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US HOUSE OF REPRESENTATIVES

ENERGY AND COMMERCE COMMITTEE

ENERGY SUBCOMMITTEE

Hearing entitled "Examining the State of Electric Transmission Infrastructure:

Investment, Planning, Construction, and Alternatives"

May 10, 2018

Thank you, Chairman Upton, Ranking Member Rush, and Members of the SubCommittee, for inviting me to testify on the state of US transmission infrastructure. Since modern society requires affordable, clean, and reliable electricity for just about every activity, there is no infrastructure more important than the interstate electric network. I serve as Executive Director of the WATT Coalition (Working for Advanced Transmission Technologies), on the board of the Americans for a Clean Energy Grid coalition, and have a consulting practice called Grid Strategies LLC that provides analysis and regulatory policy support for clean energy integration and delivery.

Transmission delivery capability has improved markedly since this Subcommittee helped pass the Energy Policy Act of 2005. While providing a source of optimism, that progress still puts the grid nowhere near where it needs to be given the age of existing transmission assets, the need to connect new generation and consumption sources, the opportunity to develop rural economies by accessing remote resources, and the many reliability and economic benefits that would accrue to electricity customers with an expanded and more dynamic bulk power network.

I recommend that FERC and Congress preserve and build upon the major twin policies that succeeded in increasing needed transmission investment over the last decade:

1) broad regional planning, and
2) beneficiary pays cost allocation.

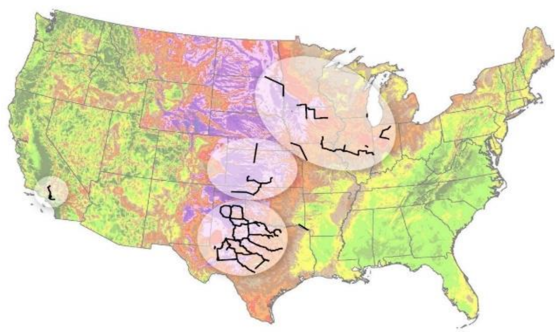
I recommend that FERC and Congress remedy the lack of progress in inter-regional transmission and innovation through:

1) Fixing inter-regional planning and cost allocation;
2) Promoting the adoption of technology and innovations to deliver more over the existing grid;
3) Implementing limited federal support permitting of inter-state transmission lines.

I. Great progress has been made

Around the time of the Energy Policy Act of 2005 ("EPAct"), annual transmission investment had fallen to around $4 billion per year. Today annual transmission investment is close to five times that amount, around $20 billion. This investment has resulted in significant new transmission highways delivering very low-cost wind onto the high voltage network. The image below shows new transmission lines in black connecting the highest quality wind resource areas (shown in red and purple), particularly in the middle of the country with demand centers.

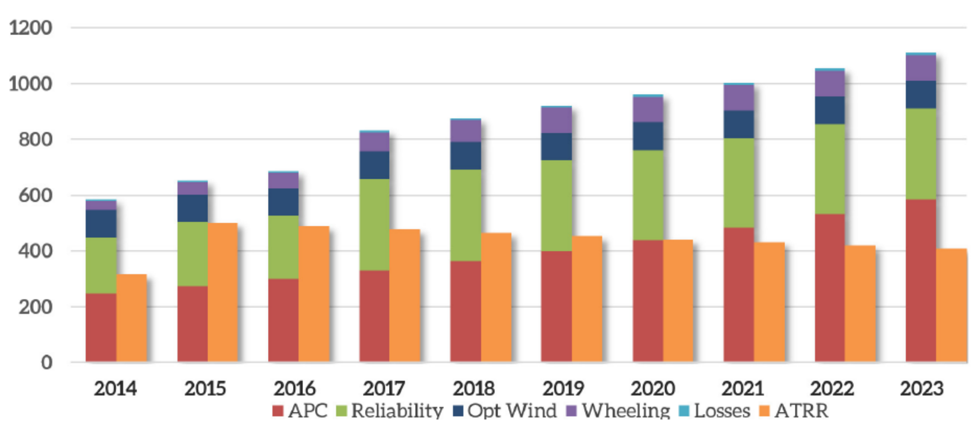
Figure 1: Recent High-Voltage Transmission and Wind Resources



A. Benefits to customers of recent transmission investment

These investments have benefitted customers. The Southwest Power Pool (SPP), the grid operator for Kansas, Oklahoma, Nebraska, and parts of neighboring states, evaluated the many categories of benefits provided by its recent transmission upgrades.[1] SPP found that the transmission upgrades it installed between 2012 and 2014 create nearly $12 billion in net present value benefits for consumers over the next 40 years, or around $800 for each person currently served by SPP, or $2,400 per each metered customer. The $16.6 billion in gross savings is higher than SPP's transmission planning models had initially estimated, and 3.5 times greater than the cost of the transmission upgrades. As shown in the following chart from SPP's report, these upgrades are already paying for themselves, and the benefits only grow over time while the costs decline.

SPP: Benefits (left bar) exceed cost (orange bar) of transmission upgrades



[1] https://www.spp.org/documents/35297/the%20value%20of%20transmission%20report.pdf

SPP's report shows the wide range of benefits provided by transmission: It reduces the cost of producing electricity, reduces the need for power plants by improving power system efficiency, increases electricity market competition, improves electric reliability, makes the power system more resilient to unexpected events, reduces environmental impacts, and creates jobs and economic development.

