The Future of Carbon Capture: A Story of the Tortoise and the Hare

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arpa·e

Research

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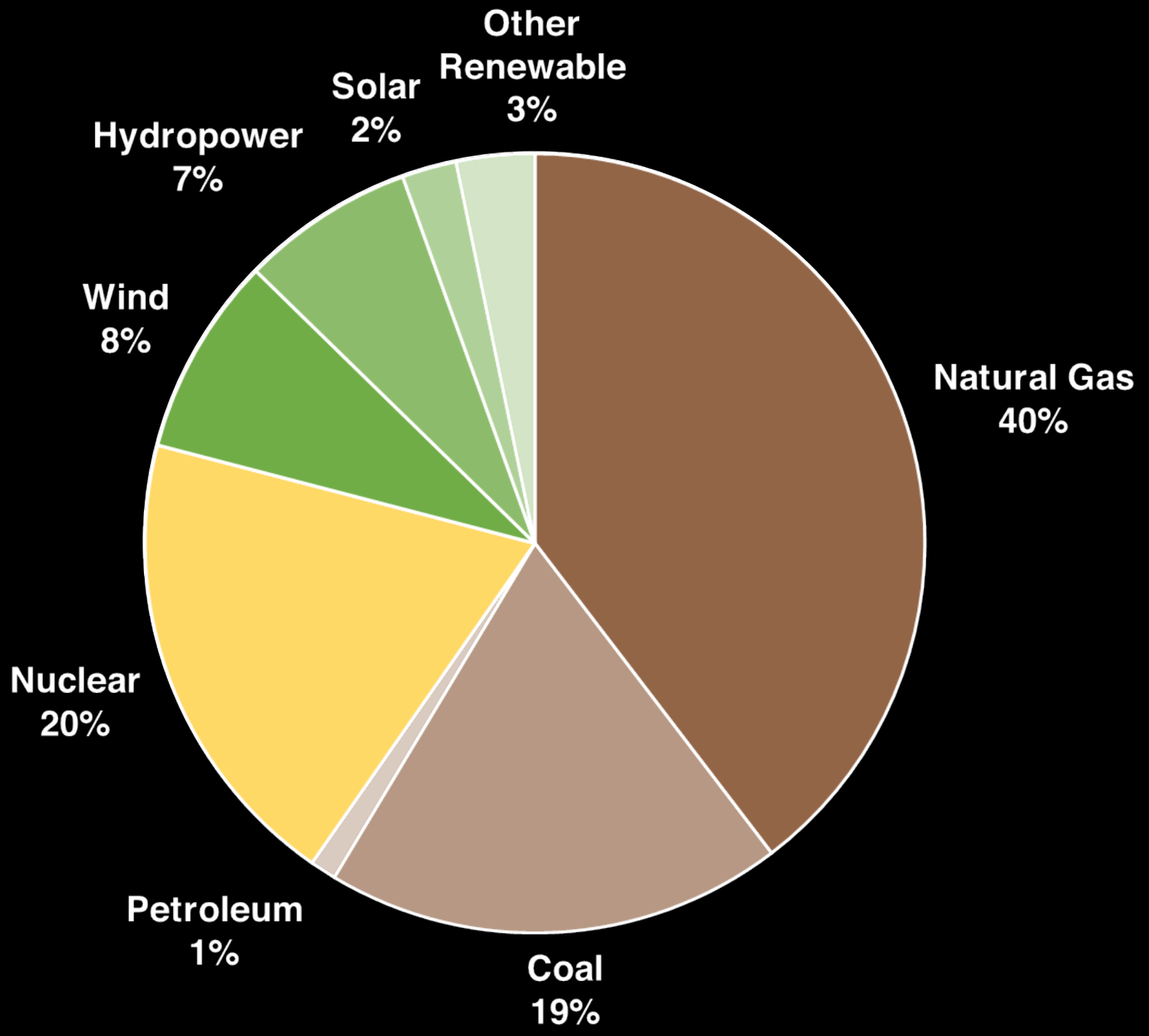
ION CLEAN ENERGY

STORWORKS POWER

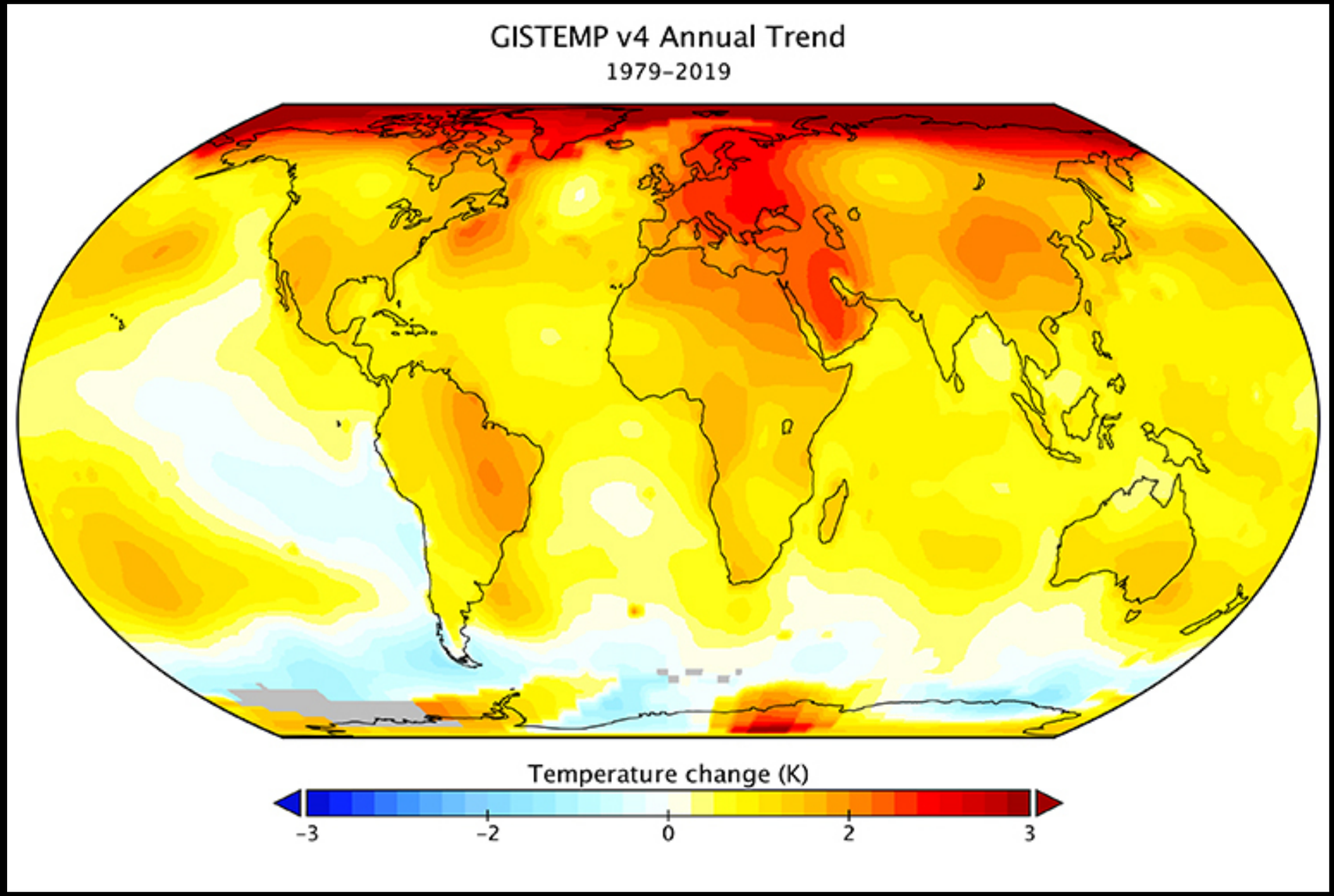
Nebraska Public Power District

Why Carbon Capture?


