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Building low-carbon resilient electricity infrastructures with nuclear energy in the post-COVID-19 era

- Electricity security is an essential public need, at the same level as food security and access to health care.
- Nuclear energy is a key contributor to electricity security and already contributes positively to building a low-carbon resilient infrastructure at the plant and system levels.
- Nuclear energy, both new nuclear projects and the long-term operation of existing reactors, can play a key role in the post-COVID-19 economic recovery efforts by boosting economic growth in the short term, while supporting, in a cost-effective manner, the development of a low-carbon resilient electricity infrastructure in the long term.

What's the problem?

The COVID-19 pandemic has highlighted the importance of electricity security in modern societies, bringing it to the same level as food security or access to health care. Electricity is indispensable to ensure the smooth operation of essential economic activities and to facilitate the continuity of business and recreational activities that have moved online, thus preserving the continuous working of the economy and social stability. While the disruption of many economic sectors has resulted in a sharp decline in global demand, the strategic importance of a reliable electricity supply has become apparent during the lockdowns imposed due to COVID-19. This underlines the fact that electricity, more than ever, is not a "normal good", but an essential service of public interest. Therefore, the underlying physical infrastructure that allows access to 24/7 electricity needs to be considered as a critical asset that must be prepared to withstand and recover from unexpected events.

Why is this important?

Achieving electricity security requires long-term strategic planning at the regional and national levels. There are three dimensions that characterise a secure source of electricity:

- The physical availability of generating capacity at all times;
- The contribution of capacity to the smooth operation of the electricity system even in the presence of sudden shifts in demand or changing meteorological conditions;
- The contribution of capacity to the stable economic behaviour of the electricity system.

Nuclear power performs very well in all three dimensions.

The OECD initiative New Approaches to Economic Challenges (NAEC) defines resilience as the "capacity to withstand and bounce back from major disruptions. Resilient systems are planned to prevent, avoid, withstand, and absorb any and all threats, and to recover and adapt in the aftermath of disruption" (OECD, 2019).

Nuclear power plants are a clear example of resilient facilities. The resilience of nuclear energy is the result of the combination of high levels of safety, operational flexibility and continuous learning from previous events. By design, and beyond design, nuclear power plants are conceived following the principles of defence-in-depth: prevention, protection and mitigation (IAEA, 2016). This results in the implementation of redundant, independent and diversified safeguards designed to withstand external hazards. From an organisational perspective, nuclear facilities also incorporate emergency and contingency plans to rapidly identify critical activities and maintain normal operations with limited personnel (NucNet, 2020).

Confronted with major disruptions in the past, the nuclear sector has always adapted while always continuing to provide a stable supply of low-carbon electricity. Current nuclear systems and operations have been refined according to an evolving regulatory environment continuously seeking the highest level of safety and reliability in the most diverse situations, including extreme weather events like those caused by climate change. The resulting nuclear governance models incorporate procedures and approaches that allow the continuous assessment of ongoing practices, the application of corrective measures and the integration of the latest knowledge available. Furthermore, international organisations such as the International Atomic Energy Agency, the Nuclear Energy Agency and the World Association of Nuclear Operators have played an active role in the dissemination of lessons learned and best industrial practices over the years. It is therefore expected that these mechanisms will allow nuclear energy to rapidly integrate the lessons of the present crisis, not only to continue operating reliably and to accelerate the recovery, but also to make the necessary adjustments to better cope with similar disruptions in the future.

At the system level, a resilient low-carbon infrastructure requires a balanced and diversified power mix. Different technologies have different complementary roles in low-carbon electricity systems. Flexible power provision by plants that are dispatchable upon demand makes nuclear power an indispensable complement to wind and solar production in countries without large amounts of hydropower capacity. Furthermore, nuclear energy also supports electric grid stability by providing valuable inertia, reactive capacity and frequency control to the system. Additional operational resilience can be obtained with strategic fuel stockpiles. One of the main advantages of nuclear power is the easiness of securing energy-dense uranium fuel for several years of operation.

