National Council on Electricity Policy
Approaches to Maximizing Existing Transmission Capacity – Speaker Bios
Webinar on Tuesday, August 3, 2021, from 3:00 – 4:00 PM Eastern

With myriad analyses showing that expanded interregional transmission would provide benefits to the grid, new policy and regulatory initiatives are revisiting how transmission gets planned, built, and paid for. Most best-case scenarios predict that it will take years for these efforts to bear fruit, however. At the same time, the types of technological advances that have increased resilience and efficiency opportunities for the distribution grid are also available at the transmission level. This webinar will feature a discussion of opportunities to maximize existing transmission line throughput as a near-term complement to planning for and building new transmission. Panelists will describe commercially available grid enhancing technologies that can dramatically increase transmission capacity factors across North America.

Moderator: Hon. Ted Thomas, Arkansas PSC

Speakers:
• Michelle Manary, Deputy Assistant Secretary, Energy Resilience Division, DOE Office of Electricity (confirmed)
• Jay Caspary, Vice President, Grid Strategies, LLC
• Dr. Babak Enayati, DG Standards and New Technology, National Grid
The recording will become available on http://electricitypolicy.org/2021/06/22/webinar-maximizing-existing-transmission-capacity/.

Hon. Ted J. Thomas, Chairman, Arkansas Public Services Commission
Ted Thomas of Conway was appointed Chairman of the Arkansas Public Service Commission by Governor Asa Hutchinson in January 2015.

He has served as Chief Deputy Prosecuting Attorney for the 20th Judicial District, Administrative Law Judge at the Public Service Commission, Budget Director for Governor Mike Huckabee and in the Arkansas House of Representatives, where he served as Chairman of the State Agencies and Governmental Affairs Committee during his final term.

Chairman Thomas received a Bachelor of Arts with High Honors in Political Science from the University of Arkansas in 1986 and a Juris Doctorate from the University of Arkansas School of Law in 1988. He is licensed to practice law before the United States Supreme Court, the Arkansas Supreme Court, the United States Courts of Appeals for the District of Columbia Circuit and the Eight Circuit, and the United States District Courts for the Eastern and Western Districts of Arkansas.

Chairman Thomas is past president of the Organization of MISO States (OMS) and continues to serve on the Executive Committee. He also serves on the National Association of Regulatory Utility Commissioners (NARUC) Committee on Electricity.

Michelle L. Manary, Deputy Assistant Secretary, Energy Resilience Division, DOE Office of Electricity
Michelle L. Manary is the Acting Deputy Assistant Secretary for the Energy Resilience Division in the Office of Electricity (OE) at the U.S. Department of Energy (DOE). Ms. Manary helps lead DOE's division focused on national transmission infrastructure policy issues in support of national clean energy objectives.

Prior to joining OE, Manary worked at Bonneville Power Administration (BPA) where early in her careers she successfully held several management positions within the agency's Corporate, Power and Transmission organizations, including as BPA's director of Strategy Integration. She also gained extensive transmission expertise in her role as the agency's vice president for Transmission Marketing and Sales for three years. In that position, she oversaw transmission sales, customer relations and contracts, transmission commercial automated systems, products and rates, the open access tariff and available transfer capability. Manary then served as executive vice president and chief financial officer (CFO) at BPA, having held the position since September 2018.

Jay Caspary, Vice President, Grid Strategies LLC
Jay Caspary provides analysis and strategic guidance on transmission grid planning and operations to support a clean energy portfolio. Jay has 40 years of experience in transmission planning, engineering, management, tariffs, transmission services, and retail marketing. Most recently he oversaw Research, Development & Tariff Services for the Southwest Power Pool (SPP). He also served as SPP's Director of Engineering and head of Transmission Development. In 2012-2013, Jay served as Senior Policy Advisor for the U. S. Department of Energy's Office of Electricity Delivery and Energy Reliability (OE) with a focus on grid modernization. Prior to SPP, he served in several staff and managerial roles at Illinois Power.

Dr. Babak Enayati, Manager, DG Standards and New Technology, National Grid
Babak Enayati received his PhD in Electrical Engineering from Clarkson University, USA in 2009. He joined National Grid, USA in 2009 and is currently the Manager of the Distributed Generation Standards and New Technology team, which is responsible for the implementation of new technologies to meet National Grid's Intelligent Electric Network objectives. Since Babak joined National Grid, he has held positions in the Protection Engineering, Retail Connections Engineering, and New Energy Solutions departments. Babak has extensive experience on renewable energy resource integration, power system protection, Research Development and Demonstration, and Data Management. Babak is a registered Professional Engineer (PE) in the state of Massachusetts.

NCEP thanks the U.S. Department of Energy for its support since 1994.

NATIONAL COUNCIL ON ELECTRICITY POLICY

Approaches to Maximizing Existing Transmission Capacity

Tuesday, August 3, 2021

Virtual Meeting

Welcome

During the webinar:

- This webinar is being recorded.
- Type in Questions to Kerry anytime in the Zoom Q&A Box.
  - Relevant clarifying questions will be asked immediately.

After the webinar:

- Presentation and recording posted on www.electricitypolicy.org.
- Unanswered questions will be sent to panelists for follow up.
- Join our listserv by checking off NCEP as an interest area in your MYNARUC account at www.naruc.org/mynaruc/ or e-mail Kerry Worthington at Kworthington@naruc.org after your profile has been created.

