Wind Energy is the Low-Cost, Low-Risk Solution for Clean Power Plan Compliance

Michael Goggin

AWEA
AMERICAN WIND ENERGY ASSOCIATION

CPP Cost Optimization and Risk Evaluation (CPP CORE) Tool

Tool and user guide available at: http://www.awea.org/applications/Forms/FormDisplay.aspx?FormID=42237

Power System Cost Results

User Input Panel

1. Select State: Illinois — Region: Great Lakes

2. Allow National Trading: YES — 3. Mass-Based Approach Type: Existing Mass / New Source Complement (selected)

2. Select User Inputs

	Low	High	Median	Std Dev
Gas Price	$2.50	$8.50	$5.50	$1.00
Coal Price	85%	115%	100%	5%
Cumulative Load Growth	5%	23%	14%	3%
Wind Cost $/MWh			$ 47.78	

Analysis Results

3. Calculate Results — GO

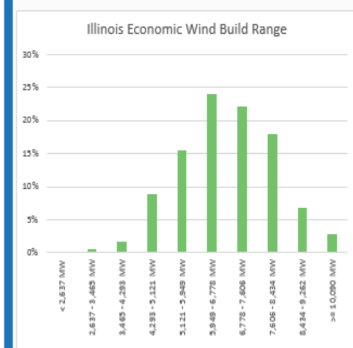
4. Median Results

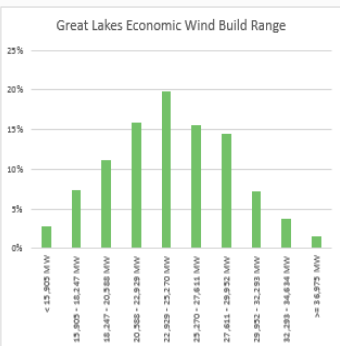
	Illinois	Region	National
New Wind Through 2030 (MW)	7,168	25,918	90,839
Incremental Power System Costs	$3,207,041,407	$ 11,596,701,544	$ 48,616,166,817
Renewable Market Share	96%	96%	84%

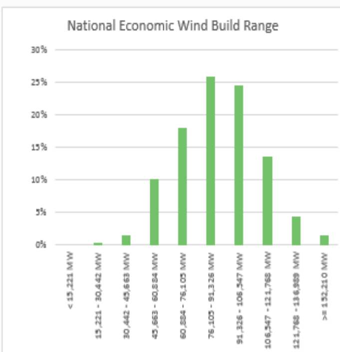
Scatterplot of Power System Costs and Renewable Energy Use

Wind Demand Results

Range of Wind Demand







Illinois Economic Wind Build Range	Frequency
< 2,637 MW	0.00%
2,637 - 3,465 MW	0.60%
3,465 - 4,293 MW	1.60%
4,293 - 5,121 MW	8.90%
5,121 - 5,949 MW	15.40%
5,949 - 6,778 MW	23.90%
6,778 - 7,606 MW	22.00%
7,606 - 8,434 MW	18.00%
8,434 - 9,262 MW	6.80%
>= 10,090 MW	2.80%

Great Lakes Economic Wind Build Range	Frequency
< 15,905 MW	2.90%
15,905 - 18,247 MW	7.40%
18,247 - 20,588 MW	11.20%
20,588 - 22,929 MW	15.90%
22,929 - 25,270 MW	19.90%
25,270 - 27,611 MW	15.60%
27,611 - 29,952 MW	14.40%
29,952 - 32,293 MW	7.30%
32,293 - 34,634 MW	3.80%
>= 36,975 MW	1.60%

National Economic Wind Build Range	Frequency
< 15,221 MW	0.00%
15,221 - 30,442 MW	0.30%
30,442 - 45,663 MW	1.50%
45,663 - 60,884 MW	10.20%
60,884 - 76,105 MW	18.10%
76,105 - 91,326 MW	25.90%
91,326 - 106,547 MW	24.50%
106,547 - 121,768 MW	13.60%
121,768 - 136,989 MW	4.30%
>= 152,210 MW	1.60%

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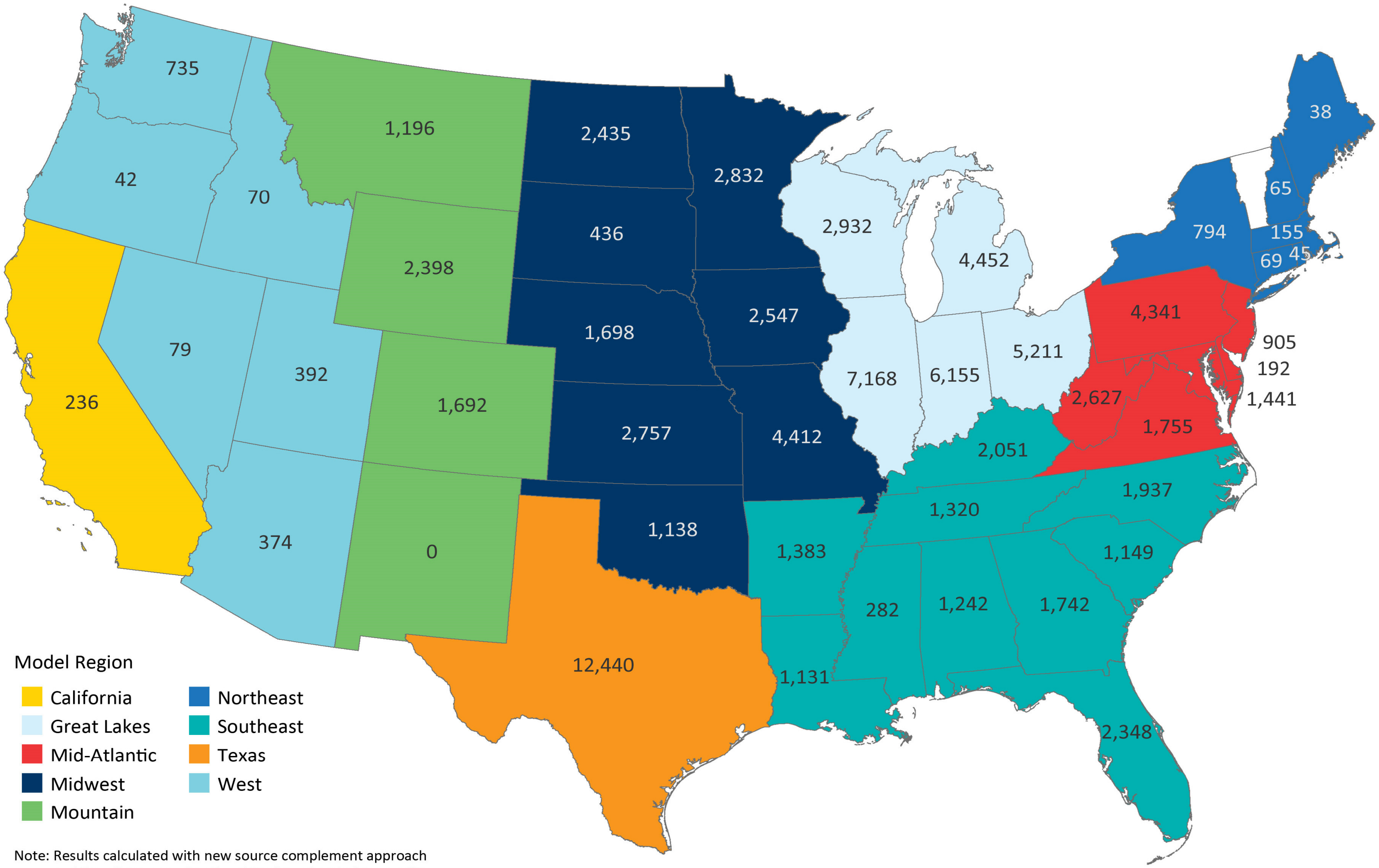
Optimal CPP Wind Build through 2030, MW

