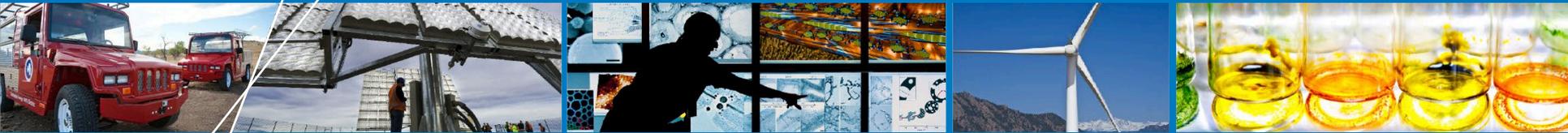


U.S. Renewable Energy Policy and Industry



Presentation at CNREC

Ella Zhou

October 2015

U.S. Renewable Energy Policy and Industry

- **Federal and State Drivers for RE**
- **Solar Update**
- **Wind Update**
- **Biofuel Update.**

Federal Drivers for Renewable Energy

- **Investment Tax Credit (ITC)**
- **Production Tax Credit (PTC)**
- **Clean Power Plan (final rule)**
- **Modified Accelerated Cost Recovery System Depreciation Schedule (MACRS)**
- **DOE Loan Program.**

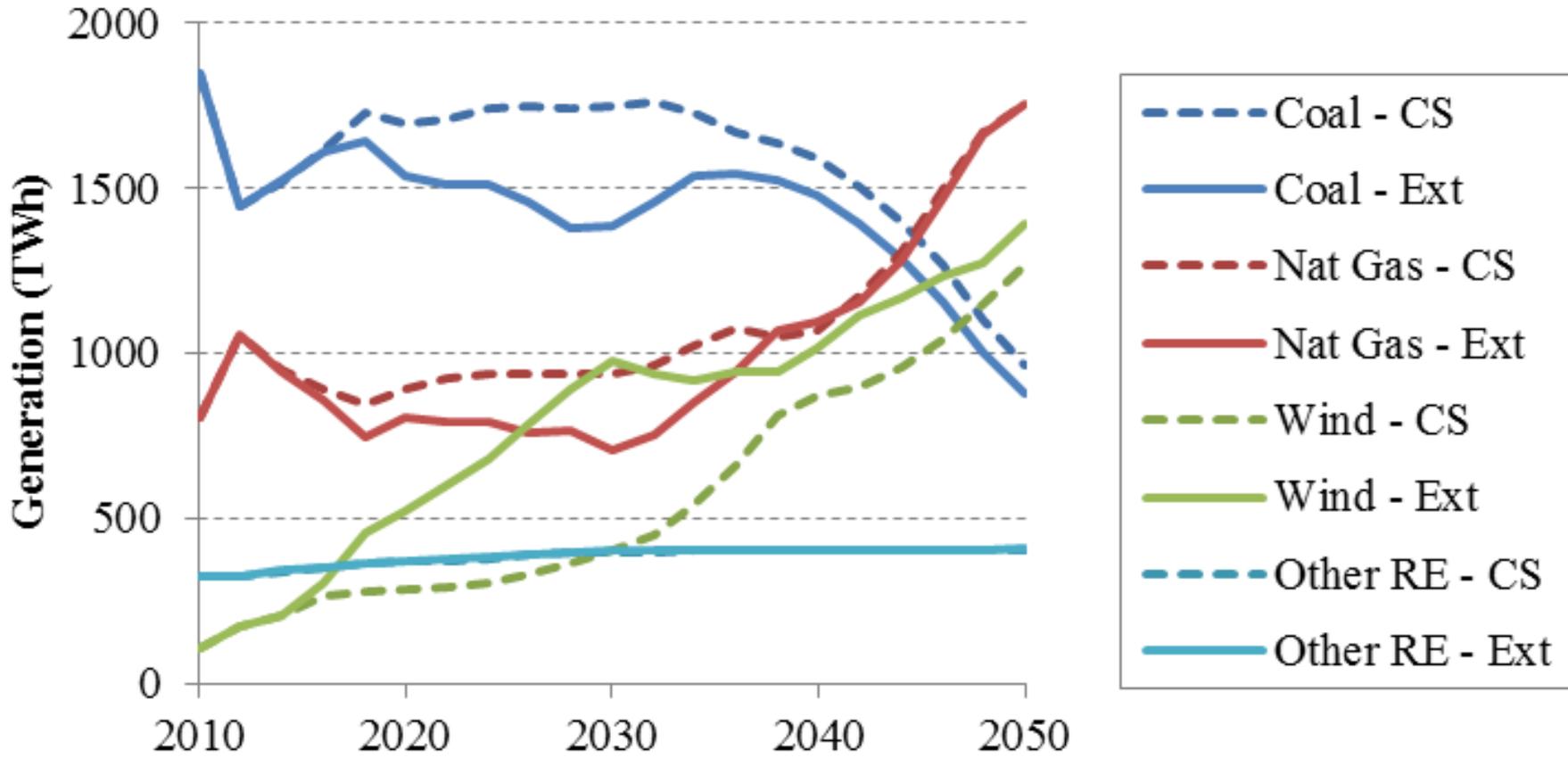
Summary of U.S. Renewable Electricity Tax Policy

Policy Name	Description	Technologies	Amount	Expiration
Production Tax Credit (PTC)	A per-kilowatt-hour tax credit for electricity generated by qualified energy resources and sold by the taxpayer; eligible projects can opt for ITC instead	Wind, closed- and open-loop biomass, geothermal, solar, small irrigation power, municipal solid waste, and some hydroelectric sources	\$23 / MWh for wind, closed-loop biomass, and geothermal. \$11 / MWh for others; generally applies to first 10 years of operation	Projects under construction prior to 2015 qualify
Investment Tax Credit (ITC)	Allows the tax credit to be taken based on the amount invested rather than electricity produced	Solar water heat, solar space heat, solar thermal electric, solar thermal process heat, photovoltaics, landfill gas, wind, biomass, hydroelectric, geothermal electric, fuel cells, geothermal heat pumps, municipal solid waste, CHP/cogeneration, solar hybrid lighting, hydrokinetic power (i.e., flowing water), anaerobic digestion, small hydroelectric, tidal energy, wave energy, ocean thermal, fuel cells using renewable fuels, microturbines, geothermal direct-use	30% for solar, fuel cells, and small wind; 10% for geothermal, microturbines, and CHP	For commercial solar placed in service after 2016, reverts to 10%; geothermal remains at 10%; for all other technologies, expires end of 2016
MACRS and bonus depreciation	Five year accelerated depreciation schedule means greater “loss” on paper, reduces taxes	All ITC-eligible technologies as well as large wind projects (essentially all renewables)	Depends on tax situation	No expiration (MACRS)

Source: United States Department of Energy (U.S. DOE)

Extended Incentives for Renewable Energy Generation

CS: central scenario (current case)
Ext: extending PTC and ITC



Source: NREL. 2015. *Annual Technology Baseline (ATB)*. Golden, CO: NREL. Accessed September 2015, http://www.nrel.gov/analysis/data_tech_baseline.html.

Clean Power Plan (final rule)

CPP sets target emission rates (or mass-totals) for each state and aims to lower total power sector emissions by 32% by 2030 from 2005 levels.

Projected Generation Mix (thousand GWh)

	Base Case	Rate-based	Mass-based	Rate-based	Mass-based
2020					
Coal	1,462	1,391	1,374	-5%	-6%
NG Combined Cycle (existing)	1,111	1,126	1,132	1%	2%
NG Combined Cycle (new)	33	53	69	61%	111%
Combustion Turbine	15	20	17	39%	14%
Oil/Gas Steam	51	51	50	0%	-1%
Non-Hydro Renewables	393	399	385	2%	-2%
Hydro	310	311	310	0%	0%
Nuclear	798	792	804	-1%	1%
Other	18	18	18	0%	0%
2030					
Coal	1,466	1,131	1,144	-23%	-22%
NG Combined Cycle (existing)	1,042	1,230	1,090	18%	5%
NG Combined Cycle (new)	324	100	207	-69%	-36%
Combustion Turbine	22	27	32	21%	46%
Oil/Gas Steam	22	11	11	-52%	-53%
Non-Hydro Renewables	450	488	485	9%	8%
Hydro	340	341	340	0%	0%
Nuclear	783	777	785	-1%	0%
Other	17	17	17	0%	0%
Total	4,467	4,122	4,110	-8%	-8%

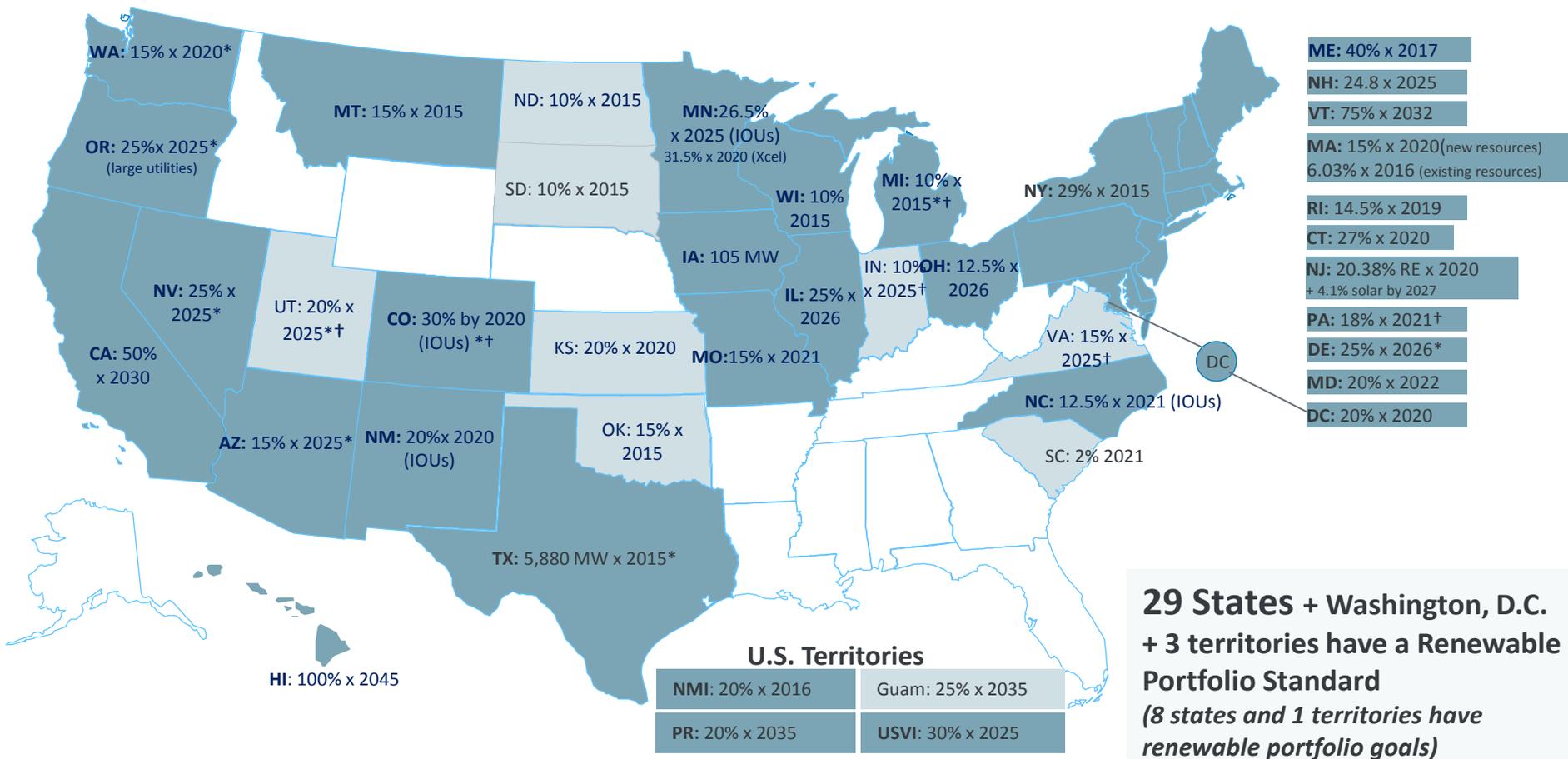
See more on CPP's impact at: EPA (U.S. Environmental Protection Agency). 2015. *Regulatory Impact Analysis for the Clean Power Plan Final Rule*. Research Triangle Park, NC: U.S. EPA. Accessed September 2015, <http://www3.epa.gov/airquality/cpp/cpp-final-rule-ria.pdf>.

