UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection	**)**	**RM21-17-000**

WATT REPLY COMMENTS
September 19, 2022

I. Introduction and Summary

The WATT Coalition ("WATT") appreciates the opportunity to respond to other comments filed regarding the Federal Energy Regulatory Commission's ("the Commission") April 21, 2022 Notice of Proposed Rule Making (NOPR) in the above-captioned proceeding. We suggest:

- There was widespread support for the Commission's proposed requirement to consider the use of Dynamic Line Rating (DLR) and Advanced Power Flow Control (APFC) in long-term regional transmission planning.
- Counterarguments to these proposed requirements are without merit.

II. Comments

1. There was significant support for the proposed requirement to consider use of DLR and APFC in LTRTP

Support was provided by elected representatives in the U.S. Congress; trade associations; the National Association of Regulatory Utility Commissioners, several state commissions, state agencies and staff, and people's counsels; a market monitor; utilities; consumer advocates; environmental nonprofits; and energy developers. Quoted passages from supporting entities are contained in Appendix A.

2. Specific responses

a. Why specific technologies need to be considered

Some parties, including LADWP, suggest that transmission providers use Good Utility Practice to identify and use technologies that maximize the use of transmission assets in order to minimize rate payer and public impacts.

WATT agrees with P268 of RM21-17. A decade of "Good Utility Practice" has failed to result in the adoption of technologies that ensure the transmission system operates more efficiently and cost-effectively.

Some parties, including Exelon, claim the Commission's proposal will likely have the unintended consequence of ultimately slowing needed transmission development while incurring unnecessary administrative costs with extremely limited benefit to customers, if any. WATT finds no basis for Exelon's concern. GETs and new transmission capacity are complementary. We note that utilities naturally prefer to add capital into their rate base and therefore it is up to FERC to put in place planning methods that balance benefits and costs to achieve just and reasonable rates. As the State Agencies suggest: "*Advanced technologies and systems are not necessarily competing with the building of new transmission lines. It is more accurate to say that in most instances new transmission buildout and advanced technologies will complement each other."*[1]

An Independent Transmission Monitor (ITM), while not proposed in this proceeding, would nonetheless help ensure transparent transmission solutions are adequately evaluated, and WATT supports further investigation of an ITM role.

Ameren, APPA, Dominion, Eversource, and some other parties urge waiting until more experience is obtained with the use of APFC and DLR. FERC should not give regions flexibility to develop criteria because, as many commenters have stated, regions include the flexibility for utilities to evaluate these solutions today, but this technology is not being proposed or adopted at-scale. FERC needs to establish a consistent requirement for all jurisdictions. Our preference would be to retain the language in the NOPR, that requires transmission providers to consider GETs for all identified needs, but if FERC wants to focus on a subset of needs, please refer WATT comments on the appropriate subset that will likely achieve the most consumer savings.[2] As the commentors from Alliant, Consumers and DTE say:

> *"transmission providers have yet to scratch the surface on the potential value from these solutions and without clear and direct action by the Commission, they will not. The advancement of Ambient Adjusted Ratings (AARs) is a case study for this fact. For over a decade the Certain TDUs witnessed many transmission owners in MISO generally kicking the can down the road regarding the adoption of AARs. While it was clear that AARs can provide both economic and reliability benefits, meaningful action did not occur until the Commission stepped in and provided direction. The same situation is occurring with GETs such as DLR and Advanced Power Flow Control Devices. The Certain TDUs participate actively in MISO's transmission planning processes and have observed that GETs along with other non-traditional transmission alternatives and non-transmission alternatives do not receive the attention they deserve as part of the process. Transmission providers are best positioned to consider these solutions and the Commission needs to ensure that meaningful time and resources are spent on their integration. Action by the Commission is needed now. From the Certain TDUs experience, currently when the topic of GETs comes up with transmission owners and transmission providers, most of the time and energy is spent on*

[1] Comments of the State Agencies, Docket No. RM21-17-000, at P 19

[2] Initial Comments of WATT Coalition, Docket No. RM21-17-000

defending the status quo and why these solutions should not be advanced more progressively."[3]

a. Whether DLR fits into long term planning

Several commenters pushed back on DLR's utility in planning processes. The WATT Coalition believes there is substantial value in considering DLR in planning, and discusses this in depth in Appendix B.