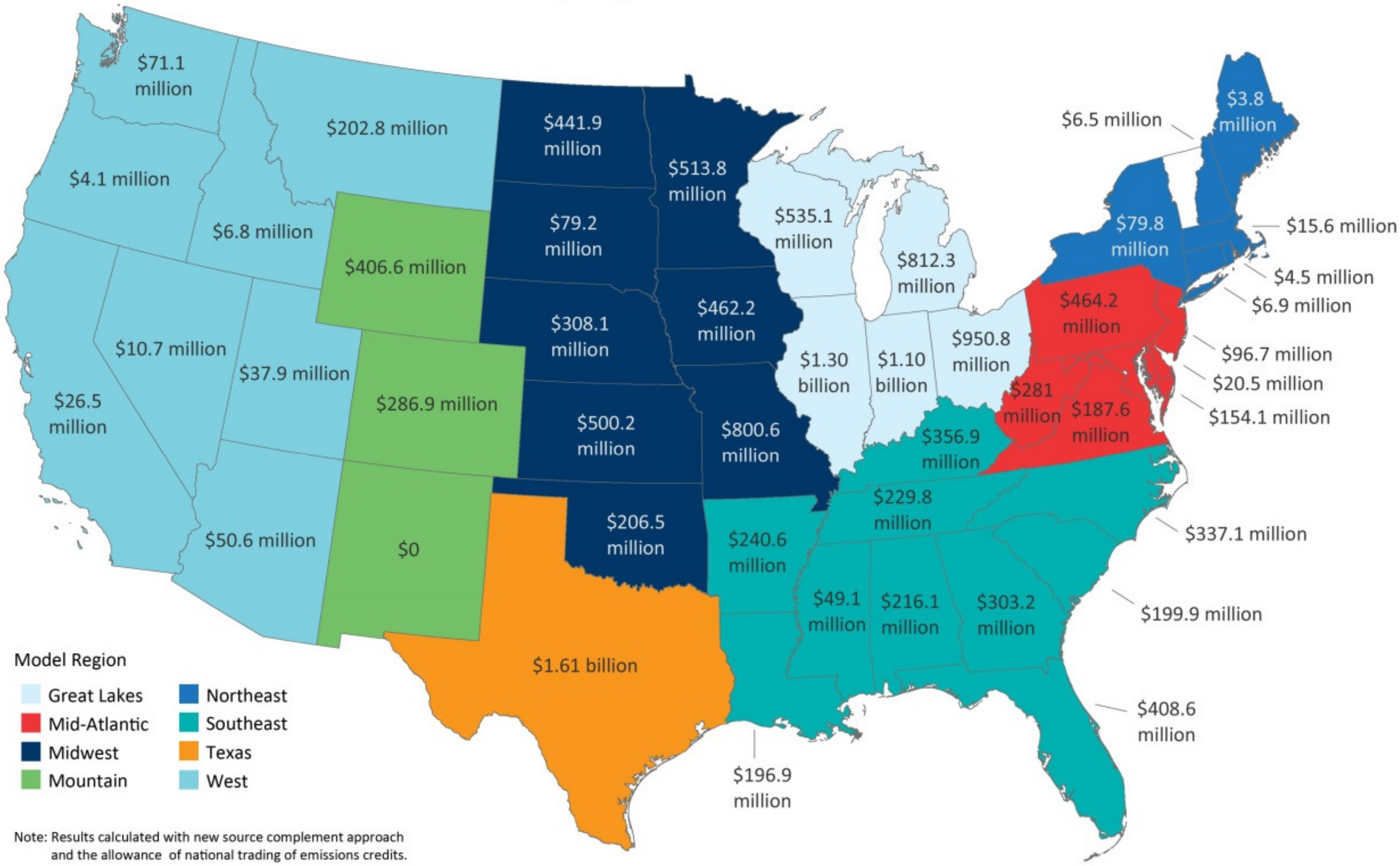


Note: Results calculated with new source complement approach and the allowance of national trading of emissions credits.

90 GW of additional wind nationwide. For states like Iowa, the map is conservative as it does not include MW from wind export opportunity. Iowa's low-cost wind resources are likely to be attractive to other states.

Large consumer savings from using wind for CPP

Cost savings in 2030 from optimal deployment of renewable energy versus no additional deployment of renewables



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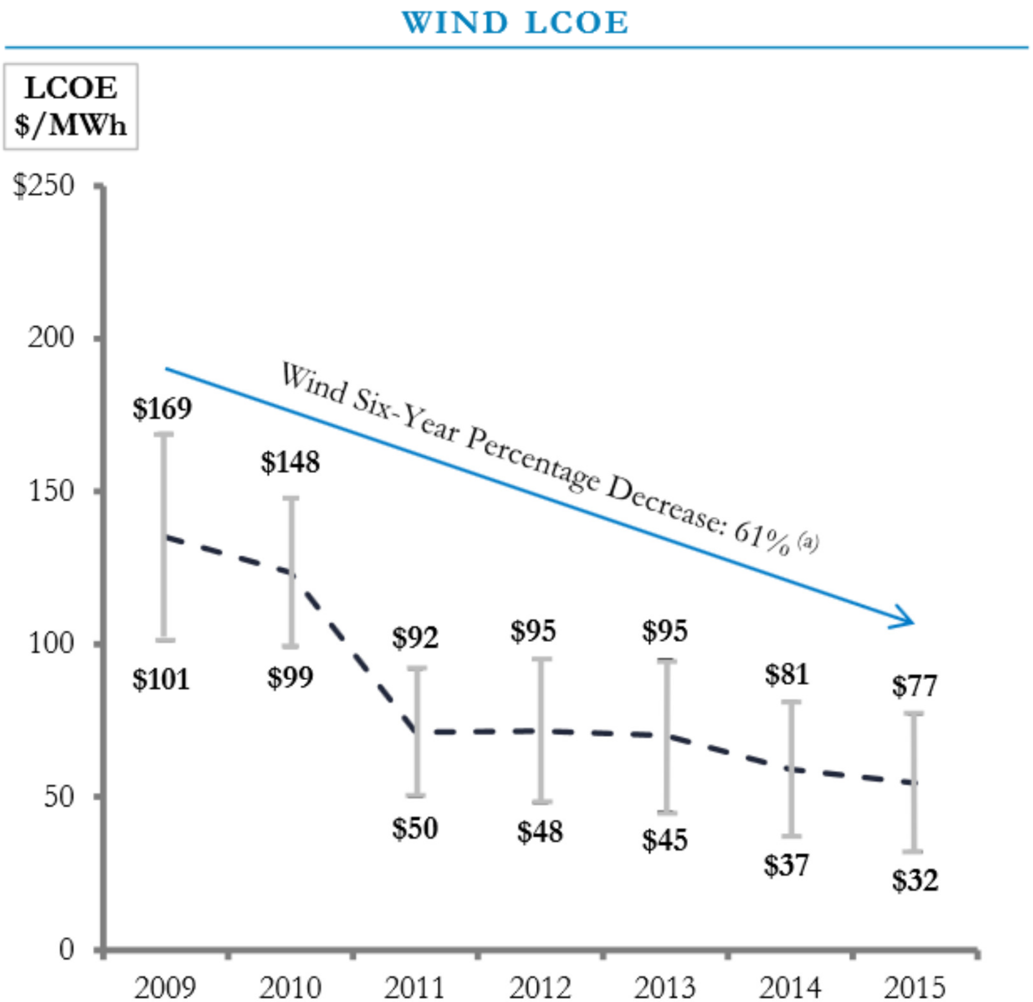
Why? Wind's recent cost reductions



