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Institute for Advanced Sustainability Studies (IASS)

Covid-19 and Carbon Lock-In: Impacts on the Energy transition

Potsdam, June 2020

Silvia Weko, Laima Eicke, Rainer Quitzow, Germán Bersalli, Flávio Lira, Adela Marian, Diana Süsser, Sapan Thapar, Bing Xue

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Contents

1. Introduction

Around the world, the Covid-19 outbreak has led to shutdowns and decreased energy demand. The economic consequences are also massive, as the world appears to be facing a severe economic recession with potentially stronger effects than the 2008 financial crisis.

As countries begin to respond to this recession, policy decisions can influence whether the energy transition accelerates, or if choices will contribute to carbon lock-in. The concept refers to the way in which energy systems have become 'locked in' to a high-carbon path, which is reinforced over time by increasing returns to scale – making changes to these techno-institutional complexes highly costly and difficult. However, it is nevertheless possible for technical and institutional change to occur when there is a shock to the system (Unruh 2002).

The economic disruption caused by Covid-19 could open up a window of opportunity for new technologies and ideas. Accordingly, the last major disruption of the status quo, the 2008 financial crisis, led in several countries to 'green recovery' plans and increased investment in clean energy industries; the electric mobility frontrunner Tesla had its beginnings in the US recovery funding and Spanish investment in concentrated solar power advanced technological learning. However, a recession can also result in countries 'doubling down' on high-carbon industries – the German policy response was centered around major support measures for the automotive industry, fostering purchases of gasoline and diesel cars – locking in fossil mobility patterns for these cars' average lifetime of almost two decades.

The coronavirus crisis is a double whammy: it has at once drastically lowered energy demand due to lockdowns, and a compounding economic crisis is emerging. Unlike in 2008, some countries also have a relatively high share of cheap renewable energy. How does this combination of factors impact energy mixes, and what role does policy play?

This IASS study takes an in-depth look at Covid-19's impacts on the global energy sector, and then zooms in to the country level to see individual country effects and responses. The case studies are compiled by energy researchers on Argentina, China, Germany, India, Israel, and the United States. Despite similar impacts of the corona crisis on energy markets, we expect different national policy responses. This is because the case studies represent different industrial structures and political and social circumstances that may lead to or away from carbon lock-in (see Table 1.1 for a representation of different dynamics).

Both the US and Germany have seen a declining importance of the coal industry, and a growing clean energy sector. However, the importance of oil and gas in the US as well as the political situation may make escaping carbon lock-in more difficult there than in Germany, which has reached a consensus on a coal phase-out. Argentina's dominant oil and gas sector is seen as key to the country’s development, and its renewables sector is still relatively small, making a transition in times of crisis less likely. China and India have benefitted from the expansion of renewable energy, but both countries expect increased energy demand in the long term, which may make them reluctant to back away from fossil fuels. The US, China, Israel and India also place high importance on energy security – and while this may be achieved with renewable energy, countries with local fossil fuel reserves still see these as a security asset.

Table 1.1: Country case studies and factors influencing carbon lock-in

Country	Importance of RE industry	Fossil fuel resources	RE Share of electricity mix (Worldbank, 2015)	Expected energy demand to 2050 (EIA, 2019)
Argentina	Low	Oil, gas	10%	growth
China	High	Coal	12%	Rapid growth
Germany	High	Coal (low)	36%	stagnation
India	High	Coal	14%	Rapid growth
Israel	Medium	Gas	4%	growth
USA	High	Coal (low), oil, gas	9%	stagnation

The study's comparative approach adds some first empirical insights to the timely discussions on the design of policy responses in light of the crisis. It highlights learnings from Israel, Germany and, to some extent, also India and China, which all included measures supporting the renewable energy sector within their policy responses. Argentina, the US and also China, in turn, run the danger of becoming even more deeply locked-in into carbon-intensive development pathways. How countries react to Covid-19 will be decisive for determining whether the global community will accomplish the Paris Agreement goals in the coming decades.

2. Key impacts of the pandemic on energy from a global perspective

Flávio Lira and Silvia Weko

The global health crisis resulted in lowered energy demand around the world, as industry closures and travel restrictions were implemented. As countries reopen, global energy demand will likely still fall by around 6% this year (IEA, 2020). However, not all fuels have been impacted in the same way. Even as overall demand fell, the demand for renewable energy has increased by around 1.5% in the first quarter of 2020, due in part to its low operating costs: RES made up 13% of overall energy, and 27.5% of the power sector (IEA, 2020). Hydrocarbon production and consumption fell significantly right from the beginning of the Covid-19 pandemic. Early numbers show a general downward trend for natural gas, coal and oil production and consumption, but scenarios for each of these fuels have some peculiarities. A significant part of the available data has been compiled by bodies such as the International Energy Agency (IEA) and country-based official agencies, which provide a clearer picture of specific sectors. Whether or not the drop in fossil fuel production and use will have longer-term impacts on the world's energy mix remains to be seen.

Renewables

So far, the coronavirus pandemic has had mixed effects on the renewable energy sector. While overall demand for RES has risen, interruptions in financing and supply chains will result in lower installations in the longer term. Firms are already laying off workers, and national governments appear to be slow to react.

Although global energy demand is falling, demand for renewable energy has increased by around 1.5% in the first quarter of 2020, due in part to its low operating costs (IEA, 2020). In countries such as Germany where renewable energy is given priority grid dispatch, this resulted in coal being pushed out of the energy mix. Nevertheless, overall falling energy demand in turn impacts pricing schemes for RES installation and carbon emissions. US and European CO2 markets have seen large decreases in the prices per unit of CO2 since the start of the crisis (ICAP, 2020). Lower energy demand in systems with large amounts of renewable energy has also resulted in negative power prices in Europe – and revenue losses for power producers overall, RES included (Waldholz, 2020).

The health crisis is slowing down the installations of renewable energy, as supply chains are interrupted and non-critical infrastructure projects are postponed. Bloomberg New Energy Finance has updated its predictions for the installation of RE in 2020 by 8% less for solar and 12% less for wind. Global supply chains for many different industries have been interrupted by the coronavirus, and clean energy equipment is no exception. Much of the world's equipment for solar PV is produced in China, which has seen manufacturing shutdowns. In addition to equipment delays, grid connections may also be delayed as many Distribution System Operators (DSOs) are delaying non-critical operations (Energy Community, 2020). Planned projects are facing significant delays around the world, with

3000MW of solar and wind on hold in India (Mylenka and Novyk, 2020), and as much as 25GW of wind that may not go online in the US because of the crisis, according to wind industry representatives (Mufson and Grandoni, 2020). A recent Wood Mackenzie report predicted that up to 150GW of renewable energy projects in Asia could be delayed or cancelled until 2024 if the recession continues (Frangoul, 2020). In the EU as well, countries have postponed auctions for renewable energy or reduced volumes for forthcoming auctions (Wiegand et al, 2020).

This is in line with the priorities of industry associations, for example the Global Wind Energy Council, which is currently lobbying for the "extension of crucial policies such as feed-in tariffs, tax credits, construction deadlines and auction rounds" in response to the crisis (GWEC, 2020). As companies feel the effects of the crisis, major RES players across the value chain are downsizing. Wind turbine supplier Vestas laid off 400 employees in April and expects further cutbacks if the crisis continues (Buljan, 2020). Siemens Gamesa, which both manufactures and operates wind turbines, reported a direct decline in profitability from the coronavirus of €56 million (Siemens, 2020). Vattenfall stated that they will not participate in new RE auctions in order to focus on delivering core activities (Shumkov, 2020), and Chinese project developer Comtec Solar revealed in its 2019 report that they expect existing projects to be impacted (Mylenka and Novyk, 2020).

Reactions by national governments to the challenges faced by the RES industry have been mixed so far. Particularly in Europe, deadlines for construction have been extended. The French Energy Minister has announced that there will be delays in construction and the next call for tenders (Lee, 2020). Changes in Austria's Green Energy Law give developers an extra half year of subsidies, and Greece has extended permit and auction deadlines. Poland, which has in the past seen resistance to any measures that challenge coal, has reacted to the crisis by allowing RES producers to postpone the date of their first sale of electricity by up to one year if they face delays in equipment (Rödl & Partner, 2020). India has also responded to developer concerns by extending commissioning deadlines for new wind farms and by giving developers extensions of the time of the lockdown plus thirty days on renewable projects.

Coal

The different characteristics of coal use have made it more susceptible to the shocks of lower energy demand especially where electricity is concerned. Between 2016 and 2018, total coal production (including steam coal, coke and lignite) ranged between 7,300 and 7,800 Mt (IEA, 2019: 4). In early 2020, coal power use and industrial production have gone down significantly because of the pandemic; compared to the first quarter of 2019, global coal demand is expected to fall by 8% in 2020 as coal generation fell by around 10% in the first quarter (IEA, 2020a: 32).

China is by far the world's largest producer and consumer of coal with around 60% of world output on a regular basis, as both primary energy and power generation in the country rely heavily on it. The overall consumption of coal fell by 8% in the country whereas coal power generation fell by around 9% (IEA, 2020a: 32) coupled with an overall contraction of the economy and industry production. Raw coal production in China increased 9.6% y-o-y, reaching 340 million tons, as of March 2020, reversing the declining trend seen from January to February. For the first quarter of 2020 total raw coal production in China was down 0.5% y-o-y at 830 million tons. Trading prices have continued to fall, which contributed to higher imports from China in March (up 18.5% y-o-y) and a 28.4% increase in imports y-o-y (National Bureau of Statistics of China, 2020).

During the first quarter of 2020, India and the United States, the largest coal consumers after China, have also witnessed a decline in coal consumption. Coal production in the US has seen an overall decline in the past decade (although not consistently). In the 2018-2019 comparison, production went

from 756 million short tons (MMst) to 705 MMSt y-o-y, whereas consumption fell from 688 MMst to 587 MMst y-o-y (EIA, 2020b: viii). A milder winter and the abundance of natural gas, placing downward pressure on prices, has made coal lose terrain in the country during the past year and the first quarter of 2020. In the EU, demand also fell sharply by more than 20% in the first quarter of 2020 (IEA, 2020a: 33). Coupled with expanding renewables, this fuel's participation in the energy mix (particularly in electricity generation) might suffer a long-lasting blow if renewables and natural gas take on its dominance in historically coal-dominated sectors.

Oil and natural gas

Gas and oil have faced different impacts of coronavirus due to their different uses, as oil is largely used for transportation and gas is used for electricity generation. Likewise, the structure of the industries differ in that oil is internationalized and natural gas is more regional (although not as regional as coal). We see demand for both oil and gas falling due to the pandemic, but the impacts for oil prices have been far more severe.

Worldwide oil demand has declined heavily mainly due to diminished mobility owing to global lockdown measures. We have seen both a massive drop in average road transport in the first quarter and the near halting of air travel in many parts of the globe. Global industry-wide revenue passenger kilometers (RPKs) fell 52.9% y-o-y in March 2020, the largest decline in recent history (IATA, 2020a); industry-wide cargo tonne kilometers (CTKs) suffered a 15.2% contraction y-o-y in March. In addition, there was a 22.7% decrease in industry-wide cargo capacity in the same period y-o-y (IATA, 2020b). This has made for a very complicated scenario for the oil industry. Jet kerosene demand is predicted to have fallen 1.2 mb/d in the first quarter of 2020 y-o-y, and world gasoline demand is expected to have fallen 1.7 mb/d and diesel, 1.5 mb/d. As lockdown and other containment measures have been adopted in several countries falling demand for oil products have spread. In the first quarter of 2020, oil demand is estimated to have fallen 5.6 mb/d (IEA, 2020a: 19). Global oil demand in April is expected to be 29 mb/d lower y-o-y whereas global oil supply for the same month should be down 10.7 mb/d y-o-y (IEA, 2020b).

Prices have fallen accordingly, reaching astonishing lows in the first quarter of 2020. In late April the WTI price reached negative values for the first time in history (-37.63 USD) (Bloomberg, 2020a) whereas Brent oil fell to USD 19 per barrel, a 28% decrease month on month and 73% y-o-y (Bloomberg, 2020b). This price decrease resulted from the failure of Russia and OPEC to agree on coordinated production cuts to stabilize prices. This group, known informally as OPEC+, gathered in Vienna in early March 2020 to negotiate a proposed agreement to reduce production by 1.5 mb/d through the second quarter of 2020 (OPEC, 2020b). After Russia's initial refusal to bear a large share of this cut, the so-called 2020 oil price war started, radically lowering oil prices. A series of actions by the Saudi government and Russia (discounts and/or increases in production) have made it hard for oil prices to pick up significantly again – and ruminations of both Moscow and Riyadh as to how better manage the shock have not born fruits.

Ironically, this sequence of events has been successful in striking competitors in the US and Canada, deeply scarring local state/province economies and amounting to difficult problems for both oil industry workers and the supply chain. These developments cast doubt on the future behavior of the oil industry, the calculation of break-even prices for traditional and alternative sources of oil (particularly shale) and the ability of oil-dependent countries (both as producers and consumers) to keep their economy going in face of such uncertainty. In case predictions materialize, global oil supply is expected to have fallen by 12 mb/d in May after OPEC+ decided on a deal to slash production by "9.7 mb/d, starting on 1 May 2020, for an initial period of two months that concludes on 30 June 2020" (OPEC, 2020a).

Policymakers in North America and Eurasia have, therefore, been faced with a conundrum: is it preferable for stimulus packages to protect and/or somehow revive local oil industries thus hoping for a return to business as usual (with the same international vulnerabilities that this might entail) or is it time to make a bolder move towards renewables while trying to factor in oil industry losses? Conversely, many of the world's oil producing countries might not be able to cope with low prices for long – mostly due to their economies being heavily dependent on the commodity. There might not be enough leeway to play the barrel game indefinitely, particularly in light of the current pandemic, during which a global economic recession is likely to be lengthy and recovery possibly difficult. How long such moves by OPEC and non-OPEC members can resist the elephant in the room of break-even prices remains to be seen.