State-Level Drivers of Renewable Energy

- **Renewable Portfolio Standards (RPS)**
- **Renewable Energy Certificates (RECs) or Performance Based Incentives**
- **Net Metering; Virtual Net Metering**
- **Carbon Markets**
- **State Tax Credit**
- **Property Assessed Clean Energy (PACE) Programs**
- **Property Tax Exemptions**
- **State Sales Tax Exemptions**
- **Grants**
- **Clean Energy Financing Program**
- **Subsidized Loans**
- **On-Bill Financing.**

RPS Policies

Source: www.dsireusa.org / June 2015



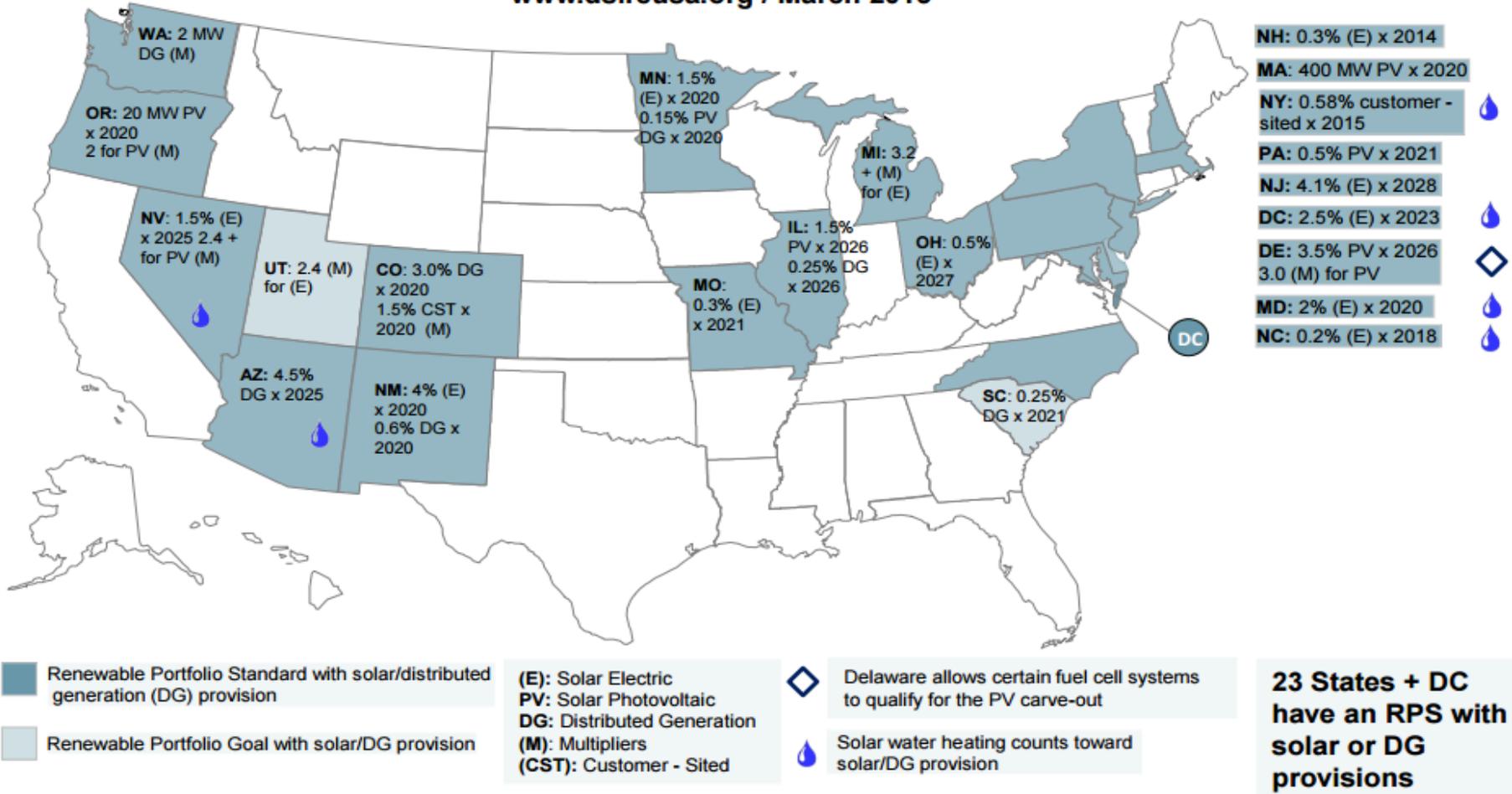
Renewable portfolio standard
 Renewable portfolio goal

* Extra credit for solar or customer-sited renewables
† Includes non-renewable alternative resources

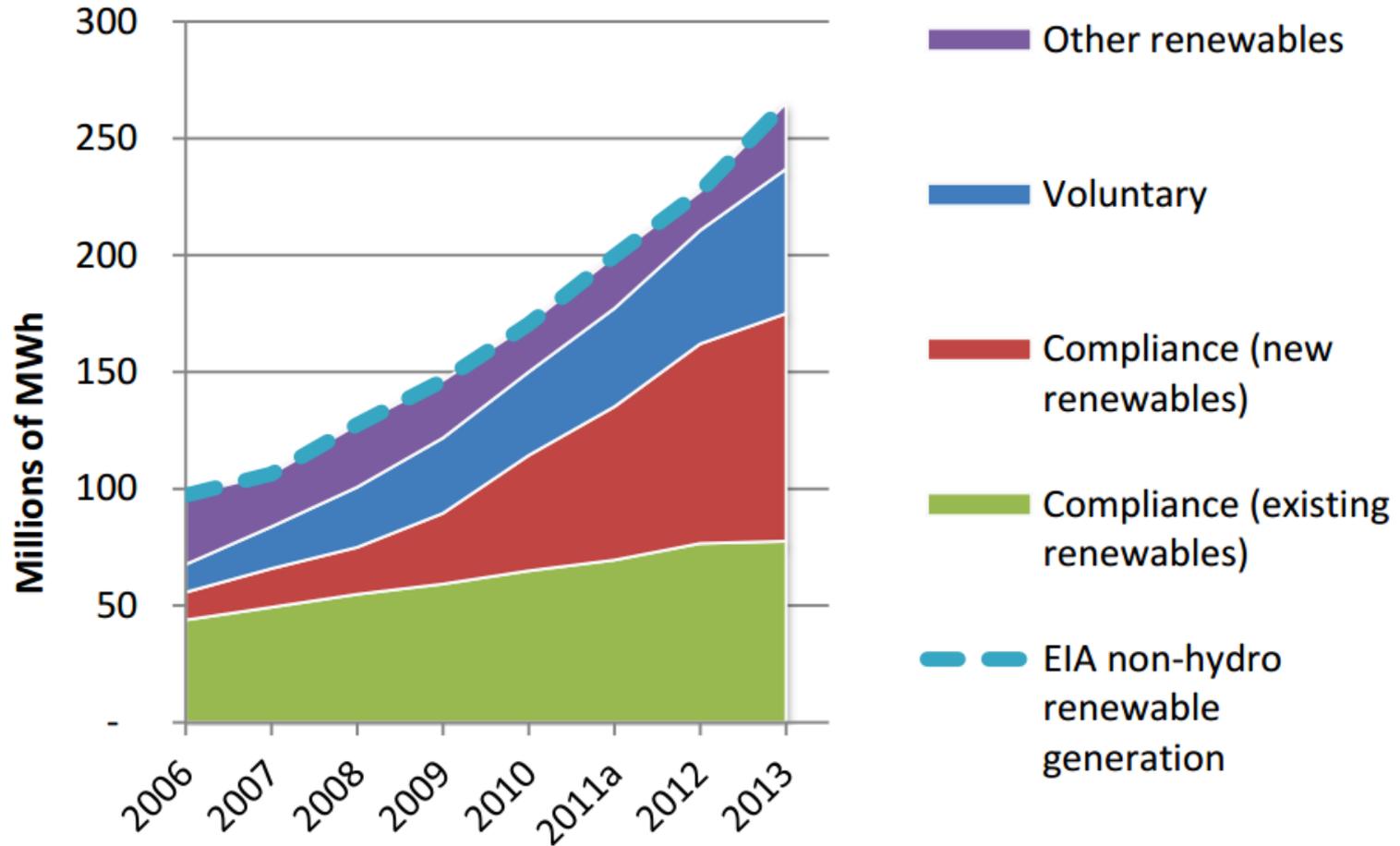
RPS with Solar or DG provisions

Renewable Portfolio Standards (RPS) with Solar or Distributed Generation Provisions

