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A Survey of the Generation Landscape

Transmission Summit 2016

March 2016

Agenda

- Changing Generation Landscape
  - Trend 1 – Regulatory Reform
  - Trend 2 – Reserve Margins
  - Trend 3 – Generation Mix
  - Trend 4 – Grid Evolution
- Generation Impacts on Transmission

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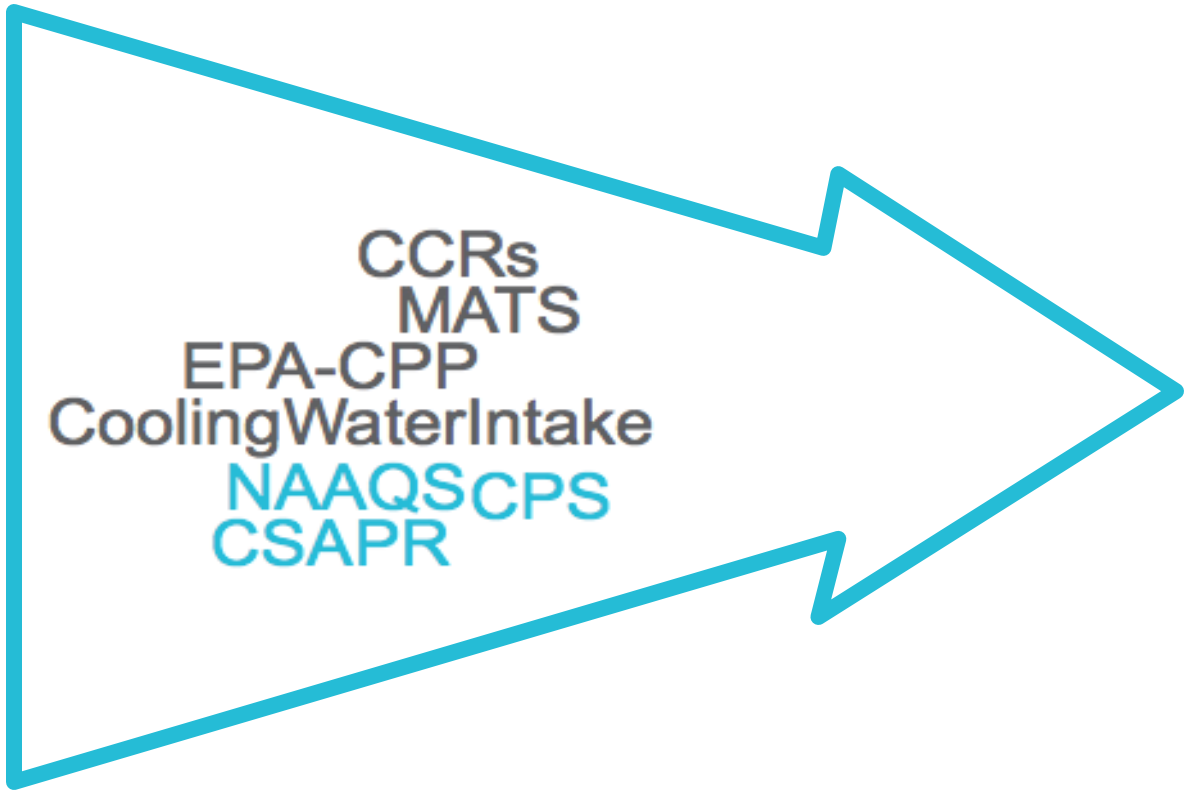
Trend 1 – Regulatory Reform

The Clean Power Plan (CPP), coupled with several other ongoing regulatory and environmental initiatives, will have a profound impact on U.S. generation



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Trend 1 – Regulatory Reform (cont'd)

Regulation	Item Regulated	Current Status	Implications
Cooling Water Intake (Clean Water Act §316(b))	Requirements to cooling water intake structures at existing facilities	Final rule issued 05/14. Published in Federal Registry 08/14	$224 M in compliance costs for ~544 existing electric generators
Mercury and Air Toxics Standards (MATS)	Requirements to limit emissions of toxic air pollutants (mercury, arsenic, and metals)	Issued 12/11. D.C. Court of Appeals upheld rule 12/15	Biggest driver of coal retirements to date (~48 GW from 2012-2021)
Cross-State Air Pollution Rule (CSAPR)	Requirements to improve air quality by reducing emissions across state lines and ground-level ozone	Restored by Supreme Court 04/14. Proposed Cross-State Air Pollution update 12/15	Adds up to coal retirements resulting from MATS (~4.8 GW)

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Sources: EPA, Economic Analysis for the Final Section 316(b) Existing Facilities Rule, May 2014
The Brattle Group, Coal Plant Retirements and Market Impacts, February 2014
EPA, Regulatory Impact Analysis (RIA) for the final Transport Rule, June 2011

Trend 1 – Regulatory Reform (cont'd)

Regulation	Item Regulated	Current Status	Implications
Coal Combustion Residuals (CCRs)	Establishes minimum criteria for the safe disposal of coal combustion residuals (CCRs)	Final rule issued 12/14. Published in Federal Registry 04/15	Estimated annual cost $509-$735 M annually
National Ambient Air Quality Standards (NAAQS)	Establishes national air quality standards for particulate matter and five other pollutants	Updated and published in Federal Registry 10/15 (Ozone)	Cost of potential control programs differs by state
Carbon Pollution Standards (CPS)	Limits emissions of greenhouse gas pollution manifested as CO2	Published in Federal Registry 10/15	Applies to new fossil-fuel-fired power plants, thus incremental cost is marginal

