International Energy Agency

Renewable Energy Market Update

Outlook for 2020 and 2021

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Key findings

- The Covid-19 crisis is hurting – but not halting – global growth in renewable power capacity. The number of new renewable power installations worldwide is set to fall this year as a result of the unprecedented Covid-19 crisis, marking the first annual decline in 20 years. But, given supportive government policies, growth is expected to resume next year as most of the delayed projects come online.
- In 2020, the IEA forecasts net additions of renewable electricity capacity to decline by 13% compared with 2019. The decline reflects delays in construction activity due to supply chain disruption, lockdown measures and social-distancing guidelines, and emerging financing challenges. This nevertheless corresponds to a 6% increase in global installed renewable power capacity, which surpasses the combined size of power systems in both North America and Europe.
- In 2021, renewables are expected to show their resilience – the majority of the delayed projects are expected to come online, leading to a rebound in new installations. As a result, next year is forecast to reach the same level of renewable electricity capacity additions as in 2019. Despite the rebound, combined growth in 2020 and 2021 is almost 10% lower compared to the previous IEA forecast published in October 2019.
- Solar PV and wind account for 86% of global renewable capacity additions this year, but their annual expansion is forecast to decline by 18% and 12% respectively compared to 2019. The forecast expects utility-scale PV and wind to rebound as the majority of projects in the pipeline are already financed and under construction. However, forecast uncertainty remains for projects that were due to achieve financial close in 2020 and become operational next year. Moreover, total PV additions in 2021 are expected to fall short compared to 2019 due to slower recovery of distributed PV applications, as individuals and small business are expected to reprioritise investment decisions.
- The impact of Covid-19 on renewable electricity technologies with long lead times, such as hydropower, offshore wind, CSP and geothermal, remains limited. Hydropower capacity additions are forecast to increase both in 2020 and 2021, driven by the commissioning of two mega hydropower projects in China and supporting the rebound of renewables next year. The forecast for

offshore wind remains unchanged as most projects are already financed and under construction.

- The Covid-19 crisis has radically changed the global context for biofuels. Transport biofuel production is anticipated to contract by 13% in 2020, the first decrease in output in two decades. Gasoline demand is forecast to fall by 9% in 2020 and diesel demand by around 6%. This, in turn, limits biofuel consumption resulting from mandate policies. Some of the impacts from the Covid-19 pandemic could be temporary. If a rebound in transport fuel demand occurs in 2021, biofuel production could return to 2019 levels. However, this would still be 5% lower than the output anticipated in our forecast for 2021 prior to the Covid-19 crisis. Longer-term implications for growth may arise from the suspension of new policy initiatives in some countries due to low oil prices.
- Renewable heat consumption is also likely to decline in 2020. The industrial sector is expected to consume less renewable heat as lower commercial, industrial and construction activity during lockdown results in a demand shock for most heat-intensive industries. Moreover, current low oil and gas prices are affecting the cost-competitiveness of renewable heat fuels and technologies: many planned investments to switch from fossil fuel heating to renewable or electric solutions are likely to be postponed or cancelled in the absence of stronger policies.
- At the start of this year, renewables in several markets were already facing challenges regarding financing, policy uncertainty and grid integration. Covid-19 is now intensifying these concerns. However, governments have the opportunity to reverse this trend by making investment in renewables a key part of stimulus packages designed to reinvigorate their economies. This offers the prospect of harnessing the structural benefits that increasingly affordable renewables can bring, including opportunities for creating jobs and economic development, while reducing emissions and fostering innovation.

Context

This report is a market update on the IEA's most recent five-year renewable energy forecast, Renewables 2019, published in October 2019. It provides an early analysis of the drivers and challenges since last October, and covers renewable capacity additions for all technologies and transport biofuel production expected during 2020 and 2021. An update on renewable heat technologies is also included; however, the analysis is qualitative due to limited data availability. Given ongoing uncertainty, the forecasts for 2020 and 2021 will be updated in the second half of the year to reassess recent market and policy developments.

Renewables are not immune to the Covid-19 crisis, but they are more resilient

Renewables are not immune to the Covid-19 crisis, but are more resilient than other fuels. The IEA's Global Energy Review 2020 projected renewables to be the only energy source to grow this year compared to 2019, in contrast to all fossil fuels and nuclear.

Globally, overall demand for renewables is expected to increase due to their use in the electricity sector. Even with end-use electricity demand falling significantly because of lockdown measures, low operating costs and priority access to the grid in many markets allow renewables to operate at near full capacity, enabling renewable generation to grow. This increased production is in part due to record-level capacity additions in 2019, a trend that was set to continue into this year. However, supply chain disruptions, construction delays and macroeconomic challenges increase the uncertainty about the total amount of renewable capacity growth in 2020 and 2021.

The IEA anticipates that consumption of transport biofuel and industrial renewable heat will be more acutely impacted by an economic downturn than will renewable electricity. Lower transport fuel demand directly affects the prospects for biofuels such as ethanol and biodiesel, which are mostly consumed blended with gasoline and diesel. Renewables directly used for heat processes mostly take the form of bioenergy for the pulp and paper,

cement, textile, food and agricultural industries, all of which are exposed to demand shocks. Suppression of global demand has a stronger impact on biofuels and renewable heat than it does on renewable electricity. This impact will critically depend on the duration and stringency of lockdowns and the pace of economic recovery.

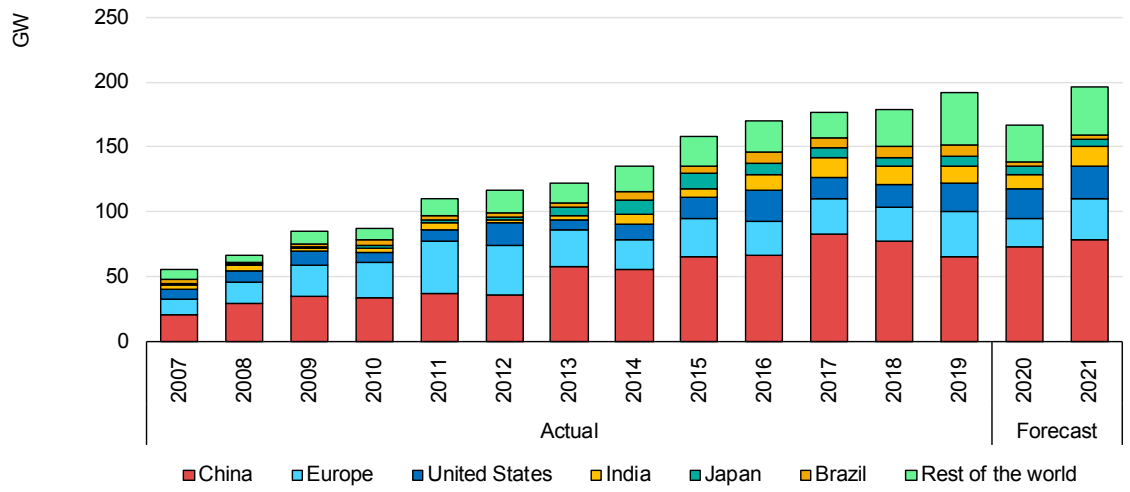
2020 and 2021 forecast overview

Electricity markets

The IEA forecasts that additions of renewable electricity capacity will decline by 13% in 2020 compared with 2019, the first downward trend since 2000. This is a 20% downward revision compared to our previous forecast in which 2020 was due to be a record year for renewable power. The update reflects both possible delays in construction activity due to supply chain disruptions, lockdown measures and social-distancing guidelines, and emerging financing challenges. The outlook also takes into account ongoing policy uncertainty and market developments such as the most recent auctions and newly financed projects before the Covid-19 outbreak.

However, the majority of these delayed projects are expected to come online in 2021 and lead to a rebound in capacity additions. As a result, 2021 is forecast to almost reach the level of renewable capacity additions of 2019. Despite the rebound, the combined growth in 2020 and 2021 is almost 10% lower compared to the previous IEA forecast.

Renewable electricity capacity additions in updated IEA forecast



The United States and the People's Republic of China (hereafter, "China") are both expected to see an increase in capacity additions in 2020 and 2021 compared with last year. The phase-out of subsidies in China and the expiry of tax credits in the United States (in 2020 and 2021, respectively) are resulting in project development rushes. However, both governments are expected to provide some flexibility, allowing projects to be commissioned in 2021 without losing their incentives. As a result, the forecast expects that some wind and solar PV will be rescheduled and commissioned in 2021.

Construction delays are expected to have an immediate impact on European utility-scale projects, as certain countries in Europe introduced some of the strictest lockdown measures in the world. However, capacity additions are expected to rebound in 2021. Covid-19 exacerbates existing policy uncertainty and permitting challenges in Germany and France, while the large pipeline of projects outside the auction scheme in Spain may see commissioning delays. Distributed PV, which has been the backbone of recent growth in large European PV markets, is expected to slow. Compared to 2019 levels, it is not expected to fully recover in 2021 as small investors reprioritise investment decisions.

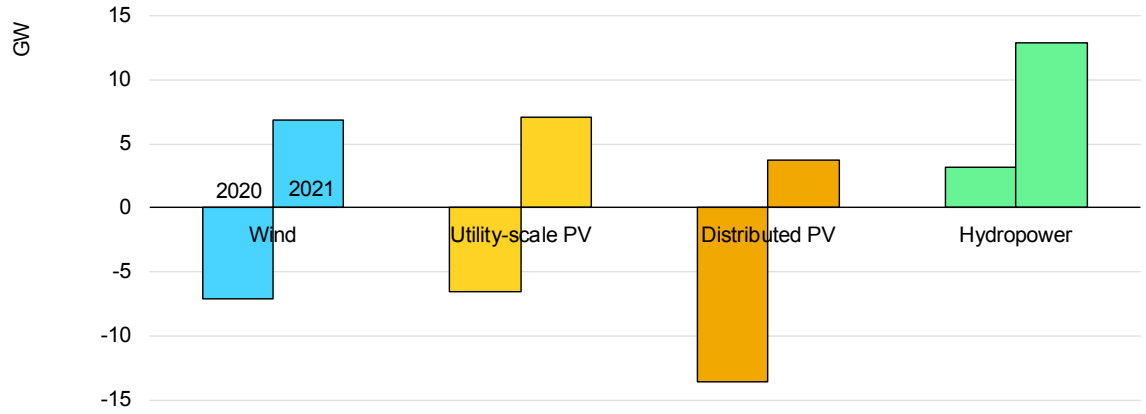
In India, Covid-19 is exacerbating existing challenges concerning the financial health of distribution companies, which play a critical role in the deployment of both utility-scale and distributed PV. In addition, India's strict lockdown

measures are expected to result in delays to wind and PV projects, and thus to slower growth in installations in 2020 compared with 2019.

The economic downturn is also expected to increase existing financing and project development challenges for developing countries in Africa, Latin America and Eurasia, pushing some planned projects beyond 2021 and resulting in downward forecast revisions in all three regions.

The IEA forecast expects 167 GW of renewable capacity to become operational in 2020. Solar PV accounts for half of this renewables expansion, but its additions decline from 110 GW in 2019 to over 90 GW in 2020. New PV installations are expected to see a partial rebound in 2021, owing to utility-scale projects that return to 2019 addition levels, while distributed PV is hit more severely and does not fully recover. Onshore wind installations are also affected by commissioning delays, although they are mostly compensated for in 2021 as the majority of projects in the pipeline are already financed and under construction. However, forecast uncertainty remains for projects that were planning to achieve financial close in 2020 and become operational next year. The commissioning of two mega hydropower projects in China in 2021 supports the overall rebound of renewables.

Renewable electricity net capacity additions growth by technology in 2020 and 2021



Overall, the updated forecast revises down combined capacity growth in 2020 and 2021 by almost 10%. The drivers behind this revision vary by

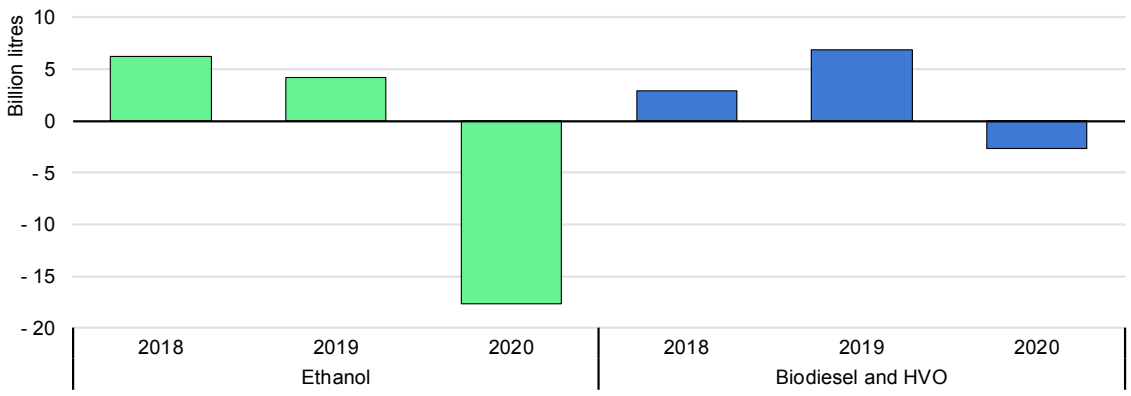
technology and country (details in the technology sections). The distributed PV forecast is revised downwards by the largest proportion, almost 36%, mainly in Europe, China and the United States. The forecast for utility-scale PV remains mostly unchanged except in the United States, where larger pipelines of utility-scale projects prior to Covid-19 underpin more optimistic growth. For wind, the European Union, China and India are mainly responsible for the downward forecast revision in 2020 and 2021. Forecast revisions for hydropower, bioenergy and other renewables are not directly connected to Covid-19. The forecast for hydropower integrates new project commissioning dates, based on recent construction activity since our previous forecast.

Transport biofuel markets

The Covid-19 crisis has radically changed the global context for biofuels. The widespread application of containment measures and stalling of economic activity has strongly reduced transport fuel demand. Global gasoline demand is forecast to fall by 9% in 2020 and diesel demand by around 6%.

This, in turn, limits biofuel consumption resulting from mandate policies that require a set percentage of biofuels to be blended with fossil transport fuels. We anticipate total transport biofuel production to contract by 13% in 2020, with ethanol output contracting by 15% and a 6% reduction anticipated for biodiesel and hydrotreated vegetable oil (HVO) output.

Annual change in biofuel production, actual 2018-19 and forecast for 2020



Some of the impacts from the Covid-19 pandemic are likely to be temporary. Biofuel production will follow gasoline and diesel demand upward as governments ease confinement measures, allowing mobility and economic activity to resume. If a rebound in transport fuel demand occurs in 2021, biofuel production could return to 2019 levels. However, this would still be 5% lower than the output anticipated in our forecast for 2021 prior to the Covid-19 crisis.

While disruption to construction activity on new biofuel production facilities may delay commissioning by a matter of months, this additional capacity should eventually come online.

Disruption to key biofuel support mechanisms may occur this year, as reduced mobility affects the intended functioning of policies. The US Renewable Fuel Standard (RFS) sets annual volume requirements for renewable fuel consumption based on projected fuel demand, as opposed to the majority of policies, which are based on achieving a given biofuel share.

Actual fuel demand in 2020 will clearly be less than projected due to the Covid-19 crisis. Therefore, it is likely that the specific biofuel volumes required by the RFS in 2020 will be far in excess of the levels that can be consumed according to technical limits on the percentage of biofuel blending. Brazil's newly introduced flagship RenovaBio programme may need to adjust its CO_2 emissions reduction targets for the year, which could have consequences for the value of associated CBIO certificates.

