Resource Adequacy and Reliability Criteria Considerations

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Resource Adequacy Analysis in ERCOT

- The analysis of long-term resource adequacy in ERCOT is conducted in two separate steps:
  1. Comparison of forecasted loads to expected resources
     - The expected reserve margin is the amount of resources above forecasted load.
     - Results are published every six months in the Capacity, Demand and Reserves (CDR) Report.
  2. Mathematical analysis of the relationship between reserve margin and the risk of rotating outages
     - Reserves are needed due to unit outages, in case loads are higher than expected, and to account for variable generation.
     - These “loss-of-load” analyses inform the development of a target reserve margin (based on a predetermined index of the acceptable level of reliability).

Step 1: Resource Assessment

- The CDR Report provides a comparison of forecasted loads and expected resources for the next 10 years.
  1. Forecasted annual peak loads are based on average weather conditions over the past 15 years.
  2. Existing resources are included unless ERCOT has received official notification of a unit retirement or idling.
  3. New resources are included following completion of an interconnection agreement and air permit (if required).
  4. Wind generation is included at 8.7% of nameplate capacity.
  5. These rules for assessing loads and resources have been developed by market stakeholder committees and are documented in the ERCOT Planning Guides.

Step 2: Loss-of-Load Analysis

- A loss-of-load study is a probabilistic analysis of the risk of rotating outages at different reserve margin levels.
- In ERCOT, the loss-of-load studies account for load volatility due to weather, unit planned maintenance outages, unit trips (forced outages), and availability of variable wind generation.
- Loss-of-load studies can assess the probability of scarcity events, the expected number of hours of rotating outages, and the expected amount of unserved load at different reserve margin levels.
- The main drivers of the risk of rotating outages in loss-of-load studies are the reliability of the generation fleet and the variability of weather.
- In ERCOT, the results of loss-of-load studies are considered by market stakeholder committees and the Board of Directors during discussions leading to the determination of a target reserve margin.

Step 2: Loss-of-Load Analysis (cont.)

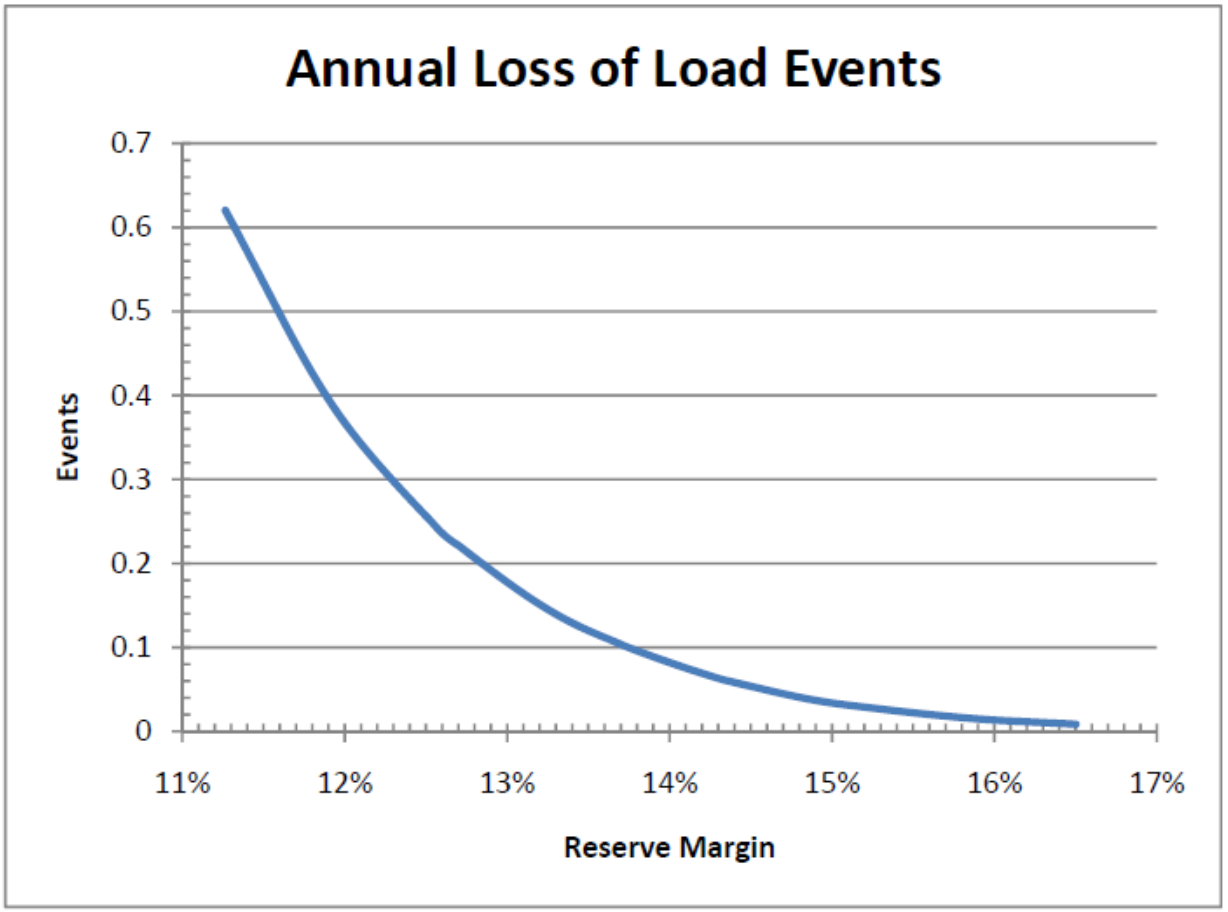
- Two analogies for loss-of-load studies:
  - Major league baseball 162-game regular season
    - Teams rotate through all of their starting pitchers over and over again (loss-of-load studies rotate through loads and wind generation based on all historical weather years).
    - Most of the games will run nine innings, with a few home runs.
    - Some of the games will have rare events, like a triple play, or all of the bullpen being used, or the Cubs winning the World Series.
  - Running a Las Vegas casino
    - Each evening is similar, with different people playing roulette, blackjack and other games of random chance.
    - Sometimes a set of unlikely events occurs, and the house loses or wins big, but, over the long-term, an average result emerges.
    - Similarly, loss-of-load studies model the same collection of random events thousands of times to quantify the expected result.

