EE590 Capacity Planning



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Capacity Planning Overview

- Midwest ISO Transmission Expansion Plan (MTEP) Process Overview
- MTEP Reliability Study Process
  - Reliability Study Scope
  - Initial Project Review at Subregional Planning Meetings
  - Reliability Analysis: Steady-State, Load Deliverability, Generation Deliverability, Voltage Stability, Dynamics, Small-Signal, Transfer
  - Results review at Subregional Planning Meetings
  - Collaborative Solution development in Open Planning process. Project review and disposition
  - Final plan review at Planning Subcommittee
  - Cost Allocation and Reporting. Board approval

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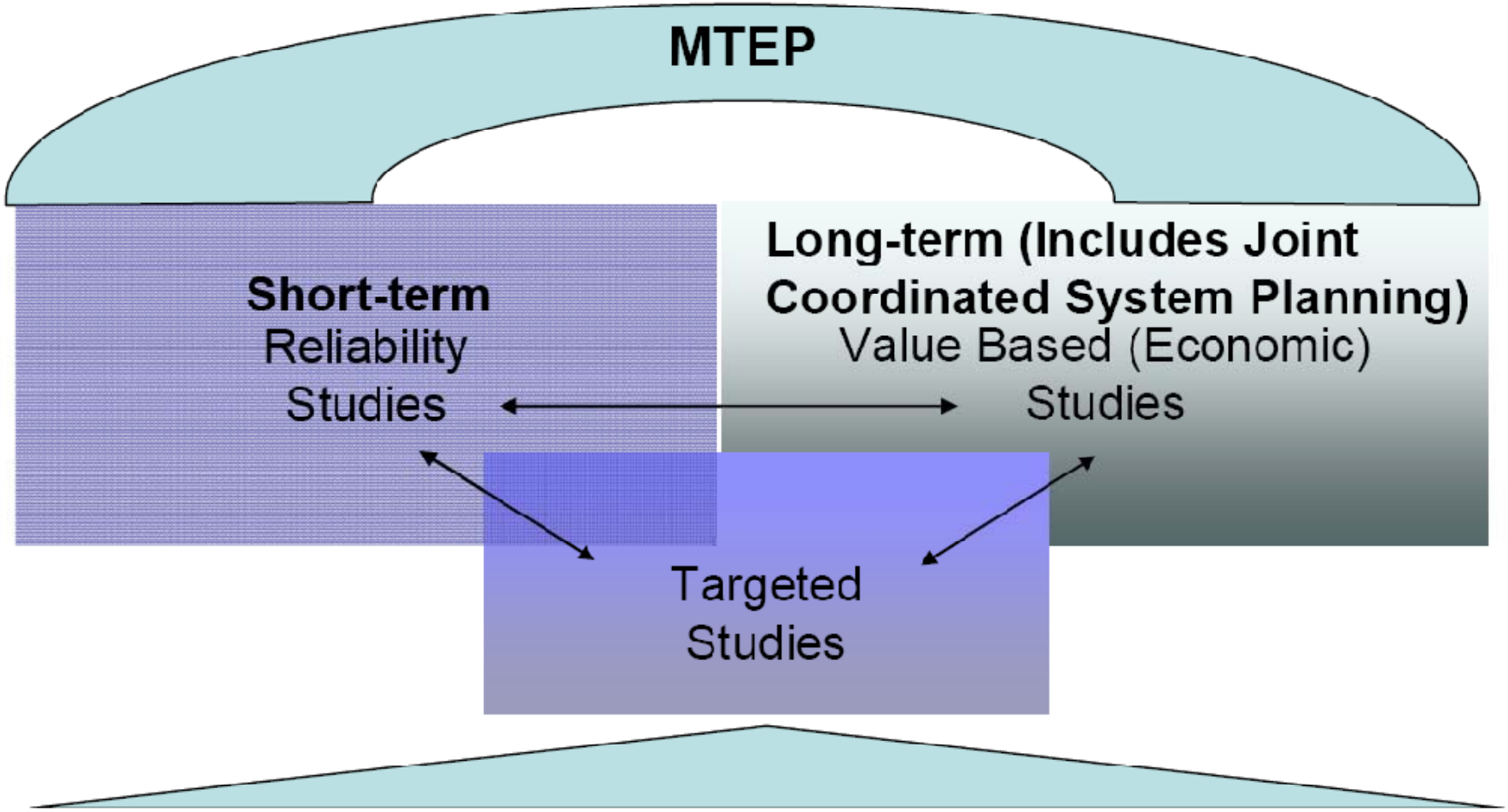
MTEP Studies



