Dynamic Optimization Final Project

Utilizing GEKKO and RELAP5-3D to Generate a Model Predictive Controller for Thermal Energy Storage Units

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Nuclear Technology

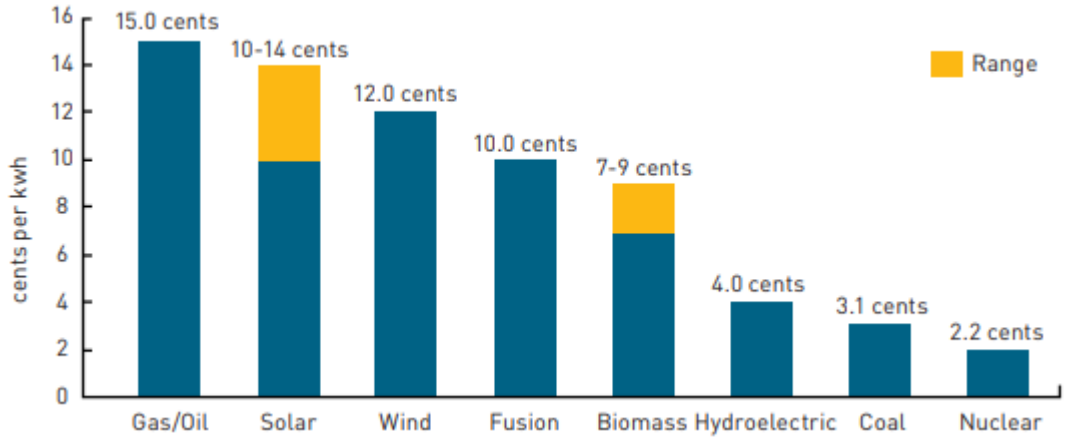

Image Source: world-nuclear.org

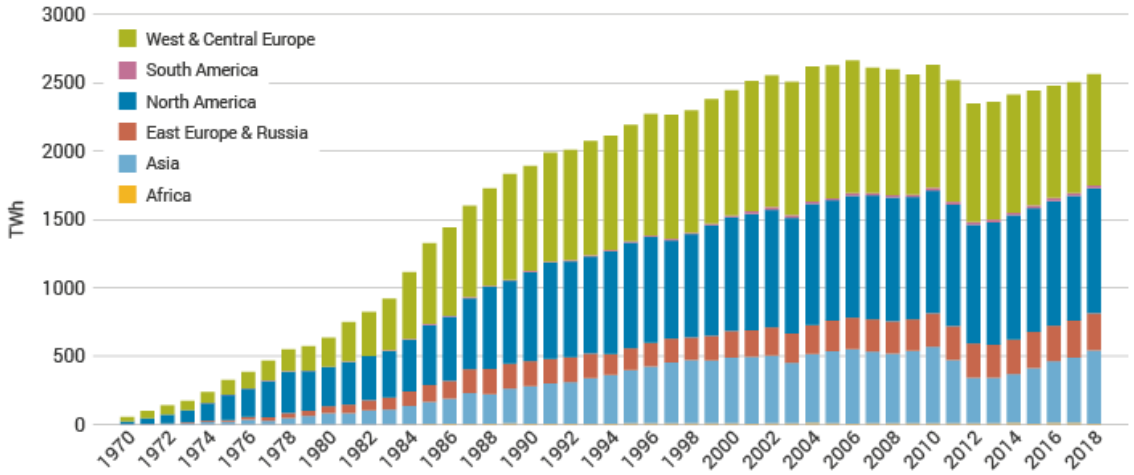

Image Source: world-nuclear.org

Energy Source	Deaths per 1,000 TWh
Coal	100,000
Oil	36,000
Natural Gas	4,000
Hydro	1,400
Rooftop Solar	440
Wind	150
Nuclear	90

