of the decarbonized power system are broadly comparable, i.e. just one fifth higher compared to the business-as-usual scenario. However, in this case higher costs are largely due to a significant nuclear new-build and to reliance on biomass. On the other hand, potential increases in the cost of coal due to European carbon pricing are ignored. Some national stakeholders would question these assumptions. The point is that *even in* a relatively costly scenario like this one, the incremental cost of a coal phase down from the power sector is not found to be significant.[8]

An important caveat on these results is that, to date, no concrete experience exists of a large economy developing an energy or electricity system completely or largely based on renewables. Other studies have suggested that significant increases in the share of variable power sources would not raise costs excessively if supported by adequate policy frameworks (e.g. Agora, 2015). These studies seem likely to offer reliable guidance up to a point. However, technical, economic and social uncertainties still exist on the cost of integrating major shares of variable renewables or back-up solutions like CCS. Scientific uncertainties also exist around the behaviour of grid frequency under high shares of renewables (i.e. beyond 80%). In principle, a number of cost-efficient solutions exist to avoid the need of large amounts of costly thermal back-stops.[9] Nonetheless, the costs of these solutions are today still somewhat uncertain.

It is therefore possible to conclude that, based on current technologies, a significant phase down of coal is likely to be more or less cost-neutral over the long period for consumers, if not advantageous. However, inevitable uncertainties remain over the exact cost of the "final quarter" of the transition.

A third important finding s that **universal electricity access – and economic growth – can be ensured** in these developing countries (i.e. South Africa and India) while also phasing down thermal coal in the power sector. This is partly because the barriers to access are not only about generation capacity (India's power plant had an average load factor of 60% in 2017), but often involve missing transmission infrastructure and lack of economic incentives for companies to build large and capital-intensive plants and transmission grids to serve small and isolated groups of consumers.

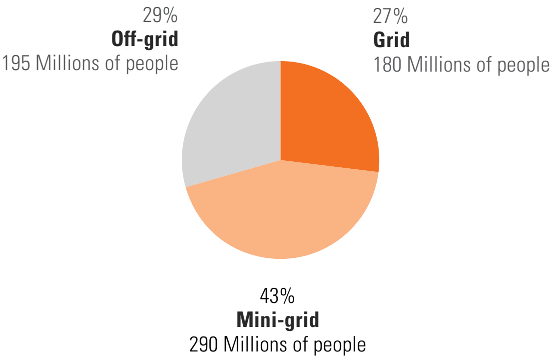
In this context, small scale solutions, such as micro-grids or rooftop solar, sometimes combined with innovative financing models (such as micro-credit loans) have tended to deliver better results in providing universal access to power. This view is also shared by the International Energy Agency. In a recent report, the IEA argues that mini-grids and small scale off-grid installations are the cheapest option for providing at least 70% of the new electricity connections needed to supply the 650 million people in the world that will still lack access to electricity in 2030 (IEA, 2017). Universal electricity access to consumers can therefore be provided more cheaply and reliably without coal.

7 Rising costs of thermal coal plants can be due to a range of factors, depending on context this can be due to local air pollution regulations, installing dry-cooling technologies, regulatory factors like carbon pricing, the cost of supercritical technologies, or the cost of running inefficient old plant.

8 It should be noted also that this cost increase is not a sudden spike of 20%. Rather, it reflects a more or less gradual rise in cost over a 30-year period to 2050. Moreover, the rise in the final cost of power paid by consumers is significantly lower because generation costs represent approximately half of the final power bill and because more efficient consumption can further reduce that cost.

9 Solutions could include, among others: demand-response systems to manage demand peaks, cross-border market integration, storage (batteries, power-to-gas, hydrogen fuel cells, etc.), decentralised power markets using less volatile renewables (offshore wind, tidal, geothermal, biomass, etc.).

Figure 18. Least cost ways to provide electricity access by 2030 (millions of people and percentages)



Source: IEA Energy Access Outlook, 2017

Policy implications and options

Specific policy recommendations to implement coal transitions in the energy sector compatible with the "below 2°C" goal differ of course from country to country (cf. individual national reports). However, some common themes emerge from the project. One of them is the need for countries to continue strengthening economic incentives and removing barriers to new investment in renewable energy technologies before building additional coal plants. While renewable energy solutions are becoming economically competitive, they can nonetheless be slowed down by excess thermal capacity, high financing costs, lack of flexibility in the generation mix and low incentives for flexibility by thermal generators, below-cost regulated prices, lack of a domestic production industry, poor auction design, lack of policies supporting small-scale micro-grids, and missing payment enforcement laws.

Another key policy priority is to continue developing innovative technologies that are complementary to variable renewable energy, both to enable large-scale penetration and to hedge against the failure of back-stop technologies. Doing this in practice means promoting the development of a broader portfolio of clean energy solutions (i.e. not limiting to onshore wind and solar PV), improving interregional trade in electricity, exploring energy storage solutions through pilot projects and incentives for commercialisation, reforming the market design to incentivise demand-response solutions and enable close to real time balancing of renewable energy and more flexibility generation by thermal power units.

Thirdly, some scenarios suggest that, even if renewable energy is pushed to the maximum, an important degree of complementary with thermal generation will be needed to support otherwise renewables-only-based energy systems. Due to long lead times and commercial and technological risks involved in these technologies, governments will need to elaborate feasible business and financing models relatively quickly if they are to play a role in the transition before 2050. While the immediate construction of all units is not necessary (and should be checked by an evaluation of a fast-evolving technological landscape), gathering experience through concrete examples of commercially viable units is a matter of urgency, as these value chains will not emerge overnight.

Finally, efforts to pursue more aggressively energy efficiency and to change consumers' behaviour in energy use are important to achieve cheaper transitions. Strengthening policies and standards to implement global best practices in energy consumption in industry, in buildings, and in the functioning of appliances is therefore critical. Policies to reduce wasteful construction and to improve recycling and re-using of energy intensive materials are equally important.

3.2 Avoiding stranded assets

While investment to decarbonise the energy system does not necessarily increase significantly costs for consumers, for owners of coal-intensive capital assets the story is more complicated. If some of their coal-fired power plants (or indeed other coal sector-financed infrastructure such as mines, railways or ports) are closed before the investments are paid off, this can lead to "stranded assets", i.e. investments that receive a lower than expected and/or negative return on capital.

Of course, all investments are inherently risky and underperforming assets occur in any economy. It can be argued that governments could simply ignore stranded assets in the coal sector. As a general rule, this approach is identified by experts in the Coal Transitions project as the first best solution for dealing with assets that are already stranded. After all, there is no a priori reason why coal sector assets should be compensated for losses while not all other loss-making investments in the economy are.

However, some nuance is important as, in practice, additional complications can arise. Firstly, asset owners will tend to request compensation from taxpayers for closure decisions that are seen to relate to government policy. This may be true even where closure is likely based on economic grounds or where the existence of the climate policy "threat" could arguably have been identified and priced by investors well before the decision is made. While not necessarily justified, such claims can create a barrier to implementing a smooth transition. Stranded assets are thus a potential problem of political economy that needs to be anticipated and avoided.

Secondly, even if generally investors should bear losses, in some cases stranded assets could have mitigating circumstances, e.g. for implementing a timely transition for affected workers and regions, or for energy security. This can often be the case in developing countries, where the line between state and energy companies can be blurred.

Unfortunately, several of the case studies identified risks of stranded assets from current or recent government policy settings and company investment behavior. In China, for example, between 2015 and 2017, the central government effectively cancelled the commissioning of approximately 120GW of new coal-fired power plants and put a cap on total coal consumption that is enforced by regional coal allocations and investment plans (Coal Transitions, 2018c). It also banned new mining permits. However, risks remain that approved but not yet commissioned plants may come online prior to 2020, adding to the overcapacity of an existing power fleet that is struggling with low utilisation rates in the order of 50%. Similarly, China retains over a billion tonnes per year of mining capacity above its current production levels.