The Midwest grid operator, also testifying today, conducted analysis of grid upgrades that are currently underway, and found $12 billion to $53 billion in net benefits, or between $250 and $1,000 for each person currently served by MISO.[2] The benefits were 2.2 to 3.4 times greater than the cost of transmission, an increase from the 1.8 to 3.0 benefit-to-cost ratio that was initially calculated when the transmission was planned in 2011.[3] MISO found that congestion and fuel cost savings associated with providing consumers with access to lower-cost energy sources accounted for between $20 billion and $71 billion of the gross benefits, a large share of the total. The New England grid operator similarly saw a large reduction in the congestion-related costs paid by consumers after it made significant investments in transmission upgrades. Specifically, congestion costs fell from in excess of $600 million per year in 2005 and 2006 to under $100 million annually.[4]

B. Ingredients for Success: planning and cost allocation

Credit for success in transmission investment in RTO and ISO regions goes to the twin policies of transmission planning and cost allocation. Each of these RTO/ISO regions use a form of wide regional transmission planning (over wider regions than planning was done prior to ISO and RTO formation), and broad beneficiary-pays cost allocation. Texas, as a single state outside of FERC jurisdiction, spreads transmission costs over all users. In FERC-jurisdictional ISOs and RTOs, the formula in each case is a form of beneficiary pays where costs are recovered in the ISO or RTO tariff. Providing a mechanism for planning and cost allocation was a major reason for ISO and RTO formation and the creation of regional planning processes and tariffs has paid off.

Broad regional planning and cost allocation are the core elements of FERC Order No. 1000 and should be preserved and expanded, as discussed below.

II. We have a long way to go

Costly congestion remains on the system. Nationally, consumers are paying approximately $4 billion per year in the areas with Regional Transmission Organizations and Independent System Operators as shown in Table 1 below. Since those cover approximately two-thirds of the country, one could extrapolate to the rest of the country and infer that total is approximately $6 billion per year.

2016 Annual Transmission Congestion Cost, in Transparent Markets[5]

Region	2016 congestion cost ($ million)
CAISO	142
ERCOT	497
ISO-NE	39

[2] https://cdn.misoenergy.org/MTEP17%20MVP%20Triennial%20Review%20Report117065.pdf

[3] https://cdn.misoenergy.org/MTEP17%20MVP%20Triennial%20Review%20Report117065.pdf

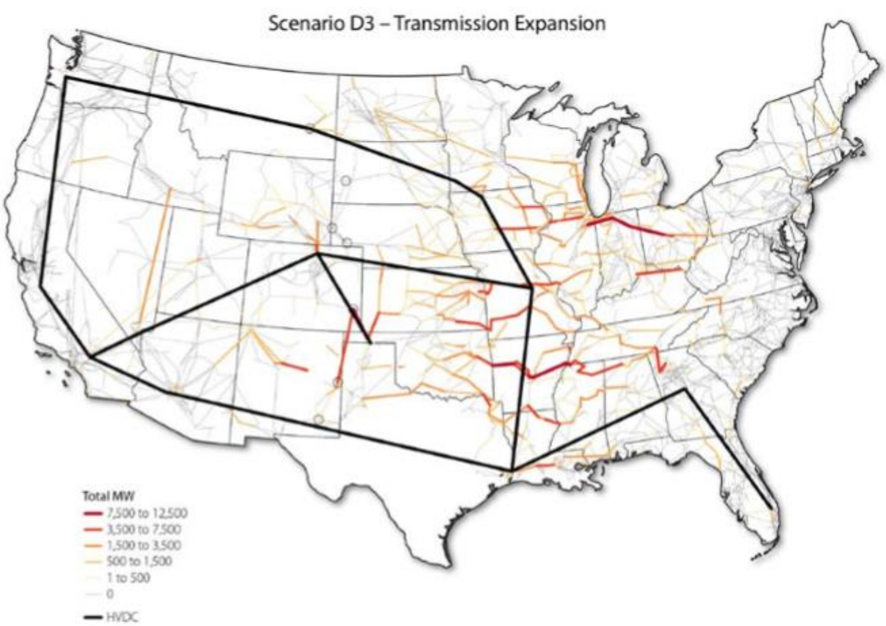
[4] https://www.iso-ne.com/static-assets/documents/2017/01/20170130_stateofgrid2017_presentation_pr.pdf, pages 39-40

[5] https://watttransmission.files.wordpress.com/2018/03/watt-living-grid-white-paper.pdf Appendix A.

MISO	1,400
NYISO	529
PJM	1,024
SPP	280
Total	3,911

Future projections of the US electric system find major opportunities for an expanded grid. A large consortium of grid operators, DOE national laboratories, and other researchers are currently developing an optimized national transmission expansion through the ongoing Interconnection Seams Study.[6] The image below shows one grid configuration being considered where a major high voltage DC overlay is added to the current network.

