

The Role of RTO/ISO Markets in Facilitating Renewable Generation Development

Presentation

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December 8, 2016



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Renewable Development in ISO/RTO Markets

Investment in renewable generation significantly exceeds state RPS mandates in some regions, providing large environmental benefits

The majority of these “beyond-RPS” renewable generation investments have occurred in regions that:

- Enjoy access to areas with low-cost renewable resource potential
- Have organized regional RTO/ISO markets that provide transparent and liquid trading for both the “energy” and “green” attributes generated by the resources

RTO/ISO markets offer:

- Ready-made market for real-time energy
- Lower-cost integration, balancing, and congestion management
- Improved regional transmission access and generation interconnection processes

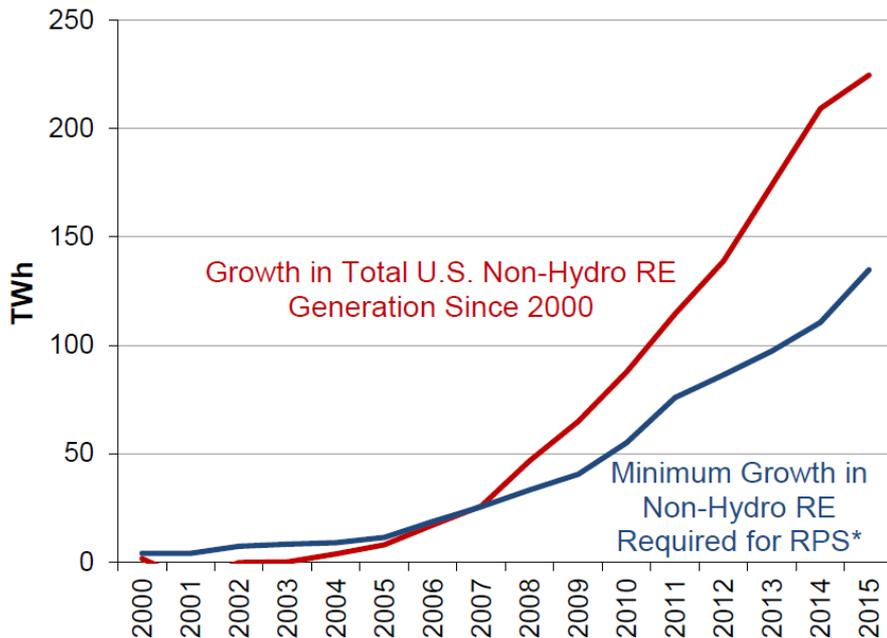
These benefits of regional RTO/ISO markets should be considered more explicitly, particularly by Western U.S. states as they currently contemplate the future of their electricity industry and its impact on the environment.

Development of Renewables Goes Beyond RPS

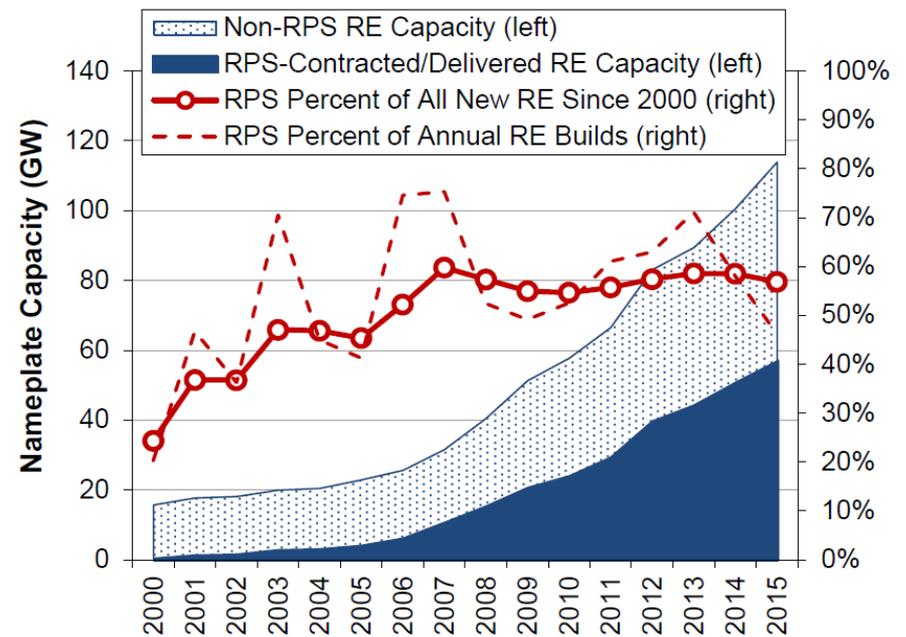
Since 2000, RPS mandates accounted for only about 50-60% of the U.S. total development of non-hydro renewable generation.

