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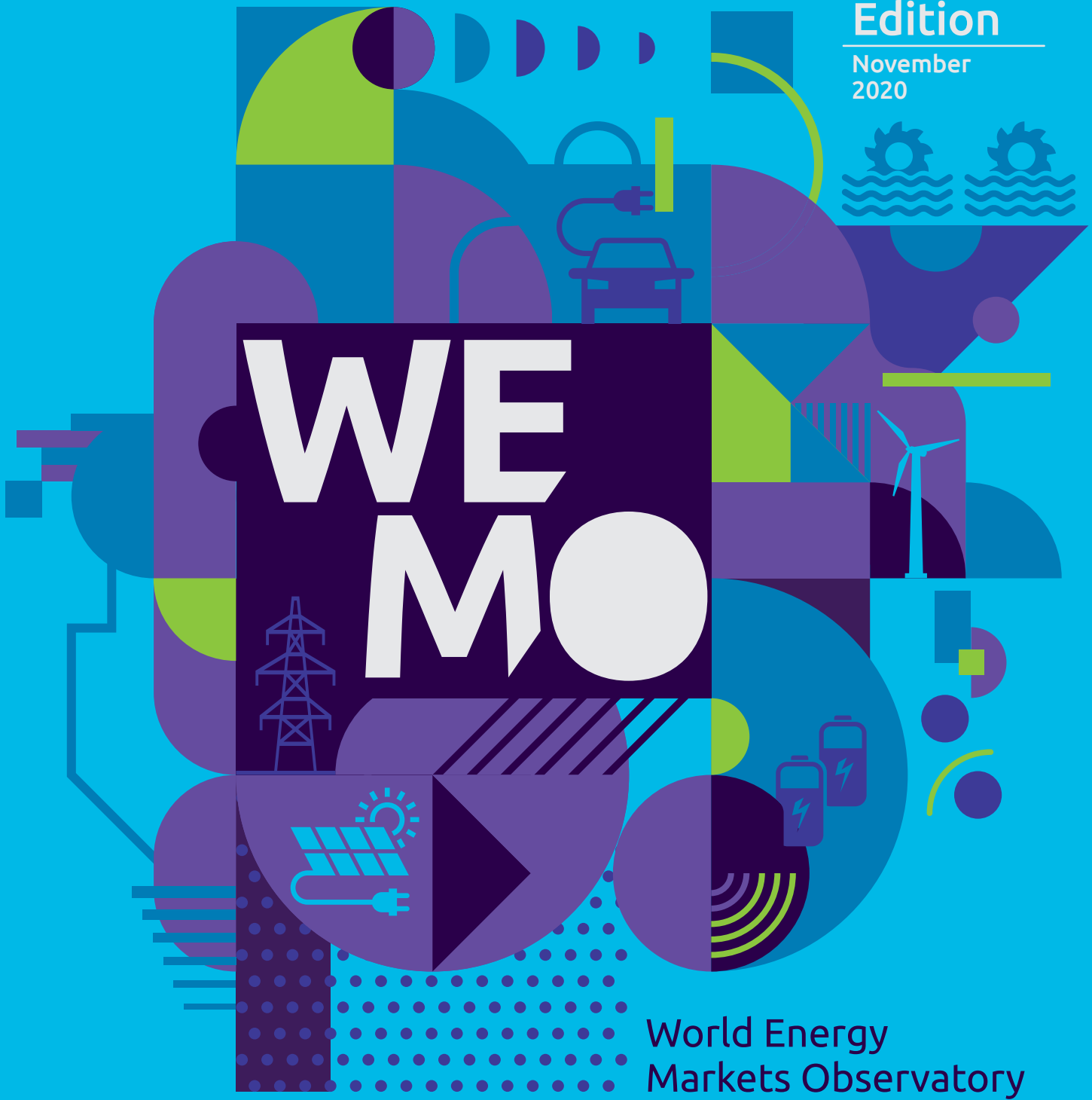

World Energy Markets Observatory

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WEMO 2020 Global Editorial

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This WEMO edition reviews an exceptional period with two distinctive phases:

- In 2019 worldwide economic slowdown combined with energy transition measures resulted in some improvements regarding climate change objectives. However, the world was not on track to meet the 2015 Paris agreement objectives.
- In 2020 our planet suffered from the COVID-19 pandemic and the economic crisis that followed, plunging our world into a long period of uncertainty.

In 2019, small progress in climate change objectives

In 2019, the worldwide economy slowed down. Average GDP for G20 countries increased by +2.9%, a 0.8 point decrease compared to 2018[1]. This resulted in a slower energy consumption increase: lower than expected oil consumption growth as a consequence of new vehicle efficiency standards, continuation of the coal to gas shift in power plants, and renewables development – all helping to decrease GHG[2] emissions. A contrasted evolution is observed between developed countries mastering energy and fossil fuel consumption and developing countries, notably China, where fossil fuel (notably coal) consumption and emissions growth continued.

Electricity is widely recognized as the best decarbonization vector, however its consumption growth across the G20 countries slowed down in 2019 (+0.7% vs +3.6% in 2018). China, which accounts for a third of G20 electricity consumption, posted a 4.5% growth, but this was much lower than the average growth observed since 2007 (7.5%per year).

Energy consumption increased less than in previous years: +0.7%[3] (compared to +2.2% in 2018). It decreased in OECD countries but increased in non-OECD ones. The reduction in energy intensity[4] is regular at around -1.5 to -2 points per year which reflects energy effectiveness progress.

Oil consumption grew by 0.9 million barrels per day (b/d) (or 0.9%) slightly lower than the 10-year average of 1.3%. The growth was weaker than expected as new vehicle efficiency measures have started to weigh on transport fuel consumption.

Growth was led by China, where demand rose by 680,000 b/d, the largest increase in the country's demand since 2015. In most developing countries the growth was below average. OECD demand fell by 290,000 b/d, the first decline since 2014.

Oil production fell slightly by 60,000 b/d in 2019 as strong non-OPEC production growth, led by the US (10% growth year on year), was offset by a sharp decline in OPEC production. Nevertheless, the market was well supplied, and oil prices decreased slightly, with Brent averaging $64.21/b, $7/b lower than in 2018. Compared with recent years, oil prices were relatively stable during the year. An exception was on Monday, September 16, 2019: After an attack on key energy installations in Saudi Arabia, the Brent oil price increased by $9/b. The price increase was relatively short, and prices returned to pre-attack levels by the end of the month as Saudi Arabia was successful in bringing production back online rapidly.

1 https://www.enerdata.net/publications/reports-presentations/world-energy-trends.html
2 GHG: Green House Gases
3 https://www.enerdata.net/publications/reports-presentations/world-energy-trends.html
4 Energy Intensity is measured by the quantity of energy required per unit output or activity.

Concerns about demand growth led OPEC+[5] countries to agree on December 7, 2019, to deepen the production cuts originally announced in December 2018.

Natural gas consumption increased by 2% in 2019 , below its 10-year average and down sharply from the exceptional growth seen in 2018 (5.3%). In volume terms, demand increase was led by the US and China.

Gas production grew by 3.4% outpacing growth in consumption. US natural gas production increased by 10% after strong growth in 2018. It accounted for almost two-thirds of net global growth. Australia and China also contributed to this supply growth.

Much of 2019's increase in gas production was used to feed additional exports of liquefied natural gas (LNG). LNG exports grew by 12.7%, the strongest import growth since 2010, driven by record increases from the US, where five terminals are now operational, and from Russia, which increased by 60% its LNG exports.

Nearly all incremental LNG supplies headed to Europe, which accounted for 36% of US LNG exportation.

The European Union is importing more and more LNG from the US to diversify its supplies and make them less dependent on pipeline imports from Russia.

US Henry Hub prices dropped almost 20% to average $2.53/Mbtu[6], while European and Asian prices fell by more than 40% (averaging $4.47/Mbtu and $5.49/Mbtu respectively). Prices in Europe, the region most affected by LNG oversupply, fell to their lowest levels since 2004.

As international gas trade is still limited, prices differ from one region to another. While there is still a significant spread between US and European prices, thanks to LNG development the spread between Asia and European prices was only $1/Mbtu.

