Long-Term Regional Transmission Planning (LTRTP) Framework Update

PJM Staff

Long-Term Regional Transmission Planning Workshop

Dec 15, 2023

Agenda

- Review LTRTP workshop feedback
- Review LTRTP Framework Revisions
- Manual Update
- Stakeholder Feedback on workshop 5 content
- Next Steps

LTRTP Workshop Feedback

Incorporation of States and Stakeholders' Feedback So Far

Area	Starting Point	Feedback	Considerations
Scenarios	• 3 Scenarios	• Additional scenarios to account for uncertainty • Concerns with the modeling of all Public Policies under reliability	• Up to 5 scenarios plus sensitivities • Public Policy modeling to Distinguish between Reliability and SAA
Analysis	• Thermal Analysis Only • All kV levels	• Consider only Higher kV levels for thermal analysis • Include Voltage analysis	• 15 year thermal analysis for > 200kV • Voltage analysis for 8-year (>200kV) and 15 year (>500kV)
Solution	• Calculate regional-level benefits for Primary Scenario Only	• Calculate zonal benefits • Consider benefits for other scenarios	• Zonal benefits for Base Scenario • Benefits can be calculated for other scenarios as needed

LTRTP Framework

Workshop Focus

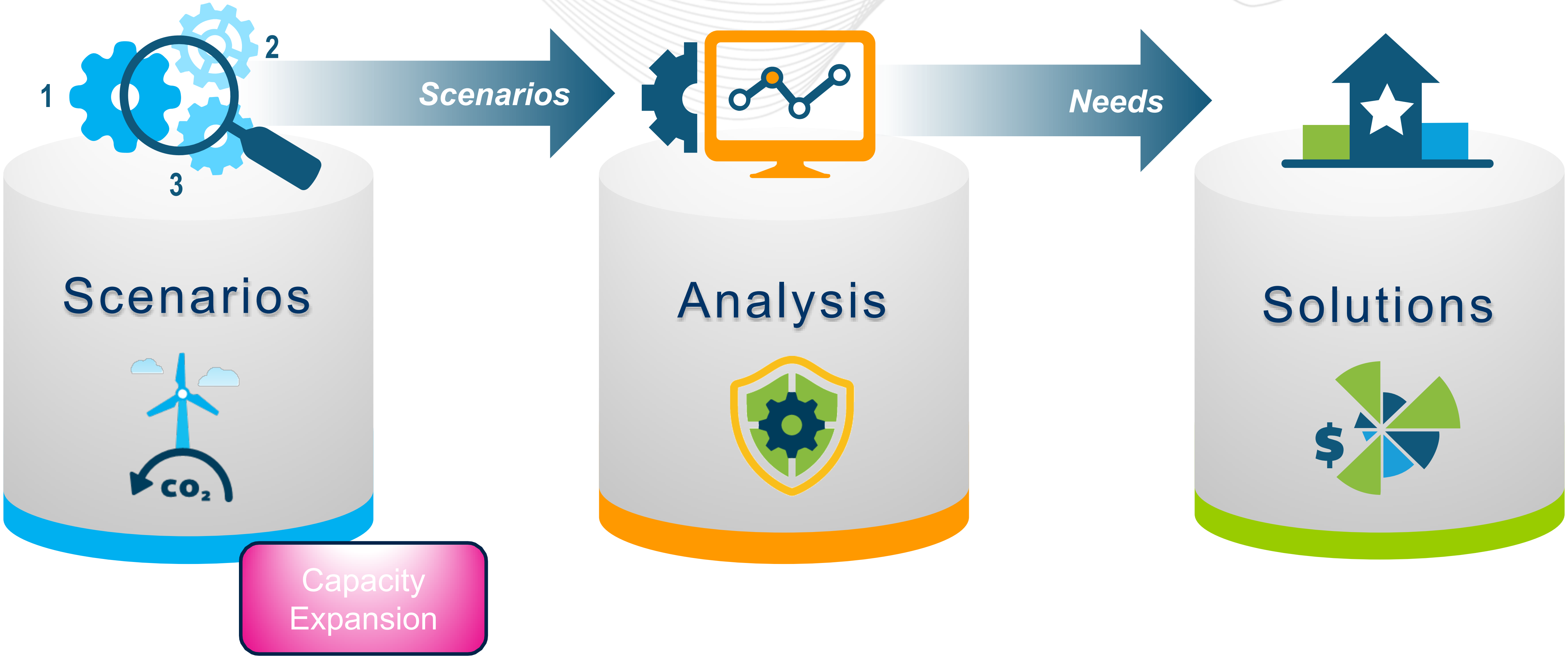
(1) Scenario based Reliability Planning

(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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Scenarios
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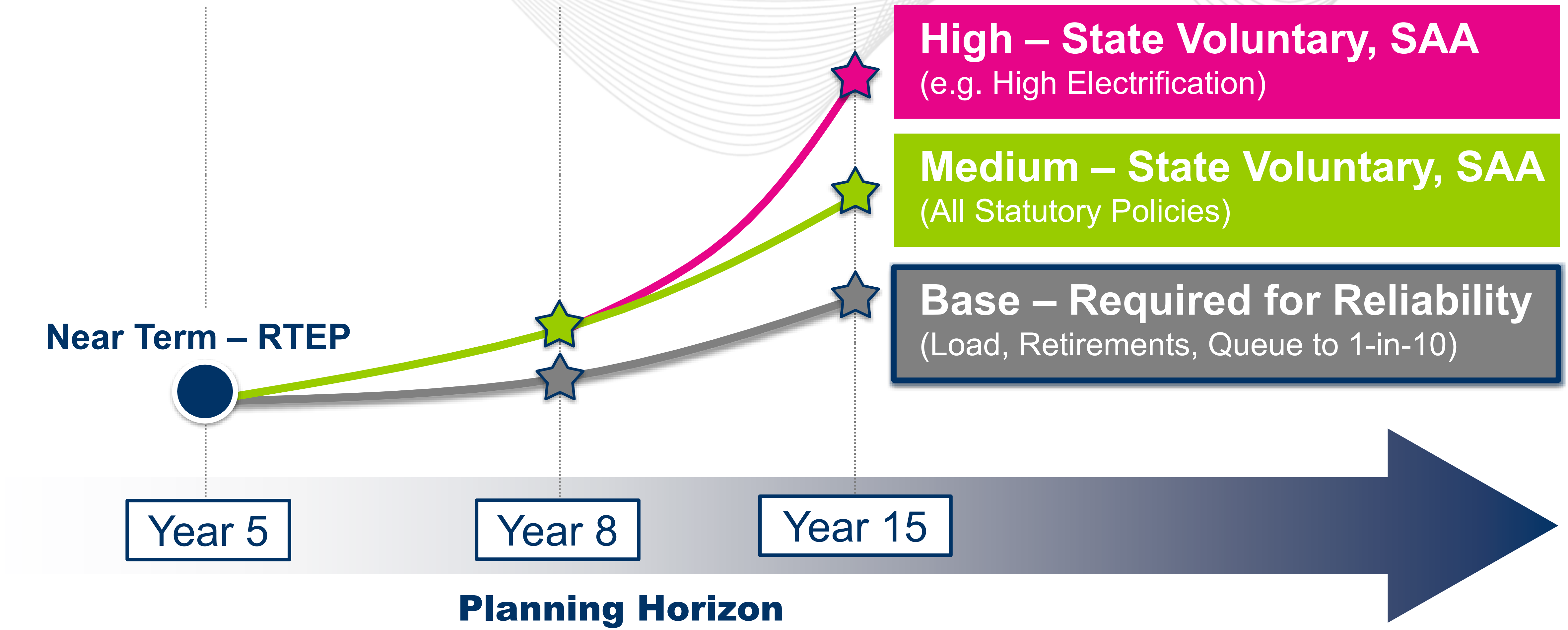
Capacity Expansion

