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Perspective

The COVID-19 crisis deepens the gulf between leaders and laggards in the global energy transition

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ABSTRACT

In this article, we review the main impacts of the COVID-19 pandemic on the global energy sector and evaluate the implications of related policy responses on prospects for a transition to a climate-friendly energy system. In doing so, we differentiate between different types of countries and different dimensions of energy supply. Firstly, we assess the impacts on leaders and laggards in the transformation of the power sector, in terms of renewable power deployment and the phase-out of coal-fired power generation. Secondly, we consider impacts of the crisis on major exporters of oil and gas resources, focusing on a selection of G20 countries. We find that the impact of the COVID-19 crisis and related policy responses vary across different types of countries but also within large countries, such as the US and China. We conclude that the COVID-19 crisis deepens the gulf between leaders and laggards of the global energy transition and will exacerbate existing imbalances in an uneven energy transition landscape. This threatens the achievement of international climate targets and points to the need for concerted international action aimed at the phase-out of fossil energy resources.

1. Introduction

The COVID-19 pandemic and measures to contain the spread of the virus have caused the most severe recession since World War II, upending economies and societies around the world. In the energy sector, short-term impacts have been staggering: lockdowns caused energy demand to plummet sending oil prices into negative territory for the first time in history. Global CO_2 emissions decreased by 6.4 percent in 2020, the largest drop in history [1]. The COVID-19 crisis has already had major effects on energy markets, but how will it influence the global transition to a climate-friendly energy system?

Initial scholarly debate was largely conceptual and focused on the importance of pursuing a "green recovery" [2,3]. Empirical contributions have offered assessments of impacts of the COVID-19 crisis on different parts of the global energy sector, including the oil sector [4], renewable energy investment [5] and electricity demand in different jurisdictions [6–9]. Other authors have provided an overview of stimulus measures in various countries, including China [10] and African countries [11], while Kuzemko et al. (2020) have explored the implications for the *politics* of sustainable energy transitions [12].

To date, there has been little emphasis on comparing impacts across different countries or regions, although such work is essential for understanding the implications of the crisis on the global energy transition. Here, we assess the implications of the COVID-19 pandemic on energy transition processes in different types of countries. We investigate both how the COVID-19 crisis is affecting progress in the expansion of renewable energy and its impact on lock-ins in high-carbon energy supply. To do so, we review the most important impacts of the crisis and the related policy responses among leaders and laggards of the energy transition along different dimensions of energy supply. Following this empirical analysis, we discuss its implications and relate it to debates on fostering a Just Transition.

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2. Leaders and laggards in the global energy transition

The energy transition is a complex process of system change aimed at the decarbonization of the energy sector. Key elements of this are the expansion of renewable energy and other sources of carbon–neutral energy, the phase-out of a fossil-based energy supply as well as the reduction of energy demand through measures to boost energy efficiency [13,14]. It also involves the transformation of end-use sectors, in particular transport and parts of industry, to enable a switch to carbon–neutral energy sources [15,16].

The most significant progress has occurred in the power sector, where the deployment of renewables has advanced significantly [14]. This process has, however, unfolded at a highly uneven pace. Over the past decade, more than seventy-five percent of global investment in renewable power has been concentrated in China, Europe, the US and India (see Fig. 1). The global leaders in per capita production of wind and solar power include G7 countries, Australia and members of the European Union (EU) (see Fig. 2).

In the US and the EU, renewable power expansion is closely linked to a concurrent decline of coal power generation, the most carbon-intensive form of power supply. Power production from coal has declined by more than 40 percent in the US and more than 30 percent in Europe over the past decade [17]. In China and India, on the other hand, rising power demand has driven the expansion of renewables along with coal-based power. Most South and Southeast Asian countries have also seen significant capacity additions in the coal power sector but little progress in the field of renewables. Mainly in response to growing electricity demand, Asian countries increased their share of global coal consumption from 48 percent in 2000 to 77 percent in 2019 (see Fig. 3).

Moving further upstream in the energy supply chain, the transition to carbon–neutral energy involves the gradual reduction of the extraction of fossil fuel resources. For countries that are heavily dependent on fossil-fuel revenues, this implies the need to diversify their economies. With the notable exception of Norway, progress in reducing this export dependency has progressed very slowly [18]. Indeed, in the US, the revolution in shale oil and gas has further increased the importance of the US oil and gas sector, both for the domestic economy and the global energy sector [19].

3. Case selection for assessing the impact of the COVID-19 crisis on the global energy transition

This uneven energy landscape represents the starting point for our analysis. We discuss the impacts on the relative leaders and laggards in selected spheres of energy supply. We investigate how the COVID-19 crisis is affecting progress in the expansion of renewable power and its impact on lock-ins in high-carbon energy supply. Regarding the latter, we focus on investment and divestment in coal power generation as well as oil and gas exploration and extraction. We do not consider the transition in end-use sectors, limiting our analysis to energy supply.

China, India, the US, and the EU, as the largest global economies and the most important leaders in the deployment of renewable power (see Figs. 1 and 2 above), are considered across all dimensions of the analysis. Within the EU, we also discuss developments in Germany as a key energy transition leader and the largest EU member state, as well as Poland as a relative laggard in the EU.

In the sphere of renewable energy investment, we juxtapose the analysis of these countries with a discussion of impacts of the COVID-19

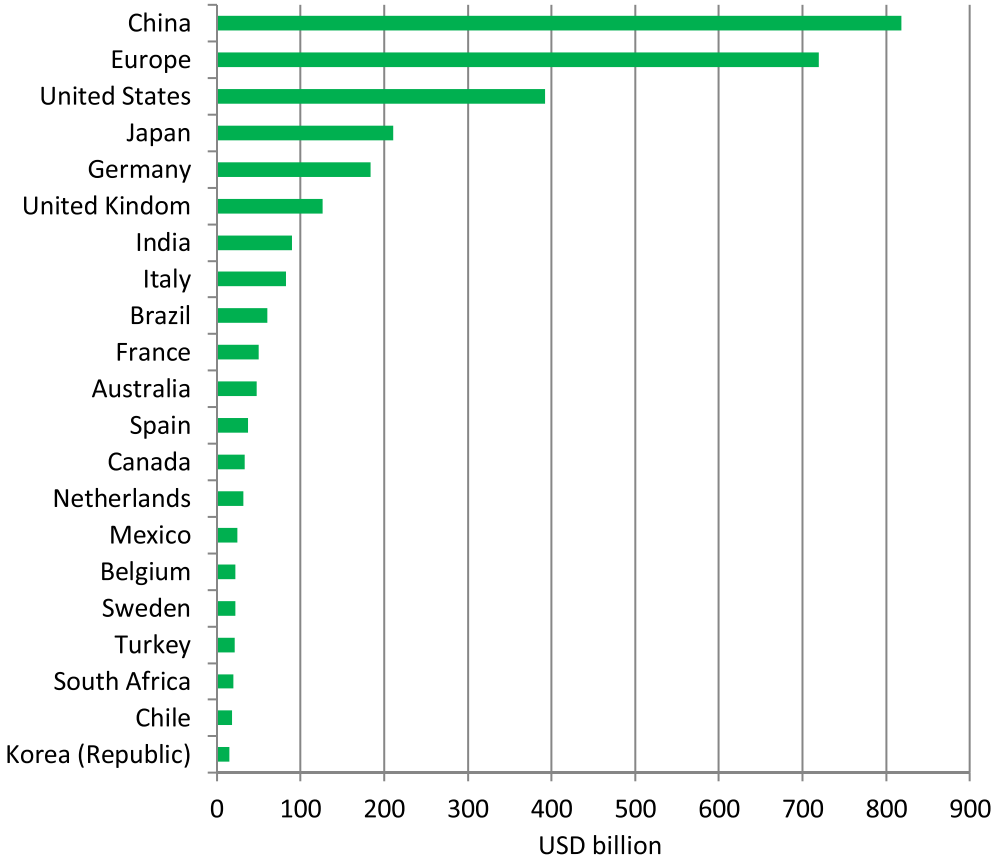

Fig. 1. Investments in renewable power generation capacity, top 20 economies, 2010–2019 [84].

