Variable Energy Resource Capacity Contributions Consistent With Reserve Margin and Reliability

by
Eugene Preston
and
Noha Abdel-Karim
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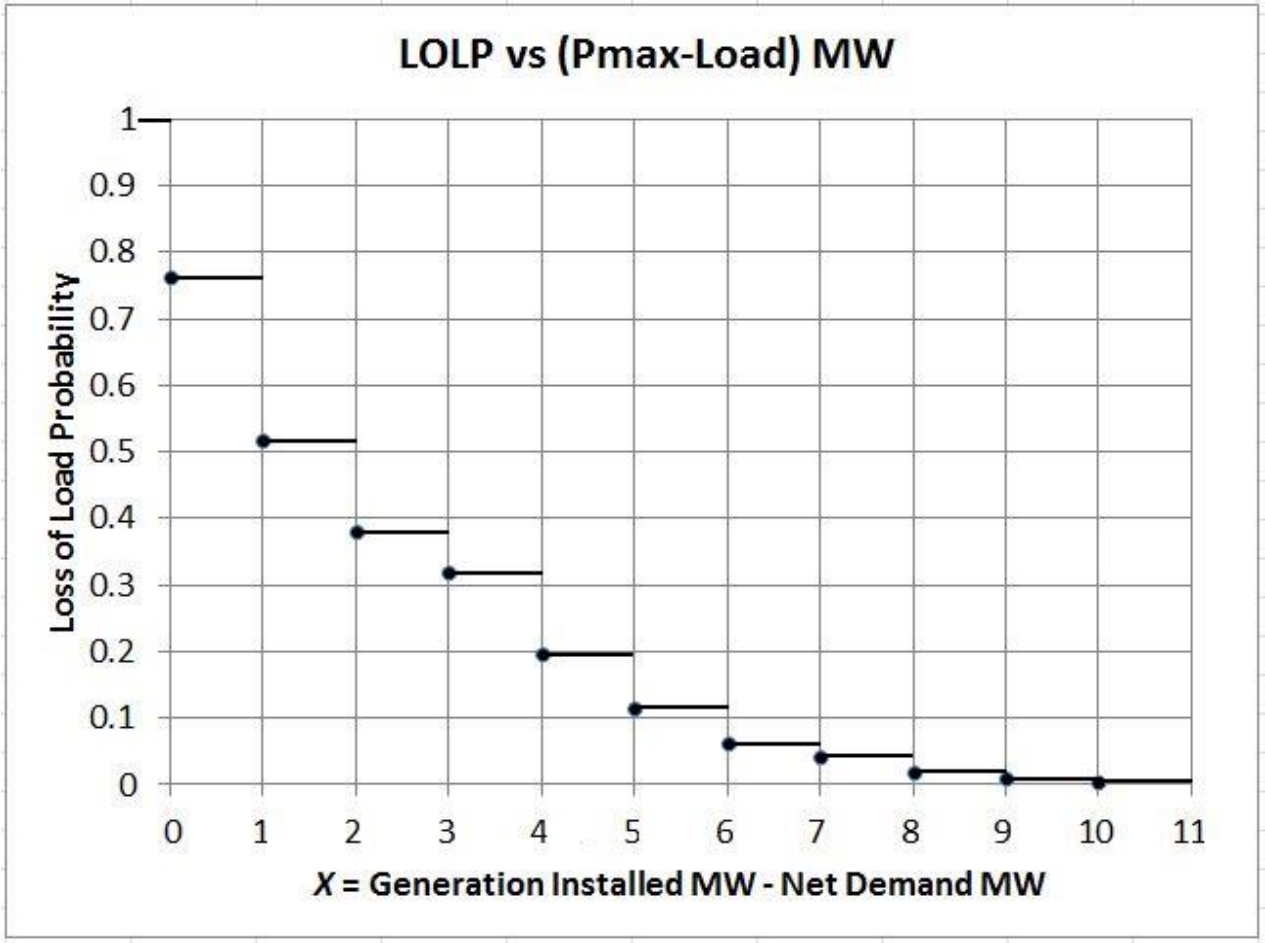
Modeling Variable Energy Resources

- Choice – VERs as generators or negative loads?
  - As generators we lose time connectivity information.
  - As hourly load reducers we retain time connectivity.
- Choice – Model a typical year or many years?
  - Combining several years loses year to year swings.
  - Combining several years loses some VER timings.
  - Combining VERs from several years may result in loss of gaps in the original VER hourly data.

