Energy storage can increase the **value** and **flexibility** of a **nuclear power plant** but makes the plant **economics** more subject to **uncertainty** in **electricity price**.

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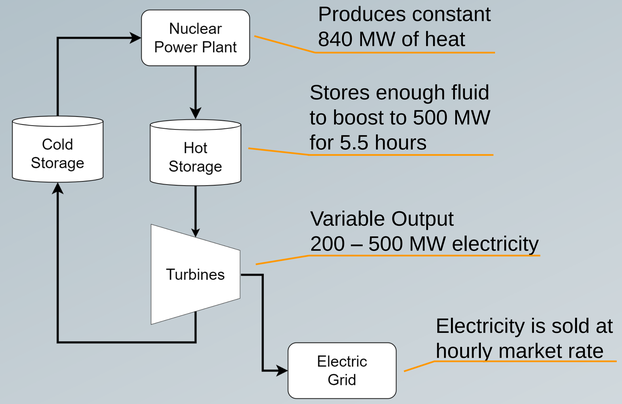
Highlights

- Nuclear power plant with integrated thermal energy storage
- Uncertainties in capital expenses, fixed annual costs, variable costs, and electricity price are considered
- Net present value (NPV) is most sensitive to capital expenses, price uncertainty
- Sensitivity to price uncertainty varies by region

System Model

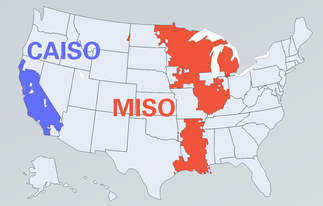
Models the Natrium system designed by **TerraPower** and **GE Hitachi Nuclear**

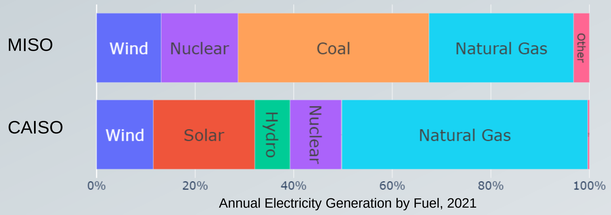


Thermal energy storage adds **flexibility** to otherwise **fixed reactor output**

Studied Regional Markets

- Regional markets have unique generator mixes, price dynamics
- Variable renewables (wind, solar) add to price and demand uncertainty



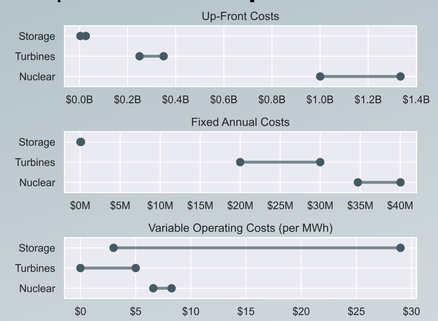


Annual Electricity Generation by Fuel, 2021

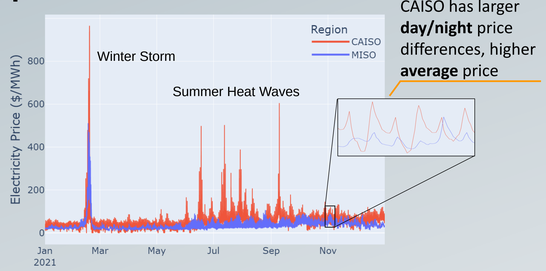
Long-Term Goal: Can flexible nuclear replace coal and natural gas generation?

Uncertainties in Model Inputs

Uncertainty in reference prices for **component costs**



Uncertainty in **time series** of historical **price** data



CAISO has larger **day/night** price differences, higher **average** price

"Synthetic histories" are sampled from statistical models fit to the time series data

Sobol indices are used to quantify **sensitivity** of net present value (NPV) to these uncertainties

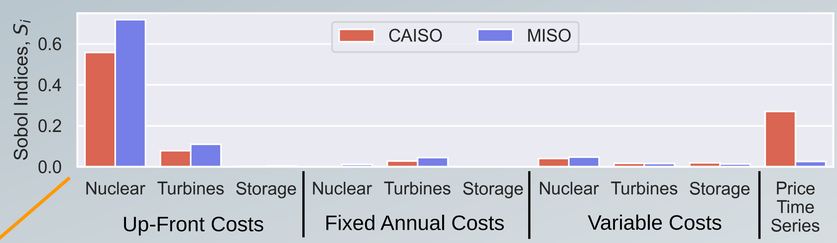
Variance in NPV due to variance in input X_i

$$S_i = \frac{Var(E[NPV|X_i])}{Var(NPV)}$$

Total variance in NPV

Results – Model Sensitivities

Capital costs are the **greatest** source of uncertainty for **both regions**



Large **difference** in sensitivity to electricity **price** is due to **reduced storage utilization**

Sensitivity to **cost drivers** is **consistent** between regions