

PHILIPS

sense **and** simplicity

Lighting and Net Zero Energy Buildings

Advanced Energy 2011
Buffalo, New York

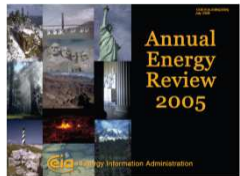
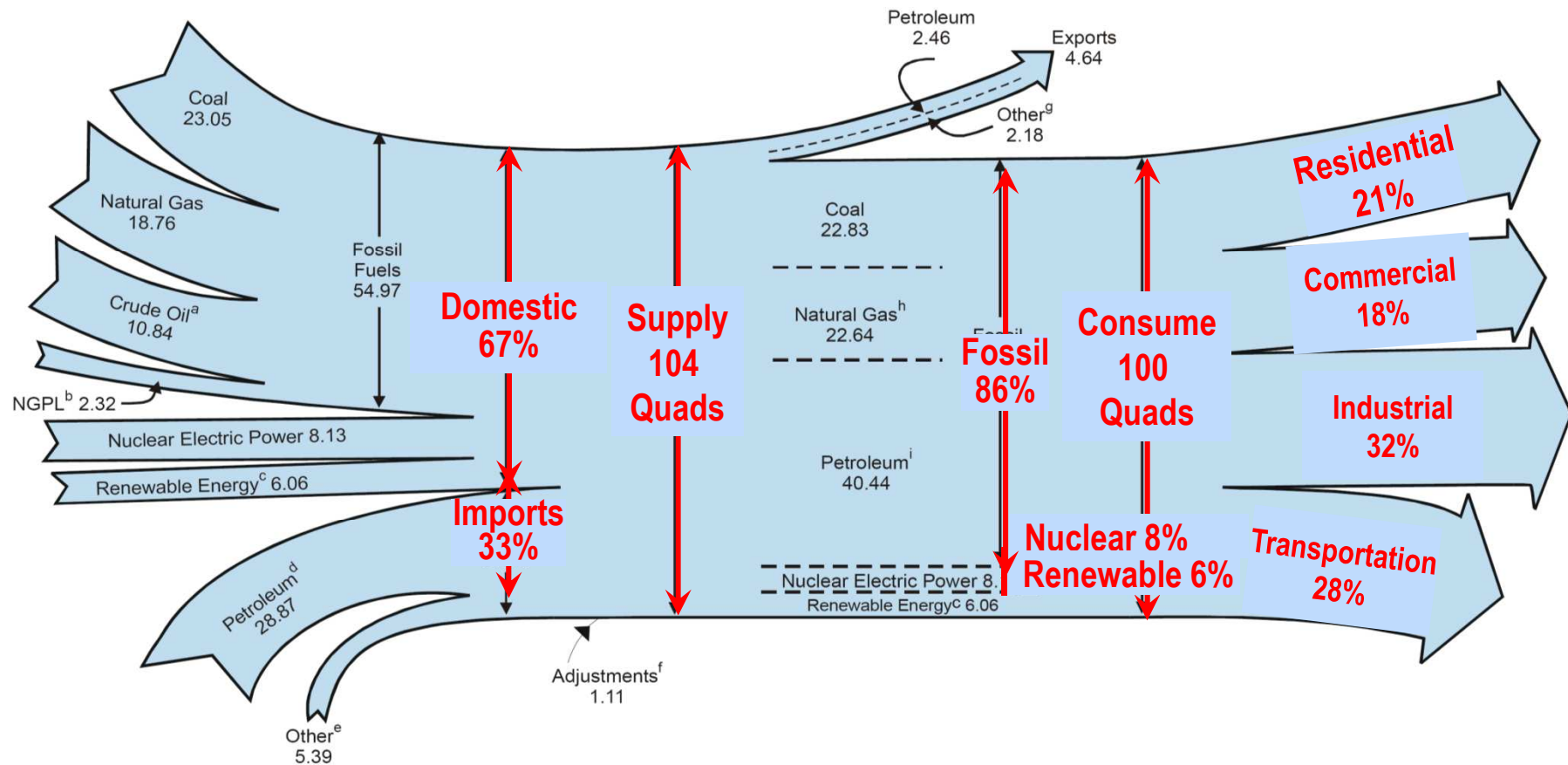
Satyen Mukherjee
Philips Research North America
Oct 13, 2011

Outline

- Why ZEB - Background
- Key Challenges
- Role of Lighting
- Results from DOD test beds
- Summary

U.S. Energy Flow, 2005 (Quads)

86% of primary energy is from fossil fuels, with 69% of the petroleum imported



Definitions

ZEB or ZNEB: *Zero Net Energy Building*

Produces more energy on-site than it consumes, on an *annual basis*.

