

Potential Role for Wind in Meeting 111(d) Rule, Iowa and Neighbors

Preliminary Results of Study
For presentation September 19, 2014

EPA Calculations of Emissions and 111(d) Goals, Iowa and Neighbors

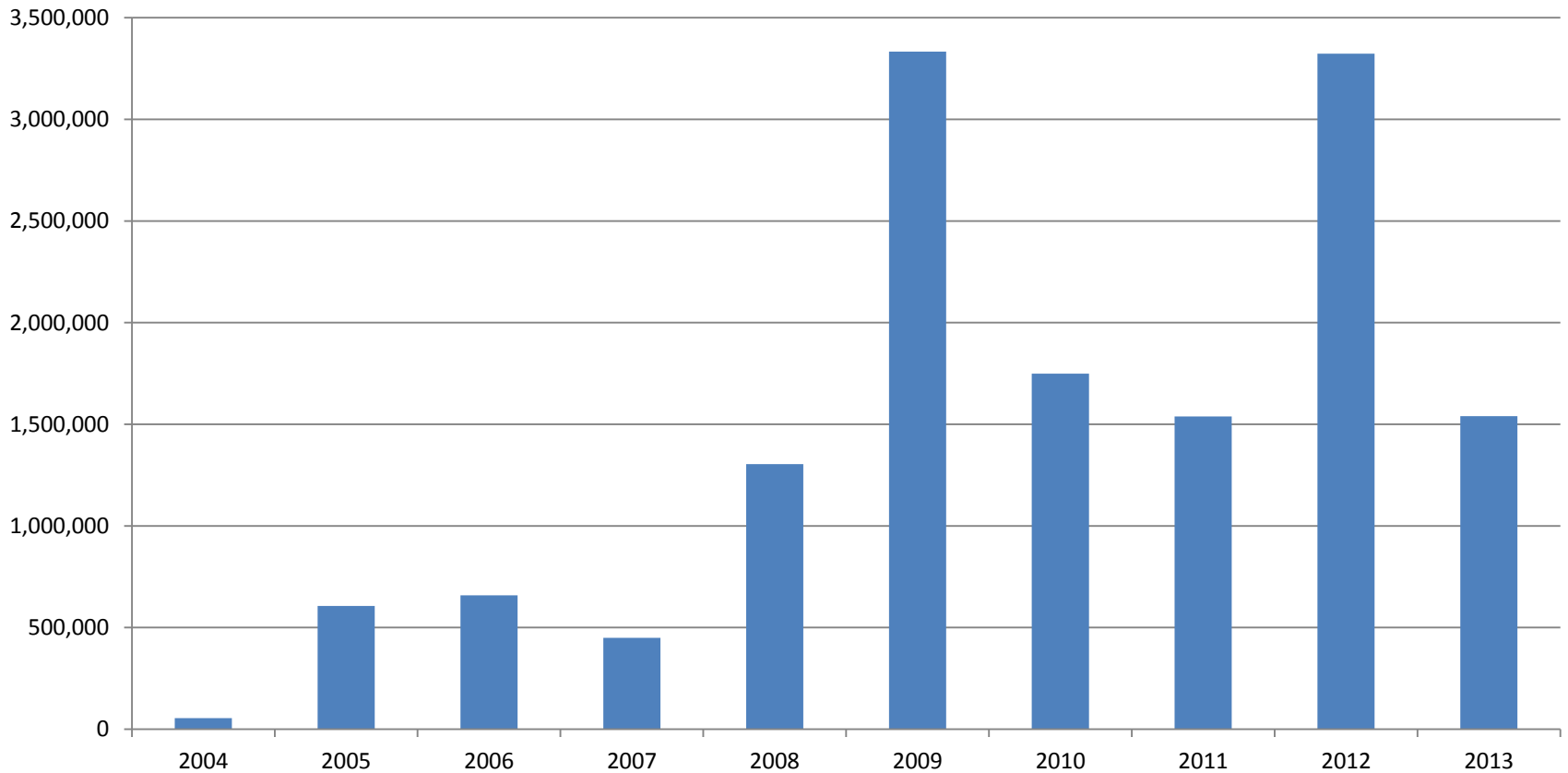
EPA Calculations of State Emissions in 2012 and Goals for 2030 under 111d, Iowa and Neighboring States							
	2012			2030 Goal			
	TWh	Metric tons	#/MWh	#/MWh	%	#/MWh	Metric Tons
State	Energy Produced	Total CO ₂ emitted	EPA calc Emission rate*	Emission rate	Rate Reduction	Rate Reduction	CO ₂ Reduction
IOWA	49	35,000,000	1552	1301	16%	251	5,660,438
IL	101	87,000,000	1895	1271	33%	624	28,648,021
MN	38	25,000,000	1470	873	41%	597	10,153,061
MO	80	71,000,000	1963	1544	21%	419	15,154,865
WI	46	38,000,000	1827	1203	34%	624	12,978,654
Total	314	256,000,000					72,595,039

