Assessment of Renewable Generation

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Project Background

- California's goal is to reach 100% carbon free energy by 2045
- Renewable energy we can use will come from energy produced by solar and wind by using generation made of photovoltaic (PV), wind turbines, and battery storage.



Project Objective

- Evaluated the impact of the high penetration of renewable generation on the system Short-Circuit level
- Accomplished by defining the characterization of the short circuit power contributions from the renewal energy resources using Simulink program
- Models were then converted to PowerWorld platform to evaluate the impact on the power system and identify the necessary mitigations
- When finally comparing both performances from Simulink and PowerWorld, we found minor differences, but the performance outcome was the same.
- Utilizing an equivalent system model, we developed 3 cases: a peak case with a mix of PV and wind generations, another case with only PV to testing the impact of the system with high solar penetration, the third case for the off-peak system condition with only batteries and wind.

Generator Requirements

- Followed WECC guidelines for model structure of renewable energy system control modules
- Each module consists of parameters that have been validated by WECC and used in our renewable models

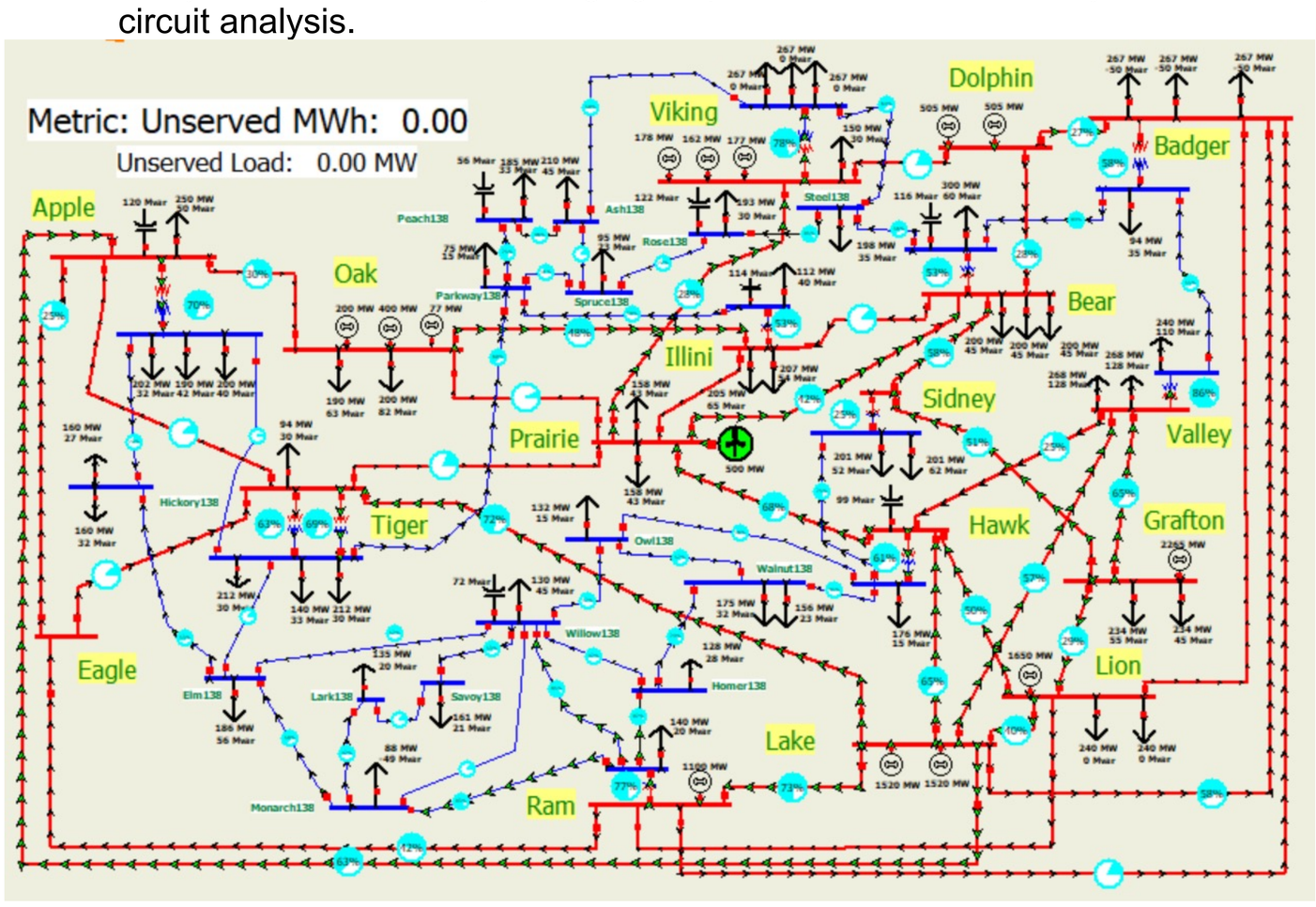
Model Class	Type 4 Wind (Second Gen)	Solar PV	Energy Storage
Wind Machine Models	REGC_A	REGC_A	REGC_A
Exciters	REEC_A	REEC_B	REEC_C
Governors	WTGT_A	None	None
Plant Controller Model	REPC_A	REPC_A	REPC_A

Conclusion

- The use of only Renewable Dynamic Models without rotating machine dynamic models support causes stability issues under stressed system conditions. This issue can be addressed by adding additional infrastructure such as SVC's
- The Renewable Models have a lower short-circuit duty contribution compared to the rotating machine. This may cause an issue with the protection relays setting. Additional protection evaluation needs to be completed to identify the necessary protection system updates.