Long-Term Scenario Development

Scenarios

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

LTRTP Scenarios

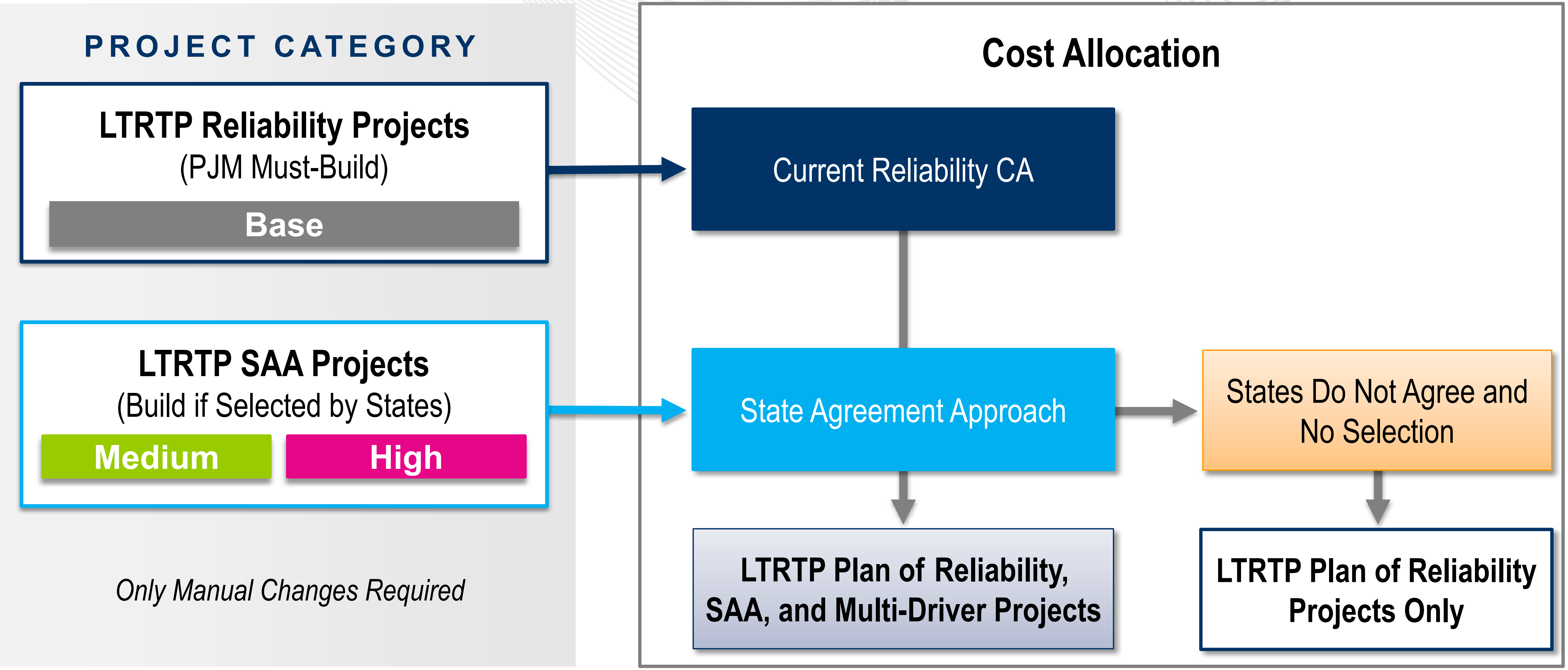


- PJM can consider performing sensitivities, e.g. for lower data center load

Use of Scenarios

- Base Scenario
  - Identifies Intermediate and Long-Term Reliability needs and informs Near-Term solutions
- Medium and High Scenarios
  - Identify needs that states may voluntarily sponsor via SAA
  - Inform PJM reliability actions (including low scenarios or sensitivities)
    - Identify robust solutions (e.g. to more EV growth or fewer data centers)
    - Postpone posting of needs
    - Accelerate needs and solutions if needs appear across multiple scenarios and sensitivities

Approach to LTRTP Scenarios and Cost Allocation



Matrix – Policies by LTRTP Scenario

Legend
- PJM's annual load forecast
- Not Included
- Included

Policies	Base	Medium	High
Load Policies*(e.g. Electrification, BTM)	PJM's annual load forecast	PJM's annual load forecast	High
Federal Policy Retirements (e.g. EPA)	Included	Included	Included
State Policy Retirements (e.g. CO_2, CEJA)	Included	Included	Included
Inflation Reduction Act	Included	Included	Included
Replacements/Generation Policies (e.g. RPS, Offshore wind)	Use queue to meet 1-in-10	Statutory	Statutory/ Objectives

***Notes:** Initial position on assumptions to be included in each scenario that will be further discussed in the assumption meetings; Sensitivities for econ. at-risk units and state policy retirements; * Includes Data Centers;*

Replacement Generation Illustration

Background

- Existing generation is mainly thermal
- 98% of pre-ISA MW is renewables or storage