Other Renewable 3%
Solar 2%
Hydropower 7%
Wind 8%
Natural Gas 40%
Nuclear 20%
Petroleum 1%
Coal 19%

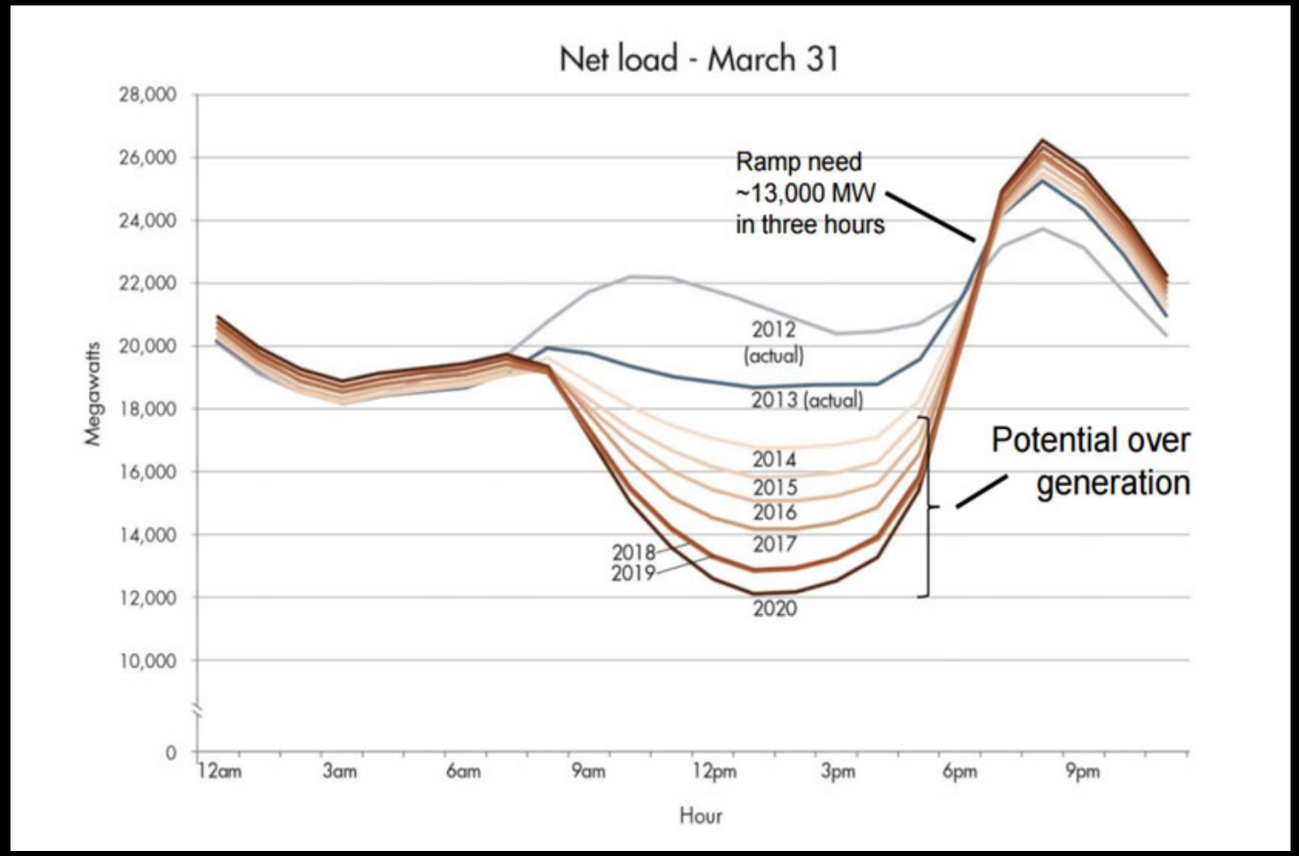
Source: EIA

Climate Change



Source: NASA Climate Center

Need reserve capacity and reliable power



Millions Lose Power In Texas, Northern Mexico As Blackouts And Bitter Cold Continue

