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Electricity Generation in North Carolina:

Explaining the Trends

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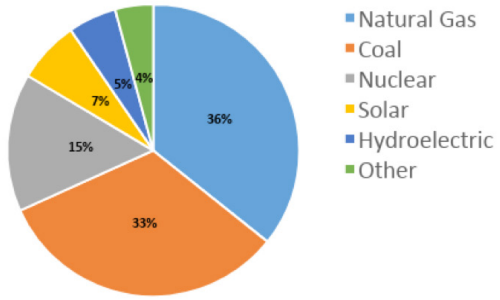
Total electricity generation has remained flat in the United States for the past dozen or so years. But the way we as a nation generate electricity has changed dramatically.

Figure 1. Electricity Generation Capacity in North Carolina in 2016



Source: Energy Information Agency's Electric Power Annual 2016

North Carolina is no exception to trends in changing electricity generation profiles. Like many other regions in the U.S., North Carolina's electricity sector has experienced rapid decline in coal-fired generation and a concurrent increase in generation from natural gas-fired power plants and from renewable energy sources, particularly solar photovoltaics (PV).

In this article, I will discuss the market forces and policies that are driving these rapid changes in electricity generation. I will also discuss how some recent developments, namely the passing of state energy bill HB 589 and the possible construction of the Atlantic Coast Pipeline, may affect North Carolina's energy future.

North Carolina's Electricity Generation Mix

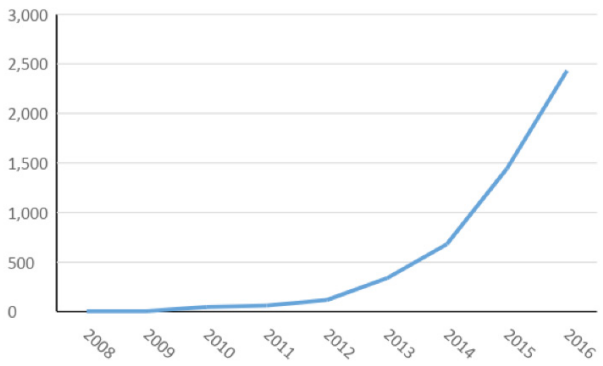
Like the rest of the U.S., about 70 percent of North Carolina's installed generation capacity is from fossil-fuel plants (coal and natural gas, see Figure 1). However, NC's fossil fuel capacity mix is skewed more toward coal than the national average: Nationally, coal- and natural gas-fired plants make up about 25 percent and 44 percent of the total installed generation capacity, respectively, whereas for North Carolina the figures are 33 percent and 36 percent. North Carolina also bucks national trends in its share of capacity from nuclear plants (15 percent compared to the national average of 9 percent) and from solar (7 percent compared to only 2 percent nationally). What is perhaps even more interesting is that less than a decade ago, North Carolina had essentially no solar capacity, but in recent years has seen exponential growth in the sector (see figure 2). The state now has the second highest level of installed solar capacity.

How did the state get to such a high level of installed solar capacity?

In part, it reflects the fact that the cost of solar energy generation has been falling over time. But North Carolina also has two policies that have significantly helped its solar industry. First, the state passed a renewable portfolio standard in 2007 that requires 12.5 percent of the state's 2020 retail power sales come from renewable sources. Second, and more importantly, North Carolina has had favorable terms for solar under the Public Utilities Regulatory Policy Act (PURPA) of 1978. PURPA requires utilities to buy power produced from independent power producers (IPP) that operate qualifying facilities (QF's). These QF's tend to be small renewable generation sources. While the act established these general objectives, it left it up to states to determine the details of what passed for a QF and to establish the terms of the Power Purchasing Agreement. North Carolina established a relatively large maximum size of 5 megawatts (MW) for solar facilities that could still pass as a QF. The length of the North Carolina's Power Purchasing Agreement under PURPA were also relatively long — 15 years — compared to more standard 5to 10 years in other states. As a result of the favorable PURPA arrangement, North Carolina has the highest installed capacity of PURPA-qualifying solar in the country and IPP-owned solar makes up about 90 percent of the state's solar capacity.

