Senate Bill 350 Study

Volume XI: Renewable Integration and Reliability Impacts

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Senate Bill 350 Study

The Impacts of a Regional ISO-Operated Power Market on California

List of Report Volumes

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Volume XI. Renewable Integration and Reliability Impacts

A. INTRODUCTION

As documented by industry experience and in a wide range of industry studies, regional market operations and planning will allow for the more cost effective and more reliable integration and balancing of intermittent renewable resources.[1] The benefits of operational efficiency, increased renewable integration and reliability associated with closer regional coordination across the many existing Balancing Areas in the WECC has been documented and recognized in the context of the Energy Imbalance Market ("EIM").[2]

A full "Day 2" regional market will magnify these EIM-related benefits by adding substantial additional regional market operations, which consist of: (1) a day-ahead energy market; (2) day-ahead and intra-day system-wide forecasting of intermittent renewable generation levels; (3) optimal economic and reliability-based commitment of conventional generating units on both a day-ahead and intra-day basis; and (4) region-wide, co-optimized ancillary services markets for procurement of regulation reserves, procurement and deployment of operating reserves, and flexible capacity for load-following reserves. In addition to these operational benefits, an ISO-based regional market will also benefit from the integrated, region-wide operational, reliability, resource adequacy management, and transmission planning functions performed by an independent system operator ("ISO").

Covered in other parts of this report, key aspects of reliability and renewable integration benefits of a larger ISO-operated regional market already have been quantified in terms: (1) the load diversity analysis, which assesses how resource adequacy requirements can be met with less

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1 See discussion of existing studies in Volume XII of this report.

2 For example, for renewable integration benefits of the EIM refer to http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=5180B3C9-2B88-4678-B6AD-2A6B55CE8DEB for actual benefits and http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=7DF86332-C71D-44B7-836B-56181A694C8C for pre-operational benefit assessments.

For reliability benefits of the EIM see FERC's Staff Report, "Qualitative Assessment of Potential Reliability Benefits from a Western Energy Imbalance Market," February 26, 2013, Available http://www.caiso.com/Documents/QualitativeAssessment-PotentialReliabilityBenefits-WesternEnergyImbalanceMarket.pdf

generating capacity (Volume VI of this report); (2) the nodal market simulations, which simulate more optimized power flows on the transmission grid, reduced curtailments, and reduced need for ramping, load following, and operating reserves at high levels of renewable resource development (Volume V); and (3) the renewable investment optimization, which recognizes integration benefits when selecting the renewable portfolios that can meet California's 50% RPS (Volume IV).

However, the estimation of the benefits associated with reliability and renewable integration benefits captured in California ratepayer savings does not reflect other value of achieving more reliable region-wide system operations. For example, expanding ISO operations to a larger regional footprint will offer significant reliability benefits to both California and the larger regional market area. Regional ISO operations and practices will offer various reliability benefits over the standard operational practices of Balancing Authorities in the WECC footprint. Because the WECC is a single interconnected power system, reliability events in neighboring WECC areas affect California as well.[3] Expanding CAISO operational practices consequently offer reliability benefits to (a) the expanded regional footprint that, in turn, (b) increases reliability in the ISO's current California footprint. Reliability-related benefits will be particularly pronounced during stressed system conditions, such as extreme weather, drought, and unexpected outages.

B. Integration and Balancing of Renewable Generation

CAISO has undertaken a number of initiatives to improve the current market structure and improve renewable integration. Our future scenarios assume these measures are in place, even in the Current Practice scenarios, including:

- The creation and regional expansion of the Energy Imbalance Market;
- Ensuring sufficient flexible generation is made available in the CAISO market;
- Refining the markets for ancillary service needed to balance intermittent generation;
- Expanding the transmission system;

[3] Examples of WECC-wide reliability events that affected California include the October 6, 2014 Northwest RAS Event; the September 8, 2011 Arizona–Southern California Outage; and the August 10, 1996 Western Interconnection (WSCC) System Disturbance.

- Introducing 15-minute scheduling on transmission interties with neighboring regions; and
- Facilitating the wholesale market integration of demand-side resource and storage.

In addition, all scenarios assume that a number of additional measures are in place by 2030:

- Time-of-use rates that encourage daytime use;
- 5 million electric vehicles by 2030 with near-universal access to workplace charging;
- 500 MW of pumped storage are developed in California;
- 500 MW of geothermal resources are manually added to California's renewable portfolio in all cases, which reduces renewable curtailment relative to a case with an equivalent quantity of solar;
- 5,000 MW of out-of-state renewable resources available to be selected on a least-cost basis;
- Unlimited storage available to be selected on a least-cost basis;
- Renewable resources are assumed to be fully dispatchable and capable of providing grid services such as operating reserves;
- Storage and hydro are assumed to be fully dispatchable and capable of providing grid services such as operating reserves and frequency response.

A larger regional ISO-operated wholesale power market will improve the integration and balancing of renewable resources by enabling:

- A single intra-hourly energy market for selling intermittent output that is integrated with optimal day-ahead commitment and pre-dispatch of the entire region's generating plants;
- Coordinated and centralized region-wide day-ahead and intra-day forecasting of renewable output to reduce balancing costs, improve congestion management, and reduce curtailments;
- Reduced system-wide operating and load following reserve requirements in a regional market because of larger-regional diversification of renewable generation variances and a more cost-effective combination of renewable resources and transmission;
- Lower-cost provision and deployment of regional operating and load following reserves through optimized security-constrained unit commitment and dispatch; and

- Lower integration-related investment needs through improved region-wide generation interconnection and transmission planning processes.

For example, SPP has recently announced that within its larger, consolidated balancing area it can now manage wind generation of up to 60% of its load. As noted by SPP's CEO, due to the larger footprint, SPP can "forecast the wind rise and decline such that we can bring other resources to bear against the variability of wind…[y]ou just couldn't have done that when we were operating as 20-plus different balancing authorities."[4]

Compared to EIM, the broader regional market design further lowers the integration and balancing costs currently faced by many developers of renewable generation projects by additionally providing:

- A system-wide generation day-ahead unit commitment and dispatch over a broader region with a more diverse set of renewable and conventional resources
- 5-minute real-time pricing for all energy generated by both intermittent resources and the entire fleet of conventional resources in the regional market's footprint (which exceeds the scope of EIM dispatch);
- Availability of market-based ancillary services with lower-cost balancing options;
- Fewer renewable curtailments through improved region-wide forecasting, optimized unit commitment, and utilization of transmission infrastructure;
- Streamlined access to existing and new transmission to deliver low-cost renewables and one-stop shopping for generator interconnection requests and transmission planning service; in the entire region; Improved regional transmission planning to provide access to low-cost renewable areas within the regional footprint;
- Easier contracting for load-serving entities (including public power companies, cooperative utilities, municipal electric companies) as well as with commercial and industrial customers who do not currently have transmission access to the low-cost renewable generation areas within the region; and
- Improved financial hedging options through day-ahead markets, optimized congestion management, and congestion revenue rights, more transparent energy pricing, more

[4] Gavin Blade, "SPP CEO: Regionalization, transmission help push renewables penetration near 50%," UtilityDive, May 26, 2016.

competitive access to a larger regional market, and improved access to more liquid trading hubs that offer longer-term forward contracting.

