The many faces of resilience

US Secretary of Energy Rick Perry may have lost his bid to prop up coal and nuclear power, but he has started a valuable conversation about the grid and its resilience.

Last month, the US Federal Energy Regulatory Commission (FERC) unanimously rejected the Department of Energy's proposed Resiliency Pricing Rule. The controversial proposal, put forth by Senator Rick Perry, US Secretary of Energy, claimed that coal and nuclear power plants were at an economic disadvantage compared to other, more flexible, power generators and that their closure would lead to the loss of resilience in the US electricity grid. As such, the proposal sought to introduce higher rates for electricity generators that met special requirements set out for providing resilience and reliability services, including the presence of a 90-day fuel supply. To many, the Resiliency Pricing Rule was simply a way of providing subsidies to coal and nuclear power, supporting President Donald Trump's campaign agenda. Indeed, as FERC Commissioner Richard Glick noted[1] when rejecting the proposal, "There is no evidence in the record to suggest that temporarily delaying the retirement of uncompetitive coal and nuclear generators would meaningfully improve the resilience of the grid."

Yet a side effect of Senator Perry's ill-fated proposal is to have opened up a conversation about what exactly we're talking about when we talk about grid resilience and reliability. While they have rejected the proposal, FERC has now committed to examine resilience issues among the regional transmission organizations and independent system operators that monitor and maintain US electricity grids. This new call for evidence will seek to develop a common understanding of what grid resilience looks like — encompassing a range of factors beyond just fuel type — and whether further action is required by FERC to support it.

This move should be welcomed and applauded, given that it seeks to take an evidence-based and consensus view on a matter that has become highly politicized and that has significant consequences for households across the country. The grid is changing rapidly in response to a shifting energy mix and the adoption of new technologies. It is also at risk from the increasing incidence of extreme weather events. In the face of so many complexities, clearer definitions of the terminology around the grid and a deeper understanding of how it behaves can support greater action in strengthening it.

Further calls for research exist beyond the US. For example, the UK Department for Business, Energy and Industrial Strategy has published its Areas of Research Interest, highlighting where it seeks further input[2]. These include the need to ensure a reliable, low-cost and clean energy system and to develop more-effective and better-balanced energy networks. Meanwhile, the European Commission's Joint Research Centre on Smart Electricity Systems and Interoperability maintains a number of programmes aimed at understanding the security and resilience of European electricity networks (http://go.nature.com/2rF3DT1). The Commission's Horizon 2020 research programme also contains many projects examining current and future power grids (http://go.nature.com/2Gh1K2g).

This issue features two papers that examine the present and future state of power grids. In one Article, Benjamin Schäfer and colleagues examine time series data for power grids across North America, Japan and Europe, analysing their dynamics and statistics. By providing a more detailed examination of power grid fluctuations, their findings could help improve power grid modelling. They also offer a framework to think about those fluctuations and how they might be reduced. In a Perspective, Thomas Morstyn and colleagues look ahead to how prosumers and peer-to-peer energy trading might be incorporated into future grid systems. They present a framework for federated power plants, which brings peer-to-peer transactions between self-organizing prosumers together into virtual power plants. Although more research would be needed to understand the detailed implementation, market design and regulatory change, such a system offers several possible advantages not just for prosumers but also for the overall network, particularly in the face of the growing complexity arising from increased distributed generation and an increasingly diverse set of generators: not just utility-scale producers, but smaller-scale local providers and individual households.

Management of such a vast array of new sources is just one problem facing future smart grids and affecting grid resilience. Already today, power grids rely on interconnectedness and vast streams of data to help their operation and coordination. This exposes them to risks of cyber-attacks from many fronts, with potentially huge consequences. Analyses[3,4] have suggested that the risk of attacks is increasing but that more needs to be done to face them down, including greater regulatory standards and introduction of better guidelines. Including cyber-attacks would thus seem prudent as part of any working definition of resilience or reliability for power grids.

In this regard, blockchain technologies may hold promise for future smart grids. By distributing record-keeping and decentralizing decision-making, blockchain can theoretically make the grid much more resilient. Many companies have appeared in the last few years that offer blockchain-based energy services, letting individuals with solar panels sell electricity to their neighbours or to local organizations, rather than back to the grid. The security offered by blockchain, as well as its cost and relative ease as a trading platform, may help alleviate many current concerns and limitations faced by the evolving grid. Time will tell if the technology can live up to the hype and deliver on its promise.

The grid is changing rapidly. New technology and shifts in demand and supply are putting it under new stresses and strains. There is a clear need for more research and evidence gathering if we're going to meet these challenges. This will include not only a greater understanding of physical resilience and operation of an increasingly decentralized grid, but also a deeper understanding of how humans interact with smart technologies and what levels of trust and reliance they place in them and in the overarching grid system. When we get closer to that, we will be closer to bringing about a smarter, cleaner, more efficient and more equitable grid of the future that is also more resilient. ❐

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References

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