Union of Concerned Scientists

EXECUTIVE SUMMARY

Beyond the Clean Power Plan

How the Eastern Interconnection Can Significantly Reduce CO_2 Emissions and Maintain Reliability

Driven by market forces, technological advances, and clean energy policies, the U.S. electricity sector is making an historic transition: away from coal and toward low- and zero-carbon energy sources. U.S. wind power capacity has more than doubled since 2009, solar power capacity has increased by a factor of 15, and the cost of both technologies has dropped by 60 to 70 percent (Wiser and Bolinger 2015; SEIA 2015). Meanwhile, advances in hydraulic fracturing and horizontal drilling have increased the domestic supply of natural gas dramatically, leading to a significant decline in prices and lower carbon emissions (Staub 2015).

The transition will continue. The Environmental Protection Agency's Clean Power Plan requires existing power plants to reduce carbon emissions an estimated 32 percent from 2005 levels by 2030, yielding significant environmental benefits according to several recent studies (EPA 2015; EIA 2015; PJM 2015).

In addition, the U.S. Department of Energy has begun preparing for large-scale changes in the nation's electric system, and these could lead to even deeper cuts in emissions. In the face of a changing electric system, Congress in 2009 authorized the department to convene electric system stakeholders to modernize multi-regional transmission planning. With DOE funding, the Eastern Interconnection Planning Collaborative (EIPC), which brings together utility system planners across 39 states, assessed electric transmission needs of potential energy futures and then estimated the costs to build and operate for one year: 2030 (EIPC 2012).

TABLE ES-1. EIPC Scenarios for Energy Futures

Carbon Reduction Nationally implemented federal carbon constraint Renewable portfolio standard Increased energy efficiency/demand response	Reduce economy-wide carbon emissions by 42 percent from 2005 levels in 2030 and 80 percent in 2050. Meet 30 percent of the nation's electricity requirements from renewable resources by 2030, with a significant deployment of energy efficiency measures and other low-carbon technologies. Utilize an implementation strategy across the Eastern Interconnection, with extensive interregional transfers of energy to ensure the availability of renewable energy from more remote locations.
Federal Portfolio Standard Regionally implemented national renewable portfolio standard	Meet 30 percent of the nation's electricity requirements from renewable resources by 2030. Utilize a regional implementation strategy. Limit interregional transfers of energy, heavily utilizing locally produced renewable energy with possibly higher cost in some circumstances.
Business as Usual	Continue forecasted load growth and existing state Renewable Portfolio Standards requirements. Operate based on EPA regulations as proposed and understood in the summer of 2011 and no federal carbon regulations and.

All EIPC scenarios examined 2030 energy demand, generation supply mix, and carbon dioxide emissions.

SOURCE: EIPC 2012 (TABLE CR-1. SCENARIO DESCRIPTIONS FOR PHASE 2 STUDIES)

Subsequently, Synapse Energy Economics, an independent consulting firm, took the EIPC work a step further, modeling construction and operating costs over 25 years. The Synapse analyses looked at the EIPC's "Carbon Reduction Scenario," which described the transmission needs and relative costs for using widespread cooperation between states to reduce carbon dioxide emissions from power plants to 42 percent below 2005 levels by 2030. Under this scenario renewable energy would generate 30 percent of electricity needs by 2030 and energy efficiency investments would significantly reduce electricity demand in homes and businesses. Synapse determined that this scenario would achieve those benefits with essentially the same cumulative costs through 2040 as the "Business-as-Usual Scenario" (Fagan, Fisher, and Biewald 2013).

