Real-time Building Performance Optimization while Empowering Occupants toward Sustainable Behaviors

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How to achieve sustainability in buildings using the PI System ?

Demonstrate real-time, analytic and visualization capabilities to integrate, monitor and diagnose building performance indices.

Occupants become key players of the building control and life.

Challenges

- Monitor, diagnose and optimize building performances
- Engage occupants in sustainable behaviour and energy conservation

Solution

- The use of the PI System as an integrated platform
  - PI Server, PI AF
  - PI ProcessBook, PI Coresight, PI Notifications
- Other Innovative solutions

Results and Benefits

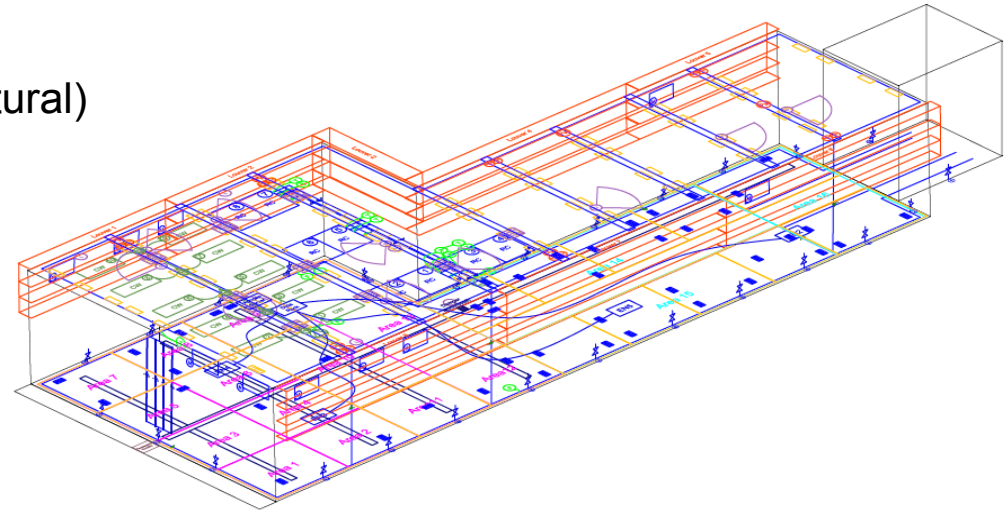
- Energy savings, carbon footprint reduction
- Improvement in building occupants satisfaction
- Gain in productivity
- Increase of the building Market Value

The Intelligent Workplace

- The Robert L. Preger Intelligent Workplace, built in 1997, is a 7000 square foot living laboratory of office environments and innovations located on the campus of Carnegie Mellon University.

The Intelligent Workplace

- Test and Integration of several systems:
  - Heating
  - Cooling
  - Ventilation (mechanical and natural)
  - Lighting, and day-lighting
  - Electrical
  - Plug load

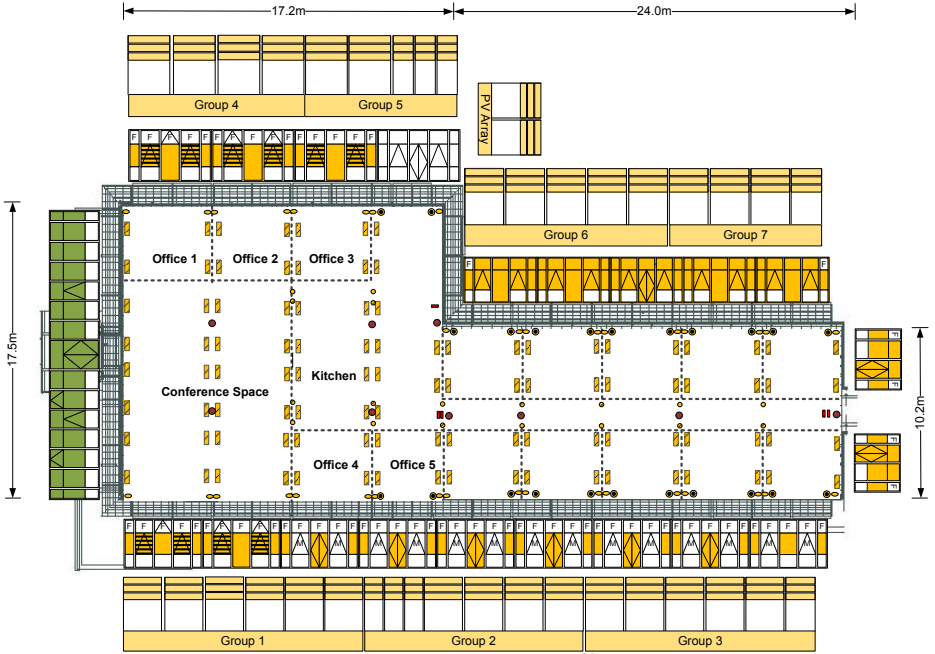


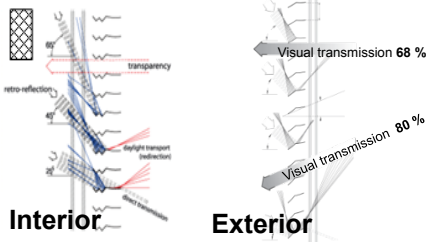
View of the sensors/actuators density

Lighting/Daylighting/Shading Systems

100 Zumtotel LaTrave Fixtures
36 Pico Fixtures
12 Zumtobel Dancer Fixtures
23 Floor Light Fixtures
8 Fire Alarm Light Fixtures
5 Fire Exit signs
10 motorized blinds
10 24VDC switches
65 motorized blinds
130 110 VAC relays

7 Daylight Redirection Louver sets
3 tiers
0˚ (closed) - 105˚ (fully open)
208 V, single phase





100 Zumtobel LaTrave relocatable luminaires
20% up, 80% down light
1-100% dimming ballast
2 x 55W U-shape lamps
LPD 1.63w/sf.

