WECC

Long-term Transmission Planning in the West

Draft for Comment

WECC is seeking comments on this draft report. Please submit comments here.

Executive Summary

On April 21, 2022, the FERC issued a Notice of Proposed Rulemaking (NOPR) on transmission planning titled "Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection." The NOPR proposes to reform both the *pro forma* Open Access Transmission Tariff and the *pro forma* Large Generator Interconnection Agreement to remedy deficiencies in the FERC's existing regional transmission planning and cost allocation requirements. Among other things, the NOPR proposes to require public utility transmission providers to conduct 20-year-and-beyond, long-term transmission planning. WECC currently creates the interconnection-wide power flow, dynamics, and production cost modeling datasets through the 10-year time horizon. WECC management and the Reliability Assessments Committee (RAC) leadership spoke about possible approaches for discussing the implications for WECC stakeholders if a final rule from FERC were to pass requiring entities to conduct long-term transmission planning.

Subsequently, on October 6, 2022, WECC's Reliability Assessments Committee (RAC) hosted a technical workshop on the topic of long-term transmission planning. The workshop was attended by various stakeholders who shared their approaches for long-term transmission planning. This paper captures the highlights of the discussion.

FERC NOPR (RM21-17-000)

During the workshop, various details and highlights from the FERC NOPR were covered:

MISO MVP Process

The FERC NOPR applauds Midcontinent Independent System Operator (MISO) for its Multi-value Projects (MVP) process. The NOPR states the benefits from the MVP process to be from \$2.20 to \$3.40 per dollar. The MISO MVP process is conducted for the 20-year planning horizon. The process considers several drivers of change, including:

- Changing state laws for resource mix; and
- Large generation interconnection requests.

The process considers a range of scenarios, then selects a portfolio of "no regrets" transmission solutions. NOPR commends the process for achieving both reliability and economic benefits.

Why Was NOPR Created?

FERC believes long-term transmission planning is not occurring regularly or consistently in most regions. Consumers may not be seeing:

- Enhanced reliability;

- Improved resource adequacy; or
- Access to lower cost and diverse resources.

Transmission needs are being met outside the regional process and, for the most part, being met piecemeal in response to generator interconnection requests. This has led to siloed transmission planning, resulting in increased interconnection costs, which are also becoming a higher percentage of the overall generation project costs. In non-RTO/ISO regions, no projects have been selected under regional transmission plan for the purpose of cost allocation since FERC Order 1000 was implemented [FERC NOPR RM21-17-000 item 39]. Therefore, FERC believes that reforms are needed.

FERC believes that the existing processes fail to:

- Require sufficiently long-term assessments;
- Adequately account for known determinants of needs; and
- Consider a broader set of benefits.

FERC proposes to reform regional planning such that:

- Long-term scenarios are considered;
- Dynamic line ratings are considered;
- Advanced power-flow control devices are considered;
- State agreements are included in cost allocation; and
- Enhanced transparency and coordination is adopted.

Long-term scenarios must be a minimum of 20 years into the future. Scenarios should be revised every three years and should incorporate a commission-identified broad set of factors affecting key future assumptions such as loads and resources. Planning regions should develop at least four plausible and diverse scenarios using the best available data. Regions should also consider whether to identify geographic zones with resource deployment potential.

Some of the key inputs that should be considered in scenario development are:

- Level and pattern of demand;
- Location and types of resources;
- Resource retirement assumptions;
- Natural gas prices; and
- Outage trends due to extreme weather and climate.

Factors

FERC has requested that the following factors to be considered when developing the scenarios:

- Federal, state, and local policies and regulations affecting resources and demand;
- State-approved integrated resource plans (IRP);

- Technological trends;
- Resource retirements;
- Interconnection requests;
- Climate risks, reliability, and resilience; and
- Facilities identified as a need but never built due to withdrawal of underlying request.

Requirements for Scenarios

Key proposed requirements for the scenarios:

- Scenarios must be plausible and diverse;
- Data inputs should be publicly disclosed;
- Must include opportunity for stakeholder input;
- At least one scenario should account for low-frequency, high-impact events.

Identification of Geographic Zones

The NOPR proposes to require transmission service providers to:

- Consider specific geographic zones of new generation;
- Assess generation developers' interest in those geographic zones;
- Incorporate zones and commercial interests into scenarios;
- Establish methods to select geographic zones; and
- Provide stakeholders opportunity for input.

