Long-Term Regional Transmission Planning (LTRTP) Update

PJM Staff

Long-Term Regional Transmission Planning Workshop

Sep 21, 2023

Agenda

- Review LTRTP workshop feedback
- Review LTRTP Framework and Feedback Consideration
- Stakeholder Feedback on workshop 3 content
- Manual update
- Next Steps

LTRTP Workshop Feedback

LTRTP Feedback

- We have had 2 LTRTP workshops in 2023 (July and Aug), with previous discussions also occurring throughout 2022
- We have received excellent feedback
- We have bucketed them into four areas

LTRTP Feedback - Scenarios

- PJM to articulate the difference between scenarios and sensitivities
- PJM to introduce scenario(s) to analyze low load growth and off-shore wind development
- PJM to consider developing bookend scenarios for the same planning horizon
- PJM to consider year-10 scenario instead of 8 to be anchor point
- PJM to clarify how transmission costs are considered in scenarios
- PJM to provide education on how scenario assumptions ultimately shape scenarios

LTRTP Feedback - Analysis

- PJM to consider conducting voltage analysis for year 15
- PJM to not consider conducting voltage analysis for year 15
- PJM to incorporate Critical Substation Planning Analysis (CSPA)

LTRTP Feedback - Metrics

- PJM to consider developing metrics to determine Near Term and Long Term needs
- PJM to consider developing a final set of metrics to conduct project selection process
- PJM to calculate benefits only for primary scenario
- PJM to not consider monetizing the enhanced reliability benefit metric
- PJM to consider calculating benefits at a zonal level

LTRTP Feedback – Other

- In addition to posting and developing solutions to address LTRTP reliability needs, PJM to consider posting and developing solutions to address Market Efficiency LTRTP needs

LTRTP Framework and Feedback Consideration

Workshop Focus

(1) Scenario based Reliability Planning

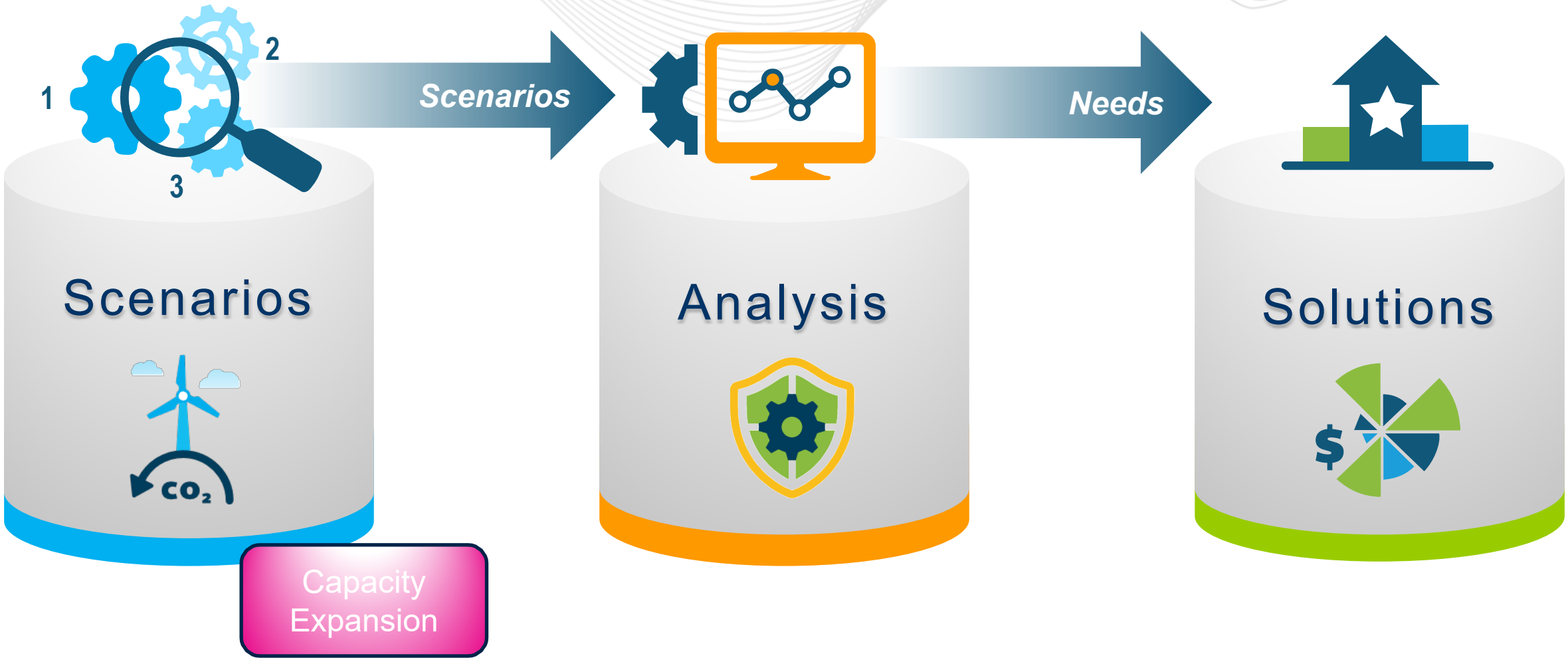
(2) Resource mix assumption updates

(3) Projected loads (electrification / data center)

(4) Capacity expansion process to develop resource mix for scenarios

(5) Broad set of economic benefits

LTRTP Framework



Long-Term Scenario Development (Recap & Feedback)

Scenarios

- *Scenarios must be plausible*
- *Scenarios capture realistic ranges of selected inputs*
- *Scenario assumptions and methods are transparent*

