Reducing greenhouse gas emissions by optimizing room temperature set-points

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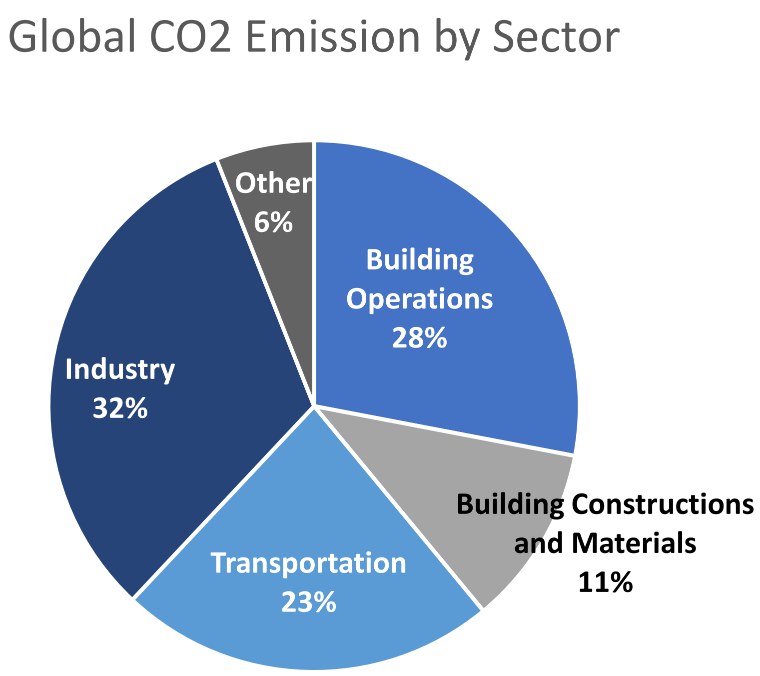
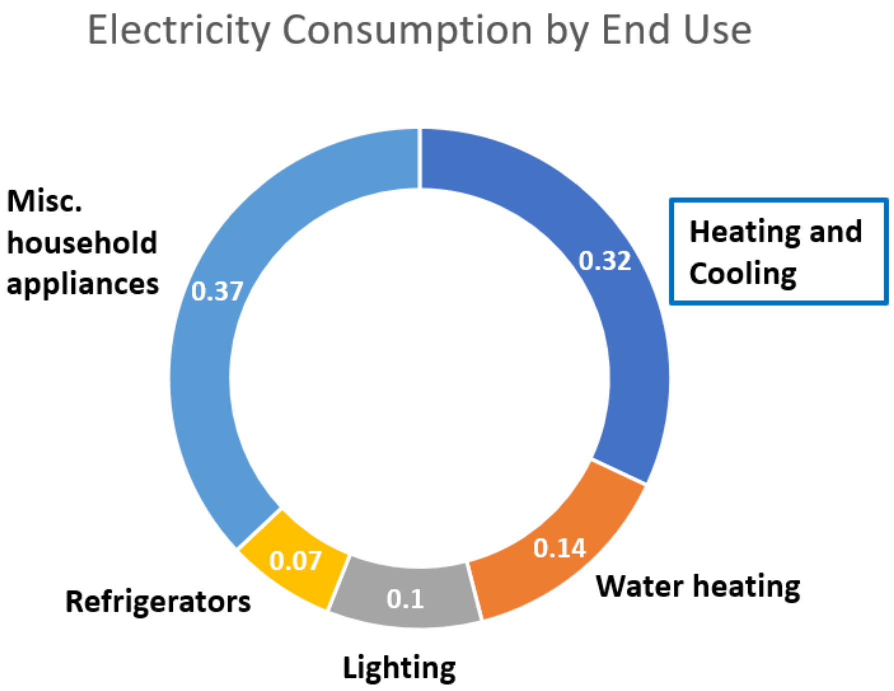
Background:
Greenhouse gas emission and the building sector