Coal consumption decreased overall by 0.6%. It continued to increase in some emerging economies, particularly in China, Indonesia and Vietnam. These increases were more than offset by decreases in demand in the developed world (-10% in OECD countries) as a result of policies in place in Europe (notably in Germany) to close coal-fired plants. In the US cheap gas continued to replace coal in the power sector. As a result of gas consumption increase and renewables growth, coal's share in the energy mix fell to 27%, its lowest level in 16 years. Thermal coal prices fell by 30% over the year.

Nuclear energy:

In 2019, nuclear energy provided about 10% of the world's electricity from 450 power reactors and is the second lowest carbon source of electricity after hydropower[7].

The nuclear situation varies. In Europe and North America, construction of new plants is difficult and projects such as the two EPRs at Olkiluoto in Finland and Flamanville in France are experiencing huge delays and budget overruns[8]. At the Flamanville reactor (which should start operations in 2023) the cost of electricity produced is estimated at € 120/MWh, nearly triple EDF's price for its new offshore wind project at Dunkirk (€44/MWh).

In contrast Russia, China and other Asian countries are successfully building new plants. In China two EPRs built by CGN with EDF support successfully started operations in 2018 and 2019 after "only" five years' delay.

Early September 2020, nuclear fuel loading into the No. 5 unit of China's Fuqing Nuclear Power Plant under China National Nuclear Corporation started, marking an important step towards its operation that is scheduled to start by end 2020. The No. 5 unit is the world's first pilot project using China's indigenous third-generation nuclear power technology Hualong One.

In 2019[9], 5.5 GW of additional nuclear capacity were connected to the grid in Russia (including "Akademic Lomonosov", a 70 MW floating nuclear reactor[10]), China and South Korea and 9.4 GW were permanently shut down in US, Japan and Taiwan-China, bringing global capacity to 443 GW. New projects were launched (about 5.2 GW), and refurbishments are under way in many countries to ensure the lifetime extension of the existing fleets.

On August 1, 2020[11], the United Arab Emirates (UAE) successfully opened a nuclear power plant, becoming the first Arab country to produce nuclear energy and the first new country to launch a nuclear power plant in three decades, the last being China in 1990. The $24.2 billion (€19 billion) Barakah plant is being developed

5 OPEC + includes OPEC-Organization of Petroleum Exporting Countries- members at its allies notably Russia.

6 Mbtu: Million British Thermal Unit

7 https://www.iaea.org/newscenter/news/preliminary-nuclear-power-facts-and-figures-for-2019

8 According to the July 2020 "Cour des Comptes "report, Flamanville EPR budget was multiplied by 3 (total amount €12.4 bn) and construction time by 3.5. Delays for Olkiluoto EPR have reached 12 years with cost overruns similar to Flamanville's

9 https://www.iea.org/reports/nuclear-power

10 https://time.com/5659769/russia-floating-nuclear-power/

11 https://www.cnbc.com/2020/08/03/uae-becomes-first-arab-country-to-launch-local-nuclear-energy-program.html

by a consortium led by the Korea Electric Power Corporation. The aim is to operate four nuclear power plants (in total 5,600 MW capacity) that will provide a quarter of the country's energy needs in an emissions-free way.

New nuclear constructions in the Western world face many hurdles among which are: public opinion, green parties' opposition, increasing complexity of reactors linked to more stringent safety requirements, and Utilities' lack of efficient construction management. Construction of Small Modular Reactors should be easier.

SMRs: Global interest in small and medium sized or modular reactors (SMRs)[12] is increasing due to their ability to meet the need for flexible power generation[13]. They also have an enhanced safety performance through passive safety features, necessitate less upfront capital investment, and are easier to build as they are deployable either as a single or multi-module plant and as they include large components designed to be built in factories. However, they occupy significantly more land per unit of electricity generated.

There are about 50 SMR designs and concepts globally. Most of them are in various developmental stages and some are claimed as being near-term deployable.

Among these the most advanced is probably the US firm NuScale Power SMR. End August 2020 the American Nuclear Regulatory Commission (NRC) had approved the safety aspects of this reactor design. It is the first SMR to receive such NRC approval. According to the Company's announcements its first plant should be operational by 2027[14].

In Canada, in 2018, NuScale signed partnership agreements with the two Canadian nuclear operators OPG and Bruce Power and is proceeding with submissions to the Canadian Nuclear Safety Commission for licensing approvals.

According to IEA, new nuclear construction is not on track with its Sustainable Development Scenario[15] as nuclear capacity in 2040 will amount to 455 GW – well below this scenario level of 601 GW. Additional lifetime extensions and a doubling of the annual rate of capacity additions are therefore required. With the present trends, this target seems extremely difficult to meet.

Renewables:

In 2019 capital spending in wind and solar PV accounted for almost half of total power plant investment.

Onshore wind-generated electricity increased by an estimated 12% in 2019[16], remaining the largest non-hydro renewable technology and generating almost as much as wind offshore and solar together.

China's onshore wind capacity expanded from 19.0 GW in 2018 to 23.8 GW in 2019 as the government lifted development bans in certain regions in response to the decrease of electricity curtailment levels reflecting better grid balancing conditions.

In the European Union, onshore wind capacity growth accelerated in 2019 with 9.1 GW becoming operational, 17% higher than growth in 2018. In the US, onshore additions rebounded from 6.9 GW in 2018 to 9.1 GW in 2019 as developers wanted to benefit from full production tax credits before they end in 2020. In India,

12 SMR produce electricity of up to 300 MW per module

13 https://www.iaea.org/topics/small-modular-reactors/smr-regulators-forum

14 https://www.neimagazine.com/news/newsnuscales-first-smr-plant-should-be-completed-by-2027-7254981

15 In this scenario, the Paris Agreement on climate change objectives are met

16 https://www.iea.org/reports/onshore-wind

deployment levels in 2019 remained at the low level observed in 2018, reaching only 2.4 GW due to policy and market uncertainties.

Grid-connected ***offshore wind*** additional capacity amounted to 5.9 GW in 2019, 40% higher than in 2018. Expansion is accelerating in China, and in the European Union additional capacity grew again after a slowdown in 2018, with record installations in 2019[17]. In France after several years of delay due to legal procedures, the first French offshore farm construction was launched in Saint-Nazaire in June 2019. This 480 MW capacity project will be built by EDF and Enbridge.

China is strengthening its position as a leader in offshore capacity additions with around 2 GW of new installations in 2019, followed by the UK (1.6 GW) and Germany (1.1 GW). In the US, developers have proposed multiple projects in four different states (Maryland, New York, New Jersey, and North Carolina). According to a Wood Mackenzie study[18], in the next decade US investment in offshore wind projects is predicted to rise from virtually nothing 10 years ago to $78 bn which is comparable with the $82 bn planned for US offshore oil development.

Solar: In 2019 additional capacities and production grew respectively by 18% and 22%, however at a slower pace than in 2018 due to China's slowdown.

After months of uncertainty, on April 10, 2019, China's National Energy Administration (NEA) released a consultation paper that defined how China intends to move forward in the remaining period of the 13th "Five Year Plan"[19,20], a period in which the Chinese market will evolve from a subsidy-driven market to both grid-parity and FIT (Feed In Tariff) supported projects. It is expected that the market will eventually enter a subsidy-free era starting from 2021 or slightly later.

These policy uncertainties have led to a 32% decline in annual capacity additions for solar PV that amounted to 30 GW compared with 44 GW in 2018[21]. Lower installation figures in China pushed Chinese manufacturers to export. PV module exports increased by 45% in 2019 compared to the previous year, meaning lower PV prices across the globe and decreasing installation costs.

One could expect a rush for renewables permits and constructions before the end of FITs in 2021; however, this rush could be slowed down by pandemic-related construction delays

In certain Chinese regions, and elsewhere with a high renewables share in the electricity mix, variable renewable plants (solar and wind) cannot operate at full capacity because of oversupply or an insufficiently robust transmission grid. During certain periods, electricity generation must be curtailed.

In 2019 in China, the curtailment rates for those energies dropped compared to the previous two years and reached "only" 4% (of annual generation) for wind and 2% for solar.

During the COVID-19 pandemic renewables developers have experienced supply chain disruptions, and lockdown measures have slowed construction and permitting activity resulting in a reduction of short-term capacity additions mainly in 2020 but also the following year.

A second consequence is that delayed projects may run the risk of not reaping the benefit of incentives ending in 2020. It is reasonable to assume that most projects missing incentive deadlines may be further delayed or cancelled. In order to address these concerns, several countries have introduced policy changes[22].

