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Nuclear and renewables: A mutualistic relationship in pursuit of Net Zero

Samuel Stone, Wholesale Markets Analyst at EDF and member of the YEP Forum Steering Committee, discusses the relationship between nuclear and renewable energy technologies in the UK's journey to net zero.

Last year, the UK became the first major economy to enshrine a target of net-zero carbon emissions in law, the deadline being 2050. This was a milestone in the fight against climate change. The need for change has long been acknowledged but legislation offers businesses greater clarity, allowing them to pursue the requisite investment strategies with conviction.

Customers expect the energy industry to make a significant contribution to net zero and progress has already been made. Whilst the UK power sector was responsible for 15% of UK emissions in 2017,[1] they were 64% below 1990 levels. Much of this success can be attributed to an explosion in renewable generation capacity and plummeting costs, which has forced carbon-intense generation out of the picture. Many coal-fired plants, having powered our nation for nearly a century and a half, have been rendered uneconomical by rising carbon costs and cheaper renewables. Globally, 50% of renewable energy projects in 2019 undercut even the cheapest coal-fired plants.[2] This follows a cost reduction of 39% and 82% for onshore wind and solar PV respectively from 2010 – 2019.

The UK is an early leader in renewable technology. EDF alone has over 2GW of future projects in planning and development, and our current combination of renewable and nuclear power means that over half of the UK's electricity is now low-carbon. This is a winning combination that is ours to keep, should we choose to. With further cost reductions anticipated going forward, it is impossible to imagine a net-zero energy system where renewables do not play a key role. The debate is less one-sided when it comes to the future of nuclear power in the UK, but no less important as most of our nuclear fleet approaches retirement.

UK power consumption could double to 600 TWh by 2050, as transport and industry electrify to reduce emissions, while an increased role for hydrogen created by renewables or nuclear power could create additional demand. Renewable energy alone is likely a sub-optimal solution for meeting these needs, the perennial issue being that we cannot dictate what time the sun shines or the wind blows. Although innovative

[1] Committee on Climate Change (2019), Net Zero Technical Report, https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf
[2] Renewable Power Generation Costs in 2019 (2020), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jun/IRENA_Power_Generation_Costs_2019.pdf

storage systems are emerging as an effective counterbalance to short-term renewable intermittency, this technology is unproven over the durations and scale required in the immediate future.[3]

Nuclear power is demonstrably capable of helping stabilise grids by adjusting operations to meet seasonal fluctuations in renewable output. Furthermore, nuclear power offers this service as the preeminent source of continuous low-carbon energy, contributing 18% of power supply to the world's advanced economies and mitigating 60 gigatonnes of CO_2 over the last 50 years.[4] This equates to nearly two years of global energy-linked emissions. Beyond seasonal adaptability though, nuclear power plants have historically been run on a relatively inflexible basis, partly due to low marginal costs and energy market structure. However, nuclear power can respond more proactively than is commonly assumed.

A recent US study showed that many nuclear power plants, beyond merely providing a dependable baseload, can interact very successfully with variable renewable power; a role usually assumed to be the domain of fossil-fired power stations.[5] Indeed, earlier this year EDF assisted National Grid Energy System Operator (ESO) by temporarily halving output from Sizewell B due to a significant reduction in demand. The support we have been able to provide demonstrates the flexibility and reliability of our PWR station type.

Aside from reforming policy and markets to allow nuclear power a wider remit, plans for inclusion of new nuclear in the Moorside Clean Energy Hub further exemplify the ready compatibility of this proven technology with solutions of the future.[6] The hub will encompass links between nuclear, renewables and hydrogen generated by renewables or nuclear generation plants, capitalising on existing supply chains and regional expertise. Responsive application to hydrogen production is an exciting example of how nuclear and renewables can work together to progress other technologies, in a manner that also helps smooth out their own respective inflexibilities.