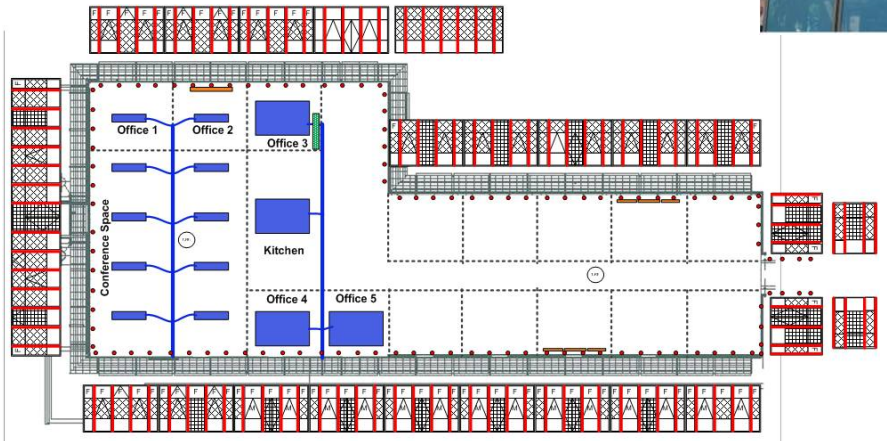
12 track light :
15W LED
3000 K
770 Lumen

Thermal/Ventilation Systems

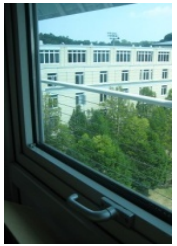
10 LTG Coolwaves
Individual on/off paddle control
Manual override
Combined zone temp control

SEMCO Desiccant Air Handler with Heat Recovery
Heat pump and gas regeneration

25 groups of Gartner water mullions
Each group w/ one modulating valve for 4, 5, or 6 vertical pipes
25 surface temp sensors for the zones



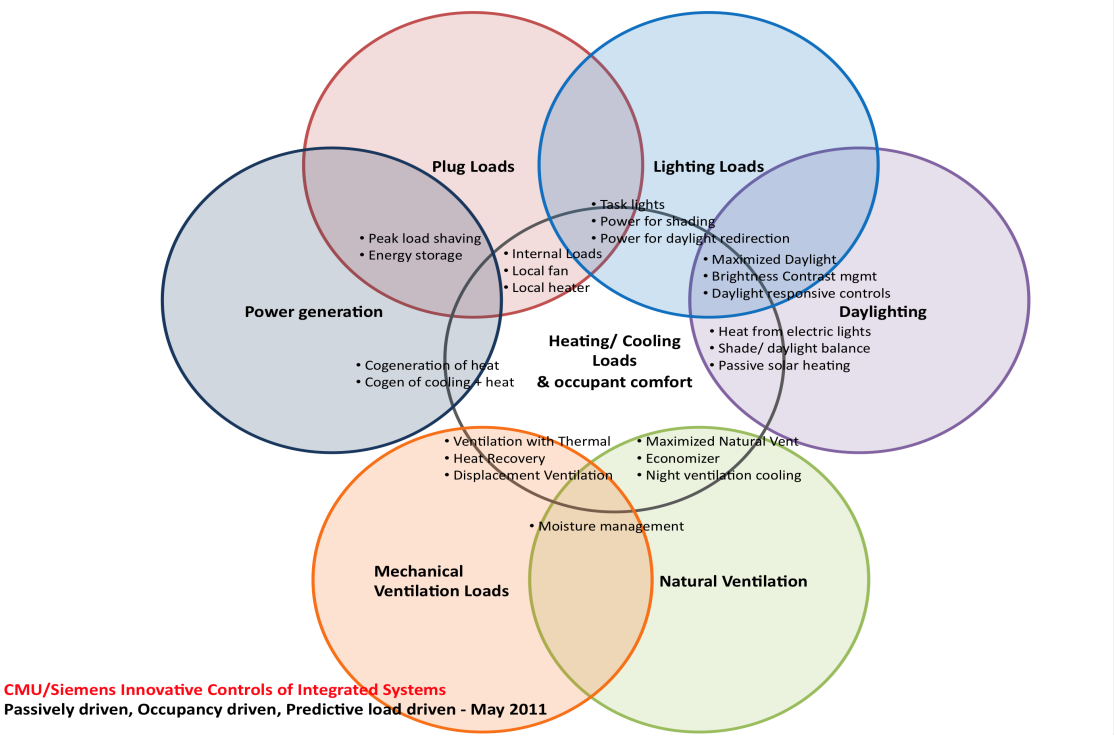
4 LTG and Trox radiant ceilings with insulation
Individual on/off/ modulating control
Manual valves



