Wind, Solar, Nuclear, and the Southwest Power Pool: Why Nebraska Utility Decisions Matter

The last five years have seen monumental change in the way most Nebraska electric utilities operate. Nebraska utilities are members of the Southwest Power Pool (SPP), a multi-state regional transmission organization that matches electricity demand throughout the region with supplies generated at power plants operated by over 100 electric utilities. Since March, 2014, the decisions on which Nebraska power plants operate each day are largely made at the regional level by the Southwest Power Pool.

By the end of this year, the amount of wind energy generated in Nebraska will have tripled to 1,324 MW in less than 3 years. Large utilities like Omaha Public Power District and Lincoln Electric System, and smaller utilities like Grand Island Utilities are all embracing inexpensive wind energy.

Lincoln Electric System will soon be buying power from the largest solar photovoltaic facility in the state, and one of the largest in the region. Smaller communities like Kearney, Scottsbluff and Central City are hatching plans to install solar farms to serve local businesses and institutions.

Omaha Public Power District is considering whether to close the Fort Calhoun nuclear power plant, due to the high cost of producing electricity at America's smallest commercial nuclear power plant.

As we explain below, the environmental implications of these decisions differ from pollutant to pollutant. But in general, when Nebraska utilities add wind or solar energy to their mix, they reduce the amount of carbon and other pollution linked to climate change, although they *might not* reduce the other pollutants like sulfur dioxide that impact the health of local communities.

Should Omaha Public Power District close down Fort Calhoun nuclear plant, the net pollution impact depends on what actions OPPD takes to replace the energy and the capacity now coming from Fort Calhoun. Unless OPPD takes action to add renewable energy or reduce demand, one result will almost surely be an increase in carbon and other climate gasses spewed into the air.

New Wind and Solar Displaces Coal and Natural Gas

When Nebraska utilities close coal-fired units, as Omaha Public Power District is doing with respect to its North Omaha power plant, the environmental implications seem clear: fewer emissions of pollutants that impact the local area (like sulfur dioxide and soot), and fewer greenhouse gases like carbon dioxide.

But when Nebraska utilities invest in or approve power purchase agreements with wind farms without closing power plants powered by fossil fuels – as Lincoln Electric System has done – what are the implications? The answers come from an understanding of how the Southwest Power Pool calls on power plants throughout the region to meet demand.

On a day-ahead basis, the Southwest Power Pool takes information from each participating utility on what its projected load will be on an hourly basis, and combines those. Each utility also provides information on which of its facilities can supply power the next day, and a bid on what that utility would need to get paid to supply power. Typically, the bids are set based on the marginal cost of the unit (the fuel and other incremental costs of producing the electricity). Using those bids, and adjusting to account for transmission congestion and other factors, the SPP then schedules the power plants which will meet the load at the lowest cost for that day.

The net result is that utility customers region-wide get electricity generated at the lowest marginal cost.

Nuclear power plants have very low fuel costs (and are difficult to turn on and off), so they are some of the first power bid in. Wind and hydroelectric energy have no fuel cost and very low operating cost, so they are the next power in. Coal-fired power plants and gas-fired combined cycle plants are generally the next in line, depending on their fuel and operating costs. Coal-fired power plants closest to low cost coal mines are some of the first coal-fired power plants called upon; those further away have higher delivered coal costs.

Natural gas plants tend to have higher operating costs than coal-fired power plants. The highest cost resources, including natural gas turbines and oil-fired generators, are typically the last resources called upon. Those are considered 'peaking units', and are typically only used when demand peaks.

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Solar power in the SPP region comes from smaller facilities that are 'behind the meter'; that is, the power is provided directly to the customer or the local utility, rather than going through the transmission system. As a result, it reduces that utility's daily and hourly demand, but is not dispatched by SPP.

When Nebraska utilities bring a new wind farm online, it will provide power that goes into the SPP queue. Since wind is some of the lowest marginal cost power, that will bump another power generator from the queue, because its power won't be needed. Since wind, hydrelectric and nuclear cannot yet supply 100% of SPP needs at any one time[1], what will almost always get bumped is electricity from either a natural gas or coal-fired power plant somewhere in the region.

In the summer when demand is high, new wind power would often displace natural gas. In seasons when demand is lower, new wind power could displace coal-fired generation. With over 800 generating units spread out across the SPP region, it is unlikely that the reduction in generation on a particular day will come from a Nebraska power plant. SPP utilities have a combined generating capacity of nearly 79,000 MW – over ten times the annual total peak demand for the state of Nebraska[2].

[1] In March, 2016, Southwest Power Pool reported a one-day peak for wind when it was providing 45% of SPP's energy. Nuclear power provides about 8% of SPP electricity, and hydroelectric about 4% of SPP electricity.
[2] Southwest Power Pool web site, www.spp.org.

Solar PV generates much of its power during summer days when energy demand is peaking, so solar would likely displace relatively more natural gas versus coal-fired generation (compared to wind), by reducing the utility's effective summer demand.

What we conclude is that when Nebraska utilities add wind or solar generation:

* ***Global impacts from greenhouse gases*** like carbon dioxide and nitrous oxide are ***almost certainly reduced***, as CO2 and NOx pollution would be reduced somewhere in the region;

**** Local impacts from pollutants like soot and sulfur dioxide*** will likely be reduced someplace in the region, but likely a small portion of that reduction would occur in Nebraska.

* To reduce the local health and environmental impacts from coal-burning power plants, Nebraska utilities ***must do more than simply add wind or solar***, they must add pollution control equipment, reduce their operations or shut down the fossil-fueled plants.

