



EPA's Clean Power Plan

Summary of IPM Modeling Results: Iowa 111(d) Stakeholder Meeting

MARCH 22, 2016

DRAFT PRELIMINARY MODEL RESULTS – For Discussion Only

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Christopher Van Atten
Senior Vice President
vanatten@mjbradley.com

MJB & A

Summary

- **Six IPM Model Runs:** 2 Reference Cases, 3 Mass-Based (E+N), 1 Rate-Based
- Rate and Mass produced very similar outcomes in terms of emissions and generation fuel mix in Iowa and the MISO region.
- Allowance/ERC prices were modest across the four policy cases due in part to the added renewable capacity additions in response to the PTC/ITC extension.
- Across the cases, CO_2 emissions in Iowa are reduced by between 7% and 15% from 2015 levels by 2030.
- Iowa is projected to remain a net exporter of electricity as wind capacity increases to about 8 GW; further capacity additions would allow Iowa to further expand its export margin.
- Relative to the reference case, retail bills are projected to be lower across the policy cases due to a combination of lower fuel costs, lower average consumption due to energy efficiency investments, and higher exports. Allowance value could be used to further mitigate potential rate impacts under a mass-based program.

Major Changes from Prior Model Runs

- **Natural Gas Prices:** Gas prices are lower than prior round of analysis. The gas supply curve that we used is derived from the average of the AEO 2015 Reference Case and the AEO 2015 High Gas Resource Case (Henry Hub Gas Price). Basis differentials were derived from ICF's Integrated Gas Module.
- **ITC/PTC Extension:** On December 18, 2015, Congress passed extensions to the investment tax credit (ITC) and production tax credit (PTC) for renewable energy projects. With the addition of these extensions, total U.S. Wind capacity in the Reference Case increases by about 50 GW from 2015 to a total of 127.5 GW in 2020, vs. the prior Reference Case of 103.6 GW by 2020. Utility-scale solar capacity more than doubles from 2015 levels to a total of 35.9 GW in the updated runs vs. 26.9 GW in the prior Reference Case.
- **Energy Efficiency Assumptions:** We continue to model a range of energy efficiency levels (current, modest, and significant), but we modified our approach to "modest" case for some states. In the revised "modest" approach, states that are already achieving annual savings levels greater than 1% (of prior-year sales) maintain their historic (2013) savings levels.

- **We continue to refine our renewables assumptions, which may alter the level and timing of renewable energy builds across all of the cases.**

Scenarios Evaluated: Integrated Planning Model (IPM®)

Mass-Based Scenarios

Code	Regulatory Approach	Level of Energy Efficiency	Trading Zones
E+N, Current EE	Mass-Based (Existing + New)	Current EE	**Nationwide trading** (except California; RGGI trades with other states)
E+N, EE1%	Mass-Based (Existing + New)	Modest EE (1%)	**Nationwide trading** (except California; RGGI trades with other states)
E+N, EE2%	Mass-Based (Existing + New)	Significant EE (2%)	**Nationwide trading** (except California; RGGI trades with other states)

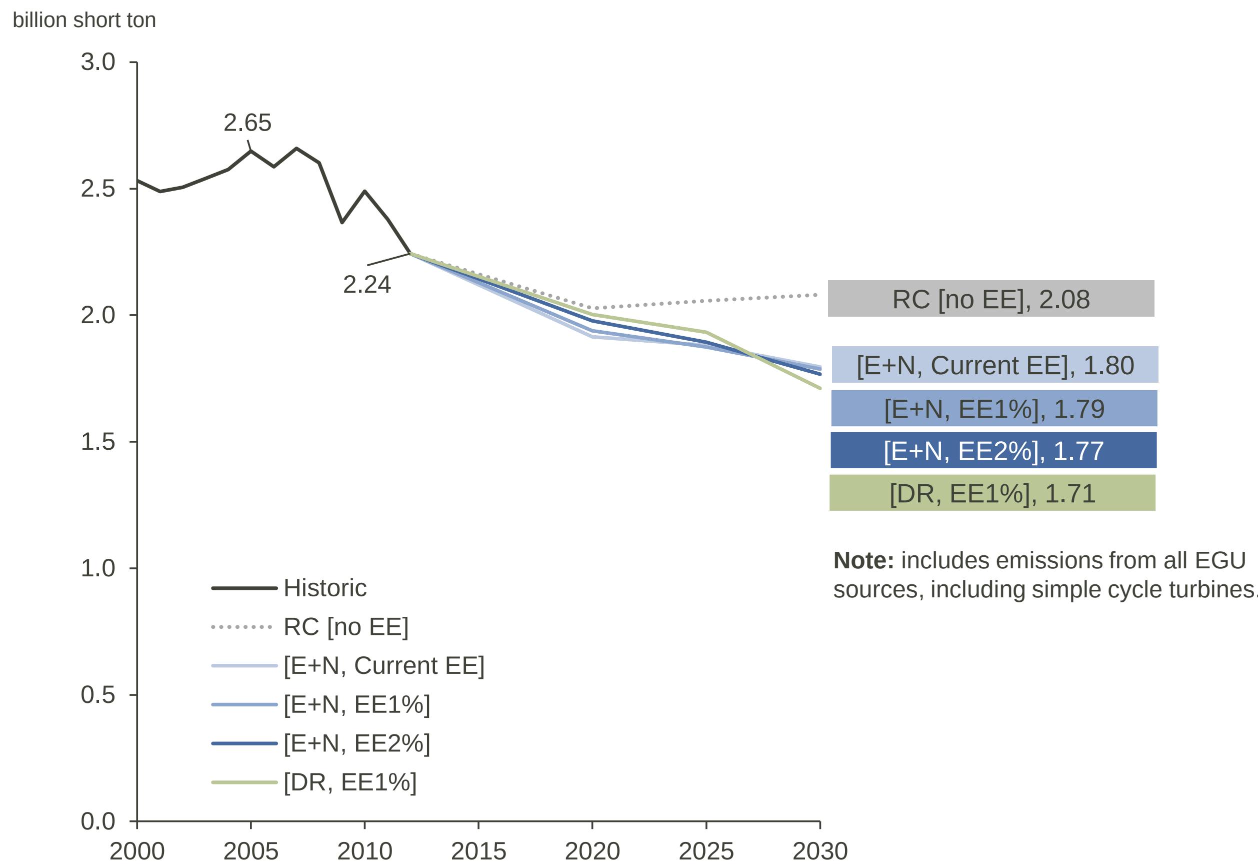
Subcategory-Specific Dual Rate Scenario

Code	Regulatory Approach	Level of Energy Efficiency	Trading Zones
DR, EE1%	Rate-Based (Dual Rate)	Modest EE (1%)	Nationwide trading of RE, EE, Nuclear, and GS-ERCs (except California and RGGI)

Total U.S.
Electric Sector CO_2 Emissions

All CPP policy cases produced similar levels of CO_2 emissions reductions (i.e., greater than 30% reduction from 2005 levels).

Historic and Projected CO_2 Emissions – **2000-2030**



Note: includes emissions from all EGU sources, including simple cycle turbines.

	% Change (2012-2030)
RC [no EE]	-7%
[E+N, Current EE]	-20%
[E+N, EE1%]	-20%
[E+N, EE2%]	-21%
[DR, EE1%]	-24%

Total U.S.
ERC/CO_2 Price

Allowance Prices **(2012$/ton)**

Description	2025	2030
[E+N, Current EE]	$0.00	$6.20
[E+N, EE1%]	$0.00	$3.33
[E+N, EE2%]	$0.00	$0.00

Note: All of these scenarios assume nationwide trading of allowances, except for California.