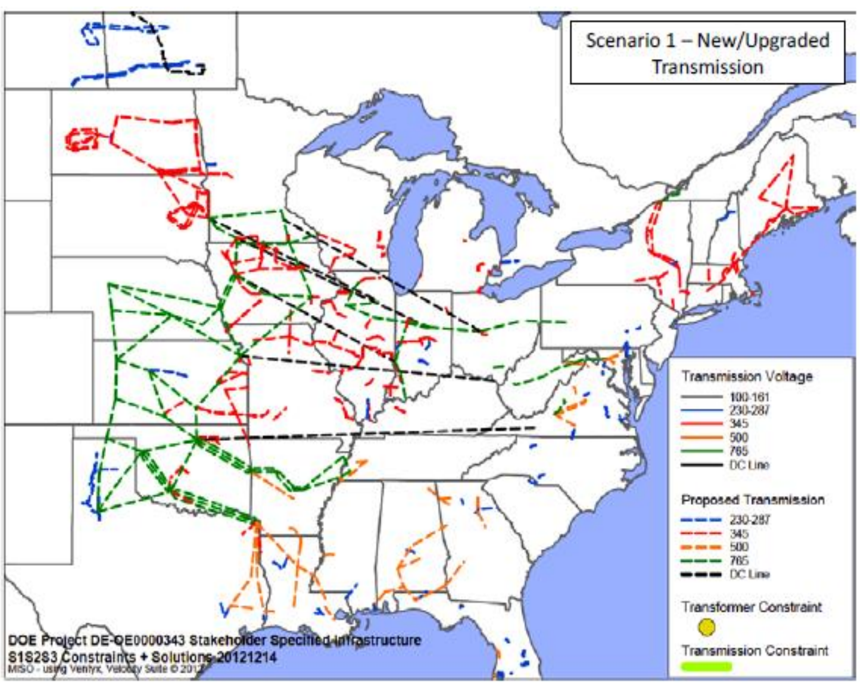
The Synapse study builds on the preliminary work of transmission planners in a three-year collaboration on an interregional scale with dedicated attention from state regulatory officials and interested stakeholders. The Synapse study models an approach to reducing carbon dioxide emissions beyond EPA requirements that is based on an authoritative, well-debated analysis, created even before the Clean Power Plan existed.

The result is an indicative guide to states for cost-effective compliance with the Clean Power Plan through the use of wind energy, energy efficiency, and transmission on a regional basis. States can now prepare to comply with the Clean Power Plan based on an authoritative, well-vetted analysis, created even before that plan existed.

EIPC's Long Term Planning for Transmission Expansion

Between 2009 and 2012, with support from the U.S. Department of Energy, the planning authorities of 23 electric systems, covering about 95 percent of the peak customer demand in the Eastern Interconnection, collaborated with state and federal policymakers and other stakeholders in an open, transparent process to explore the technical feasibility and cost

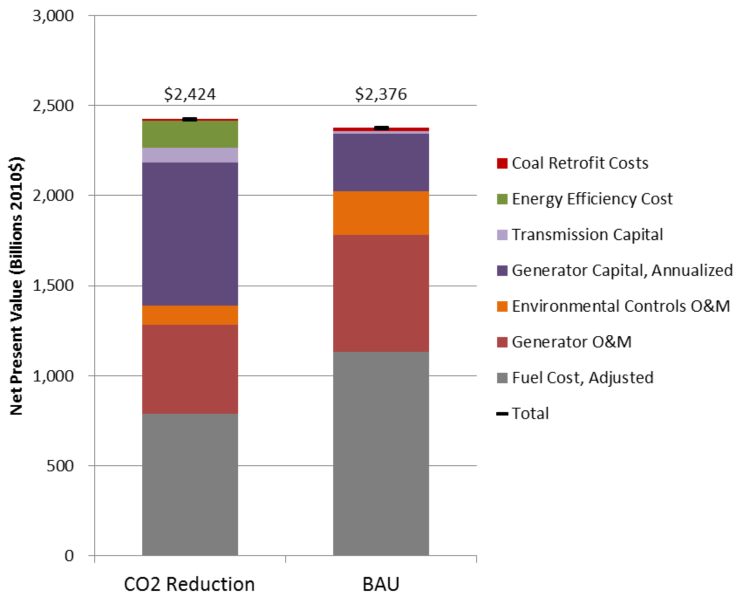
FIGURE ES-1. Carbon Reduction Scenario: Transmission Build-out to Achieve 30 Percent Renewable Energy and a 42 Percent Reduction in Carbon Dioxide Emissions by 2030



Transmission expansion required for the 118 GW of wind added and 140 GW of coal plant retirements in PJM and the Midwest Independent System Operator resulting from the Carbon Reduction Scenario.