Some Background on Iowa Power Emissions and Wind

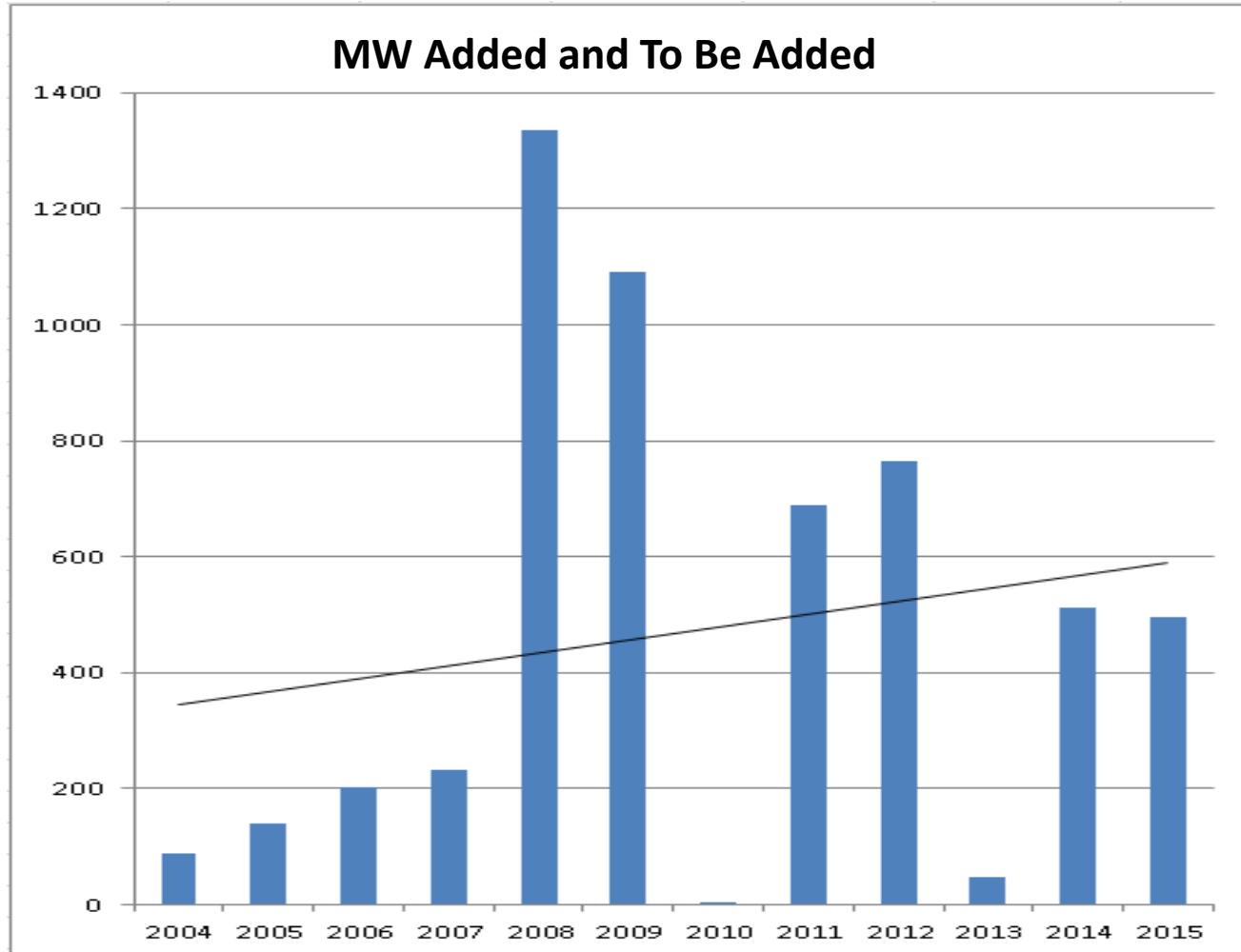
- As of 2012 Iowa's fossil fuel rate of CO₂ emissions was 2,196 lbs./MWh.
- As of the end of 2013 Iowa had nearly 5,200 MW of wind capacity installed.
- Iowa's estimated potential wind capacity is 570,000 MW.
- At present 1050 MW of wind is being added by Mid-American.
- In 2013 Iowa's generation from wind increased by over 1,500,000 MWh.

