

PERSPECTIVE

COVID-19 pandemic facilitating energy transition opportunities

This perspective paper has been suggesting and discussing some of the energy transition opportunities facilitated by COVID-19 pandemics. A strong base in a cluster of innovative technologies is expected. They have been spread out of distance meeting and learning, massive home office use, the growing popularity of e-shopping, raise in e-socialising, related to this intensifying the data transmissions as 5G and considering 6G, urban and sanitary reforms, remote and robotic health monitoring and even treatment, related preference to shortening the commuting, intelligent traffic control, strengthening to favour self-driving autonomous vehicles, advanced digital manufacturing challenging remote and distance production operating, remote construction and building as remote drilling, automated waste management collection and treatment, and also applications of novel ways for deliveries as, for example, drone. Each of them is having some pros and cons related to energy consumptions. Are the beneficial features able to offset its own energy consumption and the rebound effects of increasing demand?

1 | PANDEMIC AND ENERGY SECTOR

Pandemics caused by COVID-19 spread out to most countries around the world. As the energy sector is one of the imperatives for modern society; it has been influenced considerably. Numerous studies and analyses appeared dealing with various aspects during the pandemics. However, the most decisive is going to be post-pandemic development. This is likely to shape the energy sector for some time, and it is representing both the challenges but also the opportunities.

Consumer habits tend to change over time, but the COVID-19 outbreak is forcing consumers to reconfigure their lives, their habits and their spending patterns at speed and scale that the world has never seen. The Nielsen Company¹ has created a global lens through which to analyse these changes and identified ways of prioritising what

needs to get done, and when. He represented TYPICAL markers of these stages but are not always consistent, especially with the number of cases or deaths: (a) Proactive Health Minded Buying, (b) Reactive Health Management, (c) Pantry Preparation, (d) Quarantined Living Preparation, (e) Restricted Living, and (f) Living as Normal.

However, the new normal is going to be influenced by a new experience, new discoveries and new opportunities. What does it mean for the energy sector?

2 | LIVE AFTER PANDEMICS

One strong issue is to focus on safer life preventing infections. It means a psychological move to single-use plastics.² This means increased demand for plastics and consequently more energy for their production,³ logistics and disposal. It might also mean a psychological move to private cars with a lower exposure risk after pandemics.⁴ Related to that have been more stress paid to hygiene, which means more antiseptic and disinfection,⁵ which again means more energy and consequently waste and effluents. They are serious indications about changes in the energy supply industry,⁶ which can accelerate the transition from fossil fuels to renewables. The other associated issues are related to energy supply and security. There has significantly arisen the importance of high capacity storage.⁷ Worldwide mobility is expected to shrink due to possible fearful psychology. For example, some travel enthusiasts, mostly, the senior population who used to be making a considerable part of the holidaymakers, become more hesitating to travel to foreign destinations, and it has been considerably reducing energy and emissions for the transportation.⁸ This can perhaps return to near normal when the situation becomes under control; however, some sentiment with seniors may remain. There has been some unwanted impact on public mass transport, where it has been not easy to prevent the infection from spreading, and the population started to return to in many cases single used cars.

3 | NEW OPPORTUNITIES AND EMERGING DEVELOPMENTS

However, there have not been only issues which are leading in the post-pandemic period to increase energy consumption. They include, but not only limited to, as the emerging developments have been by COVID-19 pressure accelerating:

1. Spread out of distance meeting and learning
2. Massive home office
3. The growing popularity of e-shopping
4. Raise in e-socialising
5. Related to this intensifying the data transmissions as 5G
6. Urban and sanitary reforms
7. Remote and robotic health monitoring and even treatment
8. Related preference to shortening the commuting
9. Intelligent traffic control, strengthening to favour self-driving autonomous vehicles
10. Advanced digital manufacturing challenging remote and distance production operating, and also remote construction and building as remote drilling
11. Advanced and possible person-less waste management collection and treatment.
12. Applications of novel ways for deliveries as, for example, drones and advancing Delivery Apps
13. Promotion of renewable energy
14. Setting up a post-COVID-19 supply chain
15. Industrial Internet of Things (IIoT)

