A Smart Home Model Using JaCaMo Framework

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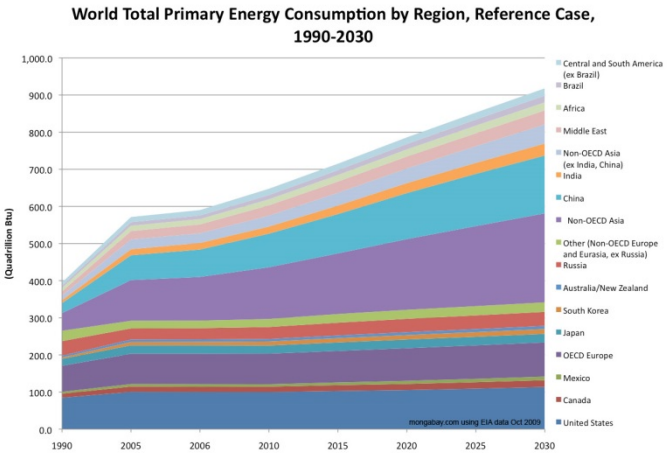
The future of the energy usage

- Demand outstrips production capacity
  - Energy consumption across the world is predicted to increase by 60% by 2030 (compared to 2010 levels)
- Peak Oil

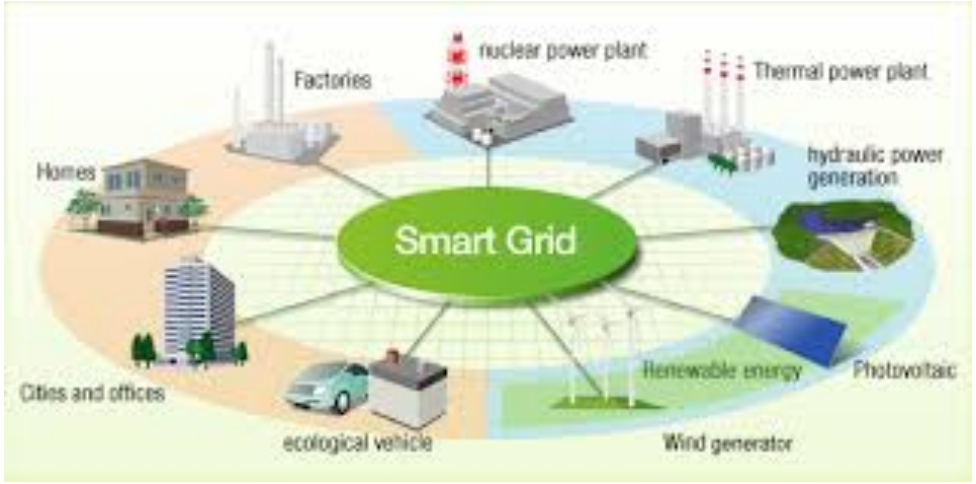


- Climate change, increasing CO2 concentration

- Effects in the economy

Smart grid comes to play

- A modern electricity system that uses sensors, monitors, communication, automation and computers to improve the electricity system.