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Sources: EPA, Economic Analysis for the Final Section 316(b) Existing Facilities Rule, May 2014
The Brattle Group, Coal Plant Retirements and Market Impacts, February 2014
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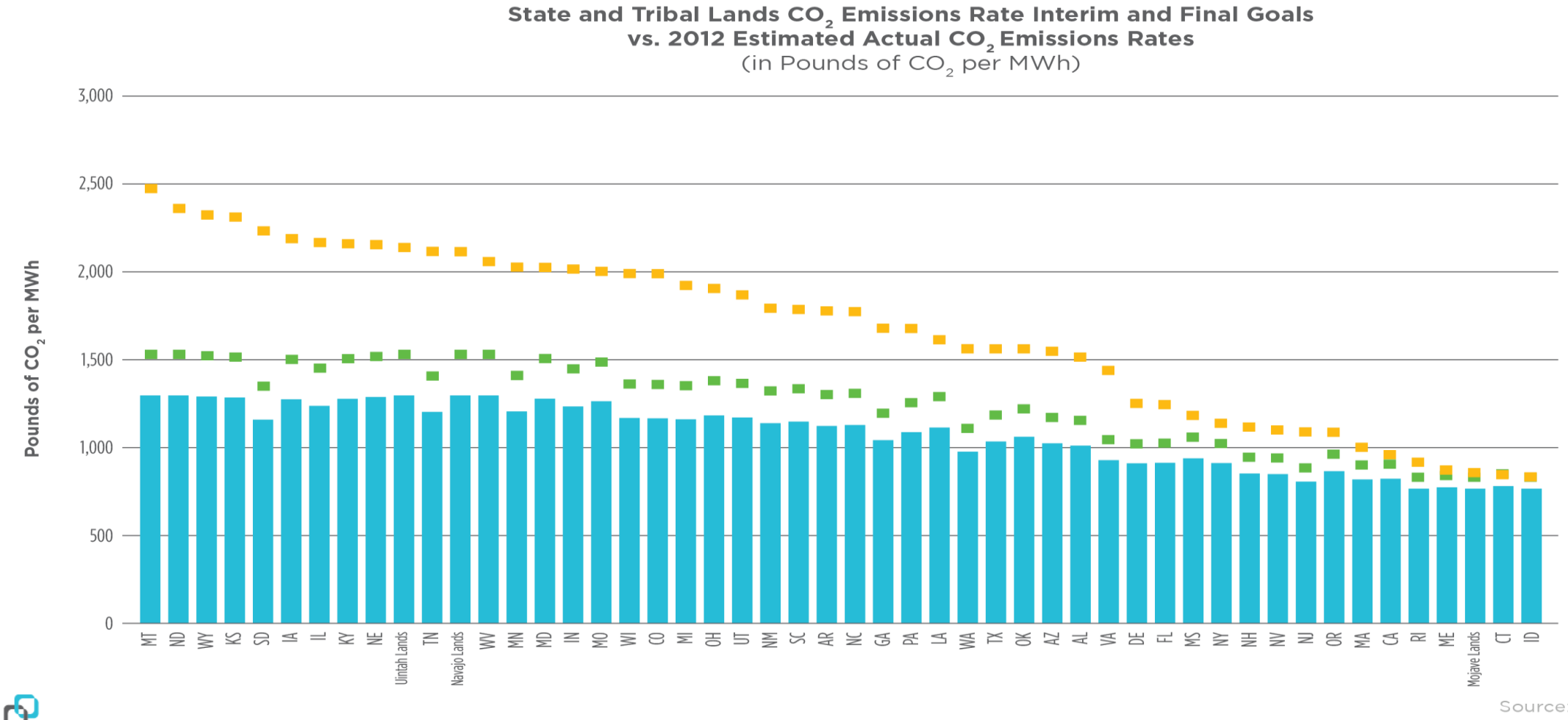
Trend 1 – Regulatory Reform (cont'd)

CPP – Where are we today?

- Published in the Federal Registry October 2015
- Immediately followed by more than 20 states filing a petition for review with the U.S. Court of Appeals of D.C. (West Virginia et al. v. EPA et al.)
- U.S. Supreme Court stayed implementation of the CPP pending judicial review (02/29/2016)
  - Prohibits the EPA from engaging in actions to implement or enforce the CPP
- Ongoing litigation, the U.S. Court of Appeals for the District of Columbia Circuit will hear arguments on June 2, 2016

