Beyond Wires

Using Advanced Transmission Technologies to Accelerate the Transition to Clean Energy

ENVIRONMENTAL LAW
& POLICY CENTER

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Introduction

As renewable energy expands nationwide, we need a robust, efficient, and modern electricity delivery network to match. By enhancing the performance of our existing transmission system with smart technology, we can maximize clean energy investments, reduce carbon pollution, and improve reliability. Advanced transmission technologies, such as battery storage, dynamic line rating, and power flow control add digital intelligence to analog wires, to unlock gigawatts of new transfer capability and bring renewable projects online. Paired with local distributed energy solutions and non-transmission solutions, these grid investments can relieve congestion to get renewables onto the grid faster and cheaper than relying on new transmission lines alone.

To be clear, this is not an "either/or" choice between traditional large wires projects and new transmission technologies. Both are critical. However, much of the US is already blanketed by underutilized transmission lines, while planners and transmission owners largely ignore lower-cost solutions that can help unclog existing transmission capacity. This puts the transition to clean energy in jeopardy.

The barriers are not the lack of technology, nor its cost. The underlying problems are regulatory. While federal regulators have pushed to open markets and improve fair competition, the reality is that implementation continues to favor entrenched monopolies and the highest-cost solution. This discriminatory treatment of competitive non-wires technologies has led to unjust and unreasonable rates, in violation of the Federal Power Act. New rules are necessary to encourage investments in the best technology now and into the future. Especially as the Biden administration and Congress map out new energy infrastructure opportunities, it is critical to ensure wise investments in an efficient and holistic energy system, including and beyond wires. A combination of legal and expert intervention is required to achieve the electricity delivery system we need.

The Environmental Law and Policy Center (ELPC) is collaborating with the Center for Renewables Integration (CRI) in a three-pronged approach to grid transformation. Building on the work done by others at the Federal Energy Regulatory Commission (FERC), our Beyond Wires campaign works to ensure that transmission- and distribution-connected technologies are fully considered and optimally deployed to maximize cost-effective electricity delivery and renewables interconnection. With a combination of legal and expert intervention, we can achieve the electricity delivery system we need.

> **"This is not an 'either/or' choice between traditional large wires projects and new transmission technologies. Both are critical."**

Transmission Lines Across the U.S.

Mobilizing Technology to Maximize Grid Performance

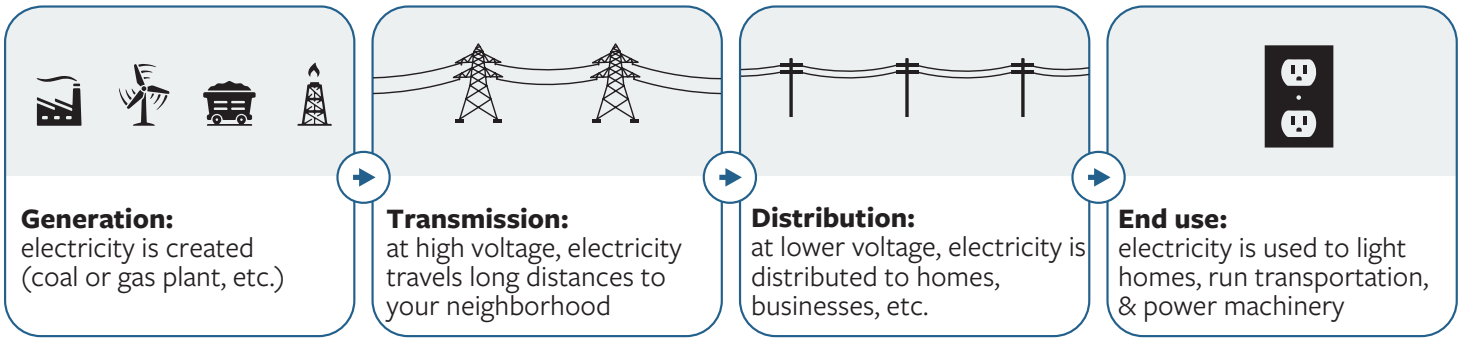
The flow of electricity on transmission lines is limited by the physical properties of wires and other hardware. If you exceed the limits, transmission lines will overheat or fail in other ways. In most of the U.S., power flows across a combination of smaller and larger transmission lines. The limits on small lines can clog up the transmission system, leaving larger transmission lines significantly underutilized. It is the electrical equivalent of a wide water pipe connecting to a narrow one. When the wide pipe is carrying a large amount of water, the connection to the narrow pipe can cause water to backup and flood. There are solutions to avoid flooding, such as connecting multiple narrow pipes to the large one, or using pumps to accelerate water through these additional smaller pipes. Similarly, technology can widen or redirect clogged points on the transmission system.