As discussed in more detail below, this reduction of integration and balancing costs faced by renewable generation developers or their contractual off-takers offered by regional ISO-operated markets reduces investment costs, thereby contributing to a more rapid development and growth of renewable generation in the regional footprint.

C. Facilitating The Development of Renewable Generation

Numerous existing studies show that ISO-operated regional markets facilitate renewable generation investment and, thus, a more rapid development and growth of renewable generating resources. Nationally, ISO-operated regional markets account for a disproportionate share of the nation-wide investment in renewables, which has been attributed to the improved integration of renewable resources in ISO-operated regional markets.[5]

For example, as of 2014 over 77% of wind generation capacity was installed in areas with regional electricity markets.[6] As shown in Figure 1, the seven states with the highest installed wind generating capacity are Texas, Iowa, California, Oklahoma, Illinois, Kansas, and Minnesota; they are all located in areas with ISO-operated wholesale power markets.[7]

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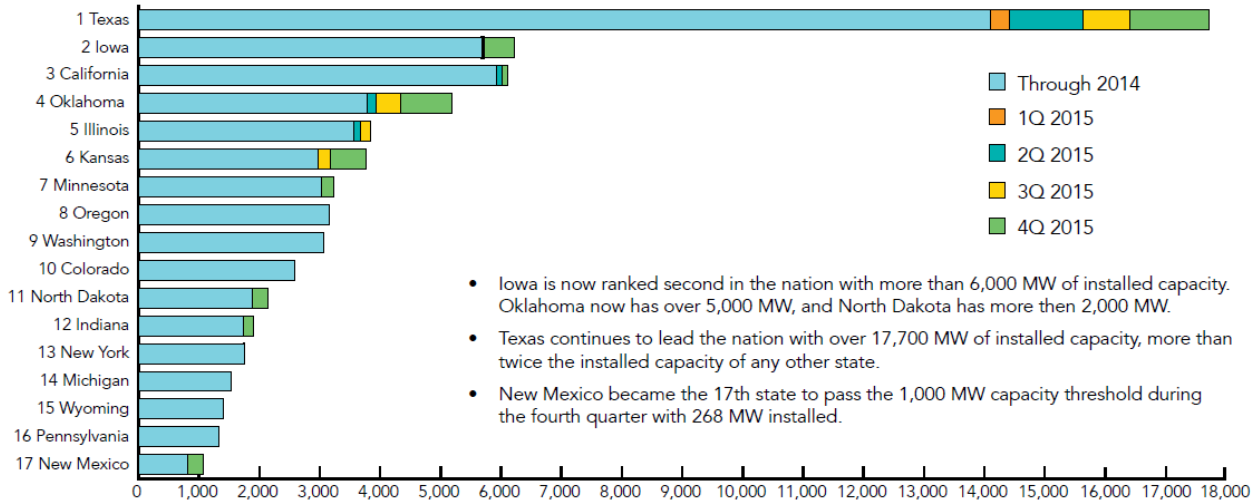
5 Hogan, W., "Electricity Wholesale Market Design in a Low Carbon Future", volume in Padilla, J. and Schmalensee, R., Harnessing Renewable Energy, p. 10, Available: https://www.hks.harvard.edu/fs/whogan/Hogan_Market_Design_012310.pdf

6 COMPETE, "RTO and ISO Markets are Essential to Meeting Our Nation's Economic, Energy and Environmental Challenges", 2014, pp. 3-4, Available: http://www.competecoalition.com/files/COMPETE%20RTO%20White%20Paper_December%202%202014%20FINAL.pdf

7 AWEA, "U.S. Wind Industry Fourth Quarter 2015 Market Report", American Wind Energy Association, January 2015, p. 14, Available: http://awea.files.cms-plus.com/FileDownloads/pdfs/4Q2015%20AWEA%20Market%20Report%20Public%20Version.pdf

Figure 1: Installed Wind Generation Capacity, End of 2015



* Source: http://awea.files.cms-plus.com/FileDownloads/pdfs/4Q2015%20AWEA%20Market%20Report%20Public%20Version.pdf

The fact that regional markets facilitate renewables integration has specifically been emphasized by developers and utilities. For example, MidAmerican stated when joining MISO that it was motivated in part by the ability of the market to provide ancillary services and facilitate integrating renewables.[8] Since joining MISO, MidAmerican has been able to greatly expand its (mostly voluntary) purchase and development of renewable resources, which are now expected to supply 58% of the utility's Iowa load by the end of 2016.[9]

As shown in Figure 2, in 2015, most of the country's wind generation additions were focused in the wind-rich areas of the Great Plains with regional wholesale power markets operated by ERCOT, SPP, and MISO. As also shown in Figure 2, significantly less development activity occurred in the similarly wind-rich areas of Wyoming, Colorado, and New Mexico without ISO-operated wholesale markets.

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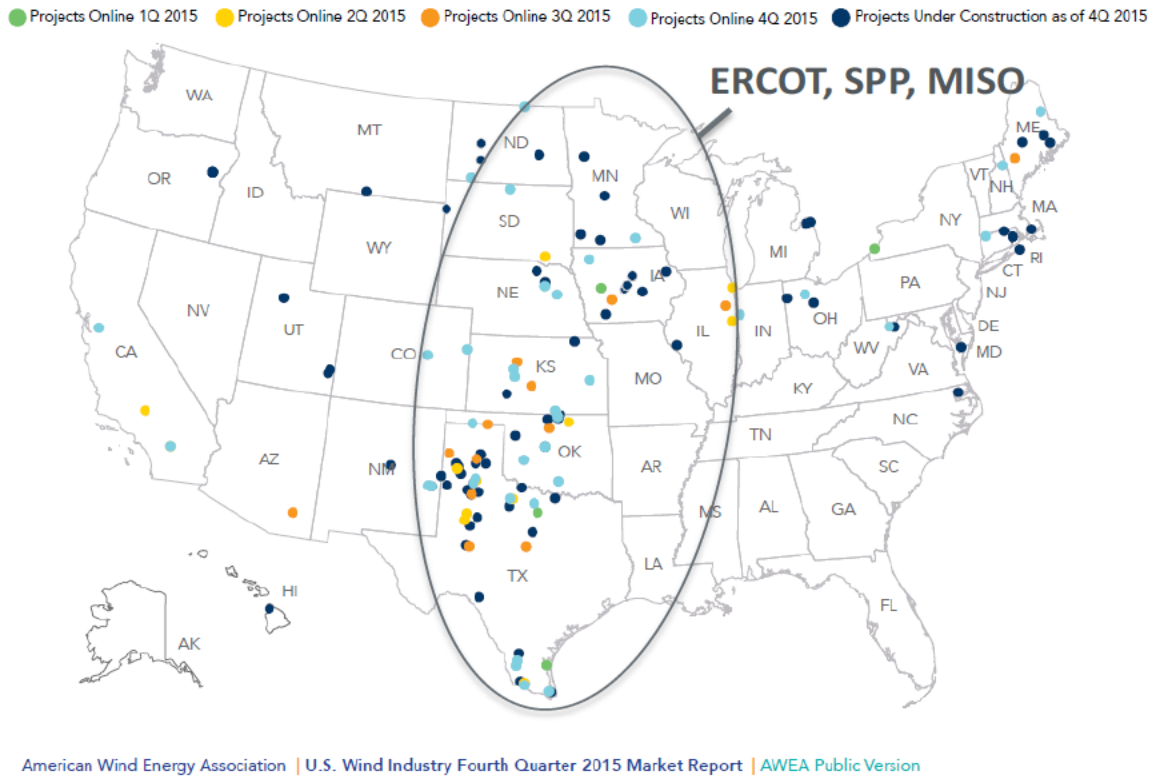
8 COMPETE, "RTO and ISO Markets are Essential to Meeting Our Nation's Economic, Energy and Environmental Challenges," 2014, pp. 3–4

9 These renewable energy purchases also allowed MidAmercian to retire 2,000 MW of coal plants. See Matyi and McGuirk, "2,000 MW of coal retired in the Midwest," *MegaWatt Daily*, April 15, 2016.