- In 2015, less than 50% of all renewables were developed to meet RPS.

2000–2015 Growth in U.S. Non-Hydro Renewable Energy (TWh)



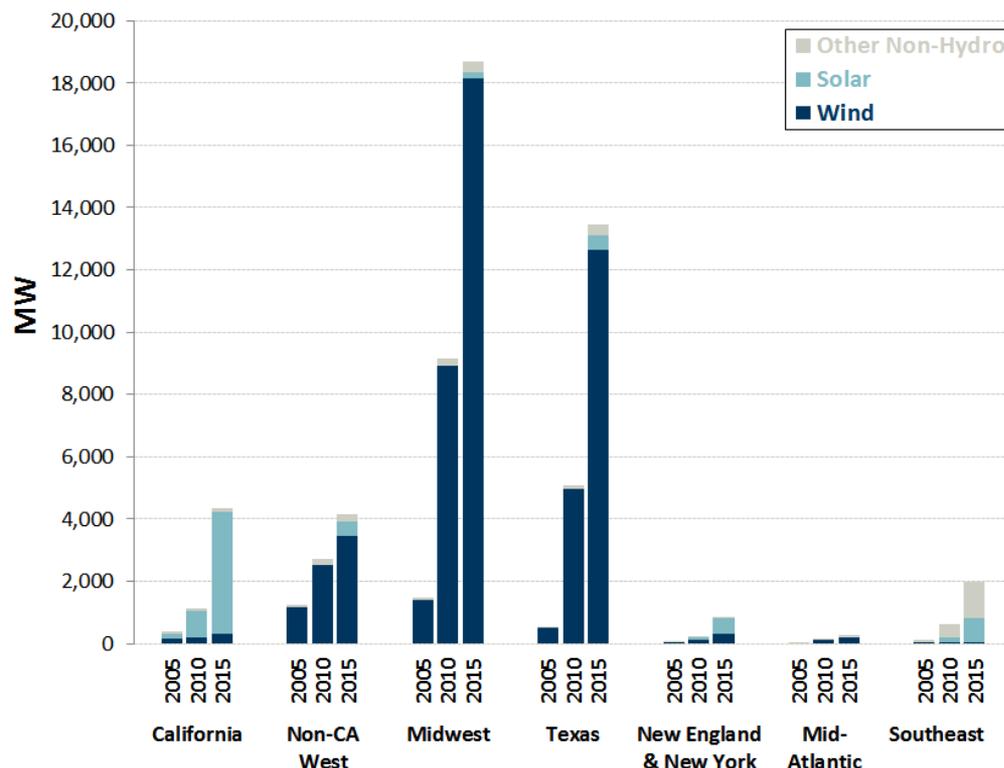
Total U.S. Non-Hydro Renewable Capacity (GW)



Source: Barbose, G., "U.S. Renewables Portfolio Standards: 2016 Annual Status Report," Lawrence Berkeley National Laboratory (LBNL), April 2016.

Renewables Beyond RPS Are Mostly in ISO/RTO Markets...

