Enhanced 15-Year Long-Term Planning (Master Plan) Discussion Paper

PJM Interconnection
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I. Purpose

PJM has developed this discussion paper to outline the details of how best to work with states and other stakeholders to identify, from among an array of future scenarios, those which transmission planners could utilize to justify moving forward with directives to build new transmission.

The goal of the exercise is to develop a robust and transparent transmission planning process capable of proactively meeting customer needs and policy goals. Many commenters in the FERC Advance Notice of Proposed Rulemaking (ANOPR) docket have urged longer-range scenario-based planning. This paper is designed to take the discussion to the next level by addressing the question of **how** transmission planners, working with states and other stakeholders, can narrow down a vast number of future scenarios to determine those that should be deemed actionable for purposes of integrating new generation.

PJM proposes herein a series of decision-making criteria that could be utilized to "sort" this vast number of future possible scenarios into actionable forecasts of future needs and a reasoned justification for a directive to build new transmission, or upgrade existing transmission, via a new scenario-based transmission planning driver. The criteria would allow transmission planners to:

- Analyze the results and trends from the scenario studies
- Consider potential variations in the generation profile
- Establish a record of customer needs through surveys of actual customers and other means
- Ensure consideration of state policies and support from states for the overall implementation plan to effectuate those strategies
- Consider non-wires solutions, including grid-enhancing technologies that can enhance throughput of the existing grid or further utilize existing rights of way

The decision-making criteria would be applied transparently through the regional transmission planning processes to serve as a basis for directing the construction of new transmission to meet the future needs of load serving entities.

Finally, as PJM explained in its comments to FERC's ANOPR, clear processes need to be established by the Commission to ensure that there is regulatory support for the specific results of the process through periodic "check-ins" to avoid constant re-litigation or later "second guessing" of decisions through contentious after-the-fact prudence reviews.

In this paper, PJM presents its initial thoughts on taking the many commenter's requests in the ANOPR for more robust long-range transmission planning to the next level by "drilling down" to address **how** a long-range planning process would lead to specific actionable steps in the development of an appropriate level of reliable and resilient transmission infrastructure.

II. Background

In the early 2000s, PJM experienced large west-to-east transfers, and was developing transmission expansion plans to mitigate voltage and thermal issues resulting from those transfers, affecting a number of congested lines in the traditional PJM footprint. In addition, PJM's planning process was responding to steady load growth projections of 2–3% and experienced an all-time peak load of approximately 165 GW in 2006.

The 2008 recession and the Marcellus and Utica shale gas boom, which resulted in generation located much closer to the load centers, mitigated many of the reliability issues and the need to build new EHV transmission. Although all transmission strengthens the system to some degree, had PJM built large amounts of unneeded transmission, consumers may have been burdened with billions of dollars of unnecessary expenditures. Moving forward, a robust, scenario-based transmission planning criteria that analyzes an array of future generation expansion scenarios based on a documented record of customer needs and a series of regulatory "check-ins" can prudently establish "guard rails" that help avoid either overbuilding or underbuilding the future transmission system.

III. Guiding Principles

1 | Prudently use the transmission planner's authority to order new transmission by focusing on serving identified customer needs while ensuring both that the reliability and resilience of the grid is maintained, and that there is not an unreasonable shift of costs or risks to end-use customers.

2 | The **creation** of scenarios should consider a number of input variables including a clear and defined record of customer needs through the planning horizon as well as other best information available.

3 | The **choice** among a host of future scenarios should be: (a) based on a clearly defined, robust set of scenario development criteria grounded in a record of customer needs and indicative interests within the planning horizon; (b) capable of adapting to an evolving set of future system conditions; and (c) crafted to foster the appropriate level of transmission expansion.