Need for Long-term Planning

The workshop discussion then focused on gaining perspectives from various stakeholders on why long-term planning beyond the typical 10-year time horizon is needed.

One perspective was that it is imperative to ensure that the near-term planning decisions fit with the longer-term planning goals. The purpose is to consider various alternatives in the near term and make the best choice as to which alternative or a set of alternatives fit best with the long-term planning. Additionally, there is a need to consider various longer-term resource plans, which then also drive the need for various transmission options.

There is also a resilience value to transmission due to climate change; therefore, building new transmission is beneficial in two ways—it provides the needed mechanism to transport energy from the new resources, and it enhances the grid against the impacts of extreme weather.

Decarbonization policies are driving transmission planning for certain entities. States such as California, Washington, and Oregon require grid decarbonization by the 2040-2045 time frame. The U.S. Department of Energy has a goal to completely decarbonize the electric grid by 2035. This will result in a significant change in the resource mix. To meet these policy objectives, non-renewable units must be replaced with firm clean resources. Electrification of the transportation, residential, and commercial sectors are also part of the state policy goals. This may double the electric demand in some areas.[1]

Driven by climate change, certain local policies at the city level are also pushing toward achieving clean energy goals by 2035. Due to these policy shifts, some major metropolitan areas are anticipated to experience significant load growth. There are challenges not only with the transmission but also the distribution networks are also expected to see significant change. The distribution system is anticipated to experience significant growth and may be planned to be connected to the grid in new ways. Long-term planning for transmission gives resource developers a signal as to where transmission will be coming.

There are precedents in the industry—such as MISO's MVP process, which was developed primarily in response to the changing resource mix—where long-term planning processes have been adapted to the needs of 20-year planning.

Planning Mindset Shift

Given the challenges with transmission planning and development, and the time it takes for regional or inter-regional transmission projects from inception to operation (greater than 10 years), it is imperative that planning mindsets change, and transmission planners adopt new approaches to system planning.

There are challenges with obtaining useful results by performing analyses in the 20-year-and-longer term horizons. Cost allocation for projects is a major concern for utilities. In some instances, depending on the size of the project, siting and permitting alone could take up to a decade to complete. The level of uncertainty of various input assumptions that go into an assessment makes it challenging for entities to make firm decisions two decades or so in advance.

One of the major inputs with a lot of uncertainty is load demand forecasts and how loads are going to be changing with the aggressive push toward decarbonization goals across all sectors of the economy at federal, state, and local levels. This would have an effect both on peak demand as well as demand profiles. For a highly decarbonized future, performing studies at an interconnection level might be more meaningful compared to the local level, due to uncertainty with the load forecasts at the local level. However, when forecasting demand 20 years or more into the future, energy efficiency would also need to be considered.

[1] Planning for an Electrified Future, Emeka Anyanwu, Powerlines, Seattle City Light, Jan 20, 2022. Planning for an Electrified Future—Powerlines. https://powerlines.seattle.gov/2022/01/20/planning-for-an-electrified-future/ (seattle.gov)

Study Approaches

To meet the challenges mentioned above, the workshop attendees then discussed some of the study approaches that needed to get meaningful results and useful information for the decision-makers.

One stakeholder shared that analyzing the system in the 10-to-15-year horizon might be the maximum that would be meaningful. The system would need to be reevaluated periodically to see how changing resource mix and demand profiles are using the transmission system. In a highly decarbonized economy, coordinated resource and transmission planning would provide the most benefit.

Policy impacts at the distribution and sub-transmission level for a particular area may have a wide-ranging effect across the grid, so the policy impacts must be studied at a broader level where regions are evaluating impacts from one part of the grid to another.

One of the approaches adopted by MISO in the longer-term planning horizon is to develop various scenarios that represent "bookends" of uncertainties and perform robustness tests on the planned system to determine how it will respond under various system conditions. This requires a significant amount of coordination among all stakeholders, including state representatives, utilities etc. The analysis involves deployment of several different types of modeling tools, e.g., economic, steady state, and stability.