Figure 2: 2015 Wind Generation Additions and Projects under Construction



* Source: http://awea.files.cms-plus.com/FileDownloads/pdfs/4Q2015%20AWEA%20Market%20Report%20Public%20Version.pdf

The industry reports we reviewed summarize a range of factors by which ISO/RTO markets facilitate renewable development. These factors are summarized in Figure 3 and Figure 4 below. ISO/RTO markets improve transmission planning processes, allowing previously inaccessible renewable sites to be developed.[10,11] Features of ISO/RTO markets, such as 5-minute pricing, nodal pricing, and financial congestion hedging, enable further savings.[12] The larger geographic scale of ISO/RTO market footprints allows the development of renewable resources in lower-cost

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10 AWEA, "Green Power Superhighways: Building a Path to America's Clean Energy Future," American Wind Energy Association, 2009, Available: http://www.tresamigasllc.com/docs/2016_02_19_US_FOSG_GreenPowerSuperhighways.pdf

11 FERC-Regulated ISO/RTOs, "2010 ISO/RTO Metrics Report," 2010, Available: https://www.ferc.gov/industries/electric/indus-act/rto/metrics/summary-rto-metrics-report.pdf

12 FERC-Regulated ISO/RTOs, "2015 ISO/RTO Metrics Report," 2015, Available: http://www.pjm.com/%5CMedia%5Cdocuments%5Cferc%5Cfilings%5C2015%5C20151030-ad14-15-000-package.pdf

locations and reduces both the variability of renewable output due to geographic diversity and improves access to low-cost balancing resources.[13]

Figure 3: Summary of Studies Discussing How Regional Markets Facilitate Renewable Generation Development

Study	Finding
Brookings Clean Economy Study (2011)	• ISO/RTOs facilitate renewables through geographic diversity • ISO/RTOs also reduce barriers to expanding transmission capacity to allow additional renewables
AWEA Green Power Superhighways (2009)	• Markets that incentivize flexibility minimize the cost of integrating renewables • RTOs have been more effective in administering large balancing areas, using short scheduling intervals, and operating sophisticated energy markets
Hogan Markets In a Low Carbon Future (2010)	• Wind installations are disproportionately in RTO markets • Markets facilitate integration of low-carbon technology through improved granularity of pricing and dispatch
COMPETE Markets and Environmental Challenges (2014)	• Renewables developers are attracted to ISO/RTO markets due to transparency, fairness of rules, and geographic diversity
ISO/RTO Metrics Report (2015)	• ISO/RTOs facilitate renewables by establishing simple interconnection processes for new resources, providing access to spot markets, and allowing resources to take advantage of geographic diversity
IRC Increasing Renewables (2007)	• ISO/RTO markets facilitate renewables by having transparent pricing, highly granular dispatch, and geographic diversity

[13] Muro, et al., "Sizing the Clean Economy: A National and Regional Green Jobs Assessment," The Brookings Institution, 2011, Available: http://www.brookings.edu/~/media/series/resources/0713_clean_economy.pdf

Figure 4: Summary of Factors by Which Regional Markets Facilitate Renewable Generation Development

Factor	Description
Improved Market Designs	Increased granularity in time (5-minute) and location (nodal) improves price signals and stimulates efficient transmission and generation investment
	Increased granularity increases the ability of prices to reflect avoided cost and improves dispatch of low carbon resources
	ISO/RTO markets provide a mechanisms for non-transmission owners (such as most renewables developers) to hedge against congestion
	RTO/ISO markets allow market participation by renewable resources by offering provide bid-based curtailments and providing ancillary services
Larger Markets	The larger geographic reach of ISO/RTO markets allows the development of renewable resources in lower-cost locations
	Allows a larger set of low-cost resources to provide balancing services for renewables
	Large footprints of ISO/RTO markets reduce balancing costs by taking advantage of the diversity of renewables output
	Liquidity of RTO spot markets further reduces the cost of addressing wind's variability and uncertainty compared to illiquid markets
Transparency, Open Access, and Fairness	Fair, transparent pricing rules give confidence to investors
	Markets reduce the potential for conflicts of interest in selecting new transmission projects and allocating the costs of these projects
	ISO/RTOs help promote Open Access to transmission, which is particularly important to the largely independent producers who develop renewables
	ISO/RTOs allow for market participation by all resources, including intermittent renewable resources

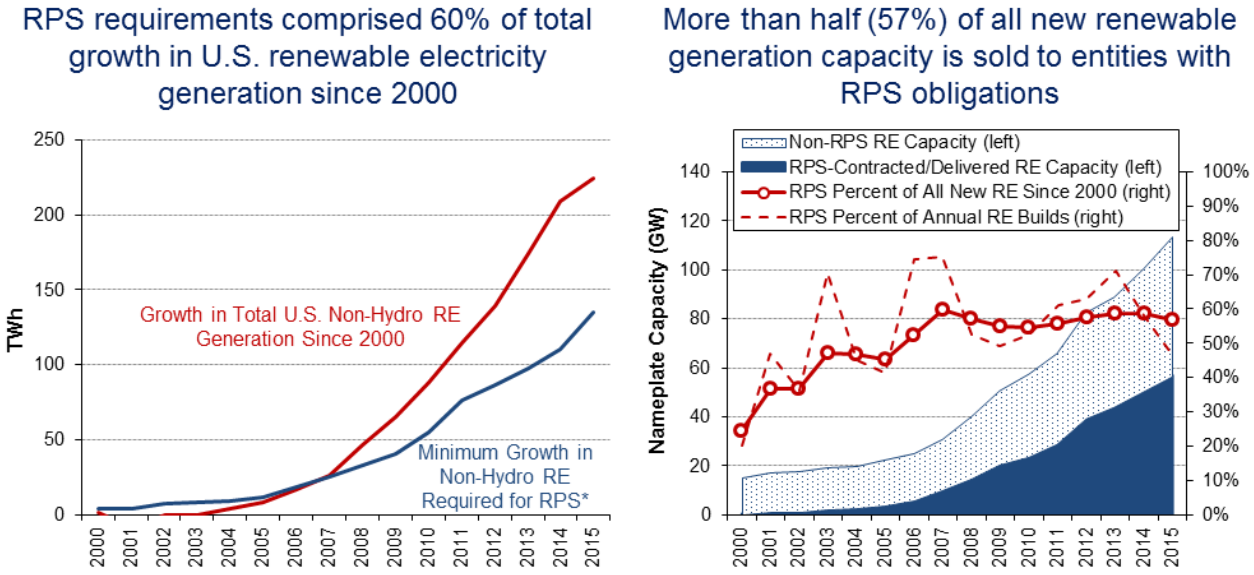
Finally, as summarized in the above tables, the transparency, fully open access to transmission, and fairness offered by independently operated RTOs provide increased confidence to investors in renewable generating plants. While ISO/RTOs support renewables penetration beyond the requirements of Renewable Portfolio Standards, they facilitate the implementation of the RPS itself. This observation is supported by the fact that most states with RPS are in regions with RTOs. Several U.S. ISO/RTOs support implementation of RPS by tracking generation and Renewable Energy Credits. This tracking is useful to market participants in meeting their RPS obligations and to states in monitoring compliance.[14]