In addition, 2020 is the milestone year in which EU member states need to demonstrate compliance with the Renewable Energy Directive's 10% renewable energy share in transport. Given the disruption to transport fuel demand and biofuel production, the shares that member states would have achieved under normal circumstances could well be different due to the impact of Covid-19. This may raise implications for compliance with the target.

Renewable heat markets

Beyond the direct impacts on heat consumption, the Covid-19 crisis further compromises the already slow growth of renewables in heat supply. First, delays in renewable district heating projects and in the manufacturing, sale and installation of renewable heating equipment may not be fully recovered in the second half of the year. Second, current low oil and gas prices are affecting the cost-competitiveness of renewable heat fuels and technologies. Given the uncertain future financial situation of many companies and households, many planned investments in switching from fossil fuel heating to renewable or electric solutions are likely to be postponed or cancelled in the absence of stronger policies.

Without government intervention, the crisis could have a long-lasting effect on the construction sector, slowing down modernisation of the buildings stock and the rate of retrofits, which play a crucial role in energy efficiency improvements and deployment of renewable heat technologies. At the same time, building renovation in several countries is being considered for inclusion in economic stimulus packages due to the early opportunity it offers for creating jobs and triggering economic recovery. This represents an important opportunity to integrate renewable heat technologies in the building sector, which could consequently lead to higher-than-anticipated deployment.

Covid-19 impact on renewable energy growth

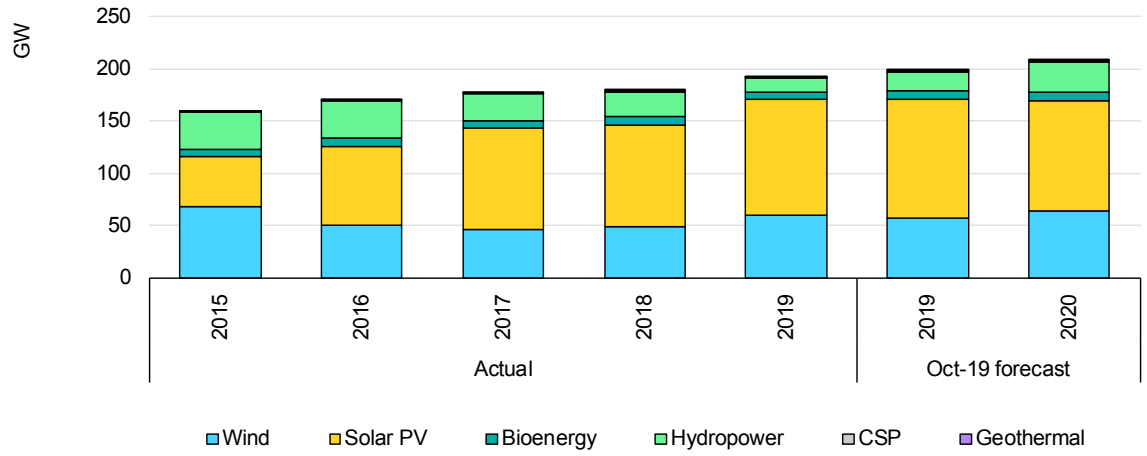
2020 was expected to be another record year for renewables

The previous IEA forecast, published in October 2019, announced that renewable capacity additions were set to achieve double-digit growth in 2019 after stalling the year before. The Renewables 2019 forecast was very close to actual performance; the 192 GW new installations actually connected to the grid last year was a 7% increase on 2018.

Renewables growth in 2019 was dominated by solar PV, with capacity additions breaking another record to reach 110 GW, slightly lower than the IEA estimate of 114 GW. Due to policy changes, China's PV additions declined for the second year in a row to 30 GW, a sharper reduction than previously forecast. China's share of global PV additions declined from a record of 55% in 2017 to less than 30% in 2019. In contrast, other markets such as the United States, the European Union, Brazil and Viet Nam outpaced expectations for PV additions.

Wind power saw its second-largest expansion since 2015, driven by faster growth in China and the European Union, while hydropower additions continued their declining trend as fewer projects came online in China.

Renewable electricity capacity additions by technology, actuals and IEA forecast in 2019



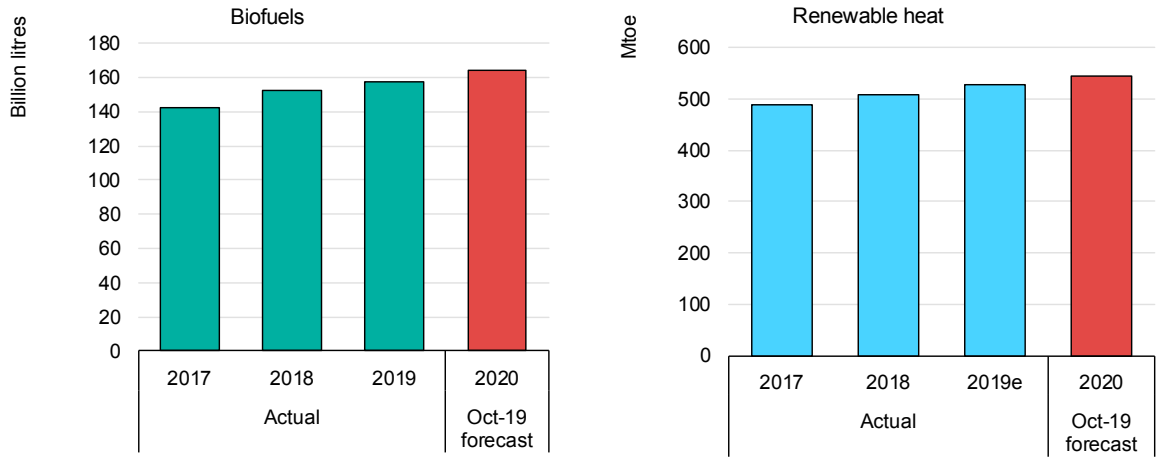
After a strong 2019, global additions were expected to hit a record in 2020 before declining in 2021, a trend resulting from policy-driven developments in major markets:

- In the United States, onshore wind additions were expected to peak in 2020 then start to decline as the production tax credit (PTC) begins to phase out.
- In China, the phase-out of feed-in tariffs (FITs) was expected to drive a rush to complete wind and solar PV projects in 2020, while several large-scale conventional and pumped hydropower projects were due to be commissioned in 2020.

- In India, the growth of wind and solar projects needed to accelerate to achieve the ambitious 175 GW target for 2022.
- In the European Union, multiple countries had previously awarded wind and solar PV capacity in competitive auctions to close their gap on 2020 targets.

Prior to the start of the Covid-19 crisis, biofuel production and renewable heat consumption were both expected to increase by around 3% in 2020. Three factors were driving our previous five-year forecast: Brazil's new biofuels policy, the wider implementation of China's ethanol blending mandates and continued biodiesel expansion in ASEAN member countries. In the European Union, renewable heat was set to benefit from further policy support, 2020 marking the start of the implementation period of new 2030 renewable energy goals.

Biofuel production and renewable heat consumption, actuals, IEA estimates and forecast in 2019



Covid-19 is expected to delay renewables deployment

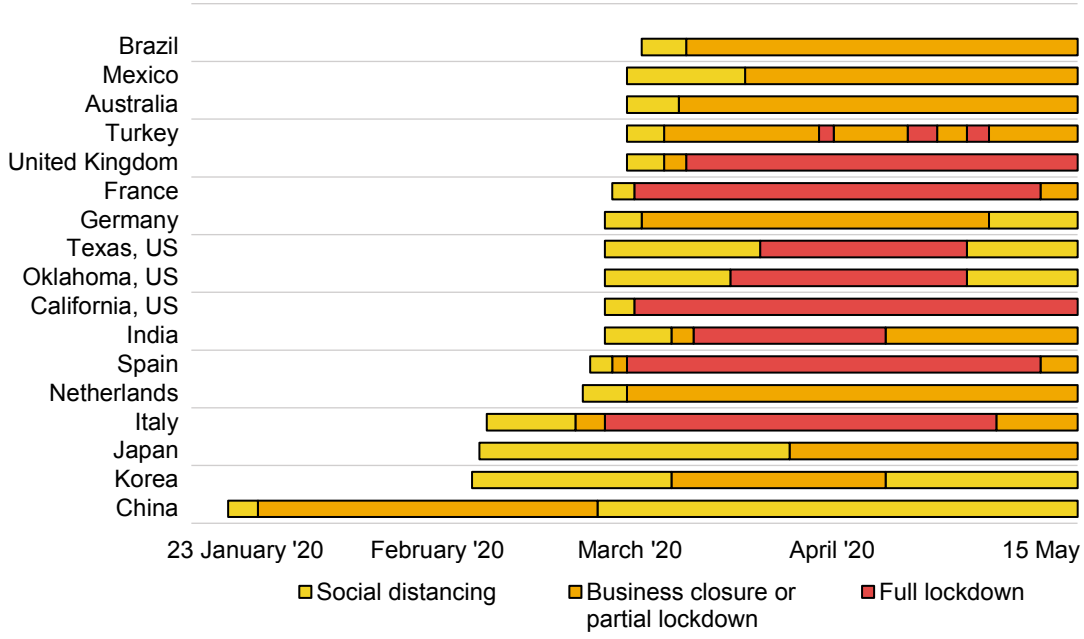
Like other industries, renewables are exposed to new risks from Covid-19, varying significantly by market sector and technology. On 5 April 2020, global lockdown measures had reached a peak with over 4.2 billion people – more than half of the global population – being subject to complete or partial lockdowns. Even though countries all over the world began to gradually lift some of these measures in early May, their impacts are still far-reaching. Social-distancing guidelines and lockdown measures have been triggering

supply chain disruption and delays in project construction, having a direct impact on the commissioning of renewable electricity projects, biofuel facilities and renewable heat investments. Restrictions on business activities, travel and border closures have sharply reduced energy demand in transport and industry, decreasing the consumption of bioenergy and other renewables. Emerging macroeconomic challenges may prompt cancellation or suspension of investment decisions for both large and small-scale projects under development. All of these factors may put projects at risk, even if they are at an advanced stage.

Delaying projects under construction

For utility-scale electricity and transport biofuel projects under construction, commissioning delays will depend on the length and severity of confinement measures. These can vary by country, state or even city. By mid-May, the world's top growth markets in 2020 had undergone four to ten weeks of non-essential business closure or lockdown, with some of the strictest measures in place in certain US states, Europe and India starting mid-March.

Length of full and partial lockdown measures in top renewable growth markets



Source: IEA analysis based on Olivier Lejeune (2020), Coronavirus Counter Measures, https://github.com/OlivierLej/Coronavirus.

While these measures are intentionally strong, in most countries the energy sector counts among the essential services. Therefore, lockdown measures do not necessarily imply that construction activity on energy projects, including renewables, has fully stopped. This varies by market, however, as in some countries, access to sites was allowed under full lockdown, while in others, work on some projects could not continue even under a partial lockdown. For instance, India allowed the construction of renewable energy projects to continue during its three-week full lockdown, while major construction firms in Japan suspended works in response to the state of emergency.

Delays due to supply chain disruptions and/or closure of construction sites have the obvious result of reducing additional short-term capacity additions, with the impacts most likely seen in 2020.

A second consequence is that delayed projects may run the risk of not reaping the benefit of incentives ending in 2020. Even with site access, almost all lockdown measures and social-distancing guidelines require companies to follow precautionary safety measures. Limitations on the number of workers allowed on site and/or stricter hygiene protocols inevitably slow construction down, increasing the risk of delays. Delays in components or construction put companies at risk of missing critical policy deadlines in China, the United States and Europe, denying them financial incentives they previously qualified for.

It is reasonable to assume that a majority of projects missing incentive deadlines may be further delayed or cancelled. In order to address these concerns, a number of countries have introduced policy changes, as reported in the table. This positively influences the outlook, in particular for 2021.

Recent policy changes providing flexibility for delays

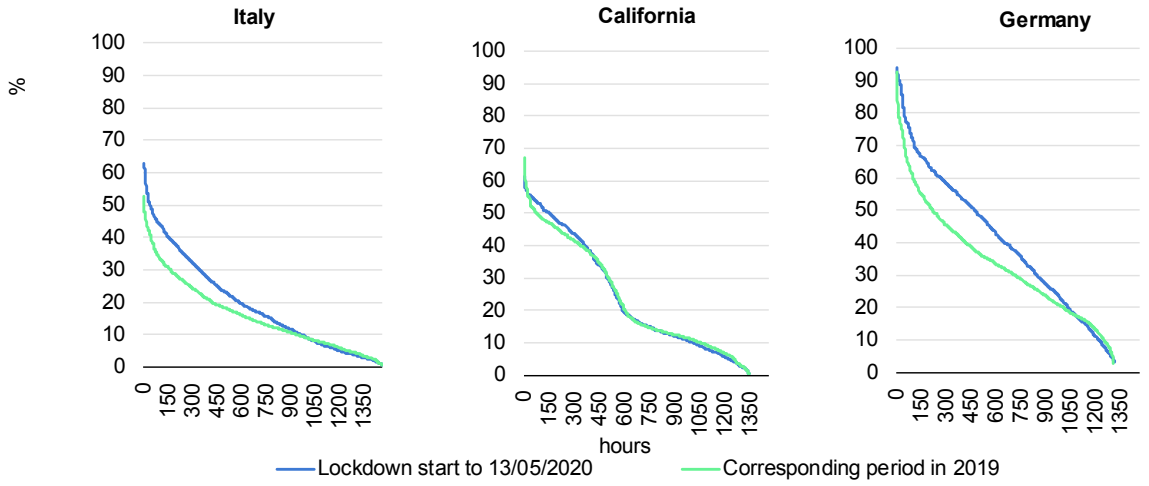
Country	Policy change	Impact year
Austria	Extension of the construction period for wind farms by 6 months	2020-21
Denmark	3-5-month extension of commissioning deadlines for household wind turbines; 2-month extension for subsidy applications for biogas projects	2020
France	Extension of commissioning deadlines by 2-6 months	2020-21
Germany	Federal network agency announced flexibility in project commissioning for previously auctioned projects	2020-21
Greece	6-month extension for projects due to come online in mid-2020	2020-21
India	30-day extension of commissioning deadlines for renewable projects after the lockdown	2020-21
United Kingdom	6-month extension of the FIT completion deadline for community solar projects	2020
United States	Extension of PTC/ITC safe harbour provision proposal	2020-21

Covid-19 poses a risk to investments made by individuals and small to medium-sized enterprises in renewable energy applications, such as distributed PV, solar thermal water heaters, heat pumps and biomass boilers. These investments run a higher risk of delay or even cancellation compared to large-scale projects. Currently, the installation of distributed solar PV has slowed in many countries as lockdown measures prevent personal contact and access to houses or commercial buildings. Moreover, households and small businesses facing financial shocks and economic uncertainty may postpone or abandon their plans to install solar PV, solar thermal water heaters or heat pumps on their property.