CPP Targets By State

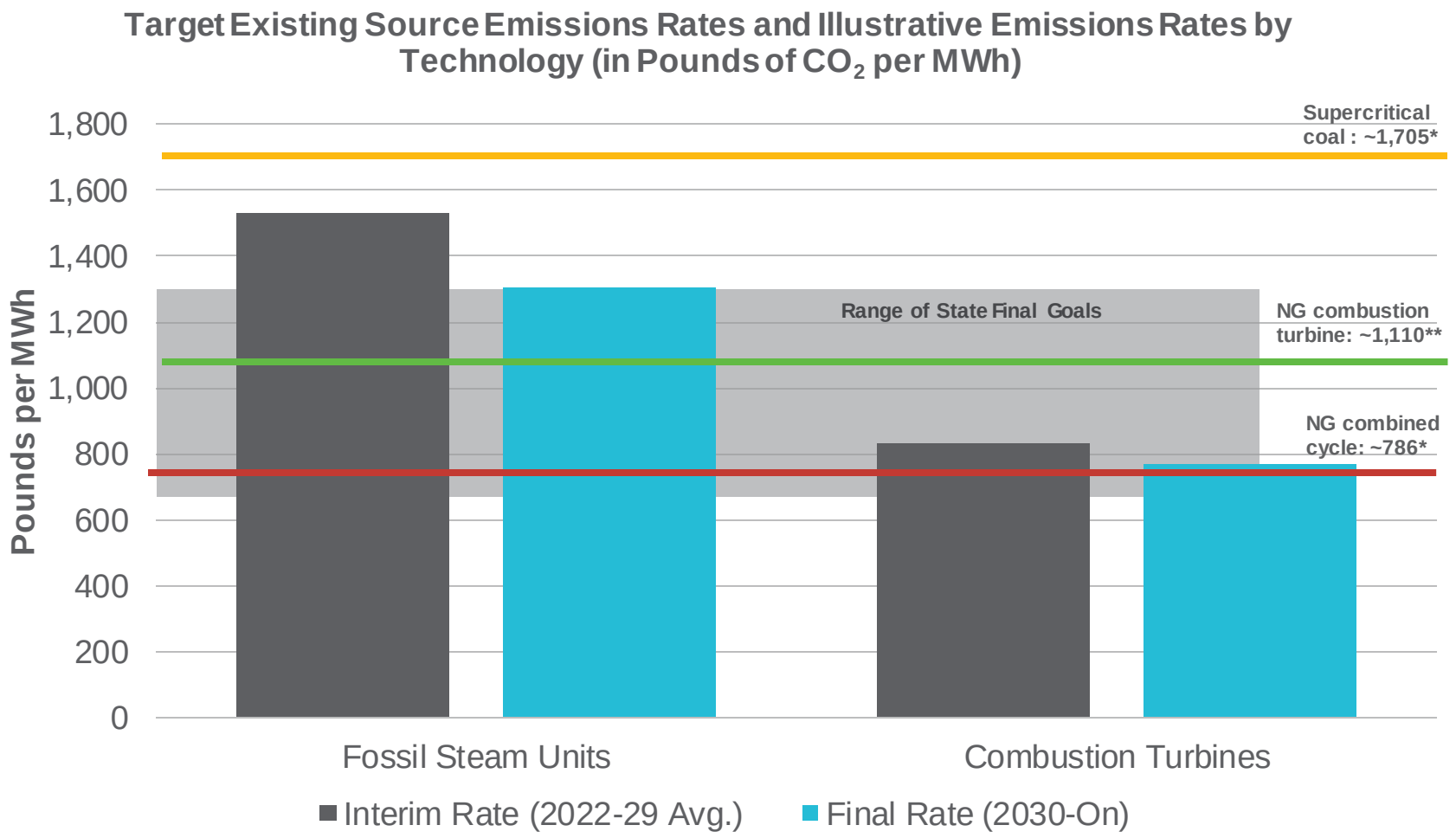
The final rule demands more from high emitting states and focuses on greenhouse gas emitters who have done little to control their emissions to this point



Source:

Sources: EPA; ScottMadden analysis; Vox

CPP Performance Rates by Technology



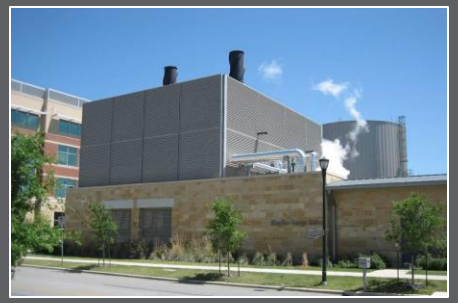
- Final state goals lie between the fossil steam and combustion turbine (CT) technology targets
- Existing technology (supercritical and natural gas CT) emissions exceed targets
- All but the coal unit "building block" fall "outside the fence line" of a power plant and, critics say, outside of the EPA's Clean Air Act authority to enforce

Notes: Dotted lines show current technology emissions rates based upon illustrative configurations; *emissions based on net power; **CT without combined heat and power

Sources: EENews; EPA; DOE Nat'l Energy Technology Laboratory; ScottMadden analysis

Trend 1 – Regulatory Reform (cont'd)

The Fossil Fleet



CPP – Impacts on generation

- Acceleration of the ongoing transformation of the resource mix
  - Coal plant retirements
  - Increased reliance on gas-fired plants
  - Impact on nuclear unclear
  - Growth of renewables
- Coordination among utilities, ISO/RTOs, NERC, and other commodities
  - Understand full impact of changes
  - Identify options for ensuring long-term system reliability

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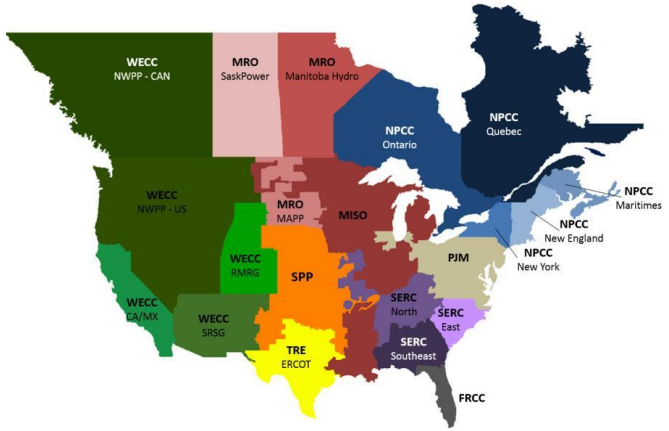
Trend 2 – Declining Reserve Margins

Reserve margins continue to trend downward despite a decline in electricity demand

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
WECC-NWPP-CA	🟢	🟢	🟡	🟡	🟡	🔴	🔴	🔴	🔴	🔴
MISO	🟢	🟢	🟢	🟢	🟡	🔴	🔴	🔴	🔴	🔴
TRE-ERCOT	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴
SERC-North	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴	🔴	🔴
SPP	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴
MRO-MAPP	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴
NPCC-New England	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴
SERC-East	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴
NPCC-Québec	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡
(Remaining 12 Areas)	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢

Reference Margin Differential: 🟢 >.5% 🟡 Between 0% and .5% 🔴 < 0%



- 21 NERC Assessment Areas – eight areas at risk of falling below reference margin levels by 2025
- Uncertainties will require more granular analysis to raise awareness of resource adequacy concerns