Project Identification by:

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Load Serving Entities
Sub Regional Planning Meetings
Transmission Owners
Other Stakeholders

MTEP Study Process

- **Step 1:** Forecast Multiple Future regional resources
- **Step 2:** Site generation and place in Powerflow Model
- **Step 3:** Design preliminary transmission plans for each future
- **Step 4:** Test preliminary transmission plans for robustness
- **Step 5:** Consolidate alternatives into a single transmission plan
- **Step 6:** Perform Reliability Assessment, project review and integration; make final design modifications
- **Step 7:** MTEP Cost Allocation and Delivery to Board of Directors

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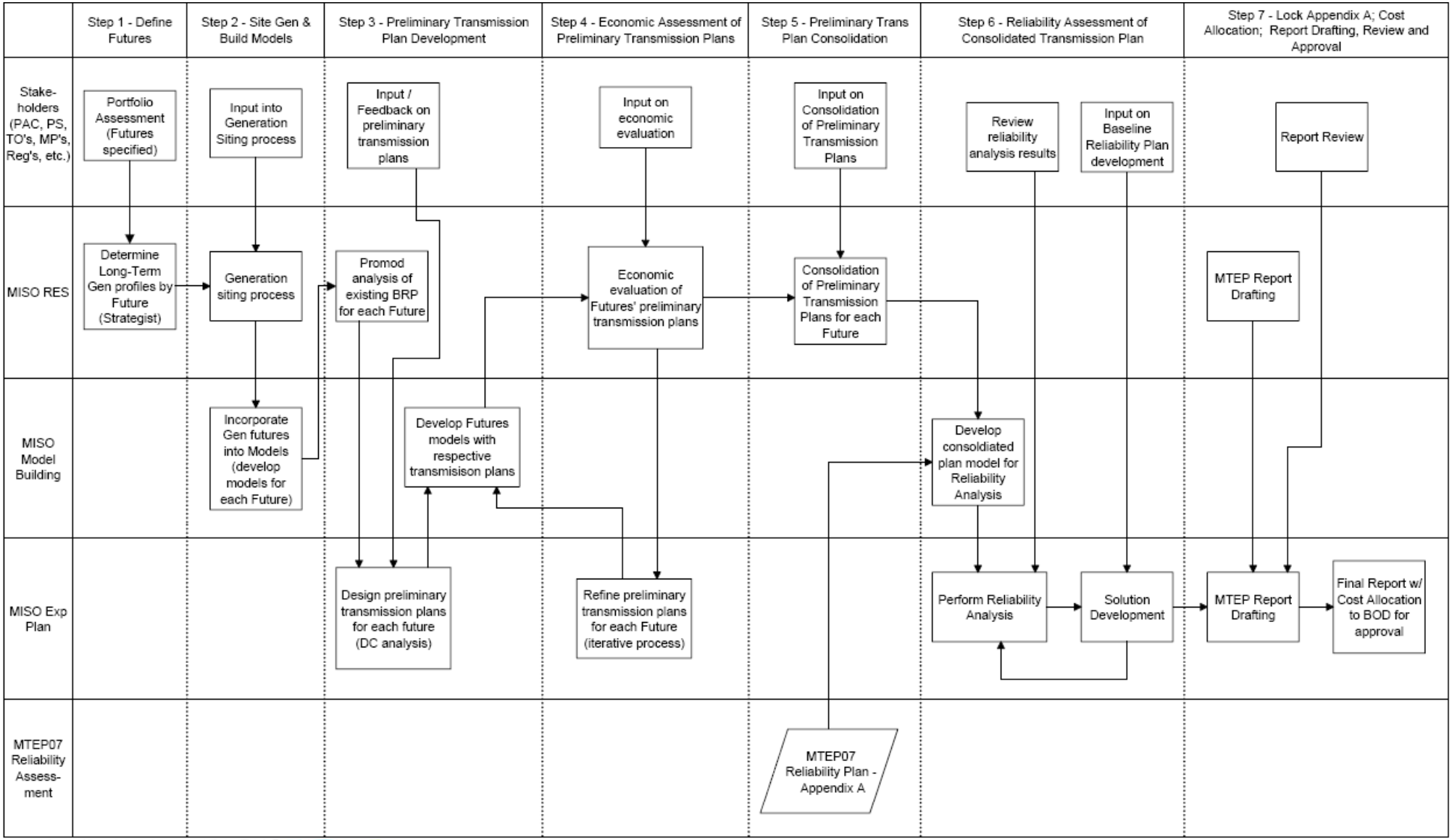
MTEP Process Diagram