India runs a similar risk. In the power sector, for example, roughly 90 GW of new capacity appears set to come online under existing approvals, but there is currently no market for this power. Load factors for Indian coal generators remain at approximately 60%. Also in the domestic mining sector, short-term expansion plans have been delayed due to missing transport infrastructure, sustained import demand, and other factors.

Germany has unofficially ceased building new coal plants, although it is not yet clear whether new permits for lignite mining will be granted. Recent reports suggest that RWE has begun land-clearing to dig new mines, despite an ongoing process to determine a phase out date for coal. This process has not been concluded. Other coal-intensive countries, such as Poland or Australia, are also still at risk of investing in long-lived assets either in mining, railways, or net additions to power plant capacity that would face a high risk of being stranded. Since most coal-sector investment have a financial lifetime of 20-30 years, the risk of stranded assets can be avoided in these countries if policies post-2020 cease to allow new net capacity additions for coal sector infrastructure.

Policy implications and options

The coal transition scenarios explored by the project suggest that the best way to manage stranded assets in the coal sector is first and foremost to avoid allowing coal-sector investors to support assets likely to be stranded. Anticipation and avoidance is key. Secondly, investors should generally be required to bear losses where it was possible to sufficiently anticipate risks, even regulatory ones. Thirdly, only as a last resort and in relatively exceptional and strongly justified circumstances.

Policy options to avoid asset stranding include:

- Setting policy defaults that effectively cap approvals sought for projects that would result in net additions to national coal-fired power or mining capacity after 2020 (albeit with possible exceptions in extreme cases).
- Signal that no public money is used to 'compensate' coal assets for closures driven by climate policy, so as to avoid gaming and uneconomic investment in new coal assets, mine extensions and coal plant refurbishments.
- Consider retirement pathways for existing coal plants in order to limit excess capacity and smooth the transition.
- Progressively liberalise power market prices (coupled with meaningful carbon pricing) and/or reform policy incentives that cause overbuilding of assets based on fossil fuels.
- Limit non-economic barriers to access for new entrants into energy markets in order to limit the relevance of any one company's balance sheet to the energy system.
- Diversify revenue streams for existing coal sector-dependent infrastructure.
- Avoid placing public money in new coal infrastructure projects.

In some scenarios, achieving 2°C-compatible coal transitions could require creating some stranded assets, even if the above policy recommendations were followed. In the South African or Indian scenarios, an assumed high growth in metallurgical and thermal coal use in industry puts pressure on the power sector, which has to decarbonise at fast pace to remain within the carbon budget. In the South African scenario, all coal-fired power plants are phased out by 2040, resulting in a handful of units closing more than 10 years earlier than their expected financial lifetime.

For economies where the state has a strong role in energy sector investment decisions, where there are mitigating circumstances and where asset value is likely to be severely impaired, the Coal Transitions project suggests a number of options that involve some form of state intervention:

- Earmark a share of new renewable energy capacity additions (or other sectoral activities with more favourable revenue streams) for structurally important incumbent power producers, to dilute the share of stressed assets on the balance sheet (an anticipatory measure).
- Instruct state-owned companies to diversify and develop coal transition plans to anticipate and manage the risk of losses.
- Allow coal-assets to partially recoup the value of stranded assets through the provision of ancillary market services with low emissions impact (e.g. through balancing markets or freeing up entry to ancillary service markets, thus allowing the role of coal to change in the power system during the transition).
- As a very last resort and where there are exceptional or extenuating circumstances, transition deals with state-led companies, potentially involving funds for diversification in return for the implementation of best-practice transition policies for affected workers and regions.

Ultimately, the appropriate solution to stranded assets will be highly dependent on the context. Given the pace of technological change, coal assets may be significantly impaired regardless of climate policy. Managing the transition will be critical, but anticipation and avoidance is simpler than finding a remedy. More effective policies to decarbonize other sectors, such as industry, can therefore reduce the need for compensation of stranded assets in the coal sector.

4. A "just transition" for workers and citizens is possible

4.1 A fair transition for affected workers

A top priority for coal transitions is the just and fair treatment of affected workers. Many labour organisations around the world, including in coal-intensive economies, are not opposed to the reality that their members may need to change jobs because of coal transitions. However, they insist upon the need for a fair and just transition process for people whose jobs will be affected.

The International Labour Organization has published a set of guidelines setting out acceptance and principles for implementing a just transition to a sustainable and decarbonised economy (ILO, 2015). These principles have in turn been adopted by labour groups in several coal-intensive economies and regions of the world. In some cases, they have even been turned into specific policy proposals and implemented becoming real-world examples of just transitions to varying degrees.

Many ideas and even concrete examples therefore exist of how a fair and just transition can be implemented. Coal Transitions is not the first research project to examine how to implement fair transitions for coal-sector employees. However, the analysis of post-transitions and the six national case studies identified some complementary insights.[10]

A first key finding is that just transition for workers is not an abstract or utopian concept. Rather, it is something that can be implemented, that has been implemented and that is being implemented in some places around the world today. Examples include the Netherlands (Limburg in the 1960s), Canada (Alberta today), Germany (Ruhr in the 1960s and today), and, to some extent, Australia (CFMEU, 2017). Of course, there are also countless examples of coal or industrial transitions where labour issues were badly managed. Every situation is different and solutions must depend on the local context. However, the key finding was that, if policy-makers and companies are willing to explore best practices, real world solutions that provide just transitions for workers do exist .

One important element of a just transition for employees in the coal sector concerns the way workers are consulted and included in the decision-making process. Employees want to be heard, in good faith, early in the process, and be given a chance to participate meaningfully in the decision-making process that concerns their future. One example of this is Limburg, in the Netherlands, where unions were given an active role in committees that oversaw the transition process for the region (Gaels et al, 2017). Another is the initiative developed by the German government under the Structural Reform Commission this year (Herpich et al, 2018). Union representatives from Germany's three lignite regions will participate in a commission that will discuss (albeit under strong time pressures) the future of coal and pathways for the transition for workers and the region.

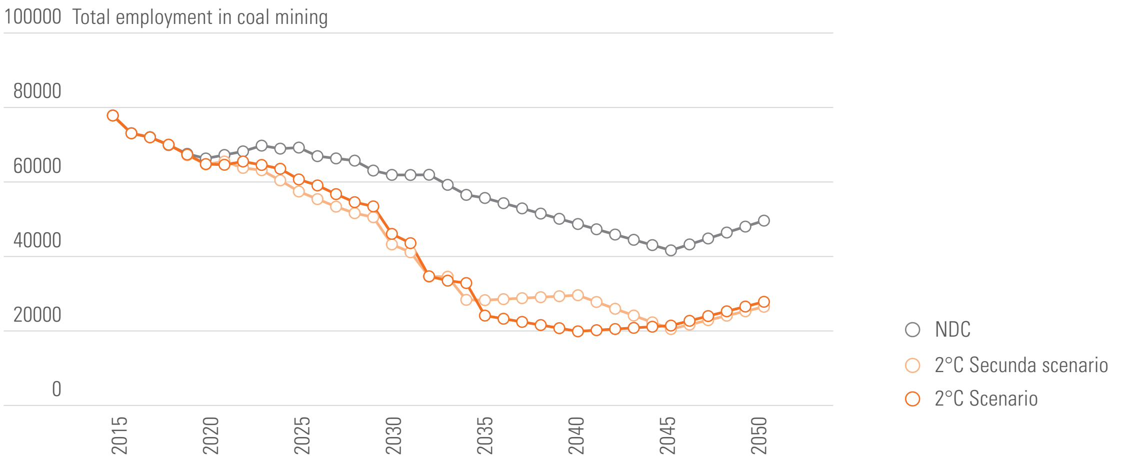
A second aspect of just transitions is about responding to the questions for which workers want answers. In brief, they want to know:

- How will you ensure that I can find an alternative job (or get a bridge to retirement)?
- How will my livelihood be guaranteed during the adjustment process?
- Who is going to pay?
- Why should I trust them?

