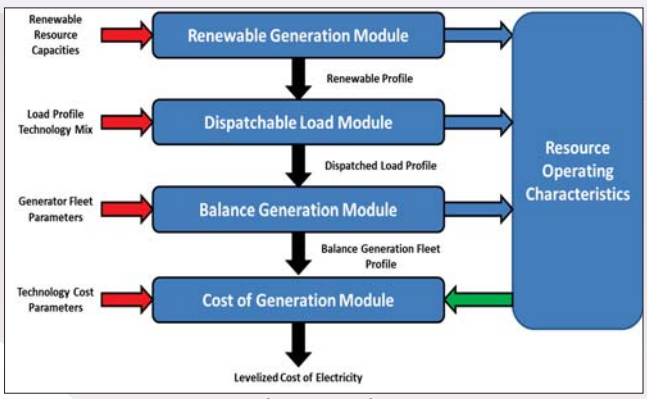
Development of the Holistic Grid Resource Integration and Deployment (HiGRID) Tool

OVERVIEW

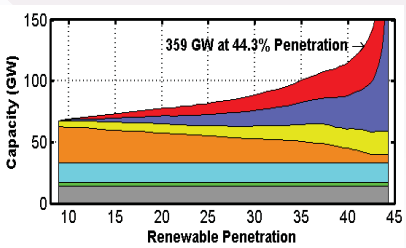
Concerns about securing the primary energy supply with growing populations and shifting climates have given rise to policies that encourage the deployment of renewable resources on the electric grid. Many challenges and questions remain, however, regarding the effects of renewable power generation on the operations and performance of the electric grid. The Holistic Grid Resource Integration and Deployment (HiGRID) tool was developed as a platform for determining these effects for the purpose of intelligently advising the deployment of renewable power generation and supporting technologies.



HiGRID Tool

GOALS

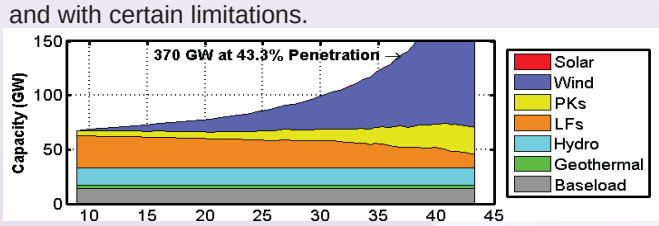
- To determine and compare the effects of different renewable resources on the technical and economic performance of the electric grid.
- To advise the deployment of renewable resources and complementary technologies to reach renewable portfolio standard goals while minimizing technical and economic impact.
- To identify key technical obstacles that must be overcome to meet renewable portfolio standard goals



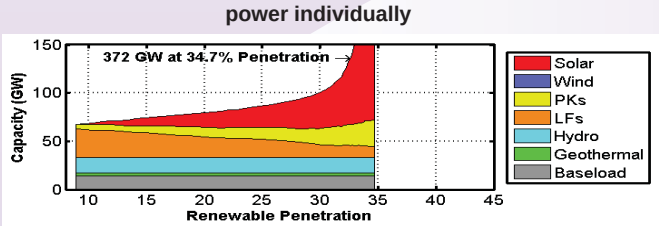
Curtailment-induced exponential capacity effects for a 50/50 mix of wind and solar power

RESULTS

For California's energy system, accommodating the behavior of renewable resources requires an increase in generator flexibility. Inflexible base-load power is unable to adjust to renewable variability, introducing curtailment of wind and solar power due to a mismatch between load and generation. An increased reliance on faster ramping generators is prevalent as well. Diversifying the renewable mix can provide some benefit. Complementary technologies can aid in reducing curtailment but at a cost and with certain limitations.



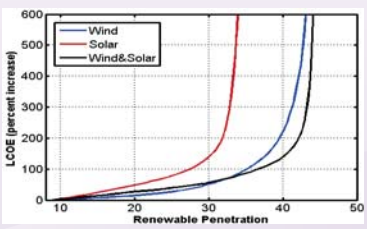
Curtailment-induced exponential capacity effects for wind power individually



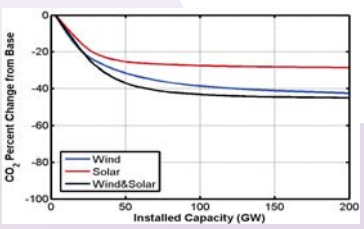
Curtailment-induced exponential capacity effects for wind and solar power individually

The onset of curtailment requires the installation of more renewable capacity for each incremental contribution to serving the load demand from renewable energy. Combined with decreases in grid capacity factor, this causes the cost of electricity to increase exponentially in this stage and the CO_2 benefit becomes limited.

This highlights the importance of increasing the flexibility of balancing power plants on the grid and managing the dispatch appropriately to accommodate renewable energy resources. This also highlights the need for other load-management technologies that may aid in providing overall flexibility.



Effects on the Cost of Electricity



Effects on Grid CO_2 Emissions

RECENT PUBLICATIONS/PAPERS

Eichman, J.D., Mueller, F., Tarroja, B., Schell, L.S., Samuelsen, S., "Exploration of the integration of renewable resources into California's electric system using the Holistic Resource Integration and Deployment (HiGRID) tool", *Energy*, 2013. 50(1): p. 353-363

Chang, M. K., Eichman, J. D., Mueller, F., & Samuelsen, S. (2013). Buffering intermittent renewable power with hydroelectric generation: A case study in California. *Applied Energy*, 112, 1–11.

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