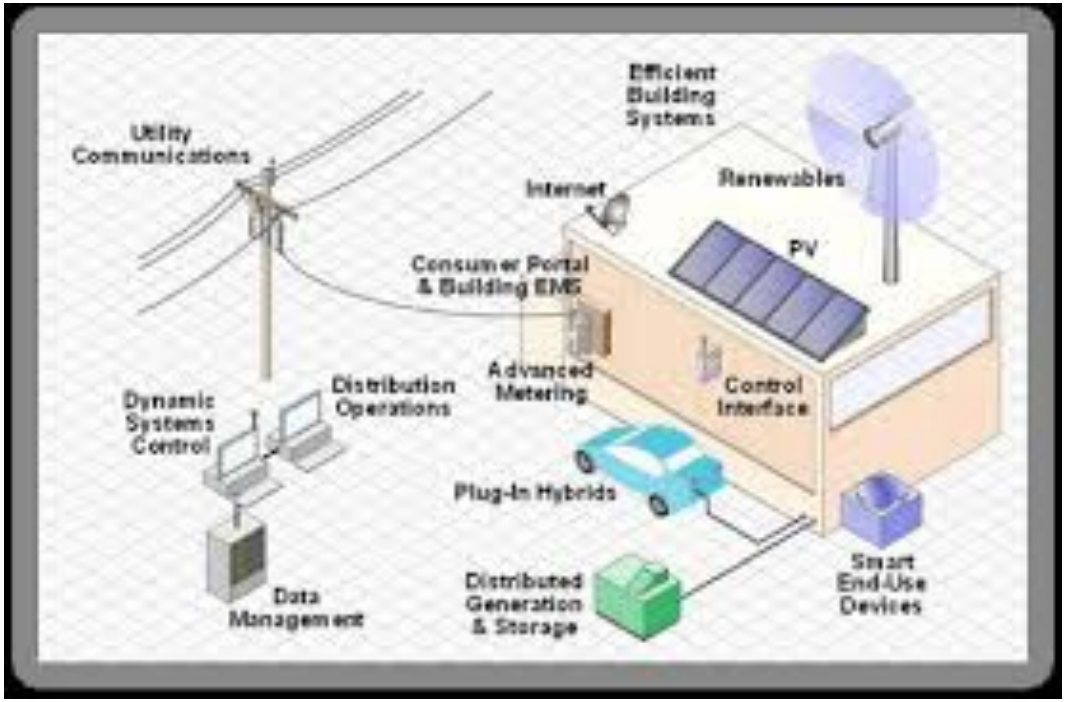
Demand-side Management

- A Smart Grid Initiative that
  - Allows end users to manage their electricity usage
  - Helps customers use electricity more efficiently

Motivation

- How to improve energy use efficiency within a single household while preparing it to attend the needs of the Smart Grid?

Smart Home


Efficient Building Systems
Utility Communications
Internet
Renewables
PV
Consumer Portal & Building EMS
Advanced Metering
Control Interface
Dynamic Systems Control
Distribution Operations
Plug-In Hybrids
Smart End-Use Devices
Distributed Generation & Storage
Data Management

Smart Appliance

- Instrumented
- Interconnected
- Intelligent

- Characterized under specific categories
  - Cold
  - Temperature Control
  - Cooking
  - Wet
  - Periodic Load
  - Entertainment
  - Lighting
  - ….

Main contribution

- An agent-based smart home model whereby
  - individual autonomous agents control each household device, and
  - an agent coordinates them all by controlling the energy meter.