ERC Prices **(2012$/MWh)**

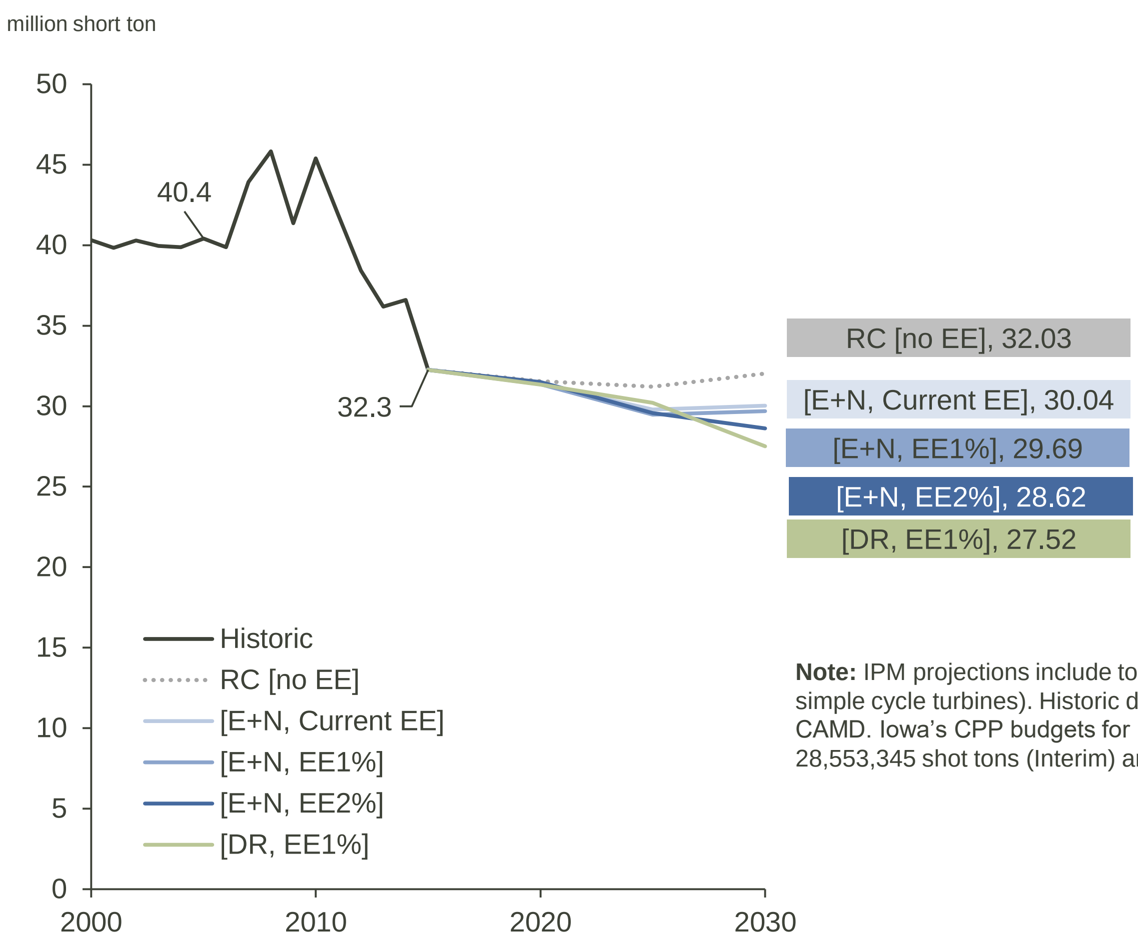
Description	2025	2030
[DR, EE1%]	$0.00	$15.67

Note: Nationwide trading of RE, EE, Nuclear, and GS-ERCs (except California and RGGI).

Iowa and North Central Region Results

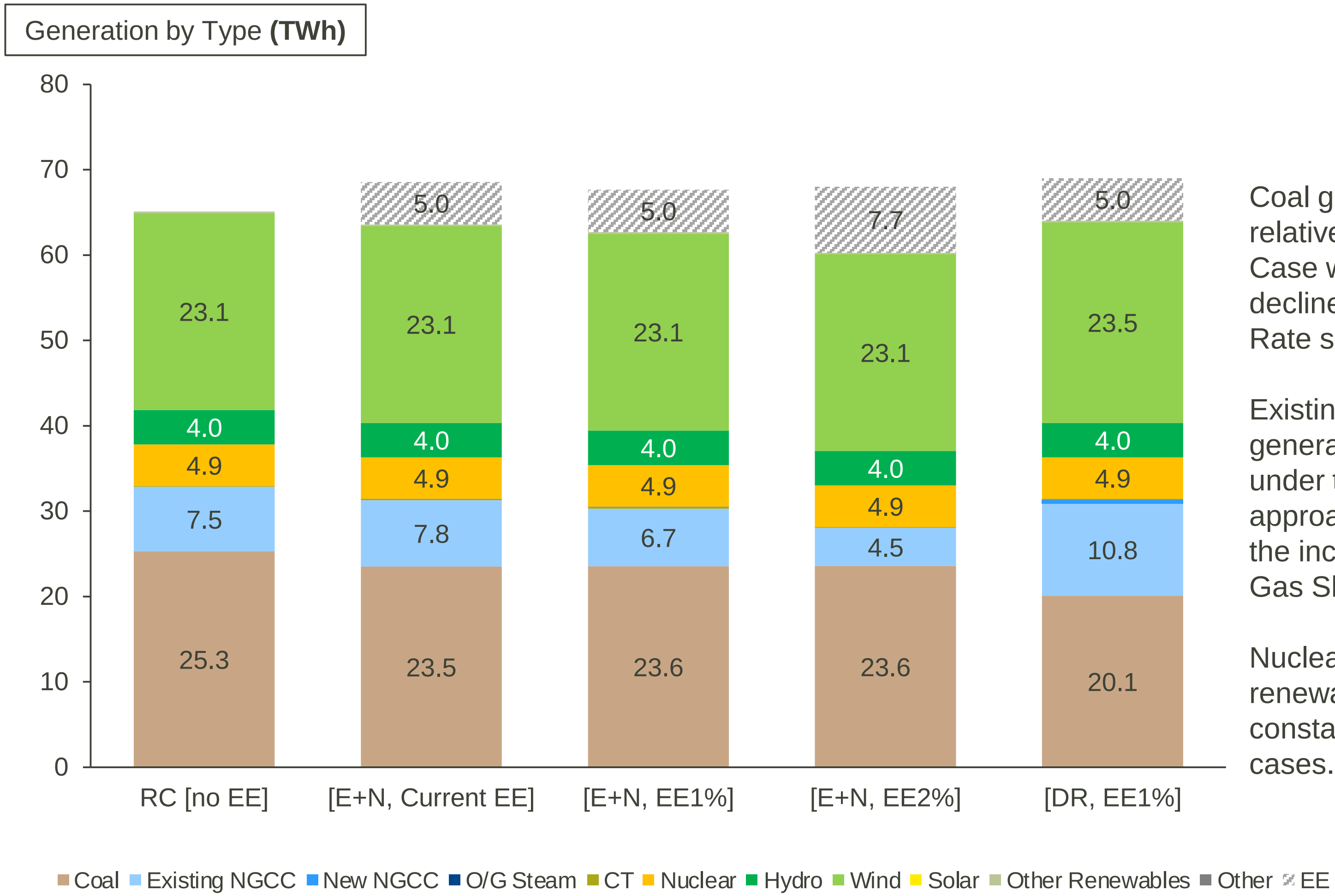
Iowa
Electric Sector CO_2 Emissions

Historic and Projected CO_2 Emissions – **2000-2030**



Note: IPM projections include total CO_2 emissions (e.g., including simple cycle turbines). Historic data from 2000-2015 from EPA's CAMD. Iowa's CPP budgets for New and Existing Sources are 28,553,345 shot tons (Interim) and 25,281,881 short tons (Final)

Iowa
Electricity Generation by Fuel Type: 2030



Coal generation declines relative to the Reference Case with the largest decline under the Dual Rate scenario.

Existing NGCC generation increases under the dual rate approach. This may be the incentive from the Gas Shift ERCs.

Nuclear, hydro, and renewable generation is constant across all of the cases.