Iowa's History of Annual Wind Generation Increases

MWh of Wind Generation Increase from Previous Year



Recent History and Near Future of Wind Additions in Iowa, by MW Installed Annually



Major Assumptions

- Total Energy Production in 2030 will be unchanged from 2012, hence for Iowa, total is 49 TWh.
- Capacity Factor for new wind in Iowa is .4 starting in 2015.
- Capacity Factor for new wind in the selected neighboring states, except for MN, is markedly lower:
 - IL and MO: .32
 - WI: .30

Implications of Capacity Factor Variation

- An Iowa wind turbine would produce 25% more energy annually than the same turbine in IL or MO, and 33% more than it would in WI.
- Put differently, to get the same generation in IL or MO as in Iowa, IL or MO would have to install 25% more turbines and WI 33% more turbines.
- If the costs are the same, the Iowa turbine would produce energy for 25% less than the IL or MO turbine, and for 33% less than the WI turbine.

Two Approaches to Calculate Wind's Potential to Reduce CO₂

- Mass-based. Estimate the total CO₂ reduction from adding Wind based on previous studies and modeling.
- Direct fossil fuel MWh displacement from adding Wind MWh. Use existing fossil fuel CO₂ rate to recalculate new CO₂ rate.

Iowa Scenario Types

Four Scenario Types Based on Amount of Wind Added:

- 1) No more wind added than currently being built (1050 MW)
- 2) EPA baseline (0 MW of wind added after 2012)
- 3) An amount of wind added roughly equal to additions in 2014 and planned for 2015 now on the books. (Average of 500 MW/yr starting in 2015 through 2029.)
- 4) Aggressive addition of wind consistent with historical peaks (1000 MW/yr in 2015 with CF increasing at rate of 1%/yr. Note that this is basically the IWEA goal of 20,000 MW by 2030. It would require considerable additions to transmission networks.)

Mass-based Scenarios

Three scenarios for each type.

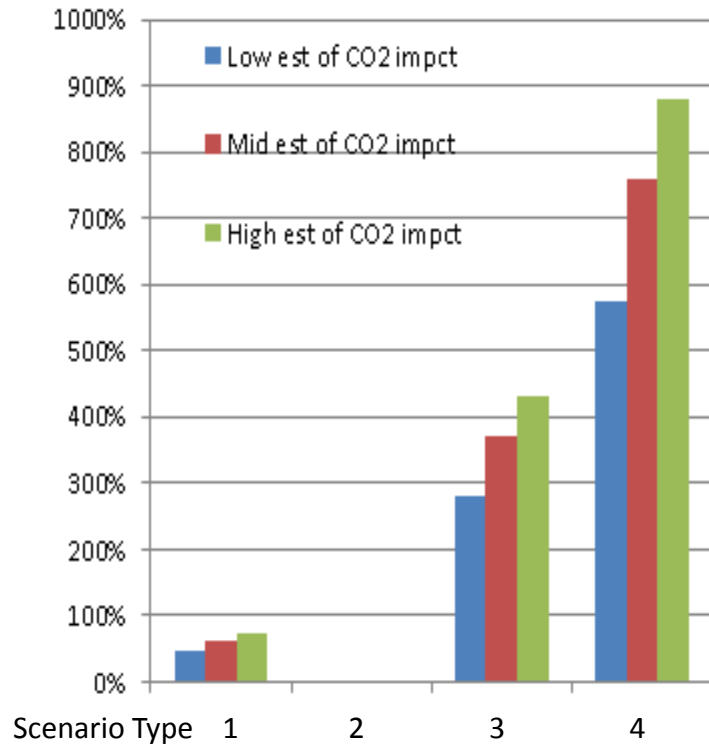
- Low estimate of CO₂ impact (1190 lbs/MWh).
From NREL empirical study of western U.S.
- Medium estimate of CO₂ impact (1567 lbs/MWh).
From EPA AVERT tool (25,000 MW) applied to GL-MA region.
- High estimate of CO₂ impact (1822 lbs/MWh).
From EPA AVERT tool (5,000 MW) applied to upper-midwest region.