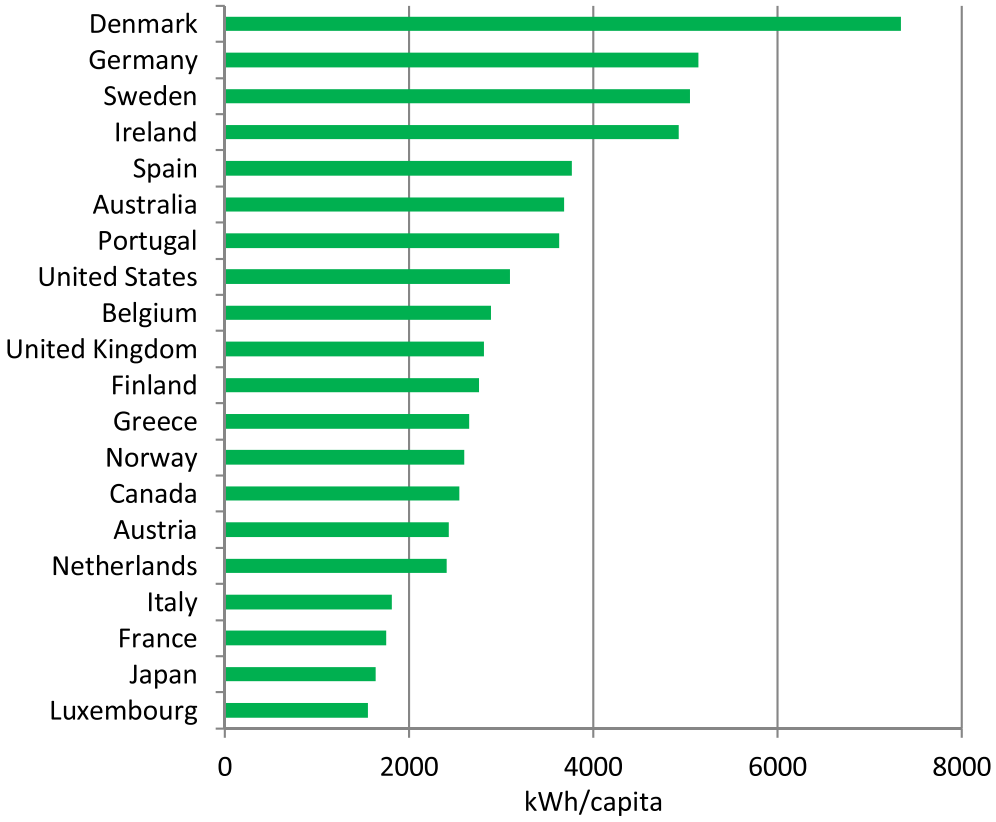

Fig. 2. Electricity consumption from wind and solar energy, per capita, top 20 countries, 2019 [85].

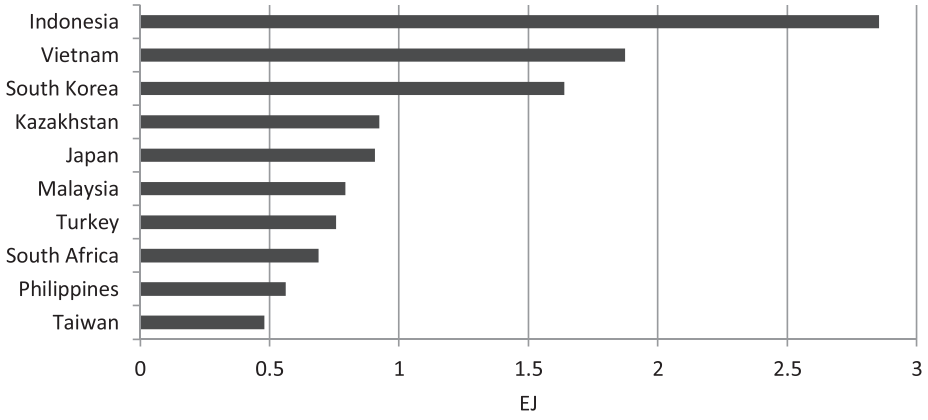

Fig. 3. Growth in coal consumption from 2000 until 2019, top 10 countries, excluding China and India [Note: From 2000 to 2019, coal consumption in China and India has grown far above rates in any other country, by 52 EJ and 12 EJ respectively. They were omitted in this graph.] [17].

pandemic on energy transition prospects in developing countries, as they have lagged behind considerably in this area of the energy transition. We do not provide a more in-depth assessment of single country cases, arguing that the impacts are expected to be relatively uniform within this country grouping.

For the field of coal-fired power generation, we consider South Korea, Indonesia and Vietnam, the three countries with the largest absolute increases in coal demand over the past decade after China and India (see Fig. 3). We also consider Japan as the only remaining G7 country that continues to increase its consumption of coal. Finally, we discuss how the COVID-19 crisis is affecting economic dependency on fossil fuels in G20 countries with significant oil and gas resources, i.e. Argentina, Canada, Mexico, Russia and Saudi-Arabia. For an overview of all countries considered, see Table 1.

For each country group, we consider both direct economic impacts resulting from the COVID-19 crisis as well as indirect impacts related to the governments' policy responses. For this purpose, we consider energy sector and financial data published by the IEA, the IMF and relevant country-level sources, government policy statements and related media reports as well as the emerging secondary literature on the crisis.

Table 1
Overview of countries considered.

Category	Countries considered	Dimension considered
Major world economies / leaders in renewable power	USA, China, India, EU (with special focus on Germany and Poland)	All dimensions
Developing countries / laggards in renewable power	No specific country focus	Renewable power
Leaders in coal power expansion	China, India, South Korea, Indonesia, Vietnam, Japan	Coal-based power
G20 countries with significant fossil-fuel resources	Argentina, Canada, Mexico, Russia, Saudi-Arabia.	Oil and gas sector

4. The COVID-19 crisis and renewable electricity

Across the world, energy demand declined as a result of COVID lockdown measures: in the hardest-hit countries, power demand declined by up to 20 percent, whereas global demand decreased by almost 4 percent in the first quarter of 2020 [20]. This decrease mainly came at the expense of coal power, while leaving renewables unscathed due to their low operating costs and priority grid access. Hence, in countries with significant renewable power capacities in place, their share of power demand increased strongly.

4.1. Leaders sustain deployment of renewable power

Despite increasing shares of renewable power, investment in renewables declined in 2020 along with overall investment in the power sector. At the same time, auctioned capacity is expected to increase, though with an even stronger concentration in the leading countries, accounting for just below 95 percent of the total. These results appear to reflect the fact that governments in leading countries seek to boost their recoveries by directing stimulus spending towards existing clean energy industries. This is confirmed by data on stimulus measures in the energy sector (see Fig. 4). Germany, France, China and the UK have committed the largest volume of funding for various types of clean energy projects: each of these countries has included more than $10 billion for clean energy investments in their recovery programs, more than double the amount of any other country [21].

In the EU, the various national schemes will be complemented by an ambitious European recovery program, based on measures previously proposed in the European Commission's Green Deal. Crucially, the EU has also taken steps to strongly increase the overall funding volume. This has been enhanced with €750 billion in additional funding, which the EU will borrow from capital markets [22]. It will focus on digital infrastructure, clean energy technologies, energy efficiency and sustainable transport. The Recovery and Resilience Facility, accounting for 90 percent of the spending, requires member states to ensure that at least 37 percent of investments support climate change mainstreaming, while the remainder should fulfill the "do no harm" criteria of the EU's taxonomy of environmentally sustainable economic activities [23]. This is underpinned by the recent increase of the EU's greenhouse gas reduction target from 40 to 55 percent by 2030 [24].