National Laboratory Seams Study Transmission Scenario



As indicated in the following table from a presentation of the study's preliminary results, these transmission investments yield benefits that are many times larger than their cost. The blue cells show the cost of each transmission addition, while the orange cells tally the benefits of that transmission. The bottom yellow cell calculates the benefit-to-cost ratio for each design, which range from 2.5:1 to 3.3:1 depending on the design over a 15-year period. Benefits continue for the estimated 40 year lifetime of the transmission lines. Even without accounting for the cost of carbon emissions, the transmission investments were found to have a benefit-to-cost ratio of 2:1 or 3:1 over 15 years, depending on the design.

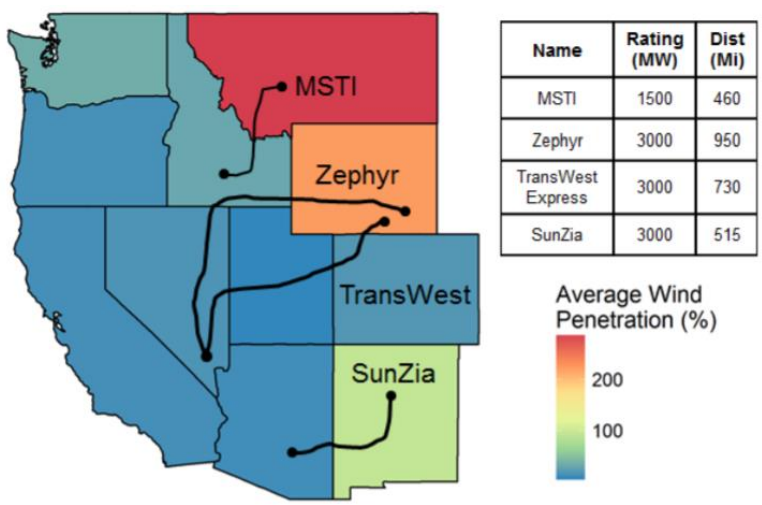
[6] https://www.nrel.gov/analysis/seams.html; preliminary results from "Interconnection Seams Study," presented at Energy Systems Integration Group spring meeting, March 2018

ECONOMICS, NPV $B	Design 1	Design 2a	Delta	Design 2b	Delta	Design 3	Delta
Line Investment Cost	61.21	73.89	12.68	74.88	13.67	80.1	18.89
Generation Investment Cost	704.03	703.32	-0.71	696.99	-7.04	700.51	-3.52
Fuel Cost	753.8	738.98	-14.82	737.3	-16.5	736.12	-17.68
Fixed O&M Cost	455.6	450.2	-5.4	448.95	-6.65	450.23	-5.37
Variable O&M Cost	64.5	63.9	-0.6	64.27	-0.23	64.39	-0.11
Carbon Cost	171.1	164.2	-6.9	162.6	-8.5	162.5	-8.6
Regulation-Up Cost	33.29	31.63	-1.66	29.96	-3.33	26.63	-6.66
Regulation-Down Cost	4.76	4.52	-0.24	4.29	-0.47	3.81	-0.95
Contingency Cost	24.41	23.19	-1.22	21.97	-2.44	19.52	-4.89
Total Non-Xm Cost (Orange)	2,211.49	2,179.94	-31.55	2,166.33	-45.16	2,163.71	-47.78
15-yr B/C Ratio (Orange/Blue)	-	-	2.48	-	3.30	-	2.52

CAPACITY, GW	Design 1	Design 2a	Delta	Design 2b	Delta	Design 3	Delta
Total gen invested (W/S/G)	600 (386/177/37)	600 (392/172/36)	0 (-6/5/1)	600 (393/172/35)	0 (7/-5/-2)	600 (392/169/38)	0 (7/-6/1)
Total gen retired	240	285	45	287	47	294	54
Total 2024 creditable capacity	838.5	809.5	-29.0	792.0	-46.5	794.1	-44.4
Total AC Xm invested	228.9	251.3	22.4	234.8	-5.9	195.1	-33.8
Total DC Xm invested	0	25.6	25.6	35.9	35.9	125.8	125.8

Another study published in the journal *Nature Climate Change* examines the benefits of building an even larger nationwide transmission network that could save consumers as much as $47 billion annually, a roughly 10 percent reduction in electric bills.[7]

Other studies have looked at regional transmission investments. Last year, the National Renewable Energy Laboratory (NREL) released detailed analysis of several proposed transmission lines in the Western U.S., shown below. It found that these lines would cost $10 billion but save $2.3 billion per year,[8] which indicates the lines themselves would have a payback period of around 4 years.



Name	Rating (MW)	Dist (Mi)
MSTI	1500	460
Zephyr	3000	950
TransWest Express	3000	730
SunZia	3000	515

[7] http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate2921.html, https://www.utilitydive.com/news/study-deep-decarbonization-of-us-grid-possible-without-energy-storage/412721/

[8] https://www.nrel.gov/docs/fy17osti/67240.pdf

In another regional study, Charles River Associates examined the potential for a high-voltage transmission overlay in SPP.[9] It concluded that the investment would provide economic benefits of around $2 billion per year for the region, more than four times the $400-500 million annual cost of the transmission investment. Of these benefits, $900 million would be in the form of direct consumer savings on their electric bills, with $100 million of these savings coming from the significantly higher efficiency of high-voltage transmission. The remainder would stem from reduced congestion on the grid allowing customers to obtain access to cheaper power.