February 16, 2021 · 4:33 AM ET

Natural Gas Power

Carbon Capture

On demand reliable power

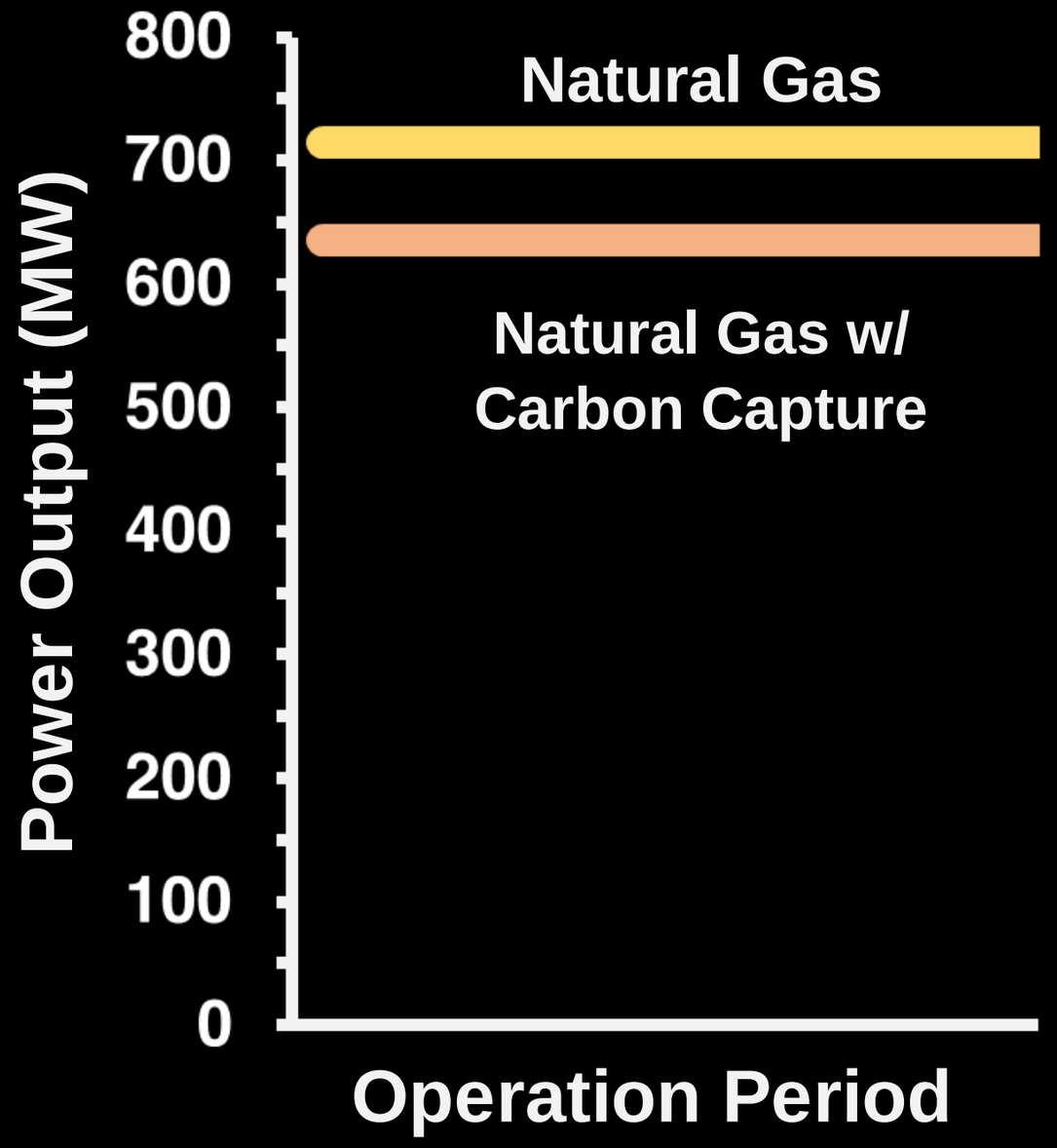
Net-zero Carbon Emissions

But carbon capture has problems…

Carbon Capture Problems

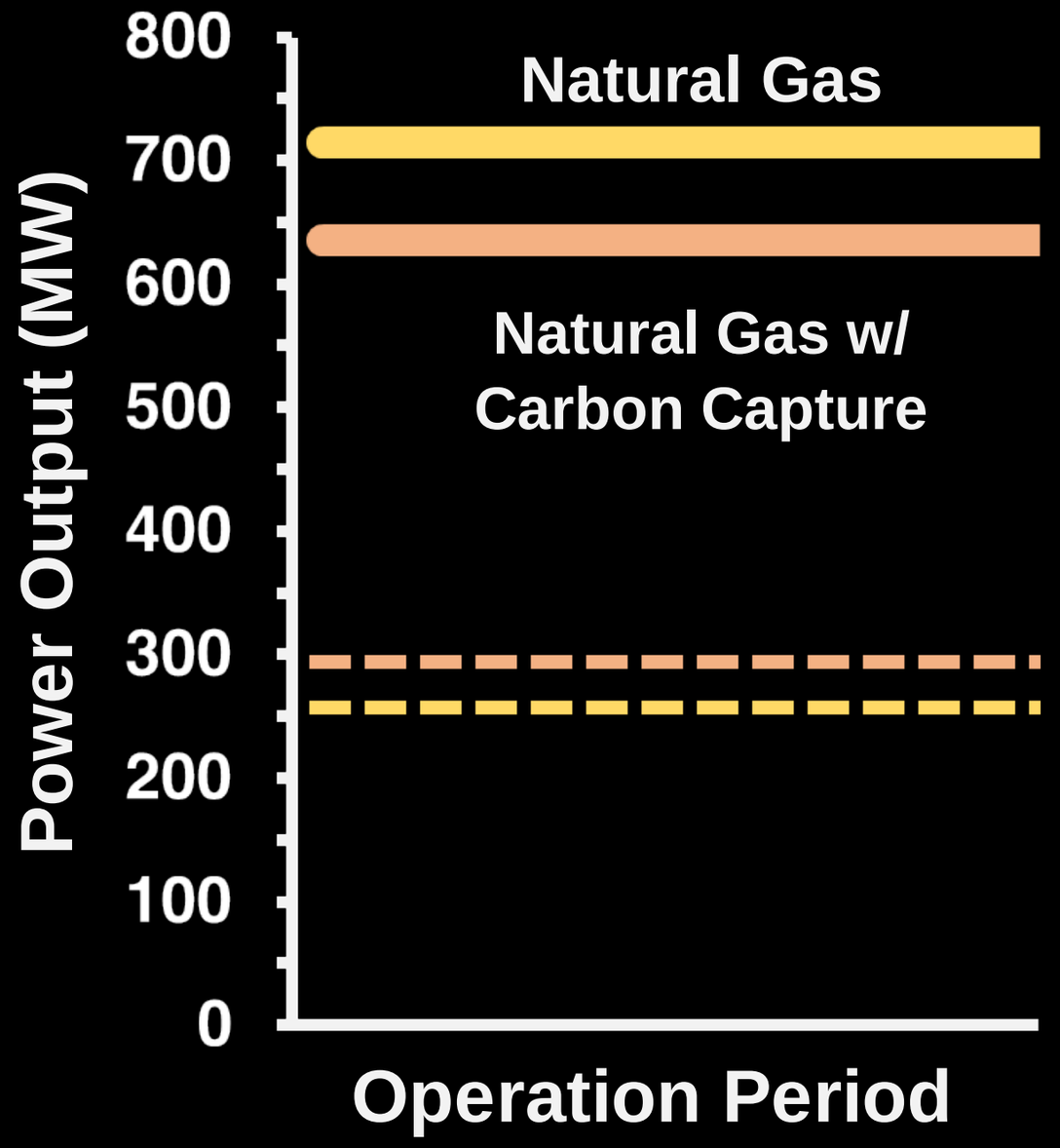
1. Huge Parasitic Load

>10% Power Output Decrease



Carbon Capture Problems

1. Huge Parasitic Load
2. Limited Plant Flexibility



How are we going to fix these?