www.dsireusa.org / March 2015

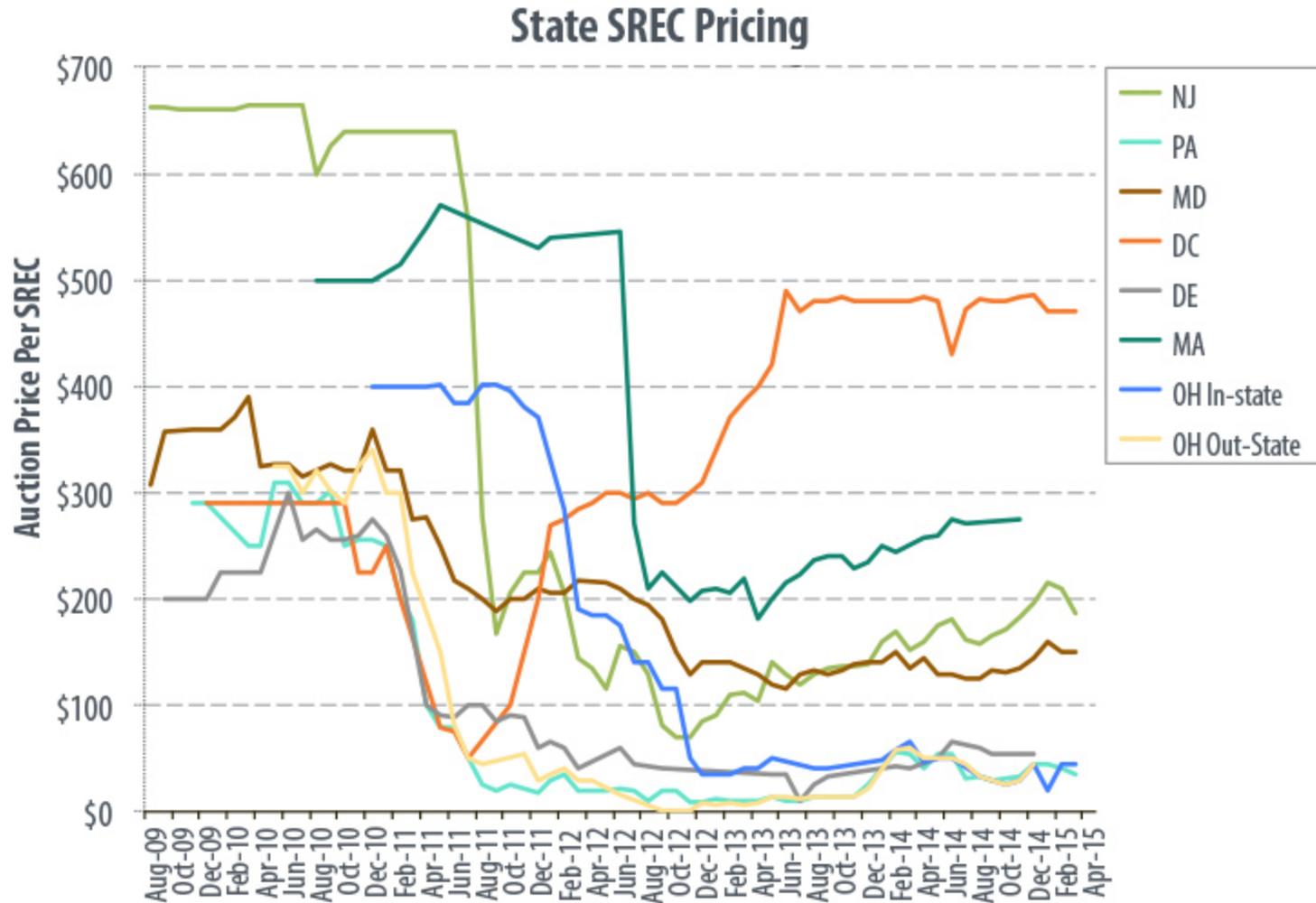


Comparison of RE Estimated Market Sizes, 2006-2013



Source: Heeter, Jenny. 2014. *Status and Trends in the U.S. Voluntary Green Power Market (2013 Data)*. Golden, CO: NREL. Accessed September 2015, <http://www.nrel.gov/docs/fy15osti/63052.pdf>.

Renewable Energy Certificates (RECs)

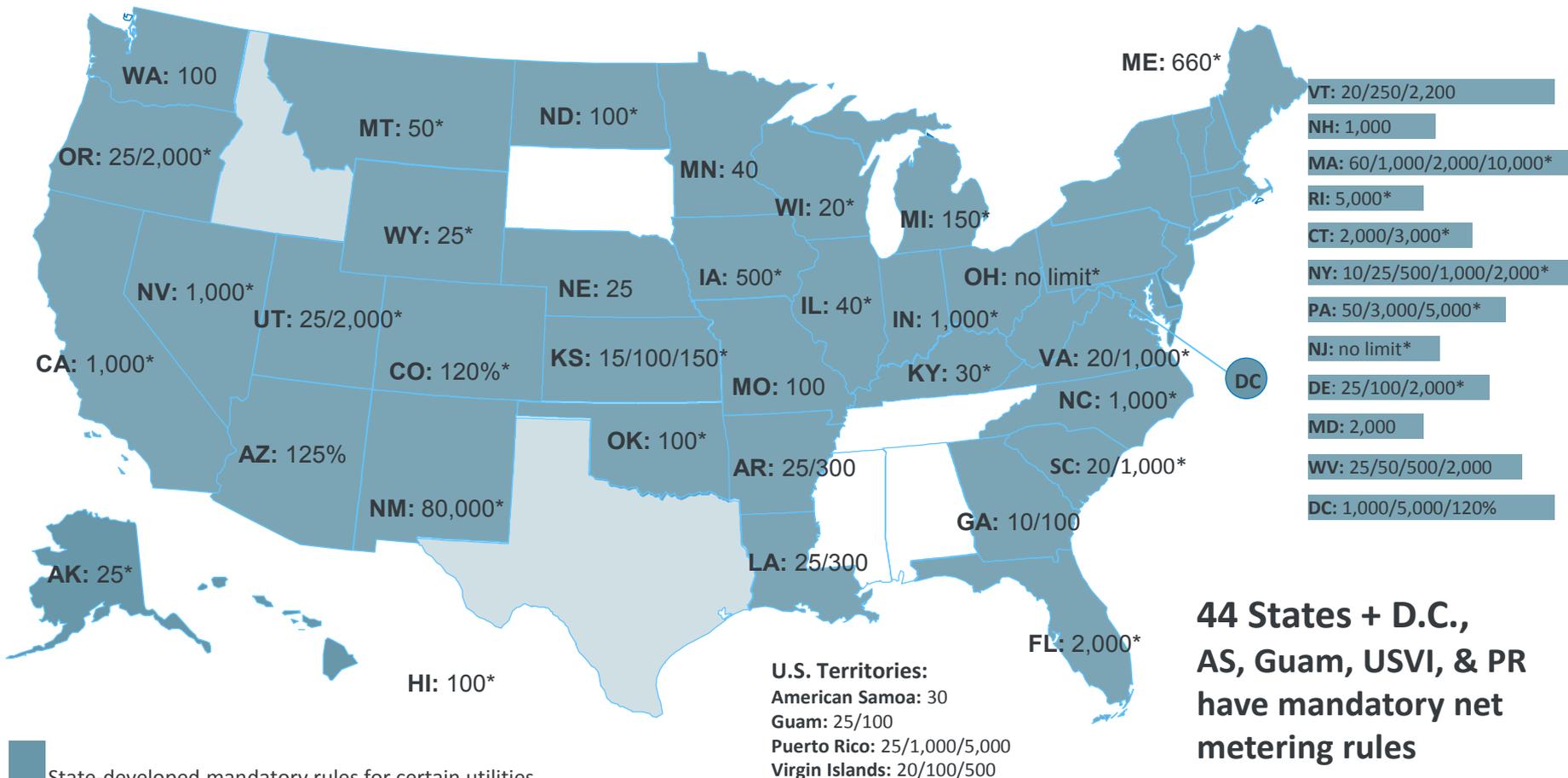


Source: "Green Power Markets: Renewable Energy Certificates (RECs)." (2015). Washington, D.C.: U.S. DOE Energy Efficiency and Renewable Energy (EERE). Accessed September 2015, <http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml?page=5>.

Net Metering

www.dsireusa.org / March 2015

- PV project capacity limits range from 10 kW to 80 MW
- Net metering rules are being actively discussed in over a dozen state public service and utility commissions across the country.



Note: Numbers indicate individual system capacity limit in kW. Percentages refer to customer demand. Some limits vary by customer type, technology and/or application. Other limits might also apply. This map generally does not address statutory changes until administrative rules have been adopted to implement such changes.