Beyond-RPS Renewable Growth Since 2000



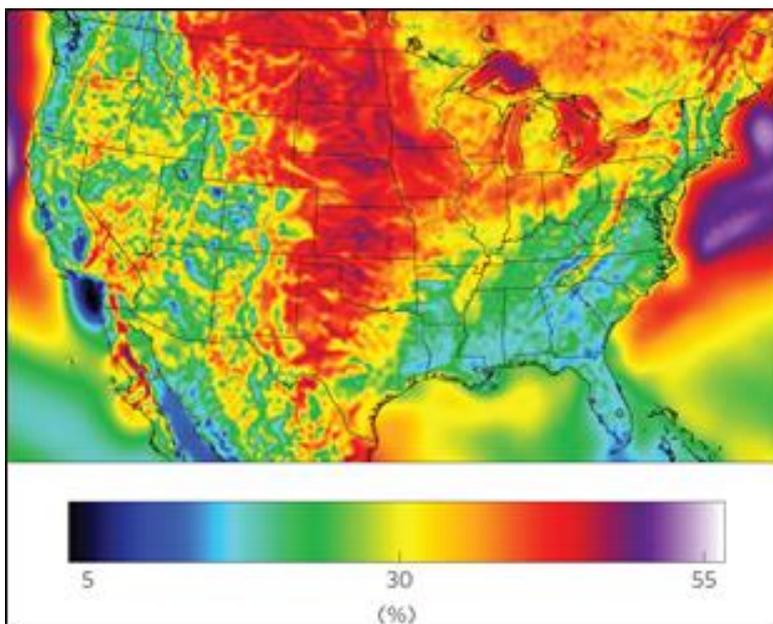
Most beyond-RPS renewable generation development occurred in ISO/RTO regions with low-cost wind resources:

- 44,000 MW of “non-RPS-related” renewable additions nationwide since 2000
- In Texas and the Midwest (ERCOT, SPP, western MISO), about 30,000 MW of wind capacity was added beyond RPS mandates (~2/3 of the regions’ total wind capacity installed exceeded RPS)
- In the last five years alone, these regions added beyond-RPS wind generation sufficient to supply 4-5% of retail load (7% of load in Texas and 3% in all of Midwest)

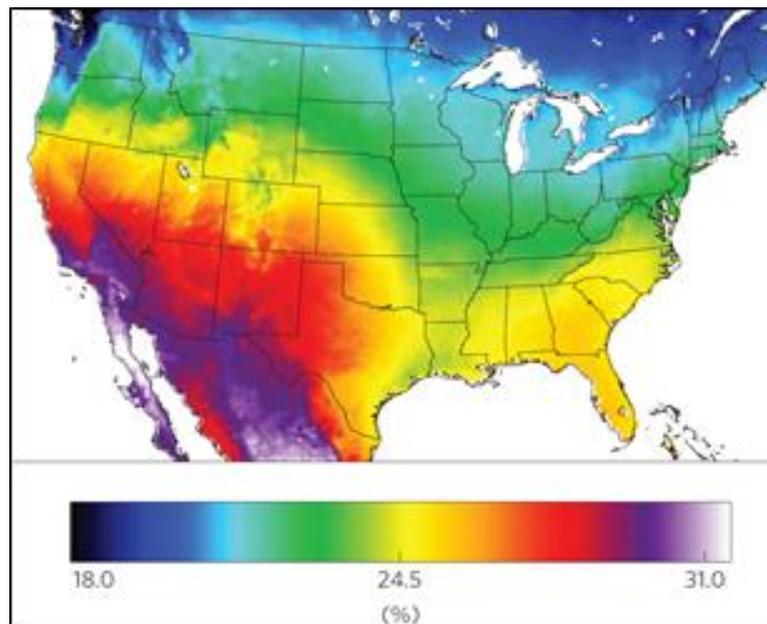
...in Areas with Lowest-Cost Wind/Solar Resources

- Wind generation investments beyond RPS occurred almost exclusively in the RTO portions of areas with **lowest-cost wind** potential (i.e., east of WECC boundary)
- Continued cost reductions and technology improvements likely will also create beyond-RPS opportunities in regions with: (1) access to **high-quality solar** areas; (2) utilities or ISO/RTO markets able to fairly compensate and cost-effectively balance solar energy output (e.g., CAISO)

