Union of Concerned Scientists

FACT SHEET

Renewable Energy on Regional Power Grids Can Help States Meet Federal Carbon Standards

In June 2014, the U.S. Environmental Protection Agency (EPA) used its authority under Section 111(d) of the Clean Air Act to confront one of the primary sources of global warming pollution: the heat-trapping carbon dioxide (CO_2) emitted by existing power plants. The standards proposed by the EPA to reduce these emissions allow states to use high levels of renewable energy including wind and solar to meet regional carbon reduction targets—a strategy that present-day experience and detailed analyses show can succeed.

Regional grid operators, including but not limited to independent system operators (ISOs), already have the tools and experience needed to operate the power grid reliably with high levels of renewables. Published studies by experienced U.S. grid operators suggest that renewable energy alone can lower the electricity sector's CO_2 emissions by 40 percent, while a combination of renewable energy deployments and energy efficiency improvements in our homes and businesses could lower emissions as much as 80 percent (NREL 2012).

Renewable energy is an available, cost-effective, and ready means to reduce global warming pollution, and adding it to regional electric grids can help states comply with the new EPA limits. All regional grid operators are capable of not only integrating high levels of renewable energy today, but also confirming wind and solar will reduce their grid's reliance on existing fossil fuel power plants (FERC 2006).

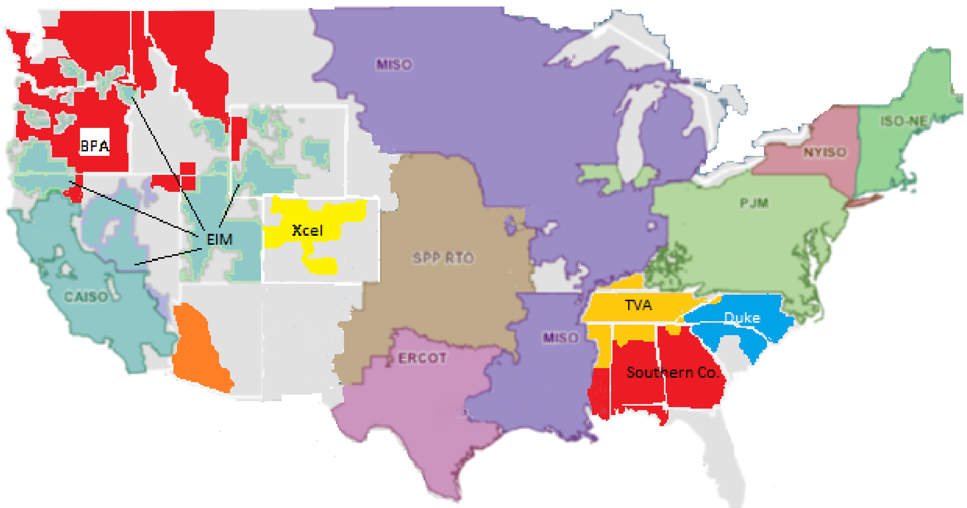
Experience Using Regional Grids to Reduce Emissions

The EPA draft carbon rule describes emissions reduction strategies that feature renewable energy growing beyond existing levels in most states. As one of EPA's four compliance building blocks, states have the flexibility to go further in deploying renewable energy to achieve their emission reduction targets. And combining this renewable energy development with electricity supply management on a regional basis would present even greater possibilities for reducing emissions from existing power plants. Because electricity flows between states, regional grid operators already manage the power production of plants owned by utilities, municipalities, or private owners, and these operators have already achieved levels of wind power produced in a single hour of 17.5 percent (California ISO), 25 percent (Midcontinent ISO), 39 percent (Bonneville Power), and 60 percent (Xcel Colorado) (AWEA 2014). Iowa currently meets 27 percent of its annual electricity needs with wind, and Colorado meets 14 percent of its needs with wind and solar (EIA 2014). Altogether, using existing tools and procedures, regional grids can accommodate enough renewable energy generation to reduce carbon emissions from existing power plants by 40 percent or more on an annual basis (GE Energy Consulting 2014).