Impacts on existing assets

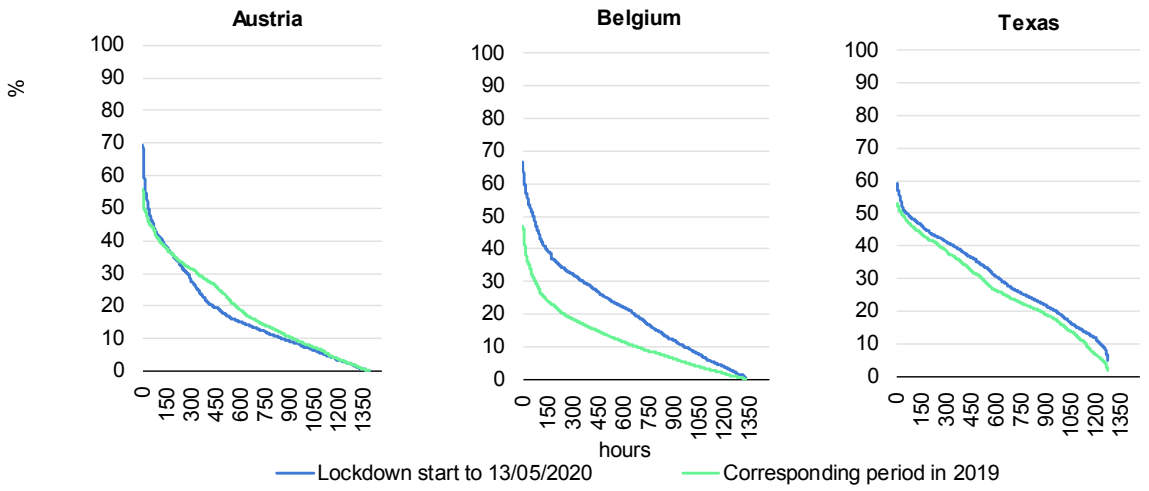
Existing renewable electricity plants are mostly sheltered from both lower electricity demand and declining prices. Many renewable electricity plants have fixed price contracts and are granted priority access to the grid, resulting in little or no output curtailment. Covid-19 lockdown measures have resulted in weekly electricity demand decreasing by 10-35% across affected regions, increasing the overall share of variable renewables to meet this demand. A combination of low electricity demand and the additional capacity coming online in 2019 and the first quarter of 2020, are leading to record high shares of infeed from variable renewables in electricity demand in some regions.

VRE share over demand in Italy, California and Germany



Italy, Austria and Belgium have experienced well above record-high hourly shares of variable renewable energy (VRE) compared to last year, reaching almost 63%, 70% and 67% instantaneous VRE penetration respectively. In addition, Germany had a new record low net load as a result of declining demand. Conversely, systems such as California and Texas experienced VRE shares similar to last year. These states experienced higher hourly VRE shares before lockdown measures, showing that in some cases variability due to weather had stronger impacts than electricity demand reduction due to Covid-19.

VRE share over demand in Austria, Belgium and Texas



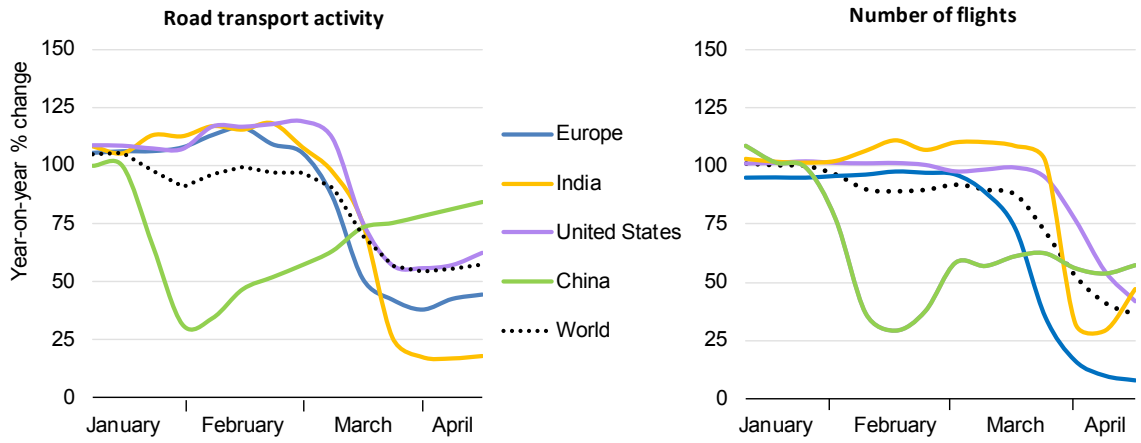
Despite increasing VRE shares, security of supply has not been jeopardised during the current crisis, even in countries with very high penetration rates. However, as we transition into summer, more challenging conditions could arise – particularly in PV-dominated systems – when even more extreme VRE shares may be expected. Systems could start facing a more recurrent challenge of either decreasing conventional generation to accommodate renewable energy or curtailing renewables.

Experience shows that balancing supply and demand during summer can be an increasing challenge, as a growing percentage of demand is served on-site with distributed PV, while generation from utility-scale solar PV and other renewables also increases. This means that conventional sources are turned off and cannot provide grid-balancing services such as frequency regulation and voltage management. This problem might be exacerbated by lower demand resulting from lockdown measures and consequently even higher VRE in-feed into the system. However, these ancillary services could be provided by solar PV and wind by implementing operational changes; some countries are already actively doing this. Covid-19 may require system operators to make use of balancing tools more frequently and for longer than

in past summers, as is already stated by Great Britain´s electricity system operator (National GridESO), in their April 2020 Summer Outlook.[1]

While existing renewable electricity assets have not seen much impact from the decline in demand, transport biofuel production plants have idled or reduced their output. In the first quarter of 2020, road transport in regions with lockdowns in place dropped by between 40% and 80% compared with 2019 during the same period. As ethanol and biodiesel are blended with oil products, their production in key countries fell in line with transport fuel demand. For instance, US ethanol production declined by almost 50% in mid-April compared to the same period in 2019. Renewable heat consumption in industry also saw a similar trend.

Evolution of road transport and aviation activity in 2020 relative to 2019



Renewable heat consumption in industry sees a similar trend, as reduced commercial, industrial and construction activities during lockdown results in a demand shock for most heat-intensive industries, in particular for large bioenergy consumers such as the cement and wood industries. Although reduced electricity demand tends to lift the share of renewables in the electricity supply, and thereby raise the indirect contribution of electric heating and heat pumps to renewable heat consumption, this effect remains marginal overall.

[1] National Grid ESO (2020), April 2020 Summer Outlook, https://www.nationalgrideso.com/document/167541/download.

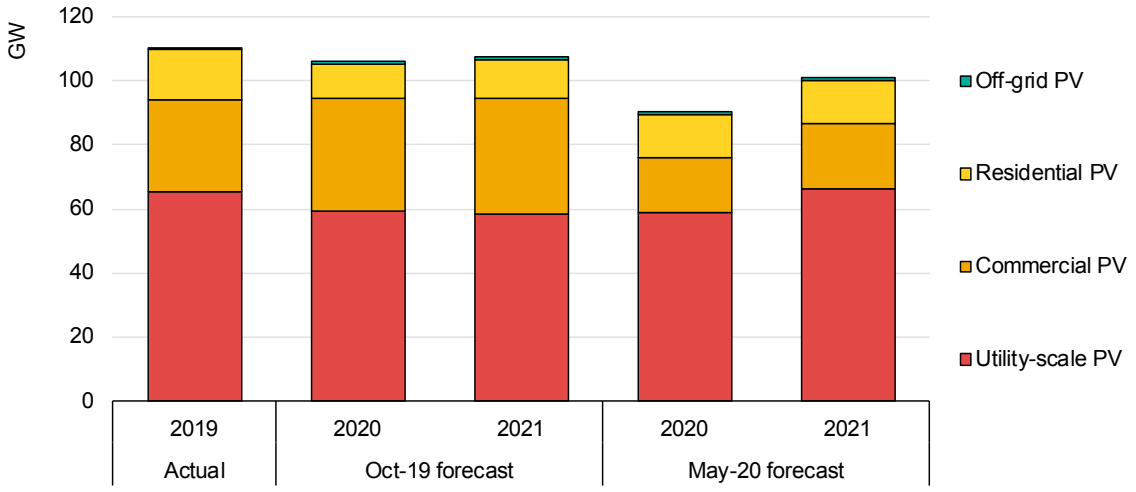
Technology summaries

Solar PV

Having stalled in 2018, solar PV capacity additions surged again by almost 14% in 2019, reaching a record of 110 GW of newly installed capacity globally. This is despite Chinese PV additions declining by almost a third, as annual installations elsewhere grew by 50% last year.

Covid-19 has led to construction delays and weaker than anticipated investment, requiring us to revise capacity addition projections down by over 15% for 2020. While the impact will be across the entire sector, Covid-19 related risks are not spread equally as distributed PV is more affected than utility-scale projects.

Solar PV capacity additions, actual and IEA forecasts



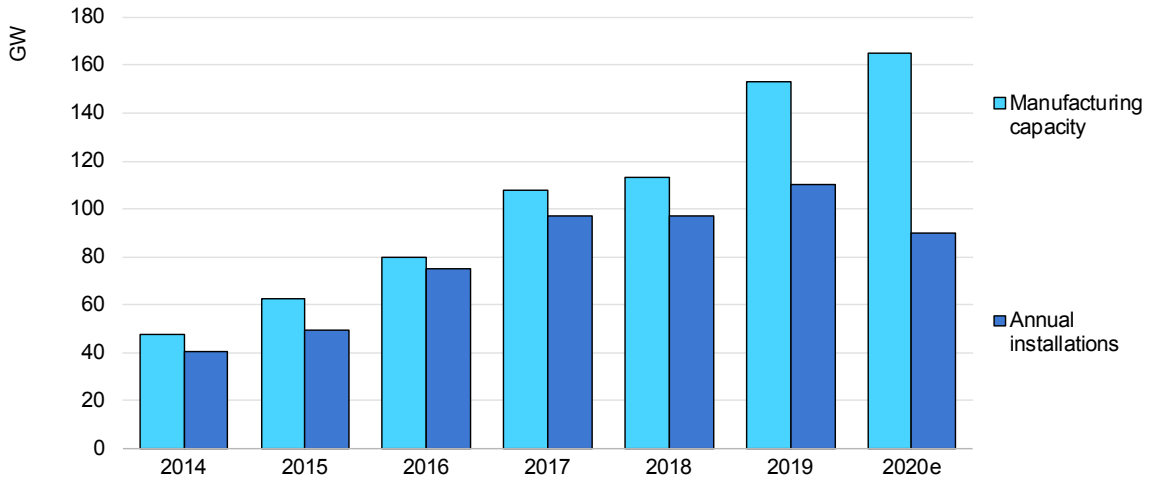
Utility-scale projects are more susceptible to supply chain concerns, labour constraints and construction delays, all leading to delays in project commissioning. The distributed PV sector is more at risk as it relies on both individuals and SMEs, who are more severely affected by lockdown measures and any economic downturn resulting from Covid-19; they will be reluctant to invest in such systems as they look to save money or reduce capital spending. Given recent precautionary measures, such as social distancing

and lockdowns, project development challenges could last through the end of Q3 2020. Our updated forecast expects a rebound for utility-scale projects in 2021, but with total PV installations remaining below 2019 levels due to much slower recovery of distributed PV applications.

All PV sectors are at risk of prolonged supply chain delays associated with Covid-19. With China accounting for 70% of global PV module manufacturing, the country's factory shutdowns in February and the first two weeks of March drastically lowered the availability of equipment. After the easing of these shutdowns, manufacturing in China has ramped up production and the solar PV supply chain is rapidly resuming activity, despite some lingering shipment delays. Other major supply markets such as South East Asia saw slowdowns in production, but for the most part maintained a similar volume of output throughout the pandemic.

Even with any production slowdown, there remains significant manufacturing overcapacity in the PV market. The global manufacturing capacity for cells is 150 GW, while 120 GW worth of solar PV cells were shipped in 2019 and 110 GW were installed. As a result, the market had 30 GW of unused manufacturing capacity and 10 GW of cells stored for later use. In addition, since 2018 manufacturers, developers and traders have built inventories, taking advantage of low prices.

Solar PV module manufacturing and demand, 2014-19 actual and 2020 estimate



IEA analysis based on Paula Mints (2020), The Solar Flare, SVP Market Research, San Francisco, CA.

Existing stocks helped most developers withstand supply chain issues and logistical delays due to Covid-19, and thus our updated forecast reflects limited supply chain-related delays. With the completion of additional manufacturing facilities in China in 2020, the supply glut is expected to reach its highest level ever globally, fostering competition and increasing downward pressure on module prices.

The major risks for solar PV are installation and at the point of sale. For utility-scale projects, lockdown measures are slowing construction activity, increasing the risk of commissioning delays. These delays will reduce the total amount of capacity installed in 2020, causing projects to slip into 2021 and resulting in a 12% rebound next year. Developers in mature markets such as the United States, China and Europe are likely to recover rapidly from delays after the easing of lockdown measures, as most have experience in increasing the pace of construction. As an example, developers in China installed over 10 GW in November and December 2019 to meet end-of-year policy deadlines.

Before the Covid-19 breakout, developers were also financing additional project pipelines for commissioning in 2021. These projects will be hit by the economic downturn, especially those being built outside a regulated environment. We expect some to be put on hold or cancelled in China, Europe and the United States.

Distributed PV has been immediately impacted by Covid-19 measures, while a longer-term economic downturn is likely to have a potentially devastating impact on overall investment in the distributed sector if new and stronger policies are not introduced. Major markets such as the United States, Europe and Brazil have seen installations of distributed PV drop following stay-at-home orders and face-to-face sales have understandably slowed drastically. This results in a dip in installed capacity growth in 2020. The rapid recovery of the distributed PV sector will depend on the pace of and the nature of any stimulus packages.

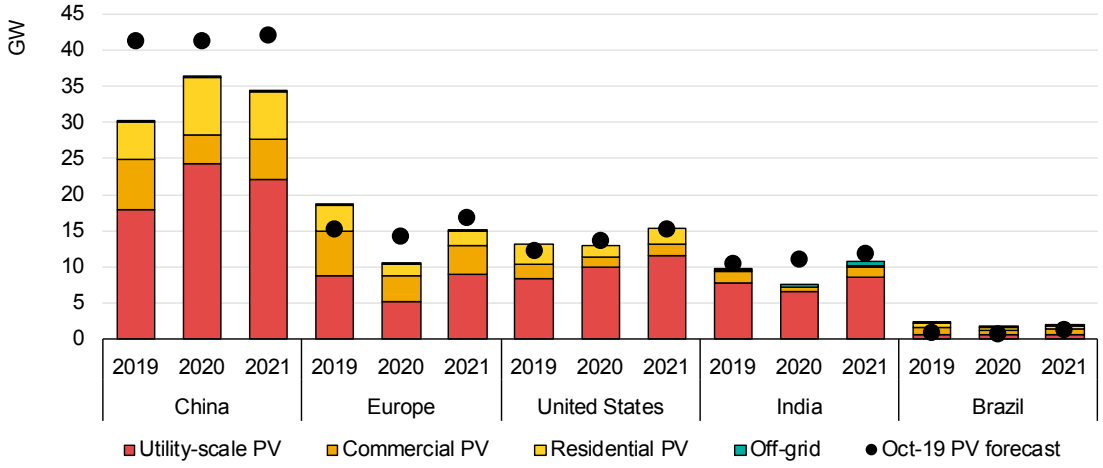
China

China's annual PV deployment declined for a second year in a row in 2019, by 32% to 30 GW. Developers had very tight commissioning deadlines after the award by auction of 23 GW of utility-scale and commercial solar PV in July 2019. The first competitive auction saw tariffs decline by 15-40% compared to previous incentives, reducing project profitability especially for commercial and industrial projects. In contrast, residential PV projects saw significantly higher additions in 2019 than in 2018 because they are outside the auction scheme and still receive FITs.