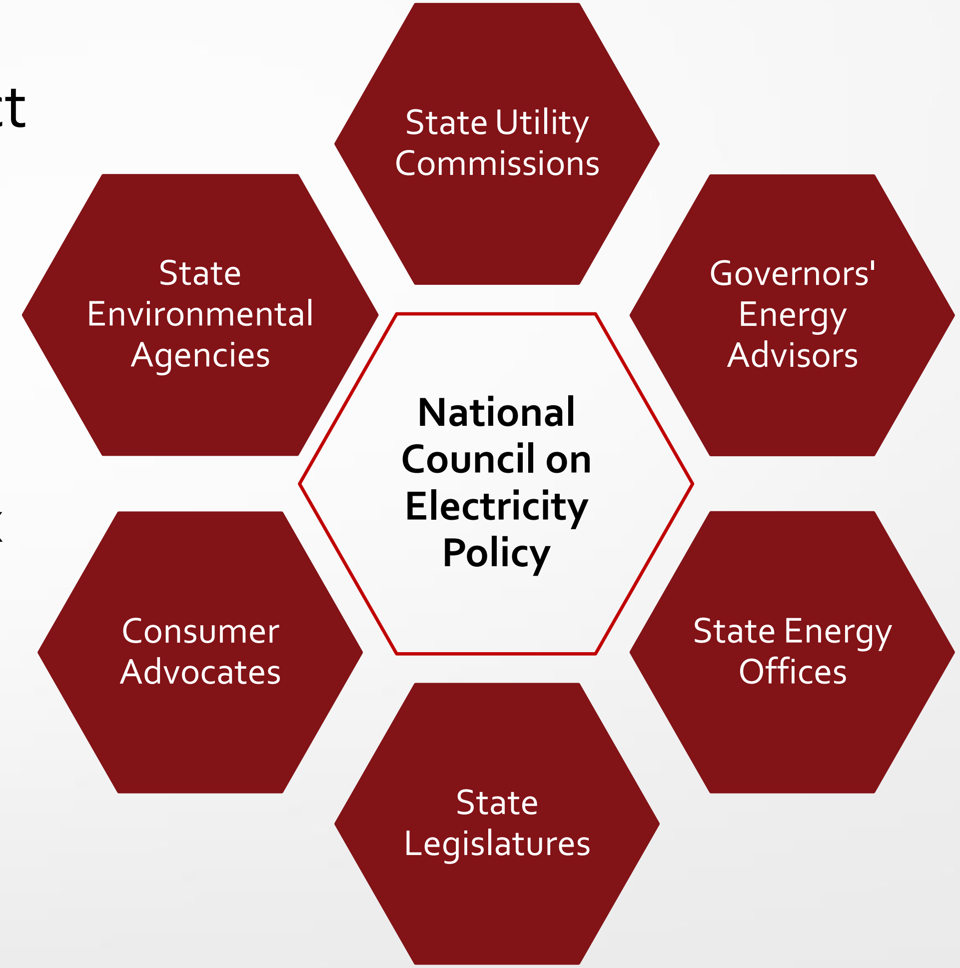
Agenda

Time	Item	Speaker
3:00 ET	Welcome and introduce Hon. Ted Thomas	**Kerry Worthington**, NCEP/NARUC Staff
3:05 ET	Department of Energy Efforts to Maximizing Existing Transmission Capacity	**Michelle Manary**, Deputy Assistant Secretary, Energy Resilience Division, DOE Office of Electricity
3:20 ET	WATT Coalition GETs Case Study	**Jay Caspary**, Vice President, Grid Strategies, LLC
3:35 ET	Approaches to Maximizing Existing Transmission Capacity	**Dr. Babak Enayati**, Manager, DG Standards and New Technology, National Grid
3:50 ET	Audience Q&A	
4:00 ET	Adjourn	

National Council on Electricity Policy

The National Council on Electricity Policy (NCEP)

- NCEP is a peer-learning platform to examine the ways new technologies, policies, regulations, and markets impact state resources and the bulk power system.
- NCEP is currently exploring the evolving interface between the transmission and distribution systems as the resource mix on the grid changes (planning, operations, and markets).
- **All NCEP resources are available at www.electricitypolicy.org.**
- NCEP thanks the U.S. Department of Energy for its ongoing support. NCEP is an affiliate project of NARUC.



NCEP Executive Committee

Hon. **Paul Kjellander**, *Idaho Public Utility Commission*

Hon. **ToNola Brown-Bland**, *North Carolina Utility Commission*

Hon. **Dave Danner**, *Washington Utility and Transportation Commission*

Hon. **Ted Thomas**, *Arkansas PSC*

Hon. **Upendra Chivukula**, *New Jersey BPU*

Mike Dowd, *Virginia Department of Environmental Quality*

John Chatburn, *Governor's Office of Energy Resources, Idaho*

Senator **Eric Koch**, *Indiana State Senate*

Hon. **Sarah Freeman**, *Indiana Regulatory Utility Commission*

Jeremey Tarr, *Office of Governor Roy Cooper*

NCEP Annual Meeting and Workshop
September 13-15, 2021
Coordinated Planning

In 2021, the NCEP community will explore developments in modern planning techniques and tools to align planning processes across distribution, resources, and transmission planning. NCEP will explore:

- What is a state's role in aligning planning for maintaining a well-managed, efficient electricity system, now with rapidly changing requirements and many more participants?
- What planning capabilities exist and are needed?
- What coordination opportunities exist?

State and system examples (case studies) and resources will be highlighted.

National Council on Electricity Policy

Hon. Ted Thomas

Chairman

Arkansas PSC

Moderator

Michelle Manary

Deputy Assistant Secretary, Energy Resilience Division

DOE Office of Electricity

Panelist

U.S. DEPARTMENT OF
ENERGY
Office of Electricity

Department of Energy Efforts to Maximizing Existing Transmission Capacity

Presented to

Michelle Manary, Deputy Assistant Secretary for Energy Resilience

August 3, 2021

Biden-Harris Administration Goals for the Grid

- Achieve net-zero emissions, economy-wide, by no later than 2050.
- A carbon pollution-free electricity sector no later than 2035 (Executive 14008 of January 27, 2021).
- Accelerate the deployment of clean energy and transmission projects in an environmentally stable manner (Executive 14008 of January 27, 2021).
- Clean and zero-emission vehicles for Federal, State, local, and Tribal government fleets, including vehicles of the United States Postal Service (Executive 14008 of January 27, 2021).