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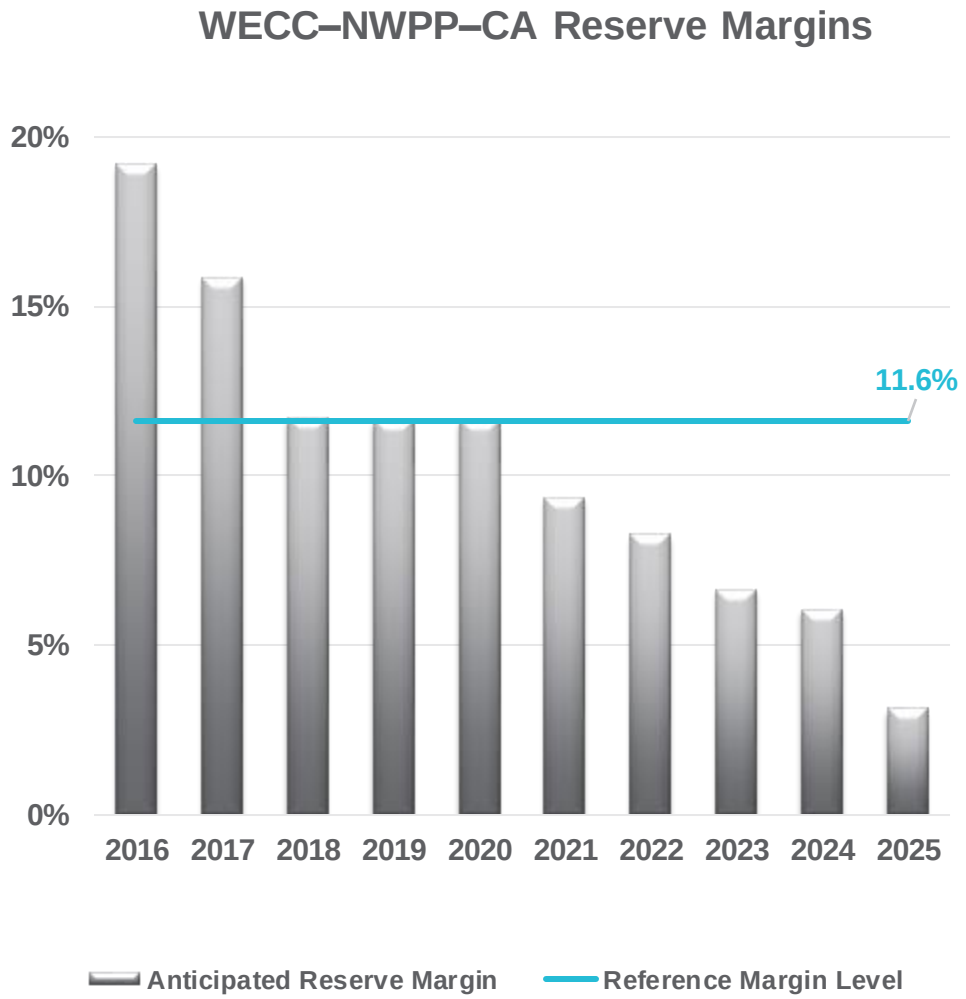
Source: NERC, 2015 Long Term Reliability Assessment, released 12/15

Trend 2 – Declining Reserve Margins (cont'd)

Example – WECC-NWPP-CA

- Anticipated demand growth in the area is a major contributor to the reserve margin shortfall in this assessment area
- WECC-NWPP-CA will require an additional 2.4 GW of on-peak available resources by 2025 to cover the capacity shortfall and maintain their reference margin level
- Tier 2 and Tier 3 resources could be advanced to cover resource adequacy concerns

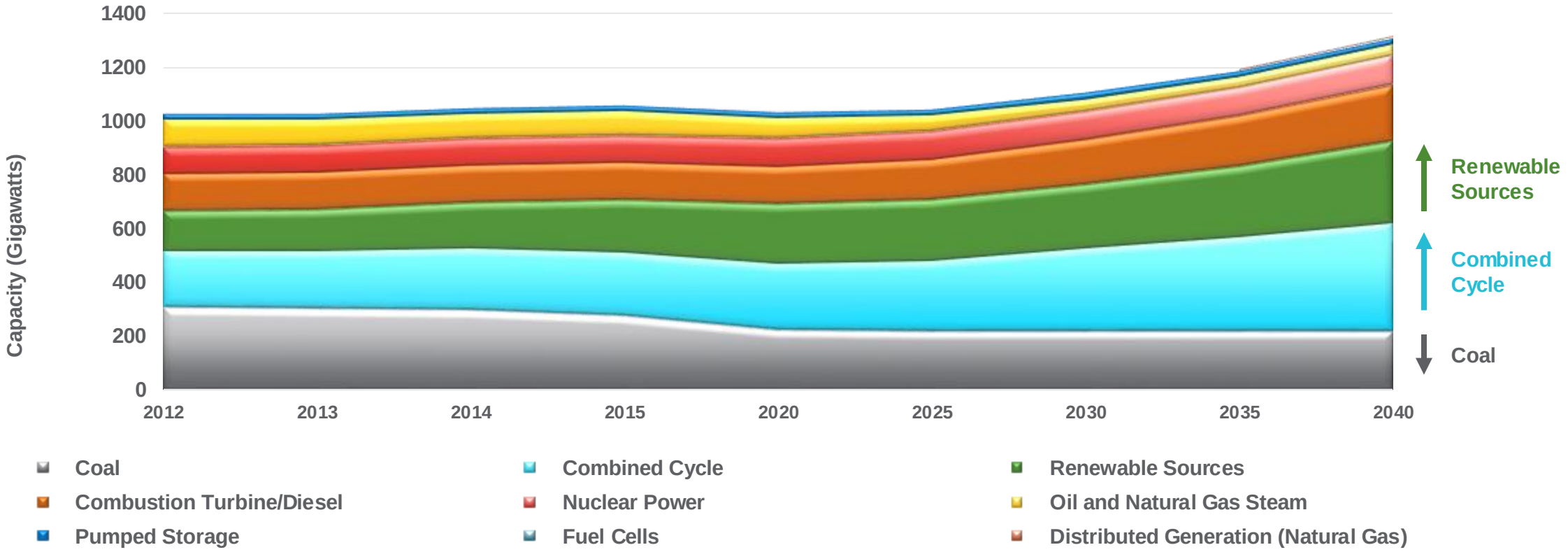


Source: NERC, 2015 Long Term Reliability Assessment, Released 12/15

Trend 3 – Changing Generation Mix

What does the future look like?