Wind Capacity Factor



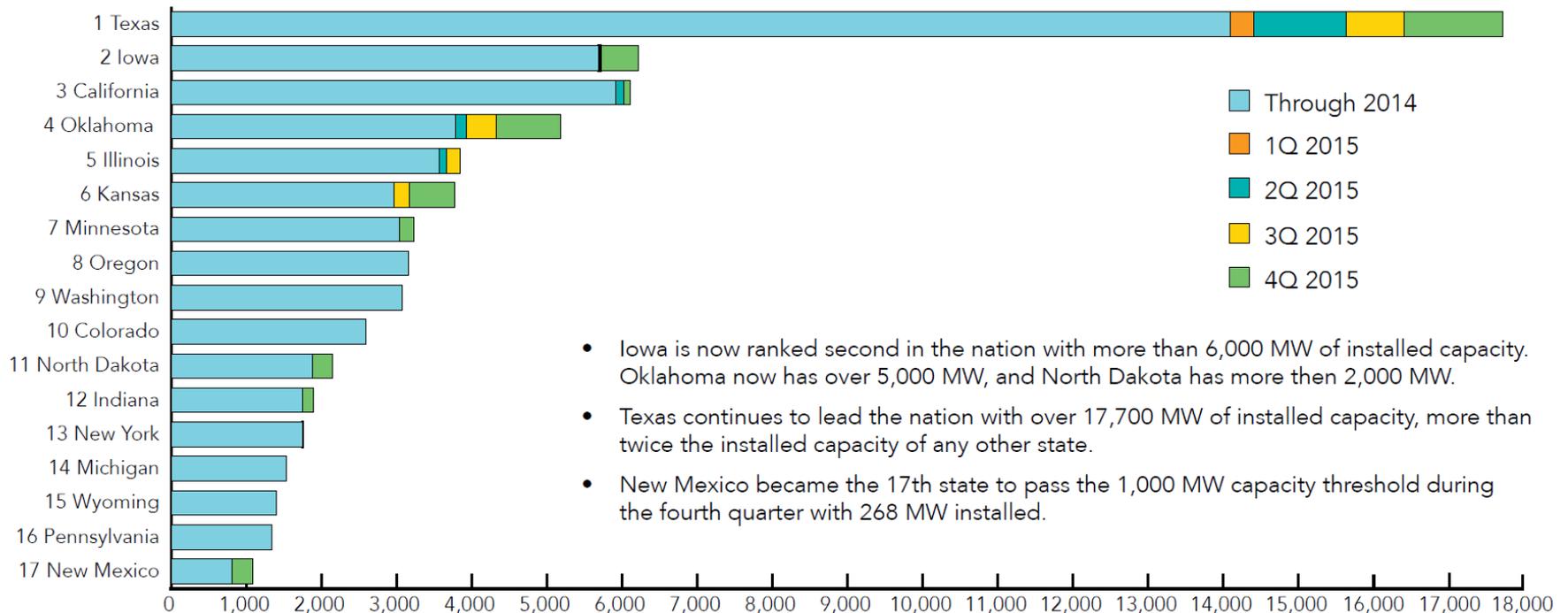
Solar PV Capacity Factor



Source: MacDonald, Alexander E, Christopher T.M. Clack, et al., "Future cost-competitive electricity systems and their impact on US CO₂ emissions," Nature Climate Change (Jan 2016): DOI: 10.1038/NCLIMATE2921. (Reproduced with permission from Earth System Research Laboratory, NOAA)

States with Most Wind Additions are in RTO/ISOs

- The seven states with the highest total installed wind generating capacity (TX, IA, CA, OK, IL, KS, and MN) are all located in areas with regional ISO markets.
- Largest 2015 additions are in ISO markets with low resource costs (TX, OK, KS, and IA)



