AN ENERGY MANAGEMENT ALGORITHM FOR SMART HOUSE

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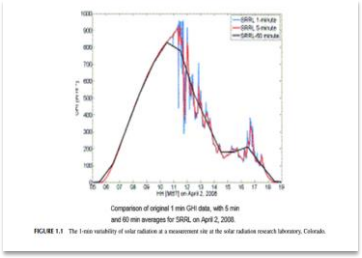
INTRODUCTION

- Optimize the energy service at a residential building
- The goal is to manage energy consumption such that households make more intelligent decisions when operating their major home appliances.
- DER(distributed energy resources) examples: distributed generation, energy storage and controllable end-use loads
- **Decision-support tool** maximize the net benefits: Total energy service benefits – Costs of energy provision; put different levels of benefits to different services at different hours of the day, optimize DER operation schedules
- Scheduler controls battery charging/discharging rate, space heater hourly heating power, water heater switch on hours, and the pool pump running hours, and must-run services to maximize net benefits

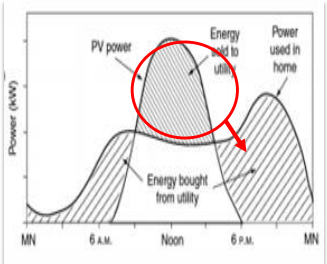
SIGNIFICANCE

- Solar generation: peak output at low demand times
- Prevent overvoltage/undervoltage to occur
  - Store energy in battery instead of sending it back to the grid during day time
  - Draw energy from battery instead of getting supplied from utility company during night time
- Fluctuations in power output: cloud cover can cause ramp-up and ramp down events



Comparison of original 1 min GHI data, with 5 min and 60 min averages for SRRL on April 2, 2008.

FIGURE 1.1 The 1-min variability of solar radiation at a measurement site at the solar radiation research laboratory, Colorado.



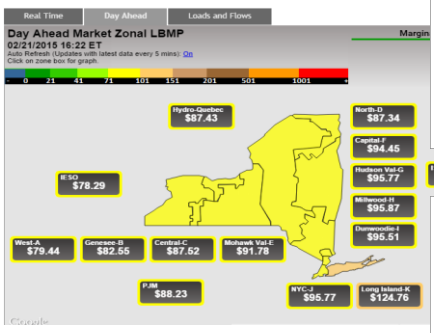
WHAT ARE AFFECTING OUR BILL?

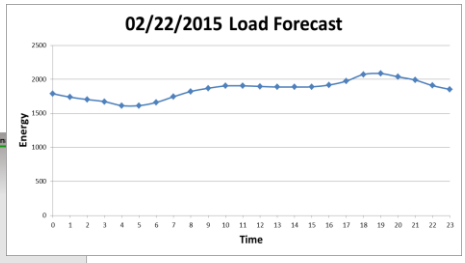
- Five lifestyle factors reflecting social and behavioral patterns:
- Air Conditioning
- Laundry Usage
- Personal Computer Usage
- Climate Zone Of Residence
- TV Use
- ~ 40% of the variance in electricity consumption

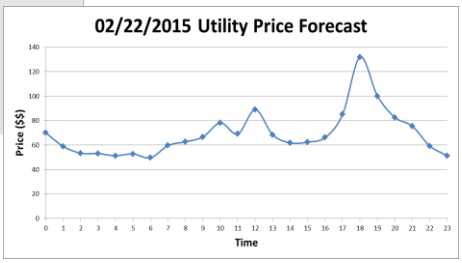
Source: Residential Energy Consumption Survey (RECS)

Electricity Rate!!