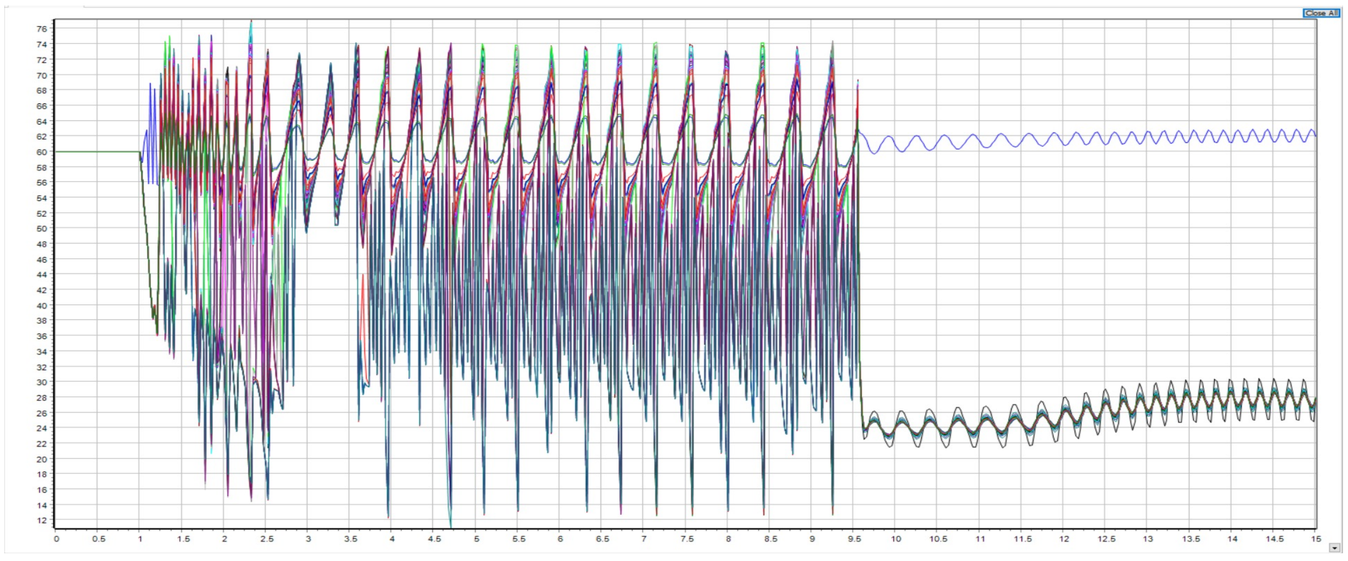
Design Model and Cases

- We modified a 42-bus system to replace the non-renewables generation model with PV, Wind and Batteries model: 13 of 14 generators changed to renewables except the slack bus unchanged.
- Original case was tested to ensure system was stable by running all analysis including steady state, contingency analysis, and transient stability
- Created 3 separate cases: full solar PV generation, 60% PV and 30% wind, and night cycle, converting 60% PV to battery storage and 30% wind
- All the analysis from previous original case is done for the 3 different cases
- System one-line was modified to reduce any violations from contingency analysis and reduce any diverging output from transient stability and short-circuit analysis.

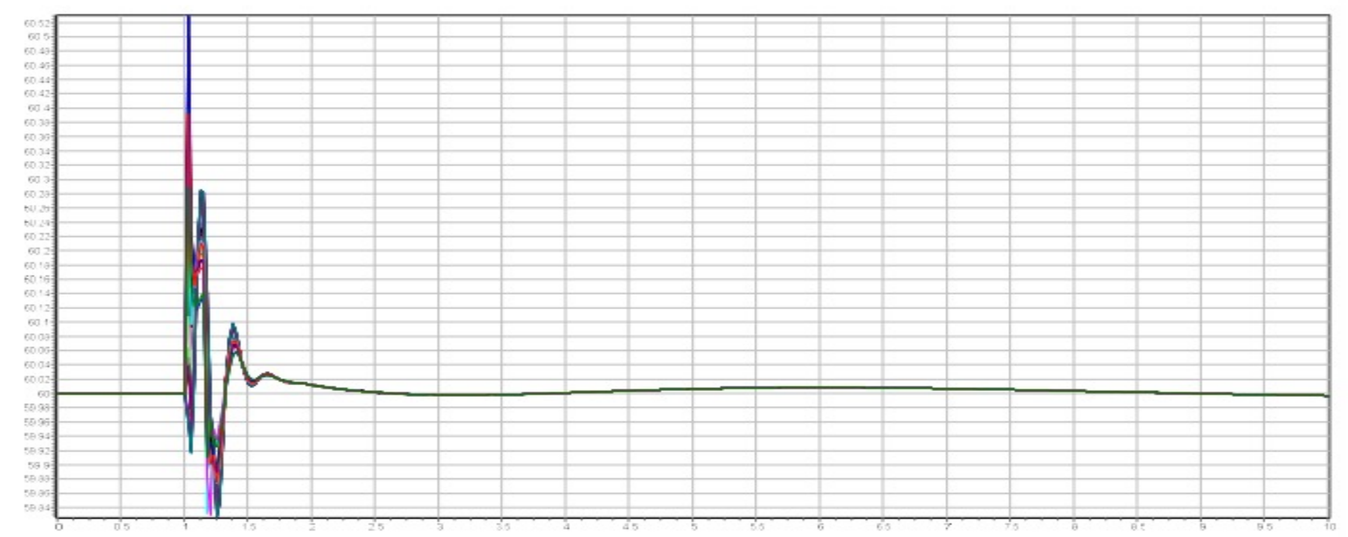


PowerWorld Model for 42-Bus System

Results



Bus Frequency (Hz) with Applied Fault before the addition of Switched Shunts



Bus Frequency (Hz) with Applied Fault after the added Switched Shunts