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sense and simplicity

Advanced Integrated Lighting Controls for High Efficiency Green Buildings

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Outline

- Energy consumption in the US
- Lighting Controls basics
- Building wide control
- Integrated controls vs independent controls
- Conclusions

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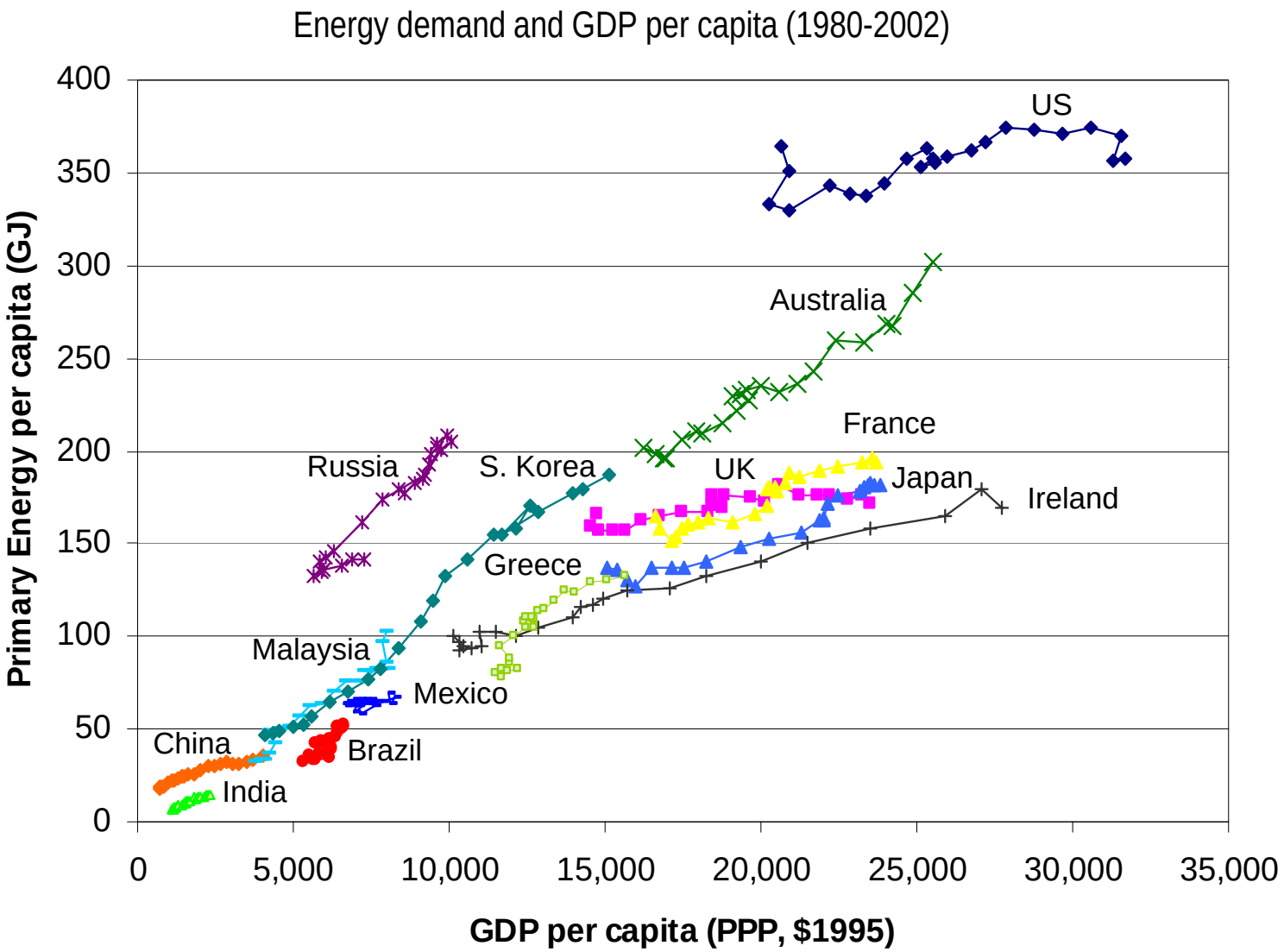
Energy Demand Grows with Economic Development



Source: UN and DOE EIA, Slide courtesy of Steven E. Koonin, Chief Scientist, BP, plc

PPP = Purchasing Power Parity - A rate of exchange that accounts for price differences across countries allowing international comparisons of real output and incomes.