In short, planning processes should be internally consistent. Transmission planning process include models of weather scenarios, generation scenarios and other likely conditions on the power system – any of these could and should include DLR calculations. Even if DLR is not found to change outcomes in reliability-driven planning, it may affect economic and public policy driven planning. See more in Appendix B.

b. Which technologies to require

Various parties suggest various other technologies. WATT does not take a position on other specific technologies besides the technologies it includes: APFC, DLR, and topology optimization. WATT believes there is a class of technologies that utilities have little incentive to deploy as a result of standard cost-of-service regulation. The Commission has labeled these "Grid-Enhancing Technologies." We believe GETs should be required in appropriate instances and encouraged through incentives. As the California PUC states: "Transmission owners, however, have a perverse incentive to not consider more efficient technologies," such as GETs, "given that they displace alternatives with greater rate base capitalization.""

c. Proceed with DLR consideration in parallel to Order 881 compliance

In response to Order 881, RTOs are preparing systems to enable DLR integration into real-time operations by July 2025. Further policy on DLR from FERC will not interfere with that progress and will only make that work more valuable in the long term.

d. APFC Applicability in Planning

A very small number of commenters suggest that APFC do not solve long term solutions or that there was a lack of experience modeling APFC in long-term planning

Some commentors referenced challenges and/or inexperience modeling APFC in steady state and dynamic studies. However, global expertise exists and FERC should direct stakeholders to learn from their peers. The WATT Coalition has included information in Appendix C which provides guidance and evidence of successful APFC modeling schemes.

In an affidavit for Duke, Mr. Pierce states his belief that there are drawbacks to advanced power flow control devices because automated changes to topology "increases the probability of placing the system in previously unanalyzed states that would not have been considered under

[3] Initial Comments of Alliant Energy Corporate Services Inc., Consumers Energy Company and DTE Electric Company, Docket No. RM21-17-000, at P 23

analyses such as TPL-001, CIP-014 and PRC-023" which "creates greater risk of wide area cascading events."

Given that APFC devices have wide flexibility in how they could potentially be operated, WATT agrees that it is prudent for each deployment to be configured to operate within constraints that achieve the objectives of the project in a known and predictable manner. Power flow models of APFC allow transmission planners to model and evaluate how a given APFC deployment will respond to different grid conditions based on its configured operational parameters. Incidentally, Duke's argument naturally extends to traditional solutions as well, such as line upgrades, new lines, series reactors, series capacitors, and phase shifting transformers. These solutions are scoped, justified, and built based on a limited set of power flow studies considering just a few potential outages and assumptions of demand and generation profiles. In real time, any of these solutions can be found to be insufficient or result in flows that were not specifically modeled in transmission planning analysis. In these situations, most of the solutions are static and cannot be adjusted to accommodate the unforeseen circumstances, introducing increased risk to the system. APFC on the other hand can be adjusted by grid operators to address unforeseen grid challenges, making them an even more valuable solution given inherent limitations of power systems studies to consider all possible scenarios.

ITC and other parties state that planning needs to be performed based on the certainty that actual transfer capacity provides under the worst-case scenario, and not on variable capacity. WATT notes that efficiency is an important criterium to achieving just and reasonable rates, not just reliability. Specifically, APFC is a control room-dispatchable asset that does not rely on ambient or other variable external conditions to define its capacity delivery. In fact, unlike many forms of legacy power flow control, the granular dispatchability of APFC enables preferable power flow to support real-time operational needs that may differ from those identified in the planning timeframe.

MISO claims that APFC devices that effectively modify the impedance of a transmission line such as a Static Series Synchronous Compensator (SSSC) applied either at the station level (larger SSSCs) or along transmission lines via many smaller devices installed directly on the transmission line conductors work best to address small specific isolated local issues where only a few facilities employ this technology and the line characteristics are infrequently modified, such as only when a specific contingency occurs.