There are three options to increase transmission capacity: building new transmission lines, using technology to unlock underutilized capacity, and developing local energy generation to fill needs at peak times, under the control of grid operators. Many parties are pursuing the first option, but building new transmission can easily take a decade. Wind and solar projects are already encountering major delays and increasing costs to connect to the grid. The U.S. needs to use all available transmission technologies—not just new wires—to ensure growing interconnection delays don't turn into a crisis.

FERC and other transmission experts use an alphabet soup of acronyms to describe non-traditional transmission solutions. FERC defines grid-enhancing technologies (GETs) broadly as "technologies that increase the capacity, efficiency, or reliability of transmission facilities." FERC Order 1000 addresses "alternative transmission solutions" (ATS) that can be comprised of "advanced transmission technologies" (ATT) as defined in the Federal Power Act. Some states require consideration of "non-transmission alternatives" (NTA) and FERC recently accepted a proposal by MISO to allow "storage as a transmission-only asset" (SATOA).

While there are nuances between these definitions, for the purposes of this paper we will refer to this entire suite of technologies that can provide transmission solutions as "advanced transmission technologies" or ATTs. These transmission technologies are not limited to facilities on the bulk transmission network. Distribution connected assets—such as distributed generation, storage, load control, and energy efficiency—can serve as advanced transmission technologies if they are designed and controlled to relieve transmission constraints.

Traditional Grid Terminology



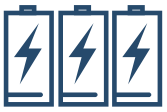
Historically, energy flowed in one direction, through a distinct chain of authorities. But today the grid is changing to embrace new renewable technology. Energy can now be created, stored, and managed at multiple points throughout the grid, offering new opportunities for flexible, decentralized, and efficient electricity delivery.

Advanced Transmission Technologies Are Rapidly Emerging as Viable and Cost-Effective Transmission Solution

Battery storage is perhaps the most flexible technology on the market today, and it can improve transmission in many ways. For example, storage can be sited in a transmission-constrained zone and used to provide voltage support in case of a fault on a line or as a backup solution to ensure reliability while repairs are executed. It can be used to reduce peak loads, increase capacity on congested lines, direct the power flow away from lower capacity transmission lines, and control the timing of power flows to remain under thresholds. With energy storage, utilities can defer investments as supply and demand patterns change, allowing them to avoid all-in, 50-year investments in favor of shorter-term flexibility. Finally, storage can provide energy, capacity, and ancillary services when not being used as a transmission asset. And it can do all of this in deployment times much lower than traditional infrastructure, and increasingly at a lower cost.

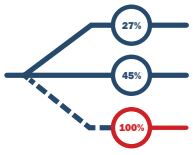
For example, in Germany, grid operators have ordered the construction of 900 MW of batteries to boost existing transmission lines and reduce the need for expensive, highly contested transmission lines. In Australia, officials are considering a "virtual transmission line" consisting of two large (250MW/125MWh) battery-based energy storage systems that will provide additional transfer capability of the existing transmission system.

Grid-Enhancing Technologies (GETs)



Battery Storage – Stores energy anywhere along the grid, ready when needed. Adds flexibility, capacity, and reliability, while reducing energy congestion.

Dynamic Line Rating – Automatically adjusts how much power a transmission line can carry based on real-time weather conditions, to increase efficiency and reduce overload outages.



Power Flow Control – Redirects power flows away from low-capacity lines to avoid creating bottlenecks, like the "WAZE of the transmission system."

