Upon completion of this module you will be able to:

- Describe the role of Transmission Planning
- Name the ERCOT Network Models
- Describe role of NMMS in maintaining network models
- Describe process for submitting model changes
- Identify functions that use Transmission Ratings
- Describe use of Dynamic Ratings
Transmission Planning
ERCOT’s Role

Responsibility for overall planning of transmission projects for transmission grid:

- ERCOT supervises and exercises independent authority over planning
- TSPs participate in and perform detailed studies as needed

ERCOT’s authority with respect to transmission projects that are local in nature is limited to supervising and coordinating the planning activities of TSPs
Planning Criteria

• Joint Evaluation Responsibility

• ERCOT and TSPs evaluate the need for transmission system improvements, according to:
  • Public Utility Regulatory Act
  • PUCT Substantive Rules

• Technical reliability criteria is established by ERCOT Protocols & Operating Guides, ERCOT Planning Guides and NERC planning criteria
Regional Planning Group

- The RPG considers and reviews proposed projects to address transmission constraints and other system needs
- Any Market Participant may develop and submit proposed projects to RPGs
- Led and facilitated by ERCOT
- Open to all Market Participants, consumers, and PUCT Staff

ERCOT is responsible for leading and facilitating the RPG process. TSP participation is required.
Regional Planning Group Goals

- Ensure planning standards are met
- Promote planning and coordination between adjacent TSPs
- Seeks cost-effective balance between costs and lead times
- Promote Market Participant review of major transmission projects
- Evaluate new Generation Resources, including renewable technologies
Long-Term System Assessment

- Performed by ERCOT in coordination with the RPG
- Performed biennially (in even-numbered years) and reviewed annually
- Assesses system needs up to 20 years into the future
- Goal is to identify system upgrades which are:
  - Robust across a range of scenarios or
  - Might be more economic than upgrades the 1 to 6 year plan
Annual Planning Model

• Look ahead year by year for 6 years

• Posted by October 15\textsuperscript{th} of each year

• Model of ERCOT as it is expected to operate during peak load conditions for the corresponding future year.

• Consistent with Network Operations Model to the extent practicable.
Responsibility of ERCOT

• Monitor differences in Locational Marginal Prices and observed Congestion

On determination of Chronic Congestion*, ERCOT will:

• Identify the constraints causing the Chronic Congestion
• Validate the Network Operations Model and the Updated Operations Network Model with TSPs and REs
• Develop recommendations for resolution

* Chronic Congestion = an active or binding constraint on 3 or more Operating Days within a rolling 30 day period.
Transmission Project & Information Tracking Report

Presents the current triannual status of transmission projects which have a material impact to power flows in ERCOT

• Five Primary sections:
  • Improvement Cost Summary
  • Future Projects
  • Completed Projects
  • Cancelled Projects
  • Regional Transmission Plan Projects

• TSPs provide updates as required
• Archived Reports Posted to:
  ERCOT.com>Grid Information>Market Reports
Planning Wrap Up

• ERCOT is responsible for overall planning of transmission projects of the ERCOT transmission grid

• RPG has established goals and evaluation process

• ERCOT and TSPs jointly evaluate need for transmission system improvements and relative values

• ERCOT may ask TSPs & REs to validate network model data in situations of chronic congestion
Network Modeling
A Network Model is:

- Representation of a physical power system
- Includes the major Transmission Elements within that system
- “Snapshot” of the network for a specific period
Network Operations Model

- Physical Characteristics
- Ratings
- Operational Limits

Provided By:
- TSPs
- REs
- QSEs
Transmission Elements and Parameters

- Transmission (Greater than 60kV)
  - Lines
  - Buses
  - Breakers and Switches
- Transformers
  - Autotransformers
  - Generation Resource Step-Up Transformers
- Reactors, Capacitors and other Reactive Controlled Sources
- Resource and Transmission Loads
- Remedial Action Schemes and Plans, Automatic Mitigation Plans
Three Types of Network Models

- Network Operations Model
- Annual Planning Model
- CRR Network Model
Network Operations Model Definitions

- Network Operations Model – a representation providing the complete physical network definition, characteristics, ratings and operational limits of all elements of the ERCOT Grid and other information from TSPs, REs & QSEs.