Many of those developments are based on “smart-city technology” which involved using smart sensors, machine learning, artificial intelligence (AI), blockchain and Internet of Things (IoT)⁹ to improve infrastructure efficiency. They have been growing in use for transport, energy and housing. From the point of energy, there is an important issue if the new options are energy more efficient and to what proportion. Figure 1 shows the source of energy consumption of IoT development, including data centre (main contributor), machine to machine communications, obsolescence of digital technologies and embodied energy. There have been works revealing that the AI can have substantial energy consumption and consequent GHGs footprint¹⁰ (see Figure 2). Although AI has presented super advantages in “AI for Good” applications, the related energy efficiency was an easily overlooked dimension, let alone that AI had also been used in some unreasonable scenarios.

There have been, for example, analysis of the home office energy consumption. On one side, reduced travel, less need for lighting, heating and air conditioning offices;

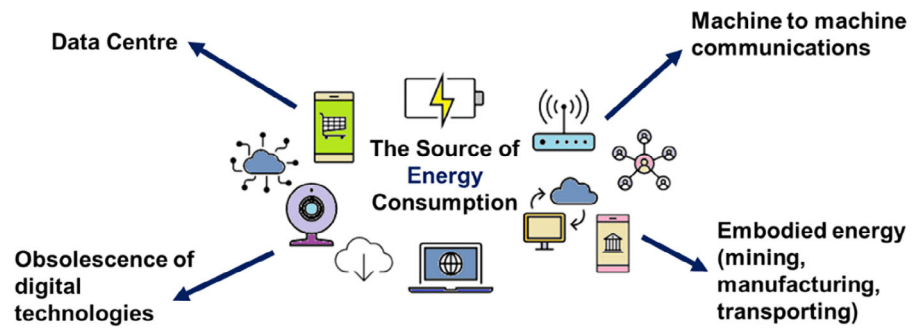
on the other side, raising need to provide this individually. They have also been issues as transporting children to schools and shopping on the way to the workplace and back. A similar analysis is important for energy consumption for e-shopping, where all the logistics should be considered from centralised to distributed and also in relation with, for example, home office.

A very important direction is remote and robotic health monitoring and even treatment. It has been facilitated by 5G. The first small step has been now common intelligent watches monitoring the basic functions and connected via Bluetooth with mobile phone applications. The next extension has been more sophisticated monitoring strips¹¹ and the most recent development facilitated by the COVID-19 pandemics is a remote online medical examination and even Telerobotic Spinal Surgery Based on 5G Network.¹² The first 12 cases were reported in March 2020.

The considerably increased intensity of the data transmissions and the strongest need for 5G and in the future even 6G is going to have also some impact on the resources. 6G is expected to support data rates of and over 1 Terabyte per s (TBps).¹³ And even before the pandemics, 5G has been projected for a “dramatically increase” network energy consumption.¹⁴ For example, Ericsson presented an overview¹⁴ where some statements from Alessio Zappone, assistant professor in signal transmission at the University of Cassino and Southern Lazioas were given as “I think it can be stated that 5G will not meet the goal of reducing the energy consumption compared to 4G,” he told EURACTIV¹⁴ in emailed comments. “One reason for this is the much larger volume of data that 5G must handle,” he explains. “This has led to new transmission techniques which are able to provide much higher communication rates, but whose energy efficiency is doubtful.” The highlighted concerns of global researchers do not mean the society should not embrace the new technologies. On the contrary, the society welcomes the innovations, especially when population are trapped by the epidemics. What should be stressed is to focus more on the energy efficiency and the resultant research, development and usage of such innovations.