Results: Mass-Based Scenarios

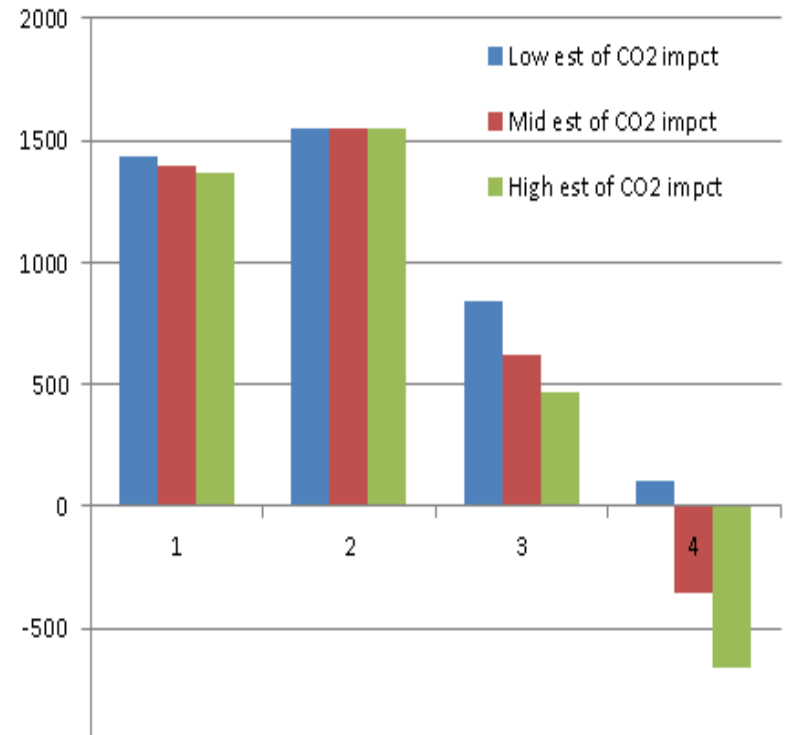
	Scenario Type 1 (only what is currently planned) + 2013	Scenario Type 2 Baseline (EPA)	Scenario Type 3 (500MW/yr)	Type 4 (Base 1000MW/yr, CF increasing at 1%)
CO ₂ Impact	% of Goal Reached by In-State Wind Alone			
Low	48%	0%	282%	570%
Mid	64%	0%	372%	750%
High	74%	0%	432%	872%
	CO ₂ Rate (Lbs./MWh) if nothing else changes			
Low	1431	1552	843	122
Mid	1392	1552	619	-331
High	1366	1552	467	-637

Mass-Based Scenarios Graphically

Percent of Goal Reached per Scenario



CO₂ Rates (lbs./MWh)

