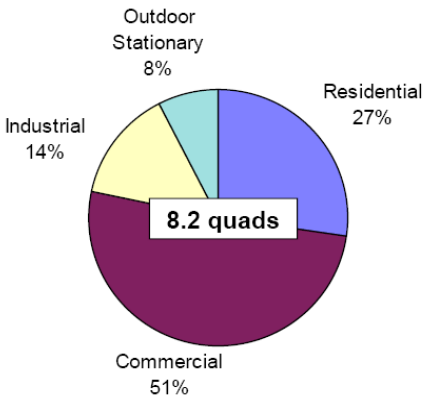
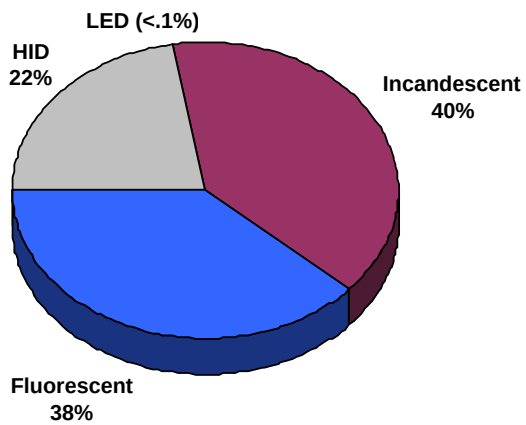
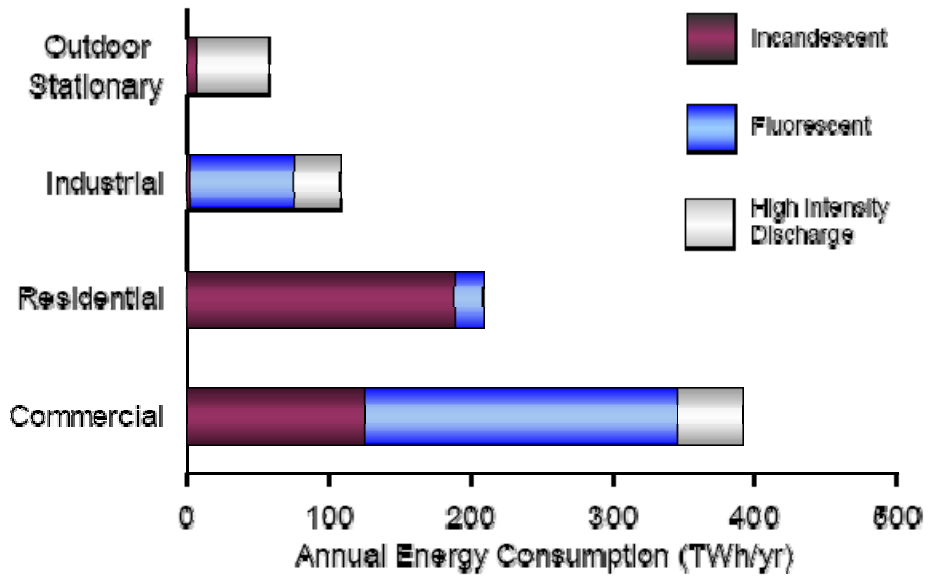
National Lighting Energy Consumption