DATA SOURCE

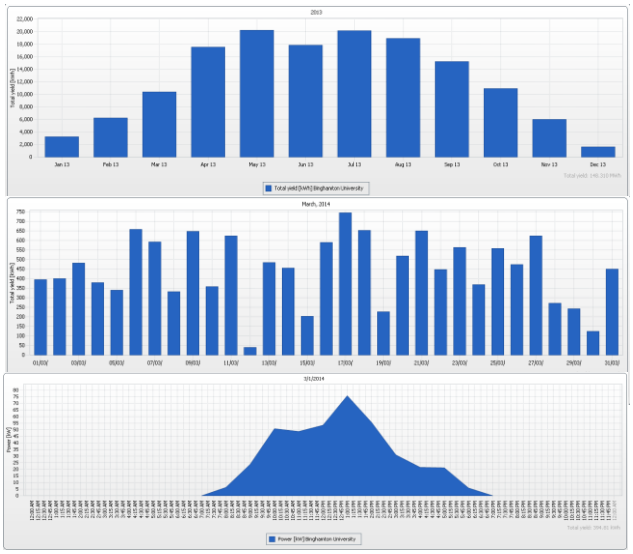






- *Source: NYISO (NY Independent System Operator)*

DATA SOURCE- ITC PV OUTPUT



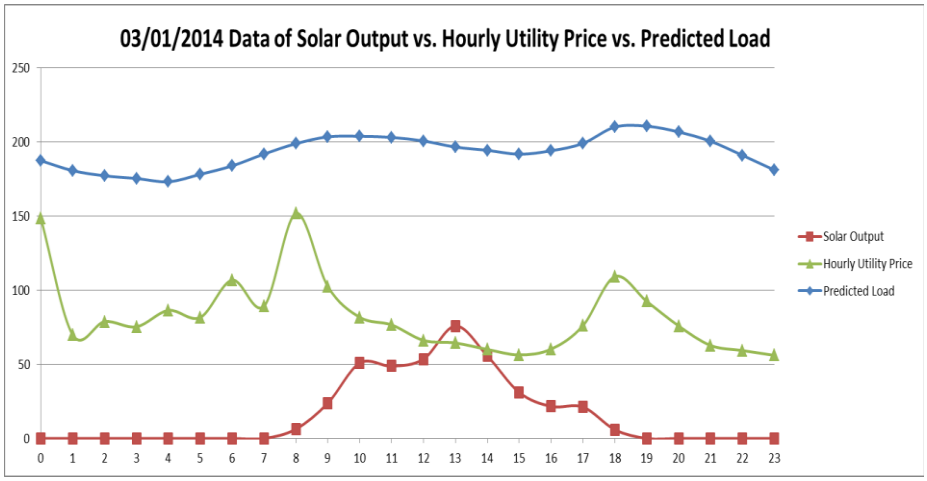
Records of the 12 months in 2013

Records of the 30 days in March 2014

Records of the 24-hour PV output on 03/01/2014

Source: ITC PV output

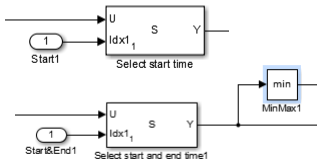
DATA SOURCE



- *Source: NYISO (NY Independent System Operator)*
- *Source: ITC PV output*

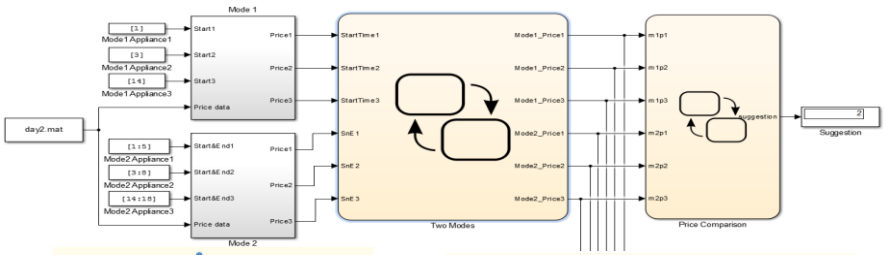
ALGORITHM

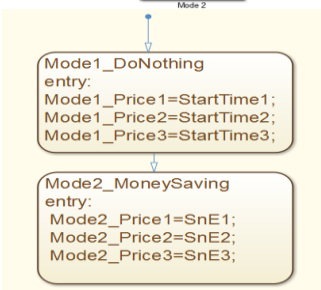
- Utility price is given in .xlsx form, convert it to a format that the data can be read
- Ask the user to input acceptable time frame, and the duration of the operation of the appliance
- Calculate prices for
  - Mode 1- Do nothing;
  - Mode 2: Money Saving