Not only can nuclear power therefore work effectively in tandem with renewables and other emergent technologies; maintaining a nuclear presence in the UK could also reduce the impact of land use change, as power demand accelerates. Although this ratio is decreasing as renewable technology continues to improve, the Nuclear Energy Institute estimated in 2015 that solar PV sites and wind farms respectively required up to 75 and 360 times as much land as nuclear power plants to generate the same amount of electricity.[7]

Moreover, although a broader remit for sympathetic design can reduce the localised environmental impact of renewable energy projects – relative to regulatorily-constrained nuclear sites – nuclear new builds are required by law to demonstrate a biodiversity net gain following construction.[8] Indeed, EDF has already created 67 hectares of new heathland and wetland habitat near to the proposed site of Sizewell C.[9]

The outlay for replacing our aging nuclear power stations is admittedly significant but could be offset by continued reductions in the capital-intensity of renewables. A 2050 net-zero power system involving nuclear and renewables would cost about the same as a high carbon power system; the only alternative scenario using current commercially viable methods. Future nuclear construction efficiency would also reap cumulative

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[3] Chen et al. (2020), Applications of Lithium-Ion Batteries in Grid-Scale Energy Storage Systems, https://link.springer.com/article/10.1007/s12209-020-00236-w#citeas

[4] International Energy Agency (2019), Nuclear Power in a Clean Energy System, IEA Fuel Report 2019, https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system

[5] Jenkins et al. (2018), The benefits of nuclear flexibility in power system operations with renewable energy, Applied Energy, https://www.sciencedirect.com/science/article/pii/S0306261918303180?via%3Dihub

[6] EDF joins major companies and unions to promote Moorside Clean Energy Hub, https://www.edfenergy.com/energy/nuclear-new-build-projects/sizewell-c/news-views/edf-joins-major-companies-unions-to-promote-moorside-clean-energy-hub

[7] Nuclear Energy Institute (2015). Land Requirements for Carbon-Free Technologies.

[8] Department for Environment Food & Rural Affairs (2020), Policy Paper 30 January 2020: Environment Bill 2020 policy statement, https://www.gov.uk/government/publications/environment-bill-2020/30-january-2020-environment-bill-2020-policy-statement

[9] Sizewell C Media Team (2019), Sizewell C and the Environment, https://www.edfenergy.com/energy/nuclear-new-build-projects/sizewell-c/news-views/sizewell-c-and-environment

benefits from a deliberate programme of uninterrupted building, rather than a series of unconnected constructions.[10] The more we build, the lower the cost.

Hinkley Point C exemplifies this, exhibiting massive productivity increases between units 1 and 2 of the project and simultaneously generating £2.27 of regional value for every £1 spent.[11] New nuclear projects can therefore be both economical and economically propitious, leveraging domestic expertise and enhancing the skills of future generations.

The UK has a mature nuclear industry that has provided dependable and safe low-carbon power to the nation since the world's first commercial nuclear power station opened at Calder Hall in 1956. We also operate at the cutting edge of the renewable energy industry. The opportunity to allow these two proficiencies to evolve further in a mutualistic manner is therefore unique to us. Electricity storage and other new technology may eventually facilitate a total replacement of nuclear with lower cost renewable sources. However, that time is not yet upon us. As 2050 marches closer, we would be remiss to delay work on retaining the only constant source of low-carbon power that has been proven at scale to date. Reliable and widely available low-carbon electricity, coupled with continued improvements in the energy efficiency of our grid and buildings, will be pivotal in delivering the net-zero future that our customers rightfully anticipate.

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[10] Energy Systems Catapult (2020), Nuclear Energy for Net Zero, A UK Whole Energy System Appraisal, Project Summary Report, https://es.catapult.org.uk/reports/nuclear-for-net-zero/#:~:text=Nuclear%20for%20Net%20Zero%20is,Zero%20carbon%20emissions%20by%202050.

[11] Hinkley Point C: Realising the Socio-Economic Benefits 2020, https://edition.pagesuite-professional.co.uk/html5/reader/production/default.aspx?pubname=&edid=dd86b444-cd47-459c-8e34-fdca673f1808