390 Billion kWh used for lighting in all commercial buildings in 2001



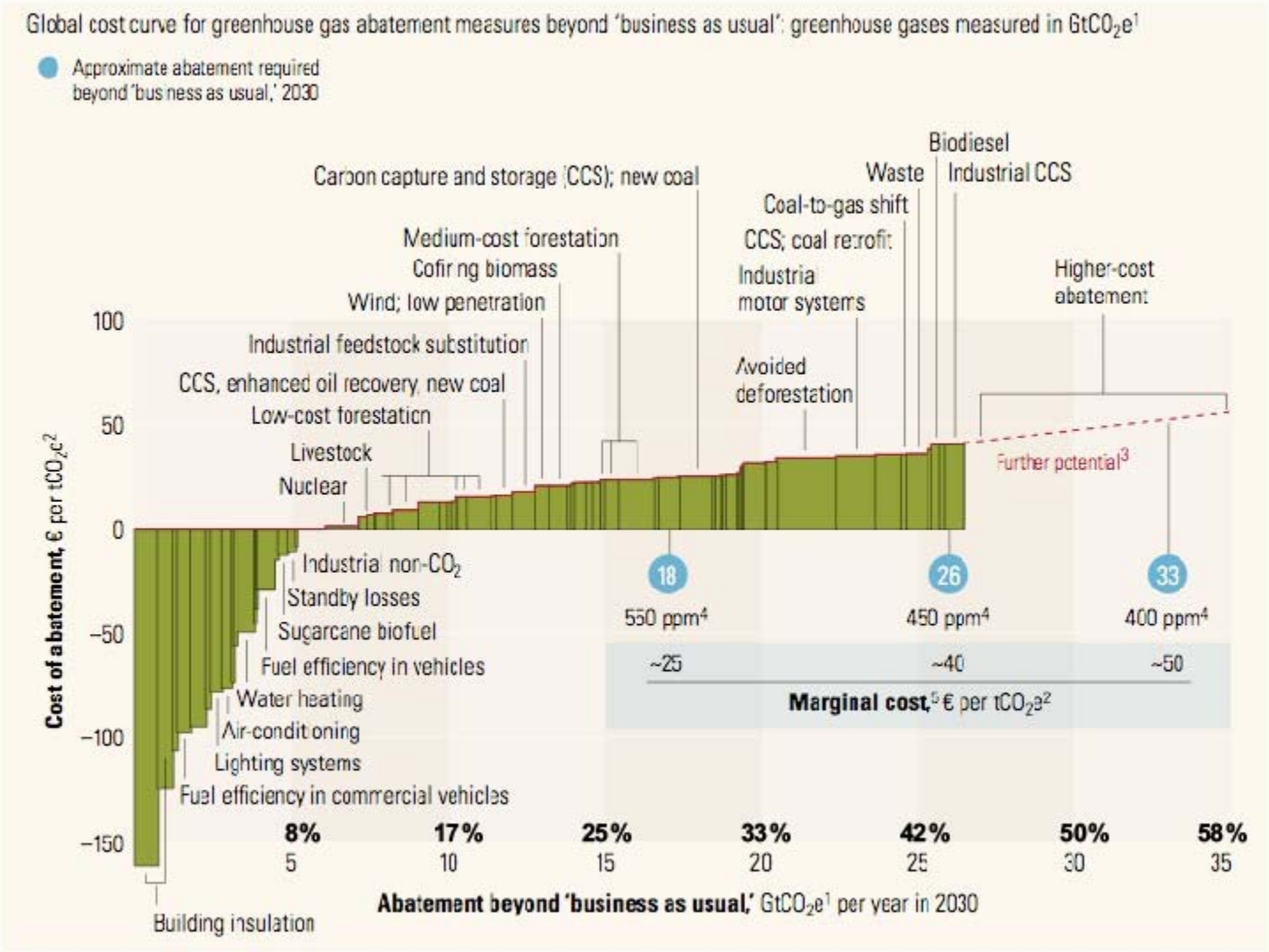


Lighting Energy Consumption by Major Sector and Light Source Type

Breakdown of Lighting Energy

Source: Navigant Consulting, Inc., U.S. Lighting Market Characterization, Volume I: National Lighting Inventory and, Energy Consumption Estimate, Final Report for US DOE, 2002

