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INVESTIGATION INTO THE USE OF DYNAMIC LINE RATINGS FOR TRANSMISSION LINES IN TEXAS	§ § §	PUBLIC UTILITY COMMISSION OF TEXAS

COMMENTS OF
WATT COALITION

TO THE HONORABLE PUBLIC UTILITY COMMISSION OF TEXAS:

The Working for Advanced Transmission Technologies (WATT Coalition) is pleased to offer a response to several of the questions shared by the Public Utilities Commission of Texas related to dynamic line ratings (DLR).

By way of background, the WATT Coalition is a trade association which advocates for policies that support wide deployment of Grid-Enhancing Technologies (GETs) to accelerate the clean energy transition and lower energy costs. WATT members include Ampacimon, EDF Renewables North America, Heimdall Power, LineVision, Lindsey Systems, NewGrid, Smart Wires, and WindSim Power. These companies represent a renewable energy developer, as well as technology providers in three technical areas:

- Dynamic Line Ratings, which determine the true, real-time capacity of power lines.
- Advanced Power Flow Control, which allows operators to reroute power to lines with available capacity.
- Topology Optimization, which identifies the best grid reconfigurations to reroute flow around bottlenecks.

These technologies reduce congestion costs and improve economic dispatch, situational awareness, and reliability. In planning, they reduce the time, cost and complexity of integrating new generation and load.

One goal of the WATT Coalition is to help regulators understand the value of DLR and other GETs, and identify effective regulatory pathways to support their deployment. The Coalition is very pleased to see this effort from the PUCT to evaluate DLRs.

I. What are Dynamic Line Ratings?

Wires carrying electricity generate heat – if they get too hot, they sag which can create safety issues and can even anneal if operated too hot for too long. Out of the factory, transmission lines are given static thermal ratings which assume hot, sunny, still conditions to prevent lines from overheating. Dynamic line ratings measure the true conditions to calculate the safe capacity of the lines. On cold or windy days, power lines can easily deliver 50% or more energy than their labeled limits.[1]

II. Benefits of using Dynamic Line Ratings

A. Accurate line ratings increase the efficiency of the system.

Capacity that is in high demand that is not provided to customers is often wasted today in the form of phantom congestion. By artificially withholding actual capacity, higher cost generation is dispatched, and consumers pay more, both in ISO/RTO regions with locational marginal pricing, and in non-RTO/ISO regions where out of merit economic dispatch takes place. As a Federal Energy Regulatory Commission (FERC) staff paper on line ratings stated:

> "Rating transmission lines more dynamically allows for adjusting line limits of those lines, which have the potential to increase transmission system efficiency; reduce production costs, congestion costs, curtailments, and reserve requirements; and help manage system disturbances."[2]

Accurate line ratings, particularly DLR, can reduce capital investment costs borne by customers. As FERC staff's paper noted, "DLRs and AARs can potentially defer capital costs by improving utilization of existing assets. Outreach participants indicated that, because transmission upgrades can be difficult to build, DLRs are an important bridge source of transmission capacity in the interim between the identification of need and project completion. Deferred capital costs can be a benefit of AARs, but to a lesser degree."[3]

DLR equipment is being considered by a number of select utilities to inform planning decisions and potentially defer major transmission expansion upgrades that may not be cost effective or in their customers' best interests. An example of this in PJM is shown by the application of DLRs on PPL's Cumberland-Juniata and Harwood-Susquehanna 230kV lines which are potential market efficiency projects with significant congestion expected in 2025 and 2028, as shown in figure 1 below from the Market Efficiency Update at a recent TEAC meeting.[4]

Figure 1: 2020-2021 PJM Regional Transmission Expansion Plan Market Efficiency Window

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[1] See examples of DLR in the field at https://watt-transmission.org/what-are-grid-enhancing-technologies/ and in section IIc of this document.

[2] FERC staff paper, Managing Transmission Line Ratings, p.17, https://elibrary.ferc.gov/eLibrary/filedownload?fileid=15333726.

[3] FERC staff paper, Managing Transmission Line Ratings, p.18, https://elibrary.ferc.gov/eLibrary/filedownload?fileid=15333726

[4] https://www.pjm.com/-/media/committees-groups/committees/teac/2021/20210309/20210309-item-03- market-efficiency-update.ashx, slide 8.