SOURCE: EIPC 2012

FIGURE ES-2. Estimated Costs of Carbon Reduction and Business-as-Usual Scenarios for Clean Power Plan Compliance, 2015-2040



The 42% Carbon Reduction and Business-as-Usual scenarios have nearly equal building and operating costs, as estimated through Eastern Interconnection Planning Collaborative modeling and the Synapse calculation of total costs to consumers.

SOURCE: FAGAN, FISHER, AND BIEWALD 2013

of building out the region's transmission system to meet the energy needs of selected policy futures. Through a parallel effort, also supported by the Department of Energy, a group of state regulators defined the future scenarios to be studied. That group included representatives from the 39 states of the Eastern Interconnection, the District of Columbia, and the City. of New Orleans, as well as explicit representation from both industry and nonprofit organizations. It was this unprecedented group of stakeholders from both utilities and public interest organizations that undertook the first interregional planning for expanding transmission, yielding both tools for continued planning activities and the example of future collaboration on a large scale.

The EIPC analyzed three scenarios for the electricity sector to determine electrical demand, supply, and transmission-capacity needs for the year 2030 (see Table ES-1). The *Carbon Reduction Scenario* combined a nationally implemented limit on carbon emissions, a national renewable portfolio standard, and increased energy efficiency and demand response. The *Federal Portfolio Standard Scenario* assumed regional implementation of the national renewable-portfolio standard. The third scenario was *Business as Usual.*

The three scenarios, selected through the intensive, collaborative process conducted by the regulators, public interest groups, and stakeholders, represented the most relevant cases to study in terms of policy goals, levels of technology implementation, transmission build-outs, and total cost. The Eastern Interconnection Planning Collaborative then produced extensive detail on expanding transmission capacity under each scenario. The EIPC included expansions of interregional transmission that could support each scenario using the industry's own reliability criteria, as well as technical modeling for the entire Eastern Interconnection. The EIPC included estimates of the cost of building generation and transmission, basing these on generic cost information rather than attempting to create more specific estimates.

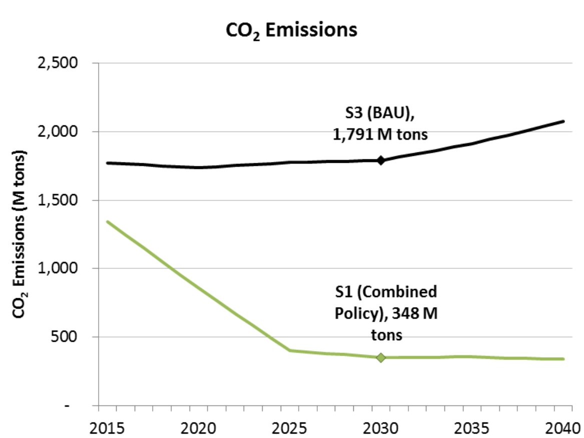
The EIPC did not examine any other year than 2030 for the effects of transmission expansion, nor did it create a timeline of investments in generation or transmission. Nor was the goal to reduce emissions from the electric-power sector. Nevertheless, the data and scenarios can prove useful in evaluating the general feasibility and relative cost for potential policy approaches and also the scale of carbon dioxide reduction for each scenario.

The EIPC report offers an example of transmission needed for the Eastern Interconnection states to add 108 gigawatts (GW) of wind and retire 140 GW of coal generation (Figure ES-1). This transmission build-out from the Carbon Reduction scenario is illustrative, and does not optimize or include every needed transmission segment.