Current Key Trends Driving Electricity System Operations

Achieving the Administration's clean energy goals will require significant investment and expansion in transmission and storage.

Information revolution in the grid (sensor-data-analysis-machine learning/AI)

The electrification of transportation and buildings will require distribution modernization.

Increasing demand resilient and reliable grid- requires additional system flexibility

Evolving markets is creating operational and planning complexity

The Electric Grid Now

The U.S. electric grid is a complex interconnected system of electric transmission lines linking generators to loads.

Source: https://www.energy.gov/sites/prod/files/2017/02/f34/Appendix--Electricity%20System%20Overview.pdf

U.S. DEPARTMENT OF ENERGY

Office of Electricity

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Transmission Innovation Symposium

May 19-20 Transmission Innovation Symposium

- Whitepapers and the symposium discussion will be used to guide upcoming infrastructure research and development goals and DOE's role in achieving these goals.

- White paper topics in Electricity Transmission System Research and Development:
  - Grid Operations
  - Distribution Integrated with Transmission Operations
  - Automatic Control Systems
  - Hardware and Components
  - Economic Analysis and Planning Tools

Transmission Innovation Symposium Insights

Issue: The increase in renewable generation will also require increased transfers of bulk power over longer distances – Construction of new transmission lines (in some cases augmented by advanced hardware technologies) will be needed, but is difficult

- **R&D priority:** *Advanced operating strategies (including training in their deployment) and control approaches that allow greater (yet equally or more reliable) utilization of existing lines (as well as reliable use of new lines) will be needed.*
- **R&D priority:** *Hardware development in Ultra-conductive systems, smart materials (constructed using advanced manufacturing techniques), transformers, wireless power transfer, superconductivity.*

Transmission Innovation Symposium Insights

Issue: There will be dramatic increase in wind and solar resources– The output from this generation is inflexible (although it can be curtailed) – Hence, to serve load, the grid must manage around this inflexibility

- **R&D priority:** *The flexibility of grid operations will be enhanced through new grid architectures and control strategies*

Issue: To meet administration goals, deployment of renewable energy will increase faster than new power system lines can be permitted and built, and existing infrastructure needs modernization and upgrades.

- **R&D priority:** *Dynamic Line Rating and Power Flow Control management tools that help operators and planners make use of these advanced hardware technologies.*
- **R&D priority:** *Hardware development for Power-flow control devices: Transmission-scale reactive power devices, low-cost hybrid systems and energy storage, power electronic building blocks for multiple applications such as flexible alternating current transmission system (FACTS) devices and solid-state transformers.*

Transmission Innovation Symposium Insights

Issue: Increasing amounts of data sources on the electricity system, increasing system complexity, and changing system context will require new tools and advanced data analytics.

- **R&D priority:** *Develop methods to improve data interpretability for data owners, as well as mechanisms for sharing that would protect the data provider from penalties (NAS study recommendation 6.4 was similar).*
- **R&D priority:** *Advanced contingency analysis and improved simulations of dynamic behavior, such as those related to inverter-based resources.*
- **R&D priority***: Collect and create well labeled data sets (both real and synthetic) that can be used by both industry and academia to develop new tools and AI/ML research.*

Transmission Innovation Symposium Insights

Issue: Although the output from renewable generation from wind and solar is inflexible, renewable generation also offers control capabilities that are like traditional generation but differ in important ways.

- **R&D priority:** *Advanced operating strategies and control approaches that recognize and incorporate the control capabilities offered by wind and solar generation will enhance grid operability, and reliability*

Issue: Load has the potential to become far less grid friendly due to growth in power electronic coupled loads (e.g., growth in EVs) – Transmission planning must anticipate and could influence future load responses. For example, addressing fault induced delayed voltage recovery.

- **R&D priority:** *Improving load modeling to support transmission planning studies and the development of standards articulating grid-friendly behavior. Perhaps try and create something like IEEE 1547 but pointed toward loads, rather than generation.*

Transmission Innovation Symposium Insights

Issue: Transmission system operators need advanced applications to support decision making in relation to changes on the distribution system and DERs.

- **R&D priority:** *Decision Support Systems for transmission operators*

Issue: Generation located within distribution will probably serve some load (perhaps 10-20%), and bulk generation/transmission will serve the rest – Transmission planners and operators need to understand/ predict the remaining, continuously time-varying net load.

- **R&D priority:** *Machine learning techniques to improve accuracy of distribution net load forecasting*
- **R&D priority:** *Multi-value planning; Adaptive Transmission Resource Planning under profound uncertainty*

Transmission Innovation Symposium Insights

Issue: Increasing system complexity and new technology integration will lead to new system phenomena that current sensor technologies may not be able to fully capture

- **R&D priority:** *Hardware development for High-fidelity sensors, asset monitoring (non-destructive evaluation, drone survey of lines), and alternative timing.*

Issue: Generation and load located within distribution will probably not be major participants in bulk power markets (perhaps 5-10% of the volumes that clear in the markets) – Participation will take place through aggregators and incentives will dictate behavior.

- **R&D priority:** *Market simulation and planning models with flexibility and scalability; Behavioral underpinnings of economic valuation and market designs*

Office of Electricity Transmission Authorities/Responsibilities

The Office of Electricity implements the following regulatory and statutory authorities:

- Issuance of **Presidential permits** for transmission facilities at the U.S. border pursuant to Executive Order 10485, as amended.
- FAST-41 Compliance/FPISC
- Lead the Integrated Interagency Pre-Application (IIP) process for qualifying interstate transmission projects per section **216(h) of the Federal Power Act**.
- Designate energy corridors on Federal land, in coordination with the Secretaries of Defense, Agriculture, Commerce, and Interior pursuant to section **368 of the Energy Policy Act of 2005**
- Produce the National Congestion Study and designate National Interest Corridors, as appropriate pursuant to section **1221 of the Energy Policy Act of 2005**
- Authority to accept third-party financing to upgrade or build new transmission facilities in the Western Area Power Administration Southwestern Power Administration footprint pursuant to section **1222 of the Energy Policy Act of 2005**

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Next Steps

- DOE is looking to partner with the industry to find ways to tackle the issues.