2020/21 RTEP Market Efficiency Window Eligible Energy Market Congestion Drivers* (Posted 03-05-2021)				ME Base Case (Annual Congestion $million)		ME Base Case (Hours Binding)				
FG#	Constraint	FROM AREA	TO AREA	2025 Simulated Year	2028 Simulated Year	2025 Simulated Year	2028 Simulated Year	Is Line Conductor Limited?	Conductor Ratings**	Comment
ME-1	Kammer North to Natrium 138 kV	AEP	AEP	$ 2.02	$ 6.56	69	167	Yes		Internal Flowgate
ME-3	Junction to French's Mill 138 kV	APS	APS	$ 9.18	$ 11.97	276	301	No	SN/SE=221/268 MVA WN/WE=250/317 MVA	Internal Flowgate
ME-4	Yukon to AA2-161 Tap 138 kV	APS	APS	$ 4.36	$ 5.16	1742	1958	Yes		Internal Flowgate
ME-5	Charlottesville to Proffit Rd Del Pt 230 kV	DOM	DOM	$ 3.76	$ 4.96	121	124	Yes		Internal Flowgate
ME-6	Plymouth Meeting to Whitpain 230 kV	PECO	PECO	$ 3.33	$ 4.09	111	101	No	SN/SE=463/578 MVA WN/WE=521/639 MVA	Internal Flowgate
ME-7	Cumberland to Juniata 230 kV***	PLGRP	PLGRP	$ 9.00	$ 6.61	213	179	Yes		Internal Flowgate
ME-8	Harwood to Susquehanna 230 kV***	PLGRP	PLGRP	$ 14.49	$ 8.69	830	501	Yes		Internal Flowgate

Notes:
** ME-2, ME-9, and ME-10 constraints no longer eligible congestion drivers (updates to the base reduced congestion below the eligibility threshold).*
*** Conductor ratings provided by TOs for congestion drivers that are limited by station equipment.*
**** Cumberland – Juniata and Harwood – Susquehanna Congestion drivers may be impacted by DLR (Dynamic Link Rating) projects (Expected in-service date 06/01/2021). Harwood – Susquehanna driver may be impacted by recently announced Talen Energy retirements. (Retirement notice not submitted to PJM).*

Benefits from more accurate line ratings are significant and worth significant policy attention. The market monitor for MISO found benefits equal to approximately 11 percent of real time congestion value across the footprint, or around $150 million per year in 2017 and 2018, just for emergency and ambient adjusted ratings, without even considering dynamic line ratings.[5] An analysis of GETs generally found benefits can be in the hundreds of millions of dollars, "comparable to the scale of some of the operational benefits provided by RTO- or ISO-operated regional power markets, and yet often for a significantly lower cost and quicker installation."[6] The US Department of Energy recently observed, "By forecasting the expected transmission capacity more accurately, a more favorable commitment of generators in day-ahead markets and more efficient dispatch within real-time markets will be possible, thus reducing congestion costs."[7]

MISO stated to the FERC that "utilizing a more dynamically generated line rating system can result in additional economic benefits through market efficiencies."[8] PJM found in one study that "The line's DLR was shown to provide significant additional capacity, as compared to its static line rating."[9]

B. Accurately rated lines are more reliable lines.

As the Department of Energy found, "DLR can potentially improve reliability by calculating the true thermal limit for those lines and informing relay settings used to protect transmission equipment."[10] DOE also noted "Another benefit of installing sensing and monitoring technologies like DLR is an increased situational awareness of the transmission system. Understanding when

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[5] Potomac Economics post conference comments in AD19-15, November 2019, https://elibrary.ferc.gov/eLibrary/filedownload?fileid=15398513

[6] Brattle/Grid Strategies, https://brattlefiles.blob.core.windows.net/files/16634_improving_transmission_operating_with_advanced_technologies.pdf, p. 2.

[7] US DOE, Dynamic Line Rating, Report to Congress, p. 13, June 2019, https://www.energy.gov/sites/prod/files/2019/08/f66/Congressional_DLR_Report_June2019_final_508_0.pdf

[8] MISO post-conference comments, AD19-15 p. 2.