Carbon Markets

Regional Greenhouse Gas Initiative

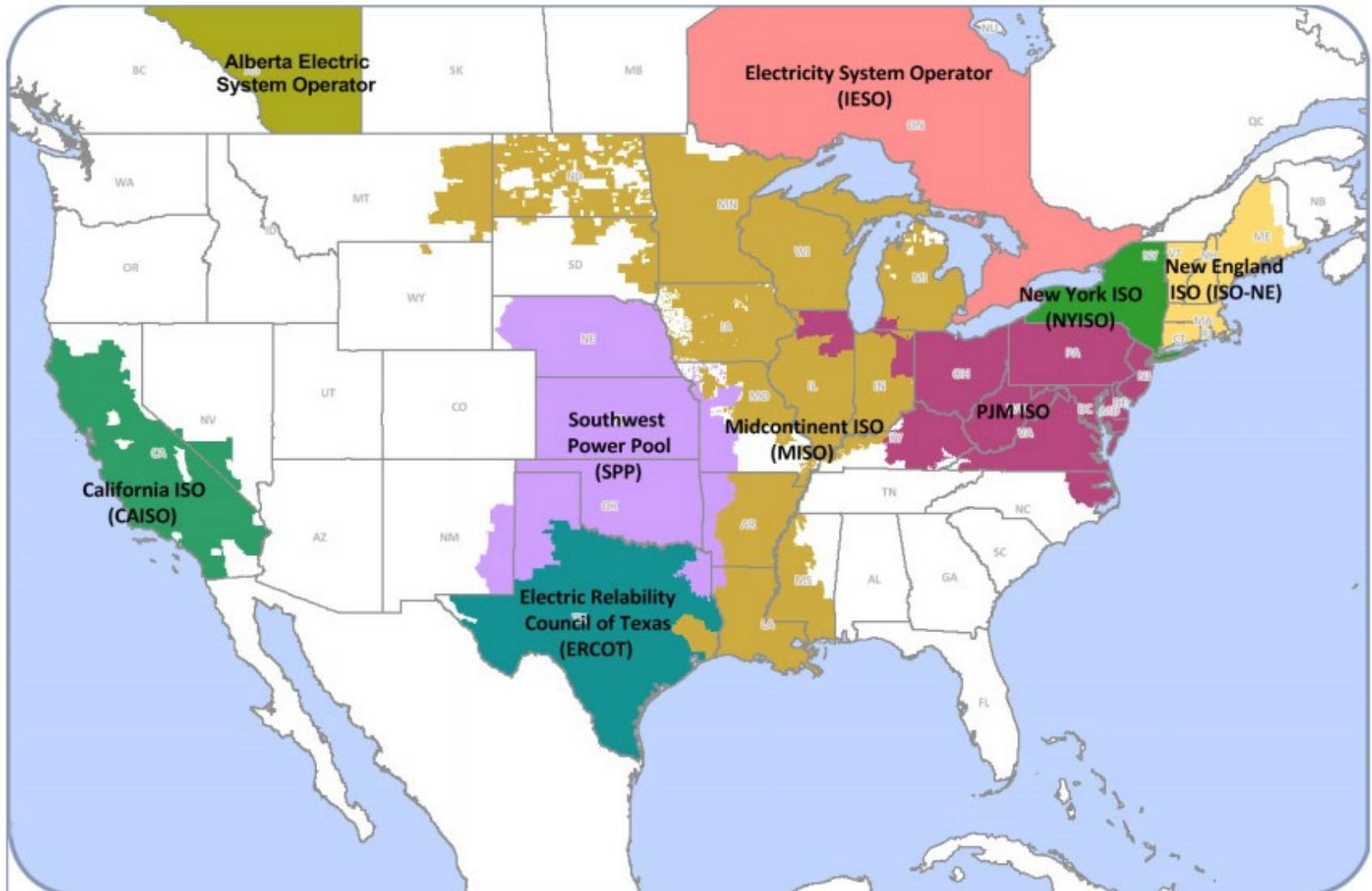
Third Compliance Period (2015-17)	
Projection	More than 45% reduction in CO ₂ emissions from the power sector by 2020 relative to 2005 emissions
Cap	RGGI 2015 adjusted cap is 66.8 million short tonnes (60.63 million tCO ₂)
Carbon price	\$4.78 (2014) \$5.41 (Q1 2015)
Green House Gasses covered	CO ₂
Number of Entities Covered	168
Sectors Covered	Fossil fuel Power Plants
Threshold	>25,000 Megawatts
Compliance tools & Flexibility mechanisms	Free allowances, auctioning, use of offsets (up to 3.3%), Banking, floor price (\$2.05), reserve adjustment (10 million short tonnes, 9.1 million tCO ₂), three year compliance period

California

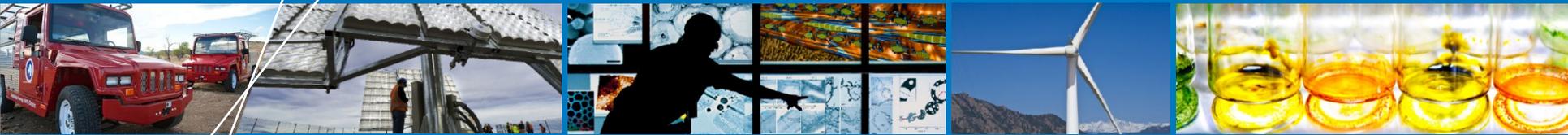
Second Compliance Period (2015-2017)	
Target	Reduce GHG emissions to 1990 levels by 2020
	80% reduction in GHG emissions below 1990 levels by 2050
Cap	394.5 million tCO ₂ e (2015)
Carbon price	\$11.65 (2014) \$12.21 (Q1 2015)
Greenhouse Gases covered	Carbon Dioxide (CO ₂), Methane (CH ₄), Nitrous Oxide (N ₂ O), Sulphur Hexafluoride (SF ₆), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Nitrogen Trifluoride and other fluorinated GHGs
Number of Entities Covered	approximately 450 entities
Sectors Covered	cement production, cogeneration, glass production, hydrogen production, iron and steel production, lead production, lime manufacturing, nitric acid production, petroleum and natural gas systems, petroleum refining, pulp and paper manufacturing, self-generation of electricity, stationary combustion, CO ₂ suppliers, first deliverers of electricity, suppliers of natural gas, suppliers of reformulated blendstock for oxygenate blending (RBOB) and distillate fuel oil, refineries that produce liquid petroleum gas in California, facilities that process natural gas liquids to produce liquid petroleum gas, and suppliers of liquefied natural gas
Threshold	>25,000 tCO ₂ e
% Total emissions covered	85%
Compliance tools & Flexibility Mechanisms	Free allowances (for some sectors), auctions, offsets (8%), allowance price containment reserve, banking, limited borrowing, three-year compliance period

Source: International Emissions Trading Association, Environmental Defense Fund, CDC Climate Research. (2015). *The World's Carbon Markets*. Accessed September 2015, <http://www.ieto.org/worldscarbonmarkets>.

U.S. Regional Transmission Organizations Regions



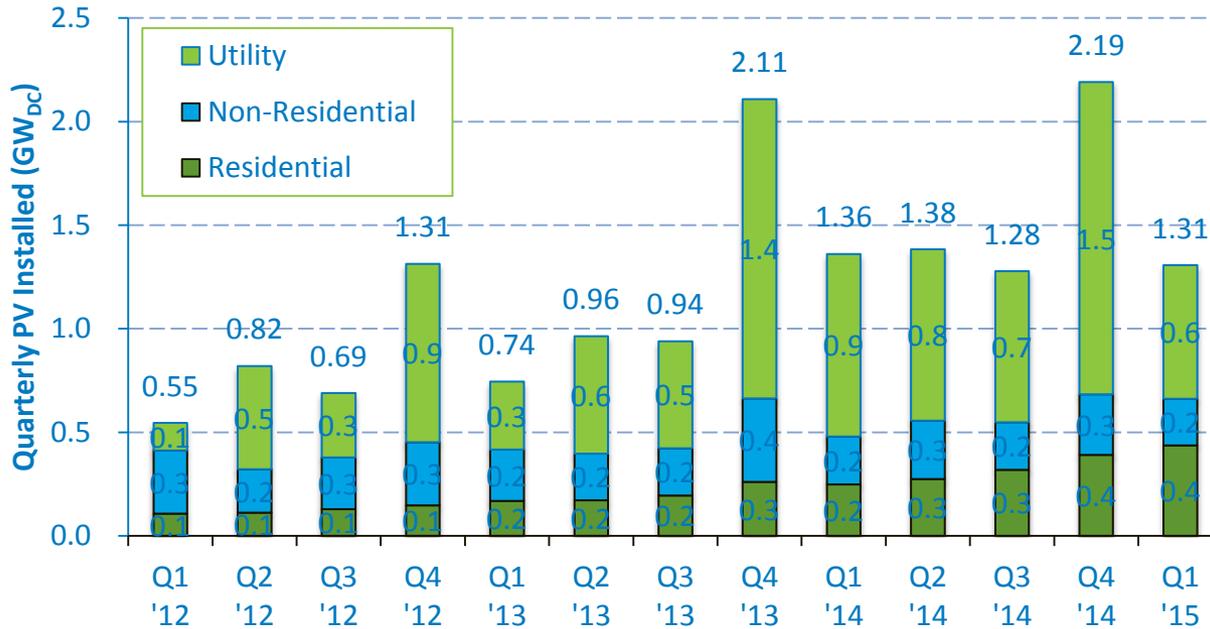
Source: "Regional Transmission Organizations (RTO)/Independent System Operators (ISO)." 2015. Washington, D.C.: Federal Energy Regulatory Commission (FERC). Accessed September 2015, <http://www.ferc.gov/industries/electric/indus-act/rto.asp>.



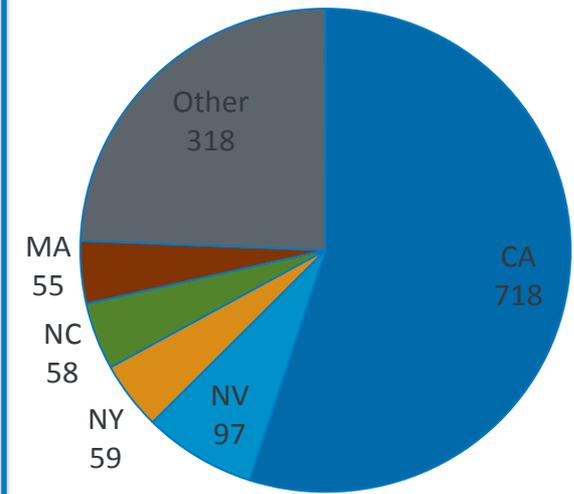
Solar Update

U.S. Installation Breakdown

U.S. PV Installations by Market Segment



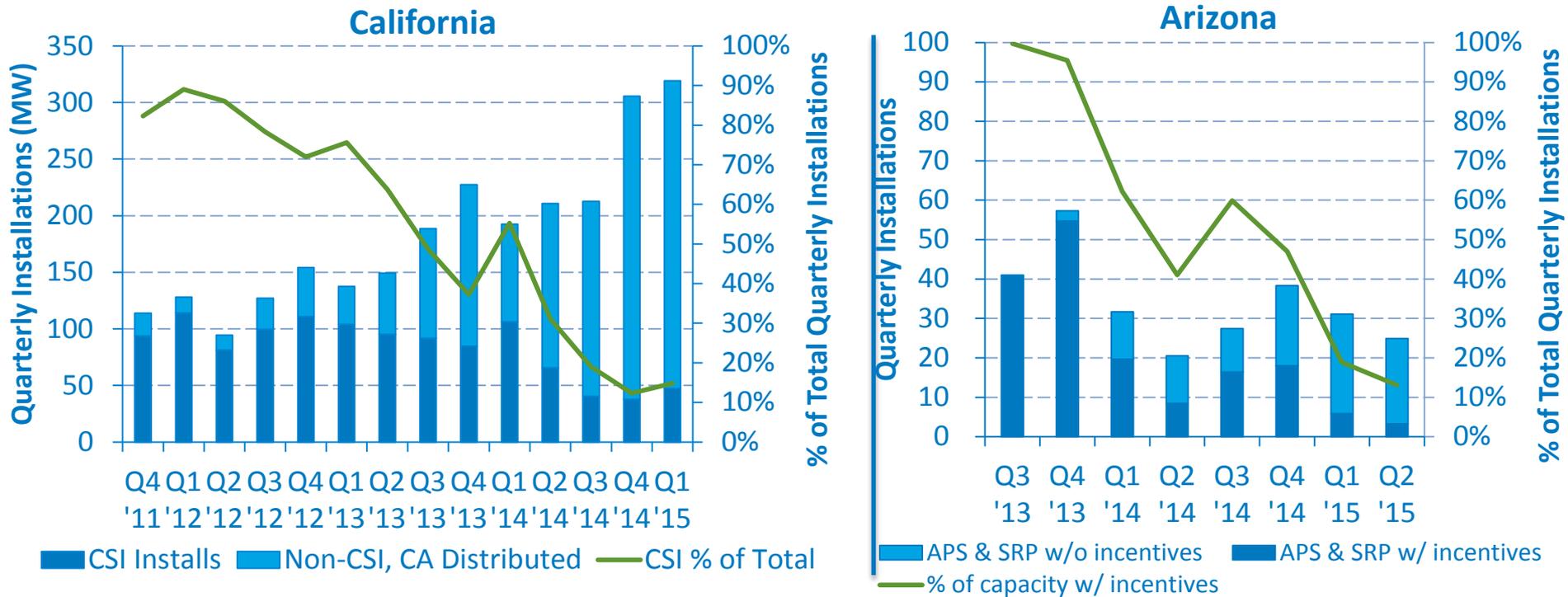
U.S. PV Installations by State (MW_{DC}), Q1 '15



