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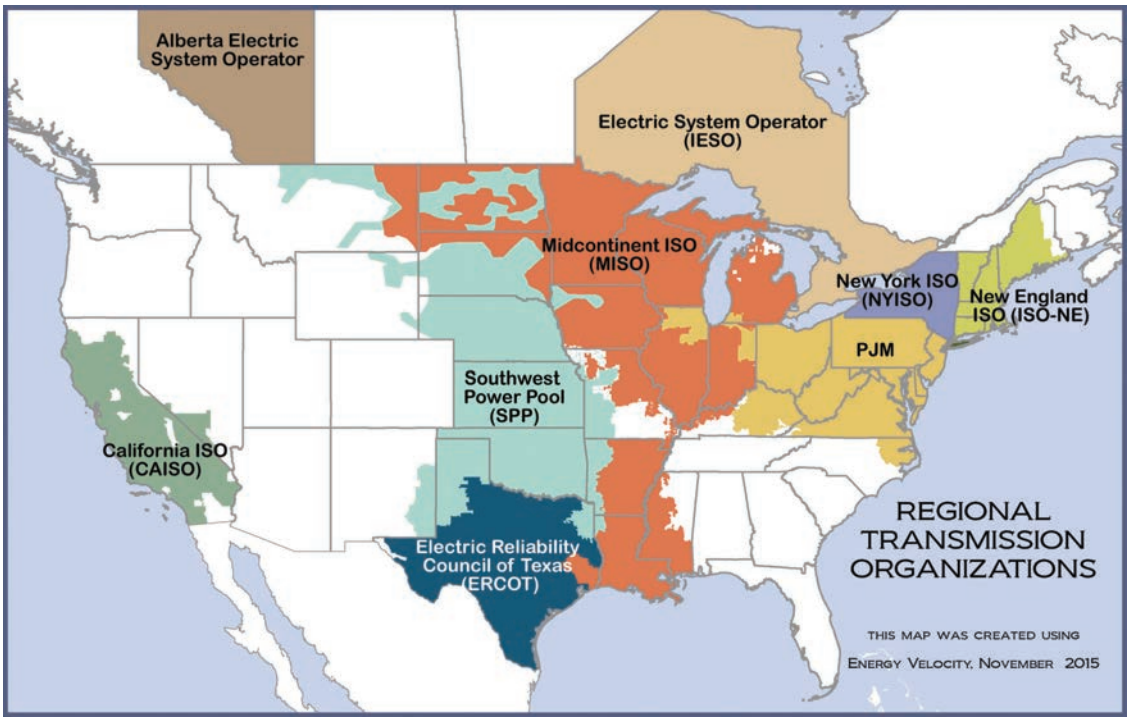
ISSUE BRIEF

REGIONAL TRANSMISSION ORGANIZATIONS: *Recommendations for the West*

INTRODUCTION

An historic reorganization of the western electricity delivery system is underway. The sources of our electricity are changing rapidly, driven by shifting economics that include plunging natural gas prices, new state and federal policy goals, and the rise of renewable energy resources. Renewable generation sources have been shown capable of reliably powering increasing shares of our economy. And as large amounts of renewable power are added to the western grid, major changes in how it operates will be needed.

There are many benefits to the potential expansion of the California Independent System Operator (CAISO) across much of the western grid (the Western Interconnection, which serves parts of Montana, Nebraska, New Mexico, South Dakota, Texas, Wyoming, and Mexico; all of Arizona, California, Colorado, Idaho, Nevada, Oregon, Utah, Washington; and the Canadian provinces of British Columbia and Alberta). These benefits include cost savings for customers across the region, the avoidance of building redundant transmission lines and expensive power plants, and the reliable and cost-effective integration of renewable energy resources. Based on experience gained in the rest of the country's organized grid regions, this Issue Brief examines issues related to renewable power integration and conventional power plant retirements as they apply to expanding CAISO's footprint.