Note: According to EIA, 2014 Retail Sales in Iowa were equal to 47,201,853 MWh

Iowa

Capacity Factor by Fuel Type: 2030

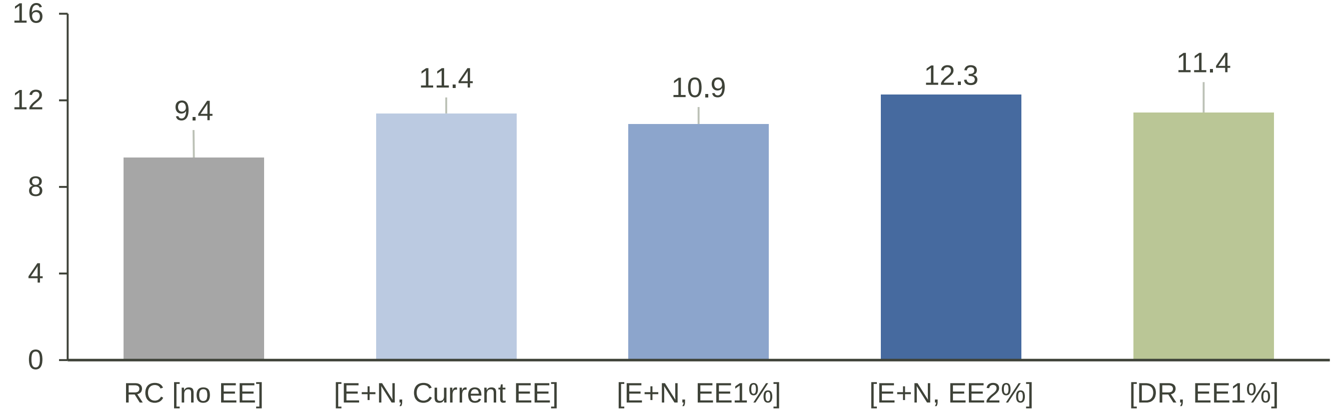
Scenario	Coal	NGCC
RC [no EE]	79%	48%
E+N, Current EE	77%	50%
E+N, EE1%	77%	43%
E+N, EE2%	76%	28%
DR, EE1%	63%	69%

- Across the mass-based scenarios, coal capacity factors are similar; NGCC capacity factors are lower with higher levels of energy efficiency.
- Dual rate scenario results in more coal-to-gas redispatch with lower average coal capacity factor and higher average NGCC capacity factor in 2030.

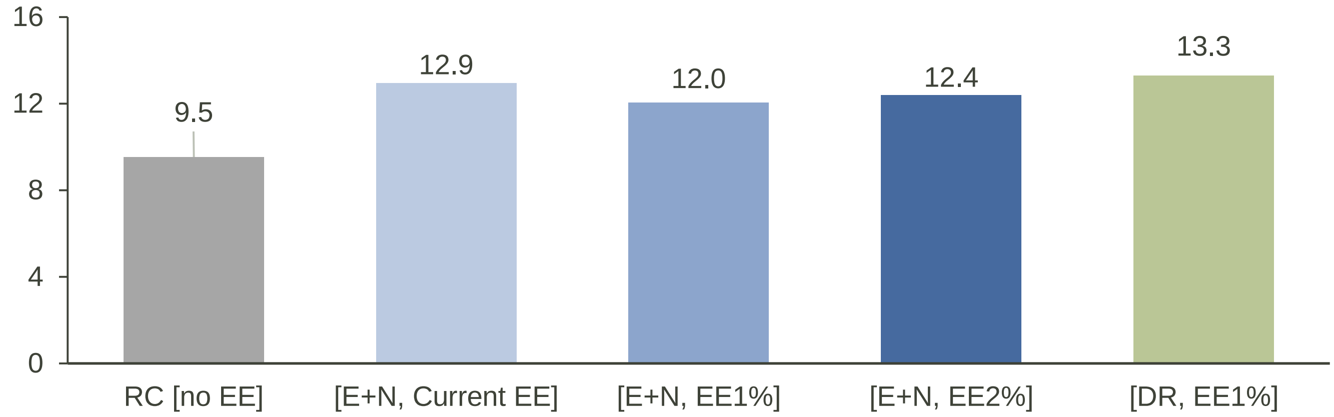
Net Exports (TWh)

Iowa remains a significant net exporter of electricity throughout the compliance period under both mass- and rate-based scenarios.