The 2013 EIPC and Synapse Analyses

The EIPC analyses and reports contained a wealth of detail and in the scoping stage reviewed spending in the scenarios in five-year increments. Still, they did not provide the comprehensive annual cost information that would enable states and stakeholders to compare the cost of different scenarios. Specifically, the collaborative did not include the total cost that ratepayers would incur. This is a critical public policy issue, especially because investments in the electricity sector last a long time. Power plants and transmission facilities can have 30- to 60-year lifetimes.

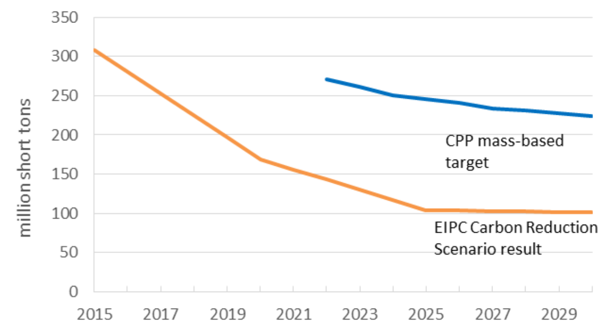
FIGURE ES-3. Carbon Dioxide Emissions Trajectory, Carbon Reduction and Business-as-Usual Scenarios



The Carbon Reduction Scenario reduces carbon dioxide emissions 80 percent by 2030 compared to the level reached in the Business-as-Usual Scenario.

SOURCE: EIPC 2012, GRAPH FROM SYNAPSE

FIGURE ES-4. EIPC Carbon Reduction Scenario versus Clean Power Plan Carbon Dioxide Emissions Targets, PJM



Using affordable energy efficiency, wind, and transmission, the Carbon Reduction Scenario provides PJM states with more carbon dioxide reduction than required by the Clean Power Plan. Source: Synapse analysis of EIPC results.

SOURCE: SYNAPSE ANALYSIS OF EIPC RESULTS

To compare total costs, in 2013 Synapse reassessed the EIPC reports and calculated the total ratepayer costs of two of the scenarios, Business-as-Usual and Carbon Reduction. Synapse chose these "bookend" cases as more distinct illustrations than the Federal Portfolio Standard Scenario. It also extended the analyses to 2040 to recognize the on-going savings from the long-lasting assets.

Synapse found nearly identical total ratepayer costs for Carbon Reduction and Business as Usual. The increase in capital costs for renewables, efficiency, and transmission under the Carbon Reduction Scenario largely replaced the higher costs for fuel and operations under the Business-as-Usual Scenario (Figure ES-2).

Carbon Reduction Scenario Exceeds Clean Power Plan Targets

The EIPC analysis modeled the power system for the **Carbon Reduction Scenario to reduce emissions in the electric-power sector across the eastern United States 42 percent below 2005 levels by 2030. Compared with the Business-as-Usual Scenario**, the reduction would be 80 percent (358 million tons of carbon dioxide emissions versus 1,791 million tons) (Figure ES-3).

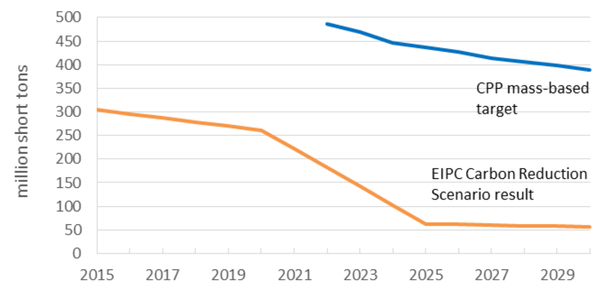
Similarly, the Carbon Reduction Scenario would also surpass the aggregated emissions reduction targets for 2030 under the Clean Power Plan for the states in two regional transmission organizations within the Eastern Interconnection, PJM and the Midcontinent Independent System Operator (MISO) (Figures ES-4 and ES-5). PJM and MISO continue regional transmission planning to aid state policymakers.

Across the Eastern Interconnection states, additional economic and public health benefits would come from reducing other major pollutants for which EPA has set standards. For example, EIPC's modeling predicts that the Carbon Reduction Scenario would avoid over one million tons of emissions of nitrogen oxides—a significant ozone precursor—and over 1.7 million tons of sulfur dioxide emissions by 2030.