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Renewables

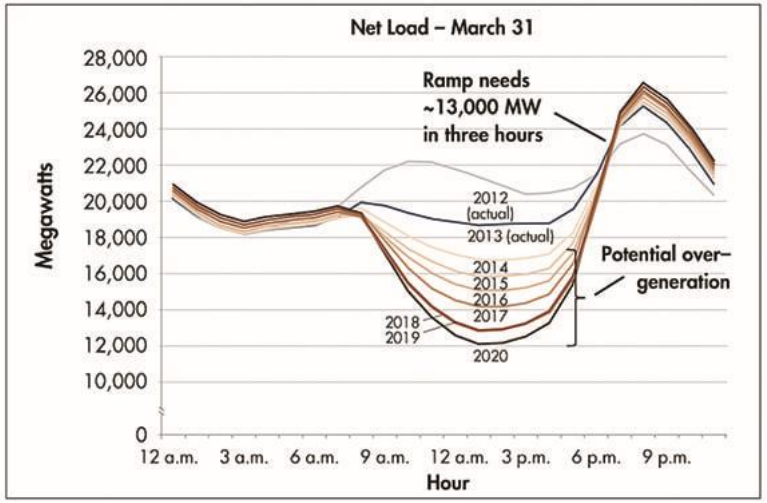
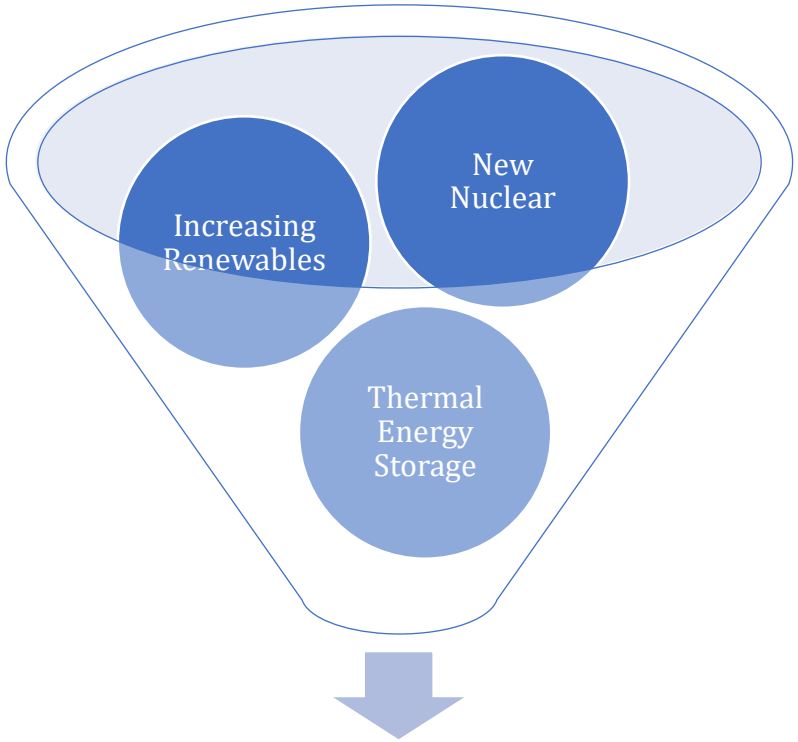


Image Source: caiso.com



Competitive Nuclear

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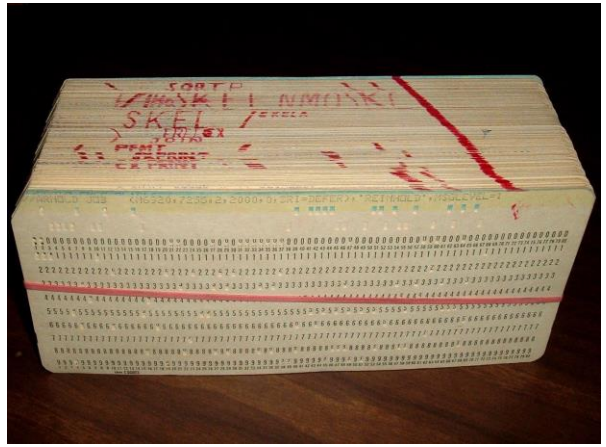
RELAP5-3D

- “A simulation tool that allows users to model the coupled behavior of the reactor coolant system and the core for various operational transients and postulated accidents that might occur in a nuclear reactor.” (relap53d.inl.gov)