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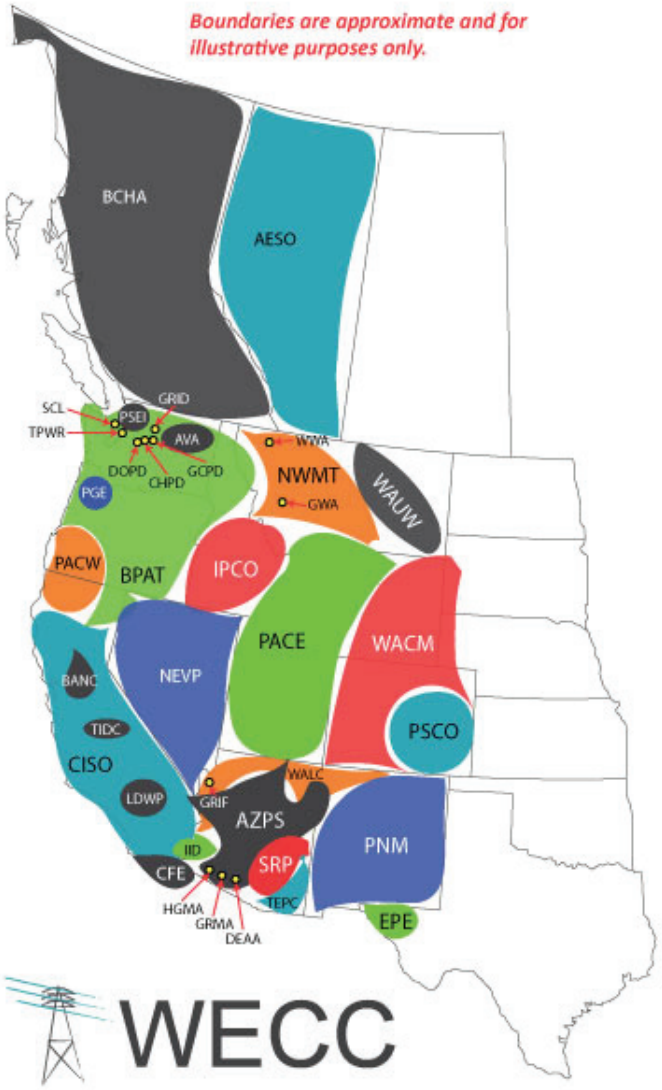
The Western grid is comprised of 38 separate "Balancing Area Authorities," each of which must control generation and load in their own territories. The divided operation of the interconnected western grid is not unlike having a bus with 38 drivers.



Regional transmission organizations (RTOs) or Independent System Operators (ISOs)—the terms are interchangeable—run large regional portions of the national electrical system across most of the country. They include the Midcontinent Independent System Operator (MISO) and PJM, the grid operator for the nation's largest electricity market stretching from the mid-Atlantic states to the Midwest. Studies by these groups have shown that large levels of renewable energy can already be safely and reliably integrated into generation supplies without having to resort to large amounts of gas-fired generation to balance out variability due to fluctuations in the wind and sun.[1] A large system footprint, combined with closely coordinated and consolidated grid operations, can avoid the need for significant fossil-fueled generation.[2]

This kind of operational control and coordination is a common trait in the RTOs/ISOs (including CAISO) that run most of the nation's electrical grid. Drawing renewable power from across large areas allows grid operators to blend the variability of geographically separated wind farms because the wind in one part of the region is often blowing when it is calm in another, allowing generation in the windy area to replace the energy lost where it calm. Similarly for solar energy, when it is cloudy in one area, it is likely to be sunny in another.

As the 2014 *PJM Renewable Integration Study* concluded:

> PJM has long held that ISOs and RTOs are better able to integrate variable energy resources because of their organized markets and regional infrastructure planning processes, but the study found that PJM's large geographic footprint also provides significant benefit for integrating wind and solar generation because it greatly reduces the magnitude of variability-related challenges.[3]

Economies of scale, technology improvements, and national policy goals have driven renewable energy penetration to new highs worldwide. More than a billion dollars *per day* was invested globally in renewable energy sources in 2015 ($367 billion total).[4] In the United States, renewable energy growth continues its relentless upward trajectory, with solar additions to the electricity system forecast to more than double in 2016 over the previous year.[5] As renewable energy's star is rising, the coal industry's market position is deteriorating at an accelerating rate, due in large part to unfavorable market conditions.

Some would resist making the changes needed to facilitate the large additions of renewable power necessary to meet our national climate goals because of the fear that some coal plants will be perpetuated in an energy market. They might point to features such as capacity markets (discussed later) in the Eastern Interconnection as proof that markets allow coal plants to stay alive, even if they are infrequently run—some as little as a few hours a year. However, since 2009, PJM (which covers 13 mid-Atlantic states and the District of Columbia) has retired 21,336 megawatts (MW) of coal unit capacity. In the same period, MISO (which covers

15 states in the Midwest and Great Plains and two Canadian provinces) retired 5,713 MW of coal generation. All of these retirements took place without material, unresolvable reliability issues and relatively few out-of-market payment arrangements to keep units running for reliability purposes. In any case, these features of existing markets needn't be replicated for an expanded western electricity market.