37 Manually Operated Windows
Drop/kick aperture

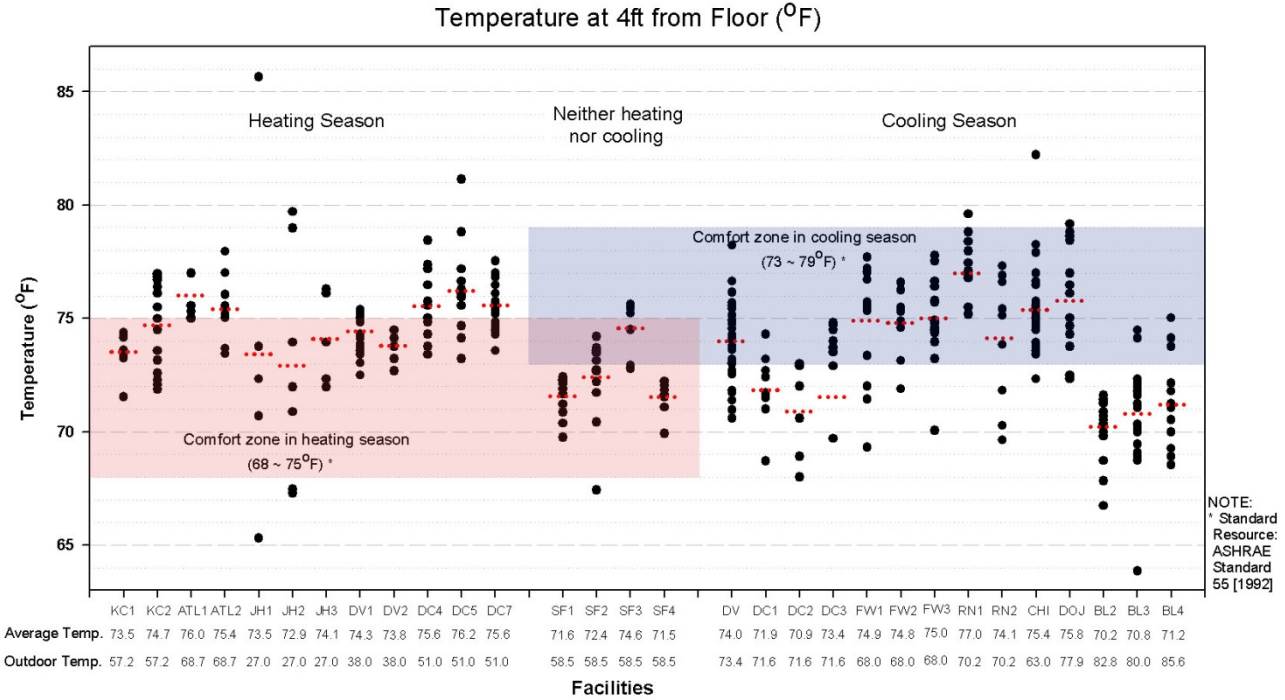
8 Motorized Traco Windows for Natural Ventilation, Night Cooling, 0- 33° Opening

Why an integrated platform?



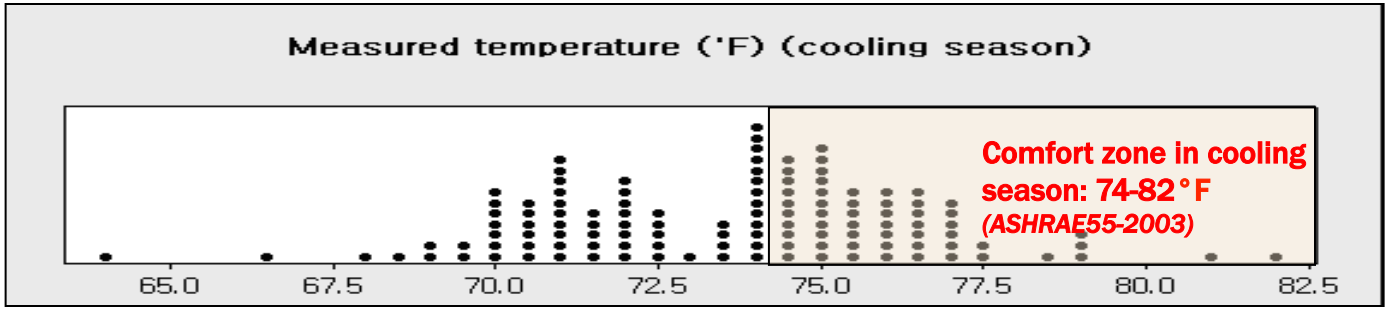
CMU/Siemens Innovative Controls of Integrated Systems

What is really happening in buildings ?

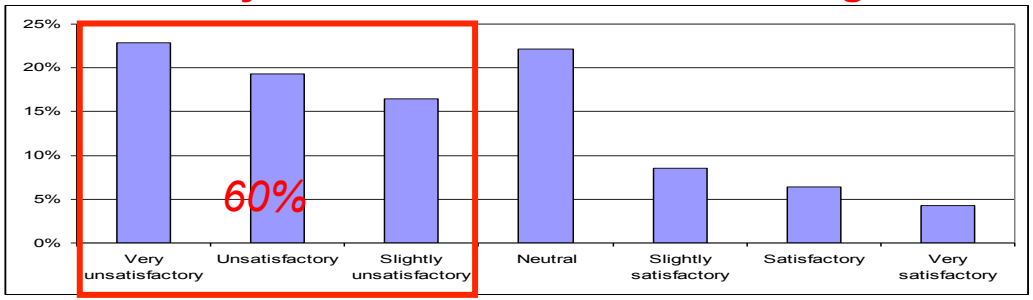


Example with indoor temperature (CMU studies for GSA)

Overcooled/Overheated = better comfort?



COPE Survey of thermal comfort in cooling season



"Temperature in your work area?" (n=140)

With appropriate engineering, raising summer temperatures in federal facilities would measurably improve employee satisfaction with thermal comfort and reduce costs.