- DOE will use all its authorities to help the industry achieve the President's goals

Michelle Manary

Deputy Assistant Secretary, Energy Resilience Division

DOE Office of Electricity

Panelist

Jay Caspary

Vice President

Grid Strategies, LLC

Panelist

WATT Coalition GETs Case Study

NCEP Webinar: Approaches to Maximizing Existing Transmission Capacity

PRESENTED BY

- Jay Caspary, Grid Strategies LLC

August 3, 2021

Unlocking the Queue

Study Outline

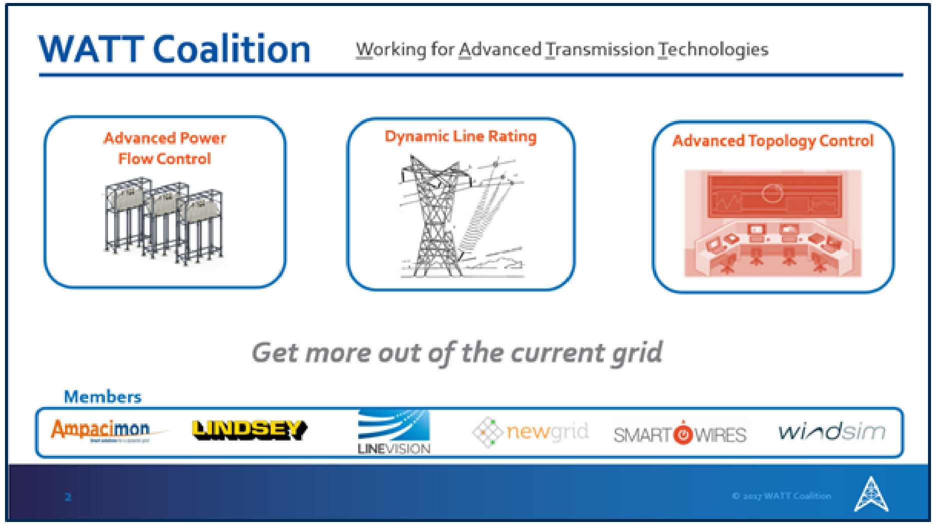
- The SPP GI Queue shows over 9 GW of renewables with signed Interconnection Agreements (IA) awaiting in the KS/OK region.
- Can GETs (Dynamic Line Ratings, Advanced Topology Optimization, and Advanced Power Flow Control) help integrate these projects?
- Analysis performed for test year of 2025 (not enough time to build new transmission).
- Analysis looks at the combined benefits of the 3 GETs.

Slides following are excerpted from the full report.
The full report is available at: https://watt-transmission.org/2021/02/22/unlocking-the-queue/

Study Overview

Goal: Analyze how much additional renewables can be added to the grid using Grid-Enhancing Technologies (GETs):

- GETs enhance transmission operations and planning.
- GETs complement building new transmission—they can bridge the timing gap until permanent expansion solutions can be put in place, and improve the B/C ratio of new transmission projects.
- The study focuses on the combined impact of the following three technologies:
  - **Advanced Power Flow Control**: Injects voltage in series with a facility to increase or decrease effective reactance, thereby pushing power off overloaded facilities or pulling power on to under-utilized facilities.
  - **Dynamic Line Ratings (DLR)**: Adjusts thermal ratings based on actual weather conditions including, at a minimum, ambient temperature and wind, in conjunction with real-time monitoring of resulting line behavior.
  - **Topology Optimization**: Automatically finds reconfiguration to re-route flow around congested or overloaded facilities while meeting reliability criteria.



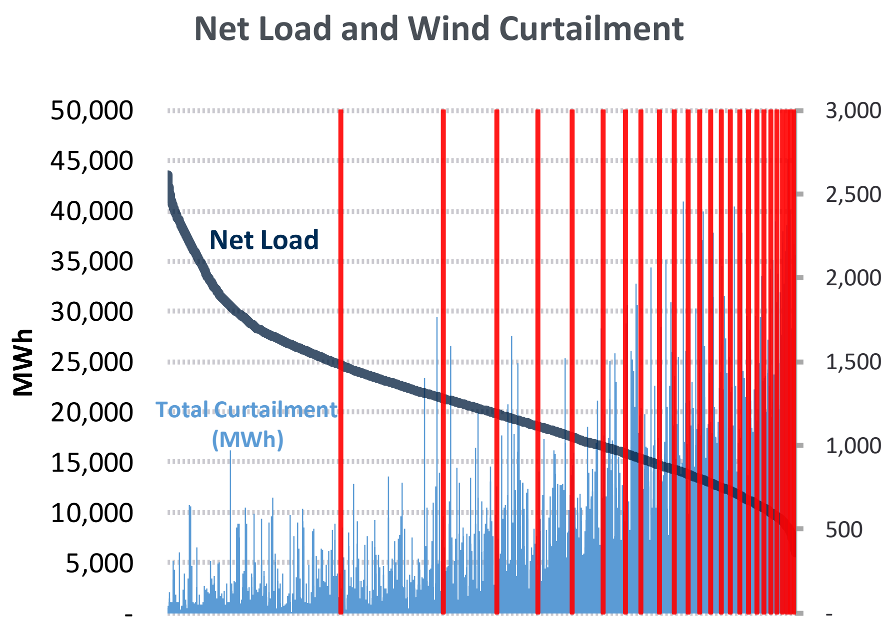
Study Approach

Study purpose

- Quantify the benefits of **the three GETs combined** for integrating renewable resources (largely wind) using SPP as a test bed.