WATT agrees that conductor-mounted APFC is limited in impact - that is why this product is no longer offered by vendors. Instead, today's APFC are ground-mounted devices that can significantly increase transfer capacity and integration of renewables across networks and under a range of contingency conditions.[4]

MISO also claims on pages 59 and 60 of its comments that "It is not feasible to coordinate the operation and/or deployment of [APFC devices] en masse, either manually or automatically." WATT observes that the electric grid has continually become more complex ever since the days of Edison. As the industry has learned better practices, produced new technologies and pursued

[4] https://www.nationalgrid.com/stories/journey-to-net-zero-stories/working-smarter-get-net-zero

different standards it has been continually changing for the better. The grid now faces it biggest hurdle yet in completely changing the generation resource mix, with the unpredictability of electrification and distributed energy resources, and mounting rate pressure in the face of rising inflation. The tools, systems and processes that are used will need to be improved. We have confidence that the leaders and engineers at MISO and other ISOs and TOs have the technical expertise and commitment to their ratepayers and policymakers to make the necessary improvements to meet the needs of the evolving grid.

Any change to the grid can result in new problems elsewhere. By adding a new transmission line, planners introduce new power flows and can result in overloads. By upgrading lines, planners lower the impedance and push more flow through lines that may not be rated to accommodate it. All transmission solutions, traditional or GETs can result in new issues. It is critical that transmission planners continue to evaluate the impacts of their solutions to ensure solving one problem doesn't create another.

The WATT Coalition is pleased to offer these reply comments.

September 19, 2022

Signed,

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APPENDIX A – Excerpt from commentors expressing support for GETs

Congressional delegation including: Rep. Kathy Castor, Rep. Bobby Rush, Rep. Paul Tonko, Rep. Sean Casten, Rep. Raja Krishnamoorthi, Rep. Jared Huffman, Rep. Veronica Escobar, Rep. Julia Brownley, Rep. Tina Smith, Rep. Edward Markey, Rep. Sheldon Whitehouse

> We support the encouragement in the proposed rule to maximize the use of advanced transmission technologies, including sensor and software solutions like dynamic line ratings and topology optimization software, as well as hardware solutions, like advanced power flow controllers and advanced conductors to increase the efficiency and resilience of the existing electric grid.

NARUC

> As NARUC stated in its ANOPR comments, an effective transmission planning process should maximize the use of existing transmission and allow for building of new transmission only where necessary or economic. Additionally, the planning process should include a clear pathway for consideration of alternative transmission solutions, including grid-enhancing technologies, non-transmission technologies, and hybrid programs for efficiency, load control, distributed generation, and storage in the regional planning process.
>
> Similarly, the ability of advanced power flow control devices to effectively control and route power to lines that have more capacity than others can benefit customers through a reduction in congestion and associated costs, and this can increase reliability of the transmission system.

California PUC

> The CPUC, and many other commenters in response to the ANOPR, expressed broad support for requiring consideration of grid-enhancing technologies ("GETs") in transmission planning processes. Although the CPUC supports the NOPR's proposal to require grid operators to fully consider dynamic line ratings ("DLRs") and advanced power flow control devices in their regional transmission planning processes, we urge the Commission to go further. Specifically, in addition to DLRs and advanced power flow control devices, the Commission should also require grid operators to consider other GETs, including storage technologies, and additional non-wire solutions, in their analysis of potential alternatives.

Kansas Corporation Commission

> The KCC sees merit in considering the benefits that improvement in dynamic line ratings and increased deployment of advanced power flow control devices can provide.

PUC Nevada

> The PUCN supports a more thorough consideration of dynamic line ratings or advanced power flow control devices in the regional transmission plan because such technologies can either avoid or defer expanding transmission systems.

NY PSC

Grid-enhancing technologies can significantly enhance system performance at lower cost to consumers than traditional investments to expand or upgrade the transmission system….

We urge the Commission to encourage transmission providers to consider in their planning processes a robust set of advanced transmission technologies.