- Developed in the 1980s

- Currently the only code for licensing



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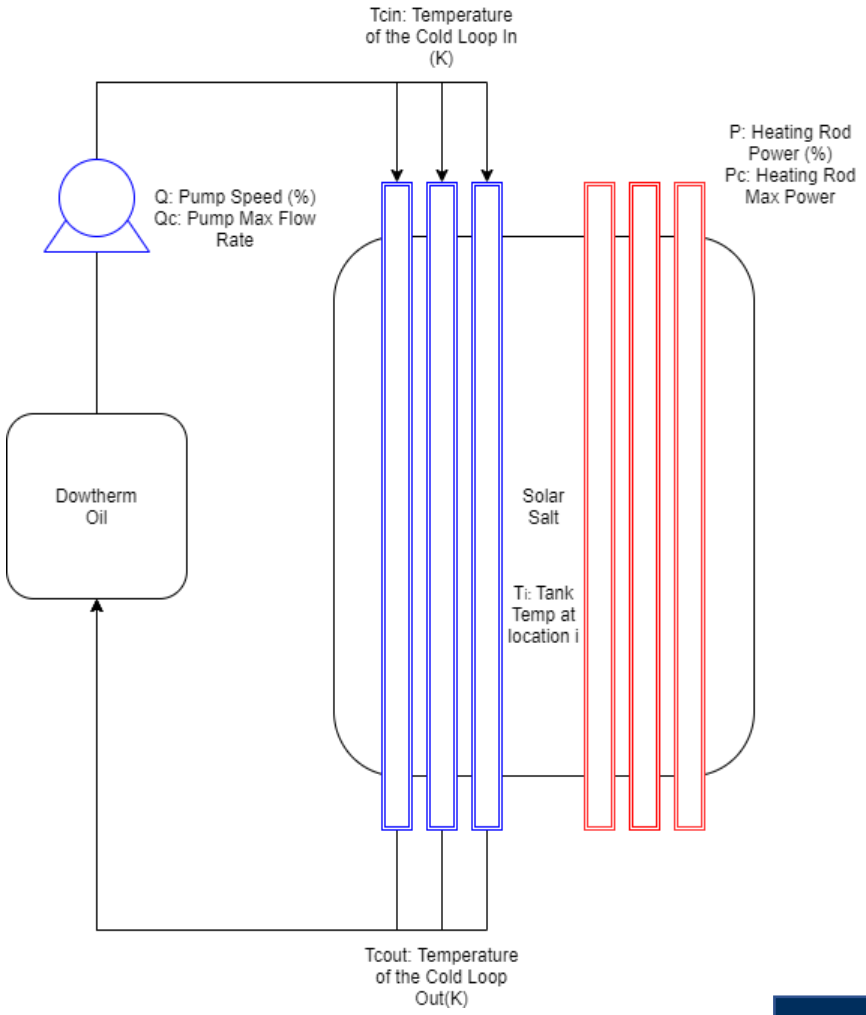
Project Scope