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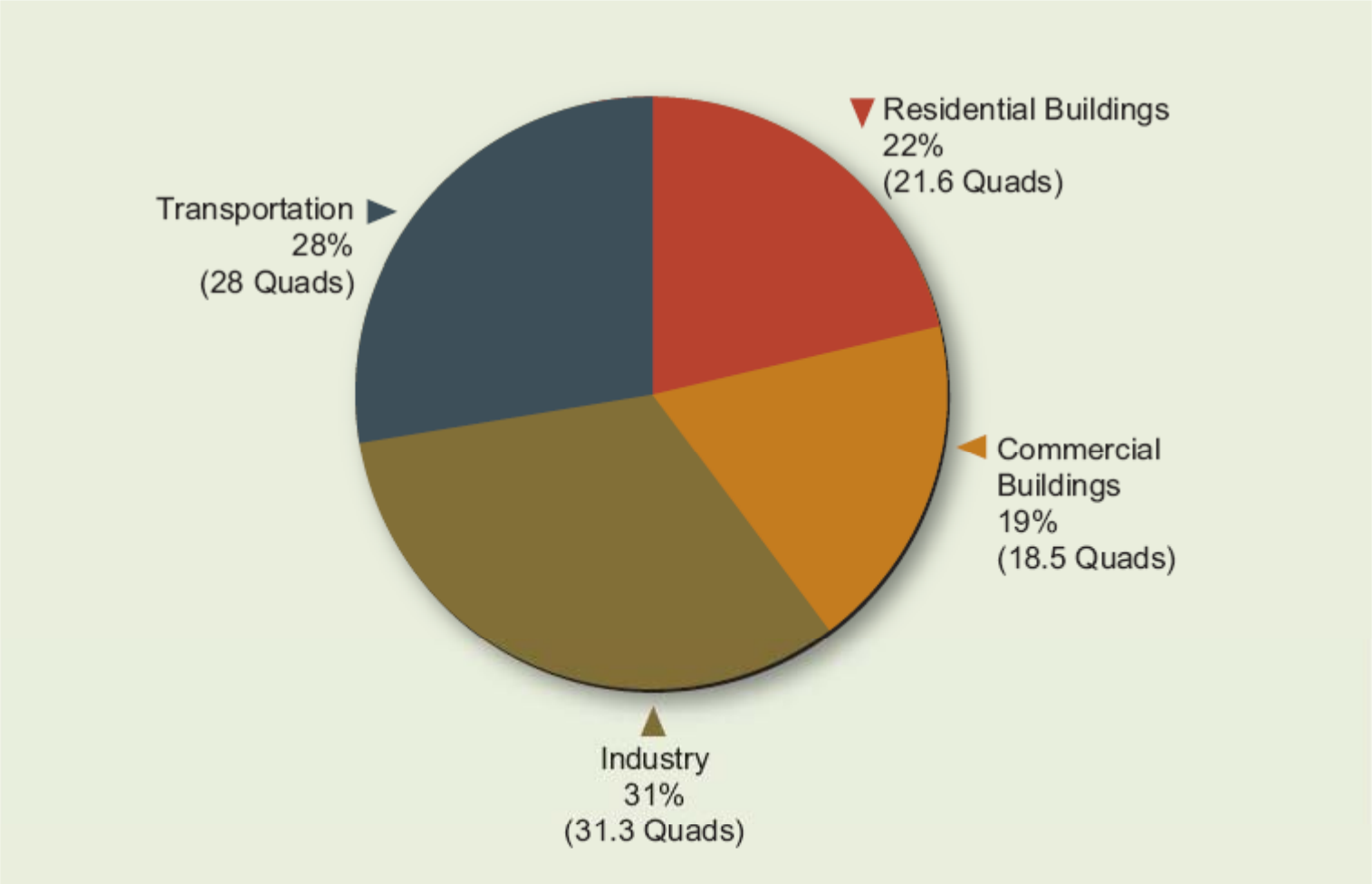
Total U.S. energy use by sector, 2008 (Quadrillion Btu or Quads)



Source: DOE, 2008c, as updated by DOE, 2009.

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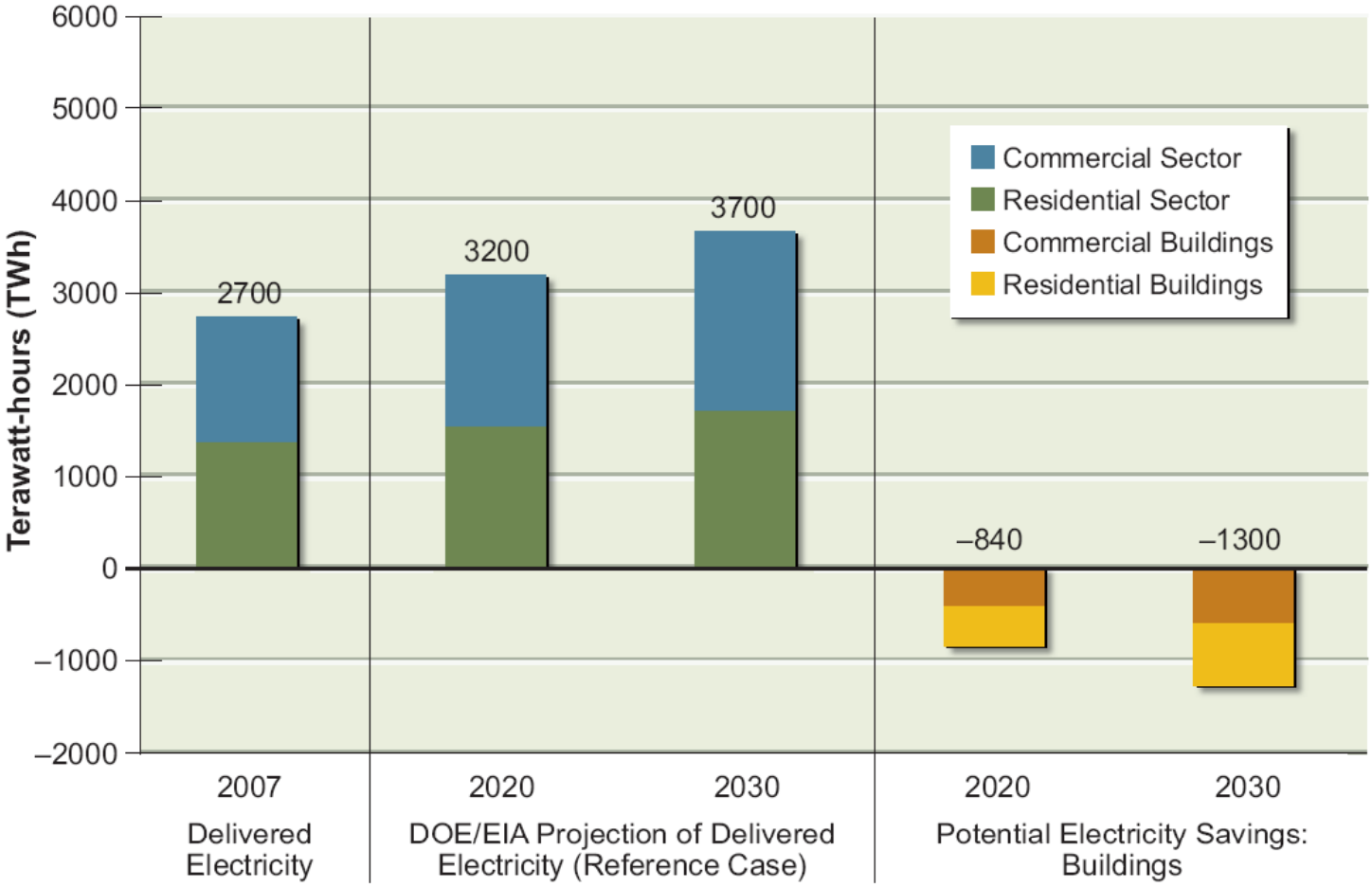
Estimates of potential energy savings in buildings in the United States