Pennsylvania PUC

The PAPUC supports the proposed requirement for transmission providers to consider dynamic line ratings and advanced power flow control devices. These technologies may help with cost containment, provided the costs of the devices and their operation does not exceed the benefits provided by the ratings and devices.

Vermont PUC

An effective transmission planning process should maximize the use of existing transmission and build new transmission only where necessary or economic. Grid-enhancing technologies can play a valuable role in deferring the need for, and intensity of, new infrastructure.

The VPUC and VDPS are supportive of a requirement that transmission providers more fully consider the application of grid-enhancing technologies when conducting regional planning scenarios.

State Agencies including the Connecticut Department of Energy and Environmental Protection, State of Connecticut Public Utilities Regulatory Authority, Connecticut Office of Consumer Counsel, Attorney General of Connecticut, California Energy Commission, Attorney General of DC, Delaware Department of Justice, Maine Office of the Public Advocate, Pennsylvania Office of the Consumer Advocate, Delaware Division of the Public Advocate, Massachusetts Attorney General, Attorney General of Maryland, Michigan Attorney General, Rhode Island Attorney General

The State Agencies assert that ratepayers benefit when transmission providers more efficiently use existing assets before considering new buildout. The State Agencies therefore support the Commission's efforts to promote the widespread adoption of advanced transmission technologies in the regional transmission planning process.

California Department of Water Resources State Water Project (SWP)

SWP supports the consideration of dynamic line ratings and advanced power flow control devices in long-term regional transmission planning.

Office of the People's Counsel for DC and Maryland Office of the People's Counsel

The Joint PCs support integrating the use of GETs into the transmission planning process.

Illinois Commerce Commission

The ICC supports the Commission's call for transmission providers to consider new grid technologies, notably dynamic line ratings ("DLR") and advanced power control flow devices in their transmission planning.

Joint Consumer Advocates – Iowa Office and Indiana Office

Joint Consumer Advocates support the evaluation of advanced technologies including dynamic line ratings and advanced power flow control devices.

Massachusetts Attorney General Office

In general, the Massachusetts AGO supports the use of grid enhancing technologies, including dynamic line ratings and advanced power flow control devices, to permit the more efficient use of existing infrastructure before committing to new and costly transmission lines. There is ample data and operational experience to support a requirement for public utility transmission providers to consider a broad range of grid enhancing technologies, even for long-term transmission needs. Requiring transmission providers to evaluate whether grid enhancing technologies can serve as alternatives to, or improve the efficiency or cost-effectiveness of, proposed new transmission facilities would result in long-term cost savings for consumers.

Ohio Consumers Counsel

OCC supports FERC's efforts to promote the use of grid-enhancing technologies ("GET") in local, regional and inter-regional transmission planning.

Washington UTC

The Pacific Northwest State Agencies strongly support this proposed reform to include this requirement for all regional transmission planning processes, not just the proposed LTRTP process.

Monitoring Analytics

The Market Monitor supports the Commission's proposal (at P 272) to require that transmission providers more fully consider the inclusion of dynamic line ratings and advanced power flow control devices.

Alliant, Consumers Energy, DTE

The Commission is correctly advancing the consideration of Dynamic Line Ratings and Advanced Power Flow Control Devices, and an overall increased focus and attention is needed on GETs.

Avangrid

Avangrid believes that near and Long-Term Regional Transmission Planning Processes should consider the potential benefits of grid-enhancing technologies.

Industrial Customer Organizations

Industrial Customers Appreciate The Proposed Requirement For Transmission Providers To Consider Certain Grid-Enhancing Technologies, But the Proposal Stops Short Of Optimizing Consumer Protections or Transmission Cost Savings.

ELCON

> ELCON's comments in response to the dynamic line rating (DLR) notice of proposed rulemaking fully supported the use of DLR to improve the accuracy of transmission line ratings and maximize the capacity on existing infrastructure. By increasing the capacity on existing transmission lines, customers can save money by deferring new infrastructure build and costly upgrades.
>
> Providing real-time information on system conditions and weather impacts will help transmission providers to better assess their capacity needs. Similarly, advanced power control technologies allow transmission providers to control pathways, send power to lines with additional capacity, and minimize congestion. This saves consumers money by optimizing current transmission infrastructure and reducing the need for new infrastructure or upgrades.