– Excludes:

- Transportation
- Embodied Energy in Water, Materials, Waste

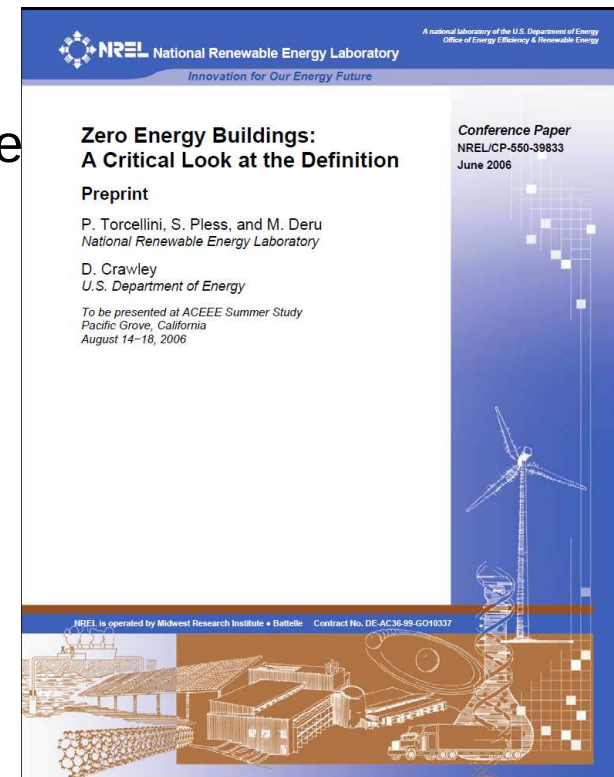
- Net-zero site energy
- Net-zero source energy
- Net-zero carbon
- Net-zero energy cost

Zero Energy Buildings: A Critical Look at the Definition

P.Torcellini, S. Pless, M. Deru - NREL

D. Crawley - DoE

2006



www.nrel.gov

Challenges

- Wide range of building types
- Variability in requirements – geographical, weather
- Drift over time
- Economic Performance
- Flexibility/Adaptability to Changing Needs
- **Balancing Energy Consumption with Occupant Comfort and Productivity**

