OMS Long-Range Transmission Planning Workshop

Little Rock, Arkansas

October 2, 2019

AGENDA

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- PART I: High Level Planning Fundamentals
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  - Transmission Needs and Issues
  - Transmission Planning Horizons
  - Transmission Geographic Domains
- PART II: MISO Planning Processes
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  - Regional / Interregional Transmission Planning
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Introduction and Opening Remarks

PART I

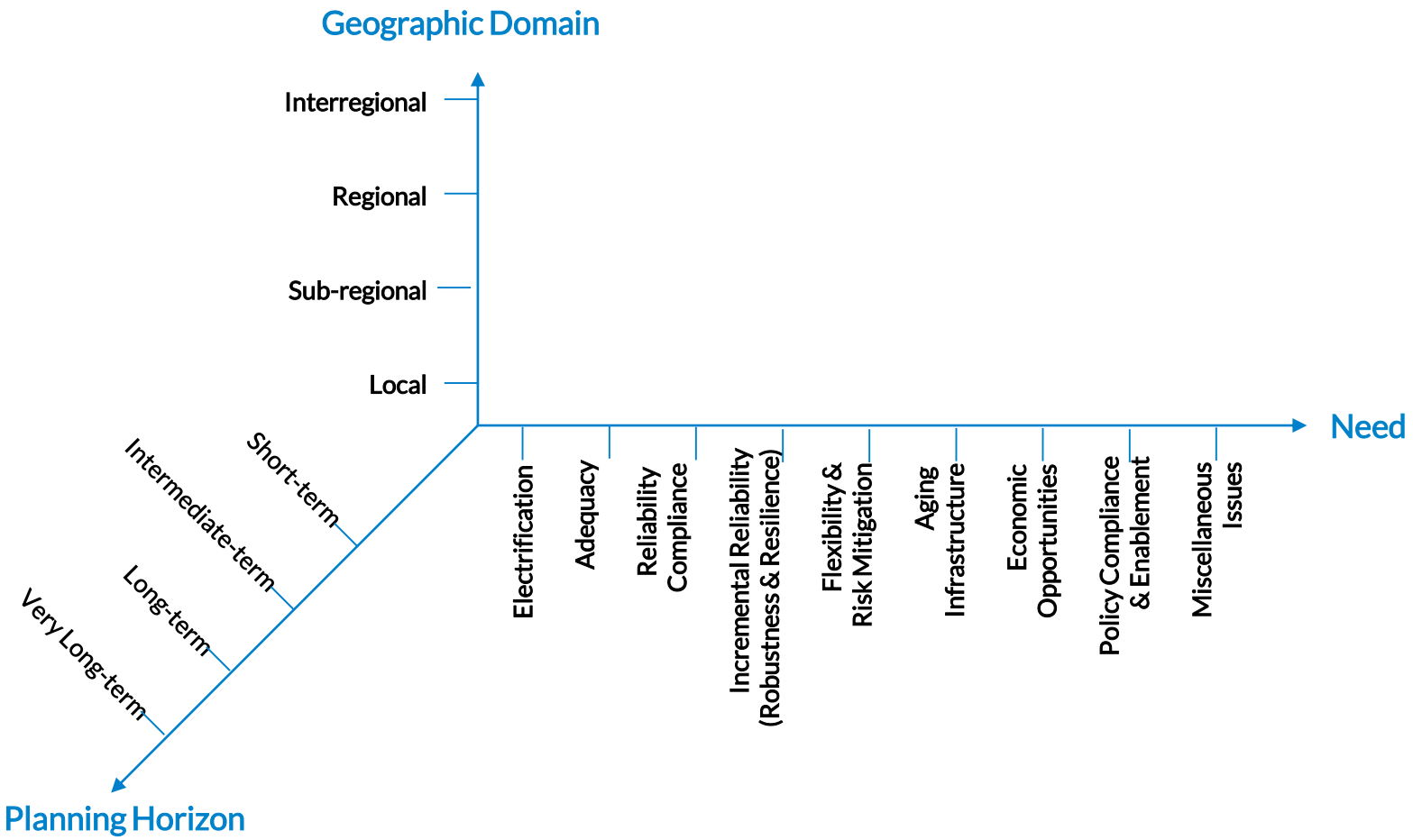
High Level Planning Fundamentals

The Three Dimensions of Transmission Planning

The Three Dimensions of Transmission Planning

- **Transmission Needs and Issues.** The drivers of transmission expansion within transmission planning.
- **Transmission Geographic Domain.** The geographic extent of the transmission planning focus, which could be local, sub-regional, regional or interregional.
- **Transmission Planning Horizon.** The length of time into the future for which transmission planning will focus.