- United States installed 1.3 GW in Q1 '15, down Q/Q and Y/Y
 - Q1 is typically a down quarter (weather, tax purposes); this year was particularly snowy
 - Residential market was actually up (11% Q/Q, 76% Y/Y), with 9 states adding more than 10 MW
 - CA (53% of res. market) had interconnection backlogs for some utilities which pushed installs from Q4 to Q1
- **GTM reports that technology convergence is gaining traction (energy storage, demand response, load control, EV charging), though it's still in its infancy due to high costs. As costs come down and rates evolve, demand should pick up.**

Source: Green Tech Media (GTM)/ Solar Energy Industries Association (SEIA). *U.S. Solar Market Insight Q1 2015*. Accessed September 2015, <http://www.seia.org/research-resources/solar-market-insight-report-2015-q1>.

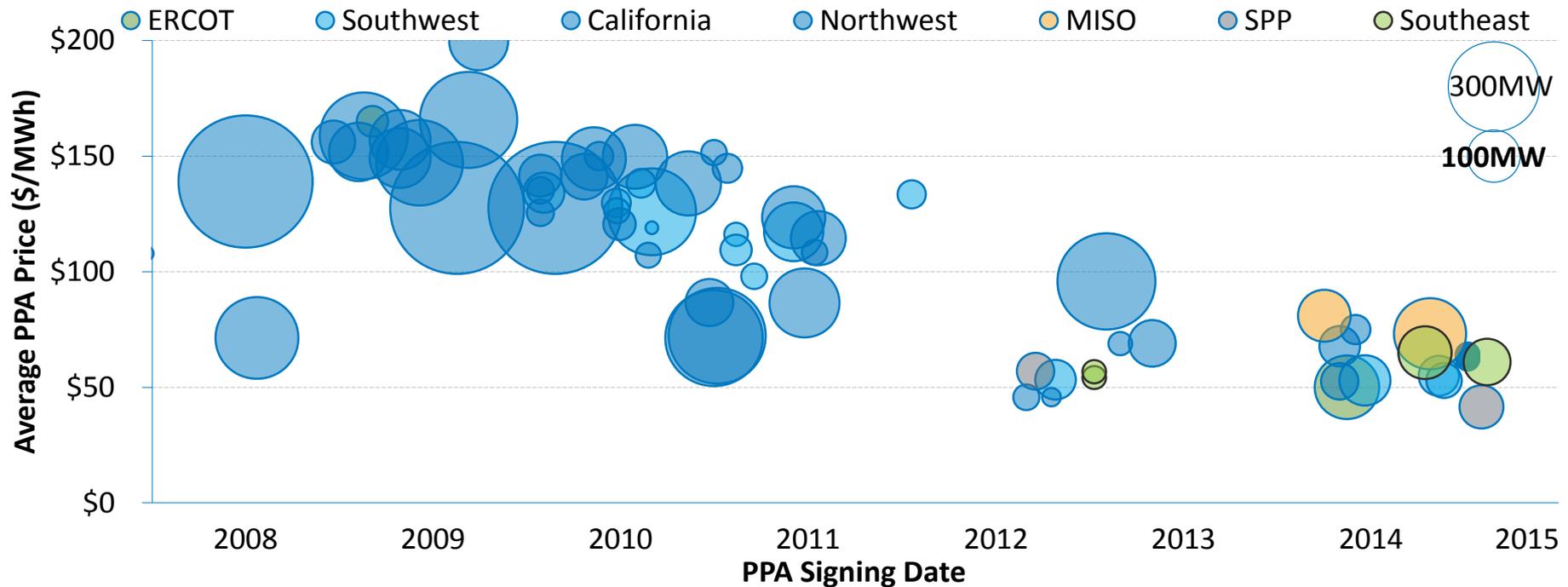
Systems Installed Without Incentives



- CA distributed PV installations continue to grow; however, majority of them are now doing so without CSI incentives
 - Only 15% of distributed PV used California Solar Incentive (CSI) in Q1 '15
 - Additionally, the queue time for projects in CSI program has significantly increased, from 133 days in 2013 to 410 days in H1 '15 for systems under 10 kW (median between incentive application to installation)
- AZ distributed PV installations in SRP & APS territories have increased between H1 '14 and H1 '15, but only 13% of these systems received incentives in Q2 '15

Sources: For CA: CSI Database, accessed April 8, 2015; GTM/SEIA Q4 2014 U.S. Solar Market Insight. For AZ: APS & Salt River Project (SRP), accessed April 10, 2015. Data set segmented by "incentive type"; all projects listed as "non-incentive", "non-incentive residential", or "non-incentive commercial" assumed to have received non-incentives.

PPA Pricing by Region

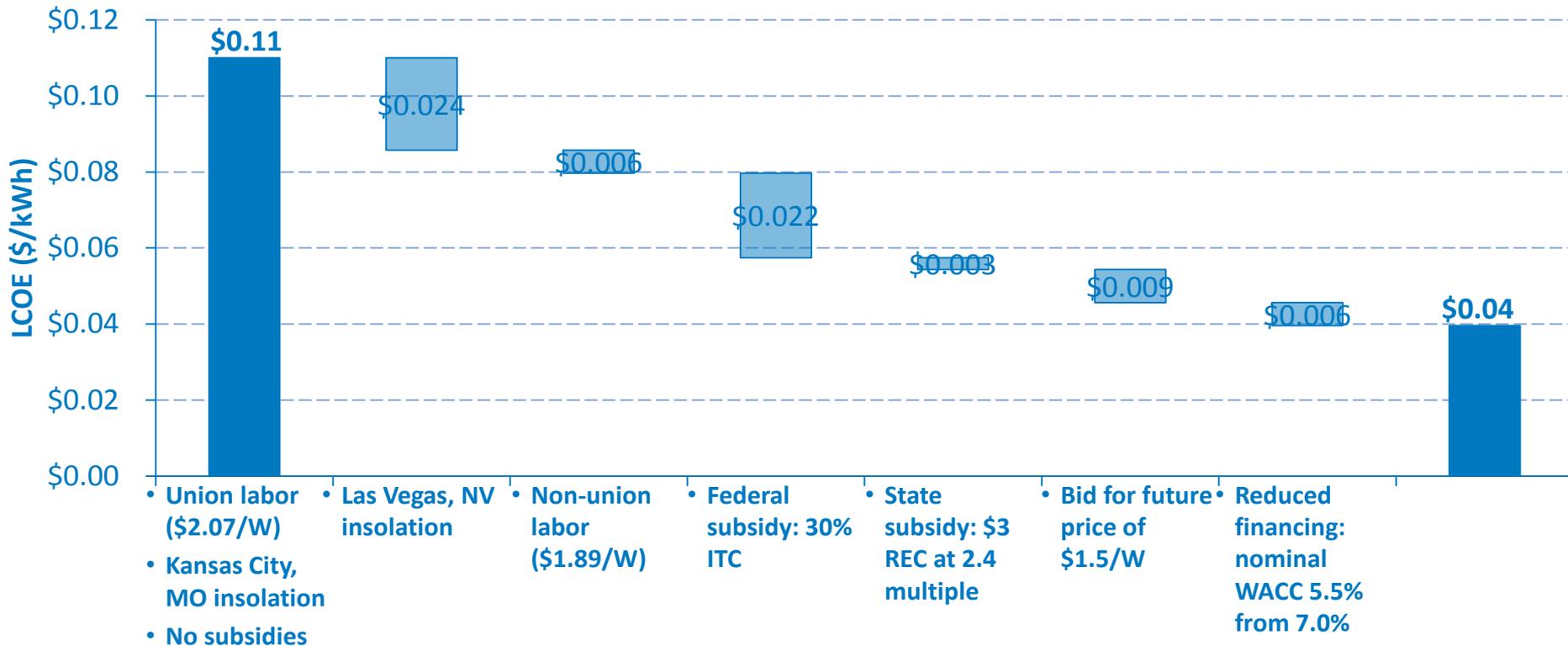


- From 2008-2015, PPA signed contracts have dropped from ~\$150/MWh to ~\$50/MWh
 - Wider geographic distribution of where contracts are being signed
- Recent announcements of much lower PPA bids
 - In June '15 Austin Energy received 1.3 GW of bids under \$40/MWh (though not yet signed)
 - In July '15 NV Energy announced that it had agreed to a PPA price of \$38.7/MWh (3% escalator) with a 100MW First Solar project
- GTM reports that over 5 GW of PV have been procured by utilities based solely on its competitiveness with natural gas

Sources: 1. Bloomberg NEF, "U.S. PPA Market Outlook." Accessed July 8, 2015. 2. GTM/SEIA. 2015. *U.S. SMI Q1 2015*.