Sources: Data from Energy Information Administration (2008)

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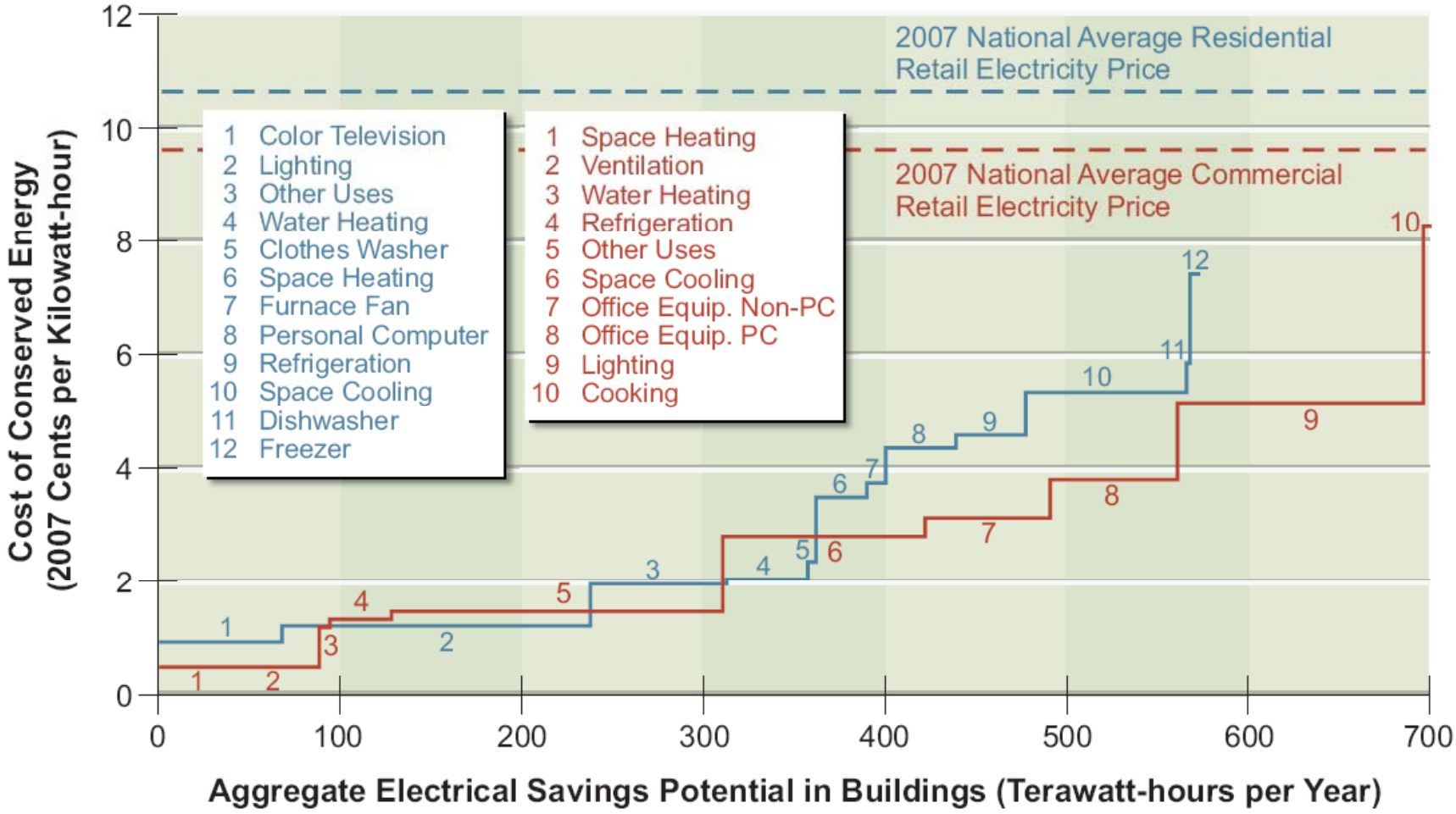
Estimates of the cost of conserved energy (CCE) and energy savings potential of electricity efficiency technologies in buildings in 2030