Our model

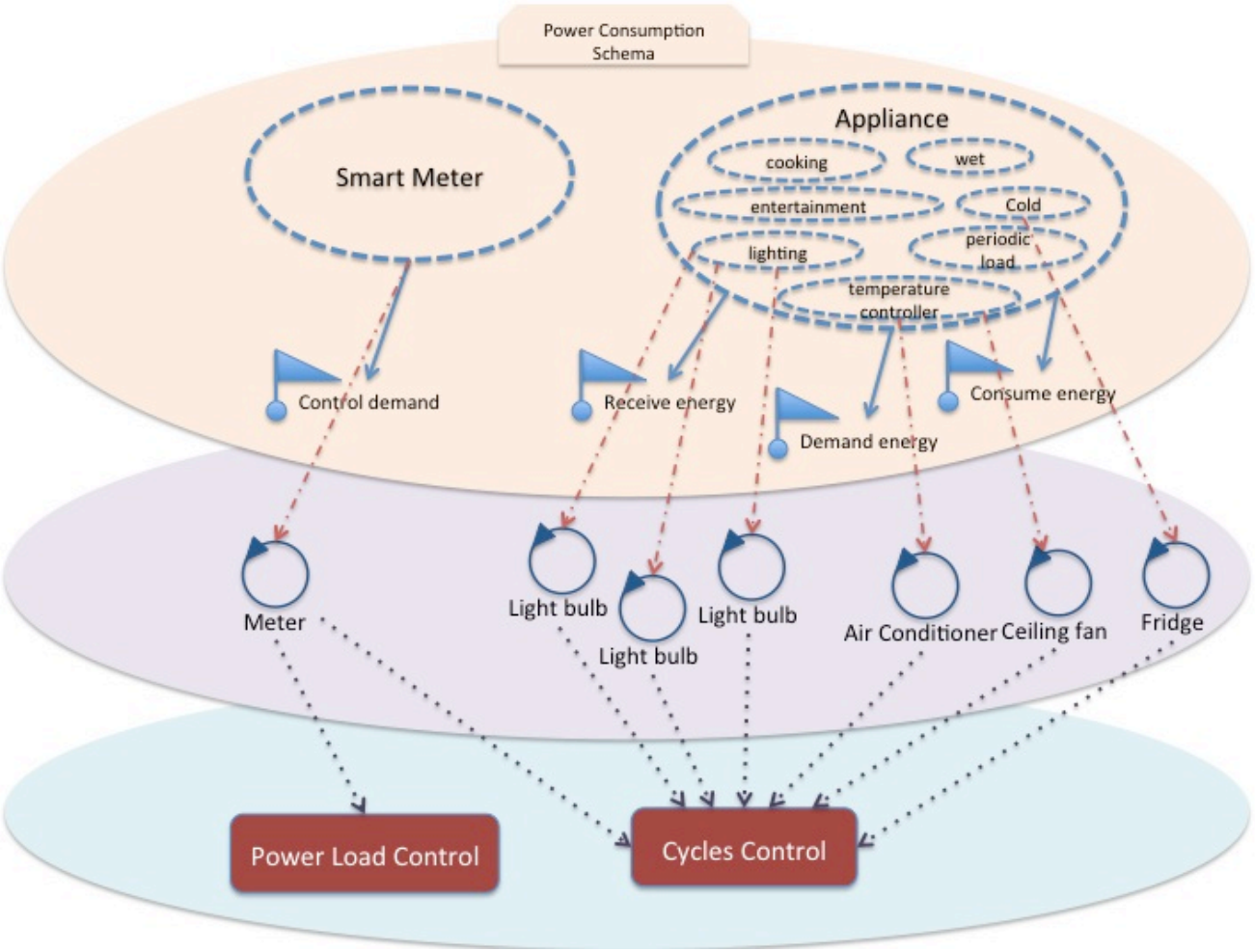
- Allows a smart home to become collaborative with the electric grid
- Balances energy demand
- Helps increase the resilience of the grid
- Optimizes user comfort.

Appliance

appliance(Pow; Cycles; Categ; Window[Start;End])

washing_machine(600; 4; Wet; Window[14;22])

JaCaMo – Power Consumption Control



Load Allocation Protocol

- The Smart Meter has the responsibility of:
  - monitoring appliances so they don't operate out of their operating window
  - controlling peak demand per cycle and load limit per day
  - releasing load for each appliance

- The appliances have to:
  - monitor their operating window
  - request the necessary load to the Smart Meter
  - negotiate with the Smart Meter to operate or wait until next cycle

Runs

- We considered three different user profiles:
  - Comfort – maximize user comfort
  - Energy Saving – minimize energy use
  - Average consumption – compromise between the two profiles