Three Planning Dimensions



1st Dimension

Transmission Needs and Issues

Transmission Needs and Issues

- Electrification
- Adequacy
- Reliability Standards Compliance
- Incremental Reliability Enhancement via Incremental Robustness and Resilience
- Flexibility and Risk Mitigation
- Aging Infrastructure
- Economic Opportunities
- Public Policy Compliance and Opportunities
- Miscellaneous Issues

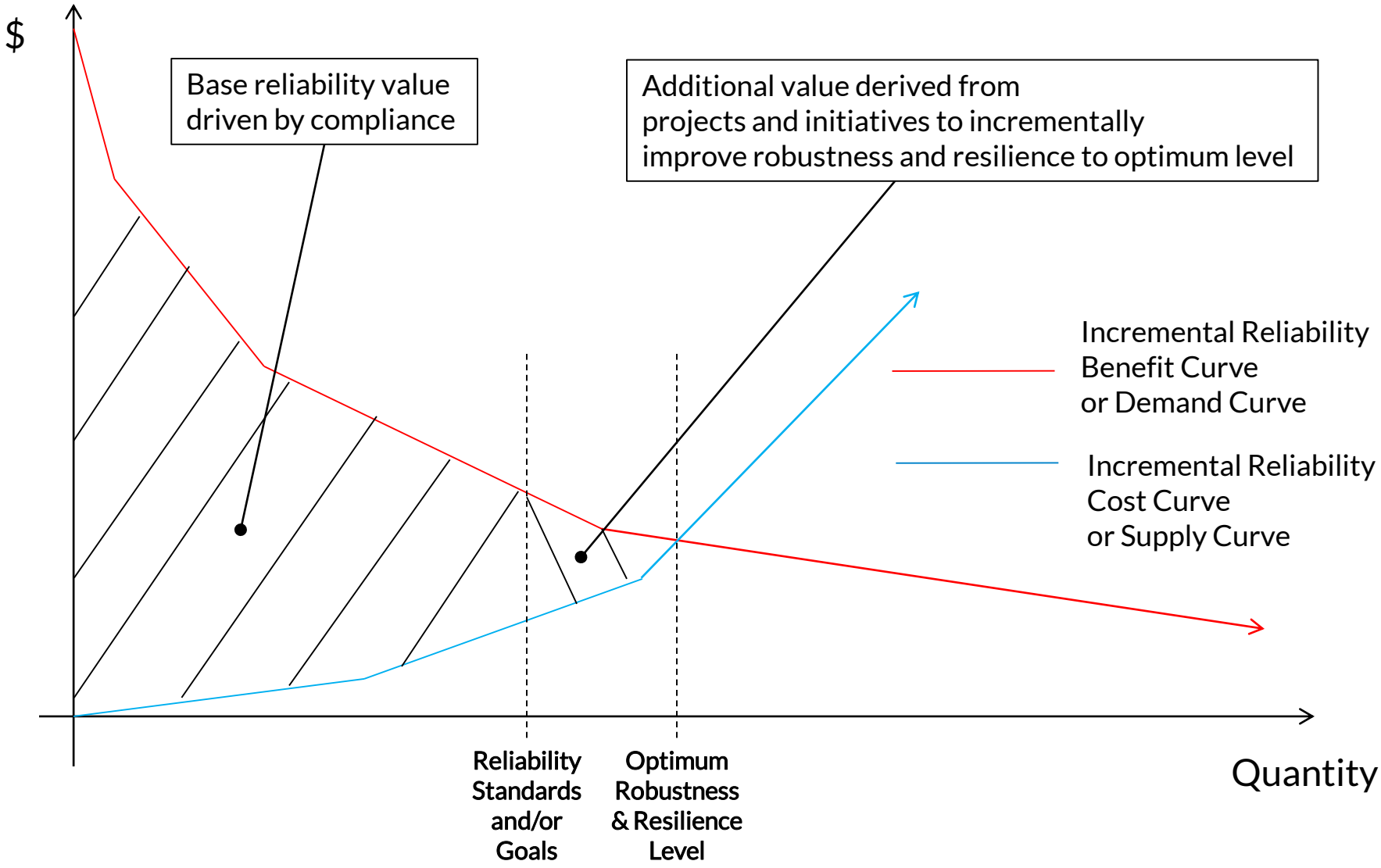
Electrification, Adequacy and Reliability Compliance