Analysis approach

- Select 24 representative historical power flow snapshots of SPP operations (2019 – 2020) that together reasonably represent a full year.
- Modify the snapshots to reflect new transmission upgrades, renewable projects from the GI queue, announced retirements, load change, etc.
- Find the maximum renewables amount (GW and GWh) that can be integrated under a business as usual scenario (Base Case) and then with GETs (With GETs Case), sequentially in the order of DLR, Topology Optimization, and Advanced Power Flow Control, by simulating the entire SPP system using the 24 power flow cases.
- Assess benefits of GETs including economic values (production costs, jobs, local benefits etc.) and carbon emissions reduction.



Areas between red line indicates the bins from which snapshots were selected, blue bars indicate curtailment of renewables. Each bin contains equal amounts of curtailment.

Study Results - 1/4

GETs enable more than twice the amount of additional new renewables to be integrated.

- Potential Renewables Considered: 9,430 MW
  - Based on queue projects with IA executed.
- Integrated Renewables (without further transmission upgrades)
  - Base Case: 2,580 MW
  - With GETs Case: 5,250 MW
  - Delta (With GETs Case – Base Case): 2,670 MW

RENEWABLE POTENTIAL ASSUMED FOR KANSAS AND OKLAHOMA

State	Wind	Solar	Total
Kansas	3,410	120	3,530
Oklahoma	5,760	140	5,900
Total	9,170	260	9,430

[Rounded to the nearest 10 MW]

~1.5 times the amount of wind SPP integrated in 2019 (1.8 GW).

ADDITIONAL RENEWABLES INTEGRATED

State	Base Case			With GETs Case			Delta (GETs - Base)		
	Wind	Solar	Total	Wind	Solar	Total	Wind	Solar	Total
Kansas	1,710	0	1,710	1,910	0	1,910	200	0	200
Oklahoma	770	100	870	3,200	140	3,340	2,430	40	2,470
Total	2,480	100	2,580	5,110	140	5,250	2,630	40	2,670

X2

[Rounded to the nearest 10 MW]

Slides excerpted from the full report, available at https://watt-transmission.org/2021/02/22/unlocking-the-queue/

Study Results - 2/4

GETs enable more than twice the amount of additional new renewables to be integrated.

- Additional renewables enabled by GETs: **2,670 MW / 8,776 GWh**.
  - 2,630 MW of **new wind** is assumed to produce over 8,640 GWh of energy per year.
  - 40 MW of **new solar** is assumed to produce about 60 GWh of energy per year.
  - GETs lower curtailment of **existing wind** by over 76,000 MWh per year.
- GETs installation cost is about $90 million.
  - Annual O&M costs is estimated to be around $10 million.
- GETs benefits (other than the value of additional renewables) include:

ANNUAL PRODUCTION COST SAVINGS

$175 million

ANNUAL REDUCED CARBON EMISSIONS

3 million tons

Additional Renewables enabled by GETs

2,670 MW / 8,776 GWh

LOCAL JOBS

650 long-term jobs and
11,300 short-term jobs

OTHER LOCAL BENEFITS

$15 million land lease and
$32 million tax revenues per year

Study Results - 3/4

Potential Nation-Wide Benefits

Extrapolating these results to a nation-wide level* indicate GETs to provide **annual benefits** in the range of:

- Over **$5 billion** (~$5.3 billion) in production cost savings.
- **90 million tons** of reduced carbon emission (more than enough to offset **ALL NEW** automobiles sold in the U.S. a year).
- About **$1.5 billion** in local benefits (local taxes and land lease revenues).
- More than 330,000 short-term (only for first year) and nearly 20,000 long-term jobs.
- Investment cost is $2.7 billion (only for first year). Ongoing costs would be around $300 million per year.

Local Interconnection Benefits

$90 million investment enables interconnecting nearly 2,700 MW of additional renewables.

- Would renewable developers agree to pay for (or share some cost of) this?
- $90 million to interconnect 2,700 MW = Less than $34/kW.
- The average capital cost for onshore wind today is around $1,500/kW.
- $34/kW is only **~2% of this estimated capital cost** ($1,500/kW).

* EIA shows 2019 generation in Kansas and Oklahoma combined (136 TWh) was about 1/30 of the nationwide generation from utility-scale resources (4,100 TWh). EIA data, available at: https://www.eia.gov/electricity/state/kansas/, https://www.eia.gov/electricity/state/oklahoma/, and https://www.eia.gov/electricity/annual/html/epa_01_01.html

Study Results - 4/4

GETs utilized in this study include:

- **Hardware solutions**: DLR on 56 lines and Advanced Power Flow Control on 8 locations.

Hardware Solutions by Voltage Level	345	230	161	138	115	69	Total
DLR*	10	3	11	22	3	7	56
Advanced Power Flow Control	3	0	4	1	0	0	8

- **Software solutions**: 204 unique Topology Optimization reconfigurations, averaging 13 per snapshot.**

Software Solutions by Voltage Level	345	230	161	138	115	69	Total
Lines	20	10	31	75	4	30	170
Substations	4	0	1	1	0	0	6
Transformers (high voltage terminal)	10	1	4	13	0	0	28

- Estimated costs for implementing the above GETs: ~$90 million.
  - Initial investment costs is estimated to be around $90 million.***
  - Ongoing costs of around $10 million per year.***

* Every DLR installation requires 15 to 30 sensors.

** Average actions represent the average number of actions that remain per case, not actions per hour. Based on other studies the average number of actions per hour is expected to be smaller, typically less than the number of topology changes due to planned outages.

*** Costs can vary project by project, and also on how the GETs service is provided—for example, Topology Optimization can be provided as a software subscription service to reduce the initial cost. We also assume utilities can incorporate these technologies without large costs.

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Jay Caspary
Vice President
Grid Strategies LLC
jcaspary@gridstrategiesllc.com
501.951.3296

Jay Caspary

Vice President

Grid Strategies, LLC

Panelist

Dr. Babak Enayati

Manager, DG Standards and New Technology

National Grid

Panelist

National Council on Electricity Policy Webinar on:

Approaches to Maximizing Existing Transmission Capacity

Babak Enayati, PhD, PE
Manager, DG Standards and New Technology
National Grid
Waltham, MA

Babak.Enayati@nationalgrid.com

August 2021

nationalgrid

Building capabilities within our transmission networks will help enable the energy transition and advance smarter asset management.

