Global overview

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Momentum in the renewable power generation

In what now appears as presciently close to the watershed moments represented by the introduction of covid-19-related lockdown measures globally in early 2020, in October 2019, the International Energy Agency (IEA) published a bullish renewable energy market forecast in which it announced that renewable capacity additions were on course to achieve double-digit growth by the end of 2019, that solar was set to expand by 50 per cent between 2019 and 2024 (an increase of 1,200GW – equivalent to the total installed power capacity of the US today) and that offshore wind capacity globally would triple by 2024 (*IEA*, 2019 – https://www.iea.org/reports/renewables-2019).

The IEA predicts that China would likely account for 40 per cent of global renewable capacity expansion between 2019 and 2024. China's improved system integration, lower curtailment rates and the enhanced competitiveness of both solar PV and onshore wind were identified as key driving forces for such growth.

The IEA was also optimistic about Europe, citing higher planned renewables auction volumes and faster distributed solar growth among member states pushing to meet European Union renewable energy targets, whereas, in the US, the imminent cessation of federal tax incentives was seen as providing an impetus to the increasingly rapid adoption of wind and solar projects (*IEA*, 2019 – https://www.iea.org/reports/renewables-2019).

The rapid rate of innovation and evolution in energy technology and the applications of energy technology coupled with lower upfront investment and development costs have meant that energy is becoming more accessible, decentralised, interconnected and intelligent than ever before.

Energy regulators have had to keep pace with this rapid rate of development and change, as reflected in the most recent (March 2018) World Forum on Energy Regulation's (WFER) summit, which had the theme 'Regulating in a Time of Innovation'. The forthcoming 2021 summit compounds the centrality of renewable energy as a space necessitating considerable attention, in the theme 'The Energy Transformation Challenge: Competitiveness and sustainability of energy markets, opportunities and achievements', which itself will encompass topics such as the competitiveness of new energy sources and sustainable management based on energy demand.

This global overview will consider some key streams that have contributed to the momentum evident in the renewable energy market over recent years and will close by considering some of the interesting questions that will arise in the renewable energy landscape in the aftermath of the covid-19 pandemic.

Significant regulations governing, and mechanisms behind, the adoption of renewable power generation

There is a vital political backdrop to the adoption of (and transition to) renewable power generation sources. Globally recognised targets including those commitments established under the Paris Climate Agreement have encouraged governments and regulatory bodies to enact legislation and promote renewable energy investment to meet their targets: such that, by 2017, 164 countries had adopted renewable electricity generation targets, and 126 of these had additionally implemented dedicated policies and regulations to achieve such targets (*the International Renewable Energy Agency (IRENA), IEA, and the Renewable Energy Policy Network for the 21st Century (REN21)*, (2018)). Indeed, in February 2019, it was reported that 11 of the 28 EU states with targets, had achieved their 2020 targets by 2017 (the EU targets obtaining 20 per cent of energy in gross final consumption of energy from renewable sources by 2020, and then at least 32 per cent by 2030) (*Eurostat* 2019 – https://ec.europa.eu/eurostat/documents/2995521/9571695/8-12022019-AP-EN.pdf/b7d237c1-ccea-4adc-a0ba-45e13602b428). Nevertheless, in the wake of the Intergovernmental Panel on Climate Change's reports on climate change, the ocean, and the cryosphere, there has been a call for increased ambition and the ratcheting up of targets and climate-change-centric initiatives.

The policies and regulations that aid the realisation of these targets have been developed along three themes, each considered below:

- quotas and tradable certificates;
- competitively priced auctions; and
- feed-in policies.

