# Dynamic Simulation of a novel nuclear hybrid energy system with large-scale hydrogen storage in an underground salt cavern

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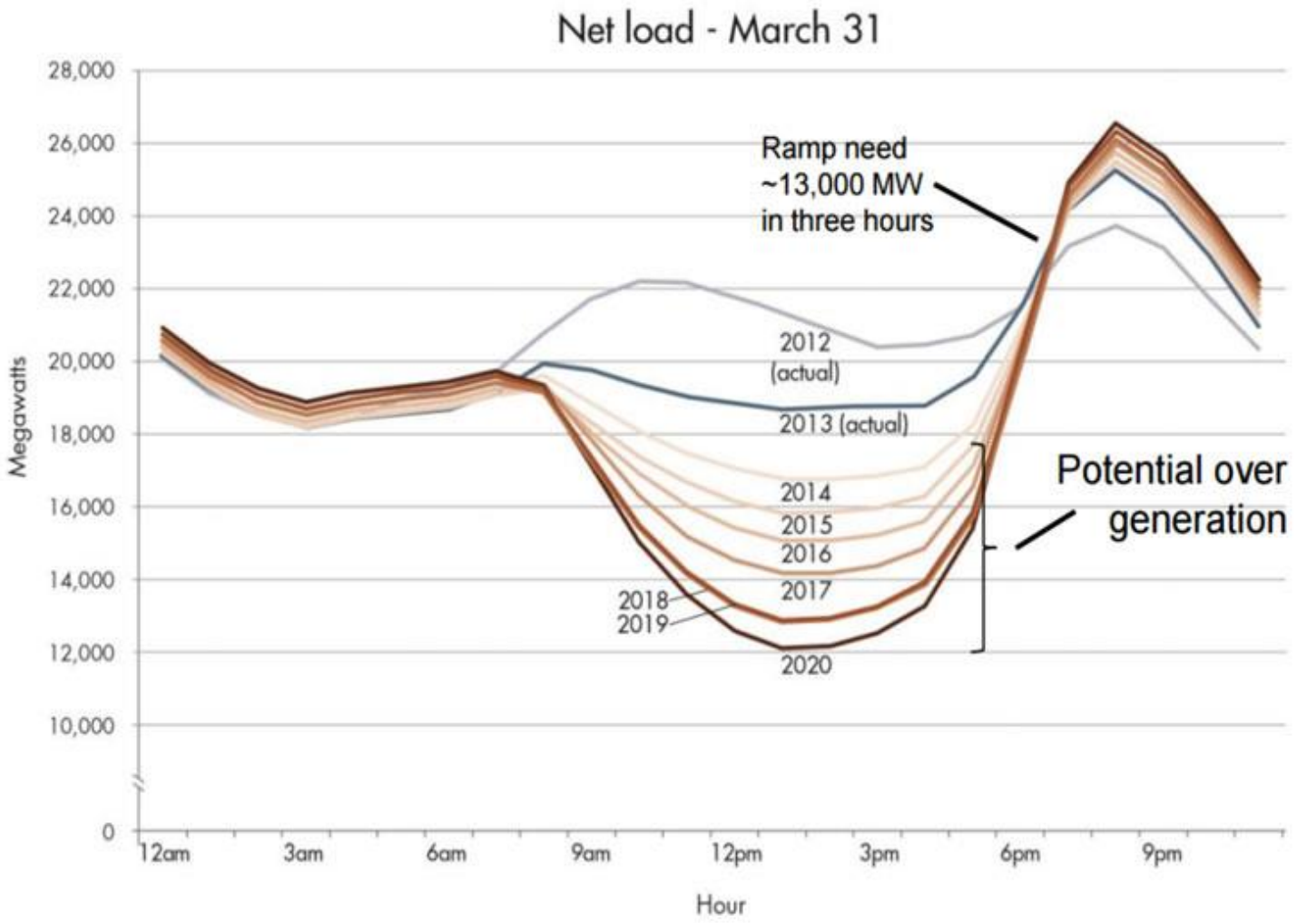
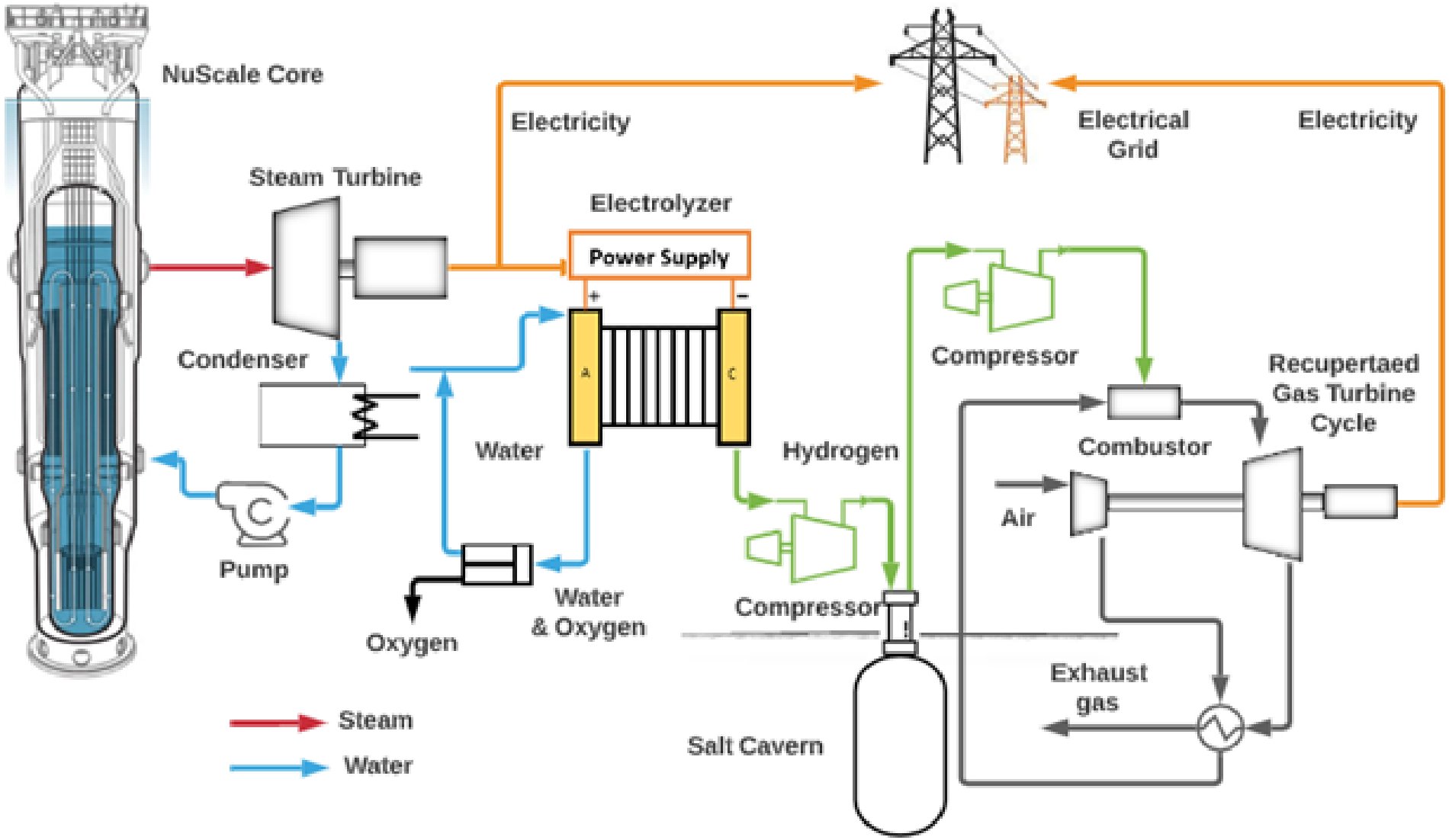
# The Duck Curve Problem