Resale Power Group of Iowa

> RPGI commends the NOPR's sensitivity to cost issues in other respects. Mandating the consideration of dynamic line ratings ("DLRs") and advanced power flow ("APF") control devices in transmission planning ensures that massive high-cost infrastructure projects do not become the preferred option for meeting system needs that can be met with lower cost approaches or enhanced operating procedures.

NESCOE

> NESCOE Supports a Requirement That All Types of Grid-Enhancing Technologies Be Considered in Long-Term Regional Transmission Planning.

NASEO

> The Final NOPR Should Support the Implementation of All Grid Enhancing Technologies on the Electric Grid and Encourage Long- Term Evaluation of Technologies

NASUCA

> Planning must ensure the opportunities to deploy grid enhancing technologies and non-wires alternatives are maximized before more expensive transmission is built.

R Street

> The Commission should require incorporation, not mere consideration, of advanced transmission technologies in transmission planning processes….
>
> Considering the huge cost advantages of advanced technologies and the fact that they reduce rate base prospect for TPs, the Commission should require incorporation of specific technologies not mere consideration, otherwise TPs will treat this as a box-checking exercise.

Public Interest Organizations including: NRDC, Sustainable FERC Project, Earthjustice, Sierra Club, Western Resource Advocates, Environmental Defense Fund, Southface Institute, Southern

Environmental Law Center, Acadia Center, Conservation Law Foundation, NW Energy Coalition, Fresh Energy

> PIOs applaud FERC's requirement that planning regions "more fully consider dynamic line ratings and advanced power flow control devices in regional transmission planning processes." In addition, FERC should mandate that planning regions specify how they will reflect increases in the efficiency of the existing grid through the use of all types of grid-enhancing technologies ("GETs").
>
> Affidavit of Johannes Pheifenberger:
>
> I concur with the Commission's proposal to require that advanced transmission technologies, such as dynamic line ratings ("DLR") and advanced power flow control devices, be actively considered in regional transmission planning processes…

Evergreen Action

> Requiring the consideration of innovative technologies and software solutions like dynamic line ratings and advanced power flow control devices is also essential. These technologies can increase transmission capacity at very low economic and social cost (and within shorter timeframes than new construction), and we support the inclusion of these requirements in the NOPR.

CARE Coalition

> The CARE Coalition also supports FERC's proposal to require greater consideration of Grid-Enhancing Technologies (GETs) in transmission planning.

Orsted

> Ørsted supports the requirement that regional transmission providers more fully consider dynamic line ratings and advanced power flow control devices in regional transmission planning processes. Ørsted believes that these types of technologies will, as the Commission suggests, result in the selection of more efficient and cost-effective transmission facilities.

VEIR

> VEIR conditionally supports the Commission's proposal to require that public utility transmission providers in each transmission planning region more fully consider dynamic line rating ("DLR") and advanced power flow control ("APFC") technologies in regional transmission planning and cost allocation processes ("Requirement").

Prysmian Group

> As such, we applaud the consideration of advanced transmission technologies such as dynamic line rating and power flow control in regional transmission planning as these technologies can serve to cost effectively enable more capacity from existing transmission lines.

Pattern

Pattern supports the consideration of grid enhancing technologies in Long-Term Regional Transmission Plans. DLRs and advanced power flow control devices are shorter-term transmission solutions – helping to "squeeze more" out of the infrastructure that is operating or planned to be constructed. Requiring new "greenfield" and upgrade transmission facilities to have DLRs and/or advanced power flow control devices installed will result in more dynamic, flexible, and resilient assets.

Shell

The Shell Companies encourage the Commission to incorporate GETs into this rulemaking proceeding instead of addressing these technologies in a separate proceeding. The Commission could provide guidance to public utility transmission providers that GETs be incorporated, when possible, and encourage their use to alleviate transmission congestion and lower the cost to customers and developers alike.