- Updated Network Operations Model – a computerized representation of the physical network topology, including some Resource Parameters, all of which replicates the forecasted or current network topology needed by ERCOT to perform its functions.
Network Operations Models

• Bus/Breaker Model

• Means that breakers and switches showing the connectivity of transmission elements are included in the model
Network Operations Models are used in:

**Day-Ahead Operations**
- Day-Ahead Market LMPs & SPPs
- Day-Ahead Market Awards
- Day-Ahead Reliability

**Real-Time Operations**
- Real-Time LMPs and SPPs
- Resource Dispatch Base Points
- Real-Time Reliability
- Real-Time Outage Status
Redacted Network Operations Model

A Network Operations Model, used by Non-TSP Market Participants, redacted to exclude CEII data pertaining to:

- Private Use Network Load data
- Defined Resource Parameters
Annual Planning Model Definition

- Annual Planning model – developed for each of the next six years that contain, as much as practicable, information consistent with the Network Operations Model.

- Model of the power system as it is expected to operate during Peak Load conditions for the corresponding future year.
Annual Planning Models:

• Bus/Branch Model

• Means connectivity is represented, but circuit breakers and switches themselves are not included in model.

• Considered less detailed than Bus/Breaker model
Annual Planning Models are used to:

- Identify system growth & needs
- Plan future projects (1-6 years in advance)
- Make long-term decisions
- Dynamic studies
- Contingency (N-1) studies
CRR Network Model Definition

• A model of ERCOT network topology to be used in conducting a CRR Auction.

• It must be based on, but is not the same as, the Updated Network Operations Model.
CRR Network Models

- Bus/Branch Model
- Means connectivity is represented, but circuit breakers and switches themselves are not included in model.
- Used to determine quantity of available CRRs for a given CRR auction.
Roles and Responsibilities: ERCOT

• Manage the Network Models using the Network Modeling Management System (NMMS)

• Use consistent information between models
  • Network Operations Models
  • Annual Planning Models
  • Congestion Revenue Rights Network Models

• Use the Network Operations Model Change Request (NOMCR) and the Resource Asset Registration Form (RARF) processes to control data input to models
Roles and Responsibilities: ERCOT

- Perform and post periodic updates to Network Models
  - Network Operations Models
  - Annual Planning Models
  - CRR Network Models

Weekly | Next 6 Years | Each Auction
Roles and Responsibilities: TSPs

- Provide updates to Network Models
- Provide updates to Transmission Project and Information Tracking (TPIT) Report
- Provide accurate modeling data
- Provide accurate telemetry mapping
- Provide planned construction information
- Adhere to naming and parameter conventions
- Provide data used to calculate dynamic ratings
Roles and Responsibilities: REs & QSEs

• Resource Entities
  • Provide updates to Network Models related to Resource Registration
  • Provide accurate modeling data
  • Provide a Commissioning Plan and Checklist
  • Adhere to naming and parameter conventions

• Qualified Scheduling Entities
  • Provide accurate telemetry mapping
  • Adhere to naming and parameter conventions
Impacts of Network Modeling
Model Change Management
How is this done at ERCOT?

Network Model Management System

• Used to prepare and manage all ERCOT Network Models

• Single point of management
  • Automated processes to ensure consistency across models

• Designed to meet Nodal Protocol modeling requirements
Change Management

• Additions and changes to the system must be coordinated with ERCOT so that the ERCOT Transmission Grid can remain accurately represented.

