The Climate and Economic Rationale for Investment in Extension of Spanish Nuclear Plants

John E. Parsons, MIT Sloan School of Management and MIT Center for Energy and Environmental Policy, 617-324-3745, jparsons@mit.edu
Anthony Fratto Oyler, MIT Technology and Policy Program and MIT Center for Energy and Environmental Policy, 801-664-3508, afratto@mit.edu

Overview

Spain's seven operating nuclear plants currently provide more than 20% of its elec- tricity. Each of these began operation in the 1980s and is approaching the end of its 40-year design life. Extending their lives will require additional investments. Should Spain make the investment and extend their lives, or should they be retired at the end of their design life?

The transformation of Spain's generation assets is a fundamental question facing industry and government leaders. Earlier this year the Spanish government released a "Commission of Experts" report analyzing a variety of installed capacity scenarios for 2030. Scenarios with and without nuclear life extensions were explored. More recently, the Prime Minister announced draft climate and energy legislation targeting 100 percent renewables by 2050 and an end to subsidies for fossil fuel generating plants. However, the announcement was silent on the role of the existing nuclear assets in the interim.

We show that investing in nuclear plant life extensions is the least- cost alternative for further reducing GHG emissions. We also show that in assessing the cost of renewable alternatives it is critical to take into account the time profile of the available renewable resource. Solar PV and especially wind capacity were expanded significantly since 2000, and significantly greater penetration, especially of solar PV, is promised out to 2030 in order to reduce GHG emissions still further. We show that at these expanded penetration levels, curtailment becomes a significant determinant of system cost. This significantly improves the relative value of nuclear life extensions as a contributor to reducing GHG emissions.

Methods

We begin with the necessary background information on Spain's current electricity system, its nuclear power industry, and its energy and climate policy. We then construct a set of alternative portfolios with and without nuclear plant life extensions that achieve the same level of GHG emissions but vary capacity between nuclear and solar PV and wind. We translate our cost inputs into LCOEs based upon assumed capacity factors and then execute the true system cost calculation using a least-cost dispatch algorithm to meet a 2030 scenario for hourly load given scenarios for hydro, solar and wind resources. Given the scale of solar PV and wind penetration anticipated by 2030, curtailment is likely to have a significant impact on system costs. The dispatch model optimizes the use of Spain's hydro reservoirs, pumped hydro and future battery capacity in order to minimize curtailment of renewable generation. Our calculation of system cost captures the impact of curtailments after minimization using storage.

Results

Ultimately we show that investing in nuclear plant life extensions is the least-cost alternative for further reducing GHG emissions. Social cost savings on the extension of all seven plants are at least €8 billion relative to the next least cost option. The research also examines the value of nuclear life extensions in comparison to natural gas-fired combined-cycle plants. We first do this without regard to any cost attributed to GHG emissions, and we again find nuclear plant life extensions are the most cost efficient option. Forecasted natural gas price would have to fall below €17/MWh before the avoided cost of combined-cycle generation fell below the incremental system cost of the nuclear generation and capacity. In addition, preserving the seven nuclear plants reduces GHG emissions by more than 16 million tons (CO_2eq).

Conclusions

Between now and 2030, Spain must decide whether to retire each of its seven operating nuclear plants, or whether to extend their lives for some additional number of years. In this paper we considered 10-year life extensions. We have calculated the system cost of alternative portfolios of capacity making use of nuclear or replacing it with solar PV or wind capacity or some combination of the two. For two levels of GHG emission reductions, we showed that nuclear life extensions provide the lowest system cost. In addition, for a wide range of potential natural gas prices, the system cost of nuclear life extensions is less than the cost of continuing to use natural gas combined-cycle plants to replace nuclear's generation.

Reducing GHG emissions is an urgent priority–for Spain, for the EU and for mankind. Our results demonstrate that extending the life of Spain's nuclear plants is the most cost effective way to do that. Nuclear plant life nuclear life are an element of the least-cost path to decarbonization.

An earlier CEEPR working paper, now published, had shown the same result for the U.S.—see Haratyk (2017). The importance of preserving the existing nuclear fleet is one of the conclusions of the recently released MIT study on the Future of Nuclear Energy in a Carbon-Constrained World (2018). Other colleagues here at MIT have also demonstrated the value of nuclear to decarbonization using a more complex and robust modeling framework—see Sepulveda et al. (2018).

References

Comisión de Expertos de Transición Energética (Commission of Experts) (2018). Análisis y Propuestas Para la Descarbonización. Buongiorno et al. (2018). The Future of Nuclear Energy in a Carbon Constrained World, MIT.

Fratto Oyler, A. and John E. Parsons (2018) "The Climate and Economic Rationale for Investment in Life Cycle Extenstion of Spanish Nuclear Power Plants" , MIT CEEPR Working Paper 2018-016.

Haratyk, G. (2017). "Early nuclear retirements in deregulated US markets: Causes, implications and policy options." Energy Policy 110: 150–166. and MIT CEEPR Working Paper 2017-009.

Sepulveda, Nestor A., Jesse D. Jenkins, Fernando J. de Sisternes, and Richard K. Lester (2018). "The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation," Joule 2:1-18.