Compared to oil demand, natural gas is supposed to fare better during the current pandemic since it is not as widely used as a transportation fuel, a sector which has been hit by Covid-19 containment measures. However, demand has also fallen over the course of pandemic, and its consumption was around 3% lower in the first quarter of 2020 compared to the same period in 2019 (IEA 2020, based on Asian, European and North American markets). An important side effect of lower gas demand has been a significant build-up of gas in storage – this is supported by exceptionally low spot prices for the Henry Hub and the TTF (the lowest yet since 1999 and 2003, respectively) (EIA, 2020a; IEA, 2020a: 29). Lower gas prices, in turn, may contribute to the coal-to-gas switch which has been ongoing in the US, China and Europe (BP, 2019: 5). Once seen as a 'bridge' fuel, switching to gas will nevertheless reinforce lock-in and dependency patterns. As prices remain low, we may expect to see ripple effects for the world's largest producers and exporters of natural gas: the US, Russia, Iran, Canada, Quatar and Norway (IEA, 2019a: 16). Russia is also one of the world's exporters, responsible for around 24% of the global amount (IEA, 2019a: 16) with a significant economic reliance on natural gas exports for its income. It has already been shown to be vulnerable to changes in demand, and this will only be worsened in the current pandemic situation.

Conclusions

Although less fossil fuel energy is being produced and consumed due to the pandemic, whether or not this will result in changes to the structures of the global market remains to be seen. Renewable energy is also subject to interruptions in finance and supply chains, and needs flexible policy responses if the transition is to continue. Moreover, the geopolitics of fossil fuel production and consumption will remain important even as demand and prices fluctuate. As crises can act as an incentive to return to familiar scenarios, there is a risk that countries will double down on hydrocarbons. This may be less likely for coal than for natural gas, given that it is relatively more expensive. If natural gas generation continues to expand, we may see a reinforced dependency pattern between gas-producing and gas-consuming actors. Although the coal-to-gas switch is environmentally preferable (from a solely hydrocarbon-based perspective), this can bring out a new type of lethargy in the energy industry that would jeopardize the significant steps made by RES so far. The very low oil prices, while they may drive American shale producers out of business, are also hard for countries whose economies rely on this commodity – especially given the likelihood of an extended recession due to Covid-19. If policymakers prioritize business as usual, the risk of perpetuating carbon lock-in remains.

3. Country cases

3.1 United States

Silvia Weko

The US is seen as a leader in the 'clean energy race' and a potential 'winner' of the energy transition (IRENA, 2019). Expanding the green industry was a key priority of the Obama administration, which supported the clean energy industry following the 2008 financial crisis through a combination of stimulus programs. These programs provided funding for renewable energy projects, investment incentives such as loan guarantees, and the Production Tax Credit for wind and the Solar Investment Tax Credit, both of which are scheduled to be phased out in 2020. Despite uncertain policy support (Wood, 2020), the renewable energy industry has been one of the fastest growing sectors in the US in recent years, employing around 250,000 workers in the solar sector (Solar Foundation, 2020) and 120,000 in the wind sector (AWEA, 2020). In comparison, the U.S. Labor Bureau (2020) estimates that the coal sector employs about 52,000 people. It appears that this growth will be hit hard by the coronavirus crisis and a lack of response from the federal government.

3.1.1 Changes in energy markets: falling demand and carbon prices

As in other countries, the US energy demand has fallen significantly since the start of the crisis. Energy demand fell in March and April, according to data collected by the US Energy Information Administration (EIA). With lower demand, total coal-fired generation dropped significantly (see Figure 3.1.1). Natural gas also declined dramatically in April. Still, the share of wind and solar in the energy mix remained relatively low, at around 13% in January and April, 10% in February and 11% in March. Gasoline demand also fell sharply after shelter-in-place orders came into force. Carbon Pulse (2020a) reported a drop in approximately 100 million gallons between the week of March 14-20 to the following week – the largest drop since January 1994.

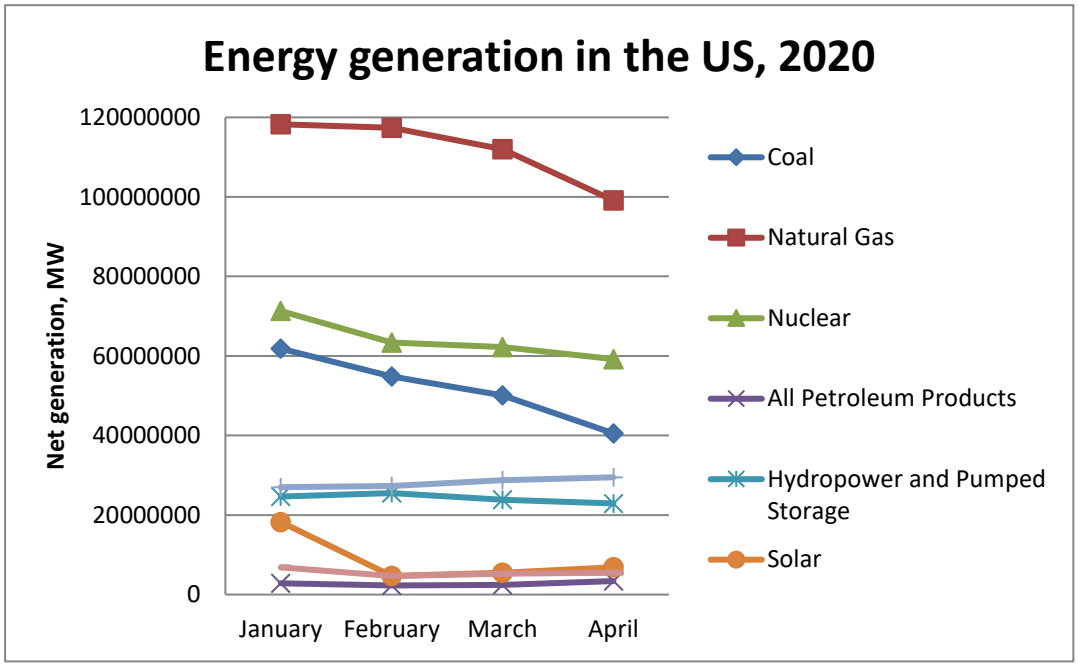

Figure 3.1.1: Energy generation, complied from EIA data

Average electricity prices also fell through the crisis: EIA data shows prices falling steadily from January 2020 ($25.75/Mwh), to around $22/hour in February and March, and approximately $18 and $17 in April and May respectively. In addition, lower overall energy demand has impacted CO2 pricing systems throughout the US. While there is no US-wide carbon price, coalitions of states have implemented their own cap-and-trade programs: the Regional Greenhouse Gas Initiative (RGGI) made up of ten states on the east coast and the Western Climate Initiative (WCI) on the west coast, which includes California and three Canadian provinces.

The RGGI is relatively less ambitious in that it includes only power sector emissions and its carbon floor price was only $2.32 this year. At the beginning of the crisis, the prices were not significantly different to pre-Coronavirus levels; the auction on March 11th had a clearing price of $5.65 (RGGI 2020). However, just after the auction, on March 23rd, market prices hit $4.73, their lowest levels since June 2018. They have since risen again to $5.86, which is nevertheless below pre-corona levels (Intercontinental Exchange, 2020) and are expected to remain stable. Carbon Pulse claims that the prices are driven by the planned supply curtailment, when RGGI states will remove surplus allowances after March 2021 – and low emissions from fallen consumption in the Covid-19 pandemic will be a part of this (Carbon Pulse, 2020c).

California's carbon price is much higher than the RGGI, with its California Carbon Allowances valued at a floor price of $16.68 (CCA, 2020a). Pre-Coronavirus auctions in November 2019 and February 2020 had clearing prices of $17/ton and $17.87 respectively. As energy use falls, however, producers are cutting their expected allowances and the surplus of allowances will be higher at the end of 2020. Unsold allowances are not removed until two consecutive sales sell out (in California, they can be shifted into the containment reserve after two years). Prices on the spot market have fallen under the floor price, and the latest round of auctions in May was dramatically under-subscribed, with less than half of the current allowances sold and only about 1/8th of advance allowances (CCA, 2020b).

This implies that carbon pricing needs more than a floor – markets also need to respond to falling energy demand and remove surplus allowances, which is quoted as keeping the RGGI price from

crashing. However, California policymakers have argued that they cannot take action without first considering the 2045 goals (Carbon Pulse, 2020b). What makes ambition more complicated is the fact that regional programs fell apart after the last recession, when the US states of Arizona, New Mexico, and Utah withdrew from the WCI following the 2011 election due to their concerns about being 'uncompetitive' (Craig, 2011).

3.1.2 Impacts on the energy sector

The decline in energy demand and energy prices has affected both the renewable energy and the fossil fuel industry in the US. The EIA predicts that energy investment will fall by 25% this year (DeConcini and Neuberger, 2020). Oil and gas consumption are predicted to be far lower this year, and projections show the industry's service sector losing 100,00 workers by the end of 2021 (DeConcini and Neuberger, 2020). Coal, which the Trump campaign promised to revive, has also continued its downwards trajectory. Before the crisis, the EIA predicted an 11% drop in coal consumption this year – but now expects it to fall by 23% (Meyer, 2020). The Financial Times also reports that utilities are retiring coal power plants earlier than planned, for example in Minnesota where Great River Energy will close a 1,151MW coal power station in 2022 and then add 1,100MW of wind.

As the crisis continues, capital investments in RES may dry up. Until now, firms were given tax credits to offset their tax burdens – but as investors see overall profits fall, this is less appealing. In addition, project developers are facing major delays in construction and equipment delivery, both because of global and local supply chain interruptions. This is especially problematic because projects must be connected to the grid by 2020 in order to receive subsidies (Bahar for IEA 2020). Industry organizations such as the American Wind Energy Association (AWEA) are currently lobbying Congress to address decreases in tax equity by allowing developers to receive direct pay equal to the value of credits. They see the potential impacts as catastrophic – AWEA's impact assessment found that the health crisis could "put 35,000 jobs at risk and jeopardize $43 billion in investments and payments to rural communities" (AWEA 2020). Likewise, the Energy Storage Association predicts falling revenue and layoffs due to equipment and permitting issues, as well as falling demand for services (ESA 2020). Even more dramatic impacts are predicted by the Solar Energy Industries Association (SEIA): already, it reports that over half of solar workers are impacted. It sees the possibility for the rooftop solar segment to fall by as much as 70%, and utility-scale down by 50%, and for the current workforce of 250,000 to be halved this year (SEIA, 2020). The Washington Post reports that about 106,000 clean energy workers filed for unemployment in March (Mufson and Grandoni, 2020).

3.1.3 Policy response

So far, the US federal government has passed three aid packages in response to the coronavirus crisis on March 6th, March 18th, and March 27th 2020 (also called the CARES act). None of these stimulus packages contained specific support for the renewable energy industry – in contrast to the 2008 crisis, when the US congress spent around $112 billion on clean energy (Mufson and Grandoni, 2020). Republicans rejected calls from Democratic representatives for renewable energy tax credit extensions, with the President tweeting that "This is not about the ridiculous Green New Deal. It is about putting our great workers and companies BACK TO WORK!"

The USD $2 trillion stimulus included in the CARES Act contains no industry-specific measures, but observers have noted that its structure rather benefits the fossil fuel industry (DeConcini and Neuberger, 2020). Bloomberg found that oil companies, service firms and contractors claimed over $1.9 billion in CARES Act tax benefits – and as the US Energy secretary Brouillette recommended oil companies take advantage of this 'liquidity tool' (Dlouhy, 2020), it seems clear that the benefits to oil

companies are a feature, not a bug. Similarly, the Bureau of Land Management has reduced royalty payments for oil companies from its typical 12.% and may reduce them to as low as 0.5% (Lefebvre, 2020).

The struggling renewable energy industry has nevertheless welcomed some elements of the CARE act, specifically those that give relief to small businesses through loans and employee protections (SEIA, 2020b). At the state level, some governors are moving to support the solar and wind industries. As part of its corona recovery plan, New York has passed the Accelerated Renewable Energy Growth and Community Benefit Act. It aims at restarting renewable energy development and upgrading the State electricity, while benefiting local communities. It includes the creation of the Office of Renewable Energy Siting and a host of measures to facilitate investments in renewable energy (Haggerty, 2020). New York also passed pro-solar provisions as part of the state budget; the reformed its permit approval system which allows for large-scale solar projects to be fast-tracked met with approval from solar industry representatives (SEIA, 2020c). California has categorized solar and energy storage workers as essential, meaning that installations will be allowed to resume (California Energy Commission, 2020). The CA state senate mandated in 2015 that its public utilities commission make procurement decisions in accordance with a GHG emission reduction of 40% by 2030; half of its procurement should be from renewable energy. This means that despite falling carbon and electricity prices, there are incentives to invest in renewables and move away from fossil fuels. Nevertheless, without a federal policy response, the RES industry in the US faces serious difficulties.

In conclusion, the coronavirus crisis has resulted in lower US energy demand and falling electricity prices. The share of coal in the energy mix is also falling and there has been a small increase in the share of renewables. Lower energy demand appears to impact CO2 pricing schemes in different ways, as the RGGI (east coast markets) will remove excess credits to keep prices steady. However, the CO2 markets in California have dropped below the floor price and do not appear to be recovering soon, resulting in under-subscribed auctions. Investment in clean energy may slow in the coming months as investors see tax credits as less relevant; and projects are not able to be completed on time due to workforce and supply chain disturbances. Over 100,000 clean energy workers have filed for unemployment in March alone. Given the current response of the Trump administration, which allows for oil companies to claim massive stimulus benefits, and the patchy local responses, it seems that the US's clean energy industry will contract dramatically.

3.2 India

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India has the third largest power system in the world, with 370 GW installed capacity including 200 GW of coal and 90 GW of renewable energy assets. The electricity generation is about 1300 billion units, with 70% attributed to coal and 10% to renewables. Key consumer sectors include industries (40%), households (25%) and agriculture load (18%). Since 2015, there has been a steady increase in the share of renewable power, both in terms of capacity as well as energy generation. Currently, the country has over 37 GW of wind power and 34 GW of solar power projects. Due to rapidly declining costs of equipment and the setting up of large-scale projects, the cost of solar and wind power has become competitive with coal (CERC, 2020), leading to an increased adoption among energy utilities.

As part of its measures to contain the spread of Covid-19, the Indian government enforced a nationwide lockdown on March 25, 2020, restricting movement of individuals and halting all non-essential economic activities. The enforcement was extended until June 8th, when places of worship and stores began to reopen, though a partial opening of several sectors was allowed during the lockdown period.