One caveat to this analysis is that while the Southwest Power Pool is the primary means for Nebraska utilities to sell electricity, it is not the only means. When utilities are priced out of the SPP queue, they may try to sell their power to a buyer in another region. That would presumably displace coal or gas-fired generation from that region, so should still result in a net reduction in global pollution, but not local pollution.

Closing a Nuclear Plant Could Increase Air Pollution

Omaha Public Power District (OPPD) management has proposed closing the Fort Calhoun nuclear power plant. OPPD management cites the high cost of generating power from the plant, and the cost of investments likely needed to keep it running safely, as concerns driving the decision.

As noted above, nuclear power has low marginal costs because of the relatively low cost of fuel. However, high fixed costs, including staff, security, and capital, can significantly raise the total cost of power from a nuclear power plant. The Southwest Power Pool reports that in 2015, the average cost of electricity bought from or sold into the SPP system was $28 per megaWatt hour (MWH). If the long-term costs of operating Fort Calhoun are significantly above that, it would explain why the proposal to close down the plant would save money.

Once Fort Calhoun went off-line, the SPP system would have 480 MW less of nuclear power in the mix. Since wind and nuclear is already called on ("dispatched") first, and currently is not enough to meet even the smallest daily SPP load, the SPP would likely call on a gas-fired or coal-fired power plant to fill the gap on any particular day or hour. In the high-load days of summer, that would more likely be natural gas; in the lower-demand spring and fall, that would more likely be coal.

Since Nebraska power plants represent a very small portion off all SPP capacity, it would seldom (but sometimes) be an in-state power plant dispatched.

With respect to air pollution[3], we conclude that, absent OPPD taking other action, due to the closure of Fort Calhoun nuclear power plant:

* ***Global impacts from greenhouse gases like carbon dioxide and nitrous oxide would almost certainly increase***, as CO2 and NOx pollution would increase somewhere in the region;

* ***Local impacts from pollutants like soot and sulfur dioxide*** would increase someplace in the region, but likely only a small part of that increase would occur in Nebraska.

* ***To reduce the global or local health and environmental impacts*** caused by shutting down Fort Calhoun, OPPD (or other Nebraska utilities) would need to bring on additional renewable energy, or reduce the demand for electricity through energy efficiency or other efforts.

Options for Offsetting Impacts

There are affordable options to fully offset the greenhouse gas impact of closing Fort Calhoun nuclear station. At 480 MW, Fort Calhoun would generate almost 3.8 million MW hours operating at an average of 90% capacity factor.

Wind: 960 MW of wind turbines, operating at 45% average capacity factor, would generate that same amount of electricity in a year. The electricity would be generated at different times of the year, but would offset over time approximately the amount of pollution that would otherwise be generated to replace the electricity lost from Fort Calhoun. Recent wind contracts in Nebraska are estimated to be in the 2.0 to 2.5 cents per kilowatt hour range based on industry sources.

Energy Efficiency: The Fort Calhoun nuclear station generates around 30% of OPPD's load. An aggressive energy efficiency program designed to offset 3% of OPPD's load each year could offset the power supplied by Fort Calhoun in about a decade. The cost of energy efficiency depends on the measures used, but state energy efficiency program costs range from 2 cents to 4.5 cents, and average about 2.8 cents per kilowatt hour[4].

Solar: 2,160 MW of solar photovoltaic, operating at 20% average capacity factor[5], would also generate that same amount of electricity in a year. The electricity would be generated in a load pattern that better matched OPPD's demand (more power in the hot summer months), but at current prices would be more expensive than wind or energy efficiency.

Smart Grid: Investments in smart meters, smart transmission and distribution technology, and other "smart grid" applications can substantially improve the efficiency of OPPD's electrical delivery system,

[3] Power plants impact other resources, including water supplies, water pollution, and in the case of nuclear power, the disposal of high level and low level radioactive waste and accidental release of radioactivity. We do not dismiss these impacts, but the purpose of this analysis is limited to trade-offs with respect to air pollutants.

[4] American Council for an Energy Efficient Economy, *The Best Value for America's Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs*, March, 2014, Washington, DC.

[5] 20% is Based on National Renewable Energy Laboratory utility-scale capacity factor for solar photovoltaic; concentrated solar technology has a capacity factor closer to 40%.

reducing the energy and capacity needed. Smart Grid technology can also help industrial, commercial and residential customers reduce their energy use and improve reliability. New energy storage solutions are coming online that will allow utilities to store intermittent energy sources like wind and solar, and better meet system demands.

Each of the approaches above has its advantages and disadvantages. Each would help replace the *energy* (kilowatt hours) from Fort Calhoun, but the approaches differ in how adequately they would help replace the *capacity* of Fort Calhoun (the ability to help meet demand when it is highest).

A more balanced approach to replacing the carbon-free electricity from Fort Calhoun could involve:

- 600 MW of new wind capacity;
- 50 MW of new solar capacity; and
- An OPPD-wide energy efficiency initiative designed to reduce 2% of OPPD's customer load per year (220,000 MW hours) on an annual basis; and
- An OPPD-wide initiative to install and use Smart Grid technologies in generation, transmission, distribution, storage and end use.

Together, these cost-effective measures would be producing 3.8 million MWh of electricity by the sixth year, and even more as the energy efficiency initiative and Smart Grid implementation continues. The wind and solar generation would also provide some creditable capacity for OPPD to help meets its obligations to Southwest Power Pool. The energy efficiency initiative and Smart Grid applications, including new energy storage techniques, should reduce the amount of peak load demand on the OPPD system, reducing OPPD's capacity obligation.

Taken together, they would continue to move Omaha Public Power District towards a clean energy future, ensure that OPPD could meet new environmental regulations, deliver jobs in OPPD's territory and other parts of Nebraska, keep dollars in local communities, keep monthly bills some of the lowest in the nation and ensure a stable, reliable system.

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