- Coal replaced with natural gas, growth in renewables, and new technologies (storage, distributed generation, etc.)



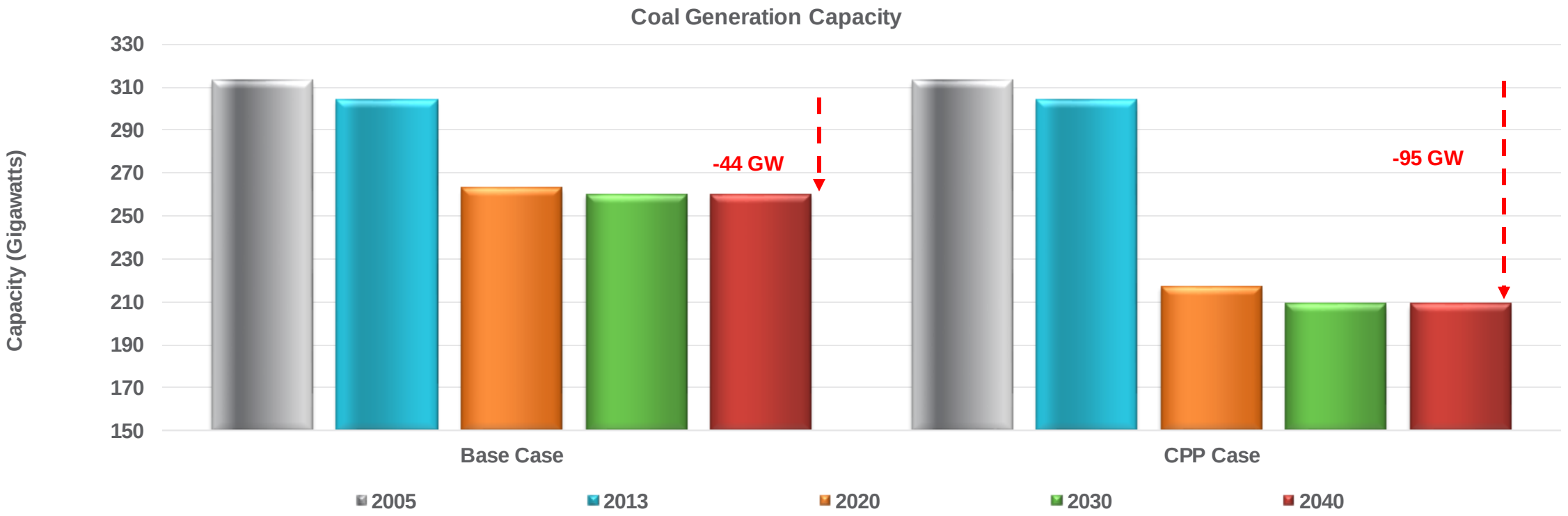
Source: EIA, Annual Energy Outlook 2015, Reference Case, released 04/15

Note: The "Reference Case" does not include impact of the CPP

Trend 3 – Changing Generation Mix (cont'd)

Coal

- Significant coal plant retirements soon due to environmental regulation
- Between 40 GW and 90 GW in the 2014-40 period (most by 2020)