Renewables technology and costs improvements: The ongoing increase in wind turbine size[23] for onshore applications should continue, from an average of 2.6 MW in 2018 to 4-5 MW for turbines commissioned by 2025. For offshore applications, the largest turbine size of around 9.5 MW in 2019 will be surpassed; projects to be commissioned in 2025 should comprise turbines with 12 MW capacity.

The combination of improved wind turbine technologies, deployment of higher hub heights, and longer blades with larger swept areas together, with digitization and better generation forecasting software, leads to increased capacity factors for a given wind resource. For onshore wind plants, the global weighted average capacity factor should increase from 34% in 2018 to more than 40% in 2030.

For offshore wind farms, more progress should be achieved, with capacity factors in the range of 36% to 58% in 2030, compared to an average of 43% in 2018.

17 https://www.iea.org/reports/offshore-wind

18 Financial times July 2020

19 https://www.apricum-group.com/towards-a-subsidy-free-era-for-chinas-solar-pv-market/

20 13th five-year plan: 2016-2020

21 https://www.power-technology.com/comment/solar-pv-capacity-additions-china-2019/#:~:text=Annual%20capacity%20additions%20for%20solar,was%20installe

22 https://www.iea.org/reports/renewable-energy-market-update/covid-19-impact-on-renewable-energy-growth

23 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Oct/IRENA_Future_of_wind_2019.pdf

Over the past 10 years, the LCOE[24] of onshore wind has fallen by 8% each year since 2010 to reach a range of $45 to $65 /MWh worldwide.

In addition to capacity factor increases and economy of scale, offshore turbine foundations are improving with floating platforms adapted from the oil and gas industry. The average worldwide offshore wind LCOE has also decreased to reach a range $79 to $118 /MWh. Further decreases are expected as illustrated by the September 2019 UK auction where the strike price for a planned commissioning in 2025 was in the range of $49-52 /MWh.

Solar Photovoltaic (PV) panel efficiencies are improving as well as their spectral responses to solar light impact.

There are three dominant technologies: multi-crystalline silicon, mono-crystalline silicon, and thin film cadmium telluride. The latter technology, which currently has the smallest market share, surpasses the crystalline silicon PV module technologies in terms of sustainability and yield performance. It is expected to increase its market share in the future.

In addition to improved solar cells, better Balance Of Plant design and smart sensor additions led to even more spectacular decreases in the generation cost for photovoltaic solar than for wind. It decreased by 18% per year to reach the range of $34-67/MWh.

In certain regions this cost can be even lower as illustrated by the Al Dhafra solar project in Abu Dhabi. On July 27, 2020, the bidder consortium, formed by French EDF Group subsidiary, EDF Renewables, and the Chinese Jinko Power Technology Co. Ltd, was awarded this solar photovoltaic project, which will be the largest solar plant in the world with a capacity of 2 GW. It will also be the first one on such a scale to deploy bifacial module technology (meaning that both sides of the PV modules capture light to yield higher generation). The bid was awarded at $13.5/MWh[25] on an LCOE basis.

As wind and solar are intermittent sources of electricity, they have negative effect on grid balancing systems.
In certain Chinese regions where there is a high share of wind generation, regulators have introduced grid penalties, or they do not authorize projects that are not contributing to system balancing. This promotes combined renewables with storage and hybrid farms linking wind, solar and storage.

If one does not consider the additional costs incurred for grid operators (grid design revision and balancing extra costs), onshore wind and solar are competitive with other sources of electricity generation such as the existing nuclear reactors.

Batteries: It is essential to add energy storage to intermittent renewables generation.

The cost of battery storage has fallen sharply (by 19% per year over the past 10 years) to reach a market average at $156/kWh[26] range of $175-234/kWh. According to BNEF's forecast, prices are projected to fall to around $100/kWh by 2023 increasing electrification of the economy[27].

Tesla is getting ready to introduce lower-cost, longer-lasting batteries for its electric vehicles in China in late 2020. This battery is being co-developed with Chinese battery giant Contemporary Amperex

24 LCOE: Levelized Cost Of Energy

25 https://www.power-technology.com/projects/al-dhafra-solar-project-abu-dhabi/

26 https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/

27 For example, commercial electric vehicles, like delivery vans, would become increasingly attractive

Technology Co. Ltd (CATL). Its cost should be as low as $100/kWh, which would allow Tesla and other automotive manufacturers to make EVs[28] far more accessible. General Motors[29] is also trying to match Telsa performances by mid-2020.

Mega-factories are expanding: As of December 2019, the number of lithium ion battery mega-factories in the pipeline has reached 115 plants, (88 of which are planned in China) amounting to 564 GWh capacity addition to a global total of 2,068.3 GWh or the equivalent of 40 million EVs by 2028.

The market is dominated by Asian players: in 2019, the largest Li-ion battery manufacturers were LG Chem from Korea (production capacity over 50 GWh), CATL (production capacity over 40 GWh) and Panasonic from Japan (production capacity 35 GWh).

Li-ion batteries have by far the largest market share. In the last decade, adjusting the chemical composition of the cathode, as well as mastering the manufacture and packing of battery cells, allowed increased energy density and significantly lowered the cost of production.

Batteries' improvements: Research and development efforts are now focusing on improving energy density, increasing charging speeds, and lowering cost.

Safety improvement by reducing Li-ion batteries' inflammability is a key issue. In April 2019 a very damaging explosion took place at a 2 MW Li-ion battery storage facility near Phoenix (Arizona). In a report released in July 2020, its root causes are debated, and the report concludes that safety standards need to be revised. Arizona Public Service had installed those batteries to help manage generation fluctuations due to clouds or the setting sun in areas with many rooftop solar panels. While APS has pledged to build 850 MW of battery energy storage by 2025, this accident has put all plans in Arizona on hold. Across the US, battery storage is projected to take off as states mandate a growing renewable power capacity share. The country was on track to install 2,500 MW of battery storage by 2023[30].

Other research and development efforts are focusing on new electrolytic couples such as Aluminum-air and Zinc -air. In the US, researchers[31] have developed a low-cost Sodium-ion battery that could compete with Lithium-ion chemistries for energy density and reliability.

BMS (battery management systems) are also getting more sophisticated in order to adapt to different battery usages.

Second-life battery re-use (for example as stationary storage improving grid balancing) and end-life recycling are issues that are starting to be addressed.

Also, battery producers are trying to limit the use of heavy metals such as cobalt: More than 50 percent of the world's supply is produced in the Democratic Republic of Congo in questionable humanitarian conditions. Thus, in early 2020, General Motors announced that its new generation of batteries will use 70 percent less cobalt.

Hydrogen: The most common way to produce hydrogen is from fossil fuels; however, this process releases a lot of greenhouse gases.

In 2019, green hydrogen produced from electricity was around three times more expensive than that produced with natural gas but as the cost of electricity generated with solar and wind continues to decrease, green hydrogen production and usages should develop.

Presently hydrogen is used in industry processes and is starting to be used in transportation (trains , buses, ships).

In the future, it could provide flexibility services on the grid becoming a good complement for important renewable intermittent generation by participating in demand response and in electricity storage. Hydraulic storage and hydrogen are the main inter-seasonal storage solutions as stationary batteries can only provide daily electricity storage. Unfortunately, in western countries nearly all suitable sites are already equipped with dams.

With the increasing share of renewables (thus a decreasing share of schedulable electricity), green competitive hydrogen could enable storage of large amounts of electricity needed to stabilize the grid.

GHG emissions: *Energy-related* global GHG emissions have decreased year on year by 0.4%[32] for the first time since 2009 with contrasting situations between non-OECD countries where GHG emissions have increased by 1.3% and OECD countries where they decreased by 2.8%.

From 2014 to 2017, *total worldwide annual GHG emissions* had stabilized, but they started to grow again by 2.7% and 0.6% in 2018 and 2019,

28 EV: electric vehicle

29 https://edition.cnn.com/2020/03/04/business/gm-electric-car-battery-400-miles-of-range/index.htm

30 According to data from the US Department of Energy's Energy Information Administration

31 Washington State University (WSU) and the Pacific Northwest National Laboratory (PNNL)

32 They represent 58% of total G20 emissions

respectively. In 2019, global emissions reached another record high.

At the end of 2019, according to IEA, the world was not on track to meet its agreed target of limiting warming to 2°C. Under current policies, expected warming will be in the range 3.1-3.7°C.

What decisions need to be made to get on track to meet climate change objectives?