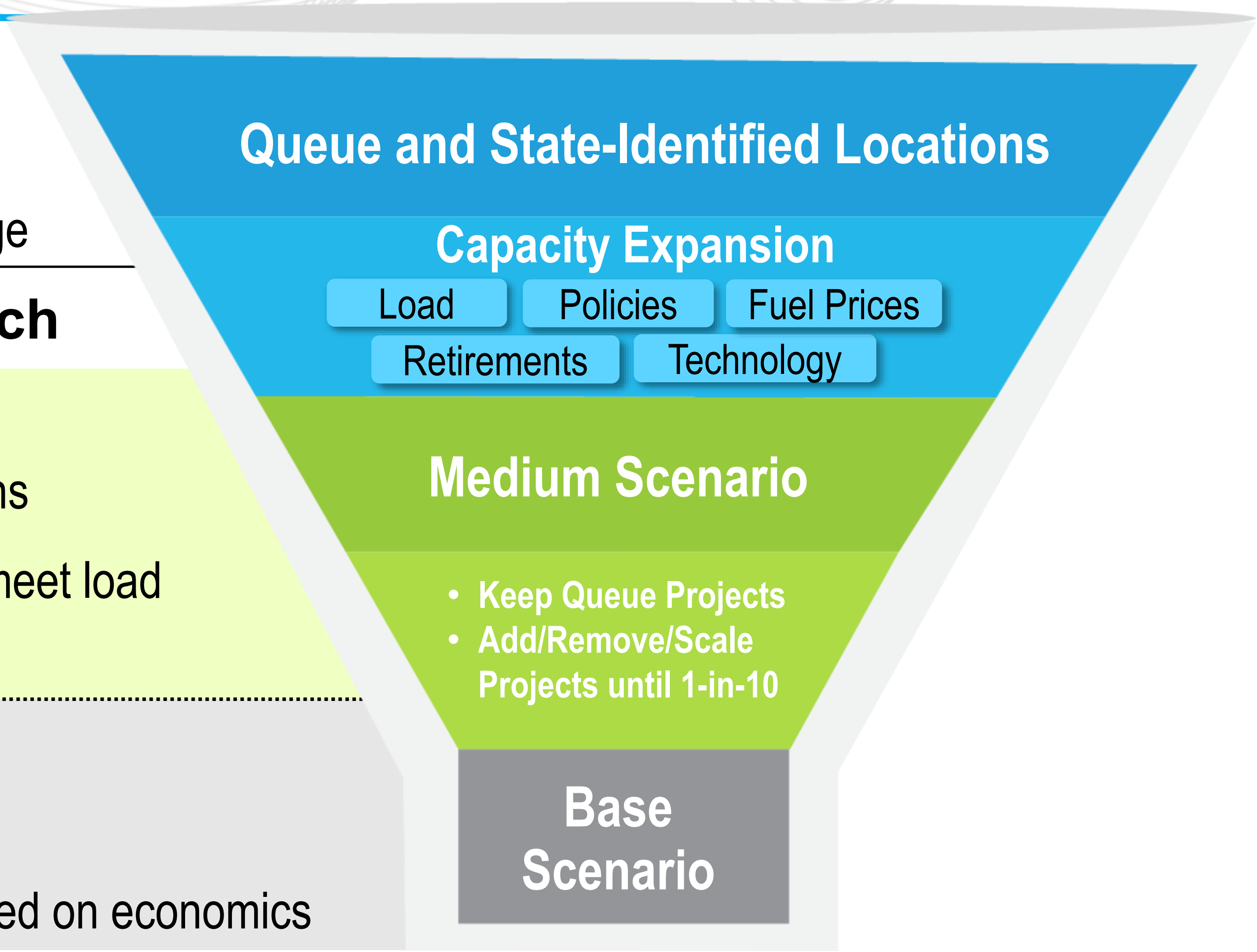
Generation Replacement Approach

Medium Scenario Replacements

- Use queue data and state-identified locations
- Select projects with capacity expansion to meet load given retirements and policies

Base Scenario

- Keep only queue projects
- Add/remove/scale projects until 1-in-10 based on economics