- Electrification
  - Line Extensions to Serve New Loads
- Adequacy and Reliability Standards Compliance
  - NERC TPL Standards
  - Other NERC Standards
  - Regional Entity Standards
  - TO Planning Criteria
  - Other Local, State or Federal Reliability Regulations and Laws
- Electrification Drivers
  - New Load Interconnections
- Adequacy and Reliability Drivers
  - Load Growth (Regional & Local)
  - Resource Retirements
  - New Resource Interconnections
  - Firm Transmission Service Requests
- MISO Electrification, Adequacy and Reliability Compliance Planning Processes
  - Baseline Reliability Planning (Load Growth, New Loads, Resource Retirements)
  - Generation Interconnection Planning (New Resource Interconnections)
  - Transmission Delivery Service Planning (Transmission Service Requests)

Incremental Reliability Enhancement via Incremental Robustness and Resilience

- Reliability in general requires robustness and resilience (i.e., robustness and resilience are components of reliability).
- Potential incremental value in enhancing robustness and resilience beyond minimum compliance requirements if there are incremental reliability benefits in excess of incremental enhancement costs.

Conceptual Illustration of Optimizing Robustness and Resilience, and thus, Reliability



Flexibility and Risk Mitigation

- In the new era of distributed resources and renewable generation, there will be far more short-term and long-term uncertainty regarding:
  - Resource Dispatch
  - Resource Availability
  - Interconnection, Retirement and Mobility regarding Distributed Energy Resources
  - Mobility regarding Certain Loads (e.g., EVs, etc.)

Aging Infrastructure

- As the average age of transmission plant increases, there will be more and more of a need to address aging infrastructure through capital replacement programs.
- The upward trend in capital replacement has already begun.
- A prudent planning approach will always ask the question: How should we build it this time?
  - In some cases, downsizing may be appropriate.
  - In other cases, upsizing may be appropriate.

Economic Opportunities

- Production Cost Reduction
  - Fuel Costs
    - Energy Losses (embedded in fuel costs)
    - Congestion Costs (embedded in fuel costs)
  - Variable O&M Costs
  - No-Load Costs
  - Startup Costs
  - Emissions Costs, if Applicable
- Capacity Cost Reduction
  - Capacity Losses
  - Planning Reserve Margins

Public Policy Compliance & Opportunities

- Compliance with Renewable Portfolio Standards
- Compliance with Hard Emissions Limits
- Infrastructure Improvement Stimulus
- Other

Miscellaneous Issues

- Transmission Facility Relocation Requests
  - Reimbursable
  - Non-reimbursable
- Transmission Facility Undergrounding Requests
  - Reimbursable
  - Non-reimbursable
- Other Miscellaneous Issues