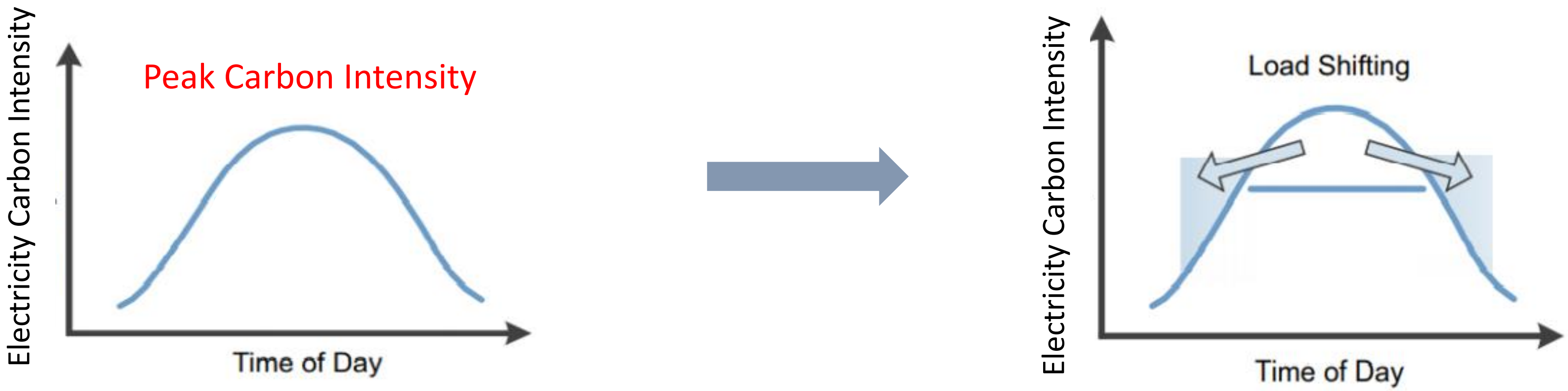




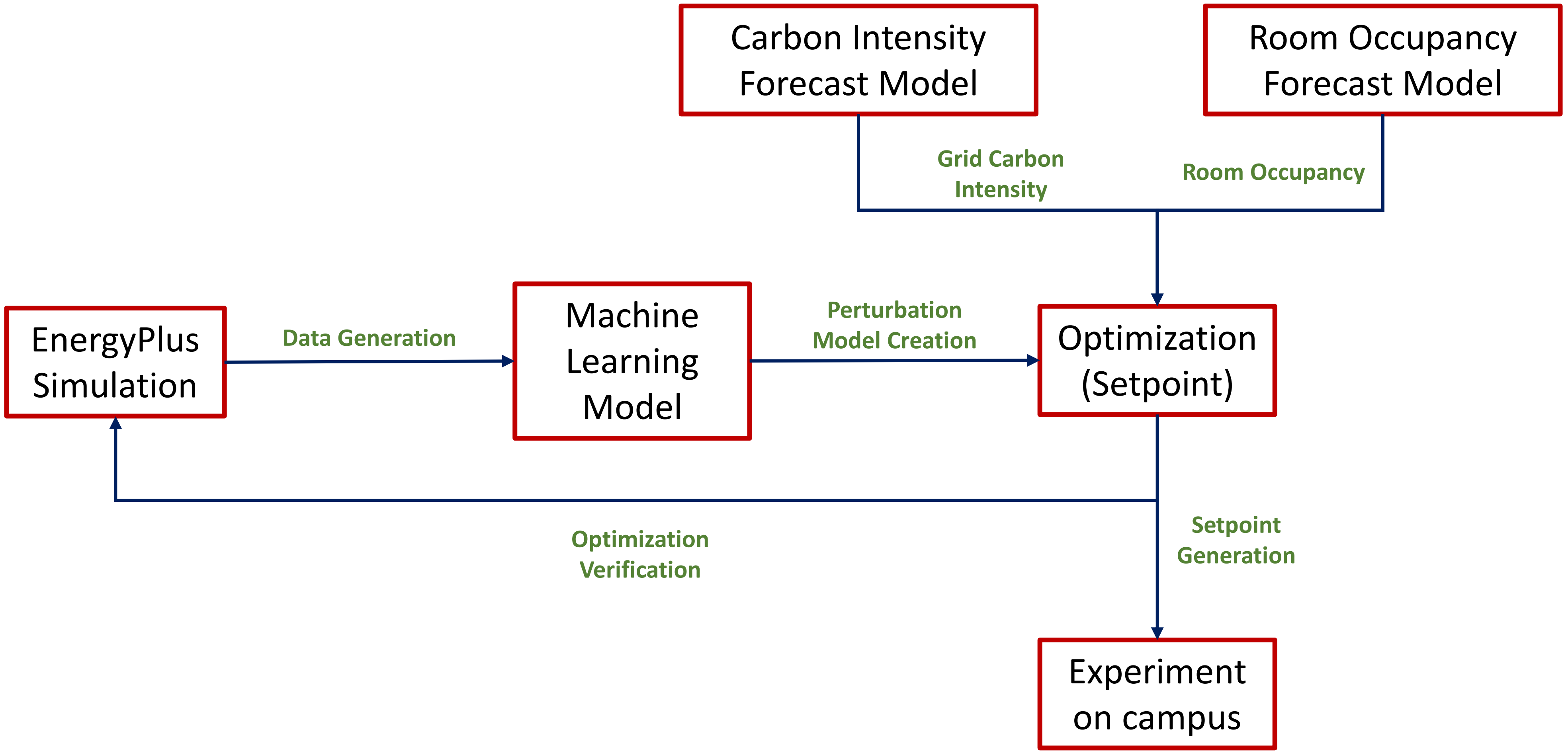
Sources:
[Residential Energy Consumption Survey (RECS) - Energy Information Administration (eia.gov)]
[Why The Building Sector? – Architecture 2030]