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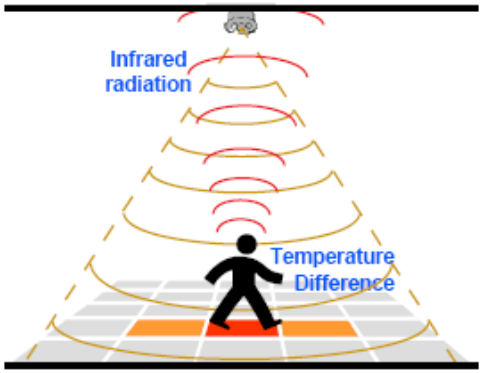
Lighting Control Technologies

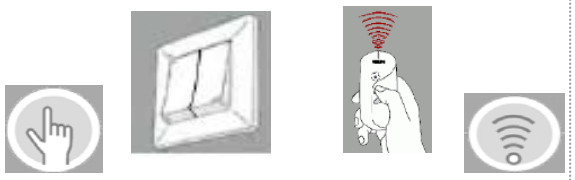
MD – Motion Detector

Presence of persons



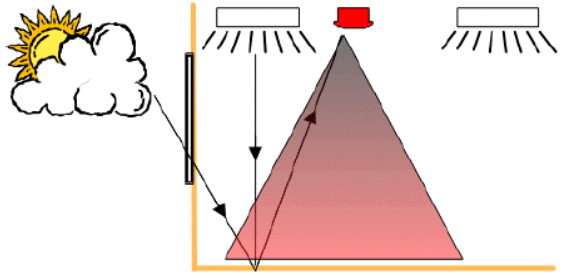
Manual control

Pushbutton and Remote Control



LS – Light Sensor

Photocell



On/Off/Dimming

Automatic control

Hourly programming

Scene sequences

Lighting

Functional

Scene

Fading

Scenes

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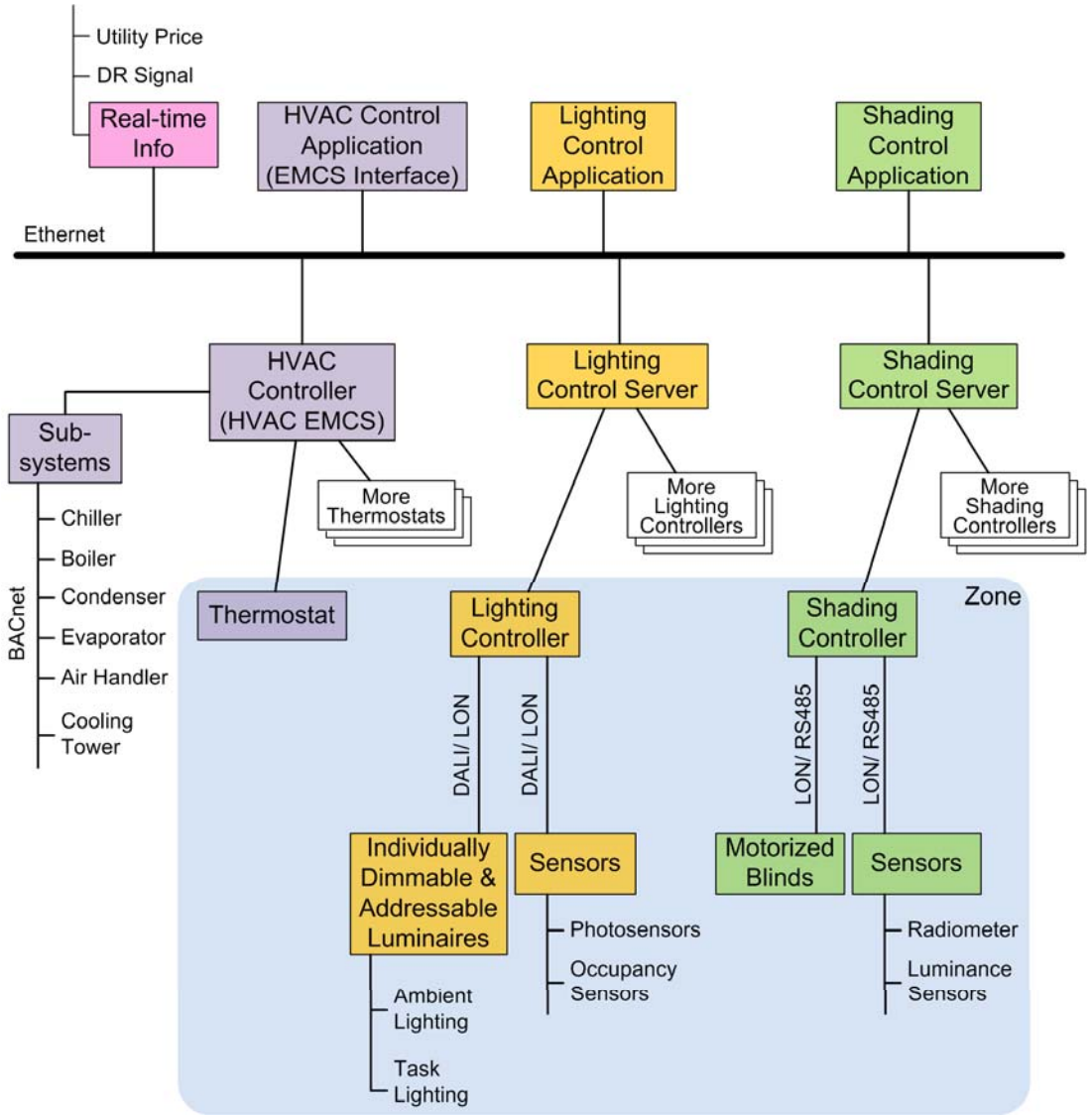
Independent Building-Wide Control