Variables in Loss-of-Load Studies

- Loss-of-load studies do include peak and off-peak extreme weather conditions.
  - Extreme load events such as April 2006 occur in loss-of-load scenarios.
- Loss-of-load studies do not account for multiple common-mode unit outages (fuel source disruptions, lack of adequate unit weatherization, sympathetic unit trips).
  - Although loss-of-load scenarios include loads consistent with December 1989 and February 2011 events, they do not account for the multiple correlated unit outages.
- Loss-of-load studies do not account for unit commitment error (insufficient available capacity committed in advance of extreme weather).
- Even though some of these conditions are not accounted for in loss-of-load studies, higher reserve margins would still increase grid reliability (especially with quick-start generation).

Loss-of-Load Study Results

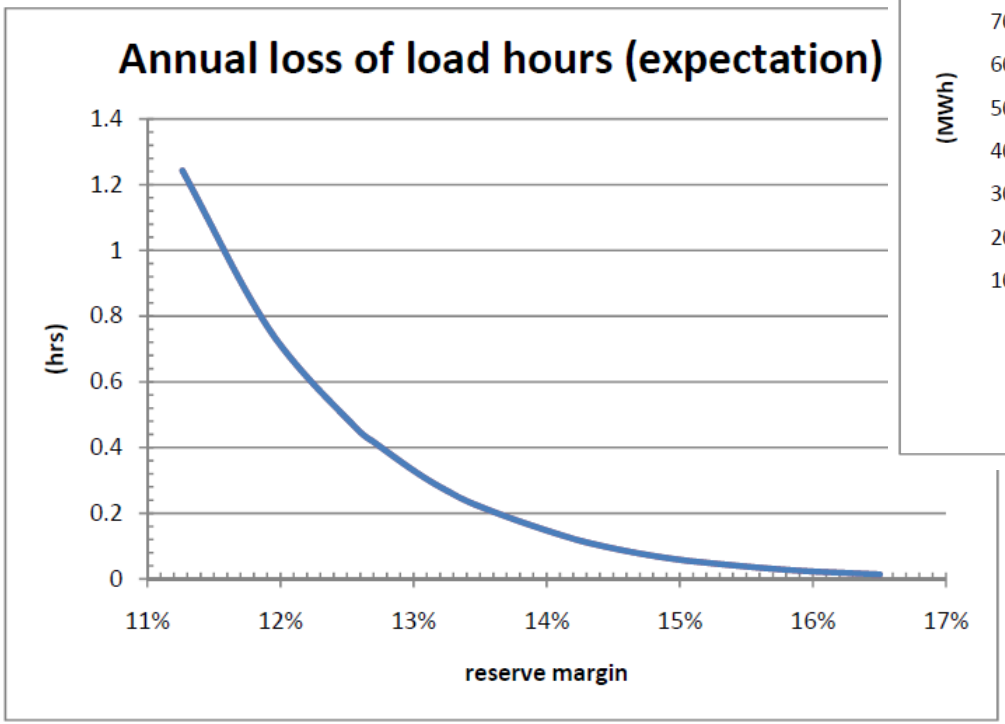
- Loss-of-load studies provide an assessment of the relationship between the risk of rotating outages and a range of reserve margin levels. The relationship is not linear.