Moreover, many European countries have responded by taking measures to sustain planned deployment of renewable energy by extending commissioning deadlines for existing projects and moving forward with auctions as scheduled or with minor delays. In Germany, an additional $12 billion in public finance is being provided to fund a share of the disbursements for renewable electricity, which are usually funded entirely through the electricity bills of consumers. In Poland, there are plans to step up renewable energy deployment in the wake of the crisis. In June 2020, the Polish climate minister proposed that the pandemic had ushered in a realignment of priorities in favor of green investment [25], reflected in new auctions of 5.9 GW offshore wind scheduled for 2021 and a recent announcement to develop an industrial strategy for solar power [26].

China doubled its deployment of renewable power in 2020 compared to 2019 and has launched a National Green Development Fund for investment in green infrastructure projects. In addition, the government announced that it would aim to achieve carbon neutrality by the year 2060 and to bring its wind and solar power capacity to 1200 GW by 2030 [87]. Otherwise, the crisis has come at a transitional time in its renewable power support policy. The government plans to phase out subsidies for renewable power, while implementing market reforms to enhance the ability of renewables to compete with coal-based power generation. The government issued a policy statement underlining its commitment to this process [27], while floating a proposal that would require regional grids to source at least 40 percent of electricity from non-fossil sources by 2030 [86].

In India, disruptions caused by the pandemic have taken a significant toll on construction in the renewable power sector, reducing new installations by more than 50 percent compared to 2019. However, it has significantly increased auctioning activity in 2020 compared to 2019 [28]. In addition, the government has launched a $12 billion rescue scheme to ensure the financial health of India's power distribution companies, a crucial measure to ensure continued viability of the sector [29].

In the US, support for the clean energy sector was initially not the focus of the Trump administration's COVID response. Nevertheless, in a last-minute rush before the end of the federal tax credit program, the main fiscal incentive for renewable power projects, annual capacity additions increased compared to 2019 [30]. In addition, the federal government extended deadlines for claiming existing tax credits to cushion the impact of the pandemic [31], which is expected to create a boom in capacity additions in 2021 [32]. In the stimulus bill passed in December, Congress included legislation to allow for the extension of the tax credits until 2023, enabling continued investment in the upcoming years [33]. President Biden's plans to invest $1.7 trillion in clean energy infrastructure will further bolster this trend [34].

Table 2 provides an overview of the developments in renewable power discussed in this section.

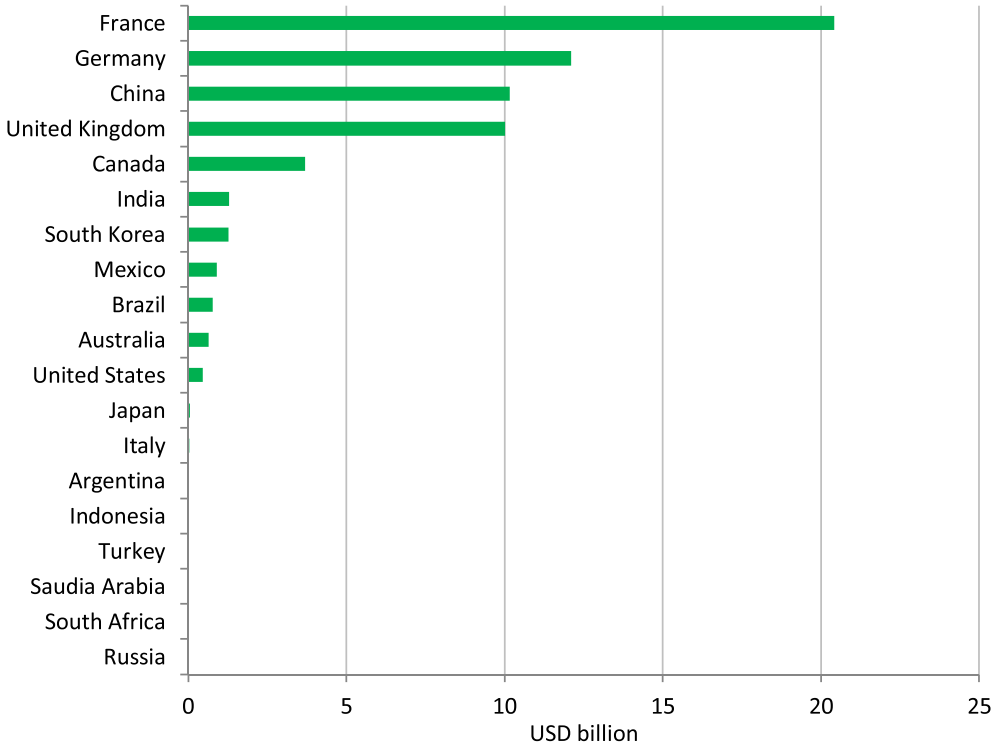

Fig. 4. Covid-19 recovery packages: committed investments in clean energy in the G20 [21].

Table 2
Main policy responses in the US, China, India and the EU (including details on Germany and Poland).

Country	Major developments
USA	- Increase in capacity additions, due to planned expiry of federal tax credits
	- Extension of commissioning deadlines for claiming tax credits, due to pandemic (May 2020)
	- Stimulus bill provides for the continuation of tax credits through 2023 (December 2020)
China	- Record deployment of renewable power in 2020
	- 2060 carbon-neutrality target and target to reach 1200 GW of solar and wind power capacity by 2030
	- Launch of National Green Development Fund
	- Opinion on Accelerating the Regulatory and Policy System of Green Production and Consumption reinforces market reforms in favor of renewable energy
	- Proposal to require regional grids to source 40 percent of electricity from non-fossil sources by 2030
India	- Slowdown in installations in 2020, due to pandemic
	- Increased auctioning of renewable energy in 2020 compared to 2019
	- Rescue scheme for power utilities to sustain financial health ($12 billion)
	- Announcement of plans to support manufacturing industry in solar energy sector
EU	- EU's Recovery and Resilience Facility provides €672,5 billion for digital and green investment, including requirement to adhere to the "do no harm" principle and to dedicate at least 37 percent to climate mainstreaming
	- Increase of 2030 greenhouse gas reduction target from 40 percent to 55 percent
Germany	- Injection of €12 billion in public funding to reduce the financial burden on consumers from renewable energy market support
Poland	- Announcement by climate minister in support of green investment strategy
	- Launch of industrial strategy for solar energy sector and adoption of law in support of offshore wind development

4.2. Developing countries fall further behind

In developing countries, the crisis has led to the further deterioration of an already challenging investment climate for renewable power. Firstly, decreasing fiscal revenues are raising concerns about the sustainability of public debt burdens, leading to depreciation of currencies and increased borrowing costs [35]. Due to their high capital intensity, this disproportionately affects investments in renewable power. Secondly, economic hardship related to the pandemic is leading to a rise in defaults on consumer electricity bills. In several countries, governments have responded by suspending the payment of electricity bills and reducing electricity prices [11,36]. This places additional pressure on the utility sector in these countries, which notoriously suffers from financial distress [37]. This will add to investment risks in the power sector, exacerbating the financing challenges faced by new renewable power projects.

In addition, developing countries lack the fiscal space to implement large-scale stimulus programs, as seen in many industrialized countries. Collectively, advanced economies have deployed fiscal measures worth over 20 percent of their annual GDP, whereas developing countries have invested less than 2 percent (see Fig. 5). Most of these scarce resources are flowing to the health sector, social protection measures or general economic stimulus programs.