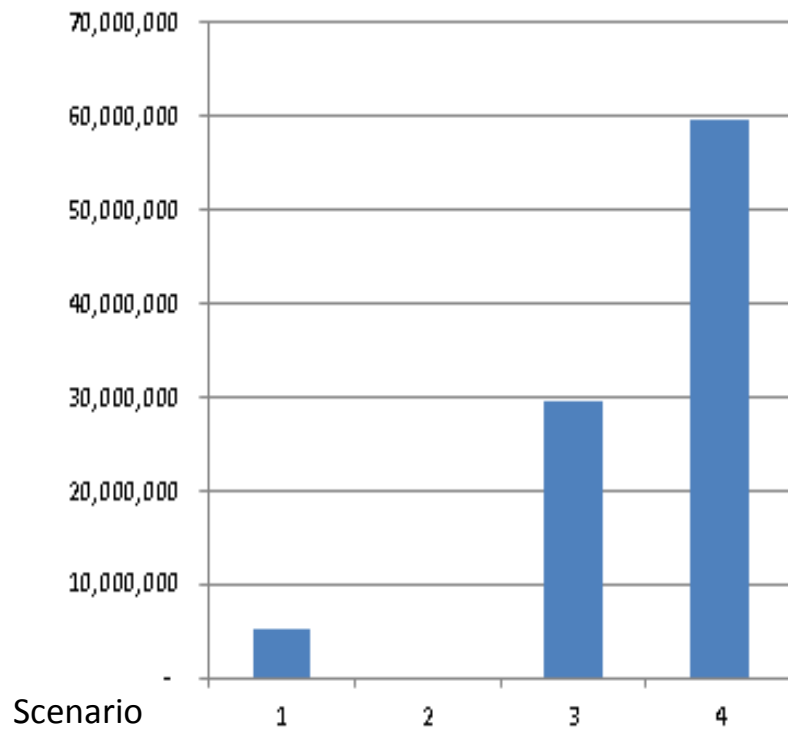


Fossil Fuel Displacement Method (One-to-one MWh to MWh displacement): Results

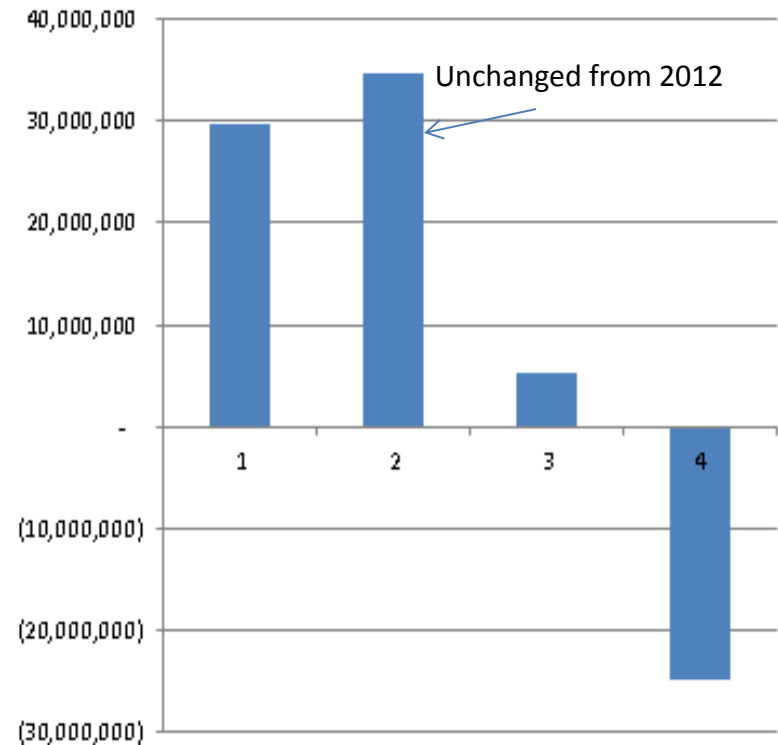
Fossil Fuel Displacement Method	Scenario Type 1 (only what is currently planned)+2013	Scenario Type 2 Baseline (EPA)	Scenario Type 3 (500MW/yr)	Scenario Type 4 (Base 1000MW/yr, CF increasing at 1%)
New MWh from Wind	5,065,024	0	29,610,544	59,734,066
FF Generation (MWh)	29,732,739	34,797,763	5,187,219	(23,145,759)
% reduction in FF Gen	10.3%	0.0%	60.4%	121.9%
CO2 Emitted (lbs.)	65,306,226,686	76,431,256,422	11,393,423,925	(50,838,309,298)
CO2 Rate (lbs./MWh)	1,333	1,560	233	(1,118)