Annual PV additions are expected to increase by about 20% in 2020. Utility-scale projects should dominate this expansion, including previously auctioned capacity that qualified for subsidies but was not commissioned in 2019. China plans to hold a PV auction for utility-scale and commercial projects in June, but the government has decided to cut the annual subsidy budget by over 50% compared to last year. In addition, there is a growing project pipeline without subsidies. With increasing financing challenges due to Covid-19, we expect slower growth in distributed PV projects, with developers focusing on large utility-scale plants in 2020.

Deployment is forecast to remain stable in 2021. In the absence of new subsidies beyond 2020 and with China's electricity demand slowing, utility-scale projects in the pipeline without subsidies may be postponed or cancelled. An improving economic and financing environment is expected to enable greater deployment of commercial PV projects in 2021. Overall, China's solar PV expansion over 2020 and 2021 is revised downward compared to our previous forecast, mostly due to slower growth in commercial solar PV, as investors are expected to delay or cancel some investments due to the Covid-19 crisis.

Solar PV capacity additions, China, Europe, United States, India and Brazil, 2019 actual and IEA forecasts



United States

The annual increase in solar PV capacity in the United States topped 13 GW in 2019, the second-highest recorded to date, due to the increasing economic attractiveness of both utility-scale projects and residential PV systems. However, annual growth is seen slowing in 2020 as the impacts of Covid-19 dampen distributed PV prospects. New installations of both residential and commercial systems are expected to decrease as social-distancing measures affect new customer acquisition and self-consumption becomes less attractive amid a period of economic uncertainty. Distributed PV growth rebounds in 2021 in the residential segment as consumers rush to take advantage of the solar investment tax credit (ITC) before it expires at the end of 2021. California's new housing mandate, which started in 2020, is also expected to bolster some growth.

In contrast, utility-scale PV growth accelerates in both 2020 and 2021 because of increasing economic attractiveness and raised renewable energy targets across several states. Compared to our previous forecast, utility-scale growth across 2020-21 is more optimistic due to an increase in the pipeline of contracted projects (40 GW) at the end of 4Q 2019.[2] The surge in development activity is driven by increased policy support in some states as

[2] WoodMackenzie (March 2020), online database, accessed by subscription.

well as the increasing economic attractiveness of both corporate PPAs and utility-led procurement to meet long-term planning needs and satisfy demand for renewable electricity from large consumers.

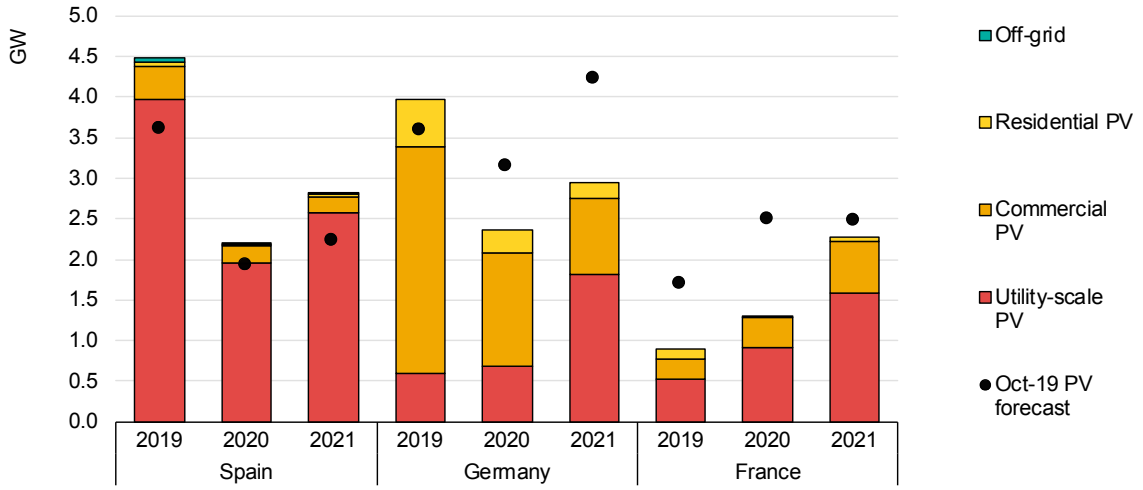
However, the impact of Covid-19 on the business case of early-stage projects, meaning those still subject to contract and yet to start construction, is a forecast uncertainty. While the government plans to modify the rules to qualify for support under the ITC, monetising this support may be a challenge if less tax equity is available in a weaker economy.

Europe

Solar PV additions nearly doubled in Europe last year, reaching almost 19 GW in 2019 compared to just 10 GW installed in 2018. This is the highest level achieved since 2011 when many countries began to remove high feed-in tariffs for utility-scale PV. The strong growth in 2019 was driven a combination of increasing economic attractiveness of distributed PV under net-metering and self-consumption policies, and utility-scale projects awarded under the new auction schemes in many countries. Almost half of Europe's utility-scale additions came from one auction in Spain held in 2017.

However, PV additions are set to decline in 2020 as a result of several trends: i) exceptionally high growth in 2019; ii) uncertainty relating to policy transitions (particularly in Germany and Spain); iii) lockdown-induced construction delays; and iv) the economic impact of Covid-19 on the business case of unsubsidised utility projects and distributed PV. In 2021 annual growth is expected to rebound to 15 GW, the second-highest level since 2013, largely due to a strong recovery in utility-scale PV as delayed project activity resumes. Distributed PV additions increase slightly in 2021, but growth is limited by uncertainties over the attractiveness of self-consumption during a period of weaker economic growth. Overall, the region is forecast to add 25 GW over 2020-21, led by Spain, Germany, and France. This is 18% lower than was expected in the October 2019 PV forecast.

Solar PV capacity additions, Spain, Germany and France, 2019 actual and IEA forecasts



Solar PV additions in **Spain** marked an all-time high of 4.5 GW in 2019, with both utility-scale and distributed PV reaching unprecedented levels of growth. For utility-scale projects, this uptick resulted from developers rushing to meet the end-of-year commissioning deadline for almost 4 GW of capacity awarded in the 2017 auction. In the absence of further auctions, additions in 2020 are expected to fall, but growth will still be far above historical levels. This is due to the large pipeline of corporate PPA and merchant projects that have emerged, particularly due to favourable market conditions in Q3 and Q4 2019. However, the impact of Covid-19 on the pace of their development is a key forecast uncertainty.

For projects under construction, work stoppages or a decreased workforce may push some commissioning dates into 2021. For earlier-stage projects with merchant exposure that are still arranging financing, the uncertainty is greater as their business case may be challenged, especially if wholesale electricity prices continue to plummet. In light of these uncertainties, our forecast expects modest growth in 2020 relative to the pipeline potential and an increase in 2021 as delayed projects resume development.

In **Germany** annual PV additions increased by almost 40% in 2019, the fifth consecutive year of growth. The increase was driven by the rapid expansion of commercial PV systems, due to attractive economics under the feed-in

premium. However, the support is set to expire when cumulative capacity reaches 52 GW, a milestone likely to be reached this year, which contributed to the surge in activity in 2019. In late 2019 the government announced plans to extend support beyond the cap, but the extension is contingent upon reaching consensus on the minimum distance regulations for onshore wind, which is still unresolved. Due to this policy uncertainty, we expect growth to fall in 2020 and again in 2021 on the expectation of lower consumer appetite during a weaker economic environment due to Covid-19.

Meanwhile, utility-scale additions are expected to remain stable in 2020, driven by competitive auctions. However, some projects may be delayed due to supply chain shortages or decreased personnel from restrictions on cross-border workers. As such, our forecast expects a sharp increase in 2021, reflecting the commissioning of delayed projects originally scheduled for 2020.

France installed about 0.9 GW of PV in 2019, a slight decline on 2018, in part due to delays in commissioning utility-scale projects. Utility-scale additions are expected to increase in 2020 and 2021 as these delayed projects are commissioned alongside those from a new auction scheme that began in 2017. Since 2017, over 4.8 GW of ground-mounted capacity has been awarded in the new auction scheme.

Annual growth in distributed PV is also expected to increase in 2020 and 2021, driven by a mix of competitive auctions, feed-in premiums and self-consumption. Recent positive policy developments are also expected to contribute to accelerated growth: (i) PV installation obligations for new warehouses, supermarkets and parking shades; (ii) a tax reduction for large-scale PV installations; (iii) grid connection fee exemptions for small-scale projects; and (iv) an extension of the FIT eligibility to larger installations.

However, supply chain disruptions caused by the global Covid-19 crisis, as well as suspension of work during lockdown and delays in permitting procedures, are growing challenges to the realisation of this large pipeline. In response to the crisis, the government confirmed its commitment to a 20-GW PV capacity target by 2023 and announced specific measures for

renewable energy projects in April 2020, including extending commissioning deadlines, freezing FIT declines for small installations scheduled for Q2 2020, and postponing scheduled auctions. In light of these uncertainties, slower growth over 2020-21 is expected relative to our previous forecast.

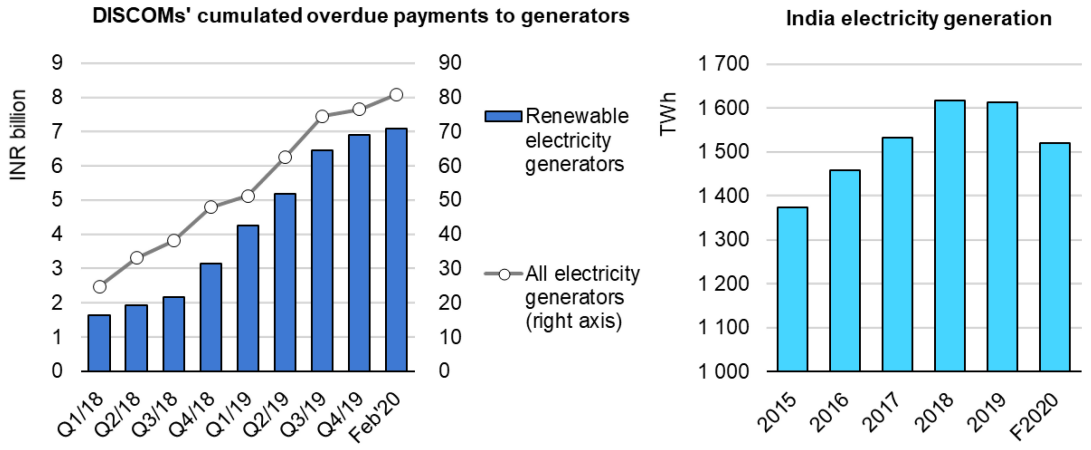
India

India's PV deployment is forecast to decrease by 23% in 2020 compared to 2019, with the largest drop anticipated in distributed PV installations. Challenges concerning the financial health of state-owned companies responsible for the distribution and sale of electricity (DISCOMs) persist, hampering faster growth of renewables. The Covid-19 crisis has put additional pressure on DISCOMs and therefore on solar PV and wind development. A rebound is expected in 2021, with capacity additions exceeding 2019 levels.

Despite government efforts to strengthen the performance of DISCOMs, the pending payments due to all electricity generators increased by 48% in 2019, and almost doubled in the case of renewables generators, a trend that continued in Q1 2020. The weak financial health of DISCOMs has already resulted in slowing development of distributed PV, delays in signing new PPAs with solar developers and contract renegotiations.

During the lockdown, India's electricity demand declined by 25%, mostly in industrial and commercial segments, which account for the majority of DISCOMs' revenues in most states. Initial IEA estimates indicate a possible 6% year-on-year decline in demand in 2020, further worsening DISCOMs' already challenging finances. This situation has been compounded by supply chain disruptions and the strict lockdown measures that forced many workers to return to their hometowns. As a result, our forecast expects a slowdown in the construction of utility-scale projects. In addition, macroeconomic challenges may lessen the willingness of electricity consumers to invest in distributed PV. Overall, our combined PV capacity additions in 2020 and 2021 are 19% below our previous forecast, as growing challenges hamper faster growth.

Electricity generation and cumulated overdue payments to generators, India



Sources: Left-hand figure – https://praapti.in/ (accessed on 30 April 2020); right-hand figure – IEA (2020).

Brazil

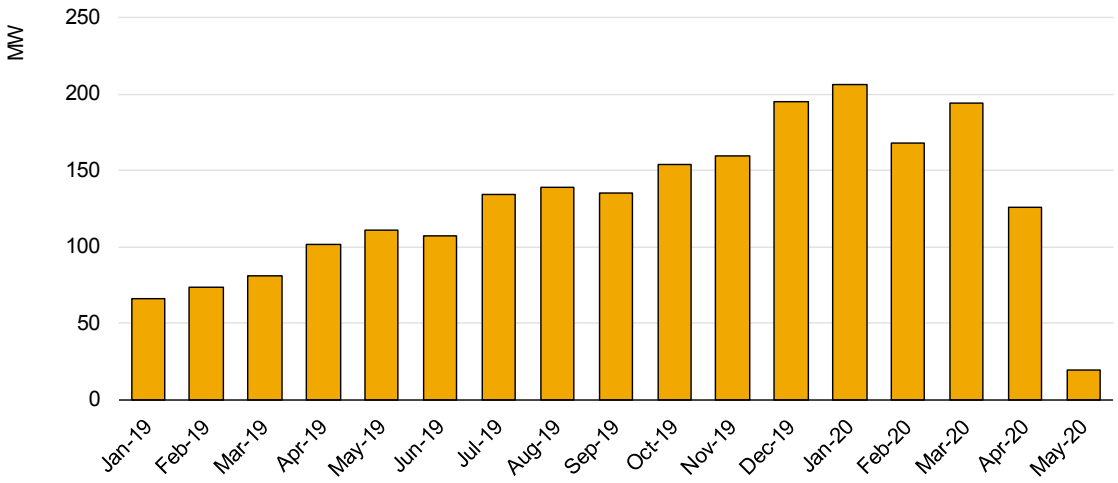
The Brazilian PV market more than doubled in 2019 over the previous year, driven by distributed installations. Due to a generous net metering scheme, residential and commercial installations exceeded utility-scale installations for the first time last year. Annual additions are projected to be lower in 2020 than in 2019, mainly because of slower growth in distributed PV as Covid-19 is expected to increase financing challenges and reduce sales. In April, distributed PV installations were around 40% lower than the monthly additions in the first quarter of 2020.

Government auctions, merchant projects and bilateral PPAs are driving utility-scale growth in Brazil. Capacity driven by auctions is expected to account for 45% of the expansion in 2020 and 2021. Merchant and corporate PPA projects represent the remainder, and those projects that have not already been financed are at risk of being postponed or cancelled with declining demand, lower electricity prices and financing challenges.

2021 is expected to see both the distributed market and utility-scale sector slightly recover, but not to 2019 levels, due to the potential macroeconomic challenges influencing investment in the distributed PV sector and project economics in the utility-scale sector. In addition, the government has decided to postpone indefinitely two energy auctions in 2020, citing the

Covid-19 related demand shock. These auctions would have had an impact on capacity growth beyond 2021.