An important challenge for many workers in the coal sector is the often high level of distrust due to past experiences of either governments or companies implementing transitions or other policies that hurt them or people they know. Thus, the difficulty sometimes consists in (re-)establishing trust in order for a constructive dialogue to take place. For instance, one criticism of the unions in some countries is that, even if they have been consulted on previous site closures, companies have in various ways reneged on the agreements that were reached to ensure a fair transition for the workforce, often to close plants or sites more quickly and cheap-

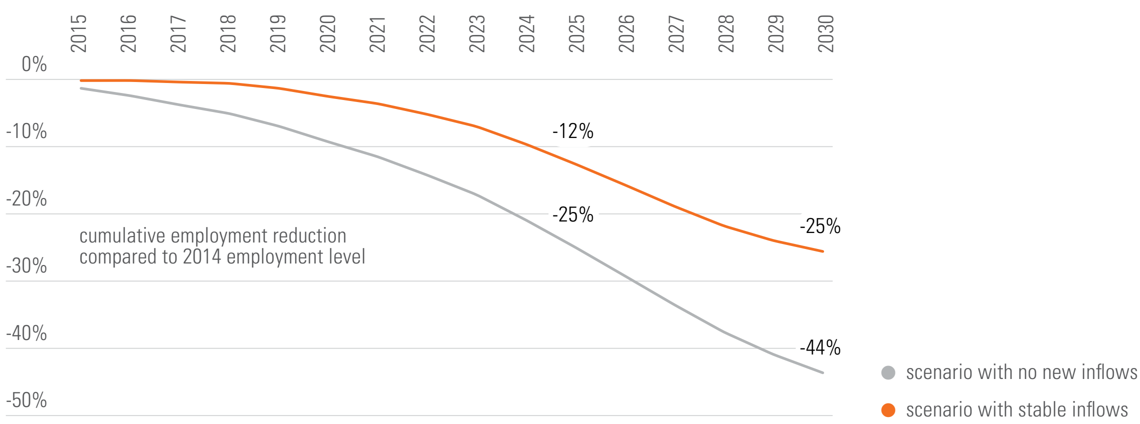
10 Previous cases analysed included, but were not limited to: Limburg, Netherlands from the 1960s to the present; Ruhr, Germany from 1960s to the present; East Germany from 1989 to the present; Upper Silesia, Poland from 1990s to the present; Czech Republic from 1990s to the present; LaTrobe Valley, Australia, 2010s; Spain, from 1980s to present; UK, from 1980s to the present; Appalachia, USA from 1970s to the present; Non-coal industrial transitions in Europe's old industrial regions. Related publications are available at www.coaltransitions.org

Figure 19. Employment in Coal Mining in South Africa under 3 alternative transition scenarios



Source: UCT.

Figure 20. Scenarios of employment reduction in hard coal sector due to outflows to retirement by 2030



Source: IBS, Coal Transitions.

ly. This can leave workers who had, for instance, made professional or retirement plans based on a certain timeline to be thrown into limbo. Depending on the national context, amendments to institutional arrangements to enforce such agreements or other laws may be worth considering. The role of the central government as a countervailing power able to strike deals with companies can also be important (cf. Limburg example).

To manage the progressive reduction in the size of the workforce in coal-related activities and the transition of workers to alternative activities, solutions for specific places depend crucially on the context of the labour market and the age, skills, and educational profile of the workforce concerned. A vast number of solutions exist. These include:

- Setting a timeline for the phase down of activities (e.g. a 5-10 year period), ceasing the training and hiring of young (i.e. future) workers and allowing existing workers to either retire naturally or leave the workforce through natural attrition. This alone can significantly reduce the number of workers for whom alternative employment must be found (cf. **Figure 20** from the Polish Coal Transitions Report above).
- Providing a bridge to pension (retirement benefits) for older workers who may struggle to find alternative employment.

- Supporting workers who have appropriate skills and/or are willing to retrain to take on alternative roles within the company.
- Offering voluntary redundancy packages with third party verification of professional reconversion plans and with caps and safeguards on eligibility to ensure safety for remaining workers.[11]
- Developing regional worker transfer programmes to support the direct transfer and on-the-job retraining of workers with appropriate skills to move to an alternative local job.
- Offering employees who may struggle to find work in other roles or sectors the option to transfer their skills to alternative coal-based sites with the company (as some sites will close faster than others).
- Establishing integrated multi-purpose retraining programmes for specific subsets of workers identified as likely to succeed (often younger workers with some post-secondary education), provided they build on best practices identified in the employment retraining literature.
- Providing relocation assistance programmes for more isolated regions,to support workers willing to relocate to pursue an alternative professional plan.

Another finding of the project is that where possible, worker transition programmes should focus on placing workers in jobs, or jobs coupled with retraining, rather than being stand-alone retraining programmes. A number of recent pieces of literature examining the effectiveness of retraining programmes have found that many are not effective (e.g. Kluwe, 2016; IMPAQ, 2008; Hamilton Project, 2016; McKinsey, 2015). For instance, Kluwe (2016) found that only 30% of programmes showed some degree of effectiveness and often their success was limited.

The reasons for the lower than expected success rate and the limited effectiveness of retraining programmes include:

- Structural unemployment and a lack of jobs in the surrounding labour market, often reinforced by missing skills and educational attainment in the region;
- Insufficient engagement with potential employers to identify needed skills;
- Lack of an holistic approach to the issue of supporting re-trainees considering the numerous barriers to find employment (need to focus simultaneously on employer-employee matching, building skills, career advice, stipends for relocation, counselling and other personal support);
- Inadequate monitoring and evaluation of success indicators to ensure stable funding and improve practices over time (Kluwe, 2016).

For some, this implies that re-training should be less emphasized in comparison to alternative solutions to unemployment and should be targeted more precisely to candidates who are more likely to succeed (often younger people with at least some post-secondary education experience. Hamilton Project, 2016).

The conclusion of this literature review is that re-training programs can be useful in some specific cases, but that other options – such as worker transfer programmes and on-the-job retraining – should be given priority. Where they are deemed necessary, re-training programs should focus on specific sub-sets of staff who are more likely to succeed. They should also be designed in a holistic way to address the range of barriers to finding employment (not just skills) and focus more on working with employers to develop on-the-job retraining.

Policy Implications and Options

The Coal Transitions project found that policy-makers can support the establishment of a just transition for affected workers in several ways. Once again, specific solutions must be context dependent, however options that could be considered include:

- Establishing national or regional transition bodies charged with kick-starting and overseeing activities by key stakeholders (companies, regions, workers, local governments) to set a timeline, consult, plan and develop policies to prepare for the transition.
- Setting a timeline immediately for the end of coal and thus helping actors to plan early.
- Requiring companies to develop asset closure and labour management plans in consultation with labour, regional governments and citizens.
- Establishing binding transition contracts with affected companies based on these plans, detailing the key terms of the transition, including closure dates, consultation, worker adjustment support, and requiring that changes of ownership do not affect the obligations under the transition plan.

11 This can allow workers with high potential to reconvert to alternative activities outside the company to leave to pursue alternative career paths, conditional on their plans and profiles being verified by a third party to ensure likelihood of success. It can also be used to free up space for workers who feel they will struggle to find work elsewhere or who do not wish to, to remain until retirement.

- Financing the transition, e.g. by establishing just transition funds into which companies pay and/or ensuring companies have adequate financial resources to pay for the transition of their labour force.
- Supporting former coal regions in developing alternative forms of employment with transferrable skills.
- Developing and supporting financially employee transfer programmes with a strong on-the-job re-training focus (e.g. by subsidising on-the-job retraining that helps recruitment in alternative industries.)
- Improving the quality and better targeting the use of re-training programmes to the most suitable candidates.

4.2 Managing economic transitions at the local level

Managing the economic transition at the regional scale as coal local activities decline is a crucially important matter for a just transition. This is not just for former coal sector employees, but also for their dependents, their children, and other economic activities in the region that depend indirectly on coal.

Is a complex issue and arguably the biggest governance challenge of coal transitions, where defining appropriate policies depend heavily on both local contextual factors and value judgements.