• TSPs communicate additions and changes to the network model to ERCOT through the use of:
  - Network Operations Model Change Requests (NOMCR)
  - Planning Model Change Requests (PMCR)
  - Special Action Model Request (SAMR)
Types of Model Change Requests

Network Operations Model Change Request (NOMCR)
Used to update Network Operations Model
For changes occurring within one year

Planning Model Change Request (PMCR)
Used to update Planning Models
For changes up to five years in the future

Special Action Model Request (SAMR)
Used to report information not yet modeled, but is related to modeling

PMCRs and SAMRs are considered a special case NOMCR. Submittal rules for NOMCRs also apply to PMCRs and SAMRs
Network Operations Model Change Requests (NOMCRs)

When do TSPs use NOMCRs?

- Adding/removing/modifying
  - Transmission Lines
  - Breakers & switches
  - Electrical buses
  - Telemetry points
- Submitting proposed energization dates
- Reporting construction sequence outages
- Changing existing line parameters
- Submitting dynamic ratings tables
- Submitting name changes

Note: Energization dates require preceding outages.
Important:

- Submittal Timelines Apply to REs & TSPs
Deadlines for:

- Submitting changes
- Publishing models
- Completing final tests
- Updating Production Environment

<table>
<thead>
<tr>
<th>In Service Month</th>
<th>Submit Changes</th>
<th>Publish Models</th>
<th>Final Tests</th>
<th>Production Environment</th>
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Lifecycle of a NOMCR

MIS Postings

- NOMCR Submitted
- Notice of NOMCR Receipt Posted

New Base Models for Month

- Day 1
- Day 5
- Day 15
- ~45 Days Prior to 1st of Month

NOMCR Approved or Rejected

MIS Postings
Testing and Validation Process

- Submit Model Changes
- Access Model
- 90 days (approx.)
- Jan 1 to Apr 30:
  - Model Tested & Prepared
  - Model Posted to Market
  - Model Finalized
  - Live Model
- Initial Testing
- Full Model Testing
- Final Testing
Postings

ERCOT shall:

• Post the full Network Operations Model to the MIS Certified area for TSP review
• Post the Redacted Network Operations Test Model to the MIS Secure area for other Market Participants review.
When do TSPs use Planning Model Change Requests?

• Add/remove transmission line or electrical buses
• Report expected in-service date
• Change existing line parameters
• Submit future dynamic ratings

For a Planning Model change to get into the Network Operations Model, the TSP must resubmit the data in a NOMCR
When do TSPs use Special Action Model Change Requests?

- To report modeling-related information
- Remedial Action Schemes (RASs), Remedial Action Plans (RAPs) and Automatic Mitigation Plans (AMPs)
- Line Rating Methodology Reports
- Contingency Definitions
- Miscellaneous documents, diagrams, etc.

ERCOT posts all RASs, RAPs and AMPs under consideration on the MIS Secure Area within five Business Days of receipt.
Model Change Process Wrap Up

NOMCRs are use to update the Network Operations Model

• Used to add/remove or modify transmission facilities
• Takes 15 days between submittal and approval/rejection
• Schedule exists for when changes must be submitted and when they are go-live.
  • PMCRs make changes to the Network Planning Model
  • SAMRs report modeling-related information
  • PMCRs and SAMRs are special cases of the NOMCR
Transmission Ratings
Ratings protect facilities from thermal overloads

- Transmission Lines (line flow ratings)
- Transformers (winding ratings)

Ratings may be Static or Dynamic

- Static ratings not automatically adjusted
- Dynamic Ratings automatically adjusted based on factors (temperature or wind speed)

Dynamic ratings may also be adjusted by ERCOT Operations Support
Ratings

- Used as the basis for constraints in the Network Models
  - Network Operations Models
  - Annual Planning Models
  - CRR Network Models
- Impact
  - Day-Ahead Operations
  - Real-Time Operations
  - Security Analysis
  - CRR Auctions
Four Types of Ratings

- **Normal** - rating at which a Transmission Element can operate indefinitely without damage
- **Emergency** - 2-Hour MVA rating of a Transmission Element
- **Conductor/Transformer** - 2-Hour rating of the conductor or transformer only
TSPs submit Transmission Ratings to ERCOT

- New equipment installation
- Rating changes
  - Old rating vs. new rating
  - Effective date
- Text reason for rating change
- Must adhere to submitted Ratings Methodology (posted for all equipment)

ERCOT may request updates for observed inconsistencies or repetitive binding constraints.