Year	$/MWh PPA
2009	$68.84
2010	$61.62
2011	$45.06
2012	$38.75
2013	$26.53
2014	$23.43

https://emp.lbl.gov/publications/2014-wind-technologies-market-0

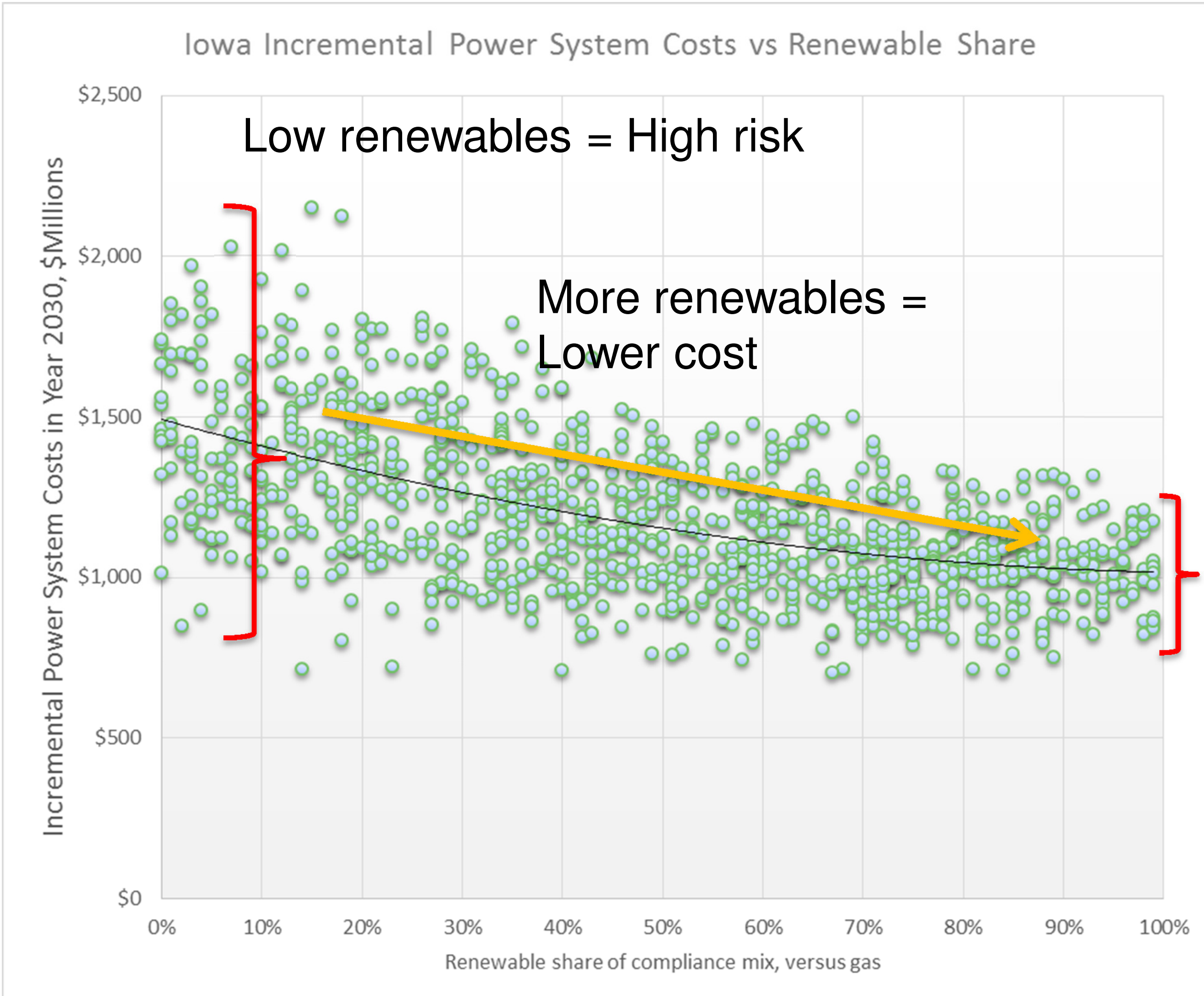
Note: Power Purchase Agreement prices on right include impact of PTC, Levelized Cost of Energy data on left do not

Source: https://www.lazard.com/media/2390/lazards-levelized-cost-of-energy-analysis-90.pdf

Probabilistic Modeling

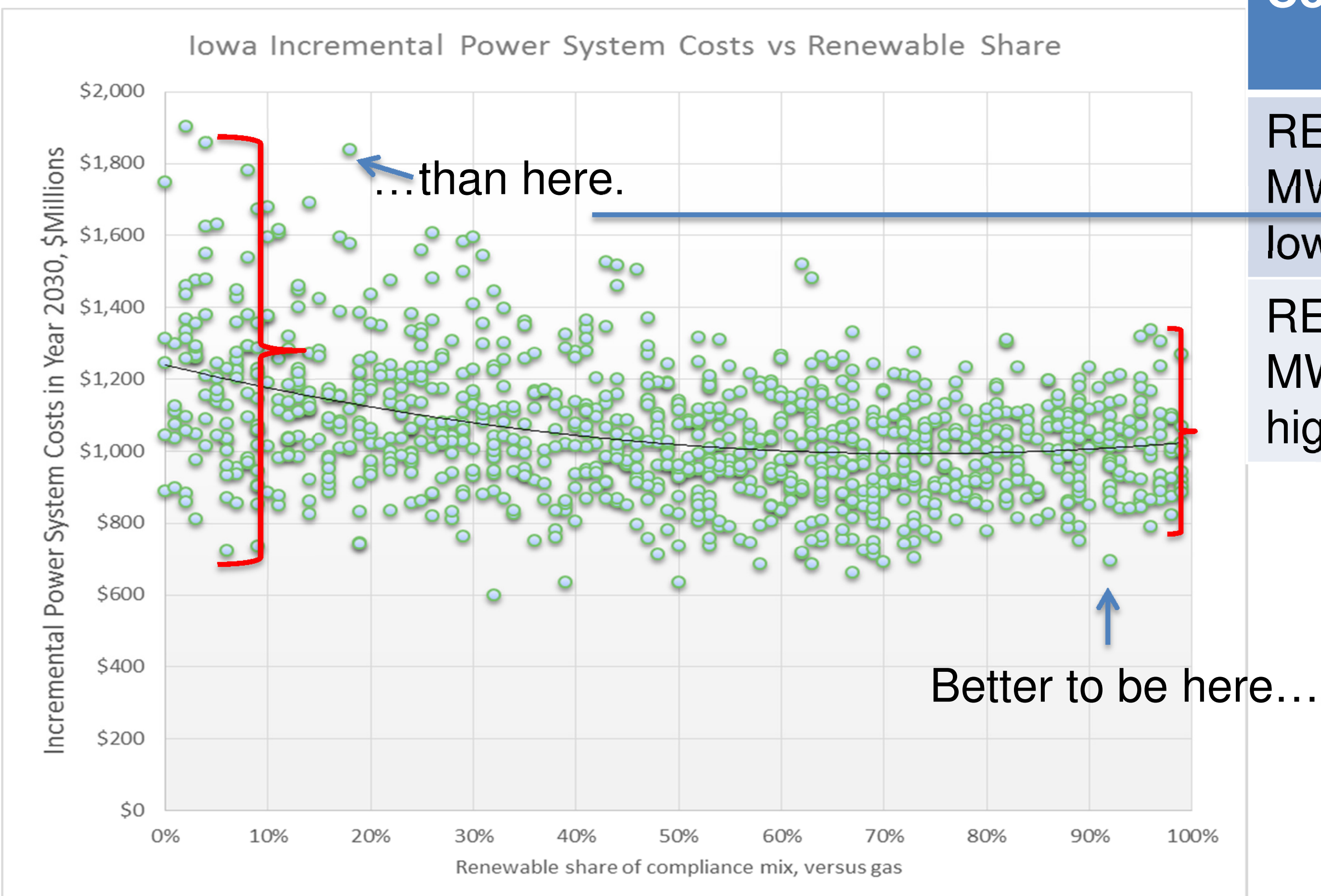
The CPP CORE tool employs Monte Carlo simulations to evaluate power system costs and risks associated with various compliance strategies. This allows the user to assess risk from volatile fuel prices and other factors under each compliance solution to determine the optimal strategy. For each run, the tool performs a Monte Carlo simulation using 1,000 random sets of inputs for natural gas prices, coal prices, and load growth.