The expansion of regional power grids such as PJM, Midcontinent ISO, and Southwest Power Pool (Figure 1) has resulted in fossil fuel savings and related CO_2 reductions (IRC 2014). Their regional power plant coordination and use of grid connections between plants also smooth the integration of renewable energy. Furthermore, the Energy Imbalance Market

Generating electricity from wind power and other renewable energy sources is available, cost-effective, and can help states meet the challenge of complying with the new EPA limits on carbon emissions. These wind turbines in Idaho are working successfully with agriculture to improve public health and strengthen local economies. Photo Source: Flickr/Idaho National Laboratory

FIGURE 1. Regional Grid Operators of All Kinds



ISOs, the Energy Imbalance Market, and regional-scale owners now cover the majority of the United States and coordinate the operation of power plants. The information systems these operators use to run fossil and renewable plants together are used to understand future energy supply scenarios and are capable of forecasting carbon reductions with higher levels of renewable energy.

SOURCES: FEDERAL ENERGY REGULATORY COMMISSION 2006, NREL 2013.

(EIM), a new institutional approach to managing the regional grid operations of utilities in five western states, provides additional fuel savings, renewable energy integration, and associated emissions reductions (NREL 2013).

The Benefits of Regional Grid Coordination

The nature of the electricity grid requires cooperation. To meet demand, utilities must coordinate the operation of power plants and the transmission system. This is the function of regional power grids, often in the form of ISOs.

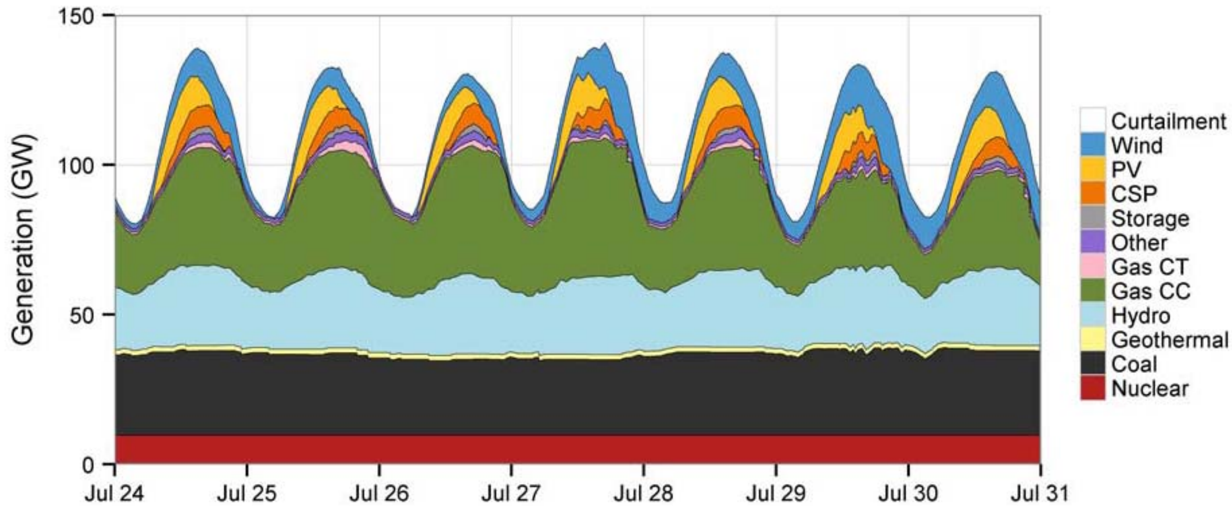
The basic principles and engineering standards developed over the past 90 years of power plant coordination can now serve the present need to reduce CO2 from existing power plants because the fundamental goal of regional grid operations remains the same: to maintain a reliable electric supply at the lowest fuel cost. As grid operators reduce total power plant fuel use by coordinating and integrating renewable energy, they will simultaneously reduce CO2 emissions.

Regional Power Grids Exist Almost Everywhere

Every state except Hawaii receives some benefit from interstate or regional power grid coordination and operation, which is provided by several types of entities whose differences do not preclude the functions most relevant to carbon reduction. The most dynamic of these institutions have been ISOs actively seeking greater integration of renewable energy.

The expansion of ISOs and the establishment of the EIM mean that regional grid operations now cover much of the country, including generators owned by small and large utilities, both private and government-owned. The primary objective of the EIM is to quickly adjust generation to meet needs across a broad geographic region; in this case, by expanding power plant dispatch from the California ISO to its neighbors in Nevada, Oregon, Washington, and Wyoming. The EIM is equivalent to an ISO in terms of the function most relevant to EPA compliance: balancing the operations of existing fossil fuel–powered plants with newly added renewable energy plants.

FIGURE 2. Supply Mix with High Levels of Wind and Solar



Wind (dark blue on graph) and solar (yellow and orange) contribute to the supply mix in Western states modeled over 8 days. Gas (green) and hydro (light blue) generation rise and decline with the daily cycle and renewable generation variations. NREL and GE examined 30 percent renewables on an annual basis, successfully matching demand and supply using historic weather data.