2nd Dimension

Transmission Geographic Domain

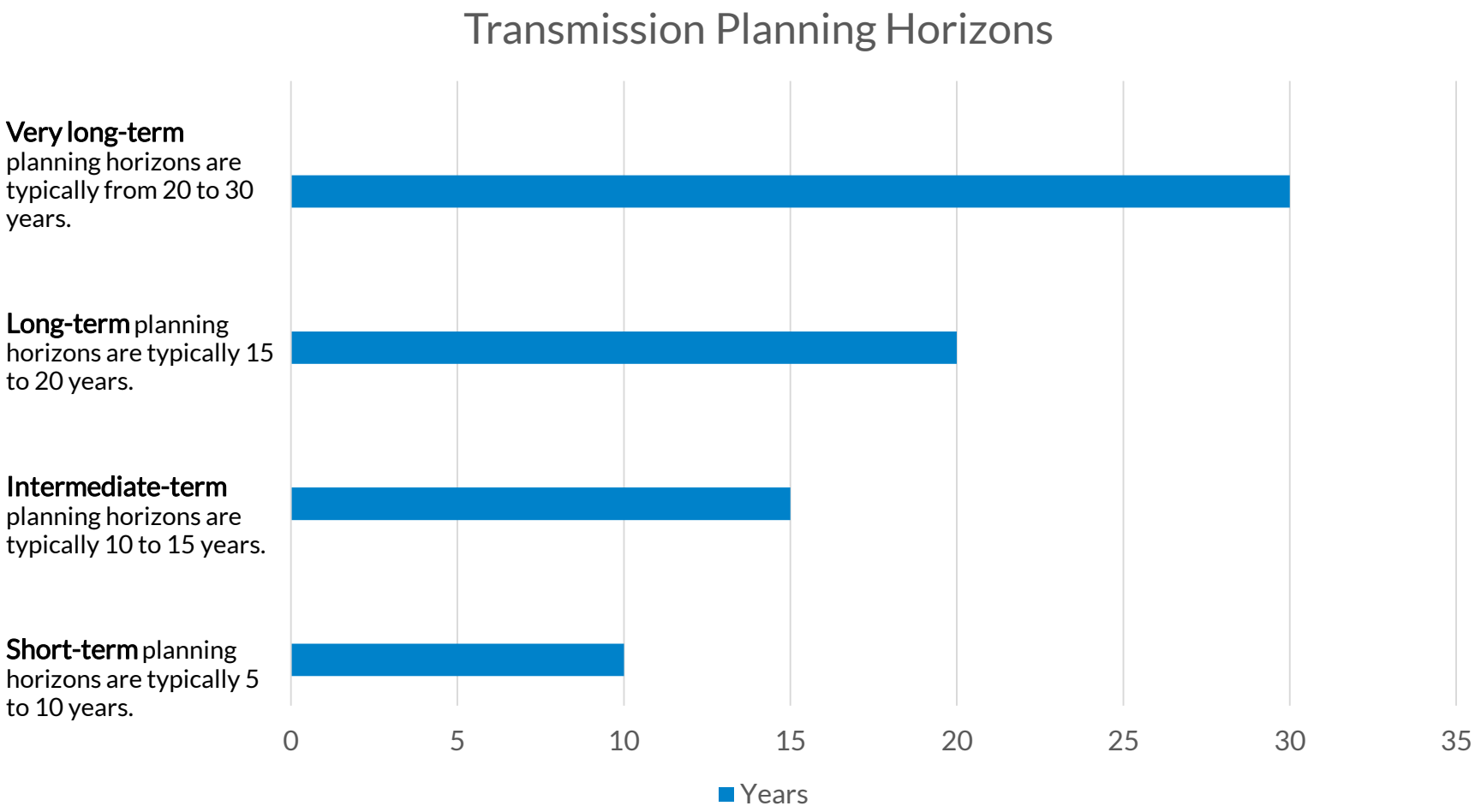
Transmission Geographic Domain

- **Local.** The local domain typically consists of the transmission facilities within a single Transmission Owner's footprint or within a single pricing zone.
- **Sub-regional.** The sub-regional domain consists of all transmission facilities within one of the four defined MISO sub-regions: Central, East, South, West
- **Regional.** The regional domain consists of the entire MISO transmission footprint.
- **Interregional.** The interregional domain consists of all MISO transmission facilities plus transmission facilities external to MISO up to the boundaries of the Eastern Interconnection.

3rd Dimension

Transmission Planning Horizon

Typical Transmission Planning Horizons



Transmission Planning Horizon

- There are two distinct aspects of the "transmission planning horizon" that are important to understand:
  - Analysis Horizon
  - Solution Horizon
- The analysis horizon represents the time period for which analysis will be conducted.
- The solution horizon represents the time period for which solutions will be sought.
- The analysis horizon is typically longer than the solution horizon to ensure transmission plans attempt to optimize the balance between short-term and long-term ultimate costs.

Illustration of Analysis vs. Solution Planning Horizons

Solution Horizon

If the analysis horizon is limited to the solution horizon, Major issues just beyond the end of the solution horizon Will not be considered and solutions may not be optimized.

Analysis Horizon

If the analysis horizon is extended beyond the solution horizon, major issues just beyond the end of the solution horizon will be considered and solutions will be better balanced.

Example of the Benefit of an Extended Analysis Horizon

- Assume the solution horizon is five-years and the analysis horizon is ten years.
- An issue is found in year 5 of the analysis horizon, and a solution costing $100 Million is initially recommended to resolve the issue in year 5 of the solution horizon.
- A second issue is found in year 6 of the analysis horizon, indicating that a solution costing $200 Million will be required in the future, but not in the current solution horizon.
- The second solution also resolves the year 5 issue.
- To minimize long-term life cycle costs, the best strategy is to move the $200 Million solution into year 5, and avoid the need to implement the $100 Million solution altogether.
- An extended analysis horizon allows for this type of optimization.