Commercial building types

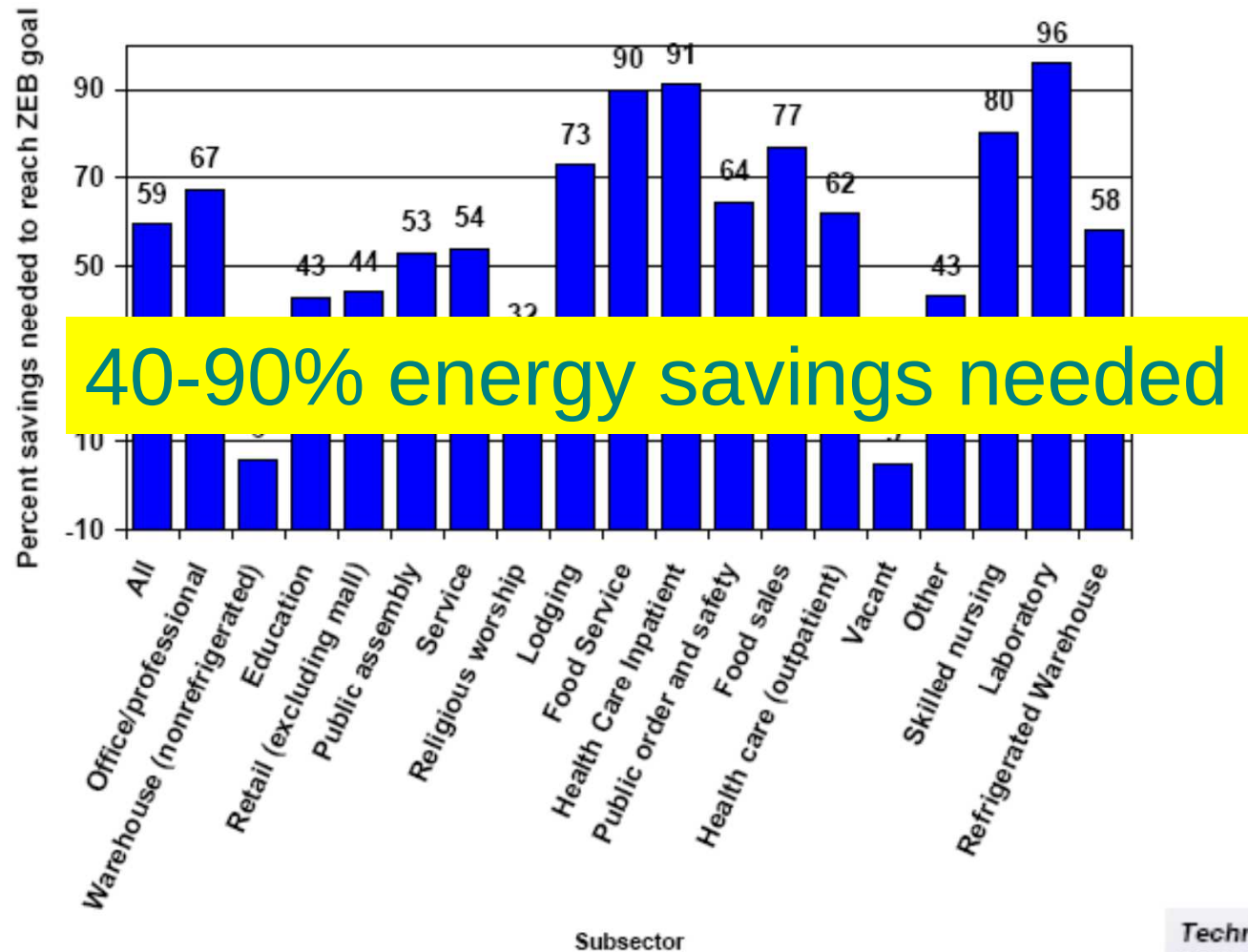
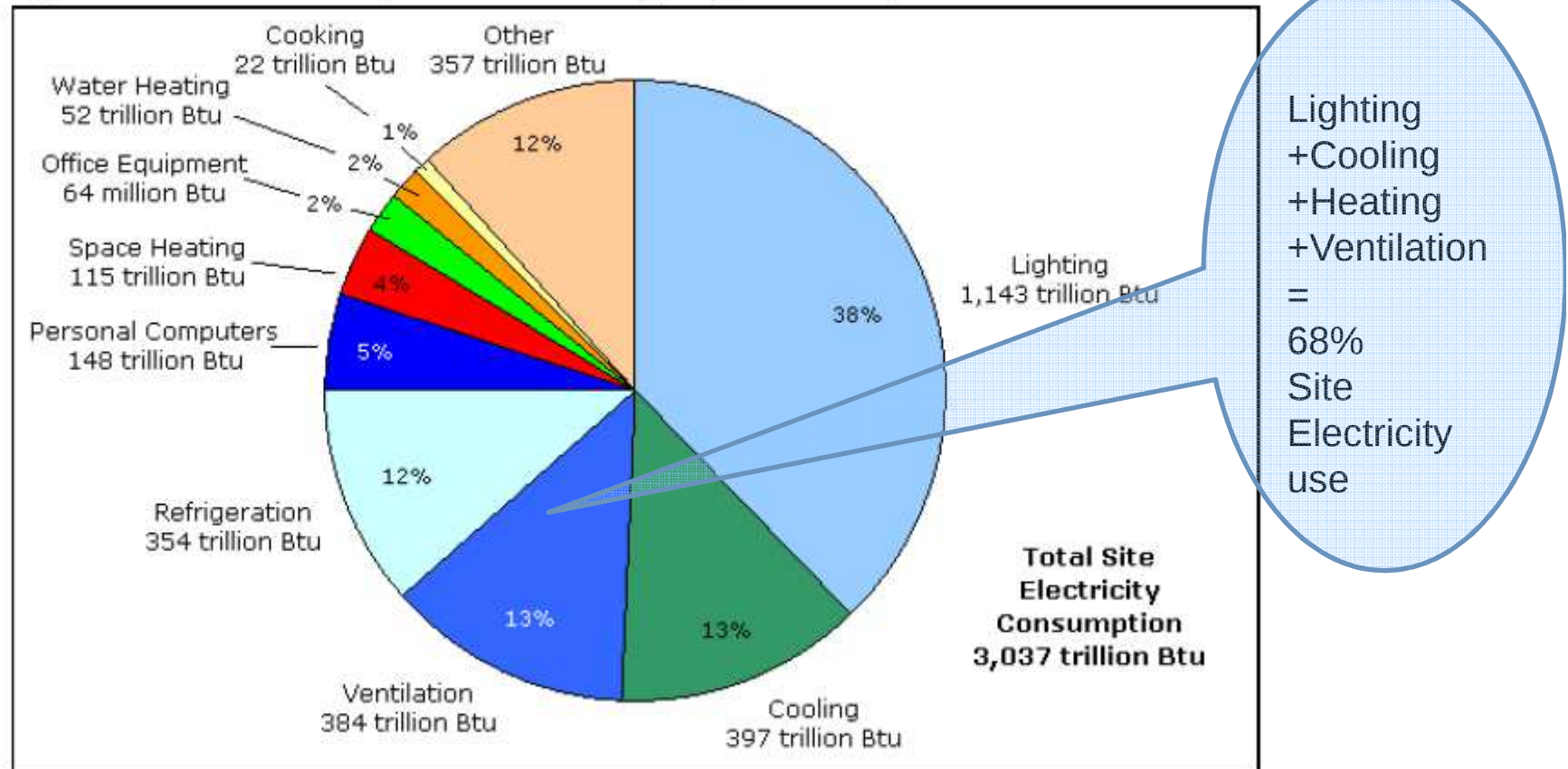