Add Thermal Storage

Natural Gas Plant

NG

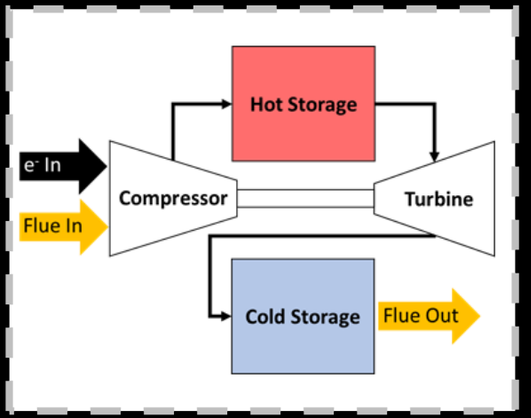
Gas Turbine Inlet Chilling

Grid e-

Off-peak e-

Flue Gas

Heat Pump
Thermal Storage



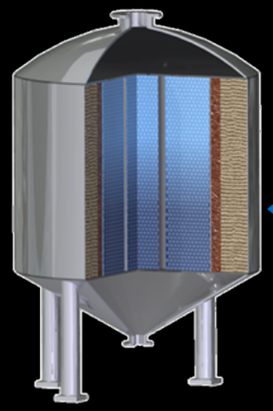
Flue Gas

ION Flexible
Carbon Capture

Solvent Regeneration

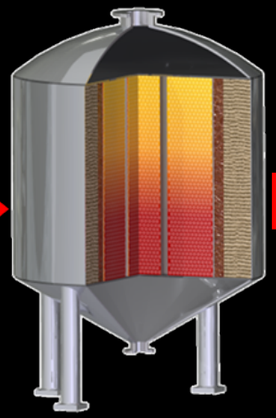
Exhaust

Pure CO2

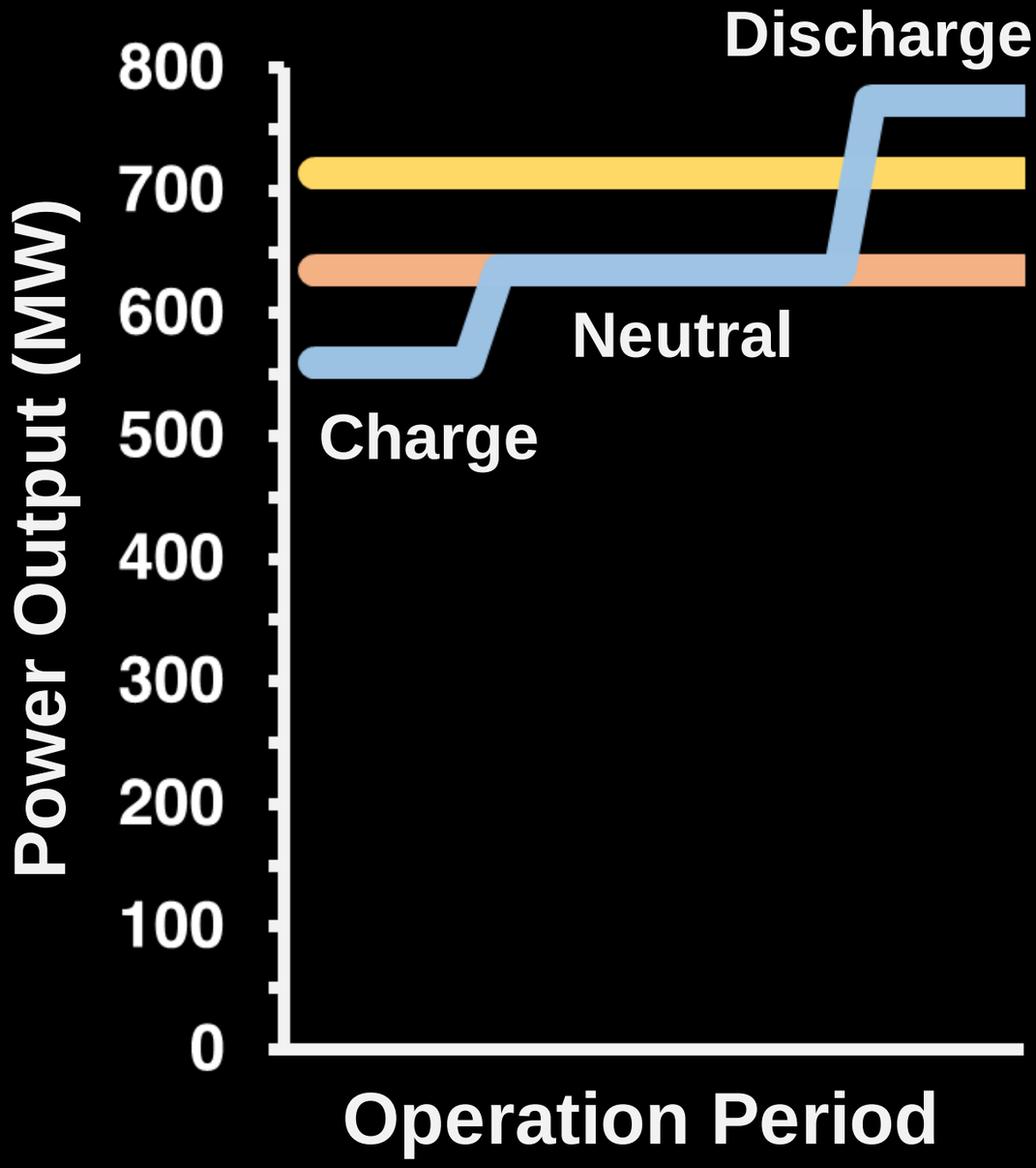


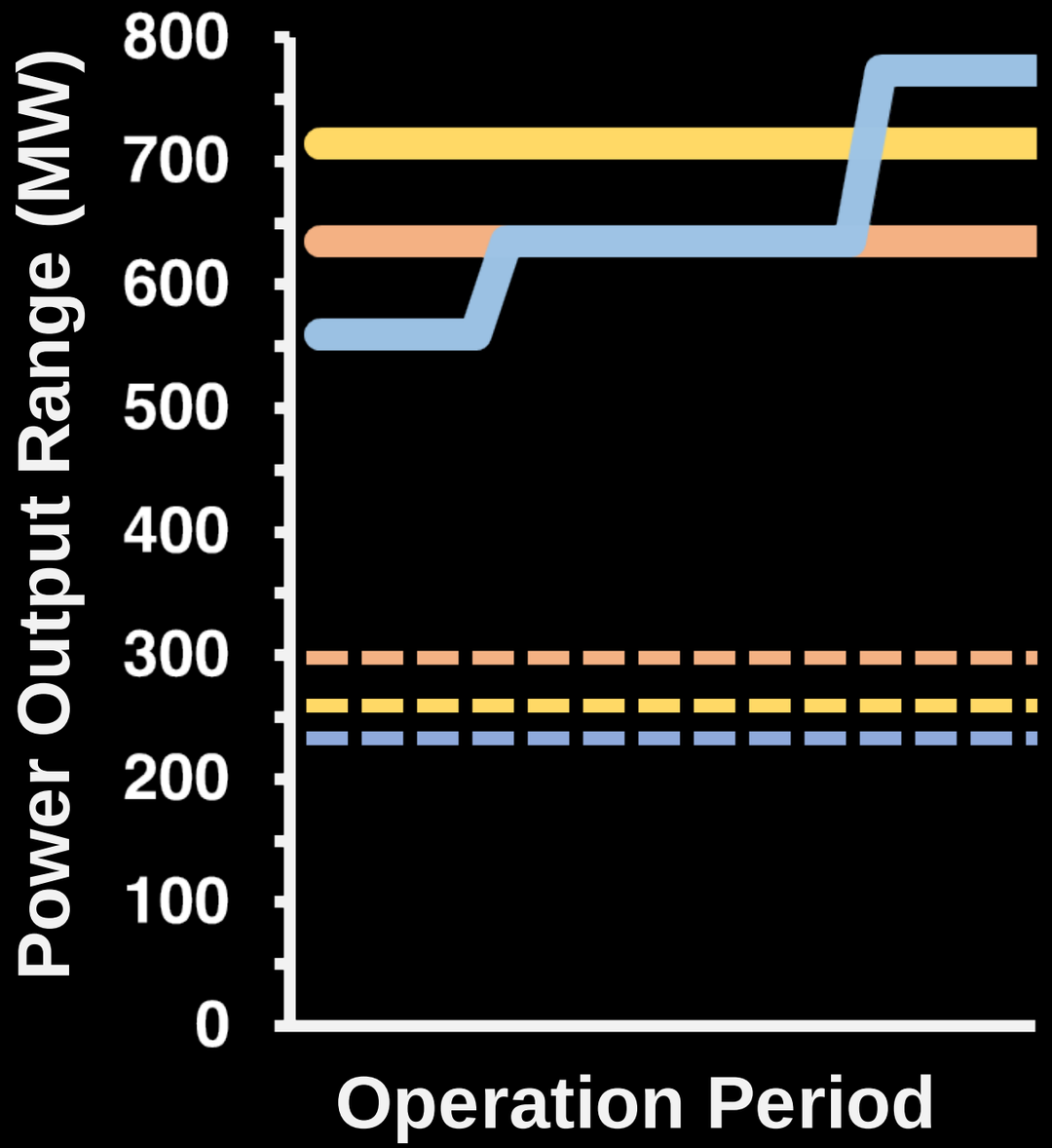
COOLING

HEATING

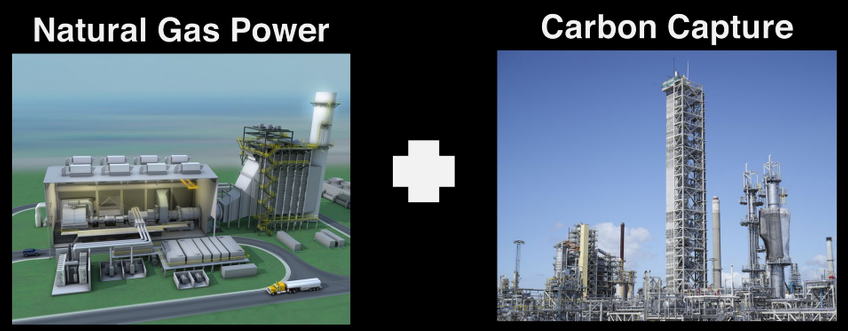


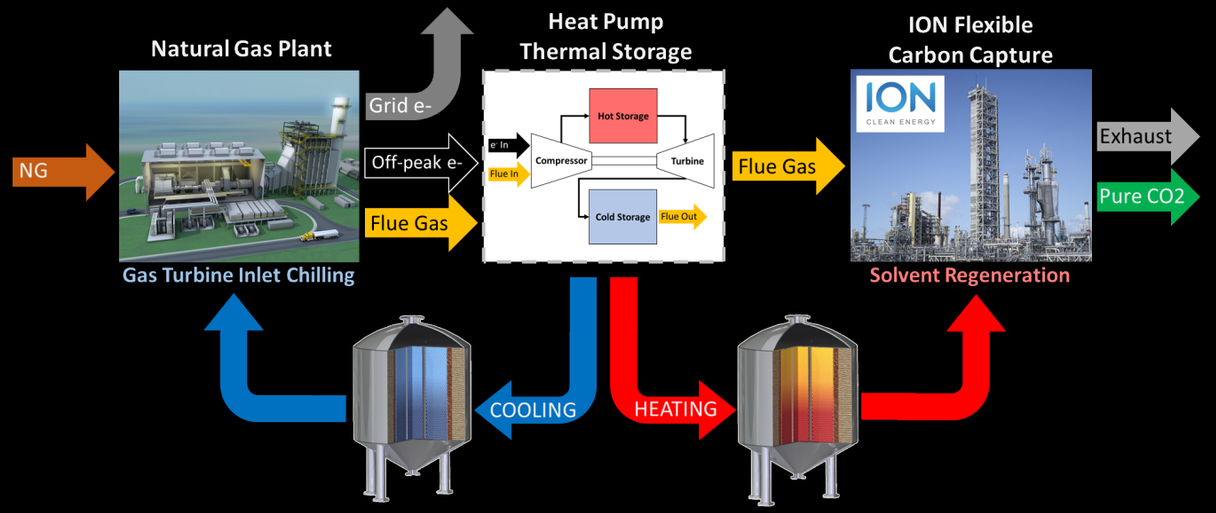
Increased Power Plant Flexibility





Why tortoise and the hare?



