Optimal Sizing of a Nuclear Reactor for Embedded Grid Systems

Preliminary Work

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ILLINOIS

Outline

iCAP Goal and Obstacles

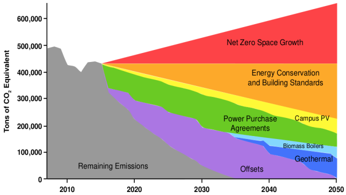


Figure: Shows projected CO_2 emissions for UIUC [6]. Offsets include shutdown of the Blue Waters Supercomputer.

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*.

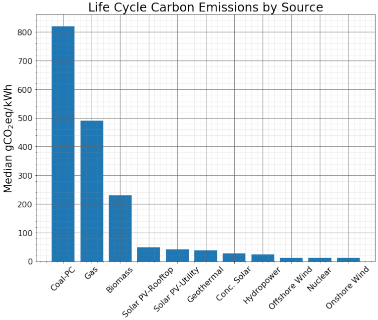


Figure: Lifetime carbon-equivalent emissions by energy source from IPCC findings [5].

*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

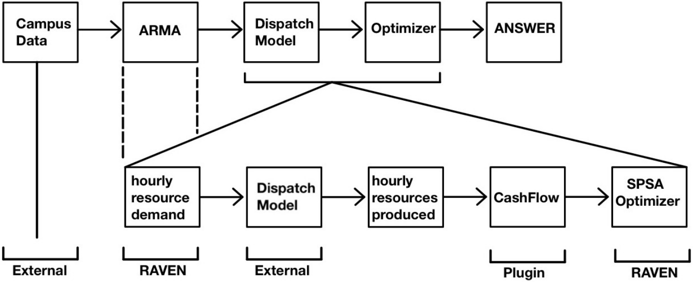


Figure: A general optimization workflow in RAVEN

Outline

Step 1: Generate Synthetic Histories

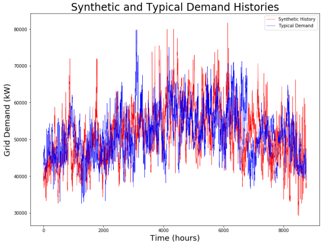


Figure: Shows the synthetic (red) vs typical (blue) hourly electricity demand at UIUC.

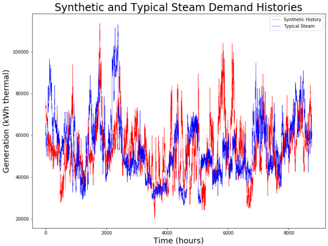


Figure: Shows the synthetic (red) vs typical (blue) hourly steam demand at UIUC.

BAU: Grid Model

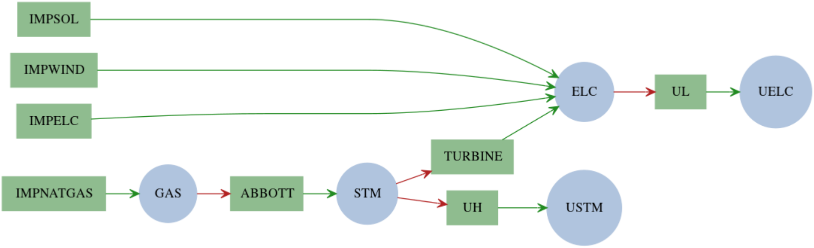


Figure: Graph representation of the UIUC embedded grid.

BAU: Generation

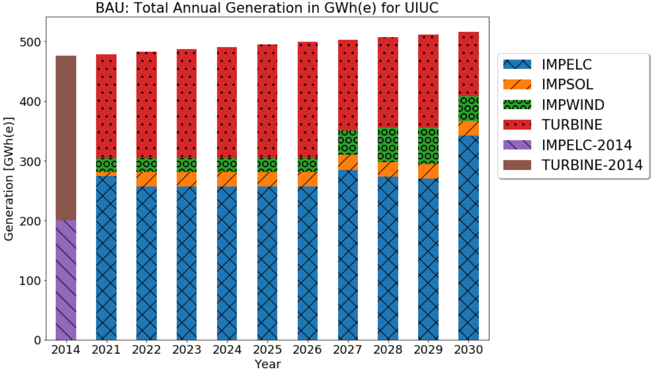
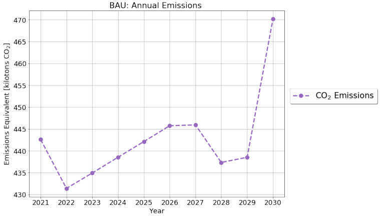


Figure: The change in activity from each energy source from 2020-2030. Assuming 1% demand growth each year

BAU: Emissions



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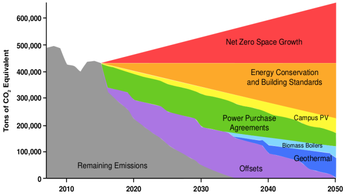

Figure: Predicted growth in emissions from iCAP [6].

Outline

Conclusion

Acknowledgement

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References I

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