PART II

MISO Planning Processes

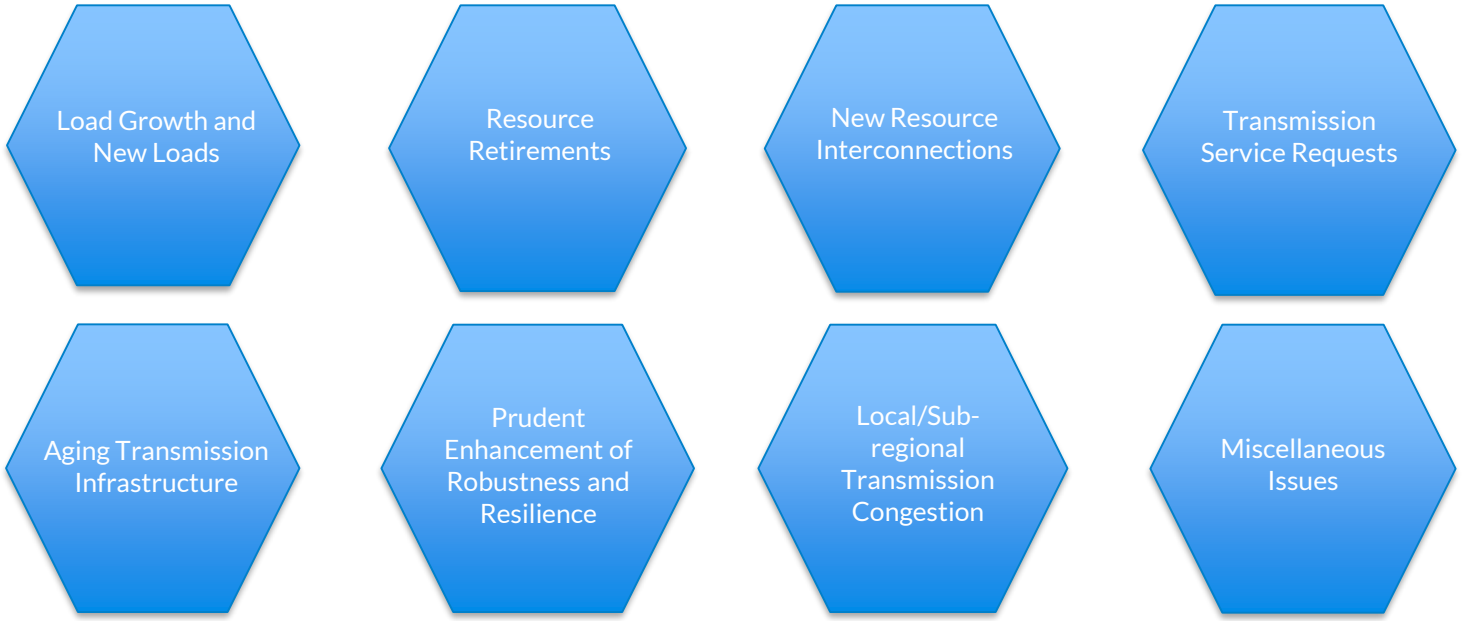
Cyclical MTEP Planning Processes

Cyclical MTEP Planning Processes

- The cyclical MTEP planning processes:
  - address the short-term and intermediate-term planning horizons, and
  - focus on the local and sub-regional geographical domain
- The cyclical MTEP planning processes include:
  - Baseline Reliability Planning
  - Market Congestion Planning
  - Generation Interconnection Planning
  - Transmission Delivery Service Planning

The Purpose of Cyclical MTEP Planning

- The purpose of cyclical MTEP planning is to ensure the local / sub-regional transmission system is adequate, reliable and economic in the future given future projected conditions.
- Cyclical transmission planning addresses the following local transmission needs and issues:



Cyclical MTEP Planning Processes
BASELINE RELIABILITY Planning Horizon & Cycle

- Baseline Reliability Planning Horizon
  - For baseline reliability planning, NERC TPL standards requires analysis against both a five-year planning horizon and a ten-year planning horizon.
  - The NERC five-year planning horizon can be considered the “solution horizon”.
  - The NERC ten-year planning horizon can be considered the “analysis horizon”.
  - NERC does require corrective action plans for issues found beyond the solution horizon (i.e., issues in years 6 through 10), but:
    - Such corrective action plans are generally not firm.
    - Such corrective action plans correspond to projects placed in MTEP Appendix B
    - Such corrective action plans could be displaced by other projects or NTAs in future planning cycles.
- Baseline Reliability Planning Cycle
  - The baseline reliability planning cycle is annual at present, although the tariff allows it to be bi-annually.