Regional socio-economic challenges often go beyond the decline of the coal sector. Economies are replete with examples of regions that grow, boom and bust due to the fortunes of specific local industries. Moreover, as discussed above, not all coal transitions are due to government fiat. This raises broader questions on whether coal regions deserve special support for their transition, while regions affected by the decline of other industries do not receive similar help. Put another way, it is fair to ask whether all regions should deserve the same attention of coal regions when an industry important for the local economy declines?

A failure to address the aspects of the local economic transition for citizens of coal-dependent regions can have negative social and economic outcomes (Coal Transitions, 2017a). Often this leads to higher intergenerational unemployment. In places where coal activities represent a significant share of the local economy and associated tax revenue, where companies are owned by the local government, or where companies contribute to the local economy in other ways, the impact can also be felt on the provision of basic public services. For example, Chinese coal mining SOE's often are an extension of government and can contribute to offering hospitals, schools, housing etc to local communities.

At the same time, coal-related activities, especially coal mining, often impose significant costs on local communities. For instance, coal intensive regions in South Africa exhibit higher unemployment rates than the national average (cf. Coal Transitions, 2018f), and this is true across many coal mining locations, both present (e.g. Appalachia, Germany's and Poland's lignite areas) or past (e.g. Limburg). This is related to a socio-economic phenomenon known as "lock-in" in specialised literature (Campbell, 2017; Herpich, et al, 2018).

In communities where coal mining or other extractive industries play an important role, there is a well-documented tendency for incumbent industries to actively resist the diversification of the local economy, because it will lead to competition for economic resources. There are also indirect impacts of mining on the environment, land value, health and automation of work, with consequences for the value of the natural, physical and human capital of the region. This, in turn, can lead to a vicious cycle whereby the declining economic attractiveness of the region for alternative industries makes it ever more reliant on the extractive industry and the few who work in it providing for their families and communities (Hochschild, 2016).

Attention should be paid not to mischaracterize the complex interplay of costs and benefits that coal mining brings to local economies. This can make the transition of a community from coal mining both more necessary and more challenging. Transitions for coal-extracting and/or using communities can be to their economic advantage and, indeed, a necessity for long-term economic and demographic survival. However, in the short term this can make the challenge appear all-the-more threatening to those that depend on the industry. A key policy challenge is how to build a bridge to that better, distant future for the region, without hitting the barriers created by the short-term "lock-in".

Historically, such issues call for a political response from governments. While solutions must be context-dependent, it is reasonable to ask what options are available to governments to manage and accompany affected citizens in a way that is fair and just.

Solutions depend on issues such as:

- the geographical proximity of the local community to other centers of economic activity;

- the size of the coal sector in the local or regional economy (GDP and employment);
- the financial links between the coal sector and the local government and provision of local services;
- the degree of psychological attachment that workers and citizens have to the region (e.g. are they fly-in/fly-out workers or local residents?).

Depending on how these questions are answered, different solutions can be envisaged. For example, in places such as Polish Silesia, with a relatively high population density, some existing economic diversity and potential for further economic diversification, but where coal represents an important but minority share of the local economy, an optimal strategy can be to promote greater economic diversification, invest in new industries, infrastructure and environmental remediation.

At the other extreme, for an isolated mining region in Australia, where over 90% of the local economy and employment is supported by mining, workers are mostly flown in and on temporary jobs, and coal is largely sold to overseas customers rather than locally, an optimal strategy may be a managed decline post-coal. Ultimately, solutions will need to be context dependent and developed with the strong involvement of the local actors who will be tasked with carrying out the bulk of the economic transition strategy.

Policy implications and options

For local regions looking to build their economic resilience and transition beyond coal, the Coal Transitions project identified a number of strategies that can be effective if well executed (Cf. Campbell et al, 2017). These include:

- ***"Related diversification":*** this involves developing industries that are related to existing economic activities and industries but do not depend on coal for their existence.
- ***"Smart specialisation":*** related to diversification, this involves supporting the growth of economic activities that build on an assessment of the region's strengths and competitive advantages. In coal regions, this could include existing power, rail or port infrastructure, land availability, cultural and industrial heritage, skills of the local workforce, existing industries with growth potential, etc.
- ***Strengthening of local entrepreneurial networks:*** Smart specialisation strategies often require creating or strengthening networks between higher education and professional training organisations, local companies and entrepreneurs, local government, organised labour, in order to identify and support the growth of suitable entrepreneurial activities.
- ***Improvement of local infrastructure:*** Improving infrastructure can be a way to increase the local economic attractiveness of the region for investors, increasing opportunities for economic linkages between the region and other zones of economic activity and employment, increasing the productivity and growth potential of local industries, creating opportunities for former coal workers to stay in their regions despite missing local jobs.[12]
- ***Improvement of "soft attractiveness factors":*** This can support re-investment in the area, underpin land-value and thus the wealth of the local community, and limit or reverse demographic outflows. Soft factors of attraction include cleaning up local pollution from mining, land reclamation and beautification, good internet access, access to local amenities for families and educational opportunities for children, policies to limit drug use, etc.
- ***Location of public sector activities in the region:*** This can help mitigate demographic decline, provide additional economic demand for the region, and potentially support the development of new strategic industries. It can include military bases, university or higher education facilities, new schools or hospitals, research hubs, regional government administration offices, etc.
- ***Location of nationally-relevant innovation or energy transition projects in the region:*** Often regions with a strong link to the energy sector are keen to retain it as it is part of the local identity, and they may possess the infrastructure to do so. Conditional on the projects having a clearly identified business case for commercial-scale activities in the region in the long-run, pursuing innovation in support of the energy transition can offer a solution. Ideas put forward in different contexts include: regional offices for thermal energy retrofit programmes, innovative solar or offshore wind projects, virtual power plants, pilot or demonstration projects for decarbonized steel or aluminium-making technologies, BECCS projects, etc.

12 Infrastructure can also include the quality of internet connections. For instance, there are examples of programmes based on digital innovation: https://www.wired.com/2015/11/can-you-teach-a-coal-miner-to-code/#.9x3ovs96p

- ***Managed decline:*** In some cases, e.g.in remote mining regions, the only realistic solution may be to accept that it makes no sense for the town to survive beyond coal.

Avoiding pitfalls

There are a number of pitfalls for regional economic diversification projects that policy-makers and other stakeholders should bear in mind. One of them is a tendency of governments to ignore the complexity of economic geography and the capacity of regions to create sustainable new industries. For instance, governments sometimes attempt to create "priority economic development zones" to support certain areas, usually by offering favourable tax rates for inward investment and some financing at favourable conditions. Past experience suggests that while these can be part of a broader package of solutions, by themselves they are likely to be insufficient to deliver significant change (Fothergill, 2017). There is a wide variety of reasons why investors choose to invest and locate in specific places. These include: the long-term economic opportunity that is presented in the region, the capacity to link cost-effectively within the value and logistics chain, the availability of qualified labour, the proximity to universities or other centers of innovation and businesses within the same industry, the attractiveness to employees to live in the region, the tax rate etc. Governments therefore cannot always effectively "centrally plan" solutions, nor provide tax breaks and finance and hope for the best. Rather, historical experience of regional economic restructuring suggests that multi-level governance is needed to (Herpich et al, 2018; Margaret-Campbell, 2017):

- Engage with local networks to reveal decentralised information about regional economic advantages and disadvantages;
- Provide broader oversight and coordination of industrial policy and matching of industrial actors to local opportunities
- Combine bottom-up knowledge with targeted top-down financial or regulatory support.

Other pitfalls from past transitions include a propensity to "lock-in" to the incumbent industry to block the arrival of economic diversification. This can often lead to actors trying to "hang on" to a dying industry, neglecting the future only to finally start economic diversification too late, or to companies refusing to sell land to new investors (cf. Herpich et al, 2018). Historical experience shows that, where coal is a significant part of the local economy and a major local employer, regional economic regeneration can be a generational or even multi-generational process (Coal Transitions, 2017a). Today, coal is often less important in regional economies as an employer than it has been in the past However structural economic change still takes significant time, resources, and a process of trial and error. Beginning the process of economic diversification is therefore a matter of urgency for all coal-and fossil-fuel intensive regions that wish to survive and provide equivalent or better economic opportunities for the next generations.