The **Intelligent Transmission Network** is key to deploying innovations that will enable National Grid to manage its network smarter utilizing real-time data to make better decisions and lower the cost to serve. Deploying new technologies is also essential to enabling the clean energy future. Such technologies as power flow control devices, energy storage, and digital substations will allow us to operate networks and change settings that optimize the flow of variable renewable generation, while intelligent smart design will enable us to build quicker and realize capex efficiencies.

Technologies we are currently deploying:

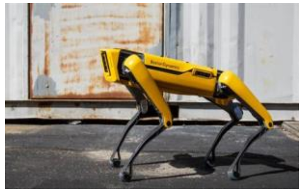
Real-time Intelligence

Digital Substations

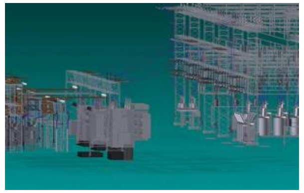
Online Monitoring

- As we address asset condition issues and build new substations, we are deploying those stations to be Digital Substations with Online Monitoring.
- These stations will allow for ***quicker deployment*** and provide ***insight*** into our assets to make ***better asset decisions.***
- ***Flow power more efficiently*** despite sudden changes due to variable generation and dynamic loads.
- We have deployed dynamic line and transformer rating technologies to demonstrate the utilization of greater line and transformer capacity.

New Tools



Asset Health Tech (AI/ML/UAS/Robotics)



Intelligent Design

- We are testing new innovations in Machine Learning and Robotics. Every year, ***we must inspect thousands of circuit miles to look for defects.*** We walk and fly our lines looking for these faults.
- We are testing robots that will crawl the line conductor evaluating the integrity of the conductor, while also testing Machine Learning to scan through millions of helicopter and ***unmanned aerial vehicles*** images to look for faults. Over time, the data will give us ***predictive data to forecast*** asset conditions.
- Using our new asset management systems **(VOLT Enablement)** this data will be utilize ***to better forecast O&M spend and reliability risks***.
- Intelligent Design will allow us to ***speed and reduce the time to engineer*** our network utilizing 3D and 4D deign capabilities.

Renewable Integration

Energy Storage

Power Flow Control

- Our networks will need to deliver ***much higher amounts of variable generation*** in the future.
- We are deploying technologies such as energy storage and Power Flow Control devices. These technologies allow to i***ncrease the capacity of our networks*** and ***deferring the need for new lines.***
- Essentially ***mitigating the need to obtain new rights of way***, and enabling connection of renewables to the network at a ***lower cost to interconnect.***

National Grid Deploys Dynamic Line Rating (DLR)

Objective: To maximize the utilization of existing transmission line capacity for optimized operations and to enable clean and affordable energy delivery to the customers.

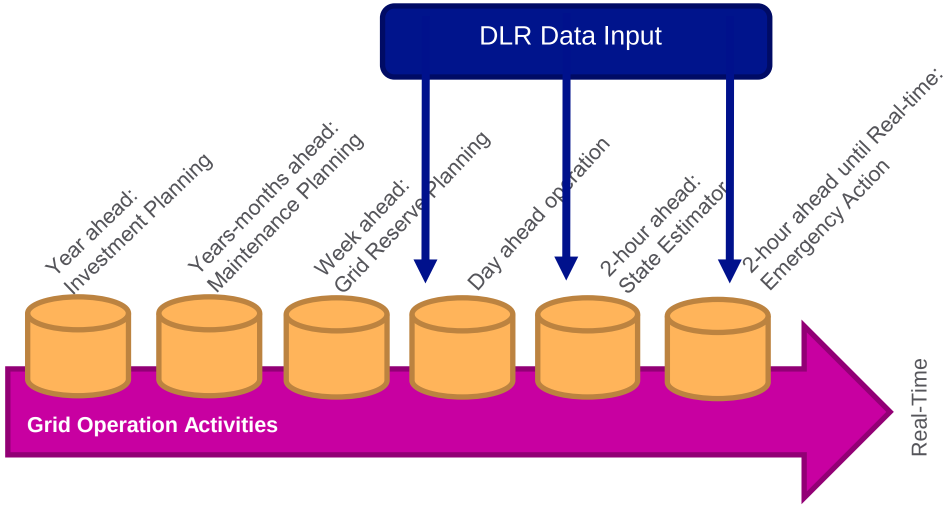
Voltage Level: 115kV

In-service date: July 2019

No outage required for installation

Straight forward installation

Data portal for Data monitoring



Challenges/Concerns

- Cyber Security
- Ability of the ISOs to accept and utilize DLR data in their administration of electricity markets and reliable grid operations
- Cloud Service
  - Type and Location
  - ISO270001 is required