LTRTP Analysis Pillar - Reliability Model Building & Analysis

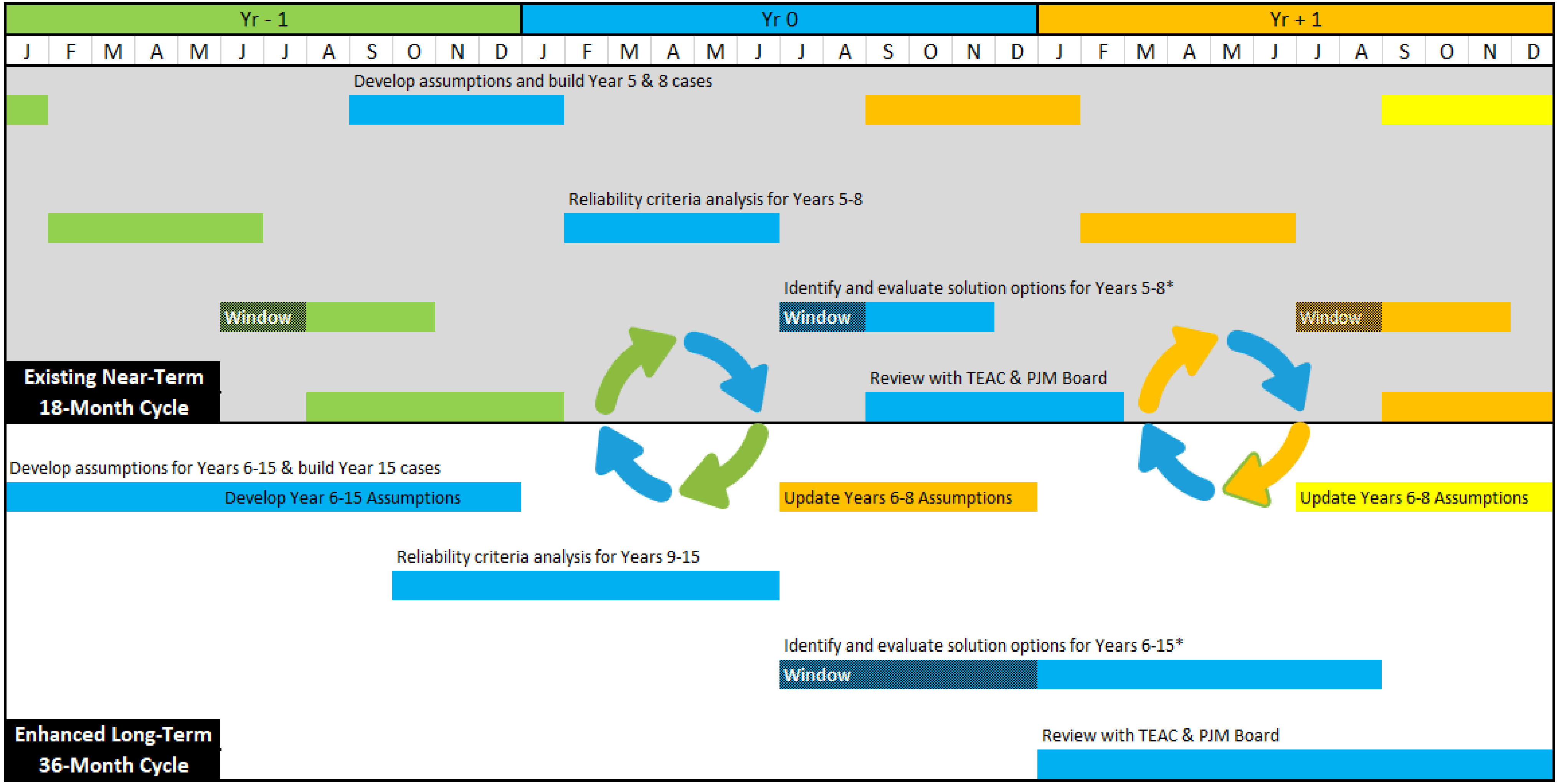
Analysis

- *Reliability analysis is the primary focus*

Long-Term Planning Process

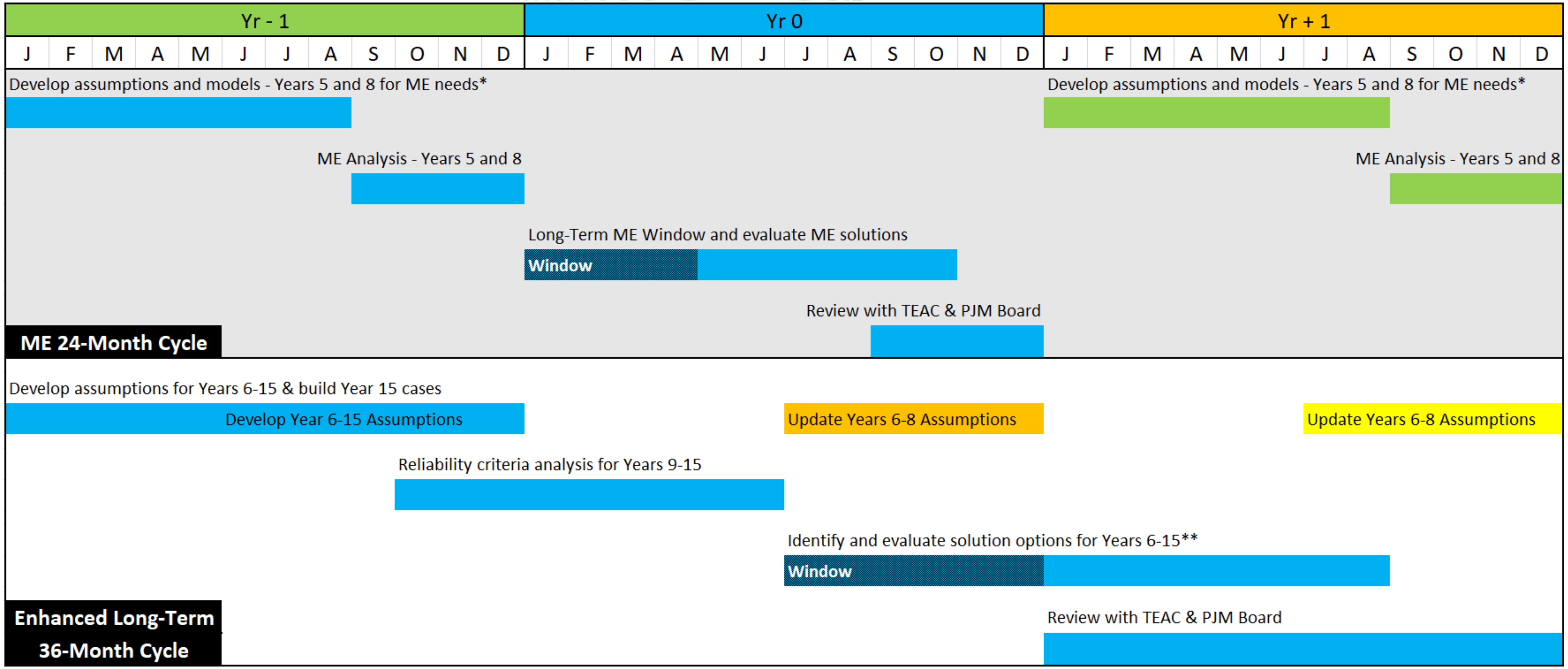
- Extend two year cycle to three year cycle to account for additional scenarios, sensitivities and transmission needs
- Supplement 8 year power flows with 15 year power flows
  - 8 year power flow model will be used to perform both thermal and voltage analysis and will replace the 10 year model used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

Recommended Enhancements To Long-Term Planning Process – NT RTEP vs LTRTP Cycles



* 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

Recommended Enhancements To Long-Term Planning Process – ME vs LTRTP Cycles



* Years 5 and 8 models are developed to determine ME needs, additional years are developed for solution evaluation.