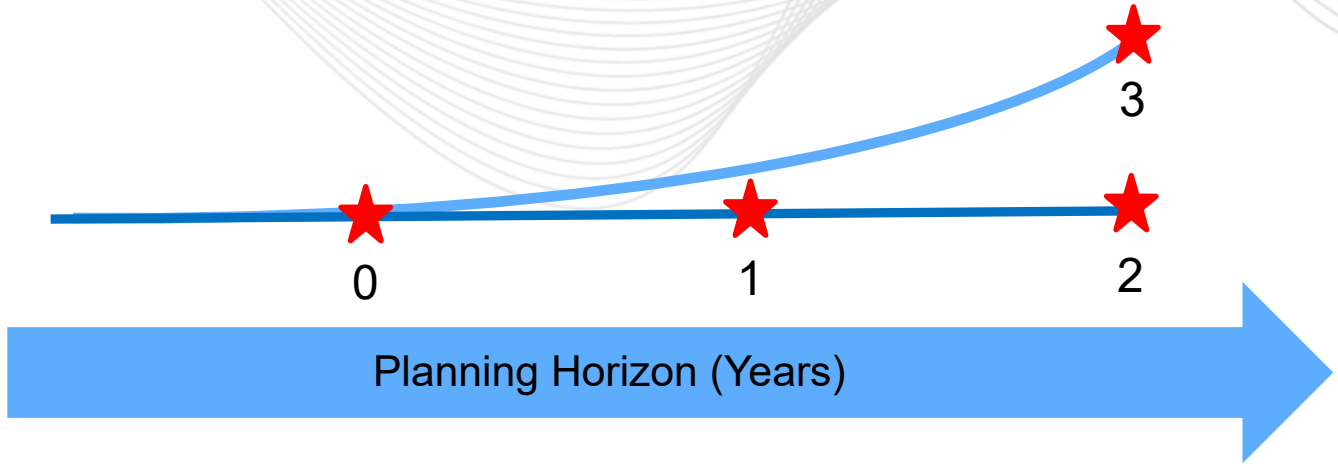
Scenarios and Sensitivities, Definitions **(Feedback)**

- **Scenario**: a system state consistent with a complete set of assumptions
- **Sensitivity**: a variation of a scenario where a single input is modified to understand the input's specific role

Illustrative Example of Scenarios and Sensitivities

	Electrification	Policies	Technol Progress	Natural Gas Price
Primary Scenario	Mid	Mandates	Mid	Mid
- Gas Price Sensitivity	Mid	Mandates	Mid	High
High Scenario	High	Goals	High	High

Previously Proposed Scenarios



0: *Near-Term* (5 Year RTEP)

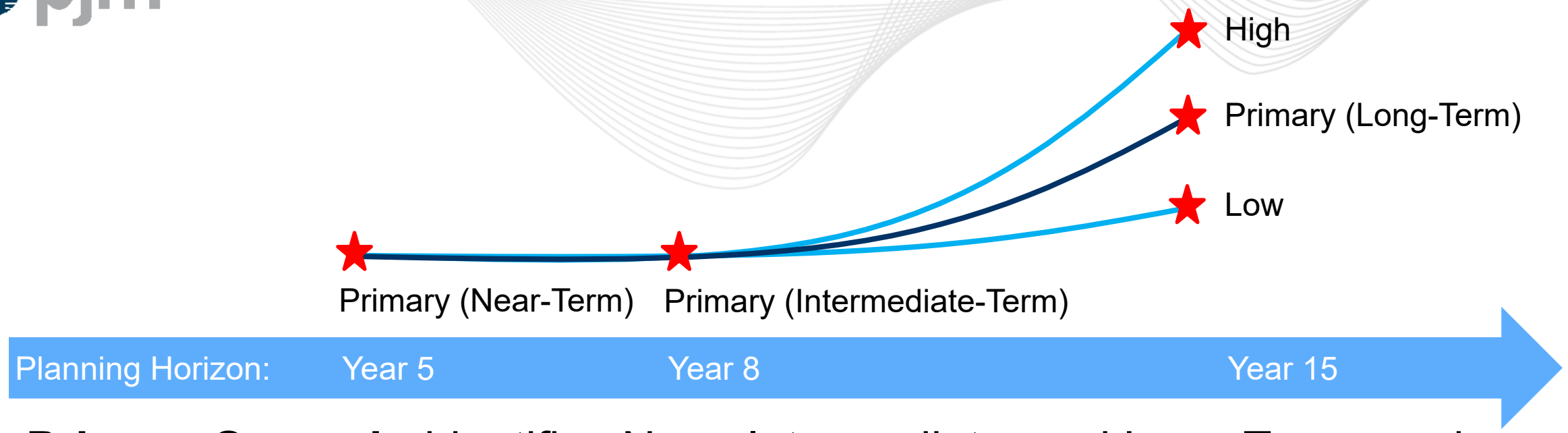
1: *Intermediate-Term* (8 Year)

2: *Long-Term, Primary* (15 Year; identify Long-Term needs)

3: *Long-Term, Accelerated* (20 Year)

Plus sensitivities for critical inputs

New Scenario Proposal **(Feedback)**



Primary Scenario identifies Near, Intermediate, and Long-Term needs

- *Three cases*: years 5, 8, and 15; 5-year case is NT-RTEP
- 8-year case informs 5-year solutions and helps identify timing of long-term needs

Low and High Scenarios inform long term-needs and solutions

- Low scenario is between Primary scenario's intermediate and long-term cases
- Goal is to provide realistic bookends based on feedback

Remarks

- Low and High scenarios must be realistic bookends
- Number of scenarios and sensitivities as needed (including based on stakeholders' feedback) accounting for analytical complexity
- Number of scenarios and sensitivities should be limited
  - FERC indicated 3 + 1 extreme event scenario in NOPR
  - Industry, at least 2

8 vs 10-year horizon for intermediate scenario **(Feedback)**

- 8 year horizon
  - More certainty
  - 8-year case may differ significantly from 5-year case
  - Better inform short-term solutions
  - Better pinpoint intermediate needs where most long-lead solutions could land
  - Consistent with current long-term planning process and already vetted through stakeholder process
- May revisit based on FERC directions