Figure 4-16 Percent savings from efficiency needed to reach ZEB

Technical Report
NREL/TP-550-41957
December 2007

Commercial Buildings Site Electricity Consumption by End Use

Figure 4. More site electricity is consumed for lighting than for any other end use.

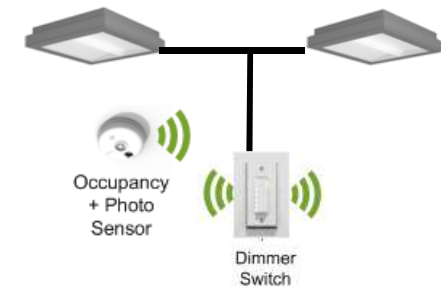


Note: Data are for non-mall buildings. Site electricity excludes energy used to generate and transmit electricity.
Source: Energy Information Administration, 2003 Commercial Buildings Energy Consumption Survey, Table E3.

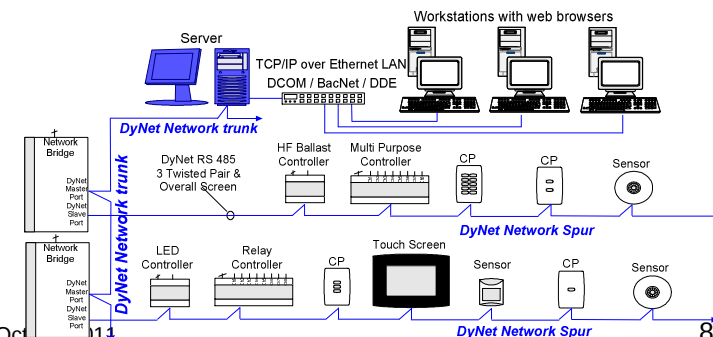
Advanced Lighting Controls: Technology Description

	OccuSwitch Wireless	Dynalite	Hybrid ILDC
System architecture	Room-based control	Distributed control bldg-wide connectivity	Room/area based control with building-wide connectivity
Scalability	Room by Room	Scalable from a single room to entire building	Scalable from a single room to wide area control
Best applications	Single offices; barracks; Retrofits; smaller budget	New construction, major renovation	Multi floor office buildings with daylight areas. Retrofit or new
In-room Connectivity	Wireless based on ZigBee PRO standard	Wired	Wireless based on ZigBee PRO standard
Cost advantage	+++ Installation ++ Commissioning	+ Installation +++ Commissioning	++ Installation ++ Commissioning
Energy adv.	++	++	+++