5. Governing and financing coal transitions

5.1 Governing the transition

Coal transitions require multi-level governance, including from local, provincial or state governments, national governments and in some cases supra-national organisations. It is not a question of whether centralized or decentralized approaches are better (Herpich et al, 2018): the active participation, agreement and support of a range of actors with different roles is required in coal transitions.

This is illustrated in **Figure 21**, which highlights the range of issues to be addressed within different levels of governance for coal transitions in the German context (Coal Transitions, 2018d). In different national contexts, institutional responsibilities could be aligned differently, but they will need to address many of the same issues. Coal transition strategies from the six countries analysed and past experiences also typically reveal the crucial importance of early consultation and broad consensus across stakeholders.

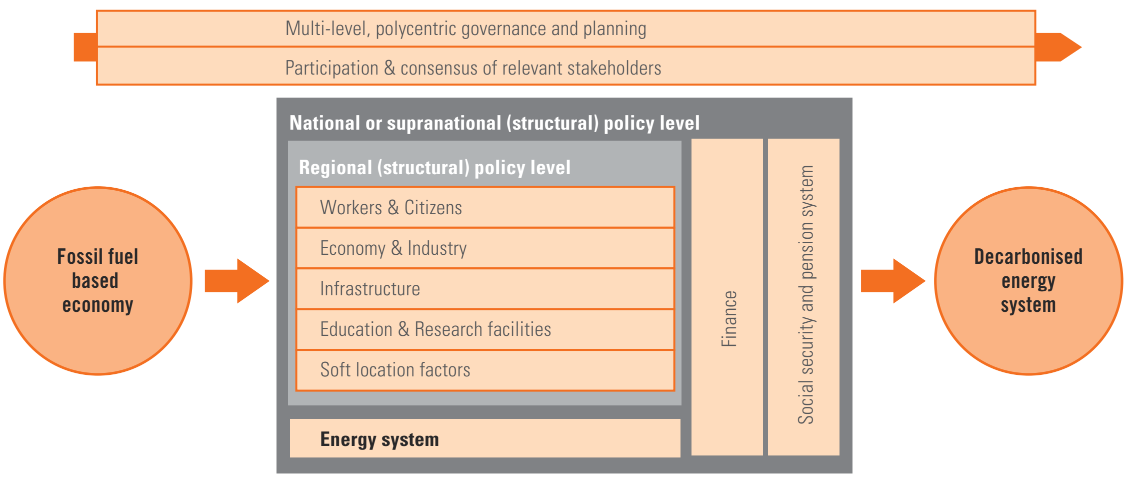
Another key aspect of the coal transitions governance is the importance of new institutional arrangements that support it. One issue is simply kick-starting the discussion, supporting the emergence of a constructive dialogue, and obtaining general consensus on key parameters of the transition strategy. This is, for example, the model that appears to be implicit in the German government's Structural Reform Commission and Committee on Coal.

Beyond this, there could be a role for institutions that oversee the implementation of the just transition. Such institutions have been proposed in Australia, for instance (cf. Wiseman et al, 2017; CFMEU, 2016). Depending on design, they could be helpful to coordinate different levels of government and stakeholders; to ensure that the issue of just transition is institutionalised within the decision making process; and to guarantee there is continuity of strategy moderated by monitoring of policy results. The appropriate form of such institutions will, once again, depend on the context.

5.2 Financing the transition

Closely linked to the governance of the transition is the question of financing. The precise cost of supporting worker transition strategies or regional economic regeneration was not systematically estimated throughout the project. This, along with options for specific revenue sources to fund the transition, are therefore a subject that calls for further research. Nevertheless, the project identified some qualitative insights that are relevant to the financing of the transition.

Figure 21. Mapping the multi-level governance requirements of coal transitions



Source: DIW Berlin, Coal Transitions.

Note: The size of each area does not implicate any valuation in terms of financial volume or importance of the dimensions

Firstly, it is not obvious that implementing a fair and ambitious coal transition implies a higher cost for governments or companies. Past experience suggests that *not* implementing a timely, fair and effective transition from coal is costly for governments (Coal Transitions, 2017a). Costs of badly managed transitions can include:

- High open-ended subsidies for uncompetitive coal mines or coal plant;
- Tax-payer subdisidation of early age retirees;
- Health-care costs of workers or local citizens whose health has been damaged by coal mining;
- Social security costs of high unemployment in coal regions that failed to diversify their economies or of former coal regions that did not prepare for the decline of coal in a timely manner;
- Social and economic costs associated with higher that average drug-use;
- Costs for liabilities that coal companies did not fund due to bankruptcy (e.g. environmental remediation, lost pension funds or health care coverage).

Thus, while a just transition from coal activities has a cost, there are qualitative reasons to believe that it is less expensive for society at large than inaction.

A second question raised by the project is who pays for the transition. Should it be companies? The regions? The central government? In countries where coal sector companies are publicly owned, this question is somewhat less important, since all costs ultimately end up on the public balance sheet. In economies where coal sector assets are privately owned, or there is a mix of public and private ownership, a legitimate debate could take place on who should pay for what and to what extent.

The answer to this question is beyond the scope of the Coal Transitions project. However, the project and its interactions with other related initiatives brought up some interesting ideas on how different aspects of the transition could be financed. These include:

- To auction the option to leave the power market for incumbent coal plants with the funds reimbursed by remaining generators and used to pay, in part, for costs related to the retirement of early leavers (Jotzo and Mazouz, 2015).
- For coal producers, to increase taxes on domestic coal exports to ensure that economic rents from exhaustible extractive industries such as coal are saved and put towards the transition to future industries. This is similar to what is done by Norway's Government Pension Fund Global (aka Norway's Oil Fund) (NBIM, n.d.). In the example of Australia, it was found that a 10USD/tCO_2 (22-26USD/tcoal) tax on sales could deliver tens of billions of dollars of revenues per annum. This could potentially be used, in part, to support the energy transition in a variety of ways (Richter et al, 2018).
- In the European Union, to ensure that existing regional and structural economic development funds are used to support coal transitions rather than being left unspent or used to support the expansion of fossil fuels-related infrastructure (Coal Transitions, 2018d).
- To reform fossil fuel subsidies, e.g. to develop more efficient ways of protecting the energy poor, allowing for energy prices to reflect the true environmental and social impact of coal (GSI, 2018).
- To redirect future planned expenditures on state subsidies for coal activities to coal transition strategies (Environment Victoria, 2018).

Further work to refine these or others ideas tha support financially the just transition in specific national contexts is needed.

6. Conclusions

Coal transitions are already happening. This is not only because of climate policy. The Coal Transitions project has shown that, around the world, coal transitions are gaining importance and momentum as an issue. This is because of existing trends that are buffeting the coal sector, such as the rebalancing of the Chinese economy, the emergence of cheaper alternative technologies, growing air, soil and water quality concerns, declining labour intensity of mining, and climate policy. This requires political leaders to respond to the challenge while, at the same time, making policies consistent with the goal of the Paris Agreement to keep temperature increases "well below 2°C".

The good news is that solutions exist. Coal transitions compatible with the 2°C goal are feasible and affordable for major coal-using and producing countries, such as India, China, South Africa, Australia, Poland and Germany. They are not necessarily easy to implement in all respects, and they will not be without conflict or the politicisation of the issue. Some important open questions not addressed by the Coal Transitions project remain (see below). Nonetheless, for the many challenges in these countries, numerous options to make coal transitions happen within the available time frame can be identified. It is up to policy makers to use and reflect them in future iterations of their contributions to the Paris climate framework.

Coal transitions can be implemented in a way that is highly coherent with other crucial socio-economic objectives in these countries. They can support stable economic growth, innovative industrial development and high levels of employment. They can be consistent with providing affordable and universal access to electricity, as well as ensuring energy security and reduced energy dependence. They can also be made consistent with objectives of social fairness and "just transition" for workers in the coal sector and citizens of coal-intensive regions, who are potentially the most affected stakeholders of coal transitions.