EE reduces carbon and saves money



Source: McKinsey Global Institute, 2007

Modernizing Our Offices

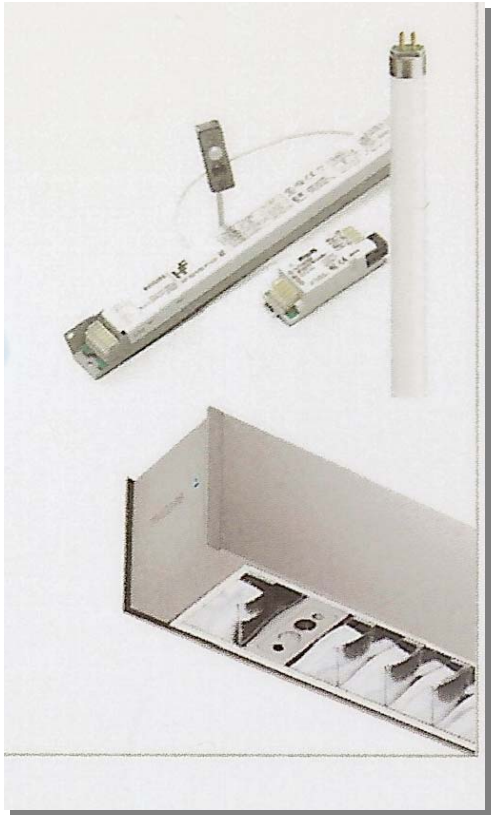
Old technology

Savings

35 BkWh in Energy
$2.6 Billion Cost Savings

7 MMT Carbon avoided
4.5 million cars removed

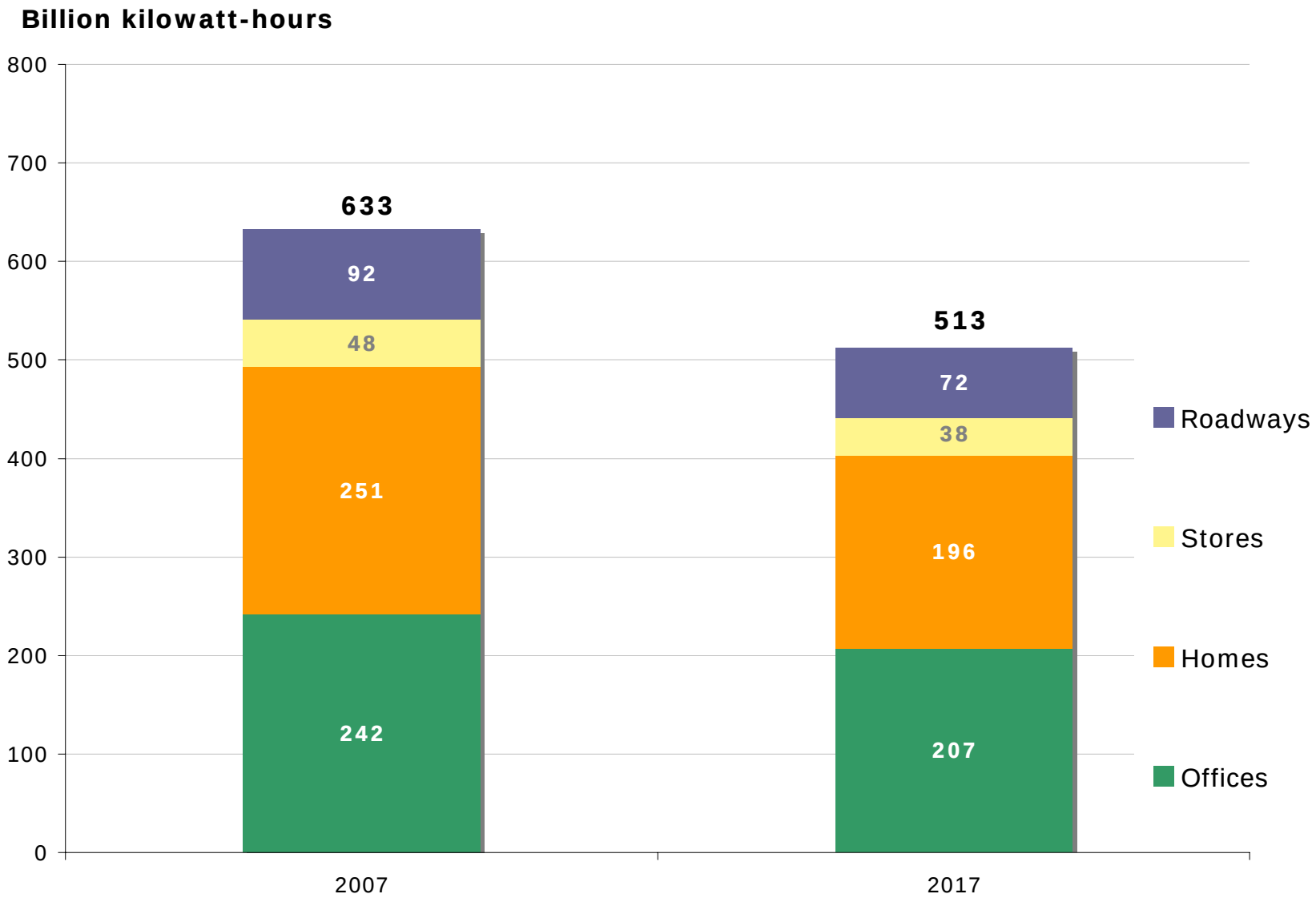
New technology



Adding Up the Savings

Sector	*Lighting Upgrade Measure*	*Estimated Energy/Cost Savings*	*Carbon Reduction (MMTCe)*	*Equivalent Cars Removed*
Offices	Replace T-12 magnetic with controlled T-8 electronic	35 BkWh $2.6 billion	7	4.7 million
Homes	Replace Incandescent Bulbs with Energy-Efficient Lamps	55 BkWh $4 billion	11	7.3 million
Stores	Replace PAR/R-lamps with Ceramic Metal Halide	10 BkWh $750 million	2	1.3 million
Roadways	Replace Mercury lamps with modern HIDs	20 BkWh $1.5 billion	4	2.7 million
Total	**All Measures**	**120 BkWh $10 billion**	**24**	**16 million**