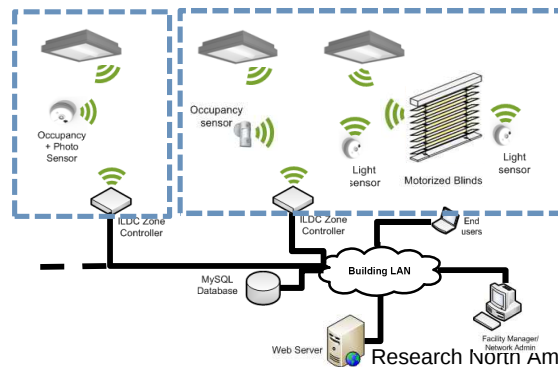
OccuSwitch Wireless



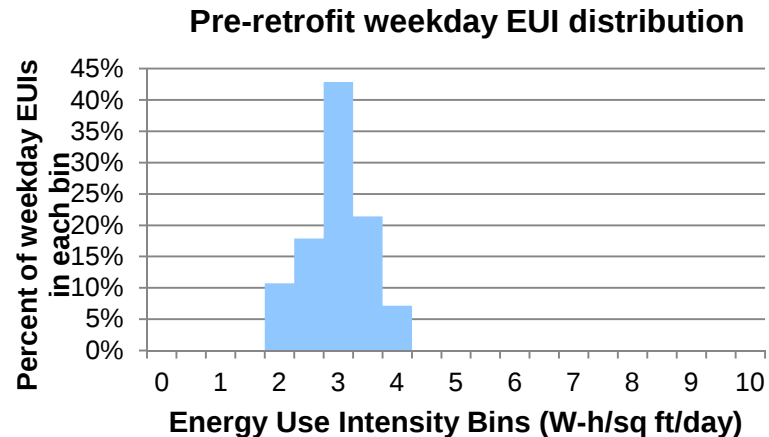
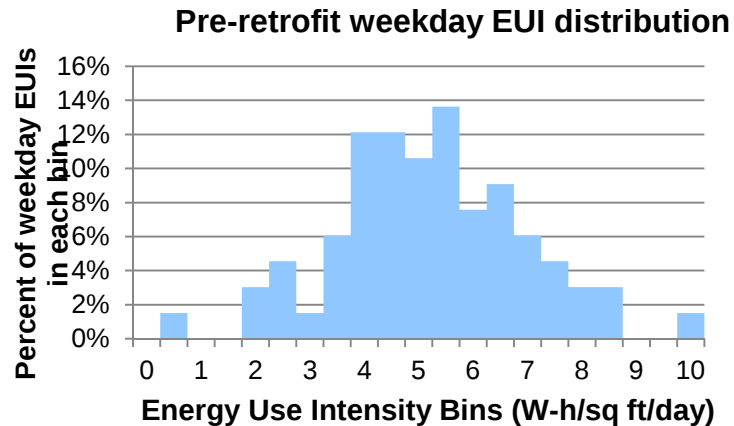
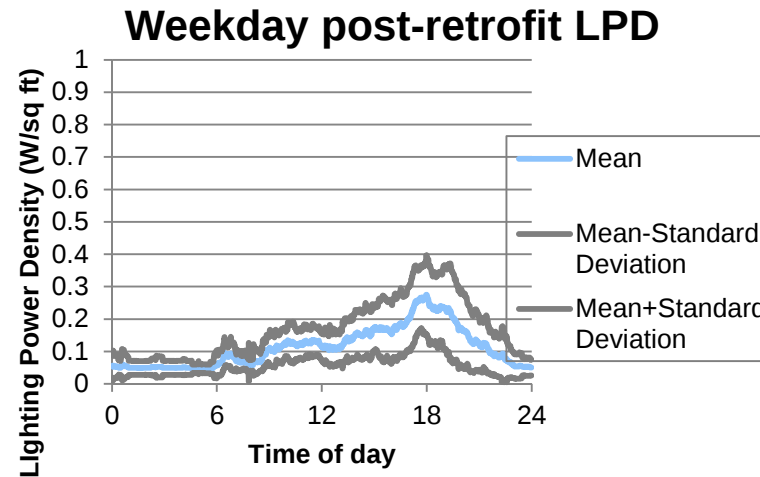
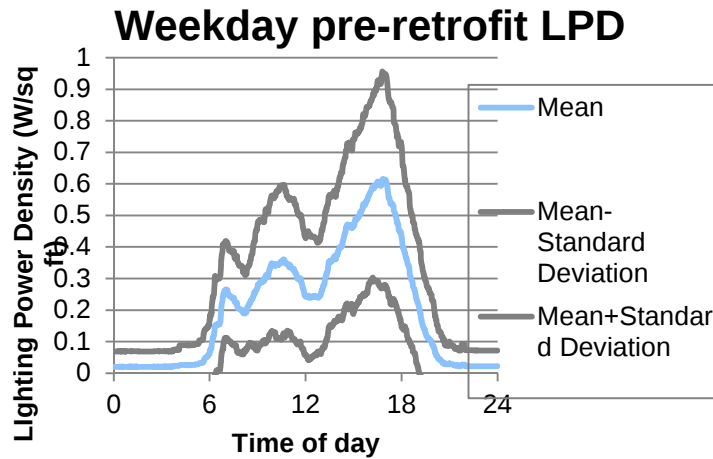
Dynalite