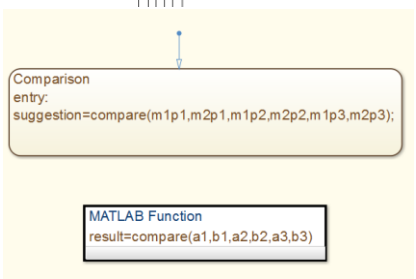


- Provide user with suggestion whether he/she should switch to mode 2 according to the money difference

SIMULATION- SIMULINK/STATE FLOW

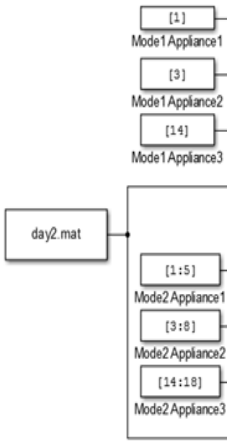




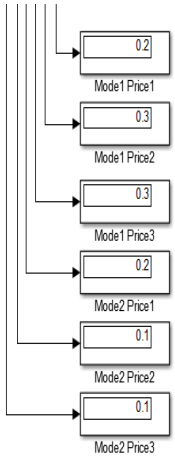


RESULTS- SIMULINK/STATE FLOW

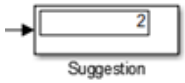
Input



Selected Data

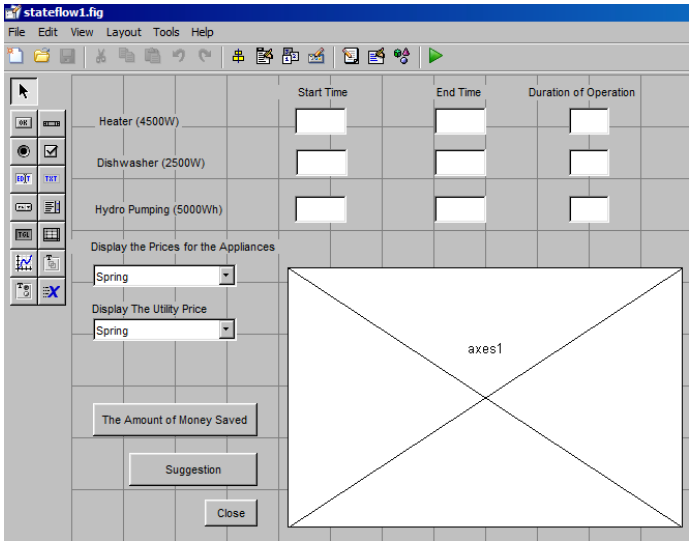


Output

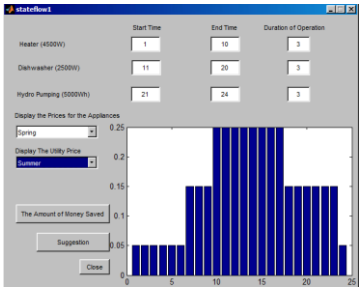


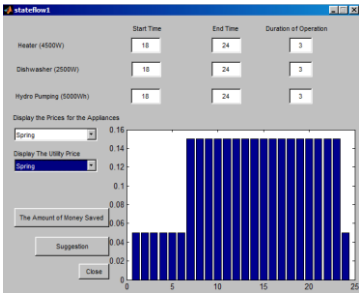
Appliance 1: 0.2-0.2=0;
Appliance 2: 0.3-0.1=0.2;
Appliance 2: 0.3-0.1=0.2;
Total Diff: 0.4;
Set tolerance=0.2
0.4>0.2, so mode 2 suggested

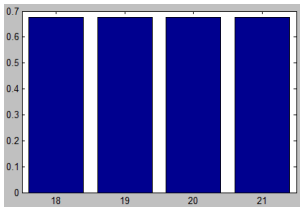
SIMULATION- MATLAB/ GUI

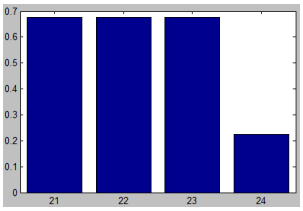


RESULTS- MATLAB/ GUI









FUTURE SCOPE

- PV array (DC) (store) Battery (DC) (inverter) AC/DC loads
  - (1) → if too much →send back to grid (usually NOT happen)
  - (2) → if too little →get supplied from grid