In addition to battery storage, FERC is taking a close look at other "grid enhancing technologies" (GETs) such as advanced line rating management systems and power flow control and transmission switching equipment. Dynamic line rating allows transmission operators to automatically adjust how much power a transmission line can carry based on real-time weather conditions. Instead of keeping lines limited to suit the safety needs of the most inclement conditions, operators can limit capacity just as needed, and increase power more consistently. These adjustments can significantly increase the effective capacity of existing and future lines and allow the system to operate at lower cost without the addition of new infrastructure.

Finally, power flow controls direct the flows of electricity on transmission lines. Coined the "WAZE of the transmission system," power flow technology redirects power flows to avoid creating bottlenecks, staying off low-capacity lines. In the UK, National Grid Electricity Transmission installation of power flow control technology will increase system capacity by 1.5 GW.

While these are a few of the most promising FERC-defined GETs available today, the list is by no means exhaustive and is only going to grow as technologies improve. FERC has recently taken an interest in GETs and has an ongoing investigation into GETs compensation, installation, and use.

> **"These adjustments can significantly increase the effective capacity of existing and future lines."**

Advanced Transmission Technologies can Postpone or Replace the Need for New High-power Lines

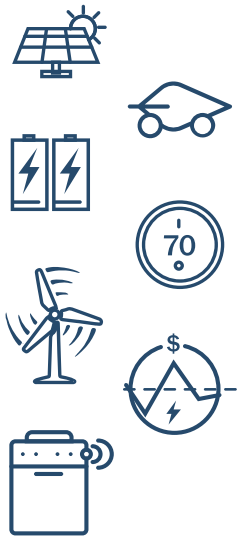
The distribution side of the grid also offers opportunities to reduce energy congestion and improve electricity delivery. For example, community solar panels and other distributed generation (DG) solutions create energy close to where it will be used, reducing the need to send energy through the transmission grid in the first place. Demand response (DR) programs balance energy supply and demand by encouraging customers to reduce or shift their energy use away from peak times. Energy efficiency (EE) helps people do more with less electricity, and battery storage adds flexible energy throughout the grid. Storage on the distribution side can provide load balancing and act as generation when needed. When technologies and programs like these (collectively, distributed energy resources or DERs) are deployed intentionally, they can solve transmission needs in lieu of a new high-power line.

Unfortunately, transmission planners rarely consider the potential for DER in the transmission planning process. Distributed energy resources are usually just factored into estimates of future load growth and rarely considered as a solution to a transmission need. Transmission operators should compensate (and cost allocate) DERs as transmission assets if they are built and controlled to solve a specific transmission need (such as an overload on a specific line). For example, consider a prescribed quantity of battery storage assets (e.g., 120 MW / 480 MWh) and demand response technologies located in a zone served by a transmission line that is expected to exceed reliability limits. These distribution-connected assets can be controlled in a manner that specifically reduces load on the transmission line (e.g., demand response is activated, or batteries are discharged, during summer peak hours, in accordance with a signal from the utility). Federal law specifically allows this scenario by designating these technologies as Advanced Transmission Technologies and requires FERC to determine how to encourage their use, by identifying means of folding these solutions into the planning process and developing compensation structures.

As real-world examples, in Oakland, PG&E will implement a solution consisting of storage, distributed generation, and infrastructure upgrades rather than build new transmission lines. Bonneville Power Administration cancelled a 500 kV transmission line designed to serve load in Portland-Vancouver, replacing the line with local storage and flow control. These DER technologies are providing transmission solutions.

Not withstanding their federal mandate, grid operators have been slow to deploy non-wires technologies to provide transmission services. We simply aren't using all the tools available to unclog the transmission system. Historically, the legal chasm between the local distribution system (managed by states) and the interstate transmission system (managed by FERC) has prevented optimal deployment of distributed-connected assets to provide transmission services. However, FERC Orders 845 and 2222 are beginning to bridge this gap by requiring regional independent service operators and regional transmission organizations (ISO/RTOs) to allow energy storage and distributed energy resources to participate in markets. While participating in markets is not the same as operating as a transmission asset, FERC's orders create an important precedent by enabling regional grid operators to communicate with and control DERs on the distributed system. This is a fundamental requirement for DERs to be considered a transmission asset.

