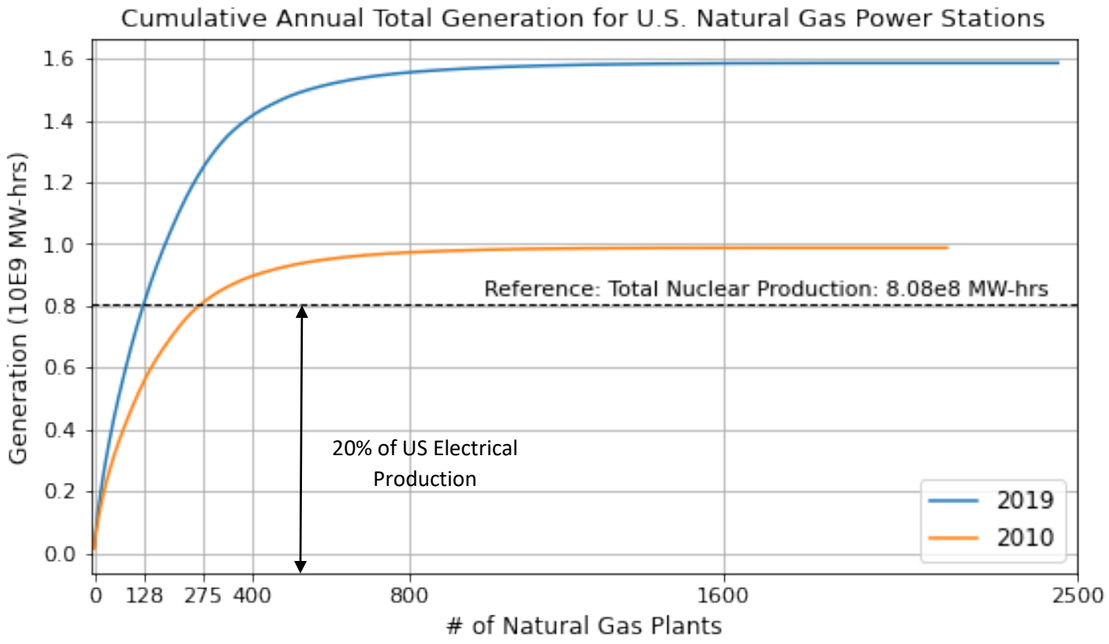
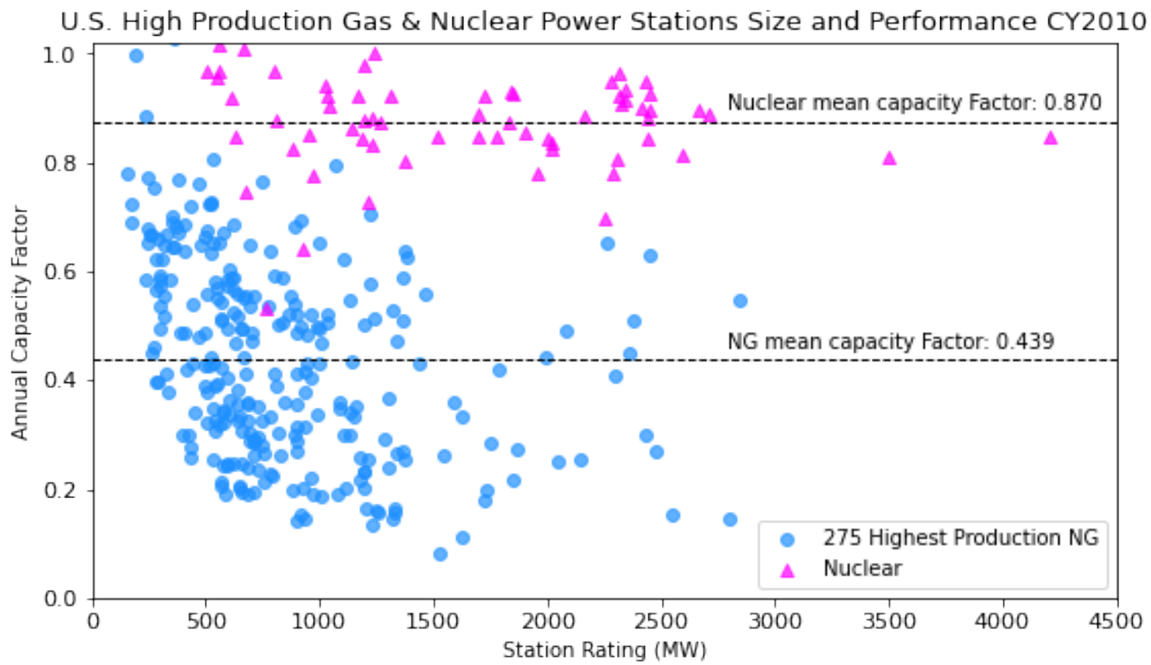
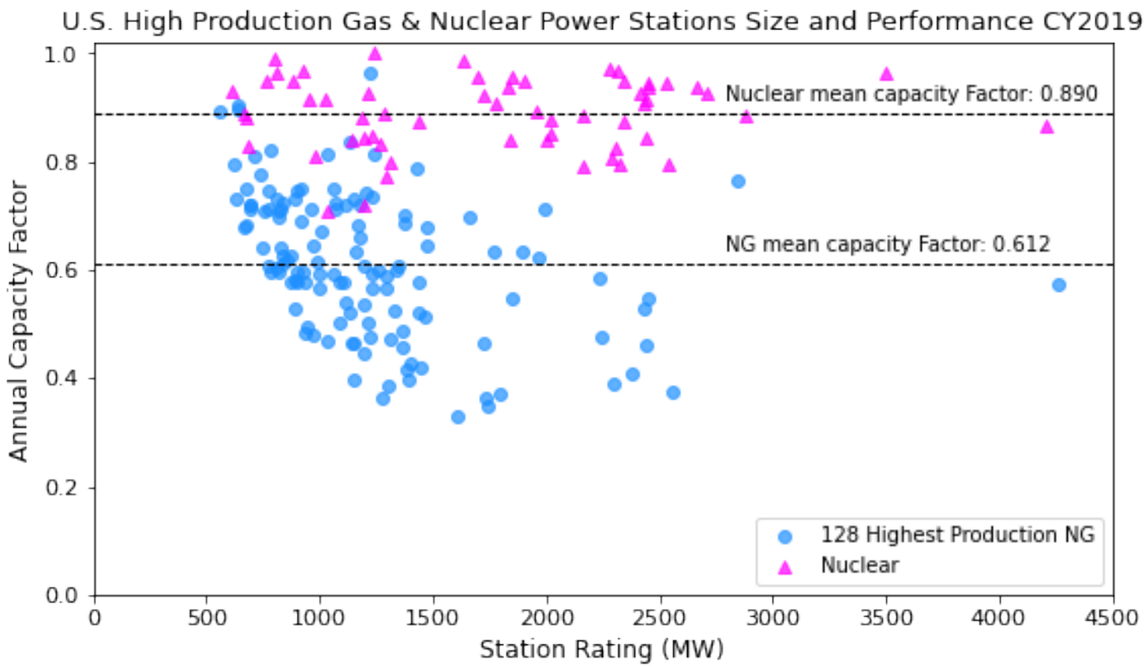
Major Changes to the Large U.S. Power Plant Landscape (2010 – 2019): Natural Gas is Closing the Capacity Factor Gap



