Upgrading America's Energy System

America's industrial success was built on affordable and abundant access to energy – driven by coal. However, our energy infrastructure is aging and nearly obsolete: hundreds of coal power plants will be 60 years old or older by 2040, as shown in Figure 1. Many coal plants are nearing the end of their expected lifespan and need to be replaced with the next generation of cost-competitive and abundant energy. It makes sense to do this at the existing plant sites where the people and infrastructure are in place to produce energy. While some coal plants may be replaced with new clean coal technology, environmental regulations, cheaper natural gas, and depletion of mine mouth coal are significant challenges. Plants are shutting down, jobs are being lost, and local communities are suffering.

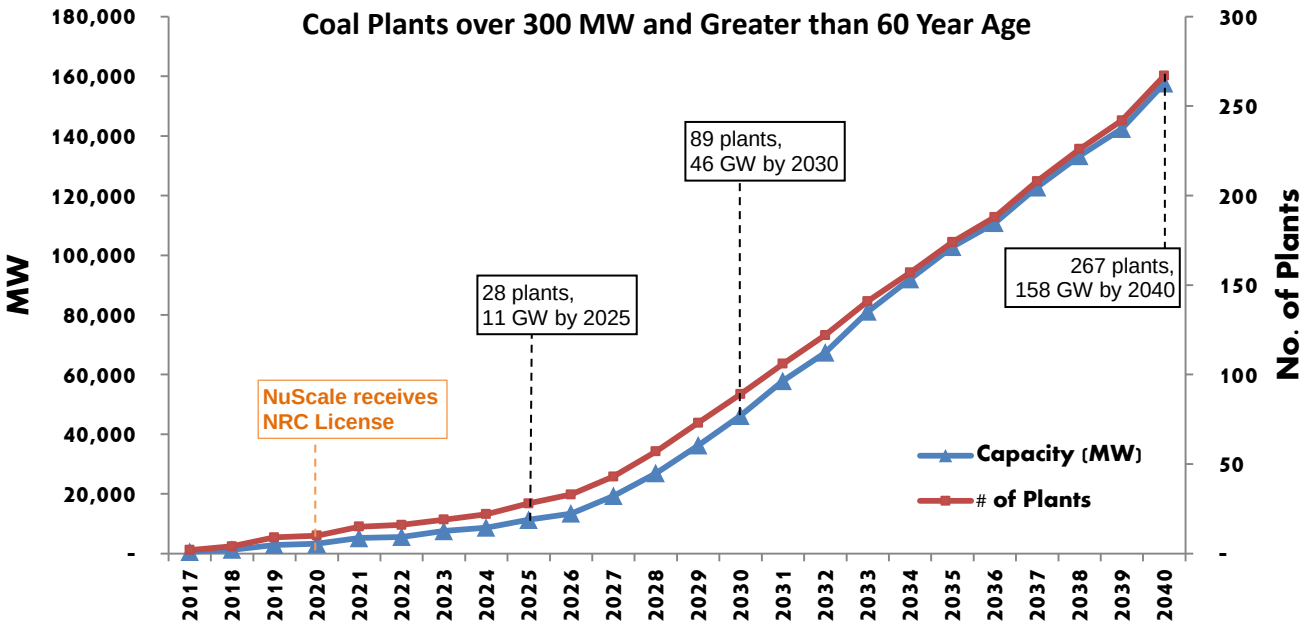

Figure 1: *The cumulative capacity and number of coal power plant projects that are expected to retire from 2018 to 2040 in the United States. Retirement and decommissioning of a project is assumed to occur after 60 years of operation and only coal plants above 300 MW in capacity are considered.*[1]

Revitalizing our electricity generation infrastructure presents an opportunity to upgrade America's energy system. It is time to turn to advanced energy sources that will provide economical, reliable, and abundant energy and cleaner air for the next 60 years. Repurposing retiring coal plant sites with small modular reactors (SMRs) can provide cost-competitive and secure electricity, foster economic development, and create more and higher-paying jobs.

The NuScale Power Plant is designed to house up to twelve, 50 MWe SMRs for a total gross capacity of 600 megawatts-electric (MWe). With a footprint of fewer than 74 acres, the NuScale Power Plant is an ideal size to replace aging coal power plants and utilize the existing energy infrastructure and human capital, without any changes in existing regulation. The reactors and attendant equipment (collectively known as the NuScale Power Module™) are fully factory manufactured and shipped to the facility site without the need for on-site construction or fabrication. This factory fabrication significantly reduces the project and construction schedules, costs, and risks. Their operation is also flexible to allow for meeting the intermittent capacity needs of today's electric grid. The U.S. Nuclear Regulatory Commission (NRC) is currently reviewing the application to certify NuScale's design. The license is planned to be issued in July 2020, which means that NuScale Power Plants can be in operation by the time many coal plants start reaching retirement age in the U.S.

Jobs

As a case study, let's examine the San Juan Generating Station, which is a four-unit coal power plant in New Mexico with a net capacity of 1683 MWe supplying electricity to about two million people in the Southwest. The facility employs 410 people along with an additional 360 people at the nearby coal mine that supplies the coal to the facility. Two of the four units are shutting down by the end of 2017 to comply with existing environmental regulations for air quality. Jobs will be lost and the local community will suffer a significant economic impact.[2]

This facility, like many other coal plants around the country, will likely be replaced with a combined cycle natural gas plant at that site or elsewhere on the Western grid. Natural gas is a good replacement right now because of the current low price, but the price of natural gas has historically seen considerable variability and our energy security is at risk by relying too heavily on one fuel for electricity generation. In addition, a natural gas fueled plant employs significantly fewer people on a per MW basis compared to the current coal fueled facility, even when the gas plant has a higher output than the coal plant. A NuScale Power Plant located on the site of the retired coal facility would actually increase the number of jobs and their wages, as shown in Table 1.