Planning Horizons and Criteria

- Planning is performed over several planning horizons and against a variety of criteria
  - Multiple parallel study efforts
- Planning Horizon: 1 to 20 years
- Criteria:
  - Reliability Standards (NERC TPL, RRO, TO)
  - Economic metrics (Midwest ISO per Attachment FF and others in development)
  - Policy needs (e.g. Renewable Energy Standards)

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Planning Cycles

- 12 Month (TO plan review and integration)
  - NERC Reliability Standards (Years 2,5, and 10)
- Multi-year (RTO initiative)
  - 10-20 year Long-Term Economic (value-based)
- 12-24 Month (RTO initiative)
  - Targeted studies (Congestion, Narrow Constrained Area, Queue related, Operational, other)
- MTEP Report
  - Annual snapshot of currently recommended expansions resulting from all completed studies

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MTEP Reliability Studies

- MTEP Reliability Studies (Capacity Planning) are done to determine system reliability with a suite of tests under a number of future system conditions. Step 6 of overall process
- For identified reliability issues, Midwest ISO and Transmission Owners develop plans to address in open, collaborative stakeholder process
  - Planning before Order 890 was less open to stakeholder participation early in process

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MTEP Study Process

- Pre-Study Activities
  - Requests for new projects from Transmission Owners for project review and integration
  - Request planning issues from stakeholders
  - Scope development and review by Planning Advisory Committee and Planning Subcommittee

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MTEP Reliability Study Scope

- Draft study scope prepared and presented to stakeholders
  - Reliability assessment
  - Project review and disposition
  - Cost allocation
- Study scope is fairly constant, but it can vary between MTEP planning cycles

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Stakeholder Forums

- Subregional Planning Groups (East, Central, West) and Subregional Planning Meetings (SPM)
  - Localized input of issues
  - Localized review of analyses, projects and alternatives
- Planning Subcommittee
  - Consolidated technical review of Subregional input/recommendations
- Planning Advisory Committee
  - Policy level input and advice on planning issues

