Clean Energy Innovation Roundtable Series

Summary:
Session II: Transmission & Reliability

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On March 25, the Aspen Institute Energy & Environment Program virtually convened the second in its 2021 series of Clean Energy Innovation Roundtables. This convening brought together experts to discuss electricity system reliability and resilience, as well as the need for inter-regional transmission. This summary captures some of the key topics of discussion.

Reliability & Resilience

Reliability and resilience are terms that are often used interchangeably, but, while related, they are somewhat different. Reliability can be thought of as keeping the lights on all the time, whereas resilience is more about the ability to withstand major events (e.g., extreme weather events) and to recover from those events when they occur. Reliability therefore involves balancing supply and demand in real time, whereas resilience involves efforts such as hardening infrastructure and putting more intelligence and flexibility into the system. Some think of reliability as being more of a short-term focus and resilience as being more long-term. Either way, they are very complementary; more resilience means more reliability.

System reliability and resilience have been in the news, with the freeze in Texas, wildfires in California, and other extreme events. In a world of progressing global warming and climate change, the underlying climatic conditions that impact the grid are not going to get any better. Planning in the power sector still focuses too much on looking in the rearview mirror on weather extremes, but the past is nearly irrelevant in terms of projecting an appropriate risk profile. The bookends of "normal" are getting wider, and there is a need for a new paradigm of risk profiling throughout the country. It is not clear who should be responsible for the risk profiling, though; these are very complex economic and system-level issues, and resilience is a multi-scale challenge, requiring action and coordination by entities at the federal, regional, state, and local levels, as well as by both public and private actors.

Risk profiles vary widely by region. While further advancements are needed to enable higher-fidelity regional projections, there are tools available now to enable regional risk profiling in a modern way. The need for improved risk profiling is particularly important if the system will have much greater levels of wind and solar – weather-dependent sources in a time of rapidly changing weather. Texas, for instance, is planning to add substantial amounts of solar power and to continue building on its huge base of wind power over the next 15 years. (The low-carbon future may well be written in Texas faster than in California simply because the resource base is so good – though it is still too soon to know if the recent freeze and blackouts and the very partisan reactions to them will hinder or accelerate the transition to a cleaner grid.) Risk profiling and resilience planning need to take a system view that accommodates variations in the availability of renewables. Studies in states such as Texas and California, for example, have shown that there can be multi-day periods with no wind. To ensure reliability and resilience, high penetrations of renewables not only need to be complemented with firm, dispatchable sources, but also need to be supported by a much more robust storage system that goes beyond batteries to cover generation lulls on the order of days, weeks, or seasons.

More broadly, the system cannot be planned around yesterday's or even current technologies. The infrastructure is not just being built for today, but for the capabilities and needs decades from now. The power system has to move from a structure designed to serve current loads to new, significant infrastructure built for much bigger purposes (including to power transportation). These are not just incremental upgrades, though incremental upgrades are certainly needed too; this is a new machine being built. That may look like overbuilding today, but it is real infrastructure investment for the future.

A resilient and reliable grid has to be planned, designed, and built for an unknown future, so regulatory regimes, policies, analyses, processes, and tools have to be adapted. For example, regulatory regimes focused on whether investments are used and useful for current customers may no longer work when planning future needs; at the same time, the costs cannot all be put onto current ratepayers, as doing so not only is unpopular but also creates intergenerational equity issues. Similarly, concepts such as critical infrastructure and transmission may need to be thought of differently if a hydrogen economy will be developed, and interdependency across types of infrastructure – such as electricity, gas, and water systems – will have to be a major factor in resilience planning. Adding lots of renewables to the grid will require models and other decision and analytic tools to address new problems that arise on the grid as different resources interact with each other. Power system modeling tools for connections should also be made available to large customers or developers so they can design systems to meet grid needs; the system operators now are a congestion point because they are the only ones with all the data. Decisions will necessarily be made under conditions of uncertainty, which means optionality and flexibility should be built into the decision process. The rest of the energy industry may be able to learn from the probabilistic risk assessments undertaken by the nuclear sector, though there are other kinds of tools in decision science that can be used too.