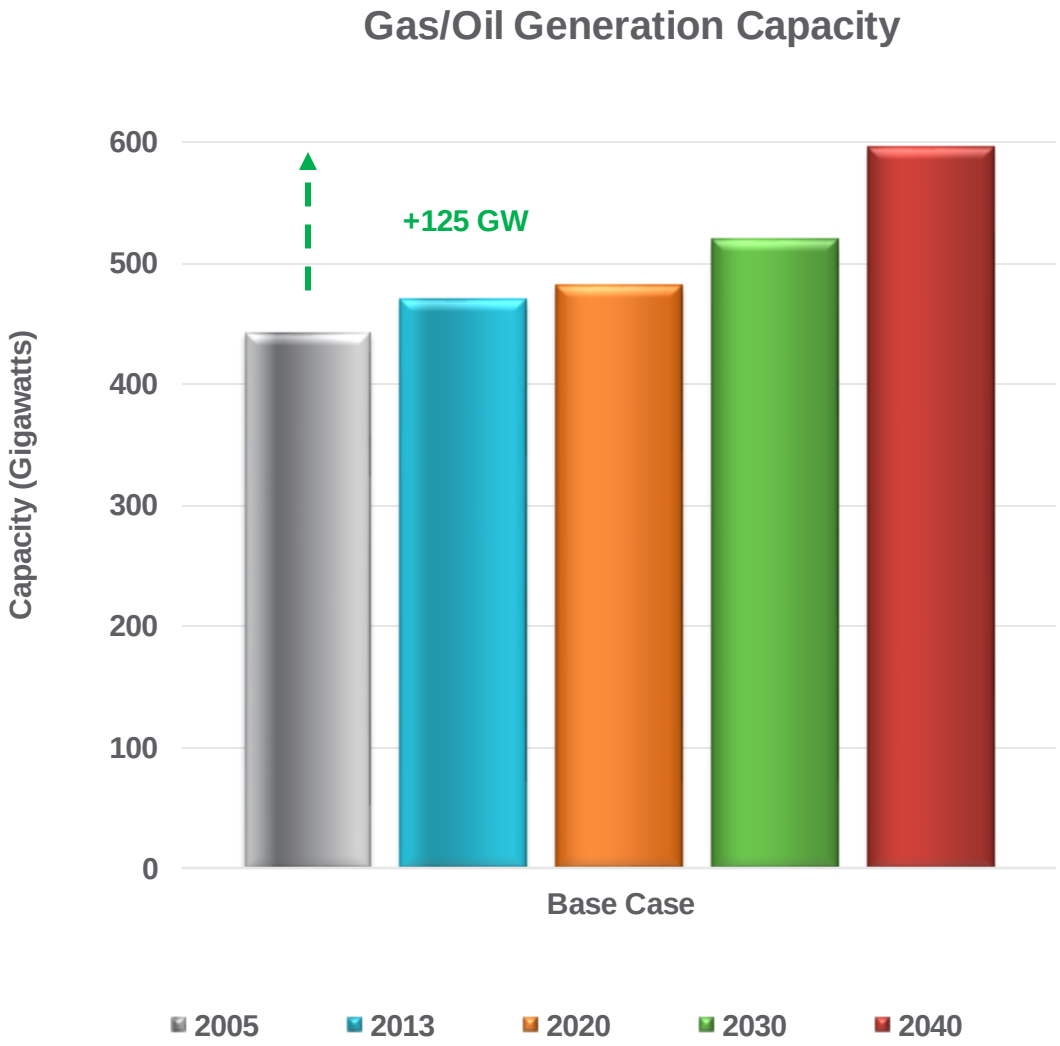


Source: EIA, Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860)

Trend 2 – Declining Reserve Margins (cont'd)

Natural Gas

- Will continue to replace coal-fired generation for base-load generation
  - Low natural gas prices and regulation have fostered the change
- Issues to consider
  - Adequacy of gas pipeline infrastructure, planning, and operational strategies to ensure fuel delivery
  - Coordination with the electric infrastructure
  - Prices are low today, but will they stay low in the future?
- Is this a sustainable long-term solution?



Source: EIA, Analysis of the Impacts of the Clean Power Plan, May 2015

Trend 3 – Changing Generation Mix (cont'd)

Nuclear

- 61 commercially operating nuclear plants with 99 reactors in 30 states
  - 2015 Capacity – 100 GW
  - Despite announced retirements, capacity is expected to growth by 3.4 GW by 2020
- All three announced retirements are single unit sites
  - Other single unit sites at risk due to market conditions (low gas prices)
- Nuclear power plant construction cost estimates tend to be "uncertain"
  - Cost overruns and delays account for up to 200% of initial estimates

Retirements

- 2017 – James A. Fitzpatrick (851.8 MW)
- 2019 – Pilgrim Nuclear Power Station (677.6 MW)
- 2019 – Oyster Creek Nuclear Generating Station (609.9 MW)
- Other?

Total: 2,139.3 MW

Planned Additions

- 2016 – Watts Bar Nuclear Plant (1,150 MW)
- 2019 – Vogtle (1,117 MW)
- 2019 – V C Summer (1,117 MW)
- 2020 – Vogtle (1,117 MW)
- 2020 – V C Summer (1,117 MW)

Total: 5,618 MW

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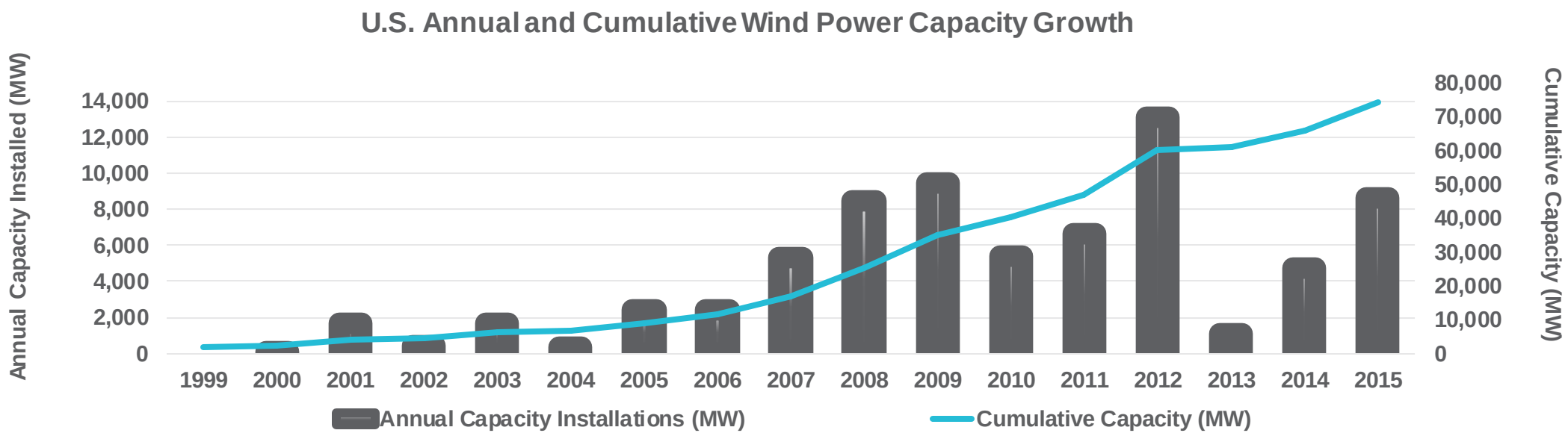
Source: EIA, Inventory of Operating Generators as of November 2015

Trend 3 – Changing Generation Mix (cont'd)

Wind

- On December 18, 2015, the U.S. Congress extended the 2.3% Production Tax Credit (PTC) for wind through 2019
- Continued state Renewable Portfolio Standard (RPS) challenges
- Proximity of load to wind may require additional investment in transmission infrastructure