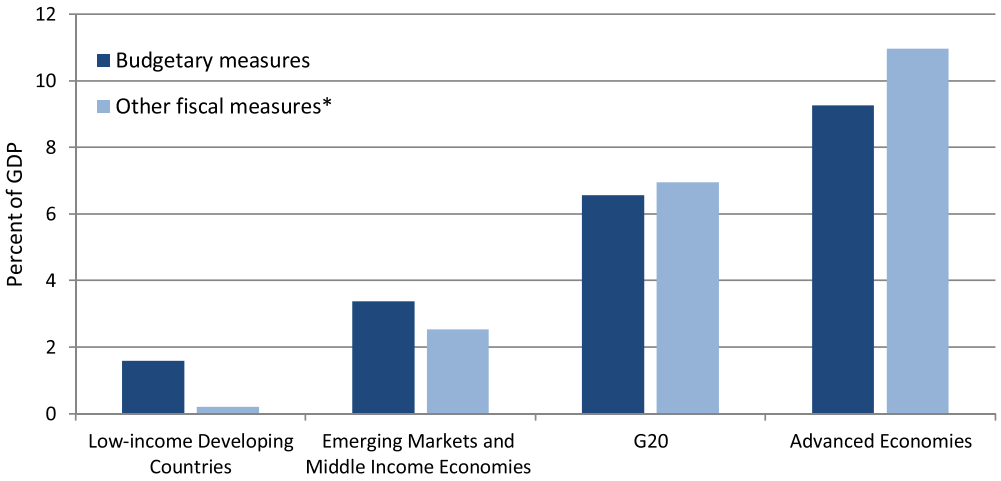

Fig. 5. Fiscal measures in response to the COVID-19 pandemic [*Note: Other fiscal measures include equity, loans, guarantees and quasi-fiscal activities, such as the purchase of corporate bonds.] [74].

5. The COVID-19 crisis and coal-based power generation

The pandemic is not only affecting investment in renewable power: decreasing electricity demand has also reduced the capacity factors of coal power plants around the world. Coal demand has dropped by 5 percent in 2020 compared to the previous year, driven primarily by reductions in coal-fired power generation [38]. These developments will add to the financial challenges faced by coal-related businesses around the world. These were already facing deteriorating business environment, with falling profit margins both on the supply and the demand side of the sector [39].

5.1. An accelerating decline of coal-fired power production in the US and Europe

In the US and Europe, this will reinforce the existing decline of coal-fired power generation, which has dropped by more than 30 percent over the past 10 years [17]. In Germany, the lockdown and economic crisis reduced annual power generation from lignite and hard coal by 20 and 26 percent, respectively, compared to 2019 [40]. The first auction organized to determine rates of financial compensation for the phase-out of 4 GW of hard coal capacity was 20 percent oversubscribed [41]. In Poland, coal power generation decreased by 9 percent, while overall electricity demand decreased by only 2.5 percent [42]. The reduced demand for domestic coal during the lockdown caused losses of €50 million per month for PGG, the country's largest coal mining company [43]. Although coal continues to dominate power generation, the sector is slowly changing; for example, construction of a new 1 GW coal-fired power plant, was suspended, causing losses of €220 million for the two state-owned developers [44]. Moreover, acknowledging the dwindling cost-competitiveness of domestic coal, the Polish government announced the complete phase-out of coal power by 2049, to be partially financed with funding from the EU's Just Transition Mechanism [45].

In the US, despite President Trump's vocal commitment to save jobs in the coal industry, similar trends are visible. Several coal mines have suspended operation due to the pandemic, leading to a 12 percent contraction of employment [46], and utilities have announced thirteen new coal plant closures [47].

5.2. Mixed impacts on Asian coal

Among the leaders of coal power expansion, economic uncertainties induced by the pandemic have reduced the appetite for new investments in a number of countries. In Southeast Asia, only 1 GW of new projects was proposed in the first half of 2020, compared to an average of 2.9 GW every six months since 2015 [49]. This adds to a deteriorating financing environment, as an increasing number of international financial institutions have imposed restrictions on coal-based investment [50]. This trend has continued during the pandemic with new restrictions announced in Japan and Korea. This is significant, as Japanese and Korean banks represent approximately 40 percent of overseas financing in the sector, with Chinese policy banks accounting for an additional 24 percent [51].

In South Korea and Japan, the governments' announcement to scale back overseas financing of coal is matched by corresponding steps in the domestic market. The Korean government has recently announced a carbon neutrality target for 2050 along with a plan to close ten coal-fired power plants by 2022 and an additional twenty by 2034, representing half of the existing total [52]. Similarly, Japan's prime minister has recently announced a carbon neutrality target for 2050 and has promised to fundamentally rethink the role of coal in Japan's energy mix, though failing to announce any concrete measures [53]. In Vietnam, there are also signals that investments in coal-based electricity generation may slow down in the wake of the COVID-19 crisis. Citing uncertainties surrounding the COVID-19 crisis, the draft PDP VIII cancels or postpones until after 2030 over 17 GW of projects, approximately about half of the previously planned additions [54].

In China signals are more mixed. Driven by subnational government efforts to stimulate the local economy, the COVID-19 crisis has

accelerated coal power investment activity, increasing the amount of coal power capacity under development by approximately 20 percent. Permits have been issued for 19.7 GW of additional capacity, more than 2018 and 2019 combined [49]. These developments have raised concerns within the central government, which announced measures to reduce excess coal power capacity, including the accelerated decommissioning of "outdated" power plants [55]. In sum, signals from China are unclear, both supporting and reining in new-build in coal power.

In India, signals are mixed as well. On the one hand, no new coal power plants started construction in the first half of 2020 [49]. Moreover, state-owned NTPC, India's largest producer of coal power, will halt land acquisition for new coal power projects and plans to increase its share of renewable power capacity from under 10 to 30 percent [56]. On the other hand, state-owned Coal India was mandated to replace at least 100 million tonnes of imported coal with domestic resources and announced over $6 billion in transportation infrastructure for this purpose. Moreover, the government rolled back requirements for ash content of domestic coal to boost its competitiveness and has offered tax rebates for coal extraction projects that are completed ahead of schedule [88]. These measures do not directly translate into an increase in coal-fired power generation, but foster increased domestic lock-in effects, making the energy transition more difficult in the future.

In Indonesia, both a major consumer and the world's second largest exporter of coal, the COVID-19 crisis is likely to slow down plans to weaken the country's coal dependence, both in the power sector and for the economy as a whole. Before the COVID-19 crisis, the Indonesian government announced plans to reduce its reliance on coal-based power generation and replace parts of its fossil power capacity with new renewable capacities [57]. Simultaneously, the government planned another 35 GW of new generation capacity by 2029, of which 57 percent coal. Due to the large drop in electricity demand since the onset of the crisis, the state-owned utility, PT PLN, reviewed its plans and announced that it would prioritize conversion to gas rather than renewables [58]. Moreover, in response to the pandemic, the government issued a regulation to facilitate administrative and business procedures for the mining sector, including coal. In addition, the coal sector is eligible for a 30 percent tax reduction for six months and a number of additional fiscal incentives aimed at reducing the impact of the economic crisis on the sector. These developments contradict the aim of reducing the share of coal-based power generation and will further increase Indonesia's economic dependence on coal extraction.

Table 3 provides an overview of developments in the coal power sector in the countries mentioned in this section.

6. The COVID-19 crisis and lock-ins in oil and gas industries

The worldwide contraction of energy demand is also putting unprecedented pressure on the global oil and gas sector. After the oil price turned negative in late April, OPEC countries and Russia intervened by removing approximately 10 percent of global supply from the market [59]. As a result, futures prices recovered but stayed significantly below 2019 levels [60]. The immediate impact of these developments is significantly reduced investment in the oil and gas sector. The International Energy Agency (IEA) estimates a contraction of investment by 30 percent in 2020 [61]. However, most oil and gas dependent economies are deploying regulatory and fiscal policies to protect the sector and preserve jobs as part of their recovery programs.

6.1. The COVID-19 crisis in major oil importing countries

Among the major world economies, the EU, China and India all represent net oil importers. In this vein, India and the EU have not directed any significant stimulus spending to the oil and gas sector. Indeed in the EU, rising climate ambition and a focus on a green recovery is increasing pressure on European oil and gas companies. The French government, for example, announced the end of public export credit guarantees for oil and shale gas projects [62]. In line with this, the COVID-19 crisis is likely to accelerate ongoing efforts to diversify the investment portfolios of the European oil majors (e.g. BP, Eni, Shell, Total) [63]. These firms have reduced overall investments in response to the crisis, while maintaining or even increasing planned investments in the clean energy sector [64,65].