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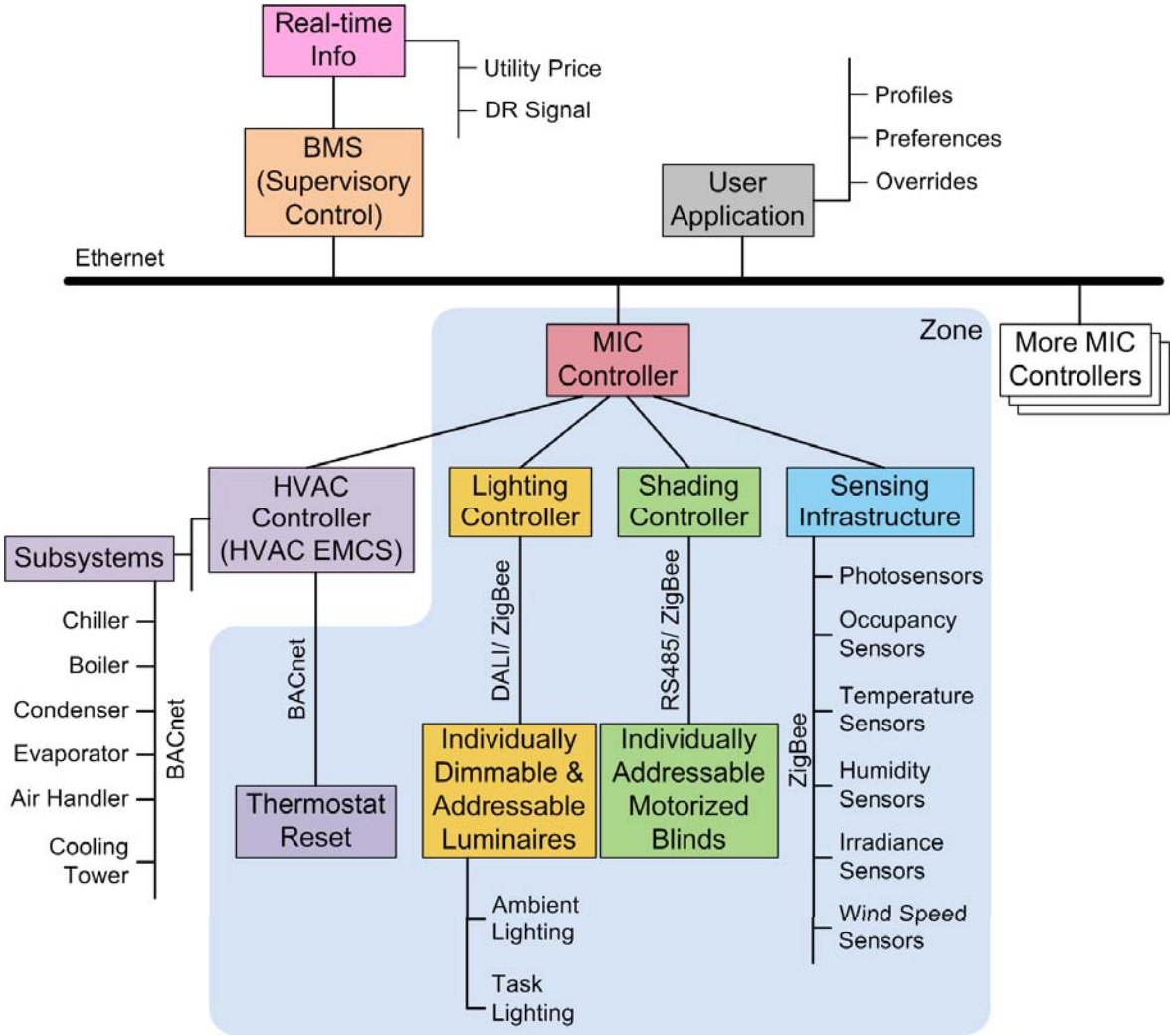
Integrated Building-Wide Control