2025

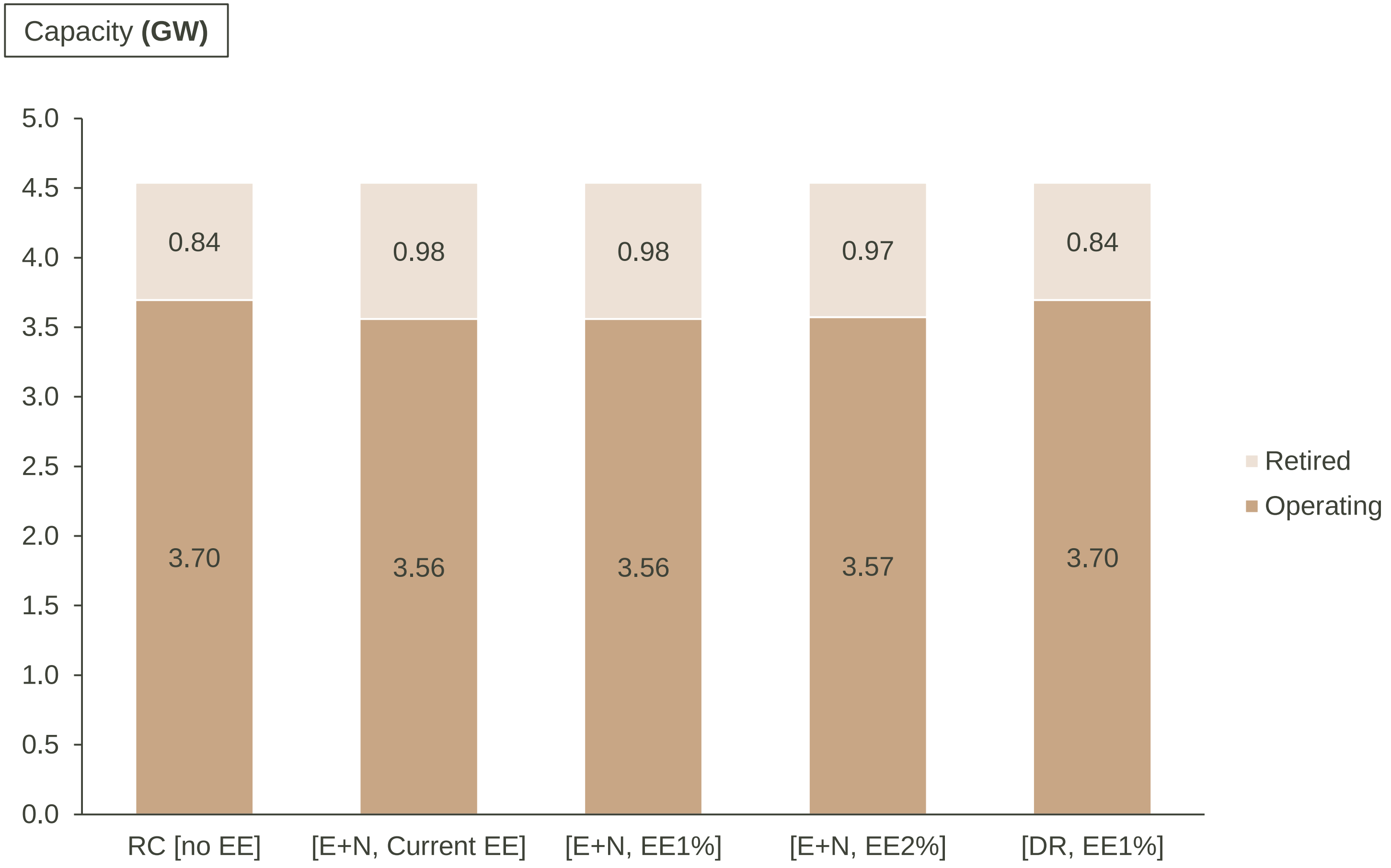


2030



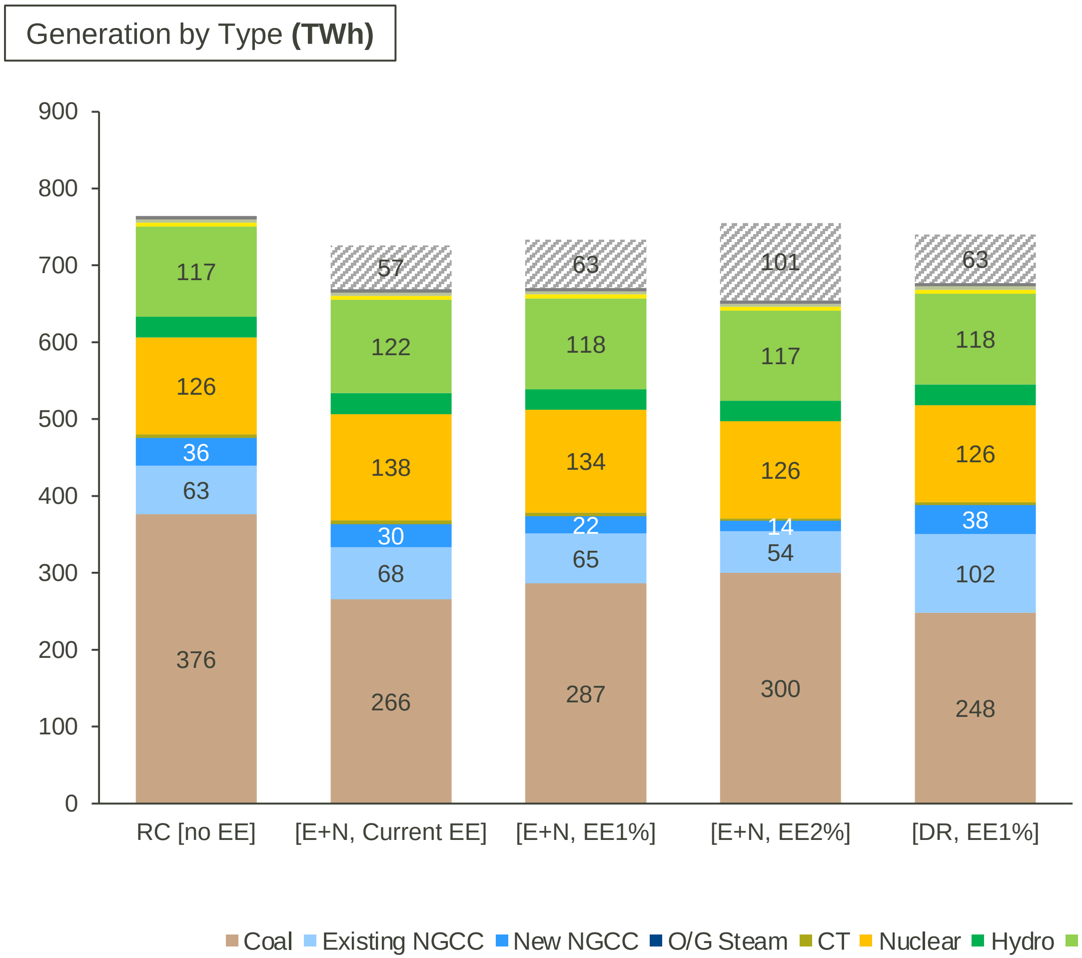
Coal Capacity: 2030

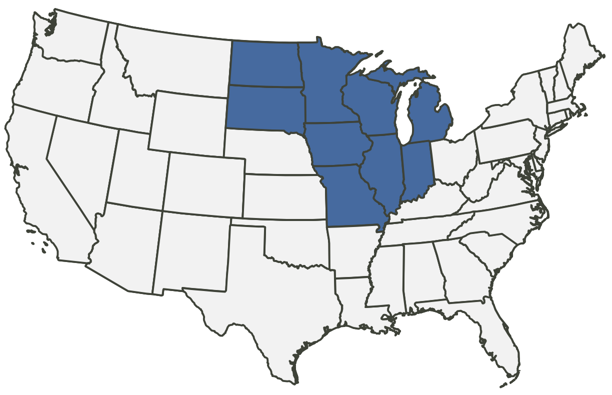
Projected coal retirements were similar to reference case levels across all scenarios.



Note: See appendix for further detail on Iowa firm builds and retirements.

North Central Region
Electricity Generation by Fuel Type: 2030





Like the Iowa results, natural gas generation was higher and coal generation was lower under the dual rate scenario.

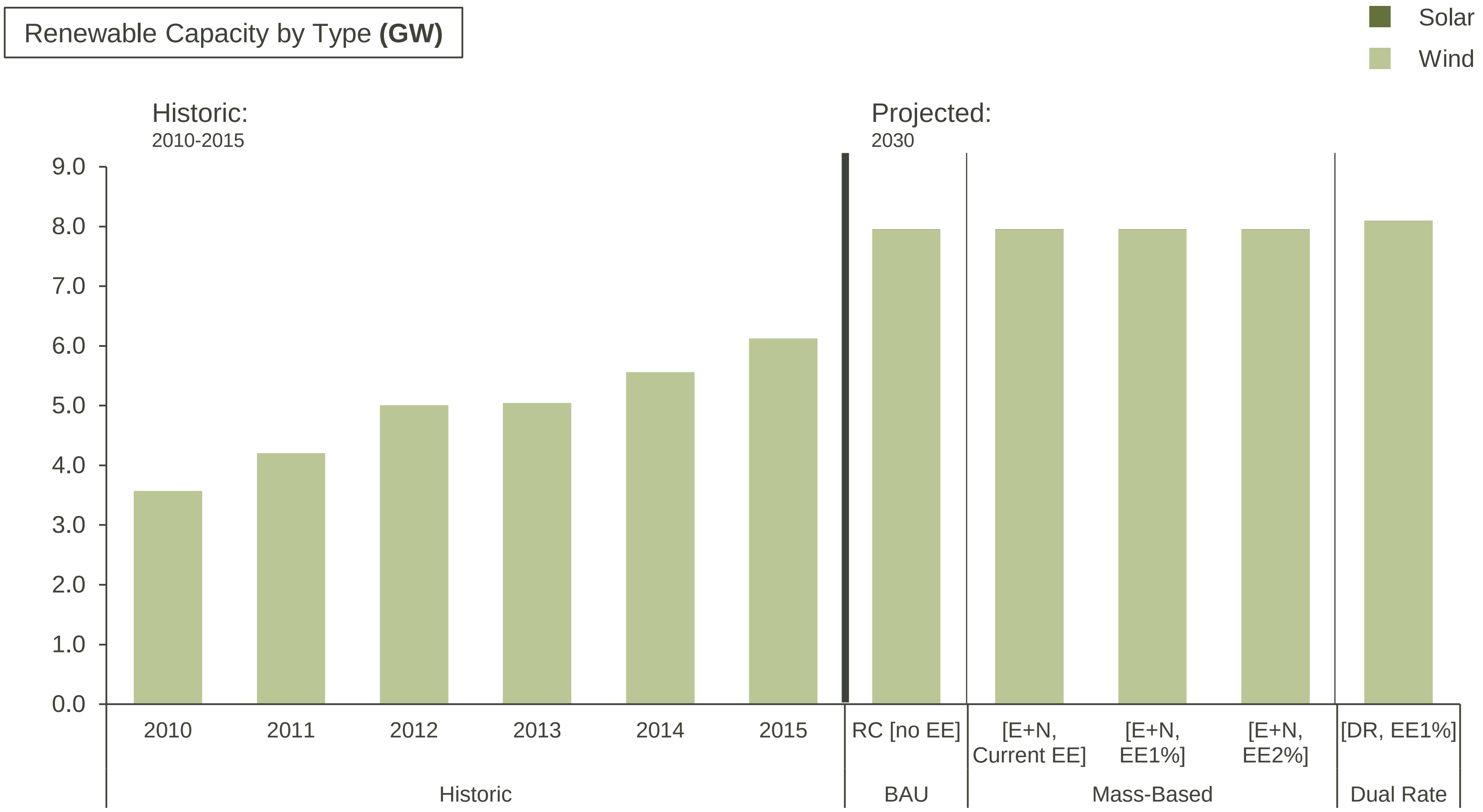
Higher levels of energy efficiency reduce gas generation. Coal generation increases as allowances prices moderate.

Otherwise the policy cases produced fairly similar outcomes in the North Central Region.