3.2.1 Impacts on the energy sector

It has been observed that the lockdown severely impacted the power demand in the country. Even though the power sector, categorized as an essential service, was allowed to operate, Phase I of the lockdown period from March 25 to April 19 saw a 25% decrease in the power demand compared with the same period in the previous year, due to a halt in all industrial and commercial activities. A similar reduction was also observed in the peak demand, with a 30% decrease recorded during this period, from 160 GW to 115 GW (POSOCO, 2020).

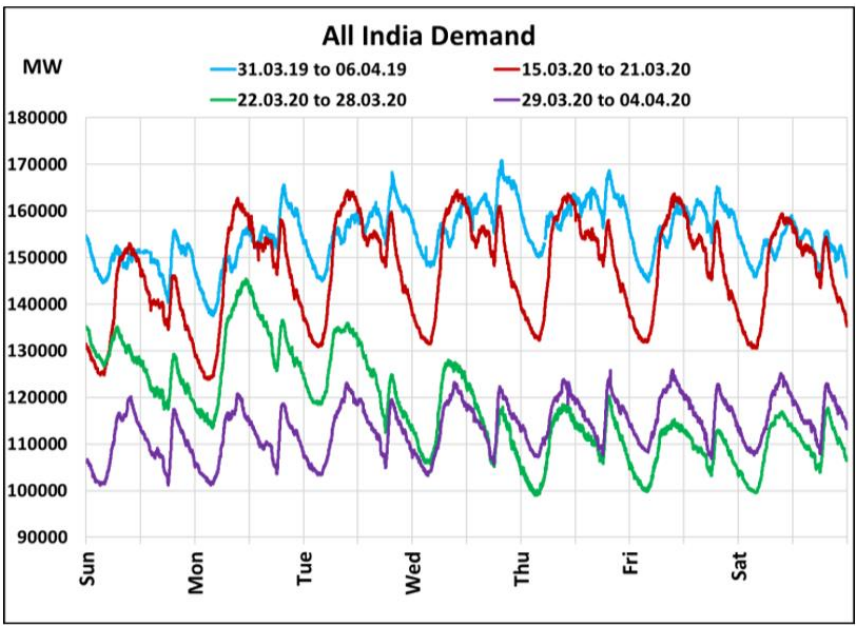

Figure 3.2.1: Demand patterns during the first two weeks of the lockdown (green and purple curves), as compared to the last normal week before the lockdown (red curve) and a similar week in the previous year (blue curve)
Source: data from https://posoco.in/covid-19/

During the lockdown period, power generation had to be adjusted to match the reduced demand. This was achieved by adjusting coal-based generation, since renewables are classified as 'Must Run' under the electricity law (MNRE, 2020a). The adjustment has led to a reduction in the load factor of coal plants and a build-up of coal stock inventory; there has been a drop of over 25% in the offtake of coal from domestic mining companies (Economic Times, 2020a). The reduced contribution from the coal sector has increased the share of renewable power in the grid, although there has been no perceptible increase in green power generation in absolute terms (CEA, 2020).

Another development has been the shift in the preference of distribution utilities towards short-term procurement through power exchange over the long-term contracts traditionally relied upon. There has been a 20% reduction in short-term power prices at the Indian Energy Exchange (INR 2.46/ kWh in March 2020 compared to INR 3.12/ kWh in March 2019), leading to an increase in the traded volume by over 18% on account of favorable prices (Economic Times, 2020b).

Several short-, medium- and long-term challenges have arisen in the power sector due to the lockdown conditions.

One of the main challenges was the reduction in demand and concomitant revenue flow to the power distribution companies. With most utilities in a financial mess, reduced power offtake may create a

bubble of cash flow crunch (Economic Times, 2020c). For most utilities in India, higher tariffs are charged to commercial and industrial segments to partly subsidize domestic consumers as part of social obligations (IEA, 2020). The decreased consumption of the high tariff-paying commercial and industrial sectors during lockdown will likely cause more hardship for the utilities. In addition, the cash-starved power distribution companies may find it difficult to settle the dues of their power suppliers, including renewable companies, which in turn, may affect the payment obligations of solar and wind companies to their service providers, leading to a vicious cycle. A lower than anticipated growth (BloombergQuint, 2020a) in the country's gross domestic product (GDP) will reduce power demand, with fallout for new installations, including related to the renewable energy sector. With coal plants running at lower operating values, this would put an additional financial burden on the generation utilities.

Another issue has been the restricted movement of personnel and the halt in industrial and commercial activities. Though routine operation and maintenance activities have been permitted at solar and wind sites (Economic Times, 2020d), availability of skilled personnel and spare parts may be a challenge. Manufacturing of solar and wind equipment, as well as project implementation activities at sites have been partly affected due to the lockdown. The virus has resulted in changes to the workforce as people travel back to their native places (villages) to minimize economic hardships; over 40 million migrant laborers have been impacted in India (Economic Times, 2020e). Dependence upon low-cost imported solar modules (especially from China) also affected the work due to restrictions on cargo movement, both within and outside the country (marine, road and rail). Moreover, the depleting value of the Indian rupee increased the import bills for solar developers. These issues may delay the commissioning of projects, leading to cost and time overruns, thus impacting the growth of the Indian renewable energy sector. Though the inclusion of force majeure in the contract clauses may provide solace, financial losses have to be absorbed by the involved entities – developers, bankers, utilities, or the ratepayers.

An unexpected challenge has arisen for the rooftop solar sector, both for self-financed projects set up by large companies and projects set up by investor groups under the capital expenditure (CAPEX) model. Net-metering regulations permit the sale of excess power to the host utility up to certain limits, albeit at lower prices than the applicable tariff for consumers in most cases. Lower captive consumption due to lockdown resulted in higher export of surplus solar power to the local grid, which presented technical challenges and resulted in lower revenues for rooftop project developers and investors. In addition, movement and construction restrictions in urban areas resulted in delayed commissioning of rooftop projects.

3.2.2 Policy response

The government is working towards solving the challenges posed to the economy, including the energy sector, by way of several policy interventions and packages. The Ministry of Finance has provided a huge stimulus package to revive the economy (BloombergQuint, 2020b) and increase the energy demand. To help the power distribution companies facing financial troubles, a liquidity injection of INR 900 billion is foreseen, which includes waiving-off fixed charges and interstate transmission charges and raising funds from the markets against the receivables of these companies (Livemint, 2020). The phased lifting of lockdown and the arrival of the summer season (associated with cooling load) may further augment demand. To help project developers, the government has also permitted construction activities for renewable projects outside city limits and allowed a phased opening of the manufacturing sector, as well (Economic Times, 2020f); the timelines for commissioning of solar and wind projects have been extended (MNRE, 2020b). To promote the domestic industry and reduce import dependence, the states have been asked to identify land for setting up renewable energy manufacturing and export services hubs (Economic Times, 2020g).

Apart from the economic stimulus package, the Ministry of Power has announced draft amendments to the Electricity Bill to revive the sector. The amendments have specific provisions for developing a "National Renewable Energy Policy", with penalty provisions for non-adherence to procurement targets and tariff rationalization[1] by directly routing subsidy to the consumers (MOP, 2020). Government-owned agencies specializing in the power sector have been asked to offer short-term lending facilities to power distribution companies to help them navigate through the payment crisis (Economic Times, 2020h). These measures should contribute to a quick recovery of the Indian power sector besides helping expand the share of renewable energy in the grid.

3.3 China

Bing Xue

The Covid-19 pandemic in China was described as "a major public health emergency that has occurred in China since the founding of New China, with the fastest spread, the widest scope of infection, and the most difficult prevention and control"(Xi, 2020). On January 23, 2020, Wuhan began to take measures to close the city for strict control, and subsequently, a wide range of prevention and control measures were implemented nationwide. On February 7, 2020, Wuhan lifted control of the lockdown of the city, which means that China has achieved important results in epidemic prevention and control. Whether in the long-term or short-term, Covid-19 has had various degrees of direct or indirect impact on various aspects of China's social and economic development (Devonshire-Ellis et al., 2020); the effects of extensive prevention and control measures such as lockdown, isolation, and social distancing also extend to the energy system.

3.3.1 Impacts of the Corona pandemic on energy consumption

In the period from January to April 2020, total electricity consumption decreased significantly, dropping by about 4.7% compared to the previous year, and by as much as 10.1% in February 2020, while almost the whole of China was in lockdown (Figure 3.3.1 and Table 3.3.1) (NEA, 2020). According to data from the National Energy Administration of China, the electricity consumption of the secondary and tertiary industries decreased by 12.9% and 10.0% year-on-year in February 2020. In March, as China began to resume production, power consumption also increased, but remained lower than the previous year by 6.1% and 8.1% respectively.

[1] Tariff Rationalization means determination of tariff as per realistic procurement and delivery costs (including operating and profit margins), without any preference for any consumer category, thus eliminating cross-subsidies

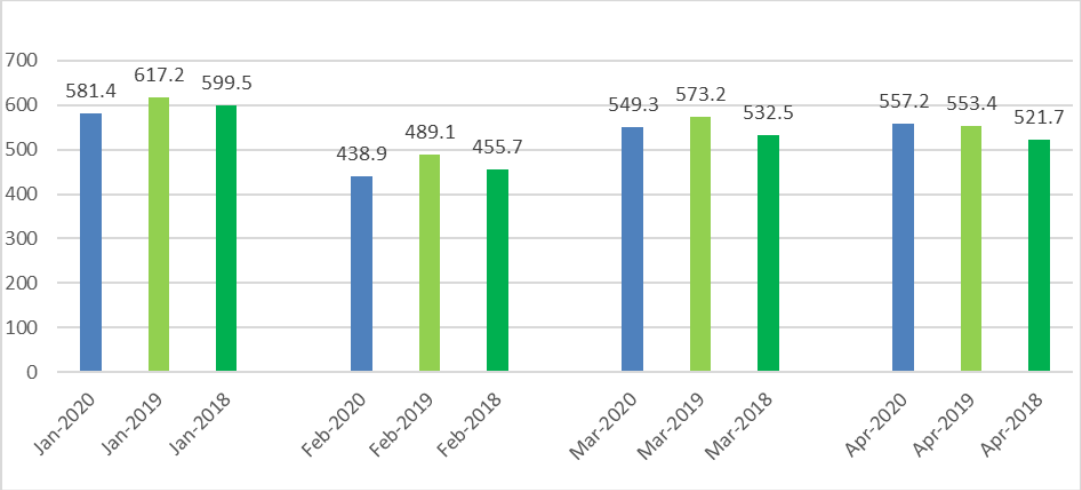

Figure 3.3.1: Total Electricity Consumption in Jan-April of 2018-2020
Source: data from NEA

The epidemic has had a longer-term impact on the tertiary industry, which has been slower to resume operations than the secondary industry. However, the electricity consumption of the four high-energy-consuming enterprises, including the building sector, chemicals, steel, and nonferrous metals, has remained basically stable. Under normal circumstances, these industries account for about 40% of the entire industrial electricity consumption. Coal consumption in 2019 was 3.94 billion tons, a year-on-year increase of 1.1%. In 2020, the status of power generation and the four major high-energy enterprises will be relatively stable. Since coal provides more than 80% of the energy consumed by these five industries, coal consumption in 2020 is expected to be largely the same as last year.

Table 3.3.1: Total Energy Consumption in Feb and the sum of Jan-April 2020

Indicators	Unit	Feb 2020		Sum of Jan – April 2020	
		Total	Percentual change compared to Feb 2019	Total	Percentual Change compared to 2019
National electricity consumption	GWh	439.8	-10.1%	2127	-4.7%
Primary industry	GWh	5.3	1.9%	22.8	5%
Secondary industry	GWh	252.3	-14.6%	1388.4	-6.1%
Industry	GWh	245.6	-12.9%	1364.1	-6.1%
Tertiary Industry	GWh	83.3	-10.0%	342.4	-8.1%
Electricity consumption of urban and rural households	GWh	98.8	3.1%	373.4	3.4%

The energy consumption of the secondary and tertiary industries generally declined, showing regional and industry differences, while the total energy consumption of private households increased. For example, from January to February, domestic gasoline and aviation kerosene consumption

decreased by about 10% to 15% year-on-year. In February, gasoline consumption fell more than 40% year-on-year, diesel consumption fell more than 30% year-on-year, aviation kerosene consumption fell more than 50% year-on-year, and natural gas consumption fell 10.2% year-on-year (CNPC, 2020). As people began to spend more time at home, the demand for electricity for heating, lighting, televisions, and computers increased significantly in North, Northeast, and Northwest China, and electricity consumption by private households continues to be high. Household electricity consumption increased by 12.3% in North China, by 10.6% in Northeast China, and by 9.5% in Northwest China. Private households in Tianjin, Hebei, Shanxi, Shandong, Liaoning, Jilin, Heilongjiang, Xinjiang, and other provinces all have growth rates of more than 10%. The proportion of migrant workers in East China is relatively high. Due to the epidemic, many workers did not return in February. As a result, household electricity consumption grew by only 2.7%. Households in Shanghai, Jiangsu, and Zhejiang all experienced negative growth. The electricity consumption of Fujian households only increased slightly by 3.2%.

The nationwide cumulative average utilization hours (CAUH) of power generation equipment in the period from January to April 2020 was 1102 hours, 115 hours less than in 2019. This reduction was concentrated in the area of thermal power equipment (146 hours less), followed by hydropower (94 hours less), with wind power experiencing the smallest drop (only 21 hours less).

Table 3.3.1: Average use of power generation equipment, Jan-April 2020

		Jan-April 2020	comparison year-on-year
CAUH	hours	1102	-115
Hydropower	hours	865	-94
Thermal	hours	1266	-146
Nuclear	hours	2230	-28
Wind	hours	745	-21

In terms of newly installed power generation capacity, the added generation capacity from January to April 2020 was 20.09GW, which was 3.27GW less than the same period in 2019. Hydropower, thermal power, and wind power have newly added installed capacities of 1.14GW, 10.78GW, and 3.65GW respectively. However, compared with the same period of last year, hydropower and thermal power increased by 400MW and 410MW respectively, and the newly installed capacity of nuclear power and wind power decreased by 1.25GW and 1.95GW respectively.

Table 3.3.3: New installed power generation capacity, Jan-April 2020 (MW)

		Jan-April 2020	comparison year-on-year
New installed power generation capacity	MW	20090	-3270
Hydropower	MW	1140	400
Thermal	MW	10780	410
Nuclear	MW	0	-1250
Wind	MW	3650	-1950

3.3.2 Discussions and policy response

China is a major energy consumer and the hub of the global manufacturing supply chain, and the epidemic has had an important impact on the global economy and the international energy market (Mao et al., 2020). However, at present, it is still difficult to judge the specific impact of the Covid-19 epidemic on China's energy policy.

