Energy Optimization of Cooling Systems in Buildings

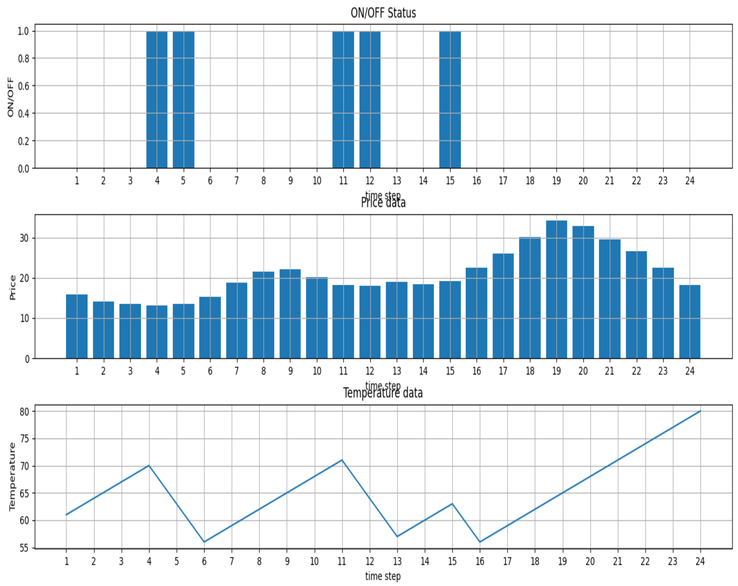
J. Alejo, A. Attia-Ibrahim, J. Herring, J. Martinez, S. Garkaka
Advisor: Dr. Ehsan Reihani

Introduction

-Simulate fan operation in miniature form using Raspberry Pi, integrated with a DC motor that spins a 3d printed fan.

-Predicted energy prices will be used in an optimization problem to determine the optimal operation of air-conditioning in a building.

-Utilize Pyomo, an open-source optimization modeling language that enables robust interfacing with cutting-edge solvers to optimize energy usage of cooling systems in Buildings.

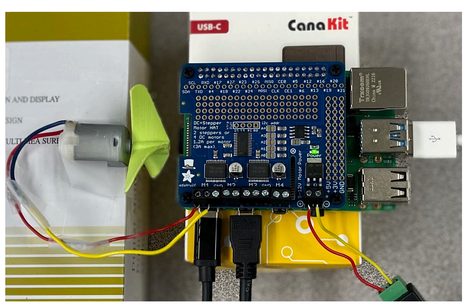


Project Description

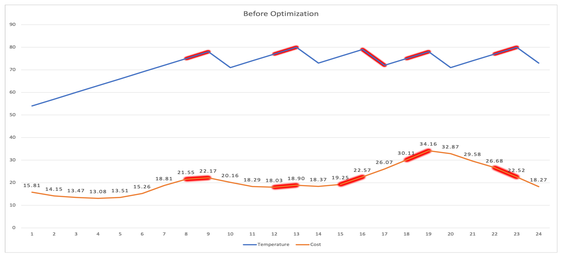
- Optimization Problem
  - Optimizing energy consumption along with cost reductions in electricity bills for consumers
- Pyomo Mathematical Modelling
  - Predictions for future scenarios
  - Optimization
    - Worst/Best case scenarios
  - Machine learning
    - Ability to learn from human behavior to give best possible solutions
    - Explains different case scenarios by giving multiple different solutions

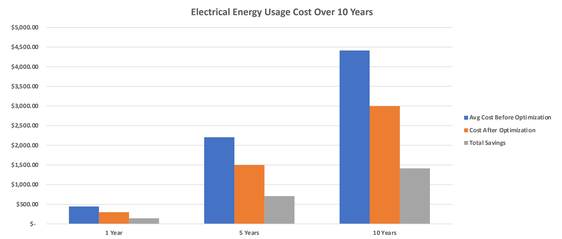
```python
# Defining cost function as summation of power times price of power
def obj_expression(model):
    return sum(model.c[j] * model.x[j] for j in model.J)
model.OBJ = pyo.Objective(expr=obj_expression)

print("The objective function is: \n",model.OBJ.pprint())
```

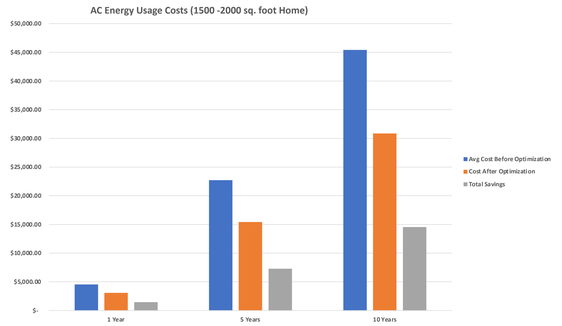
```python
# # Defining tempearrure dynamic equation as a constraint.
# # The temperature will increase by 3 degrees if fan is ON
# # and will decrease by 7 degrees if fan is OFF
def temperature_dynamics_constraint_rule(model, j):
    if j != 24:
        return model.T[j+1] == (model.T[j] - 7)*model.x[j] + (model.T[j] + 3)*(1-model.x[j])
    return pyo.Constraint.Skip
```



Simulation Results







Conclusion & Future Work

- Current science literature review of different optimization techniques suggests using a combination of methods to achieve the desired outcome and further minimize costs
- Adding battery storage and solar energy generation to the optimization problem
- Adding water heater and other loads
- Aggregating power from individual houses and selling extra power to the power market
- Creating a neighborhood microgrid to become resilient against outages
- Using game theory concepts to distribute the profit among houses