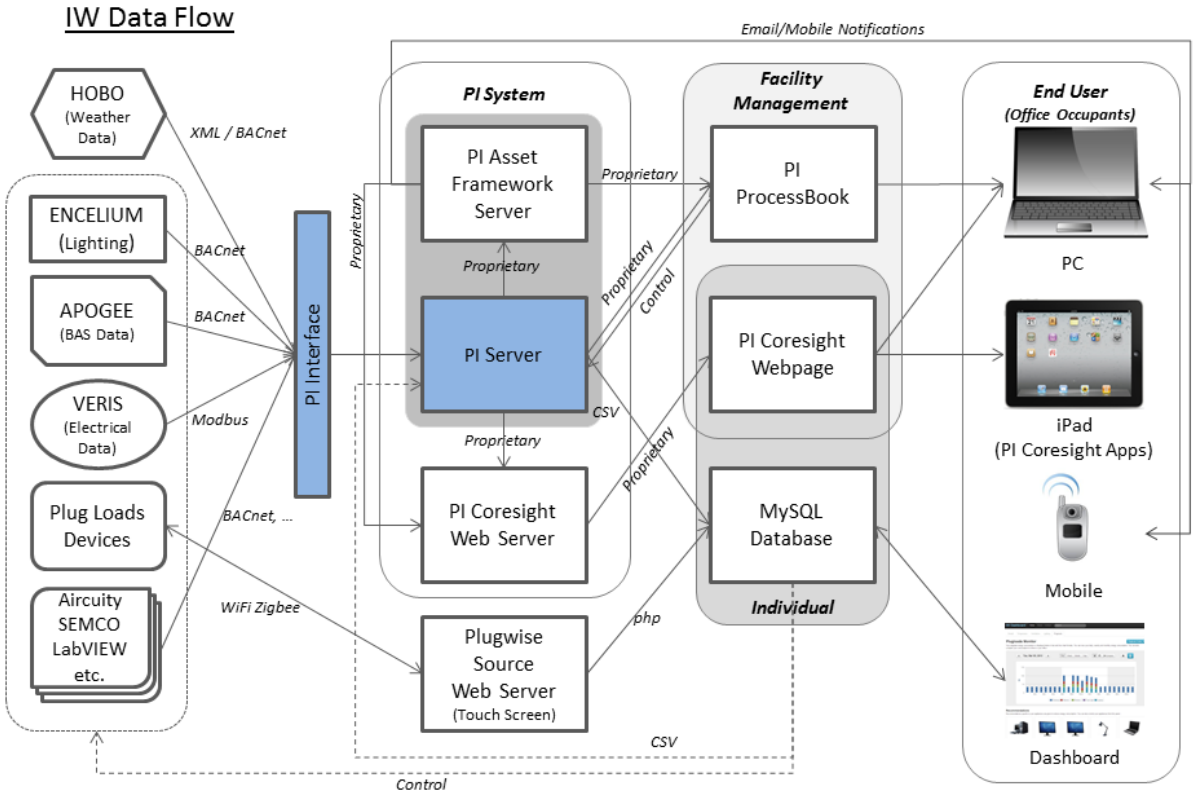
What are the steps?

1. Integrate all these information
2. Information needs to be accessible to Facility Managers
3. Continuously monitor and diagnose building performances
4. Information needs to be displayed to the public
5. Information needs to be displayed to building occupants
6. Building occupants need to control their environment

How to do it ?