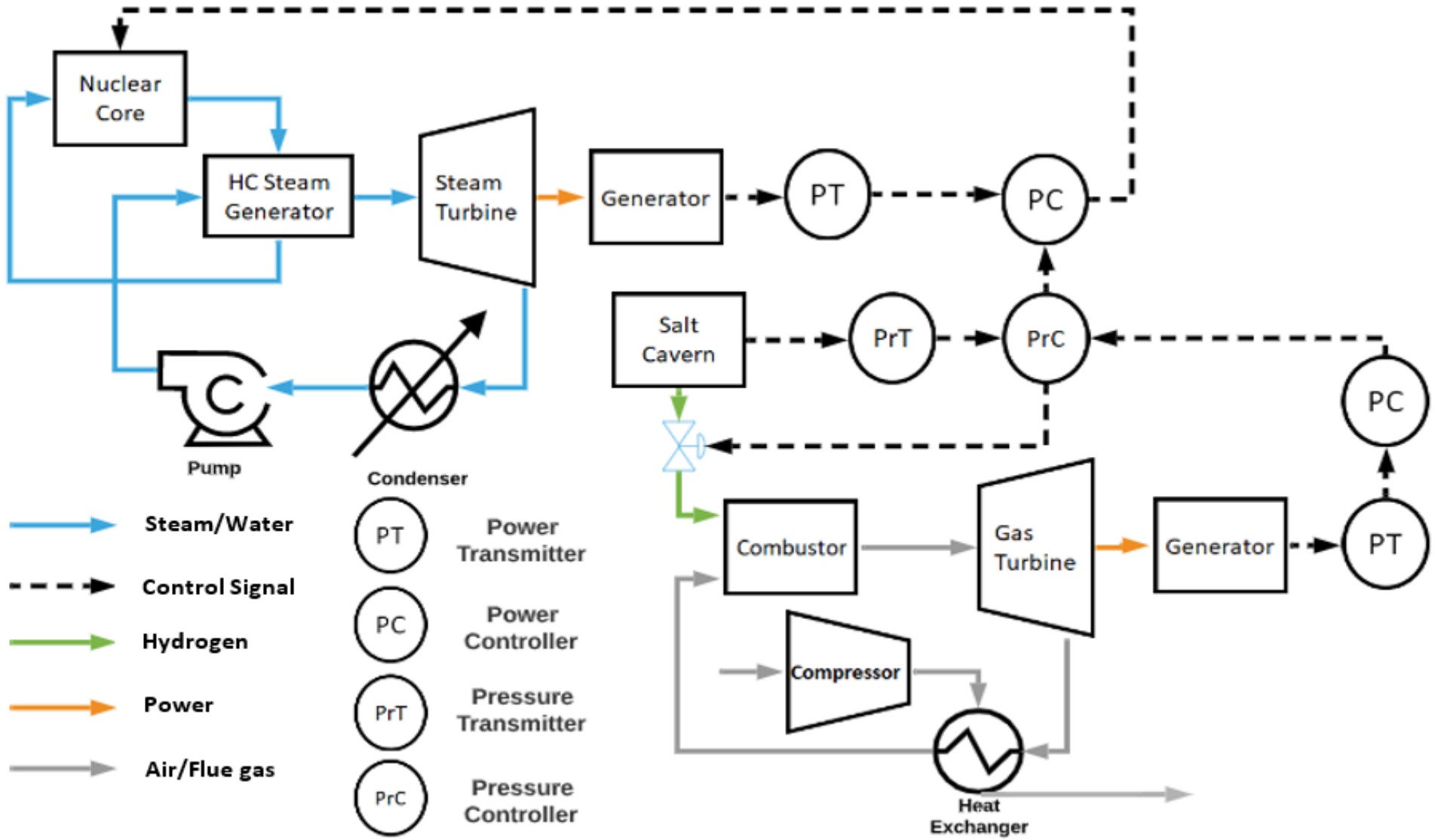
# Nuclear Power Plants (NPPs):