Modernizing Our Nation's Lighting



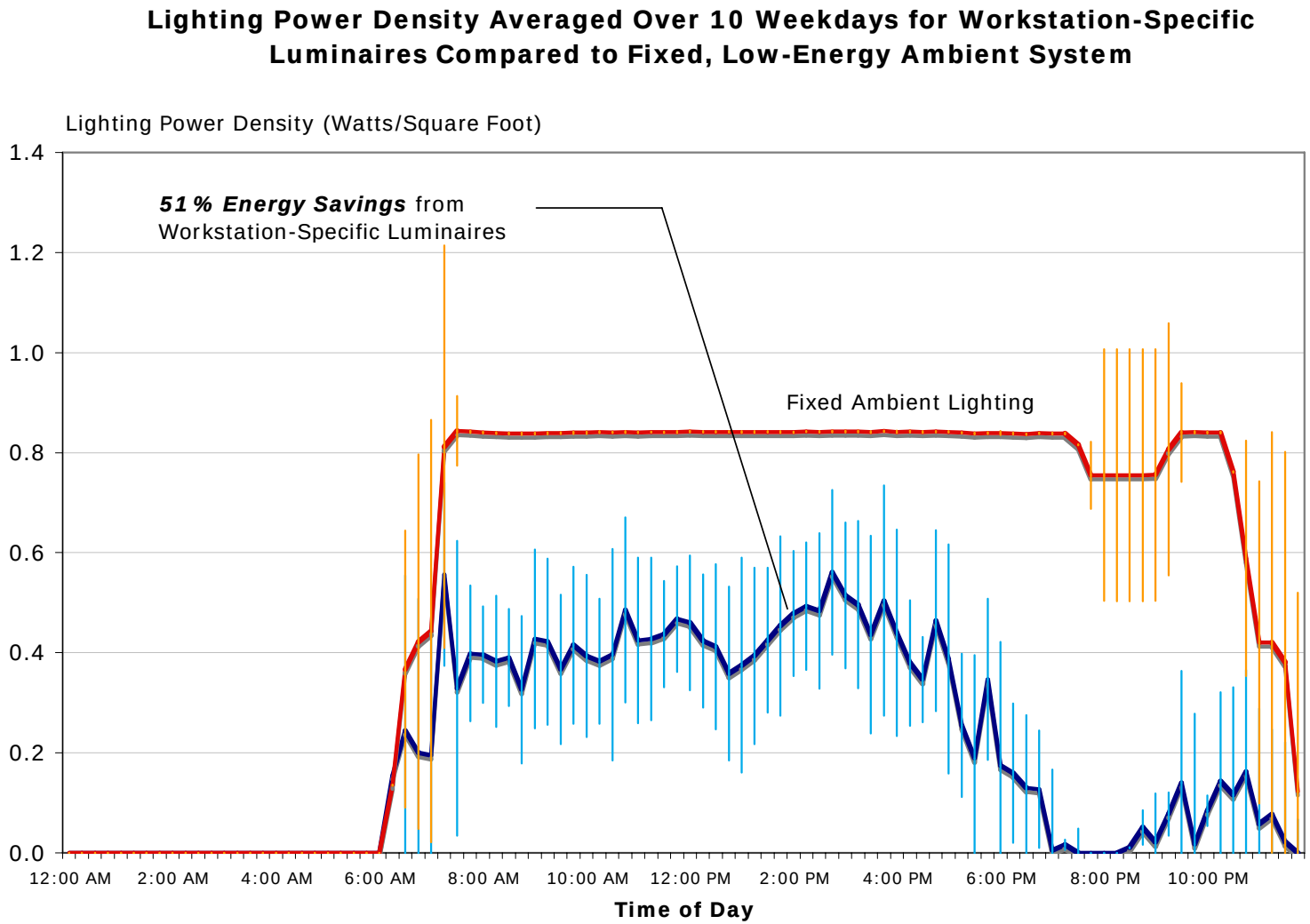
ALL lighting should be:

- Dimmable
- Addressable
- Affordable

Photo from the 8th floor of the NY Times after commissioning of shading and lighting controls.

