Dynamic Line Ratings

Key Findings

- According to the American Society of Civil Engineers, more than 640,000 circuit miles of transmission line in the U.S. are operating at or above their rated capacities.
- The consequences of this congestion can include involuntary delays in routine maintenance, reliability challenges, and higher electric costs due to out-of-merit dispatch.
- Dynamic line ratings (DLRs) represent one of the most affordable ways to upgrade the capacity of existing transmission lines.

What has changed?

In its most recent Infrastructure Report Card, the American Society of Civil Engineers (ASCE) gave U.S. energy infrastructure a D+, which is equal to the overall score for U.S. infrastructure.[1] By their estimates, most transmission and distribution (T&D) infrastructure is operating beyond its life expectancy, and more than 640,000 circuit miles of transmission line are operating at or above their rated capacities.[2] All told, ASCE projects that the cumulative investment gap for T&D infrastructure will grow to $177 billion by 2025.

The consequences of this are involuntary delays in taking critical lines out of service for routine maintenance, reliability challenges, and higher electric costs due to congestion and out-of-merit dispatch. In the PJM[3] interconnection, for instance, total congestion costs nearly doubled from $698 million in 2017 to $1.31 billion in 2018.[4] These rising congestion costs indicate that investments need to be made to increase transmission capacity, either by building additional lines or upgrading the capacity of the existing lines.

Building new transmission lines has become a notoriously challenging endeavor, with siting and permitting processes often taking up to a decade when projects are successful, and others being abandoned due to the challenges. Because of this, capacity upgrades to existing lines have become increasingly preferential to new construction. One of the cheapest ways to increase transmission capacity is through dynamic line ratings (DLRs), which rate transmission capacity based on real-time temperature, wind, and solar radiation conditions, rather than standardized worst-case conditions. Since most lines are based on static ratings, most

[1] American Society of Civil Engineers. "2017 Infrastructure Report Card." Available at: https://www.infrastructurereportcard.org/americas-grades.
[2] American Society of Civil Engineers. "2017 Infrastructure Report Card – Energy Report." Available at: https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Energy-Final.pdf.
[3] PJM Interconnection is a regional transmission organization (RTO) for all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. https://www.pjm.com/about-pjm/who-we-are.aspx
[4] Monitoring Analytics. "PJM State of the Market – 2018." March 14, 2019. Available at: http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2018.shtml.

transmission lines are operated at less than maximum capacity nearly all the time. The Valley Group puts this in perspective (see Figure 1):[5]

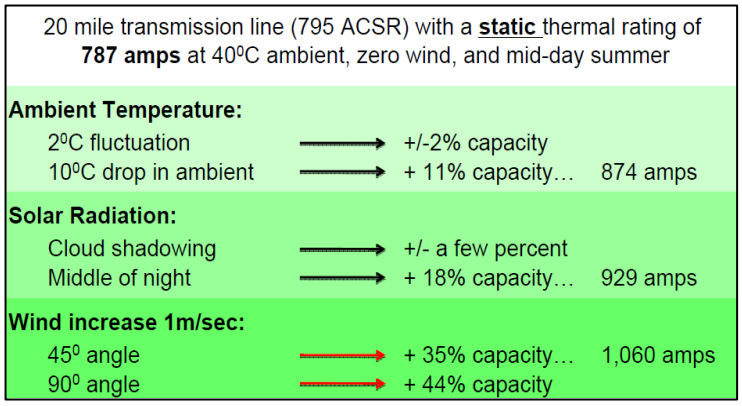

Figure 1: Relative Impact of Ambient Conditions on Line Ratings[6]

While dynamic line ratings are generally a beneficial investment, they are especially valuable for transmission lines between wind generators and load centers, since the lines are in areas with higher wind speeds and the highest level of production often occurs at night. By incorporating DLRs in these areas, grid operators can minimize curtailments due to transmission, reduce congestion costs, and minimize the need to dispatch higher-cost (generally fossil fuel) resources to meet load.

When DLRs were added to the LaCygne-Stilwell Flowgate in the Southwest Power Pool, for instance, the line was operated above the static limit for 167 hours between late June and early September, resulting in significant cost savings and a less than three-month payback period.[7] (See Figure 2.) Similar results have been seen in other applications in New York and Texas.[8]