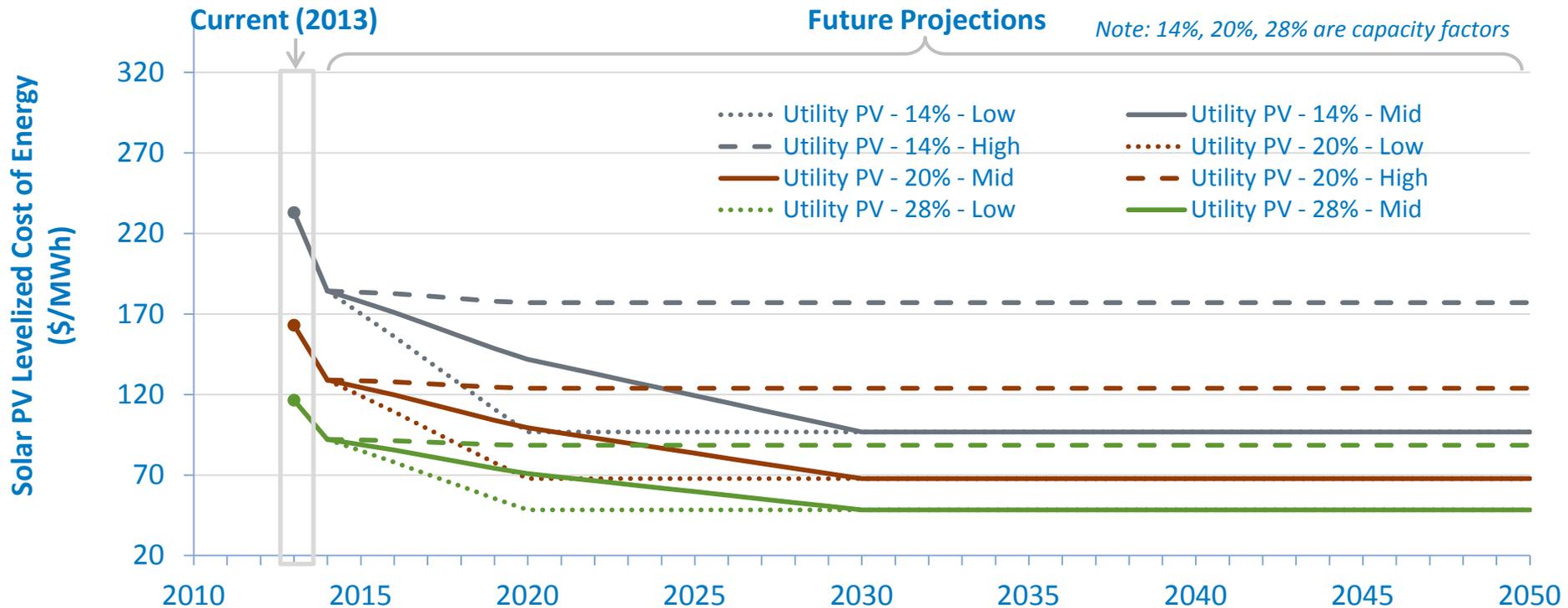
How Are Developers Able to Bid so Low?

- Current unsubsidized LCOE for PV projects across the United States is around \$0.10-\$0.11/kWh
- However, federal and state subsidies still exist, and certain locations have lower labor costs and better insolation
- Additionally, developers typically bid PPAs based on where they think system costs *will* be
 - Some are also able to achieve lower cost financing with larger projects.



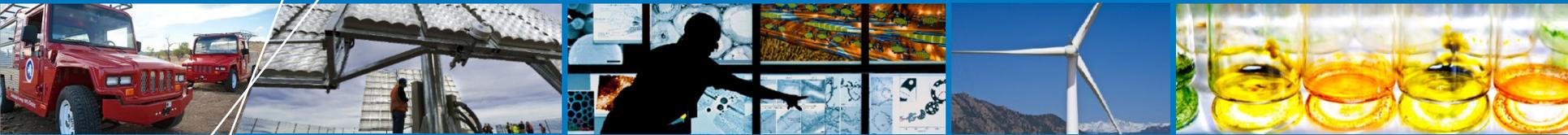
Sources: Current installed system price from Fu et al. (forthcoming). *Economic Competitiveness of U.S. Utility-Scale Photovoltaics Systems in 2015: Regional Cost Modeling of Installed Cost (\$/W) and LCOE*. Golden, CO: NREL. LCOE calculated using the System Advisory Model (SAM).

Solar PV Plant Cost and Performance Projections



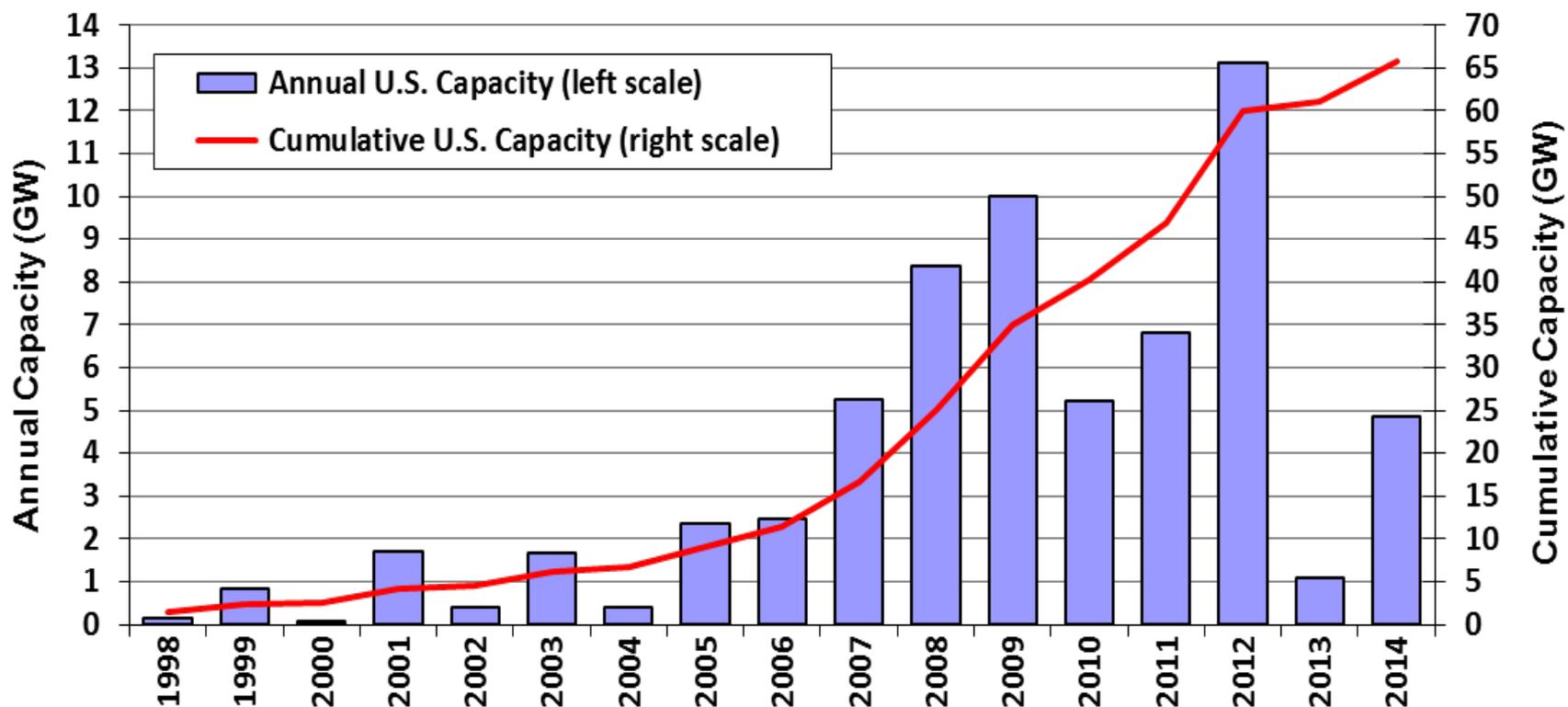
- In general, the degree of adoption of a range of technology innovations distinguishes between the low, mid, and high cost cases
- The range of LCOE associated with variation in solar resource across the United States is reduced from \$94-187/MWh for high cost to \$48-94/MWh for low cost reduction scenarios.

Source: NREL ATB 2015



Wind Update

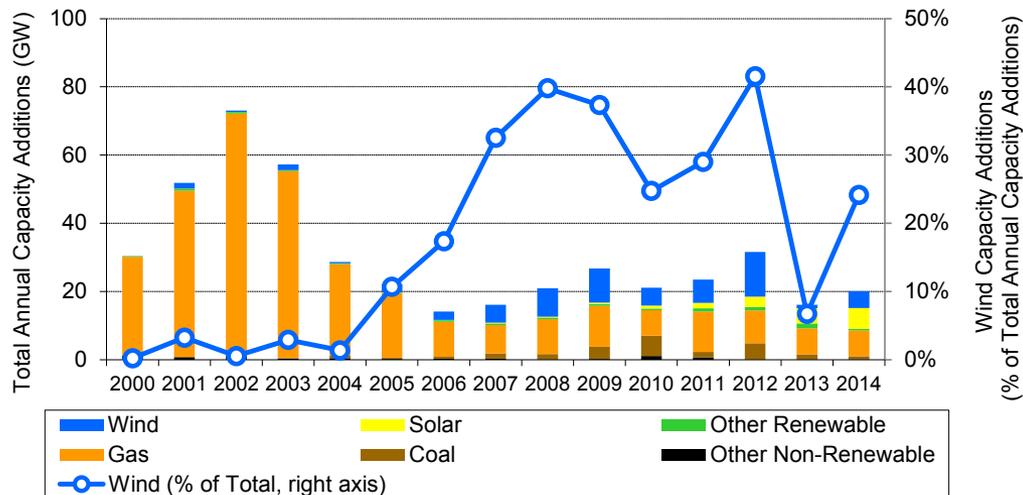
U.S. Wind Installation



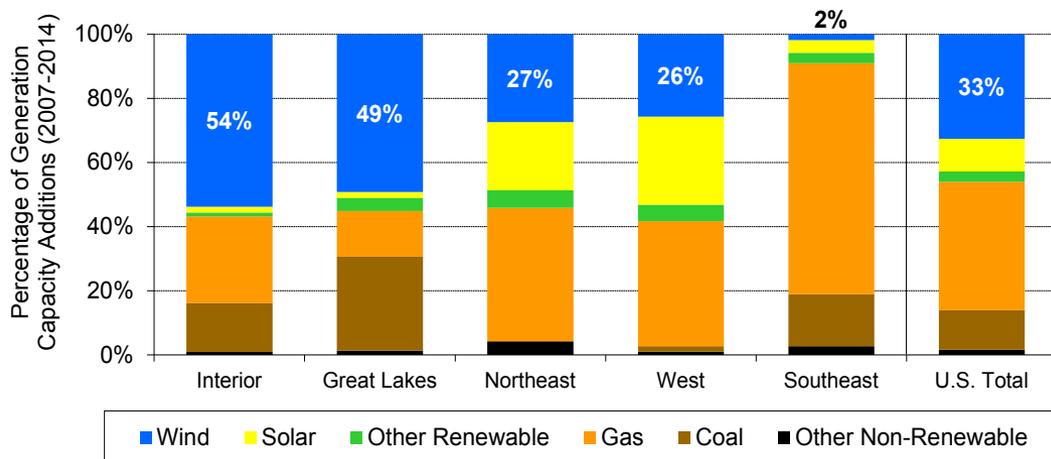
- Wind power additions rebounded in 2014, with 4,854 MW of new capacity added
- \$8.3 billion invested in wind power project additions in 2014
- Cumulative wind capacity up nearly 8%, bringing total to 65.9 GW.