[14] IRC, "Increasing Renewable Resources," ISO/RTO Council, 2007, p. 11, Available: http://www.consultkirby.com/files/IRC_Renewables_Report_101607_final.pdf

D. DEVELOPMENT OF RENEWABLE GENERATION BEYOND RPS REQUIREMENTS

In areas with access to low-cost renewable generation, regional markets have supported the development of renewable generating plants at levels well beyond RPS mandates. In fact, as shown in Figure 5, since 2000, RPS mandates have been responsible for only about 60% of the total development of non-hydro renewable generation nation-wide.[15]

Figure 5: Renewable Generation Investments for and beyond RPS Requirements



Source: Barbose, Galen. 2016. "U.S. Renewables Portfolio Standards: 2016 Annual Status Report." Lawrence Berkeley National Laboratory. http://rps.lbl.gov

Based on data provided by Dr. Galen Barbose of the Laurence Berkeley National Laboratory (LBNL), most of the development of renewables beyond RPS requirements has occurred in ISO/RTO regions with low-cost wind resources. For example, since 2000, wind generation accounted for 80% of 44,000 MW of non-RPS-related renewable generation additions nationwide, and 80% of these non-RPS-related wind generation investments (over 28,000 MW) took place in six states (Texas, Iowa, Oklahoma, Kansas, Illinois, and Indiana), all of which are in ISO-operated market areas. In 2015 alone, 6,100 MW or 95% of all non-RPS-related wind

[15] Barbose, G., "U.S. Renewables Portfolio Standards: Overview of Status and Key Trends," Lawrence Berkeley National Laboratory, January 2016, p. 7, Available: https://emp.lbl.gov/sites/all/files/2016%20CESA%20Webinar%20Barbose.pdf

generation additions were located in just these six states with low-cost wind resources and ISO-operated regional markets.[16]

Particularly in Texas and the Great Plains portion of the Midwest—with regional power markets operated by ERCOT, SPP, and MISO—the penetration of wind generation has far exceeded RPS mandates. As shown in Figure 6, 72% of Texas' total 17,800 MW of wind generating capacity installed by the end of 2015 was unrelated to RPS mandates and 7,690 MW of these "beyond-RPS" wind plants have been added in the last five years. The output of these 7690 MW is equivalent to 6.9% of Texas retail load. Similarly, the LBNL data summarized in Figure 6 shows that more than 9,200 MW of wind generation were added in the Midwest (mostly western SPP and MISO) unrelated to RPS requirements over the last five years.[17] These 9,200 MW of wind generation additions are equivalent to serving more than 3% of total Midwestern retail load beyond RPS requirements.

Figure 6: Wind Generation Investments beyond RPS Requirements in Texas and the Midwest

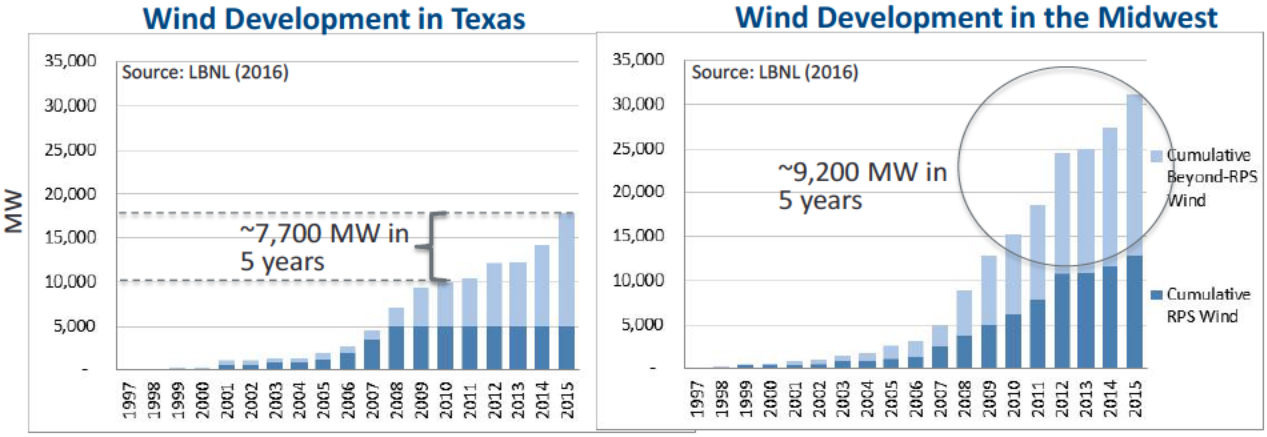


Figure 7 shows the amount of beyond-RPS wind added in Texas and the Midwest as a share of total retail load in these regions. As mentioned above, the 7,690 MW of wind unrelated to RPS that has been installed in Texas over the last five years represents 6.9% of Texas retail load. Similarly, the 9,200 MW of beyond-RPS wind installed in the Midwest over the same period represents 3% of retail load. Figure 7 also provides a benchmark for the 5,000 MW of additional beyond-RPS wind assumed to be developed between 2020 and 2030 in regional market scenarios of the SB350 study. This 5,000 MW of additional wind generation represents only 2.6% of the

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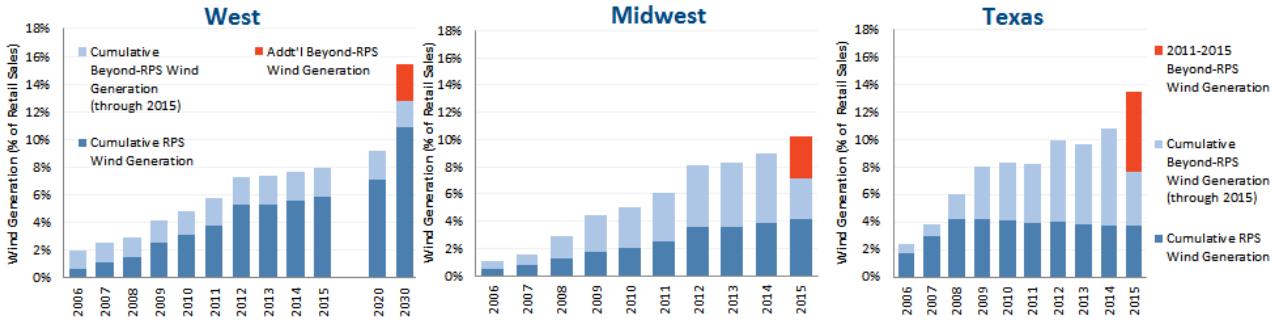
16 Based on data provided by Dr. Galen Barbose of LBNL.