Modeling Variable Energy Resources

- Choice – Direct LOLP versus Monte Carlo?
  - As long as all generators are independent, MC and Direct LOLP provide the same reliability indices provided VERs are treated as hourly load reducers.
  - Sequential MC is required to model VERs, if VERs are treated as generators; however this approach results in loss of VER connectivity even when MC is used.
  - Direct LOLP is at least a million times faster than MC.
  - Direct LOLP only requires the conventional generators be put in a COPT, capacity outage probability table.
  - All conventional generators are put into the COPT.

COPT – Capacity Outage Probability Table



Net Demand = hourly demand minus sum of VER MW that hour

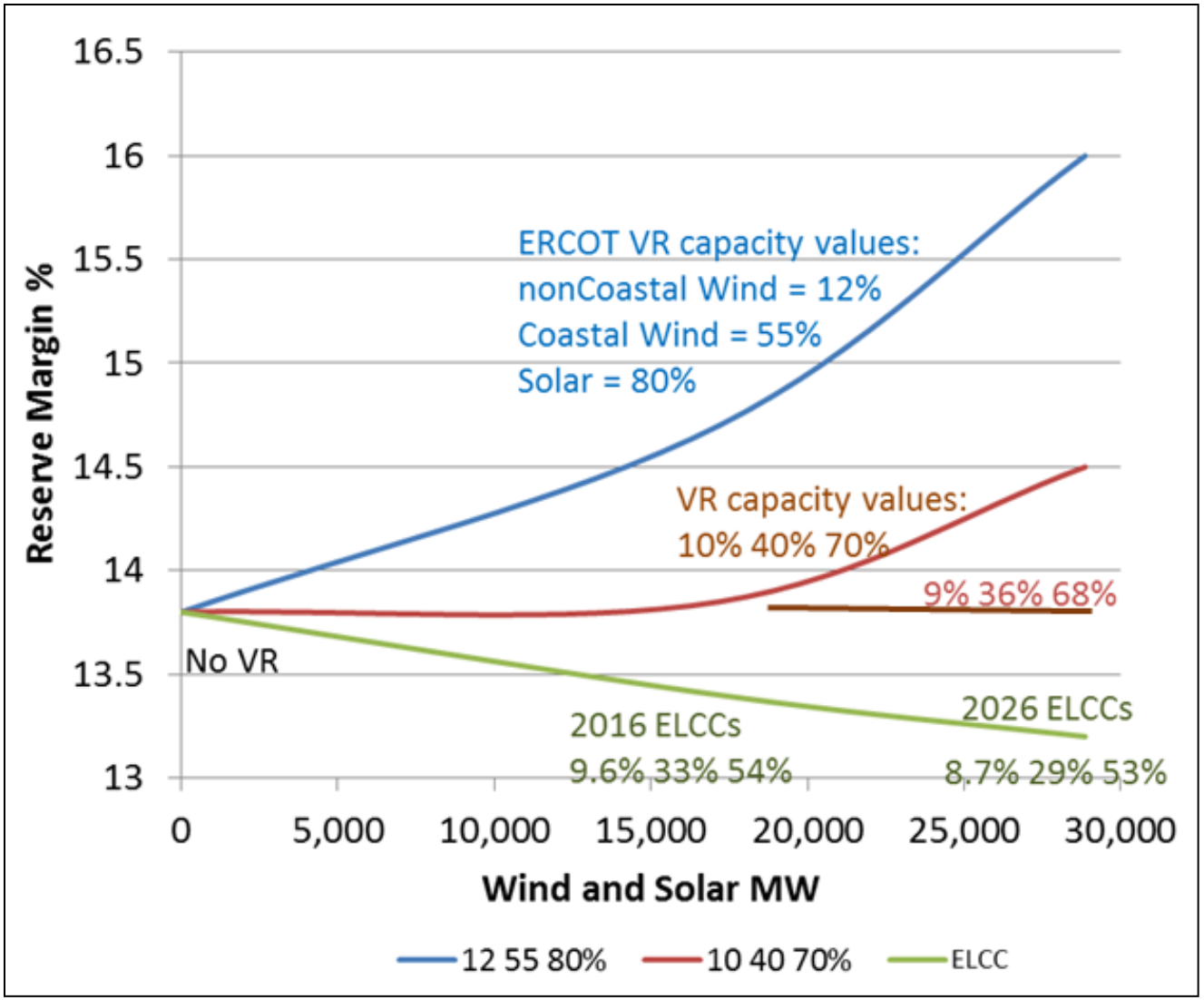
A Few Important Definitions

- LOLP is loss of load probability (every hour).
- LOLE is loss of load expectation =
  - the sum of daily max LOLPs from the COPT, or
  - the MC counting of days per year occurrences.
- LOLH is loss of load hours =
  - the sum of hourly LOLPs from the COPT, or
  - the MC counting of hours per year occurrences.
- LOLEV differs from LOLE in that more than one loss of load event per day can be counted.