Workstation-Specific Luminaires Undergoing Testing at San Francisco Federal Building

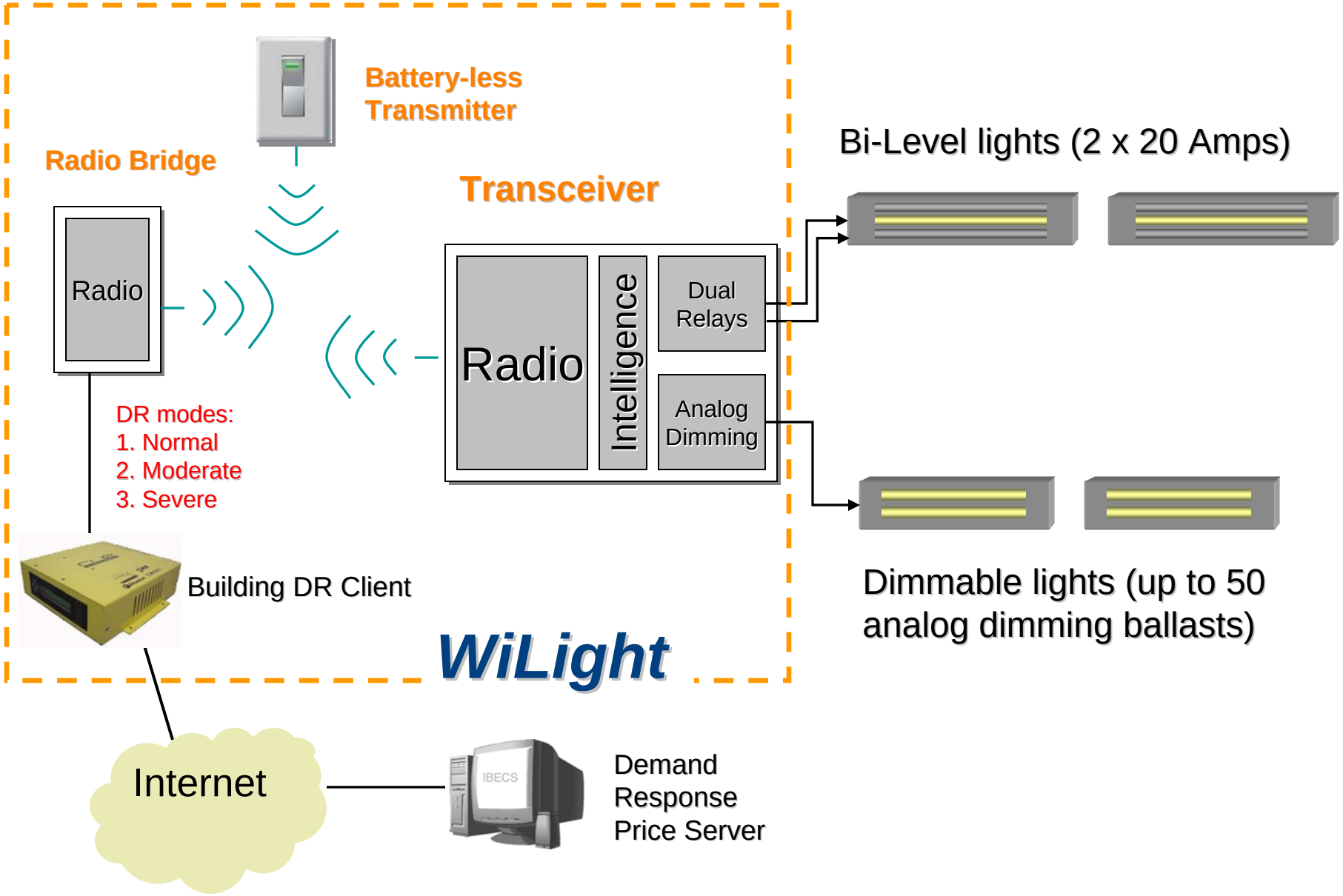
Exploiting Cubicle Vacancies to Reduce Lighting Demand