Fossil Fuel Displacement Scenarios - Graphically

New MWh from Wind

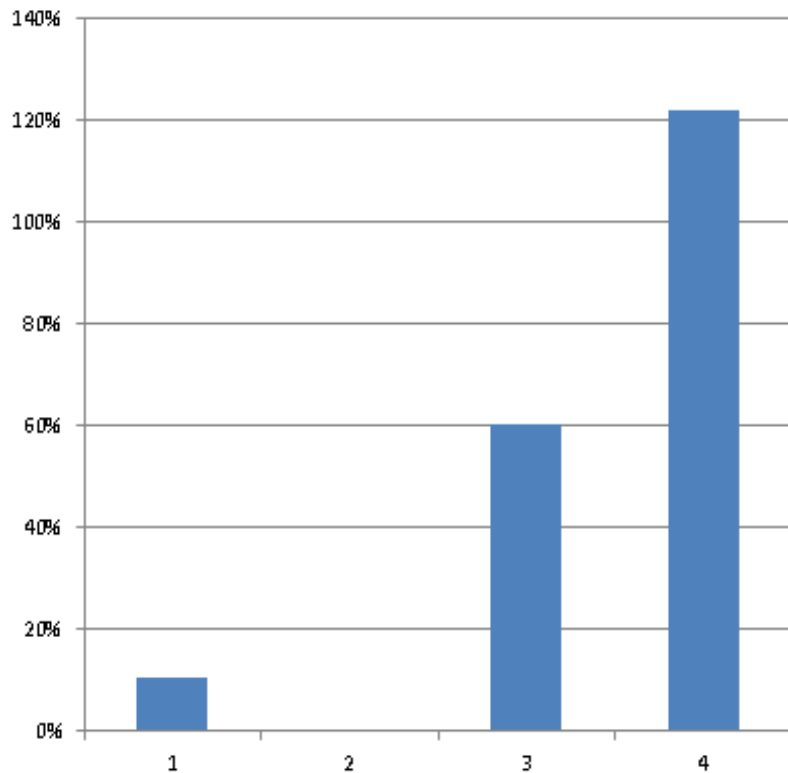


New FF Generation Result

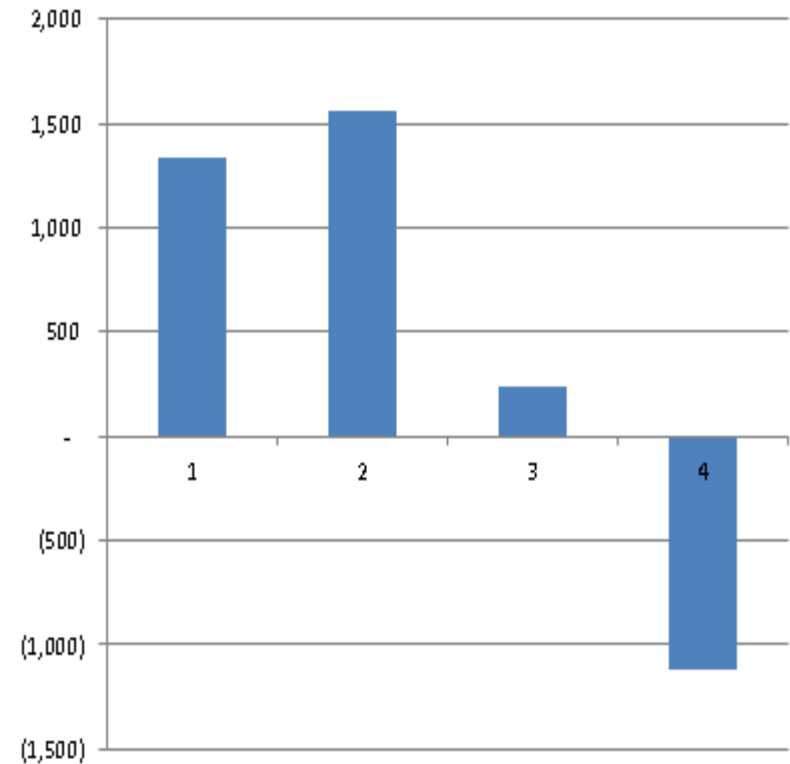


Fossil Fuel Displacement Scenarios – Graphically (Part 2)

% reduction in FF Generation



New CO2 Rate



How much new wind would Iowa need if it just wanted to meet its 111(d) goal, and do nothing else toward meeting the goal?

- Mass-based approach using the lowest estimate of wind's effectiveness:
 - » 2,380 MW total by year 2030
 - » Average of 159 MW annually, 2015-2029
- FF Displacement Approach
 - » 792 MW total by 2030
 - » Average of 53 MW annually through 2029

Some Outlines of Scenarios for Lower-Capacity-Factor Neighboring States

		% of Goal Achieved by In-State Wind Assuming Lowest Est. Mass CO2 Method		
State		10	25	50
IL	New Wind MWh	5,307,395	13,268,487	26,536,975
MO		2,807,623	7,019,059	14,038,117
WI		2,404,454	6,011,134	12,022,269
	Total	10,519,472	26,298,680	52,597,360
	Shortfall	94,675,249	78,896,041	52,597,360

		% of Goal Achieved by In-State Wind Assuming FF Displacement Method		
State		10	25	50
IL	New Wind MWh	2,864,802	7,162,005	14,324,011
MO		1,515,487	3,788,716	7,577,433
WI		1,297,865	3,244,663	6,489,327
	Total	5,678,154	14,195,385	28,390,770
	Shortfall	51,103,386	42,586,155	28,390,770

Iowa Scenario-types 3 and 4 envisage 29,600,000 and 59,700,000 MWh of new wind generation annually by 2030.

Further Questions

- It is possible that cost, especially from transmission system upgrades and potential new lines, could make some scenarios economically unfeasible. This was not addressed. We are doing some research into this.
- It appears Iowa wind could help neighboring states meet their 111(d) goals. Should it do so?

Credits

This work is a result of a collaboration with

- Dan Turner, LLC
- Wind Utility Consulting, PC
- Iowa Wind Energy Association