Another desirable feature of a resilient infrastructure is simplicity to avoid cascading failures arising from unnecessary connections while keeping necessary links more controllable and visible (OECD/NAEC, 2019). The centralised electricity generation systems enjoyed today in many OECD countries facilitates the surveillance, maintenance and, if necessary, dispatch of additional resources when systems are under stress.

With the emergence of more decentralised electricity generation models due to wind and solar power, the resilience of the resulting configuration depends largely on the evolution of digitalisation capabilities and the amount of local flexibility resources, which may or may not be available at each node. For instance, during the COVID-19 crisis, those countries with nuclear power in their energy mix took advantage of these features to secure operations and either delay or advance outages, keep the plants running at full power, or adjust their power output to adapt to lower power demand. As highlighted recently by the IEA in its Global Energy Review 2020, nuclear power has been an important source of power flexibility in Europe during pandemic times (IEA, 2020).

What should policy makers do?

After this crisis, the global economy will shift to a new equilibrium more oriented to addressing long-term systemic threats, while spurring economic recovery in the short-term amid severe budgetary constraints. Long-term operation (LTO), with more than 100 reactors operating beyond 40 years around the globe and already benefiting from a solid industrial infrastructure, offers a showel-ready opportunity to strengthen electricity infrastructures. New nuclear builds in Western OECD countries are also moving rapidly beyond first-of-a-kind conditions and present a solid option to add dispatchable generation to electricity systems, while low-carbon hydrogen production and carbon capture and storage are still in the lower stages of technology readiness. On top of that, a sustainable development path should continue to be pursued to mitigate climate risks that could result in severe socio-economic consequences similar to the ones observed during the ongoing pandemic. The stimulus packages under discussion are the perfect tool to achieve these goals simultaneously. By putting low-carbon resilient infrastructure at the core of the recovery ahead, governments can both stimulate the economy in the short-term while maximising social welfare in the longer run. Including nuclear power alongside other low-carbon technologies in these packages offers:

- Investment efficiency: in those countries with nuclear power already in their energy portfolio, pursuing LTO of the existing fleet is one of most competitive ways of maintaining a low-carbon resilient infrastructure. Moreover, new nuclear construction can further support building a least-cost option from a system perspective, especially with high shares of variable renewable energy (VRE) (NEA, 2019). At the same time, through timely decisions on new builds, it is possible to capitalise on the experience gained in recent projects and unlock additional cost reductions in the 2020s. Several financing models are available to support large-scale infrastructure projects allowing to properly allocate and mitigate nuclear construction and market risks (NEA, Forthcoming).
- Significant technological and economic spillovers: nuclear energy has a unique combination of private and public characteristics that may help galvanise broader recovery efforts. Collaboration between all stakeholders – utilities, regulators, vendors, financiers, system operators and governments – is a high priority in making these projects a success. When done right, nuclear new build, due to its size and technological and economic spillovers, can play a key role in any publicly led post-COVID-19 recovery through the creation of high-value long-lasting jobs. In advanced economies, with several projects near completion, these jobs would make use of existing skills, accelerating the economic reestablishment. Furthermore, nuclear supply chains have synergies with other technical sectors fostering the mobility of professionals with limited adaptation costs and thus representing an additional source of socio-economic resilience.

Resilience is a long-term endeavour that necessitates policy actions beyond well-designed stimulus packages in order to properly guide investment decisions over time and correct potential market flaws. Built on the principle of technology diversity, resilience requires a technology neutral market in which all technologies are recognised and properly valued for their contribution to a low-carbon resilient economy. The materialisation of major public-private partnerships for large-scale infrastructure projects has also proven to be a formidable tool to reignite the economy in the right direction in previous crises. The World Bank concludes that investing in a resilient infrastructure is urgent and economically sound: its estimates are that every USD 1 invested in infrastructure resilience yields USD 4 in socio-economic benefits (World Bank, 2019). Governments can take this opportunity to re-establish the baseline for sustainable economic growth and social stability.

Further reading

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