As western coal plants continue to be retired, the use of the extraordinary renewable resources in the West, along with distributed generation like rooftop solar, energy efficiency, and demand response programs, will ensure the system has adequate supplies to meet virtually every load condition and even enhance system reliability.

It is time to look at ways to expedite the renewable energy transition to meet the deep penetrations of clean power we will need to meet an 80 percent reduction in greenhouse gas emissions by 2050, as specified by California's groundbreaking Global Warming Solutions Act, AB 32. This transition will require a major transformation in how the electricity grid is organized, operated, and planned. In the western United States, this means eliminating as much of the operational fragmentation as possible from the system (see map) and placing coordinated operations and planning into fewer hands.

The key to deep penetration of renewable power into the grid, myriad studies tell us, is operating the system over a large geographic footprint, using both policy and market tools to define the types of power plants used and balancing power and demand over seasons, days, hours, and even minutes.[6,7]

Expanding the operational and market functions of the current CAISO footprint across more of the West, and establishing a governance framework that allows CAISO to act as a regional system operator, can provide many of the tools we need to transition to renewable energy and reliably and affordably meet the climate challenge. We can take the best of the RTO experience from around the country and avoid features that are not well-suited to our uniquely western needs.

EXPANDING CAISO TO REDUCE RENEWABLE POWER CURTAILMENT

In many hours of the year, parts of the West already produce more solar or wind power than is needed to meet demand. In the absence of a regional electricity market, which facilitates the sale of this power to neighboring parts of the West, renewable power must either be switched off (also called curtailment) or sold at negative prices (i.e., given away). In a regional market, this excess renewable power could provide a low-cost alternative to electricity from coal or gas-fired power plants to meet load in neighboring states, reducing the hours they operate. The fewer hours that coal or gas plants operate in a market, the sooner they are likely to be retired as uneconomical. Regional markets can thereby not only reduce curtailment of renewable resources but drive down greenhouse gas emissions from dirtier power sources. Studies are currently underway to better quantify the environmental, financial, and societal benefits of regional market expansion in the West.[10]

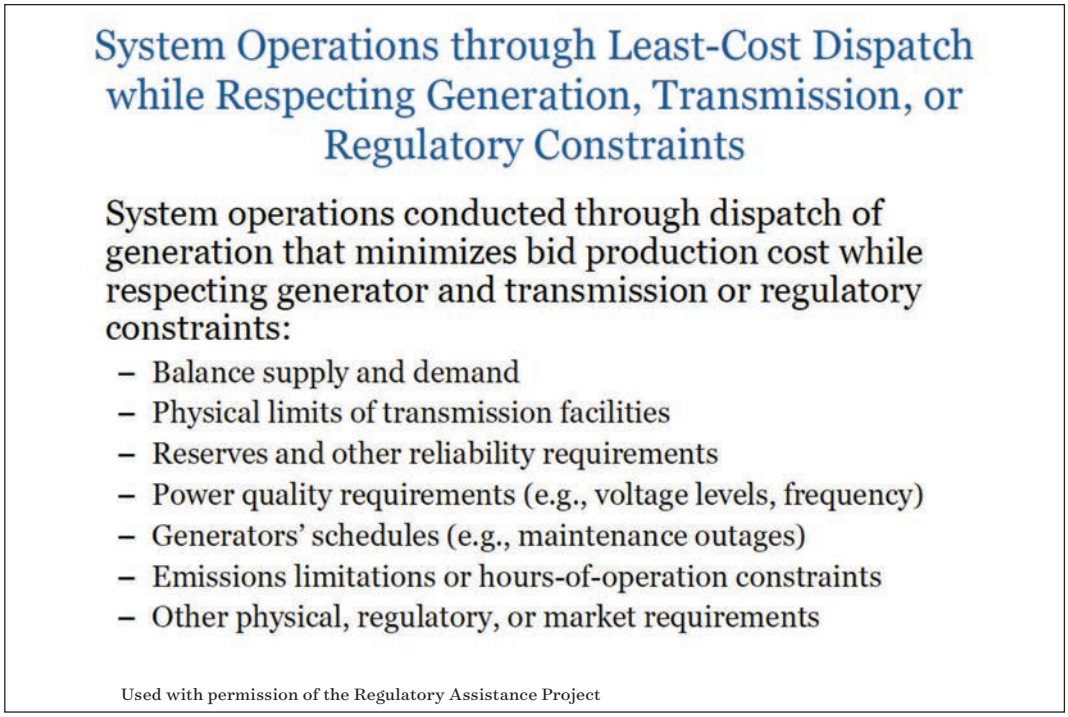
WHAT DO RTOs DO?