APPENDIX B – DLR in Planning

The WATT Coalition wishes to address claims that DLR should be used only in operations, as a tool to address real-time operational issues. The WATT Coalition agrees that DLR and other GETs should be an integral part of Operations and Operational Planning, however DLR is also a critical tool in the mid to long-term planning-process for the reasons outlined below.

When DLR technology is used in operations, that historical data set of line ratings can also be analyzed to create the probabilistic line ratings which can be available on a seasonal, monthly, or more granular level to inform the planning process. The additional data regarding the hourly /sub-hourly thermal rating that comes from DLR technology can help maximize the efficiency of transmission planning. For example, DLR has been used in operations in ERCOT since 2005[5], resulting in an estimated $30M reduction in annual congestion management costs in the first year.[6]

At present, ERCOT utilizes DLRs in their Regional Transmission Plan (RTP) Process, as noted in Appendix A, Section 3.1.5 of the 2021 RTP Report:[7]

> "Dynamic ratings will be used for both the reliability and economic portions of the analysis. The ratings in reliability analysis will be based on the 90th percentile temperature as determined for the weather zone associated with the transmission element."

Additionally, ERCOT has a feedback loop between the RTP and Operations as noted in Section 1.2 of the 2021 RTP Report:

> "ERCOT Protocols Section 3.10.8.4(3) requires ERCOT to identify additional Transmission Elements that have a high probability of providing significant added economic efficiency to the ERCOT market through the use of Dynamic Ratings and request such Dynamic Ratings from the associated ERCOT Transmission Service Provider (TSP). This report identifies such Transmission Elements as part of its economic analysis."

This requirement highlights a key application of DLRs that is informed by a well-designed transmission planning process. If thermal overloads on specific lines are identified during the planning cycle, it is possible that those overloads could manifest in operations earlier than the planning study year. With the proactive application of DLRs, these lines could be operated safely and reliably prior to the completion of any planned upgrades. Conversely, if the system conditions change for the better between that planning cycle and subsequent years of operations, DLRs would provide the data that would help the Transmission Provider make an informed decision to either delay or cancel the line upgrades.

The WATT Coalition also wishes to respond to comments that indicated that in the planning process, dynamic ratings are, or could, at times be found to be below static ratings. Having additional weather or measured line rating information can only serve to better inform the

[5] https://www.ercot.com/files/docs/2005/10/11/item_8b___october_10_transmission_report.pdf
[6] https://interchange.puc.texas.gov/Documents/31867_1_492950.PDF
[7] https://www.ercot.com/files/docs/2021/12/23/2021_Regional_Transmission_Plan_Report_Public.zip

assumptions that are used in the planning process. To ensure the system is being designed in a safe and reliable manner, if information shows that previous assumptions were not conservative enough, meaning the planning process had overestimated the available capacity, this knowledge can be used to correct the assumptions in future iterations of the planning process, thereby enhancing grid reliability.

Furthermore, long-term planning should focus on a wide range of transmission needs beyond those defined solely by existing reliability planning criteria. Currently, planning for economic & public-policy projects result in less than 10% of all U.S. transmission investments. Long-term planning should consider the other benefits of DLR technology, which includes the ability to increase energy headroom, as has been demonstrated in New York state, which issued a report requiring the state's utilities to consider advanced technologies like DLR in their local transmission and distribution planning efforts and deploy such technologies where cost effective.[8] Examples of such projects can be found in the renewable rich region of western New York, where National Grid is working on a DLR project that, along with upgrades of a 4.8 mile circuit and limiting substation equipment, will avoid the rebuild of nearly 30 miles of double circuit transmission, and is projected to reduce wind curtailments by 350MW and add 190MW in additional headroom.[9]

To ensure such benefits are captured in the planning process, the WATT Coalition proposes the following threshold for where DLR makes sense in planning:

- Under 5% overload over the conductor rating
- Certain wind scenarios along the conductor/corridor

We note that planning models must be internally consistent by reflecting the impact of the weather pattern that each planning scenario considers (e.g., summer peak, spring minimum load/high wind, etc.) not only on the load and resource dispatch but also on the potential ratings that transmission assets could achieve when using DLR technology. For example, with the use of DLR, line ratings in a high wind case should be significantly higher than in a summer peak case and this should be considered in the planning process. This will avoid the identification of unnecessary upgrades in the high wind case.