In the early stage of the epidemic, many Chinese scholars conducted preliminary discussions on the theme of "the impact of the epidemic on China's energy system", but mainly qualitative discussions. For example, the Center for Energy and Environmental Policy Research at the Beijing Institute of Technology launched the report entitled “Evaluation of the overall impact of the new coronary pneumonia epidemic on the energy system” on Feb 13 2020, which argued that due to the dual impact of supply and demand, the development of various industries has been inhibited to varying degrees in the short term, and ensuring emergency energy supply in epidemic areas was the focus of work at that time. It also pointed out that in the medium and long term, after the epidemic, various industries will gradually adjust and rebound to the original development track, and the Chinese energy industry should continue to develop in accordance with the established route and goals (Hao et al., 2020). With the acceleration of resumption of production and production, China's total energy consumption has started to pick up. However, due to the global spread of the epidemic and the related impact of the domestic epidemic, China's energy consumption will inevitably be affected by changes in economic and social activities—but at the policy level, there are currently no significant signals.

On May 22, 2020, Chinese Premier Li Keqiang stated in his government work report that China will not set a GDP growth target for 2020. This is the first time that China has not set a target for economic growth since it began in 1994. However, in the energy field, it is confirmed that ensuring energy security is one of the key basic goals and it is clearly proposed to promote the clean and efficient use of coal, develop renewable energy, improve the supply and marketing system of oil, natural gas, and power generation, and enhance energy reserve capacity.

On May 29, 2020, the People's Bank of China, the National Development and Reform Commission, and the China Securities Regulatory Commission published a draft of their 2020 revision to the Green Bond-supported Project Catalogue (Green Project Catalogue) for comments (PBC 2020), which involves multiple energy projects, including energy efficiency for power facilities and the construction and operation of renewable energy facilities. It also supports manufacturing of wind power generation equipment, hydroelectric power generation and pumped storage equipment, biomass energy utilization equipment, nuclear power equipment, gas turbine equipment, and geothermal energy development and utilization equipment. It is worth noting that the coal-related projects, which are the most controversial points in China's green debt standards, have been eliminated from the draft for consultation and are in line with international standards, which also help increase China's legitimacy to speak in the international arena.

At the time of the epidemic, the global energy system has been impacted to varying degrees (Gordon, 2020; IEA, 2020), and the whole China's energy system will certainly be affected, although these effects have not yet been well quantified. However, in order to strengthen the energy industry's supply chain resilience, China is likely to become more determined to develop renewable energy as part of its efforts to reduce energy imports from a longer-term perspective (Zheng, 2020). More efforts are likely to be conducted, for example, to further promote the intelligent construction of the energy industry, and strengthen the integration of intelligent technology and coal, oil, electricity, natural gas and other industries. By constructing a multi-layer network supply chain based on intelligent technology, an efficient, low-cost, and robust supply system can be achieved, so that the energy supply chain can have instant, visible, perceptible, and adjustable capabilities in any situation.

3.4 Germany

Laima Eicke

3.4.1 Impacts of the Corona pandemic on the power market

Energy demand in Germany fell dramatically throughout March and remained low in April, mainly driven by decreased industrial production and shutdowns, such as in the automotive sector. As industry and businesses account for half of German electricity demand, the power market has also been heavily impacted. In the first quarter, the Corona pandemic drove down power demand by around 3%. Electricity production fell even further by 17% due to decreased electricity demand in neighboring countries (Frauenhofer ISE, 2020a).

The decreased demand for electricity changed the patterns of power generation in the first quarter of 2020. Due to lower marginal costs for renewables and gas, coal has been crowded out within the merit order process. In comparison to the first quarter of 2019, power generation based on lignite and hard coal decreased by 32% (9.1 Twh) and 42% (7.2 Twh) respectively, whereas wind- and solar-based electricity generation increased by 19% (8.3 TWH) and 10% (0.7 Twh). A mild winter and a sunny spring reinforced this trend. In consequence, 2020 has been the first year in which renewable electricity generation exceeded fossil power production by 55% in the first quarter and 60% in April 2020 (Frauenhofer ISE, 2020a). During at least three days in April 2020, renewable electricity generation exceeded the total power demand (Bundesnetzagentur, 2020a).

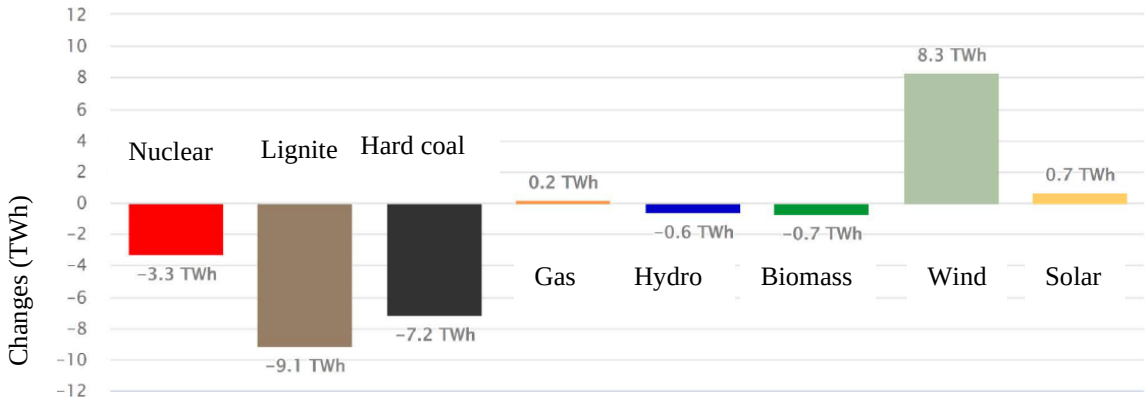

Figure 3.4.1: absolute changes in net power generation in the first quarter of 2020 in comparison to the first quarter of 2019 in Germany
Source: Frauenhofer ISE, 2020a

Prices for electricity on the day-ahead spot market have decreased; the EPEX spot price has been 33% lower in the first quarter of 2020 than the year before (Frauenhofer ISE, 2020a). Numerous times prices were negative, falling below zero for the first time on February 16th and becoming even lower in March and April, as it was impossible or unprofitable to turn thermal plants down. More flexible renewable electricity plants had, in turn, no incentive to decrease production, as they receive fixed feed-in-tariffs per kwh regardless of price changes on the wholesale market (Frauenhofer ISE, 2020b). In cases where the price on the spot exchange remains negative for six consecutive hours, large installations do not receive feed-in tariffs. However they often continue to produce power due to uncertainties involved (Amelang, 2020). On the other hand, prices for negative balancing energy have increased, driven by changes in daily consumption patterns (Sperling, 2020).

A German CO2 price for all sectors is planned for 2021. Currently, the EU-ETS determines carbon prices for the German energy and industrial sectors. While the demand for carbon certificates on the EU market decreased due to lower production, the supply increased as many businesses held reserves that are now being offered. In consequence, the EU-ETS has seen carbon prices drop dramatically by 40%, from 25.90€/tCO2 to 15.70 €/tCO2 in March 2020 (DEHSt, 2020). The ETS is meant to adjust the supply by withdrawing allowances and inserting them into the Market Stability Reserve (MSR) in order to stabilize prices, and plans to withdraw 330 million allowances in 2020. However, the mechanism has not been able to reverse the declining price trend caused by the Corona pandemic. These decreased carbon prices have a direct effect on the marginal costs of fossil power plants, lowering electricity prices further.

3.4.2 Implications for the energy transition in Germany

The current pandemic affects the German renewable energy sector in various ways:

Competitive tenders are used in order to determine the extent of financial support for new wind and solar plants. Due to the current pandemic crisis, related processes of recently completed tenders, current and upcoming projects are confronted with delays, creating uncertainty among tenderers. As supply chains are interrupted and the possibility to follow through on projects is put into question. In reaction, timeframes have been adjusted, and sanctions on delays have been paused in order to support the realization of these new installations of renewable energy (Bundesnetzagenture, 2020b).

New installations as well as operation and maintenance of existing renewable energy projects in Germany are affected by travel restrictions for technical personnel, which are regionally specific. Despite these uncertainties, PV installations did not decrease significantly in the first quarter of 2020. However, many projects have been postponed to the second quarter of the year.

The corona pandemic also exposed the vulnerability of renewable energy supply chains due to a strong dependence on imports, especially in the solar energy sector. Most German manufacturers and retailers are dependent on components or whole PV modules from China. As Chinese factories stopped production for several weeks, German manufacturers and retailers faced rising component prices as well as delayed and decreased production capacities (Lemberger, 2020). But also the wind sector is affected by the corona pandemic: the German-Spanish wind turbine manufacturer Siemens Gamesa faced decreases in sales of 8% and losses of 165 Million Euro in comparison to the first quarter of the previous year (IWR, 2020).

Yet even before the current crisis, the installation of wind turbines had slowed down in Germany due to various challenges (Windbranche, 2020). Investments had decreased by 80% within the last two years (Agora Energiewende, 2020). Legislative reforms such as introducing larger distance requirements to housing areas decreased the potential for new installations significantly (IASS, 2020). Therefore, renewable energy industry associations called for regulatory reforms removing these current challenges in order to unleash the sector's full growth potential, which could boost the economy especially in the aftermath of the current corona pandemic (Neumann, 2020).

The Covid-19 pandemic also reopened discussions on the German coal exit, which is currently planned for 2038 at the latest. An agreement had been reached by a committee of regional governments, coal producing companies, unions, environmental NGOs, scientists and representatives from affected local communities; a new law, the Coal Phase-out Act, set the foundation for its implementation. However, several key details are still hotly debated, including the amount of compensation payments for coal

power plants that would need to retire before their planned lifetime. As the corona pandemic strongly decreased coal production, it puts into question the basis for the calculation of compensation payments; the current crisis demonstrates that a coal exit might potentially come earlier than planned, as coal might become economically unprofitable (Staude, 2020).

3.4.3 Policy responses

The German President, Frank Walter Steinmeier, emphasized the need for intergenerational solidarity: "young people in particular have shown solidarity to protect the elderly. In climate policy, the reverse is now true: we older people must show solidarity with the young by leaving them a planet worth living on." Together with the Austrian and Swiss heads of state, they highlighted that investments in green technologies, including sources of renewable energy would be able to restart economic growth and foster employment and called for stronger climate policies (Steinmeier, Sommaruga and Van der Bellen, 2020). The German policy response to the Covid-19 crisis partly reflects this vision: it includes green, future-oriented investments but is not in line with the Paris Agreements' climate targets (Wehrmann, Wettengel, 2020).

Germany first reacted to the pandemic crisis with a combination of fiscal and monetary measures targeting companies across all sectors for short-term relief. These included the extension of loan programs from the state-owned KfW Bank for businesses affected by the corona crisis; the issuing of state and federal guarantees in order to improve and accelerate access to loans; deferrals of tax debts and pauses of enforcement measures; wage refunds for quarantined employees; and special support for short-time work programs that are meant to prevent unemployment.

In a second stage, in early June 2020, the government decided upon a 130 billion euro economic stimulus package, which was preceded by intense discussions on sector specific recovery programs. In the aftermath of the financial crisis 2008/2009 measures targeted mainly the economically important mobility sector with the introduction of a scrappage bonus for cars in order to increase demand. Accordingly, the car industry has been among the first to call for similar support packages within the corona crisis. However, this time the government took a different approach: buyer's premiums are limited to electric vehicles, fostering the electrification and decarbonization of the mobility sector. Further investments will go to the state-owned train company and municipal public transport systems, as well as modern shipping and aviation technologies. A 50 million euro "future package" also targets increased sector coupling with investments in future mobility and hydrogen technologies.

A further concern is the impacts of economic crisis on the renewable energy sector. In the early 2010s lower production costs in China led to a strong decrease of production volumes and employment within the Germany. In order to avoid a similar scenario within the still internationally competitive but currently struggling wind energy sector, measures for an economic recovery after Covid-19 targeting the renewable energy sector specifically have been proposed. These included decreasing bureaucratic and regulatory burdens; new special tenders; the removal of regulatory challenges for repowering old wind plants and combined solar PV and storage systems; and an expansion and digitalization of enabling infrastructure such as grids and storage components (Agora Energiewende, 2020).

In May 2020, first governmental decisions to decrease regulatory challenges for the renewable energy sector included the expansion of existing support schemes by removing a previous limit to subsidies on solar PV as soon as the total installations in the country reached 52 GW (Ullrich, 2020). As this limit is expected to be reached in 2020, high uncertainty has been influencing the investment climate throughout the past year (Solarserver, 2020). In addition, the long-discussed distance regulations for newly built wind power plants now allow regional decisions on smaller distance regulations, increasing the amount of available land for new installations. During previous votes on similar proposals

within the Parliament only a few weeks before, the conservative Christian Democratic Union (CDU) had rejected the measures. The pandemic crisis seems to have caused a change in strategy; the German economic minister Altmeier (also in the CDU) explicitly presented these regulations as important contribution to overcome the economic crisis caused by the pandemic (Wettengel, 2020). In turn, renewable support schemes might become redesigned, with the aim of decreasing energy prices (Wehrmann, Wettengel, 2020).

Furthermore, investments in the building sector that are already planned in the coming years are being incentivized and accelerated. A successful example of this is the new support program for energy efficient construction and restoration, which has been introduced in January 2020. Despite the corona crisis it led to an increase in investor applications by 150% in comparison to the year before (Bauförderer, 2020). The new stimulus program includes additional investments of € 2bn for energy-efficient modernization of buildings.

At the EU level, the German Chancellor Angela Merkel, together with the French President Emmanuel Macron proposed a 500 billion Corona Recovery Fund in order to help affected countries within the European Union. The money would be part of the EU budget and be paid by all EU countries. This proposal marks a turning point within discussions on shared financial responsibilities in times of crisis and strongly differs from the austerity policies after the financial crisis in 2007/2008. At a joint press conference, Merkel and Macron both highlighted the need for a green new deal and that green investments accelerating the decarbonization of economies and the transition of energy systems should be a key pillar of the Corona recovery fund (Bundesregierung 2020). However, it remains to be seen whether the other European partners support this bilateral proposal.

