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Support for NYISO Capacity Accreditation Project

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Overview

Goal: Support the NYISO in the selection of the technique used to determine the capacity credit or capacity value for different resources, using GE MARS

Presentation divided into:

- Introduction to MARS
- Capacity value and Expected Load Carrying Capability (ELCC)
- Overview of the approach

Introduction to GE MARS

GE's Multi Area Reliability Simulation (GE MARS)

GE MARS is a full sequential Monte Carlo simulation

Chronological system simulation performed by combining:

- Randomly generated operating histories of units through time
- Hourly chronological load cycles
- Transmission links

Years are simulated until a convergence criterion is met, or for a set number of samples

Monte Carlo Simulation

Random events to be considered

- Equipment forced outages
- Uncertainty in forecasted loads
- Transmission interface forced outages
- Uncertainty in renewable and storage output

System scenario created by randomly drawing availability of equipment based on historic data and probabilities

Each year is simulated with different sets of random events until statistical convergence is obtained

Reliability indices calculated

Expected value and distribution of

- Daily LOLE (days/year) calculated
- Hourly LOLE (hours/year)
- LOEE/EUE (MWh/year)
- Frequency (outages/year)
- Duration (hours/outage)

Unit types

- Thermal
- Cogeneration
- Energy limited
- Energy storage
- Hourly modifiers

Contracts

Firm contracts

Scheduled regardless of sending area sufficiency, curtailed only due to interface limits

Will be included in Isolated area metrics

Curtailable contracts

Scheduled only if sending area has sufficient capacity or can receive them as emergency assistance from other areas

If a sending area's margin is negative after curtailable contract is scheduled, the contract will be curtailed in proportion to the area's total shortfall

Emergency operating procedures

EOPs are steps taken as the reserve conditions on the system approach critical levels

May consist of load control and generation supplements which can be implemented before load has to be curtailed

- Load control measures could include disconnecting interruptible loads, public appeals to reduce demand, and voltage reductions
- Generation supplement includes overloading units, emergency purchases, and reducing operating reserves

Simulation process

Determine capacity available each hour from each unit in the system based on:

- Unit rating and capacity states
- Scheduled planned outages
- Random forced outages
- Renewable unit output
- Ambient unit derates

If any area has a negative margin, calculate flows between areas and resulting area margins

Accumulate statistics for interconnected indices

Repeat for each Emergency Operating Procedure until all area margins are positive, or a loss of load has occurred

Capacity Value

What is capacity value?

CAPACITY VALUE

Contribution towards meeting a reliability target

Determined by resource output during riskiest hours

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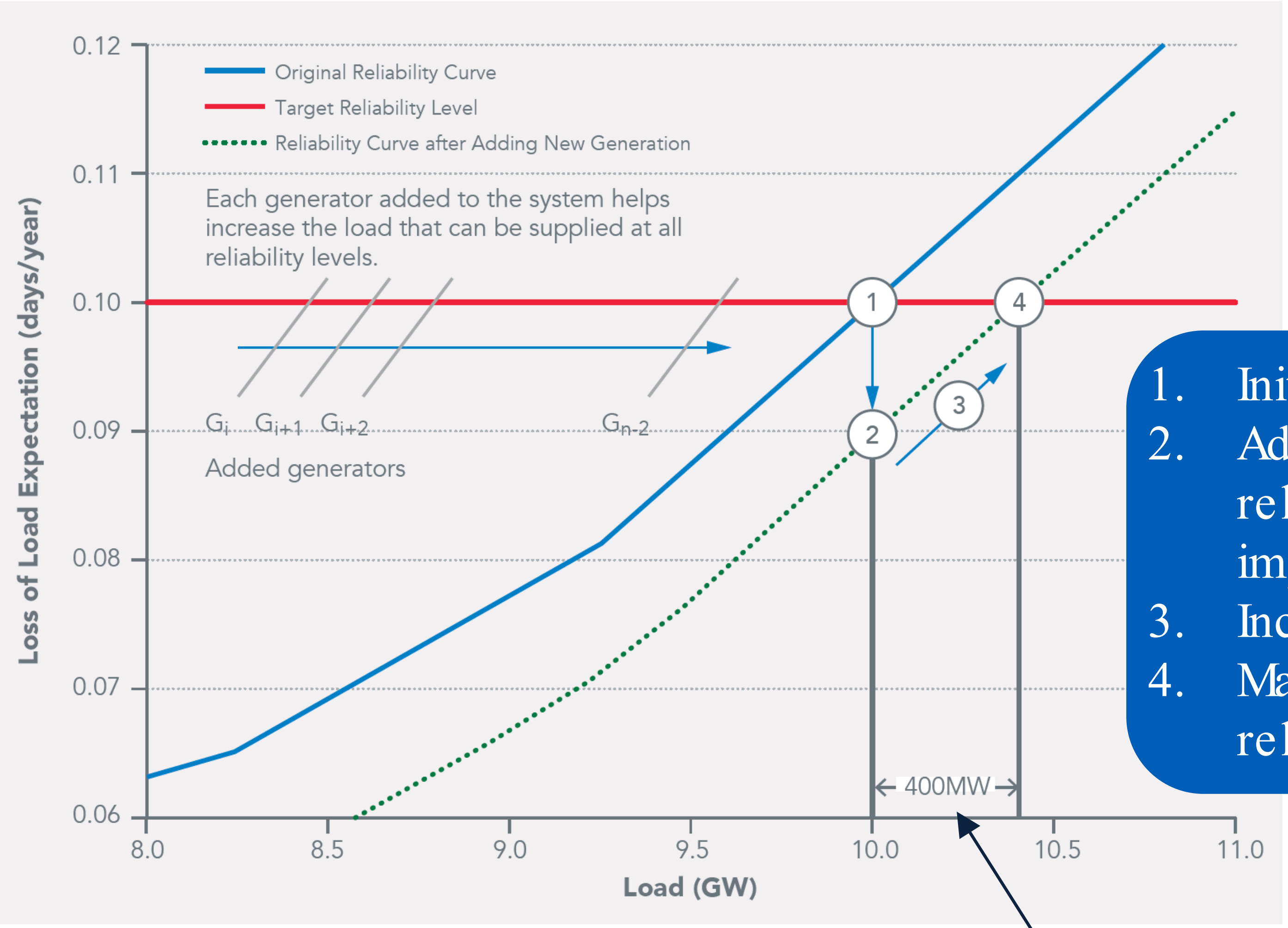
CAPACITY FACTOR

