Reactive Discussion

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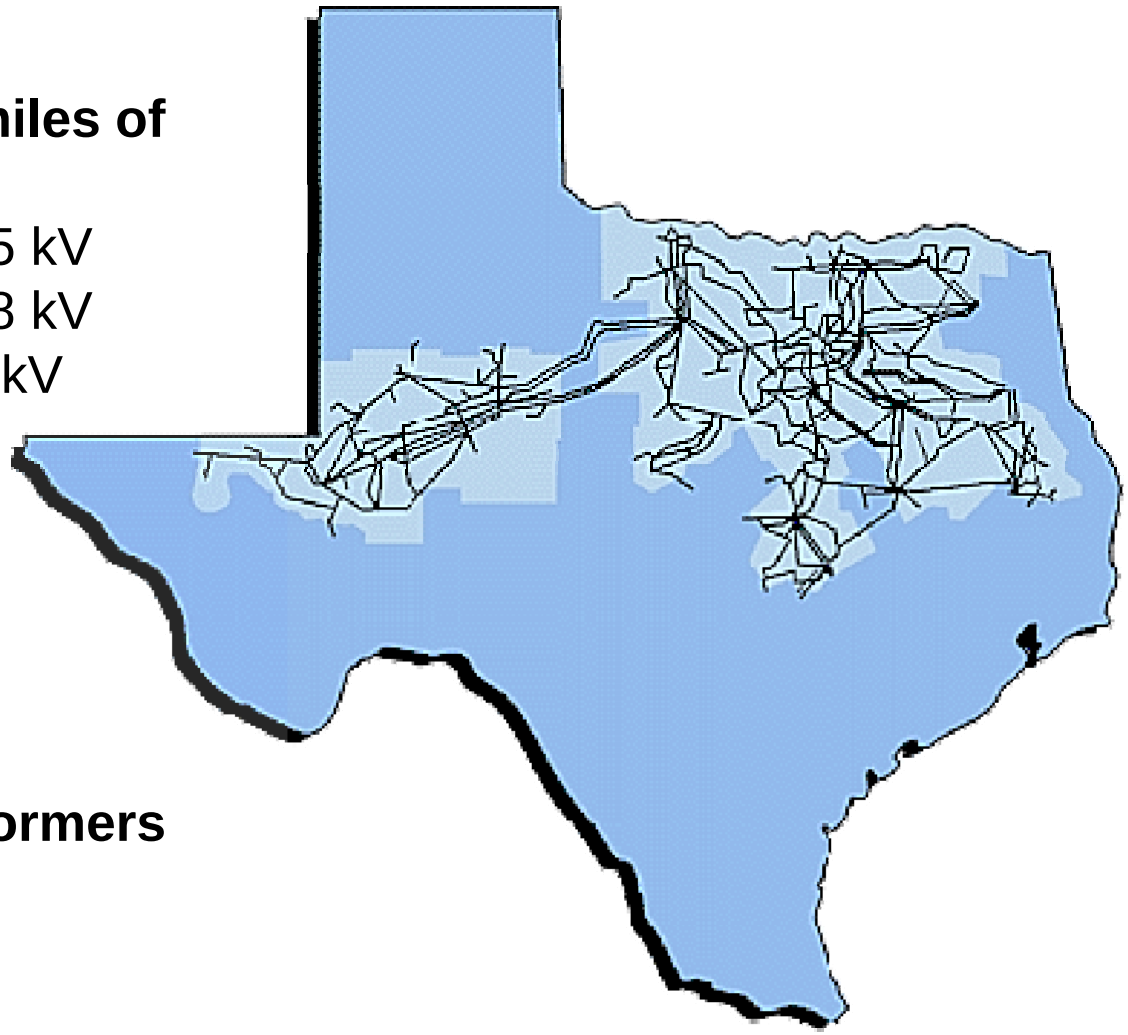
ONCOR SYSTEM

- **Wires Only Company**
- **Innovative Solutions**
- **Agility in Execution**
- **More than 14,900 circuit miles of Transmission including:**
  - 5,044 circuit miles of 345 kV
  - 6,916 circuit miles of 138 kV
  - 2,946 circuit miles of 69 kV
- **More than 970 Stations**
- **More than 1,550 Power Transformers**
- **More than 6,000 Breakers**
- **More than 180 Autotransformers**
- **Significant Load Serving Distribution System**



RELIABILITY REQUIREMENTS

- **Planning Standards and Criteria**
  - Normal Condition
  - First Contingency Condition
  - Second Contingency Condition, with adjustment
- **Operations Constraints**
  - Maintenance and construction feasibility
  - Complexity
  - Outages and clearances
  - Constantly changing

TYPES OF PROBLEMS

- **Thermal Overload**
  - Loading on an element is too high to allow needed dissipation of heat, resulting in damage (substation equipment and cable) or clearance violations (lines).
- **Voltage Problems**
  - Voltage either cannot be stabilized (voltage collapse) following a contingency event, or it cannot be maintained within a band acceptable to avoid potential damage to customer or utility equipment. Low voltage rather than high voltage, is the more common problem, by far.
- **Stability**
  - Synchronism cannot be maintained between generators, either because of a contingency event (transient instability), or because a deficiency in system damping causes oscillations which continue to grow (dynamic instability).