3.5 Argentina

Germán Bersalli

Argentina is among the countries hardest hit by the social and economic consequences of the Covid-19 pandemic. The Economic Commission for Latin America and the Caribbean or ECLAC (CEPAL, 2020) is predicting the worst economic crisis in the history of Latin America, with a fall in GDP of over 5%, and millions of people pushed into poverty. Argentina, which is currently renegotiating its massive external debt, could suffer a drop in GDP of 6.5% or more. The government is responding with social and economic policy trying to minimize the impacts of the crisis.

The energy sector is directly impacted by economic uncertainty that is stopping all new investments in both renewables and fossil fuel sectors. In the last six years, the country has made progress in its energy transition (WEF, 2020), especially through substantial investment in utility-scale renewable energy. Which sector will lead the way during a recovery phase depends largely on the regulatory measures and economic incentives that are being designed and implemented currently. Despite its environmental and economic problems, the fossil fuel sector is still perceived as a key development trigger and is supported by the federal government and several provinces. However, a fledgling renewable energy sector can (and should) play a leading role.

3.5.1 Large subsidies for a dominant oil and gas sector

Argentina's energy system is still highly dependent on fossil fuels, especially oil and gas. Hydrocarbons represent 85% of the country's energy production. In the electricity sector, installed thermal power (mainly gas-fired plants) grew from 15.6 GW in 2009 to 24.5 in 2018 (Energía, 2019).

The country has promoted the oil industry since the beginning of the twentieth century, primarily

through the partially state-owned company YPF. Nowadays, this company and the whole oil sector are still considered a pillar of the country's economic development by a substantial part of political representatives. With conventional oil and gas reserves diminishing, economic and political attention has turned to the development of the country's enormous shale oil and gas fields, especially the Vaca Muerta formation. This is one of the world's largest reserves, and the government considers it a national "golden goose" (*la gallina de los huevos de oro*). Echoing his predecessors, President Fernández declared in an address to Congress in March that "Hydrocarbons will be a lever for the productive development of our country."

In practice, however, the reality of these reserves is less promising. Even disregarding the serious adverse social and environmental impacts of mining them (Goñi, 2019), they are not cost-competitive. The sector has relatively high production costs and has so far failed to develop without state support. The oil and gas oligopoly (a small group of national and international companies) received subsidies of around USD 24 billion in the decade from 2008 to 2018 (Lahoud et al., 2020), a gigantic sum for the size of the Argentinean economy.

In the current crisis, the international oil companies operating in Argentina have announced significant cuts in costs and investments. The heavily indebted YPF, whose shares on the New York Stock Exchange plummeted in April, has largely followed suit. The pandemic reveals once again that investments in this sector are highly vulnerable to fluctuations in international oil markets and economic crises in general. And, ultimately, the government has to step in with a rescue package.

Every time the international oil price falls, pressure from the oil industry increases to set a local price – the so-called "barril criollo" – higher than the international price, the difference is covered by the national government. Since March, part of the oil industry and governors from oil-producing provinces (like Neuquen and Santa Cruz) have been lobbying for a barril criollo of USD 54. In May, the government has yielded to industry pressures and fixed a price of USD 45 dollars until the end of the year (Official Gazette of the Argentine Republic, 2020). Even though these imply new subsidies, local analysts doubt the recovery of investments in Vaca Muerta. During the months of April and May, oil production fell by 60% and gas production by 20%, accompanying the drop in consumption, and rapid recovery is not expected.

A common argument in favor of the development of Argentina's shale oil and gas fields is that they generate local employment and avoid oil and gas imports. However, the country now needs to consider to what extent these sectors should benefit from state subsidies and what the alternatives are. The same approach should be taken to the links between the state and YPF. In the coming years, economic recovery may benefit from a robust public company. But should this company continue to invest in highly polluting energy sources whose days are numbered, or should it instead commit to more promising and cleaner energy sources?

3.5.2 Fledgling renewable energy sector threatened by the crisis

In April 2020 (the first month totally affected by the quarantine), electricity generation decreased by 11.5% compared to the same month the previous year (from 8470 GWh compared to 9575 GWh) Renewable energies slightly increased their participation in the electricity mix, while the production of gas and hydropower plants decreased (CAMMESA, 2020).

In 1998, Argentina was the first country in Latin America to introduce state support for renewable electricity. However, the sector is still perceived as an "ugly duckling" (un patito feo), nice to have but far less important than the eternally "promising" fossil fuels sector. The initially higher costs of these technologies and acute economic crises hindered their deployment for many years. More

recently, support programs such as RenovAr (RenovAr, 2020) have allowed renewable technologies, especially wind power and solar PV, to take off. Argentina went from less than 2% renewable electricity production in 2017 to 8% in 2019, and is aiming to reach 20% by 2025. For that to happen, the sector requires continued and expanded government support: progress has been made, but the speed of deployment needs to increase.

Many large-scale renewable projects that won tenders do not currently have access to the financing necessary to carry them out and may soon be abandoned. Currently, 25 wind and solar projects awarded in the RenovAr auctions program are renegotiating for a total of 1307 MW (Gubinelli, 2020). The projects will have dispatch priority and are economically viable – the average prices auctioned are competitive by national and international standards – but they lack access to funding at reasonable rates. Argentina's debt crisis, the pandemic, and the lack of interest shown by a government dealing with several simultaneous crises have left the sector in wait-and-see mode.

Distributed generation is an emerging niche with very potential. In the years 2018 and 2019, the country began to implement the new law 27424, which regulates distributed generation projects. These projects must stay below 2 MW and can sell any excess power back to distributors through a net billing system. Argentina was late to diffuse these decentralized technologies and now has the opportunity to substantially boost their deployment as a response to the crisis. Indeed, they offer several social and economic advantages for the post-corona economic recovery and should be considered in the recovery plan which is under discussion. First, these technologies strengthen the self-sufficiency and resilience of users and allow for substantial savings in the energy bills of households and SMEs. Second, they are not dependent on significant capital investments by a few actors, decentralizing and dispersing such a decision over a diverse group of investors. Third, they contribute to diversifying and decarbonizing the electricity mix, one of the country's long-term objectives. Finally, together with other technologies such as storage, smart metering, demand management, and e-mobility, they are a critical element of a future cleaner and reliable electricity system.

3.5.3 Strategic integration and spending in a more resilient, fairer, and cleaner energy system post-crisis

In the coming weeks and months, the government has to make fundamental decisions that will shape the energy system for the next decades. One exit strategy from the crisis may be to support the fossil fuel sector, reinforcing the country's lock-in to old polluting technologies. An alternative exit strategy would be to embark on a new development paradigm that actively supports new and cleaner technologies in strategic sectors like energy, transport, and agriculture.

In March 2020, the government announced a post-crisis stimulus package of USD 11 billion. With private financial markets currently closed to the country and without the support of international financial institutions, a more ambitious stimulus package seems unlikely. In this context, every peso of public expenditure matters. Since all sectors cannot be supported at the same time, the government has to make choices. However, the content of this plan and its real scope are still unknown.

Vaca Muerta is portrayed as a golden goose, but it actually depends on subsidies. That will only change if oil prices increase strongly and remain high after corona, which is very unlikely. Concentrated in the hands of a few big companies, the fossil fuel sector is unlikely to help the country and its people. Public monies should, therefore, be spent in more promising sectors. As discussed above, decentralized electricity is an example of a solution that can stimulate economic recovery and, at the same time, directly help families and small companies severely affected by the crisis. Furthermore, there is an urgent need to support utility-scale renewable energy projects that are approved but lack funding. Abandoning this emerging sector would be a historic mistake. At the time of writing this paper, the

Argentinean government has not defined the new policy for the renewable energy sector, which should be an essential component of the stimulus package under discussion.

3.6 Israel

Diana Süsser

Although Israel is a country with sunny days almost all year around and is at the forefront of the use of solar thermal energy, only around 8% of the country's energy supply comes from renewable energy (IEA, 2018). One reason that Israel has yet to take advantage of its large solar energy potential may be its continued interest in natural gas. The discovery of huge natural gas reserves off Israel's Mediterranean coast has been framed as an economic, political and environmental blessing. Israel has invested heavily and could become a major natural gas exporter by end of the decade.

As a part of Israel's recovery from the Covid-19 crisis, the country may revise its 2030 renewable energy target from 17% to 30%. By 2020, renewables are expected to account for ten percent of Israel's total energy consumption, based on 3.5 GW of installed solar PV power. A draft of the revised renewable energy target for 2030 was under public consultation in June (Israeli Ministry of Energy, 2020a). If the target is implemented, renewable energy − with solar expected to account for the major share − would replace the remaining coal in the electricity mix (see Figure 3.6.1). Israel supports PV development through solar PV auctions and tenders for large-scale projects and a scheme for rooftop PV that includes net-metering and feed-in tariffs.

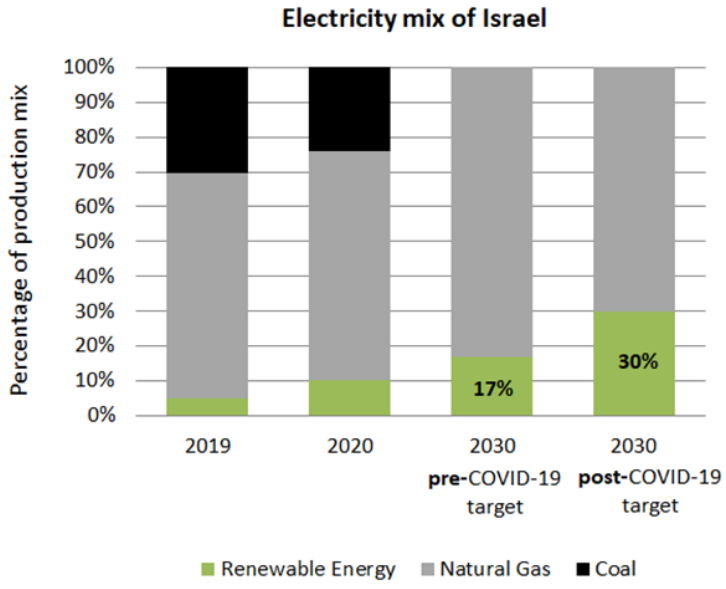

Figure 3.6.1: Electricity mix of Israel
Source: own figures based on Israeli Ministry of Energy, 2020b

3.6.1 Impact of Covid-19 on the Israeli energy market and industry

The current Corona crisis is expected to damage the Israeli economy significantly (Israeli Ministry of Energy, 2020c), and much of the attention is on how to provide employment opportunities and to bring

the Israeli economy back to economic growth. During the crisis, there was a slight reduction in electricity demand and a large drop in fuel consumption, confirmed the Israeli Ministry of Energy in correspondence with the author. The crisis also had strong impacts on the fuels distribution companies. For example, Israel's Delek Group, a giant energy holding firm with interests in the Israeli natural gas fields, has seen massive losses on the stock market and was close to bankruptcy as the global price of oil dropped (Haaretz, 2020). While some companies are less openness to spend money for new energy technologies due to financial uncertainties, even the most conservative companies started to realize that they need to innovate.

According to Israeli experts, the current Covid-19 pandemic disrupts the energy innovation ecosystem. Israel is generally characterized by a small market size and a highly regulated energy sector. Israeli start-ups largely depend on foreign markets, and thus, foreign countries' suffering from Covid-19 has a large impact on the Israeli economy. Many Israeli start-ups seek foreign markets, but it got harder to sell products and services to customers. While Israeli experts stated to us that they expect the US hunger for innovations to change, because the country was hardly affects by the pandemic, they rather advise energy start-ups to target European and Asian markets. In addition, start-ups were affected by communication and development problems due to the lockdown, and reported that it was more difficult for them to secure funding. The later adds to the general challenge of finding suitable venture funding for energy technologies, that fits to the longer time horizon needed. Many start-ups have frozen hiring, fired employees or send them home on unpaid leave. A recent survey among 400+ start-ups about what they think of fundraising, hiring and operations pre Covid-19 and today confirmed these and other issues, especially a lack of information on investor interest and current behavior (Start-up Snapshot, 2020). Nevertheless, an advantage of the Israeli energy industry might be that it centers mainly around software and service technologies, and not on hardware infrastructure, which makes the energy start-ups less vulnerable to supply chain interruptions than the clean energy industry in other countries.

The energy start-up ecosystem sees in the crisis also a chance, given the need for more resilient energy systems. The ecosystem has responded to the current crisis with a range of events to turn the crisis into an opportunity for Israeli energy technologies. Promising energy tech will likely make it through the crisis, if they manage to attract funding to fuel developments.

3.6.2 Policy response

In late April 2020, the Israeli Ministry of Energy published an energy and water infrastructure plan for accelerating infrastructure projects in the energy and water economy to help the country's economy recover from the impact of the Covid-19 pandemic (Israeli Ministry of Energy, 2020c). The plan outlines total investments of ILS25 billion (€6.4 billion). Most of the investment is supposed to come from private funding, and 12% will come from the government, mainly in form of incentives, matched funding, and loan guarantees. Almost one fourth of the investment is supposed to fund the deployment of 2 GW of new solar PV capacity across the country. A list of 47 so-called economic growth projects has been published together with the plan (Israeli Ministry of Energy, 2020d).

In June, the Israeli Ministry of Energy announced to increase its 2030 renewable energy target, and in line with that another 15 GW of solar by 2030, which would result in a cumulative capacity in Israel of more than eight times the capacity of today (~ 2 GW; see Figure 3.6.2). Beyond new renewable energy capacities, electricity storage facilities gain also increasing attention. Israel plans to set up solar energy and electricity storage facilities on a scale equal to all existing electricity production in the country today. The Energy ministry expects that renewable energy could meet around 80% of power demand by 2030 (Israeli Ministry of Energy, 2020b). To support the plan, the government will devote ILS500 million (€128 million) in state guarantees for project development. Under an incentive scheme aimed at driving rooftop PV systems with a capacity of up to 200 kW, Israel's national lottery will

grant local authorities seven-year, low-interest loans. Some 141 municipalities have already submitted requests for a total generation capacity of 141 MW of solar arrays on schools, council buildings, clinics and day care and community centers

Although Israel has raised its ambition for the deployment of renewables, the Energy Ministry's plans have been criticized for its continued promotion of natural gas. Natural gas is planned to provide 70% of countries' electricity by 2030 (see Figure 3.6.1), and set to be also an important transport fuel. New gas pipelines are planned to be built from the north to the south of the country, with a volume of ILS700 million (€179 million)[2] (Israeli Ministry of Energy, 2020c). Given the fact that the entire Eilat and Arava area (south Israel) is already self-sufficient in daytime solar energy, storage capacity would be needed. Instead, the plan seems to be in interest of the gas industry. Israel still holds on its 'natural gas fantasy'. The future will show if decreasing prices for a unit of solar energy and storage capacity will be able to displace natural gas.