- Create a simplified model of a shell and tube heat exchanger

- MPC for use with a lab scale unit



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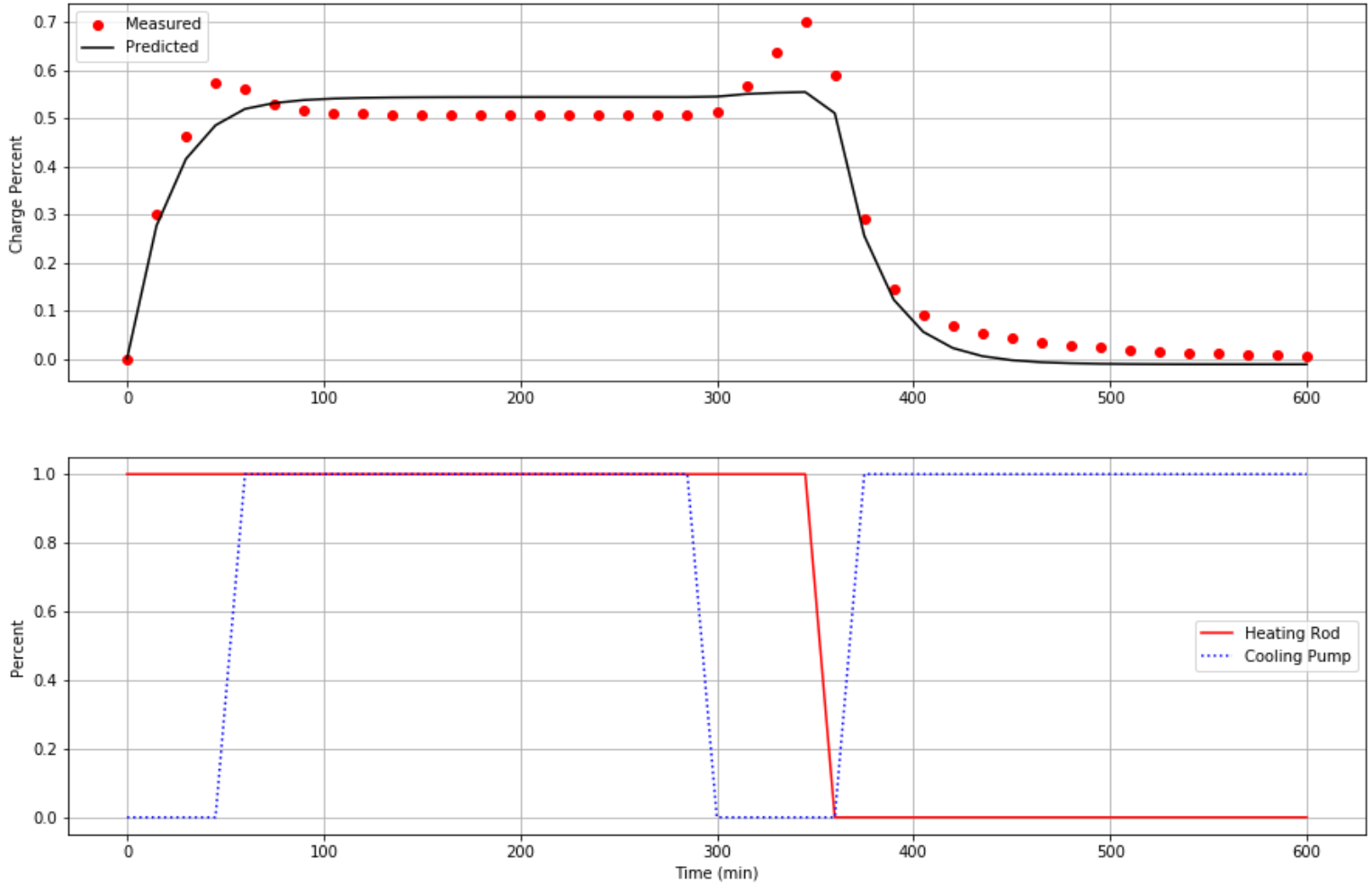
1st Order Model