Distributed Energy Resources (DERs)



- **Distributed generation, like rooftop & shared solar panels**
- **Electric vehicles**
- **Battery storage**
- **Smart inverters, meters, thermostats, etc.**
- **Demand Response**
- **Energy Efficiency**
- **Microgrids**

> **"We simply aren't using all the tools available to unclog the transmission system."**

Wires-Only Solutions are Insufficient to Meet Our Nation's Ambitious Clean Energy Goals Alone

Building new transmission is expensive, time consuming, and logistically difficult. While we will continue to need new transmission lines, building large infrastructure is not the best way to address every energy situation on the timeline that the Biden administration and others know is necessary to meet our climate challenges. Relying on wires-only solutions ignores the many other tools available to meet our transmission needs and makes it more difficult to transition to a clean energy economy.

Poles and wires transmission line projects can take years, if not a decade to plan, approve, and construct. That is especially true for large, high voltage lines. In the meantime, interconnection queues are ballooning with projects seeking interconnection as the generation cost of renewables drops below natural gas. The cost to interconnect clean energy projects rises as congestion on the grid increases. As a result, clean energy projects are already dropping out of the interconnection queue at an increasing rate. Transmission delays and rising costs have a disparate impact on clean energy projects, since they represent the majority of new generation projects getting built. A 2020 analysis of the MISO queue examines the rising cost of interconnection, showing interconnection costs rising to $1000/kW, which in some cases is almost equivalent to the cost to build the generation project itself. It is not economically viable to double the cost of a clean generation facility by constraining the solution set for transmission upgrades to wires-only solutions.

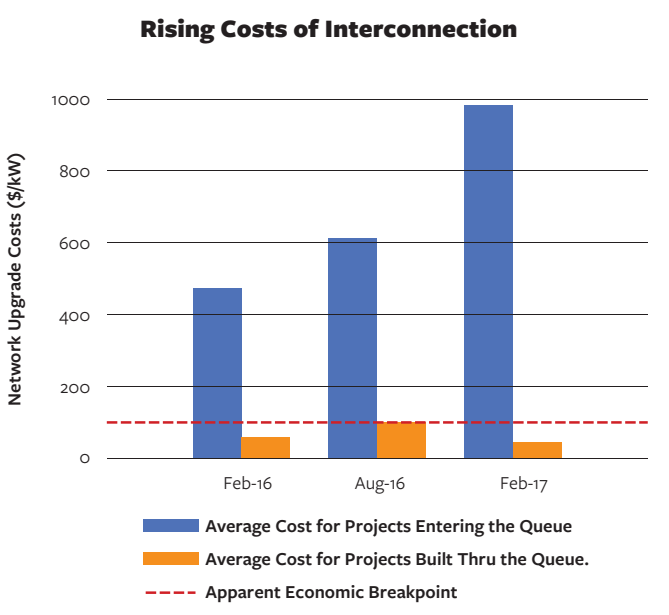
Transmission lines can also be much more expensive than GETs alternatives. The major electric utilities in the United States spend over $20 billion per year on transmission infrastructure, even though as much as 85% of our existing transmission infrastructure is operating at less than 50% of its capacity under normal operating conditions. Similar to generation, the transmission system is built to accommodate the one peak load hour per year. Targeted solutions to surgically mitigate peaks can be much cheaper than building whole new transmission lines.