Note: Results for EPA MISO (North Central)

Iowa
Wind and Solar Capacity

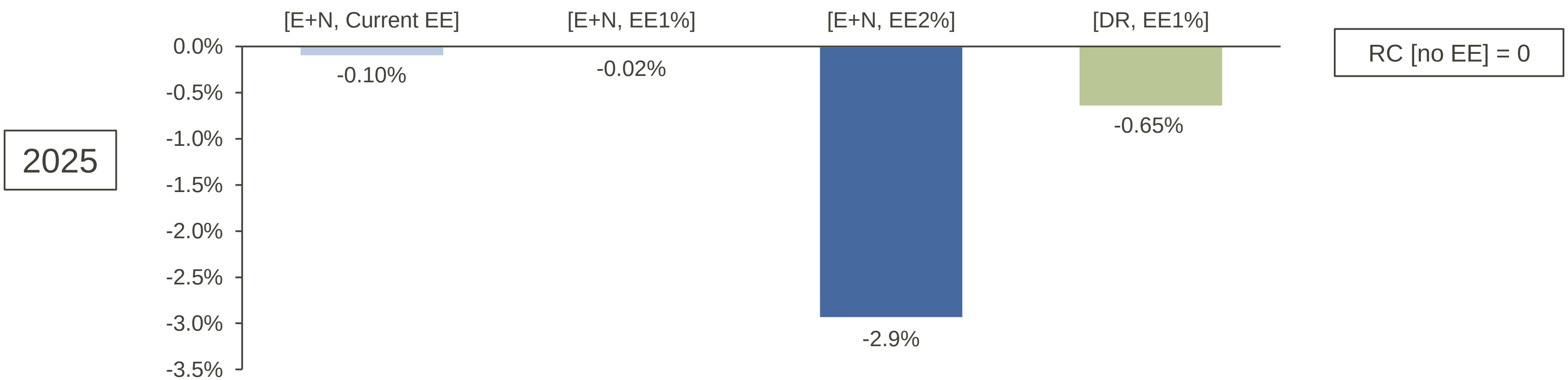
Projected wind builds are virtually identical across all cases.

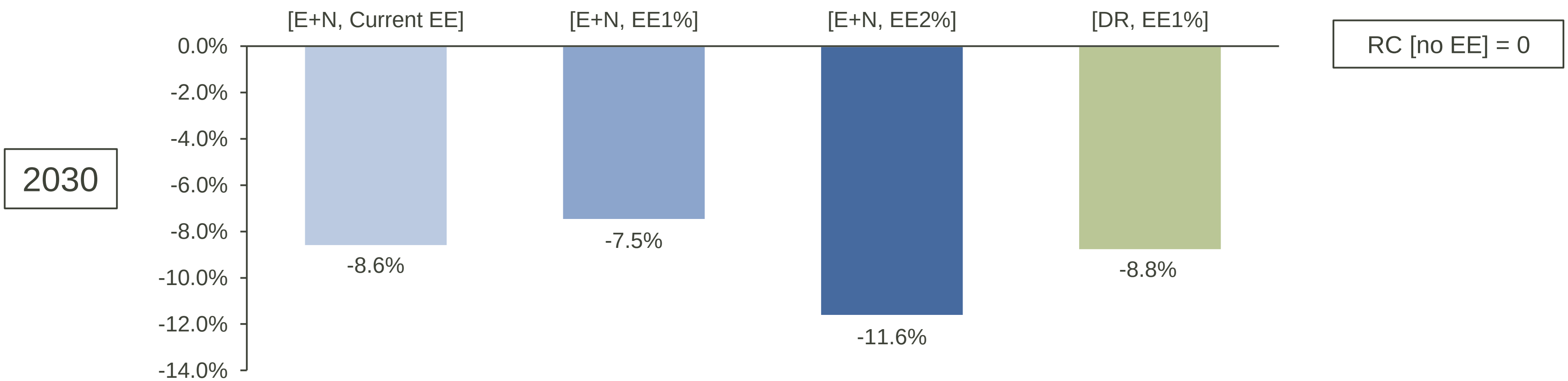


Notes: Solar capacity is utility-scale only. Historic data is from EIA 860 and Electric Power Monthly (for 2015 data through December).

Iowa Retail Bill Impacts (Relative to Reference Case)

Retail bill impacts are similar across rate and mass scenarios.





Retail Bill Analysis

- **Drivers of Bill savings in Iowa:**
  1. Reduced average household consumption
  2. Increased electricity exports
  3. Modest changes in wholesale electricity prices
  4. Reduced fuel and O&M costs
  5. Comparable capital investments between RC and Policy Cases
- Our **focus here is on bill impacts**. Even if retail rates were to stay flat or increase slightly, customers may end up paying less for electricity because of energy efficiency investments
- **Retail Rate Calculation Methodology –** Retail bill impacts were calculated based on the Retail Price Model developed by ICF International for EPA.

Efficiency, Consumption, and Bills

Annual Energy Savings (% of Retail Sales) in IPM Runs

Case	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CEE	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
1%	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
2%	1.18	1.38	1.58	1.78	1.98	2.00	2.00	2.00	2.00	2.00	2.00

In 2030, due to energy efficiency investments, the **average household saves:**

- **81.4 KWh a month** (977 KWh a year) in the 1% EE case
- **127.3 KWh a month** (1,528 KWh a year) in the 2% EE case

Note: These savings come from both energy efficiency measures taken in 2030, as well as from measures taken in earlier years that are still producing savings (e.g., installing an energy-efficient refrigerator in 2028 still produces energy savings for consumers in 2030).

Retail Cost Components Steady or Reduced Under CPP

Average Cost of Power Sales includes: fuel costs, variable operation and maintenance (VOM) costs, fixed operation and maintenance (FOM) costs, annualized capital costs, wholesale power costs for interregional transactions

2030 Costs Compared to Reference Case, No EE

Run	Fuel Costs ($Millions)	Firm Power Price ($/MWH)	Energy Exports (GWh)
MB, EN, CEE	-80	+2.09	+3,405
MB, EN, 1%	-120	-0.45	+2,507
MB, EN, 2%	-206	-4.52	+2,856
DR, 1%	-45	+1.44	+3,745

Energy efficiency savings result in higher next exports and lower fuel costs. Wholesale power prices are similar to reference case.

MJB&A Compliance Tool Scenario: 10 GW Wind

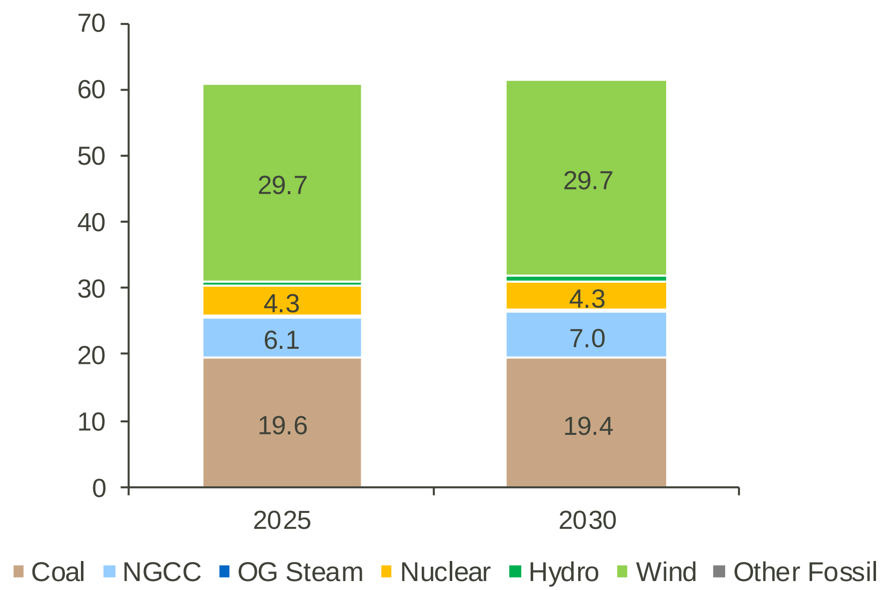
Assumptions:

- 10 GW of wind by 2020
- Average capacity factor for wind of 36%
- State meets EERS
- 800 MW of NGCC; added coal retirements – to align with IPM numbers