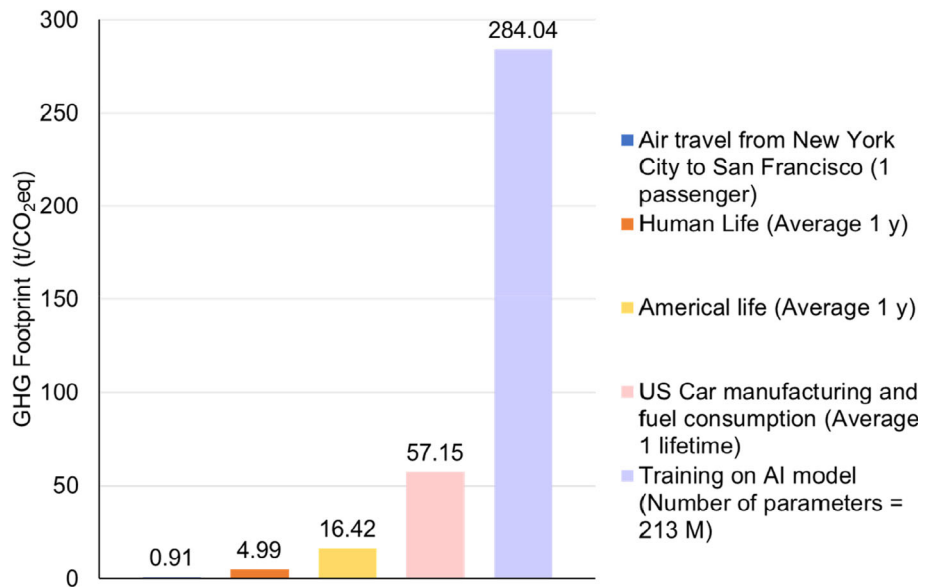
It means that intensive research and innovative solutions are needed from all potential providers as even when the efficiency is going to increase during the implementation and exploitation of 5G, the amount of massive data is going to be continuously increasing (Figure 3). The area chart with a trend projection was presented in the Ericsson Mobility Report¹⁵ before the COVID-19 pandemics struck. The purple curve in Figure 3 added by the authors shows a conjecture on the trend of 5G development by taking the COVID-19 pandemic into consideration. It is noted that the curve presents a rough trend

FIGURE 1 The source of energy consumption of digitalisation and IoT [Colour figure can be viewed at wileyonlinelibrary.com]



The advantages of digitalisation and IoT are generally known. However, the long-term sustainability is depending on (i) **Energy**, (ii) Security and (iii) Privacy. The energy efficiency measures could offset by usage (the rebound effect)

FIGURE 2 CO₂ emissions footprints comparison for various human activities compared with the AI model training (amended from¹⁰) [Colour figure can be viewed at wileyonlinelibrary.com]



which will be finally determined by the pandemics. Although the data obtained so far have been revealing that mobile data traffic has been increasing even more steeply, they are mostly based on 4G, and the 5G equipment supply and the device installation had been hit seriously during pandemics. As the COVID-19 pandemic stimulated new markets in distance meeting/learning, home office, e-shopping and e-socialising, the promising development trend of 5G is highly expected after the pandemic is well controlled.

It was found in 2015, information and communications technology (ICT) networks consumed 1.15% of the total electricity grid supply globally and contributed to 0.53% of the global carbon emissions related to energy. With new devices and use cases increasing the capacity of the networks, the demand to ensure low 5G energy consumption is critical to minimise operator expenses and ensure that they can still meet energy reduction goals. As it is obvious from the graph in Figure 3, it is likely that the share and related emissions would

increase ~50 folds and would start to play a major role in power consumption. The next Figure 4 is a summary of how ICT helped and benefited during the pandemics. In the post-pandemic period, it is highly probable that the experienced benefits are going to be continuously used.

Transport and logistics are another crucial energy-intensive area. Many innovative and intensified services as e-shopping, advanced and possible person-less waste management collection and treatment, and applications of novel ways for deliveries, for example, drones, can change the energy requirements. On the one hand, they can reduce traffic jams escalating fuel consumption, reduce commuting frequency and distances; however, on the other hand, they can bring in some issues, for example, increased energy demands. An interesting development was the exploitation of drones for the delivery. A short time ago, was considered as an issue for the distant future has now moved closer to be implemented. The major obstacles seem not to be the available technology, but the legal framework and the legislation, as published