ERCOT may request TSPs upgrade to using dynamic ratings to provide significant added economic efficiency to the Market.

Real-Time Dynamic Ratings may be found at MIS>Grid>Transmission
## Transmission Ratings Impacts

<table>
<thead>
<tr>
<th>Formation of limits and constraints</th>
<th>Normal Rating</th>
<th>Emergency Rating</th>
<th>15-Minute Rating</th>
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<tbody>
<tr>
<td>Planning Studies</td>
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<td>Day-Ahead Market (Energy Offers and Bids, Ancillary Services Offers, LMPs)</td>
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<td>Reliability Unit Commitment (commit and de-commit Resources to meet Capacity requirements)</td>
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<td>Network Security Analysis (State Estimator and contingency violations)</td>
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<tr>
<td>Security Constrained Economic Dispatch (Base Points, Real-Time LMPs)</td>
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<tr>
<td>CRR Auctions (CRR Offers)</td>
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<tr>
<td><strong>Real-time monitoring and alarming</strong></td>
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</tbody>
</table>

In all cases, the system will use dynamic ratings if available.
Dynamic Ratings

• Allow refinement of transmission and transformer limits
• In real-time using actual weather conditions
• In future hours using forecasted weather conditions

• Used for Elements in:
  • Network Operations Model
  • Network Planning Models
  • CRR Network Models

Dynamic Rating tables are input via the NOMCR process
Primary determinant for Dynamic Ratings

- Ambient temperature
- Cooler temperatures = more capacity
- Warmer temperatures = less capacity

![Diagram showing the relationship between temperature and MVA ratings.](image)
Primary determinant for Dynamic Ratings

- Ambient temperature
- Cooler temperatures = more capacity
- Warmer temperatures = less capacity

Wind speed may also be used to calculate Dynamic Ratings

Dynamic Ratings improve the economic efficiency of the market
Real-Time Dynamic Ratings

• Provided through a Static Table which is then applied to real-time temperature readings or
• Provided through ICCP

On loss of weather-related data, the TSP can manually provide updated temperatures to ERCOT.
Forecasted Dynamic Ratings

In all cases, static tables and temperature are provided in addition to what may be telemetered. This allows ERCOT to reflect dynamic ratings in:

- Future operations planning studies
- Future transmission planning studies
- CRR Models
- Day-Ahead Market
- Reliability Unit Commitment

Forecasted ratings are calculated using the Weather Forecast from an external weather service.
Dynamic Ratings usage in future hours

- Hourly forecasts used for the rest of the Operating Day, and days 2 through 7
- Daily forecast high and low temperatures used for days 8 through 31
- Future dynamic ratings updated every hour
Postings and Reports

- Forecasted Temperature Adjusted Dynamic Ratings
- Real-Time Dynamic Rating Data
- Monthly Average Dynamic Ratings Report
- Dynamic Ratings Submission Exceptions

Dynamic Ratings may be found at MIS>Grid>Transmission
Ratings Wrap Up

- Ratings protect transmission facilities from thermal overloads
- Four types (Normal, Conductor/Transformer, Emergency and 15-minute)
- ERCOT may request updates as required due to observed inconsistencies
- Ratings may be static, or dynamic if available
- Dynamic rating used for future studies as well as real-time monitoring
- Primary determinant in dynamic ratings is temperature
In Summary - You should now be able to:

- Name the types of network models used in the ERCOT system
- State the consequences of inaccurate, inconsistent, and untimely modeling
- Describe the role of NMMS in maintaining network models
- Describe the process for changing data in Network Operations Model, CRR Model, and Network Planning Model
- Identify the functions that use Transmission Ratings
- Describe methods for delivering Dynamic Ratings to ERCOT