Cyclical MTEP Planning Processes
INTERCONNECTION/TSR Planning Horizon & Cycle

- Interconnection & Transmission Service Planning Horizon
  - For generation interconnection planning, both the solution horizon and the analysis horizon are five (5) years.
  - For transmission delivery service planning, both the solution horizon and the analysis horizon are five (5) years.
- Interconnection & Transmission Service Planning Cycle
  - For generation interconnection planning, planning is tied to a queue rather than a cycle
  - But, the Definitive Planning Phase (DPP) cycle associated with the generation interconnection process is roughly equivalent to an annual planning cycle (i.e., the DPP cycle repeats with a new resource interconnection group approximately once every year).*
  - For transmission delivery service planning, planning is tied to a queue, so the concept of a planning cycle really does not apply.

***NOTE: The DPP cycle length can vary somewhat.**

Cyclical MTEP Planning Processes
MARKET CONGESTION Planning Horizon & Cycle

- Market Congestion Planning Horizon
  - For market congestion planning, the solution horizon is typically five (5) years and the analysis horizon is typically twenty (20) years.
  - The large difference between the solution horizon and the analysis horizon is to ensure sufficient analysis of future economic benefits.
- Market Congestion Planning Cycle
  - The market congestion planning cycle is an annual cycle at present.

Cyclical MTEP Planning Process Summary

- Cyclical MTEP planning includes the following formal cyclical transmission planning processes.
  - Baseline Reliability Planning
  - Generation Interconnection Planning
  - Transmission Service Request Planning
  - Market Congestion Planning
- Deliverables
  - MTEP Appendix A Projects which are Final Recommended Solutions
  - MTEP Appendix B Projects which are part of the NERC required Corrective Action Plan, but not yet Final Recommended Solutions

Regional / Interregional Transmission Planning

Regional / Interregional Transmission Planning

- Regional and interregional transmission planning has a larger geographic focus than cyclical planning and typically focuses on a longer range planning horizon as well.
- Regional transmission planning is often based on ad-hoc initiatives driven by system-wide needs (e.g., public policy).
- Examples of a regional transmission planning initiatives include:
  - The Candidate MVP Portfolio Study
  - Generation Retirement Study
  - Hydro - Wind Synergy Study
  - Other targeted studies
- Interregional planning studies are typically governed by interregional planning protocols in place between MISO and neighboring regions.

The Purpose of Regional / Interregional Transmission Planning

- The purpose of regional and interregional transmission planning is to ensure the regional / interregional transmission system is reliable, economic and compliant with public policy in the future given future projected conditions, industry trends and/or public policy changes.
- Regional / Interregional transmission planning addresses the following regional and interregional transmission needs:
  - Major Baseload Fleet Retirements
  - Enhancement of Robustness and Resilience
  - Establishment of Distributed Energy Resource Fleets
  - Increased Uncertainty and Risk Regarding Resource Location and Dispatch
  - Interregional Reliability Issues and Enhancement Opportunities
  - Interregional Economic Opportunities
  - Establishment of Renewable Portfolio Standards
  - Establishment of Other Environmental Policies

Regional / Interregional Transmission Planning
Planning Horizon & Cycle

- Planning Horizon
  - For regional planning, the solution horizon is typically ten (10) years and the analysis horizon is typically twenty (20) years.
  - For interregional planning, the solution horizon is typically five (5) years and the analysis horizon is typically ten (10) to twenty(20) years depending on the type of need.
- Planning Cycle
  - The regional planning cycle is not fixed, but instead regional planning studies are currently carried out on an “as needed” basis, and are often triggered by major changes in public policy or the industry in general.
  - The interregional planning cycles can be as frequent as annually, but typically interregional plans (e.g., coordinated system plans, etc.) are only developed when interregional expansion opportunities are identified in the cyclical regional planning processes, up to once per year if needed.