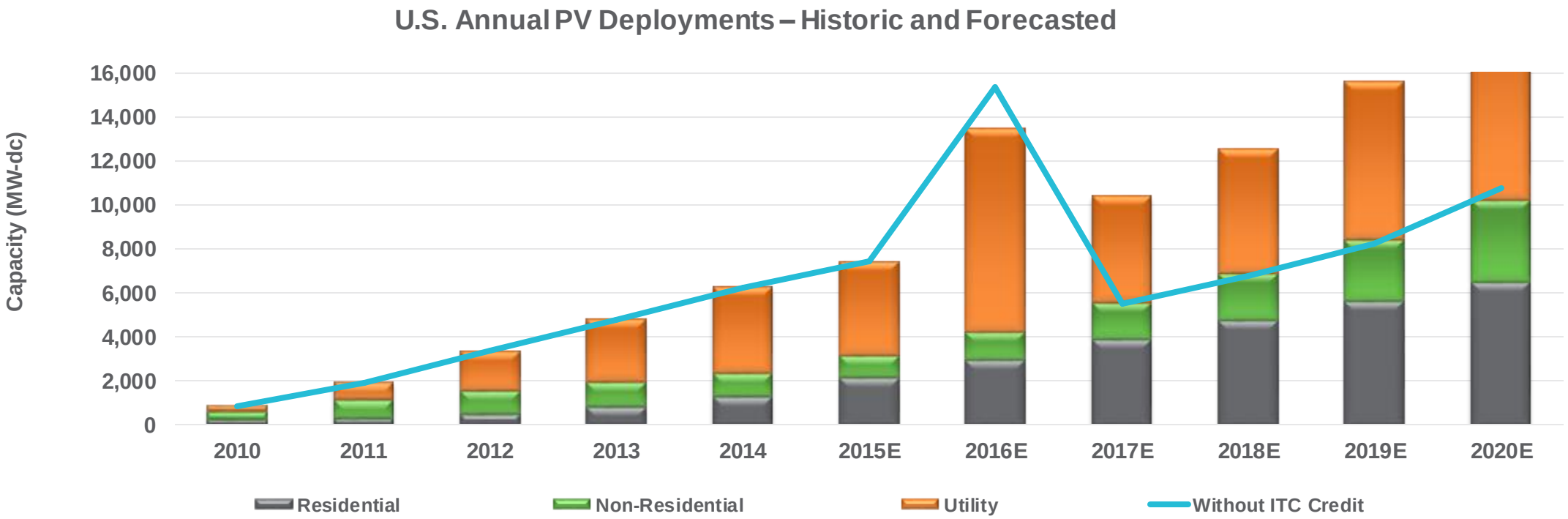


Source: American Wind Energy Association, Fourth Quarter 2015 Market Report

Trend 3 – Changing Generation Mix (cont'd)

Solar

- On December 18, 2015, the U.S. Congress extended the 30% Investment Tax Credit (ITC) for solar through 2021
  - +25 GW of extra solar capacity (2016-2020) and $40B in incremental investment
- Solar prices will likely continue to decline although at a slower rate

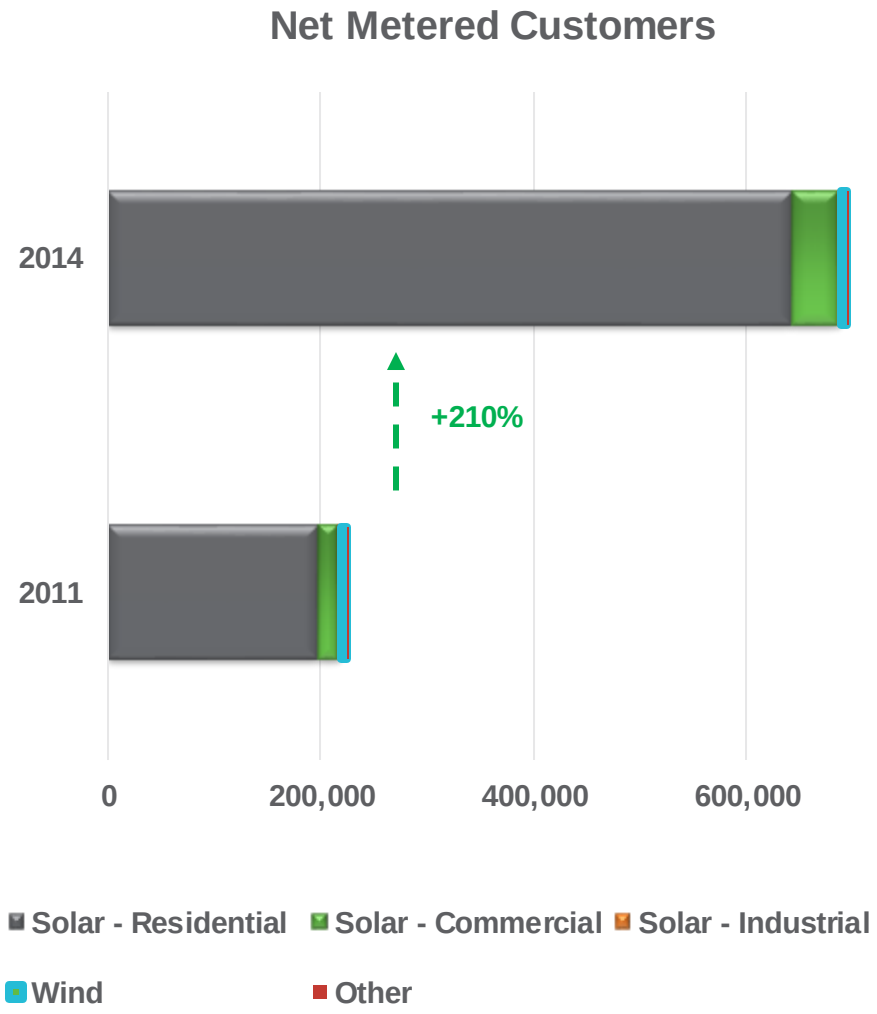


Source: GTM Research, US Solar Market Insight Report 3Q 2015

Trend 4 – Evolving Grid

Major Drivers

- New technologies, evolving resource mix, and market conditions changing energy delivery infrastructure
- Energy efficiency, demand response (DR), and demand side management programs (DSM) encourage conservation
- Deployment and integration of distributed energy resources (DERs) is a game-changer facilitated by:
  - Regulatory policy and incentives
  - Technology advancements
  - Increased acceptance levels
- Technology forcing the need to manage both sides of the supply/demand equation

