



Renewable Capacity Value Analysis for the California RPS Integration Study

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- Goals of Capacity Analysis
- Reliability and Capacity Value
- Phase I Capacity Results
- Issues
- Next steps

Goal of Capacity Analysis

- Goal: Establish a method that can be applied to all renewable technologies to assess the capacity value that is contributed
- Phase I
 - Develop method to assess capacity benefit/value
 - Apply to current renewables in CA
- Phases II-III
 - Develop a method that can be used to evaluate potential bids from renewable developers
 - Location, technology, and other factors

Reliability and Capacity Value

Proposed Method

- Recommended a reliability-based approach
- Based on standard utility reliability analysis using LOLP or other reliability index
- Focus is on system adequacy
- The recommended approach can be applied to any generator in any system
- Based on physical behavior/risk
 - Solid foundation for a market/bids
 - Encourage reliability

Effective Load Carrying Capability (ELCC)

- Defined as the increase in load that can be supplied with a new generator, holding annualized risk constant

Effective Load Carrying Capability (ELCC)

- Reliability/adequacy required all year
 - Time-varying risk
 - Capacity that is provided during low-risk hours has relatively low value
 - ...but during high-risk periods has value, even if not the peak hour
 - We often don't know in advance when the annual peak will occur
 - Reliability is expensive, so we want to limit the system reliability, subject to LOLP criterion or other objective
- ELCC can finely discriminate between generators with varying reliability characteristics, size, intermittency

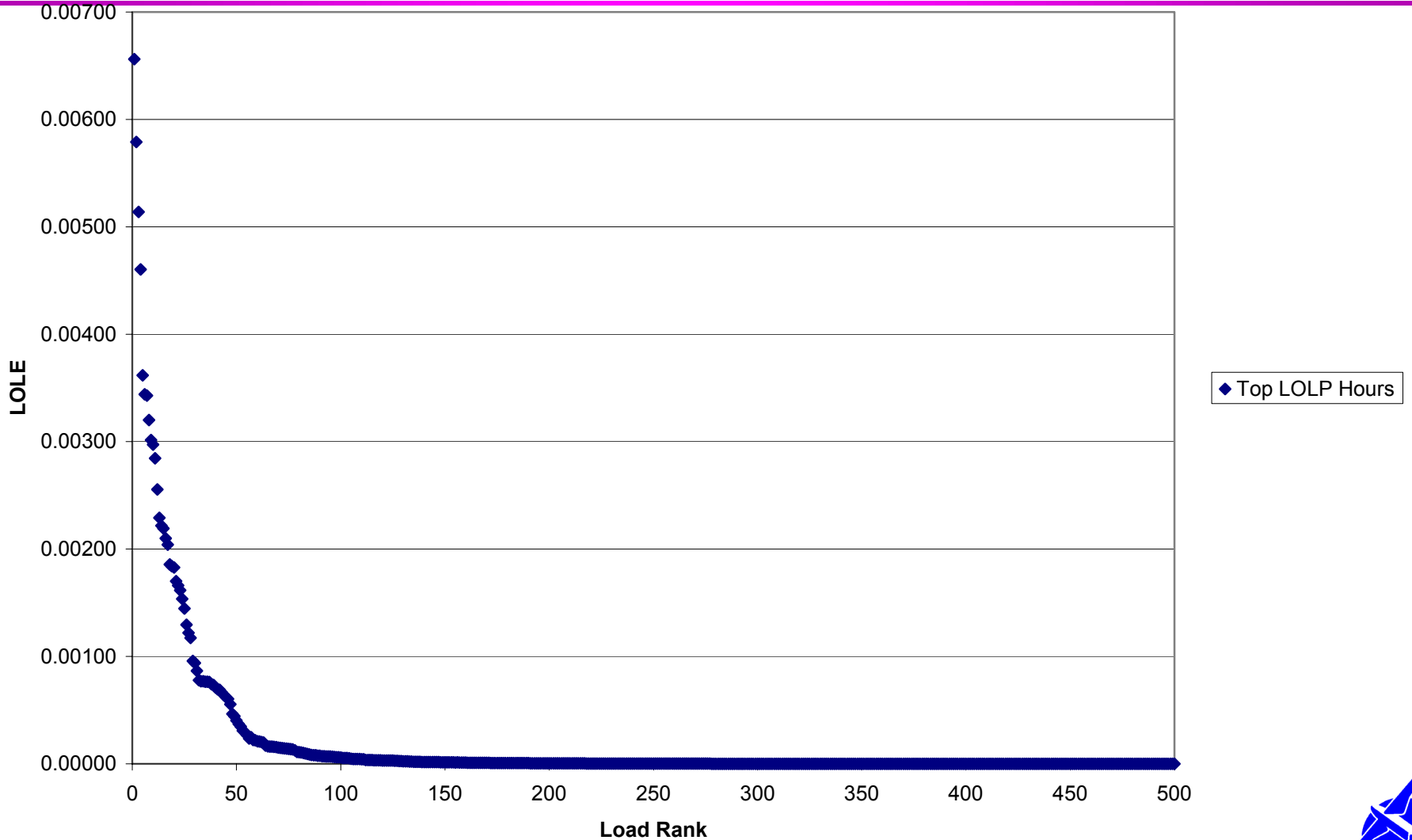
What Can ELCC Distinguish Between?

- Reliable vs. unreliable units
- Large vs. small units
- Base-load units vs. intermittent units
 - Intermittent units with different time profiles
 - Units that are available during high-risk periods vs. those that aren't