In cases where there are overloads on overhead transmission lines not limited by the conductor, the planning process should consider the upgrade of the limiting elements to at least 5% above the conductor rating, and such that the asset becomes conductor-limited and able to leverage DLR technology.

Additionally, while the WATT Coalition acknowledges the need for new transmission development as identified through the transmission planning process, it firmly believes that these new transmission facilities will be best served if installed with capacity enhancing technology applications, including DLR. With passage of the Inflation Reduction Act (IRA), the Princeton

[8] https://www.nyserda.ny.gov/About/Publications/Research-and-Development-Technical-Reports/Electric-Power-Transmission-and-Distribution-Reports/Electric-Power-Transmission-and-Distribution-Reports---Archive/New-York-Power-Grid-Study

[9] Case 20-E-0197; Petition of Niagara Mohawk Power Corporation D/B/A National Grid for Cost Recovery of Phase 1 Local Transmission Projects; November 2021

University-led REPEAT Project found that the IRA could increase annual utility-scale wind capacity additions from 15 GW in 2020 to 39 GW in 2025-2026 and annual solar capacity additions from 10 GW to 49 GW over the same period[10] -- this development will impact system congestion in ways that are not yet fully understood. Installing new transmission with DLR technology ensures that congestion can be proactively addressed while also creating needed energy headroom for renewable generation during most hours of the year. Given its ability to quickly integrate renewable energy onto the existing grid as well as increase the cost-effectiveness of new multi-value transmission projects that are being evaluated through the new long-term regional planning process, DLR is a valuable input to transmission planning for the market efficiency and public policy benefits of the technology.

Lastly, some comments questioned the ability to forecast ambient conditions over the planning horizon, thereby proposing that unknown line rating changes may introduce complexity and risk. This calls into question the utilization of assumptions in system planning, a practice which currently occurs in utilities' traditional integrated resource planning processes (IRPs), where a variety of assumptions are made regarding least cost resources, load modifiers, impacts of electrification, and new technologies. With the implementation of Order 881, the utilization of forecasted AAR's stands to demonstrate that more granular data inputs can and should be captured to increase the value of new transmission investment as well as increase reliability and market efficiency. By using probabilistic historical based weather models to generate line ratings, that forecasted data helps capture the true available transfer capability of a transmission line; that additional data can only help, not harm, reliability.

[10] https://repeatproject.org/docs/REPEAT_IRA_Prelminary_Report_2022-08-04.pdf

APPENDIX C – Modeling Advanced Power Flow Control

Advanced Power Flow Control is easy to model in steady state transmission planning

In the US, most transmission planners use either PSSE, PSLF, PowerWorld, and/or TARA for steady state reliability planning, which is the foundational modeling required for reliability planning.

For this response, APFC is more specifically categorized as a modular Static Synchronous Series Compensator (SSSC). It is important for planners to understand how to model SSSCs in their preferred planning software. Modular SSSCs work by injecting a voltage in quadrature with the line current, either leading or lagging. This creates an effective series compensation (capacitive or inductive, respectively). The recommended way to model these modular SSSCs for steady state transmission planning in PSSE, PSLF, or PowerWorld and/or TARA is to create an adjustable reactance. This is possible by simply tapping the transmission line and creating a new "modular SSSC" bus along with a new line segment in parallel with nearly zero impedance to represent the bypass.