While the growth in solar capacity installations has been impressive in North Carolina, it can be misleading in terms of the importance of solar in actually generating electricity. Despite being 7 percent of total capacity, solar generates less power than is derived from hydroelectric sources (which account for only 5 percent of capacity), and about the same as generated from petroleum, biomass, wood pellets, wind and other non-conventional sources combined. How can it be that we derive so little generation from solar given it makes 7 percent of the total installed capacity? The reason is that solar is non-dispatchable generation — meaning that we do not, in general, get to decide when we generate power from solar facilities like we do for dispatchable technologies such as gas- and coal-fired plants. Instead, we get power from solar sites when the sun shines; as such, the capacity utilization rate — the actual amount of energy generated divided by the maximum amount that could be generated — for solar facilities is relatively low. In North Carolina, the average capacity utilization rate of the installed solar is about 20 percent, which is close to the national average.

Figure 2. Solar Generation Capacity in North Carolina, 2008-2016 (MW)

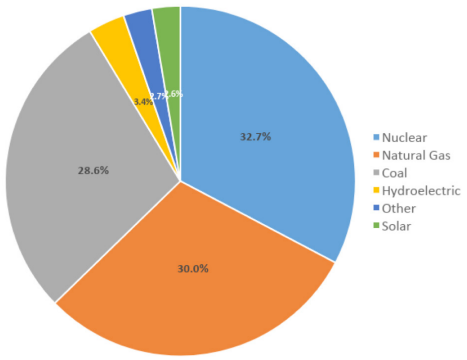


Source: Energy Information Agency's Electric Power Annual 2016

As shown in Figure 3, North Carolina gets about 90 percent of its generation from coal, gas, and nuclear facilities, with each now contributing about 30 percent toward total generation. These three generation technologies have combined to generate 90 percent or more of the state's electricity for the last 25 years. What has changed substantially though is the relative shares coming from coal and natural gas fired plants. Just a decade ago, coal was king in North Carolina, accounting for about 60 percent of total generation (see Figure 4). At the same time, gas generation was barely on the radar, contributing less than 10 percent of total generation. From 2008 on, these positions began to change rapidly. Coal-fired generation in North Carolina is now about half of what it was in 2008, while gas-fired generation has increased 9 fold over that time period.

Now the generation of these two sources are roughly the same. This, of course, prompts the question of what is driving this major shift in generation sources. Renewable generation from wind and solar is often cited as a reason for the decline in coal-fired generation, but as noted above North Carolina only gets about 2.5 percent of the total generation from wind and solar. We also hear a lot about the "war on coal," implying that regulators, particularly those at the EPA, are a major reason for coal's declining importance in the state (and nationally). While it is true that the regulatory environment, particularly as enforced in previous administrations, has been unfavorable toward coal generators, previous research I have done with my colleague Dan Kaffine suggests that market forces, particularly falling natural gas prices, are more at play here (Fell and Kaffine 2017).

Figure 3. Actual Electricity Generation Shares in North Carolina by Source, 2016

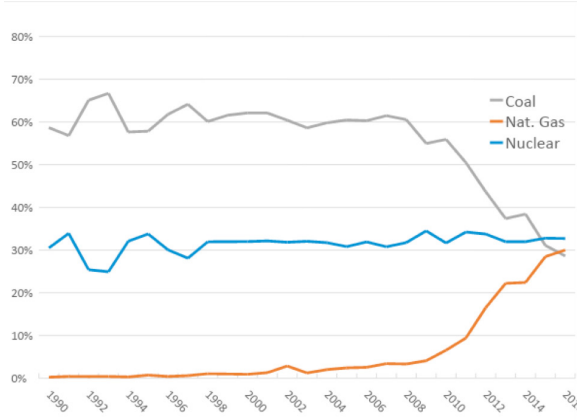


Source: Energy Information Agency's Electric Power Annual 2016

Looking at Natural Gas

The wide-spread use of hydraulic fracturing — or fracking — in the oil and gas sector that began at the end of 2008 has massively increased oil and gas production in the U.S. Since there is only a limited amount of international trade in natural gas, that gas stayed in domestic markets. The resulting supply glut caused gas prices to drop from around $9 per million Btu (MMBtu) in 2008 to the $2-$4/MMBtu range we have seen from 2009 to now. Meanwhile, coal prices have remained relatively constant over that same time period. Kaffine and I analyzed this natural gas supply shock, along with the growth in renewable generation, particularly wind generation, in many parts of the U.S. to see how these two factors have led to the decline of coal-fired generation. More specifically, we conducted a rigorous statistical analysis of coal-fired generation using generating-unit level data across several different regions of the U.S.—including regions with substantial levels of renewable generation. We then conducted a "counterfactual" analysis to determine the role that falling natural gas prices and rising wind generation has played in reducing coal generation.