- Problems:
  - NPPs cannot “Load Follow” to match volatile energy demand.
  - Quick and frequent Control Rod adjustments strains NPP materials.
- Suggested Solution:
  - Use a Hybrid power system to store excess power until it is needed.
  - Combine Nuclear Power with Hydrogen Production and storage.

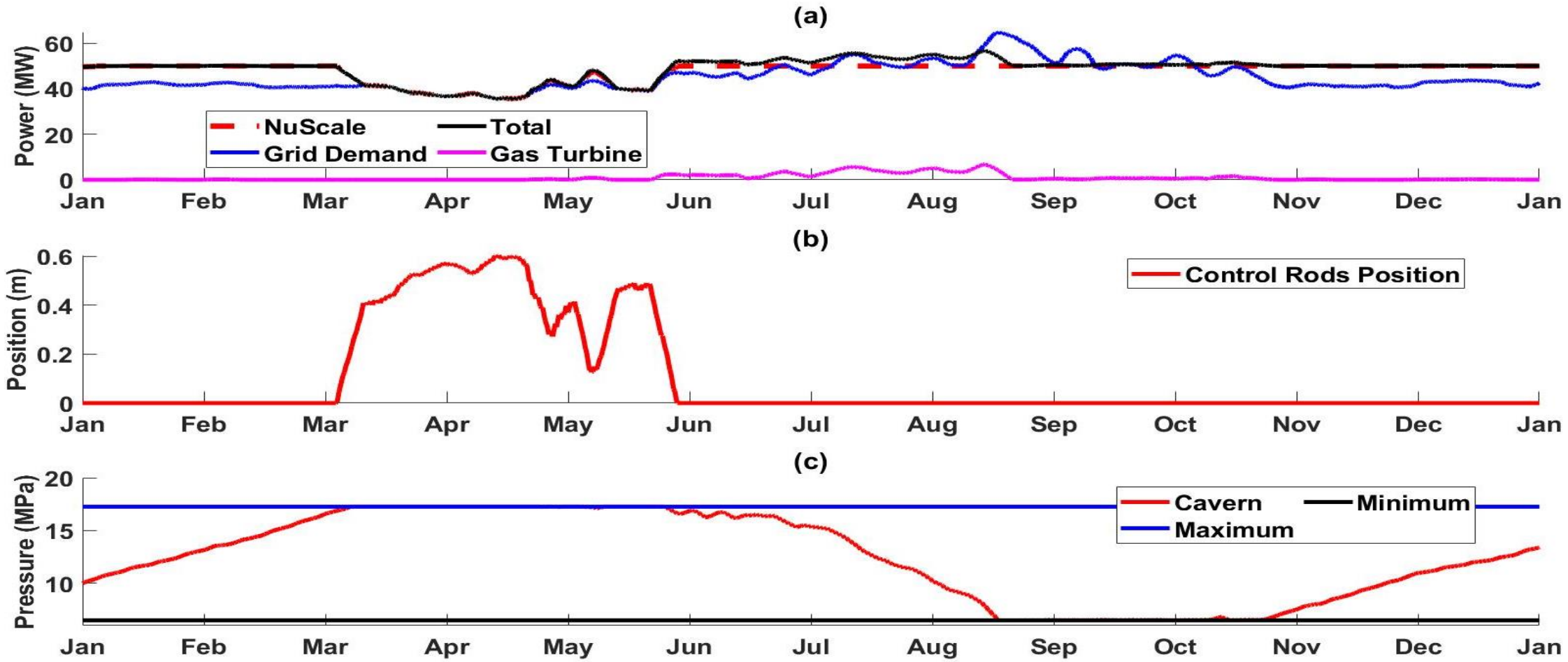
# Proposed Nuclear Hybrid-Energy System



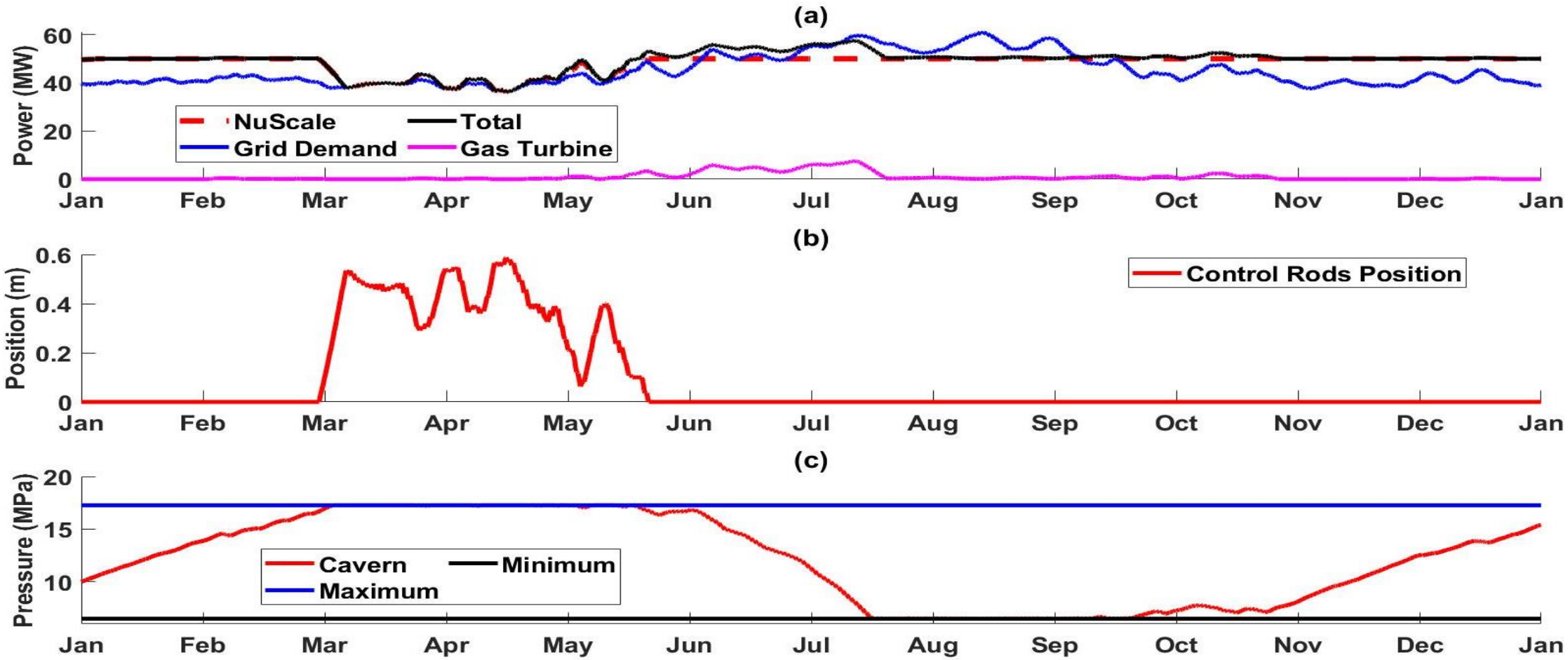
# Control Scheme



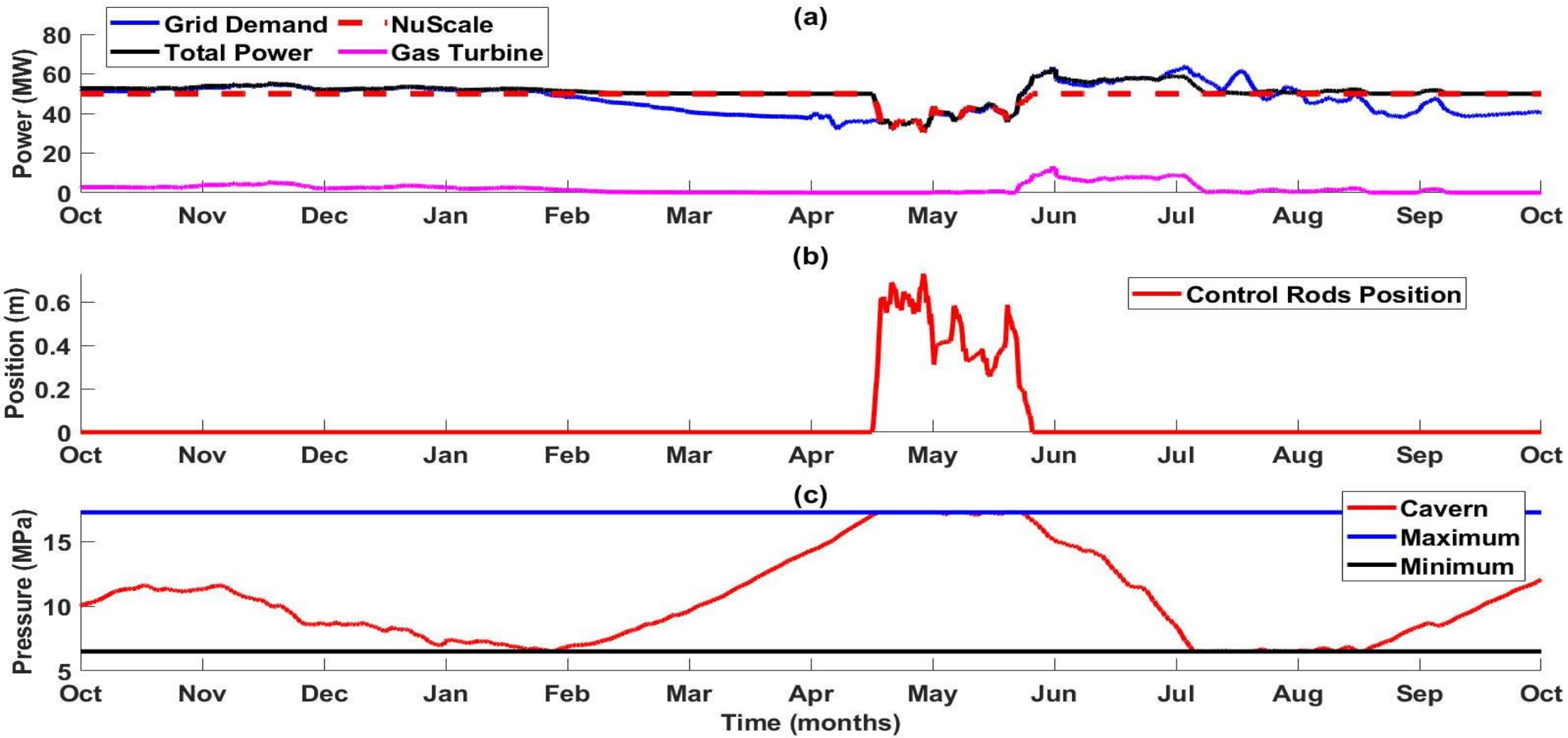
# CAISO (California)