RTOs manage flows in the power system by directing generator output from power plants, solar and wind farms, and so on. They also operate electricity markets and plan new infrastructure. For a system to provide reliable electricity service, demand and supply must be continuously balanced. Resources are selected in two ways: State procurement policies influence the mix of resources the RTO will control, and the RTO/ISO chooses which ones to turn on (dispatch) to meet demand, based on resource cost. The box at the bottom of this page illustrates some of the main operational RTO functions.[8]

HOW REGIONAL ENERGY MARKETS WORK

Existing RTOs operate different types of centralized energy markets within their regions. All of the RTOs and ISOs have *day-ahead* and *real-time* wholesale energy markets. As with other commodities, utilities buy this electricity in bulk amounts and then sell it to consumers as a retail product. Some of the RTOs and ISOs also have an additional market tool, called a *forward capacity market* (discussed later), along with various ancillary service markets from which they obtain energy and operational capabilities from some strategically located power plants. Ancillary services are tools that keep the grid stable and operating smoothly by ensuring that the system is energized properly or operating within the correct specifications. Ancillary services include things like frequency response and operating reserves.

Organized energy markets function similarly across RTO regions. In the day-ahead market, the RTO or ISO first works with the utilities in its region to predict customer demand for each hour of the following day. Utilities and other power plant owners offer bids for power in the day-ahead market to satisfy demand on an hourly basis. The RTO then selects the resources to meet that demand the following day. It selects the lowest-cost resource first, then the next lowest, and so on until it has chosen enough generation to meet predicted demand. Because the RTO selects the lowest-cost resources available to meet demand (load), renewable generation—which has no fuel cost—is usually dispatched first. The price paid to all generators providing power within a given hour of the day is the price offered to meet the last megawatt of demand from the highest-cost power plant that clears the market. This price is called the *clearing price*. The units that clear are obligated to provide energy during the hours for which they cleared the following day.



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In reality, customer demand at any given hour will not be exactly what was predicted. As a result, RTOs operate *real-time markets* during each operating day to account for the differences between predicted and actual demand, in 5- to 15-minute intervals. Resources bid into the real-time markets (or *spot markets*) are cleared in a lowest-to-highest-cost fashion, just like the day-ahead market, and are dispatched in real time.

Because of renewable energy's free fuel, the more renewable energy that is available, the fewer hours of higher-cost fossil generation will be dispatched to meet a system's load. As the electrical system transforms by converting from conventional generation to renewable energy, conventional power plants become increasingly uneconomical and less competitive with cleaner resources. As carbon costs are added (as with AB 32 provisions in California, or as expected with the U.S. Environmental Protection Agency's Clean Power Plan to limit power plant emissions), this shift occurs even faster. One strategy for reducing carbon dioxide pollution is to add an additional cost to electricity from conventional plants based on how much pollution they release to the atmosphere. This cost, often called a *carbon adder*, makes power from these generators more expensive and less likely to be chosen in the day-ahead or real-time markets.