** 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

- 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 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

- N-1, generator & load deliverability (years 8 & 15)
  - Thermal analysis monitored facility (ignore terminal limits) and contingency kV levels
    - Year 8: Same as year 5
    - Year 15: 230 kV+
  - Voltage analysis monitored facility and contingency kV levels
    - Year 8: 230 kV+
    - Year 15: 500 kV+
  - Contingency Types
    - Singles & Towers (Year 8 and 15)
    - Stuck breakers and bus faults (Year 8 only)
- N-1-1 (year 8 only)
  - Thermal & voltage analysis focusing on 230 kV+ monitored facilities and contingencies

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 on each scenario, PJM will categorize the potential long-lead time transmission needs into reliability and SAA needs, and either post 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

Solution Identification and Approval

Solutions

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

Long-Term Planning Projects

- Long-lead (> 5 years from need identification, typically 230kV and Up)

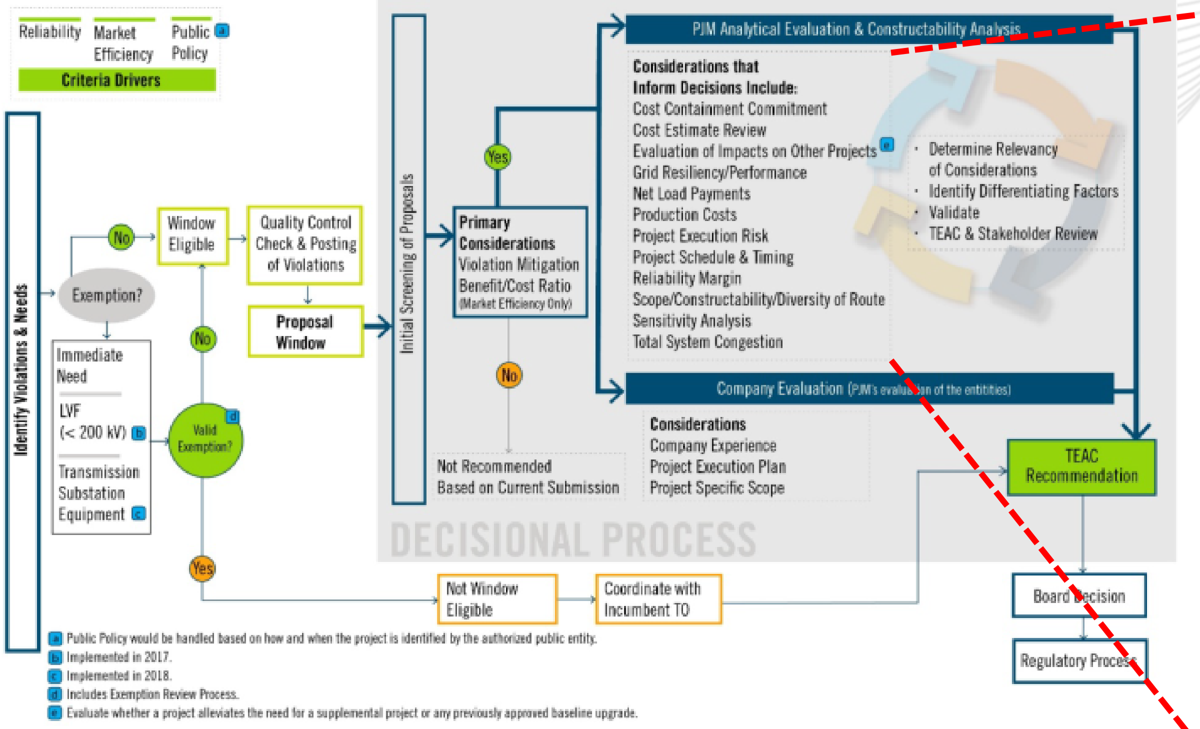
- Address reliability needs or SAA needs
  – Projects addressing SAA needs are provided to sponsoring states for consideration

- Reliability projects can be accelerated if sufficiently large benefits

Project Selection Process

1. Projects must address reliability or SAA needs
2. Feasibility assessment – cost and constructability analyses
3. Do-no-harm analysis
4. Secondary benefits to select among alternative projects
   – Consider robustness across scenarios/sensitivities (expandability)
5. Other M-14 F Considerations
6. Support states in the identification of solutions for SAA needs

Project Selection Process – M-14F



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 identify long-lead transmission solutions that maintain reliability or address SAA needs at the lowest possible *system* cost

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

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

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

* These benefit categories are to be intended broadly. For example, PJM will start with Adjusted Production Cost (APC) savings used in Market Efficiency, but could include other metrics in the production cost savings category, as needed, such as reduced RMR, congestion from transmission outages, etc.