# ERCOT (Texas)


(a)
Power (MW)
60
40
20
0
NuScale
Total
Grid Demand
Gas Turbine
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
(b)
Position (m)
0.6
0.4
0.2
0
Control Rods Position
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
(c)
Pressure (MPa)
20
15
10
Cavern
Minimum
Maximum
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan

# ISO New England



# Results Summary

| Parameters | ISO NE | CAISO | ERCOT |
|---|---|---|---|
| Nuclear capacity factor | 98.3% | 95.85 % | 96.27 % |
| Total power produced (MWh) | $443 \times 10^3$ | $419 \times 10^3$ | $421 \times 10^3$ |
| Percentage of total demand met | 98.39 % | 97.69 % | 97.14 % |
| Percentage of time when demand is met | 93 % | 89.71 % | 83.89 % |
| Total number of cycles | 39 | 135 | 82 |
| Standard deviation of nuclear power output | 0.808 MW | 2.156 MW | 1.951 MW |
| Percentage of time ramping up and down | 7.4% | 20.14% | 20.27 % |

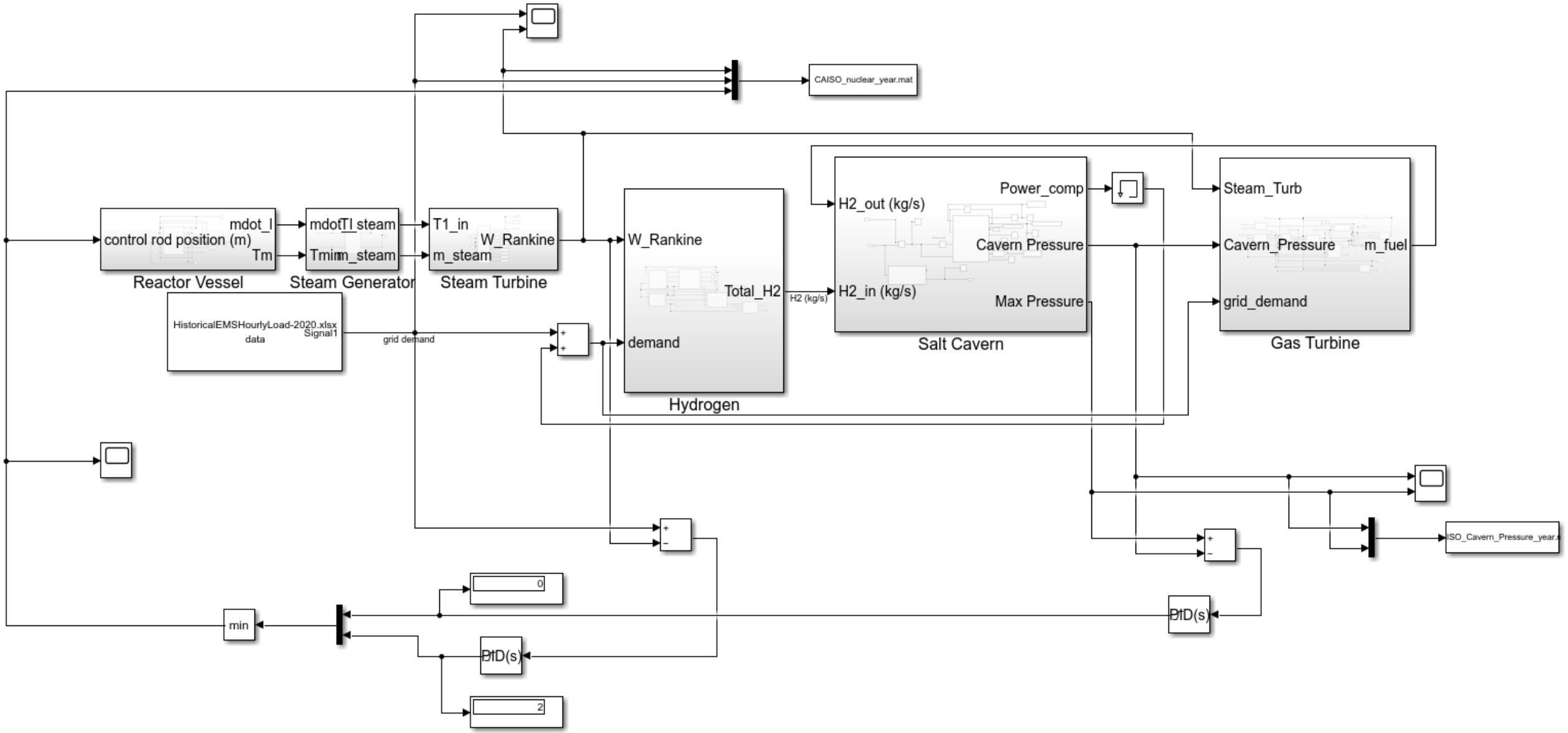
# Conclusions and Future Work

- This Hybrid System Would be best suited for the New England Climate.
- Future Work:
  - Run an economic analysis on each simulation to find what works best.