17 Based on data provided by Dr. Galen Barbose of LBNL.

regional market's 2030 retail load, a smaller share than the amount of beyond-RPS wind that has already been developed in Texas and the Midwest. This assumption is also discussed in more detail in Volume I of this report.

Figure 7: Wind Generation Development to meet RPS Requirements and Beyond
Historical (and simulated WECC future) in Regions with ISO-markets and Low-Cost Resources



Historical RPS and beyond-RPS wind installations data and retail load data provided by Dr. Galen Barbose of LBNL. We used average 2012 wind capacity factors by region to estimate wind generation based on installed capacity. We assumed a 10% loss factor when comparing wind generation and retail load.

Most of these wind generation investments beyond RPS mandates are supported by power purchase agreements ("PPAs") voluntarily signed by utilities, public power companies, and large commercial or industrial customers. However, the combination of transmission access, an improved wholesale market design, and liquid forward markets even allowed ERCOT to attract over 1,400 MW of pure "merchant" wind projects in 2014. Expanded transmission and the improved wholesale market design allowed ERCOT to reduce wind curtailments from 17% of generation in 2009 to 0.5% of generation in 2013, thereby increasing renewable energy generation without the need for new construction of renewable resources.[18]

The industry studies reviewed show that the drivers behind renewable generation development beyond RPS mandates fall into four distinct categories:

- **Voluntary PPAs by Investor-Owned Utilities in Excess of RPS Requirements.** While Investor Owned Utilities are often subject to RPS requirements, many utilities in areas

[18] Wiser, R. and Bolinger, M., "2014 Wind Technologies Market Report," Lawrence Berkeley National Laboratory, August 2015, pp. 38, 66, Available: http://energy.gov/sites/prod/files/2015/08/f25/2014-Wind-Technologies-Market-Report-8.7.pdf

"Merchant" projects are those whose electricity sales revenue is tied to short-term contracted and/or wholesale spot electricity market prices (with the resulting price risk commonly hedged over a 10- to 12-year period) rather than being locked in through a long-term PPA. (*Id.*, at 27)

with access to low-cost wind generation have procured additional renewables for economic reasons. For example, because of MidAmerican's voluntary purchases and development of low cost wind resources, wind generation is projected to supply 58% of the utility's Iowa load by the end of 2016.[19]

- **Purchases by Public Power and Municipal Utilities Not Subject to RPS.** Public Power and Municipal Utilities, who are generally not subject to RPS requirements, have voluntarily contracted for significant amounts of renewable generation. For example, publicly-owned utilities were responsible for 15% of the renewable generation purchases in 2014.[20]
- **PPAs by Commercial and Industrial Customers.** Commercial and industrial electricity customers are increasingly opting to purchase renewable power through PPAs with renewable power developers. As discussed further below, in regional markets that can readily accept the energy produced by renewable generating resources, such PPAs with retail electricity customers are possible even in states without retail access. According to Renewable Choice Energy, 3,420 MW of voluntary PPAs for renewable energy were signed by commercial and industrial customers in 2015 (up from 1,615 MW in 2014 and 559 MW in 2013).[21,22]
- **Merchant Renewable Generation Development.** Merchant wind generation projects have been developed without a long term PPA. They often sell power into spot energy markets and may use multi-year financial hedges to support the financing of the generation investments. While utilities remain the largest purchaser of renewables, merchant wind installations reached 33% of the total renewable generation development in 2014.[23]

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19 These renewable energy purchases also allowed MidAmercian to retire 2,000 MW of coal plants. See Matyi and McGuirk, "2,000 MW of coal retired in the Midwest," MegaWatt Daily, April 15, 2016.

20 Wiser, R. and Bolinger, M., "2014 Wind Technologies Market Report," Lawrence Berkeley National Laboratory, August, 2015, p. 27

21 O'Shaughnessy, E. *et al.*, "Status and Trends in the U.S. Voluntary Green Power Market (2014 Data)," NREL, October, 2015, p. v., Available: http://www.nrel.gov/docs/fy16osti/65252.pdf

22 Powers, J. "The Rise of the Corporate Energy Buyer," Renewable Choice Energy, 2016, Available: http://www.renewablechoice.com/blog-corporate-energy-buyer/

23 Wiser, R. and Bolinger, M., "2014 Wind Technologies Market Report", Lawrence Berkeley National Laboratory, August 2015, p. 27, Available: http://energy.gov/sites/prod/files/2015/08/f25/2014-Wind-Technologies-Market-Report-8.7.pdf

Recently, several new mechanisms have emerged to enable voluntary purchases of renewable electricity. In some states, community choice aggregation programs allow municipalities to purchase renewable electricity on behalf of some or all of the customers in their jurisdictions. Community solar programs allow customers to directly support the construction of a solar facility while continuing to receive power from their local utility. Of particular interest, large commercial and industrial customers have increasingly been signing PPAs to procure renewable energy directly. Such PPAs are facilitated by organized markets.

According to NREL, "voluntary" renewable purchases by retail customers accounted for 26% of U.S. non-hydro renewables generation in 2014 (74 million MWh), an increase of 10% over 2013.[24] Such voluntary purchases could be executed in several ways. First in de-regulated states, customers may purchase renewable electricity from competitive suppliers. Second, in regulated states where no retail choice exists, utilities may procure renewable electricity and then sell it to their customers using green pricing programs or tariffs. Third, customers in any region can purchase "unbundled" Renewable Energy Credits (RECs) that are sold independently of the underlying renewable energy. And finally, customers can sign PPAs that financially support renewable generation investments whose energy is injected into the regional wholesale power market while customers continue to be served by their local utility through the utility's standard regulated retail service.

Commercial and industrial purchasers account for an increasingly large share of renewable PPAs and such retail purchases are increasing over time. Non-utility entities have been reported to account for over 50% of all wind PPAs in 2015.[25] The recently formed Renewable Energy Buyers Alliance (REBA), a collection of more than sixty companies interested in increasing purchases of renewable energy, set a goal of procuring 60,000 MW of new renewable generation in the U.S. by 2025.[26,27] Figure 8 shows aggregate commercial and industrial (C&I) PPA deals over time by counter-party.

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[24] O'Shaughnessy, E. *et al.*, "Status and Trends in the U.S. Voluntary Green Power Market (2014 Data)," NREL, October, 2015, Available: http://www.nrel.gov/docs/fy16osti/65252.pdf

[25] Copley, M. "Business coalition doubles down on corporate demand for renewables," SNL, May 13, 2016, Available: https://www.snl.com/InteractiveX/article.aspx?id=36493637&KPLT=2

[26] WRI, "RELEASE: Renewable Energy Buyers Alliance Forms to Power the Corporate Movement to Renewable Energy," WRI Press Release, May 12, 2016, Available:

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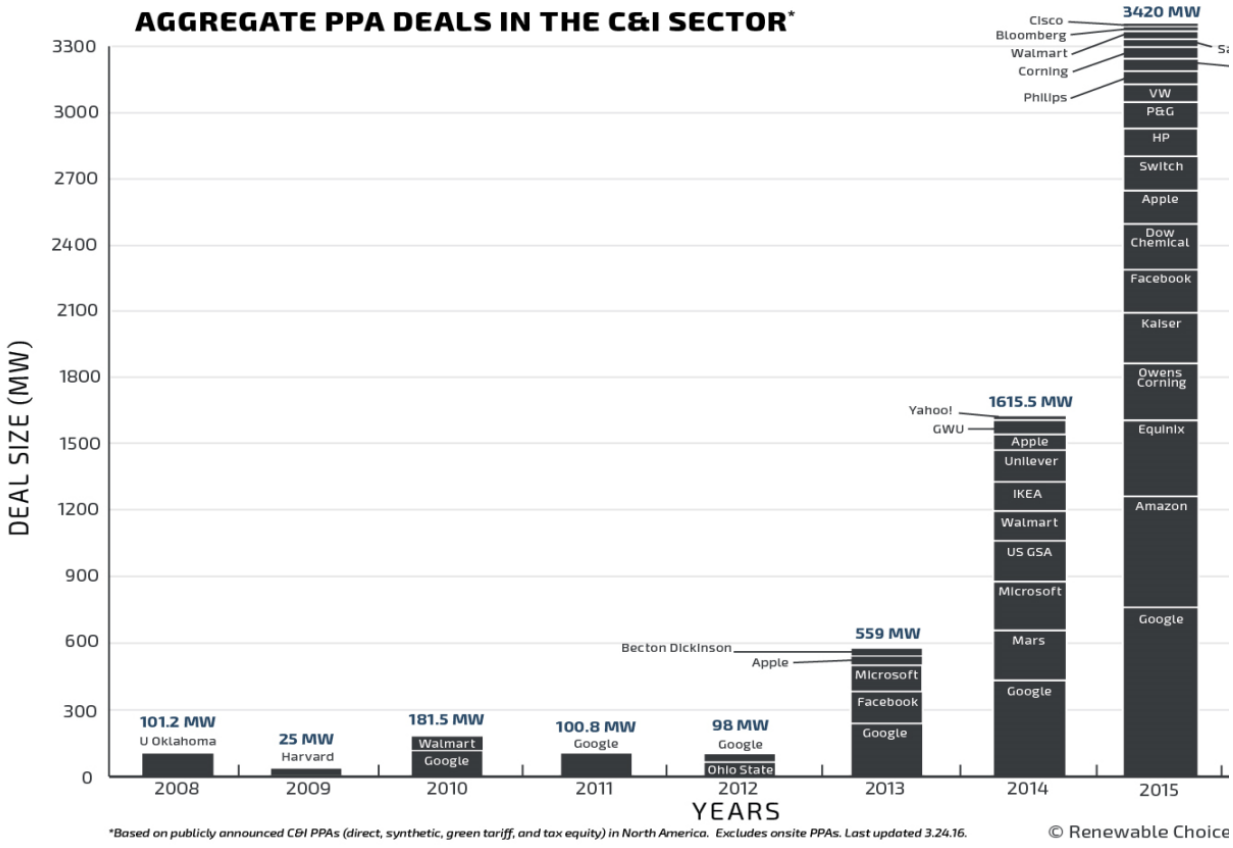
Figure 8: Aggregate PPA deals with Commercial & Industrial Customers
(Reproduced from renewableenergychoice.com)



Source: http://www.renewablechoice.com/blog-corporate-energy-buyer/
See also: http://www.renewablechoice.com/blog-electricity-corporate-ppa-buyers/

Based on the authors of Figure 8, all PPAs shown on the chart involve long-term PPAs, for bundled off-site resource (not unbundled RECs), involve new construction, are mostly for wind generation (with some solar), and are generally (but not always) located in the same ISO market as the retail customers.

Continued from previous page
http://www.wri.org/news/2016/05/release-renewable-energy-buyers-alliance-forms-power-corporate-movement-renewable

27 WRI, "Corporate Renewable Energy Buyers' Principles: Increasing Access To Renewable Energy," December 2015, Available: http://www.wri.org/sites/default/files/Corporate_Renewable_Energy_Buyers_Principles.pdf

Google, one of the most active companies in this regard, states the following about its renewable power purchases:[28]

> Google's goal is 100% renewable power, and to date we've signed 16 contracts to purchase over 2.2 Gigawatts of clean energy…To achieve our goal, we're buying clean electricity directly from wind and solar farms around the world through Power Purchase Agreements (or PPAs), and we're additionally working with our utility partners to make more renewable energy available to us and others through renewable energy tariffs and bilateral contracts.
>
> We hold ourselves to the highest standards when purchasing clean power. First, our contracts must create new sources of green power on the grid. Second, we purchase renewable energy in the same grid regions from which we're withdrawing power. And third, we purchase "bundled" energy and RECs, meaning the same quantity of energy and RECs at the same time.

More recently, organized wholesale markets have been facilitating the development of renewable generating facilities through PPAs with commercial and industrial customers in the form of so-called Contracts for Differences ("CfD")—a novel mechanism allowing non-utility purchasers to access both the environmental and economic benefits of new renewables in states with or without retail access. In a CfD arrangement, customers obtain bundled RECs directly from the renewable generator, but leave their existing retail arrangement unchanged. Meanwhile, the renewable generator sells the PPA-related energy output into the local wholesale market at market rates. The customer and renewable generator then settle for the difference between the wholesale market price and the contract price. If the wholesale price is less than the contract price, the customer pays the renewable generator. If the wholesale price is higher than the contract price, the renewable generator pays the customer. The CfD arrangement provides a steady revenue stream for the renewable generator and allows the customer to hedge against electricity price risk while obtaining the environmental benefits of purchasing renewable generation in the wholesale power region in which they are located.

Figure 9 illustrates the concept. While such contracts have recently been used by Apple, Google, and Kaiser Permanente to execute renewable PPAs in California,[29] they are particularly

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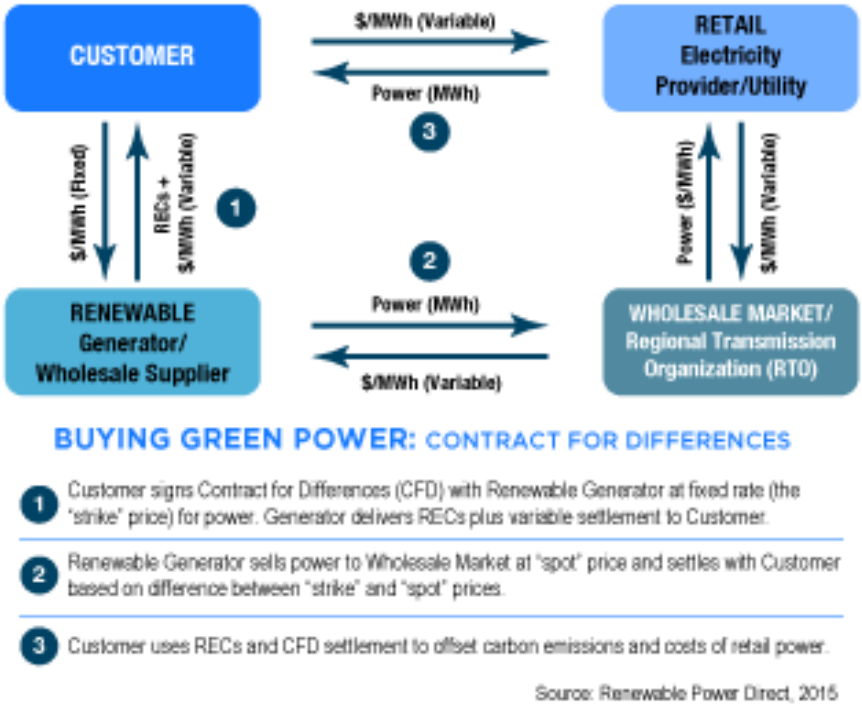
[28] See https://www.google.com/green/energy/use/#purchasing. Amazon's goals and approach are very similar: http://aws.amazon.com/about-aws/sustainability/

[29] Catasein, J. "A New Way for Companies to Go Green," Renewable Power Direct, February 27, 2015, Available: http://renewablepowerdirect.com/a-new-way-for-companies-to-go-green/

attractive in regional wholesale markets that provide access to the lower-cost renewable resources.