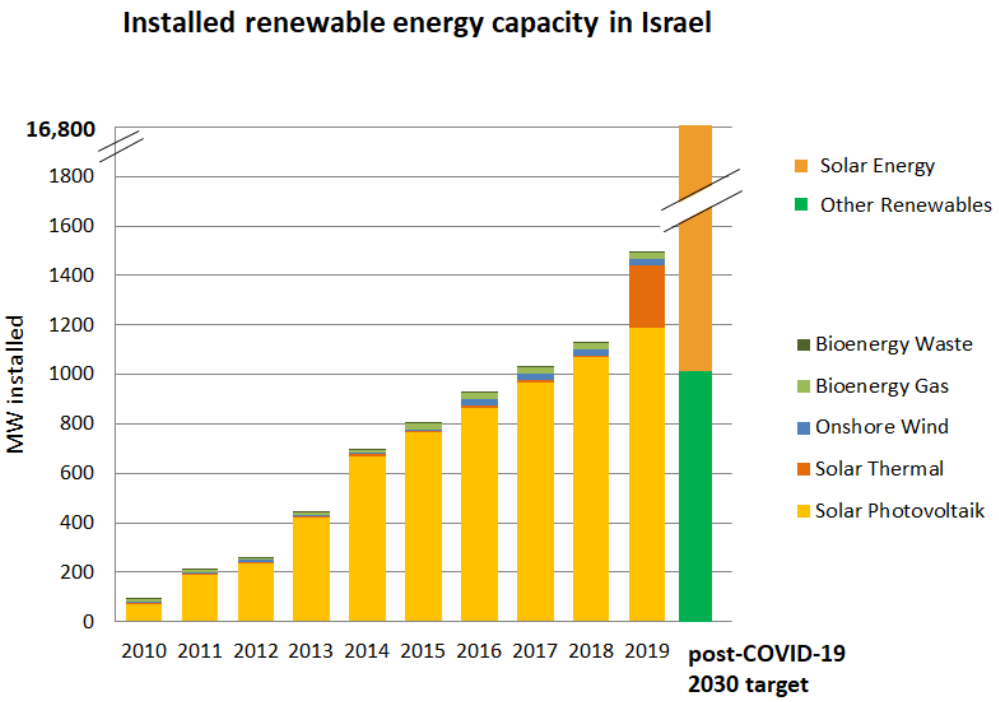

Figure 3.6.2: Installed renewable energy capacity in Israel
Source: own figures based on data from IRENA, 2020 and Israel Ministry of Energy, 2020b

3.6.3 Importance of green innovation for Israel's recovery from the Covid-19 crisis

Israel's recent plans are a step in the right direction, but they need to lead to a green stimulus package. Two priority areas which have not sufficiently been addressed in the plans are solar-powered desalinization and the electrification of Israel's transport sector. These must be addressed, as the energy and water sectors will both play a central role in setting Israel on a pathway towards net-zero emissions. In this course, the government will need to make choices to invest in renewable energy technologies

2 In the original document a number of NIS 700 (Israeli Ministry of Energy, 2020c). It is assumed that this number is supposed to be millions.

and abandon the support of old polluting technologies. Moreover, remaining barriers for renewable energy and energy efficiency projects must be removed to facilitate the renewable energy development and improve the grid-connection process for projects (e.g., Israeli Ministry of Energy, 2020e). For example, the tender for the Dimona solar power plant (Israeli Government Procurement Administration, 2020) has led to disagreement between the solar sectors and the country's Land Authority, which claims the project could interfere with sand-mining near Dimona.

Innovation can be expected to play an essential role for the execution of post Covid-19 energy sector recovery, as it has already been emphasized as a path to deliver on the SDG's (Israel Ministry of Foreign Affairs, 2019). Green innovation can be a catalyst for Israel's economic recovery and contribute to climate and SDG targets in long-term (Süsser, in press). By letting go the support of natural gas, Israel would make the way free for R&D and commercialization of clean and renewable energy technologies with large benefits for health, economy and employment.

4. Conclusion

This IASS Study analyses the impacts of coronavirus on the energy sector, both at the global and at the national level. At the global level, we see drastic reductions in hydrocarbon production and consumption since the beginning of the pandemic, and policymakers in producer countries face a choice between whether to revive local industry or cut their losses and focus on renewables. Meanwhile, the share of renewable energy in the overall energy mix is increasing due to its low operating costs, placing further downward pressure on wholesale electricity prices. Due to subsidy schemes and long-term power purchase agreements, this affects renewables less than thermal power generation. However, interruptions in supply chains and financing have resulted in firm closures and we will see lower overall installations, at least in the medium term. The country case studies of Israel, the United States, Germany, India, China and Argentina reveal different short-term effects of the crisis on energy systems.

Some similarities emerge between Germany and India, where the clean energy industry is important, renewables have priority grid dispatch and enjoy political support. In these cases, a growing share of clean energy in the mix has driven down coal production. In India, government-owned agencies have been asked to offer loans to power distribution companies in order to avoid a payment crisis. However, both Germany and India are encouraging investments in the clean energy industry as future-oriented and offering policy support. Similarly, Israel is looking at investments in clean energy as a recovery program, although its new-found ambition does not come with reduced support to fossil gas, where investments are also encouraged.

While the renewable energy industry is well-developed and relatively important in the US, the federal government seems unlikely to repeat the support for clean industry that was a key element of the previous administration's response to the 2008 economic crisis. The design of the $2 trillion stimulus package favors the oil industry, which has already applied for $1.9 billion in tax benefits. Hence, state-level intervention plays an important role, with progressive states like New York and California, offering renewed support. It is unlikely, however, that state-level measures can fully compensate for the lack of federal action. State-level carbon markets were also unable to manage the impacts of lower energy demand, causing a collapse of carbon prices. Both markets have fixed floor prices, but this no longer works when demand is so low that auctions become under-subscribed; in this case, the withdrawal of surplus certificates increases price stability.

Like the US government, Argentina appears to be leaning towards an economic recovery strategy based on oil and gas. Given the scarce resources available for Argentina's recovery program, this means that its incipient renewable energy industry will take a major blow as it navigates the ecological fallout of the crisis without state support. Overall, this will result in further carbon lock-in in the country, exacerbating barriers to accelerating the required transition to clean energy and increasing its financial risks.

China's goals for energy security have been strengthened by the Covid-19 crisis, fostering both the promotion of coal but also the development of renewable energy as well as enhanced energy reserve capacities. However, the revision of the Green Project Catalogue in May 2020, which eliminated coal-related projects and strengthened the construction and operation of renewable energy facilities and the manufacturing of related generation equipment, can be interpreted as a step away from locking in fossil fuels.

Stimulus packages to revive struggling economies in the wake of the global pandemic will be necessary. For now, it appears that some countries will attempt to strengthen the domestic fossil fuel sectors, despite the fact that the OPEC+ price cuts are making this strategy more and more risky. As Covid-19 and the ensuing economic crisis could slow down the energy transition in certain countries, the risk of a globally uneven transition intensifies, bringing with it additional financial and political risks for late decarbonizers in particular, but also for the global community (Eicke et al. 2019). Our authors suggest focusing on greener stimulus packages, as renewable energy can promote local value creation and at least does not contribute to the same dependencies we see in the global energy market. Here, the efforts of India, Israel, Germany and China are a start, but escaping carbon lock-in will need an even more concerted push.

Literature

Section 1, Introduction

Unruh, G. C. (2002) 'Escaping carbon lock-in', Energy Policy, Elsevier, vol. 30(4), pp. 317-325.
Worldbank (2015) Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework led jointly by the World Bank, International Energy Agency, and the Energy Sector Management Assistance Program. [online]. Available at: https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS (Accessed: 10 May 2020)
EIA (2019) International Energy Outlook 2019.[online]. Available at: (https://www.eia.gov/outlooks/ieo/(Accessed: 10 May 2020)

Section 2, Key impacts of the pandemic on the global energy sector

Bloomberg. (2020a) CL1:COM - Generic 1st 'CL' Future. [Online]. Available at: https://www.bloomberg.com/quote/CL1:COM. (Accessed: 10 May 2020)
Bloomberg. (2020b) CO1:COM - Generic 1st 'CO' Future. [Online]. Available at: https://www.bloomberg.com/quote/CO1:COM. (Accessed: 10 May 2020)
BP. (2019) BP Statistical Review of World Energy. 2019: 68th Edition [online]. Available at: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf. (Accessed: 10 May 2020)
Buljan, A. (2020) 'Vestas to Lay Off 400 People, Close Temporary Offshore Wind Facility,' Offshorewind.biz, 22 April [online]. Available at: https://www.offshorewind.biz/2020/04/22/vestas-to-lay-off-400-people-close-temporary-offshore-wind-facility/. (Accessed: 6 June 2020).
EIA [U.S. Energy Information Administration]. (2020a) Natural gas: data - Henry Hub Natural Gas Spot Price. [Online]. Available at: https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm. (Accessed: 10 May 2020)
EIA [U.S. Energy Information Administration]. (2020b) Quarterly Coal Report: October-December 2019. [Online]. Available at: https://www.eia.gov/coal/production/quarterly/pdf/qcr.pdf. (Accessed: 10 May 2020)
Energy Community. (2020) Energy Community DSOs committed to keeping lights on during COVID-19 crisis. [Online]. Available at: https://www.energy-community.org/news/Energy-Community-News/2020/04/21.html. (Accessed: 6 June 2020).
Frangoul, A. (2020) 'As the coronavirus continues to impact renewables industry, another turbine manufacturer suspends guidance,' CNBC 22 April [online]. Available at: https://www.cnbc.com/2020/04/22/as-coronavirus-impacts-renewables-siemens-gamesa-suspends-guidance.html. (Accessed: 6 June 2020).
Global Wind Energy Council. (2020) COVID-19 response hub. [Online]. Available at: https://gwec.net/wind-industry-covid-19-response-hub/. (Accessed: 6 June 2020).

IEA [International Energy Agency]. (2019a) Key World Energy Statistics 2019 [online]. Available at: https://webstore.iea.org/key-world-energy-statistics-2019. (Accessed: 10 May 2020)
IEA [International Energy Agency]. 2019b. Statistics: natural gas information overview. [Online]. Available at: https://iea.blob.core.windows.net/assets/a8ac4236-67ec-4987-9752-38ab60fb839a/Natural_Gas_Information_2019_Overview.pdf. (Accessed: 13 May 2020)
IEA [International Energy Agency]. 2019c. Statistics: Coal information overview. [Online]. Available at: https://iea.blob.core.windows.net/assets/c40f0317-f8e6-4f00-b183-27a24c7b6a8f/Coal_Information_2019_Overview.pdf. (Accessed: 3 May 2020)
IEA [International Energy Agency]. 2020. Global Energy Review 2020: the impacts of the Covid-19 crisis on global energy demand and CO2 emissions. [Online]. Available at: https://webstore.iea.org/download/direct/2995. (Accessed: 2 May 2020)
IEA [International Energy Agency]. 2020b. Oil Market Report-April 2020. [Online]. Available at: https://www.iea.org/reports/oil-market-report-april-2020. . (Accessed: 9 May 2020)
International Carbon Action Partnership. (2020) Allowance Price Explorer. [Online]. Available at: https://icapcarbonaction.com/en/ets-prices. (Accessed: 6 June 2020).
Lee, A. (2020) 'France eases wind and solar deadlines over coronavirus as latest tender results revealed,' ReCharge News, 2 April [online]. Available at: https://www.rechargenews.com/transition/france-eases-wind-and-solar-deadlines-over-coronavirus-as-latest-tender-results-revealed/2-1-787060. (Accessed: 6 June 2020).
Mylenka, T. and B. Novyk. (2020) 'Impact of Covid-19 on the global energy sector,' PV Magazine, 24 April [online]. Available at: https://www.pv-magazine.com/2020/04/24/impact-of-covid-19-on-the-global-energy-sector/. (Accessed: 6 June 2020).
National Bureau of Statistics of China. 2020. Energy production in March of 2020. [Online]. Available at: http://www.stats.gov.cn/english/PressRelease/202004/t20200420_1739767.html. (Accessed: 10 May 2020)
OPEC [Organization of the Petroleum Exporting Countries]. 2020a. The 10th (Extraordinary) OPEC and non-OPEC Ministerial Meeting concludes. [Online]. Available at: https://www.opec.org/opec_web/en/press_room/5891.htm. (Accessed: 10 May 2020)
OPEC [Organization of the Petroleum Exporting Countries]. 2020b. OPEC 178th (Extraordinary) Meeting of the Conference concludes. [Online]. Available at: https://www.opec.org/opec_web/en/press_room/5865.htm. (Accessed: 10 May 2020)
Rödl & Partner. (2020) Anti-crisis shield in Poland: Questions and answers, https://www.roedl.com/insights/covid-19/poland-anti-crisis-shield-questions-answers#ee. (Accessed: 6 June 2020).
Siemens Gamesa (2020), 'Press Release: Siemens Gamesa Q2 performance impacted by the pandemic, but shows long term potential of wind energy,' 06 May [online]. Available at: https://www.siemensgamesa.com/en-int/newsroom/2020/05/200506-siemens-gamesa-q2-2020-results. (Accessed: 6 June 2020).
Shumkov, I. (2020) 'Vattenfall not bidding in Dutch offshore wind auction due to coronavirus,' Renewables Now, 3 April [online]. Available at: https://renewablesnow.com/news/vattenfall-not-bidding-in-dutch-offshore-wind-auction-due-to-coronavirus-693580/. (Accessed: 6 June 2020).
Waldholz, R. (2020) 'Coronavirus slump will lead to more hours of negative power prices in Germany – study,' Clean Energy Wire, 06 Apr [online]. Available at: https://www.cleanenergywire.org/news/coronavirus-slump-will-lead-more-hours-negative-power-prices-germany-study. (Accessed: 6 June 2020).
Wiegand, F. et al. (2020) Impact of COVID-19 on Renewable Energy Auctions, AURES [online]. Available at: http://aures2project.eu/wp-content/uploads/2020/05/AURES_II_Policy_Brief_Covid-19.pdf. (Accessed: 6 June 2020).