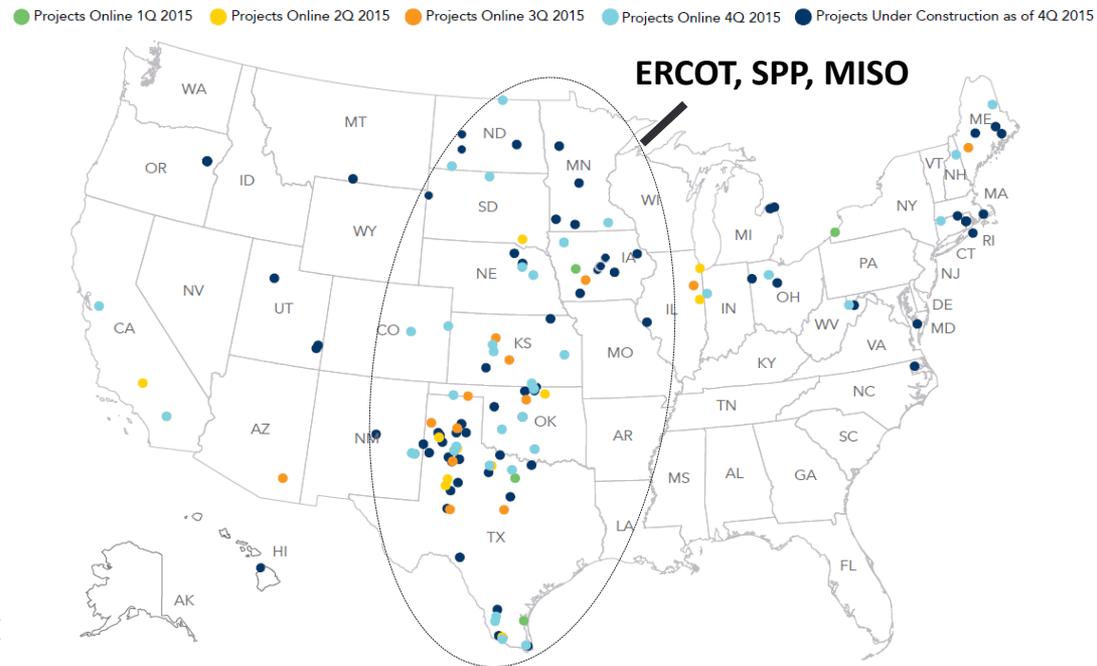
Source: AWEA, "U.S. Wind Industry Fourth Quarter 2015 Market Report," American Wind Energy Association, January 27, 2016.

2015 Wind Additions Mostly in RTO/ISO Markets

Wind-rich areas in ISO markets account for most of the recent renewables development

- AWEA data shows that the majority of the 2015 additions and projects under construction (shown on map) are in areas that offer both:
 - Access to very wind-rich areas
 - ISO-operated markets (ERCOT, SPP, MISO)
- Significantly less development in similarly wind-rich areas without ISO/RTO markets (e.g., WY, CO, MT, NM)

Wind Generation Projects Online & Under Construction in 2015



Source: AWEA, "U.S. Wind Industry Fourth Quarter 2015 Market Report," American Wind Energy Association, January 27, 2016.

Renewables Beyond RPS Reduce CO₂ Emissions

Beyond-RPS renewable generation additions since 2000 annually displace approximately 150 million MWh of fossil-fuel generation

- **Reduces annual CO₂ emissions by 100 million tonnes/year** (assuming half of the displaced generation is from gas plants and the other half is from coal plants)
 - Corresponds to about 5% of the U.S. electric sector CO₂ emissions nationwide, or about twice the entire electricity sector emissions of California
 - In some of the fossil-fuel intensive states (such as TX, OK, KS, and IA) in-state beyond-RPS renewable generation displaces between 15% and 40% of state's total electric sector emissions

Looking forward, the ability of RTO/ISO markets to facilitate renewable development beyond regulatory mandates will be a significant driver of emission reductions in the U.S. electric power industry. This benefit should be considered, particularly now that western states contemplate the future of their electricity industry and its impact on the environment.