Hybrid ILDC



Building A—Lighting Power Density



Weekday LPD decreased deeply throughout the day.

Preliminary Performance Summary – June 2011

Building A: Hybrid ILDC – Area covered 1782 sq.ft.

Performance objective	Code baseline	Post-retrofit	Reduction compared to code baseline
Annual EUI (kWh/sq ft/yr)	4.54	0.82	82%
Peak LPD over a 15 minute period (W/sq ft)	1.81	0.64	65%
Average deviation from specified illuminance range (lux)	N/A	1	N/A

Building B: Occuswitch - Area Covered 4821 sq.ft.

Performance objective	Code baseline	Post-retrofit	Reduction compared to code baseline
Annual EUI (kWh/sq ft/yr)	4.54	1.74	62%
Peak LPD over a 15 minute period (W/sq ft)	1.81	0.9	50%
Average deviation from specified illuminance range (lux)	N/A	40	N/A

Building C: Dynalite – Area Covered 6450 sq.ft.

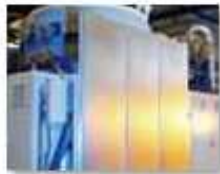
Performance objective	Code baseline	Post-retrofit	Reduction compared to code baseline
Annual EUI (kWh/sq ft/yr)	4.54	2.90	36%
Peak LPD over a 15 minute period (W/sq ft)	1.81	0.82	55%
Average deviation from specified illuminance range (lux)	N/A	to come	N/A