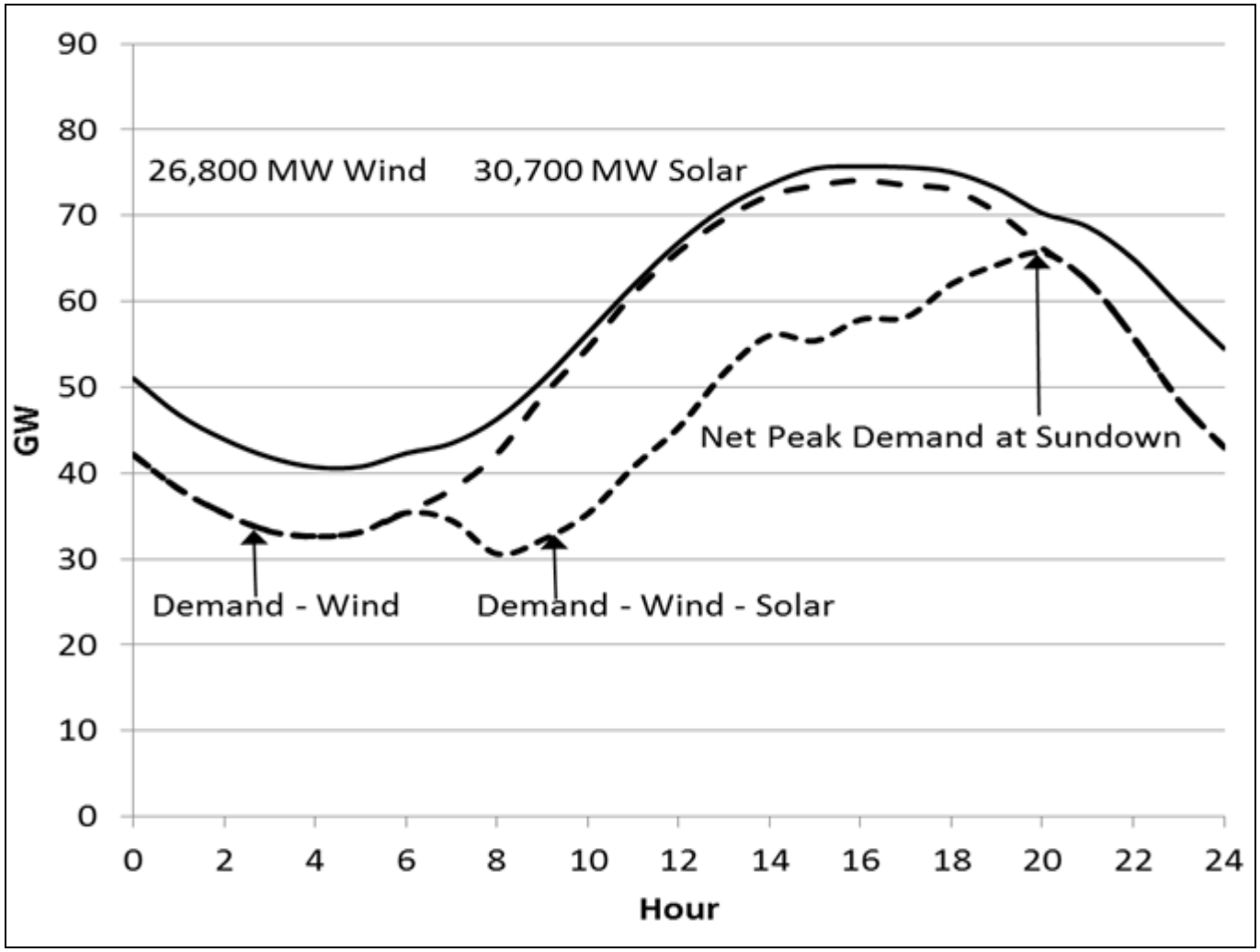
Modeling ERCOT

- Hourly VER data for 2010 – 2015.
- 2016 conventional generation = ~75000 MW
- 2016 wind + solar (nameplate) = ~17000 MW
- 2016 pk load = ~68000 MW for LOLE=0.1 d/y