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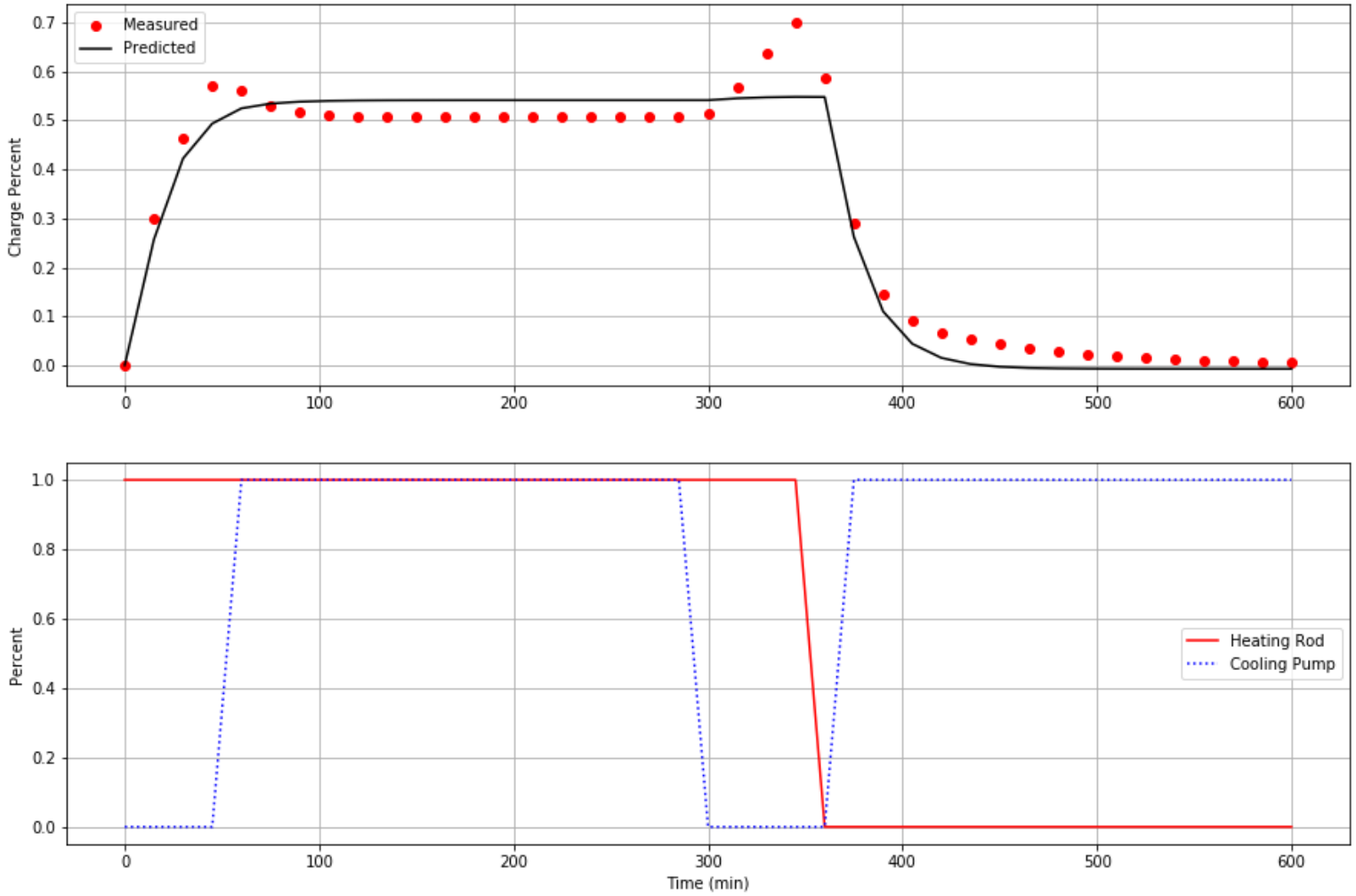
2nd Order Model