SOURCE: GE ENERGY CONSULTING 2010.

How Regional Power Grids Maximize Wind and Solar Output

Electricity supply is more reliable and less expensive when multiple generators in a given region are directed by advanced computer programs. The more generators that are available and coordinated, the more efficiently a computer can select specific generators for daily needs and minute-by-minute operation. This centralized operation allows the most cost-effective unit in the region to be fully utilized before the next most cost-effective unit. And when wind or solar energy is produced, even if varying in output, computer-controlled operation manages the supply and ensures lower emissions and costs.

Another benefit provided by ISOs and regional grid operators is better utilization of the transmission system. ISOs in particular are well equipped to analyze and actively manage the reliability and economic considerations of any combination of generators on the grid (IRC 2010). Regional coordination also makes it easier to handle grid disturbances and smooth variability by drawing on more generators over a wider area. These advantages of regional grids have made renewable energy integration much less challenging than once predicted.

These same benefits are expected across the western states included in the EIM, which, by adjusting generators every five minutes, allows for more economical balancing than in cases where power plant operation is less flexible. Some of this adjustment is needed to address the variability associated with wind and solar generation. Like other regional power grids, the EIM reduces variability by pooling resources; in other words, changes in wind speed or cloud cover are minimized when averaged across a wide area. And, by drawing upon a broader geographic range of generation resources, the EIM provides better generation-load balancing through economies of scale (NREL 2013).

Regional grid operators base their selection of generators on economic factors (which often include environmental permits) and transmission limits. The same tools these operators use to control the daily power supply also help them manage the addition of new generators to the grid, including

> [***Regional grids have made renewable energy integration much less challenging than once predicted.***]

FIGURE 3. Emissions Reduced Including Variability

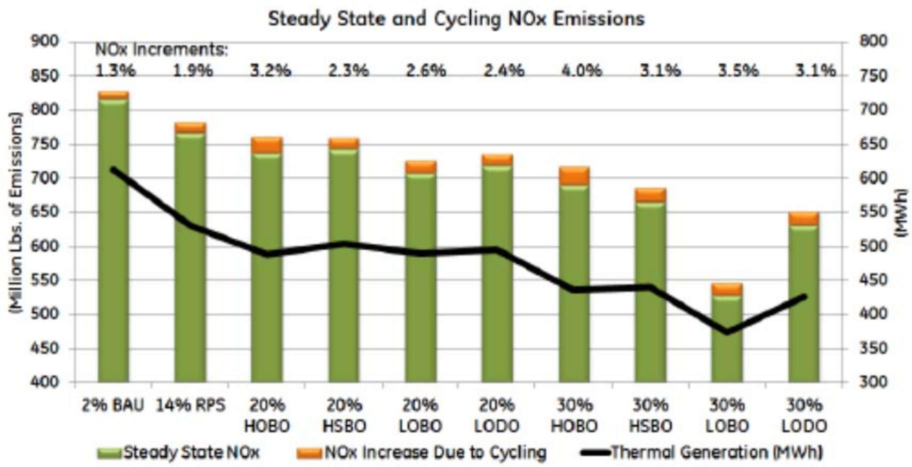


Figure 2-3: NOx Emissions for Study Scenarios, With and Without Cycling Effects Included

Close scrutiny of renewable generation variability in regional grids with high levels of renewable energy addresses the impacts on fossil plant emissions. GE and PJM found much greater amounts of emissions reduction (shown in green) from increased use of renewable energy than the small increase in emissions (shown in orange) from the cycling up and down of the fossil fuel plants.

SOURCE: GE ENERGY CONSULTING 2014.

wind and solar, and anticipate needs, costs, and savings 10 years into the future.

The regional grid operator's task of running the right number of generators at all times has always required complex problem-solving that takes numerous limits and conditions into account. For example, burning fuel to make steam for conventional power generation takes time, and larger plants need more time to heat up than smaller plants. Because fuel is the primary variable in terms of cost, the optimal power plant schedule is the one that has the lowest fuel costs while still providing a reliable supply.

Of course, wind and solar have no fuel costs. As grid managers have gained experience integrating wind and solar, they have adapted to use the least expensive electricity whenever it is needed. The fuel costs associated with coal- and natural gas–fired plants lead to those resources being displaced when wind and solar are available.