CPP CORE: Wind reduces Iowa's cost and risk



Wind always reduces fuel price risk

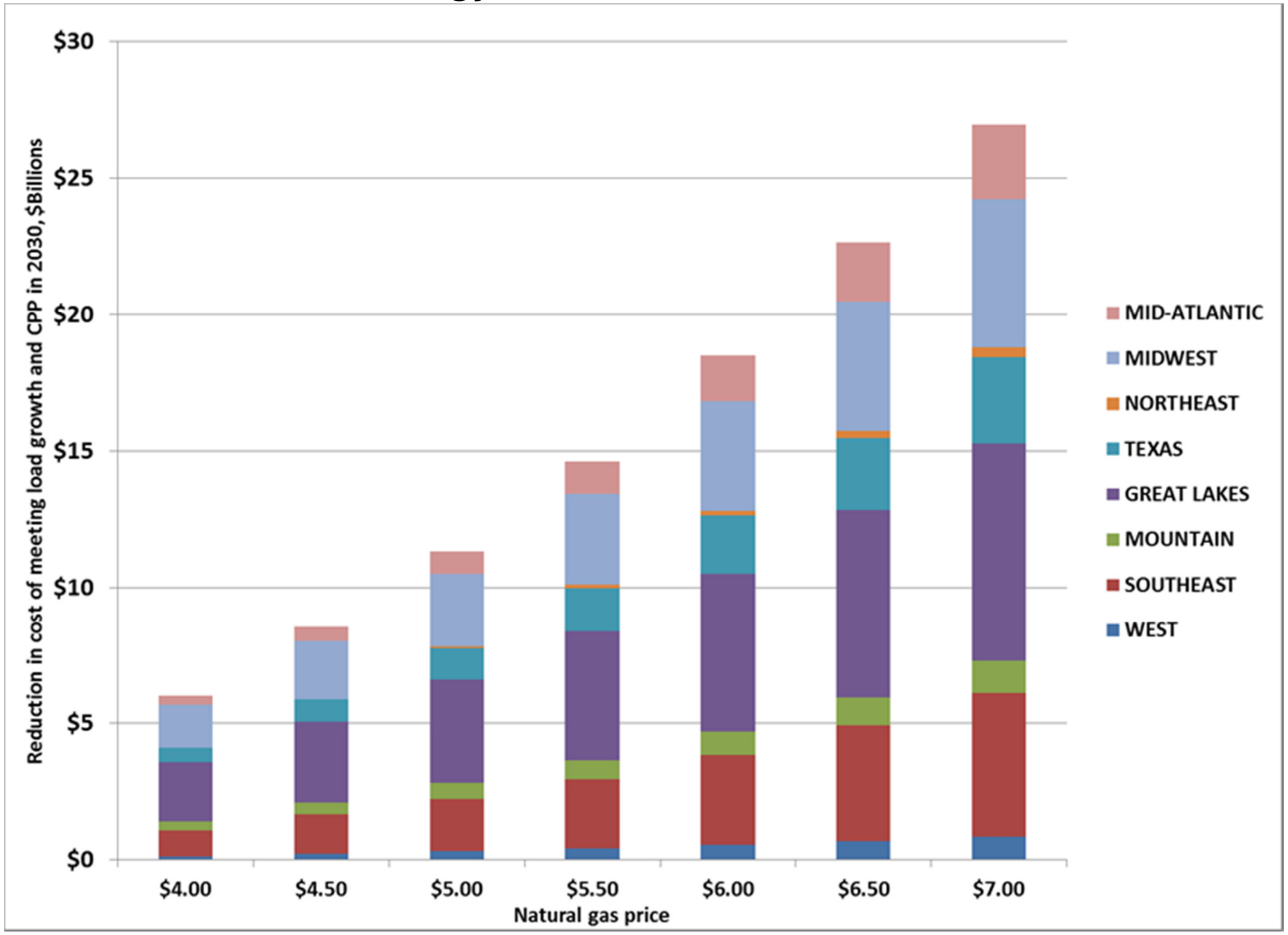
In this example, gas prices reduced $1.50/MMBtu below DOE projection



Cost	Gas $ low	Gas $ high
RE MW low	Low	High
RE MW high	Low	Low

"No regrets" at low gas prices, consumer benefits increase at higher gas prices

Reduction in cost with optimal level of renewable energy versus no renewable energy, in billions of annual dollars in 2030



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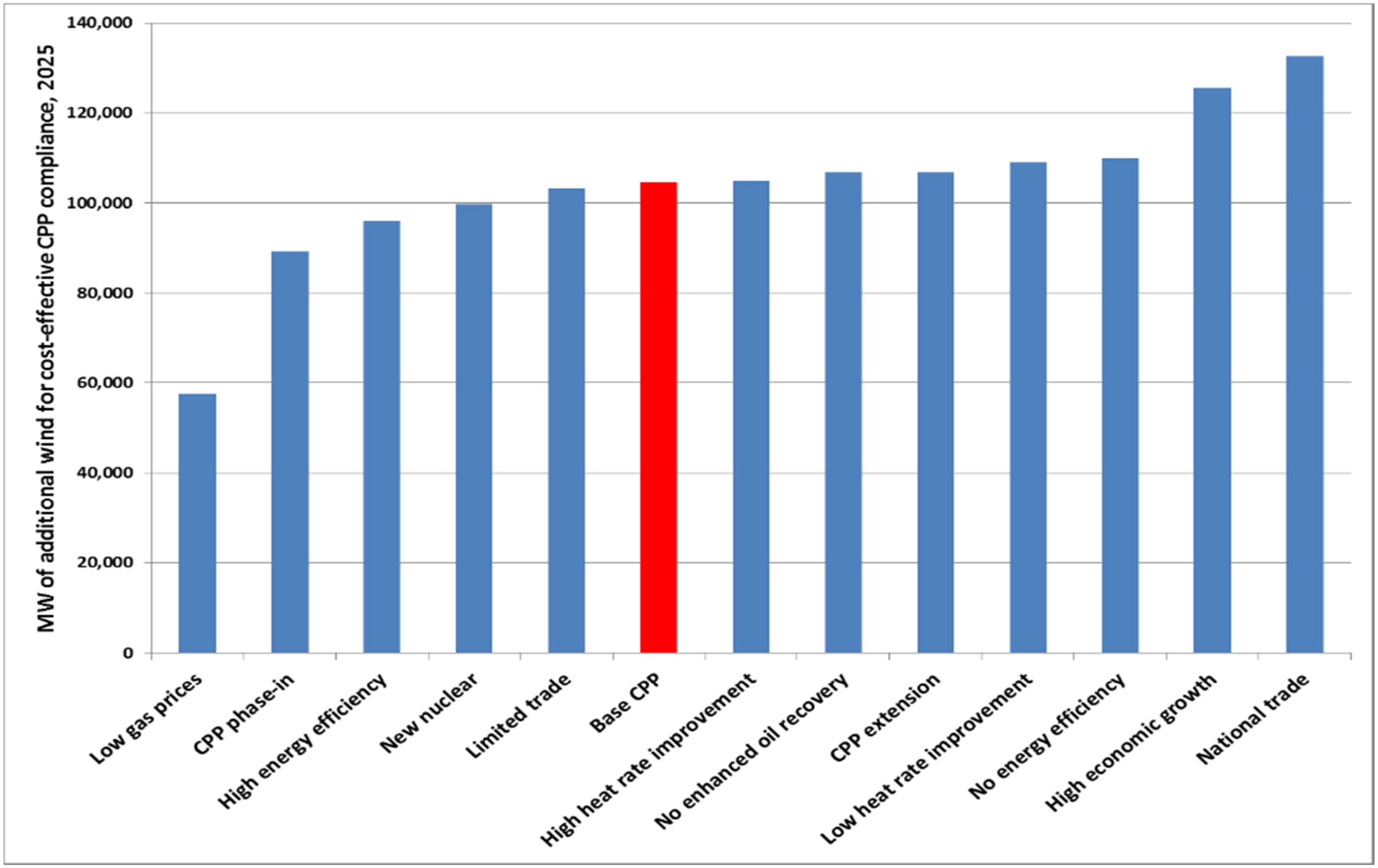
Default assumptions used in CPP CORE model