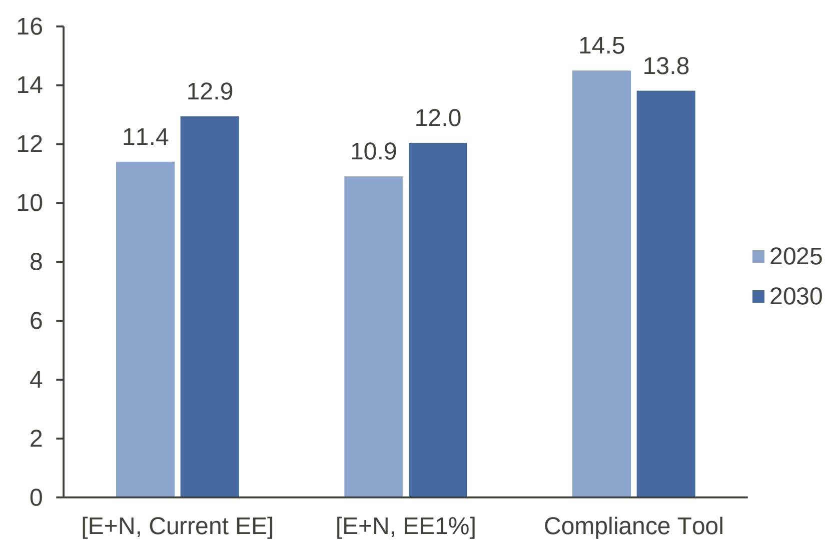
Net Allowance Position

	2025	2030
Net Allowance Position	3,561,300	5,515
Cumulative Allowances	17,686,652	25,683,465

Generation by Fuel Type **(TWh)**



Exports **(TWh)**



Appendix

Run Year Structure

Model Year:	Representative of Average for Years:
2020	2019-2022
2025	2023-2027
2030	2028-2033

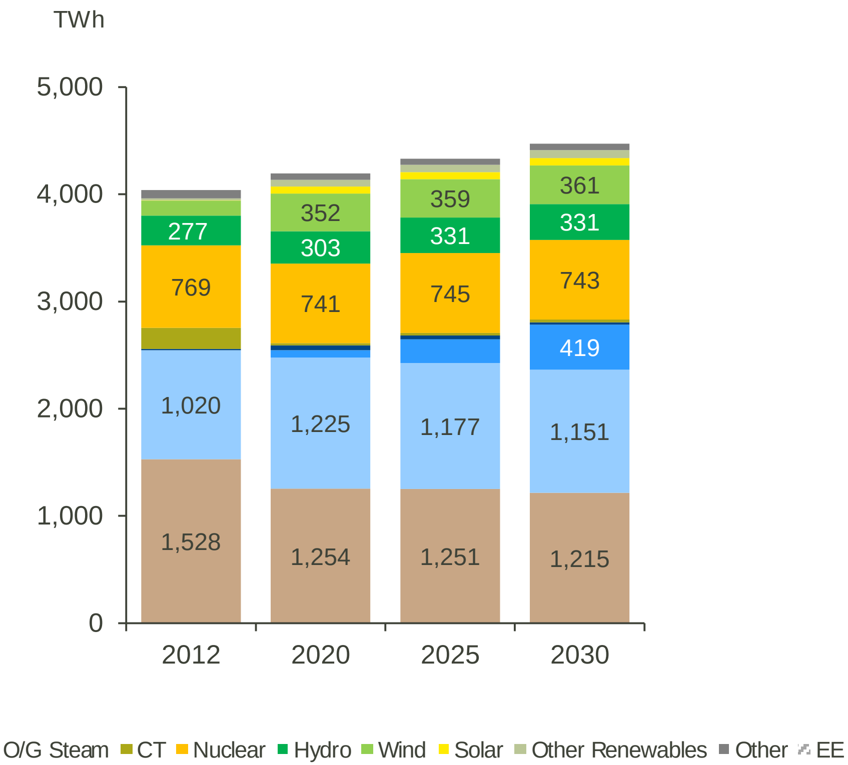
Note: throughout this presentation, when we refer to results in 2020, 2025, and 2030, we are referring to the model years above.

Total U.S.
Reference Case Highlights

Reference Case Highlights

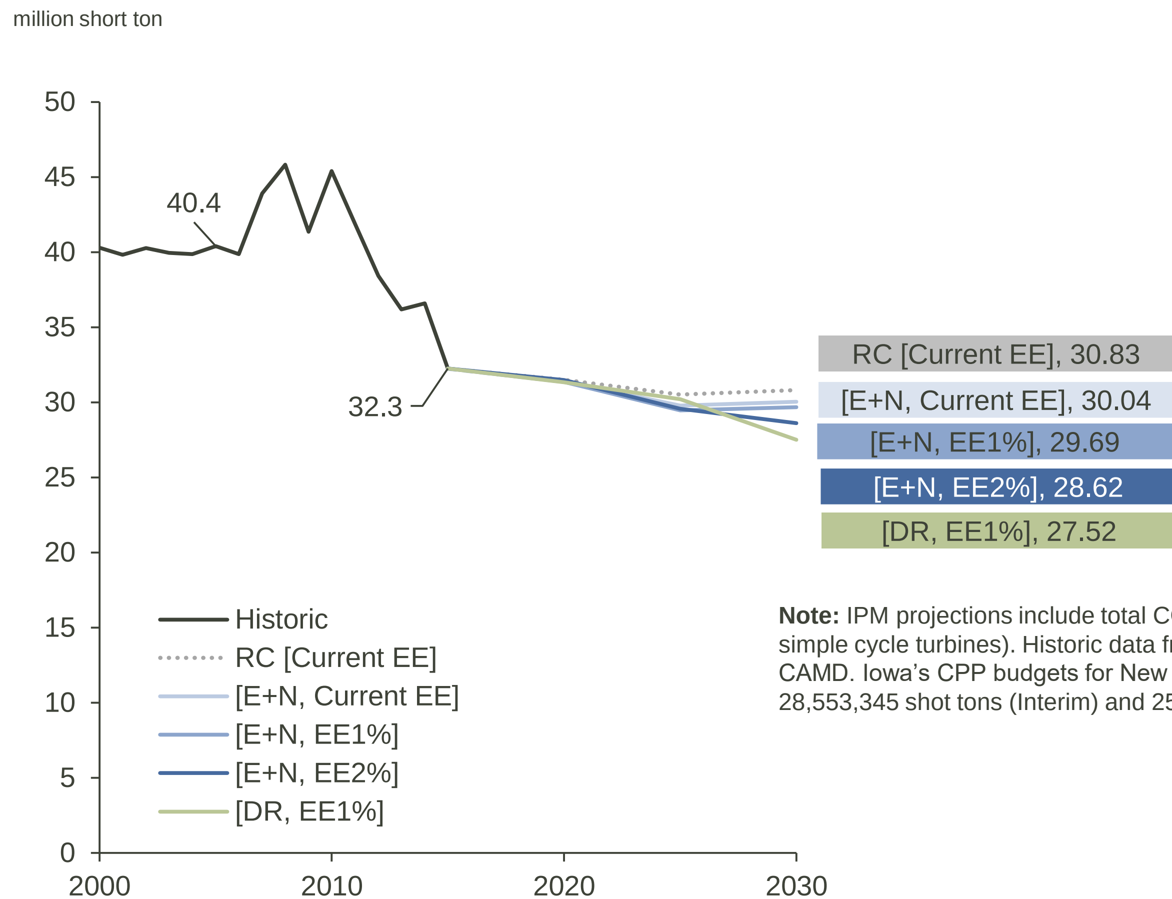
- Assumes existing power sector regulations (MATS, CSAPR, 316(b), AB 32, RGGI, state RPS)
- No Clean Power Plan
- AEO 2015 demand growth
- Henry Hub Gas price = $4.15 to $4.69 ($/MMBtu)
- PTC and ITC extension
- 82 GW of coal retirements by 2030 (after 2016)
- 11 GW of nuclear retirements by 2030 (after 2016)