Figure 9: Renewable Purchases Using Contracts for Differences
(Reproduced from renewablepowerdirect.com)



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As the industry data discussed earlier shows, the majority of renewable generation developed beyond RPS requirements occurred in areas that offer both (1) low-cost renewable generating resources that make contracts economically attractive; and (2) ISO-operated regional wholesale power markets. Regional markets without access to low-cost renewable resources (such as CAISO, ISO-NE, NYISO, and PJM) show significantly less renewable development beyond RPS requirements.

E. Reliability Impacts

The quantitative analyses of ratepayer savings and environmental and economic impacts presented in this report focus on maintaining the existing level of reliability in a more cost-effective fashion. The estimated ratepayer impacts include only the following cost savings associated with meeting applicable planning and operational reliability standards:

- Lower generation investment costs from load diversity based on estimated market price for capacity. This does not capture the additional reliability value of any achieved higher reserve margins.
- Production cost savings associated with lower operating, regulation, and load-following reserve requirements and the reduced cost of providing these operating reserves due to reserve sharing and net load diversity.

This quantification of ratepayer benefits does not reflect the value of achieving more reliable region-wide system operations.

Expanding ISO operations to a larger regional footprint additionally offers significant reliability benefits to both California and the larger regional market area for several reasons. Regional ISO operations and practices will offer various reliability benefits over the standard operational practices of Balancing Authorities in the WECC footprint. Because the WECC is a single interconnected power system, reliability events in neighboring WECC areas affect California as well.[30] Expanding regional market operational practices consequently offers reliability benefits to (a) the expanded regional footprint which, in turn, (b) increases reliability in the ISO's current California footprint. Reliability-related benefits will be particularly pronounced during stressed system conditions, such as extreme weather, drought, and unexpected outages.

As presented in Figure 10 (prepared by CAISO), even relative to the enhanced reliability benefits achieved by EIM, an ISO-operated, consolidated regional market and balancing area offers important additional reliability benefits.

As the table shows in significantly more detail, these enhanced regional reliability-related benefits include:

- Improved real-time awareness of system conditions[31];

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[30] Examples of WECC-wide reliability events that affected California include the October 6, 2014 Northwest RAS Event; the September 8, 2011 Arizona–Southern California Outage; and the August 10, 1996 Western Interconnection (WSCC) System Disturbance.

[31] This would be complementary to the role of the reliability coordinator for the Western Interconnection (Peak Reliability) – a NERC registered entity responsible for providing provide situational awareness and real-time monitoring of the Reliability Coordinator (RC) Area within the Western Interconnection.

- More timely, more efficient, and lower-cost congestion management and adjustments for unscheduled flows;
- Regionally-optimized, multi-stage unit commitment;
- Enhanced systems and software for monitoring system stability and security;
- Enhanced system backup;
- Coordinated operator training that exceeds NERC requirements;
- More frequent review of operator performance and procedures;
- Consolidated standards development and NERC standards compliance;
- More unified regional transmission planning to address long-term reliability challenges;
- Broader fuel diversity to more effectively respond to reliability challenges associated with changes in fuel availability or costs and hydro/wind/solar conditions; and
- Better price signals for investment in new resources of the right type and in the right geographic locations
- More effective deployment and dispatch of resources and reserves that will enhance reliability and recognizes system conditions across the entire regional foot print.

Figure 10: Reliability Benefits of Regional Market Operation, Compliance, and Planning

	Reliability Benefits of Regional Market Operation, Compliance, and Planning			Extent Achievable	
	Function	**Western Interconnection Operations/Standard Practice**	**Regional Operations/ISO Practice**	**EIM**	**Full Day-2 Market**
1	Locational 5-minute Real-Time (and Hourly Day-Ahead) Price Signals	Bilateral markets achieve reliability based on contractual rights and industry standards with little guidance from locational prices or focus on economic impacts	• ISO enhances reliability by informing all market participants on the state of grid conditions and market operations through locational electricity prices and the day-ahead and real-time posting of other key system information • As a reflection of actual real-time (and projected day-ahead) system conditions, market prices in the ISO energy market provides specific locational signals where more (or less) generation is needed to maintain reliabilty	Limited to real-time prices and conditions	Provides Day-Ahead and opportunity to converge prices reflective system conditions between markets and thus providing
2	Congestion Management	• Performed using WECC Unscheduled Flow Mitigation Procedure or internally developed operating procedure based on congestion management system • 30 – 60 minute response time	• Market-based congestion management that relies on a five minute security constrained economic dispatch to mitigate transmission congestion on a least-cost basis allows for more timely and efficient congestion management • Look Ahead Commitment Tool provides unit commitments, de-commitments, online extension recommendations for congestion management, and models near-real-time conditions to utilize resource capabilities • Simultaneous feasibility tests performed to capture transmission security constraints in DA market processes, while Real-time contingency analysis of Energy Management System provides real-time security constraints for real-time clearing and pricing	Limited to real-time condtions	Day-Ahead can anticipate and position system to avoid congestion in real-time based on the greater situtational awareness.
3	Unscheduled Flow Management	• Unscheduled flows are managed sub-optimally on a limited set of qualified paths	• A regional integration allows congestion management to more effectively manage unscheduled flows in the entire grid and also solve the related congestion	Limited to real-time condtions	Day-Ahead can anticipate and position system to avoid unscheduled flow. A broad region would elminate unscheduled flow because all flow would be managed by congestion management
4	Regional Unit Commitment	Decentralized unit commitment decisions without region-wide perspective and differing granularity can lead to inconsitencies and unintended reliability	Regional unit commitment to address footprint-wide reliability needs: • Advisory 2-day ahead process • Multi-day residual unit commitment (RUC) • Regional Reserve Requirements Calculation • Day-Ahead RUC • Intra-Day RUC • Ensure availability of flexible capacity	Limited to short-start resources	Incorporates all periods of unit commitment and can ensure commitment aligns with flexibility needs