Green = uncertainty range

Variable	Input	Source
Wind cost	Due to assumed use of national credits for CPP compliance, all regions have access to lowest-cost wind in the Interior region; the model uses the Wind Vision mid case cost numbers for the Interior region in 2026 for all regions	DOE Wind Vision
Average Henry Hub gas price over 2022-2030	$5.50/MMBtu Henry Hub (2013$) plus AEO adders for regional delivered gas cost; +/- $1	DOE AEO 2015
Energy efficiency realized	5% cumulative savings by 2030	Assumption used by NERC and other analysts
Load growth before energy efficiency	15.9% from 2012 to 2030, 14.4% after EPA's projected CPP price increase drives reduced demand; +/- 3% load growth	AEO 2015
Cost of exceeding gas combined cycle capacity factor ceiling	-Under CPP new source complement, ~$10/MWh at 70% cf, representing levelized capital cost of new gas CC capacity -Under existing source CPP, ~$25/MWh, per EPA's calculation of incremental cost of out-of-merit order commitment and dispatch from taking gas CCs from 70% CF to 75% CF	-Half EIA cost of capacity, based on assumption that other half is recovered by providing capacity or ancillary services -EPA Proposed rule TSD
Gas CC capacity factor ceiling	70% of nameplate, ~75% of net summer capability	EPA
Coal heat rate improvement attained	National average of 3.86%, higher in East and lower in West and ERCOT	EPA's updated assumptions in final rule
Wind supply curve slope	$10/MWh increase for wind meeting 100% of incremental demand	Approximate slope of wind supply curve in Wind Vision
Coal prices	AEO 2015 regional projection for 2022-2030 average delivered coal price to electric sector; +/- 5%	AEO 2015
Wind's market share of total renewable energy demand	40% in CA; 50% in SE, SW, and HI; 70% elsewhere	Conservative assumption relative to EIA and Navigant CPP proposed rule analyses, which show wind capturing 75-80% of total RE market share under CPP

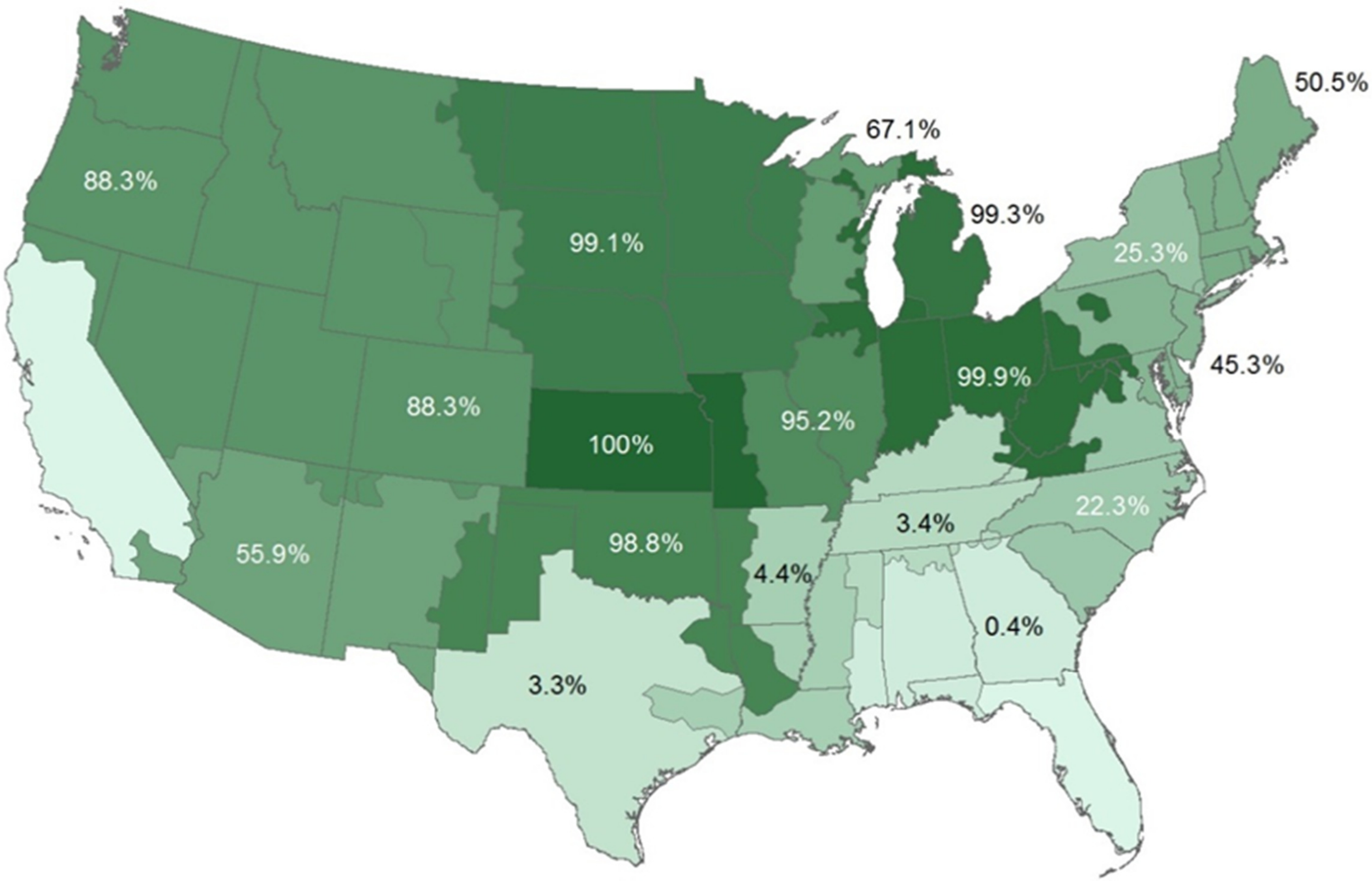
CPP CORE findings consistent with other analyses

EIA May 2015 analysis of proposed CPP finds wind is lowest-cost solution in nearly all scenarios. The final CPP has more aggressive targets, so the wind demand would likely be higher.