Figure 4. Historical Electricity Generation Shares by Source in North Carolina



Source: Energy Information Agency's Electric Power Annual 2016

To do this counterfactual analysis, we predicted what average capacity utilization rates of coal-fired generators would have been in each region in 2008 had that region seen the much lower 2013 natural gas prices, the much higher 2013 renewable generation levels, and had the region seen both the 2013 gas prices and 2013 renewable levels. We then compare this to observed 2013 capacity utilization levels to get a sense of how much of the observed fall in coal was due to these factors. Our results indicate that the majority of the decline in coal-fired generation from 2008 to 2013 can be attributed to falling natural gas prices in each region. Renewable generation played a lesser role in most regions, though it did still displace significant amounts of coal. And, the combination of low gas prices and increased wind generation account for almost all of the decline in coal-fired generation in the regions we explored.

While we did not analyze regions that included North Carolina, the patterns of generation and prices look similar here to the regions we did explore. As such, it would appear very likely that North Carolina's fall in coal-fired generation is also primarily driven by falling gas prices.

Moving Forward

There are a couple of major energy-related interventions that may alter the solar growth trend and may reinforce the coal-to-gas trend. One of these significant actions was the passage last summer by state legislature of House Bill 589, "Competitive Energy Solutions for North Carolina." While the bill covers many energy-related issues, there are several aspects of it that will affect solar growth. First, it lowers the Purchasing Power Agreements under PURPA from 15 years to a maximum of 10 years. While a 10-year term is more in line with other states, this term reduction clearly hurts solar developers by reducing the long-range certainty that they previously were afforded.

HB 589 also alters the PURPA arrangement by lowering the maximum size of a Qualifying Facility from 5 MW to 1 MW. To put the ramification of this into perspective, about 50 percent of Independent Power Producers operating solar facilities in the state have capacities of exactly 5 MW. This implies that for many facilities it is economically advantageous to install the largest system possible to still be a Qualifying Facility under PURPA. Reducing that maximum size would then make proposed facilities similar to these existing ones less attractive. In addition, HB 589 states that after a public utility has set up contracts under PURPA with QF's totaling 100 MW in capacity, the maximum system size for a QF will fall to 0.1MW (100 KW). At such a small size, many new developments will not be economically viable.

However, HB 589 is not all doom and gloom for the solar industry. It requires Duke Energy to procure 2,660 MW of renewable power over the next 45 months, and most if not all of this power is expected to be generated by solar facilities (the 2,660 MW limit may also be adjusted up or down depending on the amount of renewables installed outside of this mandate). This solar power will be procured under a competitive bidding process, as opposed to standard contract rates that are offered under PURPA. Beyond this 45-month window, it is clear that solar will be supported to a lesser degree in the state. Future growth of the sector will then depend largely on how fast solar capacity costs fall.

The Atlantic Coast Pipeline (ACP) is the other major energy-related intervention on the horizon. The ACP is a proposed pipeline, largely being developed by Dominion Energy and Duke Energy, that would carry natural gas from gas-rich West Virginia across Virginia and down through eastern North Carolina. While the ACP is still in the process of clearing regulatory hurdles, I would be very surprised if it is not approved. What would it mean for electricity generation in North Carolina? I foresee two significant potential impacts. First, to the extent it brings cheaper natural gas to the state, it should further push the generation mix from coal- to natural gas-fired production. Second, many of the solar contracts Duke Energy offers to developers hinge on "avoided cost of electricity," which is the cost that Duke Energy would incur to generate if it did not buy the solar power. With lower gas prices, the avoided cost falls, and this in turn would lower incentives for some solar development.

In summary, the electricity sector in North Carolina has been among the more dynamic in the U.S. Where it goes from here will largely depend on the price of natural gas, the level of federal and state support for renewable power, and the rate of cost decline for renewable generation, particularly for solar generation. What I am more confident about is that in 10 years time our electricity sector will likely look as drastically different as today's sector looks compared to 10 years ago.

Research Cited

Fell, H. and D. Kaffine. 2018. "The Fall of Coal: Joint Impacts of Fuel Prices and Renewables on Generation and Emissions." American Economic Journal: Economic Policy (forthcoming).