Monthly distributed PV installations, Brazil

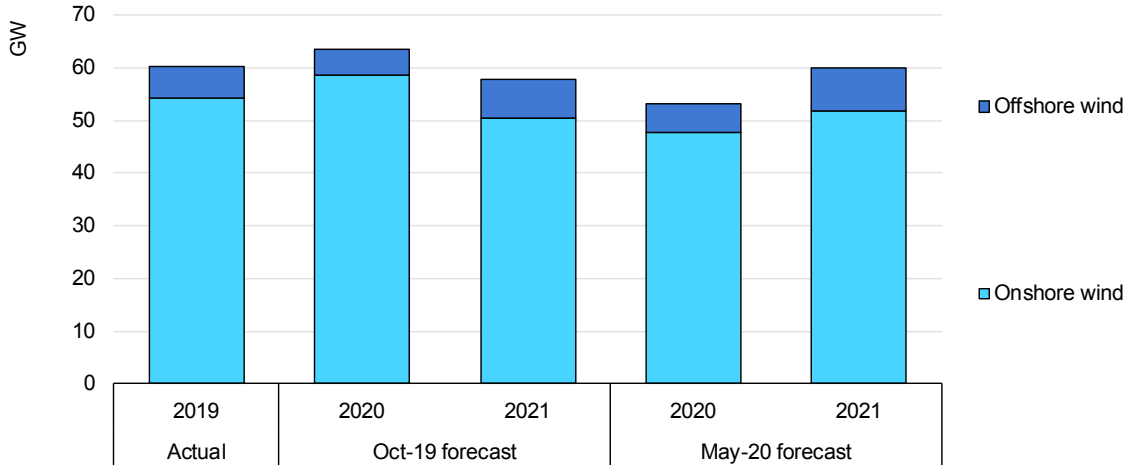


Source: Geracao Distribuida [Distributed Generation], Agência Nacional de Energia Elétrica [National Electricity Agency] (May data represented through 15 May 2020).

Wind

Global onshore wind capacity additions jumped by 20% in 2019 compared to 2018, thanks to increasing expansion in China and the European Union. 2020 was expected to be another year of acceleration in deployment. However, the unprecedented global crisis caused by Covid-19 has pushed our onshore wind growth forecast for 2020 down by 12% compared to 2019 additions. This decline is mainly driven by project delays rather than cancellations, thus leading to a recovery in 2021. Despite a rebound in 2021, combined expected onshore wind growth in 2020 and 2021 is still lower than in our October 2019 forecast by 9%.

Wind capacity additions in 2019-21, actual and IEA forecasts



The wind energy sector has developed a globally interconnected supply chain, with manufacturing dispersed across all continents. China, Europe, the United States and India are major manufacturing hubs for various wind turbine parts. The assembly of a complete wind turbine usually requires inputs from multiple countries, seamless logistics and timely delivery. However, recent lockdowns in major manufacturing hubs have disrupted wind turbine supply chains.

In February, China's wind manufacturing plants mostly paused production, followed by shutdowns in Italy and Spain in March due to strict confinement measures. In late March lockdown in India required wind turbine component manufacturers to halt production. Although production is gradually restarting in Europe, China and India, the effects of supply chain disruptions are being felt in almost all markets, with multiple projects receiving *force majeure* notices from suppliers warning developers about possible delivery delays.

In addition to equipment supply disruption, lockdown measures slowed construction activity, as they often require workers to stay at home or developers to implement social-distancing rules at construction sites. The majority of onshore wind projects due to come online in 2020 and 2021 are under construction. However, some still need to complete the necessary permitting with multiple government institutions before financial closure. These processes may require human interaction, which may not be as

efficient while officials work from home. While permitting processes can be partly moved online, community outreach cannot. Social acceptance of wind has already been a major challenge in many countries and reduced social interaction due to Covid-19 increases the risk of onshore wind project delays.

The impact of Covid-19 on offshore deployment in 2020 and 2021 remains limited, causing negligible changes to the updated forecast. Offshore projects have longer construction periods than do onshore projects. Most projects in our forecast for 2020 and 2021 are either partially commissioned or at an advanced stage of development, particularly in Europe, which is the largest offshore market. China is a growing market with many projects in the pipeline, but our forecast expects that Chinese developers will make up for any delays. The Covid-19 crisis may impact offshore wind deployment beyond 2021, as some pre-development work such as permitting and environmental approval is being delayed.

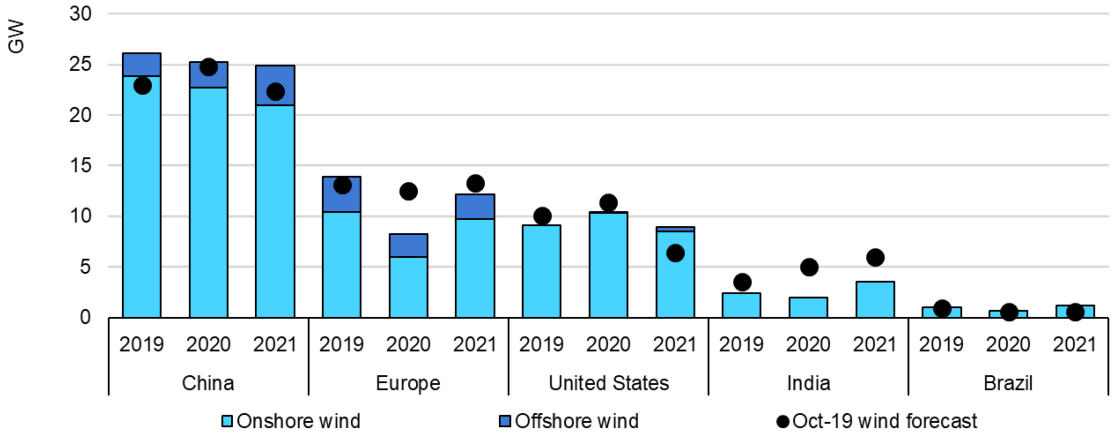
China

China's wind capacity additions in 2019 reached 26 GW, 27% higher than in 2018 as developers rush to complete projects before the phase-out of onshore wind FITs by the end of 2020. Onshore wind projects that qualified for FITs in 2018/19 are under a very tight commissioning deadline of 31 December 2020. Covid-19 has already caused construction delays, with additions in Q1 2020 40% lower than last year. However, construction activity is ramping up after lockdown measures were eased at the beginning of April. Accordingly, our forecast expects wind capacity additions to decline only slightly in 2020 compared to last year.

We expect developers to shift some delayed projects to 2021, as the government may provide flexibility for projects that are behind schedule. In addition, multiple provincial wind auctions are expected to award new capacity this year, to be operational in 2021 and 2022. However, uncertainty remains concerning the amount of capacity that will be auctioned this year. Outside the FIT and auction scheme, a large pipeline of projects without subsidies has emerged over the past year. These are at higher risk of delay,

and even cancellation. Our forecast expects some projects without subsidy to be commissioned in 2021, although financing challenges remain a key uncertainty.

Wind capacity additions, China, Europe, United States, India and Brazil, 2019 actual and IEA forecasts



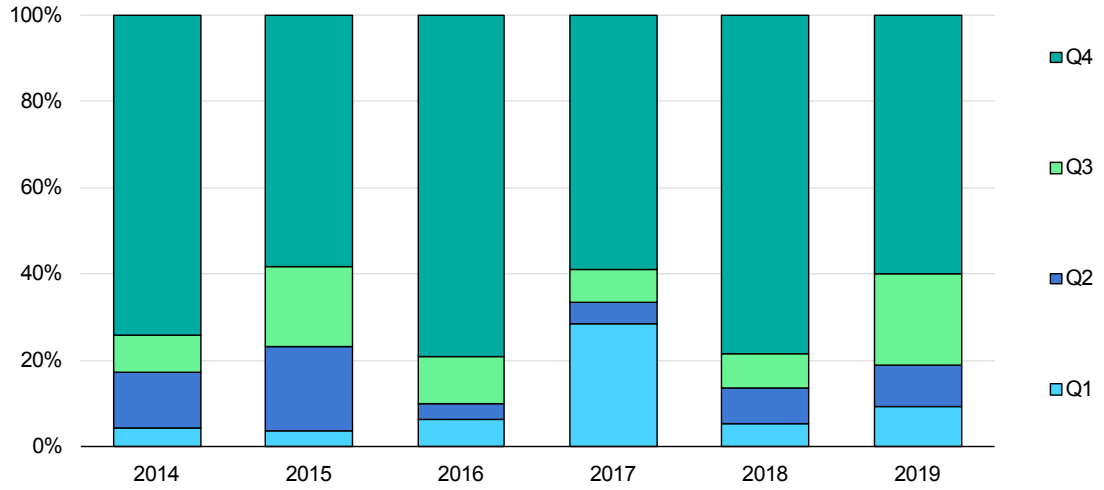
United States

In 2019 the United States deployed 9.1 GW of wind capacity, a third higher than in 2018. In 2020 additions are expected to outpace 2019 deployment, driven by the first production tax credit (PTC) deadline at the end of calendar year 2020. 2021 is also projected to be a strong year due to the next tranche of PTC projects coming online. This growth is despite the risk of delays related to Covid-19, as underlying market fundamentals remain strong, with few areas of concern.

In states accounting for over 35% of projected US wind growth in 2020, such as Texas, Oklahoma and South Dakota, wind workers are allowed to continue construction with social-distancing guidelines. However, adhering to these guidelines could lead to projects being delayed, as the US wind sector is on a tight schedule to commission 10-14 GW by the end of the year. Since 2014, 60-80% of capacity added annually has come online in Q4 and, given this schedule, any delay in the supply chain or build at any point during the year will put projects at risk of not commissioning before the end of the year.

In response to Covid-19 delays, the US Department of the Treasury has signalled that they may grant an extension of the PTC safe harbour provision, allowing projects that started construction in 2016 or 2017 extra time to complete, alleviating pressure on an already compressed construction schedule. These risks have led to a slight revision down of installed capacity in 2020, with some projects slipping into 2021. Even with 2019 capacity additions being lower than our previous forecast, the longer-term outlook is potentially strong, with the extension of the PTC to 2021.

Share of wind deployment by quarter, United States



Source: American Wind Energy Association (2020), Wind Powers America First Quarter 2020 Report.

Even with the PTC extension, the lasting impact of a wider economic recession could have a dramatic impact on the US wind market as a whole, with the availability of capital and the use of that capital, especially tax equity, being reduced.

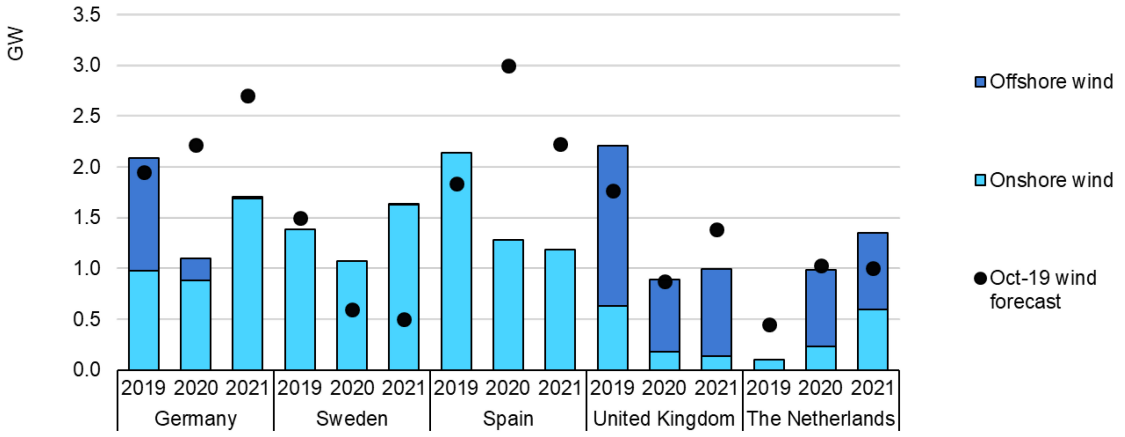
In addition to the short-term impacts on current and announced projects, Covid-19 also presents a longer-term planning challenge. For example, a 2.5 GW offshore wind auction in New York State has been postponed, which could have a negative effect on the nascent offshore wind market in the United States.

Europe

Net annual wind additions in Europe grew by 23% in 2019, reaching 14 GW. Onshore wind accounted for three-quarters of the increase, led by Spain, Sweden, France and Germany, among others. Offshore wind growth reached its highest level to date at 3.5 GW, as large projects were connected in the United Kingdom, Germany and Denmark. Growth in 2020 is expected to decline as construction stoppages and supply chain disruptions slow onshore wind development. To avoid these risks jeopardising the bankability of projects under development, some governments have modified support mechanisms by extending commissioning deadlines or postponing auctions. As such, we expect some projects originally scheduled for commissioning in 2020 to shift by several months and drive a rebound in annual growth in 2021.

More than half of the wind growth in Europe over 2020-21 is expected to occur in Germany, Sweden, Spain, the United Kingdom and the Netherlands. In addition to the impact of lockdown measures, less growth is expected compared to last year owing to persistent permitting challenges in Germany and France, and increasing uncertainty over the timing of Spain's planned auctions. The uncertainty over the impact of Covid-19 on the demand for corporate PPAs is also a forecast uncertainty, particularly in markets where there may be less demand or weaker electricity prices during a period of slower economic growth. Offshore wind growth over 2020-21 is mostly in line with last year's forecast, largely driven by the ending of large construction pipelines in the United Kingdom and the Netherlands.

Wind capacity additions, Germany, Sweden, Spain, United Kingdom and Netherlands, 2019-21



As predicted in our previous forecast, **Germany's** onshore wind growth in 2019 plummeted to its lowest level since 1998, as the policy transition from feed-in premiums to competitive auctions created a lull in the project pipeline. In line with last year's trend, growth in 2020 is expected to remain stable and then increase in 2021 as capacity from auctions begins to be commissioned. However, the forecast is revised down for both years due to lower expectations that capacity awarded in previous auctions will obtain permits and anticipation of some supply chain disruptions from Covid-19.

Permitting challenges stemming from social acceptance issues and administrative barriers continue to prevent faster onshore wind growth in Germany. In addition, higher rates of decommissioning are expected compared to our previous forecast. The business case for lifetime extensions with corporate PPAs or merchant exposure are less optimistic in a period where demand and electricity prices could be lower post Covid-19. Offshore deployment is forecast to slow in 2020 and 2021, as projects awarded in earlier auctions remain in the early stages of development and will not be operational until 2022.

The **Swedish** wind market achieved its highest growth to date in 2019, adding over 1.3 GW of new capacity, driven by capacity from both green certificates and corporate PPAs. A robust pipeline of new turbine orders indicates continued growth in 2020 and 2021. However, supply chain disruptions related to Covid-19 could delay projects and result in lower growth in 2020.

A strong rebound is forecast in 2021 as projects rush to complete construction to meet PPA deadlines and to connect before the proposed end of the current certificate scheme.

