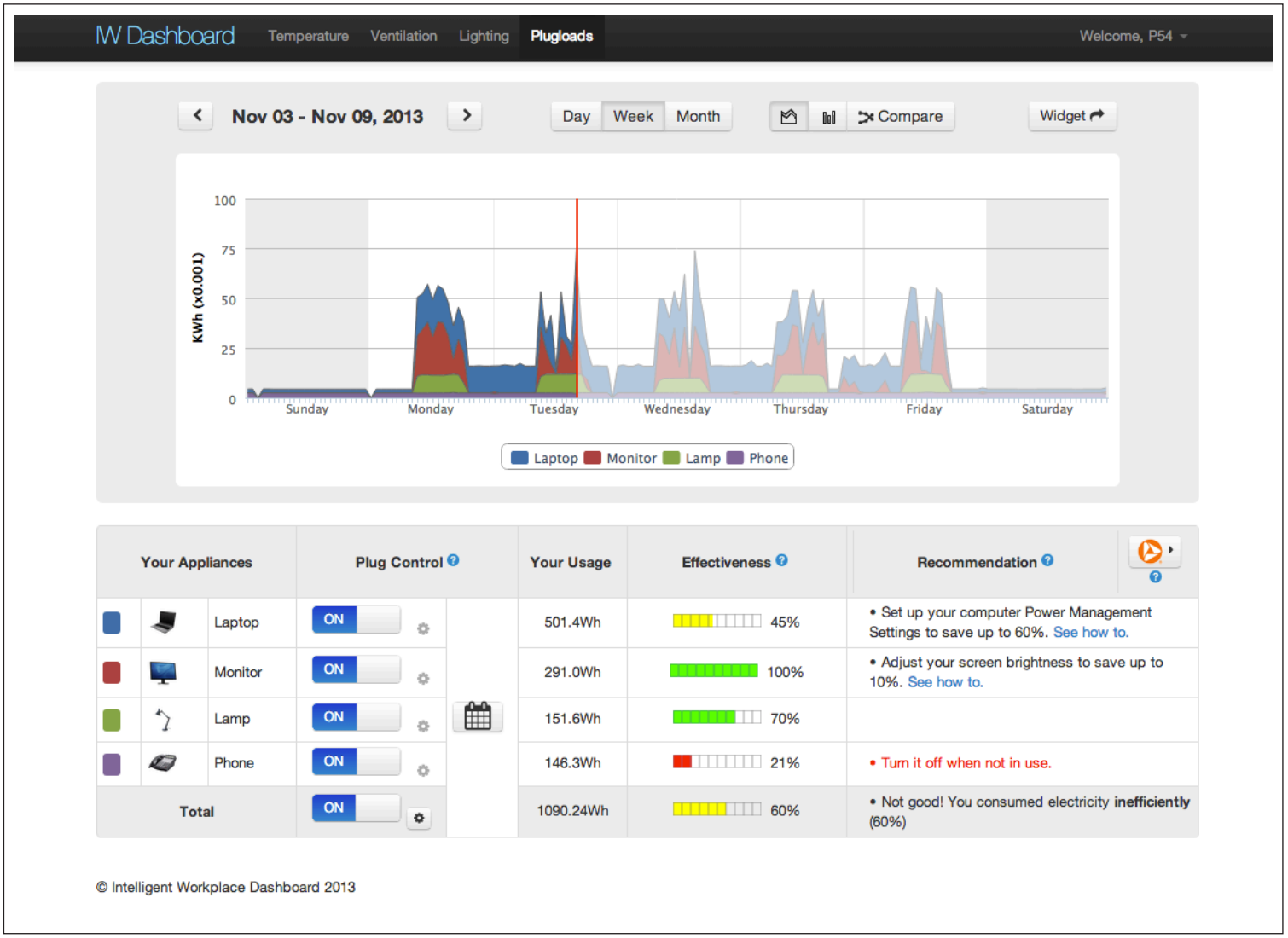

Energy Dashboard and Environmental Behavior

The Design of a Dashboard to Promote Environmental Behavior for Energy Efficiency in the workplace