Regional / Interregional Transmission Planning
Current Processes and Deliverables

- Regional / Interregional transmission planning is currently performed via a number of processes.
  - Interregional Planning Studies with:
    - PJM
    - SPP
    - SERTP
  - Non-cyclical regional planning Initiatives such as the Candidate MVP Portfolio Study in 2011.
- Deliverables
  - MTEP Appendix A Regional Projects which are Final Recommended Solutions
  - Coordinated System Plan which may contain recommendations for Interregional Projects

Long-range Transmission Planning

The Purpose of Long-range Transmission Planning

- The purpose of long-range transmission planning is to ensure the transmission system is optimized across the long-term as well as the short-term.
- The long-range transmission plan does not lead directly to transmission expansion commitment decisions, but does serve as a roadmap that informs shorter term processes where transmission expansion commitment decisions are made.
- The long-range transmission plan typically focuses more on regional infrastructure than local infrastructure, so it is “big picture”.

Long-range Transmission Planning
Planning Horizon & Cycle

- Long-range Planning Horizon
  - The solution and analysis horizon would typically be for twenty to thirty years
- Long-range Planning Cycle
  - Long-range plans are currently not developed and updated on a routine planning cycle, but are performed on an as-needed basis, often in response to major changes in public policy or the Industry.

Long-range Transmission Planning
Current Processes

- Examples of past long-range transmission planning initiatives include the following:
  - MISO Vision Exploratory Study
  - Regional Generation Outlet Study (RGOS)
  - Regional Transmission Overlay Study (RTOS)
- Deliverables
  - A long-range regional plan (or plans) which include a list of solutions and serves as a road-map to inform future shorter term planning processes where actual transmission expansion commitment decisions will be made to implement specific solutions.

Planning Roles and Responsibilities: Local vs. Regional

Roles and Responsibilities

- MISO planning processes include both local planning and regional planning.
- For issues that are localized and/or related to reliability, a local planning process is typically used.
- For issues that are regional in nature and/or relate to public policy and economic enhancements, a regional planning process is typically used.
- The Tariff and BPM outline how each of these processes work.

Roles and Responsibilities

- Both the Transmission Owners and MISO have NERC compliance obligations and thus participate in the MISO transmission planning process.
- For local reliability issues, the Transmission Owners will develop expansion plans and then roll them up to MISO for review.
- MISO and stakeholders will then review the Transmission Owner plans and may make suggestions to optimize solutions when opportunities arise to solve multiple issues across multiple TO areas in a more prudent manner.
- Local planning is a two-part process where the Transmission Owners develop the first cut and then MISO and stakeholders review and make suggestion to optimize the overall plan (including NTAs).

Roles and Responsibilities

- For regional and interregional issues related to economics and public policy drivers, MISO will typically drive the process to identify issues and propose solutions.
- Transmission Owners and other stakeholders will participate in the process and also submit ideas for solutions under regional planning.
- Regional planning is a single integrated process in which everyone participates.