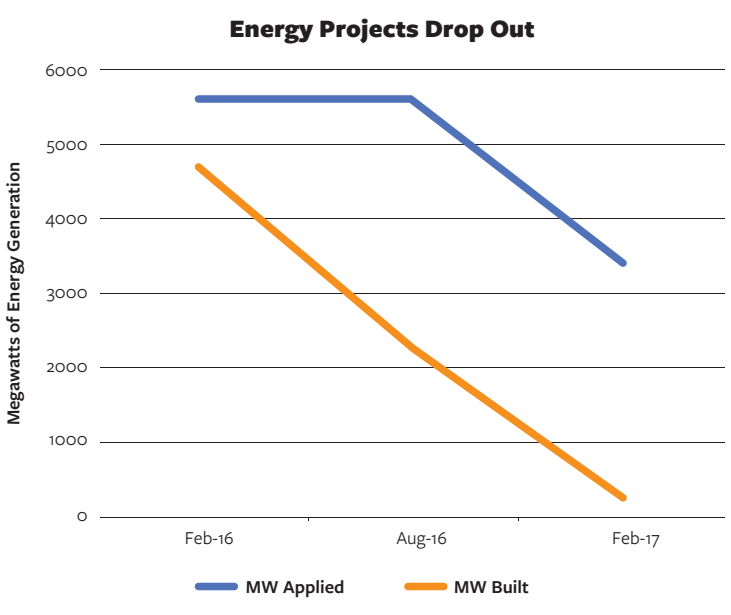
Experts have estimated that the cost of additional transmission necessary to reach 100% renewables in the United States could be as much as $700 billion, a prohibitive cost that doesn't even take into account the significant environmental and land-use impacts that would accompany such a massive transmission build-out. While this expense benefits the current incumbent transmission owners, who are awarded a guaranteed rate of return on these large projects, reliance solely on wires solutions dramatically increases the cost and time of adding the renewables we need to meet society's carbon goals.

Advanced transmission technologies can significantly reduce the cost of renewables integration as compared to wires strategies alone. A 2021 analysis prepared for the WATT Coalition determined the addition of power flow technology, dynamic line rating, and topology optimization

Interconnection Costs Prevent Energy Projects from Completion

Generation interconnection for MISO-WEST (includes parts of MN, IA, WI, IL)





Source: Midcontinent Independent System Operator (MISO)

could more than double the amount of wind generation that can be interconnected in the Southwest Power Pool (SPP), from 2.5 GW to 5.2 GW, at a cost of only $90M. (To put the cost in context, MISO 2020 Transmission Expansion Plan proposes $4.2B in wires-based transmission line upgrades.) Similarly, a 2016 analysis of the cost to upgrade PJM's grid to 30% renewables concluded that adding power flow controls to transmission would save ratepayers approximately $1.8 billion as compared to a wires-only approach ($2.2B vs. $4B). Adding energy storage, local solar, and other DERs operating as advanced transmission technologies could likely reduce this cost even further.

Transmission Planners and Utilities Undervalue Advanced Transmission Technologies in the Planning Process

While energy storage and other advanced transmission technologies could provide a faster "on-ramp" for renewable energy projects stranded in ISO interconnection queues, the current transmission planning process thwarts reasonable consideration of these alternatives. As noted by former FERC Chairman Jon Wellinghoff, grid-enhancing technologies "can do for the transmission system what smart meters did at the distribution level ... but they aren't being deployed because transmission developers have no incentive to use them." In order to incorporate and fairly value these advanced technologies in long-term planning, here are four ways that the transmission planning, modeling, and operations must improve.

First, planners should require transmission owners to report the utilization rates of existing transmission lines. In most infrastructure-dependent industries, we consider utilization of fixed cost capital assets a measure of efficiency, but we hold no such standards for monopoly transmission owners. They are not even required to determine the efficiency of the transmission system, despite the billions they cost us. It is important to get a better handle on utilization rates across the country, while also recognizing the need for redundancy and backup in cases of a fault on a transmission line.

Second, FERC must level the playing field for non-wires transmission solutions. The current transmission planning process in the United States provides an undue advantage for wires-only transmission projects over nimbler, cost-effective, technologically advanced alternative solutions. Skewing planning towards a specific (wires-based) transmission technology is unjust and unreasonable, and it threatens to block the timely achievement of our nation's clean energy transition. Wires-only projects are becoming increasingly difficult to permit and build because of the public's concerns about the impact of transmission lines on landscapes, habitats, and communities, as well as increasing costs. FERC and the RTOs must reform the planning process to ensure full consideration of technologies that can help integrate renewables better, cheaper, and faster. Recent work at FERC has been a great step forward, but we need to ensure that any ISO/RTO tariff changes in this area provide a level playing field for all technologies.