CAPACITY MARKETS

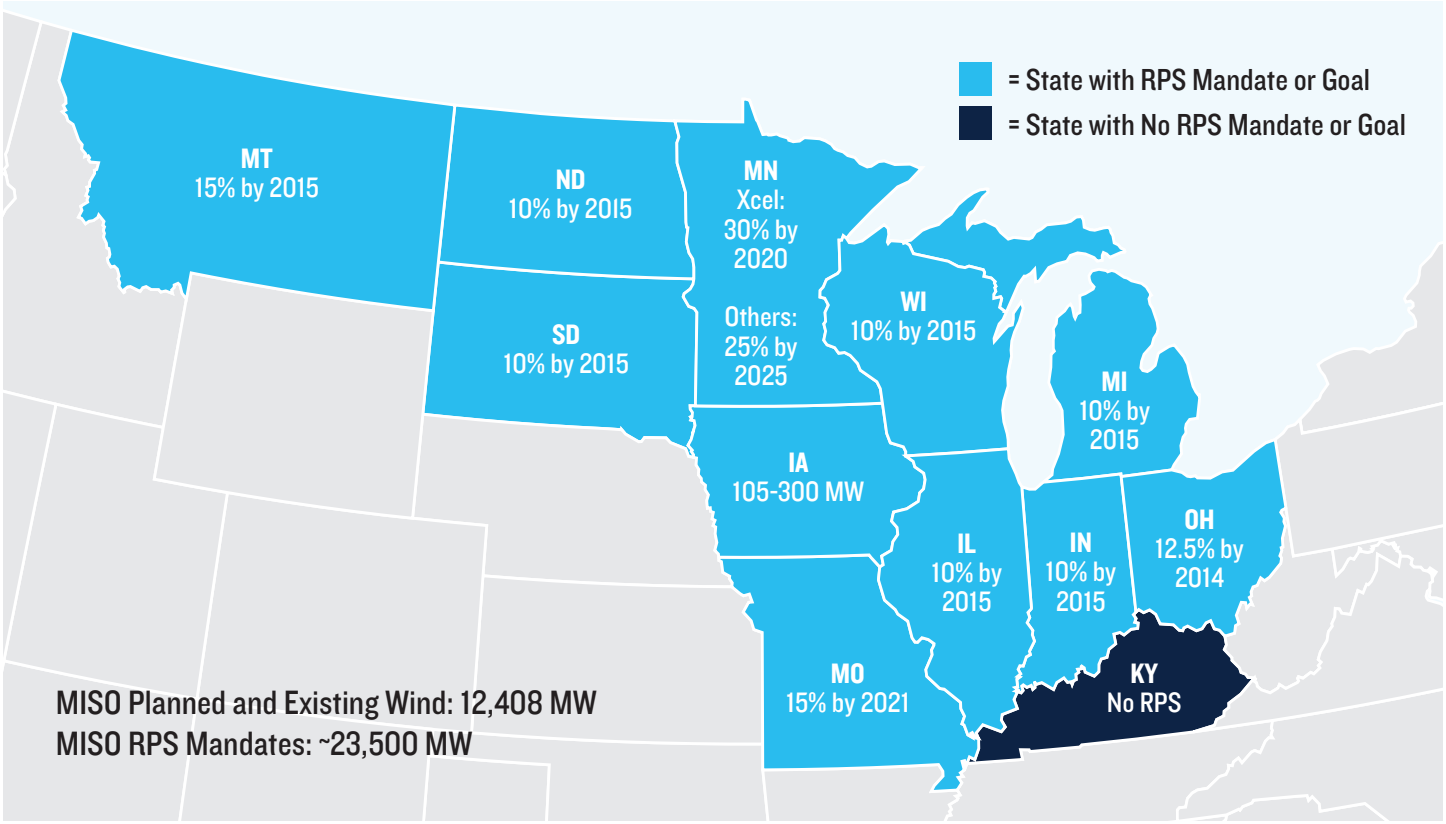
In addition to the organization of energy markets and dispatch, some RTOs and ISOs have devised ways to ensure that sufficient resources are available not only tomorrow but also next month, next year, and even three years ahead. The RTOs and ISOs refer to these types of markets and mechanisms as *capacity markets* or *capacity constructs*.

Capacity markets and more limited capacity constructs emerged out of concern on the part of the RTOs and ISOs that power plant owners were not making enough money in the energy markets alone to ensure they would continue to operate in the future when they were needed. They developed capacity payments as a revenue stream designed to ensure a sufficient amount of power plant capacity in the future, known as *resource adequacy*.

Capacity markets are a mixed bag. While they can keep a few uneconomical and polluting power plants on life support, capacity markets have also provided a way for technologies that increase or reduce electricity demand in the distribution system to compete with power plants. If demand can be predictably adjusted upward or downward when needed to keep the system's supply and demand balanced, new conventional power plants or any new generation for capacity can be avoided. For example, PJM's annual capacity market clears more than 10,000 MW of demand response to serve resource adequacy purposes, thereby avoiding 10,000 MW of existing or new fossil-fueled generation. The Federal Energy Regulatory Commission regulates all RTOs and ISOs. The commission's ability to regulate demand response programs that participate in the capacity markets at RTOs was recently upheld by the U.S. Supreme Court, strengthening this avenue by which the need for conventional power plants can be reduced.[9]