ISO STUDIES OF RENEWABLE ENERGY INTEGRATION

Regional grid operators, especially ISOs, provide a capable, centralized authority for studying changes in the grid. Starting in 2004, they began to include high levels of wind, and then high levels of solar, in their studies. The results, with renewable energy contributing between 10 and 30 percent of total annual supply, demonstrate the viability of adding renewables for the purpose of reducing CO_2 emissions (NREL 2102a).

These studies use the same computer modeling capabilities the regional power grids use in their planning and operations to help them understand the partial use, and cycling use, of fossil fuel–fired plants, and the associated costs and impacts. The studies that incorporate renewables explicitly address these operating costs and operators' need to maintain reliability.

In addition, regional ISO studies test how different development patterns for wind and solar may affect results in their particular power systems. The location of existing fossil fuel–fired plants and renewable energy facilities, for example, has some effect on operations and emissions savings, and changes in the renewables mix can also produce a modest difference in results. Furthermore, these studies estimate the additional transmission required by new generation capacity, and allow for different results based on comparative geographic scenarios.

IMPRESSIVE EMISSIONS REDUCTION RESULTS

A study of the 13-state region served by PJM illustrates how different levels of renewable energy additions can affect

TABLE 1. Greater CO_2 Reductions From Increasing Renewable Energy in the PJM Grid

Scenario	Reduction in Energy from Coal and Gas Plants Relative to Business as Usual	Reduction in CO_2 Emissions Relative to Business as Usual
14% Wind and Solar reflecting existing state RPS	15%	12%
20% Wind and Solar: best wind sites, 1/10 offshore wind, 1/5 from solar	20%	14%
20% Wind and Solar: 1/10 offshore wind, 2/5 from solar	18%	15%
20% Wind and Solar: best wind sites, 1/10 offshore wind, 1/5 from solar	19%	18%
20% Wind and Solar: wind in-state, 1/10 offshore wind, 1/5 from solar	18%	17%
30% Wind and Solar: best wind sites, 2/5 offshore wind, 1/5 from solar	35%	27%
30% Wind and Solar: 1/10 offshore wind, 2/5 from solar	31%	28%
30% Wind and Solar: best wind sites, 1/10 offshore wind, 1/5 from solar	40%	41%
30% Wind and Solar: wind in-state, 1/10 offshore wind, 1/5 from solar	30%	29%

While higher levels of renewable energy provide greater CO_2 reductions, studies show that there are differences in savings with different deployment of renewable generation on the system. The best results in the recent PJM analysis came from using more onshore wind than offshore wind, and solar providing one-fifth of the renewable energy.

SOURCE: GE ENERGY CONSULTING 2014.

emission reductions. In each case, higher levels of renewable energy always produced greater reductions in CO_2 (Table 1). For example, in a scenario in which wind and solar accounted for 14 percent of total supply, CO_2 emissions were reduced by 12 percent; a 20 percent renewable scenario led to CO_2 reductions of 14 to 18 percent. The best results were obtained by a 30 percent renewable mix that included the best onshore wind locations, a small amount of offshore wind, and solar providing one-third of the renewable energy; this scenario reduced CO_2 by 41 percent (GE Energy Consulting 2014).

Similarly, New England's ISO, which serves six states, found in its own regional study that a 20 percent contribution by wind would reduce CO_2 25 percent on average, and a 24 percent contribution by wind would lead to a 30 percent reduction (GE Energy Consulting 2010).

Recommendations for the States

As experience and sophisticated studies show, the levels of renewable energy described in the EPA's June 2014 draft rules do not represent a challenge to reliable grid operations where regional coordination is available. In reality, states can make even greater use of renewable energy and reduce their CO_2 emissions by a proportionally greater amount. Adding wind and solar to regional grids will not only help states comply with the EPA's CO_2 standards but also provide additional benefits such as improved public health and economic development.

State officials should adopt the following strategies when considering how to meet the power plant carbon standards:

- Recognize that ISOs have the best data and experience for predicting how high levels of renewable energy will affect the operation of the generating fleet and the resulting CO_2 emissions.

- Provide all parties (generation sector, transmission owners, regional grid operators, public utility commissions) with instruction on how renewable energy expansion in state implementation plans can achieve the needed CO_2 reductions.
- Work with regional grid operators to coordinate whatever changes are needed to bring additional generation online.

Solar panels are an excellent way to provide affordable and reliable electricity while complying with the power plant carbon standards set forth by the EPA. Photo Source: Flickr/MountainAsh

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