Optimal Sizing of a Nuclear Reactor for Embedded Grid Systems

Preliminary Work

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May 21, 2020

Outline

iCAP Goal and Obstacles

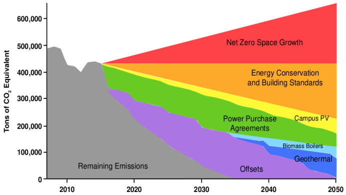


Figure: Shows projected CO_2 emissions for UIUC [6]. Offsets include shutdown of the Blue Waters Supercomputer.

Goal:
Carbon neutrality by 2050 or sooner.

Obstacles:

1. Requires *zero net space growth*.
2. Campus depends on a system of steam tunnels for heating.
3. and more...

The Nuclear Option

Nuclear energy...

1. ...produces almost no carbon emissions [5].
2. ...can produce high-temperature steam.
3. ...requires little physical space*.

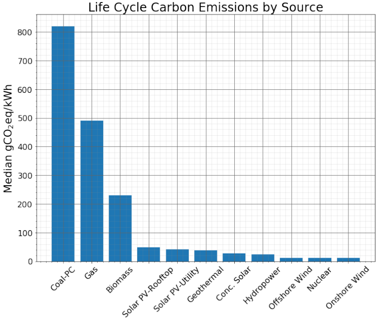


Figure: Lifetime carbon-equivalent emissions by energy source from IPCC findings [5].

*compared to solar and wind.

What is the optimal size for a nuclear reactor on the UIUC grid?

Outline

To answer this question we considered two modeling approaches:

1. `RAVEN` (INL) - Risk Analysis and Virtual Environment [1][4]
2. `TEMOA` (NCSU) - Tools for Energy Model Optimization and Analysis [3][2]

Workflow in RAVEN

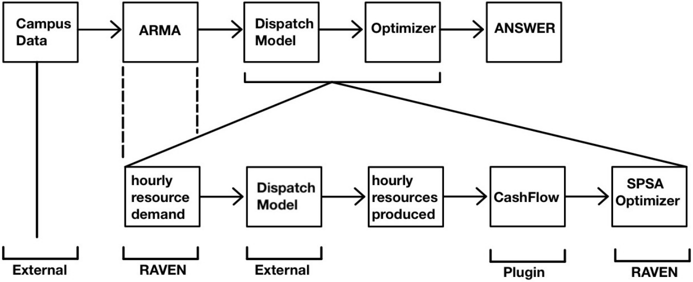


Figure: A general optimization workflow in RAVEN

Outline

Step 1: Generate Synthetic Histories

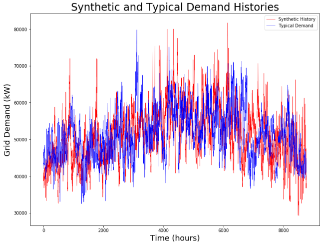


Figure: Shows the synthetic (red) vs typical (blue) hourly electricity demand at UIUC.

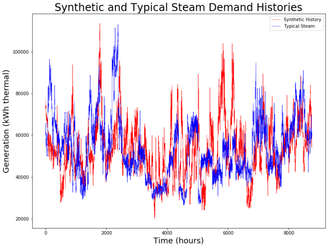


Figure: Shows the synthetic (red) vs typical (blue) hourly steam demand at UIUC.

Preliminary Results: Grid Model

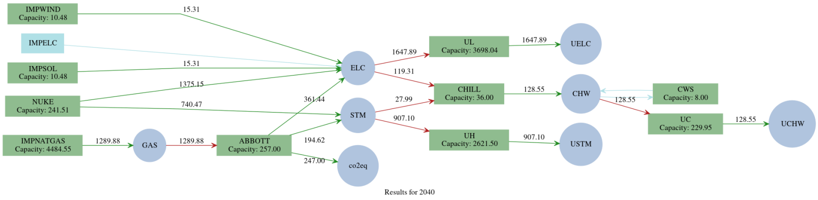
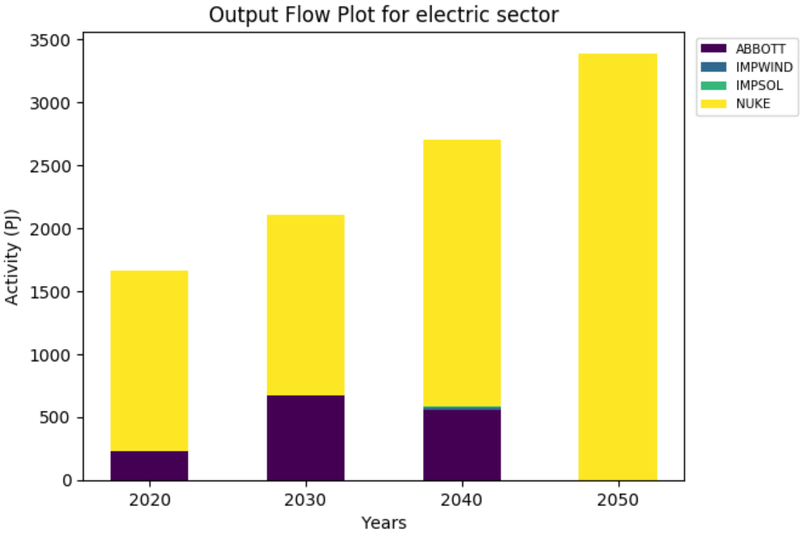


Figure: Preliminary dispatch results in year 2040 at UIUC

Preliminary Results: Acivity



Outline

Conclusion

Acknowledgement

This work was made possible with data provided by UIUC Facilities and Services, in particular, Morgan White, Mike Marquissee, and Mike Larson.
Additionally, this work is funded by the NRC Fellowship Program.

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