Benefit Metrics – Approach

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 Reliability and SAA Solutions

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

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
    - State-sponsored projects subject to acceptance by sponsoring state(s), *per* SAA

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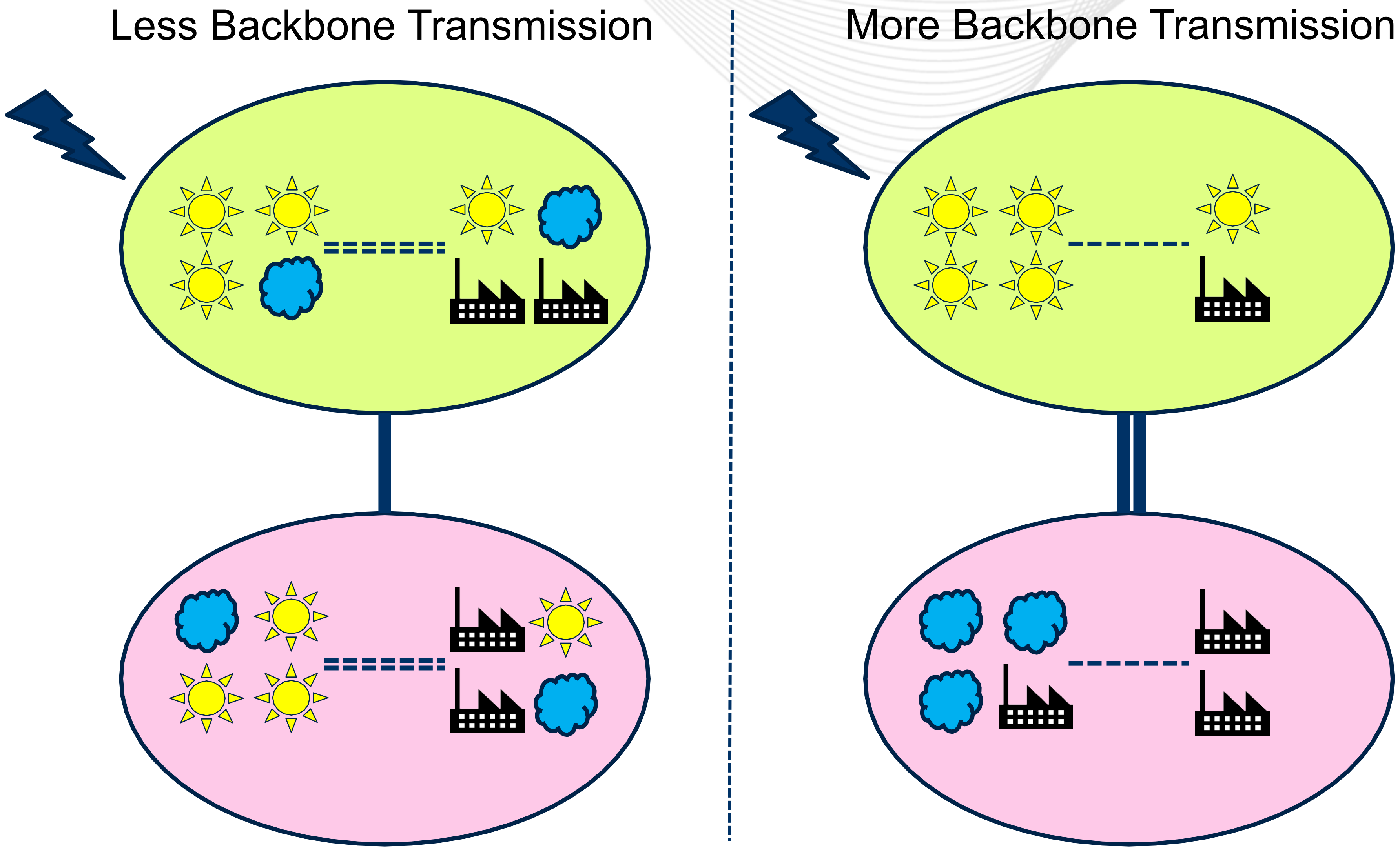
APPENDIX

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.

LTRTP Benefits, Illustrative example



- Efficient generation and transmission build
- Increased utilization of low-cost resources
- Exploit regional diversification
- Enhance reliability through energy imports to sub-region hit by a storm

Calculation of Benefits

- Benefits can be calculated by comparing two different transmission topologies:
  1. Reference Case – *with* the transmission project
  2. Counterfactual Case – *without* the transmission project

- PJM will simulate *both* system topologies (through the use of capacity expansion, production cost, and reliability models)

- The *value* created by the project is the benefit-difference *between* the reference and counterfactual cases

Within the State Agreement Approach (SAA), the counterfactual is defined as the Base scenario's topology with the Medium scenario's Public Policy Requirements; States can consider other benefits for the SAA as well

Benefit #1 – Production Cost Savings

- **Production Cost Savings** – the value of lower electricity costs resulting from transmission carrying economic energy to more locations