4 | In order to support transparency and reduce volatility within the planning process, the application of the scenario development criteria would form the basis for triggering the need for new long-lead-time transmission expansions. Specifically, the application of the criteria and choice of scenarios would drive:

a. Long-term conceptual design and Right-Of-Way (ROW) acquisition triggers near the end of the planning horizon

b. Short-, intermediate- and long-term triggers to determine when new needs are actionable

5 | PJM suggests that all transmission planners be required to develop a 15-year forward-looking master plan. The master plan is designed as a strategic planning document and is designed to guide and inform specific tactical studies at the intermediate-term (six to 10 years) and short-term (0 to five years) periods. The master plan should enable identification of potential long-lead transmission needs as they first begin to materialize. Clearly, to the extent that the 15-year-out review identifies issues that require a resolution that would require a very large project that would take years to bring into service, the 15-year master plan could include such plans in the final transmission plan. More likely, even large projects would require a time frame that would be more compatible with the intermediate- and short-term tactical analysis. Accordingly, the master plans developed by transmission planners should provide clear criteria for determining the "triggers" as to when competitive solicitations for projects should commence versus waiting until some of the uncertainties associated with future system topology, congestion and public policy are further clarified, so that the planners could "right size and locate" the needed transmission developments based on more certain nearer-term information. This approach will not only help inform the near-term development needs and align those with potential future expansions, but will also allow for reasonable staging of capital investment in a staged manner that is triggered based on well-defined milestones. This approach will also assist and guide future generation developers on the longer transmission expansion plans and hence strategically align their planned developments with efficient, well designed and ready-to-execute transmission capability additions.

6 | The longer-term planning scenario studies that identify and trend future needs, and the subsequent application of the decision-making criteria through the master plan development process, will in turn inform and support the intermediate-term (six to 10 years) and short-term (one to five years) planning timelines when trends of recurring needs become more actionable.

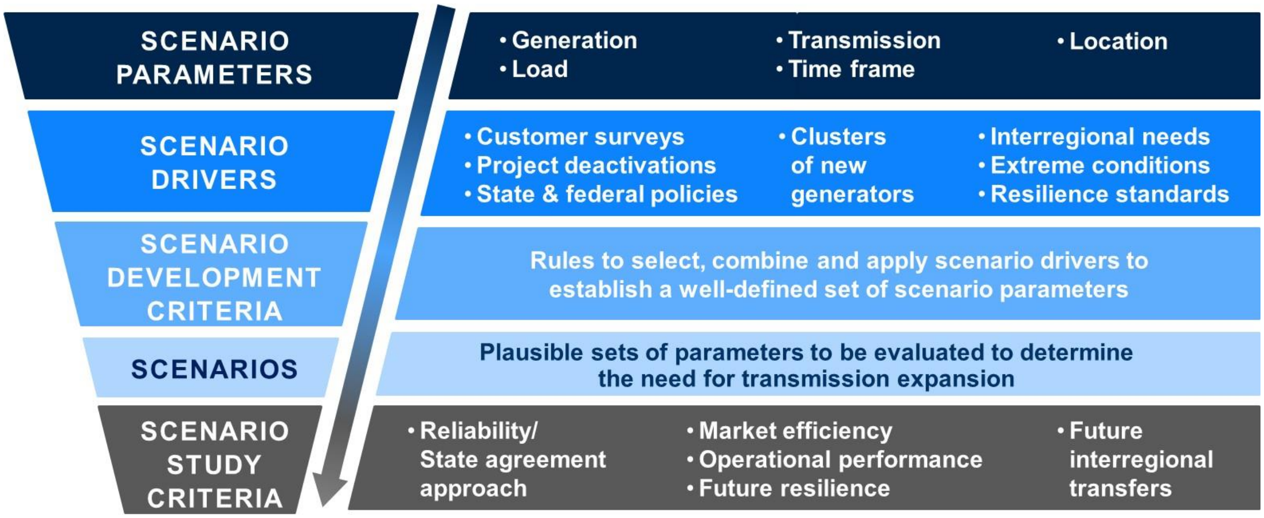
IV. Solution Details

Scenario-based transmission planning will help highlight areas of the system that may experience increased transfers and subsequent transmission criteria violations, providing advanced situational awareness of potential needs for required system reinforcements. The following scenario terminology definitions help provide context as the terminology is repeated throughout this discussion paper.