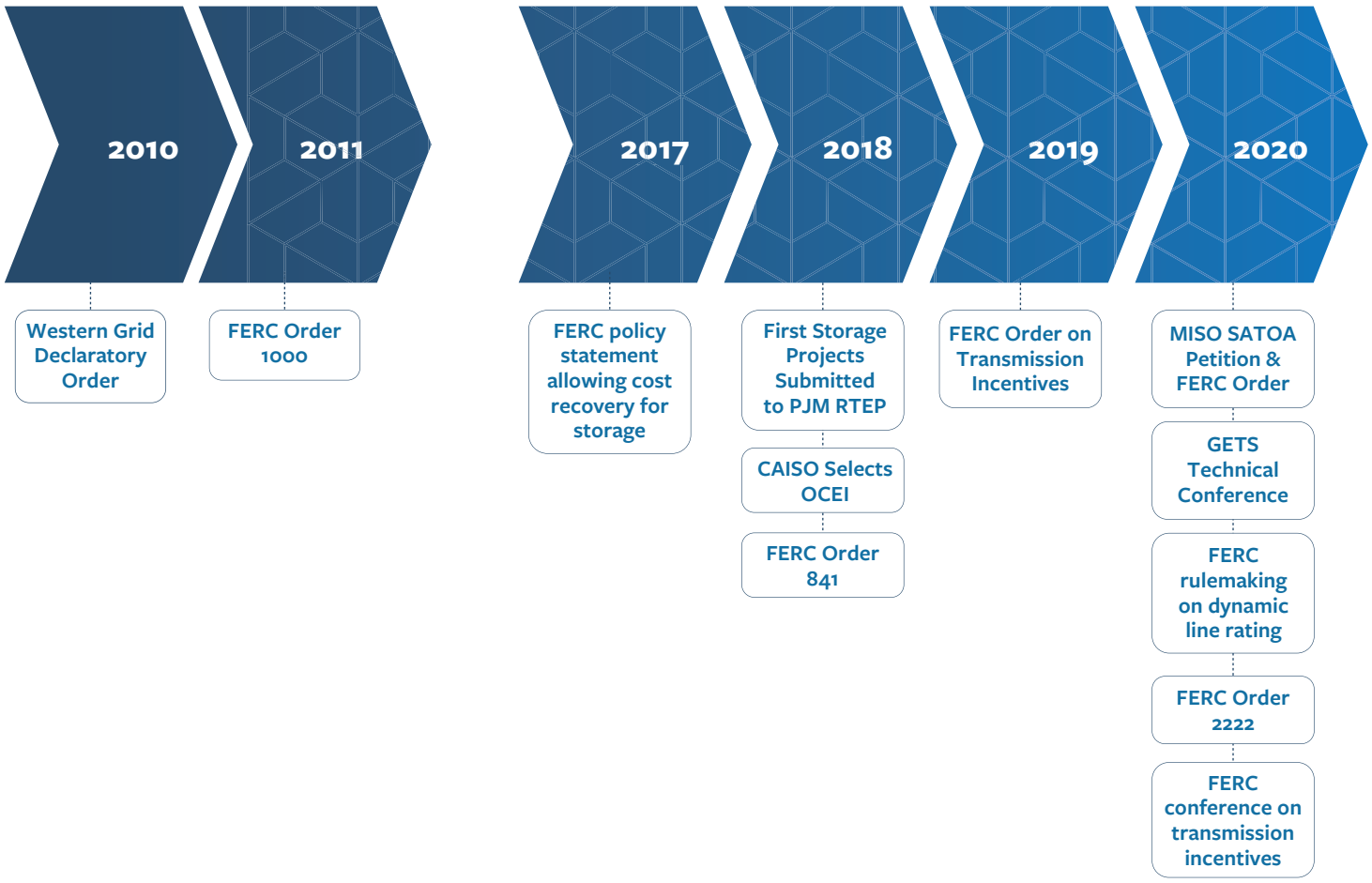
Third, FERC must ensure comparable cost allocation for advanced transmission technologies. Transmission planners too often shunt advanced transmission technologies into categories such as "non-transmission alternatives" where they are either not compensated or left to fend for themselves in the wholesale markets while traditional wires solutions receive regional cost allocation for providing the same transmission services. This is a clear violation of the Federal Power Act's focus on technology-neutral services and prohibition of unduly discriminatory rates. Even when they are eligible for return on equity cost allocation, grid- enhancing technologies are often less expensive than traditional wires projects and so are less valuable to the incumbent utility, in that they generate a lower total profit for utility shareholders. New cost allocation and shared incentives rules and requirements would make grid-enhancing technologies attractive to both incumbent utilities and new entrants alike. We need to broaden the types of projects that can be compensated as transmission and incorporate appropriate incentives to level the playing field.