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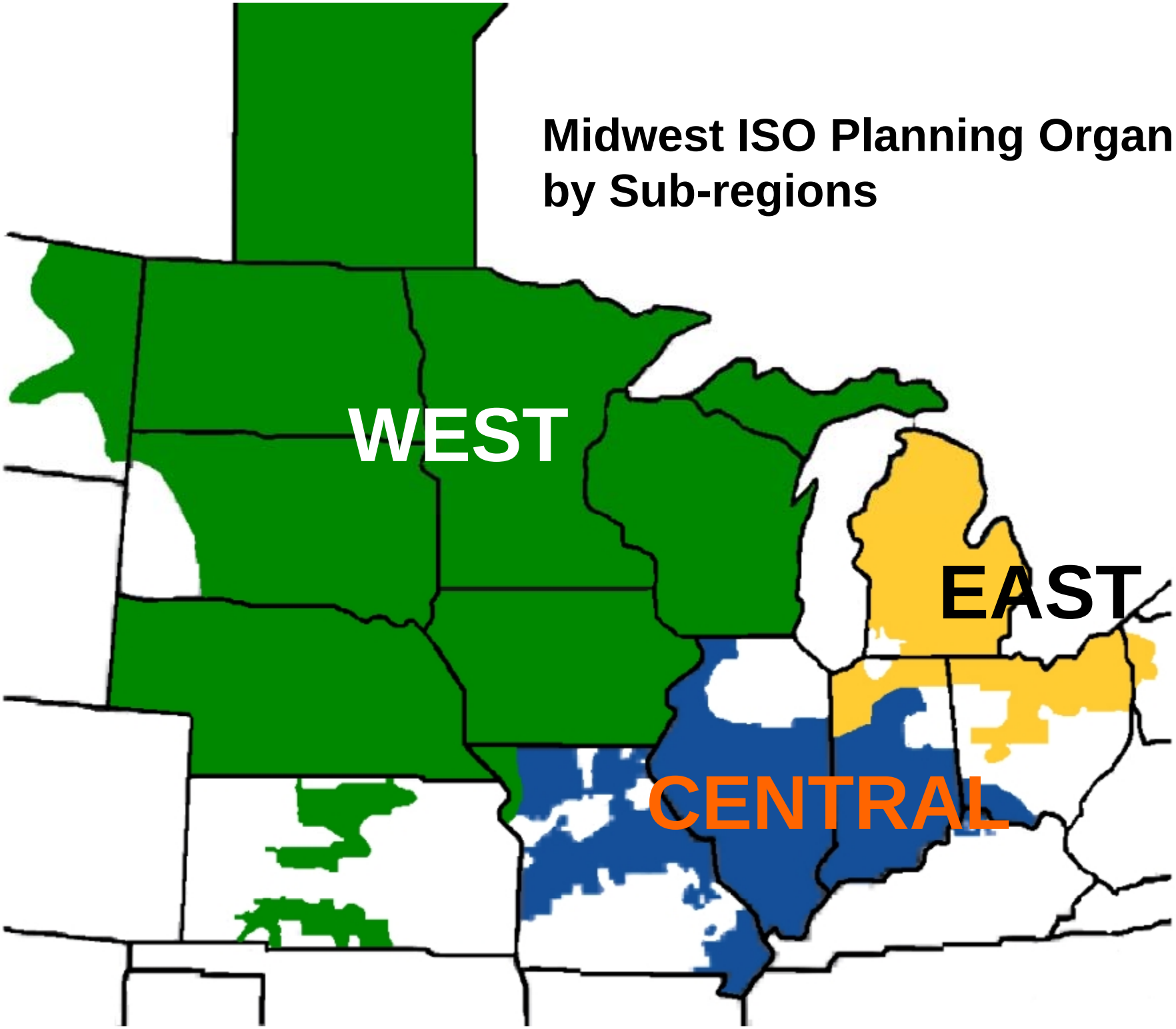
Midwest ISO Planning Organized by Sub-regions



Reliability Analyses

- Suite of tests to determine system performance
  - Steady-State contingency analysis
  - Load Deliverability analysis
  - Generation Deliverability analysis
  - Voltage Stability/Reactive Resources
  - Dynamic/Transient stability simulations
  - Small-Signal Stability analysis
  - Transfer analysis (FCITC)

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System Conditions/Models

- What system conditions are to be studied?
  - Years 1-10 (2, 5 and 10) under Peak, shoulder, and light load conditions. Analysis types look at subset of conditions.
- Data Required
  - Load Forecasts at substation level
  - Transmission topology
    - Existing system
    - Future facilities: generation, transmission
  - Generation dispatch: BA, RTO Merit, SCED, wind
  - Interchange schedules vs. OASIS reservations
- Model validation and testing. Solution tolerance
- Model of entire Eastern Interconnection

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Contingencies

- NERC Transmission Planning (TPL) standards
  - TPL-000 System Intact. Category A
  - TPL-002 Single element. Category B
  - TPL-003 Multiple element. Category C
  - TPL-004 Extreme events. Category D
- Run most severe events

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Steady-State Analysis

- Use Siemens PTI PSS/E or MUST to run NERC TPL events table
- Document potential future reliability issues. Typically peak hour
- Review of non-converged events
  - Is it switched shunt toggling or voltage collapse?