Research goal

Optimize room temperature setpoints for campus buildings to **minimize total greenhouse gas emission.**



Workflow


Carbon Intensity Forecast Model
Room Occupancy Forecast Model
Grid Carbon Intensity
Room Occupancy
EnergyPlus Simulation
Data Generation
Machine Learning Model
Perturbation Model Creation
Optimization (Setpoint)
Optimization Verification
Setpoint Generation
Experiment on campus

Machine learning model

Model Features (hourly):

1. Ambient dry-bulb temperature
2. Room temperature setpoint
3. Time-difference of the temperature setpoint
4. Functions of the time of day

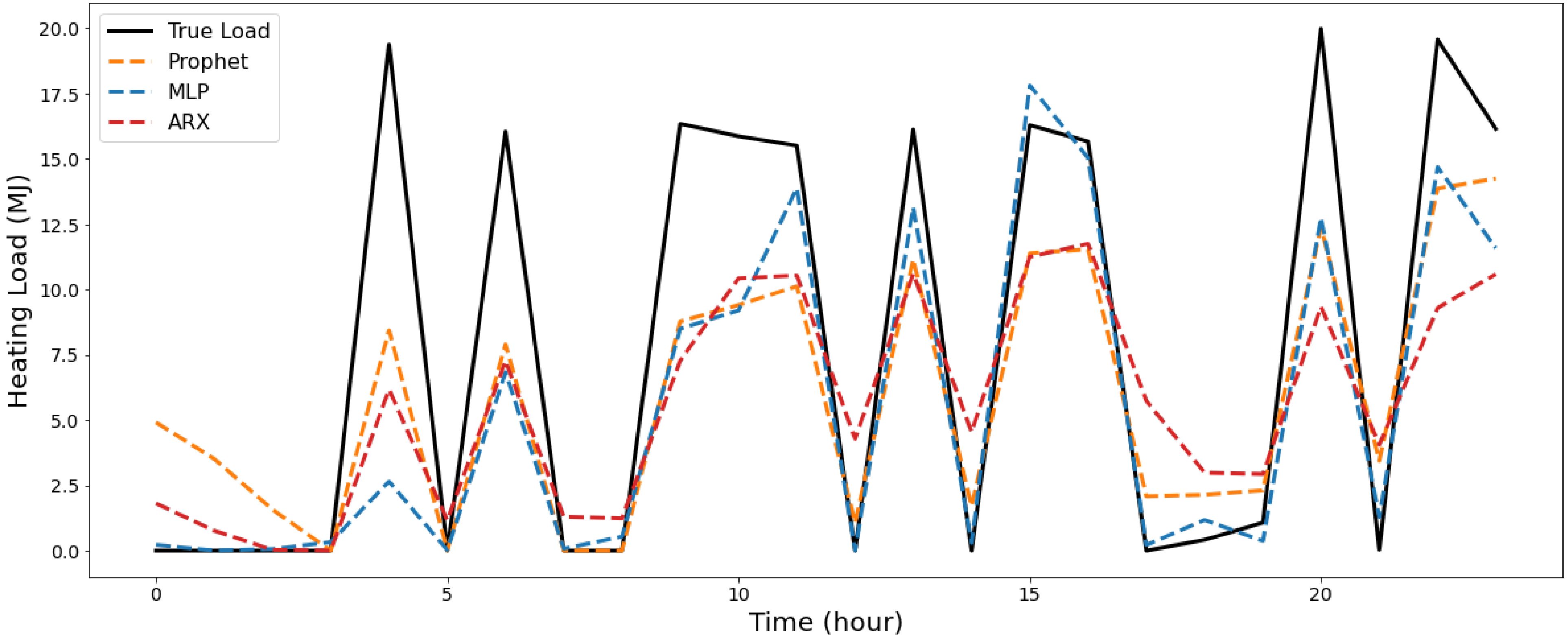
Model Target (hourly):
Heating/cooling load

1. **Linear Autoregressive Exogenous Model**
2. **Prophet model (Facebook)**
3. **Multilayer Perceptron**

Load forecasting results

RMSE Comparison in the test data, in units of MJ

ARX	Prophet	MLP
4.25	4.04	1.77



1. Linear model; convex optimization

- Pros
  - Global optimality guaranteed
  - Standard solver (CVX) readily available
- Cons
  - Linear model forecast is not as accurate as non-linear ones

2. Non-linear model; non-convex optimization

- Pros
  - Non-linear model forecast is more accurate
- Cons
  - Global optimality not guaranteed
  - Requires custom solver

Idea: warm start NO.2 with solutions from NO. 1

Thank you!

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