Similarly, in China, support to the oil and gas sector has not played a major role in the central government's stimulus measures. However, at the provincial level, it represents a popular target of stimulus spending. In anticipation of continued growth in oil consumption, 20 percent of provincial stimulus spending is earmarked for investments in oil refining [66]. This is likely to further exacerbate existing overcapacities in China's refinery sector [67], and it will reinforce carbon lock-in in the affected provinces.

6.2. Destabilization of the oil and gas sector countered by government support in North America

In the US and Canada, both major exporters of oil and gas, initial government efforts sought to counterbalance negative effects of the COVID-19 crisis on fossil-fuel investment. Indeed, as a result of the drop

Table 3
Overview of major developments in the coal sector in the selected countries.

Country	Major developments in the coal sector
USA	- Announcement of 13 new plant closures as a result of pandemic
China	- Strong increase in local level permitting for the construction of new coal-fired power plants
	- Central government announces intention to curb expansion of coal-fired power
India	- Announcement by largest state-owned power utility to halt land acquisition for new coal-fired power plants, while increasing investments in renewable energy capacity
	- Coal India mandated to replace at least 100 million tonnes of imported coal
	- $6 billion investment in coal-related transportation infrastructure
	- Roll-back of environmental requirements and tax rebates for coal extraction projects
EU	- Launch of Just Transition Mechanism to support regions affected by coal phase-out
Germany	- Coal phase-out plans largely unaffected by pandemic
Poland	- Construction of major coal power plant suspended
	- Announcement of complete coal-phase out by 2049
South Korea	- Announcement to close 10 coal-fired power plants by 2022 and an additional 20 by 2034
Indonesia	- Program to convert power capacity to renewables placed on hold, due to pandemic
	- Fiscal incentives provided to the coal mining sector
Vietnam	- Cancellation or postponement of 17GW of planned investments in coal-fired power capacity
Japan	- Statement on the need to reduce the role of coal-based power in energy mix, though no specific phase-out measures announced

in oil prices, investments in new drilling have plummeted in both countries. In October 2020, there were only 296 active rigs in the US, compared to 822 in October 2019 [68]. In Canada, 86 rigs remained, compared to 142 a year before.

To prop up the sector, the Trump administration deployed a series of fiscal and regulatory measures. The oil and gas firms benefited from the massive purchase of corporate bonds by the US Federal Reserve, accounting for approximately 8 percent of purchases by June 2020 [69], and the Federal Bureau of Land Management reduced royalty and rent payments for oil firms drilling on federal lands. In addition, the US administration introduced a range of measures to facilitate new investments in oil drilling and pipeline construction by granting permits and relaxing environmental regulations [70]. It appears that this trend may be reversed with the new Biden administration, however. It has temporarily halted all permitting of drilling rights, revoked the permit for the controversial Keystone pipeline and plans to impose a moratorium on oil drilling on federal land [71].

Canada has also implemented a set of measures that are heavily skewed towards support for the existing oil and gas sector in the country. Despite public statements about a green recovery, most announced and funded programs target the fossil fuel sector, albeit partly in an effort to reduce their impact on the environment and the climate. Key support measures at the federal level include Can$1.7 billion to clean up orphaned and inactive oil and gas wells[1]. Additionally, Can$750 million from the Emissions Reductions Fund with a focus on methane will benefit offshore oil and gas firms "to support their investments to reduce greenhouse gas emissions" [72]. Finally, Canada's energy resources are owned and managed by the Provinces and Territories, not the Federal government, and they are also directing support to the oil sector. The province of Alberta, for example, is providing additional direct financial support – a $1.5 billion investment, along with a $6-billion loan guarantee – for the Keystone pipeline project[2] [73].

6.3. Increasing lock-in in fossil-fuel dependent emerging economies

Emerging and developing economies with a relatively high dependence on the fossil fuel sector are particularly affected by the contraction of oil demand and the related decline of the oil price. This is also reflected in their fiscal response to the COVID-19 crisis. As depicted in Fig. 6 below, the fiscal measures deployed by oil-exporting developing and emerging economies are significantly lower than in non-exporting countries, limiting their ability to utilize the crisis as an opportunity to diversify the economy.

Even in Saudi Arabia, where oil production remains profitable at current prices, the decrease in fiscal income will reduce the government's ability to promote investment aimed at the diversification of its economy. The government has responded to the oil revenue decline by cutting public expenditure by 20 to 30 percent. In the renewable energy sector, it has postponed the signing of power purchase agreements for 1,5 GW of previously auctioned capacity [28].

Similarly, in Russia, the government has taken a very cautious approach to fiscal stimulus. Moreover, the government has emphasized support for the development of additional oil and gas extraction most notably in the Arctic. Article 14 of the new Law 8220 supports entrepreneurial activity in the Arctic through tax reductions and subsidies [74].

Even Argentina and Mexico, whose economies are relatively less reliant on oil and gas exports, have offered support to the sector. The Argentinean government issued a decree that fixed the domestic price for crude oil at $45 per barrel to protect domestic oil investments [75]. Moreover, the government has approved a new credit line to provide subsidized funding to national companies in strategic sectors, especially mining and oil and gas. In Mexico, the government reduced the tax on oil extraction, thereby providing a stimulus of up to $3.2 billion to foster investments by the national oil company Pemex [76]. Meanwhile, like in the rest of Latin America, not a single auction for renewable power capacity was undertaken in Argentina and Mexico in 2020 [28].

Table 4 provides an overview of policy responses to the COVID-19 crisis targeting the oil and gas sector in the countries discussed in this section.

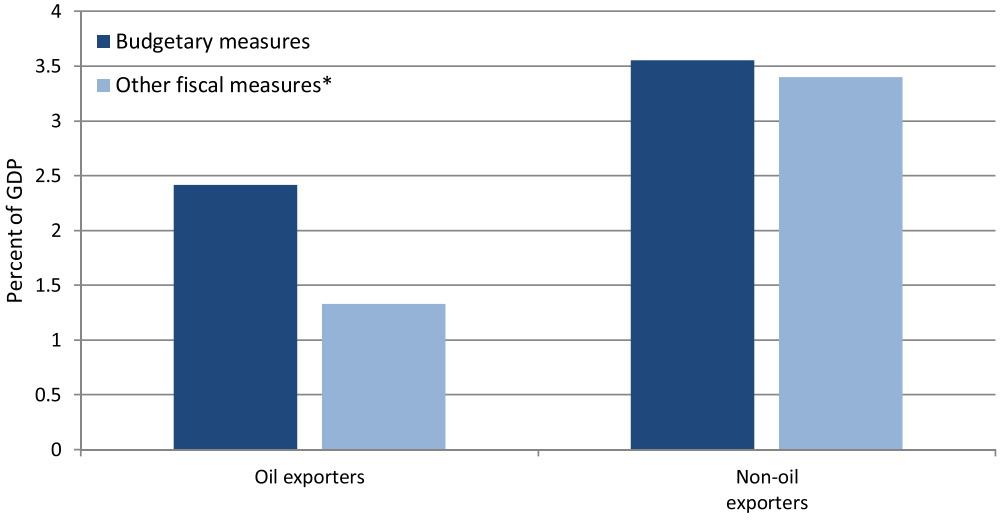

Fig. 6. Fiscal measures in response to the COVID-19 pandemic: oil exporters and non-oil exporters among developing and emerging economies [*Note: Other fiscal measures include equity, loans, guarantees and quasi-fiscal activities, such as the purchase of corporate bonds.] [74].

[1] Note that financial responsibility for cleanup lies with oil and gas firms as part of their lease so this represents a direct subsidy of firms

[2] The Keystone pipeline project may now be halted, due to the measures taken by the Biden administration.