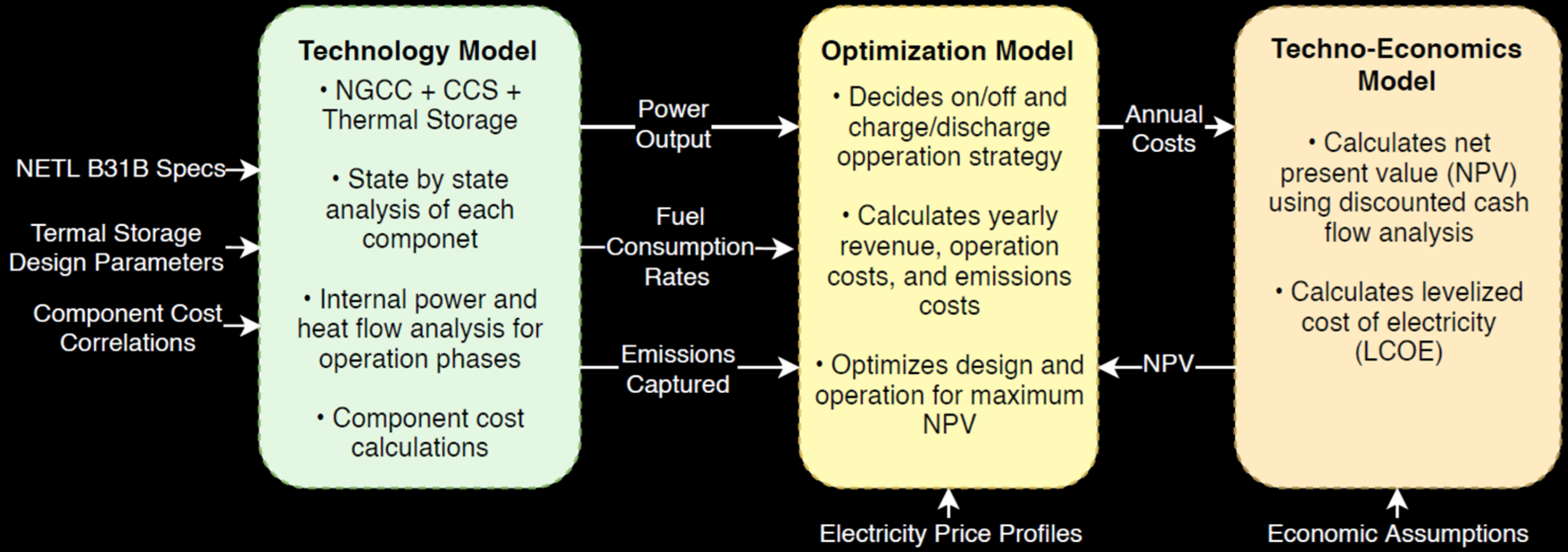


1. Limited Power
2. Limited Operating Modes
3. Consistent

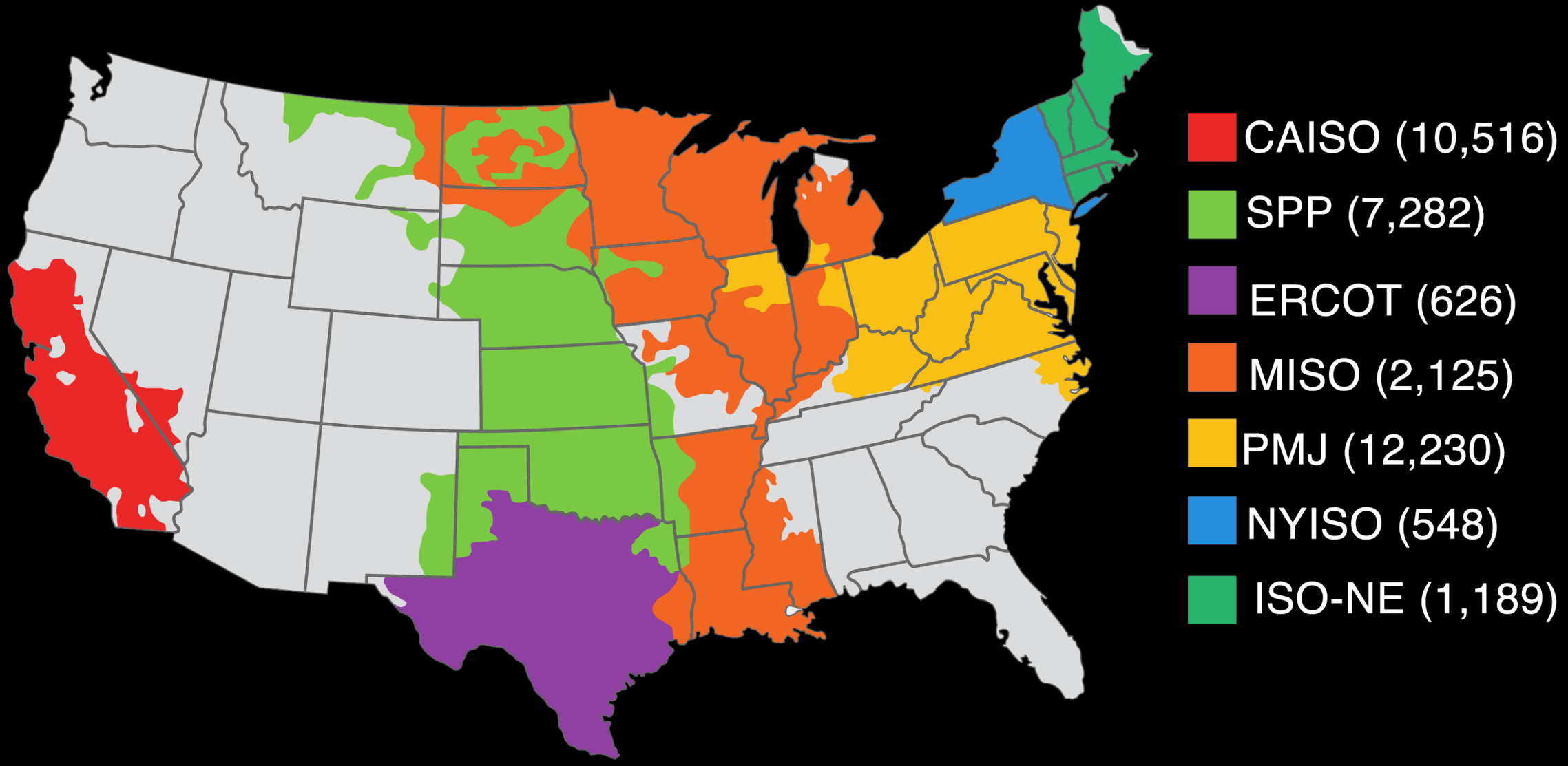
1. Full Power + Limited Boost
2. Flexible Operation Modes
3. Unproven

How to decided which is best?