The bulk of evidence points to a pathway out of coal by 2050 that is realistic. It should also be reminded that the coal transitions of the past have often been more significant in scale that those required today. The question is whether coal transitions linked to climate policy present an opportunity to make future shifts more just and smooth than those of the past.

At the same time, it should be emphasized that coal transitions are not only about mitigating negative "impacts" on stakeholders. In several cases, it could be plausibly argued that a transition from coal is desirable *independently* of climate policy objectives, because of other social, health, environmental and economic reasons. In the countries studied, what holds thermal coal in place is a combination of lock-in effects from the historical use of this energy source to achieve social and economic goals. These goals can increasingly be achieved through other means, which are becoming cleaner, safer, and often cheaper.

The Coal Transitions project has sought to present plausible scenarios with a broad fact-based approach that can support a comprehensive discussion on the future of coal in major coal-consuming economies. However, despite the wide scope of the research, some outstanding questions remain. In each country further analysis is needed on certain points. For instance, the Chinese analysis focused relatively little on workforce and regional transition options.

More generally, further research on the following issues could complement this project's findings:

- Deepening the understanding of specific options related to the local context in relation to the transition of the labour force and the impacts of inhabitants in strongly affected regions, in dialogue with those stakeholders and their governments (where they do not yet exist).
- Deepening plant and site-specific scenario analysis for asset retirement schedules in different countries.
- Strengthening the understanding of options for industry to limit its use of thermal and metallurgical coal. This is particularly important, as many scenarios suggested that industrial coal use was a limiting factor to the emissions reductions that can be achieved by 2050.
- Further developing existing energy transition scenarios to explore more fully the implications of uncertainties inherent in the existing scenarios and their implications for today's policy-choices. For instance, what are the potential impacts of failures to develop certain ther-

mal backstop technologies or gas infrastructure? How could declining costs of as yet immature alternative energy solutions affect results? Etc.

- Analysing how the options identified in the "well below 2°C" scenarios can be concretely reflected in future iterations of Nationally Determined Contributions.
- Continuing monitoring, analysis and knowledge sharing on ongoing experiences of coal transitions linking them to new initiatives.
- Further analysing company diversification options, especially for large state owned and coal-intensive enterprises.

Bibliography

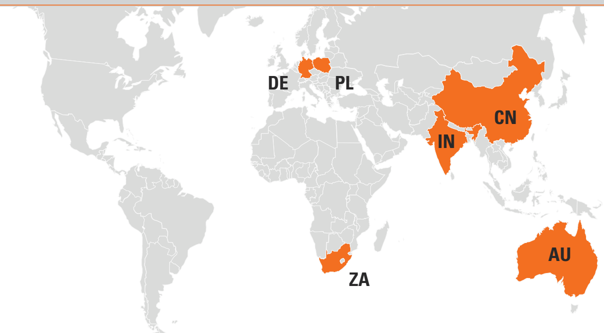
- ABC.net (14/04/2018): Coal Industry in Transition, www.ABC.net.au http://www.abc.net.au/news/2018-04-14/coal-industry-in-transition/9644812
- ACTU (2016): A Just Transition for Coal-fired Electricity Sector Workers and Communities: an ACTU discussion paper, Australian Confederation of Trade Unions, Australia. https://www.actu.org.au/media/1032953/actu-policy-discussion-paper-a-just-transition-for-coal-fired-electricity-sector-workers-and-communities.pdf
- Agora Energiewende (2015): The Integration Costs of Wind and Solar Power, Agora Energiewende, Berlin, https://www.agora-energiewende.de/fileadmin/Projekte/2014/integrationskosten-wind-pv/Agora_Integration_Cost_Wind_PV_web.pdf
- Agora Energiewende (2018): Energiewende 2030: The Big Picture, Agora Energiewende, Berlin, https://www.agora-energiewende.de/fileadmin2/Projekte/2017/Big_Picture/134_Big-Picture_EN_WEB.pdf
- BHP (n.d.): Statement on BHP's Website. Accessed July 2018. https://www.bhp.com/environment/climate-change
- Business Day (28/08/2018): EDITORIAL: Let's talk about our energy plan, Business Day, South Africa. https://www.businesslive.co.za/bd/opinion/editorials/
- Campbell, S., L. Coenen (2017): Transitioning beyond coal: Lessons from the structural renewal of Europe's old industrial regions, CCEP Working Paper 1709, November 2017, Published by Coal Transitions and CCEP. https://coaltransitions.files.wordpress.com/2017/11/australian-coal-transition-industrialization-final.pdf
- CFMEU (2016): Just Transition for Coal Workers, Submission to the Senate Environment and Communications Reference Committee Inquiry on Retirement of coal power stations November 2016, CFMEU Mining and Energy, file:///C:/Users/89278/Downloads/Coal%20fired%20power%20stations%20-%20sub18%20(1).pdf
- CFMEU (12/12/2017) AGL LIDDELL PLAN ENSURES JOB SECURITY FOR OVER 300 WORKERS, CFMEU Mining and Energy https://me.cfmeu.org.au/news/agl-liddell-plan-ensures-job-security-over-300-workers
- CFMEU (12/12/2017) HAZELWOOD WORKER EXPRESSES APPRECIATION FOR WORKER TRANSFER SCHEME, CFMEU Mining and Energy, https://me.cfmeu.org.au/news/hazelwood-worker-expresses-appreciation-worker-transfer-scheme
- China Dialogue (14/01/2016): Roundtable: What are the benefits of China's ban on new coal mines? Article by John McGarrity, China Dialogue, Beijing. https://www.chinadialogue.net/article/show/single/en/8546-Roundtable-What-are-the-benefits-of-China-s-ban-on-new-coal-mines-
- China Dialogue (08/07/2017): 2.3 million Chinese coal miners will need new jobs by 2020, Article by Feng Hao, China Dialogue, Beijing. https://www.chinadialogue.net/article/show/single/en/9967-2-3-million-Chinese-coal-miners-will-need-new-jobs-by-2-2-
- Clean Technica (2018): Wind and solar plus storage prices smash records, https://cleantechnica.com (accessed 24/07/2018) https://cleantechnica.com/2018/01/11/wind-solar-storage-prices-smash-records/
- Coal Transitions (2017a): Lessons from past coal transitions, HIGH-LEVEL SUMMARY FOR DECISION-MAKERS, Authoring Instution: IDDRI, Paris, and Climate Strategies, London; Published by IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.files.wordpress.com/2016/09/coal_synthesisreport_v04.pdf
- Coal Transitions (2018a): What does "peak coal" mean for global exporters? A global modelling analysis on the future of the international steam coal market, Authoring Institution: DIW Berlin, Berlin, IDDRI, Paris, TERI, New Dehli, Published by: IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.org/reports/
- Coal Transitions (2018b): Coal Transition in India: Assessing India's Energy Options, A Country Case Study for the Coal Transitions Project, Authoring Institution: IIMA, Ahmedabad; Published by IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.org/reports/
- Coal Transitions (2018c): Coal Transition in China: Options to move from coal cap to managed decline under an early emissions peaking scenario, A Country Case Study for the Coal Transitions Project, Authoring Institution: Tsinghua University, Published by: IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.org/reports/
- Coal Transitions (2018d): Coal Transition in Germany: Learning from past transitions to build phase-out pathways, A Country Case Study for the Coal Transitions Project, Authoring Institution: DIW Berlin, Berlin, Published by: IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.org/reports/
- Coal Transitions (2018e): Coal Transition in Poland: Options for a fair and feasible transition for the Polish coal sector, A Country Case Study for the Coal Transitions Project, Authoring Institution: IBS, Warsaw, Published by: IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.org/reports/
- Coal Transitions (2018f): Coal Transition in South Africa: Understanding the implications of a 2oC-compatible coal phase-out plan for South Africa, A Country Case Study for the Coal Transitions Project, Authoring Institution: ERC, University of Cape Town, Cape Town, Published by: IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.org/reports/
- Coal Transitions (2018g): Coal Transition in Australia, A Country Case Study for the Coal Transitions Project, Authoring Institution: Crawford School of Governance, Australian National University, Canberra, Published by: IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.org/reports/
- Del Rio, P. (2017): Coal Transition in Spain: An historical case study for the project "Coal Transitions: Research and Dialogue on the Future of Coal", Published by: IDDRI, Paris, and Climate Strategies, London. https://coaltransitions.files.wordpress.com/2016/09/coal_es_v04.pdf
- Denver Post (27/08/2017): Xcel Energy plans to retire two coal-fired plants in Pueblo, increase renewables: Consumers should come out ahead long term, utility says, The Denver Post, Denver, https://www.denverpost.com/2017/08/29/xcel-energy-pueblo-coal-plants-retiring/