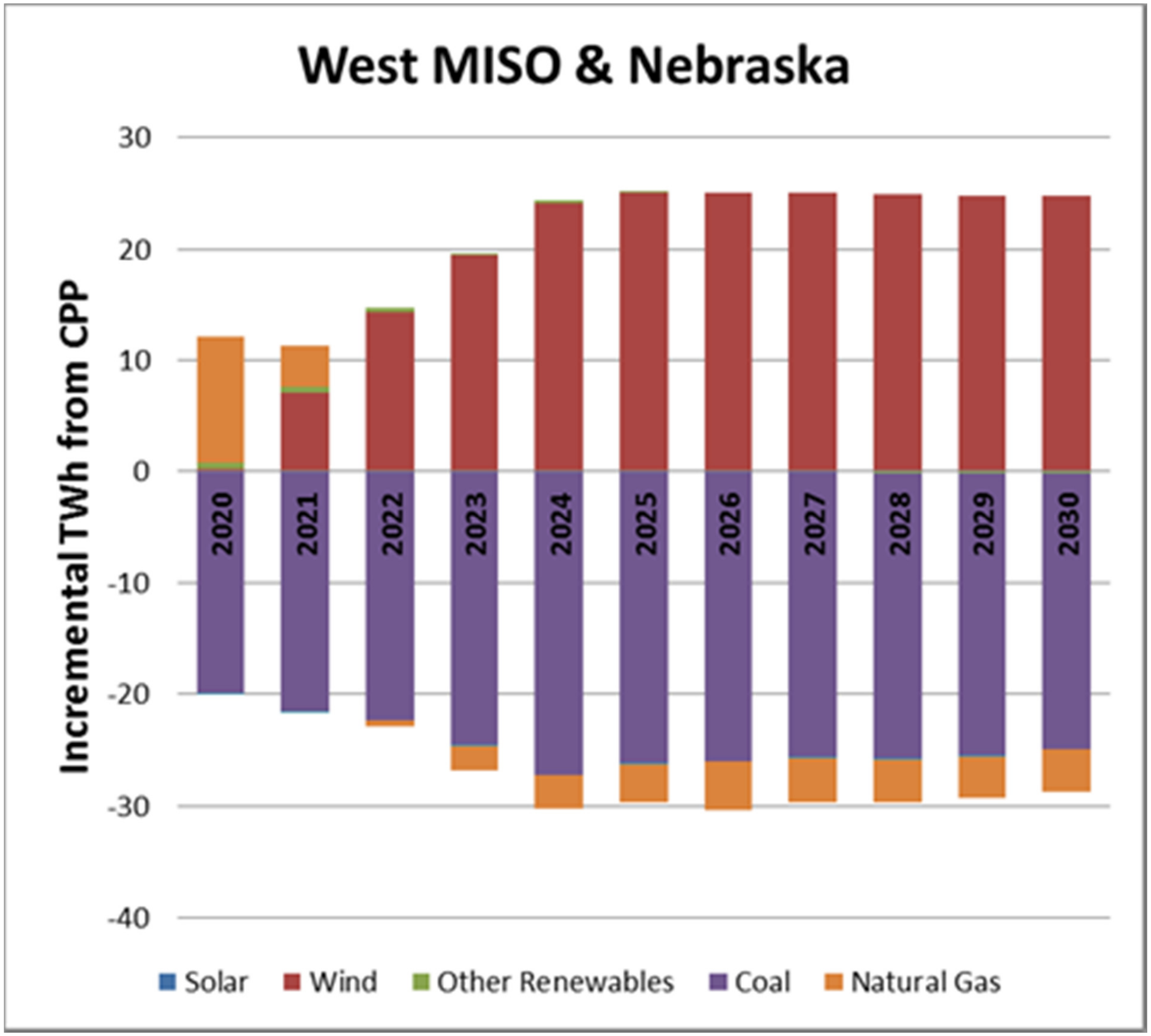


EIA: Wind is the low-cost CPP compliance solution for Western MISO

Wind's share of total generation increase under EIA's optimal compliance mix, by region