Transmission Costs in Scenarios **(Feedback)**

- The capacity expansion model identifies the resource mix that minimizes system costs over time subject to constraints (Load Balance, Resource Adequacy, Policies, etc.)
  - PJM exploring ways to introduce transmission considerations directly into capacity expansion in the future
- System cost minimization is related to load payment minimization
- In siting resources, we prioritize locations with the most interconnection headroom, hence minimizing the need for additional transmission (conservative approach)

Education Request – Illustrative example to demonstrate the use of assumptions in Scenarios and Sensitivities

Scenario Building, Main Inputs

1. **Load and Electrification** (Data centers, Heating, EVs)

2. **Policies** (Federal and States policies affecting retirements and new builds)

3. **Renewables' capacity factors**

4. **Fuel Prices**

5. **Discount Factor** (for NPV)

6. **Power system's initial state**

7. **Generation and storage candidates** **(**Sites, assets characteristics and costs)

8. **Resource Adequacy** (Reliability Target and ELCC)

Disclaimer

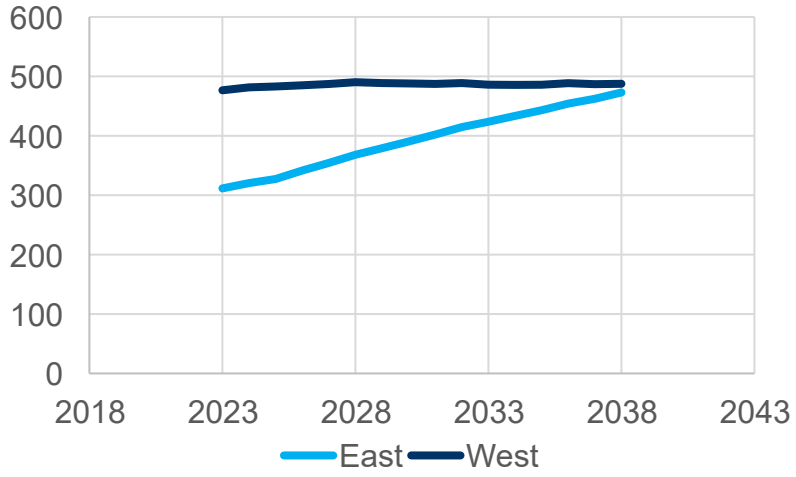
- These slides present examples of a scenario and a sensitivity
- The example is illustrative and uses some actual data sources only to provide stakeholders with a more concrete illustration
- The first year of the LTRTP cycle will be used to discussing assumptions, sources, and methods

Example, Scenario Assumptions

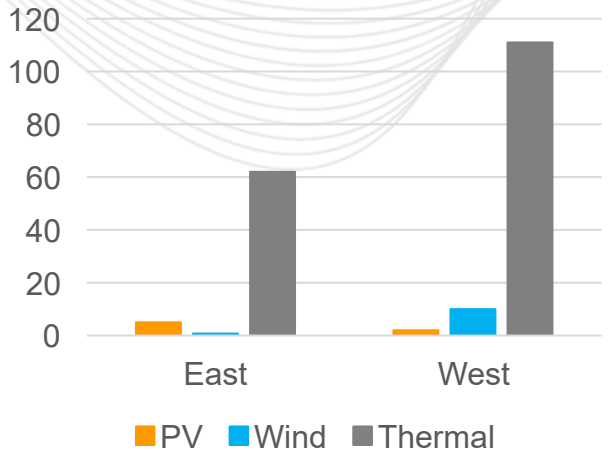
- Two areas, East and West
- Load (2023 PJM's load forecast)
- East and West 10GW transfer capability
- Five technologies: thermal (only existing), solar, onshore, offshore, batteries
- CAPEX (EIA's AEO 2023 + NREL's ATB learning curves)
- Thermal heat rate 10 MMBtu/MWh
- Fuel prices (RTEP 2023 Henry Hub)
- IRA modeled as 30% investment tax credit
- RPS for RTO with East solar carve-out (loosely based on mandates)
- Nameplate targets for batteries and offshore wind in East
- Policy retirements (loosely based on 4R paper)

Example, Scenario Assumptions

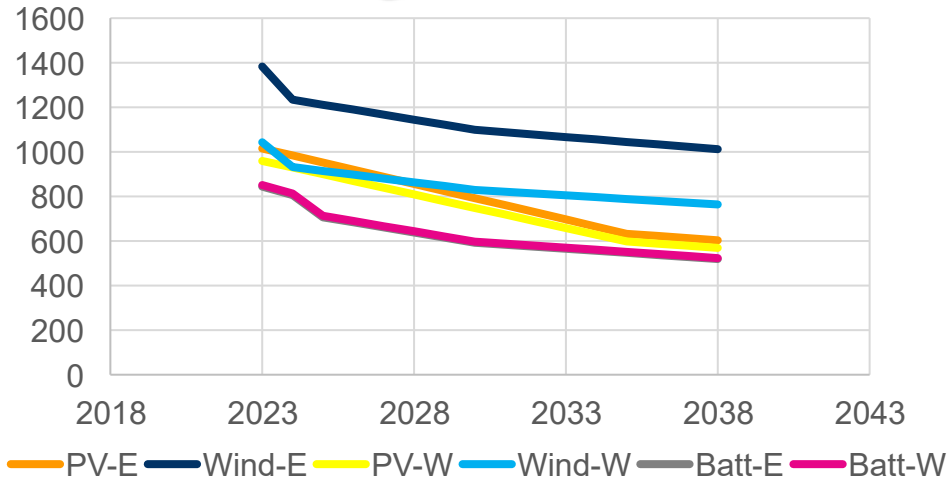
Load (TWh)