Section 3.1, U.S.

American Wind Energy Association. (2020) American Wind Energy Association Releases COVID-19 Outlook: Virus to impact workforce, investments, rural communities [online]. Available at:

https://www.awea.org/resources/news/2020/american-wind-energy-association-releases-covid-19 (Accessed: 6 June 2020).
Bahar, H. (2020) The coronavirus pandemic could derail renewable energy's progress. Governments can help. IEA commentary [online]. Available at: https://www.iea.org/commentaries/the-coronavirus-pandemic-could-derail-renewable-energy-s-progress-governments-can-help (Accessed: 6 June 2020).
Bureau of Labor Statistics. (2020) All employees, thousands, coal mining, seasonally adjusted, Series ID CES1021210001 [online]. Available at: https://data.bls.gov/timeseries/CES1021210001 (Accessed: 6 June 2020).
California Cap and Trade. (2020a) Auction Notice, California Cap-and-Trade Program and Québec Cap-and-Trade System Joint Auction of Greenhouse Gas Allowances On May 20, 2020 [online]. Available at: https://ww3.arb.ca.gov/cc/capandtrade/auction/may-2020/notice.pdf (Accessed: 6 June 2020).
California Cap and Trade. (2020b) Summary of California-Quebec Joint Auction Settlement Prices and Results [online]. Available at: https://ww3.arb.ca.gov/cc/capandtrade/auction/results_summary.pdf (Accessed: 6 June 2020).
California Energy Commission. (2020) 'State clarifies solar photovoltaic and energy storage installers as essential energy workers during COVID-19 response', 27 April [online]. Available at: https://www.energy.ca.gov/news/2020-04/state-clarifies-solar-photovoltaic-and-energy-storage-installers-essential (Accessed: 6 June 2020).
Carbon Pulse. (2020a) 'COVID-19 impacts on US power markets rise, as fuel data points to lower California consumption', 7 April [online]. Available at: https://carbon-pulse.com/96351/ (Accessed: 6 June 2020).
Carbon Pulse. (2020b) 'California not considering change to ETS auction schedule, compliance deadline', 8 April [online]. Available at: https://carbon-pulse.com/96492/ (Accessed: 6 June 2020).
Carbon Pulse. (2020c) 'New Jersey's RGGI emissions hide significant drops for Q1', 2 May [online]. Available at: https://carbon-pulse.com/98132/ (Accessed: 6 June 2020).
Craig, G. (2011) 'Six US states leave the Western Climate Initiative', S&P Global, 18 November [online]. Available at: https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/111811-six-us-states-leave-the-western-climate-initiative (Accessed: 6 June 2020).
DeConcini, C. and J. Neuberger. (2020) 'Oil & Gas Win, Clean Energy Loses in U.S. COVID-19 Response', WRI, 10 June [online]. Available at: https://www.wri.org/blog/2020/06/coronavirus-stimulus-packages-clean-energy. (Accessed: 15 June 2020).
Dlouhy, J. A. (2020) 'Stealth Bailout' Shovels Millions of Dollars to Oil Companies,' Bloomberg, May 15 [online]. Available at: https://www.bloomberg.com/news/articles/2020-05-15/-stealth-bailout-shovels-millions-of-dollars-to-oil-companies. (Accessed: 15 June 2020).
Energy Information Administration. (2020a) Table 5.3. Average Price of Electricity to Ultimate Customers: Total by End-Use Sector, 2010 - March 2020 (Cents per Kilowatt hour) [online]. Available at: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_03 (Accessed: 6 June 2020).
Energy Information Administration. (2020b) U.S. Electric System Operating Data, EIA-930 Balance 2020 [online]. Available at: https://www.eia.gov/realtime_grid (Accessed: 6 June 2020).
Energy Storage Association. (2020) Impacts of COVID-19 on the Energy Storage Industry [online]. Available at: https://energystorage.org/wp/wp-content/uploads/2020/04/2020-COVID-report_FINAL-2.pdf (Accessed: 6 June 2020).
Haggerty, J. (2020) 'Renewable energy to play a role in New York's Covid-19 economic recovery,' PV Magazine, 7 April [online]. Available at: https://pv-magazine-usa.com/2020/04/07/renewable-energy-to-play-a-role-in-new-yorks-covid-19-economic-recovery/. (Accessed: 15 June 2020).
Intercontinental Exchange. (2020) Regional Greenhouse Gas Initiative Vintage 2020 Future [online]. Available at: https://www.theice.com/products/68361254/Regional-Greenhouse-Gas-Initiative-Vintage-2020-Future/data?marketId=5758941&span=3 (Accessed: 6 June 2020).
International Renewable Energy Agency. (2019) 'A New World: The Geopolitics of the Energy Transformation' [online]. Available at: https://www.irena.org/-

/media/Files/IRENA/Agency/Publication/2019/Jan/Global_commission_geopolitics_new_world_2019.pdf> (Accessed: 6 June 2020).
Levebvre, B. (2020). 'Trump administration cuts royalty payments for oil companies,' Politico, 21 May [online]. Available at: https://www.politico.com/news/2020/05/21/trump-administration-cuts-royalty-payments-for-oil-companies-273548. (Accessed: 15 June 2020).
Meyer, G. (2020) 'Trump campaign for US coal undermined by industry slump,' FT.com, 18 May [online]. Available at: https://www.ft.com/content/39909dd4-7c6c-425e-8f05-4f6e63b60c43. (Accessed: 15 June 2020).
Mufson, S., and Grandoni, S. (2020) 'Coronavirus crisis hits solar and wind energy industry', The Washington Post, 5 April [online]. Available at: https://www.washingtonpost.com/climate-environment/2020/05/04/coronavirus-crisis-hits-solar-wind-energy-industry/ (Accessed: 6 June 2020).
Regional Greenhouse Gas Initiative. (2020) Allowance Prices and Volumes [online]. Available at: https://www.rggi.org/Auctions/Auction-Results/Prices-Volumes (Accessed: 6 June 2020).
Solar Foundation. (2020) National Solar Jobs Census 2019 [online]. Available at: http://www.SolarJobsCensus.org (Accessed: 6 June 2020).
S&P Global. (2020) 'California carbon allowance prices slide ahead of first auction of 2020', 19 February [online]. Available at: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/california-carbon-allowance-prices-slide-ahead-of-1st-auction-of-2020-57176827 (Accessed: 6 June 2020).
Solar Energy Industries Association. (2020a) 'COVID-19 and the US solar industry' [online]. Available at: https://www.seia.org/sites/default/files/2020-04/2020-April-SEIA-COVID-Factsheet.pdf (Accessed: 6 June 2020).
Solar Energy Industries Association. (2020b) 'Solar Industry Statement on $2 Trillion COVID-19 Stimulus Package', 25 March [online]. Available at: https://www.seia.org/news/solar-industry-statement-2-trillion-covid-19-stimulus-package (Accessed: 6 June 2020).
Solar Energy Industries Association. (2020c) 'New York Begins Solar Market Recovery With Permitting Fix for Large Scale Projects', 3 April [online]. Available at: https://www.seia.org/news/new-york-begins-solar-market-recovery-permitting-fix-large-scale-projects (Accessed: 6 June 2020).
Wood, J. (2020) 'These countries are leading the transition to sustainable energy', World Economic Forum [online]. Available at: https://www.weforum.org/agenda/2020/05/energy-transition-index-2020-eti-clean-sustainable-power/ (Accessed: 6 June 2020).

Section 3.2, India

BloombergQuint. (2020a) 'Fitch Cuts India GDP Growth Forecast to 30-Year Low of 2% For FY21', 3 April [online]. Available at: https://www.bloombergquint.com/business/fitch-slashes-india-growth-forecast-to-30-year-low-of-2-for-fy21 (Accessed: 12 June 2020).
BloombergQuint. (2020b) 'What India Has Released From Its Rs 1.7 Lakh Crore Relief Package For The Poor', 13 April [online]. Available at: https://www.bloombergquint.com/coronavirus-outbreak/what-india-has-released-from-its-rs-17-lakh-crore-relief-package-for-the-poor (Accessed: 12 June 2020).
CEA. (2020) Central Electricity Authority: Daily Renewable Generation Reports [online]. Available at: http://cea.nic.in/dailyregeneration.html (Accessed: 12 June 2020).
CERC. (2020) Central Electricity Regulatory Commission New Delhi: Order 5/SM/2020 [online]. Available at: http://www.cercind.gov.in/2020/orders/5-SM-2020.pdf (Accessed: 12 June 2020).
Economic Times. (2020a) 'Coal India April shipments fall 25.5% as lockdown erodes demand', 2 May [online]. Available at: https://energy.economictimes.indiatimes.com/news/coal/coal-india-april-shipments-fall-25-5-as-lockdown-erodes-demand/75506989 (Accessed: 12 June 2020).
Economic Times. (2020b) 'Spot power price touches 3-year low of 60 paise per unit on IEX', 26 March [online]. Available at: https://energy.economictimes.indiatimes.com/news/power/spot-

power-price-touches-3-year-low-of-60-paise-per-unit-on-iex/74820716 (Accessed: 12 June 2020).
Economic Times. (2020c) 'Discoms to suffer Rs 30K cr revenue loss, face Rs 50K cr liquidity crunch due to lockdown: CII', 17 April [online]. Available at: https://energy.economictimes.indiatimes.com/news/power/discoms-to-suffer-rs-30k-cr-revenue-loss-face-rs-50k-cr-liquidity-crunch-due-to-lockdown-cii/75197169 (Accessed: 12 June 2020).
Economic Times. (2020d) 'COVID-19: No impact on operating projects; expect up to Rs 13,000-mn revenue in FY20, says Azure Power', 13 April [online]. Available at: https://energy.economictimes.indiatimes.com/news/renewable/covid-19-no-impact-on-operating-projects-expect-up-to-rs-13000-mn-revenue-in-fy20-says-azure-power/75123562 (Accessed: 12 June 2020).
Economic Times. (2020e) 'Lockdown in India has impacted 40 million internal migrants: World Bank', 23 April [online]. Available at: https://economictimes.indiatimes.com/news/politics-and-nation/lockdown-in-india-has-impacted-40-million-internal-migrants-world-bank/articleshow/75311966.cms?from=mdr (Accessed: 12 June 2020).
Economic Times. (2020f) 'COVID-19: Govt allows construction of renewable energy projects in revised guidelines', 15 April [online]. Available at: https://energy.economictimes.indiatimes.com/news/renewable/covid-19-govt-allows-construction-of-renewable-energy-projects-in-revised-guidelines/75164060 (Accessed: 12 June 2020).
Economic Times. (2020g) 'COVID-19: MNRE to promote local manufacturing, export hubs for renewable energy', 14 April [online]. Available at: https://energy.economictimes.indiatimes.com/news/renewable/covid-19-mnre-to-promote-local-manufacturing-export-hubs-for-renewable-energy/75141750 (Accessed: 12 June 2020).
Economic Times. (2020h) 'PFC and REC may extend loans with stricter riders to state power discoms' [online]. Available at: https://economictimes.indiatimes.com/industry/energy/power/pfc-and-rec-may-extend-loans-with-stricter-riders-to-state-power-discoms/articleshow/72985771.cms?from=mdr (Accessed: 12 June 2020).
IEA. (2020) India 2020 - Energy policy review. Country report – January 2020 [online]. Available at: https://www.iea.org/reports/india-2020 (Accessed: 12 June 2020).
Livemint. (2020) 'Power discoms get ₹90,000 crore liquidity lifeline', 14 May [online]. Available at: https://www.livemint.com/industry/energy/power-discoms-get-90-000-cr-liquidity-lifeline-11589397789530.html (Accessed: 12 June 2020).
MNRE. (2020a) India's Ministry of New and Renewable Energy: Order F. No. 283/20/2020-Grid Solar (ii).
MNRE. (2020b) India's Ministry of New and Renewable Energy: Order F. No. 283/18/2020-Grid Solar.
MOP. (2020) India's Ministry of Power: Draft Amendment in the Electricity Act, 2003 to Introduce key Reforms in the Power Sector [online]. Available at: https://pib.gov.in/PressReleasePage.aspx?PRID=1615781 (Accessed: 12 June 2020).
POSOCO. (2020) Power System Operation Corporation Limited of India: Weekly Reports [online]. Available at: https://posoco.in/reports/weekly-reports/weekly-reports-2020-21/ (Accessed: 12 June 2020).

Section 3.3, China

CNPC [China National Petroleum Corporation]. (2020) 'The Impact of New Coronary Pneumonia Epidemic Situation on my country's Energy Supply Chain and the Countermeasures and Suggestions for Strengthening the Energy Supply Chain' [online]. Available at: http://news.cnpc.com.cn/system/2020/03/12/001766444.shtml (Accessed: 10 May 2020).
Devonshire-Ellis, C., Livermore, A., Kapur, R. et al. (2020) 'The Current Social & Economic Impact of Covid-19 Upon the BRICS Nations', 13 April [online]. Available at: https://www.silkroadbriefing.com/news/2020/04/13/current-social-economic-impact-covid-19-upon-brics-nations/ (Accessed: 5 May 2020).
Gordon, J.T. (2020) 'The implications of the coronavirus crisis on the global energy sector and the environment', Atlantic Council, March 24 [online]. Available at:

https://www.atlanticcouncil.org/blogs/new-atlanticist/the-implications-of-the-coronavirus-crisis-on-the-global-energy-sector-and-the-environment/ (Accessed: 9 June 2020).
Hao, Y., Lv, X., Ba, N. et al. (2020) 'Evaluation of the overall impact of the new coronary pneumonia epidemic on the energy system' [online]. Available at http://ceep.bit.edu.cn/docs/2020-02/20200213040116135473.pdf (Accessed: 5 May 2020).
IEA. (2020) 'Global Energy Review 2020 – The impacts of the Covid-19 crisis on global energy demand and CO2 emissions' [online]. Available at: https://www.iea.org/reports/global-energy-review-2020 (Accessed: 9 June 2020).
Mao, J., Hou, D., and Zhang, Y. (2020) 'The epidemic may spur changes in global energy governance', China Energy News, 6 April [online]. Available at: http://paper.people.com.cn/zgnyb/html/2020-04/06/content_1980506.htm (Accessed: 11 May 2020).
NEA [National Energy Agency of China]. (2020) Monthly Report of National power industry statistics [online]. Available at: http://www.nea.gov.cn/2020-05/21/c_139075313.htm; http://www.nea.gov.cn/2020-04/23/c_139002144.htm; http://www.nea.gov.cn/2020-03/23/c_138908389.htm ; http://www.nea.gov.cn/2020-01/20/c_138720881.htm; http://www.nea.gov.cn/2019-04/19/c_137990694.htm;and http://www.nea.gov.cn/2019-03/20/c_137910039.htm; (Accessed: 9 June 2020).
PBC [The People's Bank of China]. (2020) Available at: www.pbc.gov.cn/ (Accessed: 9 June 2020).
Xi, J. (2020) Speech at the conference on overall planning to promote the prevention and control of the new coronary pneumonia epidemic situation and economic and social development [online]. Available at: http://www.gov.cn/xinwen/2020-02/24/content_5482502.htm (Accessed: 9 June 2020).
Zheng, X. (2020) 'Epidemic accelerates shift toward clean fuels' [online]. Available at: https://global.chinadaily.com.cn/a/202004/16/WS5e97bd68a3105d50a3d1699b.html (Accessed: 9 June 2020).