Synapse Energy Economics also analyzed the net benefits of a large transmission upgrade in the MISO footprint. This analysis found significant net savings for consumers from this transmission expansion, between $3 billion and $9.4 billion in net savings per year, or $63-200 in annual benefits per household in the region.[10]

Transmission investment is needed at a minimum to replace old transmission assets. Like most infrastructure, this equipment will likely see a higher failure rate as it nears the end of its life, putting reliability at risk. Nationally, most of our transmission infrastructure was built between 1960 and 1980; according to one estimate, just replacing that infrastructure alone will cost around $8-14 billion per year over the next 25 years.[11] A similar estimate is that the grid will need $57 billion over the next five years alone.[12] Grid operators confirm that their transmission infrastructure is reaching the end of its life and must be replaced.[13] As America undertakes that investment, it should also account for future needs and ensure that the size of transmission investment is optimized to realize the benefits outlined in this section.

The vision of a high-capacity transmission network is being realized in other countries like China, India, and Europe. China is building a network of extra-high-voltage AC and DC transmission lines.[14] The 800kV DC links have a capacity of around 8,000 MW, and China recently awarded a contract to build a 12,000 MW 1,100 kV DC line, which will be a world record.[15] For comparison, the DC Pacific Intertie that ties the U.S. Pacific Northwest to Southern California operates at 560kV and can carry up to 3,800 MW.

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[9] CRA International, "First Two Loops of SPP EHV Overlay Transmission Expansion: Analysis of Benefits and Costs," available at http://www.spp.org/documents/8272/analysis_of_benefits_two_loop_sppfinal.pdf

[10] http://www.synapse-energy.com/sites/default/files/SynapseReport.2012-08.EFC_.MISO-T-and-Wind.11-086.pdf

[11] http://files.brattle.com/system/publications/pdfs/000/005/190/original/investment_trends_and_fundamentals_in_us_transmission_and_electricity_infrastructure.pdf?1437147799, pages 6-7

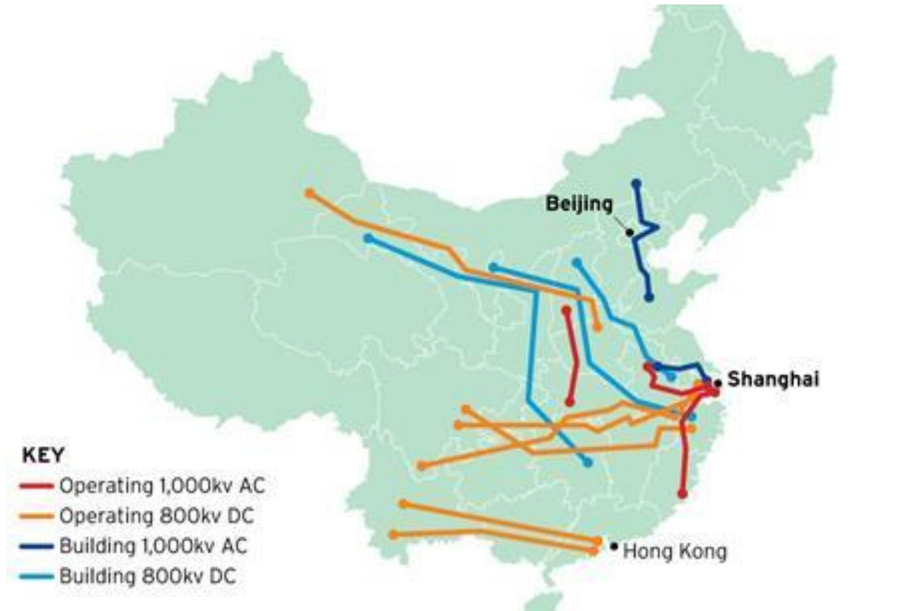
[12] http://www.cg-la.com//documents/Maximizing-the-Job-Creation-Impact-of-%241-Trillion-in-Infrastructure-Investment.pdf

[13] http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2016-power-trends-FINAL-070516.pdf, page 2

[14] https://www.windpowermonthly.com/article/1361466/analysis-china-adds-uhv-network-transfer-surplus-wind-energy

[15] http://www.abb.com/cawp/seitp202/f0f2535bc7672244c1257ff50025264b.aspx

China's Transmission Grid Expansion Plan



III. We should start by using the existing grid more efficiently

As with most other forms of infrastructure, great advances in monitoring and control systems can improve electricity reliability and efficiency. Customers who are required to pay for transmission understandably want to assurance that the existing wires are being used to their maximum capacity. FERC and state regulators should first make sure that efficient, low cost solutions are deployed.

There are a set of cost-effective technologies that can increase the flexibility, reliability and utilization of the existing grid. When Congress passed the Energy Policy Act of 2005 encouraging FERC to deploy advanced technologies, these network optimization options were not sufficiently developed for wide commercialization. They are now.