The Impacts of Lower-than-Expected Costs for Wind

The Eastern Interconnection Planning Collaborative and Synapse both assumed that the capital cost of wind would start at around $2,500/kW in 2015; the EIPC also assumed the cost would fall by 0.75 percent per year, while Synapse assumed a 1 percent per year reduction. In fact, the actual national average wind installation costs in 2014 were $1,710/kW (Wiser and

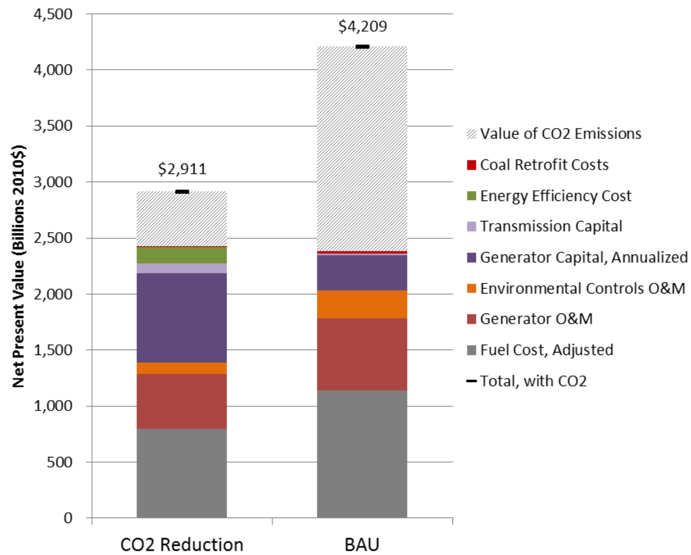
FIGURE ES-5. EIPC versus Clean Power Plan Carbon-Dioxide Emissions Targets, Midcontinent Independent System Operator



Using affordable energy efficiency, wind, and transmission, the Carbon Reduction Scenario provides MISO states more carbon dioxide reduction than required by the Clean Power Plan. Source: Synapse analysis of EIPC results.

SOURCE: SYNAPSE ANALYSIS OF EIPC RESULTS

FIGURE ES-6. Net Present Value of Revenue Requirements of Carbon Reduction and Business-as-Usual Scenarios with Consistent Valuation of Carbon Dioxide Emissions



Comparing total costs, including a uniform price on all carbon dioxide emissions, over the years 2015-2040 for the Carbon Reduction and Business-as-Usual scenarios.

SOURCE: FAGAN, FISHER, AND BIEWALD 2013

Bolinger 2015). This was lower than projected at any time before 2030 in the EIPC analysis. Turbine productivity and capacity factors have also increased, causing the total cost of wind-energy production to decline by more than 60 percent since 2009. Applying actual costs for 2014 to the EIPC analysis reduces the cost of the Carbon Reduction Scenario by more than $100 billion (4 percent). That savings exceeds the cost differential between the Carbon Reduction Scenario and the Business-as-Usual Scenario results identified by Synapse in 2013.

Further, the EIPC assumed high costs for solar energy, which led to EIPC using no distributed solar power.[1] Including cost reductions of 60 to 70 percent over the past five years for solar photovoltaics could lead to lower costs in an updated Carbon Reduction Scenario.

Treating Carbon Dioxide Costs Uniformly Changes Relative Costs

The EIPC study did not address an important policy aspect relevant to plans for reducing carbon dioxide emissions: given the goal of minimizing the cost of actions to reduce emissions, planners need to be able to put a price on emissions in a way that is equitable across all scenarios. However, the EIPC developed a "carbon price adder" only for the Carbon Reduction Scenario, running models that would achieve the desired carbon dioxide reduction. The results only applied carbon dioxide costs in the Carbon Reduction Scenario and did not include those for emissions resulting in the other scenarios. As noted in Figure ES-2, the estimated costs of the Carbon Reduction Scenario and the Business as Usual Scenario were essentially equal using the EIPC approach. **When Synapse treated carbon dioxide costs equitably under all scenarios, the result was that the Carbon Reduction Scenario was 30 percent less expensive cumulatively through 2040 than Business as Usual** (Figure ES-6).