[9] PJM post-conference comments, AD19-15, p. 5.

[10] DOE DLR Report to Congress, p. 13.

conditions may exceed constraints is critical in situations where lines may sag below clearances, making the system vulnerable to faults and safety hazards."[11] Further, DOE stated, "Generally, methods, tools, and technologies that relax constraints on a system, give it more flexibility, or provide better situational awareness increase the resilience of the system. DLR can support more electric-delivery options during a disruption to mitigate load interruptions and facilitate recovery and restoration after an event."[12]

DLR's resilience benefits were summarized in a paper presented to the CIGRE 2015 Grid of the Future Symposium: "Widespread preemptive installation of DLR can address the problem of determining long term line overload ratings that are necessary when facing the sudden yet long term absence of major assets. DLR can alleviate congestion and other constraints that may appear during recovery. Finally, DLR can provide the added capacity that may be required by lower voltage lines in such events but which would otherwise be difficult to justify economically for normal operation."[13]

C. Proven results

Oncor Electric Delivery Company installed a DLR system supported by a federal Smart Grid Investment Grant. According to the International Renewable Energy Agency:

> "The DLR system monitored the real-time capacity of eight transmission lines that were being used for daily operations and wholesale market transactions. The project covered five 345 kV and three 138 kV transmission lines; it had an installed cost of USD 4.833 million. The real-time capacity of the 138 kV lines increased by 8–12% on average, while the 345 kV line experienced 6–14% increase in real-time capacity on average. As a second project, Oncor deployed DLR on five lines in West Texas for congestion relief."[14]

In 2006, AEP installed real-time line ratings on a 138 kV transmission line in Texas, which allowed them to avoid a $20 million upgrade which would have quickly become a stranded asset as new lines were built.[15]

Belgian Transmission System Operator Elia began using DLR in 2008. Ampacimon reports that to date more than 150 devices have been installed on more than 30 lines from 70 kV to 380 kV.

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[11] DOE DLR Report to Congress, p. 15.

[12] DOE DLR Report to Congress, p. 14.

[13] McCall and Goodwin, Dynamic Line Rating as a Means to Enhance Transmission Grid Resilience, https://watttransmission.files.wordpress.com/2018/01/11t-002-dlr-resilience-10-2015.pdf.

[14] Dynamic Line Rating Innovation Landscape Brief, International Renewable Energy Agency (IRENA), 2020. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jul/IRENA_Dynamic_line_rating_2020.pdf?la=en&hash=A8129CE4C516895E7749FD495C32C8B818112D7C

[15] Sandy K. Aivaliotis, Dynamic Line Ratings for Optimal and Reliable Power Flow: Enhanced Power Flow for the Smart Grid, FERC Technical Conference, page 29. https://cms.ferc.gov/sites/default/files/2020-05/20100623162026-Aivaliotis%2C%2520The%2520Valley%2520Group%25206-24-10.pdf

The technology is credited by IRENA as helping Belgium resolve import and export limits and speed interconnection in response to the retirement of 3 GW of nuclear generators in 2014.[16]

Kansas City Power and Light deployed DLR equipment from the Valley Group in 2002 in advance of a reconductor project on the LaCygne-Stilwell 345kV 32-mile line in southeast KS. The project paid for itself in less than three months.[17]

III. Recommendations to guide and accelerate implementation

A. Address incentive misalignment

Expert testimony at a FERC technical conference on managing transmission line ratings shows that transmission asset owners operate with an unintentional disincentive to invest in capacity-expanding technologies like DLR.

Bruce Tsuchida, Principal at the Brattle Group said:

> "The industry typically awards maintaining reliability over operational efficiency, so if the industry sees that changing operations is taking a risk, that's also going to work against the operations. And the transmission owners who -- especially are gaining sufficient returns through larger investments, may not want to look into these relatively smaller projects because they know that they can make more money through the larger investments."[18]

Other experts noted that unless the transmission owners also own generation that is transmission-capacity constrained, the owners would not have an incentive to use DLR or other GETs.[19]

B. Ensure that transmission owners can operationalize DLR

In Order 881, the FERC ordered RTO/ISOs to "establish and implement the systems and procedures necessary to allow transmission owners to electronically update transmission line ratings at least hourly." Without these systems to incorporate DLR into markets and system operations, the value of the DLR will be limited. The WATT Coalition recommends that ERCOT take a similar step to ensure that the full value of DLR can be realized.