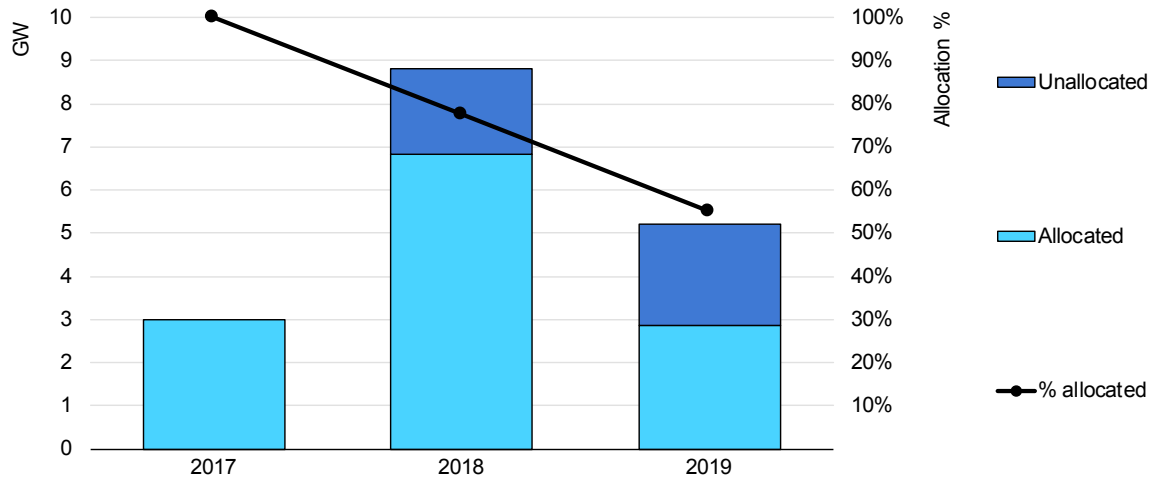
Spain's annual wind growth surged in 2019, reaching its highest level in ten years as developers rushed to meet the end-of-year commissioning deadlines for 4.6 GW awarded in auctions. However, growth is expected to slow in 2020 and 2021 due to the impacts of Covid-19 on the remaining project pipeline. Almost 2 GW remain to be commissioned and are at various stages of development. These could experience delays from construction halts or slowdowns to maintain safety protocols. Overall, our forecast expects lower growth over 2020-21 compared to 2019. Our previous forecast expected that government plans to resume competitive auctions for onshore wind would be fulfilled in 2020, but no auction schedule has been released to date.

India

India added 2.4 GW of wind capacity in 2019. However, our forecast expects capacity additions to slow in 2020. The increasing undersubscription of wind tenders and the limited improvement in the financial condition of DISCOMs is leading to a slowdown in wind deployment, while the Covid-19 crisis has worsened these existing challenges.

In 2019 India could only allocate half of its planned wind capacity through auctions, with undersubscription increasing to 55% from 22% in 2018. In addition, several tenders were cancelled or postponed due to lack of interest in auctions. Low tariff ceilings, combined with risks associated with payment delays and contract negotiations, are bound to increase the financing costs of wind projects. Furthermore, land acquisition and grid access challenges remain. In addition to pre-existing challenges, the impact of the Covid-19 crisis on wind deployment in India is much more profound than in the case of other utility-scale technologies. Lockdowns have slowed the progress of wind plants during the main construction season. Projects that cannot be finished before the start of the monsoon season risk further delays. As a result, compared to our previous forecast published in October 2019, combined capacity additions in 2021 and 2022 are down by about 50%.

Auctioned and allocated capacity in Indian wind auctions



Source: BNEF (April 2020), 2Q 2020 Global Auction and Tender Calendar and Results.

Brazil

Brazil added almost 1 GW of wind capacity in 2019, its lowest increase since 2014. In 2020 we expect this trend to continue, with additions slowing by another third. Supply chain disruptions and construction delays are expected to push projects scheduled for commissioning in 2020 into 2021. In addition, given the amount of projected capacity that has reached financial close, 2021 is forecast to have higher additions than both 2019 and 2020. However, this will depend on the progress of projects outside the auction scheme, as Covid-19 reduces demand for electricity and spot market prices are pushed to the regulatory floor, which may influence the motive to develop projects without a firm price guarantee.

Bioenergy for power

Global bioenergy capacity increased by almost 8 GW in 2019, a stable level of deployment compared to 2018. China's share of global bioenergy additions, primarily driven by energy-from-waste projects, increased from a third in 2018 to 60% last year. Japan and Turkey were the next largest markets in terms of new additions, although one tenth of the size. China's increased deployment offset lower 2019 capacity additions in Brazil, India and the European Union.

Bioenergy capacity additions are anticipated to decline in 2020. This is to an extent related to Covid-19. Major deployment of biomass power projects is concentrated in relatively few countries. In 2019 just ten countries accounted for 90% of new capacity. Of these, China, Brazil, Japan and the United Kingdom have been among those most disrupted by the crisis, with lockdown measures stalling or slowing project construction. Consequently, capacity additions are anticipated to be 9% lower than our previous forecast from October 2019. However, significant disruption to biomass fuel supply chains for existing projects (e.g. wood chips and pellets) is not anticipated, with forestry activity ongoing and ports operational.

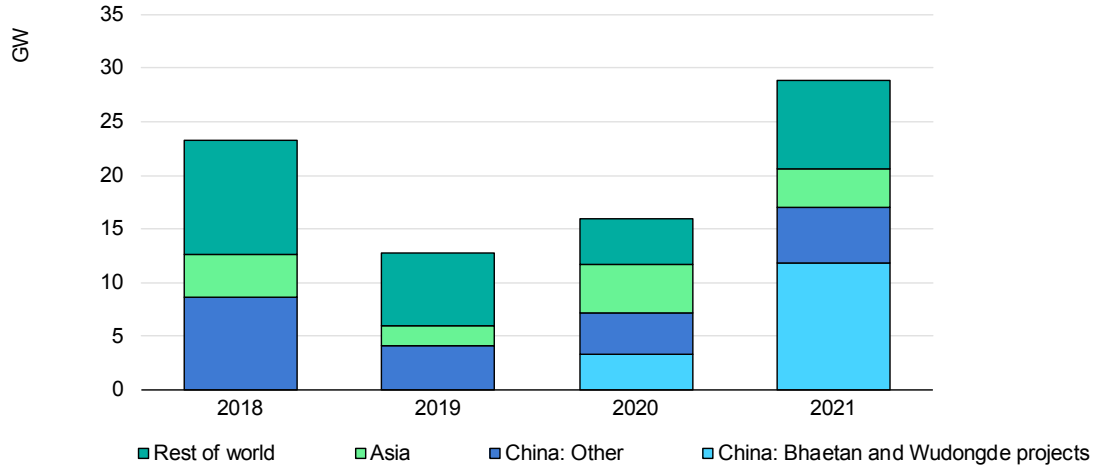
Reduced policy support also contributes to lower anticipated bioenergy deployment in 2020 and 2021. While many countries have undertaken technology-specific auctions for wind and solar PV, these are less widespread for bioenergy. Furthermore, bioenergy deployment has fallen in countries that have replaced FIT and certificate schemes with technology-neutral auction frameworks due to generally higher generation costs than wind or utility solar PV.

Policies that had previously delivered higher levels of bioenergy deployment have now closed, or will shortly close, to new applicants in Germany, Japan and the United Kingdom, with these countries seeing lower deployment in 2020 and 2021 than in previous years. In addition, China and India have already achieved their stated bioenergy targets.

Hydropower

Global net additions of hydropower fell to 12.7 GW in 2019, the lowest level recorded since 2001. This is due to the continued slowdown in China, the country that has led global hydropower growth since 1996. Development has slowed significantly in China since 2013, as costs have increased due to resource availability and social acceptance issues. As a result, for the first time since 1996, in 2019 hydropower capacity growth was not led by China, but by Brazil, where close to 5 GW were commissioned as several large projects came online.

Global hydropower capacity additions, 2018 and 2019 actual and IEA forecasts



Annual additions are expected to increase in 2020 and further in 2021 largely due to the development of two mega projects in China: Wudongde (10 GW) and Bhaetan (16 GW). One-third of global growth over 2020-21 (45 GW) is expected to come from these two projects alone; therefore the timing of turbine commissioning will have a considerable impact on global annual growth. Turbine commissioning is likely to start in 2020, with developers targeting completion dates of 2021 and 2022 respectively.

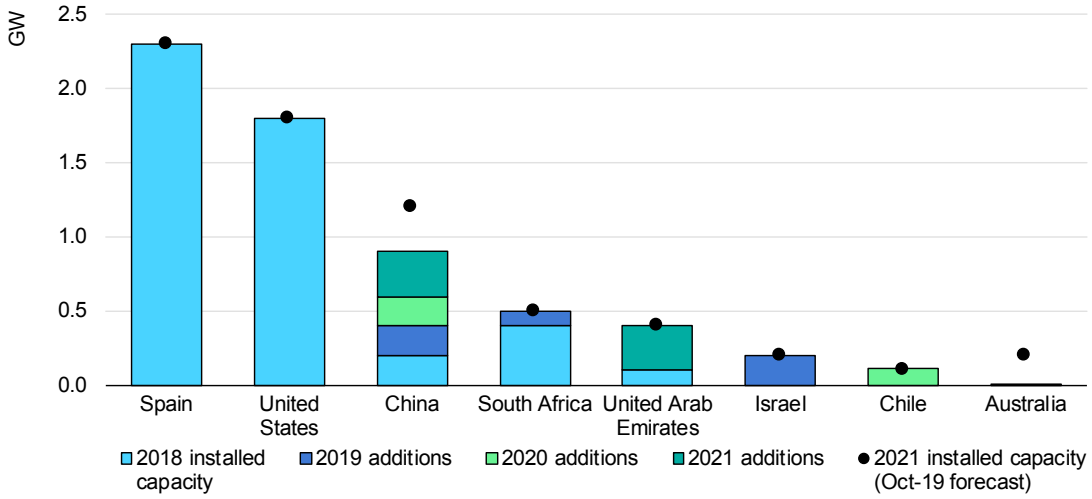
Outside these two projects, global growth in 2020 remains stable as development in Asia offsets declines in Latin America, and as increases in 2021 are driven by investment in pumped storage in Switzerland and China as well as by large hydropower plants in Canada, Turkey, and sub-Saharan Africa. Although, annual additions over 2020-21 correspond to projects currently under construction, some projects may be delayed due to Covid-19 lockdown measures. A number of projects in Southeast Asia have halted construction due to a shortage of staff as a result of lockdown measures and travel bans on cross-border workers.

CSP and geothermal

For CSP (concentrated solar power), our forecast is not subject to major revisions in most countries and any delays in the period analysed have not been due to Covid-19. In 2019 Israel commissioned two CSP projects (230 MW), while four projects came online in China (200 MW).

China leads future global CSP growth, but this is lower than our previous forecast for 2020-21, as planned projects are being delayed due to material cost increases and financing challenges. Outside China, financing challenges were the main reason for the cancellation of a CSP project in Australia. This year, the Cerro Dominador project in Chile is expected to come online after the salt melting process was announced as completed in April. This project will bring 110 MW with 17.5 hours of storage in molten salts. Projects in the United Arab Emirates are expected to come online on schedule, bringing 300 MW of capacity in 2021.

Expected CSP capacity additions, selected countries, 2020 and 2021



Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the IEA/OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

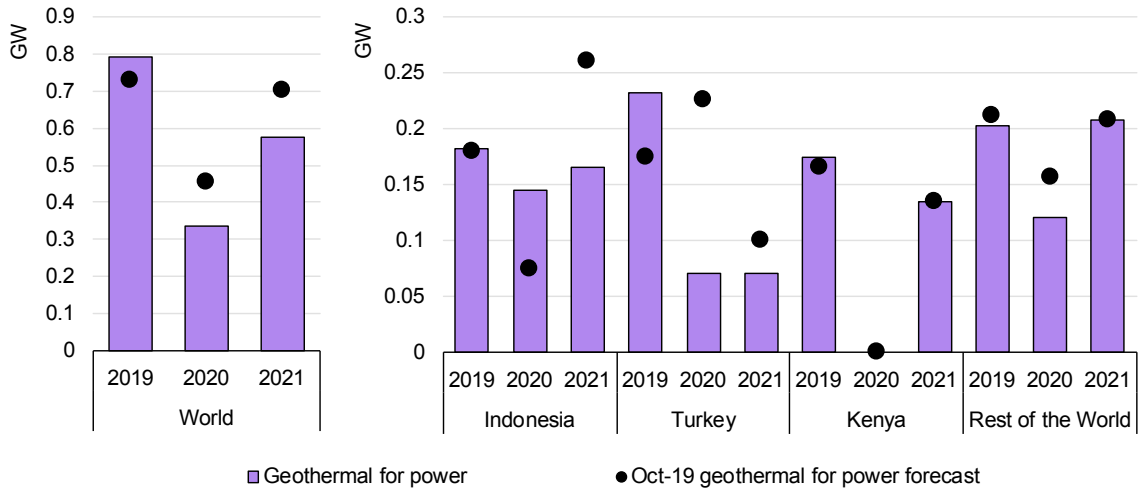
Source: IEA (2019), Renewables 2019.

In 2019 global **geothermal** capacity additions amounted to almost 0.8 GW, the highest level ever recorded. Turkey, Indonesia and Kenya were by far the largest contributors to this increase, together accounting for three-quarters of global additions. These three countries are expected to continue leading geothermal growth over 2020-21. However, in Turkey and various other countries, the Covid-19 crisis is causing delays in project development due to hold-ups in strategic decisions needed for projects to proceed, and disruption of the global supply chain for machinery and materials. In Turkey, unless current support mechanisms scheduled to finish at the end of the year

are extended, delayed projects originally scheduled to come online at the end of 2020 may face financial challenges.

In Indonesia, while the commissioning of some small projects has been postponed to 2021, so far development remains almost unaffected for the largest projects due to come online in 2020 (i.e. 90 MW at the Rantau Dedap plant, which we previously expected to be commissioned in 2021, and 45 MW at the Sorik Marapi plant). Overall, our outlook for global cumulative additions of geothermal power over 2020-21 is revised down by about 20% compared to our October 2019 estimates.

Geothermal capacity additions, selected regions, 2019-21



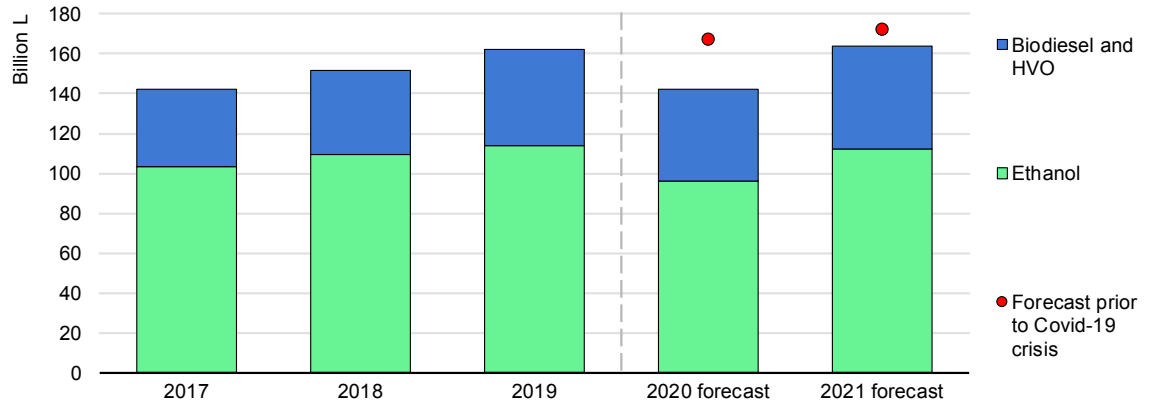
Transport biofuels

Global transport biofuel production reached a record 162 billion litres (L) in 2019, or 2.8 million barrels per day. This represented a 7% year-on-year (y-o-y) increase. The primary cause of growth was a surge of ethanol production in Brazil and expansion of biodiesel production in the ASEAN region.

However, the Covid-19 crisis has radically changed the global context for biofuels, and we anticipate production to contract by 20 billion L (13%) in 2020, returning to 2017 output levels. By comparison, prior to the start of the Covid-19 crisis, output was anticipated to increase by a further 5 billion L (3% y-o-y) in 2020. On the assumption that the pandemic is brought under control, transport fuel demand could rebound in 2021 and facilitate a return

to 2019 biofuel production levels. However, this would still be 5% lower than the output anticipated in our forecast for 2021 prior to the Covid-19 crisis emerging.