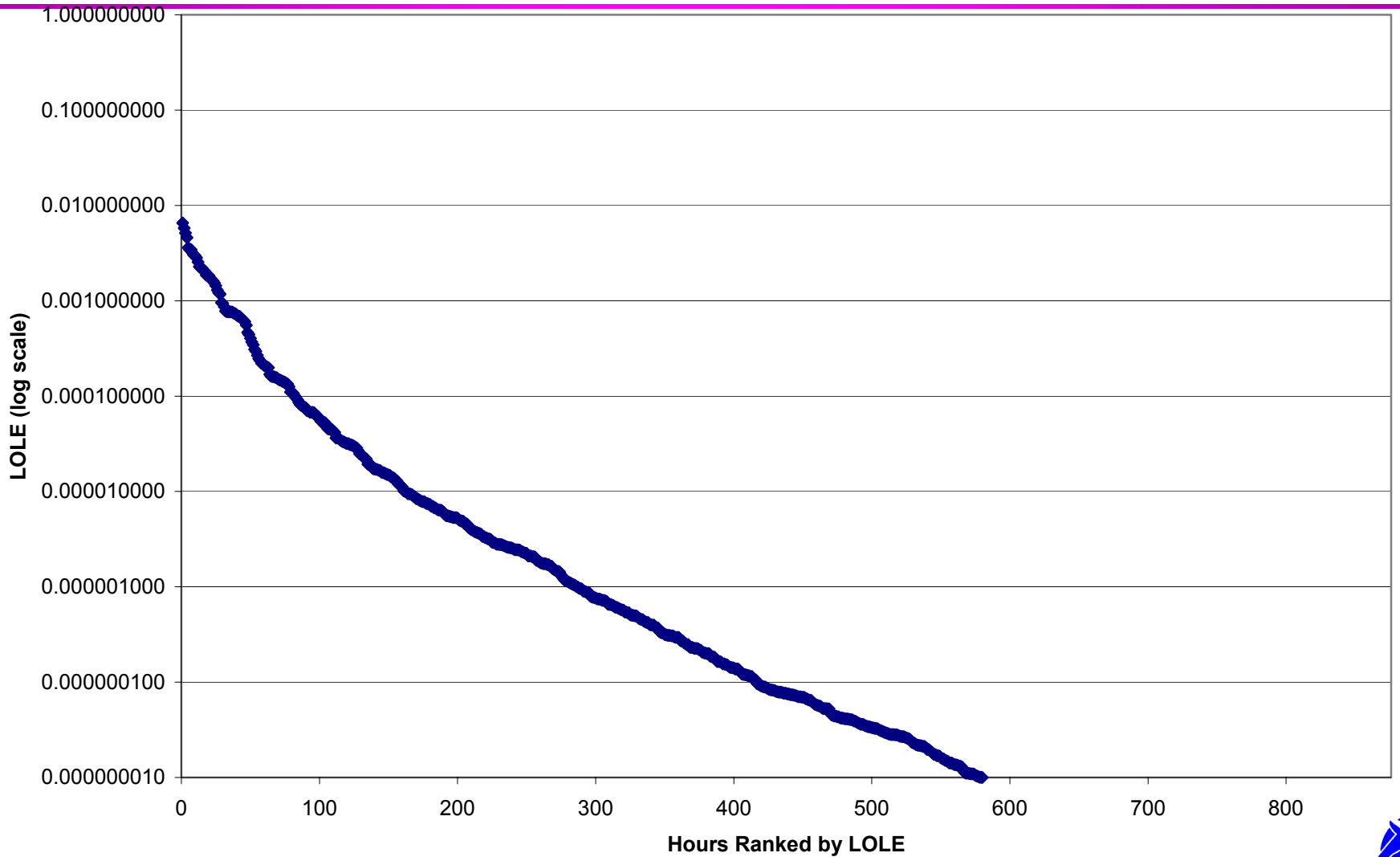
Recommended Approach

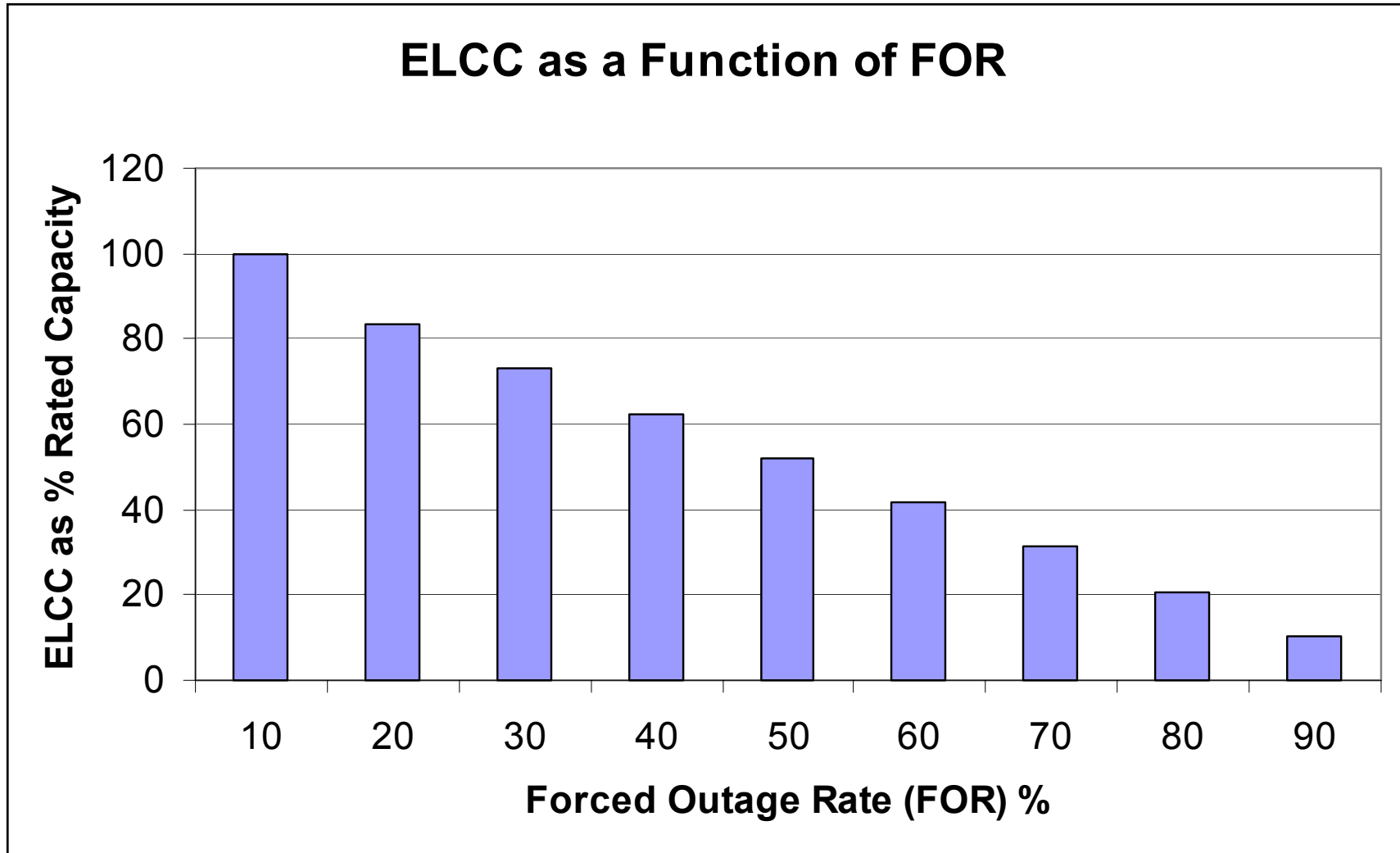
- Establish the relationship between ELCC and capacity factor for existing renewable generation
- Evaluate whether a simplified method can do a good job of capturing ELCC
- Based on findings, use simplified method for bid evaluation process for each relevant generation technology

Reliability and Top 500 Hours Ranked by Load/LOLP (See legend)



