SWG Long-Term Scenarios Modeling—Lessons Learned

October 6, 2022

Amy Mignella, Chair

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SWG History

- Formerly a WECC Scenarios Task Force
- Composed of volunteers, one WECC engineer, two consultants; consultants now in limbo
- Prior reports addressed system shifts but included climate change (initial treatment across WECC studies) and rate of technology change; last year targeted a 100% clean energy scenario
- Produced extensive modeling detail and reference information catalogue
- Extensive work scope in last two study cycles; last cycle only produced a sensitivities segment of work proposal (80/90/100 clean energy)
- Last report of interest to broadest audience to date

Key Points by Category

- Role of scenarios—compile projection of the future
- Study duration significance
- Study scoping significance
- Data needs—sources, detail, assumptions
- Understanding complexity of multiple factors—how to reference
- Policy considerations—material to study structure
- Risk metrics—treatment in assumptions
- SME resources—when to reference, balance opinions, understand assumptions

SWG Studies and Findings—WECC 2038

How might customer demand for electric services in the Western Interconnection evolve as new technologies and policies create more market options, and with that, what risks and opportunities may emerge for the power industry in sustaining electric reliability?

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- **Load growth—**Most of the electrification load growth is concentrated around evening peak demand periods; this is considered to create higher risks of unserved load and greater dependence on resource flexibility.

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- **Load growth**
- **Variable generation**—With displacements of baseload resources (primarily coal fired) and increased penetrations of variable generation (primarily solar PV and wind), increases to diurnal evening peak demands from electrification increases operational challenges and risks to the operation of the BPS. If, however, distributed EV (DER-EV) infrastructure were strategically designed with time-of-use considerations in mind, the diurnal load demand shapes could be smoothed to shift load demand from evening peak to those times when energy production from solar PV is at its highest.

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- Load growth
- Variable generation
- **DER**—To the extent that it was modeled in the study, dispatchable DER-EV proved to be highly effective at mitigating unserved load. While DER-EV amounted to less than 2% of total annual energy production of the portfolio, DER-EV proved to reduce the occurrence of unserved load by as much as 50%.

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- Load growth
- Variable generation
- DER
- **Solar resources—**While annual energy production from solar averaged roughly 12% of the total resource portfolio energy production across all the simulations, the dispatch from solar at evening peak demand when unserved load occurred averaged less than 1% of the total resource portfolio dispatch.

SWG Studies and Findings—WECC 2040

The purpose of this study assessment was to gain a better understanding of the opportunities, challenges, and uncertainties associated with achieving a 100% clean energy future across the Western Interconnection and to build upon what was learned from the WECC 2038 Scenario Studies (2018–2019 study cycle) to ensure reliability with respect to:

- Resource Adequacy and Performance,
- Changing Resource Mix, and
- Distribution System and Customer load impacts on the BPS.

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- **Reliability at high levels of renewables**—This assessment examined the reliability implications of reaching clean energy levels of 80%, 90%, and 100% in the Western Interconnection by 2040. To understand these clean energy portfolios, over 200 possible resource-load mixes during two-week seasonal heavy and light load periods were simulated using a production cost model (PCM) tool. These simulations allowed WECC to find optimal resource mixes at 80%, 90%, and 100% clean energy levels at various seasonal load levels. Full-year PCM simulations were then performed to further refine these resource mixes on an annual basis. Based on the full-year PCM cases, WECC saw that:

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- **Reliability at high levels of renewables**
  - **Operational challenges**—Penetrations of variable Renewable Energy (VRE) resources, such as solar and wind, will need to significantly increase over the next 20 years to achieve a 100% clean energy future. Operational challenges will also significantly increase with these higher penetrations of VRE resources, especially in terms of ramping requirements.

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- **Reliability at high levels of renewables**
  - **Operational challenges**
  - **VRE and load peak misalignment**—A saturation point is reached with the deployment of new battery energy storage systems (BESS) and VRE resources alone at 90% where the benefits of further deployments are greatly diminished, primarily due to the misalignment of energy production from VRE resources with hourly load demand. As a result, renewable energy curtailments increase over all hours of a day (primarily light load days) minimizing the opportunities for batteries to dispatch and resulting in negative locational marginal prices (LMP), where an LMP represents the incremental marginal price to balance energy supply with load demand at a given location. Resource planning and operations must be carefully coordinated among the many entities in the Western Interconnection to arrive at a balanced resource portfolio mix that ensures a reliable BPS while minimizing operational challenges and market disruptions.

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- **Reliability at high levels of renewables**
  - **Operational challenges**
  - **VRE and load peak misalignment**
  - **Storage saturation level—**BESS resources will be a key component to achieve a 100% clean energy future. BESS and VRE resources alone will not, however, be enough to achieve a 100% clean energy future. Other emerging clean energy resource technologies will be needed to replace lost resource flexibility that would otherwise be provided by displaced gas-fired resources. At increasing VRE penetrations, increasing implementation of BESS provides decreasing benefits. While BESS can store VRE production for use later in the day, when VRE penetrations are extremely high, the opportunities for BESS resources to dispatch fully are diminished. This leads to less efficient performance of BESS resources at higher penetrations of VRE resources.

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  - **VRE and load peak misalignment**
  - **Storage saturation level**
  - **Dispatchable resources—**There is a need for emerging clean and flexible resources that can perform like gas resources without carbon emissions. Because VRE output and customer loads vary significantly during any given day, and over the course of the year, and because there are limitations on BESS performance, there is a need for other clean resource types with performance characteristic similar to that of gas-fired generation resources.

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▪ **Reliability at high levels of renewables**

- **Operational challenges**
- **VRE and load peak misalignment**
- **Storage saturation level**
- **Dispatchable resources**
- **Inter-regional flows**—Increasing VRE resources may create transmission challenges. As VRE penetrations increase above 90%, the resulting changes in resource dispatches significantly change the inter-regional flows in the Western Interconnection. In some cases, the changed flows result in transmission utilizations in a range between 90% to 100% of their rated capacities.

Conclusions

- Long-term scenarios planning is important for identifying BPS potentialities
- Margins of uncertainty are managed using reasonable assumptions and tracking those into the results and conclusions
- Modeling results can uncover underemphasized aspects of the system, including influences not otherwise referenced or called out
- Studies emulate system integration performance, but can only do so with reference to inputs used
- Regular re-examinations are critical to keep pace with system changes
- Comprehensive examinations depicting multiple scenarios and cases are key to meaningful scenarios modeling efforts

WECC

Electric Reliability and Security for the West

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