Another approach is the use of probabilistic approaches in transmission planning to deal with the uncertainties involved in long-term (20+ years) planning. "Probabilistic transmission planning" is not a well-defined or well-understood term. Transmission planning involves using probabilistic approaches to determine anticipated loads and resource profiles; however, application of probabilistic approaches to transmission systems in and of itself has been limited to determining transmission outage rates. Work has been done to determine the failure rate of transmission lines. However, a consolidated approach where failure rates and typical power flow and stability are combined has not been developed. Typical approaches involve a determination of failure rates associated with various pieces of transmission equipment. A combined failure rate and power flow/stability analysis approach will require a large amount of data for every piece of equipment and could potentially be very time consuming. Transmission assessments—such as those done for NERC TPL standards and planning assessments—already incorporate transmission failure rates into the contingency analysis and expected system performance requirements. Therefore, calculating transmission equipment failure rates alone will not provide any additional meaningful information to existing transmission planning processes.

Models and Tools

When analyzing the system in the long-term planning horizon, there are three main drivers that are considered:

- Reliability drivers,

- Economic drivers, and
- Policy drivers.

Entities deploy various tools to analyze the system in each domain. For reliability analyses, power-flow and stability tools are used. The policy drivers are considered in developing the appropriate load forecasts and inputs such as resource mix selection. For economic analyses, production cost modeling is a typical tool of choice. Long-term capacity expansion tools are also used in deciding which resource mix, and which locations, will provide the most optimal resource plan.

Depending on the type of analysis being performed, the models must represent the appropriate level of detail. A nodal modeling approach is used when a more detailed topology of the system is analyzed. Whereas, a zonal modeling approach is used where the system is defined into various zones, then the aggregated transmission system is represented with certain capacity connecting the zones. There are pros and cons of using each approach.

Certain transmission solutions may involve looking beyond the Western Interconnection. The size and type of the model will then need to reflect the appropriate level of details to properly study the desired system.

Modeling Approach and Key Assumptions

After the selection of the right tool and the right level of detail for the model, the next step is to decide on the key assumptions to include in the model. Assumptions like loads, resources, and future transmission topology are some of the main assumptions that must be considered. Typically, the load-serving entities in the Western Interconnection only forecast up to 10 years into the future. To study the system in the 20-year time horizon and beyond, appropriate load forecasts must be developed. Not only the magnitude of demand must be forecast, but the appropriate hourly profiles must be developed. In developing hourly load forecast profiles, impacts of behind-the-meter generation must be considered. Similarly, appropriate resource mix assumptions must be made in the 20-year-and-beyond future.

Another thing to consider is the appropriate level of detail to which the transmission system must be represented. Depending on the purpose of the study or assessment, it may be prudent to represent the anticipated transmission system in full detail for the long-term planning horizon, or it may be appropriate not to represent the transmission system beyond the planned future to determine which parts of the transmission system need enhancements. For example, at a local level, there is too much uncertainty with the long-term load forecasts; or from a regional or inter-regional transmission perspective it may not matter what the load forecasts are at a local level. In such cases, it might be prudent to analyze the system in broader zones and develop forecasts on a zonal level. It also might be prudent to only analyze the impacts of outages at the main grid level and assume that the sub-grid issues will be addressed through local transmission planning.

Since the level of uncertainty increases exponentially into the 20-year-and-beyond future, it may not be appropriate to study a single future scenario and, based on various drivers such as policy, economics, or environment, it may be prudent to study multiple futures and determine which transmission needs consistently appear in each or several of these scenarios.

Scenario Development

As mentioned in the previous section, forecasting for 20-years and beyond requires dealing with a greater level of uncertainty, and the confidence level associated with the probability of certain assumptions, such as load forecasts, becomes increasingly low. Additionally, a broader range of other assumptions must also be studied, including the increased amount of variation in transmission costs, natural gas prices, wind, and solar resource costs, and impacts of climate change. Policy drivers have a significant effect on load growth and load profiles. With policy increasingly pushing toward decarbonization, the load forecasts depend greatly on how aggressive these policy objectives are adopted across various sectors of the economy and how they contribute to load growth. This, in turn, has a significant impact on how much transmission will be needed and where that new transmission should be located. Impacts of climate change may also need to be considered in the form of derated transmission capacity or reduced hydro, wind, and other types of generation.