SOLUTION: A SIMPLIFIED AC/DC HYBRID COUPLED POWER NETWORK

ENERGY SOURCES



AC/DC Site
Generation



DC Campus Fuel
Cells



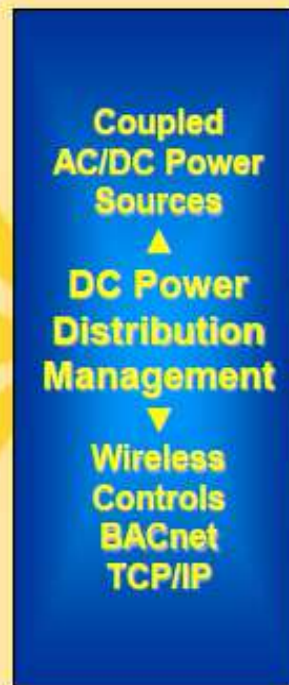
DC
Photovoltaic



DC Wind
Power



AC Line Power



ELECTRO-ACTIVE DEVICES



Electronic
Lighting



HVAC Actuators



Sensor & Controls



AV/IT Devices



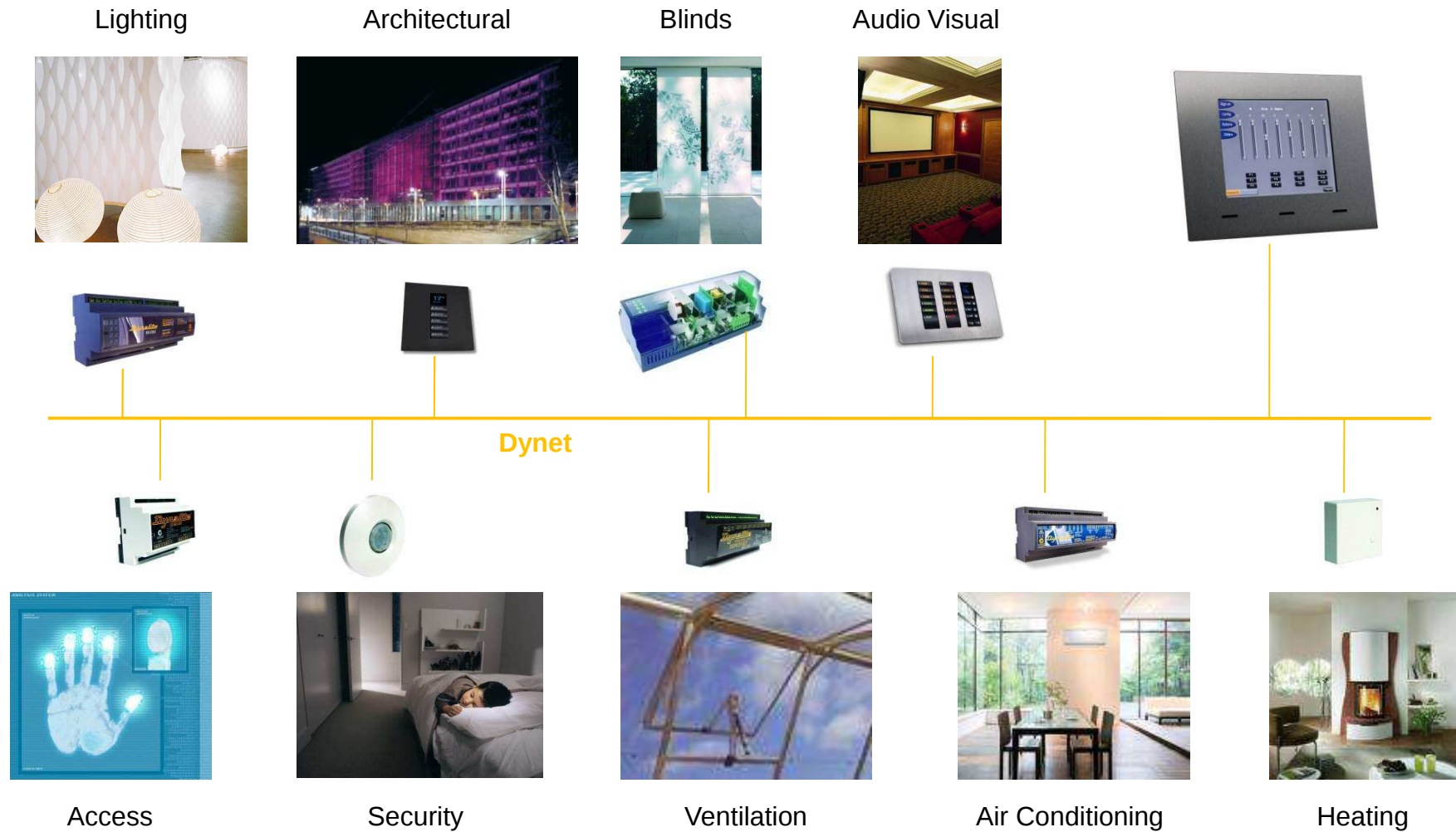
Data & Telecom Centers



Security & Safety

OPPORTUNITY: 30% LESS ENERGY, 15% LESS CAPITAL, 200% MORE RELIABLE

Integrated Solution



NZEB around the Globe



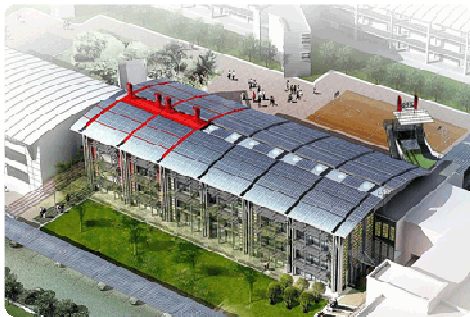
East Asia



Massachusetts, USA



Florida, USA, both source and emissions NZEB, 2010



Singapore planned 2009 educational



Colorado USA



NREL, USA, 2011

The opportunity space



Show the **power of conservation** by demonstrating
conservation of power