- European Commission (n.d.) EU coal regions: opportunities and challenges ahead, European Commission, Brussels https://ec.europa.eu/jrc/en/news/eu-coal-regions-opportunities-and-challenges-ahead
- Economist, The (12/06/2017): Mini-grids may be the best way to illuminate the “bottom billion” - Governments need to rethink what is meant by a national grid, The Economist, Print Edition, London, 12/07/2018, https://www.economist.com/leaders/2018/07/12/mini-grids-may-be-the-best-way-to-illuminate-the-bottom-billion
- EIA (2016): Capital Cost Estimates for Utility Scale Electricity Generating Plants, Energy Information Agency, U.S. Department of Energy Washington, DC. https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capcost_assumption.pdf
- EIA (n.d.): US Coal Consumption Statistics, US Energy Information Agency (last accessed: 24/07/2018) https://www.eia.gov/todayinenergy/detail.php?id=35572
- EIA (n.d.): US Coal-fired Power Capacity Statistics, US Energy Information Agency (last accessed: 24/07/2018) https://www.eia.gov/todayinenergy/detail.php?id=35572
- Enerdata (n.d.) Enerdata Energy and CO_2 Data Database, Enerdata, Grenoble, https://www.enerdata.net/user/?destination=services.html (subscription required)
- Environment Victoria (2018) Election 2018: Latrobe Valley Policy Priorities, Environment Victoria, http://environmentvictoria.org.au/wp-content/uploads/2018/05/LV-Policy-Priorities.pdf
- Environment Victoria (2018) Life After Coal : Pathways to a Just and Sustainable Transition for the Latrobe Valley, GCCN, http://gccn.org.au/wp-content/uploads/2018/03/Life-After-Coal_Pathways-to-a-Just-and-Sustainable-Transition-for-the-Latrobe-Valley.pdf
- Fothergill, S. (2017): Coal Transition in the United Kingdom, An historical case study for the project “Coal Transitions: Research and Dialogue on the Future of Coal”, Coal Transitions, IDDRI-Climate Strategies, Paris-London. https://coaltransitions.files.wordpress.com/2016/09/coal_uk_v04.pdf
- Gales, B., R. Hölsgens (2017): Coal Transition in the Netherlands: An historical case study for the project “Coal Transitions: Research and Dialogue on the Future of Coal,” Coal Transitions, IDDRI-Climate Strategies, Paris-London. https://coaltransitions.org/reports/
- Government of Canada (2018): Task Force: Just Transition for Canadian Coal Power Workers and Communities, Government of Canada, (last accessed: 2018-04-25) https://www.canada.ca/en/environment-climate-change/services/climate-change/task-force-just-transition.html
- Government of the United Kingdom (2018): Powering Past Coal Alliance: Joint Declaration, Government of the UK, www.gov.uk. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700613/powering-past-coal-declaration.pdf
- Grubb, M., F. Sha, T. Spencer, N. Hughes, Z. Zhang, P. Agnolucci (2015): A review of Chinese CO_2 emission projections to 2030: the role of economic structure and policy, *Climate Policy*, Volume 15, 2015, pp. S7-S39.
- GSI (2018) Getting on Target: Accelerating energy access through fossil fuel subsidy reform, GSI Report, IISD. https://www.iisd.org/sites/default/files/publications/getting-target-accelerating-energy-access.pdf
- Guardian, The (29/03/2018): Majority of Australians Support Phasing Out Coal by 2030,Survey Finds, The Guardian (Australian Edition) https://www.theguardian.com/australia-news/2018/mar/29/majority-of-australians-support-phasing-out-coal-power-by-2030-survey-finds
- Guardian, The (29/03/2018): AGL rejects Alinta's bid for Liddell power plant, confirming its closure The Guardian (Australian Edition) https://www.theguardian.com/australia-news/2018/may/21/agl-rejects-alintas-bid-for-liddell-power-plant-confirming-its-closure
- Hamilton Project (2016): Retraining Displaced Workers, A Policy Brief, October 2010. http://www.hamiltonproject.org/assets/legacy/files/downloads_and_links/10_displaced_workers_lalonde.pdf
- HBR (2016): What if All US Coal Workers Were Retrained to Work in Solar?, Harvard Business Review, Harvard, Massachusetts, https://hbr.org/2016/08/what-if-all-u-s-coal-workers-were-retrained-to-work-in-solar
- Herpich, P., H. Brauers, P.Y. Oei (2018) An historical case study on previous coal transitions in Germany: Part of the project “Coal Transitions: Research and Dialogue on the Future of Coal”, Authoring Institution: DIW Berlin, Berlin, Published by: IDDRI, Paris and Climate Strategies, London. https://coaltransitions.files.wordpress.com/2018/07/2018-historical-coal-transitions-in-germany-report2.pdf
- Hillary Clinton Campaign (2016) Policies on Climate Change, The Office of Hillary Rodham Clinton, https://www.hillaryclinton.com/issues/
- Hochschild, A.R. (2016): Strangers in Their Own Land: Anger and Mourning on the American Right, The New Press, https://thenewpress.com/books/strangers-their-own-land
- Huffington Post (06/23/2017): Most Job Training Programs Don't Work. Here's How To Do Better. Huffington Post https://www.huffingtonpost.com/entry/trump-apprenticeships-job-training_us_594ad64ce4b0312cfb613523
- IEA (2017a) Energy Access Outlook 2017: From Poverty to Prosperity, A World Energy Outlook Special Report, IEA/OECD, Paris. https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf
- IEA (2017b) Tracking Clean Energy Progress 2017: Energy Technology Perspectives 2017 – Excerpt Informing Energy Sector Transformations, IEA/OECD, Paris. https://www.iea.org/publications/freepublications/publication/TrackingCleanEnergyProgress2017.pdf
- IEA (2017c) World Energy Outlook, 2017, IEA/OECD, Paris. https://www.iea.org/weo2017/
- ILO (2015) Guidelines on a Just Transition to a Sustainable Economy for All, International Labour Organisation, ILO, Geneva. http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_432859.pdf
- IMPAQ (2008): Workforce Investment Act Non-Experimental Net Impact Evaluation: Final Report, IMPAQ International. https://wdr.doleta.gov/research/FullText_Documents/Workforce%20Investment%20Act%20Non-Experimental%20Net%20Impact%20Evaluation%20-%20Final%20Report.pdf
- IRENA (2017) Electricty Storage and Renewables: Costs and Markets to 2030, IRENA, October 2017, Abu Dhabi, http://www.irena.org/publications/2017/Oct/Electricity-storage-and-renewables-costs-and-markets