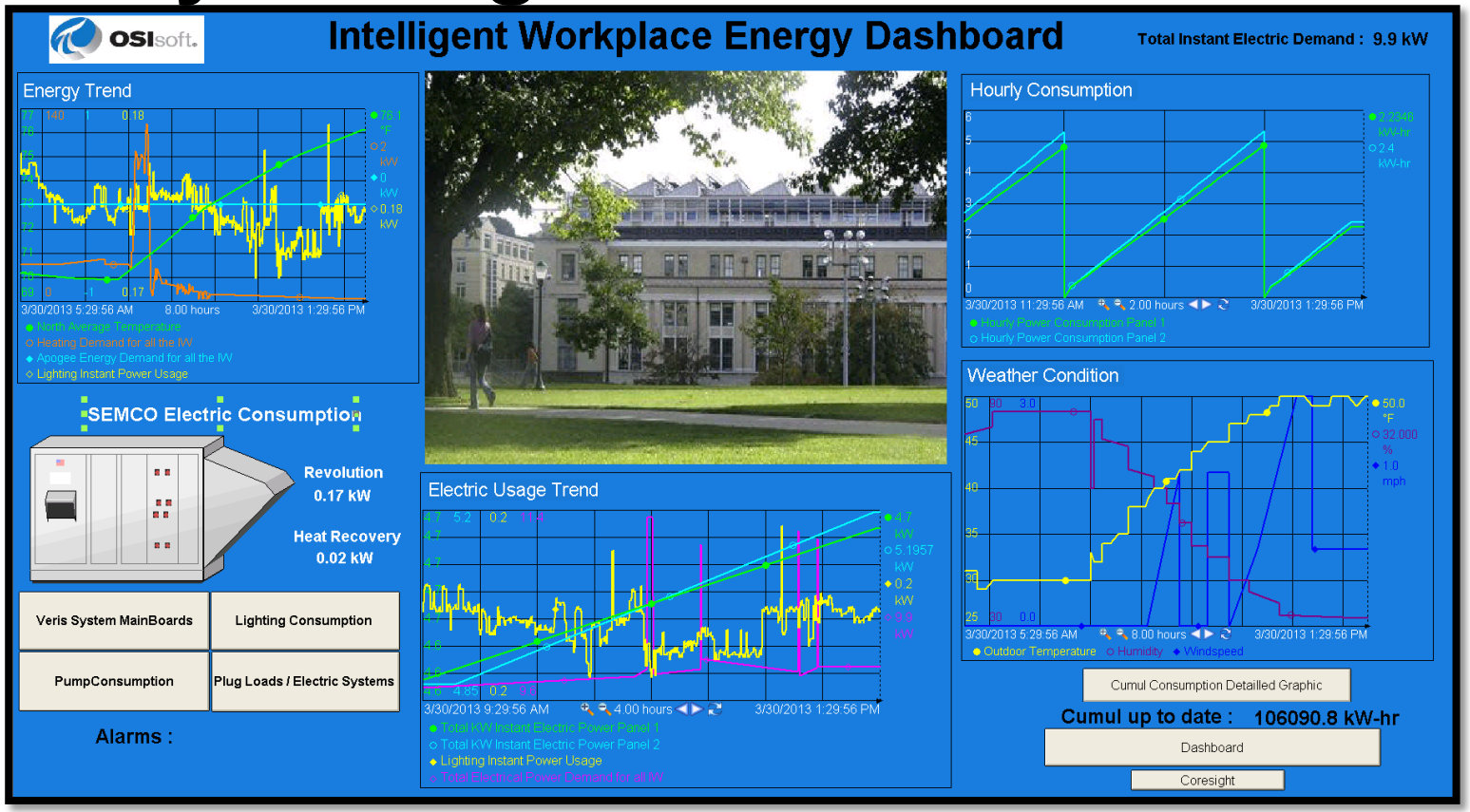
The PI System

The PI System at Carnegie Mellon University



Integrated Platform

Facility Manager Interfaces

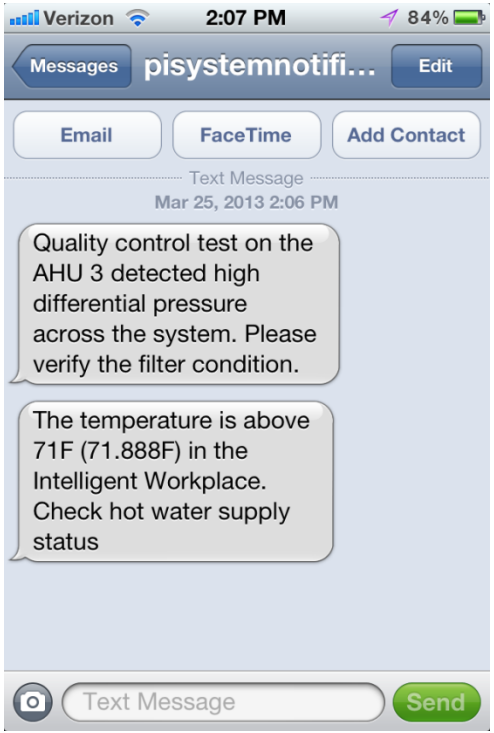


Energy Performance Tools

- Benchmarking
- Energy Information Systems
- Energy Anomaly Detection
- Fault Detection and Diagnostic
- Quality control at the components, the equipment and the system level

How to inform Facility Managers?

- The use of PI Notifications to trigger quality control :
  - Sensors drifts over the time
  - Abnormal values
  - Losses of connection to sensors, systems
  - …
- Email or text notification (virtual SMTP server located on the PI Coresight Server)

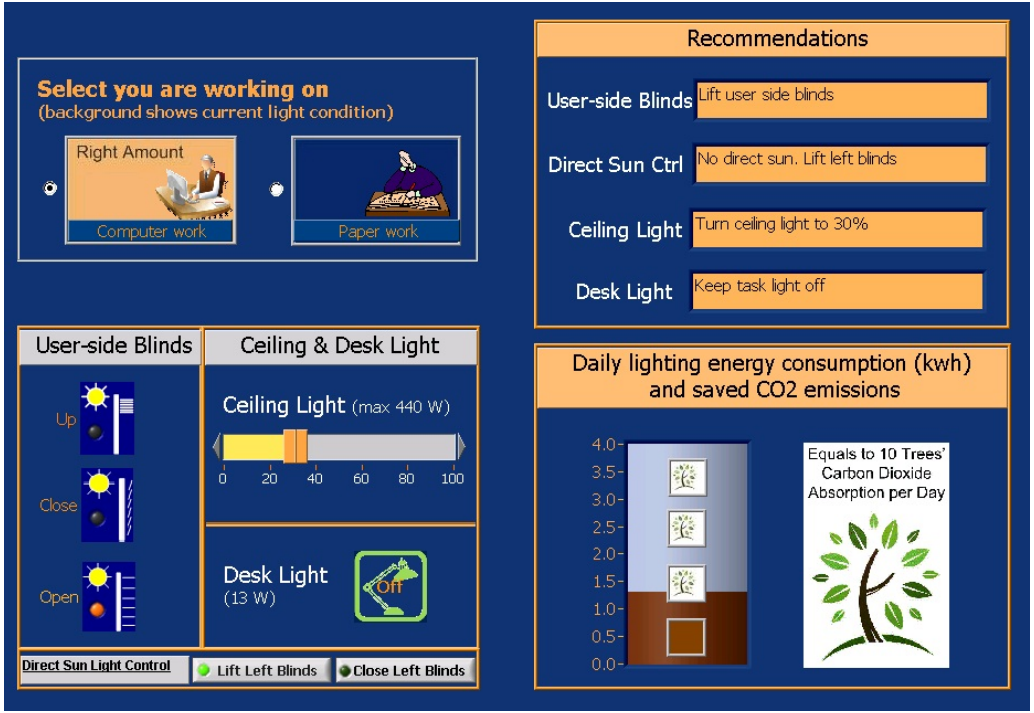


SMS Notifications

Public Interface

PI Coresight on Touchscreen Displays

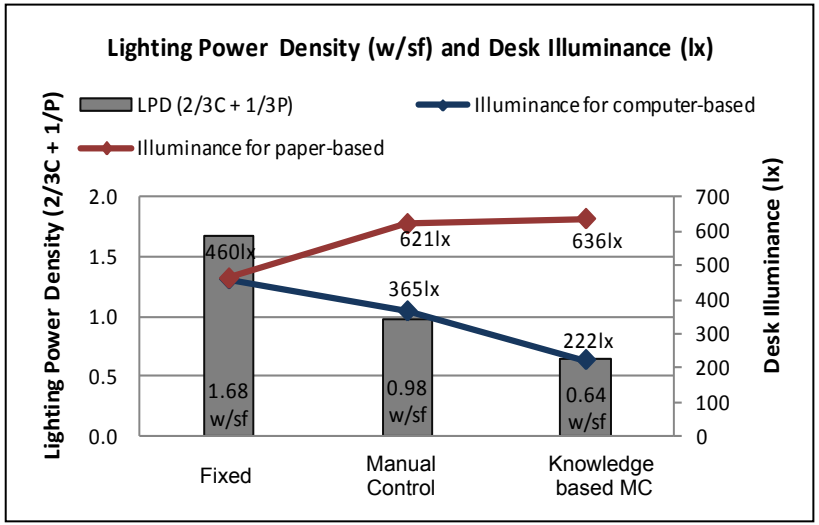
How and why do we engage building occupants?