Table 4
COVID-19 policy responses targeting the oil and gas sector in the US, China, the EU and oil and gas dependent G20 countries.

Country	Major policy developments targeting the oil and gas sector
USA*	- Substantial share of stimulus spending is benefitting oil and gas sector, i.e. 8 percent of government's corporate bond purchases - Reduction in royalty payments to federal government - Waiver of environmental regulations to facilitate continued investment in oil and gas infrastructure
China	- Significant share of provincial stimulus spending (approximately 20 percent) is dedicated to increasing oil refining capacities
India	- No major support measures for oil and gas sector
EU	- Stimulus is not directed to the oil and gas sector - Accelerated diversification of European oil majors
Canada	- Significant stimulus spending by central government with conditionalities to reduce the sector's carbon footprint - Major support by Alberta government for provincial oil sector
Saudia Arabia	- Significantly reduced government revenues reduce fiscal space to support economic diversification
Russia	- Low levels of stimulus spending - Increased incentives for new oil-related activities in the Arctic
Argentina	- Concessional loans for companies in the oil and gas sector - Domestic floor price for oil to protect domestic oil and gas sector
Mexico	- Reduced taxes on oil extraction to boost investment by national oil company

*Refers to measures taken in 2020 by the Trump administration.

7. Discussion

Our review of developments in the global energy sector reveals that the COVID-19 crisis is deepening the gulf between the leaders and laggards of a global energy transition. In the power sector, the impact of the crisis and the related policy responses reinforce preexisting trends: the renewable power leaders are continuing the deployment of renewables, while ongoing divestment trends in the coal sector are accelerating in the wake of the crisis. These power sector developments are most visible in the EU. The Commission's Green Deal has even stimulated laggard Poland to accelerate its incipient energy transition.

In developing countries, the pandemic is exacerbating the financing challenges that also hampered the deployment of renewable power before the crisis. Moreover, in countries with strong lock-ins in fossil fuel industries, government spending is strongly oriented towards propping up those sectors, further slowing down the transition to clean energy. In the coal sector, Indonesia is a case in point. As a major coal exporter, the government has chosen to direct major stimulus spending to the coal mining sector, while slowing the transition to renewable power. Similarly, major oil and gas producers have all chosen to direct significant amounts of stimulus spending to support investment in the oil and gas sector. In emerging economies, this financial support for fossil-fuel industries is likely to come at the direct expense of more active support for renewables. In Latin America, this trend is particularly visible, as all auctioning activity in the renewable power sector has ceased.

In the US and Canada, support to the oil and gas sector will not slow down the expansion of renewables. However, unless reversed in the coming months, government support may deepen regional lock-ins in oil and gas extraction. A similar trend is visible in China and to a lesser extent in India. Chinese provincial governments have chosen to place strong emphasis on investments in coal power as well as oil refining, while India is directing part of its stimulus spending to the domestic coal mining sector. In both countries, these developments will exacerbate lock-ins at the regional level, despite efforts at the national level to sustain investment in renewable power.

These developments exemplify how the economic dependencies and institutional lock-ins that characterize incumbent fossil-fuel regimes may lead to the persistence of fossil fuel investment, even in the face of a potentially destabilizing crisis. It confirms that a gradual expansion of renewable power is not enough to foster systemic change. Instead, a phase out of incumbent, fossil sectors needs to be actively supported and managed [77].

The scholarly literature on a "just transition", with its origins in the environmental justice movement, has focused particular attention on developing an ethical rationale for such managed phase-out strategies, exploring different concepts of equity and justice in this context. From a more practical perspective, the global trade union movement has called for approaches to foster green jobs, and various actors have promoted approaches for supporting the workers and communities most affected by the phase-out of fossil fuel industries [78–80].

However, both the scholarly debate and practical experiments with just transition processes have – at least implicitly – been focused on energy transition processes in the US and Europe. Although the call for energy justice includes questions of energy poverty and access in the Global South, there has been little explicit engagement with phase-out strategies in developing countries.[3] Our analysis points to the urgency of involving emerging and developing countries more actively in this debate.

Moreover, most country-specific analyses and policy experiments have focused on the coal power sector. Arguably, this is the sector where phase-out strategies are both the most urgent, given the high carbon content of the fuel, and the most feasible in the short-term, due to the existence of a viable alternative (i.e. renewable power). Nevertheless, the prevalence of strategies aimed at propping up ailing oil and gas industries is a major cause for concern. In the context of budget constraints, this comes at the expense of investments in clean energy technologies, perpetuating lock-ins in high carbon development models.

This problem has been vocally addressed by the divestment movement, which has pointed out the increasing risk of stranded assets as the result of continued investment in fossil fuel industries around the world [80]. Its proponents have correctly pointed out that the UNFCCC process fails to address the reality that international climate targets are not compatible with business strategies based on the exploitation of so-called "unburnable fuel reserves". According to an estimation by McGlade and Ekins (2015), these include all oil and gas resources in the Arctic as well as unconventional oil and gas resources [82]. The valiant efforts of the divestment movement to pressure private shareholders to divest from fossil-fuel industries only address a relatively small share of overall oil and gas resources, however. Approximately two-third of global oil reserves are controlled by national oil companies [83].

As this analysis has shown, COVID-19 is likely to further entrench vested interests in major oil and gas producing countries, further decreasing the scope for governments in these countries to proactively manage a transition to a climate-neutral energy future. It is, therefore, high time that the plight of fossil-fuel dependent economies is addressed at the international level. As pointed out in the debate on a just transition, workers and communities employed in the fossil-fuel industry have a legitimate claim to compensatory measures to ensure decent livelihoods in a post-carbon world. This has been acknowledged by the Just

[3] A notable exception to this is the vibrant debate on a just transition in South Africa, supported by the historical significance of the trade union movement as a political actor in the country [81].

Transition Mechanism with the EU's Green Deal, and, as the case of Poland indicates, this may already have triggered first steps to break out of the country's coal lock-in.