PART III

Common Elements of Planning

M = Model
A = Analyze
P = Plan

MAP Process

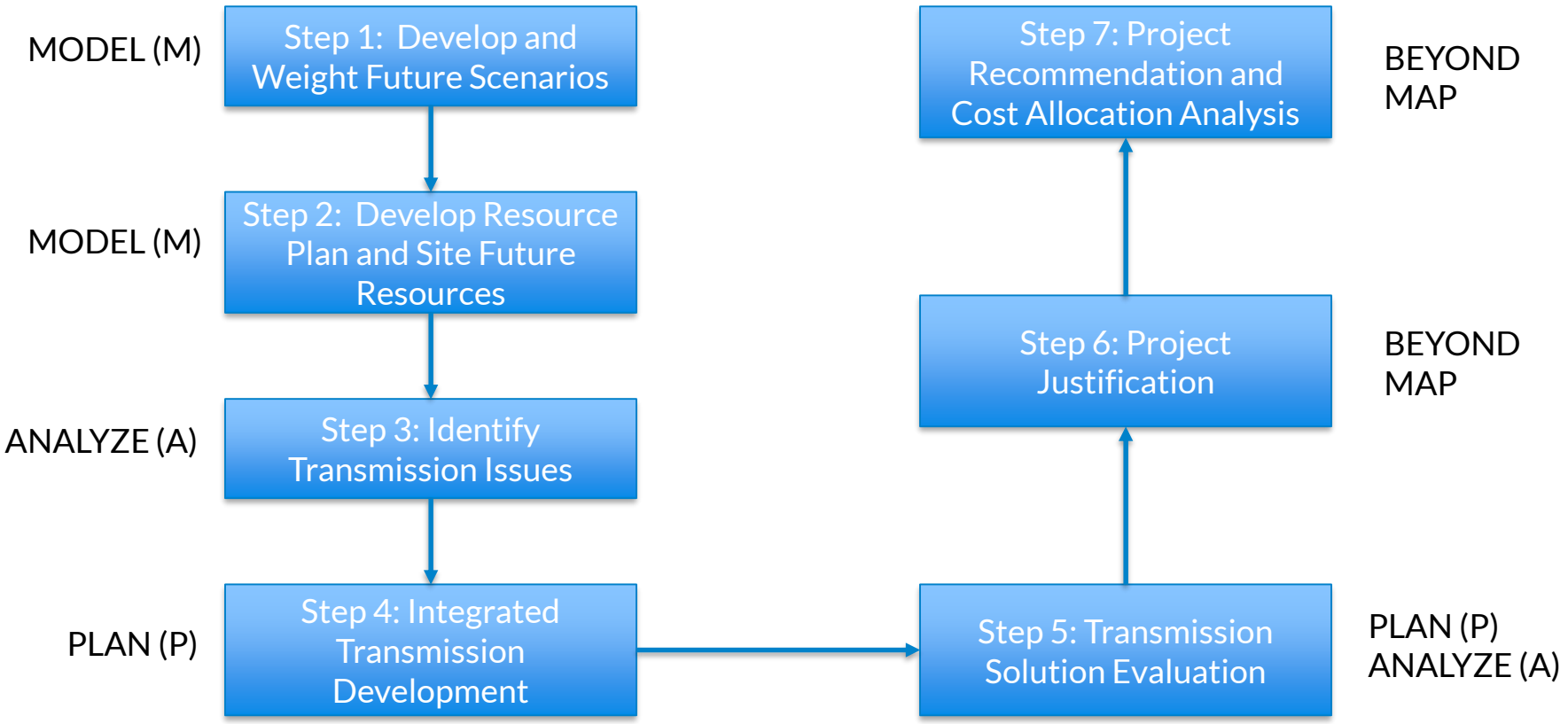
All system planning processes include the MAP process:

- **Model.** Build models to represent projected future conditions and allow for simulation and analyses of future system performance (e.g., power flow, production cost modeling, loss-of-load expectation, etc.).
- **Analyze.** Use models to simulate future system performance and identify future system needs and issues. Also use models to test alternative solutions and verify validity of solutions.
- **Plan.** Determine the best solutions to future system needs and issues, which includes consideration of alternatives (for transmission issues, both transmission and, when proposed, non-transmission alternatives would be considered in the planning phase of the MAP process).

Beyond the MAP Process

- The MAP process is the common element for all system planning processes (generation, transmission and distribution).
- For some planning processes such as shorter term planning initiatives where construction lead times require project commitment decisions, the following additional steps may be required beyond the MAP process:
  - Business Justification
  - Cost Allocation (if applicable)
- For other planning processes such as long-range planning initiatives where the goal is to create a future roadmap or guiding document, but not to commit to the implementation of specific solutions, only the MAP process is needed.

MAP Process applied to Seven Step Process



Specific Tools used for Modeling and Analysis

- **Reliability Modeling and Analysis:**
  - For reliability modeling and analysis, typical tools include power flow simulation for steady-state and voltage stability analyses and special dynamic models for angular stability analyses.
  - Reliability modeling and analysis tools tend to be more granular, but are limited to a single system state or point in time.
- **Economic Modeling and Analysis:**
  - For economic modeling and analysis, typical tools include production cost modeling simulation software that attempts to simulate the commitment and dispatch of resources across a long period of time, such as a year.
  - Economic modeling and analysis tools tend to be less granular, but are capable of analyzing performance over multiple time periods.
- **Scenario Development Tools:**
  - To develop future resource scenarios, generation planning software such as EGEAS are used to simulate the future evolution of the generation system under various policy assumptions to drive future economic and/or reliability analysis of the transmission system.

Summary and Key Takeaways

Key Takeaways

- Transmission Planning has Three Dimensions
  - Transmission Needs and Issues
  - Transmission Planning Horizon
  - Transmission Geographic Domain
- MISO Planning Processes are Categorized as Follows
  - Cyclical Planning Processes
  - Regional and Interregional Transmission Planning
  - Long-range Transmission Planning
- All MISO and industry planning processes contain the following comment elements:
  - Modeling
  - Analysis
  - Planning
- The MISO planning processes are designed to address each of the three dimensions of transmission planning as appropriate in an efficient and effective manner.

Open Discussion