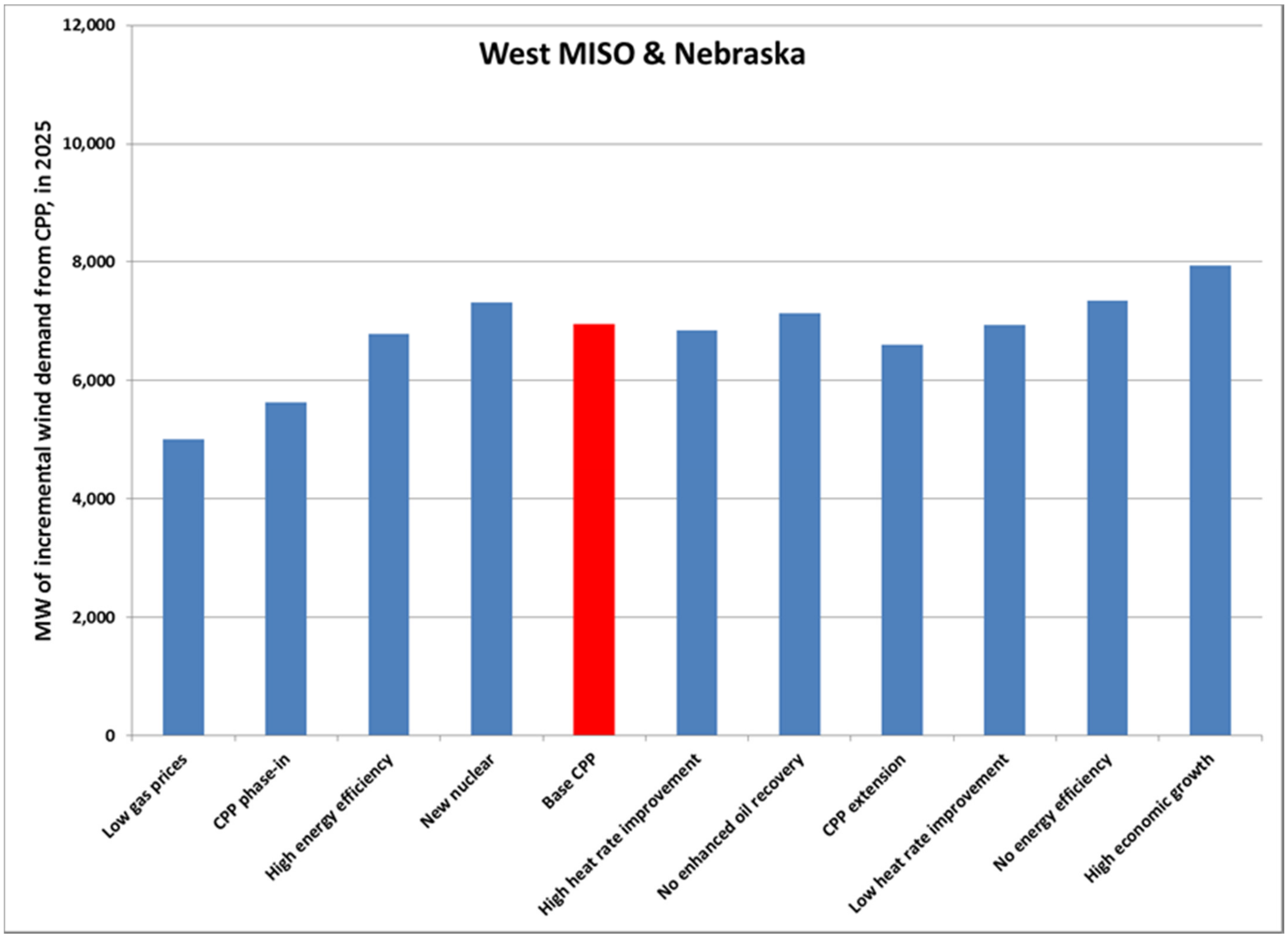


EIA: Wind is majority of optimal compliance solution in Western MISO

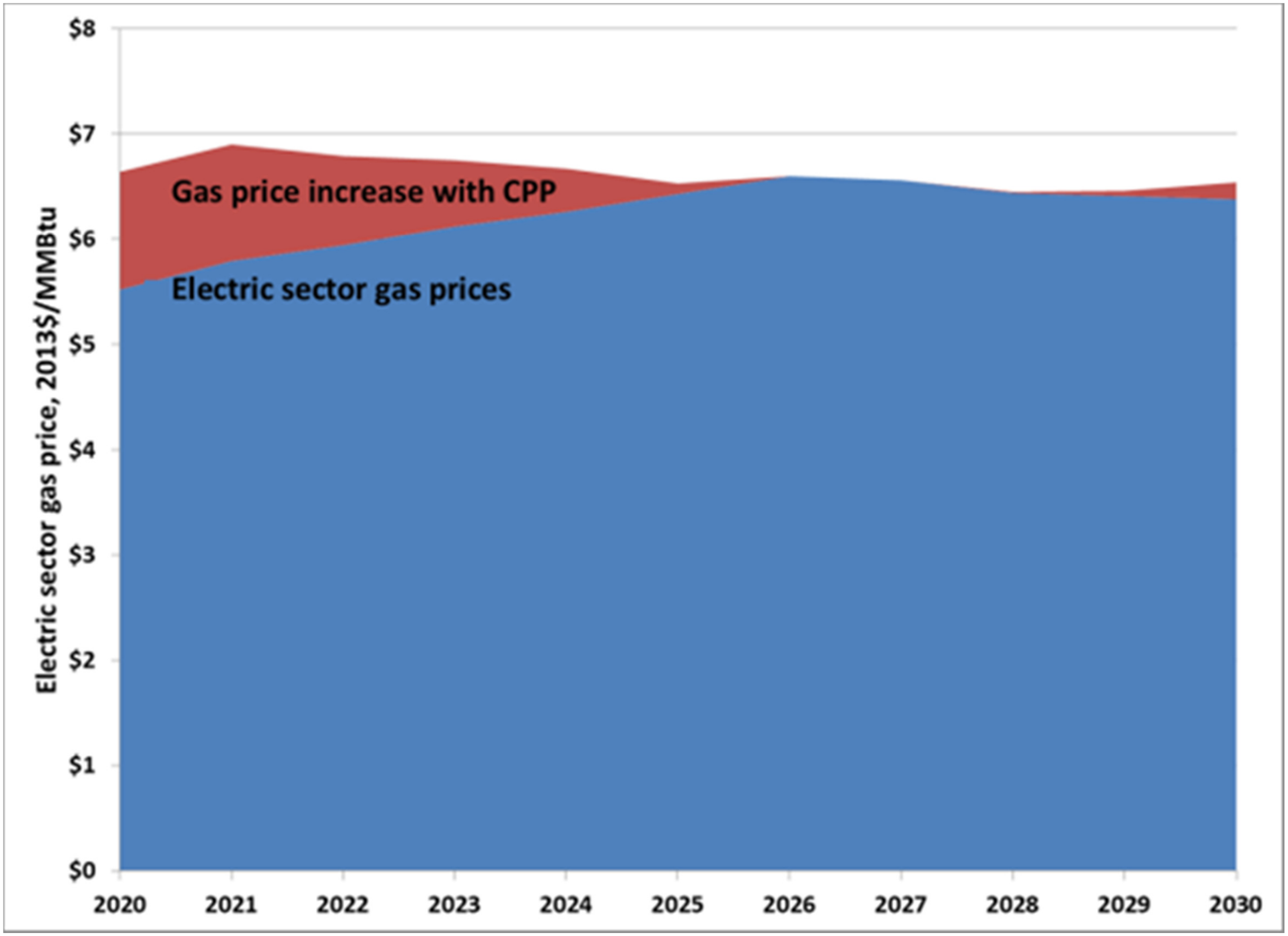


EIA finds wind is “no regrets” strategy for Iowa

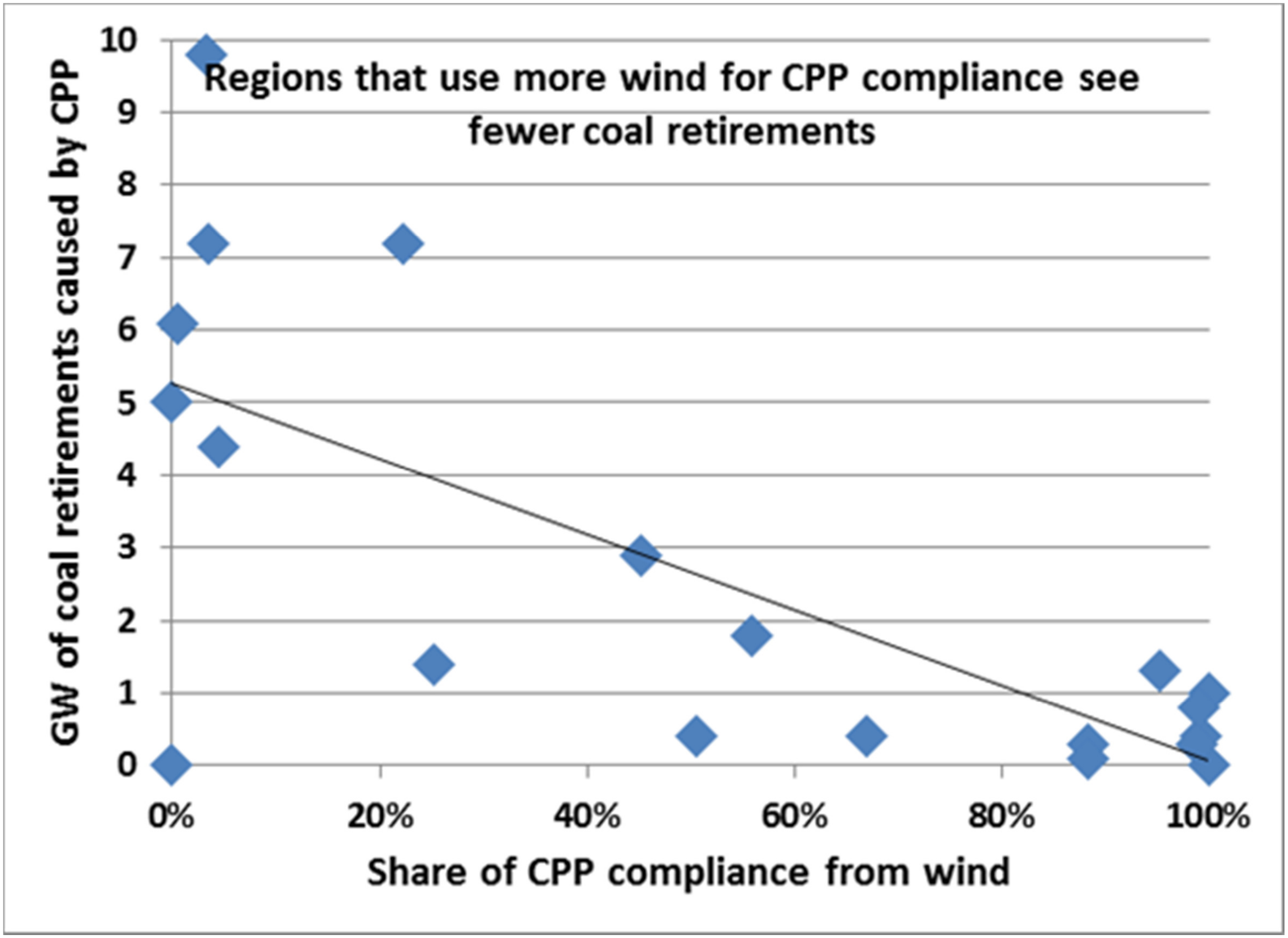
The final CPP has more aggressive targets, so the wind demand under the Final Rule would likely be higher.



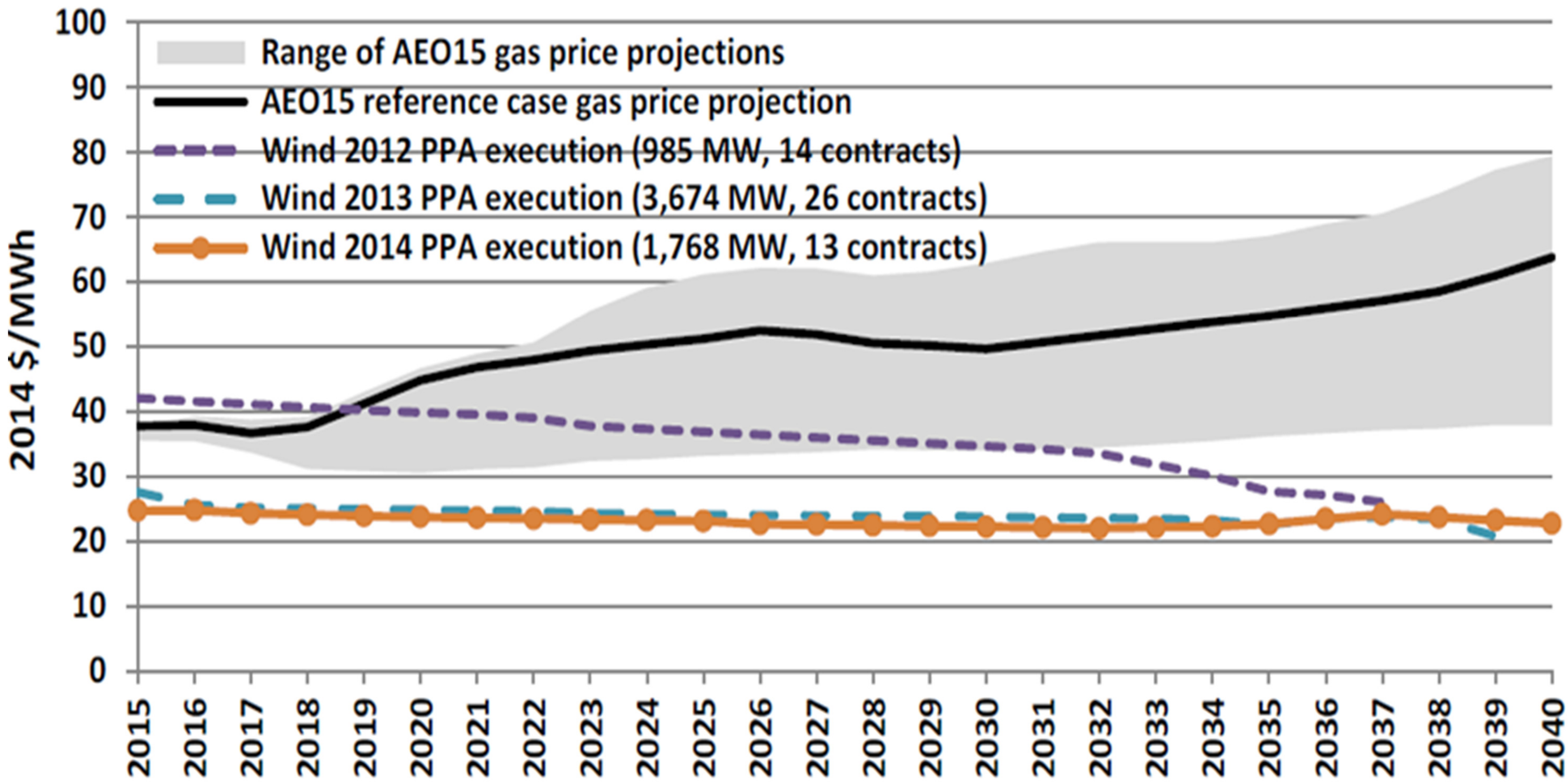
Wind energy moderates spike in gas prices from CPP demand