Source: Wiser, Ryan and Mark Bolinger. 2015. *2014 Wind Technologies Market Report*. Washington, D.C.: DOE. DOE/GO-102015-4702. Accessed September 2015, <http://eetd.lbl.gov/sites/all/files/lbnl-188167.pdf>.

Wind Represented 24% of Generating Capacity Additions in 2014

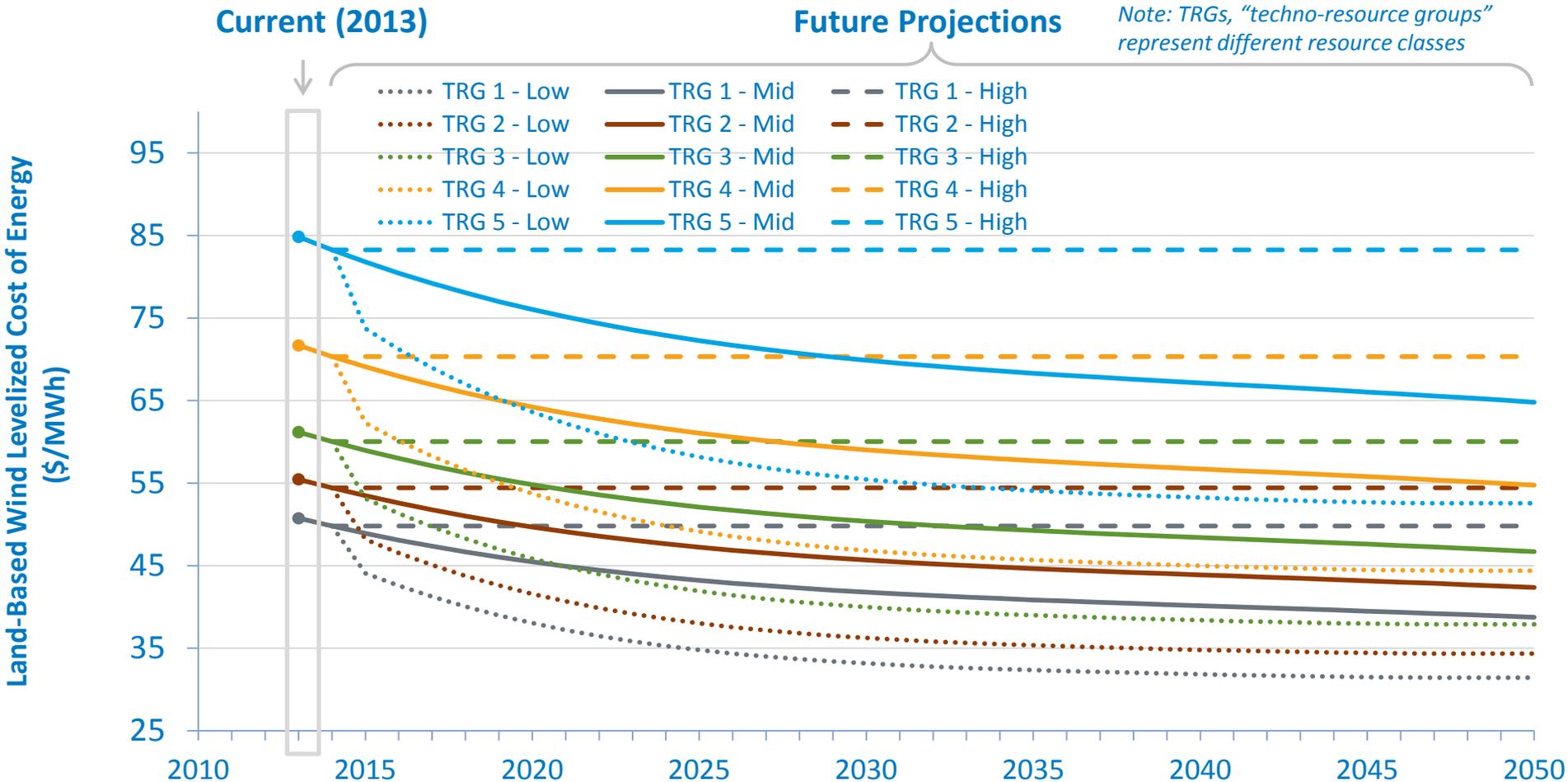


From 2007-2014, wind comprised 33% of capacity additions nationwide, and a much higher proportion in some regions.



Source: Wisner, Ryan and Mark Bolinger. 2015. *2014 Wind Technologies Market Report*. Washington, D.C.: DOE. DOE/GO-102015-4702. Accessed September 2015, <http://eetd.lbl.gov/sites/all/files/lbnl-188167.pdf>.

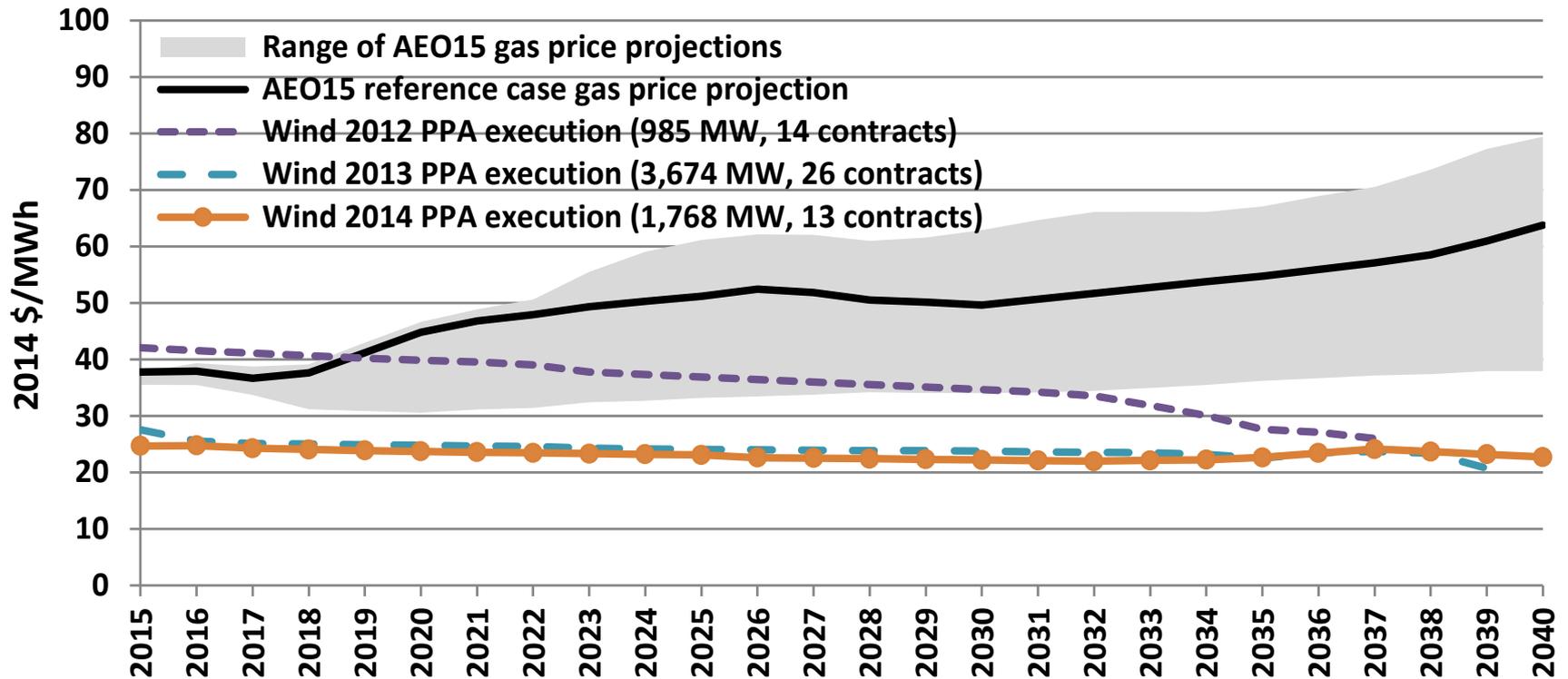
Land-Based Wind Cost and Performance Projections



- In general, the degree of adoption of a range of technology innovations distinguishes between the low, mid, and high cost cases
- The range of LCOE associated with variation in wind resource across the United States is reduced from \$50-83/MWh for High Cost to \$31-53/MWh for Low Cost reduction scenarios.

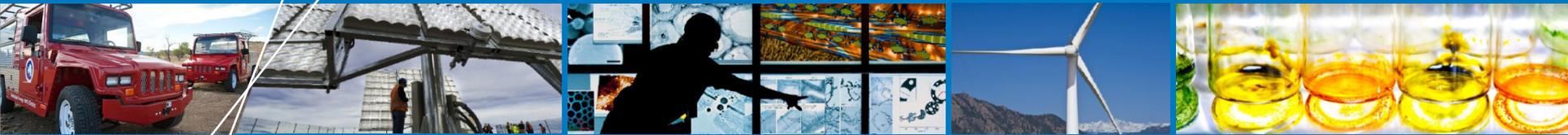
Source: NREL ATB 2015

Recent Wind Prices Competitive with Expected Future Cost of Natural Gas Plants



Price comparison shown here is subject to variability; see full report for caveats.

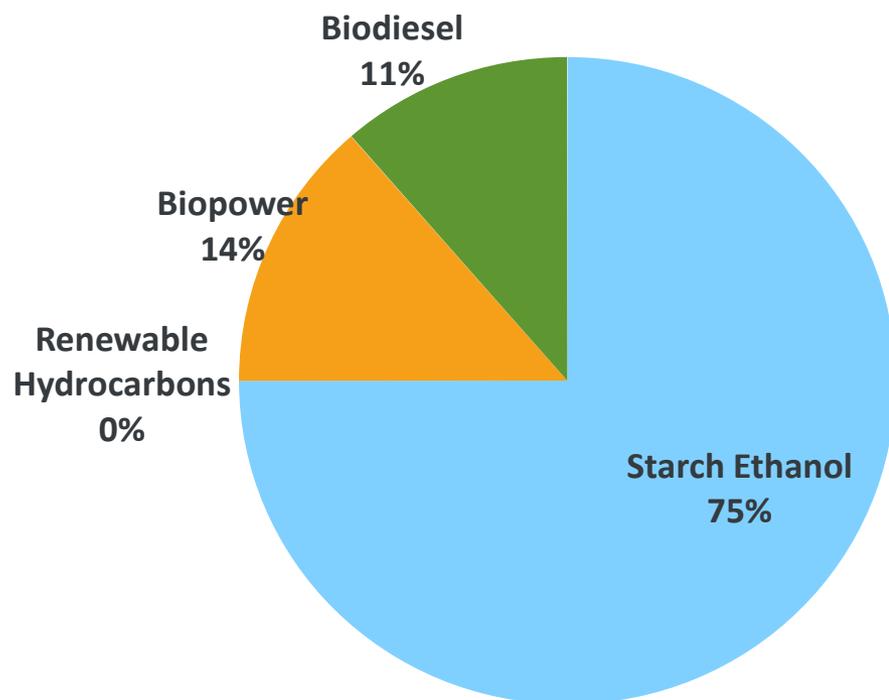
Source: Wiser, Ryan and Mark Bolinger. 2015. *2014 Wind Technologies Market Report*. Washington, D.C.: DOE. DOE/GO-102015-4702. Accessed September 2015, <http://eetd.lbl.gov/sites/all/files/lbnl-188167.pdf>.