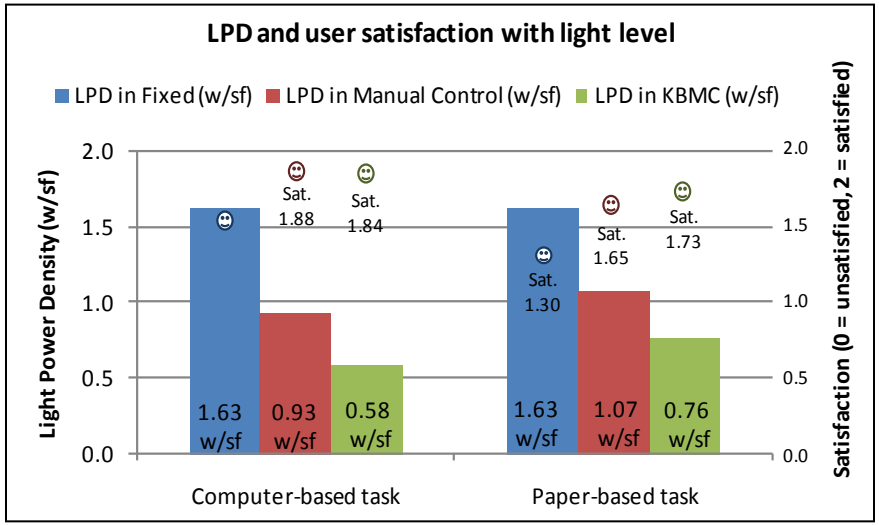


The Impacts of Real-time Knowledge Based Personal Lighting Control on Energy Consumption, User Satisfaction and Task Performance in Offices

Yung Gu, PhD dissertation

Lighting power demands with different user controls

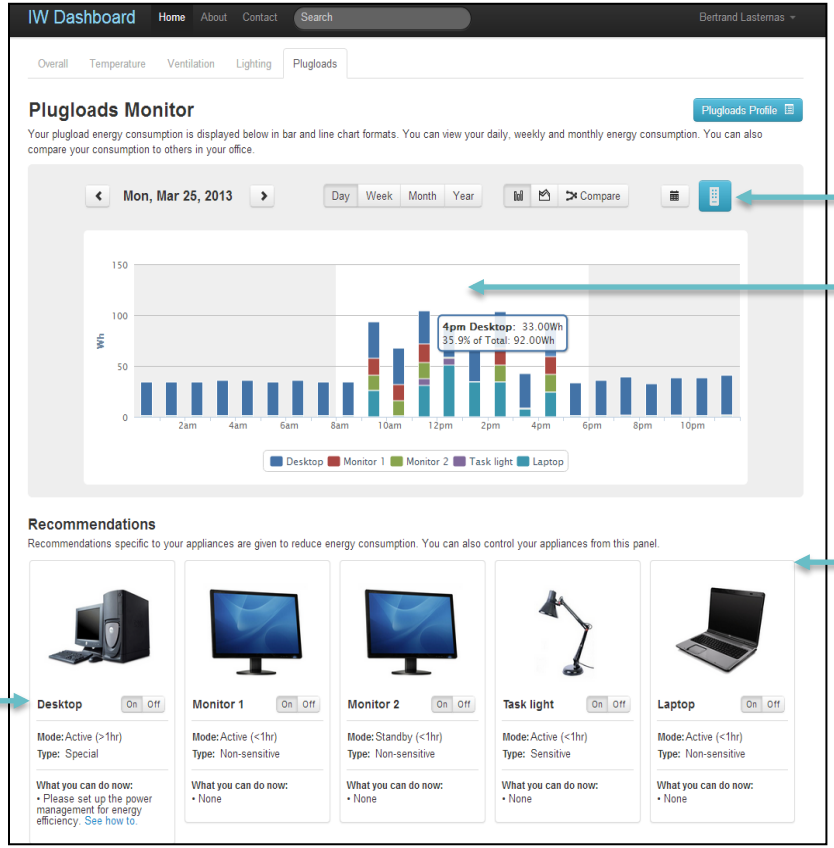




- Lighting power demand was significantly reduced in Manual Control (MC) compared to Fixed (F) and was further reduced in Knowledge Based MC (KBMC) regardless of task type
- For paper-based tasks, the light level was significantly increased in MC and KBMC compared to no control (Fixed) because task lights were used.