LOLE Duration

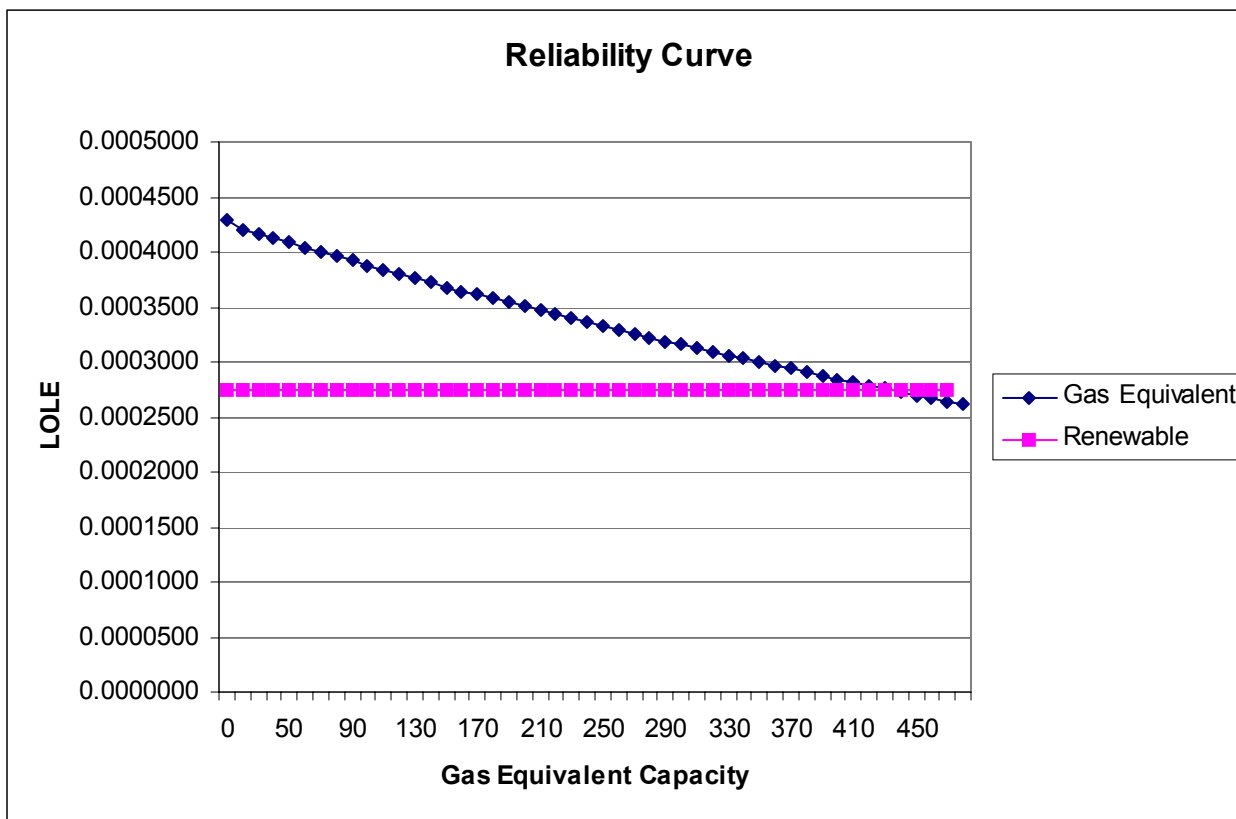




Phase I Capacity Results

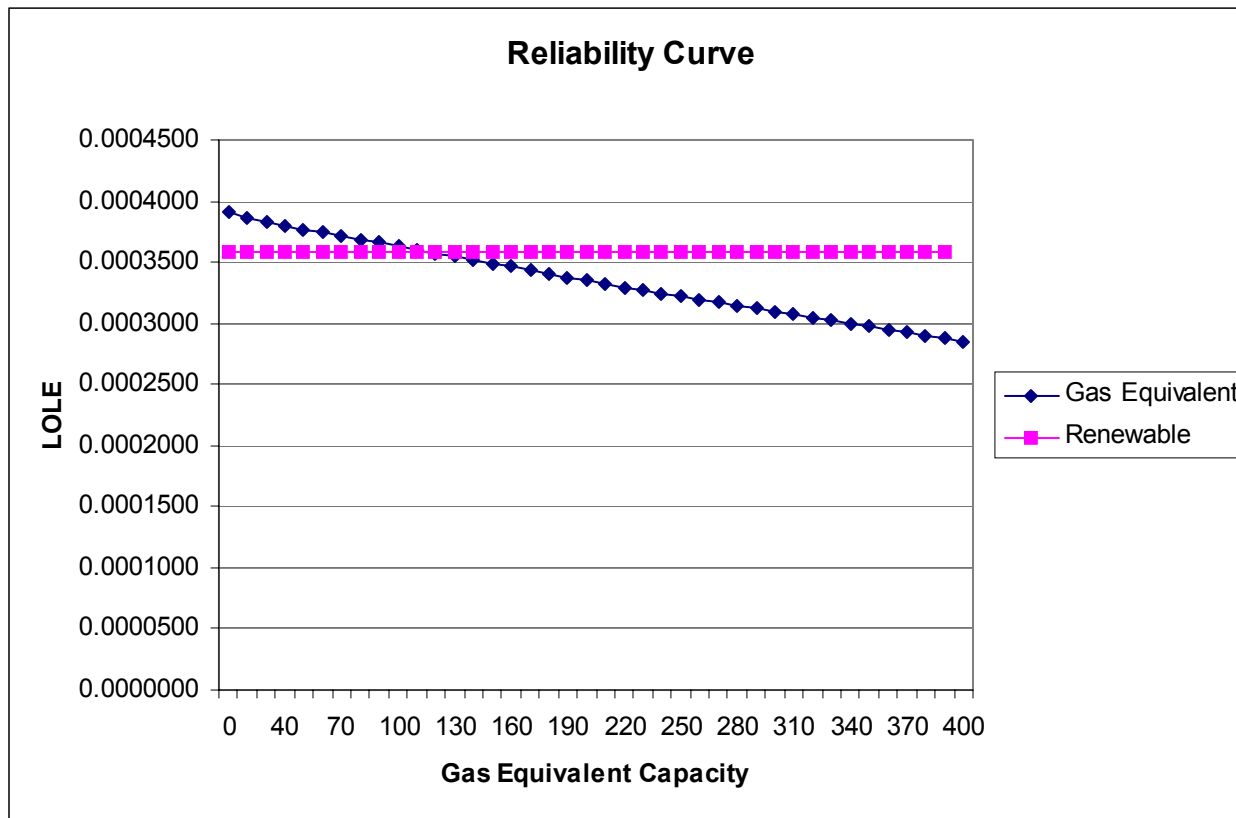
Biomass

ELCC = 97.8%



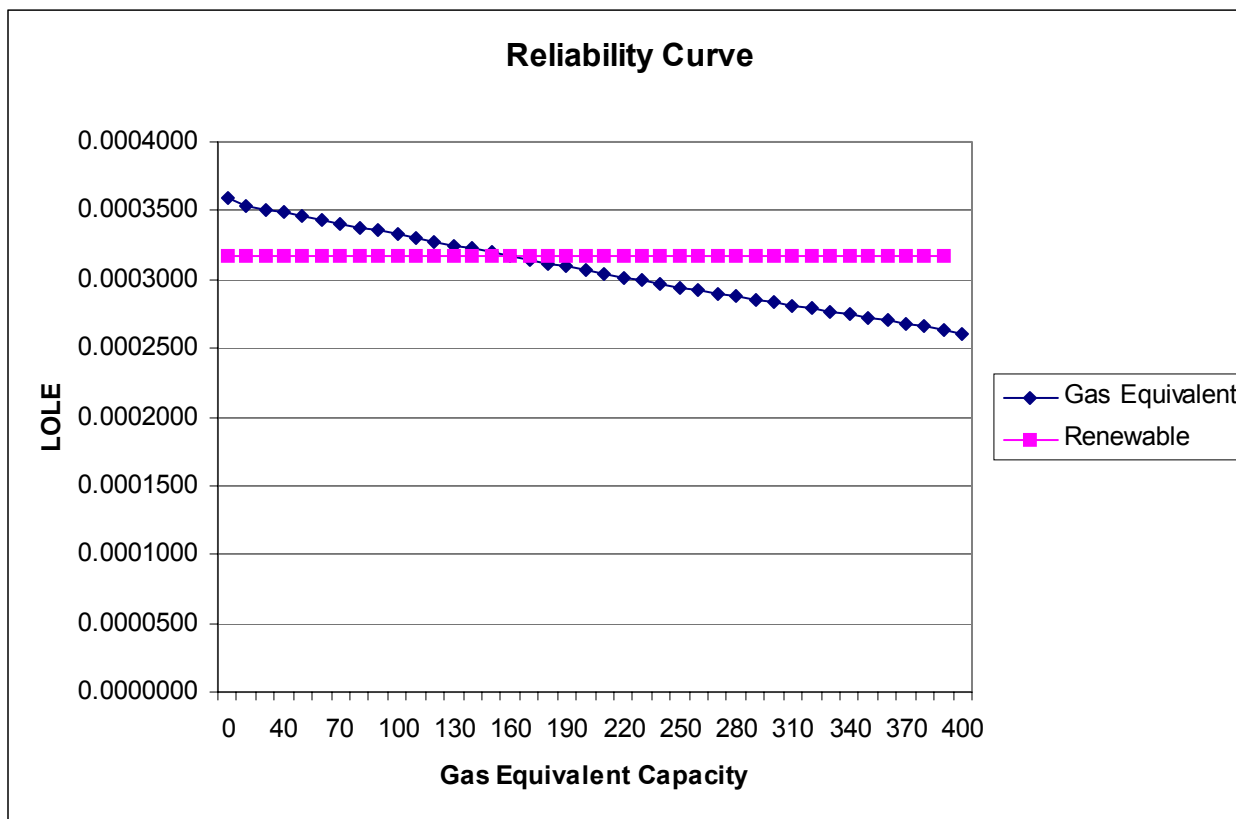
Geothermal (steam constraint and dispatch response)