Section 3.4, Germany

Agora Energiewende. (2020) Der Doppelte Booster. Vorschlag für ein zielgerichtetes 100-Milliarden-Wachstums- und Investitionsprogramm [online]. Available at: https://www.agora-energiewende.de/fileadmin2/Projekte/2020/2020-05_Doppelter-Booster/179_A-EW_A-VW_Doppelter-Booster_WEB.pdf (Accessed: 8 June 2020).
Amelang, S. (2020) 'Coronavirus impact lays bare inflexibility of German power generation and demand', Clean Energy Wire [online]. Available at: https://www.cleanenergywire.org/news/coronavirus-impact-lays-bare-inflexibility-german-power-generation-and-demand?pk_campaign=daily_newsletter_2020-05-12&pk_keyword=coronavirus-impact-lays-bare-inflexibility-german-power-generation-and-demand&pk_source=newsletter&pk_medium=email&pk_content=furtherbackground (Accessed: 8 June 2020).
Bauförderer. (2020) Trotz Corona-Krise: Investitionsförderprogramme für energieeffizientes Bauen und Sanieren Stabilisieren die Konjunktur [online]. Available at: https://www.baufoerderer.de/service/nachrichten/trotz-corona-krise-investitionsfoerderprogramme-fuer-energieeffizientes-bauen-und-sanieren-stabilisieren-die-konjunktur (Accessed: 8 June 2020).
Bundesnetzagentur. (2020a) Electricity generation and consumption in Germany [online]. Available at: https://www.smard.de/en/5790 (Accessed: 8 June 2020).
Bundesnetzagentur. (2020b) Ausschreibungen für EE- und KWK-Anlagen [online]. Available at: https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Ausschreibungen/Ausschreibungen_node.html (Accessed: 8 June 2020).
Bundesregierung. (2020) Pressekonferenz von Bundeskanzlerin Merkel und dem französischen Präsidenten Emmanuel Macron [online]. Available at: https://www.bundesregierung.de/breg-de/aktuelles/pressekonferenzen/pressekonferenz-von-bundeskanzlerin-merkel-und-dem-franzoesischen-praesidenten-emmanuel-macron-1753844 (Accessed: 8 June 2020).
Bündnis 90/Die Grünen Bundestagsfraktion. (2020) Alles Erforderliche tun, um Arbeitsplätze und Unternehmen zu erhalten [online]. Available at: https://www.gruene-

bundestag.de/themen/wirtschaft/kleine-unternehmen-und-selbststaendige-unterstuetzen (Accessed: 8 June 2020).
Carbon Pulse. (2020) 'EU to withdraw another 330 mln carbon allowances from ETS after supply glut drops 16%', 8 May [online]. Available at: https://carbon-pulse.com/98713 (Accessed: 8 June 2020).
DEHSt [Deutsche Emissionshandelsstelle]. (2020) Der Europäische Emissionshandel und seine Umsetzung in Deutschland [online]. Available at: https://www.dehst.de/DE/Europaeischer-Emissionshandel/Emissionshandel-verstehen/Umsetzung-Ausgestaltung/umsetzung-ausgestaltung-node.html (Accessed: 8 June 2020).
Frauenhofer ISE. (2020a) Stromerzeugung in Deutschland im ersten Quartal 2020 [online]. Available at: https://www.energy-charts.de/index.htm (Accessed: 8 June 2020).
Frauenhofer ISE. (2020b) Tägliche Börsenstrompreise in Deutschland in 2020 [online]. Available at: https://energy-charts.de/price_avg_de.htm?price=nominal&period=daily&year=2020 (Accessed: 8 June 2020).
IASS. (2020) Windpotenzial an Land [online]. Available at: https://www.iass-potsdam.de/windkraft-potenzial/ (Accessed: 8 June 2020).
IWR. (2020) 'Siemens Gamesa Zahlen Q 2 2020: Umsatz rückläufig, Verluste ausgeweitet', 6 May [online]. Available at: https://www.iwr.de/news.php?id=36731 (Accessed: 8 June 2020).
Lemberger, I. (2020) 'Corona & Photovoltaik: 5 Auswirkungen auf den PV-Markt' [online]. Available at: https://www.interconnector.de/energieblog/erneuerbare-energien/corona-und-photovoltaik-5-auswirkungen-auf-den-pv-markt/ (Accessed: 8 June 2020).
Neumann, H. (2020) '2000 Unternehmen fordern Eilverfahren zum Solardeckel' [online]. Available at: https://www.topagrar.com/energie/news/2000-unternehmen-fordern-eilverfahren-zum-solardeckel-12004453.html (Accessed: 8 June 2020).
Solarserver. (2020) 'Marktbefragung: 52-GW-Deckel ist Investitionsbarriere für Photovoltaik' [online]. Available at: https://www.solarserver.de/2020/04/24/marktbefragung-52-gw-deckel-ist-investitionsbarriere-fuer-photovoltaik/ (Accessed: 8 June 2020).
Sperling, C. (2020) 'Die Coronakrise und der Strommarkt' [online]. Available at: https://www.next-kraftwerke.de/energie-blog/coronakrise (Accessed: 8 June 2020).
Staude, J. (2020) 'Kohleausstieg schneller als das Gesetz', 13 March [online]. Available at: https://www.klimareporter.de/strom/kohleausstieg-schneller-als-das-gesetz (Accessed: 8 June 2020).
Steinmeier, F.-W., Sommaruga, S. and Van der Bellen, A. (2020) 'Wachstum durch kluge Klimapolitik', Frankfurter Allgemeine Zeitung, 5 June [online]. Available at: https://www.faz.net/aktuell/politik/ausland/weltumwelttag-wachstum-durch-kluge-klimapolitik-in-corona-krise-16800362.html (Accessed: 8 June 2020).
Ullrich, S. (2020) 'Der Solardeckel wird abgeschafft' [online]. Available at: https://www.erneuerbareenergien.de/der-solardeckel-wird-abgeschafft (Accessed: 8 June 2020).
Wehrmann, B., and Wettengel, J. (2020) 'Germany gives energy transition mild boost with economic stimulus programme', Clean Energy Wire, 4 June [online]. Available at: https://www.cleanenergywire.org/news/germany-gives-energy-transition-some-extra-boost-economic-stimulus-programme (Accessed: 8 June 2020).
Wettengel, J. (2020) 'German government coalition agreement removes key hurdles to renewables rollout', Clean Energy Wire, 18 May [online]. Available at: https://www.cleanenergywire.org/news/german-government-coalition-agreement-removes-key-hurdles-renewables-rollout?pk_campaign=daily_newsletter_2020-05-19&pk_keyword=german-government-coalition-agreement-removes-key-hurdles-renewables- (Accessed: 8 June 2020).
Windbranche. (2020) Windenergie-Markt Deutschland [online]. Available at: https://www.windbranche.de/windenergie-ausbau/deutschland (Accessed: 8 June 2020).

Section 3.5, Argentina

Official Gazette of the Argentine Republic [Boletín Oficial de la República Argentina]. (2020) HIDROCARBUROS Decreto 488/2020, 18 May [online]. Available at: https://www.boletinoficial.gob.ar/detalleAviso/primera/229470/20200519 (Accessed: 9 June 2020).
CAMMESA. (2020) 'Informe Mensual. Principales Variables del Mes Abril 2020' [online]. Available at: https://www.cammesa.com/linfomen.nsf/MINFOMEN?OpenFrameSet (Accessed: 9 June 2020).
CEPAL. (2020) 'Latin America and the Caribbean and the COVID-19 pandemic: Economic and social effects', 3 April [online]. Available at: https://repositorio.cepal.org/bitstream/handle/11362/45351/6/S2000263_en.pdf (Accessed: 9 June 2020).
ENERGÍA, S. 2019. Informe Estadístico Anual 2018. Presidencia de la Nación Argentina [Online]. Available at: https://www.argentina.gob.ar/produccion/energia/energia-electrica/estadisticas/informes-estadisticos-del-sector-electrico. (Accessed: 9 June 2020).
Goñi, U. (2019) 'Indigenous Mapuche pay high price for Argentina's fracking dream', The Guardian, 14 October [online]. Available at: https://www.theguardian.com/environment/2019/oct/14/indigenous-mapuche-argentina-fracking-communities (Accessed: 9 June 2020).
Gubinelli, G. (2020) 'Uno por uno, los proyectos eólicos y solares del Programa RenovAr en negociación con el Gobierno', Energía Estratégica, 22 April [online]. Available at: https://www.energiaestrategica.com/uno-por-uno-los-proyectos-eolicos-y-solares-del-programa-renovar-en-negociacion-con-el-gobierno/ (Accessed: 9 June 2020).
Lahoud, G., Lozano, C. and Rameri, A. (2020) 'La cuestión petrolera en el marco de la emergencia. ¿Barril criollo? ¿Otra vez sopa?' IPYPP [online]. Available at: https://ipypp.org.ar/descargas/2020/La%20cuestion%20petrolera%20en%20el%20marco%20de%20la%20Emergencia.pdf (Accessed: 9 June 2020).
RENOVAR. (2020) RenovAr. Programa de abastecimiento de energá eléctrica a partir de fuentes renovables [online]. Available at: https://www.argentina.gob.ar/energia/energia-electrica/renovables/renovar (Accessed: 9 June 2020).
WEF. (2020) 'Fostering Effective Energy Transition. 2020 edition' [online]. Available at: http://www3.weforum.org/docs/WEF_Fostering_Effective_Energy_Transition_2020_Edition.pdf (Accessed: 9 June 2020).

Section 3.6, Israel

Haaretz. (2020) 'Israel's Delek Group Headed for a Debt Deal Amid Signs It Can't Meet Payments' [online]. Available at: https://www.haaretz.com/israel-news/business/.premium-israel-s-delek-group-headed-for-a-debt-deal-amid-signs-it-can-t-meet-payments-1.8820553. (Accessed 11 June 2020).
IEA. (2018) Israel [online]. Available at: https://www.iea.org/countries/Israel
Israeli Government Procurement Administration. (2020) Tender for Dimona PV solar plant [online]. Available at: https://mr.gov.il/Files_Michrazim/318193.pdf. (Accessed 11 June 2020).
Israeli Ministry of Energy. (2020a) Public hearings Draft public reference - Increase electricity generation targets for renewable energy by 2030 [online]. Available at https://www.gov.il/he/departments/publications/Call_for_bids/shim_2030yaad. (Accessed 11 June 2020).
Israeli Ministry of Energy. (2020b) Presentation: 30% renewables in 2030 [online]. Available at: https://www.gov.il/he/departments/news/2030_press_paper. (Accessed 11 June 2020).
Israeli Ministry of Energy, 2020c. Accelerating infrastructure projects in energy and water management to promote economic growth [online]. Available at: https://www.gov.il/BlobFolder/reports/economic_growth/he/economic_growth.pdf. (Accessed 11 June 2020).
Israeli Ministry of Energy, 2020d. Presentation: Accelerating infrastructure projects in energy and water management to promote economic growth [online]. Available at: https://www.gov.il/he/departments/publications/reports/economic_growth. (Accessed 11 June 2020).
Israeli Ministry of Energy, 2020e. Excel: Growth projects [online]. Available at: Whttps://www.gov.il/he/departments/publications/reports/economic_growth. (Accessed 11 June 2020).

Israel Ministry of Foreign Affairs. (2019) Implementation of the Sustainable Development Goals. National Review Israel 2019 [online]. Available at: https://mfa.gov.il/MFA/PressRoom/2019/Documents/Israel%20SDG%20national%20review.pdf. (Accessed 11 June 2020).
PV Magazine. (2020) 'Israeli national lottery supports rooftop PV program with $0.12/kWh feed-in tariff', 28 May [online]. Available at: https://www.pv-magazine.com/2020/05/28/israeli-national-lottery-supports-rooftop-pv-program-with-0-12-kwh-feed-in-tariff/. (Accessed 11 June 2020).
Startup Snapshot. (2020) 400+ Startup Founders share Key Data [online]. Available at: https://www.startup-snapshot.com/. (Accessed 11 June 2020).
Süsser, D. (in press) Accelerating Cleantech Commercialization Green Innovation as Catalyst for COVID-19 Recovery for Climate and Sustainable Development, IASS Policy Brief.

4. Conclusion:

Eicke, L., S. Weko and A. Goldthau. (2019) 'Countering the risk of an uneven low-carbon energy transition.' IASS Policy Brief [online]. Available at: https://publications.iass-pots-dam.de/rest/items/item_4812898_2/component/file_4812900/content. (Accessed: 15 June 2020).

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Institute for Advanced Sustainability Studies e.V. (IASS)

Funded by the ministries of research of the Federal Republic of Germany and the State of Brandenburg, the Institute for Advanced Sustainability Studies (IASS) aims to identify and promote development pathways for a global transformation towards a sustainable society. The IASS employs a transdisciplinary approach that encourages dialogue to understand sustainability issues and generate potential solutions in cooperation with partners from academia, civil society, policymaking, and the business sector. A strong network of national and international partners supports the work of the institute. Its central research topics include the energy transition, emerging technologies, climate change, air quality, systemic risks, governance and participation, and cultures of transformation.

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