Investment decisions:

Hydropower is the largest source of low-carbon electricity worldwide and nuclear power the second. Together, they represent 70% of low carbon electricity generation. In advanced economies nuclear power is the largest low carbon source of electricity but in those countries its future role will decrease as governments trying to get green parties' support are prematurely phasing out nuclear plants. A good example of these political decisions that have no technical or environmental grounds is the closure of the two French Fessenheim reactors in H1 2020: If renovation work had been carried out, they could have continued for 10 more years. Moreover, the French Energy Transition law did not request such closure as the new Flamanville reactor will not start before 2023. An indemnification protocol was signed between the government and the reactor's owner, EDF, amounting to a fixed part of around €400 million and a variable part corresponding to EDF lost production revenue until 2041.

The extension of hydropower and nuclear generation installations are sound investment decisions. This is also the case for energy efficiency measures in industry, buildings and transportation. With buildings accounting for more than 30% of global energy consumption and 30% of energy related GHG emissions, investment in retrofitting existing buildings[33] needs to accelerate. However, as a result of COVID-19 lockdown, investment in buildings energy efficiency is likely to drop by nearly 15% in 2020 from around $150 billion in 2019.

Most post-COVID stimulus plans include incentives for building efficiency improvements. In addition to increased funds, simplified administrative approaches addressing shortages of skilled providers, and increasing decision makers' confidence, are crucial.

In contrast, measures such as switching to biofuels, or adding CCUS[34] to a coal-fired power plant, would reduce emissions but would also generate significant additional cost over their lifetimes.

Regulatory decisions:

- *In China,* the emphasis of the 13th plan on environmental development was impressive with measures related to the electric power development and sustainable energy supply. Emissions reductions goals were partially achieved by 2018 as carbon intensity decrease reached more than 45% of the 2020 goal, while the use of non-fossil energy has almost hit its 15% goal. However, after a dramatic decline in 2016-2018, 2019 saw an increase of 5% in coal utilization. Let's not forget that coal is a domestic Chinese resource and the new countries' nationalistic approach could explain this trend change.

33 Existing buildings are expected to account for up to 80% of the stock in 2030 in certain countries

34 CCUS: Carbon Capture Usage and Storage

- *Carbon Dioxide* (CO_2)
  Two main regulatory schemes exist to limit CO_2 emissions: The Emissions Trading Scheme and the carbon tax. Of the 34 OECD members (out of 37) who have implemented one or other scheme, 45% have an ETS system, 39% combine this with a carbon tax, and 8% impose the carbon tax alone.
  - ***ETS scheme in Europe:*** Carbon prices increased in 2019 up to €25/t thanks to the Market Stability Reserve (MSR) implementation that absorbed excess allowances off the market. In March 2020 during the COVID-19 pandemic lockdown, carbon prices decreased to €15 /t accelerating the electricity spot price decrease. At these low levels it has little effect on CO_2 emissions decrease. On September 14, 2020 it increased again to €30/t[35].

    One important issue is to clean coal fired plants, which are numerous and still growing, by installing a CCUS system. A minimum carbon price of €50 /t is needed to make this happen.
  - In 'The Value of International Electricity Trading'[36] report, researchers from UCL and the University of Cambridge show that the *tax on carbon dioxide emissions* in Great Britain, introduced in 2013, has contributed to the decrease of the coal-fired share in the electricity mix, from 40% to 3% over six years, replaced by less emissions-heavy sources of generation such as gas and renewables as well as increased imports from the continent. The Carbon Price Support tax increased to £18/t in 2015 and researchers measured the positive impact of this in reducing coal-fired generation.

    This tax translated to an average £39 additional cost on British households' electricity bills. If EU countries adopted a high carbon tax, significant carbon emission reductions would happen throughout the Continent. However, this point has been debated for years, with some countries such as Poland opposing this measure.

    Upon her arrival, the new European Commission President, Ursula von der Leyen, announced her intention to install a carbon tax including imported products, which makes sense. Otherwise, with carbon leakage, production of goods would become more delocalized to less environmentally cautious countries and transportation would add to overall CO_2 emissions.

    However, with the post COVID-19 crisis, some countries such as France[37] are cautious as taxes are unpopular. Adding expenses to household budgets when unemployment resulting from the COVID-19 crisis is growing, could trigger a social crisis.
- **Global methane emissions have risen nearly 10%** over the past two decades[38], resulting in record-high atmospheric concentrations of this powerful greenhouse gas. Methane is an important contributor to global warming because it traps heat in the atmosphere. Its atmospheric lifetime – around 12 years – is much shorter than that of carbon dioxide, which stays for more than a century, but methane is, per unit, more than 20 times as potent as CO_2 as a greenhouse gas. This means that over a 20-year period, the global-warming potential of one ton of atmospheric methane is like 85 tons of CO_2[39].

  While the European Green Deal identifies energy-related methane emissions as an important issue requiring an accelerated initiative from the European Commission, the American administration, through its Environmental Protection Agency, announced in mid 2019 plans to loosen regulations on methane!

  According to a recent IEA study[40], it is crucial for the oil and gas industry to be proactive in limiting, in all ways possible, their environmental impact and for policy makers to recognize methane curbing is a pivotal element of global energy transition.

2020 COVID-19 pandemic and its consequences

To combat the COVID-19 pandemic, many governments decided to lockdown their populations for several weeks, in January in China, from March to May in Europe, later in America. In August, some countries imposed new focused population containments to try to avoid a second pandemic wave.
Those decisions led to an economic crisis with dramatic drops in GDP, rising unemployment, and social unrest. According to OECD[41] scenarios, with one worldwide pandemic wave GDP would contract by 6% in 2020 while this contraction would reach 7.6% in the case of a second wave.

35 https://ember-climate.org/carbon-price-viewer/
36 https://phys.org/news/2020-01-british-carbon-tax-coal-fired-electricity.html
37 Emmanuel Macron interview on July 3, 2020, « Aujourd'hui en France »
38 https://www.nature.com/articles/d41586-020-02116-8
39 According to the Intergovernmental Panel on Climate Change. When looking at its impact over 100 years, one ton of methane is still equivalent to about 28 tons of CO_2
40 https://www.iea.org/reports/methane-tracker-2020
41 OECD June 10, 2020

The COVID-19 crisis has severely impacted on the transportation sector with a strong decrease in all travel activities. Some of them are recovering post lockdown, others such as aviation are affected in the long term. Work was also transformed by the implementation of social distancing rules and by the need to operate teams at a distance. All industrial and tertiary activities were negatively affected during the period.

Consequently, all types of energy consumption dropped significantly.

Energy companies enforced their business continuity plans and their collaborators were very dedicated, insuring notably electricity security of supply. This was of utmost importance as electricity and telecommunications were vital for companies managing a significant part of their activities virtually.

Oil crisis:

The oil crisis started before the coronavirus spread to the Western world. It was worsened by the crisis.

On March 8, 2020, in response to Russia's refusal to reduce its oil production to push up prices, Saudi Arabia initiated a price war that resulted in an oil price drop of around 30% (in addition to a 30% drop since the beginning of 2020). Shortly after, oil consumption went from around 100mb/d in early 2020 to 75-80 mb/d during the midst of the pandemic lockdown. Oil excess filled storage facilities and oil tankers.

WTI oil prices went from $64/b in early 2020 to negative territory for the first time in history (minus $37.63/b on April 20) as anxiety grew in the US over what to do with excess oil. Finally, on April 12, 2020, OPEC+ members decided to adjust downwards their overall crude oil production by 9.7 mb/d, starting on May 1, 2020, for an initial period of two months that was further extended until the end of July. Consumption recovered at 90 mb/d in June 2020 and prices increased to around 40$/b and seem to stabilize at that level.

These OPEC+ cuts should decrease to 7.7 mb/d in the following months until year-end.

Oil production also decreased in the US as the number of rigs went down from 630 in November 2019 to 290 in June 2020, which is the lowest level since 1987. Most of shale oil basins are not profitable at such low oil prices and many shale producers are highly indebted. At the end of June 2020, a shale oil pioneer company, Chesapeake Energy Corp, filed for Chapter 11 bankruptcy protection as it bowed to heavy debts and the impact of the coronavirus outbreak.

In June 2020, forecasts are for a decrease in US oil production by 670 mb/d from its 2019, 12.2 mb/day level.