- **Scenario parameters** are building blocks that are defined in order to construct a scenario.
- **Scenario drivers** are those factors that impact scenario parameters.
- **Scenario development criteria** are the rules by which the scenario drivers are selected.
- **Scenario** is a plausible set of parameters to be evaluated as part of power flow base case.
- **Scenario study criteria** are the methodologies by which the scenario is analyzed including the decision-making process that determines whether potential reliability violations warrant transmission expansion.

At a high level, scenarios are developed by defining input parameters and associated thresholds based on a set of drivers. Predefined study criteria are then applied to a plausible subset of scenarios. The Scenario-Based Transmission Planning graphic summarizes the scenario planning process. Additional details follow in sections A through E.

Figure 1. Scenario-Based Transmission Planning



A. Scenario Parameters

The first step in scenario-based transmission planning is to define the basic set of parameters to consider in each scenario that will constitute a potential need for transmission expansions. The parameters can be distilled into five essential categories:

- Time frame
- Geographic and electrical location
- Generation
- Load and
- Transmission topology

However, there are numerous considerations within each category and numerous factors or drivers that influence how these categories should be configured, and, frequently, there is a many-to-one relationship between the categories and the drivers that influence them.

PJM currently considers years six to 15 in its intermediate-term (six to 10 years) and long-term (10 to 15 years) planning studies and feels that these are appropriate time frames to consider. For the PJM system, these time frames strike a proper balance between the time required to construct long-lead-time transmission expansions and the uncertain nature of input variables that drive such expansions in further-out years. Currently, PJM uses reliability study results from the five-year short-term studies to extrapolate projected load growth through year 15.

B. Scenario Drivers

Below is a suggested list of scenario-based transmission planning drivers that PJM will consider for a long-term 15-year time frame set of scenario studies to expand upon the assumptions currently used in developing the long-range planning solutions.

15-Year Scenario-Based Transmission Planning Drivers

- Electric load trends in the residential, commercial and industrial areas
- State & federal policy; documented input on state plans to meet policy
- Documented record of customer needs developed through surveys and other means; customer survey trends and goals (including identification of existing and potential future PPA sources, DER plans of local governments etc.)
- Future generation interconnections
- Future generation deactivations/retirements
- Interregional transfers and criteria

C. Scenario Development Criteria

Deterministic vs. Probabilistic Analysis and Potential Application of Each

The scenario development criteria will specify the parameters to consider for each scenario driver, determine how the various drivers should be considered in relationship to one another, and determine which of the various scenarios should be selected. The scenario study criteria will provide the methodology by which the scenario is analyzed as well as the decision-making process that determines whether the scenario study results warrant the addition of a new, or the removal of, approved transmission expansion. Criteria for selecting which scenarios will trigger the need for transmission expansions can be either deterministic or probabilistic. In practice, there will need to be some combination of the two given that certain variables and assumptions in scenario development, and triggers for new transmission expansions, may more naturally align with a probabilistic approach and others with a deterministic approach.

For example, PJM annually assigns generation in the PJM interconnection queue a probability that the proposed generation will achieve commercial operation. Such statistics could be used to develop metrics that quantify the probability of a transmission need. A similar statistic could be developed for future generator deactivations based on the history of the unit's participation in the various PJM markets, information as to whether the unit's costs are covered under long-range contracts or state legislative programs, and the "net revenue" analysis undertaken by the IMM. However, other variables in the planning process, such as state and federal policies, appropriate levels of interregional transfers, and certain extreme events, may lend themselves more to a deterministic treatment.

