Energy Imbalance Markets




Energy Imbalance Markets Help Balance Fluctuations in Variable Generation and Load

The anticipated increase in variable renewable generation such as wind and solar power over the next several years has raised concerns about how system operators will maintain balance between electricity production and demand in the Western Interconnection—especially in its smaller balancing authority areas (BAAs).[1] Given renewable portfolio standards in the West, it is possible that more than 50 gigawatts of wind capacity will be installed by 2020. Significant quantities of solar generation are likely to be added as well. Meanwhile, future load growth and challenges siting new transmission and generation resources may add additional stresses on the Western Interconnection of the future.

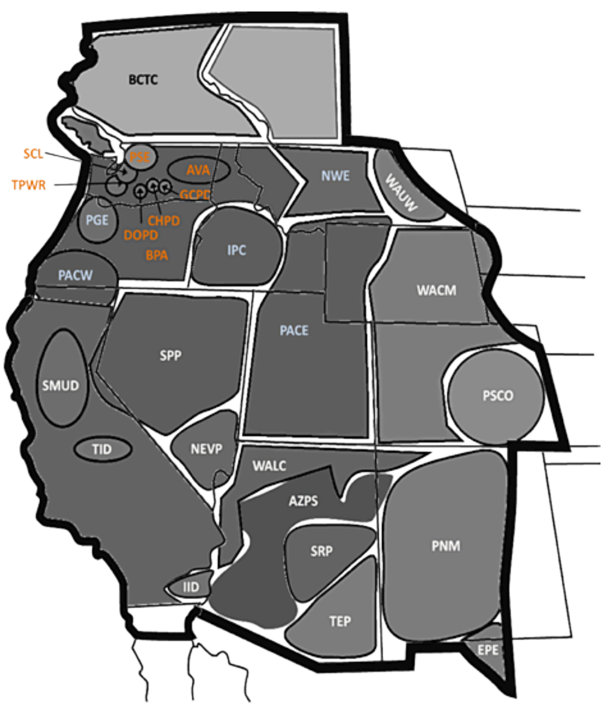

Figure 1. Western Electricity Coordinating Council balancing authority area map with subregional groups. The color of the BAA name indicates to which subregional group it belongs. Orange indicates the Columbia Grid, light blue is Northern Tier Transmission Group, white is WestConnect, and black is British Columbia Transmission Corp. and Los Angeles Department of Water and Power.[2]

One proposed method of addressing these challenges is an energy imbalance market (EIM). An EIM is a means of supplying and dispatching electricity to balance fluctuations in generation and load. It aggregates the variability of generation and load over multiple BAAs.

The Proposed Energy Imbalance Market

In the proposed Western EIM, BAAs would pool their variable and conventional generation resources to improve operational efficiency over a wider area. This sub-hourly, real-time energy market would provide centralized, automated, and region-wide generation dispatch for imbalances. By increasing the temporal and geographic footprint of the total BAA, an EIM in the Western Interconnection could serve to moderate the variability of renewable generation resources and electricity demand. By introducing five-minute security-constrained economic dispatch of generation resources to meet energy imbalances, the market would also introduce new efficiencies by enabling decision-making and response based on near-term system data. This could result in more efficient dispatch of generators, more efficient clearing of imbalances between demand and production, and a reduced need for flexibility reserves, which are often provided by quick-response generators, to address those imbalances.

As proposed, the EIM does not consider any form of coordinated unit commitment; however, over time, it is possible that BAAs would develop formal or informal plans to coordinate unit commitment. As the penetration of variable generation increases on the power system, additional interest in coordination may develop.

NREL Analysis

The National Renewable Energy Laboratory's (NREL's) Transmission and Grid Integration Group is performing analysis on the flexibility reserve requirements of several forms of EIMs proposed in the Western Interconnection. In collaboration with the Western Electricity Coordinating Council, the group has examined the benefits of various implementation options. It is now incorporating more accurate data sets and using the PLEXOS model, which can simulate the five-minute dispatch of the energy imbalance market, to enhance its efforts. The results will be shared with utility commissioners and other stakeholders to inform future decision-making for Western Interconnection operations. In addition, the group has worked directly with a variety of BAAs to identify individual benefits of energy imbalance markets.