The COVID-19 crisis has underlined the urgent need to develop similar programs in fossil fuel-dependent countries and regions around the world. This will require the development of new international partnerships and financing arrangements that are explicitly tailored to the challenges of fossil-fuel dependent regions. Not national efforts but a concerted international effort is needed to confront the twin challenges of economic recovery and the global fight against climate change.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] J. Tollefson, COVID curbed carbon emissions in 2020 — but not by much, Nat. Clim. Change 589 (2021).
[2] C. Hepburn, B. O'Callaghan, N. Stern, J. Stiglitz, D. Zenghelis, Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?, Oxford Rev. Econ. Policy 36(S1) (Forthcoming).
[3] B. Steffen, F. Egli, M. Pahle, T.S. Schmidt, Navigating the clean energy transition in the COVID-19 crisis, Joule 4 (2020) 1137–1141.
[4] M. Jefferson, A crude future? COVID-19s challenges for oil demand, supply and prices, Energy Res. Social Sci. 68 (2020) 101669.
[5] S.E. Hosseini, An outlook on the global development of renewable and sustainable energy at the time of COVID-19, Energy Res. Social Sci. 68 (2020) 101633.
[6] A. Bahmanyara, A. Estebsarib, D. Ernst, The impact of different COVID-19 containment measures on electricity consumption in Europe, Energy Res. Social Sci. 68 (2020) 101683.
[7] A. Abu-Rayash, I. Dincer, Analysis of the electricity demand trends amidst the COVID-19 coronavirus pandemic, Energy Res. Social Sci. 68 (2020) 101682.
[8] K. Aruga, M. Islam, A. Jannat, Effects of COVID-19 on Indian Energy consumption, Sustainability 12 (2020) 5616.
[9] R. Madurai Elavarasan, G.M. Shafiullah, R. Kannadasan, V. Mudgal, M.T. Arif, T. Jamal, S. Senthilkumar, V.S. SriRajaBalaguru, K.S. Reddy, U. Subramaniam, COVID-19: impact analysis and recommendations for power sector operation, Appl. Energy (2020).
[10] J. Gosens, F. Jotzo, China's post-COVID-19 stimulus: no green new deal in sight, Environ. Innov. Societal Transit. 36 (2020) 250–254.
[11] M.M. Akrofi, S.H. Antwi, COVID-19 energy sector responses in Africa: a review of preliminary government interventions, Energy Res. Social Sci. 68 (2020) 101681.
[12] C. Kuzemko, M. Bradshaw, A. Goldthau, G. Bridge, Covid-19 and the politics of sustainable energy transitions, Energy Res. Social Sci. 68 (2020) 101685.
[13] D.J. Davidson, Exnovating for a renewable energy transition, Nat. Energy 4 (2019) 254–256.
[14] R. York, S.E. Bell, Energy transitions or additions?: Why a transition from fossil fuels requires more than the growth of renewable energy, Energy Res. Social Sci. 51 (2019) 40–43.
[15] P.A. O'Connor, Energy transitions, Pardee Papers 12 (2010).
[16] R. Fouquet, P.J.G. Pearson, Past and prospective energy transitions: insights from history, Energy Policy 50 (2012) 1–7.
[17] BP, Statistical Review of World Energy, 69th ed., 2020.
[18] J.M. Godzimirski, The Norwegian energy security debate: domestic and international dimensions, in: E. Moe, P. Midford (Eds.), The Political Economy of Renewable Energy and Energy Security. Energy, Climate and the Environment, Palgrave Macmillan, London, 2014.
[19] T. Fetzer, Fracking growth, CEP Discussion Papers, Centre for Economic Performance, London School of, Economics and Political Science, London, 2014.
[20] OECD/IEA. Global Energy Review, Paris, 2020.
[21] IISD. Energy Policy Tracker, 2020. www.energypolicytracker.org/. (Accessed 08 August 2020).
[22] European Commission, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: Europe's moment: Repair and Prepare for the Next Generation: COM/2020/456 final, Brussels, 2020.
[23] European Commission, Guidance to Member States: Recovery and Resilience plans. Commission Staff Working Document SWD (2020) 205 final, Brussels, 2020.
[24] Council of the European Union. Interinstitutional File: 2020/0036(COD), Brussels, 2020.
[25] M. Kurtyka. Green investment plan will be an impulse for economic growth, Euractiv, 29 June 2020. www.euractiv.com/section/energy/opinion/green-investment-plan-will-be-an-impulse-for-economic-growth/. (Accessed 11 November 2020).
[26] Emiliano Bellini, Polish solar manufacturers unite to compete with imports, PV Magazine (2020).
[27] A. Hove, Current direction for renewable energy in China, Oxford Energy Comment, 2020.
[28] OECD/IEA, Renewables 2020, Paris, 2020.
[29] Governmentof India, Ministry of Power. Union Power Ministry writes to States/UTs extending Rs 90,000 crore package under Atmanirbhar Bharat Abhiyan, Press Information Bureau, 2020.
[30] Federal Energy Regulatory Commission, Energy Infrastructure Update for November 2020, Office of Energy Projects, 2020.
[31] S. Ray, Renewables account for most new U.S. electricity generating capacity in 2021. U.S. EIA, 2021. www.eia.gov/todayinenergy/detail.php?id=46416. (Accessed 26 January 2021).
[32] IRS, Beginning of Construction for Sections 45 and 48; Extension of Continuity Safe Harbor to Address Delays Related to COVID-19: Notice 2020-41, 2020.
[33] H. Cooper, P. Tingle, COVID-19 stimulus bill includes key renewable energy tax credits, National Law Rev. X (363) (2020).
[34] Biden for President, The Biden Plan for a Clean Energy Revolution and Environmental Justice, 2020. joebiden.com/climate-plan/. (Accessed 26 January 2021).
[35] The World Bank, Global Economic Prospects, 2020.
[36] P. Mastropietro, P. Rodilla, C. Batlle, Emergency measures to protect energy consumers during the Covid-19 pandemic: a global review and critical analysis, Energy Res. Social Sci. 68 (2020) 101678.
[37] R. Puliti; D. Ogunbiyi, Energy Access Takes Center Stage in COVID-19 Fight, Powering Africa's Recovery. All Africa 2020, 21 April 2020. allafrica.com/stories/202004210827.html.
[38] OECD/IEA, Coal 2020: Analysis and forecast to 2025, 2020. www.iea.org/reports/coal-2020/demand#abstract. (Accessed 26 January 2021).
[39] P.-Y. Oei, R. Mendelevitch, Prospects for steam coal exporters in the era of climate policies: a case study of Colombia, Clim. Policy 19 (1) (2019) 73–91.
[40] Agora Energiewende, Corona-Jahr 2020: Rekordrückgänge bei CO2-Emissionen und Kohleverstromung, 2021. www.agora-energiewende.de/presse/neuigkeiten-archiv/corona-jahr-2020-rekordrueckgaenge-bei-co2-emissionen-und-kohleverstromung/. (Accessed 26 January 2021).
[41] Bundesnetzagentur, Aus-schrei-bung nach dem KVBG / Ge-bots-ter-min 1. Sep-tem-ber 2020: Öffentliche Bekanntmachung der Zuschläge, 2020. www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Kohleausstieg/0109_2020/Termin01092020_node.html. (Accessed 26 January 2021).
[42] S&P Global Patts, Hydrogen: Beyond the Hype, 2021. www.spglobal.com/platts/en/market-insights/topics/hydrogen. (Accessed 26 January 2021).
[43] Polska Grupa Górnicza, Propozycja związków zawodowych jest nieakceptowalna, 2020. www.pgg.pl/aktualnosci/z-zycia-firmy/1054,PGG+S.A.%3A+Propozycja+zwi%C4%85zk%C3%B3w+zawodowych+jest+nieakceptowalna. (Accessed 08 July 2020).
[44] C. Turp-Balazs, Polish energy giants abandon coal-fired power plant project. Has the country turned a corner? Emerging Europe 2020, 21 May 2020. emerging-europe.com/news/polish-energy-giants-abandon-coal-fired-power-plant-project-has-the-country-turned-a-corner/. (Accessed 08 July 2020).
[45] A. Hernández-Morales, Coal-dependent Poland pivots toward green energy: There's been a reassessment of clean energy by Warsaw, POLITICO, 25 September 2020. www.politico.eu/article/coal-dependent-poland-green-energy-pivot/. (Accessed 11 November 2020).
[46] G. Meyer, Trump campaign for US coal undermined by industry slump: Miners are losing their jobs at the fastest rate in decades in shift to cleaner energy. Financial Times 2020, 18 May 2020. www.ft.com/content/39909dd4-7c6c-425e-8f05-4f6e63b60c43. (Accessed 08 July 2020).
[47] B. Storrow, Coal's Decline Continues with 13 Plant Closures Announced in 2020: the fuel is increasingly uncompetitive with cheaper natural gas and renewable energy. Scientific American 2020, 27 May 2020. www.scientificamerican.com/article/coals-decline-continues-with-13-plant-closures-announced-in-2020/. (Accessed 08 July 2020).
[49] C. Shearer, Analysis: The global coal fleet shrank for first time on record in 2020, Carbon Brief, 03 August 2020. www.carbonbrief.org/analysis-the-global-coal-fleet-shrank-for-first-time-on-record-in-2020. (Accessed 10 November 2020).