ELCC = 73.6%



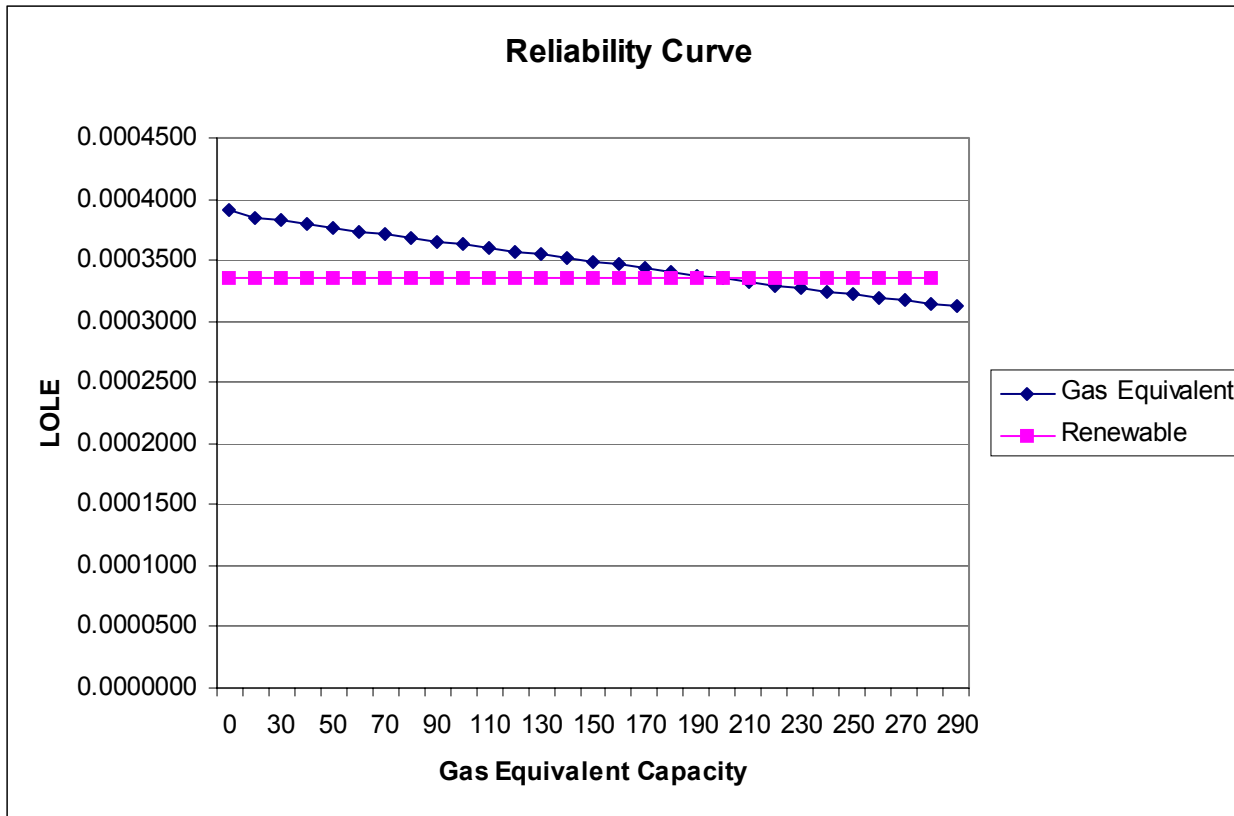
Geothermal (no steam constraint)