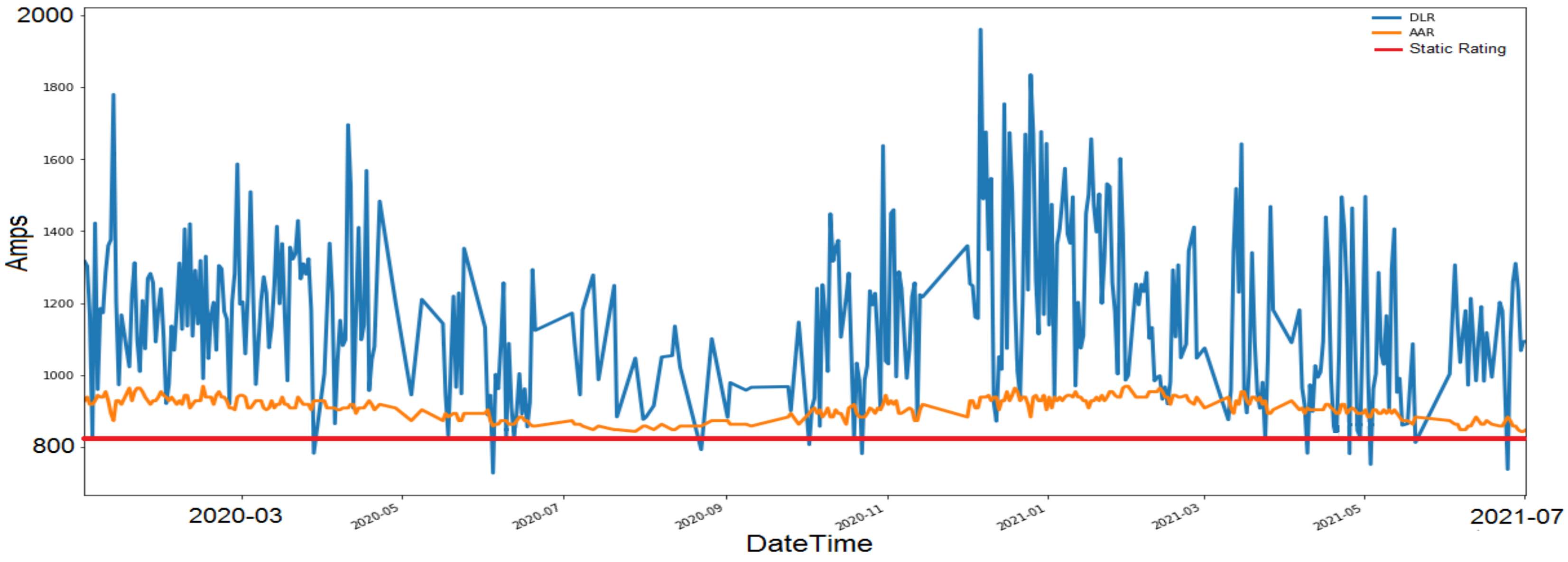
Lessons Learned/Benefits

- In average, 31% line capacity increase compared to the Ambient Adjusted Rating (AAR)
- Additional Clean Power Delivery
- Potential Congestion Relief

Next Step

- Identify opportunities for larger scale deployment

Line Capacity Gain Using real-time DLR and AAR



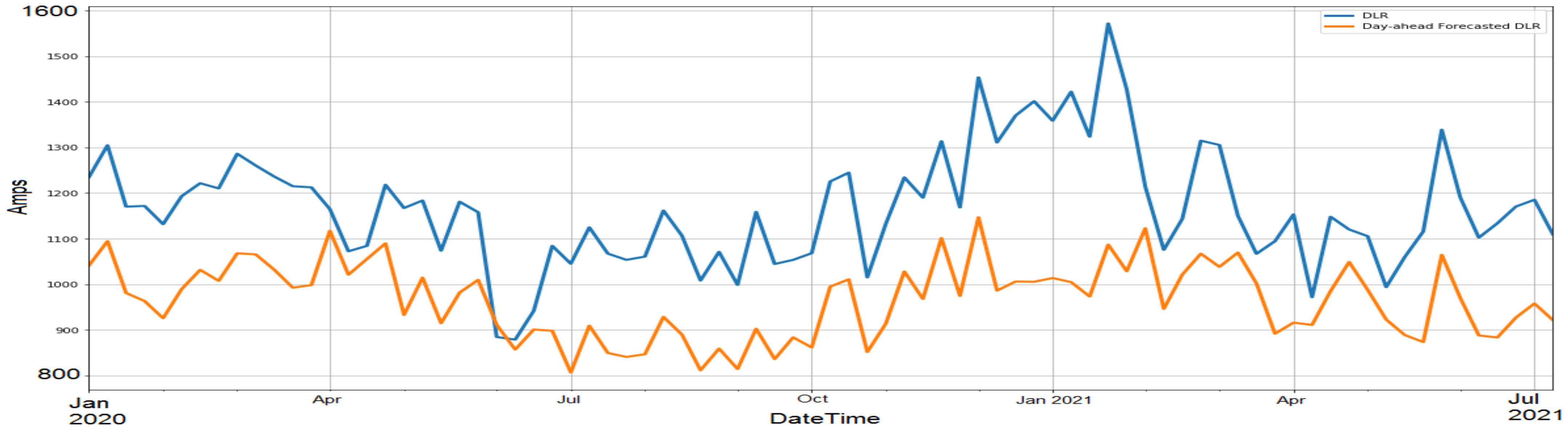
1- DLR exceeds the Static Rating for 94% to 97% of the time.

2- Recorded DLR data shows a mean (average) increase of 31% in line's capacity above AAR.

3- Recorded DLR data shows a mean (average) increase of 47% in line's capacity above Static Rating.

4- Recorded AAR data shows a mean (average) increase of 11% in line's capacity above Static Rating.