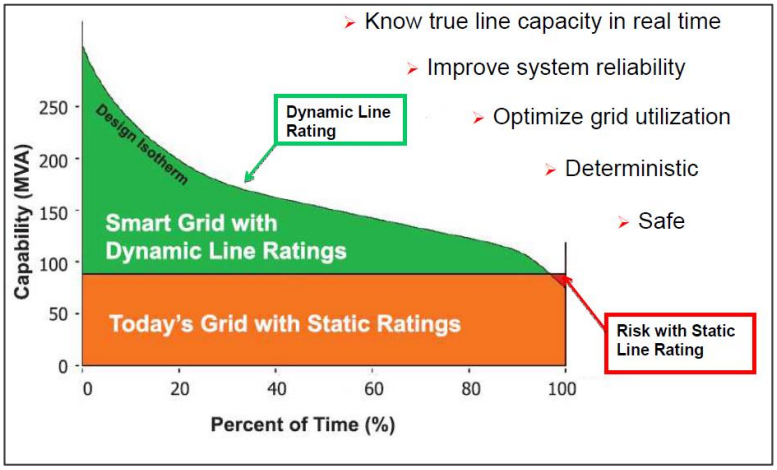

Figure 2: Static vs. Dynamic Ratings

[5] FERC. "How Weather Conditions Affect Line Ratings." June 24, 2010. Available at: https://www.ferc.gov/CalendarFiles/20100623162026-Aivaliotis,%20The%20Valley%20Group%206-24-10.pdf.
[6] FERC. "How Weather Conditions Affect Line Ratings."
[7] FERC. "How Weather Conditions Affect Line Ratings."
[8] Department of Energy "Dynamic Line Rating Systems for Transmission Lines." April 25, 2014. Available at: https://www.smartgrid.gov/files/SGDP_Transmission_DLR_Topical_Report_04-25-14_FINAL.pdf.

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What challenges do DLRs face?

While DLRs have been used in Europe for more than 40 years, their use in the United States is still relatively limited, with Oncor Electric Delivery (ERCOT), Bonneville Power Administration, the New York Power Authority (NYISO), and Idaho Power representing the earliest adopters of this technology.[9] The common feature among these four utilities is that they each received funding for their projects through the U.S. Department of Energy, which has since funded pilot projects with American Electric Power (PJM)[10] and Kansas City Power & Light (SPP)[11] as well. However, utilities have become less dependent on DOE funding for DLRs in recent years, with even smaller utilities such as Associated Electric Cooperative, Inc. (AECI) finding dynamic rating programs to be "consistent with good utility practice" for their ability to enhance the reliability of transmission and distribution systems and increase situational awareness for operators.[12,13] Nevertheless, several barriers to greater use remain.

One major barrier to deployment is the lack of a clear incentive structure for non-traditional transmission investments. When FERC opened an inquiry on transmission incentives in March of this year, several stakeholders — including the market monitors for MISO, ERCOT, NYISO, and ISO-NE — encouraged FERC to incentivize transmission operators to employ DLRs and other advanced technologies to increase the capacity of existing lines. One of the primary recommendations for doing this was to restore the advanced transmission technology adder,[14] which was abolished in 2012 in favor of a "risks and challenges" adder that is less suitable for more established technologies like DLRs.[15] Final comments were due in late July,[16] and a technical conference entitled "Managing Transmission Line Ratings" is scheduled for September.

What do cooperatives need to know or do about it?

With energy demands constantly changing, initiating long-term transmission infrastructure projects is riskier than ever. The use of DLRs can avoid these risks by enabling more efficient use of existing assets. Compared to traditional upgrades, such as reconductoring, DLRs can have a near-immediate impact while freeing up capital for other investments. As such, DLRs should be evaluated as an alternative to full-scale upgrades or new construction, particularly as renewable penetrations increase.

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This advisory was researched and written by Alicia Brown, NRECA 2019 summer intern for the NRECA Resource Adequacy and Markets work group.

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[9] Dalibor Kladar. "Dynamic Line Ratings in the World – Overview." Nov. 2015. Available at: http://www.nri.ac.ir/Portals/0/images/Technology/BPTransmission-Center/Docs/1.pdf
[10] PJM. "Report: New Line Technology Boosts Reliability, Reduces Costs." Nov. 2018. Available at: http://insidelines.pjm.com/pjm-finds-opportunities-in-new-dynamic-line-rating-technologies/
[11] FERC. "How Weather Conditions Affect Line Ratings."
[12] Jeff Harrison (VP of Engineering and Operations) and Brian Prestwood (Chief Compliance Officer), Associated Electric Cooperative.
[13] AECI applies dynamic ratings based on ambient temperatures on all transmission equipment with an operating voltage between 34.5 kV and 500 KV, using a rating methodology based on contingency loading with no loss of life.
[14] Amanda Durish Cook. "Tx Incentives NOI Brings Calls for Broader Reforms." *RTO Insider*. July 2, 2019. Available at: https://rtoinsider.com/tx-incentives-noi-broader-reforms-139303/
[15] 141 FERC ¶ 61,129. Docket No. RM11-26-000. Available at: https://www.ferc.gov/whats-new/comm-meet/2012/111512/E-3.pdf
[16] 166 FERC ¶ 61,208. Docket No. PL19-3-000. Available at: https://ferc.gov/whats-new/comm-meet/2019/032119/E-1.pdf

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