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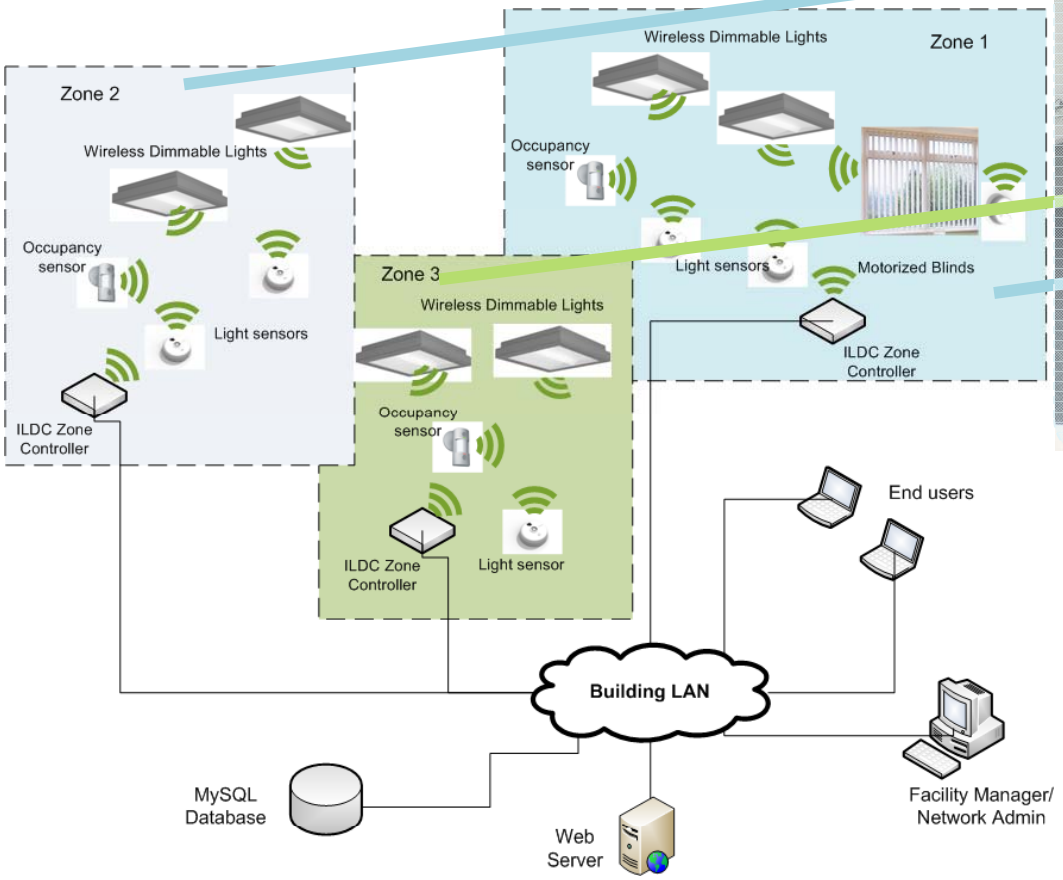
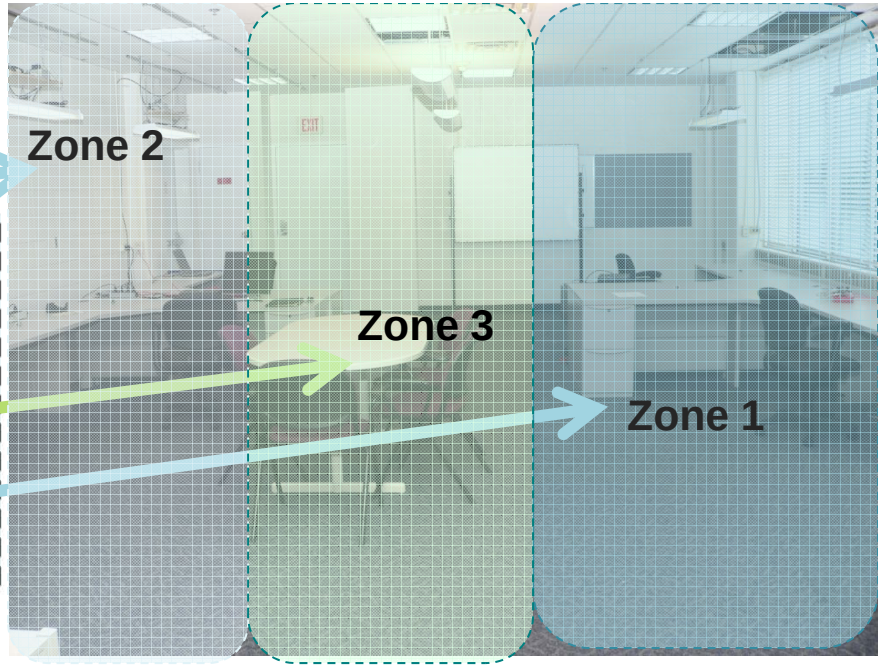
Lighting Control Testbed



System Architecture



Key concepts demonstrated:

- Hybrid system architecture (wireless+wired connectivity)
- Integrated Daylight and Artificial Light control Algorithm
- Estimated Energy Savings
- User interaction capabilities (end users, facility manager, network administrator)

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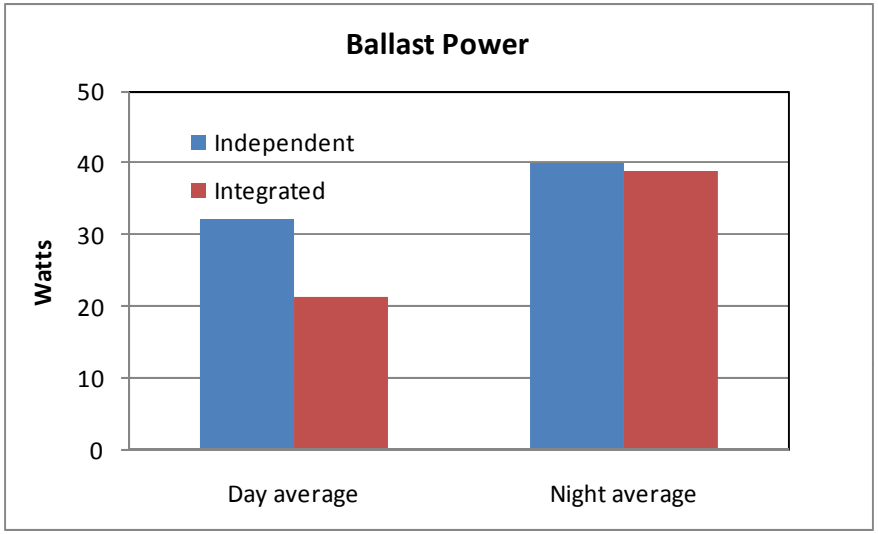
Sample average of ballast power