Reference Case Generation – **2012-2030**



Iowa
Electric Sector CO_2 Emissions

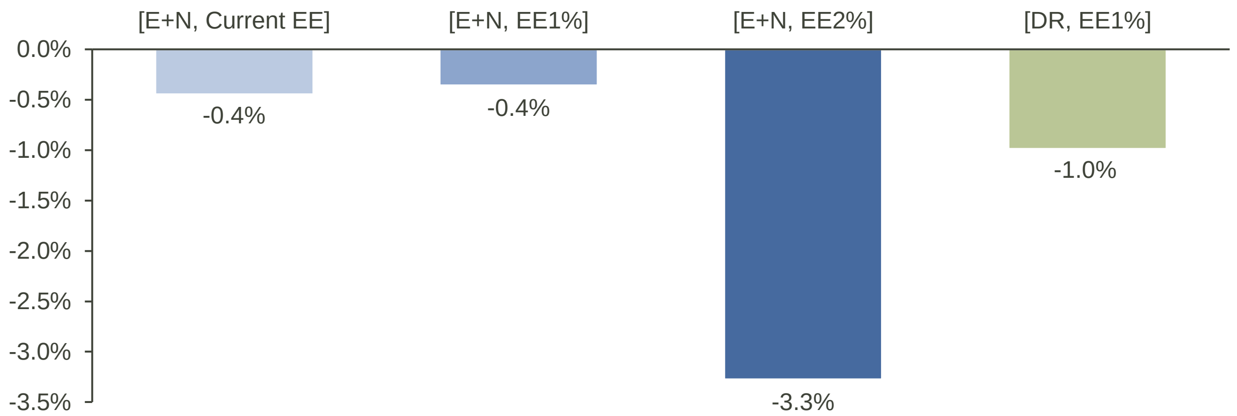
Historic and Projected CO_2 Emissions – **2000-2030**



Note: IPM projections include total CO_2 emissions (e.g., including simple cycle turbines). Historic data from 2000-2015 from EPA's CAMD. Iowa's CPP budgets for New and Existing Sources are 28,553,345 shot tons (Interim) and 25,281,881 short tons (Final)

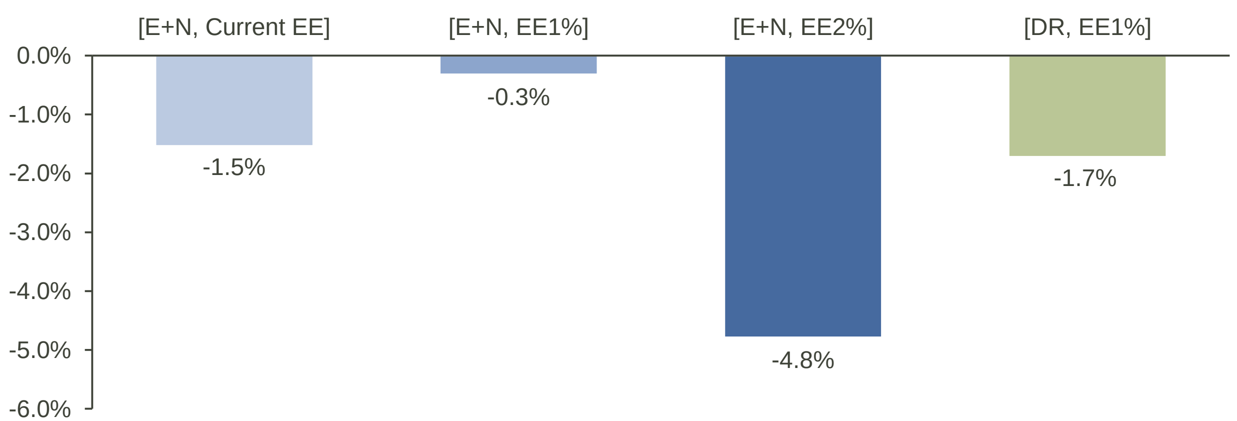
Iowa Retail Bill Impacts (2012$/Month)

2025



RC [Current EE] = 0

2030



RC [Current EE] = 0

Retail Cost Components Steady or Reduced Under CPP

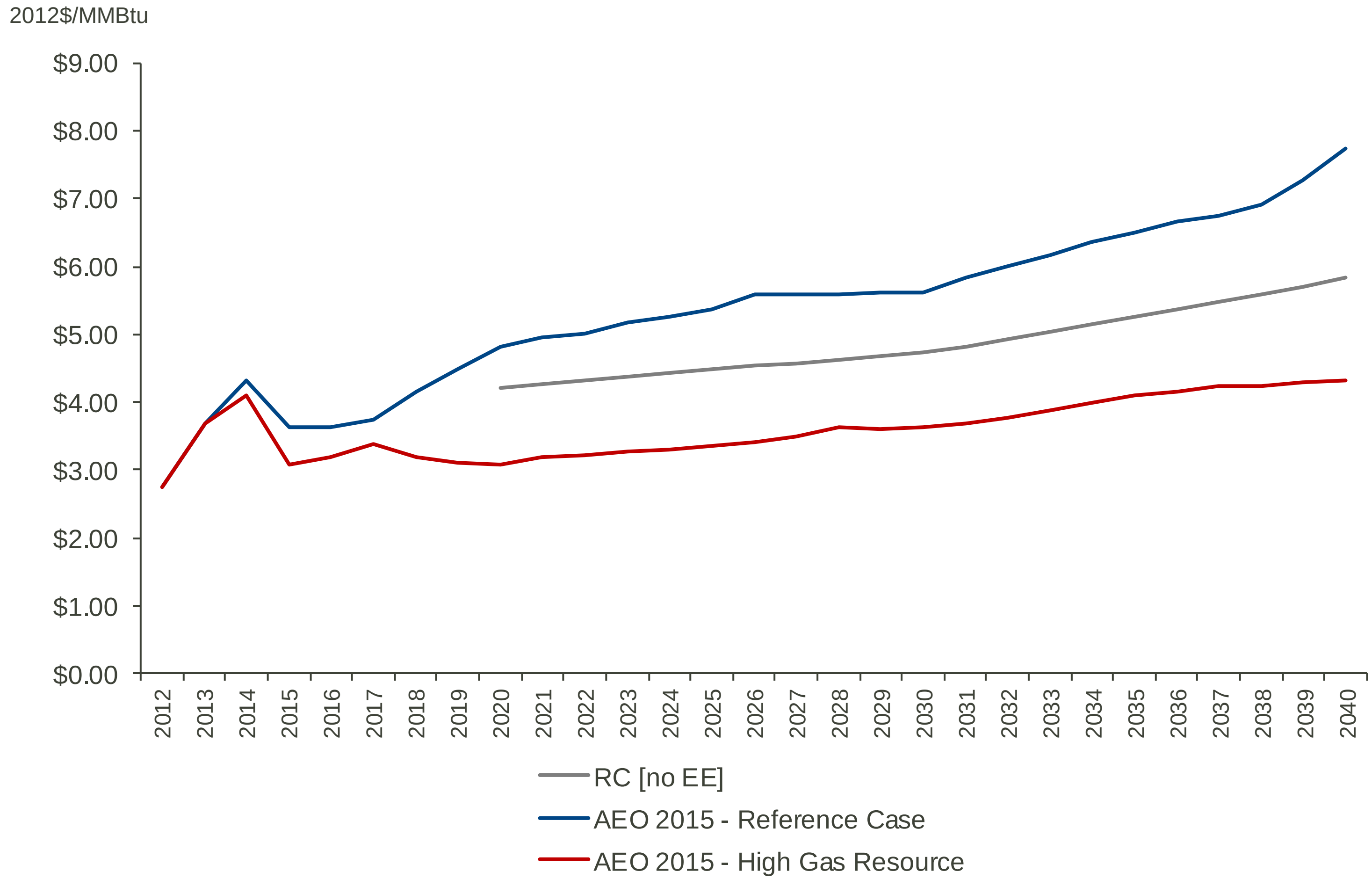
Average Cost of Power Sales includes: fuel costs, variable operation and maintenance (VOM) costs, fixed operation and maintenance (FOM) costs, annualized capital costs, wholesale power costs for interregional transactions

2030 Costs Compared to Reference Case, Current EE

Run	Fuel Costs ($Millions)	Firm Power Price ($/MWH)	Energy Exports (GWh)
MB, EN, CEE	+19	+5.46	+540
MB, EN, 1%	-21	+2.92	-358
MB, EN, 2%	-107	-1.15	-10
DR, 1%	+54	+4.81	+880