Table 1: *Comparison of employment and life cycle cost and environmental impact of various power plants*

	Coal Power Plant	Natural Gas Combined Cycle Power Plant	NuScale Power Plant
Plant Employees (per 600 MWe)[3]	146	24	360
Average Annual Wage for Plant Staff[4]	$71,800	$75,130	$89,940
Levelized Cost of Electricity ($/MWh)[5] [with CCS]	[$140]	$57 [$85]	$86
SO_x (mg/kWh)[6]	6700	300	11
NO_x (mg/kWh)[6]	3350	550	9
PM2.5 (mg/kWh)[6]	9210	100	~0
Greenhouse Gas Emissions (CO_2-equivalent (g/kWh) [with CCS][7]	1025 [167]	492 [167]	15

Economic Benefits

The Energy Information Administration projects that all new coal plants will need to be built with carbon capture and sequestration (CCS) technology to adhere to federal regulations, thus bringing the levelized cost of electricity (LCOE) to $140 per megawatt-hour (MWh) for new coal plants. By comparison, new advanced combined cycle natural gas plants will have an LCOE of $57, or up to $85 with CCS. A NuScale Power Plant is expected to have an LCOE of $86/MWh. While the levelized cost of a natural gas plant without CCS is lower compared to a new NuScale facility, gas prices have historically been volatile and could increase dramatically over the next 40 years. In addition, stricter regulations on emissions could further drive up the cost of natural gas plants.

In comparison, building and operating a nuclear power plant brings direct economic benefits to the community it serves. Better and higher-paying jobs allow citizens to invest more locally, creating a stimulus for the regional economy. On average, a nuclear power plant generates $470 million in sales of goods and services in the local community and pays about $16 million in state and local taxes, which can benefit schools and infrastructure.[8] In addition, a NuScale Power Plant creates more than a thousand jobs over a 3 to 4 year period during on-site construction of the plant.

The supply chain for NuScale's technology resides in the United States. Investment in NuScale's nuclear technology boosts the national economy by supporting potentially 12,000 jobs in the domestic nuclear supply chain. NuScale Power Modules™ fabricated in the U.S. can be exported to the many other countries interested in building nuclear power plants, with the potential to generate billions of

dollars in exports per year to help reduce the trade deficit. Exporting nuclear technology would help restore U.S. leadership in nuclear energy and nuclear security.[9]

Environmental Impact

Environmental regulations are causing many coal plants to shut down. Replacing coal units with small modular reactors would result in cleaner air and therefore easier adherence to regulations on emissions for years to come. Table 1 shows the relative comparison of air pollutants – sulfur dioxide (SO_2), nitrogen oxides (NOX), and particulate matter (PM2.5) – emitted during the life cycle of coal, gas and nuclear power plants per kilowatt-hour (kWh). NuScale's power plants emit no harmful air pollutants during operation and very little over their life cycle.

Nuclear energy also has a significantly smaller environmental impact than coal and natural gas, from mining (or extraction) to waste. Over the entire life cycle, coal plants produce an average of 1025 grams of gas emissions (in terms of CO_2-equivalent) per kWh that is directly emitted into the environment and natural gas plants emit about 492 g/kWh. This amount is reduced to an average of 167 g/kWh with CCS for fossil-fueled plants but nuclear plants still emit much less, only about 15 g/kWh. In addition, the 600 MWe NuScale Power Plant has a total footprint of only 74 acres and an emergency planning zone contained within the site boundary.[10] This means that NuScale Power Plants can be built directly on existing coal plant sites.

It's time to upgrade America's energy system and invest in the deployment of new nuclear technology to replace aging coal plants. This transition would keep and increase jobs, provide economic benefits for plant communities and the country, and result in cleaner and clearer air. NuScale's technology is only a few years away from deployment, so we must act now to foster government and public support for this effort.

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[1] GlobalData Analysis for NuScale Power

[2] PNM San Juan Generating Station Factsheet: https://www.pnm.com/documents/396023/440009/San+Juan+plan_fact+sheet.pdf/a37f9be1-f592-4437-b98b-54414ad3fff2

[3] Sources for sample plant staff: Utah Associated Municipal Power Systems (UAMPS); NuScale Power

[4] Occupational Employment and Wages, May 2015, Bureau of Labor Statistics

[5] Estimated Average US Levelized Cost of New Generation Resources (2022 costs in 2015 $/MWh). Source: U.S. Energy Information Administration; NuScale LCOE Model for nth of a kind.

[6] Masanet, E. et al., "Life-Cycle Assessment of Electric Power Systems," Annu. Rev. Environ. Resour. 2013. 38:107–36; Spath PL, Mann MK, "Life cycle assessment of a natural gas combined-cycle power generation system," National Renewable Energy Laboratory, 2000.

[7] International Atomic Energy Agency, Nuclear Power and Climate Change, 2016

[8] Nuclear Energy Institute, Economic Benefits: https://www.nei.org/Why-Nuclear-Energy/Economic-Growth-Job-Creation/Economic-Benefits

[9] For more information see Third Way, "Getting Back in the Game: A Strategy to Boost American Nuclear Exports" http://www.thirdway.org/report/getting-back-in-the-game-a-strategy-to-boost-american-nuclear-exports

[10] Source: NuScale Power; includes plant protected area, cooling towers and out-buildings