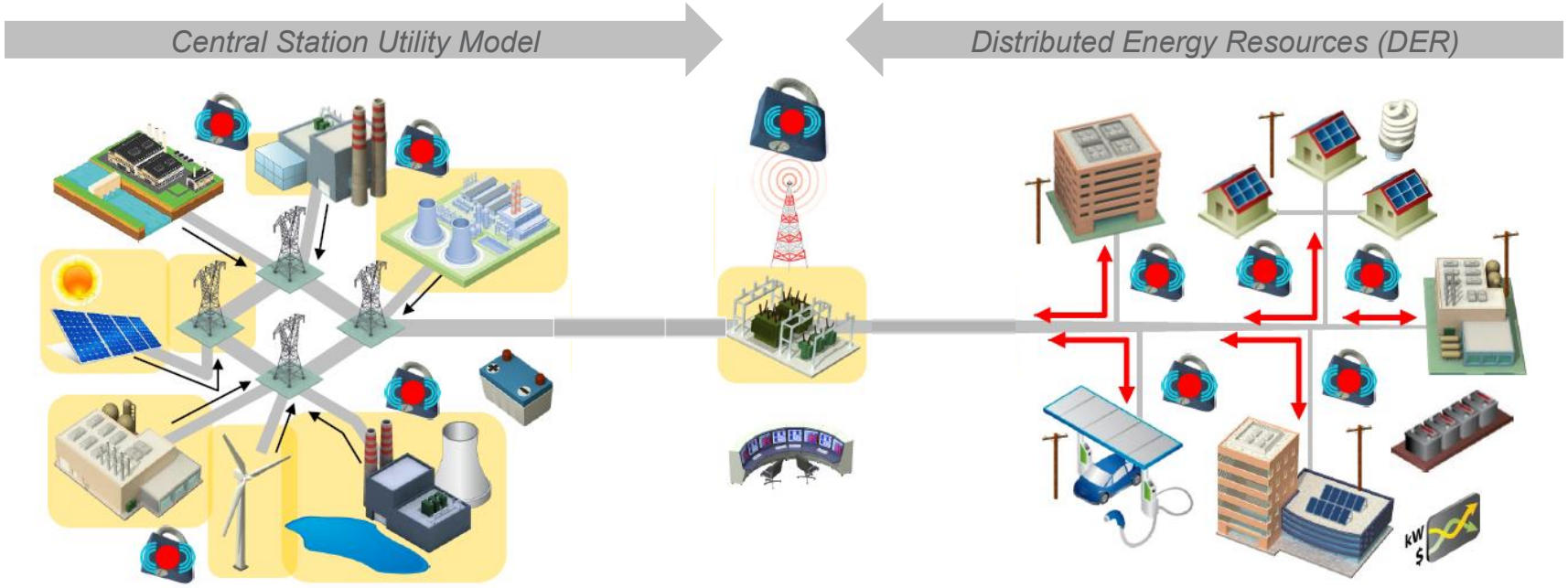


Source: EIA, Form EIA-861, January 2016

Trend 4 – Evolving Grid (cont'd)

Challenges

- Reliance on central station generation being called into question
- Regulatory models need to be reconsidered
  - Accommodate new market entrants
  - Address stranded investments
- Market operations are no longer one-way, centralized, and fully transparent



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Transmission Impacts

Areas of Consideration

- ***Infrastructure*** – upgrades or new transmission build to alleviate constraints or connect new supply
- ***Planning*** – creativity in transmission modeling and planning to address uncertainty
- ***Operations*** – adjustments to real-time operations to ensure reliability of the bulk electric system
- ***Commodities*** – expanded collaboration and communication across commodities as dependence on natural gas grows
- ***Regulation*** – rethinking of the traditional regulatory model to animate markets, accommodate new entrants, and address cost recovery

Evolving Utility Business Model

Think Global, Act Global	Think Global, Act Local	Think Local, Act Local
		
(Controlled centrally, one integrated system)	(A Centrally Orchestrated Network)	(Control is dispersed, many systems loosely tied)
Low	*Increasing change and complexity*	High
Traditional Vertically Integrated Utility	**Managed Network**	**Disaggregated Supply and Demand**
n Continued focus on central station generation, long-haul transmission n Technology initiatives focus on improving the existing integrated system n May see reduced loads due to energy efficiency and distributed resources, but customers do not secede n Utilities driving the "discussion"	n High penetration of DG (combined heat & power and renewables) n Emergence and increased penetration of microgrids n Initiatives focus on integrating new grid components n Utilities orchestrating the "discussion"	n High penetration of DG (combined heat & power and renewables) n Emergence and increased penetration of microgrids n Others driving the "discussion"

Impacts extend beyond transmission, and the traditional utility business model must evolve

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Transmission Impacts (cont'd)

Industry Response to Changing Generation Mix

- ***Avoid the wait and see*** approach and continue pursuing alternatives given the lead time required to implement transmission solutions
- ***Continue collaborating*** with neighboring utilities, regions, and commodities to understand outcomes and coordinated responses
- Take a ***creative approach to planning***, considering a range of scenarios and resulting impacts of potential regulatory or policy outcomes
- Adopt technologies or ***enhanced operational practices*** to address ***system reliability challenges***
- ***Remain active*** and a ***vocal*** industry advocate to preserve the integrity of a safe, reliable, and efficient transmission grid

A fundamental change in the electricity generation mix is occurring.

It will transform grid level reliability, diversity, and flexibility.

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