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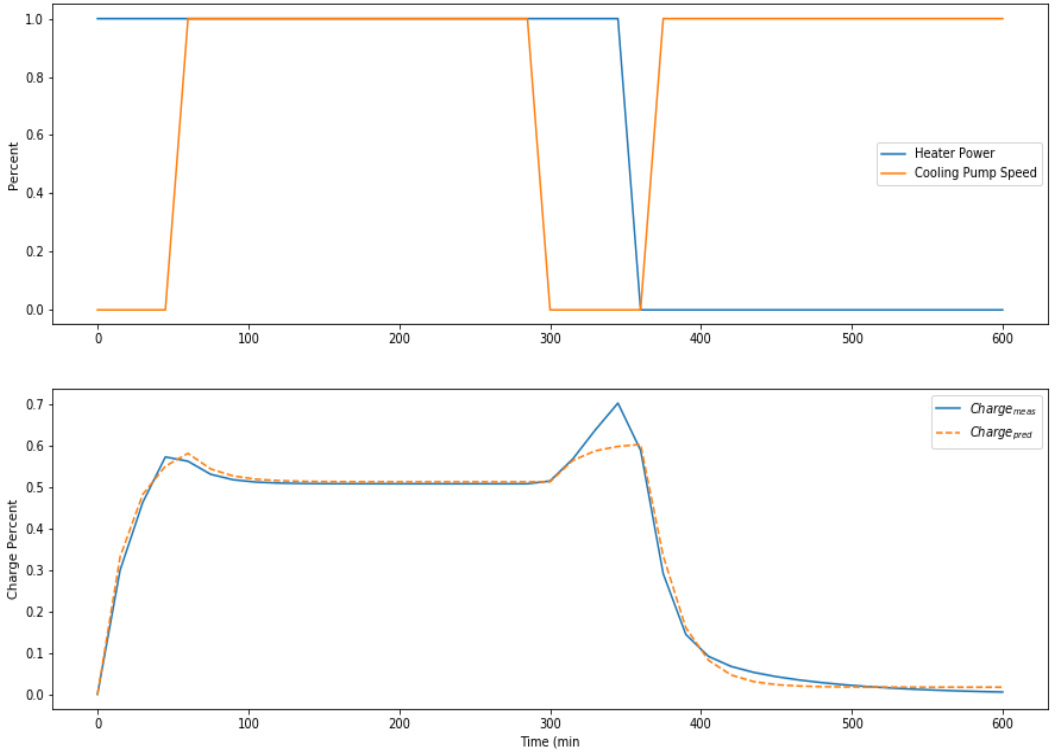
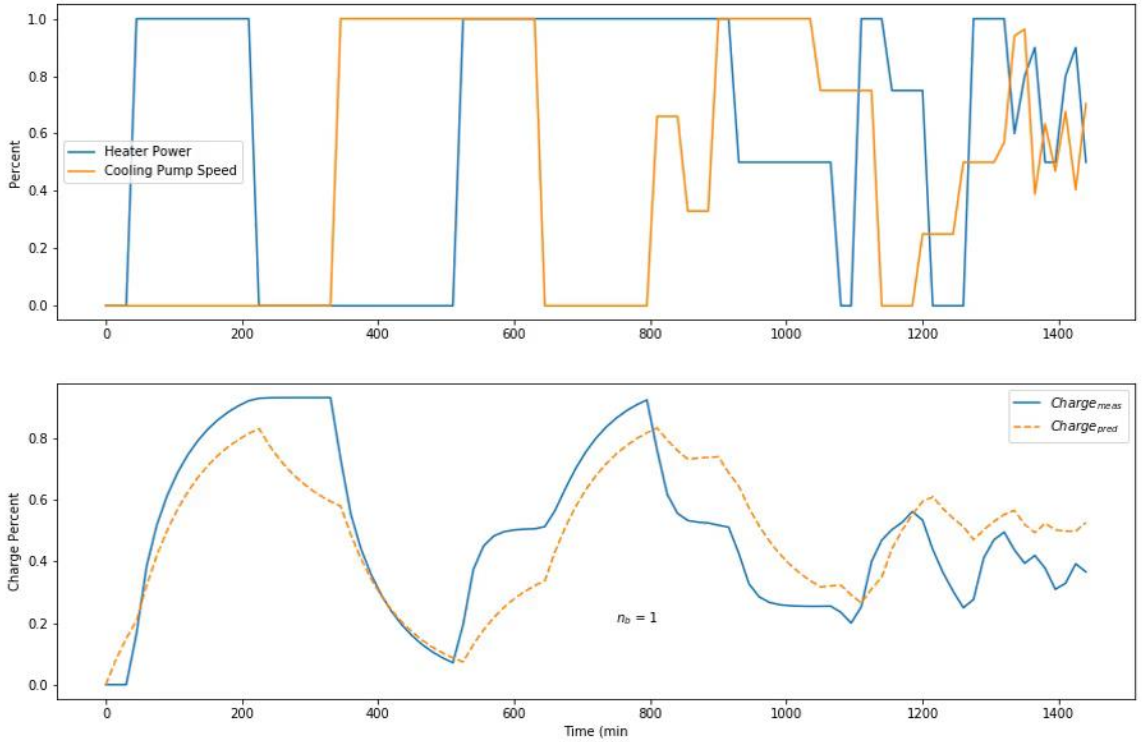
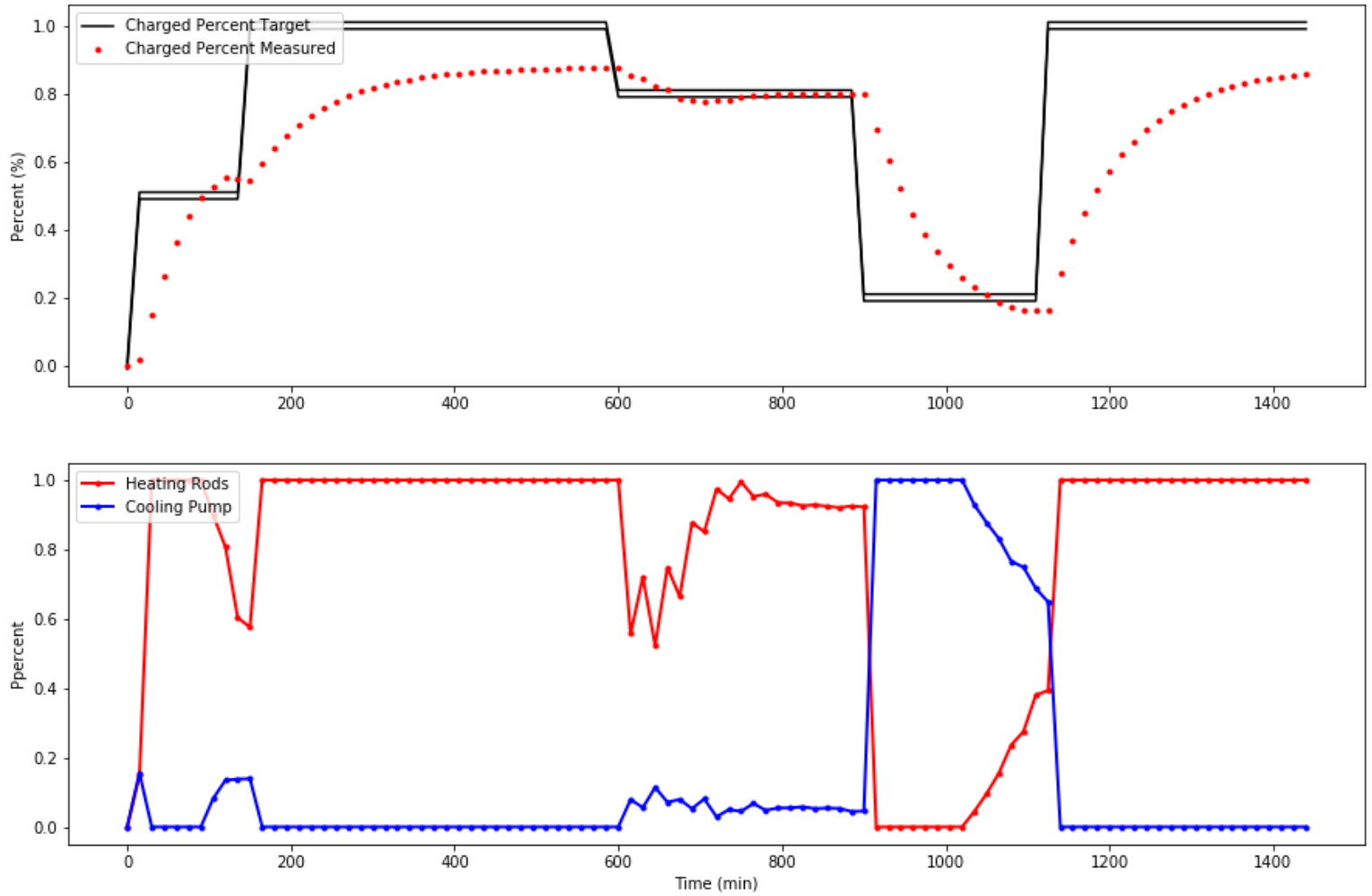
ARX Model


Percent
Heater Power
Cooling Pump Speed
Charge Percent
$Charge_{meas}$
$Charge_{pred}$
Time (min


Percent
Heater Power
Cooling Pump Speed
Charge Percent
$Charge_{meas}$
$Charge_{pred}$
$n_b = 1$
Time (min

MPC


Charged Percent Target
Charged Percent Measured
Percent (%)
1.0
0.8
0.6
0.4
0.2
0.0
0
200
400
600
800
1000
1200
1400
Heating Rods
Cooling Pump
Ppercent
Time (min)

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Future Work

- Possible machine learning model
- Run MPC with actual lab scale unit
- Adjust MPC to allow for input of artificial load data and have MPC control the operation of the thermal energy storage unit.

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