PJM envisions that a hybrid criteria and set of thresholds for triggering transmission expansions based on both probabilistic and deterministic considerations will be necessary to properly account for the myriad different variables that need to be considered in a robust, long-term transmission expansion planning process. This criteria and associated thresholds will need to be well defined and vetted with stakeholders. Ultimately, the decision-making criteria will be designed to support a transparent, repeatable transmission planning process that values the above information as well as stakeholder and policymaker input.

D. Examples of Scenario Study Criteria

Below are the general types of scenario study criteria that PJM currently has utilized in the planning process.

- NERC and PJM reliability criteria (including State Agreement Approach)
- Market efficiency (persistent congestion)
- Operational performance
- Future resilience: FERC-defined resilience criteria – CIP 14 facilities elimination and extreme weather analysis
  - CIP 14 facility elimination
  - Storm hardening based on extreme weather events
  - Storm hardening to protect against "extreme weather" events
  - Identification of infrastructure most vulnerable to flooding or other weather-related events
  - Identification of infrastructure that could be most impacted by a cybersecurity event
- Future interregional transfer capability
- Identification of locations on the grid where a more robust solution could address a cluster of interconnection requests
- Development of holistic solutions to tangible recurring issues, such as the conversion of multiple 138 kV aging facilities to 230 kV facilities as a means to address similar violations within a common electrical area multiple years in a row
- National interest transmission corridors developed by DOE

E. Scenario Example

PJM sets forth below an example of how drivers, scenario development criteria and scenario study criteria would work together to address a specific resilience issue using the "inverted pyramid" structure set forth above.

- ***Step One – Identification of a Specific Scenario Driver***: In this example, PJM, working with stakeholders, would have developed a specific resilience driver focused on substation resilience. For example, the driver could be focused on ensuring no adverse reliability impact from the loss of an entire substation.

- ***Step Two – Application of Scenario Development Criteria***: In this step, PJM would test the above primary scenario driver as well as other identified scenario drivers utilizing standard and extreme forecast conditions for the planning horizon.

- ***Step Three – Utilization of Scenario Study Criteria***:

  At this stage, PJM would analyze the impact to reliability on the scenario developed by applying the scenario development criteria in order to determine whether some ameliorative action was warranted. To undertake this step, PJM would:

  - Identify potential reliability violations resulting from the loss of an entire substation using a probabilistic cascading trees analysis
  - Identify reliability violations that are identified with a frequency of greater than X% that require mitigation measures

- ***Step Four – Identify if Scenario Results Are Actionable and Determine Required Time Frame***:

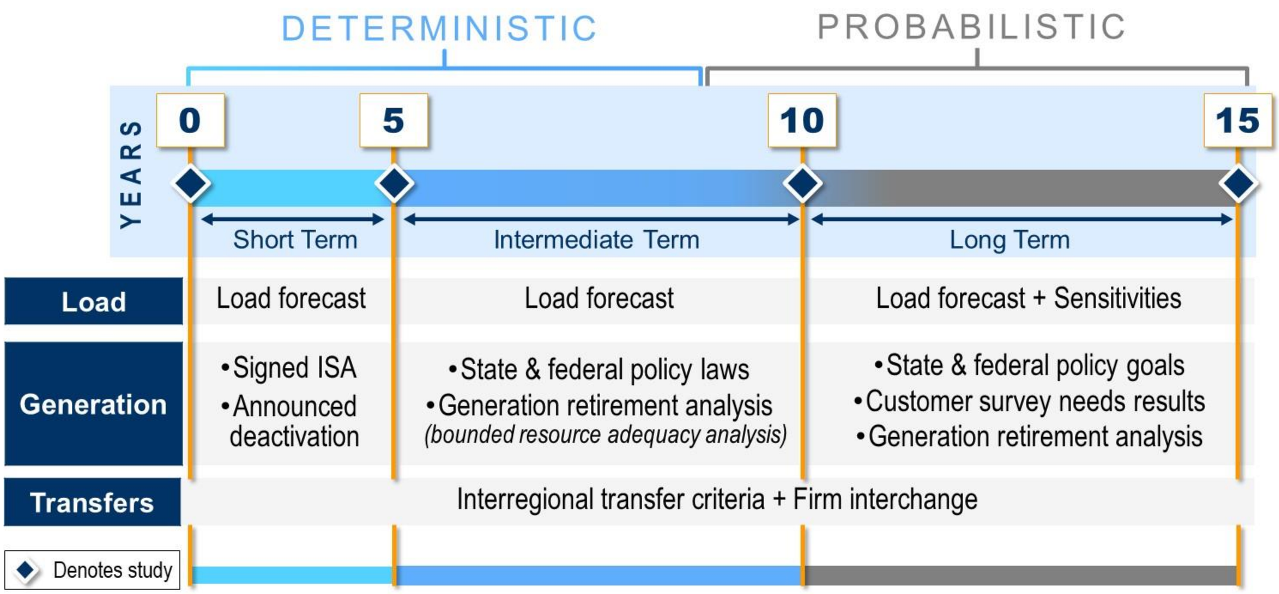
  - Depending on the nature and severity of the violations resulting from the above analysis, PJM would consider whether and when the issue would need to be addressed consistent with established criteria by examining:
    - The severity and risk indicated from the above analysis to include voltage level, magnitude of violation and frequency of violation
    - Whether the severity and risk exists only in the long term but also in the short term
    - The probabilities of intervening changes in system topography or market solutions that would ameliorate or eliminate the risk
    - An analysis of potential solutions and expected time frames for planning, siting and construction of such solutions

In summary, PJM would determine whether the long-term plan analysis results would remain on a "watch list" for future review, designed to be actionable on a defined trigger, or would be immediately actionable. A predefined methodology/metric or trigger would need to be developed in order to determine when identified needs based primarily on probabilistic analysis require immediate action. The transmission development plan may also utilize risk mitigation measures that allow larger transmission development need drivers to be well established before initiating major development activities.

V. Transition to the Intermediate- and Short-Term Planning Time Frames

The 15-year long-term analysis results will inform stakeholder discussions, future development interests, and set in motion the review of potential solutions as input assumptions become more certain as part of the intermediate- and short-term planning analysis. For example, the identification of similar violations within a common electrical area multiple years in a row would allow transmission planners to identify more holistic solutions, such as the conversion of multiple 138 kV aging facilities to 230 kV facilities as violations are identified in the intermediate-term analysis.

Figure 2. Planning Time Frame Details



The intermediate-term analysis should be more deterministic in nature and more informed by established state and federal laws that are actionable, not generic policies or goals. Scenarios would reflect a level of projected future renewables that is bounded by resource adequacy requirements (i.e., load plus required reserve requirements). The generator retirement analysis would reflect state and federal laws that are actionable, not generic policies or goals, and include a well-defined generation retirement economic analysis. To the extent possible, replacement generation would be selected from the PJM interconnection queue. Generally, the intermediate-term study includes the following input drivers:

1 | PJM load forecast, which includes residential, commercial and industrial load projections

2 | State and federal policy laws

3 | Customer survey trends and goals [including identification of existing and potential future Purchase Power Agreement (PPA) sources, distributed energy resources (DER) plans of local governments, etc.]

4 | Generation interconnections including DER

5 | Results of generation retirement analysis (driven by state laws and economic analysis)

6 | Interregional criteria

Once the scenario is developed, PJM can apply its scenario study criteria (suite of existing planning tests to perform the planning assessment).

The short-term planning time frame (0 to five years) analysis would remain unchanged.

As described in detail above, PJM presents this discussion paper in order to further flush out the "how to proceed" issues that have been prompted by the various comments submitted in the ANOPR and to prompt discussion among states and stakeholders on this next level of decision-making. PJM looks forward to dialogue, thoughts and reactions from all affected stakeholders to the concepts raised in this discussion paper.