	Reliability Benefits of Regional Market Operation, Compliance, and Planning			Extent Achievable	
	Function	**Western Interconnection Operations/Standard Practice**	**Regional Operations/ISO Practice**	**EIM**	**Full Day-2 Market**
5	Sytem Monitoring and Visualization	• Real-time monitoring using SCADA on a local area basis (Some has limited Real Time Contingency Analysis) • Use of standard vendor supplied displays • Operator interface of standard monitor display screen augmented with static map board (some has digital dynamic map board) • Ad-hoc and off-line voltage security analysis review	• Regional view/monitoring of the power system including: – A State Estimator - runs every 60 seconds – Contingency analysis of over 2000 contingencies every five minutes that is scallable to higher number of contingencies – 24-hour shift engineer coverage responsible for maintaining security application performance - Advanced real-time voltage stability and security application • Extended use of custom tools and displays to allow for faster analysis and better situational awareness • Large video wallboard (80 feet) that provides operators with live data reflecting the state of the power system and real-time market results • Real-time Voltage Stability Analysis Tool (VSAT) and Transmission Security Assessment Tool (TSAT), which allow comprehensive analyses of system operating conditions for predicting and preventing voltage insecurity and transient instability	Limited to real-time conditions and EIM footprint	Can monitor and visualize prior to real-time and thus respond to security conditons prior to real-time expanding solution options for secure operation over entier region.
6	Backup Capabilities	• Offline and/or scaled down backup facility • Significant time to bring backup facility up in the event a failover or failback is needed • Testing of failover process performed annually	• 24 x 7 staffed back-up control center • On-line back-up facility with full coverage of power system and market applications immediately available • Less than 30 minutes required for failover or failback for critical applications • Testing of failover process is performed quarterly for critical applications	Not covered because BA maintains its role	Consolidated back-up capablity
7	Operator Training	• Classroom training only (some has limited simulators) • Train to meet minimum NERC requirements • Five-person rotation (no training rotation) and some has six person rotation • Offline power system restoration procedure review	• Training methods include extensive use of full-dispatch training simulator • Training exceeds NERC requirements • Six-person rotation at key operator positions (allowing a training week during each cycle) • Annually conduct a regional “live” power system restoration drill that includes dozens of companies in the region	Not covered because BA maintains its role	Consolidated, consistency across region
8	Performance Monitoring	• Performance reviewed on a “post-event” basis • Operator call review on a “post-event” basis	• Daily review of operational performance including: – Frequent near-term performance feedback to operators and support personnel – Routine review of upcoming operational events • Standardized operator call review process • Feedback provided to each operator	Not covered because BA maintains its role	Consolidated, consistency across region
9	Procedure Updates	• Procedures updated on an ad-hoc, as-needed basis	• Annual procedure review conducted on all control room procedures • Routine drills including member participation conducted on capacity emergency procedures • Annual Emergency Operating Procedures training session with members, neigboring entities, and reliability coordinator	Not covered because BA maintains its role	Consolidated, consistency across region

	Reliability Benefits of Regional Market Operation, Compliance, and Planning			Extent Achievable	
	Function	**Western Interconnection Operations/Standard Practice**	**Regional Operations/ISO Practice**	**EIM**	**Full Day-2 Market**
10	Standards Development	• Utilities are varied in their approach to standards engagement. • Many are "standards takers," relying on the good judgment of others in the industry to develop standards.	• By collaborating and participating in the standards creation, the ISO and its members can better manage the ultimate compliance responsibilities • ISO engages in several WECC/NERC drafting teams to actively manage the scope of standards development and to limit the number of changes required to MISO and stakeholders • ISO's integrated efforts lighten the workload on all members for a given level of input and control of the process	Not covered because BA maintains its role	Consolidated, consistency across region
11	NERC Compliance	• Many parties in the WECC region are responsible for managing NERC compliance • 30+ Interchange Authorities, Transmission Service Providers, Balancing Authorities (BA) • Several Planning Authorities • Individual Reserve Sharing Groups	• With ISO as a regional balancing authority, many compliance responsibilities are consolidated (and member responsibilities decreased) • Single regional Transmission Service Provider • Significantly fewer BAs and related compliance requirements • Fewer Planning Authorities • Consolidated Reserve Sharing Administrator • Centralization of some Transmission Operator Requirements • Allows members to avoid hiring compliance-dedicated staff or reduce existing compliance-driven staff to track these compliance-related issues	Not covered because BA maintains its role	Conssolidated, consistency across region
12	Regional Planning	• Planning by many individual utilities focused on local needs • Regional and interregional planning require complex coordination amont many utilities and planning groups	• Single regional view and planning can address reliability needs more accurately and consistently • Offers opportunities to find most efficient solutions across multiple transmission owners	Not covered because BA maintains its role	Consolidated, consistency across region
13	Fuel Diversity	• 38 WECC Balancing Areas with limited fuel diversity within many of the areas	• Regional market can mitigiate reliability risks associated with fuel supply risks (Gas, Hydro/Drought, Renewable Intermittency)	Limited to real-time and voluntary	More fully leverages diverstiy across region and market time frames
14	Long-term Investment Signals	Bilateral markets provide less granular price signals which can result in less efficient investment and placement of generation resources and transmission infrastructure	Price signals sent by the ISO's market provides investors in generation assets with more economic signals upon which they can anchor their forecasts for future wholesale prices and provide the basis for market driven investments	No real-time, too limited	Full leverages signals across regoin and market time frames leveraging regional resource adequacy opportunity

F. REGIONAL TRANSMISSION PLANNING

A larger ISO-operated regional market will offer improved regional transmission planning, from a reliability, economic congestion management, and renewable integration perspective. Transmission planning is currently undertaken in a coordinated but not integrated fashion by the CAISO and each of several sub-regional transmission planning groups in the West.

As shown in Figure 10, this planning process currently requires the coordination of utility planning efforts through four transmission planning groups: (1) CAISO; (2) WestConnect (and its three embedded sub-regions, Sierra, Southwest, and Colorado); (3) Northern Tier Transmission Group; and (4) Columbia Grid.

Figure 11: Western Sub-Regional Planning Groups

Source: http://www.westerngrid.net/western-sub-regional-planning/

Outside the CAISO, which employs a single integrated planning process, intra-regional planning within each of these planning sub-regions is conducted by aggregating individual transmission plans of the member utilities and conducting sub-regional studies to identify possible sub-regional transmission projects that are more effective than the projects proposed by the

individual utilities. Planning of transmission projects that cross the boundaries of the individual sub-regions requires substantial and complex coordination across these individual planning groups, which employ their own (in many aspects unique) planning processes. This coordination is time consuming and challenging even under the coordination requirements under FERC Order No. 1000 on transmission planning and cost allocation.[32] The challenges of interregional planning are further magnified by the absence of a clear cost allocation framework for valuable interregional transmission projects.

In comparison, the more unified transmission planning process of an expanded regional ISO offers significant benefits and additional long-term value through the following features:

- A single, unified planning process and set of planning criteria that will apply to a larger regional footprint;
- ISO-market operations and price signals that allow for an enhanced focus on identifying valuable economic and public policy transmission projects (while maintaining reliability) that reduce overall system costs;
- Planning for a larger regional footprint that will facilitate regional access to and integration of renewable resources;
- Generator interconnection and repowering processes that are simplified because more power flows are internalized within the planning region and fewer individual planning will be affected by unscheduled loop flows;
- Fewer planning coordination challenges, enhanced regional planning visibility, and more consistent and unified regional planning tools in a regional footprint that includes a greater number of individual transmission owners;
- Streamlined cost allocation processes that facilitate development of valuable regional transmission projects; and
- Fewer interregional planning challenges related to "market seams" between small, individual planning areas.

[32] See http://www.ferc.gov/industries/electric/indus-act/trans-plan/filings.asp

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