ELCC = 102.3%

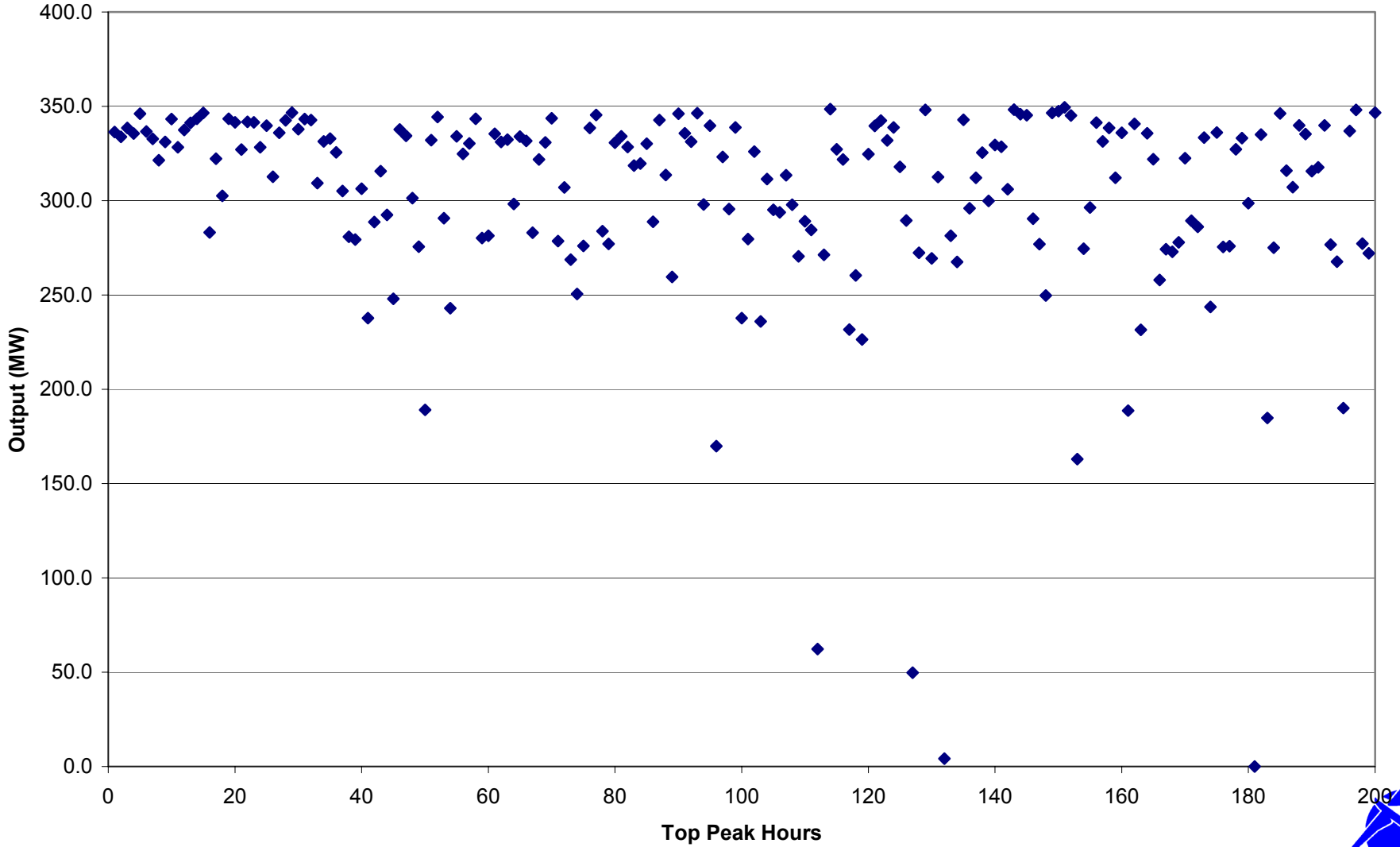


Solar

ELCC = 56.6%

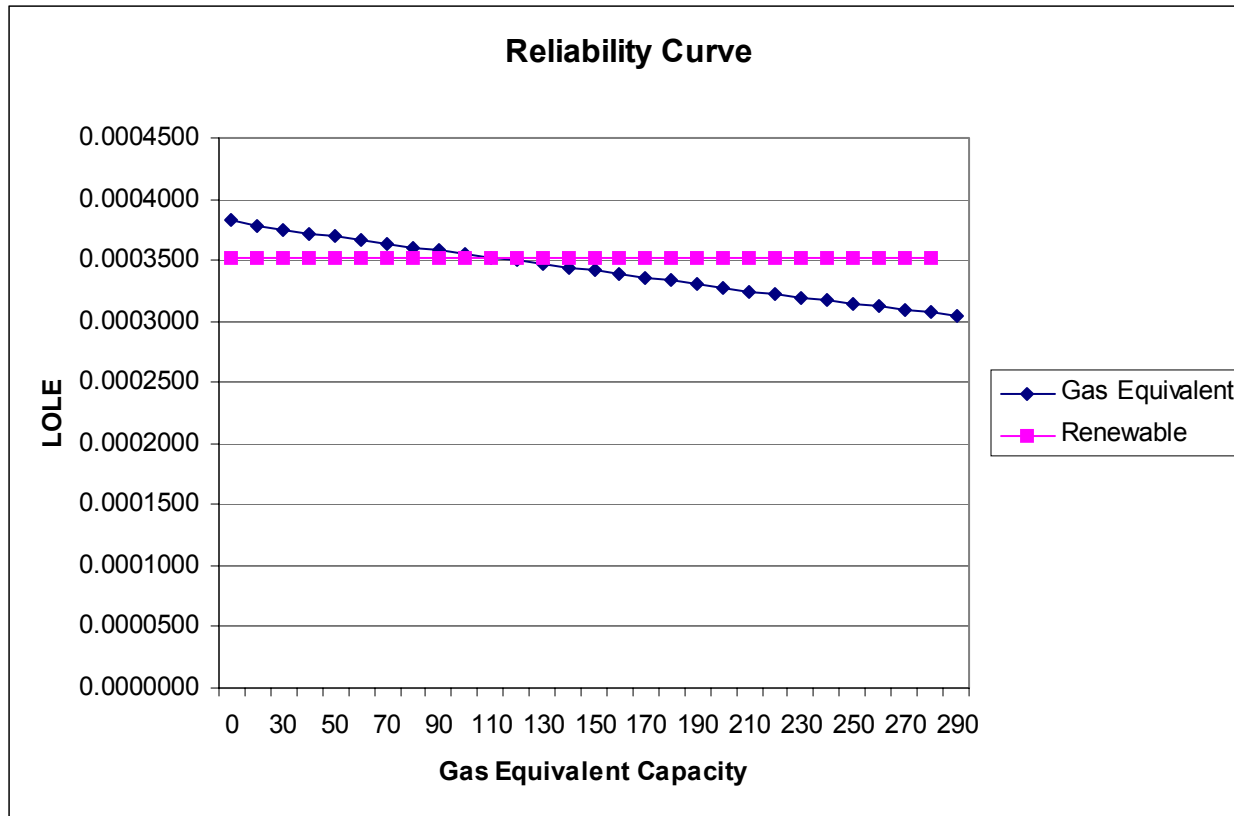


Solar Output



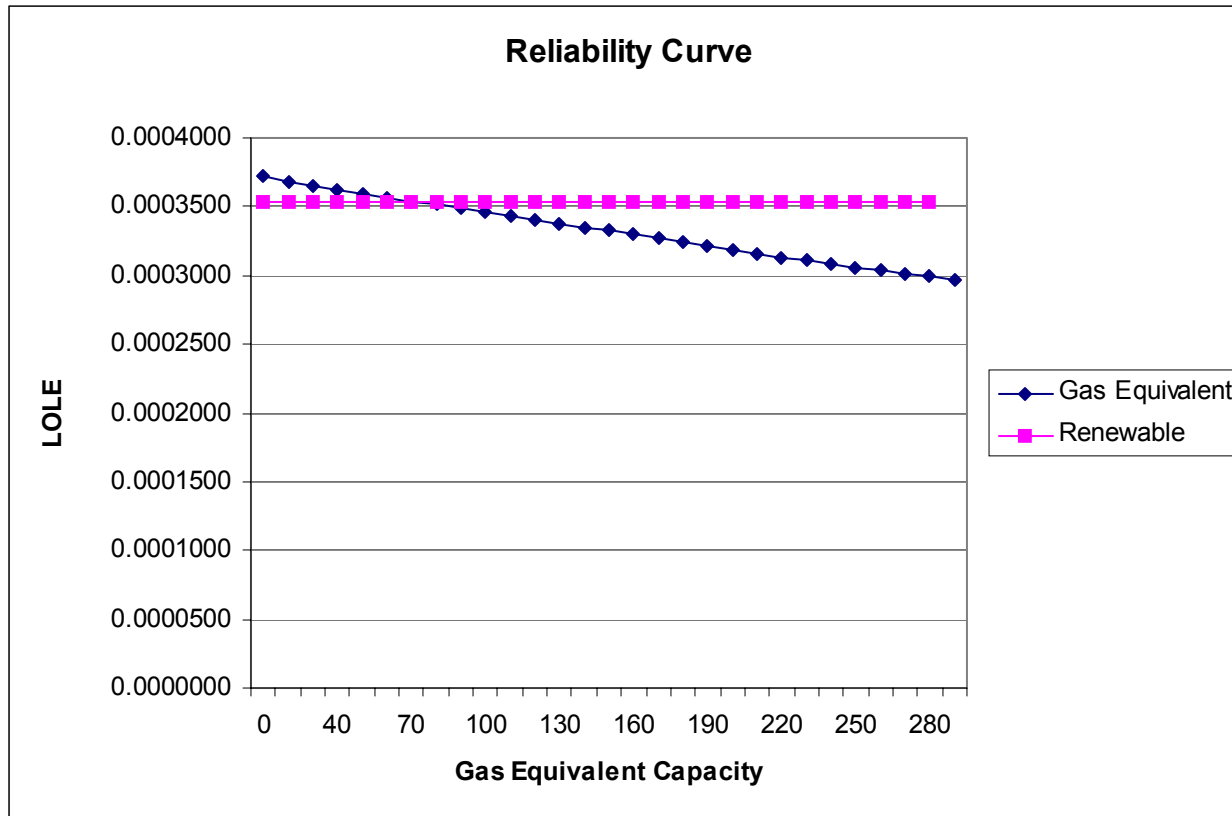
Wind A

ELCC = 26.0%