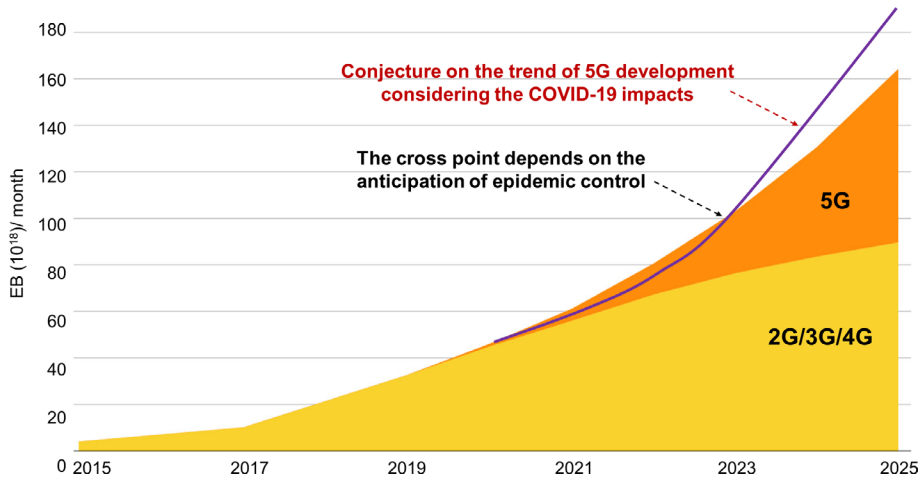


FIGURE 3 Global mobile data traffic outlook (Adapted from Ericsson Mobility Report, June 2019¹⁵). Traffic generated by fixed wireless access (FWA) services is excluded [Colour figure can be viewed at wileyonlinelibrary.com]

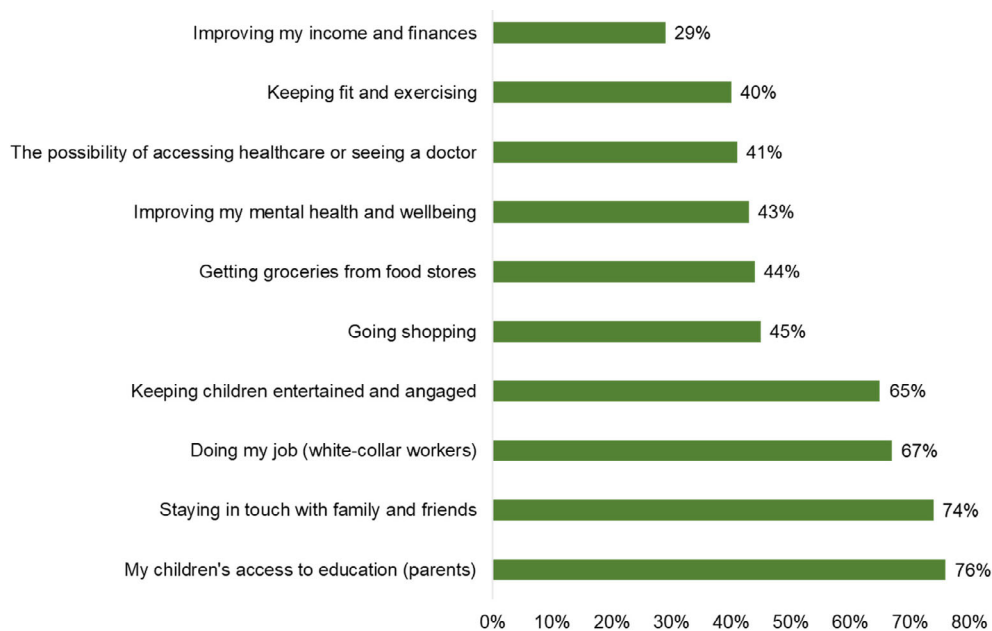


FIGURE 4 The exploitation of smartphones. The users appreciated the help of ICT with a lot with various tasks supporting their daily lives during the COVID-19 pandemic.¹⁶ Based on smartphone users within ages 15-69 who claimed their daily life had been highly impacted by the lockdown restrictions (Brazil, China, France, Germany, India, Italy, South Korea, Spain, Sweden, the UK and the USA) [Colour figure can be viewed at wileyonlinelibrary.com]