Zero-emission wind energy provides states with compliance flexibility



DOE: Current wind price below future gas costs



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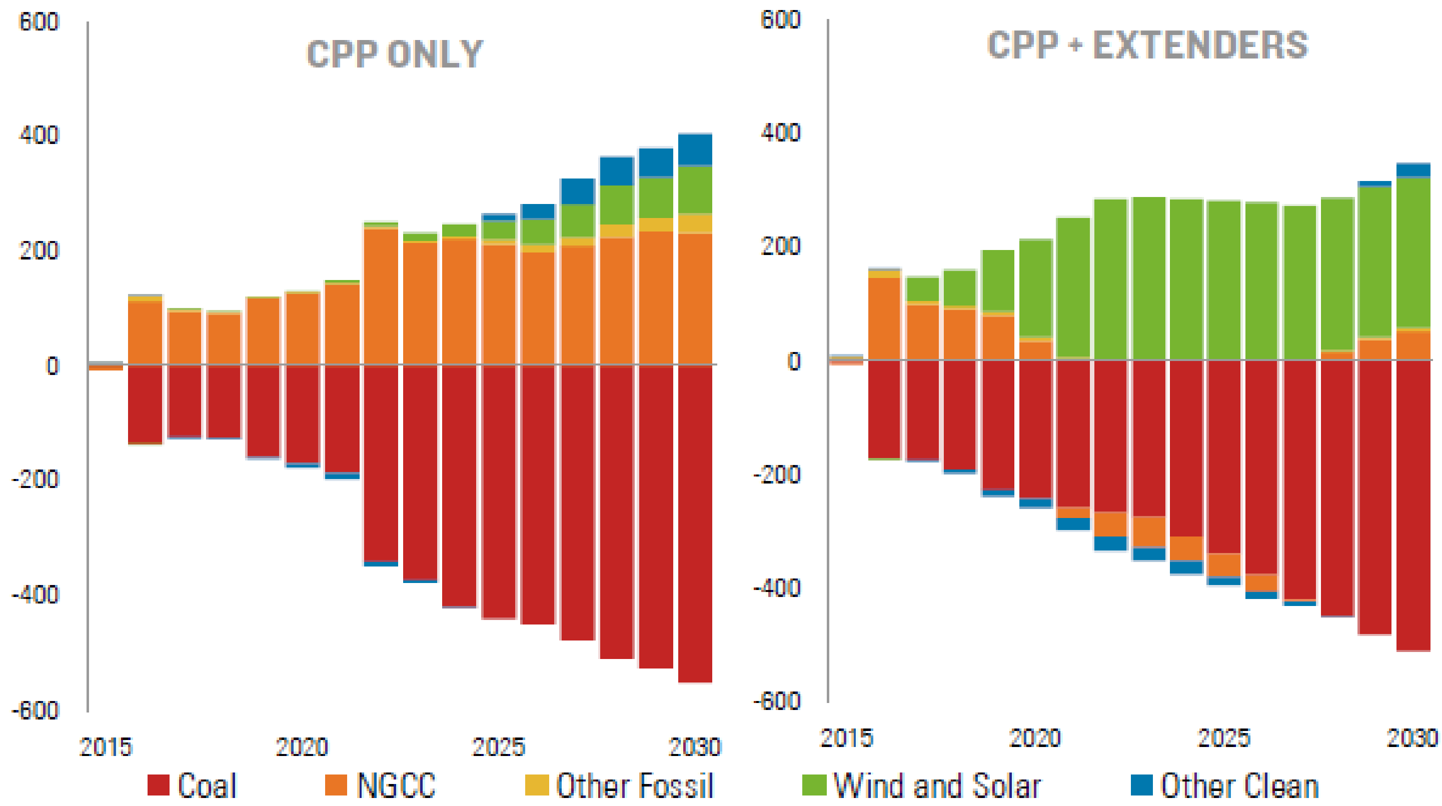
New analysis using DOE model: Wind+PTC winning strategy for CPP Compliance

Figure 1: Change in generation from AEO2015 reference case, 2015-2030

TWH



Source: Rhodium Group analysis. Note: "Wind and Solar" includes utility-scale generation only. "Other Fossil" includes combustion turbines, oil/gas steam, and carbon capture equipped units. "Other Clean" includes nuclear, hydro, and biomass.

Allowance allocation under existing source mass-based

Known as an "updating" or "output-based" allocation, this approach incentivizes recipients to generate electricity, which can be used to incentivize behavior that reduces electricity prices and emissions. In contrast, allocating based on historical generation or emissions provides no marginal incentive, as it is impossible to change behavior that has occurred in the past.

This allocation is most effective when all allowances are used to incentivize generation from existing low-emitting and new non-emitting resources, as this helps to reduce carbon emissions and therefore carbon prices and consumer costs. Key principles for this allocation strategy are:

- To achieve maximum benefits, most if not all allowances should be awarded to existing low-emitting and new non-emitting resources.
- Allowances should be allocated in inverse proportion to the emissions rate of a resource to incentivize the maximum emissions reductions, resulting in the lowest carbon prices and consumer costs.
- An allocation to existing non-emitting resources is typically inefficient as it does not lead to additional generation from those resources.

Benefits of updating allocation

-**Reduces electricity and carbon costs for ratepayers.** Using allowance allocation to incentivize generation reduces electricity prices, particularly if the allocation is tied allocation is tied to emissions as that keeps allowance prices low. This in turn turn minimizes the impact to ratepayers and reduces the risk of leakage.

-**Drives in-state benefits including economic development.** Allowances are likely to be allocated to resources within a state, ensuring that the value of those allowances, allowances, the investment they drive, and the electricity cost and emission emission reductions they drive are located in that state.

-**Proceeds used to keep electricity costs low instead of flowing to the government under an auction.** This avoids several potential problems, including revenues potentially being used for inefficient purposes and, in many states, the need to pass authorizing authorizing legislation.

-**Provides allowances to entities that need them for compliance.** Utilities and generation owners that have taken steps to reduce emissions receive the allowances they need they need for compliance, achieving the same goal used to justify an historic historic allocation.

-**Meets requirement to control leakage.** Leakage occurs when un-regulated new fossil generators compete against regulated facilities, creating an uneven playing field and playing field and significant market distortion that harms both ratepayers and and market participants. A state that fails to control leakage is taking significant significant regulatory risk and the risk of stranded assets on the bet that EPA will EPA will approve the state plan and that EPA will not revisit the CPP rule in the future, the future, as statute directs it to at least every eight years if not sooner.