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Pennsylvania's electricity production in the face of artificial intelligence

Introduction: In a previous *Policy Brief*, the question was posed: Can Pennsylvania's energy supply keep up with demand? This question came about as the subject of artificial intelligence (AI) was just entering into the lexicon and leaders were grappling with how Pennsylvania might capitalize on the fast-growing technology.

In this *Brief*, the amounts of electricity generated, and the sources used to produce it, will be examined. The growth rates in Pennsylvania over the years will be compared to the United States. More importantly, will Pennsylvania be positioned to capitalize on the growth of power-hungry AI data centers?

All data come from the U.S. Energy Information Administration (EIA). EIA data for electricity generation goes back to 1990 with the most recent data being for 2024.

Electricity generation in Pennsylvania

In 1990, more than 175.6 million megawatts of electricity were generated from all sources across Pennsylvania. By 2024 generation grew by 37.5 percent to reach 241.5 million. Breaking that down over the last three 10-year periods, the growth from 1994 to 2004 was 16.6 percent, just 2.97 percent from 2004 to 2014 and then that growth accelerated by 9.26 percent from 2014 to 2024.

Nationwide, the growth from 1990 to 2024 was a bit faster at 41.8 percent, going from 3.04 billion megawatts to approximately 4.31 billion. The national growth during those same 10-year periods was, 22.3 percent, 3.10 percent and then 5.25 percent.

The pickup in generation in the years from 2014 to 2024, both nationwide and in Pennsylvania, may be a direct result of the emergence of AI and the data centers needed to house the large number of computers to produce it. As noted in that earlier *Brief*, AI queries require 10 times the amount of energy as a traditional web-based query.

But that uptick may not be fast enough. That *Brief* further goes on to say "…new data centers are being built that would consume anywhere from 100 to 1,000 megawatts of energy—roughly the equivalent of 80,000 to 800,000 homes…." This steep increase in demand will be a challenge.

Electricity generation by source

As these data centers proliferate across the state and country, it will take all sources of electricity generation to make them work.

In 1990, the major source of electricity generation in Pennsylvania was coal which was responsible for 60 percent of the megawatts produced—106.7 of 175.6 million. Nuclear generation followed at 33 percent followed by petroleum at 2.6 percent. Natural gas came in at 1.6 percent. Solar and wind power didn't even register at that time.

By 2000, the percentage of electricity being generated by coal had dipped to 57.2 percent. That decline would accelerate over the next 24 years dropping to just 5.4 percent of the state total.

Natural gas in 2000 remained a small source of generation, at just 1.34 percent of statewide generation. However, it grew steadily to reach nearly 15 percent in 2010 before leaping to 52.5 percent in 2020. In 2024, natural gas generation accounted for nearly 60 percent of Pennsylvania's total electricity generation—taking coal's place as the main source of generation—undoubtedly the result of drilling and extraction from the shale formations beneath the state.

It is worth noting that nuclear generation remained consistent throughout the 1990-to-2024-time frame, ranging from 36.6 percent in 2000 to 31.2 percent in 2024. Wind generation wasn't recorded until 2001 (0.01 percent). Its high-water mark was 1.7 percent in 2017 and in 2024 came in at 1.4 percent of total generation. Solar generation didn't register until 2011 (0.01 percent) and in 2024 remains at less than one-half percent of statewide generation.

Nationally, coal generation consisted of 52.5 percent of the total in 1990 before falling to below 50 percent in 2004 and then fell to just 15 percent of all megawatts generated in 2024. In 1990 natural gas accounted for 12.3 percent of all electricity generation and slowly rose to 43.4 percent in 2024.

Much like in Pennsylvania, nuclear generation nationwide has remained steady over the decades. It accounted for 19 percent in 1990 and comprised 18.2 percent in 2024. Wind and solar generation also mirrored the Pennsylvania growth. Wind production was just a very small fraction of that national total in 1990 (0.09 percent) before slowly increasing to 9.2 percent in 2024. Solar generation was a very small portion of production from 1990 until 2017 when it finally crested 1 percent (1.3 percent). In 2024 it peaked at 5 percent of total production.

Facilities and generators

According to the EIA, a facility is defined as a planned or existing location where generators create electric energy. A facility may contain one or more generators. A generating unit operates to produce electric power.

Pennsylvania's number of facilities rose 40.5 percent from 1990 to 2024 while nationally the increase was much larger at 151.4 percent. In both, the number of coal facilities fell by two-thirds. Natural gas facilities rose by a larger percentage in Pennsylvania (94 percent) while nationally they rose only 50 percent.

Nationwide, the largest jump in facilities happened with solar and wind. In 2010 there were 118 solar facilities and by 2024 that spiked to nearly 6,500. Wind facilities jumped from 576 to 1,356

over that same period. Despite this large increase, they are only producing 5.10 percent and 10.5 percent of the nation's total amount of megawatts, respectively.

At the Pennsylvania level, data on the number of generators begin in 2011. From 2011 to 2024 the number of generators in Pennsylvania increased by 19 percent. Once again, the number of coal generators dropped (78 percent) while the number of natural gas generators increased (96 percent).

Nationwide, the number of generators during that period grew at twice the rate of Pennsylvania—45 percent—in large part to the boom in solar and wind generators. Once more, the number of coal generators fell dramatically (67 percent) while the number of natural gas-powered generators rose by 20 percent.

Implications

AI data centers have placed the spotlight on electricity production as states race to accommodate the emerging, electricity-hungry industry.

But there are many questions surrounding the ability to accommodate them. The first regards the grid itself. Can it handle these large data centers' demand and can it handle any new generation facilities that come online?

Will any strain on the grid because of these data centers affect existing customers, not just reliability, but in the cost of energy? Large increases in demand will cause market prices to rise, assuming the supply remains constant or doesn't keep up. In that earlier *Policy Brief*, it was mentioned that it is quicker to build a data center than it is to build a generating facility and get it connected to the grid to meet that demand.

A simple solution is to allow the data center operators to build their own energy-generating facilities behind the meter, also known as the bring-your-own-power model. This keeps the data centers off the grid. While this makes sense on the surface, any such move would require the permission of the Pennsylvania Public Utility Commission as well as the Federal Energy Regulatory Commission. Both held technical conferences on the topic in November 2024.

While noting the issues and possibilities of behind-the-meter generation will pose, both technical conferences explored the option and recognized it may be the best solution to power these large data centers. What they decide still hasn't been settled. But time is running out as the demand for artificial intelligence in computing is growing rapidly.

Frank Gamrat, Ph.D., Executive Director

Allegheny Institute for Public Policy
305 Mt. Lebanon Blvd.* Suite 208* Pittsburgh PA 15234
Phone (412) 440-0079
E-mail: aipp@alleghenyinstitute.org
Website: www.alleghenyinstitute.org
X (Twitter): AlleghenyInsti1