Bioenergy Update

U.S. Bioenergy Market Overview

2013 U.S. Bioenergy Production

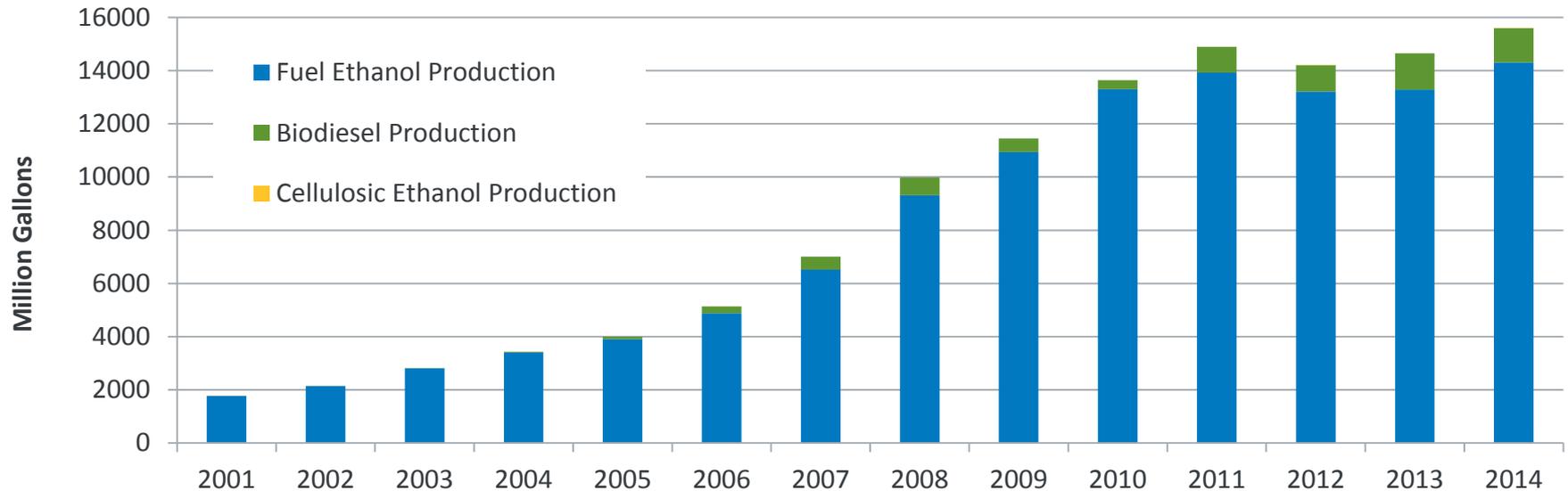


Sources: 1. EIA Annual Energy Review 2. EPA 2014 RFS2 Data 3. Lewis, John. 2015. "Systems-Level Analysis & Bioenergy Market Assessment". Golden, CO: NREL. Accessed September 2015, http://energy.gov/sites/prod/files/2015/04/f22/sustainability_and_strategic_analysis_lewis_4121.pdf.

- **1,500 trillion Btu total** produced in 2013, or **1.8% total primary energy production** in the United States
- 98% of U.S. ethanol production use corn as feedstock
- Key driver of the biofuel industry is the federal **Renewable Fuel Standard (RFS)**, which requires transportation fuel sold in the United States to contain a minimum volume of renewable fuels. The majority of fuel ethanol and biodiesel made in the United States is blended with gasoline

U.S. Renewable Biofuels Production

U.S. Renewable Fuels Production



Sources: Ethanol and biodiesel production: EIA *Annual Energy Review*. Washington, D.C.: EIA. Accessed September 2015, <http://www.eia.gov/totalenergy/data/annual/>; cellulosic ethanol: EPA-RFS2 2014, EPA-420-R-10-006. Washington, D.C.: EPA. Accessed September 2015, <http://www3.epa.gov/otaq/renewablefuels/420r10006.pdf>.

- **Ethanol:** More than 96% of gasoline sold in the United States contains ethanol, and nearly all ethanol is used in E10 (10% ethanol 90% gasoline blend which does not require vehicle modification), creating an effective **constraint on total ethanol use at near 10% of total gasoline consumption**. This is referred to as the “blend wall”. Ethanol is competitive against fossil fuels without subsidies.
- **Biodiesel:** Accounted for approximately 2% of the 50 billion gallon diesel market in 2013, driven primarily by the RFS. The biodiesel PTC(\$0.50- \$1.00/gallon) expired at the end of 2014.
- **Cellulosic:** Since 2010, the renewable volume obligations under RFS for **cellulosic ethanol has been adjusted down** due to insufficient capacity. Annual cellulosic ethanol production capacity is estimated at 113 million gallons, with 60.3 million gallons registered under RFS2 (Bloomberg New Energy Finance June 2015).
- **Advanced biofuels:** Small quantities entered commercial markets in 2012 and 2013 due to RFS2.

Renewable Fuel Standard

RFS1: 2005

- Required gasoline refiners or importers to meet specific volume-based requirements for biofuels.
- **7.5 billion gallons of renewable fuel to be blended into gasoline by 2012.**
- Renewable identification numbers assigned to each gallon of qualifying fuel to demonstrate compliance and are traded as credits.

RFS2: 2007 Amendment

- Increased the volume of renewable fuel blend from 9 billion gallons in 2008 to 36 billion gallons by 2022.
- Included diesel in addition to gasoline, included new categories of renewable fuel (ethanol, biodiesel, and cellulosic biofuels), and set separate volume requirements for each one.

Revised Quotas 2014-2016

- EPA proposed new renewable volume obligations for biofuels in the United States for 2014-2016.
- Cut corn ethanol and cellulosic biofuel markets below the original RFS2.
- Biodiesel sees continued increase from 2014-2016.
- The new regulations still must be finalized to be in effect.

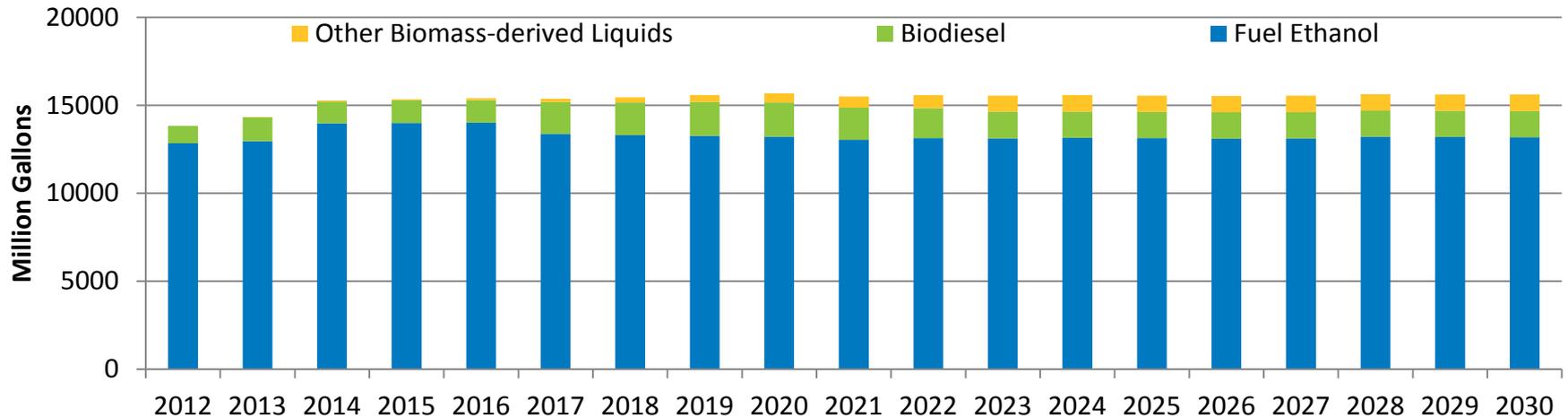
EPA Proposed Renewable Fuel Standards for 2014, 2015, and 2016

	Renewable Fuel		Biomass-based diesel		Cellulosic Biofuels		Other advanced		Total biofuel	
	Original	New Proposed	Original	New Proposed	Original	New Proposed	Original	New Proposed	Original	New Proposed
2014	14.4	13.3	1.0	1.6	1.7	0.0	1.0	0.2	18.1	15.9
2015	15.0	13.4	1.0	1.7	3.0	0.1	1.5	0.2	20.5	16.3
2016	15.2	14.0	1.0	1.8	4.2	0.2	2.0	0.5	22.5	17.4

Source: EPA Proposed Renewable Fuel Standards for 2014, 2015, and 2016, and the Biomass-Based Diesel Volume for 2017. Washington, D.C.: EPA. Accessed September 2015, <http://www.gpo.gov/fdsys/pkg/FR-2015-06-10/pdf/2015-13956.pdf>. (billion gallons)

Biofuel Outlook

U.S. Biofuel Production Outlook, 2012-2030



Source: EIA Annual Energy Outlook 2015 reference case

- **Ethanol:** EIA's projection assumes that both ethanol blending into gasoline and E85 consumption are essentially flat through 2030. The United States is expected to experience decline in gasoline consumption and limited penetration of flexible fuel vehicles that can accommodate E85.
- **Biodiesel** production is also expected to remain constant, assuming the EPA will continue to follow the 1.38 billion gallons per year requirement in the RFS.
- In June 2015, EPA proposed **reducing the RFS renewable biofuel requirement** for 2014-2016 due to the blend wall (10% of demand) and limited cellulosic production. If passed, cellulosic production would be limited and biodiesel would experience an increase in demand.
- **Renewable Fuel Standard (RFS)**, which requires transportation fuel sold in the United States to contain a minimum volume of renewable fuels. (The new regulations still must be finalized to be in effect).
- Near term opportunity to expand the ethanol market is selling more E15 and E85. The U.S. Department of Agriculture has issued \$100 million to build E15 and E85 infrastructure.