Several Studies Discuss How ISO/RTO Markets Facilitate Renewable Development

Study	Findings
ISO/RTO Metrics Report (2015)	<ul style="list-style-type: none"> • 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
COMPETE: Markets and Environmental Challenges (2014)	<ul style="list-style-type: none"> • Renewables developers are attracted to ISO/RTO markets due to transparency, fairness of rules, and geographic diversity
Brookings: Clean Economy Study (2011)	<ul style="list-style-type: none"> • ISO/RTOs facilitate renewables through geographic diversity • ISO/RTOs also reduce barriers to expanding transmission capacity to allow for the development of additional renewables
Hogan: Markets In a Low Carbon Future (2010)	<ul style="list-style-type: none"> • Wind installations are disproportionately in RTO markets • Markets facilitate integration of low-carbon technology through improved granularity of pricing and dispatch
AWEA: Green Power Superhighways (2009)	<ul style="list-style-type: none"> • Markets provide incentives for resource flexibility and reduce renewable integration costs • RTOs have been more effective in administering large balancing areas, using short scheduling intervals, and operating sophisticated energy markets
IRC: Increasing Renewables (2007)	<ul style="list-style-type: none"> • ISO/RTO markets facilitate renewables by having transparent pricing, highly granular dispatch, and geographic diversity

Example Quotes from ISO/RTO Market Studies

Brookings: Clean Economy Study (2011)

- “In addition to its role in lowering prices, the ISO/RTO model is more conducive to clean energy because the market shares generation and transmission over a larger geographic area and harbors fewer conflicts of interest in expanding capacity to accommodate new renewable generators or in allocating costs to market participants.” (p. 36)

Hogan: Markets In a Low Carbon Future (2010)

- “In the US, installations of wind energy are disproportionately found in the RTO markets because of the greater ease of integration.” (p. 10)

ISO/RTO Metrics Report (2015)

- “Open access to the grid and competitive wholesale electric markets have facilitated the increased development of renewable energy projects.” (p. 261)

IRC: Increasing Renewables (2007)

- “...these large wholesale electricity markets play an especially critical role in the development of renewable resources.”

Factors by which ISO/RTO Markets Facilitate Renewable Development

Factor	Description
Improved Market Design	<ul style="list-style-type: none">• Intra-hour energy markets, integrated with optimized day-ahead commitment and pre-dispatch of the entire region's generating plants, maximize the energy value of intermittent resources• Increased pricing granularity in time (5-minute) and location (nodal) improves signals for resource dispatch while reducing balancing costs• Allows renewable resources to participate in energy market and ancillary services• Reduced curtailments through improved utilization of transmission infrastructure• Makes available more effective congestion management mechanisms, including allowing renewable generators to hedge their congestion exposures
Larger Geographic Market Footprint	<ul style="list-style-type: none">• Allows access to and use of more renewable resources in larger regions' lowest-cost locations• Improved day-ahead and intra-day forecasting of more diversified variable generation output• Large footprints of ISO/RTO markets reduce balancing need by taking advantage of: diversity of renewables output, a larger set of other generation resources, and increased liquidity in spot markets to reduce the cost of load-following/balancing services• Increased market liquidity facilitates forward contracting, risk management, and merchant entry
Improved Regional Transparency and Transmission Access	<ul style="list-style-type: none">• Regional access and transparent pricing provide developers and investors confidence of fairness• RTOs offer scale advantage in: providing region-wide transmission access, planning regional transmission solutions, and allocating the costs of transmission projects• Streamlined "one-stop shopping" for interconnection and transmission service in larger region• Easier contracting for load-serving entities (including coops/munis) and commercial/industrial customers without their own transmission access to the region's lowest-cost renewables