- 2026 conventional generation = ~80000 MW
- 2026 wind + solar (nameplate) = ~29000 MW
- 2026 pk load = ~76000 MW for LOLE=0.1 d/y

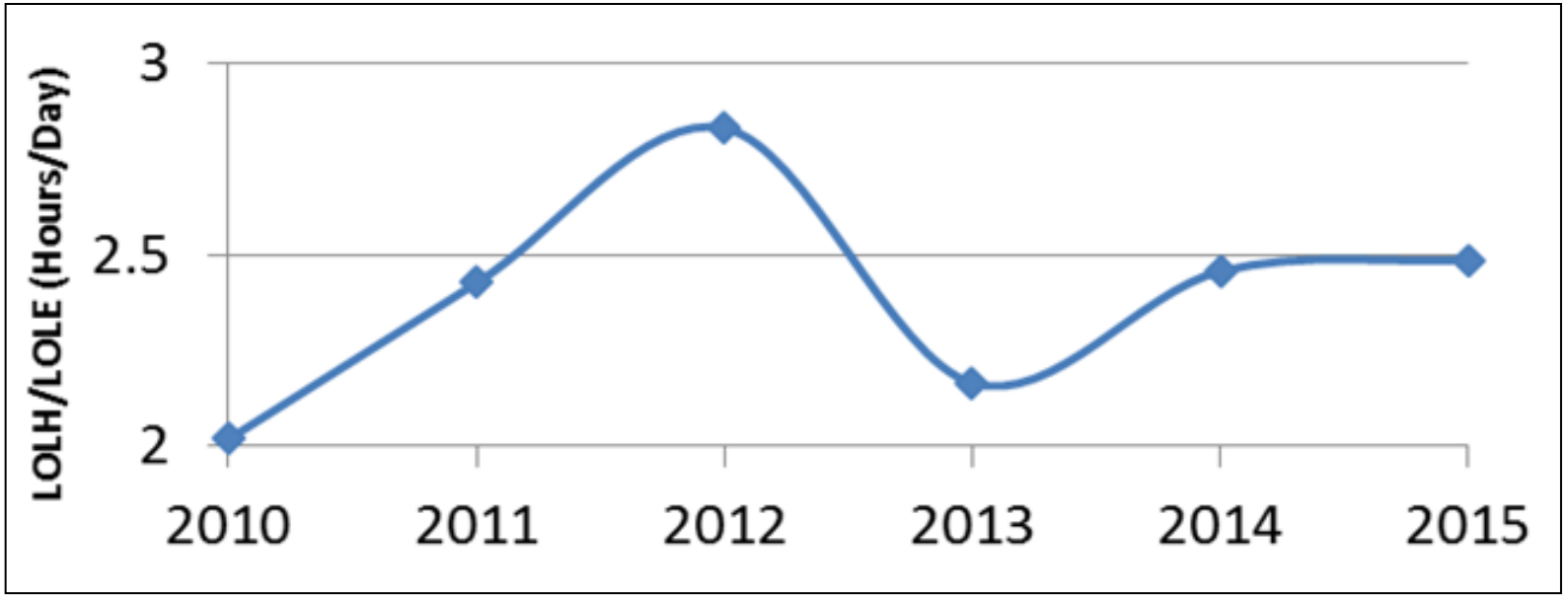
ERCOT VER RM at Different Capacity Contributions