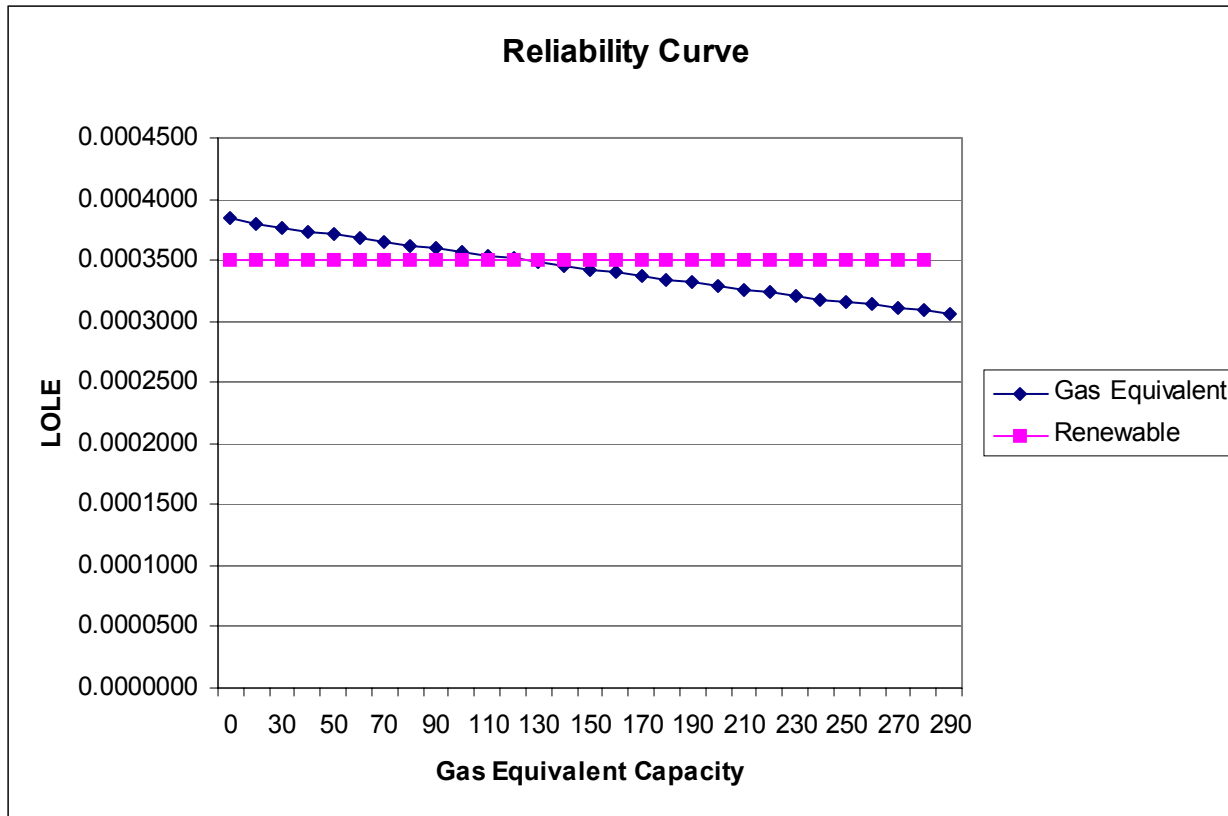
Wind G

ELCC = 23.9%

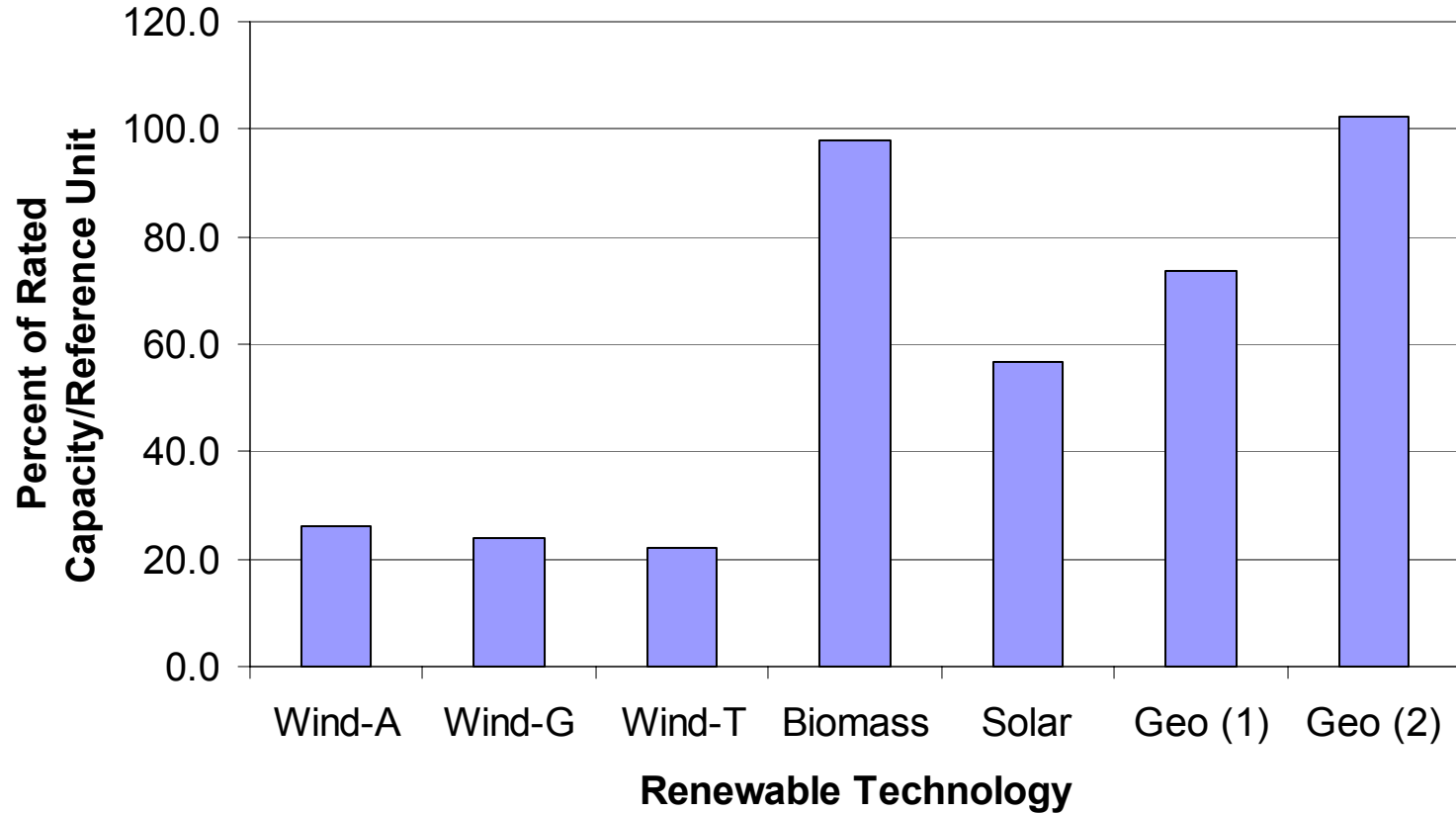


Wind T

ELCC = 22.0%



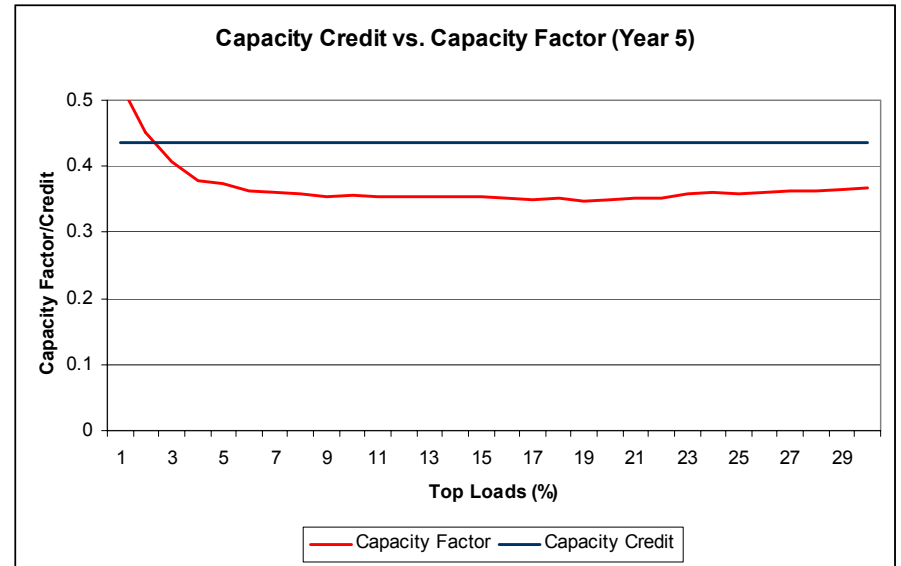
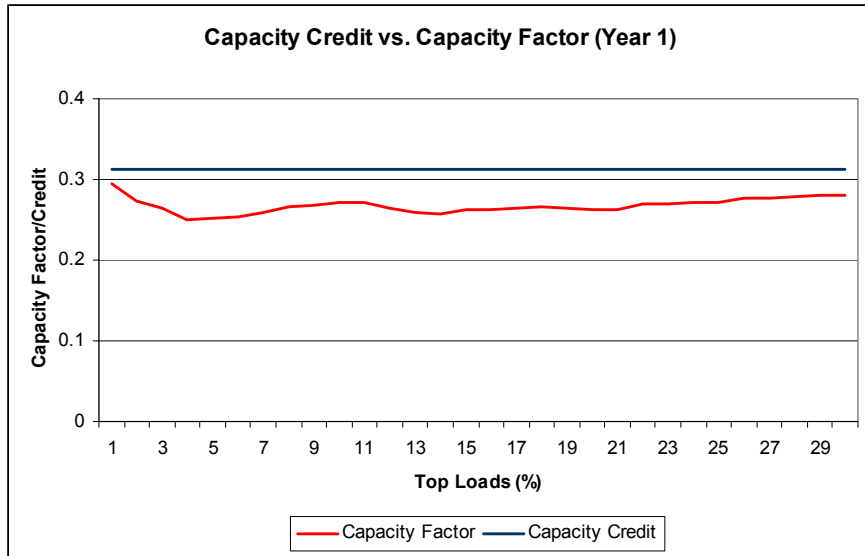
ELCC Results