Implications for State Strategies to Comply with the Clean Power Plan

With EPA's August 2015 release of the final Clean Power Plan, energy and environmental planners began evaluating their options for meeting its carbon reduction targets. The final Clean Power Plan strongly encourages regional coordination in accomplishing its goals, and the EIPC effort provides a successful example of large-scale regional planning that can potentially meet and exceed the Clean Power Plan's targets.

The impact of increased wind capacity on carbon reduction

TABLE ES-2. Summary of PJM Regional Results of EIPC Business-as-Usual and Carbon Reduction Scenarios

	2015		2020		2030	
	Business-as-Usual	Carbon Reduction	Business-as-Usual	Carbon Reduction	Business-as-Usual	Carbon Reduction
Coal Retirements (MW)	24,608	51,430	31,312	69,614	31,312	80,102
New Wind Capacity (MW)	9,956	9,956	9,956	10,897	16,707	14,292
Carbon Dioxide Emitted (million tons)	450	309	405	169	399	101
Clean Power Plan Carbon Dioxide Allowed (million tons in 2022 and 2030)			270	270	224	224

TABLE ES-3. Summary of MISO Regional Results of EIPC Business-as-Usual and Carbon Reduction Scenarios

	2015		2020		2030	
	Business-as-Usual	Carbon Reduction	Business-as-Usual	Carbon Reduction	Business-as-Usual	Carbon Reduction
Coal Retirements (MW)	9,049	25,274	12,522	46,404	12,522	60,182
New Wind Capacity (MW)	6,069	6,069	8,060	6,631	12,639	103,853
Carbon Dioxide Emitted (million tons)	406	304	382	262	384	56
Clean Power Plan Carbon Dioxide Allowed (million tons in 2022 and 2030)			486	486	388	388

in MISO and PJM can be significant. Both the Business-as-Usual and Carbon Reduction scenarios incorporate the building of substantial amounts of additional wind generation in the MISO and PJM states. In the EIPC's Business-as-Usual modeling, 16 GW of new wind is built in PJM by 2030, primarily to meet existing state Renewable Portfolio Standard requirements. Less new wind capacity is built for these states in 2030 under the Carbon Reduction Scenario: the model projects building considerably more wind capacity in MISO states in that case, so energy transfers to PJM states would be greater. In the Carbon Reduction Scenario the EIPC projects 103 GW of new wind construction in MISO with corresponding new transmission, driving a 42 percent carbon reduction in the entire Eastern Interconnection (Table ES-2).

Utilities, state officials, and other stakeholders can find ample illustration here that they can meet or exceed the carbon-reduction requirements of the Clean Power Plan with essentially no additional costs to the electric power system at least through 2040. Moreover, recognizing and revisiting scenarios developed by the EIPC suggest that state planning around the Clean Power Plan can draw clear benefits of regional cooperation and transmission expansion. Taken together, the EIPC and Synapse analyses provide a strong basis from which states can pursue additional research, planning, and implementation, based on updated costs for key variables.

The full report being summarized here was written and published by Synapse Energy Economics, and can be found online at www.ucsusa.org/beyondcleanpowerplan.

ENDNOTES

1 The $2,875/ MWh cost for distributed solar in the Phase 2 EIPC materials appears to be an error, as a repeat of their calculation implies the cost at $287/MWh.

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NATIONAL HEADQUARTERS
Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

WASHINGTON, DC, OFFICE
1825 K St. NW, Suite 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

WEST COAST OFFICE
500 12th St., Suite 340
Oakland, CA 94607-4087
Phone: (510) 843-1872
Fax: (510) 843-3785

MIDWEST OFFICE
One N. LaSalle St., Suite 1904
Chicago, IL 60602-4064
Phone: (312) 578-1750
Fax: (312) 578-1751