There are also still enormous unharvested opportunities to boost reliability, resilience, and emission reductions by fully integrating information technology into key systems. This includes sensors on high-voltage and distribution systems, artificial intelligence, machine learning, and more technologies that allow faster situational awareness and response, as well as improved demand management, efficiencies, and energy services for consumers. Integrating all the digital technologies into a system full of diverse, non-emitting sources to meet a lot more demand as other sectors electrify will require significant building and overbuilding (i.e., redundancy), but affordability then starts to become a key issue.

Indeed, affordability, resilience/reliability, and sustainability are now the key social objectives for the electricity grid. Markets do not operate in isolation, but rather are conditioned by policies, which set the guardrails and the social objectives. Markets work when they have proper definitions as defined by social imperatives. Some view part of the shortcoming in Texas as stemming from not having sufficient guardrails, requirements, authorities, communications, and planning. Texas regulators were very focused on affordability, and to a degree on sustainability (e.g., with the Competitive Renewable Energy Zones), but they took their eye off the ball on reliability. It is important to balance market rules, robust infrastructure, and vigilant oversight, and Texas probably dropped the ball on all three of those. Reforms of some kind will be needed to the guardrails in Texas, though the tools and mechanisms will likely look very different from what PJM and other system operators utilize.

Still, the fact that the operators in Texas stopped the system from going down entirely is heroic, and they did not get the recognition they deserved. These also are not new stories or issues. These types of things happen again and again (e.g., California in 2000); they are repeating stories with different wrinkles. Everything old is new again, though it is a new new, as the challenges and technologies are substantially different than in the past.

Inter-Regional Transmission

The situation in Texas has also raised the salience of inter-regional grid connections. Texas may not decide to interconnect to the rest of the country, even if it would boost reliability and resilience, though it is possible the federal government could promise Texas that it would not use interconnection as a backdoor for federal authority over the Texas grid.

While increasing the volume of inter-regional transmission can enhance reliability and resilience, people have different end visions for such a buildout. Some envision a continental-scale macro-grid as a long-term goal, to the extent it can be planned and actually built. Others envision interconnections between regional infrastructures, preferring to strengthen the ties between regions (e.g., requiring minimum bulk power transfer capacity between regions as a system reliability and resilience measure) rather than build an expensive new system. There have been federal studies that demonstrate the high value and reliability benefits of a macro/interconnected grid, particularly as the grid decarbonizes.

Under either vision, there is a need for an effective inter-regional transmission planning process in the United States to identify projects in the best interests of interconnections and the nation. The lack of inter-regional lines is a national problem; some other countries (e.g., Australia) use integrated system planning on a national basis, with the government supporting funding for a transmission buildout as infrastructure, and the United States needs a federal solution as well.

The planning process needs to incorporate a future vision – 20-30 years out – and work backwards to ensure the infrastructure is located where it will be needed. (If there is a large buildout of transmission to places where it is not used much yet, though, it is important to think through who pays for it while it sits unused.) The planning process has to recognize the potential doubling of demand due to electrification, the potential quadrupling of capacity due to the variability of some renewable resources, and the need for grid stability as penetrations of variable renewables increase.

This process could involve a range of elements and approaches. For example, the Department of Energy (DOE) and the Federal Energy Regulatory Commission (FERC) could use their national interest electric transmission corridor authorities. FERC could mandate inter-regional planning that uses scenarios, identifies plausible futures a couple of decades out, and incorporates assumptions about binding carbon goals, approved utility goals, technology trends, and weather events. FERC could also empower new regional planning boards under the Federal Power Act, led by representatives of states, to identify and plan inter-regional transmission; projects that come out of an inter-regional planning board with state representatives might see more state support, though some worry that regional power boards might end up as just another layer of bureaucracy. DOE also has power marketing administrations whose territories are already inter-regional and could be used for planning. FERC and DOE can do a lot right now to accelerate transmission, but they need the courage to do it and to act fast.