Finally, FERC and the RTOs must reform the generator interconnection process. Interconnection improvements could reduce the time and expense of connecting new wind and solar projects to the grid. RTO interconnection studies increasingly subject renewables projects to huge transmission upgrade costs based in large part on the purported need to construct high-voltage transmission lines to accommodate the new generation. FERC should require RTOs to begin properly considering how energy storage and other advanced technologies could reduce those upgrade costs and delays.

FERC will play an important role in fixing the flaws in the existing transmission planning and compensation regime. Thanks in large part to the WATT Coalition, Jon Wellinghoff, and others, FERC has recently begun to recognize the value that grid-enhancing technologies can provide. In 2020, FERC proposed two rulemakings - RM20-10 and RM20-16 - that begin to address grid- enhancing technologies through transmission incentives and requirements to standardize transmission line ratings. The tide is turning, and momentum is slowly building to move beyond wires and include a broader range of transmission technologies to accelerate the United States' transition to renewable energy.

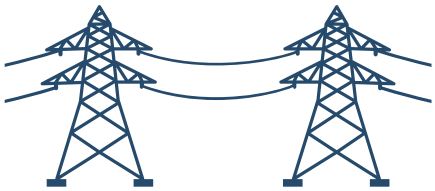
Momentum is Growing

Momentum is building to rethink transmission and technologies that can participate



Plan of Action

The Beyond Wires Coalition works to ensure that transmission and distribution-connected technologies are fully considered and optimally deployed to maximize the cost-effective delivery of renewable electricity while maintaining reliability. ELPC is working with the Center for Renewables Integration (CRI) on this project, with feedback from other organizations, thought leaders, and businesses. This work will require significant advocacy and participation at the federal, regional, and state levels, starting with these three areas of policy and legal intervention:



1. Utilization

We will advocate for increased transparency and the development of utilization metrics to show how electricity is used throughout the grid on a more granular level. Regular and standardized transmission utilization studies will help identify opportunities for targeted non-wires solutions.

2. Planning

We must ensure distribution-connected resources and other grid enhancing technologies are given full consideration in the energy planning process. Utilities must be required to present, and RTOs to evaluate, whether these technologies could replace or reduce the cost of traditional large wires solutions to grid and interconnection needs.

3. Compensation

Our current transmission planning process gives undue advantage to wires-only solutions. We will push for rule/tariff changes to fairly compensate grid- enhancing technology and distribution-connected resources when they are providing transmission services. This will create a level playing field for all possible transmission solutions.

At the federal level, we are exploring opportunities to initiate new actions at FERC challenging the status quo of comparable treatment and cost allocation for advanced transmission technologies through rule and tariff changes. To the extent that FERC or Congress acts, there will be considerable work to be done to ensure that regional grid operators effectively and fairly implement any new federal policies. The Beyond Wires Coalition is already working to expand consideration of advanced transmission technologies in multiple states and RTOs, including CAISO, MISO, and PJM. We expect all three of those grid operators to make major steps toward advanced transmission technologies in the next year.

Our planned work on advanced transmission technologies will dovetail with ELPC and our regional partners' existing work to integrate storage and other technologies in Midwest states. The success of this project will depend on effective partnerships with other leading advocacy and industry groups. We intend to engage other leading organizations as potential partners in this work. These organizations and companies will help us adjust and flesh out this plan moving forward.

Conclusion

As battery storage, distributed solar photovoltaics, and other resources become increasingly affordable, these technologies are unlocking new opportunities to meet transmission needs and accelerate renewable energy deployment. It is time for the Midwest, and the United States as a whole, to take full advantage of advanced transmission technologies to modernize electricity delivery and meet our society's urgent climate goals.

