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Expansion Planning Challenges and Research Gaps

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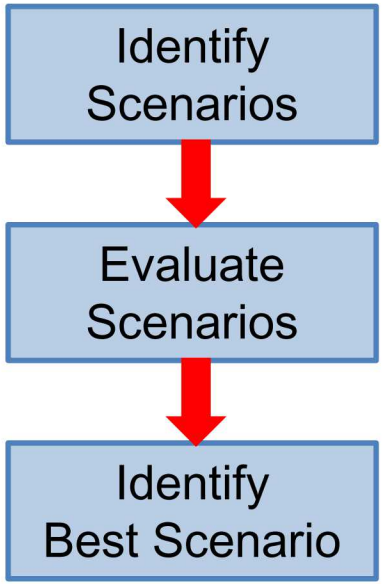
Expansion Planning Process



Transmission Planning
FERC Order 890
FERC Order 1000

Identify Scenarios

- Generator retirements
- Location of future renewable generation
- Representative load data/load models
- Representative renewable variability
- Consideration of interactions with additional infrastructure (e.g., natural gas, water, etc.)
- Identify contingencies (N-1 versus N-k)
- Identify metrics
- Modeling of DER's

Evaluate Scenarios

- Power flow analysis
- Contingency analysis
- Voltage assessments
- Transient stability assessment
- NERC Reliability Standards

Evaluate Scenarios

- Unit Commitment and Dispatch models (Production cost models)
  - Modeling renewable variability and reserve requirements
  - Linearized DC-OPF versus AC (reactive power and voltage)
  - Deterministic optimization, stochastic optimization, robust optimization

Evaluate Scenarios

- Threat -> consequence modeling
  - EMP, cyber, physical
- Incorporating resilience models
  - Metrics
  - Restoration/recovery models
  - Societal impact of long term outage
  - Co-optimizing resilience and reliability
- Modeling interaction with other critical infrastructure

Evaluate Scenarios

- Energy storage challenges
  - Siting and sizing requires technical and economic analysis
  - Evaluating alternatives is often difficult
  - Value is often based on definitions (e.g., what is capacity) and rate/tariff structure - introduces regulatory risk