AN RTO WITHOUT CAPACITY MARKETS COULD BE A MODEL FOR THE WEST

Only two of the Eastern Interconnection RTOs operate full capacity markets. However, a capacity market is not needed in the West to meet resource adequacy needs. States can continue to maintain their role in determining



resource adequacy, and in conjunction with the states, an expanded regional grid operator can continue to utilize a model similar to what CAISO already employs, to ensure sufficient generating capacity exists in the future. In the Western Interconnection there is a surplus of gas-fired resources available to meet this need, both within and outside California, as renewable generation is being scaled up.[11] In the footprint of the Western Electricity Coordinating Council (WECC), parts of Montana, Nebraska, New Mexico, South Dakota, Texas, Wyoming, and Mexico; all of Arizona, California, Colorado, Idaho, Nevada, Oregon, Utah, Washington; and the Canadian provinces of British Columbia and Alberta, the capacity factor (the percentage of the time a power plant operates at its rated capacity) of natural gas plants hovers at around 30 percent.[12] WECC is an entity charged with analyzing the reliability and use of the entire western grid and providing data for transmission planning organizations to use in identifying needed transmission expansions across the West. Some natural gas power plants are used only to provide flexibility to the system and are not intended to run all the time, which drives the overall capacity factor down. But by and large, the West's electricity system has more gas-fired capacity than we currently require, and little or no need to build more. By comparison, Wyoming, New Mexico, and Colorado wind generators have capacity factors in the 40 percent range and sometimes even higher.

PLANNING

A final consideration in whether RTOs and ISOs would be valuable for a renewable energy transition in the electrical sector is system planning. Consolidated planning of the electricity system provides a better overview of how the system is functioning now. By looking on a larger scale, it would also improve the identification of short- and long-term system and reliability needs. Such planning allows a full accounting for "non-wire" approaches—energy efficiency, demand response, and on-site electricity storage—to meet customer demand and provide grid services. Consolidated operation of the system enables RTOs to more efficiently see and use capacity in the existing grid, avoiding duplicative or unneeded reserves and transmission, and it also helps identify real impediments to renewable integration and system reliability. Thus, system planning on a large scale enables operators and planners to better use the current system and build the necessary infrastructure when it is most needed. In the Eastern Interconnection, for instance, MISO has planned transmission to meet both reliability and public policy needs, helping states in its service territory meet their energy and environmental goals. MISO's so-called multi-value projects (MVPs) specifically help states meet their renewable portfolio standard (RPS) goals (see map above), which require that a specific percentage of renewable energy be included in the state's electricity mix.

Current planning in the Western Interconnection has been adequate thus far, but as more renewable power is added, a more holistic planning process will be needed. The Federal Energy Regulatory Commission requires utilities across regions to plan together to better identify and meet system needs, setting up a process in the West that involves four planning regions (WestConnect in the southwest and southern Rockies, Columbia Grid and the Northern Tier Transmission Group in the northern Rockies and Pacific Northwest, and the CAISO in California) that identify needs and coordinate them across boundaries. Organizing regional planning across a larger geographic area, as would occur through a western RTO, would better help meet the needs of all the states therein and facilitate the orderly transformation of the electricity delivery system in the West to one that is cleaner, cheaper, and faster and safer to operate.

CONCLUSIONS

- A western RTO or Regional System Operator (RSO) would greatly facilitate efforts to transform the electricity sector in the region to a low-carbon energy delivery system.
- An RSO can help all western states more efficiently meet load and more cost effectively help them comply with federal and state pollution and energy procurement mandates and goals by providing access to lower-cost renewable power from throughout the region.
- All RSOs (including CAISO) have been able to reliably integrate increasing amounts of renewable energy into their systems.
- A balkanized, multi-balancing-area authority system results in an inefficient use of the grid and unnecessary investment in transmission and generation infrastructure, and it makes renewable integration more difficult.
- Geographically large electric system footprints aid renewable integration, aggregate renewable energy's variability, and reduce the need for flexibility reserves, saving money and enhancing reliability.
- RTOs, because they control the dispatch of all generation in their footprint, can better take advantage of existing gas generation—avoiding the need for new fossil-fueled power plants—to integrate high penetrations of renewable energy.
- Energy markets have led to a large number of conventional plant retirements in the Eastern Interconnection.
- Capacity markets have been used to guarantee reliability in eastern RTOs with mixed results. Greater participation has been provided for demand response products in capacity markets, but some uneconomical plants have been preserved by capacity payments when they are no longer competitive in the wholesale market. These include uneconomical coal plants, though they may be infrequently used.
- Regional markets intrinsically favor renewable electricity generators that have zero fuel costs and very low marginal costs.
- A capacity market is not necessary in the Western Interconnection, which is already long on natural gas resources and rich in diverse renewables that often operate during different hours.
- The consolidated operation of RTOs has been shown to reduce and better manage renewable energy curtailment.
- RTO consolidated planning can lead to better identification of infrastructure needs, avoided overinvestment in infrastructure, better use of the existing system, and better justification of new infrastructure when it is needed.