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Carnegie Mellon University

eeb HUB Energy Efficient Buildings Hub

Project Description

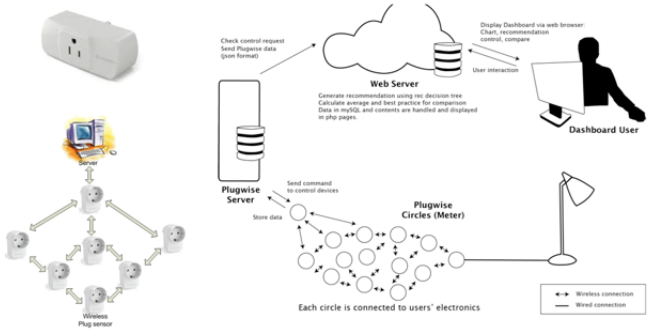
1. **Time Frame Selector**
   Day, week, month time frame
2. **Chart Type Selector**
   Area, bar chart to monitor appliance-specific data and line chart to compare to others
3. **Widget**
   Desktop widget panel for your computer screen
4. **Energy Chart**
   Real-time and historic energy consumption
5. **Plug Control**
   Individual/group on/off switches and calendar for automatic control
6. **Your Usage**
   Total KWh use per equipment
7. **Effectiveness**
   Percentage behavior effectiveness for energy savings
8. **Recommendation**
   Recommendations for energy savings
9. **Organizational Impact**
   Monetary impact if all the employees acted as you have done

Figure 1. The Intelligent Dashboard Home Screen and the Main Feature Description

Plug loads consume 15-20% of electrical energy in U.S in office buildings . Tracking and visualizing this energy use, and providing effective controls through Human-Computer Interaction (HCI) design, can save up to 40% of the energy used to power our desktop technologies [NBI 2012].

THE INTELLIGENT DASHBOARD™ – COMMUNICATION, CONSULTATION AND CONTROLS (C3)

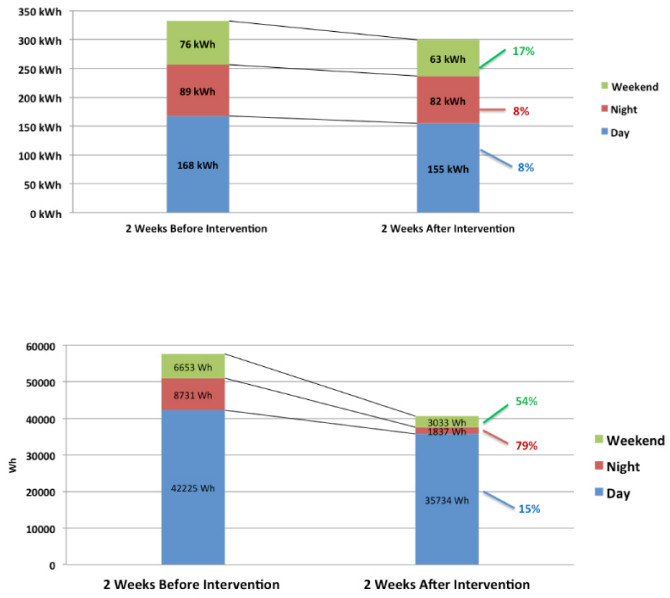
The Center for Building Performance and Diagnostics at Carnegie Mellon University is developing an intelligent dashboard system (Figure 1.) with three strategies - self-monitoring, expert recommendations and individual controls – eventually to support controls for plug loads, lighting, heating, cooling and ventilation. For the plug load dashboard, CMU partnered with Plugwise™ to enable both energy tracking and remote control .

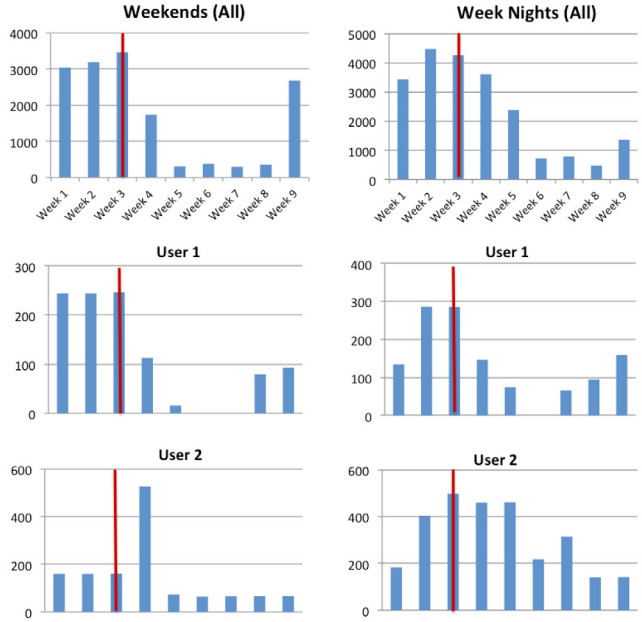


Communication: The self-monitoring interface displays real-time and historic data for each device at your desk. The dashboard provides different chart options: daily, weekly and monthly; bar charts and continuous plots; precise energy demands; and comparative use in your workgroup.