The modular SSSC reactance can be either capacitive or inductive, because SmartValve injects a voltage waveform in quadrature with the line current that can be either capacitive or inductive in nature. The modular SSSC synthesizes capacitance or reactance, and it does so by injecting a voltage waveform. This is different than adding reactance directly, like a series reactor, or adding capacitance directly, like a series capacitor. Although the modular SSSC can essentially function as a series reactor or series capacitor, for modeling purposes, it should not be modeled as one of these elements because this would incorrectly characterize the device capabilities and lead to improper modeling assumptions in other domains (e.g. in dynamic simulations).

This approach to modeling modular SSSCs makes the most sense in cases where a utility will operate the device at a fixed level of reactance for any given scenario. If a utility is planning to leverage modular SSSC variable reactance capabilities and plans to dynamically optimize the setpoint, then it makes more sense to adopt the approach detailed below in the *production cost simulation section*.

Tools exist to make this process easier

Adding this adjustable reactance can be done manually for one-off needs. Some modular SSSC vendors offer free tools that allow planners to run scripts to automatically insert modular SSSCs for multiple locations, lines or needs. And finally, if planners do not know where they want to put modular SSSC, some modular SSSC vendors offer tools that assess a network (or subsection of a network) to identify the location(s) where it would be most effectively placed.

Advanced Power Flow Control is easy to model in production cost simulation

Although not often relevant for long term transmission planning, sometimes transmission planners (or other stakeholders such as renewable developers) will conduct production cost studies as they explore transmission planning or generation interconnection to understand the economic implications of a planning decision because it models the system over the course of an

entire year, an “8760 model” (8760 being the number of hours in a year). Production cost simulations are required in economic planning.

Production cost simulations run an optimization to determine what generation to dispatch given certain system conditions and constraints. Among other things, many production cost simulation tools are also capable of determining the optimal set points for a PAR (phase angle regulator) or PST (phase shifting transformer). In the DC load flow domain used in production cost software today, modular SSSC injection capabilities can be mapped to an equivalent phase shift. The production cost software will output a set of taps or degrees at which the PST should be set based on various system conditions. Planners can then take those values and convert them into an equivalent SSSC voltage, which can be used to size a modular SSSC solution (this conversion is done automatically by PLEXOS).

Some production cost simulation software vendors, such as Energy Exemplar have already implemented generic power flow control classes, which allow the user to directly model SSSCs and modular SSSCs. This allows the planner to take full advantage of the dynamic power flow control capabilities of the modular SSSC. For instance, an initial set point may be ideal when there is high wind generation in the western part of a planner’s grid, but another set point may be ideal when there is high solar generation coming from the southern part of a planner’s grid.

Advanced Power Flow Control is easy to model for dynamic studies

Steady state transmission planning looks at the transmission planning at a single point in time. Dynamic studies explore what happens in phasor domain or time domain to ensure the system remains stable after any event (fault, loss of a component, etc.) and to make sure that all system components will interact correctly with each other in real-time.

In most cases, when transmission planners want to complete dynamic studies on a system component, they need information from that component manufacturer. For instance, transmission planners are very accustomed to working with inverter manufacturers to secure the necessary libraries for the controllers. This is the same approach that is required with modular SSSCs.

For RMS-domain dynamics, modular SSSC vendors have worked with the major software vendors to build dynamic controller libraries around native elements of the respective software. For example, in PSS/E a modular SSSC controller is built around a dynamically controllable series reactance component called CRANIT. In PSLF, a modular SSSC controller is built around the TCSC (Thyristor Controlled Series Capacitor) element. The dynamics and control functions of these models are tested and validated against a vendor’s modular SSSC control hardware.

When planners need to run time domain simulations, they will use EMT (electromagnetic time domain) software such as PSCAD or EMTP-RV. Modular SSSC vendors also build and maintain validated modular SSSC models for these software packages.

Advanced power flow control will become even easier to model in the future

Although it is possible to model advanced power flow control, and specifically modular SSSC from individual vendors, there is no native SSSC element in any tool that US planners currently

use that fully represents modular SSSC from individual vendors. It is up to the software vendors to integrate, and this is happening in other parts of the world. For instance, PowerFactory, a planning tool that is popular in Europe and Latin America, will be adding a SSSC element that works for both steady state and dynamic studies. This will be available for planners as of next year.