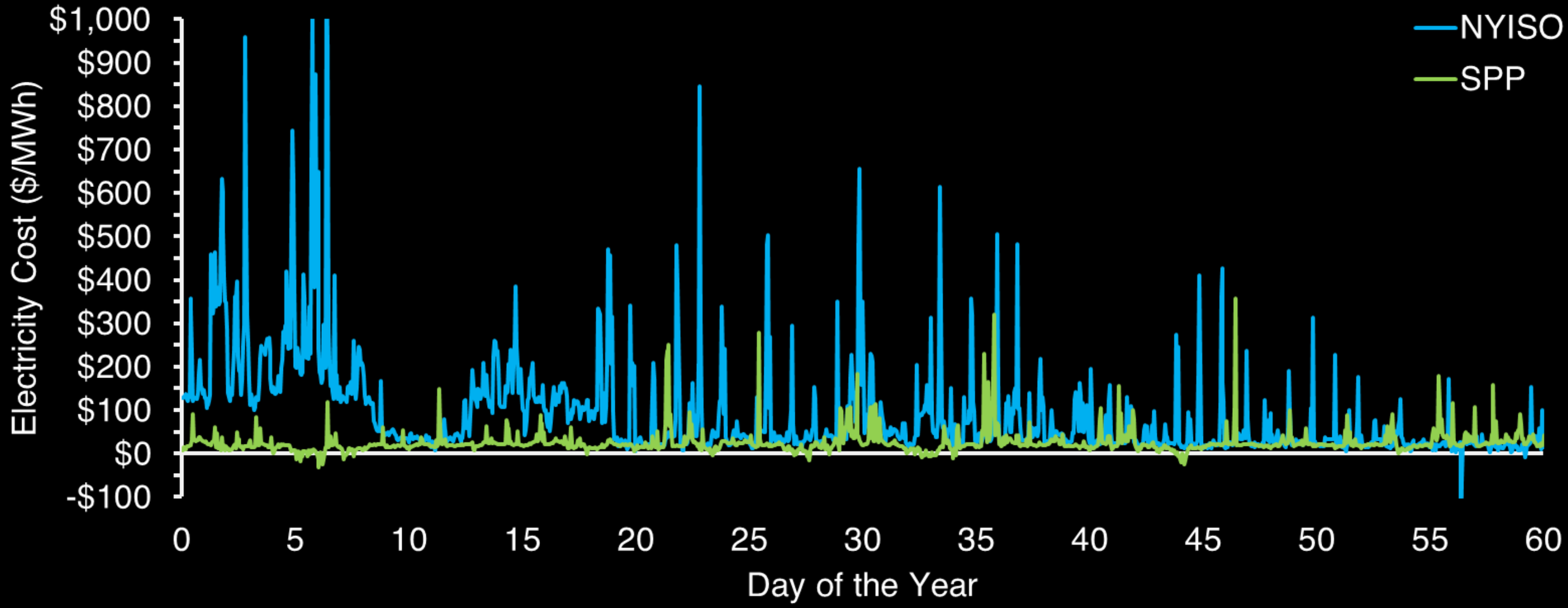
Interconnected Simulation Models



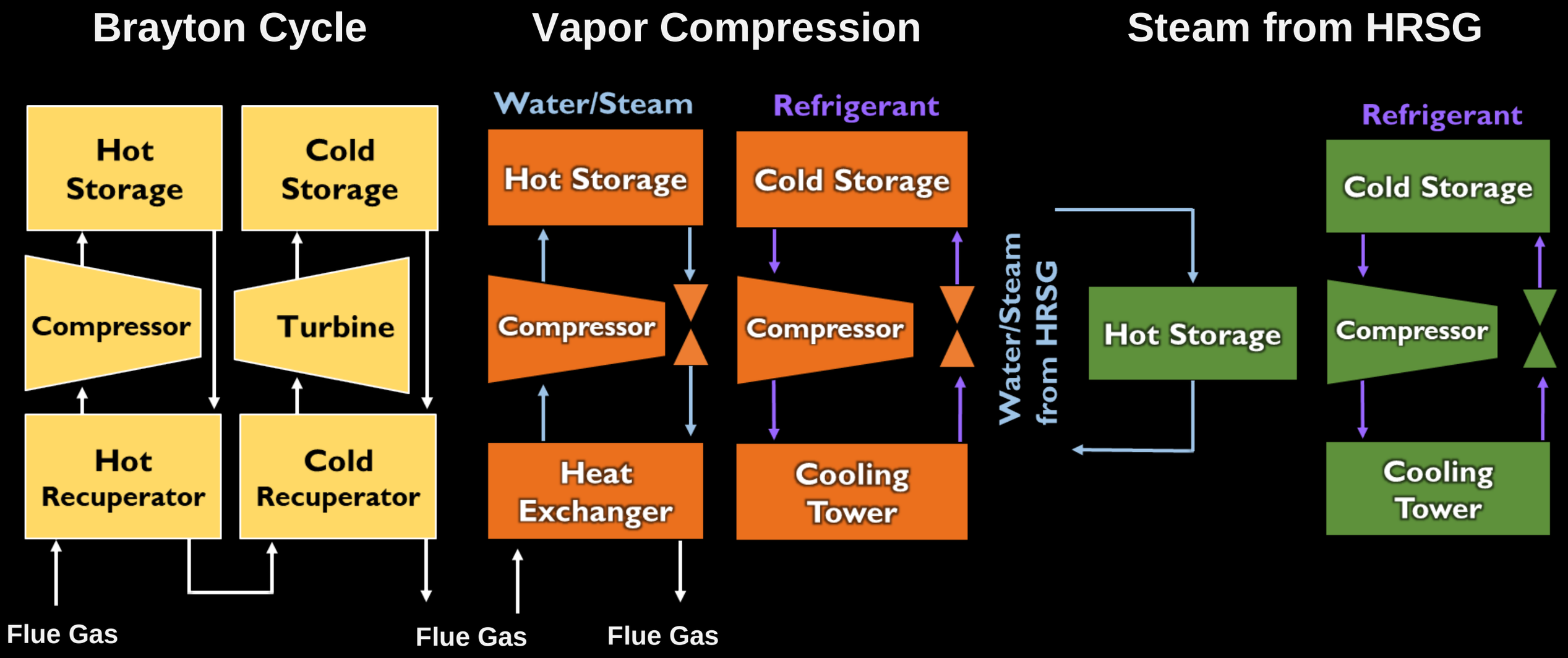
Wholesale Electricity Price Data



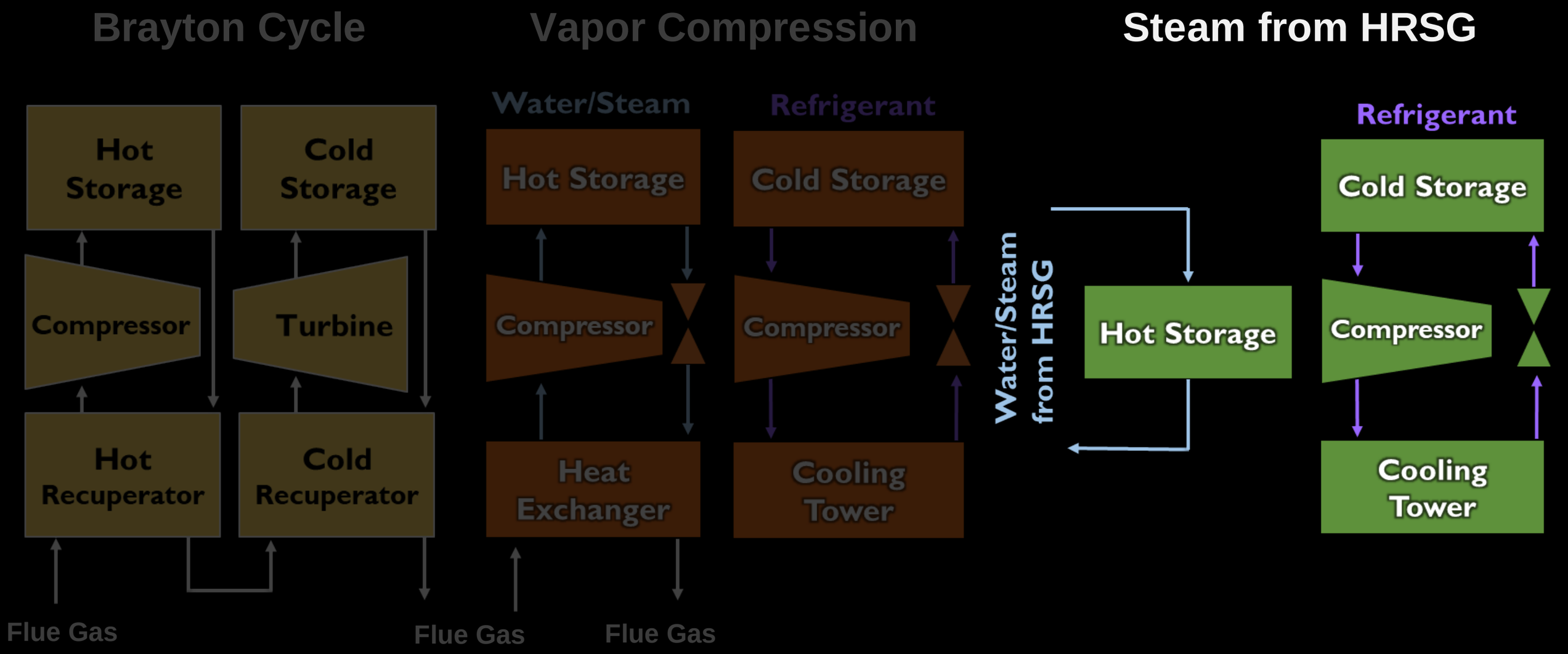
Example Electricity Profiles