Electricity markets:

During the lockdown period (March 17 – May 11, 2020) the demand for electricity in France (as elsewhere in Europe) fell by 15-20% depending on the day[42]; renewable production increased by 18%. In contrast, nuclear production fell by 18% and that of fossil fuel power stations by 53%. At the end of lockdown, thanks to the resumption of activity, the drop in electricity consumption was only 9% and by the end of June 2020 it had almost reached its normal level.

This new supply-demand balance as well as the significant drop in commodity prices resulted in a sharp

42 Decryptage 63

drop in prices on the spot markets. The average price in France was €15.3/MWh during the confinement period against €37.8/MWh over the same period in 2019. The excess of renewable production associated with low demand pushed prices into negative territory for 38 hours during the two lockdown months, while the entire year 2019 totaled only 27 hours of negative prices.

The coronavirus crisis has also affected electricity futures markets. At the beginning of the crisis, the prospect of a global economic slowdown and falling commodity prices led to a decline in electricity futures markets across Europe: in France, the price of the 2021 annual product fell from€ 45.70 / MWh on January 2, 2020 to € 37.4 / MWh on March 17.

Prices then went up to reach € 46.9 / MWh on May 26, 2020, following EDF's announcements regarding the nuclear fleet reduced availability the during winter 2020-2021 and the year 2021.

During the lockdown period carbon prices decreased to €16.6/t on March 23 and increased again to more than € 29/t on June 30, 2020 recovering their 2019 level.

There is a lot of uncertainty around the world economy recovery, and the total energy consumption for 2020 should be significantly below that of 2019.

Electricity grid flexibility must be enhanced

Renewables growth impacts on grid management

- **The lockdown period foreshadowed future grid management issues.**

During lockdown, electricity consumption decreases combined in Europe with sunny and windy weather resulted in high shares of renewable electricity on the grid. Near blackouts[43] happened in Germany and in the UK, demonstrating that grids and regulations are not adapted to deal with the high renewables share planned for the end of the decade[44].

Outside Europe, Mexico has taken radical measures to preserve its national energy security during the COVID-19 pandemic. In May and June 2020, the Mexican government significantly increased grid connection fees for renewable power plants (up to nine-fold) and introduced restrictions on grid connections for new wind and solar power projects.

Such measures have already existed for a few years in China where renewables operators face grid penalties and electricity curtailment. They are strongly incentivized to be equipped with their own balancing systems (hybrid farms with battery storage for example) and precise weather and generation forecasts.

- With traditional schedulable generation (fossil fuels, nuclear and to a certain extent hydropower) grid balancing was well mastered and managers procured ancillary services (such as frequency control) for slow adjustment in case of unavailability of a plant for example.
  With the increasing share of intermittent renewables generation (wind and solar power), grid balancing is more difficult, and security of supply can be endangered.

  This issue was illustrated by mid-August 2020 with rolling blackouts in California. Officials at the California Independent System Operator described a "perfect storm" of conditions that caused demand to exceed available supply: scorching temperatures, diminished output from renewable sources, and fossil-fueled power plants affected by the weather, and in some cases plants going offline. In addition, as neighboring states were hit by the same heatwave, they could not provide electricity to California as they usually do for 30% of its needs.

  California's electricity supply relies on 33% from renewables with a large share of solar energy. This is challenging on hot summer evenings, when electricity from solar generation drops to zero but demand for air conditioning remains high. This challenge will intensify as California adds more solar panels and wind turbines to meet its targets of 60% renewable electricity by 2030 while phasing out fossil fuel and nuclear plants schedulable generation.

  For many officials, there is a need for more generation redundancy, battery storage, and efficient demand response systems to incentivize customers to reduce their consumption (e.g. for air conditioning) when requested.

  The grid system needs to become more flexible and its regulation has to change in order to accommodate energy transition to low-carbon electricity.

- **Copper investments:** Intermittent renewables generation necessitates additional line constructions as these new energy sources injections must be connected to the overall grid.
  The majority of solar or wind farms are connected to distribution lines. However, more and more countries have voted for energy transition plans in which the renewable generation output

43 See Europe Editorial for more details

44 By 2030, according to IEA reports, renewables (including hydropower) will represent 53% of the total installed capacity in Europe.

increase coincides with closure of schedulable electricity plants such as coal-fired plants or nuclear plants. In this situation a grid overhaul is needed.

Germany has closed half of its nuclear plants (and will close all of them by 2022) that were in the south of Germany near the industrial consumption centers. At the same time large investments were dedicated to offshore wind farms in the North Sea. Because of administrative procedures and local public opposition, construction of new transmission overhead lines[45] to transport electricity from the north to the south of the country were rejected, and wind farms that were ready to operate were not connected to the grid.

To overcome these oppositions, German TSOs decided to build underground lines which are roughly 10 times more costly in CAPEX investments[46] and more difficult to maintain generating additional OPEX. In early 2020, all four of them (TenneT, TransnetBW, 50Hertz Transmission, and Amprion) launched the German Link project to build HVDC[47] underground cables in three corridors of 700 km each. Completion of these corridors should be in 2026 and the cost will be at least €10 bn.

When built, the new lines will enable solutions to congestion point issues.

In Europe new interconnection lines, by leveraging different consumption times in different countries and aggregating more generation sources, are also contributing to security of supply.

- **New flexibilities are needed:** However, solutions other than building extra lines must be implemented[48].

  - ***Storage equipment:*** Additional electricity storage helps to balance this increasingly intermittent generation. In most Western economies, hydropower sites are saturated and green hydrogen is not yet competitive. The extra storage needs will be provided by stationary batteries that benefit from electric vehicle battery technology and production improvements. Consequently, the global stationary battery storage market size is anticipated to grow at a 17.6% compound annual growth rate (CAGR)[49] and to surpass 74 GW by 2030.

    However, insufficient ROI[50] on storage capacity investments is slowing down their implementation. Better remuneration of ancillary services should be provided by grid operators, for consumption load shedding, and frequency control, etc. A multiple user approach could also enhance attractiveness of those investments such as batteries participating in hybrid farms development (wind, solar and storage) avoiding energy losses and enabling better grid integration.

    In some countries, like China, battery storage can decrease renewable curtailment losses and, in some provinces, it is required for permitting renewables connection to the grid.

  - In addition to electricity energy markets, many countries in Europe have established ***capacity markets*** (with different models) in order to ensure security of supply at peak consumption times (in

45 Usually it takes 5 to 10 years to build overhead lines in Western countries and this lead time delays renewable generation grid connection and electricity output.

46 Between 4 and 14 times more costly https://www.power-grid.com/2013/02/01/underground-vs-overhead-power-line-installation-cost-comparison/#gref

47 HVDC: High Voltage Direct Current

48 https://www.thinksmartgrids.fr/wp-content/uploads/2020/07/TSG_Livret_Plan_de_relance_vDEF_1707.pdf

49 https://www.gminsights.com/industry-analysis/stationary-battery-storage-market

50 ROI: Return On Investments

winter usually) if there is no wind and no sun. They remunerate additional available capacity during high-stress days as well as peak shaving. For example, the French capacity market relies on balancing responsibility. For the first time, in 2019, French capacity market auctions selected carbon-free solutions and awards went to battery investment and to demand response operators as industrial or tertiary aggregators able to guarantee peak shifting. Consequently, remuneration was higher than previous years.

- On the consumption side:

  Consumer patterns are also changing with an increasing number of self-consumption customers, microgrids, smart cities, and so on. Grid managers' demand forecast tools must be enhanced and network tariffs adapted. To develop demand response that improves grid balancing and enables customers to take advantage of low prices (when renewable generation is high), dynamic pricing (including time of use tariffs) should be implemented. Smart metering deployment, completed some years ago in North America and nearly complete in Europe, enables these new price implementations. Dynamic tariffs have been effective for many years in the US. Under an EU-level agreement reached in June 2019, energy companies with more than 200,000 clients will be obliged to provide households with at least one offer comprising dynamic price contracts. This agreement must now be implemented in Member States.

- *Electrical vehicles (EVs)* are developing all over the world boosted by battery improvements, environmental concerns, public subsidies, and regulation[51]. Their charging must be managed in order not to saturate DSO grids at certain times of the day (for example at lunch time if many EV owners decide to charge their car in the office car park at the same time). Smart charging must be widely enabled, for example by new pricing signals. In addition, cooperation between DSOs, charging station[52] owners[53], and local public authorities should be instituted in order to position new charging stations according to the networks' ability to accommodate them, hence decreasing extra grid costs.
  Idle vehicle batteries could provide ancillary services to grid managers (such as frequency regulation). Remuneration varies according to networks and regulations and it should be increased in the future.