Engaging occupants to save plug load energy

Dashboard Features



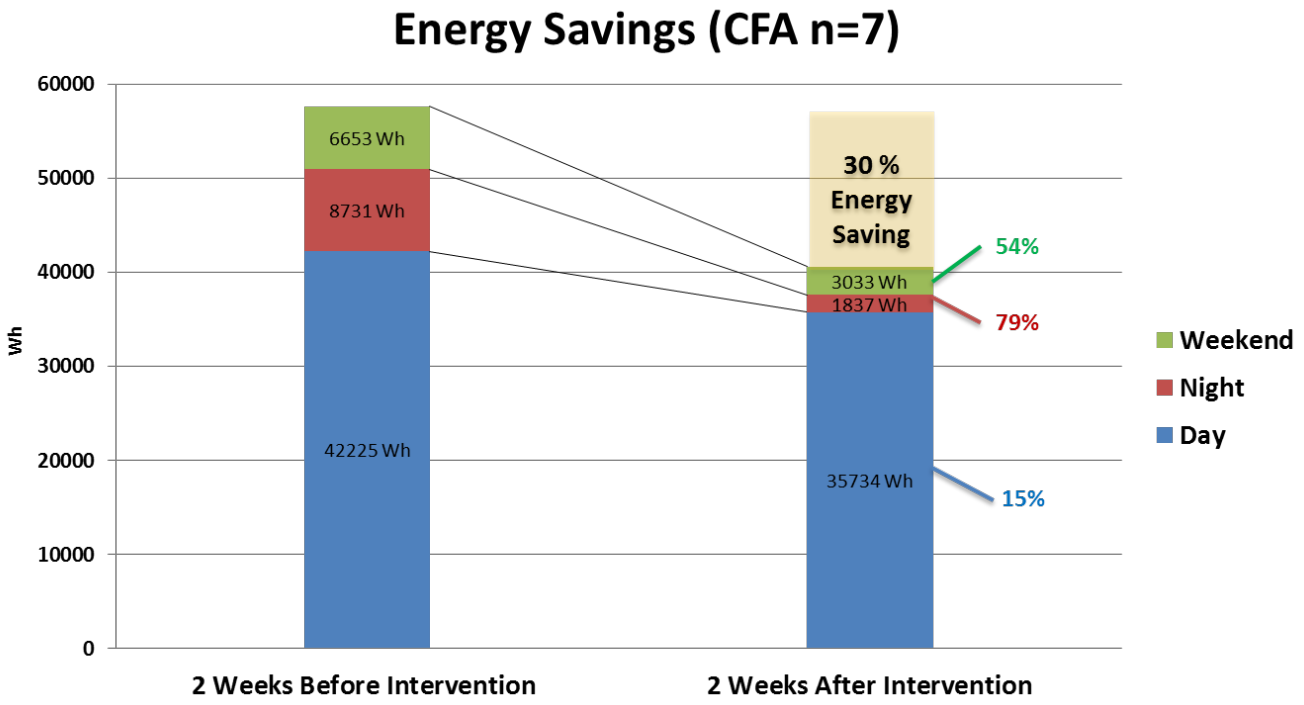
Control

Communication

Expert Consulting [Recommendation]

Control

Study results of users engagement



End Users Interfaces

PI Coresight on iPad

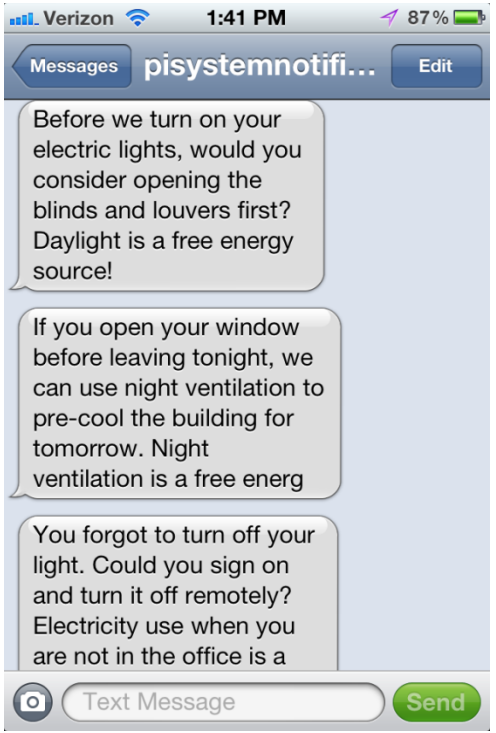
How to engage them?

The building occupants as key players in the building control :

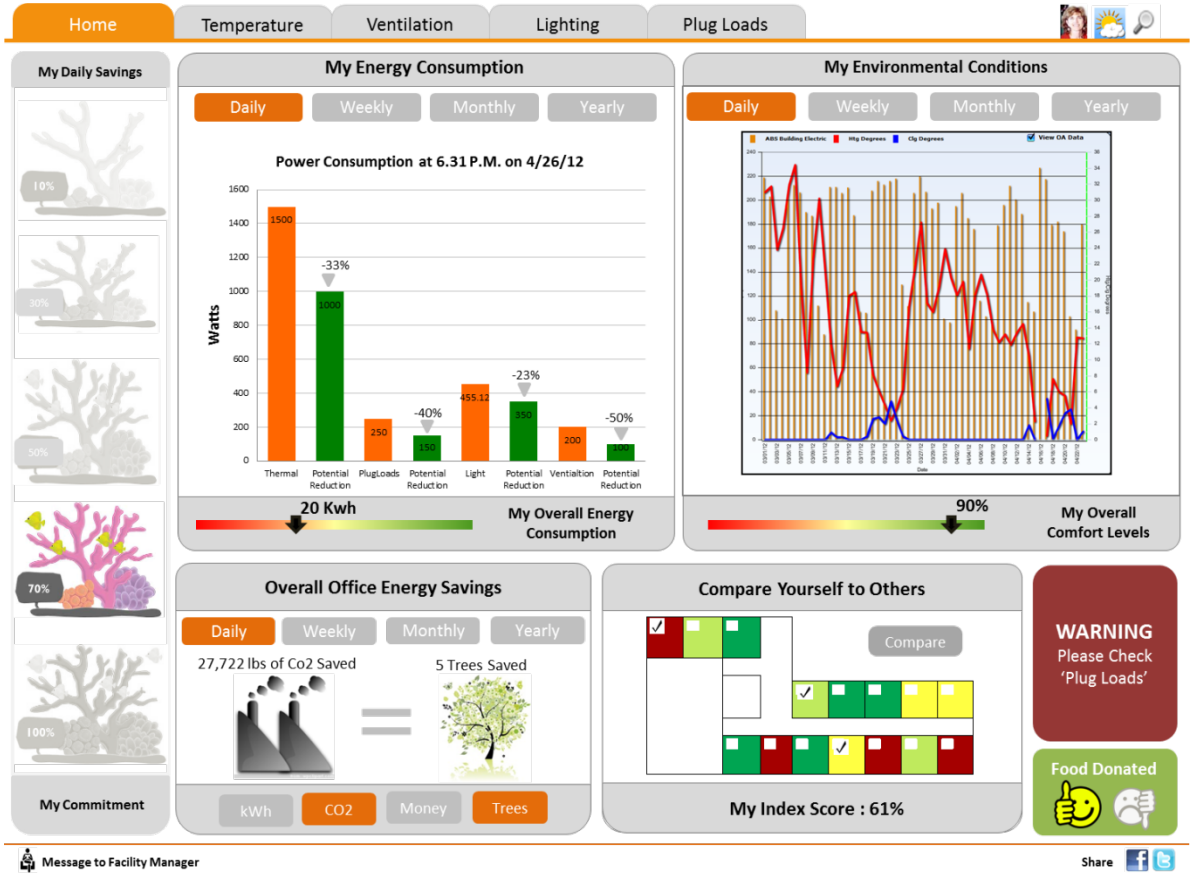
1-Night ventilation (extensive Night cooling strategies)