A. Technology options

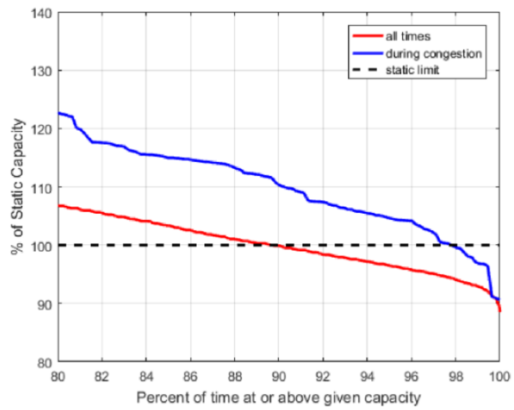
Leading technology options which can be used separately or together include:

Dynamic Line Ratings

The capacity of many transmission lines is limited by the temperature at which it can safely operate. Ambient temperature, sunlight, wind speed and direction, sunlight, and other weather factors that cool the lines can significantly increase their capacity. Dynamic Line Ratings (DLR) increase capacity on existing transmission lines by calculating capacity ratings based on actual monitored conditions rather than fixed worst-case assumptions. With DLR, even relatively low wind speeds can significantly increase the rating of a line by cooling it, reducing the impact of curtailments and transmission congestion on customers and producers of wind energy. The benefits are particularly large for wind energy because high wind speeds cooling the lines also increase the amount of wind electricity being generated and transmitted over the line. [16]

Estimates of increased capacity have been 40 percent[17], 30 to 70 percent, and 30 to 44 percent on three different tests.[18] DLR systems also provide forecasted ratings up to 48 hours ahead. For the line shown in the chart below, the increase in capacity tends to be highest when congestion is highest. DLR systems also improve reliability by alerting operators to conditions such as line sag clearance violations if conditions are hotter and actual capacity on the line is lower than the fixed engineering estimates.

Modeled Capacity in Kansas Transmission Line[19]



DLR supports grid resilience by offering condition-based line capabilities when contingencies occur. For example, when a line trips, the increased flow on other lines may be tolerable based on actual

[16] Doug Bowman and Jack McCall, "Reducing Contingency-based Windfarm Curtailments through use of Transmission Capacity Forecasting," CIGRE US National Committee 2017 Grid of the Future Symposium. https://watttransmission.files.wordpress.com/2017/11/reducing-curtailment-through-tcf-cigre2017-bowman-mccall.pdf

[17]Jake Gentle, Warren Parsons, Michael West, Catherine Meibner, Philip Anderson, "Increasing Transmission Capacities By Dynamic Line Rating Based on CFD." https://watttransmission.files.wordpress.com/2017/11/2015_awea_dlr_validation_final.pdf

[18] US Department of Energy, Dynamic Line Rating Systems for Transmission Lines, https://www.smartgrid.gov/files/SGDP_Transmission_DLR_Topical_Report_04-25-14_FINAL.pdf, April 2014, https://www.smartgrid.gov/files/SGDP_Transmission_DLR_Topical_Report_04-25-14_FINAL.pdf

[19] Verga, N. Pinney, and J. Marmillo, "Incorporating Dynamic Line Ratings to Alleviate Transmission Congestion, Increase Wind Resource Utilization, and Improve Power Market Efficiency," CIGRE US National Committee 2016 Grid of the Future Symposium. https://watttransmission.files.wordpress.com/2017/11/cigre-gotf-2016-genscape-finalsubmission1.pdf

conditions even if the static, worst case assumption-based setting would lead to a protective action to trip the line. Relays could be programmed to take actual conditions into account.[20]

DLR technology can be rapidly deployed as it is minimally invasive and usually does not require de-energization of transmission lines and the resulting complex outage coordination required. A variety of systems have been demonstrated, including directly measuring line temperature and other properties, and in a non-contact form, measuring line Electromagnetic Fields (EMF).[21]

DLR has been deployed on a large scale in Europe. Belgium's Transmission System Operator Elia deployed systems on all of its critical overhead lines to France and the Netherlands, helping it maximize import capability after the retirement of three large power stations.[22]

Advanced Power Flow Control

Power Flow Control refers to a set of technologies that effectively push or pull power away from overloaded lines and onto underutilized corridors within the existing transmission network. Advanced power flow control provides this same function with advanced features such as the ability to quickly deploy, easily scale to meet the size of the need, or redeploy to new parts of the grid when no longer needed in the current location.

Topology Optimization

Transmission topology optimization is a software technology that automatically identifies reconfigurations of the grid to route power flow around congested or overloaded transmission elements, taking advantage of the meshed nature of the power grid. The reconfigurations are implemented through switching on/off existing high voltage circuit breakers. By more evenly distributing flow over the network, topology optimization increases the transfer capacity of the grid. Acting as a grid configuration "search engine," topology optimization can reduce congestion by up to 50 percent and improve response to contingencies, supporting reliability and resilience.[23] It can reduce renewable

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[20] J.C. McCall, T. Goodwin, "Dynamic Line Rating as a Means to Enhance Transmission Grid Resilience," CIGRE US National Committee 2015 Grid of the Future Symposium.