Drivers of Beyond-RPS Renewable Development

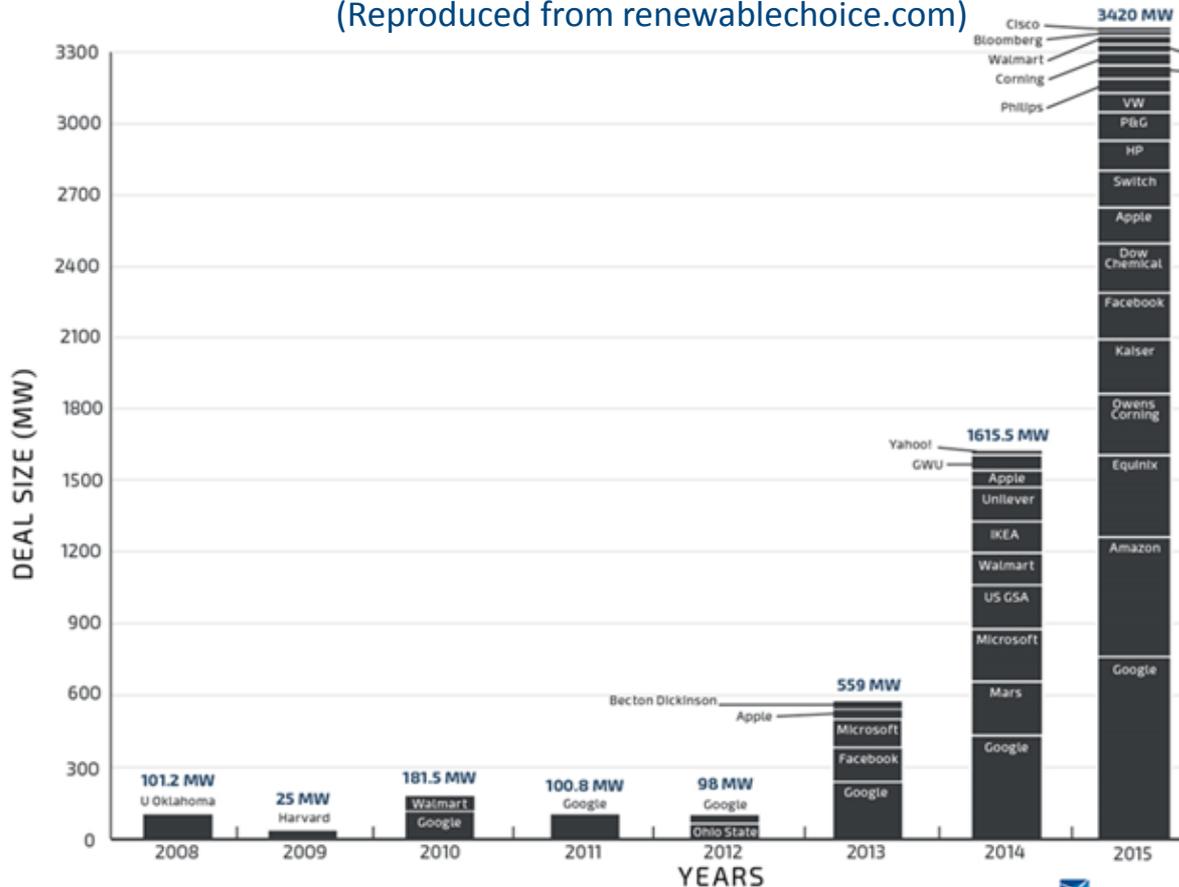
Based on the experience in other regional markets with low-cost renewable resources (ERCOT, MISO, SPP), renewable development beyond RPS comes in the form of:

1. Voluntary PPAs by investor-owned utilities in excess of RPS requirements due to low-cost resources available and fuel-cost hedge value (e.g., because of MidAmerican's voluntary purchases, wind generation is projected to supply 58% of the utility's Iowa load by the end of 2016).
2. Purchases by public power and municipal utilities not subject to RPS were responsible for 23% of the renewable generation purchases in 2015
3. PPAs with commercial & industrial customers (e.g., Google, Amazon) accounting for increasing shares of renewable deals (3,420 MW in 2015)
4. Merchant renewable generation developed with financial hedges to support the financing of generation investments (merchant or quasi-merchant wind projects reached 29% of the total development in 2015)

Growth in Renewable PPAs with C/I Customers

Aggregate PPA Deals with Commercial & Industrial Customers

(Reproduced from renewablechoice.com)



*Based on publicly announced C&I PPAs (direct, synthetic, green tariff, and tax equity) in North America. Excludes onsite PPAs. © Renewable Choice Energy

In 2015, 3,420 MW of low-cost wind resources were developed through PPAs with large C/I customers (up from 1,615 MW in 2014 and 559 MW in 2013)*

These C/I-based contracts are greatly facilitated by regional ISO-operated markets**

* Reproduced from Powers, J. "The Rise of the Corporate Energy Buyer," Renewable Choice Energy (2016).

