Automated Home Energy Management (AHEM) System Integration Research

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Leveraging Opportunities

Smart Grid

market and technology trends expected to enable and accelerate development of cost-effective AHEM systems

Smart Appliances

Touch-Screen Smart Phones

Cloud-Computing

Home Office ➔ Home Area Networks

Home Office

http://www.treehugger.com

http://hr.armstrong.edu/sac/

http://tecnoplaneta.wordpress.com

http://thewere42.wordpress.com

http://photobucket.com
Key Technical Approaches

Initial Testing & Analysis

DATA NEED

TEST RESULTS

Options for BEopt System Analysis

NEW ANALYSIS NEED

NEW SYSTEM OPTIONS

Test Houses

BEopt System Analysis: Technology Package for Pilot Studies

Community-Scale Evaluation

Aggregate Energy Savings

IMAGE SOURCES
- http://www.mbpservice.com/images/header/originals/control4-1.jpg
- http://www.aztechmeter.com/files/content/ACME/Pictures/animation_02_final.gif
- http://folk.uio.no/hansoei/electronics_lab.jpg
Why So Difficult?

- Diversity in devices, each responsible for small load. What & how to target?
- Consumer Electronics are cheap, so not much incentive to improve EE
- Plug loads move around the house, so difficult to quantify savings
- Moving target, so technologies must be robust: Appliances & Consumer Electronics continue to improve EE, but we continue to introduce more into our homes
- Human behavior factors heavily into estimates of energy-savings
- Control systems should require minimal power to operate
- Controls must be smart and not interfere with the main function
Home Automation is a key emerging technology in improving the energy-efficiency of residential buildings.

Our focus is to develop a cost-effective combination of home control functions and features that can reduce an average home’s energy use by 6% relative to a mid-90’s construction home.

Key work in progress:
- Controls lab design / setup
- Field prototype house instrumentation development
- Engaging partners for community-scale study
Laboratory Testing of Auto-switching Technologies

The average U.S. household wastes 1000 kWh per year powering devices that are off or in standby mode.

Conventional Power Strips
- allow you to plug multiple devices into a single outlet
- provide surge protection

Advanced Power Strips
- automatically cut off supply power to devices not in use
- master-slave configuration
- minimum current threshold
- occupancy-sensor activated
- remote (IR) control
Sacramento Municipal Utility District (SMUD): Greenbuilt House / Control4 System

**DEEP-ENERGY RETROFIT**
- All-electric house
- 2.3 kW of PV
- Heat pump DHW
- Hardwired CFL

**WHOLE-HOUSE CONTROL VIA CONTROL4**
- PV production
- Lighting
- Wireless outlets
- Automatic shades & awning
- Home entertainment
- TV screen & web portal interface
- Smart-meter ready
- Garage door
# Home Automation for Forest City / Stapleton

<table>
<thead>
<tr>
<th>Central Park West</th>
<th>500 homes</th>
<th>Model Lots</th>
<th>December 2010</th>
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## Minimum / Base package
- Display of energy use & cost on in-home and web display

## Upgrade package
- Control via touch-screen smart phone & PC
- Whole house “green switch” mode
- Smart thermostat
- Lighting control
- Home office control
- Home entertainment control

Document energy savings to provide incentive for builders?
Gaps & Barriers

• Datasets from real occupants (large-scale community studies)
• Load-disaggregation and advanced monitoring techniques (SPEED, for example)
• Incentivize promising technologies to increase market awareness & penetration → bring costs down
• Partnerships with utility programs
• Device interoperability
• User-interfaces that people want to use
• Visualization tools and communication with occupants about their energy usage