- Jotzo, F. and S. Mazouz, (2015) Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations, CCEP Working Paper 1510, November 2015 https://ccep.crawford.anu.edu.au/sites/default/files/publication/ccep_crawford_anu_edu_au/2015-11/ccep1510.pdf
- JRC (2018) EU coal regions: opportunities and challenges ahead, Joint Research Center, European Commission, Brussels https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/eu-coal-regions-opportunities-and-challenges-ahead
- Kluve, J., S. Puerto, D. Robalino, J. Manuel Romero, F. Rother, J. Stöterau, F. Weidenkaff, M. Witte (2016) Do Youth Employment Programs Improve Labor Market Outcomes? A Systematic Review, Discussion Paper, DP No. 10263, , Bonn http://ftp..org/dp10263.pdf
- Kok, I. (2017) Coal Transition in the United States, An historical case study for the project "Coal Transitions: Research and Dialogue on the Future of Coal", Coal Transitions, IDDRI-Climate Strategies, https://coaltransitions.files.wordpress.com/2016/09/coal_us_v04.pdf
- Martinez, S. & D. Sullivan (2014) Using Energy Efficiency To Meet Flexible Resource Needs And Integrate High Levels Of Renewables Into The Grid, Natural Resources Defense Council, California, 2014 https://aceee.org/files/proceedings/2014/data/papers/5-1012.pdf
- McKinsey (2015): Education to Employment, Designing a System that Works http://www.mckinsey.com/industries/social-sector/our-insights/education-to-employment-designing-a-system-that-works
- McKinsey (2016): The New Economics of Energy Storage, McKinsey & Co. https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-new-economics-of-energy-storage
- Medium (2016): Https://www.medium.com/ https://medium.com/energy-access-india/commentary-can-india-lead-global-mini-grid-market-like-china-did-with-solar-pv-7136bd5183fd
- Munoz-Galeano, E. The Dark Side of the Mining Boom in Colombia, University of Remington, Colombia. http://www.uniremington.edu.co/images/investigacion/libros-investigacion/the-dark-side-web.pdf
- NBIM (n.d.) Norges Bank Investment Management, NBIM, Norway, https://www.nbim.no/en/the-fund/
- New York Times, (16/11/2017): "19 Countries Vowed to Phase Out Coal. But They Don't Use Much…", New York Times, www.nytimes.com
- Province of Alberta (2017) Support for workers affected by coal phase out: Financial, employment and retraining supports for workers affected by the end of coal-fired electricity generation in Alberta. A Government Program, Government of Alberta, https://www.alberta.ca/support-for-coal-workers.aspx
- RAP (2014): Integrating Renewables into Power Systems in China: A Technical Primer - Power System Operations, Regulatory Assistance Project. https://www.raponline.org/knowledge-center/integrating-renewables-into-power-systems-in-china-a-technical-primer-power-system-operations/
- Rečková, D., L. Rečka, M. Ščasný (2017) Coal Transition in the Czech Republic, An historical case study for the project "Coal Transitions: Research and Dialogue on the Future of Coal", Coal Transitions, IDDRI-Climate Strategies, Paris-London. https://coaltransitions.files.wordpress.com/2016/09/coal_cz_v04.pdf
- Reuters (17/12/2017): China Unveils 2017-2021 Winter Clean Heating Plan, Reuters.com, (last accessed 24/07/2018). https://www.reuters.com/article/us-china-energy-heating/china-unveils-2017-2021-winter-clean-heating-plan-media-idUSKBN1EB02P
- Richter, P., R. Mendelevitch, F. Jotzo, (2018): Coal taxes as supply-side climate policy: a rationale for major exporters? 16 February 2018 # Springer Science+Business Media B.V., part of Springer Nature 2018 https://coaltransitions.files.wordpress.com/2018/03/richter-mendelevitch-jotzo-climch-coal-taxes.pdf
- Rodrik, D. (2015): Premature Deindustrialization. NBER Working Paper No. 20935, NBER, U.S., February 2015. http://www.nber.org/papers/w20935
- SEI (2017) Transition lessons from Colombian coal politics, SEI Colombia, Nov 2017, https://www.sei.org/perspectives/colombian-coal-politics/
- Spencer, T., R. Pierfederici, O. Sartor, N. Berghmans (2016) State of the Low-Carbon Energy Union: Assessing the EU's progress towards its 2030 and 2050 climate objectives, IDDRI Study No 08/16, IDDRI, Paris. https://www.iddri.org/sites/default/files/import/publications/st0816_ts-et-al_low-carbon-energy-union.pdf
- Spencer, T., N. Berghmans, O. Sartor (2018): Coal transitions in China's power sector: A plant-level assessment of stranded assets and retirement pathways N°12/17, IDDRI, NOVEMBER 2017 https://coaltransitions.files.wordpress.com/2017/11/st1217_china-coal-final.pdf
- Szpor, A. (2017): Coal Transition in Poland, An historical case study for the project "Coal Transitions: Research and Dialogue on the Future of Coal", Coal Transitions, IDDRI-Climate Strategies, Paris-London. https://coaltransitions.files.wordpress.com/2016/09/coal_pl_v04.pdf
- Technology Review (2016): Can we help the losers in climate change? MIT Technology Review, MIT, Massachussets. https://www.technologyreview.com/s/602093/can-we-help-the-losers-in-climate-change/
- US BLS (n.d.): Statistics on Employment in Coal Mining, US Bureau of Labour Statistics https://www.bls.gov/
- Vox (21/03/2016): Clinton has a $30 billion plan to help coal miners, but it got buried by a silly "gaffe", https://www.vox.com/2016/3/21/11278138/clinton-coal-gaffe
- Wiseman, J., S. Campbell, F. Green (2017) Prospects for a Just Transition Away FromCoal Fired Power Generation in Australia: Learning from the Closure of the Hazelwood Power Station https://ccep.crawford.anu.edu.au/publication/ccep-working-paper/11847/prospects-just-transition-away-coal-fired-power-generation

Annex

Coal Transitions Case Study Countries: Key Facts



DATA FROM CASE STUDIES ANALYSED

Legend

Country *Coal transition policy debate status* • Current Challenges

Share of global coal consumption	Share of coal in domestic power production	Change in coal mining jobs since 2000 *	Share of global imports	Share of global exports

China *Emerging debate*

- Limiting stranded power and mining assets due to overbuild and falling coal demand
- Coordinating a progressive and managed phase down of coal assets to manage social impacts of already declining coal employment and public services provided by coal SOEs

49%	62%	- 30% ↘ 4,500,000 current jobs		35%

India *Emerging debate*

- Providing access to electricity to all through renewable « minigrid » solutions
- Avoiding growth of new and unnecessary coal plant, mine and transport infrastructure given existing sector overcapacity

13%	70%	- 63% ↘ 315,000 current jobs		18%

South Africa *Active debate*

- Phasing in cheaper domestic renewables as old coal assets retire as per existing plans
- Strengthening national industrial diversification and workforce skills

3%	82%	+ 60% ↗ 77,000 current jobs		7%

Germany *Active debate*

- Reaching consensus on the end date for coal use in 3 remaining lignite-producing regions
- Agreeing on a fair transition policy package for affected workers and regions

3%	37%	- 68% ↘ 30,000 current jobs		

Poland *Emerging debate*

- Agreeing labour transition strategy as old mines become uncompetitive by 2030s
- Developing alternative domestic energy sources for energy security from Russian gas

2%	81%	- 67% ↘ 88,000 current jobs		

Australia *Stalled*

- Developing trans-partisan political agreement on energy transition policy and social transition strategy, building on existing stakeholder demands and proposals
- Preparing for the coming decline to export revenues due to lower future international coal demand, as China and other Asian customers transiton from coal post 2020.

2%	82%	- 18% ↘ 49,000 current jobs		27%

** from 2012 to 2017 for Australia ; forecast for 2013-2020 for China*

COAL TRANSITIONS:
RESEARCH AND DIALOGUE ON THE FUTURE OF COAL

COAL TRANSITIONS is a large-scale research project leaded by Climate Strategies and The Institute for Sustainable Development and International Relations (IDDRI) and funded by the KR Foundation.

The project's main objective is to conduct research and policy dialogue on the issue of managing the transition within the coal sector in major coal using economies, as is required if climate change is to be successfully limited to 2°C.

THIS PROJECT BRINGS TOGETHER RESEARCHERS FROM AROUND THE GLOBE, INCLUDING AUSTRALIA, SOUTH AFRICA, GERMANY, POLAND, INDIA AND CHINA.

www.coaltransitions.org

Climate Strategies

IDDRI