	Reduction in Average Power consumption	
	Independent	Integrated
Day time average (7 am to 5:30 pm)	27%	52%

* Minimum level used =1 (~30% of max level power)

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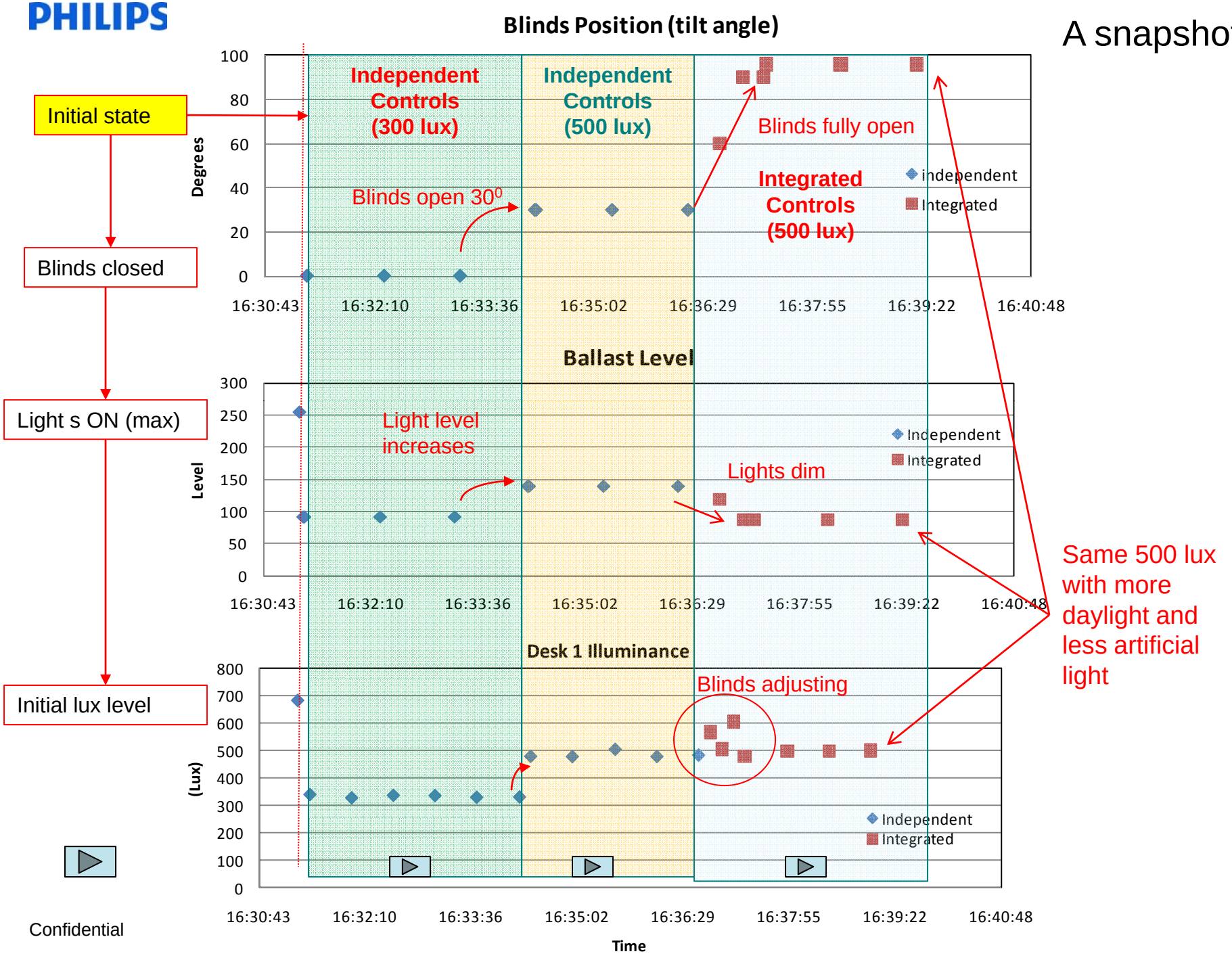
A snapshot



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Simulated Integrated Control in Buildings

Controllable subsystems
- Electric lighting
- Window transmission

	Non Integrated	***Partially Integrated***	***Fully Integrated***
Lighting energy	reduced	minimized	minimized
HVAC energy	neutral[2]	reduced[3]	minimized

Control strategies

- *Non-Integrated* control[1]
  - Electric lighting control only
  - Maximize electric lighting savings, no window transmission control
- *Partially Integrated* control
  - Integrated control of window transmission and electric lighting
  - Maximize electric lighting savings while reducing HVAC cooling energy
- *Fully Integrated* control
  - Integrated control of window transmission and electric lighting integrated with HVAC
  - Maximize electric lighting savings while minimizing HVAC energy

[1]Truly non-integrated control of window transmission and electric lighting would result in non-optimized electric lighting and HVAC energy
[2]Climate dependent. Addressing lighting only results in 1.92% HVAC energy savings averaged over all climates
[3]Depending on climate, building type, etc., total HVAC energy may increase or decrease