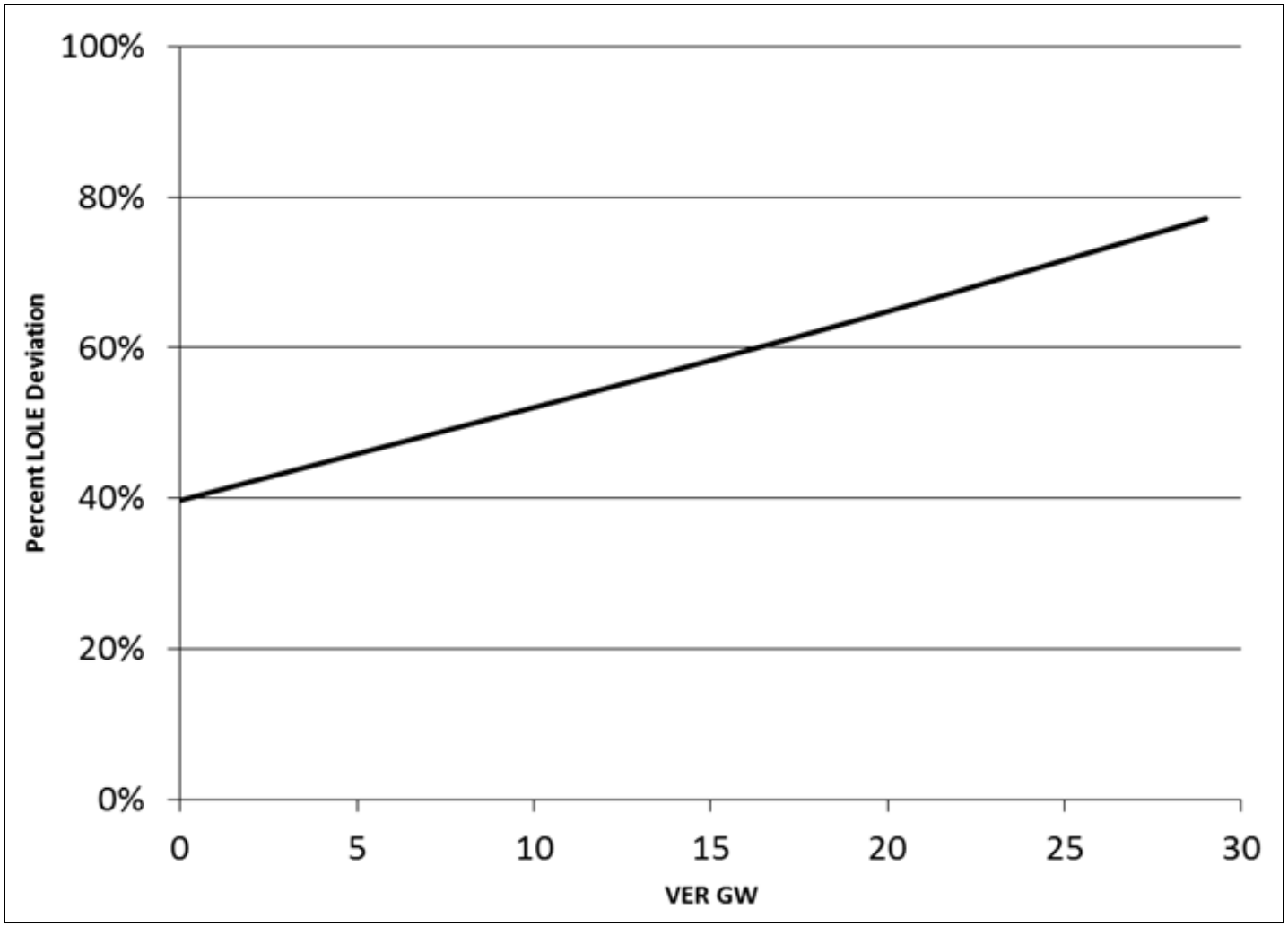
Solar Shifts the Net Demand Peak to 8 PM



Historical Years Ratio LOLH/LOLE



Historical LOLE Deviation Increases with VER



Recommendations

- Provide reliability evaluations of VER impacts.
- It’s very important to maintain chronology between variable energy generation and load.
- It will be necessary to develop and maintain public databases of wind, solar, and hydro historical production.
- VERs should be given capacity credits from the running of loss of load probability studies.