- *Data usages:* With increasing levels of distributed renewable energy being brought online, power can flow in the reverse direction (towards the transformer).
  This changes the TSO/DSO relationship. They need to coordinate their operations in a way closer to real time. Thus, frequency of data exchanges between them have to be enhanced and data exchange protocols have to be compatible enabling quick analysis and decision making if needed.

  Thanks to smart meter deployment, accurate consumption data is known to within half-hour intervals, for example. Data transparency is a key flexibility enabler. DSOs should continue developing data exchange systems and share relevant data with all stakeholders while ensuring their protection[54] and preventing security breaches.

  Some DSOs, notably Enedis in France, are publicly sharing electricity consumption, profile coefficients[55], and self-consumption for consumer clusters, as well as distribution infrastructure location, quality of electricity supply, and EV charging station locations.

  This data, added to other public data, could enable energy efficiency service companies, renewables providers, and smart charging station developers to build new offers.

  Greater precision and real-time data would enhance these offers, which could avoid grid congestion and improve grid flexibility.

- New regulations
  - *Grid tariffs:* In order to increase grid flexibility, "soft" investments (in software, IT systems, artificial intelligence, modeling, etc.) should be promoted. Presently this is not the case in the grid remuneration tariffs calculation. Only equipment and lines investment are included in the Regulated Asset Base used to establish grid tariffs. This calculation method must evolve in order to also include those "soft" investments.
  - Market rules: In Europe, because the "merit order" used to bring generation equipment onto the grid is based on variable costs, renewables such as solar and wind

51 In Europe for example, car makers will have to pay in 2021 and onwards, fines that could reach €34bn if the cars they sell are emitting gases beyond a certain threshold

52 3 million public charging points should be installed in Europe by 2030

53 More and more Utilities and Oil and Gas companies are investing in charging stations or buying charging station companies

54 For example, in Europe by complying with GDPR (General Data Protection Rules)

55 The coefficient used to generate an estimate of consumption https://www.elexon.co.uk/operations-settlement/profiling/

that have very few variable costs (no fuel costs) are called first. As they are not schedulable, when their share becomes important (more than 50%) grid stability is difficult to maintain as was demonstrated by the British near blackout in April 2020.

New regulations allowing curtailment of renewables injection in the grid if needed should be adopted as it seems to be the case in Portugal[56]. In addition, incentives for renewables generation developers to add storage and provide accurate generation forecast (based on local, timely meteorological forecast, for example) could be introduced. This is already done in many Chinese provinces where grid penalties are applied if renewables are not matched with equipment making them more schedulable.

Companies organizations:

Digitization: The pandemic crisis was a catalyst for digitization as expressed by Satya Nadella (Microsoft CEO): "We saw two years of digital transformation in two months".

Post lockdown, companies will not go back to previous practices.

According to a study published in July 2020 by BCG and ANDRH[57] on the organization of work in the new reality, 85% of human resources managers wish to develop telework practice within their company in a sustainable way even if it will not apply to all the company's functions. They are in favor of a hybrid model combining face-to-face and telework (usually 2 to 3 telework days a week), even if managing virtual and face-to-face working together is complex. Among HR managers, 88% are aware of the risks that this practice can pose for the company culture empowerment, cohesion between employees, and creativity.

These wishes meet those of their employees that are happy to reduce commuting time but wish to have face-to-face meetings with their colleagues.

Productivity gains are expected from these new working methods combined with accelerated digitization and reduction of office space and travel expenses.

Western world industry changes: On the one hand, the crisis has seriously endangered certain sectors, such as aeronautics for example. In addition, the post COVID-19 crisis will speed up closures of fragile industrial plants that were hardly profitable before.

On the other hand, there is a political desire for reshoring, notably supply chain regionalization and for subcontracting relocation near consumption sites.

During the last year Saudi Aramco has had to react quickly to many crises. They had to restore production after the September 2019 attacks, to increase production after the OPEC Saudi decision on 20 March, and to operate during the pandemic when many of their subcontractors' plants were closed. They decided to relocate production of their equipment to reach 70% of their suppliers located in the Saudi Kingdom compared to 56% before the crisis.

Unless national policies are in place with increased import taxes on certain products (as in the US), relocating imported products can only be wishful thinking. Manufacturing labor costs for spare pieces or equipment are

56 Enerpresse n°12644 du vendredi 28 août 2020, p4

57 Boston Consulting Group and Association Nationale des Directeurs de Ressources Humaines, June 2020

much lower in developing countries and with the economic crisis the population is not ready to buy more expensive goods.

Electricity and oil products' consumption patterns will be different in future, whether those relocations happen or not. In case of failure, tertiarization of developed economies will increase with positive local effects on GHG emissions but with increased global emissions.

Energy players must revisit their strategy:

All energy players are implementing savings plans and, up to June 2020, total expenses cuts of $400 bn were announced.

Utilities: Low electricity prices and decreased consumption have significant impacts on their

financial situation, pushing them to seek productivity gains. In addition to traditional OPEX and CAPEX expenses cuts, digitization and telework offer cost reduction opportunities provided they have their employees' support. Some Utilities, such as EDF in France, have also suffered from maintenance work delays due to the lockdown and afterwards from the slower pace of work due to social distancing measures. This has strongly impacted on nuclear reactors' yearly shut-down planning resulting in lower nuclear generation. EDF has launched a new cost-cutting plan called Mimosa and is resuming assets divestments with a new €3 bn plan.

Oil and gas companies have even tougher strategic choices to make as they are suffering from larger consumption drops. According to EIA estimates in July 2020[58], oil production will fall in 2020 to

94.6 mb/d compared to 106.6 mb/d in 2019, and consumption in 2021 (98.8 mb/d) will still be lower than in 2019. Production could be even lower if a second pandemic wave pushes governments to impose new widespread lockdowns.

- **Increased flexibility in operations:** Oil and gas companies had to be very flexible in operations and trading as consumption and prices became more volatile. Consumption was 17.8 mb/d lower in Q2 2020[59] compared to the same period in 2019, and Brent crude oil spot prices fell from a monthly average of $64/bl in January to a minimum of $18/bl and grew to around $40/b in June 2020.
  Oil refineries are struggling as demand for oil products has crashed and refinery margins are squeezed. Europe is considered the most at risk because facilities are generally old, and governments are planning to reduce oil product usage from transportation.
  Analysts at UBS have forecast that almost 3m barrels a day of refining capacity equivalent (about twice as much as the UK consumes) need to be removed from the markets by 2021[60].
- **Heavy expenses cuts:** To protect their financial situation OPEX and CAPEX expenses were severely cut by around €200 bn globally. Cuts were especially important in exploration areas and impacted on oil service companies such as Schlumberger, which announced a plan to reduce its workforce by 20,000 people (a third of its total headcount).
  As operators need between five and seven years to bring projects to life, one could fear an oil shock in the medium term if consumption grows again.
  Many oil majors are depreciating their assets[61] as they predict that the impact of the COVID-19 crisis on oil demand and prices will last for a few years.
  All these factors add to the complexity of managing oil and gas companies and must be considered in their new strategic plans.
- **M&As:** Financially robust companies will take advantage of other, weaker players to acquire them. At the end of July 2020, Chevron announced that it had agreed to buy Noble Energy for $13 bn in the first big oil and gas industry deal of 2020. This acquisition could trigger other deals in the oil sector as flourishing companies such as Chevron or Exxon may spot potential acquisitions among indebted US shale operators. Chevron's decision not to acquire Anadarko in 2019 was wise as today the acquirer, Occidental Petroleum, is struggling with its debt increase from the $55 bn deal.
  This purchase fits with Chevron's strategy to focus on the international natural gas business and US shale production[62].
- **Longer term strategy:** For a few years, major oil companies' shareholders have pushed them to decrease their greenhouse gas emissions for scope 1, 2 and 3[63] activities. In some cases, they include in scope 3 the companies' customers: this is the "well to wheel" concept.

58 https://www.eia.gov/outlooks/steo/report/global_oil.php

59 https://www.cnbc.com/2020/06/16/oil-prices-iea-sees-largest-drop-of-demand-in-history-this-year.html

60 Financial Times, July 8, 2020

61 At the end of June 2020, Shell announced $22 bn asset depreciations. Financial Times, July 1, 2020

62 Financial Times, July 21, 2020

63 Scope 1 covers direct GHG emissions from owned or controlled sources. Scope 2 covers indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company. Scope 3 includes all other indirect emissions that occur in a company's value chain.