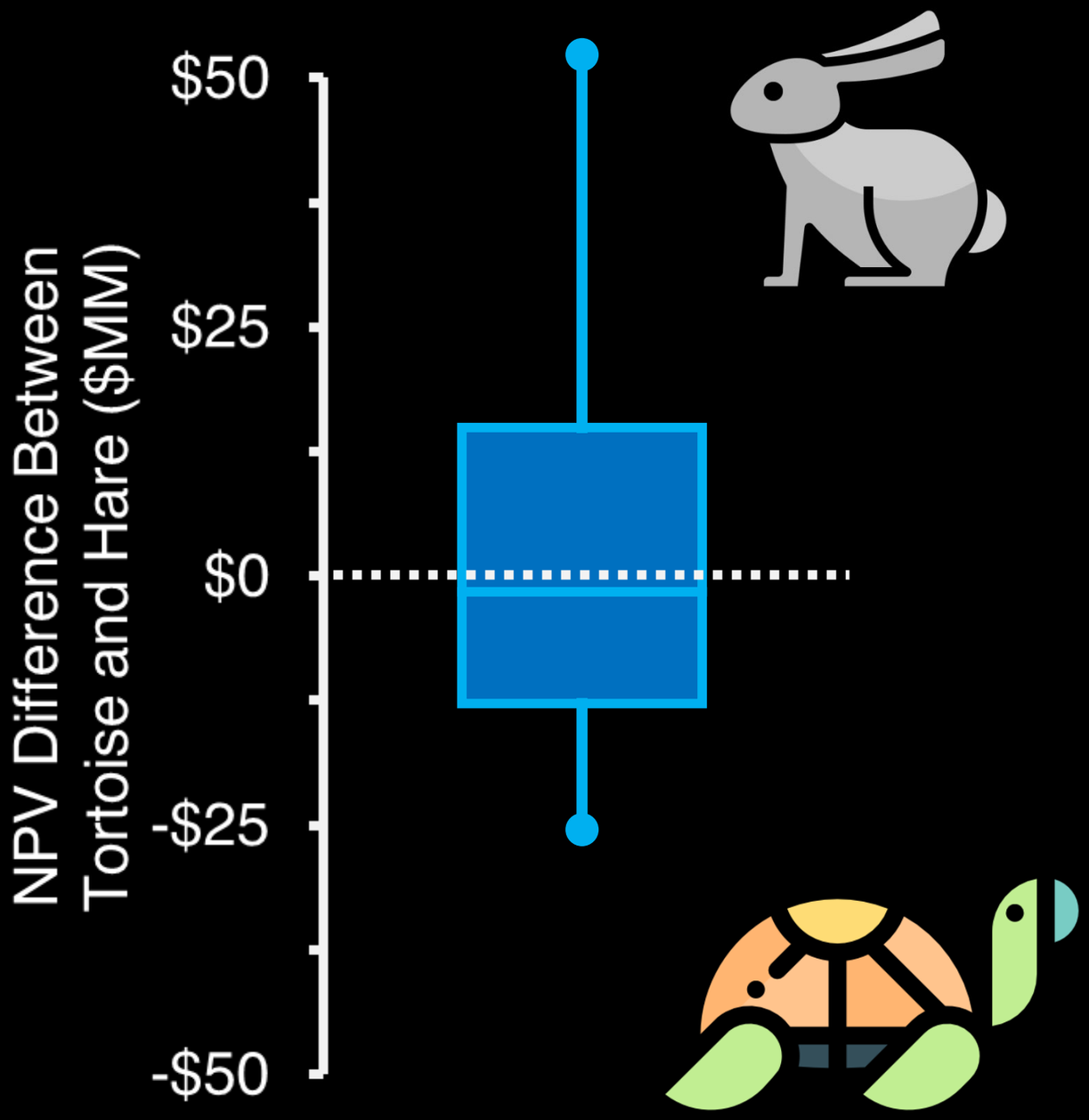
Thermal Storage Options

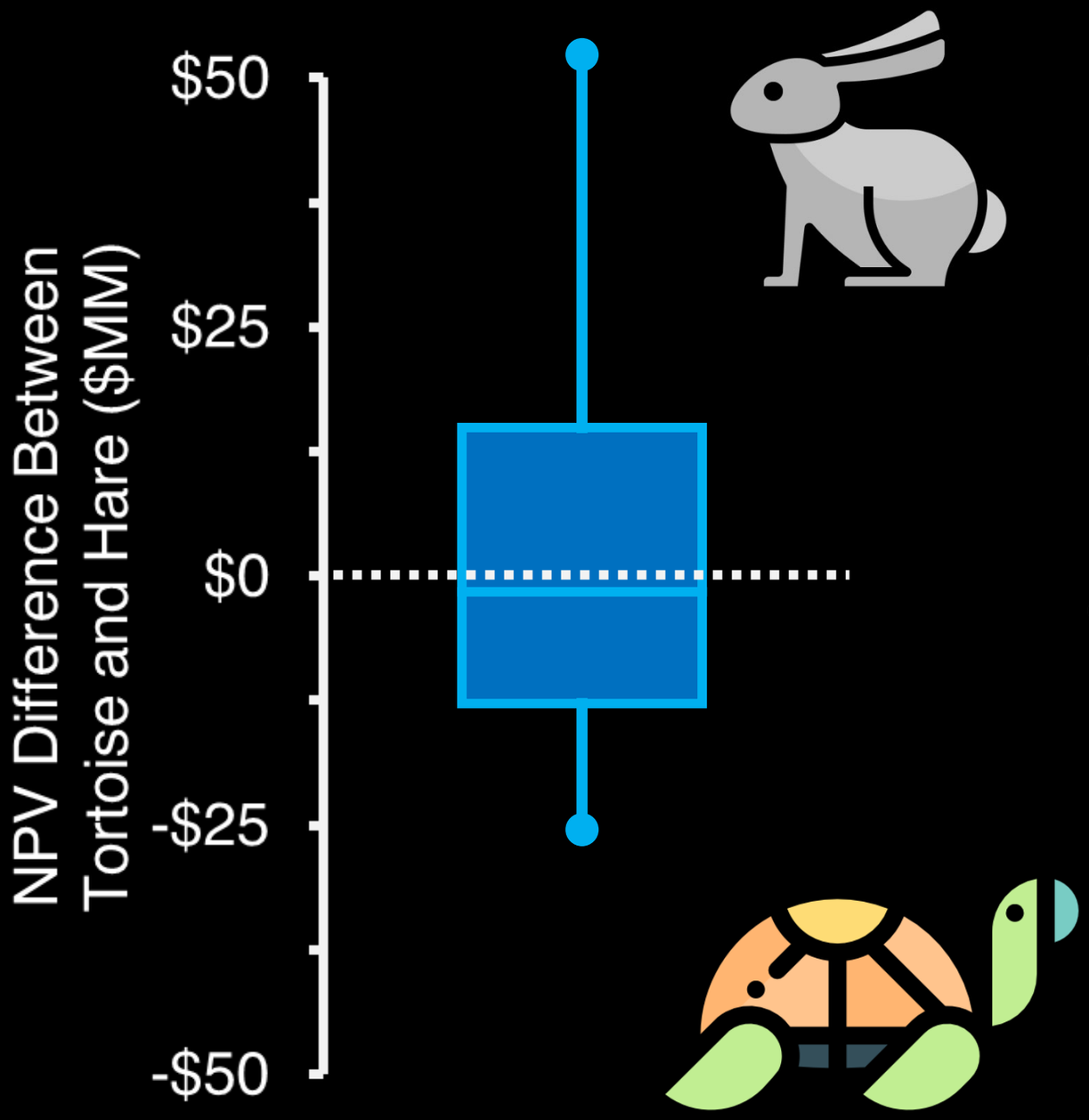


Thermal Storage Options



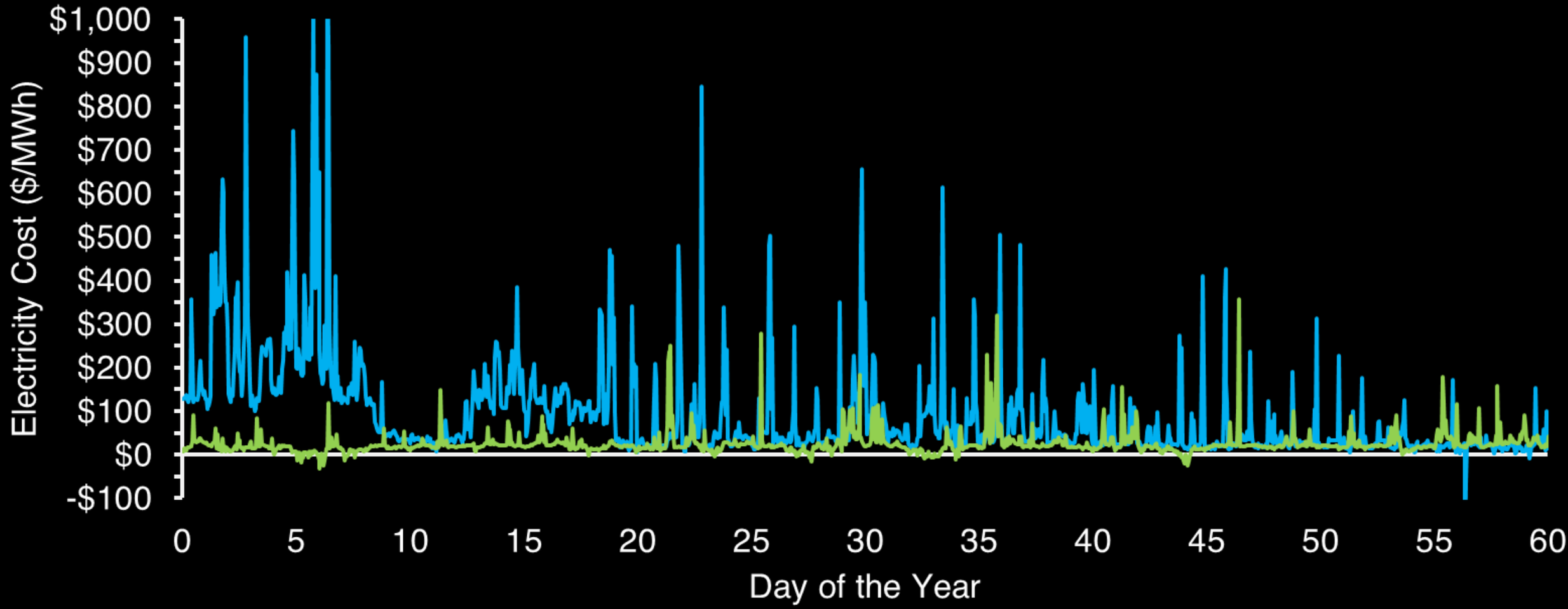
Which technology wins?