at the end of April 2020, for example, Amazon Moves Closer with FAA Approval.¹⁷

Regardless of the type of the services that IoT is facilitating or enabling, one issue that needs to be comprehensively assessed is the marginal change in efficiency improvement and increase of service demand (see Figure 5). Data centre workloads mean web requests, such as multimedia rendering, data analysis and other applications in the data centre. The compute instances mean managed and configured development environments in the cloud for big data, AI, machine learning and IoT. The service demand is increased where the relative change is more significant than the efficiency improved. The need for reliable bottom-up estimates has been highlighted by Masanet et al¹⁸ to ensure a low carbon emission and energy-efficient future of data centre energy use (205 TWh in 2018).

4 | WHAT ARE POSSIBLE WAYS AHEAD

They appeared various forecasts on how long and how extensive the pandemics are going to be. They have been some possible pessimistic side forecasts as, for example, “An estimated 250 M people have been infected worldwide, and 1.75 M is dead”¹⁹ as Megan Scudellari estimated. They are some other possibilities as, for example, “Another possibility is that immunity to SARS-CoV-2 is permanent. In that case, even without a vaccine, it is possible that after a world-sweeping outbreak, the virus could burn itself out and disappear by 2021. However, if immunity is moderate, lasting perhaps about two years, then it might seem as if the virus has disappeared, but it could surge back as late as 2024” as Megan Scudellari mentioned based on the the analysis from the Harvard team.²⁰

FIGURE 5 Trends in global data centre energy use drivers – relative change of 2018/2010. The dotted lines show the change trends; however they are not necessarily linear in practice. Data source: Masanet et al¹⁸ [Colour figure can be viewed at wileyonlinelibrary.com]

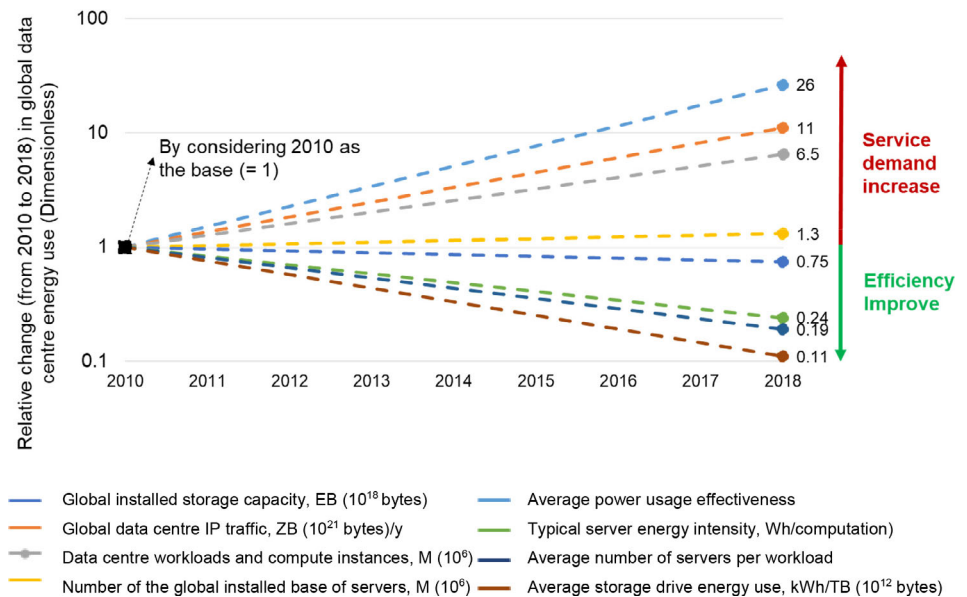
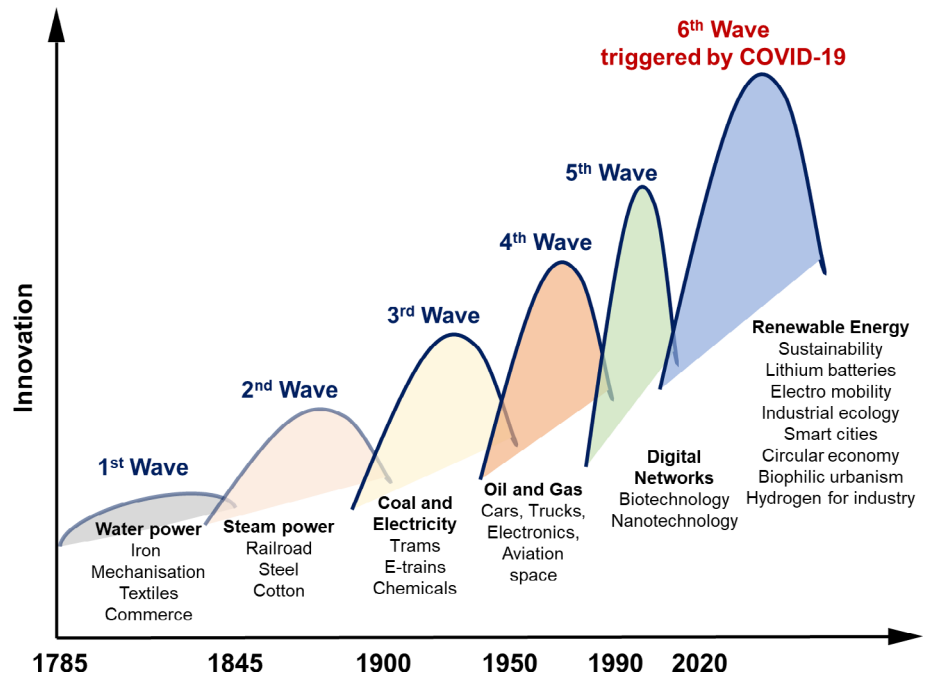