Results

- The first appliance that gets power operates

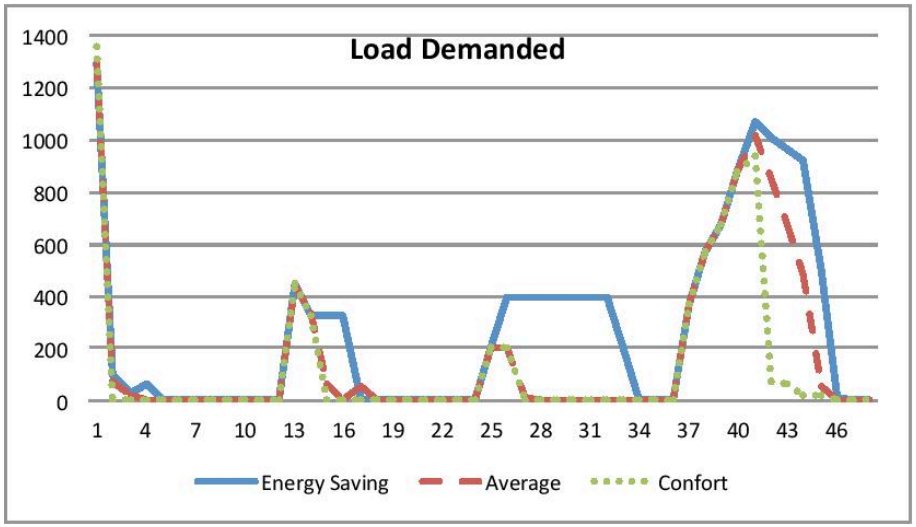
- The user cannot prioritize

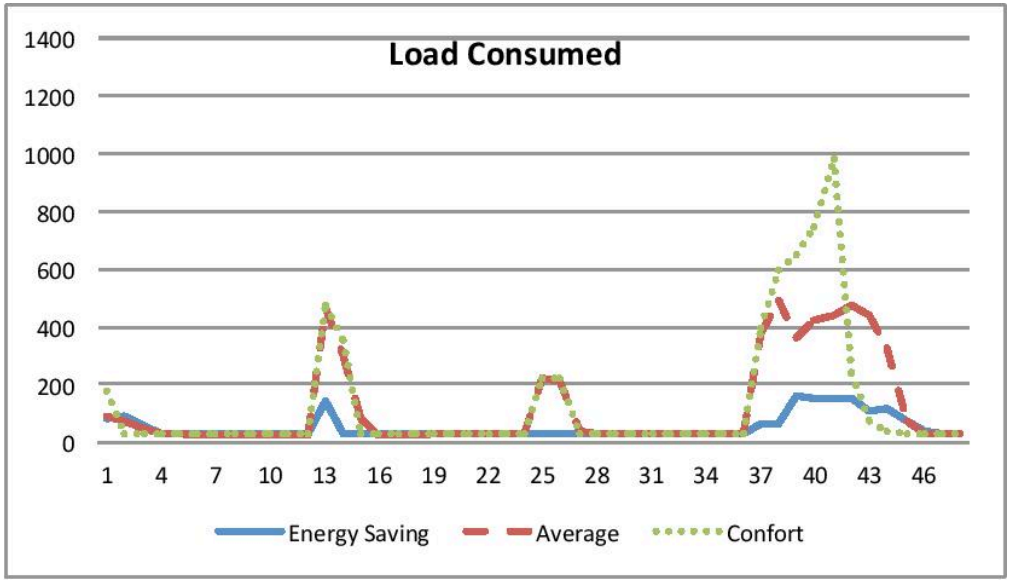
Vs

AC
(314; 4; temp_controller; Window[27;34])

tv_system
(215; 5; entertainment; Window[28;36])

Results


Load Demanded
1400
1200
1000
800
600
400
200
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46
Energy Saving
Average
Confort


Load Consumed
1400
1200
1000
800
600
400
200
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46
Energy Saving
Average
Confort

Conclusions

- Goal: develop a smart home model to strike a balance in:
  - optimizing comfort;
  - electrical efficiency; and
  - household resilience.
- Contribution: application of software agents in the smart grid, **but it covers a small part within current Smart Grid initiatives.**

Future Work

- Aggregate micro generation to the smart home model
- Improve the control system and the communication protocol between smart entities using an auction approach (mechanism design)
- Introduce shifts to appliance windows, using rewards and penalties

Thank you

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