Quotas, mandates and renewable energy certificates

Renewable energy electricity targets permeate to electricity suppliers, generators and consumers through electricity quota obligations. By the end of 2016, 100 jurisdictions had adopted some variety of electricity quota obligations, including 29 US states (*IRENA*, *IEA* and *REN21* (2018)). For example, in South Korea, which has a 10 per cent renewable energy target by 2020, the government implemented its renewable portfolio standards to accelerate its renewable energy deployment by requiring the 13 largest power companies at the time (with installed power capacity larger than 500MW) steadily to increase their renewable energy mix in total power generation (*IEA*, 2018). Power companies can meet their renewable portfolio standards targets by investing in renewable energy installations, or by purchasing renewable energy certificates (RECs) on the market.

RECs are awarded to generators for each MWh of renewable energy produced. Market operators participate by receiving or buying a number of certificates to meet the quotas set each year. The implementation of a framework of tradable certificates has become an internationally prevalent system for meeting such quotas.

Similarly, in 2017, China (via its National Development and Reform Commission) announced its intention to launch a 'green certificate' trading and subsidy scheme that requires polluters, such as coal-fired power generators, to buy certificates from renewable energy suppliers (eg, wind and solar) in a bid to decrease the extent of government subsidies provided to the renewables sector (worth 75 billion yuan in 2017). The first rollout had been criticised as unsuccessful owing to its voluntary nature (at present, few details have been provided, perhaps because the Chinese government has instead focused on green bond issuances). China has by some accounts been the world's largest issuer of green bonds since 2016, and collected US$22.9 billion in green bond proceeds in 2019).

Competitively priced auctions

An increasing number of countries are also relying on auctions to develop their energy capacity (often awarded on an annual basis), which are appealing owing to their flexibility in design and transparency in the market. In 2019, the number of countries that have held auctions for renewables reached 100 (REN21, 2004-2019) (https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jun/IRENA_Auctions_beyond_price_2019_findings.pdf).

The UK's most recent auction in 2019 awarded 12 contracts to low-carbon electricity schemes (in particular, offshore wind), which are expected to produce 29TWh of electricity each year. The contracts were awarded at such record-low prices that it is anticipated that the windfarms could generate electricity more cheaply than gas-fired power stations by 2023, seven years earlier than expected (https://www.carbonbrief.org/analysis-record-low-uk-offshore-wind-cheaper-than-existing-gas-plants-by-2023). The IEA noted that, in 2019, EU member states awarded wind and solar PV capacity in competitive auctions successfully enough to close the gap on 2020 targets (IEA, 2019).

However, the limitations of auctions include the risk of underbidding to win the contracts and the risk of driving smaller entry-level players out of the market. Therefore, auctions are commonly implemented alongside other initiatives, such as RECs, or simply backed by government guarantees (as is the case in Argentina and Zambia).

Feed-in tariffs and feed-in premiums

Administratively set feed-in-pricing policies (FITs and FIPs) have been crucial in encouraging renewable projects worldwide, providing stable income to generators, in turn increasing the bankability of energy projects, such that in 2017, according to IRENA, 80 countries had adopted FITs and FIPs (up from 34 in 2005). Feed-in pricing policies have proved to be successful across the globe, no more so than in Japan, which, marking a change in its energy policy following the Fukushima earthquake, introduced its FIT scheme in 2012. Since then, Japan's solar photovoltaic capacity has increased markedly, to more than 56GW at present.

Dynamic markets

Known as the 'three Ds', the world's electricity systems have begun 'decentralising, decarbonising, and democratising', each driven by a need to reduce electricity costs, replace ageing infrastructure, improve resilience and reliability, reduce carbon emissions and provide reliable electricity to areas lacking electrical infrastructure (*Hirsh*, et al, 2018). Distributed Energy Systems (DES) is a term that encompasses a diverse array of generation, storage and energy monitoring and control solutions, offering building owners and energy consumers significant opportunities to reduce cost, improve reliability and secure additional revenue through on-site generation and dynamic load management (*Arup and Siemens*,2016).

Two DES technologies reshaping the energy market in this way are energy storage and microgrids.

As the latter is significant to the provision of sustainable infrastructure, this is addressed in more detail below.