The purpose of performing analyses using a scenarios-based approach is to ultimately create robust transmission plans that will result in much improved chances of selecting a transmission solution or a portfolio of solutions of "least regret." Once scenarios are developed, there may be an opportunity and benefit in performing some sensitivity analysis to see how changing some of the input assumptions changes the simulation outcomes. It may be worth spending extra time reviewing the assumptions that have the most influence on the end results. Scenario definitions are about developing various futures based on drivers such as technology adoption, policy impacts, etc., whereas sensitivity analysis is about adjusting one or two variables within a broader scenario to see the effect on outcomes.

Long-term scenario planning must also have a feedback mechanism. As system evolves and entities are approaching closer to the planning year (e.g., going from 20 years out to 10 years out), there may be additional needs that should be considered or certain drivers of key assumptions, such as policy or technology adoption, that may have shifted from the original assumptions. Interconnection-wide scenario development will need to look at the policy drivers of each state that will have a material impact on key assumptions.

The developed scenarios will need to consider the load profiles and the appropriate resource types to meet the required energy profiles. Any interconnection-wide scenario assessments will need to consider the assessments performed by various planning entities and how such assessments will provide meaningful results to those involved in system planning.

A benefit of building interconnection-wide scenarios is that each planning entity does not have to develop **all** the scenarios and a more coordinated approach to scenario development can be adopted interconnection-wide. Once baseline scenarios are developed at the Western Interconnection level, each planning entity can adjust the scenarios for its own footprint as needed. WECC can make generic scenario data available for all entities involved. This will also help facilitate inter-regional coordination and collaboration. Developed scenarios must be informational, useful, plausible, and provide a baseline for regional entities and other entities involved in planning to devise and develop their own system planning strategy.

The approach for scenario development involves creating scenarios incorporating bookends of the key assumptions so that they can be appropriately assessed and analyzed for impacts to the transmission system and to determine where transmission needs might be. However, such an approach to scenario development must consider that the bookend scenarios must be plausible and not overly aggressive at either end of the assumptions. This for example, may involve making reasonable bookend assumptions around state renewable energy target goals both for resources as well as electrification. Similarly for any other assumptions, plausible bookend futures would be most appropriate. State policies regarding in-state versus out-of-state resource development must also be considered. The ideal outcome of scenario development would be that all stakeholders see themselves somewhere in the scenario space, and scenarios represent plausible futures for all stakeholders. Scenario development must also consider any scenarios developed by planning entities to make sure that the efforts are not duplicated and scenario work at the RAC level is supplementary or complementary to the work being done by entities.

Another approach suggested by one of the stakeholders was to focus on a particular future driver, e.g., a renewable policy goal rather than forecasting assumptions for a particular year in the future. This is a different approach than trying to build datasets for a particular future planning year and may have merits in its own. There must be more discussion to determine what types of scenarios might be most beneficial to develop, regardless of any planning date into the future.

Input Assumptions

Development of scenarios requires development of input assumptions and data to create baseline datasets. As mentioned previously, input assumptions would need to be developed to consider the bookends of the assumptions. At the interconnection level, planning entities are mostly interested in getting data from their neighbors or other entities that might have a significant influence on their systems. That is why it is beneficial to develop datasets in a coordinated manner across the interconnection.

Scenario input assumptions should also reflect different system conditions such as extreme heat, drought, or other influential system events. Development of such datasets is important especially in the backdrop of FERC NOPR RM21-17-000.

The assessments would incorporate evaluating the ability of the transmission system to deliver the required amount of energy at different parts of the system. With increasing levels of variable energy resources, it has become increasingly important to perform assessments for each hour of the year. Not only that, but load variability is also increasing due to microgrids and rooftop solar development. The growing shift toward transportation electrification is also increasing variability in loads.

At a regional or interconnection-wide level, certain input assumptions will need to be represented appropriately depending on each entity or region's plausible future outlook. For example, the penetration levels of behind-the-meter distributed energy resource (DER) may not be the same in all regions. Different states have different policies concerning DER penetration and will need to be considered in the model for each state, depending on the plausible future penetration rates in each area of the system. Similarly, the electrification rates of residential and commercial heating and cooling systems and transportation may be different in different states.