2-Daylighting first

3-Friendly reminders



Integrated Dashboard Interface



Innovative Solutions

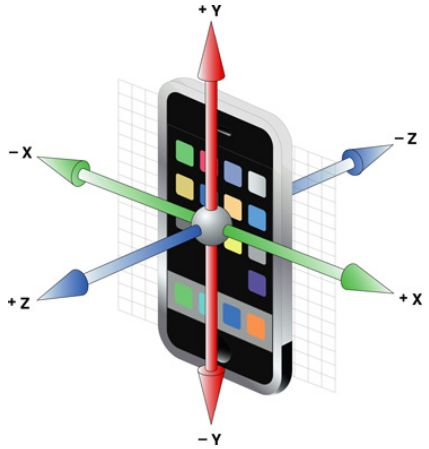
We Integrated two Controls into a Smartphone: A “Magic” Remote and an Occupancy Sensor

Home Gestures

Embedded Video

Use the iPhone sensors to select targets

Remote Control



Data from the Gyroscope, the Accelerometer and the Compass are integrated.

Occupancy Sensor

Geo-fencing
Wi-Fi triangulation
Bluetooth (computer-devices)
Electrical signature

Conclusion

- The use of PI System for:
  - Integrating information
  - Diagnosing performances
  - Displaying information (Visually and easily understandable)
  - Supervisory level control with human intervention
  - Both new constructions and retrofits

Conclusion

- Benefit of PI System:
  - Energy savings, carbon footprint reduction
  - Improvement in building occupants' satisfaction
  - Gains in productivity
  - Increase of the building Market Value

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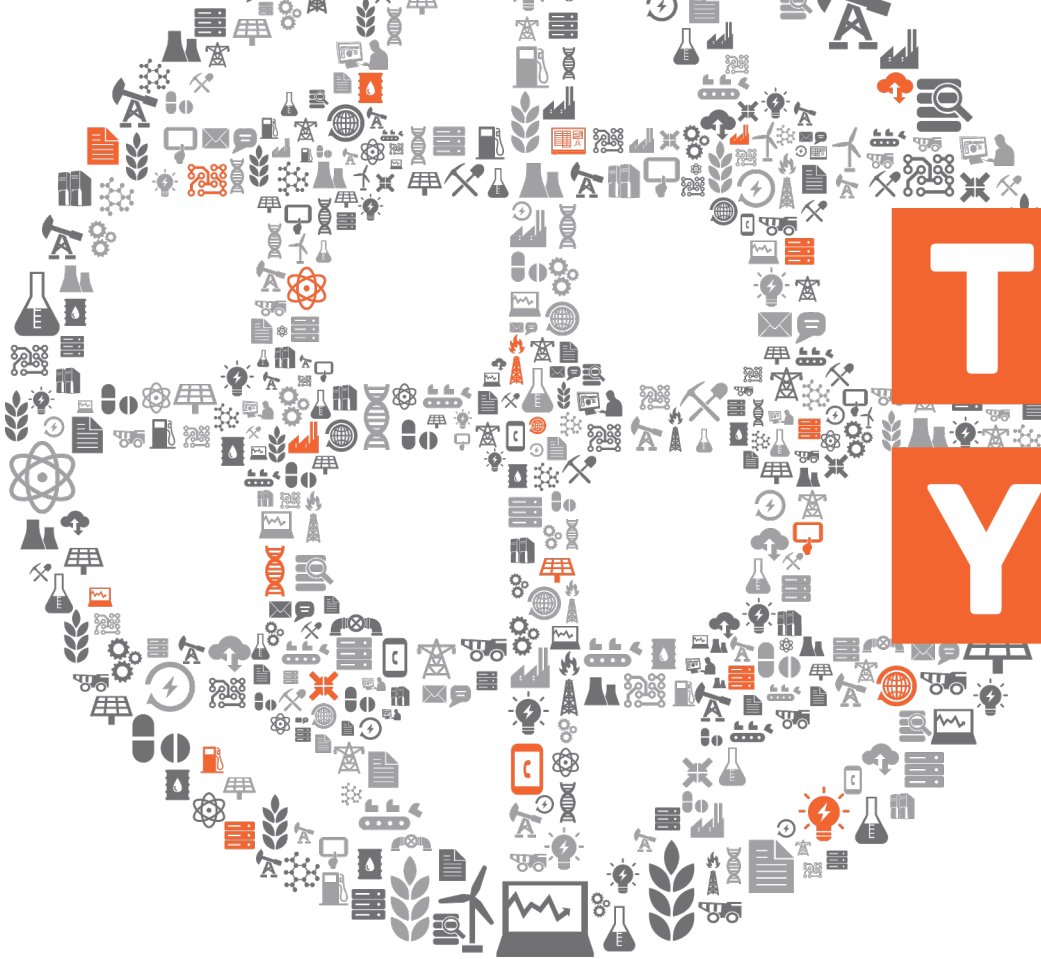
Supported by OSIsoft, SEMCO flaktwoods, VERIS Industries, …



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