Oil companies (mainly European ones but also Saudi Aramco) are committing to reduce methane emissions, to invest in CCUS in order to sequestrate their GHG, and to become significant players in renewables and in electric vehicle charging stations.

Major European oil companies are committing to become carbon neutral. In February 2020, BP set the goal of becoming a net zero company by 2050 (or sooner) by:

- reducing its operation's GHG emissions,
- cutting 50% of the carbon intensity of products they sell,
- installing methane measurement at all their major oil and gas processing sites by 2023 and reducing methane intensity of operations by 50%, and
- increasing the proportion of investment into non-oil and gas businesses.

Smaller European players have accomplished this turnaround, such as the Norwegian oil company Statoil (that became Equinor) or the former Danish oil company Dong. The latter changed its name to Oersted and is operating successfully in offshore wind. Its market cap increased spectacularly from less than $20 bn in November 2017 to more than $50 bn in July 2020.

It will be interesting to observe the strategies of American oil and gas majors (Exxon, Chevron) regarding GHG emissions.

In the longer term, the question is: Who will be the new players? One can speculate that they will come from developing countries such as China and India.

A greener post COVID-19 society?

By early April 2020, daily global carbon dioxide emissions had fallen by 17% compared with 2019 levels[64] demonstrating that a radical and forced change in lifestyle could reverse the trend.

This was done at the cost of many human lives and cannot be envisaged as a lasting solution.

The 2020 annual emissions drop will depend on the pandemic development with a low estimate of -4% and a high estimate of -7%.

When the virus is contained, the world will probably return slowly to pre-pandemic conditions and if no measures are implemented, the daily rate of GHG emissions will increase again to 2019 levels or more.

In many countries, politicians have announced that the post COVID-19 world will be "greener". This is also their citizens' aspirations even if after the crisis, worries about health, employment and individual revenues are stronger and viewed as first priorities. In many countries and regions, huge stimulus plans are being adopted.

- ***Stimulus plans:*** Around $9,000 bn worldwide of emergency packages were pledged to mitigate the effects of this unprecedented economic crisis. In G20 countries, the GDP share of those packages is very dispersed, the largest being Japan with 21% of GDP. In absolute terms, the US has the largest finance package (nearly $3,000 bn). Priority is given to economic recovery, job salvage, and health questions (including research and education). A study published in May 2020 by Oxford University[65] surveyed the relative performance of 25 major fiscal recovery plans in G20 countries, including significant

64 https://www.nature.com/articles/s41558-020-0797

65 https://www.smithschool.ox.ac.uk/publications/wpapers/workingpaper20-02.pdf

worker and business compensation schemes which protect livelihoods. Their assessment is that out of $7,300 bn fiscal rescue measures, 4% of policies are 'green', with potential to reduce long-term GHG emissions, 4% are 'brown' and likely to increase net GHG emissions beyond the base case, and 92% are 'colorless', meaning that they maintain the status quo.

Many of those packages acknowledge the central role for electricity which is a vital need in developing countries with plans to extend electrification and reinforce electricity grids but also in developed countries as electricity is also The vector for decarbonization.

Many packages include sustainability components with short- or longer-term views. For example, the European €750 bn stimulus plan adopted in June 2020 provides that 30% of these funds will be dedicated to climate change issues[66].
Several Member State packages are going in the same direction.

In early July 2020 the European Union commission unveiled a plan to invest between €180-470 bn by 2050 to reach a share of 12-14% in 2050 for green hydrogen in the European energy mix, boosting its two industrial champions Air Liquide and Linde. Germany and France stimulus plan will allocate respectively €9bn and €7bn for hydrogen development. Europe would thus regain some sovereignty on electricity storage as battery production is presently mainly located in Asia (China, Japan and South Korea) and in the US.

In July 2020, in a move that marks a partial shift from its strong support of coal, the Japanese government said it will tighten state-backed financing criteria for overseas coal-fired power plants[67].

In China, announcements during the National People's Congress in May 2020 included additional investments in electric and fuel cell vehicles, as well as in new EV charging stations and investments in ultra-high voltage electricity transmission[68].

A very ambitious and well documented global three-year stimulus recovery plan proposal was published in June 2020 by IEA[69] with a $1 trillion investment per year (70% of spending would come from private sources). It aims at boosting economic growth, creating jobs, and building more resilient and cleaner energy systems.

According to their modelling, globally, annual energy-related CO_2 emissions would be nearly 3.5 Gt lower than they would have been otherwise, and methane emissions would be cut by 0.8 Gt CO_2-eq.

In addition, around 420 million people would gain access to clean cooking solutions in low-income countries, and nearly 270 million people would gain access to electricity.

This plan is a framework to be reflected on for the future. However, there are many obstacles to its implementation as it asks for a huge amount of financing (including private funds), quick and agile changes in regulations, real cooperation between players, and genuine international coordination.

In conclusion, the right balance must be found between climate change related expenses and those needed to combat the pandemic and boost employment after the crisis. This could be even more true if, as is probable, a second pandemic wave hits the world.

- ***Private initiatives:*** In July 2020, nine multinationals came together at the initiative of Microsoft to share their research and strategies in order to enable them to achieve a carbon neutral footprint by 2050. Called Transform to Net Zero, this initiative currently brings together the Danish carrier AP, Moller-Maersk, the American Starbucks, the French Danone, the Anglo-Dutch Unilever, the German Mercedes-Benz, the Brazilian Natura & Co, the American Nike as well as the Indian IT services group Wipro.
Since the 2015 Paris Agreement on climate change, more and more companies are committing to become carbon neutral by 2050 at the latest. Cumulatively, they represent an annual turnover of more than 4.7 trillion dollars.

Although very positive, these declarations arouse a certain suspicion in many experts, including the UN environmental agency. In order to achieve this neutrality, companies mainly rely on carbon offsets, which allow carbon to be captured, for example in deforestation projects. "The most effective way today to eliminate carbon, for less than 10 dollars a ton, is reforestation", confirmed the CEO of Total, in July 2019. However, certain precautions must be taken ensuring that the project would not have existed without this funding, the permanence of the CO_2 storage for forest projects (it could disappear in case of fire destruction, for example), and the consent of indigenous peoples. In addition, the probability that these carbon offset actions achieve what is announced is low.

The risk is indeed that the companies' carbon credits purchasing policies can lead to a significant delay in the fight against climate change if they are not accompanied by an ambitious reduction of their own emissions.

On the financing side, developed countries committed to mobilize jointly $100 bn a year in climate

66 See Europe editorial

67 https://www.reuters.com/article/us-coal-japan-finance/japan-tightens-rules-on-support-for-overseas-coal-fired-plants-idUSKBN24A0CH

68 China super grids are at very high voltage – 1.1 million volts – in order to reduce electricity losses in this huge country.

69 IEA Sustainable recovery June 2020

finance by 2020 to address the needs of developing countries to mitigate climate change consequences. Several countries and multilateral development banks pledged in 2019 and 2020 to scale up the climate finance they would provide in future. Significant progress has occurred: According to a 2020 OECD study, countries should increase the levels of public climate finance – bilateral and multilateral – to $67 bn by 2020 compared to $44 bn in 2014. In addition, if every dollar of projected public finance would mobilize private finance in the same proportion as during the 2013-2014 period, the projected private finance amount would be an additional $24.2 bn.

- ***Individual behaviors:*** During lockdown, there was a significant reduction in energy consumption notably linked to telework, the absence of commuting and international travel, and plant closures or slowdown. Countries in full lockdown experienced an average 25% decline in energy demand per week and countries in partial lockdown an average 18% decline[70]. The relaxation of lockdown has of course reduced these savings.

  In June 2020, an "energy-post.eu" global study[71] revealed that if everybody able to work from home were to do so for just one day a week, it would save per year around 1% of global oil consumption for road passenger transport. Considering the increase this would bring in energy use by households, the overall impact on global CO_2 emissions would be an annual decline of 24 million tons – equivalent to the bulk of Greater London's annual CO_2 emissions. This is a notable decline but small compared to the reductions that would be necessary to put the world on a path towards meeting long-term climate goals. If everyone who can work from home were to do so more frequently than one day a week, the reduction in emissions would most likely be proportionally larger. It is probable that some of these saving will be sustained for a couple of years thanks to new HR policies and restrictions in company travel policies.