Expert Consulting: Unlike most dashboards that give generic advice, the Intelligent Dashboards recommendations for action are generated on-the-fly, based on each device's energy use pattern. The advice can be short-term (e.g. turn off the equipment nights and weekends) or long-term (e.g., replace the excessive energy user with an Energy Star™ device) based on actual use patterns and energy use data bases.

Project Description





Control: Most dashboards do not allow occupants to personally control equipment. The Intelligent Dashboard™ has several control strategies to enable occupants to reduce unnecessary plug load energy uses: clicking a digital on-off button, setting up group controls for all non-sensitive equipment, adding calendars and even i-phone occupancy sensors that use "geo-fencing" to record that you have left the building.

2012 SHORT TERM PILOT STUDIES

With over Plugwise™ interfaces and the web-based Intelligent Dashboard™, we conducted a pilot study with 120 appliances and 22 occupants at three sites for 8 weeks. The sustained energy savings at the university lab were 31.5%, the government research lab savings were -5% due to policy changes, and the university office savings were 30% . In particular, the university offices sustained 54% savings over weekends and 79% savings on weekday nights.

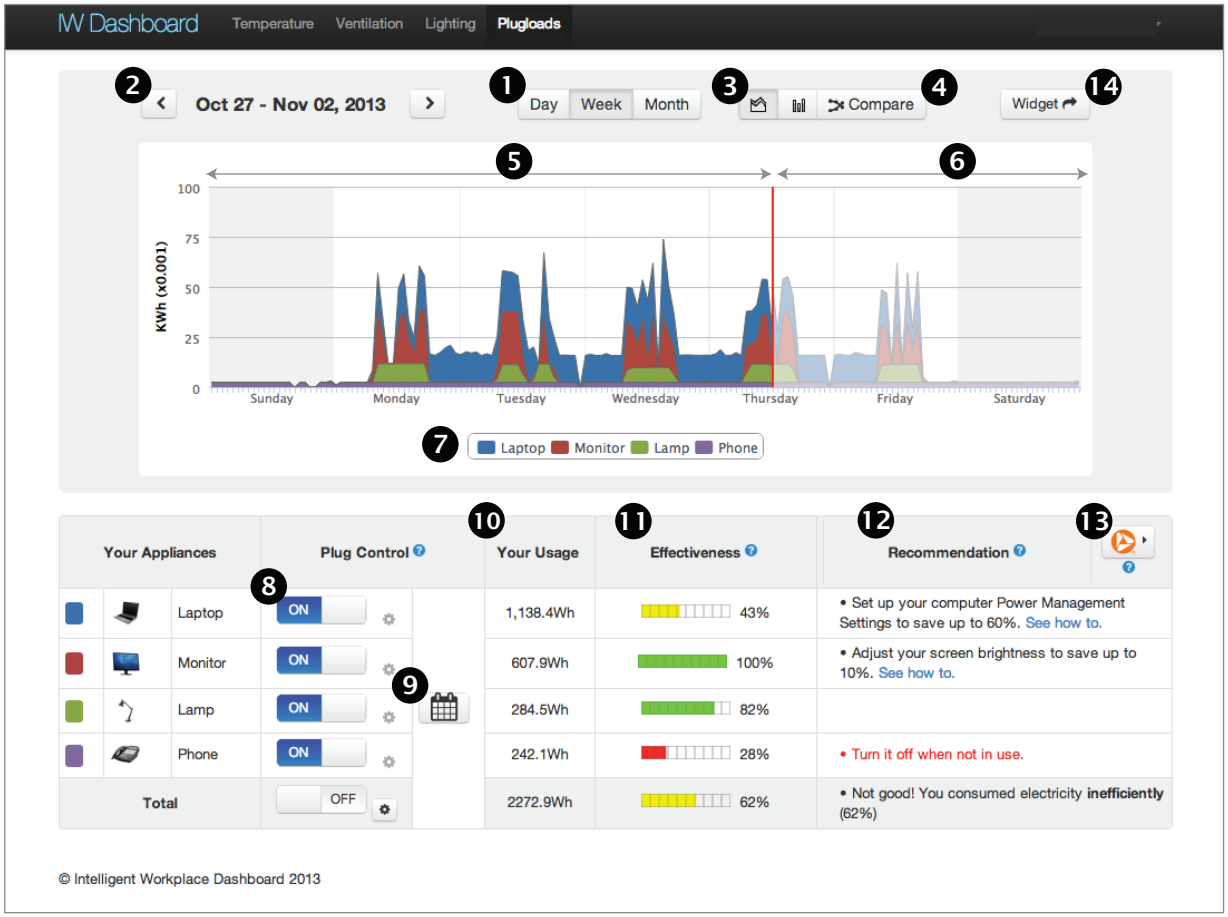
2013 COMMERCIAL CLIENT LONGITUDINAL STUDY