Energy storage

To ensure all electricity grids maintain a stable and safe electricity supply, consumption has to be perfectly balanced with the generation of electricity. The development of energy storage can help address fluctuations in demand and generation by allowing excess electricity to be 'saved' for periods of higher electricity demand. In turn, energy storage technologies can contribute to better use of renewable energy in the electricity system, as renewable energy produced can be stored when conditions are optimal but demand may be low. Similarly, the right of consumers to produce and consume their own electricity may lead to an increase in demand for storage services and small-scale storage solutions

However, the European Commission has noted several factors slowing the development of energy storage technologies, such as administrative and regulatory barriers, limited access to grids, and excessive fees and charges. Treatment of electricity storage is not consistent between EU member states and so, in several countries, storage facilities pay grid fees both as consumer and producer, despite being unable to provide a positive net flow of electricity, which is used to justify double network usage charges (*Gissey, Dodds and Radcliffe*, 2018).

In March 2018, in the UK, Abu Dhabi energy company Masdar and Norwegian multinational Equinor (formerly Statoil) unveiled the world's first energy storage battery connected to a floating windfarm in Scotland. Deployed at an onshore substation, the battery system known as Batwind has a storage capacity of 1.2MW and is aimed to mitigate peaks and troughs in electricity production. This combination of battery storage and microgrid technology is a prime example of innovative technologies creating a dynamic market; however, these technologies are equally significant in providing sustainable infrastructure. In 2019, a windfarm near Rotterdam adopted a similar battery system, with a 10MWh capacity, thereby enabling the 68GWH produced by the windfarm each year to be utilised more efficiently (https://www.energy-storage.news/news/large-scale-battery-prevents-dutch-wind-farms-power-from-being-wasted).

Disruptive sustainable infrastructure technologies

Microgrids

Taking the US as an example, the majority of its current electrical grid is outdated and in need of repair, such that a combination of maintenance and power outages costs the US economy (and treasury) billions of dollars in losses (*Arshavsky*, 2017). This is illustrated by the fact that the US averages 360 minutes of outages each year, compared with 15 minutes in Germany and 11 in Japan (G Bakke, 2016). Coupling this with recent disastrous natural disasters in the US, such as the three successive hurricanes in the Gulf of Mexico and the southern US in 2017, the usefulness and sustainability of microgrids is becoming increasingly apparent (*Metelitsa*, 2017). Indeed, the global microgrid market is expected to reach US$47.4 billion by 2025, up from US$28.6 billion in 2020 (https://www.marketsandmarkets.com/Market-Reports/micro-grid-electronics-market-917.html#:~:text=The%20global%20microgrid%20market%20size,at%20a%20CAGR%20of%2010.6%25.) Many point to the following definition from the US Department of Energy as a commonly understood description of microgrids:

> *[A] group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both a grid-connected or island mode.*

Navigant Research, which has tracked the development of microgrids across the globe, suggests the US and Asia have similar capacity for operating, developing and proposed microgrids – each with 42 per cent of the market, with Europe on 11 per cent, Latin America on 4 per cent, and the Middle East and Africa currently sharing only 1 per cent (Hirch et al, 2018).

African countries have been relatively slow to adopt the technology, however, Nigeria's Rural Electrification Agency announced plans to develop 10,000 microgrids by 2020 to meet its universal electrification ambitions, to be secured by a US$350 million loan from the World Bank (*ClimateScope*, 2017).

The WFER summit identified the following projects as recent leading examples in this sector:

- provision of stable energy supply for an off-grid island, Ventotene, in Italy;
- installation of a low-carbon based microgrid in Blue Lake, Rancheria, California, with the capacity to island and supply uninterrupted electric power for seven days during an outage;
- operation of a self-sufficient island grid in Wildpoldsried, Germany, disconnected from the main grid while using a hybrid structure of wind turbines and photovoltaic systems and battery storage systems; and
- developing a state-of-the-art dynamic combustion chamber with an energy back-up and integrated data network for the Minera Buenavista del Cobre, Mexico.