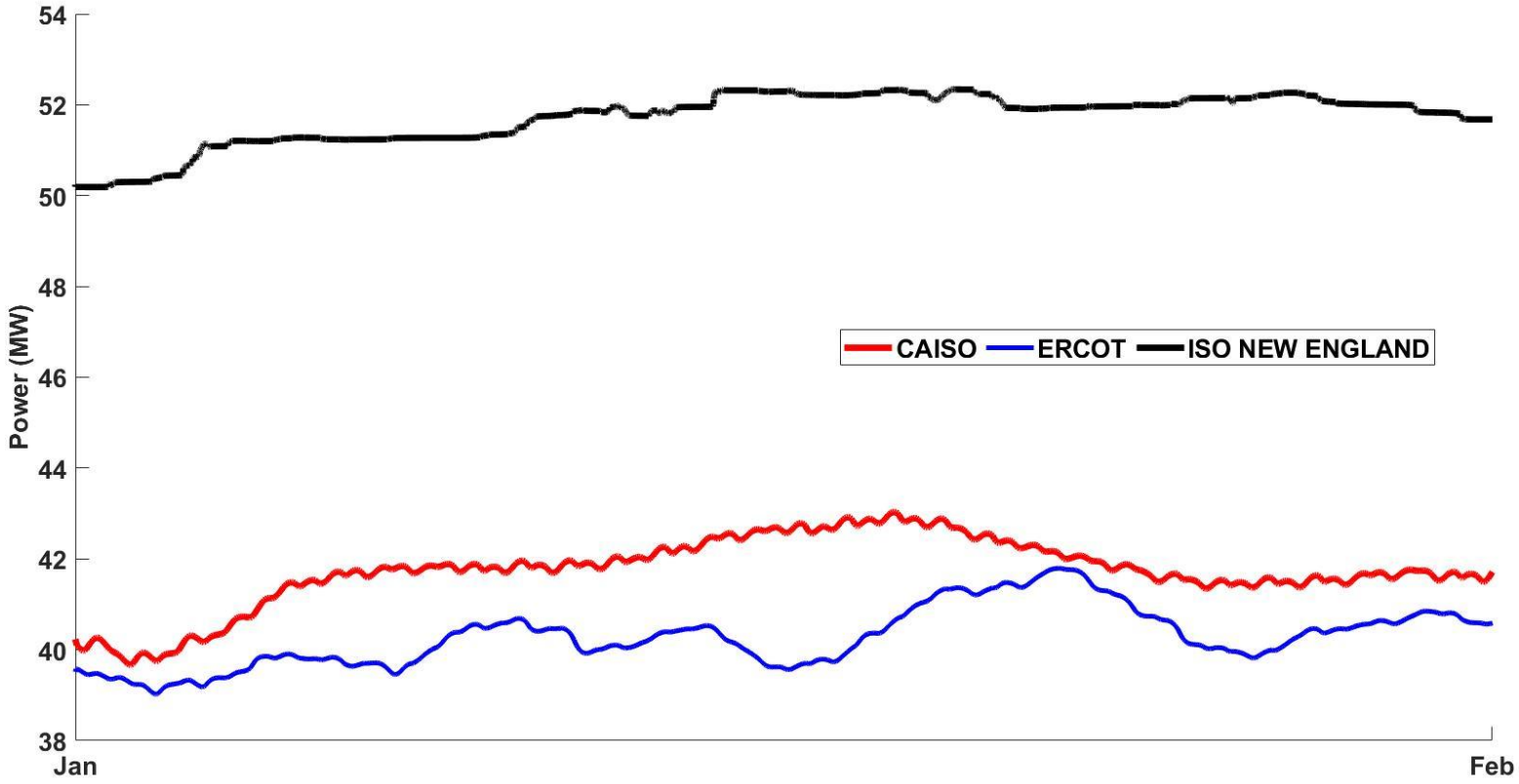
# The End

Supplemental Material Below

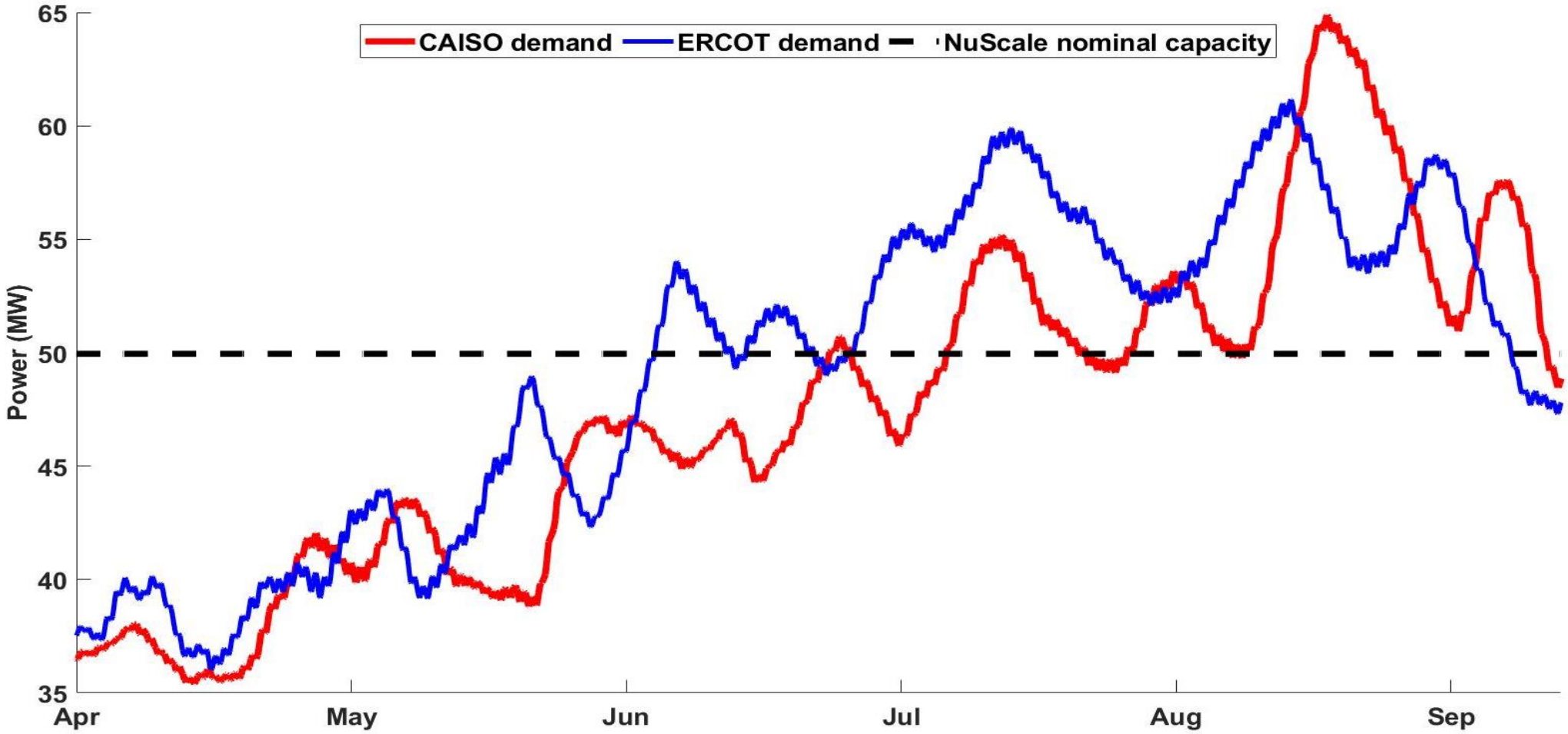
# The Simulation