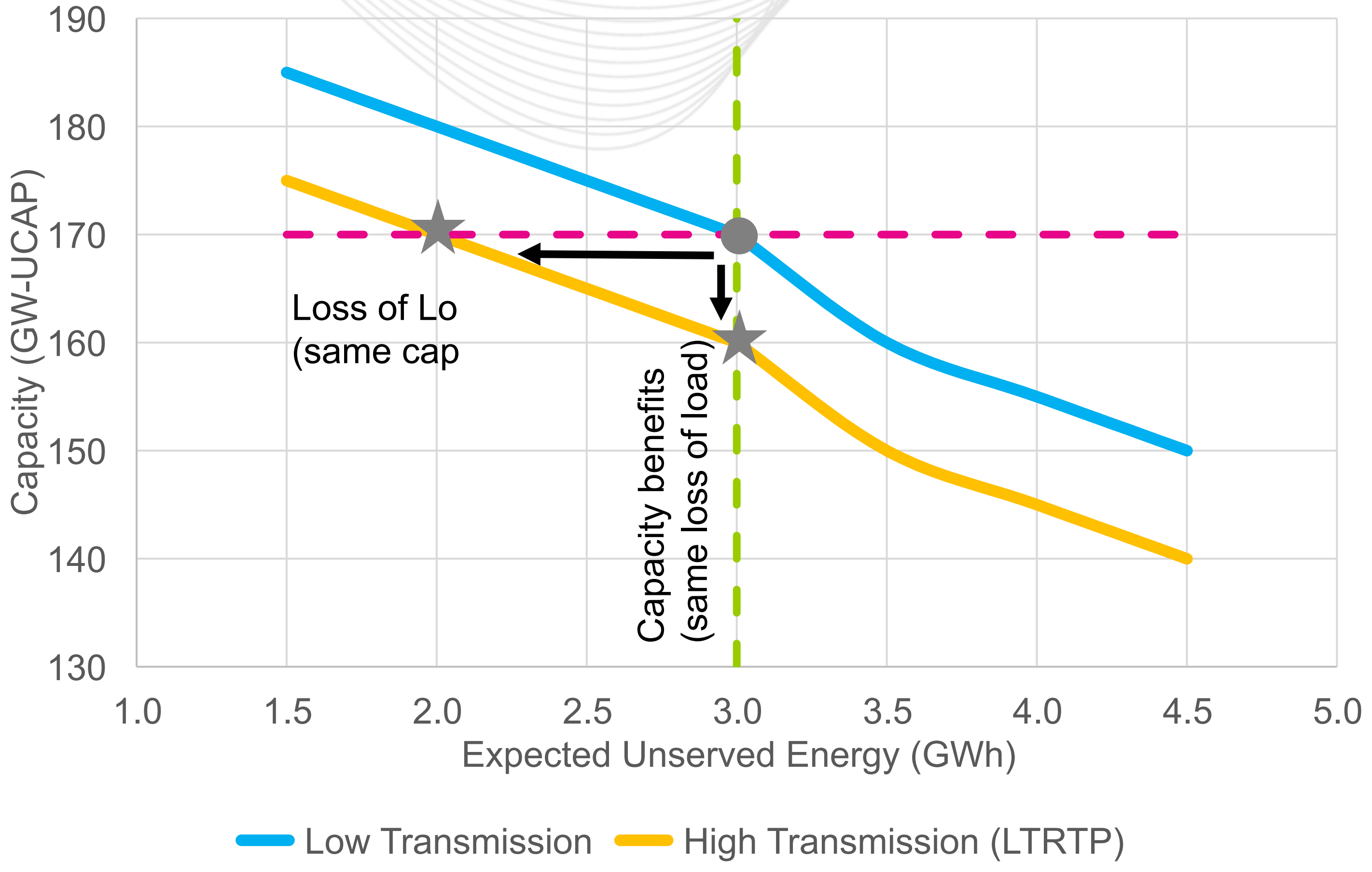
- **How LTRTP can increase production cost savings:**
  1. Concentrate resources where they have lower cost/are more productive:
     - More combined-cycle units located where gas prices are lower
     - More zero-marginal cost renewables located in areas with higher capacity factors
  2. Increase utilization of low cost resources (Higher combined-cycle capacity factors and fewer renewable curtailments)

- LTRTP will start with **Adjusted Production Cost (APC) Savings** used in Market Efficiency, but PJM can extend this definition to other production cost savings as needed
  – This can include a reduction in Reliability Must Run (RMR), congestion from transmission outages, etc.

Benefit #2 – Avoided Generation Investments

- **Avoided Generation Investment** – savings from lower generation investments needed to serve the same amount of load
  - Increased transfer capability across non-coincident peak areas allows PJM to serve load with less generation
  - Allowing resources to locate in more productive locations will result in fewer resources needed
    - Ex: 10 wind turbines suffice to serve load (instead of 14, for example) if the 10 turbines are in richer wind areas

Loss-of-load/generation investment interdependency (Illustration)



Benefit #3 – Avoided Transmission Investments

- **Avoided Transmission Investments** – savings identified through holistic long-term planning by identifying more efficient transmission solutions and reducing the need for rebuilding transmission

- **Reduced Loss of Load** – the value of reducing load-shed events
  - Backbone transmission can reduce the probability and scale of load-shed events by increasing the transfer capability between areas impacted by extreme events and other areas of the RTO

Loss of Load Calculation

- 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