TEMPORARY SOLUTIONS CONSIDERED

- **Thermal**
  - Add temperature monitoring to allow real-time dynamic rating
  - Add a Special Protection System to reduce generation or reconfigure network
  - Create a Remedial Action Plan which directs specific operator actions
- **Voltage**
  - Change transformer taps
  - Replace remote generation with local generation
  - Maintain extra reactive reserve
- **Stability**
  - Add Special Protection System that trips some units to save others
  - Adjust operations to maintain dynamic reactive reserve

PERMANENT SOLUTIONS CONSIDERED

- **Thermal**
  - Increase thermal capability of the overloaded element
    - Reconductor lines
    - Rebuild lines
    - Raise line voltage
    - Increase line clearance
    - Add cooling to transformers
  - Redirect excess flow onto unconstrained parallel path(s)
    - Increase impedance of overloaded path (switchable thermal equipment, series reactors, FACTS devices)
    - Decrease impedance of parallel path(s) (series capacitors)
    - Build new parallel path(s)
    - Add phase-shifting transformer(s) (change phase angle)

PERMANENT SOLUTIONS CONSIDERED

- **Voltage**
  - Increase reactive power support in areas of depressed voltage
    - Improve load power factor
    - Add distribution feeder capacitors
    - Add substation (distribution or transmission) capacitors
    - Add dynamic reactive device (STATCOM, FACTS device) (synchronous condensor option rare)
  - Decrease reactive power losses in the network
    - Add series capacitors to lines
    - Add Static Synchronous Series Compensator (SSSC, FACTS device) to lines
    - Add Superconducting Magnetic Energy Storage (SMES) device

PERMANENT SOLUTIONS CONSIDERED

- **Stability**
  - Minimize fault duration (trip breakers quickly)
  - Add independent pole fault clearing
  - Decrease impedance of network by adding or upgrading lines
  - Install fast generation excitation systems (usually new generating units only, difficult to retrofit)
  - Use FACTS devices to boost voltage during faults, decrease line impedance, or provide damping through the modulation of reactive power flow
  - Add power system stabilizer(s) to increase damping of oscillations

REACTIVE COMPENSATION

Voltage control has been problematic in West Texas due to varying load, generation and transmission topology conditions.

Distance from large load centers adds additional complexity and challenges operations.

Appropriate dynamic/static and series/shunt reactive devices should be included to handle possible operating conditions. Plan should not be limited to account for unidentified operating conditions (additional reactive reserve).

Generally, we include shunt reactors to compensate for about 30% line charging.

We apply series reactors to redirect flows.

Actual reactive design to meet ERCOT reactive standard varies by location, study and actual operating conditions.

REACTIVE CAPABILITY TESTING

ERCOT Protocols:

- **6.10.3.5:**
  - generator must conduct reactive tests
  - testing required on "initial qualification"Planning Standards and Criteria

REACTIVE CAPABILITY TESTING

ERCOT Operating Guides:

- **3.1.4.3.1:**
  - Reactive capability curve (CURL) must be suppled by Generator to ERCOT
- **3.1.4.3.2:**
  - Non-coordinated Testing...QSE must schedule reactive verification tests with ERCOT
- **3.1.4.3.3:**
  - Coordinated testing: discusses testing
- **3.1.4.3.4:**
  - ERCOT implementation: ...ERCOT to review results of tests. Reactive tests to be reviewed by ERCOT to determine if they fall within 90% of CURL curve.
- **3.1.4.3.5:**
  - Enforcement of Unit Reactive Capability Testing....details of enforcement of reactive testing can be found on Compliance Template on ERCOT Compliance Web Page.

REACTIVE CAPABILITY TESTING

ERCOT Procedure:

- **Go to Services, Registration & Qualification, Resource Entities...**
- **New gen commissioning checklist...Operating Day....gen should make plans for MVAR testing**
- **RARF Guide, section 7.3 and 7.4 says gen to provide reactive curve data points and perform reactive testing.**