[21]Marmillo, N. Pinney, B. Mehraban, S. Murphy, "A Non-Contact Sensing Approach for the Measurement of Overhead Conductor Parameters and Dynamic Line Ratings," CIGRE US National Committee 2017 Grid of the Future Symposium, https://watttransmission.files.wordpress.com/2017/11/genscape-cigre-gotf-whitepaper-2017.pdf

[22] Bourgeois, Raphael and Lambin, Jean-Jacques, "Dynamic Ratings Increase Efficiency," T&D World, 4/4/2017. http://www.tdworld.com/print/32183

[23] Pablo A. Ruiz, "Transmission Topology Optimization Software – Operations and Market Applications and Case Studies," ERCOT Emerging Technologies Working Group Meeting, Austin, TX, December 2016, http://www.ercot.com/content/wcm/key_documents_lists/85542/05._Transmission_topology_control_--_ERCOT_ETWG_12616.pdf

energy curtailment by up to 40 percent.[24] Optimization methods are much cheaper than hardware options such as phase angle regulators (PARs).[25]

Storage

Battery and other forms of storage can alleviate transmission congestion through charging and discharging at either side of a constraint. While storage can only move power over time and not space, and therefore is not a total replacement for all transmission needs, it can shift flow to times when congestion is less pronounced. It is very often the case that congestion changes over the timeframe that storage sources can store energy. Helping to alleviate transmission congestion or defer essential transmission upgrades is one of the many uses of storage technologies.[26]

B. Policies to Promote Advanced Transmission Technology Deployment

Deployment of the technologies described above requires some action on an important piece of unfinished implementation business in The Energy Policy Act of 2005. The Act states that "In carrying out the Federal Power Act (16 U.S.C. 791a et seq.) and the Public Utility Regulatory Policies Act of 1978 (16 U.S.C. 2601 et seq.), the Commission shall encourage, as appropriate, the deployment of advanced transmission technologies."[27] The Act provided for incentives to "encourage deployment of transmission technologies and other measures to increase the capacity *and efficiency* of existing transmission facilities *and improve the operation* of the facilities." (italics added) FERC implementation of this Act focused on grid expansion and has yet to address the operations part of the job.

The Commission, to its credit, has recognized this gap. After five years of experience with Order No. 679 which implemented this Act the Commission undertook a review. In a Notice of Inquiry the Commission observed "To date, the vast majority of applications for transmission incentives filed with the Commission have focused on the enlargement of facilities, including construction of new transmission facilities. Few applications have focused on the improvement, maintenance, and operations of transmission facilities or on increasing their capacity or efficiency… For example, this could include software improvements that enhance scheduling and dispatch or investment in tools to enhance self-healing grid capabilities or

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[24] Pablo A. Ruiz, Michael Caramanis, Evgeniy Goldis, Xiaoguang Li, Keyurbhai Patel, Russ Philbrick, Alex Rudkevich, Richard Tabors, Bruce Tsuchida, "Transmission Topology Optimization – Simulation of Impacts in PJM Day-Ahead Markets," FERC Technical Conference on Increasing Market Efficiency through Improved software, Docket AD10-12-007, Washington, DC, June 2016, http://newgridinc.com/wp-content/uploads/2016/06/PRuiz-FERCTechConf-28Jun2016.pdf, slide 11.

[25] T. Bruce Tsuchida, Xiaoguang Li, Pablo A. Ruiz, "Reducing Renewable Curtailments Through Flexible Operation," North American Wind Power, Feb 2014, pp. 10-12. https://nawindpower.com/online/issues/NAW1402/FEAT_03_Reducing-Renewable-Curtailments-Through-Flexible-Operation.html

[26] http://energystorage.org/energy-storage/technology-applications/transmission-support-and-avoidance-congestion-charges

[27] EPAct 2005, Section 1223, Title 42 U.S. Code § 16422, Chapter 149, Subchapter XII, Part A (2005).

improved situational awareness."[28] The inquiry led to a policy statement that clarified FERC's incentive policy for grid expansion related issues, but not grid utilization. It acknowledged once again the issue: "Investments in the following types of transmission projects may face the types of risks and challenges that may warrant an incentive ROE based on the project's risks and challenges that are not either already accounted for in the applicant's base ROE or could be addressed through risk-reducing incentives: …3. projects that apply new technologies to facilitate more efficient and reliable usage and operation of existing or new facilities…Examples of projects that meet this description include those that create additional incremental capacity without significant construction (e.g., through the use of dynamic line rating), that allow for more efficient balancing of variable energy resources, and/or that provide increased grid stability. In addition, the Commission is concerned that its current practice of granting incentive ROEs and risk-reducing incentives may not be effectively encouraging the deployment of new technologies or the employment of practices that provide demonstrated benefits to consumers. Accordingly, the Commission remains open to alternative incentive proposals aimed at supporting projects that achieve these ends."

The Commission has attempted to include transmission utilization technologies in its planning requirements. In the Commission's major reform of Open Access Transmission Tariffs in Order No. 890 in 2007, it stated:

> "Through the regional transmission planning process, public utility transmission providers will be required to evaluate, in consultation with stakeholders, alternative transmission solutions that might meet the needs of the transmission planning region more efficiently or cost-effectively than solutions identified by individual public utility transmission providers in their local transmission planning process. … When evaluating the merits of such alternative transmission solutions, public utility transmission providers in the transmission planning region also must consider proposed … alternatives on a comparable basis. If the public utility transmission providers in the transmission planning region, in consultation with stakeholders, determine that an alternative transmission solution is more efficient or cost-effective than transmission facilities in one or more local transmission plans, then the transmission facilities associated with that more efficient or cost-effective transmission solution can be selected in the regional transmission plan for purposes of cost allocation."[29]

Later in the Commission's major reform of regional transmission planning in Order No. 1000, it reinforced this Order No. 890 requirement:

> "However, we note that in Order Nos. 890 and 890-A, as well as in orders addressing related compliance filings, we have provided guidance regarding the requirements of the Order No. 890 comparability transmission planning principle. Specifically, public utility transmission providers are required to identify how they will evaluate and select from competing

[28] Promoting Transmission Investment Through Pricing Reform, May 2011, RM11-26, p.13.