Problems

- Cost: > $500/fixture
- Lack of connectivity to building EMS
- Software, security issues

WiLight: A Novel Application of Energy-Scavenging Wireless Communications



Measurements of Wireless Propagation in Modern Building

Molecular FOUNDRY
A NANOSTRUCTURES USER LABORATORY

Molecular Foundry steel construction

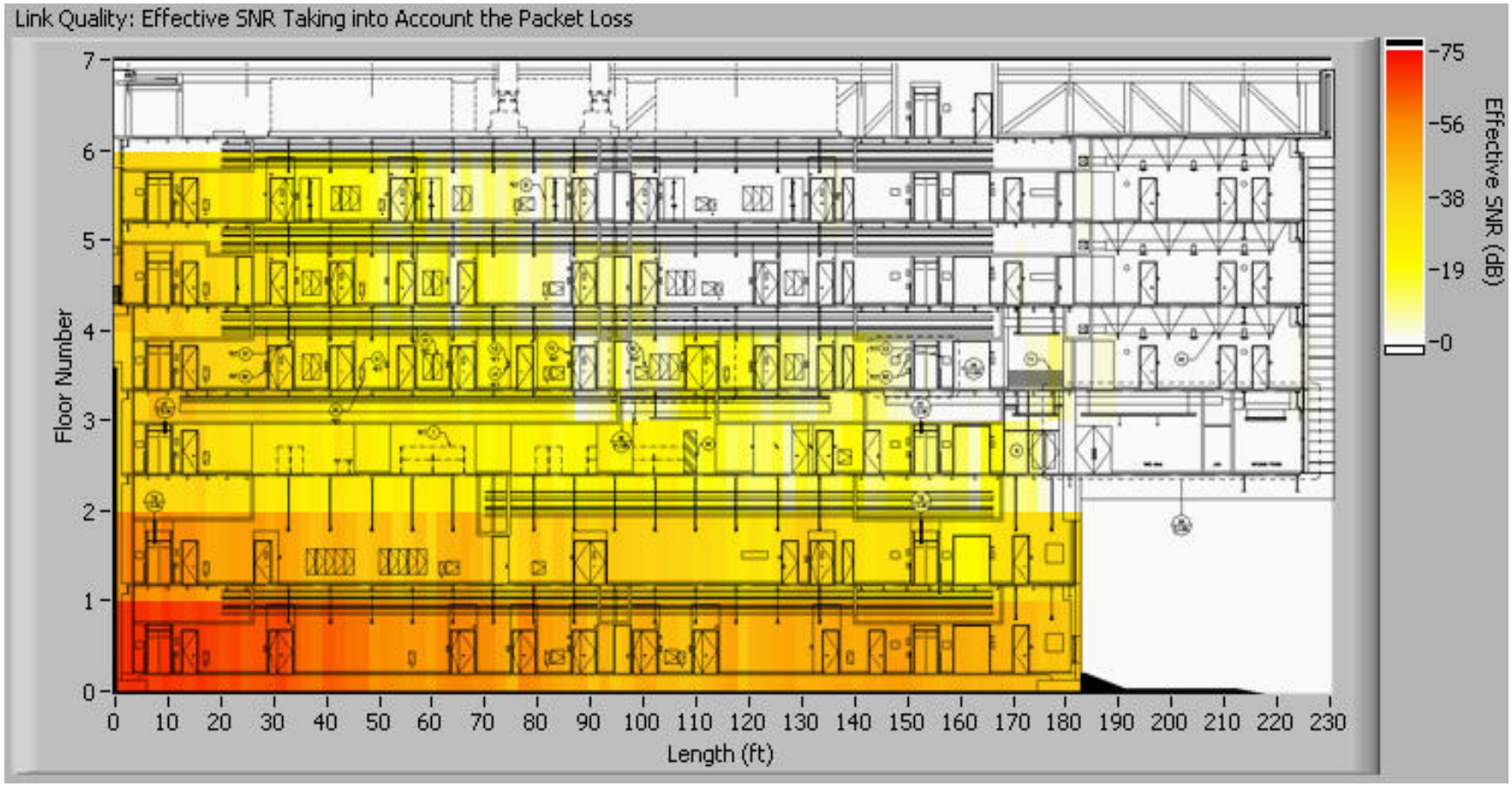
Wireless Technologies

	IEEE Standard						
	WLAN			Bluetooth	Dust Nets	UWB	Zigbee
	802.11a	**802.11b**	**802.11g**	**802.15.1**	**802.15.4**	**802.15.3**	**802.15.4**
Operational Frequency	5 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	3.1-10.6 GHz	2.4 GHz (900 MHz)
Maximum Data Rate	54 Mbps	11 Mbps	54 Mbps	1 Mbps	250 Kbps	>100 Mbps	250 Kbps (115 Kbps)
Maximum Range	100 M	100 M	100 M	10 M	100 M	10 M	50 M (900 M)