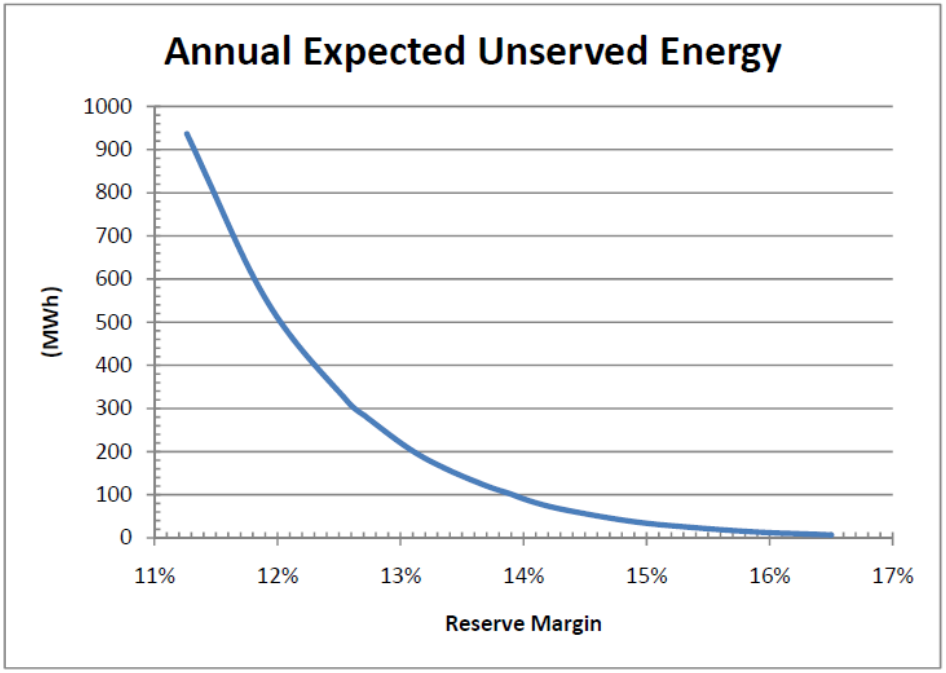


This chart (from the ERCOT 2010 Loss-of-Load Study) shows that having reserve margins just 1 or 2 percent above a target significantly reduces (but doesn't preclude) loss of load events. Reserve margins just 1 or 2 percent below the target will lead to a significantly greater number of events.

Loss-of-Load Study Results (Cont.)

These charts from the ERCOT 2010 Loss-of-Load Study show similar results for expected hours of rotating outages and the amount of unserved energy.