[50] T. Buckley, Over 100 Global Financial Institutions Are Exiting Coal, With More to Come: Every Two Weeks a Bank, Insurer or Lender Announces New Restrictions on Coal, 2019.
[51] K. DeAngelis, B. Tucker, Adding Fuel to the Fire: Export Credit Agencies and Fossil Fuel Finance, Friends of the EarthUnited States and OilChange International, 2020.
[52] En:former, South Korea to expand offshore wind as coal closure plans develop, En: former, 02 October 2020. www.en-former.com/en/south-korea-to-expand-offshore-wind-as-coal-closure-plans-develop/. (Accessed 11 November 2020).
[53] I. Gerretsen, Japan net zero emissions pledge puts coal in the spotlight, Climate Home News, 26 October 2020. www.climatechangenews.com/2020/10/26/japan-net-zero-emissions-pledge-puts-coal-spotlight/. (Accessed 10 November 2020).
[54] M. Brown, T. Vu, Vietnam's EVN Faces the Future: Time to Get Renewables RightThe Key to Success for PDP 8 Will Be Investment in New Renewables Technology and the Grid, IEEFA, 2020.
[55] China Energy Portal, Key tasks for resolving excess capacity in coal-fired power generation in 2020, 2020. chinaenergyportal.org/en/key-tasks-for-resolving-excess-capacity-in-coal-fired-power-generation-in-2020/. (Accessed 08 July 2020).
[56] IANS, NTPC stops land acquisition for greenfield coal-based power projects, ETEnergyWorld, 27 September 2020. energy.economictimes.indiatimes.com/news/power/ntpc-stops-land-acquisition-for-greenfield-coal-based-power-projects/78343346. (Accessed 10 November 2020).
[57] Republic of Indonesia, First Nationally Determined Contribution, UNFCCC, 2016.
[58] A. Suharsono, L. Lontoh, Indonesia's Energy Policy Briefing, IISD, 2020.
[59] S. Reed, OPEC and Russia Agree to Extend Oil Production Cuts. The New York Times 2020, 06June 2020. www.nytimes.com/2020/06/06/business/energy-environment/opec-russia-oil-coronavirus.html. (Accessed 08 July 2020).
[60] U.S. EIA, This Week in Petroleum, 2020. www.eia.gov/petroleum/weekly/. (Accessed 08 July 2020).
[61] OECD/IEA, World Energy Investment, Paris, 2020.
[62] G. Guichard, Gaz de schiste: Engie renonce à un contrat géant, Le Figaro, 03 November, 2020. www.lefigaro.fr/societes/gaz-de-schiste-engie-renonce-a-un-contrat-geant-20201103. (Accessed 08 November 2020).
[63] M.J. Pickl, The renewable energy strategies of oil majors – from oil to energy? Energy Strategy Rev. 26 (2019) 100370.
[64] BP, Progressing strategy development, bp revises long-term price assumptions, reviews intangible assets and, as a result, expects non-cash impairments and write-offs, Press Release, 15 June 2020. www.bp.com/en/global/corporate/news-and-insights/press-releases/bp-revises-long-term-price-assumptions.html. (Accessed 10 November 2020).
[65] OECD/IEA, Investment estimates for 2020 continue to point to a record slump in spending, 2020. www.iea.org/articles/investment-estimates-for-2020-continue-to-point-to-a-record-slump-in-spending. (Accessed 26 Janauary 2021).
[66] L. Myllyvirta, Analysis: China's Covid stimulus plans for fossil fuels three times larger than low-carbon, Carbon Brief (2020).
[67] S. Chen, Q. Zhang, B. McLellan, T. Zhang, Review on the petroleum market in China: history, challenges and prospects, Pet. Sci. 17 (6) (2020) 1779–1794.
[68] Baker Hughes, Rig Count Overview & Summary Count, 2020. rigcount.bakerhughes.com/. (Accessed 08 November 2020).
[69] A.C. Kaufman, The Fed's Coronavirus Spending On Fossil Fuel Could Dig A $19 Billion Money Pit. Huffpost 2020, 23 June 2020. https://www.huffpost.com/entry/federal-reserve-coronavirus-oil-fossil-fuel_n_5ef0d000c5b694977f2a8219. (Accessed 08 July 2020).
[70] J. Eilperin, J. Stein, Trump signs order to waive environmental reviews for key projects. The Washington Post 2020, 05 June 2020. www.washingtonpost.com/climate-environment/2020/06/04/trump-sign-order-waive-environmental-reviews-key-projects/. (Accessed 08 July 2020).
[71] The White House, Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, 2021. www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-protecting-public-health-and-environment-and-restoring-science-to-tackle-climate-crisis/. (Accessed 26 January 2021).
[72] Government of Canada, Canada's COVID-19 Economic Response Plan, 2020. www.canada.ca/en/department-finance/economic-response-plan.html#energy. (Accessed 12 November 2020).
[73] Government of Alberta, Investing in Keystone XL pipeline, 2020. www.alberta.ca/investing-in-keystone-xl-pipeline.aspx#:~:text=About%20the%20investment,-The%20Government%20of&text=The%20government%20will%20backstop%20the,our%20shares%20at%20a%20profit. (Accessed 08 July 2020).
[74] IMF, Fiscal Monitor Database of Country Fiscal Measures in Response to the COVID-19 Pandemic, 2020. www.imf.org/en/Topics/imf-and-covid19/Fiscal-Policies-Database-in-Response-to-COVID-19. (Accessed 26 January 2021).
[75] El presidente del la nación argentina. Decreto 488/2020 - Petróleo Crudo en el Mercado Local. Establécese Precio para Facturación de Entregas.: DCTO-2020-488-APN-PTE, 2020.
[76] S. Djunisic, Global auctions place 3.35 GW of wind capacity in Q1 2020 - GWEC. Renewables Now 2020, 15 May 2020. renewablesnow.com/news/global-auctions-place-335-gw-of-wind-capacity-in-q1-2020-gwec-699066/. (Accessed 10 July 2020).
[77] F.W. Geels, B.K. Sovacool, T. Schwanen, S. Sorrell, The socio-technical dynamics of low-carbon transitions, Joule 1 (3) (2017) 463–479.
[78] M.S. Henry, M.D. Bazilian, C. Markuson, Just transitions: histories and futures in a post-COVID world, Energy Res. Soc. Sci. 68 (2020) 101668.
[79] G. Evans, L. Phelan, Transition to a post-carbon society: linking environmental justice and just transition discourses, Energy Policy 99 (2016) 329–339.
[80] N. Healy, J. Barry, Politicizing energy justice and energy system transitions: fossil fuel divestment and a "just transition", Energy Policy 108 (2017) 451–459.
[81] M. Swilling, J. Musango, J. Wakeford, Developmental states and sustainability transitions: prospects of a just transition in South Africa, J. Environ. Plann. Policy Manage. 18 (5) (2015) 650–672.
[82] C. McGlade, P. Ekins, The geographical distribution of fossil fuels unused when limiting global warming to 2 degrees C, Nature 517 (7533) (2015) 187–190.
[83] OECD/IEA, Share of oil reserves, oil production and oil upstream investment by company type, 2018 2020. www.iea.org/data-and-statistics/charts/share-of-oil-reserves-oil-production-and-oil-upstream-investment-by-company-type-2018. (Accessed 26 January 2021).
[84] Frankfurt School-UNEP Centre, Bloomberg New Energy Finance. Global Trends in Renewable Energy Investment, Frankfurt School of Finance & Management, Frankfurt, 2020.
[85] Our World in Data, 2020. (Accessed 02 October 2020).
[86] M. Xu, D. Stanway, China plans to raise minimum renewable power purchase to 40% by 2030: government document, Reuters, 10 February 2021. https://www.reuters.com/article/us-china-climatechange-renewables-idUSKBN2AA0BA. (Accessed 16 February 2021).
[87] M. Xu, D. Stanway, China doubles new renewable capacity in 2020; still builds thermal plants, Reuters, 21 January 2021. https://www.reuters.com/article/china-energy-climatechange/china-doubles-new-renewable-capacity-in-2020-still-builds-thermal-plants-idINL4N2JW12K. (Accessed 16 February 2021).
[88] Ministry of Environment, Forest and Climate Change, India, Notification, The Gazette of India, New Delhi, 21 May 2020. http://egazette.nic.in/WriteReadData/2020/219495.pdf (Accessed 17 February 2021).