The NREL reserves method uses a technique for estimating flexibility reserve requirements adapted from the Eastern Wind Integration and Transmission Study. This technique uses statistical analysis of simulated historical wind and solar generation to estimate reserve requirements at periods faster than the dispatch interval (regulation) and slower requirements (spin and non-spin reserves) to follow longer unforecasted changes in variable generation output. The method is used to calculate the reserve requirements for a business-as-usual case and compares those results with calculations for several EIM implementations to estimate the savings in reserves resources.

The reserves analysis focuses only on the ramping and flexibility reserve impacts of the EIM. It does not consider or evaluate production costs[3] or the costs of establishing the EIM or operating the EIM. The flexibility reserve calculations also do not consider transmission limitations that might affect the delivery of an EIM transaction across congested transmission interfaces.[4] The flexibility reserve calculations establish the need for these reserves, and the production simulation provides a means to evaluate whether the demand for energy and reserves can be met.

Associated Publications

King, J.; Kirby, B.; Milligan, M.; Beuning, S. (2012). *Operating Reserve Reductions From a Proposed Energy Imbalance Market With Wind and Solar Generation in the Western Interconnection*. NREL/TP-5500-54660. Golden, CO: National Renewable Energy Laboratory. Accessed September 2012: www.nrel.gov/docs/fy12osti/54660.pdf.

GE Energy. (2010). *Western Wind and Solar Integration Study*. NREL/SR-550-47434. Work performed by GE Energy, Schenectady, NY. Golden, CO: National Renewable Energy Laboratory. Accessed September 2012: www.nrel.gov/docs/fy10osti/47434.pdf.

King, J.; Kirby, B.; Milligan, M.; Beuning, S. (2011). *Flexibility Reserve Reductions From an Energy Imbalance Market With High Levels of Wind Energy in the Western Interconnection*. NREL/TP-5500-52330. Golden, CO: National Renewable Energy Laboratory. Accessed September 2012: www.nrel.gov/docs/fy12osti/52330.pdf.

More Information

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See our website at www.nrel.gov/electricity/transmission/.

[1]A BAA is an entity responsible for maintaining balance between load and generation at all times. Balancing the same variable renewable generation penetration percentage is more difficult for numerous small BAAs than for fewer large BAAs because variability partially cancels as BAA size increases while access to flexible resources continues to increase.

[2]Colombia Grid: Avista (AVA); Bonneville Power Administration (BPA); Public Utility District No. 1 of Chelan County (CHPD); Public Utility District No. 1 of Douglas County (DOPD); Public Utility District No. 1 of Grant County (GCPD); Puget Sound Energy (PSE); Seattle City Light (SCL); Tacoma Power (TPWR). Northern Tier Transmission Group: Idaho Power Corp. (IPC); Northwest Energy (NWE); Pacificorp East (PACE); Pacificorp West (PACW); Portland General Electric (PGE). WestConnect: Arizona Public Service (AZPS); El Paso Electric (EPE); Imperial Irrigation District (IID); Public Service Company of New Mexico (PNM); Public Service Company of Colorado (PSCO); Sacramento Municipal Utility District (SMUD); NV Energy [Sierra Pacific Power (SPP), Nevada Power (NEVP)]; Salt River Project (SRP); Tucson Electric Power (TEP); Turlock Irrigation District (TID); Western Area Power Administration (WAPA) - Colorado Missouri Region (WACM); WAPA - Lower Colorado Region (WALC); WAPA - Upper Great Plains West (WAUW); California: Los Angeles Department of Water and Power (LDWP). Canada: British Columbia Transmission Corp. (BCTC)

[3]The work with the PLEXOS model, currently under way, examines the impact of the EIM on production cost. Results will be published in late 2012.

[4]The PLEXOS work will also incorporate transmission congestion.

Photos (from top): *Photo by NREL, NREL/PIX 17591; photo by Dennis Schroeder, NREL/PIX 18525; photo by NREL, NREL/PIX 18700; photo by Raymond David, NREL/PIX 19498*

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