C. Cybersecurity considerations

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[16] Dynamic Line Rating Innovation Landscape Brief, International Renewable Energy Agency (IRENA)

[17] Dynamic Line Ratings for Optimal and Reliable Power Flow: Enhanced Power Flow for the Smart Grid, FERC Technical Conference, page 26.

[18] FERC Technical Conference on Managing Transmission Line Ratings, Day 1 Transcript, beginning page 17 line 25.

[19] FERC Technical Conference on Managing Transmission Line Ratings, Day 1 Transcript, on page 70 line 14, page 72 line 3.

DLR only provides operators with more information. Implementation directions could clarify that operators may always default to a static rating if there is a lapse or suspected corruption of the information being sent. Obtaining information on line sag or wind provides attackers no ability to disrupt a system. Moreover, the communications channel used by DLR systems provides an extra, alternative source of information to operators that is in addition to their existing channels, thus decreasing their dependence on their existing systems which can also fail or be hacked. Like all electronic systems, DLR equipment can and should be physically and cyber protected to safeguard the accuracy of the measurements of actual conditions.

D. Cost-benefit analysis and recommendations for implementation

Models consistently demonstrate rapid payback periods for installations of DLR and other GETs. For example:

- A Brattle Group analysis found that a modeled $90 million deployment of DLR, advanced power flow control and topology optimization would pay for itself in 6 months of full operation in Kansas and Oklahoma. This model did not consider the potential for increased imports and exports, which would find further cost-savings for ratepayers.[20]
- One PJM authored CIGRE Grid of the Future paper showed an analysis that projected the payback period of an operationalized DLR system would be as rapid as two months.[21]
- A European study found that GETs, including DLR, could reduce the congestion and redispatch costs by more than 90% and the congestion-related curtailment of renewables by 3 TWh in 2030.[22]

The cost-benefit analysis for any individual line or system will depend on many variables. We recommend that transmission owners be required, for each line that has or is forecast to become congested, to be assessed for the applicability of DLR and implement DLR if cost-benefit criteria are met. In addition, DLR should be considered in interconnection processes where thermal transmission limits are a constraint.

E. DLR will identify, not exacerbate other constraints

Using dynamic line ratings will not change any existing infrastructure. While addressing a thermal constraint on a transmission system with DLR may lead to another factor becoming the limiting constraint, DLR will not create that constraint.

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[20] Unlocking the Queue with Grid Enhancing Technologies, The Brattle Group, February 2021, https://watt-transmission.org/unlocking-the-queue/

[21] S. Murphy & al. "Simulating the Economic Impact of a Dynamic Line Rating Project in a Regional Transmission Operator (RTO) Environment", CIGRE Grid of the Future 2018, https://watt-transmission.org/wpcontent/uploads/2018/10/cigre-gotf-2018-ngn-pjm-aep-linevision-final.pdf

[22] The Benefits of Innovative Grid Technologies, Consentec, December 2021, https://www.currenteurope.eu/wp-content/uploads/2021/12/currENT_Consentec_BenefitsOfInnovativeGridTechnologies_FinalReport_20211208_clean.pdf

Respectfully Submitted

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Executive Summary – WATT Coalition

Dynamic Line Ratings (DLR) are enabled by proven technologies and have shown valuable system benefits in transmission system operations around the world. The financial and environmental benefits of widespread use of DLR in the United States have been estimated in sophisticated models. Reliability benefits are also evident in the increased situational awareness of the various approaches to real-time monitoring in the many technologies available for DLR today.

The main obstacles to DLR deployment are institutional inertia and cost-of-service regulation of transmission owners, which creates a small disincentive for asset owners to deploy DLR and other grid-enhancing technologies.

DLR should create negligible additional risk on the system because technology providers use systems for DLR calculation and communications that are parallel to existing systems. At any time, system operators could default to static line ratings.

Cost-benefit ratios for installations of DLR cannot be easily generalized, and individual installations must be analyzed for their suitability. Previous installations and models provide evidence of short pay-back periods through operational cost savings.