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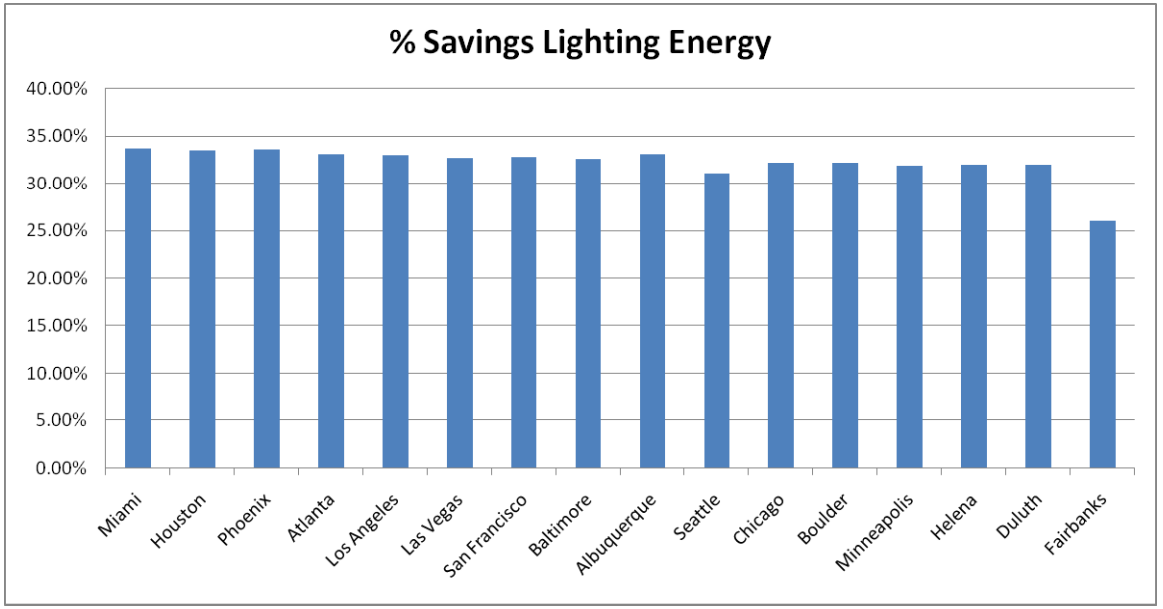
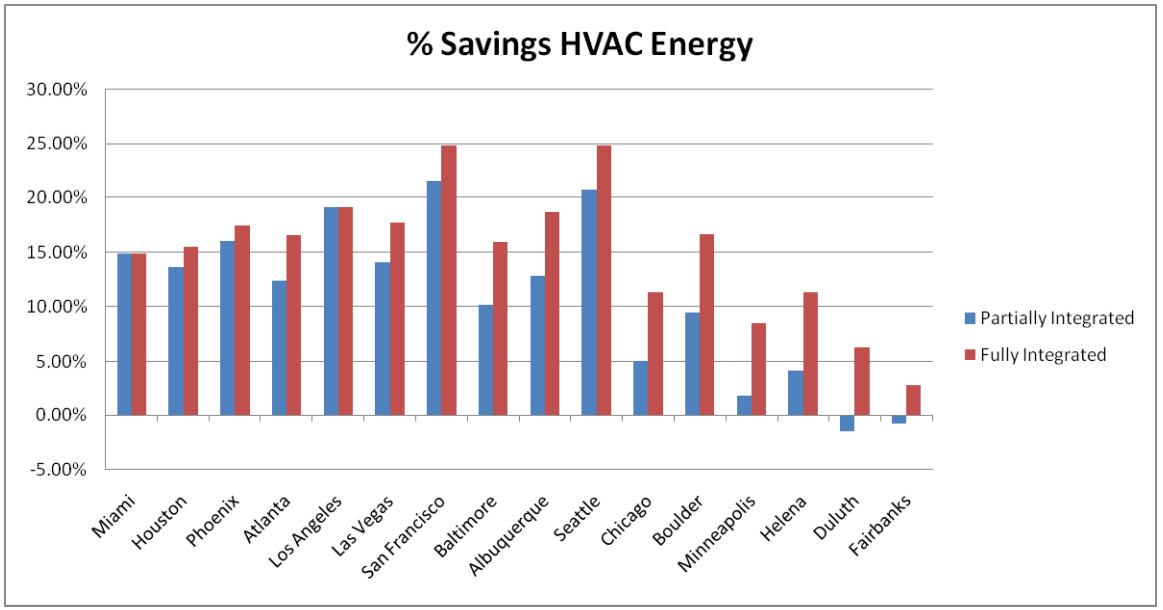
Simulation Results

- New construction (ASHRAE 90.1-2004) medium office building
- All control strategies maximize lighting energy savings
- *Partially Integrated* minimizes cooling energy (benefits warm climates)
- *Fully Integrated*[1] minimizes cooling and heating energy (benefits mixed cooling and heating climates to cold climates)[2]
- HVAC savings are relative to *Non-Integrated* control





[1] *Due to software limitations Fully Integrated control was approximated*

[2] *True Fully Integrated control expected to result in more HVAC energy savings depending on climate*

Source: Shen, E.; Hong, T. *Simulation assessment of the energy savings benefits of integrated control in office buildings*. Joint PRNA LBL draft. January 26, 2009.

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Conclusions

- In the US, buildings consume the highest amount of energy (41%) followed by industry(31%) and transportation(28%)
- Significant energy savings potential exist in buildings with:
  - Lighting controls based on occupancy, schedule, light level tuning and daylight integration
- *Integrated* control of electric lighting & daylighting provides increased energy savings over *independent* control for:
  - Lighting related energy (25% in the lab. demonstrations)
  - HVAC cooling and heating related energy up to 25% in the simulated cases
  - Increased visual comfort !!


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Initial state

Exp. II

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Independent Controls at set point = 300 lux

Exp. II

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Independent Controls at set point = 500 lux

Exp. II

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Integrated Controls at set point = 500 lux

Exp. II