Economic and Carbon Impacts of Potential Illinois Nuclear Plant Closures

The Cost of Closures

Prepared for:
NUCLEAR MATTERS
CONTRACT NN-NNNN

Prepared by:
Suzy STUDENT
Gary GRAD

Principal Investigator:
Prof. Kathryn D. HUFF

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ADVANCED REACTORS AND FUEL CYCLES

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1 Summary

Exelon Generation annouced planned premautre closures of two nuclear plants, . Byron and Dresden. Both plants, within the PJM interconnection have suffered under the capacity market situation. Nuclear is carbon free, high energy density, etc. This report explores the extent to which economic and decarbonization goals in the state of Illinois will be undermined by these closures. Clean energy goals will not be reached if these plants prematurely retire. Additionally, the economic value provided by these plants to the surrounding community will be lost.

double check

Eleven (11) carbon free nuclear power reactors at 6 sites produce the majority of electricity in Illinois and critically underpin its clean energy future. This report quantitatively demonstrates the role nuclear energy must play in maximizing job creation, minimizing cost, and meeting Illinois' carbon goals through 2050. We have conducted a 50-year techno-economic optimization of the Illinois energy system to analyze scenarios with and without the at-risk plants. With these, we compared and contrasted the economic and carbon implications of these energy futures.

Statements from the ANS students Our regional findings are consistent with the February 2021 National Academy of Sciences, Engineering, and Medicine report, "Accelerating Decarbonization of the U.S. Energy System", which determined unequivocally that US decarbonization will require keeping existing nuclear plants open [**?**].

Describe the simulations at a high level. Describe the major assumptions. (how did we model the carbon emissions, what generation did we assume would replace these plants, etc.)

2 Introduction

In the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois, we have published multiple energy analysis studies of this kind [**?**]. Most recently, we conducted a detailed techno-economic optimization of the UIUC campus microgrid as part of a DOE-NE award. We propose to expand this UIUC microgrid optimization to capture the state of Illinois by incorporating data directly from the Energy Information Administration, the Illinois Department of Employment Security, and previous reports on this topic (e.g. [**?**]).

Our current model leverages a robust dataset that populates multiple analytic models, trained neural networks, and the Temoa framework (Tools for Energy Model Optimization and Analysis). Temoa is an open-source framework for simulating and optimizing energy systems. With our UIUC microgrid model in Temoa (Figure 1), we are able to determine the optimal energy generation mix for the UIUC microgrid for various objective functions (minimize carbon, minimize cost, etc.) while meeting system constraints (zero carbon by 2050, practical deployment speeds, realistic improvements in storage technology capabilities, etc.). The UIUC microgrid model includes transportation as well as campus steam, electric, and chilled water demand and provides cross-decadal deployment solutions which optimize the scenario objective function (Figure 2).

3 Methods

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This model is underpinned by multiple advanced techniques. For example, a predictive model of net electricity demand on campus has been created with an echo state network machine learning approach to generate representative synthetic predictions of net grid load (Figure 3). This predictive model incorporates weather information to account for solar and wind power generation as well as heating and air-conditioning demands. Such predictive models are trained using multi-year historic campus electricity generation and consumption data. A similar approach will be used in the proposed simulations of the state as a whole.

3.1 Generated Waste Data

description of waste calculator notebook for nuclear/wind/solar

Coal power plants primarily produce solid wastes in the form of ash and slurries from the scrubbers. Coal ash is produced from coal burning in approximately a 6:1 burned coal:coal ash ratio. While the solid wastes are comprised of multiple elements, the waste is generally half coal ash, and half anhydrite ($CaSO_4$) - a product of chemical reactions in the scrubbers [1].

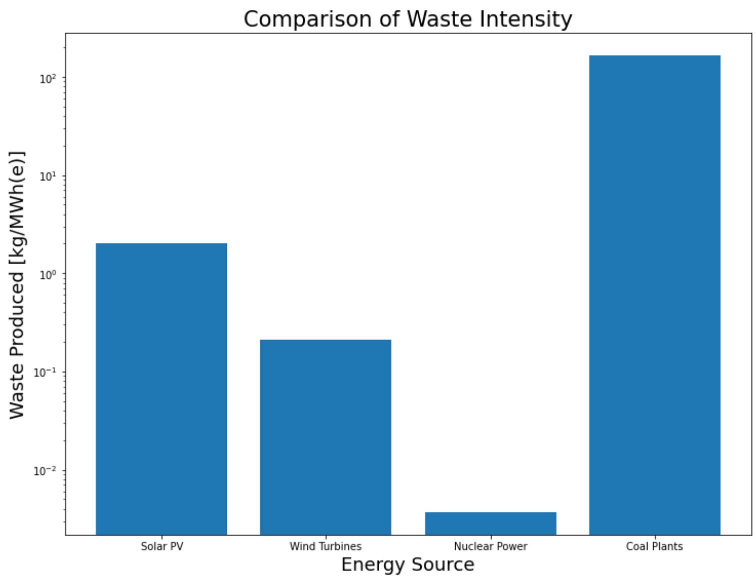

Figure 1: Solid Waste in $\frac{kg}{MWh}$ by Energy Source

4 Results

5 Discussion

text

References

[1] Marilyn A Brown, Daniel D'Arcy, Melissa Lapsa, Isha Sharma, and Yufei Li. SOLID WASTE FROM THE OPERATION AND DECOMMISSIONING OF POWER PLANTS. page 104.