  It is thus important to change behaviors, particularly those of households. According to various studies[72] there is no one single motivating factor that can drive individuals to adopt energy-saving attitudes. Multiple factors such as financial considerations, environmental concerns, competitiveness, cooperation, conformity and altruism come into play. There are also barriers that prevent or limit changes in behavior (e.g. comfort, aesthetics and the physical layout of homes). Behavior change programs based on routine reporting of comparative consumption information and energy efficiency advice have led to small (around 3%) but consistent reductions in energy use in the home.

Geopolitical impacts on energy

Awareness by Western nations and particularly the US of the increasing power of China heightened tensions in 2019 between this country and the US (and its traditional allies). The COVID-19 crisis exacerbated these tensions.

The complex situation in the Middle East, which is the scene of several conflicts, but which remains the major oil-producing region, has given rise to potentially explosive situations with Iran.

Thanks to its shale oil production, the US is in a stronger position toward such oil producing countries compared to previous decades.

70 https://www.iea.org/reports/global-energy-review-2020

71 https://energypost.eu/calculating-the-energy-saved-if-home-working-becomes-the-norm-globally/

72 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69797/6921-what-works-in-changing-energyusing-behaviours-in-.pdf

US-China tensions consequences:

During 2019, trade tensions between the US and China increased with periods of crisis and periods of appeasement.

In the energy sector, US dependence on Chinese technologies has been contained by US tariffs on Chinese solar panels prompting companies like SunPower (a Total subsidiary) to repatriate their production to the US, however at an increased cost. Elsewhere, dependency has increased in line with PV installed capacity mainly procured by Chinese manufacturers. Moreover, the domestic slowdown in China's PV installations has pushed manufacturers to export more. In 2019, PV module exports increased by 60% hitting 66[73] GW.

Asia has a dominant position in the batteries market and the increased sales of EV and stationary storage batteries has also increased dependency on Asian manufacturers, especially Chinese ones. Finally, wind turbines and batteries use rare earths and metals that predominantly come from China.

With the COVID-19 crisis, American nationalist and isolationist politics intensified. This notably resulted in the ban on the use of telecommunications equipment manufactured by Huawei[74], based on accusations of spying on information exchanges. The US has pushed its European partners to take similar action.

Tensions between China and the European Union have increased. For example, in mid-July 2020 the UK announced that it would ban Huawei equipment from the country's high-speed wireless 5G network, a victory for the American administration. In addition, the British Prime Minister has offered to host up to 3 million Hong Kong residents and seeks (like other European countries) to strengthen the control of foreign investment on its soil.

The construction of new nuclear reactors in the UK could suffer from potential Chinese retaliatory measures. Indeed, the Chinese company CGN[75] could question its partnership with EDF for the construction of several reactors in the UK. This is unlikely to happen with the two Hinkley Point C reactors under construction because 33.5% partner CGN has invested around £3.5 bn (in mid-June 2020). The financing of Sizewell project, for which an authorization request was filed in June 2020, could be affected; and new financing schemes would be needed

Probably the longer term Bradwell project is the most vulnerable. In this project CGN is a 66.5% shareholder and plans to build an HPR 1000 reactor using Chinese technology adapted to British safety standards.

Oil and gas related tensions

- *On the oil side,* increased shale oil production enabled the US to become the first oil-producing country strengthening its position, notably toward Iran and Venezuela on which it has imposed sanctions.

  In 2019 and early 2020, heightened tension between Iran and the US was linked to the US withdrawal from the JCPOA (also known as the Iran Nuclear Deal) and imposition of new sanctions on Iran by the US. This tension was illustrated by many incidents in the Strait Of Hormuz (SOH) in May and June 2019.

  Also, in retaliation for the Gibraltar government seizing a tanker carrying Iranian oil, supposedly bound for Syria, a British-flagged bulk carrier was seized in July 2019 by the Iranians while transiting the SOH.

73 https://www.infolink-group.com/en/solar/feature-china-exports/analysis-of-2019-china-module-exports

74 Huawei equipment is recognized as being of good quality, reliable and competitive)

75 CGN : China Guangdong Nuclear

On January 3, 2020, the American drone that killed Maj. Gen. Qasem Soleimani, the powerful Iranian commander, drastically increased tension between Washington and Tehran.

These various incidents did not have a sustained impact on oil prices.

Later in 2020, the COVID-19 crisis led to a sharp drop in oil prices endangering several shale producers, such as Chesapeake which was one of the pioneers of hydraulic fractionation. In an election year, the President of the US is satisfied with cheap gasoline. However, as American shale oil production decreases, his country's strategic position in the Middle East could be weakened.

- *On the gas side,* in 2019 the increase in the number of American liquefaction terminals in operation boosted liquified shale gas exports to Europe, reducing this region's dependence on Russia.

  In order to sell more of its LNG and to weaken Russia's position in Europe, the American Administration entered a harsh battle against Nord Stream 2 – the new pipeline that should transport directly gas from Russia to Germany bypassing Ukraine – with the objective of derailing this near-completed infrastructure. By mid-July 2020, the US Secretary of State had threatened to impose sanctions on any company helping to build this pipeline and particularly the foreign shareholders that have provided half of the funding (Shell, Engie, Uniper, OMV, Wintershall).

  The political impact of Russian dissident Alexei Navalny poisoning in August 2020 may force Germany to disassociate itself from this project, it has supported so far, casting doubt on its completion in the near future.

  Thanks to the giant 3,000 km Power of Siberia gas pipeline between Russia and China inaugurated on December 2, 2019, Gazprom was able to decrease its dependence on Europe by increasing its sales to Asia.

Conclusion:

The period studied by this 2020 edition of WEMO is exceptional. It had two distinct phases.

During 2019, lower economic growth and the implementation of certain energy transition measures led to only minor progress towards achieving climate objectives. Despite the decline in emissions from the energy sector, global emissions reached an all-time high. The good news is that the costs of renewable energies and electricity storage by batteries continued to drop dramatically and this should continue. However, our planet remains far from reaching global climate objectives: Extension of the 2019 trajectory would have led by 2050 to a global temperature increase of 3.1-3.7° C – well above the 1.5-2° C desired by international agreements.

In early 2020, the COVID-19 pandemic, and the lockdown that a very large number of countries adopted to combat the spread of the virus, led to a very significant change in this trajectory. During this confinement period, electricity consumption fell by 15-25% and the share of renewables in certain electricity grids, in Europe in particular, exceeded 50%, posing grid stability problems. GHG emissions decreased by 17% during this period and over the year are expected to drop by 4-7%.

Analysis of this period demonstrates, as I pointed out in the WEMO 2019 editorial, that by changing lifestyles and consumption patterns, GHG emissions drop dramatically. Of course, lockdown is not a solution to fighting climate change. By way of illustration, it would take a similar

confinement every year for the next 10 years to get on the right environmental trajectory, which is of course totally unthinkable.

To get on the right trajectory to meet the Paris Agreement objectives these measures should be adopted:

- Master GHG emissions:
  - Strengthen carbon-related regulatory measures to reach a higher carbon price
  - Apply carbon tax to imported products in order to avoid overall emissions growth by offshoring product manufacturing
  - Alternatively impose carbon taxes
  - Better control methane emissions (as methane is a potent GHG)
- Incentivize carbon-free generation plant construction (renewables but also safe nuclear plants) to generate "green" electricity
- Consequently, incentivize electrification of uses (notably for transportation) allowing decarbonization of the whole economy.
- Ensure safe grid management with a high, intermittent renewables share by:
  - Grid upgrading with increase digitization
  - Imposing dynamic tariffs to increase demand side response
  - Changing grid tariff calculation methodology to also remunerate "soft" investments
  - Modifying the European "merit order" to allow renewables curtailment if needed
  - Revising DSO missions.
- Encourage green hydrogen as, along with hydropower, it's the only way to store electricity for weeks or months
- Ensure that the "green" share of stimulus plans becomes a reality:
  - Track these funds' sustainability in relation to other urgent needs, particularly health and social
  - Strengthen those plans' "green" conditionality.

Finally, energy players must adapt to a more volatile environment and become more agile and forward-looking. Increasing digitization and innovation will be key levers.

Enjoy reading this new and enriched WEMO edition.

Colette Lewiner

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