NPV Difference Between
Tortoise and Hare ($MM)
$50
$25
$0
-$25
-$50

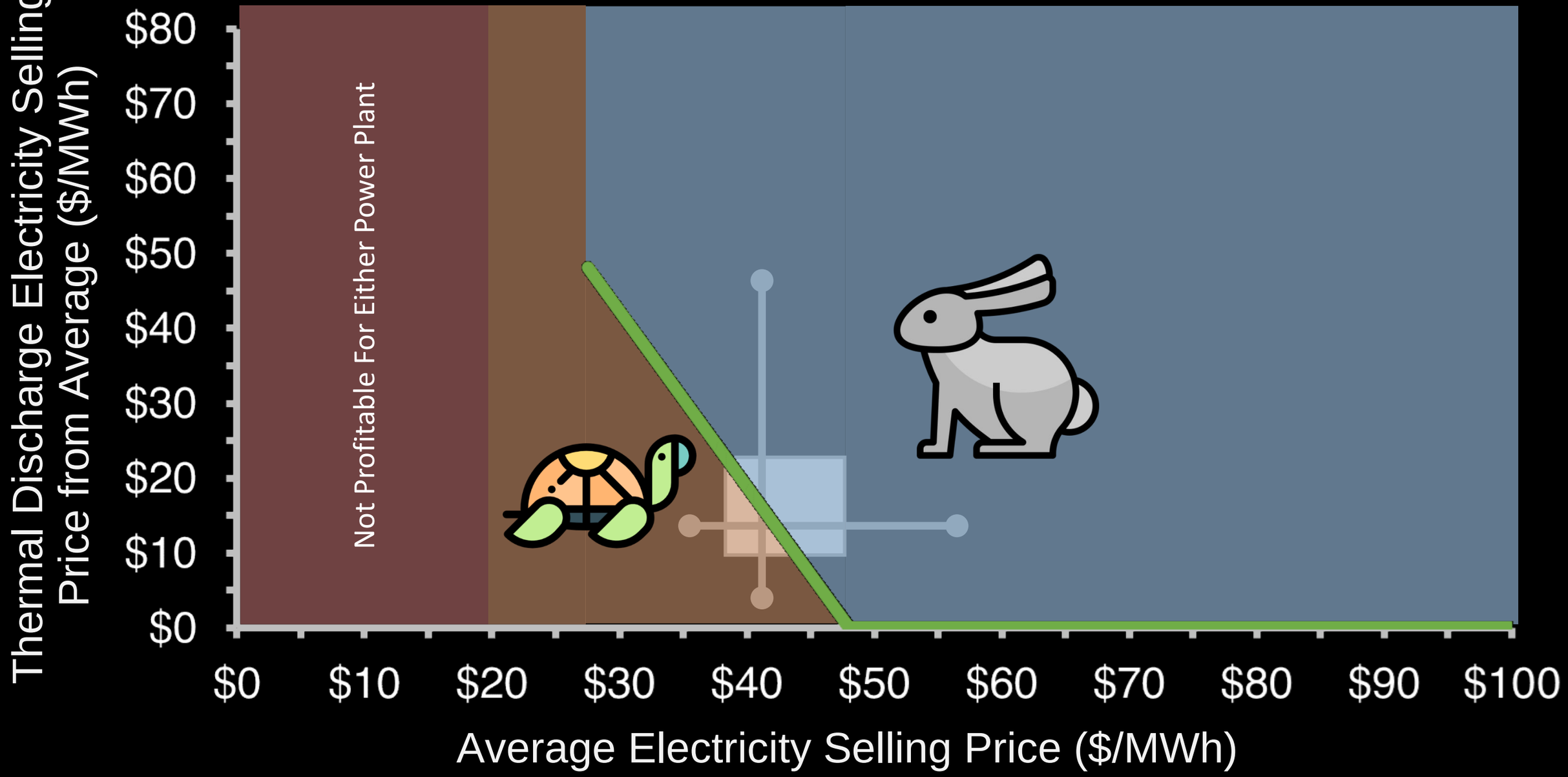


- **Thermal Storage won 236 of 548 (43%) of NYISO Nodes**
- **When it did win, it won by a larger amount**

Thermal Storage Needs High Variably



Variably Needed for Thermal Storage



What about future prices?

We Are Working With Grid Modeling Teams to Understand Future Markets

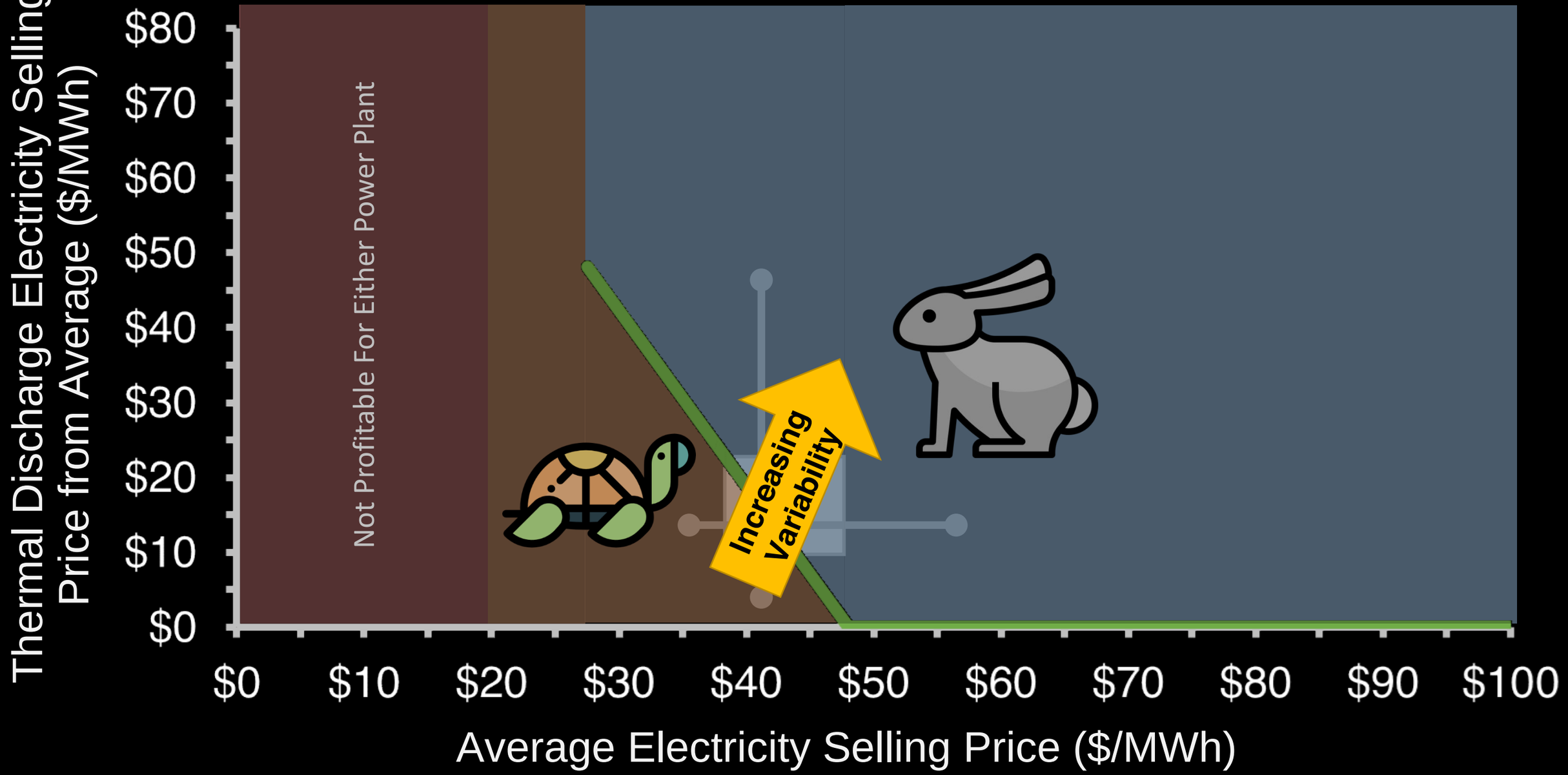
PRINCETON UNIVERSITY

GenX

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Regional Energy Deployment System (ReEDS)

More Variability is Better for Thermal Storage



Future Work

- Evaluate additional thermal storage configurations
- Optimize best performing thermal configurations
- Work to better understand future electricity markets

Questions?

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