Transportation electrification is a topic that must be better understood. Further knowledge is needed concerning the comprehensive impacts to the grid that will come with the electrification of various sub-sectors within the broader transportation sector and the time frame for electrification in different regions. Beyond simply considering electric vehicles, transportation electrification will also involve airports, seaports, and dry ports. There is a greater need to understand what it means for the electric load experienced by the larger grid as the broader transportation sector shifts toward electrification. In addition to the impacts on the bulk power system, impacts to sub-transmission and distribution systems must also be understood for local utilities. Understanding transportation electrification also involves understanding the complexity of mobile loads (electric trucks and other vehicles), such as transportation that might be shifting locations based on consumer choices and how that affects the load profile. These inputs will affect load profiles and which resources will be needed at every hour to meet the demands. Transportation electrification will affect load profiles especially during the day. Load modeling may involve representing low, medium, and high rates of adoption of electrification at the distribution level. Additionally, with increased amounts of storage resources coming online, the impact of storage charging load during certain times of the day must also be considered in the load profiles. Changing load profiles may also affect transmission use and the diurnal flow patterns of transmission between regions.

Extreme events (heat, cold, and wildfires) are becoming more frequent and their effects on demand and resources are also important when assessing the long-term planning horizon. Incorporation of weather and climate data into load forecasts will also be important. Such assessments could help inform system planners as to whether there is benefit in making investments in transmission that will not only meet the demands of the system more effectively, but provide resilience against extreme events. When studying extreme events, while it is important to keep in mind what role transmission plays in ensuring reliability, another important component to remember is resources. Without adequate resources, focusing only on transmission may not be enough to provide resilience against extreme events. Similarly, some extreme events may affect multiple regions simultaneously, so it is beneficial to create coordinated datasets that represent that possibility.

Extreme events may also affect Facility Ratings and, in some of the recent FERC NOPRs such as RM21-17-000—*Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection*, FERC is proposing to use dynamic line ratings (DLR) in long-term transmission planning. Using DLR for long-term planning may be challenging due to the unpredictability of weather-dependent DLR that is 20 or more years into the future. If entities are relying on DLR to get additional transmission capacity, there is a risk that anticipated capacity may not be available and may result in underbuilding the system. However, there may be instances in which using the more dynamic nature of Facility Ratings might be appropriate. For example, when evaluating extreme cold events, it may be prudent to evaluate higher Facility Ratings under such conditions. On the other hand, when evaluating extreme heat events, using lower Facility Ratings might be more prudent.

Input data requirements will also depend on the types of assessments being performed. For example, data required for a full topology nodal model will be different from the zonal model. Depending on the types of assessments being performed and the associated purpose, required data inputs will need to be developed appropriately.

Resource assumptions are also important. Location, type, amount, and energy profiles of future resources will need to be determined, as these assumptions will have a significant impact on transmission.

Modeling Tools

Typical modeling tools include power flow, stability, production cost models, and capacity expansion models. The more complex the models, the longer it will take to run the analysis. The capabilities of the computational systems and resources should also be taken into consideration when deciding which modeling tools to use.

FERC NOPR

FERC NOPR RM21-17-000 has proposed that specific requirements be met by public utility transmission providers. A final rule is expected to come into effect soon, however, as long-term planning processes are developed, they will need to consider the requirements of the FERC NOPR. The appropriate datasets developed will need to account for the needs of individual planning entities. There is heavy focus on scenario development in the FERC NOPR, so development of appropriate scenarios will be a useful exercise so each planning entity can pick the scenarios that best suit its needs based on regulatory requirements and the size of its system. Different parts of the system may have different requirements, but a baseline set of plausible scenarios developed from an interconnection-wide perspective are needed. Such scenarios will serve as a set of reasonable assumptions for the rest of the system outside of any planning entity's own area. Harmonization of assumptions is also a key benefit. The final FERC ruling may look different from what is in the NOPR; however, the challenges with long-term transmission planning are real and are being faced by all planning entities. The question for RAC to consider is: "What are the reasonable set of activities that the RAC should undertake so that, regardless of which direction the FERC ruling eventually goes, the outcome of this effort will still be beneficial for a broader set of stakeholders?"

Next Steps

The RAC must decide how to proceed on the topics discussed above—modeling approach, datasets, tools, scenario development, etc. Development of key datasets will be crucial to moving forward and providing value. Challenges with long-term planning are complex, but the complexity of the problem should not keep entities from creating the required datasets.