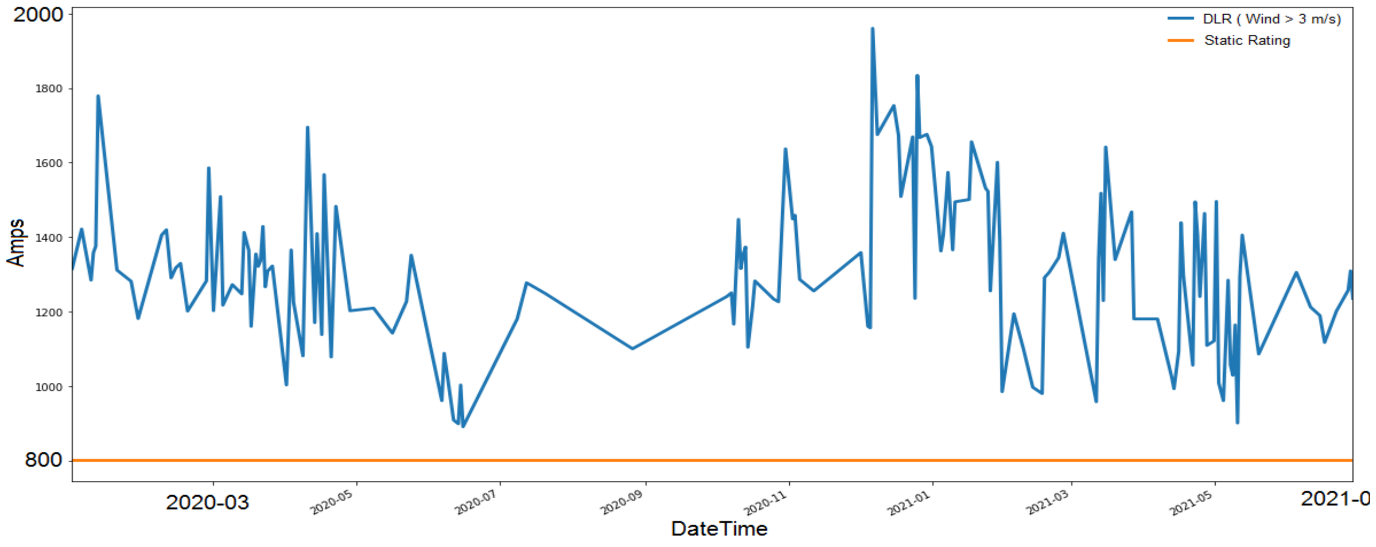
DLR Sensors provide real-time and forecast ratings

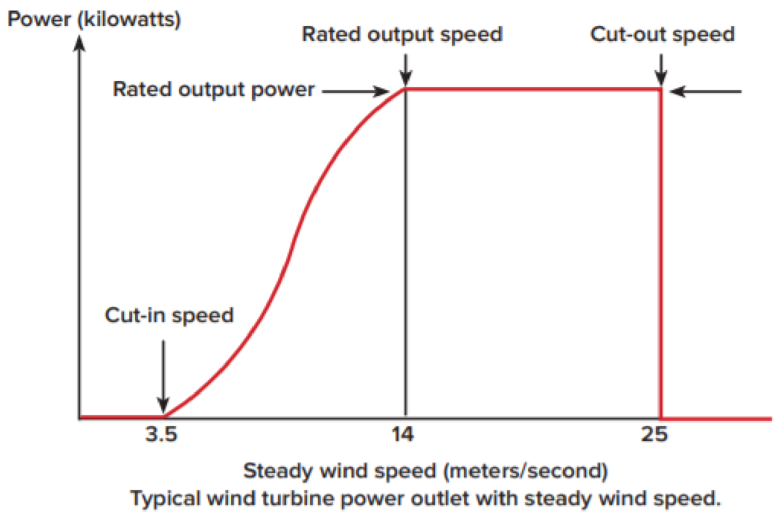


- Forecast follows the DLR with sufficient conservative assumptions. Hence, forecast rating is slightly lower than DLR.
- Day-ahead Forecast rating exceeds the Static Rating 81% to 87% of the time.
- Recorded day-ahead forecast data shows a mean (average) increase of 26% in line's capacity above Static Rating.

Forecast ratings should be utilized for day-ahead market operations to maximize the utilization of the existing transmission line capacity.

Line Capacity During Wind Generation





Reference: New York Wind Energy Guide for Local Decision Makers: Wind Energy Basics
Published by NYSERDA

- Recorded DLR data that corresponds to Wind Speed ≥ 3 m/s shows a mean (average) increase of 60% in the line capacity above the static rating.

- DLR must be considered as a tool in the toolbox for wind generation integration to the grid.

Power Flow Control

In February 2021, National Grid commissioned its first Smart Wires' Smart Valve Power Flow Controller.

Installation:

- **Installation on a 69kV line**
- **Integrated to EMS**
- **Remote control and monitoring**

Benefits:

- Clean power delivery
- Potential deferred capital investment for reliability system upgrades by maximizing the utilization of the existing transmission line capacity.

Next steps:

- Evaluate the technology performance- The preliminary studies show that this technology by itself or in combination with energy storage may be a cost-efficient solution for some transmission reliability issues.
- Identify opportunities that benefit from

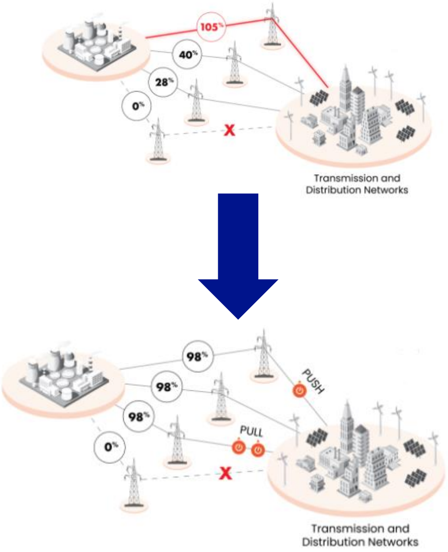
capital investment deferral and/or congestion relief.

CURRENT

- ✓ No control over the magnitude of the power flow
- ✓ Traditional Line Upgrade Solutions
- ✓ Conservative Decision Making

FUTURE

- ✓ Control the power flow of the transmission lines
- ✓ Potential line upgrade deferrals.
- ✓ Smart decision making on power flow management



Conclusion

- DLR maximizes utilization of existing line capacity, if there are not other limiting elements on the line.
- Forecast line rating can be utilized in day-ahead operations.
- DLR technologies can potentially relieve some line congestions.
- Cyber security challenges must be properly addressed prior to EMS integration.
- Adoption of the DLR technologies require ISOs to accept and utilize DLR data in their administration of electricity markets and reliable grid operations.
- DLR is a key element of wind power integration to the electric grid.
- Smart Wires' Smart Valve is a tool in the toolbox for system reliability issues.

Contact: Babak Enayati

Babak.Enayati@nationalgrid.com

781-697-1707

Dr. Babak Enayati

Manager, DG Standards and New Technology

National Grid

Panelist

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