Total U.S.
Natural Gas Prices: Reference Case

Projected Henry Hub Natural Gas Price – **2012-2040**



Henry Hub Gas Price (2012$/MMBtu)

Description	2020	2025	2030
RC, no EE	$4.21	$4.48	$4.73
RC, Current EE	$4.25	$4.40	$4.56
E+N, Current EE	$4.29	$4.40	$4.69
E+N, EE1%	$4.29	$4.37	$4.53
E+N, EE2%	$4.33	$4.33	$4.30
DR, EE1%	$.4.21	$4.31	$4.76

Iowa
Firm Builds and Retirements

Capacity **(MW)** Built by Year Online

Fuel Type	2013	2014	2015	2016	2017	2018
Wind	113.7	9.0	556.2	1,251.5	-	-
Combined Cycle	-	-	-	-	650.0	-
Combustion Turbine	2.5	8.0	-	-	-	-
Hydro	-	-	-	-	-	36.4
Biomass	1.1	2.8	-	-	-	-
Landfill	-	4.8	-	-	-	-

Announced Retirements

Facility	Fuel Type	Number of Retiring Units	Summer Capacity (MW)	Year of Retirement
Milton L. Kapp	Coal	1	212.4	2015
Walter Scott Jr.	Coal	2	133	2015
George Neal North	Coal	2	423.6	2016
Southerland	Coal	2	110.5	2016
Dubuque	Oil/Gas	2	65.4	2016
Dubuque	Combustion Turbine	1	2.3	2016
Lansing	Combustion Turbine	2	2	2014
Milford	Combustion Turbine	2	1.1	2018
Duane Arnold	Nuclear	1	578.3	2035

Demand-Side Energy Efficiency Assumptions

- Historic rates of energy efficiency savings differ for each state and were drawn from the data reported by utilities in Energy Information Administration (EIA) Form 861, 2013, available at http://www.eia.gov/electricity/data/eia861/.
- In the "Current EE" scenario, the available supply of EE is calculated based on an extension of each state's 2013 annual savings rate. The annual savings rate is held constant between 2018 and 2030 to derive incremental annual savings and cumulative savings estimates for each state.
- In the "Modest EE" scenario, the available supply of EE is calculated based on the methodology in EPA's Regulatory Impact Analysis (RIA) for the Clean Power Plan. Cumulative efficiency savings are projected for each state for each year by ramping up from historic savings levels to a target annual incremental demand reduction rate of 1.0 percent of electricity demand over a period of years starting in 2020, and maintaining that rate throughout the modeling horizon.
  - Consistent with EPA's approach, the pace of improvement from the state's historical incremental demand reduction rate is set at 0.2 percentage points per year, beginning in 2020, until the target rate of 1.0 percent is achieved.
  - States already at or above the 1.0 percent target rate are assumed to remain at their historic savings rate beginning in 2020 and sustain that rate thereafter.
- In the "Significant EE" scenario, the available supply of EE is calculated based on the same methodology as the "Modest EE" scenario, but each state ramps up to a target annual incremental demand reduction rate of 2.0 percent of electricity demand.
- In the "Modest EE" and "Significant EE" scenarios, adoption of efficiency was modeled endogenously using a supply curve of program costs. In this simplified supply curve approach, the highest amount of savings assumed to be available to states in the supply curve varies by scenario, as described in the methodology above. The costs are based on LBNL's comprehensive 2015 cost study, available at: https://emp.lbl.gov/sites/all/files/total-cost-of-saved-energy.pdf.
- Participant costs are accounted for in the calculation of total system costs.

Retail Bill Calculation

The projected monthly average electricity bills (residential) reflect the combined effects of changes to average retail rates and average household electricity demand under the various modeling scenarios, and by region. Monthly bill impacts would change if the allowance value under a mass-based trading system was returned to customers.

The Retail Price Model accounts for variations in regulated and deregulated markets by calculating cost-of-service and competitive retail prices for each region and then weighing and allocating both to individual IPM regions according to the market structure that best represents each region:

Regional Average Price (mills/kWh) = Competitive Retail Power Price * Deregulation Share (%) + Cost-Of-Service Retail Power Price * Cost-Of-Service Share (%)

Competitive retail power price is comprised of competitive generation cost and transmission and distribution charges. Cost-Of-Service retail power price (cost divided by net sales) includes the cost of generation and the recovery of costs associated with transmission and distribution facilities and services.

Average retail bills are calculated based on retail rates and household demand, after energy efficiency savings.

Retail Rate Calculations – Methodology[1]

For regulated markets (like Iowa), ICF utilizes a Cost-Of-Service (COS) Model to develop retail costs. The COS Model estimates prices based on average cost to generate power and includes regulated returns to utilities, taxes, and transmission and distribution costs:

Cost-of-Service Retail Power Price = (Final Cost of Power Generation + Transmission Charge + Distribution Charge)

In the above calculation of retail prices, "Final Cost of Power Generation" is calculated as:

Final Cost of Power Generation (mills/kWh) = (Average Cost of Power Sales + Utility Depreciation Costs + Return to Equity and Debt + Non-Utility Generation Adder) × (1+Tax Rate)

[1] This slide is derived from EPA's documentation of the Retail Price Model, *available at:* https://www.epa.gov/airmarkets/documentation-retail-price-model

Renewables Capital Assumptions

- Renewables cost assumptions are presented on the following slide.
- These model runs assume that renewable resources are limited to 20 percent of net energy for load by technology type and 30 percent of net energy for load in total at each of IPM's U.S. sub-regions, on the assumption that grid integration impacts are relatively minor below these levels.
- Short-term capital cost adders are also assumed for wind and solar consistent with EPA's Base Case v.5.15. Capital costs increase when capacity additions exceed specified thresholds.
- Also, 2018 solar builds are limited to a 7.5 GW per calendar year and 2018 wind builds are limited to a 15 GW per calendar year.

We continue to refine our renewables assumptions, which may alter the level and timing of renewable energy builds across all of the cases.

Renewable Cost Assumptions

We continue to refine our renewables assumptions, which may alter the level and timing of renewable energy builds across all of the cases.

	RE Potential Build Cost and Performance - EPA v5.15					
Renewable Technologies	First Year	Vintage	Overnight Capital Costs in 2016-2054 (2012$/kW)	Heat Rate in 2016-2054 (Btu/kWh)	VOM (2012$/MWh)	FOM (2012/kW)
Biomass BFB	2018	2018-2040	4,111	13,500	5.2	103.8
Landfill Gas*	2016	2016-2040	8,554	13,648	8.5	381.7
Solar PV	2016	2016	2,182	-	-	7.4
		2018	1,880	-	-	7.4
		2020	1,579	-	-	7.4
		2025	1,448	-	-	7.4
		2030	1,317	-	-	7.4
		2040	1,053	-	-	7.4
Solar Thermal	2016	2016	5,015	-	-	42.2
		2018	4,935	-	-	42.2
		2020	4,857	-	-	42.2
		2025	4,660	-	-	42.2
		2030	4,463	-	-	42.2
		2040	4,059	-	-	42.2
Onshore Wind	2016	2016	1,724	-	-	46.5
		2018	1,717	-	-	46.5
		2020	1,711	-	-	46.5
		2025	1,701	-	-	46.5
		2030	1,697	-	-	46.5
		2040	1,696	-	-	46.5
Offshore Wind	2016	2016	5,243	-	-	101.4
		2018	4,970	-	-	101.4
		2020	4,697	-	-	101.4
		2025	4,141	-	-	101.4
		2030	4,032	-	-	101.4
		2040	3,929	-	-	101.4

Note: Capital cost multipliers are used to adjust region specific capital cost assumptions. For example, the Capital Cost Regional Multiplier for Onshore Wind in Iowa (MIS_IA) is 1.03.
*EPA's analysis includes three different landfill gas build options with varying capital costs (LGLo, LGvLO, LGHi). The costs shown above are for the mid range LGLo.

Concord, MA

Headquarters

47 Junction Square Drive
Concord, Massachusetts
United States

Tel: 978 369 5533

Fax: 978 369 7712

Washington, DC

1225 Eye Street, NW, Suite 200
Washington, DC
United States

Tel: 202 525 5770

www.mjbradley.com