Measure of energy produced by resource

Determined by resource output during all hours

Effective load-carrying capability (ELCC) technique



1. Initial system
2. Add resource, reliability improves
3. Increase load
4. Match initial reliability target

J. Katz, P. Denholm "Using Wind and Solar to Reliably Meet Electricity Demand, Greening the Grid" http://www.nrel.gov/docs/fy15osti/63038.pdf

Effective load-carrying capability (ELCC) technique

Steps:

1. Start with the system "as is" and record the LOLE
2. Add resource to be measured
   (LOLE is reduced because the resource provides a contribution)
3. Remove perfect capacity by a fixed amount in the same location
   (LOLE gradually increases)
4. Stop when the LOLE returns to the original starting value (in 1)

The capacity value is the perfect capacity removed to bring the system back to the starting LOLE.

The capacity value as a percent of the resource's total capacity is the perfect capacity removed divided by the resource capacity added.

Iterative process could be computationally intensive. A simplified approach, such as Potomac's Marginal Reliability Improvement (MRI) could reduce the number of calculations.

Marginal Reliability Improvement (MRI) technique

Steps:

1. Start with the system "as is" and record the LOLE
2. Add resource to be measured. Record change in LOLE from starting system ($\Delta LOLE_{resource}$)
3. Replace resource with perfect capacity of the same size in the same location. Record change in LOLE from starting system ($\Delta LOLE_{perfect\ capacity}$)

$$\text{The capacity value is } \frac{\Delta LOLE_{resource}}{\Delta LOLE_{perfect\ capacity}}$$

The MRI technique produces capacity values bounded by 0 and 1 as $\Delta LOLE_{perfect\ capacity}$ will be greater than or equal to $\Delta LOLE_{resource}$

Proposed approach

Exploratory analysis

As mentioned by the NYISO, there are several parameters/open questions that need to be studied to better understand how they would impact results.

Project will start with:

- NYISO LCR database
- Using daily LOLE (days/year) as the driving metric

First questions:

- What tolerance should be used to establish that a case has converged?
- How large should the incremental resource be?
- What zones/locations should be considered?

Main Analysis

Determine how many resource types could be needed (for instance):

- Thermal generators
- Onshore wind: how does location (wind shapes) affect results?
- Offshore wind
- Solar
- Energy-limited resources (ELRs)
- Storage: how do hours of storage affect results?
- Demand-side resources
- Etc.

Summary

Capacity accreditation calculations can be computationally intensive:

- Iterative processes increase run times 10x normal simulations
- Variations across different "dimensions":
  - Location
  - Sizing
  - Resource type and characteristics

The project will determine a common approach across all resource types.

GE will provide NYISO staff with an implementation that is accurate and can be solved in a reasonable amount of time.

GE

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In this document, we sometimes use information derived from consolidated financial data but not presented in our financial statements prepared in accordance with U.S. generally accepted accounting principles (GAAP). Certain of these data are considered "non-GAAP financial measures" under the U.S. Securities and Exchange Commission rules. These non-GAAP financial measures supplement our GAAP disclosures and should not be considered an alternative to the GAAP measure. The reasons we use these non-GAAP financial measures and the reconciliations to their most directly comparable GAAP financial measures are posted to the investor relations section of our website at www.ge.com. [We use non-GAAP financial measures including the following:

- Operating earnings and EPS, which is earnings from continuing operations excluding non-service-related pension costs of our principal pension plans.
- GE Industrial operating & Vertical earnings and EPS, which is operating earnings of our industrial businesses and the GE Capital businesses that we expect to retain.
- GE Industrial & Verticals revenues, which is revenue of our industrial businesses and the GE Capital businesses that we expect to retain.
- Industrial segment organic revenue, which is the sum of revenue from all of our industrial segments less the effects of acquisitions/dispositions and currency exchange.
- Industrial segment organic operating profit, which is the sum of segment profit from all of our industrial segments less the effects of acquisitions/dispositions and currency exchange.
- Industrial cash flows from operating activities (Industrial CFOA), which is GE's cash flow from operating activities excluding dividends received from GE Capital.
- Capital ending net investment (ENI), excluding liquidity, which is a measure we use to measure the size of our Capital segment.
- GE Capital Tier 1 Common ratio estimate is a ratio of equity