A massive societal shift towards renewable energy is needed to meet the global climate crisis. Communities, manufacturers, and Americans of all stripes are eager to build out the clean energy generation that will get us there. We cannot afford to let our outdated transmission system and dysfunctional planning process hold us back. Energy storage and other novel transmission technologies must be part of the solution. Thinking beyond wires can help to reduce carbon pollution, protect the environment, limit costs, increase flexibility, create jobs, and promote transparency and competition. The Beyond Wires Coalition will work to accelerate smart technology to meet the energy challenges of the 21 st century.

References

Amelang, Soren *German power grid operators plan gigantic batteries to ease grid congestion* – report Clean Energy Wire (Jan. 12, 2021) https://www.cleanenergywire.org/news/german-power-grid-operators-plan-gigantic-batteries-ease-grid-congestion-report

Aniti, Lori *Utilities continue to increase spending on transmission infrastructure* EIA Today In Energy (Feb. 9, 2018) https://www.eia.gov/todayinenergy/detail.php?id=34892

DNV GL, *Assessment of Applicability And Cost Savings of Deploying Smart Wires Power Flow Controls To Integrate Renewable Energy in PJM*. Report No.: 10004216. June 23, 2016

Doherty, Paul *PGE Proposes Two Energy Storage Projects for Oakland Clean Energy Initiative to CPUC* PGE Currents (Apr. 15, 2020) http://www.pgecurrents.com/2020/04/15/pge-proposes-two-energy-storage-projects-for- oakland-clean-energy-initiative-to-cpuc

Fluence *Call for Non-Network Options – VNI West* (March 2020) https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/victorian_transmission/vni-west-rit-t/report-submissions/fluence-submission-to-the-pscr.pdf

Grid Strategies and The Brattle Group, *Improving Transmission Operation with Advanced Technologies: A Review of Deployment Experience and Analysis of Incentives* (June 25, 2019) https://cdn.misoenergy.org/20200520%20AC%20Item%2004%20Current%20Issue%20-%20Generator%20Interconnection%20Queue447230.pdf

Jammalamadaka, Swaraj *Apex Clean Energy Presentation FERC* Grid-Enhancing Technologies Technical Workshop, AD19-19 (Nov. 5, 2019) http://ferc.capitolconnection.org/110519/ferc110519.htm

MISO System Plannign Committee of the Board of Directors *MISO Transmisison Expansion Plan 2020* (Oct 26, 2020) https://cdn.misoenergy.org/20201026%20System%20Planning%20Committee%20of%20the%20BOD%20Item%2003%20MTEP20%20Review486318.pdf

Shreve, Dan & Schauer, *Wade Deep Decarbonisation requires deep pockets: trillions required to make the transition* Wood Mackenzie (June 2019) http://www.decarbonisation.think.woodmac.com/summary/

St. John, Jeff *Smart Wires Looks to Ease Transmission Grid's Mounting Challenges with Digital Controls* Green Tech Media (Mar 13, 2020) https://www.cleanenergywire.org/news/german- power-grid-operators-plan-gigantic-batteries-ease-grid-congestion-report

Trabish, Herman K. *Can new transmission tech boost capacity and save billions? Two proposals aim to find out* Utility Dive (Dec. 3, 2019) https://www.utilitydive.com/news/can-new- transmission-tech-boost-capacity-and-save-billions-two-proposals-a/567947/

Walton, Robert BPA *turns to non-wire alternatives in cancellation of transmission project* Utility Dive (May 19, 2017) http://www.pgecurrents.com/2020/04/15/pge-proposes-two-energy- storage-projects-for-oakland-clean-energy-initiative-to-cpuc/

Working for Advanced Transmission Technologies (WATT) Coalition *Unlocking the Queue: Advanced Transmission Technologies Shown to Double Regional Renewable Energy Capacity* (Feb. 22, 2021) https://watt-transmission.org/unlocking-the-queue/

Sec. 1223 of Energy Policy Act of 2005 (Aug. 8, 2005) https://www.congress.gov/109/plaws/publ58/PLAW-109publ58.pdf

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