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Utility Design Limits

- How do we know we are ‘keeping the lights on’? What is acceptable voltage? What thermal ratings are used?
- Thermal limits: Category A normal. Category B,C,D use emergency
- Voltage limits: Category A 0.95 to 1.05 per unit, contingent 0.9 to 1.1 pu. Metro areas 0.92 pu. Many other variations

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Load Deliverability

- Probabilistic Loss of Load Expectation analysis. Can system serve load under worst generation outage event
- De facto industry standard of 1 day in 10 years generation outage event
- Issue is resolved by increasing transmission import capacity or adding generation

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Generation Deliverability

- Energy market related analysis
- Can generation in market be delivered to all of market? Are there generator outlet constraints?
- Network Resources should be fully deliverable. Energy Resources use available transmission capability.

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Voltage Stability

- Power-Voltage (PV) analysis
  - Critical interfaces or load area imports. Export/import limits on interfaces
- Reactive-Voltage (QV) analysis
  - Are there adequate reactive resources to withstand contingencies? How close are we to limit? Typically, load serving area study
- System wide screening studies. Analysis can be used to examine TPL voltage stability events also.

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Dynamic/Transient Stability

- NERC TPL events. Model size matters
- Severe events are analyzed
  - Selection based on experience
    - Faults with delayed clearing near large plants
    - Stressed interfaces between regions
  - Computationally intensive. Simulation one disturbance for 20 second period equivalent to running 80 steady-state cons.

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Small-Signal Stability

- PowerTech SSAT tool used
- Inter-area and local stability modes.
- Used to determine damping modes and need for Power System Stabilizers (PSS)
- How is this related to transient stability?
  - Frequency domain analysis vs. time domain. Examining point in time after event
  - System-wide interaction of machines (large groups of remote machines)

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Transfer Studies

- Linear analysis using SPTI MUST
- Can we move X MW from A to B?
- Zone to Zone transfer limits used in Load Deliverability studies
- Typically used in Transmission Service Request (TSR) studies.

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Reliability Analysis Results

- You just ran 100,000 contingencies. Now what are you going to do?
  - Converged, non-converged, blown
  - Valid vs. invalid results
  - Results database and reporting
- Map needs to projects. Mitigation Plan
- Document open issues
- Share results with stakeholders at SPM

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Other Needs

- Market efficiency via constraint reduction is also important issue to review in planning
  - Historical and future congestion is reviewed
- If congestion can be cost effectively mitigated with transmission, make the upgrades
- Market congestion is often not an indication of a reliability issue
  - Off-peak, economic flows result in system redispatch. System operated near limits. Economic transactions can be curtailed, if necessary
  - Congestion is reliability problem if cannot be operated around within safe operating limits. Firm use should be maintained.

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Solution Development

- FERC Order 890 has nine planning principles. Three of them are Coordination, Openness, Transparency
- It's a new world. Customers are involved in development of solutions
- Subregional Planning Meetings. Study teams as necessary
- Fix problem or fix contingency?

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Project Justifications

- Independent review by RTO/ISO
- Economic comparison of options
- How long does it work?
- Allocation of scare resources. Management needs to know why. Regulators need to know why
- Construction and permitting: I love electricity but...NIMBY, BANANA

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Regional Cost Allocation

- FERC requirement
- Midwest ISO method
  - Project classifications and applicable cost allocation
    - Baseline Reliability Projects (BRP) may be shared
    - Regionally Beneficial Projects (RBP) may be shared
    - Transmission Access Projects (TAP). Generator Interconnection Projects are shared.
    - Other Projects (local criteria) are not shared

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MTEP Report

- Snapshot of completed analysis prepared annually. Board of Directors approval in October
- Must communicate results of analysis in MTEP report. Not all readers are engineers. What did we learn? What does it mean?
- Hint: Write now, not at end of process. Easier to document analysis while you are doing it, then months later

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