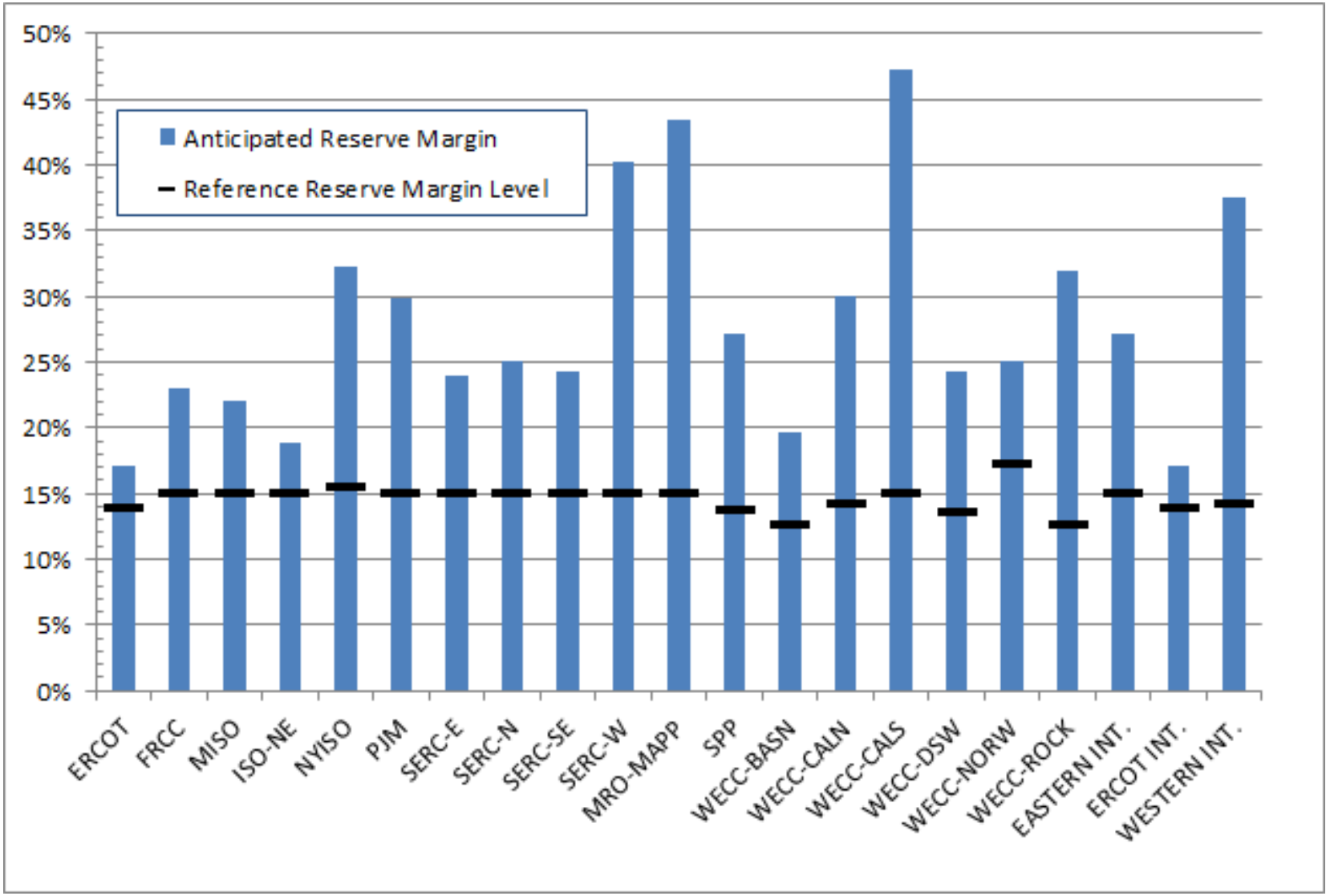
Developing a Target Reserve Margin

- In ERCOT, the target reserve margin has been generally based on the “one day in 10 years” standard as the acceptable level of the risk of rotating outages.
  - “One day in 10 years” has been interpreted to mean one loss of load event in 10 years.
- The “one day in 10 years” standard is not a legally binding requirement.
- Meeting this (or any) target reserve margin does not provide perfect reliability.
- The determination of a target reserve margin is based on the loss-of-load study results, market impact and public policy considerations.

Target Reserve Margins in Other Regions

- The “one day in 10 years” criterion is used in many other regions (Cal ISO, PJM, NE-ISO, Midwest ISO, and NY ISO). This target is widely interpreted to mean one loss-of-load event in 10 years.
  - In docket RM10-10 (Approval of NERC Regional Reliability Standard BAL-502-RFC-02), FERC defines the “one day in 10 years” standard such that: “…the expected frequency of loss of load due to inadequate resources does not exceed 0.1 events per year, which equates to one event in ten years.” Note: this regional standard only applies in the RFC region.
- Some regions use more stringent standards (BPA uses 1 in 20) or focus on the magnitude of outages (expected unserved energy) rather than the number of events.
- SPP has evaluated the impact of using a 24 hours-in-10 years standard.
- The target reserve margin in some regions is based on a minimization of total system costs (i.e., the cost of outages plus cost of new generation capacity).
- Target reserve margins in many regions are bolstered by reserve margin requirements in sub-regions.