[29] Preventing Undue Discrimination and Preference in Transmission Service, FERC Order 890, P 148 (2007).

solutions and resources such that all types of resources are considered on a comparable basis."[30]

Despite these attempts to address advanced transmission technology in its incentive and planning policies, the job has not been accomplished. Now that technologies have matured to a point that much more market potential exists, it is a good time for the Commission to rectify this gap and review its planning and incentives policies. This does not necessarily mean there is a need for *more* incentives (which are appropriately viewed with skepticism by customers), but rather better *alignment* of incentives. In transmission as with other regulated industries, the challenge of the regulator is to structure incentives and rules to lead regulated entities towards efficient outcomes. That alignment is not currently present on transmission operations. It would benefit customers to allow for technology improvements where the savings are shared between customers and shareholders. The Commission has ample authority to pursue such reforms.

IV. Grid expansion policy improvements

Along with improving grid operations, policy makers can build on the last decade's success in expanding the grid to further capture the benefits of a more national integrated grid through the following actions:

A. Fix inter-regional planning and cost allocation

Although FERC Order No. 1000 required neighboring transmission planning regions to coordinate planning, it has resulted in very little expansion of inter-regional grid capacity. Some of the problems include differences between regions in benefits metrics, criteria, and cost allocation policies. Since each region's approach is different, there is a "triple hurdle" where a project must clear three tests, one for each region, and one combined test.

FERC can remedy the "triple hurdle" by harmonizing the different methods and criteria between each neighboring RTO. The Commission could also provide an affirmative obligation to identify and jointly evaluate alternatives proposed by stakeholders, remove exclusions on projects of certain voltage levels or project sizes, and require consideration of public policy requirements as part of the assumptions that go into planning models. FERC has sufficient existing authority to take this action.

B. Improve federal backstop permitting

After the 2003 blackout where transmission infrastructure constraints were among the many contributing factors, this Subcommittee and Congress included a limited backstop permitting role for the federal government in Section 1221 of EPAct 2005. This authority has never been used. A couple of court decisions have raised uncertainty about how it can be applied. The program will likely be needed if we are going to create the robust inter-regional delivery capacity we need. Congress, DOE, and FERC could each play a role to clarify this authority and establish workable processes so that it can be used where needed. I recommend that for specific extra high voltage (e.g., 500kV and up), long distance lines that provide broad multi-state reliability benefits and long-term consumer benefits, where state approval has been withheld after thorough consultation, DOE and FERC should be encouraged to be

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[30]Order No. 1000, Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities, 136 FERC ¶ 61,051, Par 155. https://www.ferc.gov/whats-new/comm-meet/2011/072111/E-6.pdf

willing to use the current authority. The current authority is still a meaningful amount. It is also important for Congress to clarify the authority in response to the court decisions.

C. Require pro-active planning that captures all values of transmission

Transmission planning, both within and across regions, tends to be reactive and fails to capture the range of benefits that new lines create. A study prepared by five universities for the Eastern Interconnection Planning Collaborative, National Association of Regulatory Utility Commissioners, and the Department of Energy found that traditional planning approaches are not adequate to achieve least-cost outcomes in light of the modern market and challenges in today's electric transmission system, including plant retirements, renewable integration, and changing environmental regulations.[31] The study found that anticipatory transmission planning would, as compared to the outcome of traditional reactive planning, reduce total generation costs by $150 billion, increase interregional transmission investments by $60 billion, and achieve an overall system-wide savings of $90 billion.

The WIRES group has provided a series of helpful white papers that provide guidance on how efficient planning can be performed.[32] The basic formula is simple: 1) transmission should be pro-active, to build the transmission expected to be needed in the future with different resources and loads; and 2) transmission planning should consider all of the expected benefits including reliability and efficiency, with public policies taken into account. Failure of planners to either pro-active or consider all the benefits leads to underbuilding of transmission.

One benefit of transmission--connecting new generators and resource areas--is particularly disconnected from the rest of the transmission planning process. In its recent order on transmission interconnection queue reform, FERC provided many improvements to the process. But it did integrate planning and interconnection, and it did not require consideration of advanced transmission technologies as alternatives. Those issues remain to be addressed.

Transmission planning can also be more efficient if done probabilistically (considering many future scenarios) rather than deterministically (with one or a small number of expected futures). Probabilistic methods that quantitatively account for uncertainty in the transmission planning process result in a larger and more optimal transmission build, saving consumers tens of billions of dollars relative to deterministic methods that fail to account for the value of transmission in providing flexibility and hedging against uncertainty. Moreover, the probabilistic method saved hundreds of billions of dollars relative to some deterministic planning methods that greatly underbuilt transmission.[33]

FERC can lead these changes, following three decades of Commission work to improve regional transmission planning: "Regional Transmission Groups" in the late 1990s, Independent System Operators and Regional Transmission Organizations beginning in the late 1990s, Order No. 2000 in 1999, Order No. 890 in 2007, and Order No. 1000 in 2013.