However, Hirch et al (2018) argue that a clear legal identity for microgrids is needed to achieve the regulatory certainty required to make microgrid projects 'bankable', otherwise the potential costs are too high and benefits too uncertain to justify investing time and money. Pointing to the US as an example, Hirch et al (2018) warn that state utility regulatory agencies may treat microgrid services like utilities, such that they can regulate the rates charged for utilities and decide whether to approve the facility construction. However, should microgrids qualify as a distribution utility, they may inadvertently take on an obligation to service retail customers at request. Both of these designations pose significant implications for microgrid developers, owners and investors.

Covid-19: friend or foe for renewable energy?

Foe

In May 2020, as countries in Europe, the Middle East and Africa began to announce roadmaps for easing lockdown, the IEA published an update to their October 2019 *Renewable Energy Report*. This updated report noted that renewables, like other industries, are vulnerable to new risks stemming from the covid-19 pandemic.

Immediate effects include the impact of social-distancing and lockdown measures on supply chains – causing disruption and delays in project construction – as well as to the maintenance of existing projects (the availability of staff to run them). By mid-May, the world's top growth markets in 2020 had been subject to four to 10 weeks of non-essential business closure or lockdown. The effects of this on the renewable energy sector will vary from country to country: in India, for example, renewable energy project construction continued throughout lockdown whereas in Japan major construction sites were closed when the country entered a state of emergency. Even where construction continued, where restrictions were in place capping the numbers of workers allowed on site at one time, construction is expected to have been slowed down, in the view of the IEA, putting projects in Europe, China and the US at risk of missing financial incentives tied to policy deadlines (and so, if such incentives are no longer within reach, putting the projects at risk of cancellation altogether). To combat this, the Austrian, German, Danish, French and Greek governments, among others, announced some form of extension to the commissioning or construction periods for renewable energy projects (*IAE*, 2020).

The effects of supply chain disruption will be similarly uneven across regions. More than 40 per cent of the world's supply chain is reliant on the export of certain parts from China, Vietnam and Thailand. For example, in solar PV, the Chinese companies Hanwa, Jinko, Rene Solar, Yingli and Trina Solar supply more than 50 per cent of the world's photovoltaic modules and cells. These companies halted production at their sites in response to the pandemic for two months, triggering a global supply chain upheaval (*Power Technology*, 2020 – https://www.power-technology.com/comment/covid-19-impact-renewable-energy-projects-poll/).

The effect of liquidity squeezes on the development of renewable projects is a further potentially negative ramification of the covid-19 pandemic. Governments across western Europe have warned of imminent recessions. Such severe liquidity squeezes at the governmental level is concerning both for projects already at an advanced stage of development (will there be enough liquidity to finance them?) and for projects not yet commissioned. The IEA also raised concerns as to the dampening effect the crisis may have had on the commissioning of new renewable energy projects (*IEA*, 2020 – https://www.iea.org/reports/renewable-energy-market-update/covid-19-impact-on-renewable-energy-growth).

Commercial banks additionally appear set to suffer from liquidity shortages. Standard & Poor's (S&P) has said that covid-19 will expose funding and liquidity weaknesses at banks in Turkey, the Middle East and Africa (in particular). S&P points towards higher funding costs, increasing capital outflows and lower lending growth as 'characterising the months to come' (*Standard & Poor's*, 2020 – https://www.spglobal.com/ratings/en/research/articles/200406-covid-19-exposes-funding-and-liquidity-gaps-at-banks-in-the-middle-east-turkey-and-africa-11408159). Whether these liquidity issues will feed through into damped appetite for investing in greenfield projects is yet to be clearly shown (though certainly seems likely). Against this backdrop, the role of development banks, as in 2008, may again take on special significance in project financings. Indeed, Germany's KfW has already announced plans to increase lending by €100 billion. The European Investment Bank, too, has extended its existing Sustainability Awareness Bond (due in 2028) to deploy €40 billion to support European recovery through the financing of urgent infrastructure improvements and equipment needs (in the health sector).