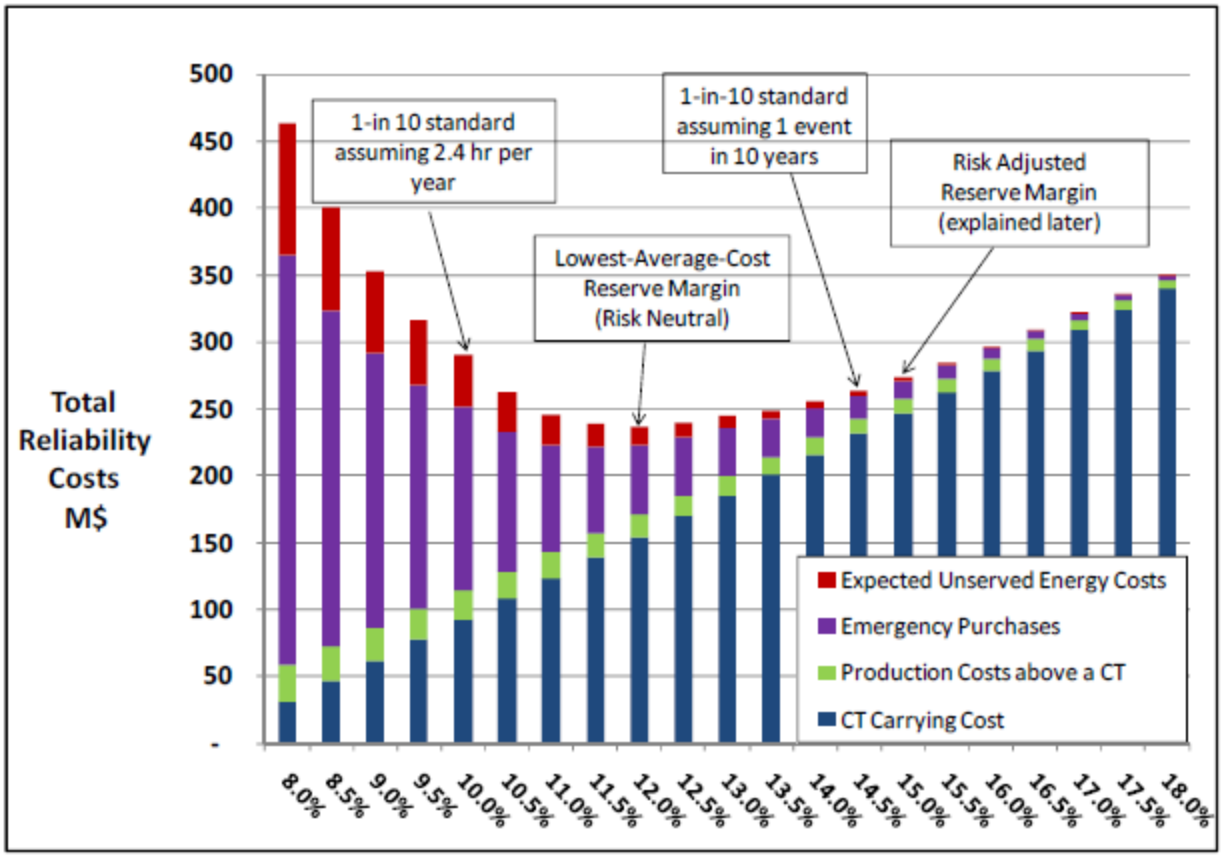
Regional Reserve Margins for 2011



Data from Tables 7 and 8 in the NERC 2011 Long-Term Reliability Assessment (Nov. 2011)

Economic Evaluation of Loss-of-Load Impacts

- Some regions evaluate the total customer cost of reliability and select a reserve margin that minimizes overall cost.
- Requires an evaluation of the regional value of unserved customer load



Source: Carden, Pfeifenberger and Wintermantel, *The Economics of Resource Adequacy Planning: Why Reserve Margins Are Not Just About Keeping the Lights On*, NRRI Report 11-09, April 2011.

Summary

- The CDR report shows us what reserve margins we expect to have. Loss-of-load studies show us what reserve margins we would like to have.
- The “one day in 10 years” standard is used widely in the industry, and is commonly interpreted to mean one loss-of-load event in 10 years due to resource inadequacy.
- The “one day in 10 years” target is not legally required and is not based on a region-specific assessment of economic impacts in the ERCOT region.
- Meeting a “one day in 10 years” target does not ensure there will be no rotating outages.
- Regardless of what the target reserve margin is, ERCOT will focus on maintaining operational reliability, using all tools available to the system operators.