Transport biofuel production 2017-21



Note: HVO = hydrotreated vegetable oil, also known as renewable diesel in North America.

The widespread application of containment measures saw mobility grind almost to a halt in many countries towards the end of the first quarter of 2020, strongly reducing transport fuel demand. This in turn limited biofuel consumption from mandate policies that require a set percentage of biofuels to be blended with fossil transport fuels.

Overall, global gasoline demand in 2020 is forecast to fall by 9% and diesel demand by around 6%. Diesel is less affected as a substantial share of consumption is for the transport of goods, which the crisis is affecting less than personal mobility. Consequently, the Covid-19 pandemic is forecast to impact ethanol output (15% contraction) more than biodiesel and HVO output (6% contraction) in 2020.

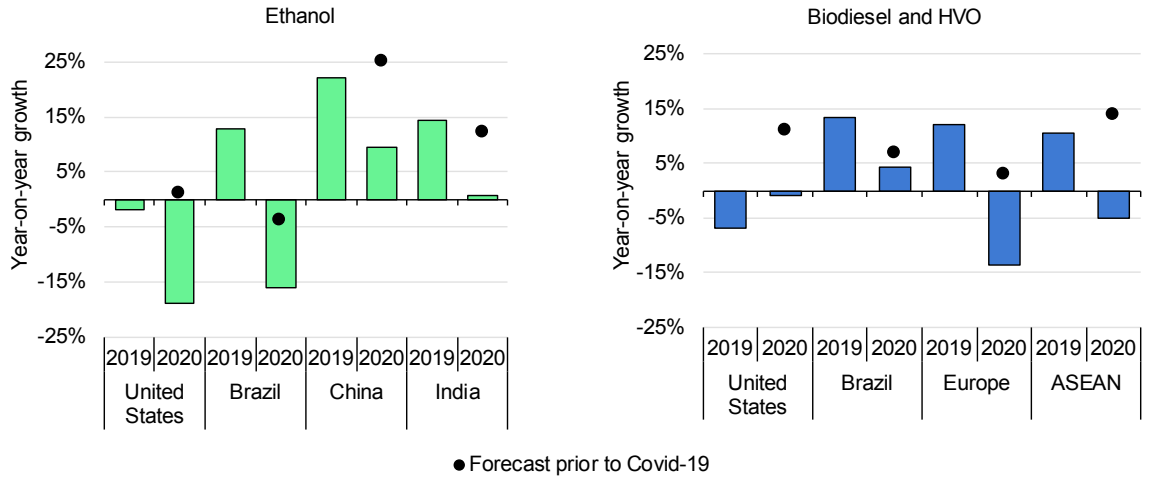
The sharp reduction in crude oil prices puts further pressure on the biofuels industry, as lower petroleum product prices drag down biofuel prices. This compounds the effect of lower biofuel demand driving stocks higher in many markets, which also depresses prices and compromises the profitability of production.

The upheaval from the crisis also extends to markets integrated with biofuels by affecting demand and prices for agricultural commodities, and the availability of co-products (e.g. animal feeds and CO_2 for beverages and cooling). Ethanol plants in many countries have ventured into production of much-needed hand sanitiser, although this does not compensate for lost transport fuel demand.

Regional biofuel forecasts

The extent to which the Covid-19 crisis effects biofuels output differs by country, depending on policy frameworks and the size of the reduction in fuel demand caused by containment measures.

Biofuel output, selected countries and regions, 2019 and forecast for 2020



Note: "Europe" refers to OECD Europe.

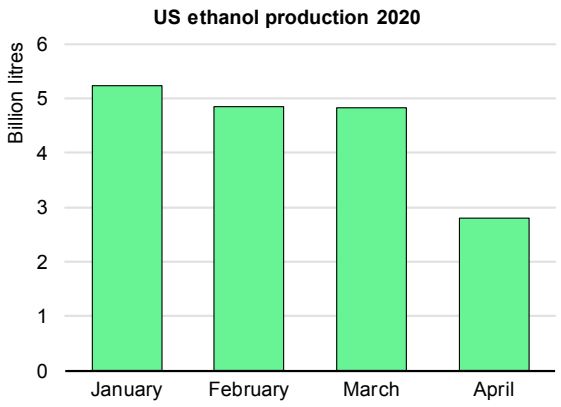
In the **United States** ethanol production reached 59 billion L in 2019, a decrease of just over 2% y-o-y. We anticipate a 19% reduction in production in 2020, with output at its lowest level since 2009, as opposed to stable output levels in our last forecast prior to the crisis.

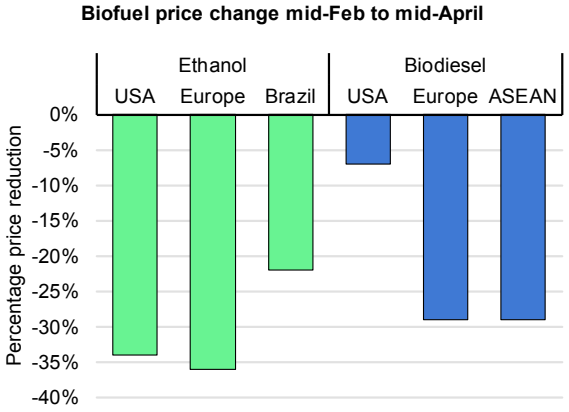
The pandemic has severely affected the US ethanol industry. Output fell by nearly 50% between the end of February and early April, as numerous plants idled or reduced output in response to the dramatic drop in gasoline consumption, negative operating margins and constrained storage capacity. Blending levels remained steady at 10% of this lower volume, as higher

ethanol blends such as E15 or E85 remain a small part of the market. The near simultaneous drop in fuel demand worldwide caused by the crisis also affected ethanol export prospects. The Coronavirus Food Assistance Program financial stimulus package for the agricultural sector does not contain specific measures for biofuels.

The pandemic affects biodiesel and HVO to a lesser extent. Our forecast expects production to remain stable at 6.5 billion L in 2020, although the policy-driven growth anticipated prior to the Covid-19 crisis will not be realised.

Selected impacts of Covid-19 on biofuel markets in 2020





Note: US EIA (2020), Weekly Ethanol Plant Production; HIS Market (2020) Licht Interactive Data (subscription service).

Brazil produced close to 36 billion L of ethanol in 2019. Output grew by 13% year-on-year as low international sugar prices saw mills maximise ethanol production at the expense of sweetener. Consumer demand for unblended ethanol was also strong owing to tax incentives that supported its price competitiveness versus gasoline.

We anticipate a 16% reduction in ethanol production to 30 billion L this year in Brazil, the lowest level since 2017. Brazil faces dual pressure, from reduced gasoline demand constraining consumption of ethanol blended under the 27% mandate, and low oil prices affecting the competitiveness of unblended ethanol versus gasoline at the pump.

Our forecast assumes that low ethanol prices mean mills may direct a higher share of sugar cane to the production of sugar than observed during the last two years. A rescue package for the ethanol sector is under consideration, with timely support crucial to ensure mills have enough cash flow to undertake harvest activities.

By comparison, our forecast prior to the onset of the pandemic anticipated that a favourable sugar cane crop, production facilities coming online and the introduction of the RenovaBio policy would see Brazil sustain output in 2020 close to 2019's elevated levels.

Brazil's biodiesel output increased by 13% in 2019 to 5.9 billion L. Despite the impacts of the Covid-19 crisis, we anticipate production will grow a further 4% in 2020 to 6.2 billion L, supported by an increase in its mandate to 12%.

In **Europe**, biodiesel and HVO production increased by 12% in 2019, reaching a record 17.5 billion L. Italy provide the biggest increase in output, with new HVO capacity coming online.

We now forecast a 13% reduction in European biodiesel and HVO production for 2020, as opposed to the stable output we anticipated prior to the pandemic. This is primarily due to significant reduction in diesel demand across the continent, with several European countries among those most affected by the pandemic. Saturated storage capacity and a faster decline in biodiesel than feedstock prices have severely challenged production economics. Mandate increases in many EU member states in 2020, including major producers France, Italy, Spain and Germany, will soften the reduction in demand to an extent.

Biodiesel from used cooking oil (UCO) plays an important role in the EU biodiesel market, since its energy content counts double against compliance with the EU Renewable Energy Directive. UCO supply has fallen due to the closure of restaurants in many countries and imports from China are likely to decline. European ethanol output is forecast to reduce 12% y-o-y to 4.3 billion L in 2020.

Biofuel production, selected markets, 2019 and 2020 (billion L)

Country/ region	Fuel	2019 output	2020 forecast	Market observations
Argentina	Biodiesel	2.5	1.8	Lowest output since 2009 expected this year; reduced export prospects to Europe.
ASEAN	Biodiesel	12.3	12.8	Rollout of higher biofuel blends delayed in Indonesia, Malaysia and Thailand.
China	Ethanol	4.0	4.4	Plan for nationwide 10% blends abandoned, but supply extended to some new provinces; new capacity coming online.
India	Ethanol	1.9	1.9	Purchase tenders not yet filled due to low sugar cane supply; storage capacity near maximum; ethanol prices > gasoline.

Note: China made its decision to abandon nationwide 10% ethanol blends before the emergence of Covid-19.

Renewable heat

While heat accounted for half of global final energy consumption in 2019, modern renewable energy[3] met only 10% of global heat demand. This share is increasing slowly, with very few new policy developments in the last two years. The number of countries with national targets for renewable heat is less than a third of the number with national targets for renewable electricity, and fewer than half of those have nationwide regulatory heat policies in force.

Overall support for the uptake of renewables in the heating and cooling sector therefore remains limited. In this context, increasing the share of renewable heat has been challenging, and current economic impacts of Covid-19 measures could potentially slow its growth beyond the short term. Both the industrial sector and the buildings sector are likely to be affected,

[3] In this report, "modern renewable energy" excludes the traditional uses of biomass. "Modern renewable heat" covers direct and indirect (i.e. through district heating) final consumption of bioenergy, solar thermal and geothermal energy, as well as renewable electricity for heat based on an estimate of the amount of electricity used for heat production and on the share of renewables in electricity generation. For the sake of simplicity, "modern renewables" is referred to as "renewables" in the remainder of this report.

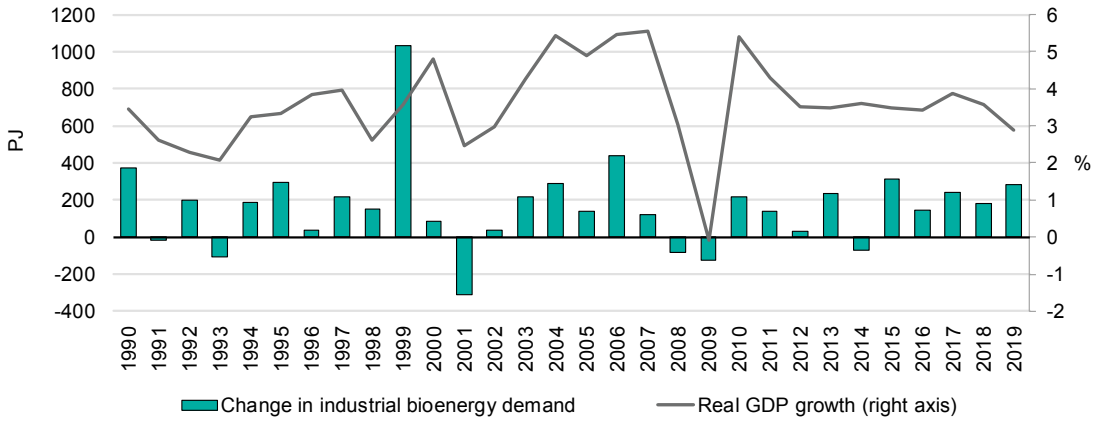
although impacts will differ in nature, extent and timescale, and across regions.

In industry, bioenergy accounts for the large majority of renewable heat consumption (more than 85% in 2019), and in our October 2019 forecast was expected to comprise more than half of the growth in renewable heat for industry. Bioenergy is used mostly in industries that produce biomass waste and residues, such as food and tobacco, sugar and ethanol (Brazil and India), and most of all in the pulp and paper industry (mainly in North America, Europe and Brazil). Thanks to the increasing use of municipal waste in China and the European Union, the cement industry was also expected to contribute significantly to the growth in industrial bioenergy consumption.

The Covid-19 crisis has reduced commercial and construction activity, meaning lower demand for print paper, cement and lumber from the wood products industry. This demand shock is likely to translate into a temporary decline in the consumption of bioenergy from these sectors. Yet, cement plants with waste management contracts may have to keep on processing municipal waste since it is still being produced and requires disposal.

In other heat-intensive industries such as chemicals and petrochemicals, iron and steel and non-ferrous metals, the global contraction in economic activity following lockdown measures entails reduced overall heat demand. However, renewable consumption in these sectors – essentially supplied indirectly through electricity and district heat – remains limited. On the supply side, the fall in electricity demand tends to lift the share of renewables in the electricity supply, which increases the indirect contribution of electric heating and heat pumps to renewable heat consumption, albeit the effect remains marginal. Should a prolonged economic slowdown occur, such effects on industrial renewable heat consumption would be felt beyond 2020.

Annual GDP growth and changes in industrial bioenergy demand, world, 1990-2019



Sources: IMF (2020), World Economic Outlook, April 2020: The Great Lockdown; IEA (2020), Global Energy Review.

In buildings, direct impacts of Covid-19 measures on renewable heat consumption are likely to remain limited in the short term. First, Covid-19 impacts have so far occurred during a period of lower demand for heat in buildings due to the exceptionally high winter temperatures in the northern hemisphere, where 2019/20 was the warmest winter ever recorded. Furthermore, the timing of Covid-19 lockdown measures came towards the end of the heating season in most northern hemisphere countries (with the exception of China), especially in Europe and North America which are major heat consumers. This has also contributed to limiting the effect on buildings heat demand so far. Should lockdowns be maintained or reinstated later in the year, the impact could be higher.

In many countries, during periods of full lockdown, reduced space and water heating demand in the commercial sector counterbalances the slight uptick in residential buildings. This may somewhat modify the composition of global buildings renewable heat consumption in 2020, as renewable electricity, used by heat pumps and electric heaters and boilers, is the largest renewable heat source in the commercial sector globally, whereas biomass is dominant in the residential sector.

Beyond these direct short-term impacts, the Covid-19 crisis further compromises the already slow penetration of renewables in heat supply. First, lockdown measures and labour restrictions may induce delays in the

manufacture, sale and installation of renewable heating equipment. This may affect projects due to install solar thermal panels, heat pumps, biomass stoves or boilers, and renewable district heating networks. In France, for instance, heat pump sales during the lockdown (from mid-March to the end of April) were 70% lower than during the same period in 2019, and annual sales for 2020 are expected to remain almost 20% below 2019 levels.

Work on new and retrofit bioenergy CHP plants and boilers is suspended during lockdown in many countries. The high season for district network construction is typically summer, but site preparation and equipment supply are required beforehand and could be subject to disruption. Depending on lockdown duration, delays may accumulate, which would need to be partly recovered after lockdown, putting more strain on workforce and equipment capacity and potentially leading to longer project lead times.