** For discussion see: <http://www.renewablechoice.com/blog-corporate-energy-buyer>
<http://www.renewablechoice.com/blog-electricity-corporate-ppa-buyers>

Growth in Renewable PPAs with C/I Customers

- Non-utility entities accounted for purchases of >50% of all wind PPAs in 2015
- Renewable Energy Buyers Alliance (REBA), including more than 60 major companies, set a goal of procuring 60,000 MW of new U.S. renewable generation by 2025
- Example: Google
 - 100% renewable power goal
 - Signed 16 contracts; 2,200 MW to date
 - PPAs with wind and solar project or through utility's renewable energy tariffs
 - All contracts must create new sources of green power on the grid
 - Purchased renewable energy is located on the same grid as Google's load
 - All "bundled" energy and RECs
- Contracts for Differences (CfDs) as financial hedge for physical deliveries to the electric grid (see chart)
 - Almost exclusively in RTO/ISO markets
 - Does not require retail choice

"Virtual PPAs" Using Contracts for Differences (Reproduced from renewablepowerdirect.com)



BUYING GREEN POWER: CONTRACT FOR DIFFERENCES

- 1 Customer signs Contract for Differences (CFD) with Renewable Generator at fixed rate (the "strike" price) for power. Generator delivers RECs plus variable settlement to Customer.
- 2 Renewable Generator sells power to Wholesale Market at "spot" price and settles with Customer based on difference between "strike" and "spot" prices.
- 3 Customer uses RECs and CFD settlement to offset carbon emissions and costs of retail power.

Pure “Merchant” Renewable Development

Some renewable generation development is also occurring on a pure merchant basis without PPAs

- Renewables-rich regions with liquid wholesale power markets support “merchant” developers to finance their renewable projects by relying on financial hedges (instead of PPAs)
- Merchant and quasi-merchant projects accounted for 29% of all new wind generating capacity in 2015 and 24% of cumulative capacity
- All of the merchant wind generation projects built in 2015 are located in RTO/ISO-operated regional markets (mostly Texas) with:
 - Ready access to liquid trading hubs
 - Low-cost renewable resource potential
 - Robust regional transmission infrastructure
 - High correlation between natural gas and electricity market prices that allows for long-term financial hedging through natural gas market

Conclusions

ISO/RTO markets are facilitating the accelerated development of renewable generation, well beyond regulatory (RPS) mandates

- **ISO/RTO regions lead the growth** in renewable generation
 - Ready-made market for real-time energy
 - Lower-cost integration, balancing, congestion management
 - Improved regional transmission access and generation interconnection processes
 - Also facilitate implementation of state RPS mandates
- Significant renewable generation is being developed **beyond RPS targets**
 - RPS mandates account only for 55% of renewable generation growth since 2000
 - Voluntary purchases by utilities, public power, and C/I customers; some merchant
 - Growth mostly concentrated where: (1) ISO/RTOs provide market access to (2) areas with low-cost renewable generation potential
 - Beyond-RPS renewables already **reduce CO₂ emissions by 100 million tonnes/year**
- PPAs and Green Tariffs with C/I customers growing rapidly
 - 3,400 MW of C/I PPAs in 2015 (up from 100 MW in 2012)
 - REPA goal: C/I members will procure 60,000 MW of new U.S. renewables by 2025
 - Innovative “Contracts for Differences” to finance projects in RTO/ISO regions
 - Almost exclusively in regions with ISO/RTO markets (even without retail choice)

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