Friend

Irrespective of the risks described above, the specialist industry but also everyday media have expressed a shared and cautious sense of optimism about the leading role renewable energy could play in economic and social recovery plans.

In the UK, business leaders and environmental campaigners have called for a 'green revolution' as the country rebuilds after the crisis. Greenpeace and chief executives from entities such as HSBC, the National Grid and Heathrow airport, have written to the prime minister, Boris Johnson, asking that the government prioritise investment in low carbon technologies, and calling for the UK's existing decarbonisation process to be accelerated. Johnson has said that he seeks a 'fairer, greener and more resilient global economy' following the covid-19 pandemic.

Perhaps of more importance than goodwill is the financial benefits of a 'green revolution' – which appear convincing.

Lockdowns across the world have precipitated a unique and sustained drop in energy demand (including for electricity). As people have begun to work from home, this has manifested in many different ways including by reducing demand for power across the transport sector. Changes in work and home life patterns are resulting in changes to peak usage times and both residential and commercial demand curves. The IEA estimated that weekly electricity demand had decreased by 10 to 35 per cent across affected regions. Such lifestyle changes may in some cases be here to stay: for example, Sadiq Khan (the mayor of London) is championing plans to transform London into a greener city than ever before, with, at the time of writing, a focus on adapting the city's transport system to accommodate and encourage cycling over driving (and taking public transport such as the tube – now intended to be as empty as possible for the benefit of key workers).

Coal has been particularly hard hit (though the fall in the oil price by more than half has also shown the oil industry's fragility). In Britain, as of midnight on 10 June 2020, the electricity grid had not burnt any coal for 60 days – the longest period of non-coal burning on the grid since the Industrial Revolution more than 200 years ago. In India, one of the fastest-growing users of coal, demand has significantly dipped (contributing to the country's first fall in carbon dioxide emissions for nearly 40 years). Some commentators have begun to question whether the coal industry will ever recover (*BBC*, 2020).

At the same time as a decrease in overall electricity demand, the overall share of renewable energy to meet remaining demand has increased. Falling electricity demand, paired with additional renewable 2019 capacity coming online, has caused record-high shares of infeed from variable renewables in electricity demand regions such as Italy, Austria and Belgium (which have seen record-high hourly variable renewable energy use of almost 63 per cent, 70 per cent and 67 per cent respectively) (*IEA*, 2020).

Crucially, renewable energy is significantly cheaper than traditional fossil fuel energy generation. Renewable projects are increasingly cheaper to build than fossil fuel projects, and, once built, the 'fuel' of wind, sunshine and rain are all free – whereas coal (and other fossil fuel feedstocks) must be bought during the lifespan of the project. Long-term investors may become reluctant to invest in coal projects with lifespans of 30 to 40 years when it is those projects that are the first to be turned off in times of crisis (as renewable energy can meet a fall in demand), and renewable projects can be built more cheaply in any case. When governments decide between which industries to bail-out during recovery, renewable energy projects can convincingly compete with traditional fossil-fuel-burning projects.

Added to this is the social and reputational pressure that investors are increasingly under to move away from coal-fired projects (the Norwegian sovereign wealth fund (the biggest wealth fund in the world), and several financial players such as Blackrock, Standard Chartered and BNP Paribas, have all blacklisted coal investments).

On balance, and while there are no winners from the covid-19 pandemic, the outlook for robust renewable energy development is significantly less bleak than the discussion on economic and social recovery. Tentatively, and amidst the otherwise relentlessly negative after-effects of the pandemic, there is reason for real hope and optimism in the renewable energy space.