Feedback from the pilot study is contributing to improvements in the user interface and advances in automated control with calendaring and occupancy (geo-fencing) technologies. With a commercial building partner, a longer term controlled field study is undertaken to record energy use before, during and post-intervention, and answer three hypothesis: Introducing a C3 dashboard with self-monitoring, expert recommendations, and control will improve individual's 1) short term energy use, 2) awareness about energy consumption, and 3) sustained energy savings after the system is removed.

INTELLIGENT DASHBOARD™ FUTURE EEBHUB WORK

In addition to the web-based Intelligent Dashboard for individuals, mobile control apps are in development, and a public touch display will be developed for shared appliances. In parallel with these plug load dashboard advances, our next target domain will be lighting and daylighting dashboards, to be followed by temperature and ventilation dashboards.

Energy Dashboard Manual | Group 3

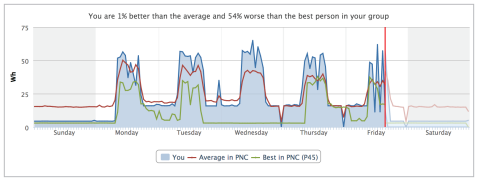


1 Time Frame Selector Day Week Month
Select day, week, month time frame

2 Date Selector Sep 22 - Sep 28, 2013
Pick specific day, week, month of interest

3 Chart Selector Compare
Choose bar graph or area under the curve

4 Compare Feature Compare
Compare with average and best in office



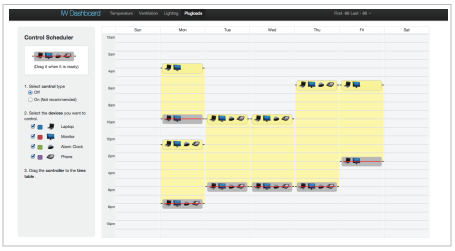
5 Real time consumption
Hourly electricity consumption of each device

6 Projected Area
Historic data of last period for comparison

7 Legend Laptop Monitor Underbin Light Phone
Equipment that is being monitored
Click items to exclude for monitoring

8 Control ON
Individual/group quick on-off buttons

9 Calendar
Calendar for automatic on-off control



If you want to save additional energy, you can cut off power to all plugs when you know you will not be in the office.

1) Click on the off button
2) Check all items you wish to have the residual power turned off at times you absolutely will not be in the office
3) Drag bar created to set times to "turn off my plugs"

You will want to have the computer and monitor plug reactivated before you come to work so you can turn on equipment easily.

1) Click the on button
2) The rest is the same as above

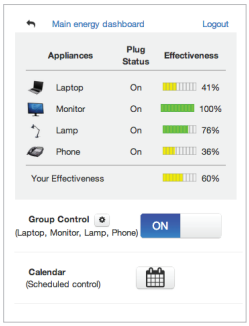
10 Your Usage Your Usage (Last week)
Last weeks total KWh use per equipment

11 Effectiveness Effectiveness (Last week)
Percent effectiveness for your behavior towards energy savings

12 Recommendation Recommendation
Recommendations for saving energy painlessly

13 PNC Impact
PNC impact if 50.000 employees acted as you have done

14 Widget Widget
Desktop widget panel for your computer screen



NOTE: **1) When you need to turn the sensors back on without using the dashboard, simply unplug and plug them.**
2) Contact Ray Yun (ryun@cmu.edu) for any inquiry on the system features or the overall study.