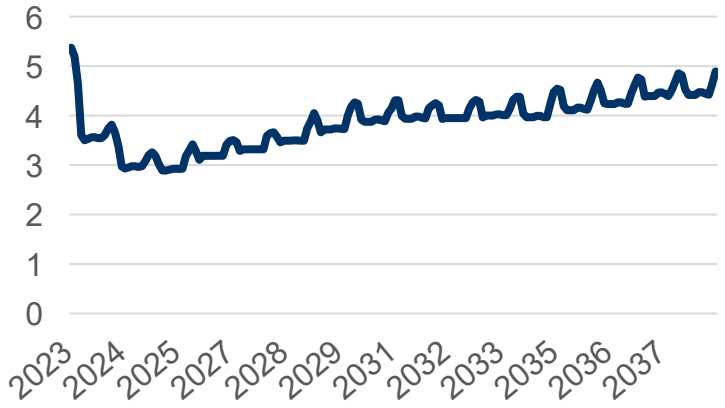
2023 Resource Fleet (GW)



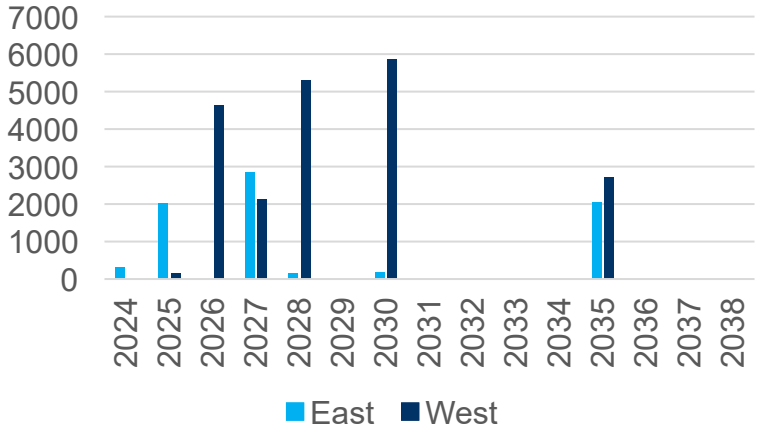
CAPEX ($/kW)



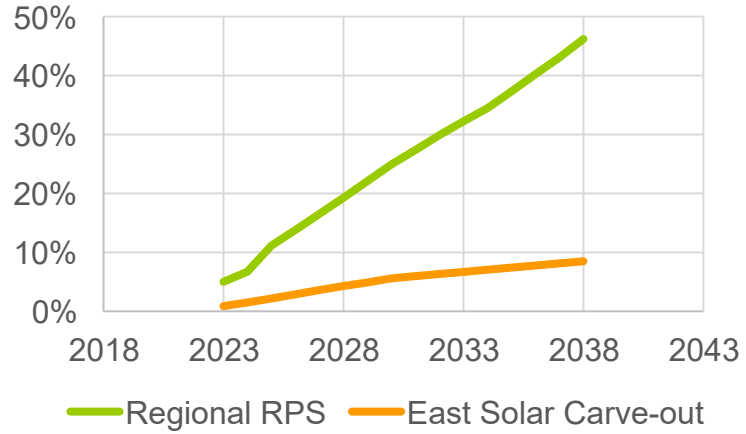
Fuel Price ($/MMBtu)



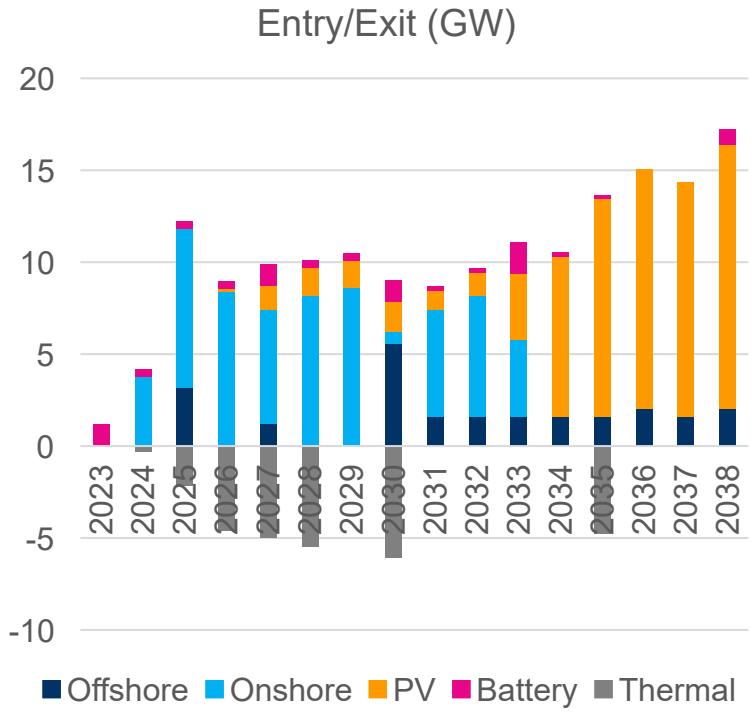
Policy Retiremens (MW)