RECOMMENDATIONS

- Western state legislators and regulators should approve the consolidation of the various transmission and electricity balancing areas in the western grid into an RTO/RSO to better manage and more efficiently integrate increasing amounts of renewable power.
- Authorities should approve expanding the existing successful ISO platform from CAISO to across the West. This will save resources and time and facilitate a more rapid system transformation. It builds on the already expanded ISO regional real-time market.
- A new RSO should avoid the establishment of a capacity market, which can perpetuate uneconomical generation. It is not needed in the Western Interconnection to meet reliability. Resource adequacy will continue to be assured through competitive utility procurement under the supervision of state regulators and local utility boards even as many older power plants are retired.

ENDNOTES

1 General Electric International, Inc., *PJM Renewable Integration Study*, Executive Summary Report Revision 05, prepared for PJM Interconnection, LLC, March 31, 2014, www.pjm.com/~/media/committees-groups/subcommittees/irs/postings/pris-executive-summary.ashx. This study looked at a 30 percent integration of wind and solar resources into the nation's largest electricity market.

2 Volume 4 of the NREL *Renewable Electricity Futures Study* modeled the national grid at an 80 percent penetration of renewable energy by midcentury and showed how large geographies and operational consolidation made this level of penetration possible. See: Milligan, Michael, et al., *Renewable Electricity Futures Study*, Vol. 4, "Bulk Electric Power Systems: Operations and Transmission Planning," National Renewable Energy Laboratory, June 2012, www.nrel.gov/docs/fy12osti/52409-4.pdf.

3 General Electric International, *PJM Renewable Integration Study*.

4 For a report on 2015 global investment of renewable energy, see: Clean Energy Canada, A Year for the Record Books, February 2016, cleanenergycanada.org/wp-content/uploads/2016/02/A-Year-for-the-Record-Books_final.pdf.

5 For one perspective of solar growth forecasts, see: Ryan, Joe, "U.S. Solar Growth Will More Than Double in 2016, Study Finds," *Bloomberg News*, March 8, 2016, www.bloomberg.com/news/articles/2016-03-09/u-s-solar-growth-will-more-than-double-in-2016-study-finds.

6 In addition to the above-referenced studies by PJM and NREL, the National Oceanic and Atmospheric Administration released a study in January 2016 that concluded: Our results show that when using future anticipated costs for wind and solar, carbon dioxide emissions from the US electricity sector can be reduced by up to 80 percent relative to 1990 levels, without an increase in the levelized cost of electricity. Future cost-competitive electricity systems and their impact on US CO_2 emissions, MacDonald, A.E., et al., "Future Cost-competitive Electricity Systems and Thier Impact on US CO2 Emissions," Nature Climate Change, January 25, 2016, http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate2921.html..

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8 For an introduction to RTO functions intended for state air regulators, see: Regulatory Assistance Project and Great Plains Institute, "Introduction to Regional Transmission Organizations for State Air Regulators," webinar briefing for state air quality regulators, September 11, 2015, bit.ly/1UOsGKg.

9 Bade, Gavin, "Updated: Supreme Court Upholds FERC Order 745, Affirming Federal Role in Demand Response," *Utility Dive*, January 24, 2016, www.utilitydive.com/news/updated-supreme-court-upholds-ferc-order-745-affirming-federal-role-in-de/412668/.

10 For complete information on the status of these studies, see: California ISO, "Benefits of a Regional Energy Market," last updated March 30, 2016, www.caiso.com/informed/Pages/BenefitsofaRegionalEnergyMarket.aspx.

11 Sopinka, Amy, and Lawrence Pitt, "Trends in the Western Electricity Coordinating Council: Retrospect and Prospect," Pacific Institute for Climate Solutions, October, 2013, bit.ly/1RBtiw6.

12 Ibid.