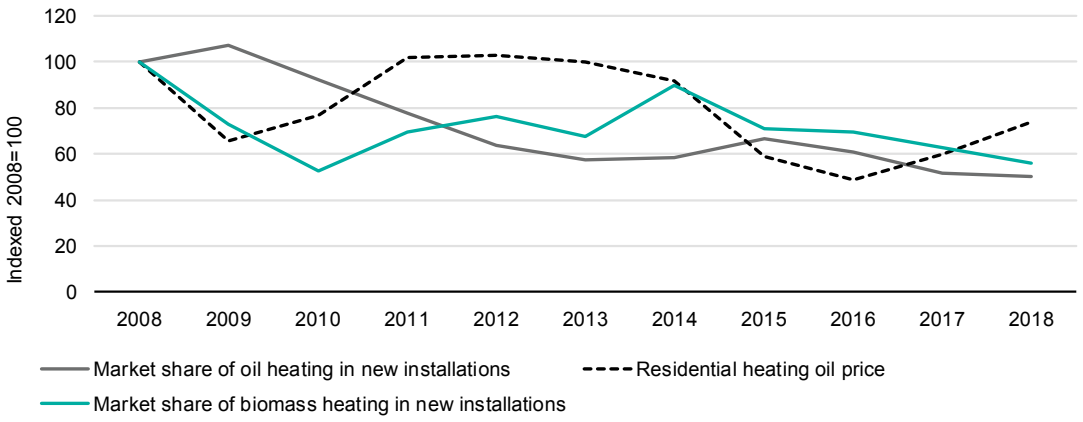
Second, and perhaps more importantly, current low oil and gas prices are affecting the cost-competitiveness of renewable heat fuels and technologies relative to fossil options. For instance, low fossil fuel prices have made oil boilers for residential heating more attractive in Germany in the past. Besides, the evolution of wood pellet prices in the short term remains uncertain: on the supply side, lower availability of sawmill residues may lead to a shift to alternative feedstocks that could push pellet prices up, while lower industrial demand could push prices downward.

In addition, the Covid-19 crisis is weakening the financial situation of companies and households. As a result, planned investments in switching from fossil fuel use to renewable or electric heating solutions may be postponed or cancelled in the absence of stronger policies. Policy support, however, could dampen the effect of this crisis. In China, for instance, the "Coal to Electricity" programme may benefit from additional fiscal support, which would help maintain heat pump demand.

Third, without strong government intervention, the uncertain global macroeconomic impacts of the pandemic in the longer term may affect the building construction sector for a long period of time, given that it is particularly sensitive to the macroeconomic situation, as confirmed by the

2008 crisis. This could significantly slow down renewable heat deployment, since building energy codes used to mandate energy efficiency standards and renewable heat technologies often target new construction and retrofits.

Impact of fossil fuel price on new heating equipment installations, Germany, 2008-18



Sources: IEA (2019) World Energy Price Database; Baulinks (2019)

Considering these elements, the IEA outlook for renewable heat consumption over 2020 and 2021 is likely to be revised down compared to the October 2019 forecast, with the largest changes relating to industry. While our previous projections were already not in line with global climate change targets, recent evolutions sharpen the need for strong and ambitious policy support to reduce non-renewable energy uses for heat, through a combination of energy efficiency and fuel switching to renewables. With multiple benefits for local job creation, environmental sustainability, energy security and resilience, governments should view such policies as a critical ingredient in their stimulus packages.

Challenges and opportunities beyond 2021

The pandemic has the potential to change the priority of government policies and budgets, developers' investment decisions and the availability of financing through 2025. This casts a great deal of uncertainty on a market that had been expanding at a rapid pace in the previous five years.

At the same time, several countries are introducing massive stimulus programmes to respond to the current economic meltdown and support their economies. Some of these stimulus measures may be relevant for renewables. The IEA has been re-emphasising that governments should bear in mind the structural benefits of increasingly competitive renewables, such as economic development and job creation, while also reducing emissions and fostering technology innovation.

Wind and solar costs continue to go down

There is little doubt that massive cost reductions in the last decade are one of the main reasons behind renewables rapidly transforming the global electricity mix. The cost of electricity from onshore wind and solar PV is increasingly cheaper than from new and some existing fossil fuel plants. In most countries, renewables are the cheapest way of meeting growing demand.

Wind and solar PV developers in 2020 won auction bids at record low contract prices, ranging from below USD 20/MWh to 50/MWh. Offshore wind has achieved significant scale-up and cost reduction over recent years driven by policies in Europe. This success should soon be repeated in emerging offshore wind markets in Asia and North America, with economies of scale further reducing costs.

The increasing share of VRE has opened a new horizon to maximise hydropower's contribution to flexibility and spur investment in battery storage technologies. All these developments were mainly driven by government policies fostering competition and new flexibility sources.

While supply disruptions may lead to local transitional price fluctuations, there is no sign to date that the Covid-19 crisis will change these declining cost trends. For instance, in the case of solar PV, manufacturing overcapacity is expected to reach record levels in the coming years (see next chapter), which will put further downward pressure on module prices.

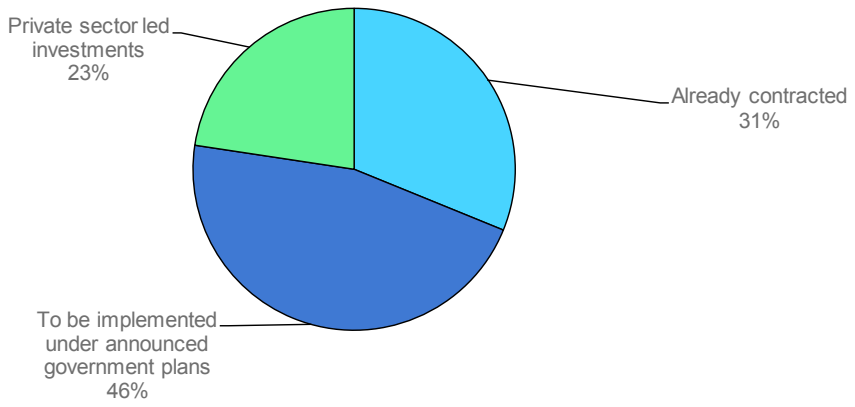
The resilience of renewables will be tested beyond 2021 if governments policies waver in the face of Covid-19

The continuing decrease in cost trends alone will not shelter renewables projects from a number of challenges. The pace of economic recovery, heightened pressure on public budgets and the financial health of the energy sector as a whole further exacerbate already existing policy uncertainties and financing challenges.

For renewable electricity, we can distinguish three main categories of projects: (i) those already contracted and/or financed and under construction; (ii) those driven by government action (e.g. auctions, FITs, other incentives); and (iii) those mainly driven by market forces (e.g. corporate power purchase agreements, merchant projects). Each project category will face different challenges and opportunities, depending on two key variables: renewables cost trends and policies in place.

Looking at the project pipeline through 2025, almost one-third of wind and solar PV projects are already contracted and/or financed. Those have limited risk of cancellation and thus are expected to become operational in 2020 and 2021, with some facing further delays carrying over to 2022 or beyond.

Solar PV and wind project pipeline, 2020-25



The role of government will remain instrumental to renewable energy deployment

In the next five years, almost half of wind and solar PV projects in the pipeline are tied to planned, but not finalised, government-backed auctions or other incentives such as tax credits, rebates and FITs. The Covid-19 crisis poses challenges to the timely implementation of previously announced government plans. For instance, the implementation of projects under government-backed auctions will critically depend on whether countries maintain their planned schedule of tenders. This may be unlikely in the context of stalling or decreasing electricity demand, and low fossil fuel prices.

Planned renewable electricity projects with long-term contracts will be mostly shielded from low natural gas prices. Although in the short term, governments may delay scheduling new renewable capacity auctions and turn to existing natural gas plants to meet new demand, in the medium and long term the economic case of wind and solar remains strong thanks to expected continuing cost reductions and to the long-term price predictability over project lifetimes.

Some impacts on policies are already visible. Initial government policies to tackle Covid-19 challenges have focused mainly on extending project-commissioning deadlines and postponing planned auctions. France, the United Kingdom, Greece and Germany have provided some flexibility for developers who are not able to meet policy-related final commissioning dates. While these measures protect deployment in 2020 and 2021, the delay of auctions will also have an impact beyond 2021. In some countries the postponement is indefinite, creating significant uncertainty and increasing risk for investors and finance.

Recent policy changes affecting renewables beyond 2021

Country	Policy change	Impact year
Brazil	Postponement of 2020 electricity auctions indefinitely	2023-25
Chile	Delay of auctions from June 2020 to December 2020.	2024-26
China	Postponement of subsidy-free project application from February 2020 to April 2020	2022-23
France	Delay of some solar PV auctions by 6 months	2021-22
Germany	Delay in the selection of bidders in previous auctions	2022-23
Portugal	Delay of 700 MW solar PV auction	2022

New market-driven projects may face stronger challenges

With the declining cost of renewables, corporates have increasingly signed power purchase contracts directly with wind and solar projects outside the main government policy schemes to meet their private decarbonisation goals and also to hedge against future price volatility. Developers of wind and solar projects entering these agreements have accepted additional risk from shorter contracts and greater exposure to wholesale electricity prices. While project development tied to private agreements accounts for about a quarter of projects in the pipeline, lower electricity demand, plummeting power prices and a weaker financing environment may lead to such projects being reconsidered.

At the same time, the hedging value of renewables to both electricity price volatility and climate liabilities remains intact. Most renewables for electricity generation, especially wind and solar PV, have high investment costs but low operating and maintenance costs. Once operational, renewables projects with long-term power purchase contracts can provide stable revenues to investors while sheltering buyers from future electricity and fuel price volatility. The willingness of corporates to continue procuring renewables in a low fossil fuel price environment will also strongly depend on the ambition

of their own climate change mitigation policies and on carbon pricing regimes implemented by governments.

Covid-19 has the potential for long-lasting impacts on biofuels markets

In the case of the EU policy framework for biofuels, the Renewable Energy Directive dictates that member states may increase the contribution of conventional (crop-based) biofuels to renewable energy in transport by no more than one percentage point over levels achieved in 2020. As such, any Covid-19 market disruption this year that alters the share of conventional biofuels consumed would affect the maximum permitted share in member states well beyond 2020.

A sustained period of low oil prices heightens the possibility of policy makers delaying or abandoning increases in biofuel policy support. This has already been evident in the ASEAN region, where governments have paused action to bring higher biofuel blends to market as low oil prices compromise the budget available for biofuel support measures. In Indonesia and Thailand, revenues for the funds used to support biofuels have reduced at the same time that low oil prices have increased the cost of biofuel subsidy. Low oil prices also test the willingness of fuel suppliers to blend biofuels in markets without strong enforcement of blending mandates.

Brazil, India and Indonesia, among other countries, have long-term ambitions to increase the contribution of biofuels in transport. Scaling up production to meet such ambitions will require the delivery of new production capacity, which in turn is dependent on the financial health of the industry to invest in new plants. The impact of an extended period of low biofuel demand and prices in 2020, and possibly beyond, could undermine the ability of the industry to deliver increased production capacity. This is particularly relevant to India and Brazil, as concurrent low sugar and ethanol prices negatively affect producer balance sheets. In Brazil the situation is already precarious, with numerous producers in a fragile economic condition.

Conversely, the significant impact of the Covid-19 crisis on aviation opens the door to the scale-up of aviation biofuel use through the inclusion of environmental conditions in bailout packages. This is demonstrated by the 2% sustainable aviation fuel requirement proposed in a rescue package for the Air France-KLM group.

Designing stimulus packages for a cleaner energy future

Policy makers need to put clean energy at the centre of recovery efforts to secure a structural downward trend in carbon emissions

Global energy-related CO_2 emissions are expected to reduce by 8% in 2020, the largest contraction since the World War II. But that will not be anything to celebrate. What matters is putting emissions into structural decline. While renewable electricity should show stronger resilience compared to other fuels, new capacity growth is also expected to slow in 2020, after record deployment last year. Putting emissions into a structural decline needed renewables to grow much faster across all sectors even before the Covid-19 crisis. To regain and exceed the growth rates seen in the years before the pandemic, policy makers need to put clean energy – including renewables and energy efficiency – at the centre of recovery efforts.

Reflecting a rapidly changing public health crisis, initial government rescue packages have focused on sustaining livelihoods and minimising economic damage through immediate relief for individuals, families and businesses. In the current and next phases of easing lockdown restrictions, stimulus packages may focus on global economic recovery. Experience shows that the economic recovery after the last financial crisis resulted in significant growth in CO_2 emissions: in 2010 global CO_2 emissions saw the largest increase ever recorded – four times the drop in emissions the year before. To mitigate the increase in CO_2 emissions in the recovery from the current crisis, governments should put clean energy transitions at the heart of their stimulus packages.

Governments should consider three main policy strategies:

1) Ensuring policy predictability and reassuring investors about their energy and climate commitments by confirming ambitious targets and objectives, including providing visibility on forthcoming capacities to be auctioned in the power sector. This is key to enabling industry and businesses to plan in advance and establish smooth project pipelines.

2) Reducing administrative barriers to renewable project development and corporate sourcing of renewable energy by streamlining permitting and other administrative procedures.

3) Including renewables in stimulus packages. The priority should be on those sectors and project categories that offer early opportunities for job creation and economic recovery, take stock of the lessons of the past, and can lead to structural benefits in the form of highly efficient and resilient energy systems with lower associated GHG emissions. Expanding the scope of and budget for existing support schemes that have already worked offers an avenue to delivering quicker results. Priority areas for action could include:

Introducing specific financing measures and cost-effective incentives for renewable projects in upcoming stimulus packages by using proven support mechanisms, such as auctions, tax incentives that reduce investment risk in large-scale projects (e.g. solar or wind), and other targeted support schemes for small-scale projects.

Focusing on the labour-intensive building sector with specific additional measures, including specific economic incentives, building renovation plans and/or upgrading programmes for public buildings, which can support consumer and SME investment in the highly vulnerable distributed solar PV and renewable heat sectors. These incentives can also be combined easily with energy efficiency programmes.

Aligning short-term policy actions with new medium- and long-term visions for emission reductions, including investment in power network infrastructure and flexibility resources, enabling more rapid, secure and economically efficient deployment and integration of variable renewables.

Fostering investment and job creation in smart, digital and resilient energy infrastructure, connecting renewables with efficient services and mobility solutions.

While a detailed description of policy options for including renewables in post-Covid-19 economic stimulus packages is beyond the scope of this report, it will be the subject of a separate IEA article.

Acknowledgements

This study was prepared by the Renewable Energy Division in the Directorate of Energy Markets and Security. It was designed and directed by Heymi Bahar, Senior Analyst.

The report benefited from analysis, drafting and input from multiple colleagues.The lead authors of the report were, Yasmina Abdelilah, Heymi Bahar, Trevor Criswell, Piotr Bojek, Francois Briens and Pharoah Le Feuvre. Grecia Rodríguez Jiménez was responsible for data management and contributed to drafting. The report also benefited from analysis, data and input from Chenlu Cheng, Andrea Dertinger, Hideki Kamitatara.

Paolo Frankl, Head of the Renewable Energy Division, provided strategic guidance and extensive input to this work. Valuable comments, feedback and guidance were provided by other senior management and numerous other colleagues within the IEA, in particular, Keisuke Sadamori, Laura Cozzi, Laszlo Varro, Michael Waldron, Lucila Sarazola Arboleya

Thanks go to the IEA Communication and Digitalisation Office for their help in producing the report and website materials, particularly to Jad Mouawad, Jethro Mullen, Merve Erdem, Astrid Dumond, Jon Custer, Christopher Gully, Julie Puech, Rob Stone and Therese Walsh.

Justin French-Brooks carried editorial responsibility.

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Typeset in France by IEA, May 2020