The rapidly occurring retirements of coal fueled generation is precipitating major changes to the landscape of large U.S. power plants. Based on data from the U.S. Energy Information Administration overall electric power generation during this time period has remained nearly flat and nuclear has held its market share steady at approximately 20%. However, as natural gas production fills the coal deficit, there are substantial changes to both the rating and utilization of natural gas plants that are remaking the market. As existing nuclear has continued to fill a niche of large nameplate plants operating at high capacity factors, novel nuclear designs looking to enter the market are talking about smaller scales and increased load following (which would result in lower capacity factors). Of interest is an apparent trend in natural gas, of relatively high capacity, larger stations ("super plants"). For example (see figure left), in 2010 it required the 275 highest production natural gas plants to provide the same overall output as all operating nuclear stations, however in 2019 that number was more than halved to 128 stations. This was achieved by both increases in station size and operating at higher annual capacity (see figures below). The operating nuclear fleet prides itself on the highest annual capacity factors of any form of generation and offers this as a sign of superior technology, but in 2019 we can see that natural gas plants have substantially closed the gap and have demonstrated the capability to operate within the borders of a space previously reserved for nuclear. However, annual capacity factors do not tell the whole story. Increased penetration of renewables is eroding pure base load, leaving more and larger opportunities for load followers, especially larger plants that can handle the massive (but predictable) diurnal (daily) and seasonal fluctuations associated with solar and wind. This is most observable in California which achieved 17% of its total electrical output from utility scale solar in 2019, but closer to 50% at mid-day peaks in the summer. The trend towards natural gas super plants is highly influenced by coal retirements and may be less indicative of the best plant operating and nameplate characteristics for increased penetration of renewables. However, this trend should not be ignored and the U.S. nuclear industry needs to consider the best opportunities for future operating spaces. It is clear it will not be coal replacement (that ship has largely sailed), so will it be replacement of the aging fleet with large plants with load following capability or many smaller ones? For now, natural gas is going big, but maybe that's because there is no competition yet.





Analysis and visualizations produced in Jupyter Notebooks using Python, available at: https://github.com/run2win2k/Energy-Infographics-in-Python

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