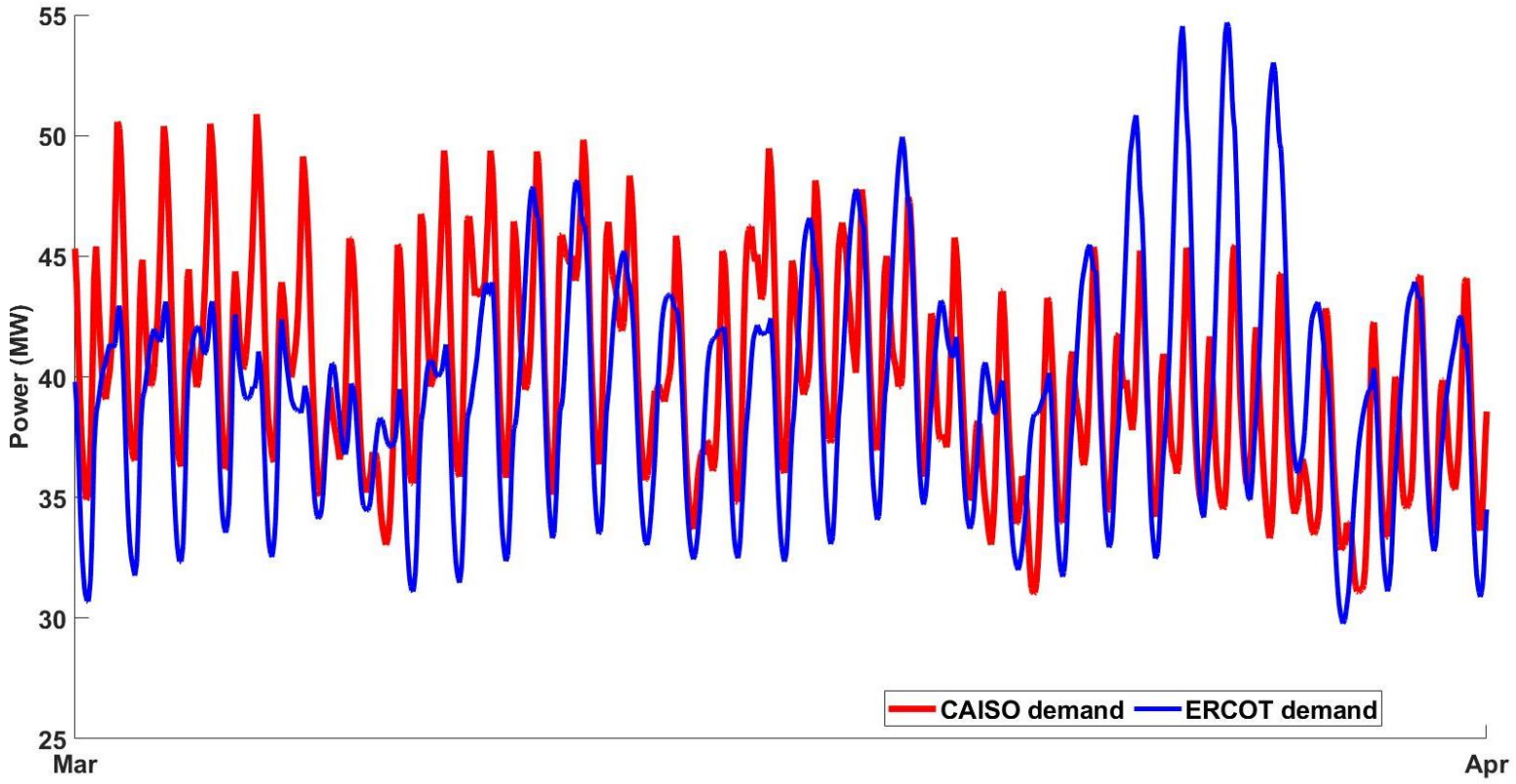
# Grid Demands from January to February



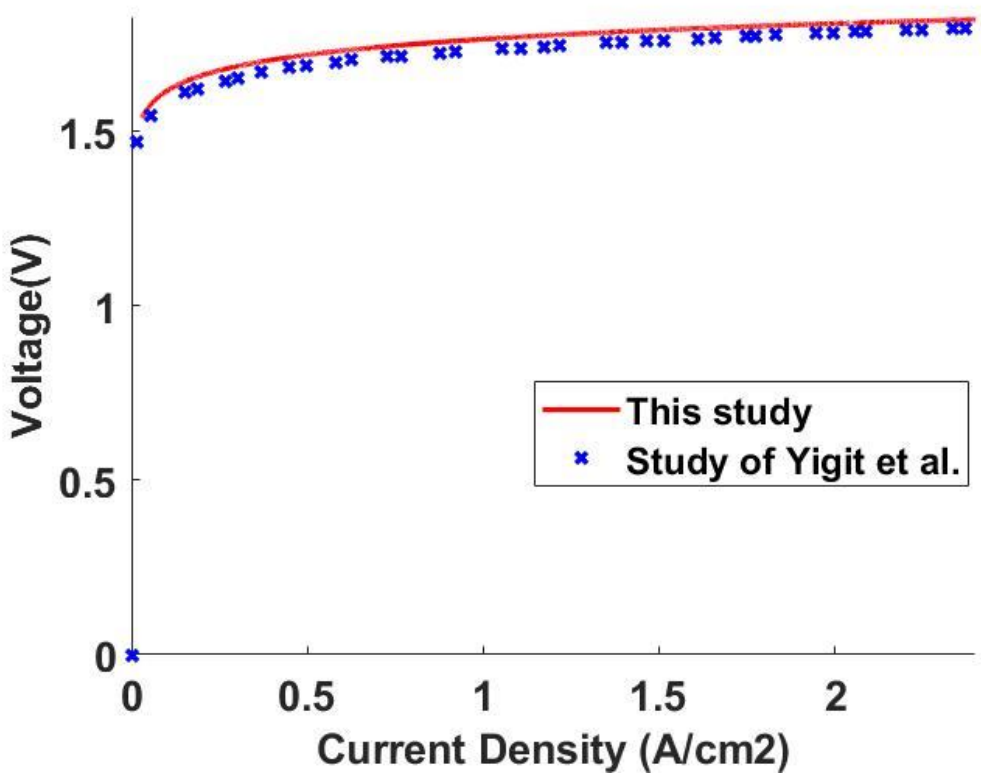
# Grid Demand Comparison (Apr-Sept)

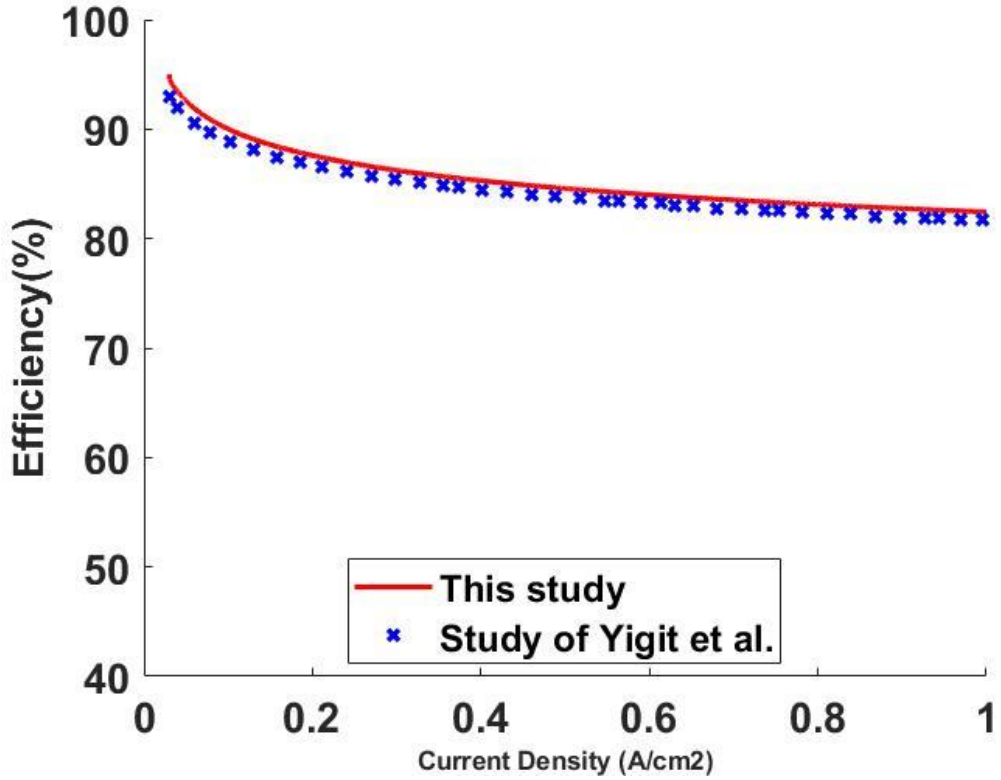


# CAISO vs. ERCOT demand curves



# Validation Results



# Nuclear Data and Model Fit