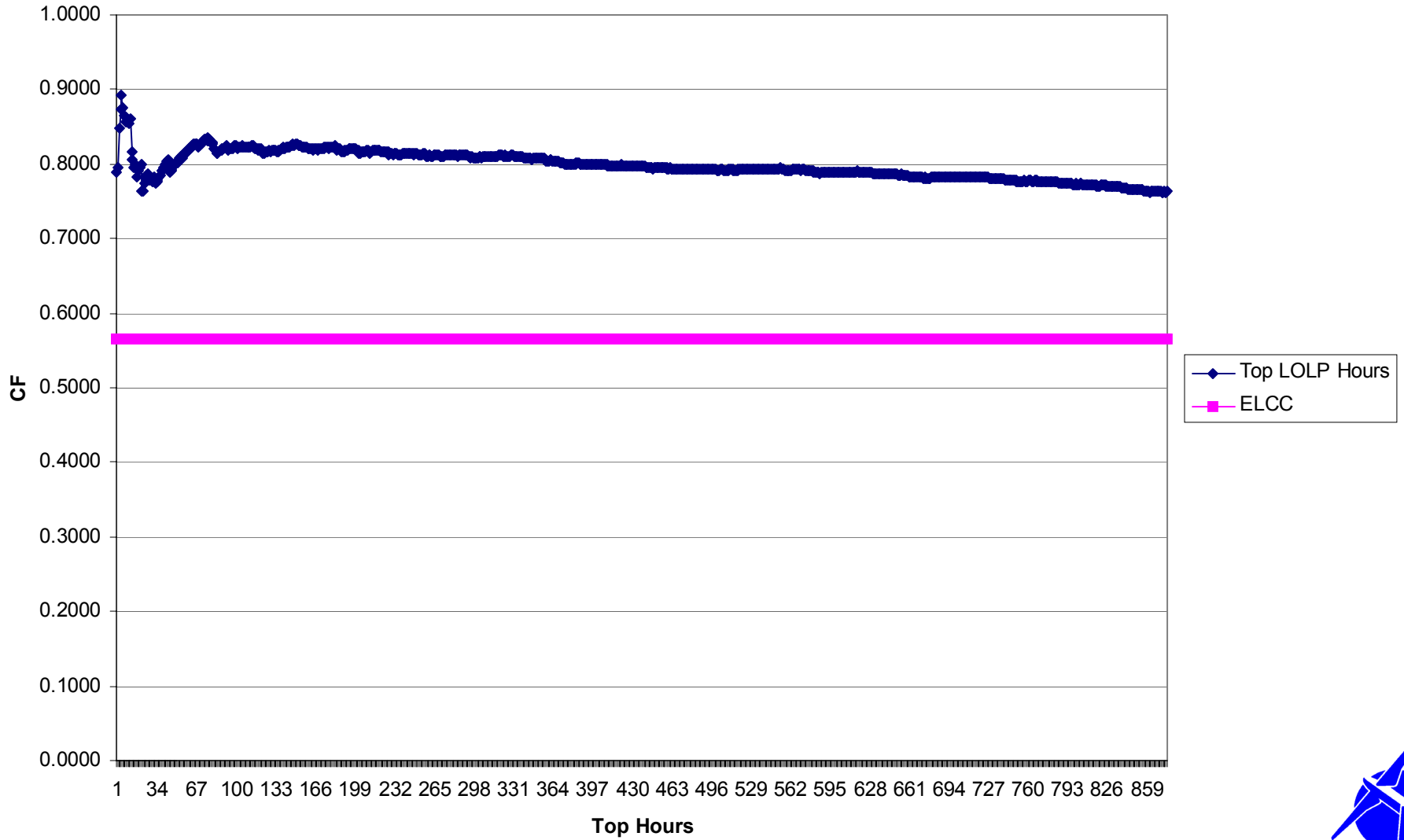
Geo(1) includes a steam constraint and dispatch instructions. Geo(2) does not.



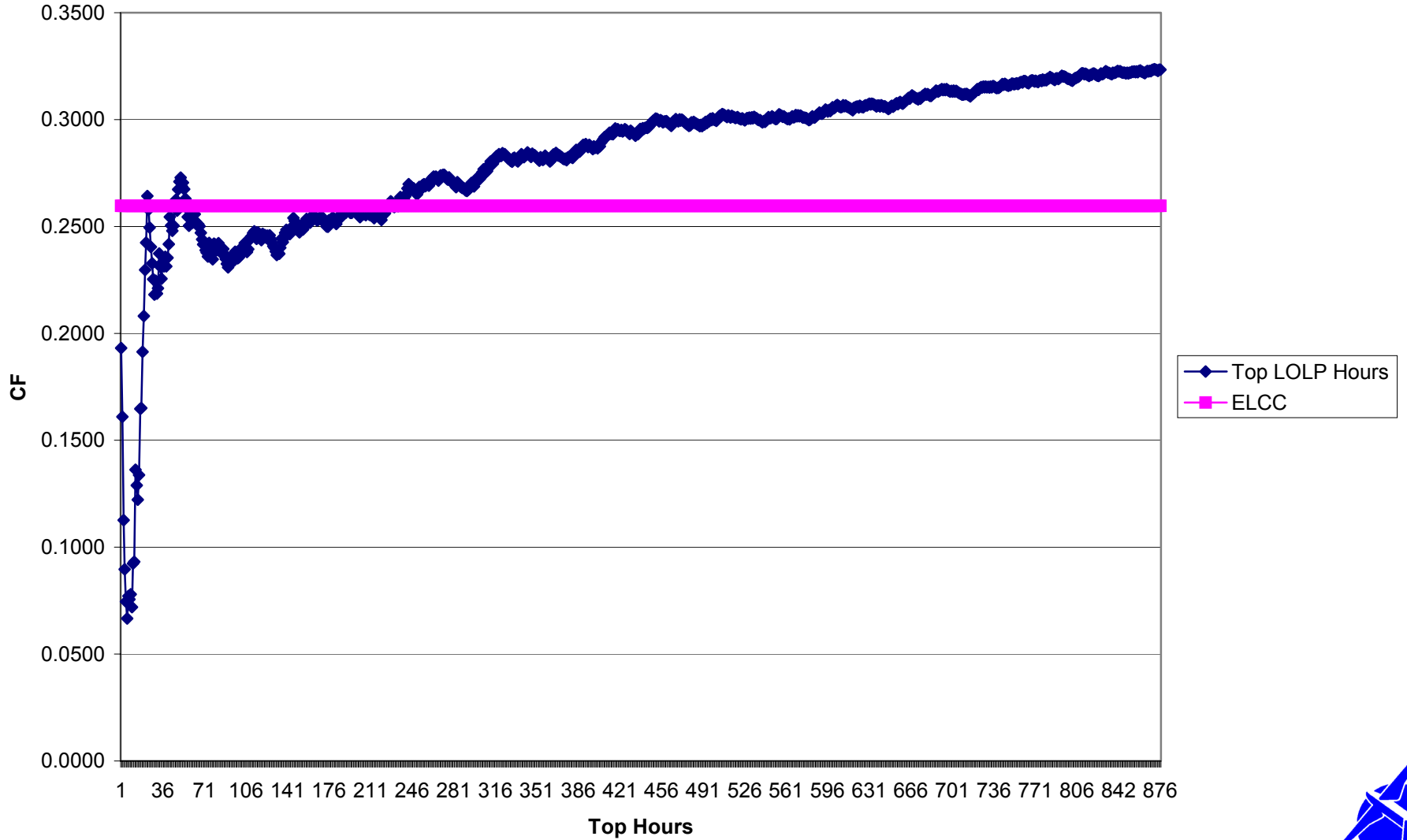
Example of Simple Methods to Estimate ELCC