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[31] See Eastern Interconnection States' Planning Council, Co-optimization of Transmission and Other Supply Resources (September 2013), available at http://pubs.naruc.org/pub/536D834A-2354-D714-51D6- AE55F431E2AA.
[32] See, eg, http://www.wiresgroup.com/docs/reports/WIRES_LEI_TransmissionBenefits_Jan2018.pdf, http://www.wiresgroup.com/docs/reports/WIRES%20Brattle%20Report_TransmissionPlanning_June2016.pdf .
[33] http://hobbsgroup.johnshopkins.edu/docs/FD_Munoz_Dissertation.pdf, page 102;

There is a role for the Department of Energy as well. Effective regional planning requires active engagement of stakeholders, especially states. States and other stakeholders can better participate with support for modeling and process facilitation, which are both strong capabilities of DOE.

D. Improve federal agency coordination and transmission permitting

On February 2, 2016, DOE published a Notice of Proposed Rulemaking titled *Coordination of Federal Authorizations for Electric Transmission Facilities*, which proposes a simplified Integrated Inter-Agency Pre-application (IIP) Process for inter-jurisdictional engagement. The DOE should explain how the energy corridor designations mandated by Section 368 of the Energy Policy Act, which are under revision by the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS), and the DOE's IPP Process will be integrated with one another. These agencies should identify transmission routes and paths that align with future energy resource areas that are expected to be developed in the near future and prioritize permitting and agency coordination.

The administration can support infrastructure development with sound and strong implementation of the FAST/DRIVE Act. Subpart D of this Act includes the Federal Permitting Improvement Act that aims to improve the permitting process for major infrastructure projects, including transmission, costing $200 million or more. The law establishes a federal interagency council chaired by a Presidential appointee to develop permitting performance standards, set deadlines, and enable the public to track the progress of major federal permitting actions. However, the provisions terminate seven years after enactment and should be made permanent. Administrative improvements such as deadlines, a single point of contact, enforcement of timelines, and agency disagreement resolution are important activities that could speed up the decision-making process. National Environmental Policy Act (NEPA) review of clean energy transmission over federal lands should include the positive environmental benefits of the lines – e.g., supporting zero carbon electricity -- when considering alternatives.

E. Harness the authority of the Power Marketing Administrations to build additional transmission

The Power Marketing Administrations (PMAs), including Bonneville Power Administration, Western Area Power Administration, Southwestern Power Administration and Southeastern Power Administration, under the authority of DOE, own tens of thousands of miles of existing high-voltage transmission lines and have transmission financing and development authority. This massive existing transmission infrastructure and strong related authority should be harnessed to accelerate U.S. transmission development for new energy sources.

PMAs should be encouraged to partner with private developers, which allows private parties and not taxpayers to fund infrastructure development, while utilizing PMA assets and tools. Section 1222 of the 2005 Energy Policy Act authorizes the Secretary of Energy, acting through WAPA or SWPA, to "design, develop, construct, operate, maintain, or own, or participate with other entities in designing, developing, constructing, operating, maintaining, or owning, an electric power transmission facility and related facilities" needed to upgrade existing transmission facilities owned by SWPA or WAPA or in connection with new facilities located in any state in which SWPA or WAPA operates. BPA has similar transmission development authority under the Federal Columbia River Transmission System Act. This authority has only been used once, and that action was recently terminated by mutual agreement of the parties.

F. Couple DOE federal transmission planning with the Department of the Interior's development of federal renewable energy zones

Using authorities established by the Energy Policy Act of 2005, the administration should revise the energy corridor designations by prioritizing transmission that specifically links the DOI renewable energy zones to large population (load) centers throughout the western United States. As the DOI moves to streamline approval processes and identify lands targeted for renewable energy development, the BLM, USFS and DOE should leverage the work required by a landmark 2012 settlement agreement reached with a coalition of conservation organizations and a western Colorado county. The agreement requires changes to a Bush-era plan mandated by Section 368 of the Energy Policy Act of 2005 designating "energy corridors" in the West. As the DOI develops renewable energy zones, the BLM, the USFS and DOE should designate "renewable energy transmission" corridors to service those zones.

G. Consider Public Financing to "Right-Size" Transmission

Money is wasted when we build lines that are too small. Even in the best US example to date of pro-active transmission planning of Texas Competitive Renewable Energy Zones, many of those lines are now oversubscribed, and it is clear that it would have been better for customers to build the higher capacity option that was considered and rejected. There is solid and stable information on where resource areas exist so if we pro-actively build transmission to those areas, development will come and our children and their children will benefit from it. However there is often not private market interest in financing capacity that will be used years into the future. There is therefore a good economic policy argument for public financing to fund the "right-sizing," or a higher capacity version of a line that private parties are willing to partially fund. The co-funding by private parties provides an important check to ensure lines are valuable, and the public financing achieves the more efficient level. Public financing could take a variety of forms.

V. Conclusion

I appreciate the Subcommittee's interest in this important topic. I hope it can support both better grid utilization and grid expansion with some of the ideas provided.