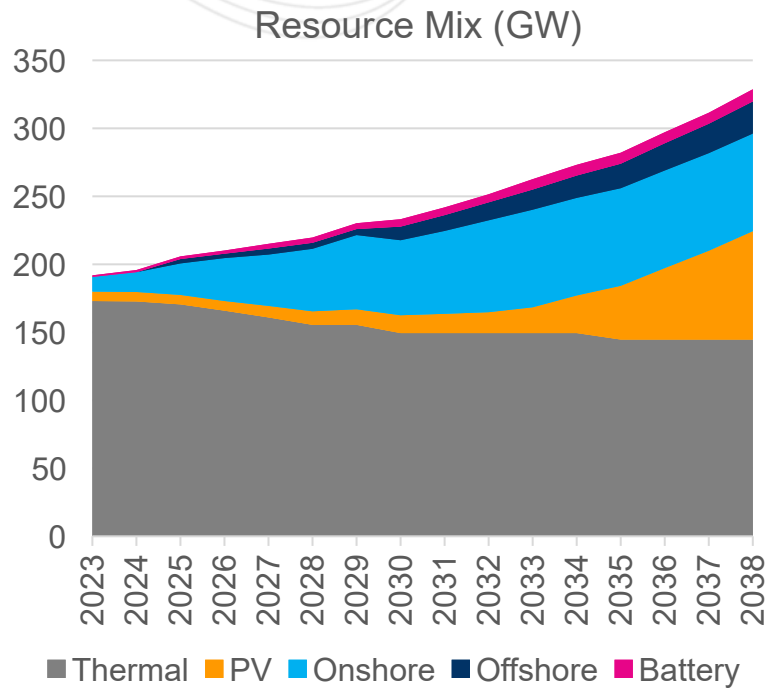


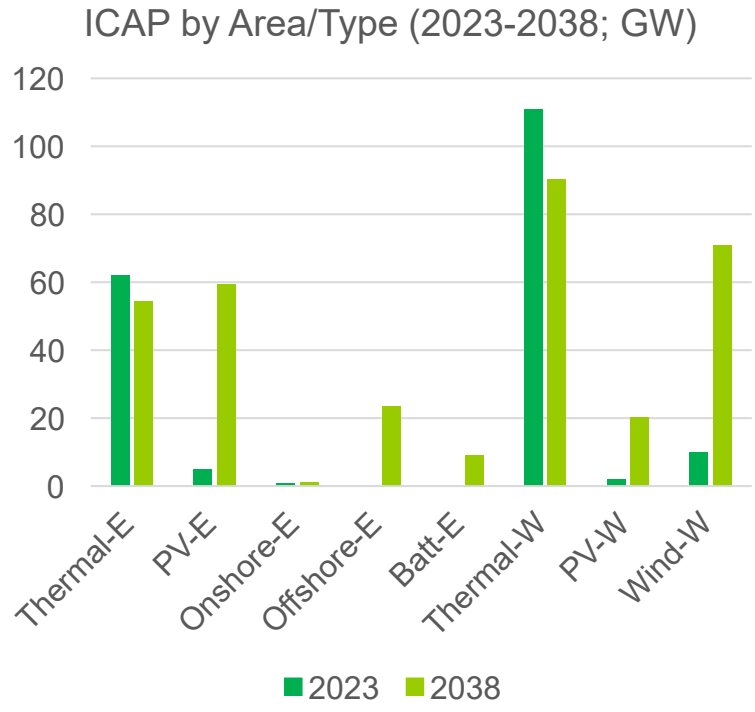
RPS Policies



Scenario Results

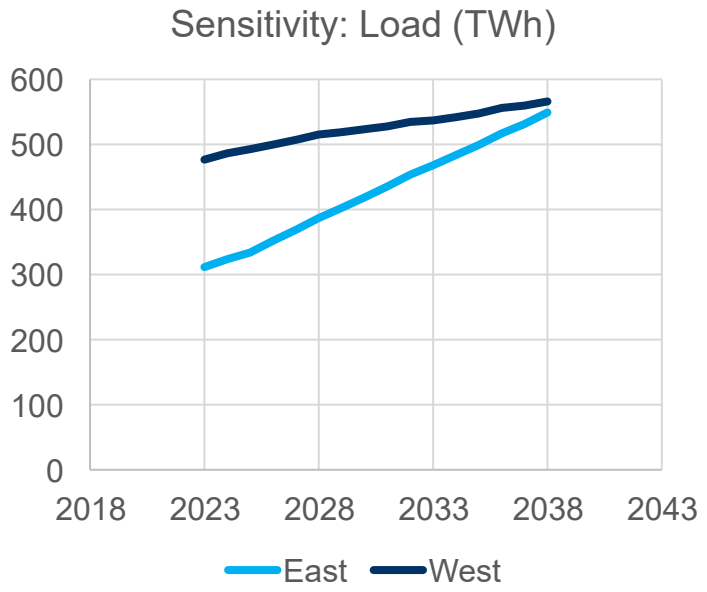


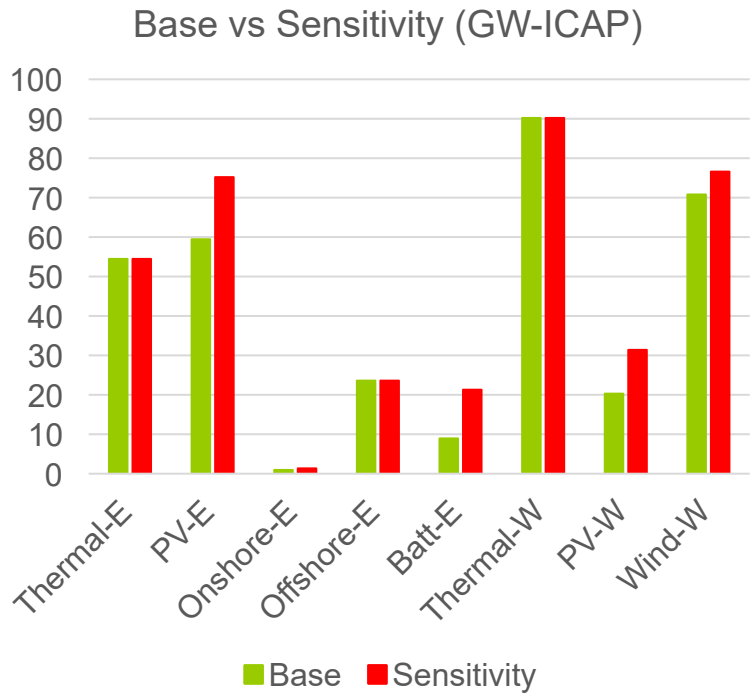




Sensitivity

- Load grows 1 percentage point more in each year





LTRTP Analysis Pillar - Reliability Model Building & Analysis

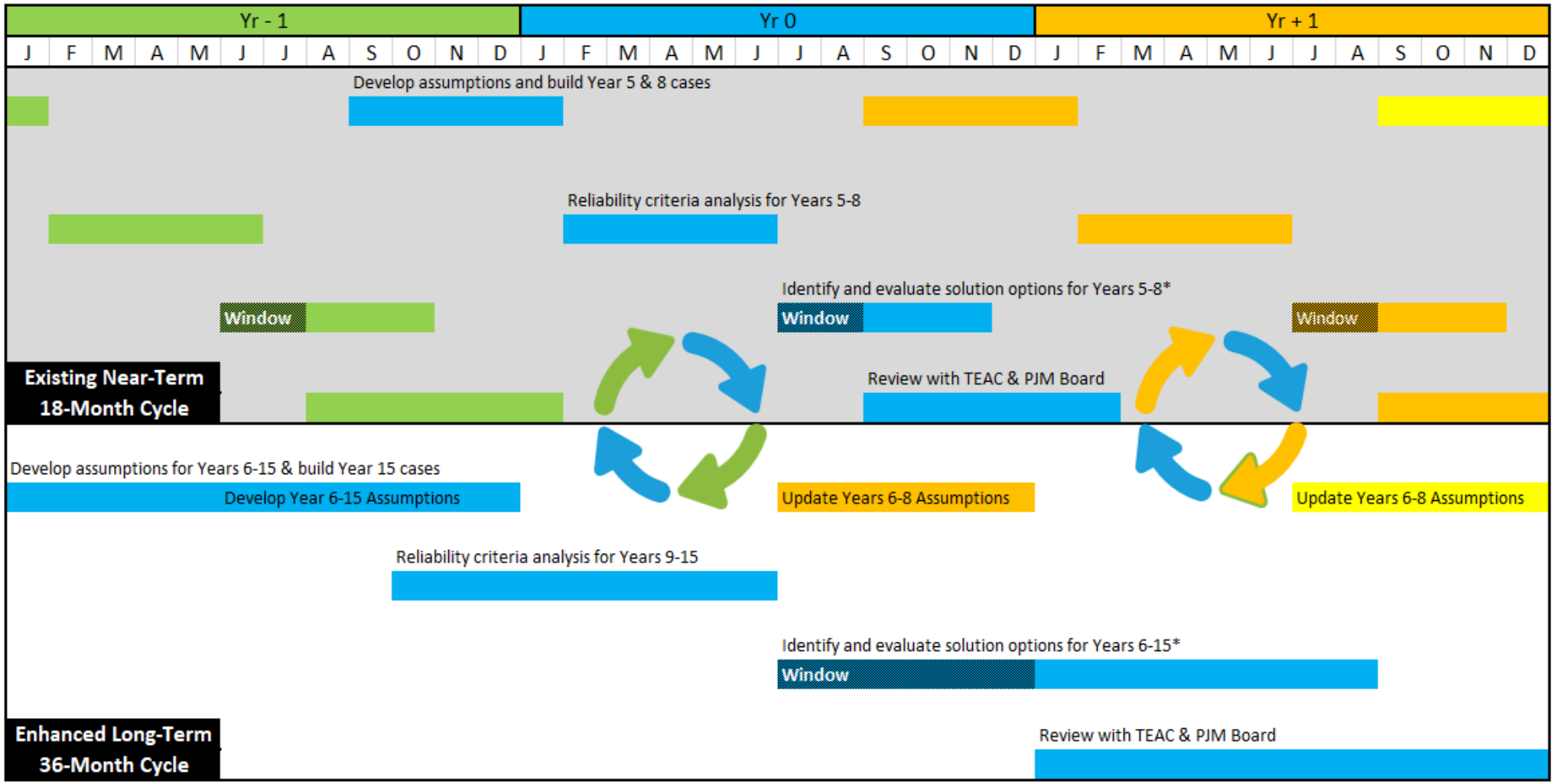
Analysis

••*Reliability analysis is the primary focus*

Long-Term Planning Process **(Feedback)**

- Extend two year cycle to three year cycle to account for additional scenarios, sensitivities and transmission needs
- Supplement 8 year power flows with 15 year power flows
  - 8 year power flow model will be used to perform both thermal and voltage analysis and will replace the 10 year model used for voltage analysis
  - 15 year model will be used to perform thermal analysis and limited voltage analysis
    - Primary/High/Low scenarios
  - Linear interpolation using year 5, 8 and 15 thermal analysis to determine required in-service dates

Recommended Enhancements To Long-Term Planning Process



* Seek transmission solutions for less complex needs in the near-term 18-month cycle window, and address remaining more complex needs in the long-term 36-month cycle window

Reliability Model Building **(Feedback)**

- The LTRTP process will begin every three years in January
- During the first year of the three year cycle a set of assumptions for years 6-15 will be developed and intermediate-term (year 8) and long-term (year 15) power flow models will be built
  - Develop year 8 and 15 cases in parallel with year 5 cases after capacity expansion developed
  - Seek transmission solutions for less complex needs in the near-term18-month cycle window, and seek remaining more complex needs in the long-term 36-month cycle window
    - PJM will determine on a case by case basis which needs will be considered complex and will be based largely on the concentration, magnitude and voltage level of reliability violations in a particular area of the system

Reliability Criteria Analysis For Years 8 & 15 **(Feedback)**

- N-1, generator & load deliverability (years 8 & 15)
  - Monitor same facilities considered in year 5 analysis
  - Ignore terminal equipment limitations
  - Contingencies
    - Singles & Towers (Year 8 and 15)
    - Stuck breakers and bus faults (Year 8 only)
  - Voltage analysis focusing primarily on 230 kV+ in Year 8 and 500 kV+ in Year 15 as needed
- N-1-1 (year 8 only)
  - Thermal & voltage analysis focusing primarily on 230 kV+