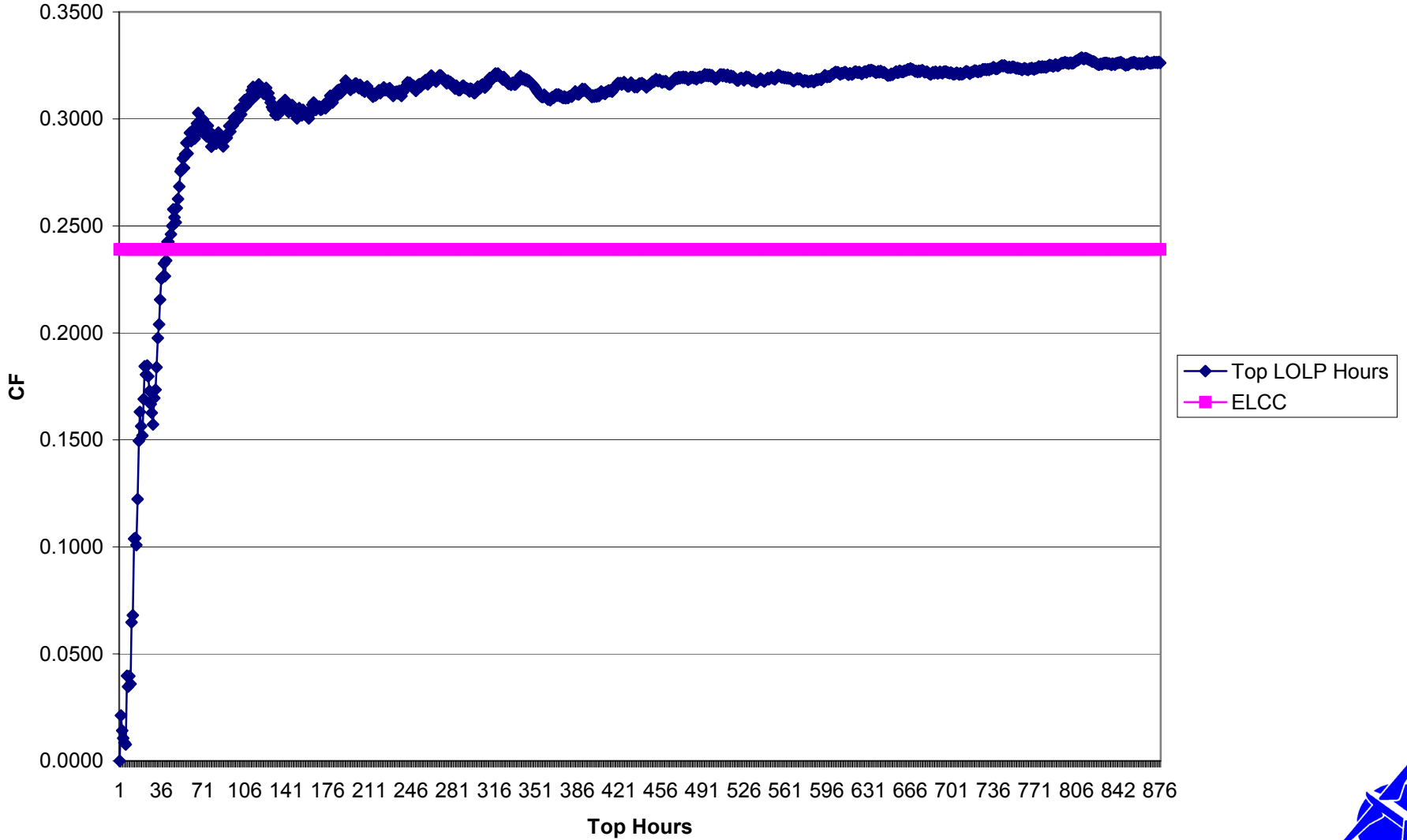
Solar Cumulative CF



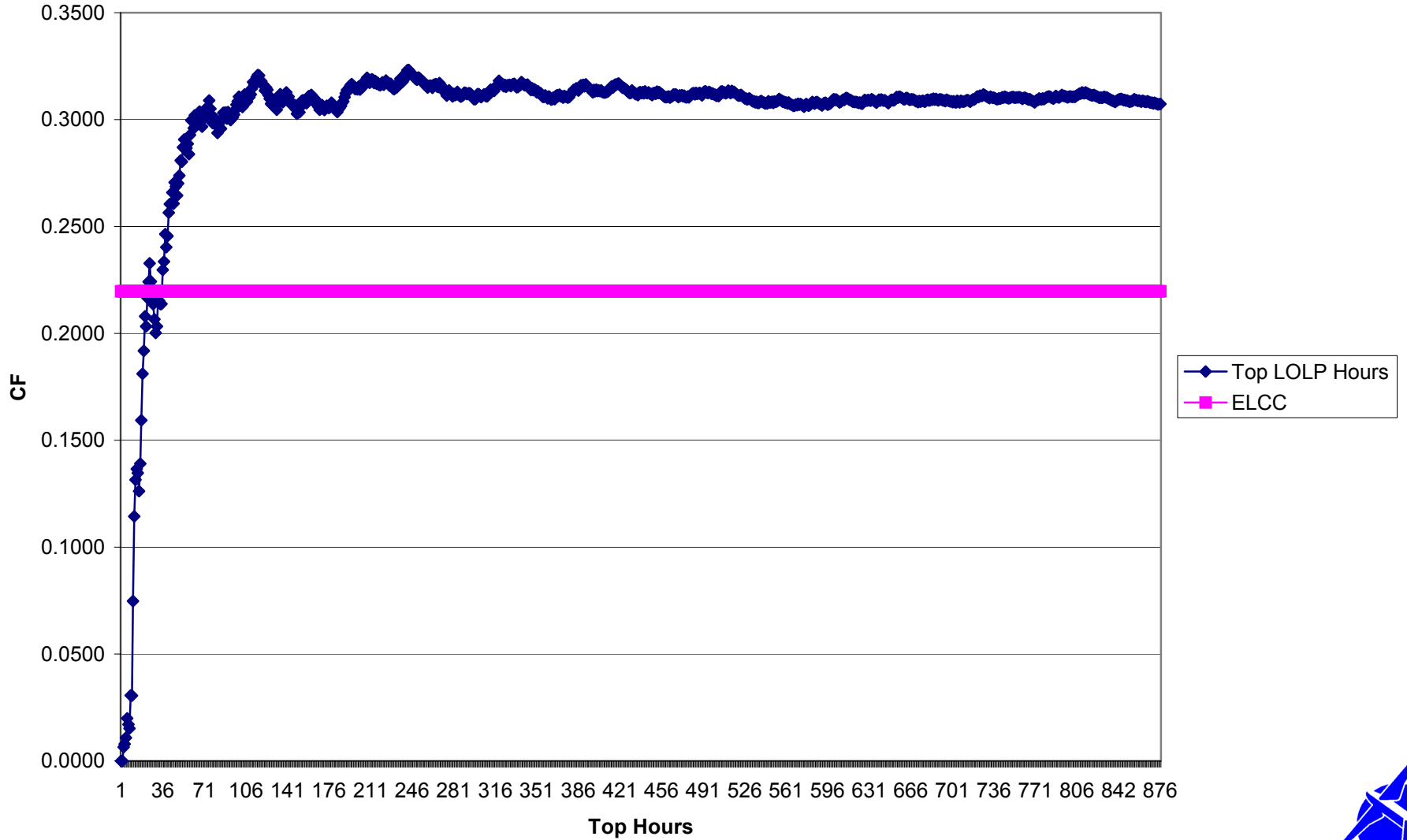
Wind-A Cumulative CF



Wind-G Cumulative CF



Wind-T Cumulative CF



- Eliminated maintenance scheduling from ELCC runs
- Recommended separate study to examine impacts of maintenance on reliability
- Solar data may not be representative of gas-assist solar
- Geothermal steam constraints should be examined
- Application of simpler methods to wind

Next Steps

- Develop simplified methods
- Apply to selected dis-aggregate data
- Begin constructing higher penetration cases and other locations
- Verify solar data