Once the planning processes are complete, there is a need to make sure the plans are binding when handed off to system operators or other authorities – and that the needed transmission actually gets built relatively quickly, given the urgency of addressing climate change.

Permitting and getting land rights for inter-regional transmission lines can often be very challenging. The split between the states and the federal government on permitting has been dysfunctional for decades – a vestige of the fact that electricity was more localized than interstate natural gas pipelines were. Even permitting reform, though, would only go so far in the face of public opposition. When it comes to developing transmission projects, regions tend to look inward, engaging local stakeholders to address local concerns about perceived winners and losers. Eminent domain, in particular, is never easy and is always unpopular, which means states are unlikely to support its use in local processes related to transmission lines. Traditional inter-regional lines also require multiple states to agree on who pays for them, which is often contentious. If the country is serious about moving to high levels of clean energy, though, substantial investments in transmission are needed, and exercise of federal jurisdiction over interstate commerce, as well as the use of eminent domain, may be necessary.

One option that could avoid some of these challenges is privately financed merchant transmission located in existing railroad and highway corridors. Merchant transmission lines cost ratepayers nothing, as those who use them pay for them. Co-locating transmission lines with existing railroad and highway rights-of-way can also avoid eminent domain fights and virtually eliminate landowner opposition. (Expanding broadband access could be accomplished in a similar fashion.) Some doubt that co-location will be sufficient in itself, while others think it could be. Existing railroad and highway corridors already go everywhere and can expedite permitting, development, and deployment, as the path the transmission will follow is known from the start. Transmission usually takes years to approve and build, but taking a decade to get built is a failure from a climate perspective. Co-location, the right financial incentives, and the deployment of private capital could expedite deployment.

Financial incentives to help developers build more inter-regional lines could take a variety of forms. For example, the idea of a tax credit for transmission lines has been gaining traction; while they can be a huge pain to deal with, and some fear that tax credits could slow projects down given the complexity and cost of tax equity, tax credits do bring down costs, and a tax credit with a direct pay option might be a preferable approach. Congress renewing the 48C advanced manufacturing tax credits to include underground HVDC cables would also help. The cables are currently built in Europe and Asia, and manufacturers need market certainty to invest in U.S. plants. The combination of tax credits could provide the needed signals to invest in U.S. manufacturing capacity – and the plants could be located in places where energy jobs have been displaced, which could be politically resilient policy. The modest federal investment represented by the tax credits could get several inter-regional projects built around the country, bring the grid into the digital age with advanced grid technologies, get more renewables built in remote regions, help achieve decarbonization goals, and put union labor to work in a vital technology sector.

Another mechanism to reduce risks for transmission developers could be tweaks to DOE's loan guarantees to get the government to effectively underwrite the risk of filling up lines. (In a country where utilities are small by global standards, the big HVDC lines are hard to fill by one entity; more utility consolidation could actually therefore be of help to transmission development by concentrating load and resources.) Similarly, there are discussions about the federal government underwriting capacity purchases on certain critical lines.

A national clean energy grid, however, cannot be built quickly enough without fixing policies, rules, and regulations that are not currently set up to enable speedy deployment of transmission. PJM, for instance, has an antiquated grid connection process that needs to be updated. Modern HVDC technologies can make the grid more resilient, with undergrounded lines that are bi-directional and dispatchable, but modern HVDC projects are currently languishing in PJM's generation queue. FERC can provide leadership and direct grid operators to update their interconnection rules to have such projects studied as transmission. Like batteries, modern bi-directional HVDC transmission lines also should also be compensated for the range of benefits they bring, including boosting resilience. In addition, state regulatory structures will be big hurdles to transmission development if the question of how utilities can recover fixed expenses is not addressed.

In general, resilience and reliability may be an effective framing to actually get inter-regional transmission built. When inter-regional projects get developed, cheap and clean megawatts can flow around the grid, and everyone benefits – including in terms of reliability and resilience.