Required In-Service Date For Years 6-15

- Replace DFAX extrapolation with linear interpolation of thermal results from year 5, 8 and 15 analyses to determine required in-service dates
  - Use year 5 and year 8 thermal loadings from generator deliverability, load deliverability and N-1-1 to determine year 5-8 required in-service dates
  - Use year 8 and year 15 thermal loadings from generator and load deliverability to determine year 8-15 required in-service date

Line A-B loading increase from Years 5 through Year 15 using linear interpolation of Year 5, 8 and 15 loadings

Line	Rating (MVA)	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15
A-B	3500	**98.0%**	98.3%	98.6%	**98.9%**	99.2%	99.5%	99.8%	100.1%	100.4%	100.7%	**101.0%**

LTRTP Needs Identification

- Once the reliability analysis has been completed, the potential long-lead time transmission needs will either be submitted into the near-term RTEP window or into the long-term LTRTP window, depending on the nature of the identified transmission needs

- For years 6-15, PJM will request window participants to address transmission needs that have transmission solutions with a lead time beyond 5 years

Long Term Planning and Market Efficiency

ME

••*Market Efficiency as today*

PJM Planning - Market Efficiency Considerations

- The primary goal of LTRTP is reliability, to ensure a reliable energy transition.
- PJM recognizes the importance of economic efficiencies and accounts for them to a large extent in LTRTP by:
  - Planning for an efficient generation fleet via approximating outcome of an efficient market.
  - Addressing reliability needs to enable the efficient fleet will also create economic efficiencies.
  - Utilizing economic benefits to identify reliability solutions that may be accelerated to maximize social welfare.
  - No Market Efficiency Bright Line test.
- PJM Market Efficiency RTEP Planning Process
  - Existing Order 1000 Competitive Windows Market Efficiency process remains Status Quo
    - It includes Bright Line test (B/C Ratio > 1.25).
    - Addresses congestion drivers as needed for longer term horizon (5-8 years).
  - Annual Acceleration and Reevaluation analyses.
  - Targeted Market Efficiency (TMEP) analysis.

Solution Identification and Approval

Solutions

- *Transmission solutions must address reliability needs*
- *Secondary benefits inform project selection and portfolio savings*

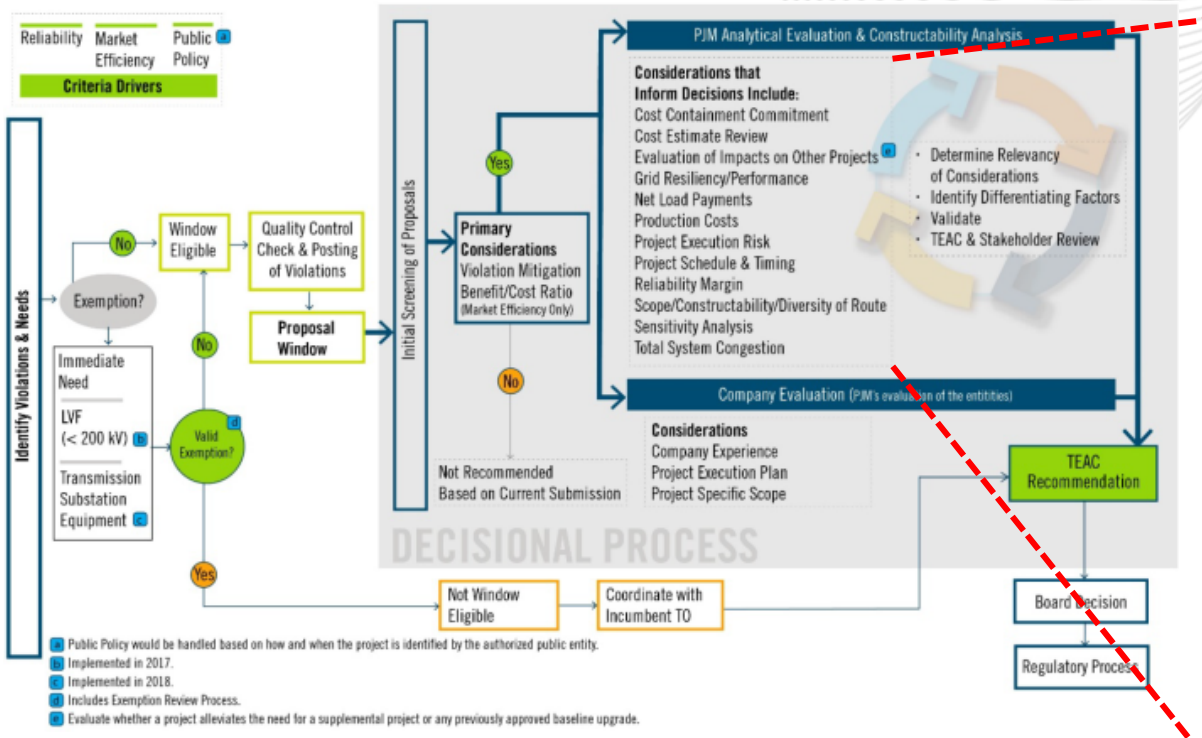
Long-Term Planning Projects

- Long-lead (> 5 years from need identification, typically 230kV and Up)
- Address reliability needs
- Reliability projects can be accelerated if sufficiently large benefits

Project Selection Process **(Feedback)**

1. Projects must address reliability needs
2. Feasibility assessment – cost and constructability analyses
3. Do-no-harm analysis
4. Secondary benefits to select among alternative reliability projects
   - Benefits are comprehensive
   - Robustness to other scenarios and sensitivities is also considered
5. Other M-14 F Considerations

Project Selection Process – M-14F **(Feedback)**



Considerations that Inform Decisions Include:

Cost Containment Commitment
Cost Estimate Review
Evaluation of Impacts on Other Projects (e)
Grid Resiliency/Performance (Includes CSPA)
Net Load Payments
Production Costs
Project Execution Risk
Project Schedule & Timing
Reliability Margin
Scope/Constructability/Diversity of Route
Sensitivity Analysis
Total System Congestion

Benefit Metrics

- Benefit metrics identify long-lead transmission solutions that maintain reliability at the lowest possible *system* cost

	Benefit Metrics	
System Cost	**Energy Market Benefits**	**1.** Production Cost Savings
	Capital Investment Benefits	**2.** Avoided Generation Investments
		3. Avoided Transmission Investments
	Enhanced Reliability Benefits	**4.** Reduced Loss of Load

- Alternative benefit metrics are *comprehensive* load payments + enhanced reliability benefits

$$\Delta \text{ Load Payments} = \Delta \text{ System Costs} + \Delta \text{ Profits}$$

Benefit Metrics – Approach **(Feedback)**

Latest Approved Near-Term RTEP

Latest Approved Long-Term RTEP

Capacity Expansion, Reliability, Production Cost Models

System Cost + Enhanced Reliability

Latest Approved Near-Term RTEP

Latest Approved Long-Term RTEP

Current Cycle Long-Term RTEP

Capacity Expansion, Reliability, Production Cost Models

System Cost + Enhanced Reliability

Δ Benefits

Benefits are calculated for Primary Scenario(s)

PJM Will consider calculating zonal benefits (But may be easier with load payments)

Loss of Load Calculation **(Feedback)**

- PJM thinks an enhanced reliability metric is needed
  - Other benefits assessed under normal operating conditions
  - More robust transmission helps maintain reliability during extreme events
  - Evaluation must be comprehensive to identify solutions with largest social value
- FERC discussed extreme weather scenario in NOPR and could require it
- FERC order 896 - NERC to develop new or modified Reliability Standard concerning extreme weather

- PJM aims to adequately model extreme events
  - PJM will calculate loss of load
  - Monetization may be considered in the future as PJM continues improving extreme weather events' modeling

TEAC Discussions and Board Approval

- Once the window closes:
  - PJM staff reviews project proposals
  - PJM reports progress to TEAC and produces LTRTP reports for selected projects (1st and 2nd reads)
  - LTRTP projects are brought to PJM's Board for approval

Manual Update

PJM Review of Manuals

- PJM has performed an initial review of existing manual language to identify sections that may require update based on the LTRTP framework discussed at these workshops

- M14B – PJM Region Transmission Planning Process
  - Includes specifics on Assumptions, Analysis and Timelines
- M14F – Competitive Planning Process
  - Details specifics around proposal window process

M14B Sections

- 1.3 Planning Assumptions and Model Development
  - Seeking input and establishing assumptions
- 2.1 Transmission Planning
  - LT Scenario Analysis
  - Reliability Planning (2.1.2) – 3 Year process
- 2.2 RTEP Process Drivers
  - Addition of LTRTP
- 2.3.14 Long Term Reliability Review
- 2.3.15 Stakeholder Review of and input to Reliability Planning
- Attachment B – Scope of 15 year plan, Scenario Planning Procedure
- Attachment C – Long Term Deliverability Analysis and Upgrades

M14F Sections

- 1.1 Proposal Window Type and Duration
  - Timing of LT proposal window
  - 3 year process
  - Update Exhibit 1
    - 24-Month Reliability Planning Cycle

- 6.1 Proposal Requirements
  - Add requirements specific to LT projects

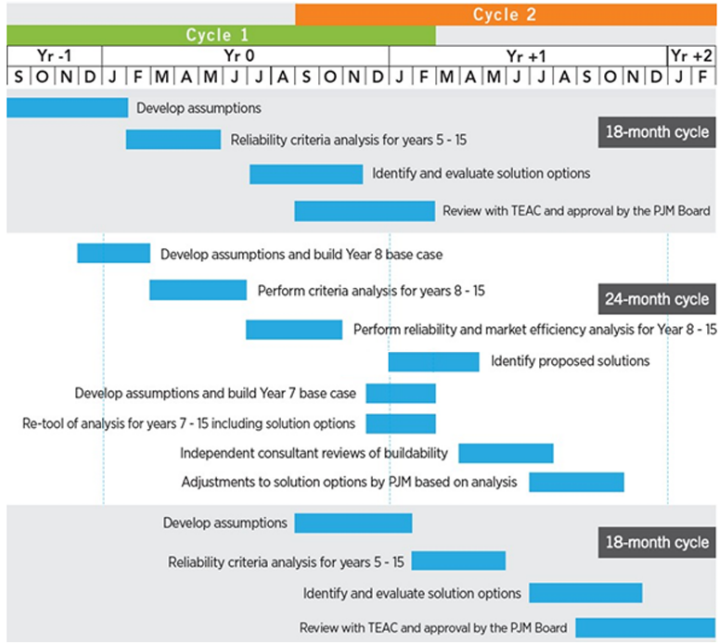


Exhibit 1: 24-Month Reliability Planning Cycle

Stakeholder Feedback on Workshop 3 Content

Next Steps

- Review any additional feedback and framework updates
- Manual Revisions to follow the normal stakeholder process

Contact Information

Facilitator:
Bhavana Keshavamurthy, bhavana.murthy@pjm.com

Secretary:
Julia Spatafore, julia.spatafore@pjm.com

SME/Presenters:

Asanga Perera, Asanga.Perera@pjm.com

Michael Herman, Michael.Herman@pjm.com

Jonathan Kern, Jonathan.Kern@pjm.com

Emmanuele Bobbio, Emmanuele.Bobbio@pjm.com

Long Term Regional Transmission Planning Update

Member Hotline

(610) 666 – 8980

(866) 400 – 8980

custsvc@pjm.com