FIGURE 6 Waves of innovation through industrial history and into the future, adapted from Newman (2020)²² [Colour figure can be viewed at wileyonlinelibrary.com]



It means that with many options opened the new emerging options and opportunities for energy saving and making the generation, distribution and usage more efficient becomes a crucial issue and the research in this direction should be encouraged and facilitated. Austrian economist Joseph Schumpeter in 1942 introduced a term of Creative destruction “the essential fact about capitalism” and wrote the great new technologies and processes continuously revolutionise the economic structure from within, “incessantly destroying the old one, incessantly creating a new one.”²¹

The economic disruptions have been facilitating faster changes and stronger creativity. Innovations meet both

cultural and material requirements for the acceleration. Old and traditional structures preventing income of novel technologies are weakening. Old economy has been collapsing, and the novel “clusters” of the innovation are becoming the core of a novel emerging economy. This had been happening during the past three centuries. It has been witnessed five substantial’s “waves” regularly causing economic destructions and related re-clustering. The first wave was driven by employing the power of water, and the steam power was the second wave. Coal and electricity brought the third wave, the fourth exploiting oil and gas, and the fifth wave was triggered by digital transformation.²²

It is the opportunity that the humans are presently at the start of the sixth immense wave of innovation (Figure 6), driven by renewable energy combined with e-mobility, e-activities and e-services, smart-city technology and the number of activities listed, including hydrogen energy.²³ And this wave has been strongly initiated by the pandemics. It is interesting to see that the new waves are in most cases, coincided with some crises or critical situations where the society has been mobilising all possible researches strongly to overcome.

5 | CONCLUSIONS

The way ahead demands a continuous analysis of all novel emerging energy-related opportunities, under careful balancing of energy savings and energy increasing demands. Not all novel smart and high-tech options are energy efficient, and each of them should specifically balance in case-specific conditions. However, with the started intensive development, the energy efficiency has been in most directions increasing. The enhancement of energy efficiency in digitalisation is promoting economic growth but regretfully also the usage and the energy demand. One issue becomes more and more evident that the largest energy carrier in the period ahead is going to be electrical power.




As the final judgement should be quantified by GHG, Energy and the other environmental footprints²⁴ it becomes more and more obvious that a decisive issue will be how green (ie, with minimum environmental footprints) the electrical power is going to be. The future research should follow several avenues: novel opportunities continuously arising as a response to the new demands, energy efficiency and savings as well as reducing and minimising the environmental burden created by electrical power generation, transmission and distribution.

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DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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