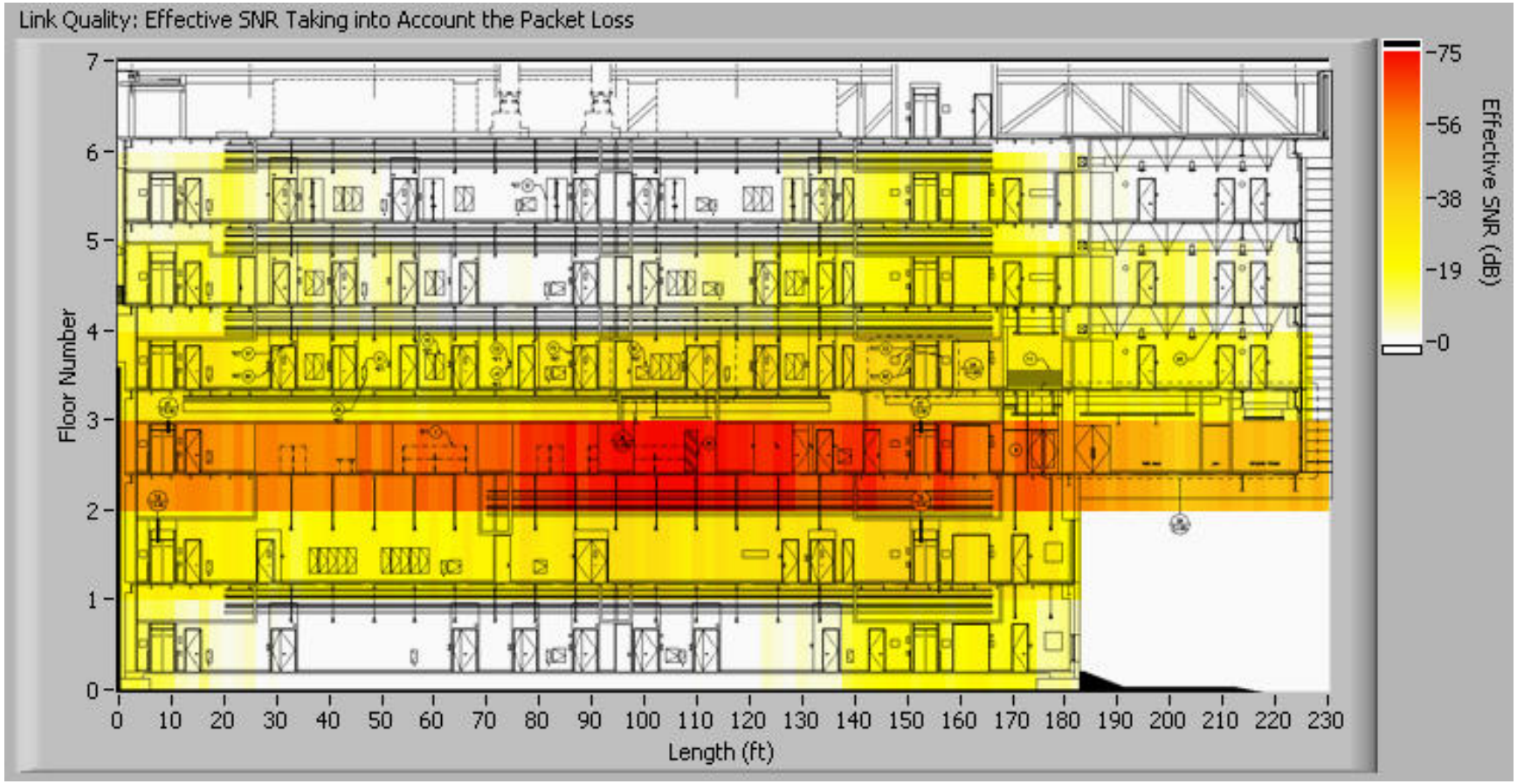
Challenge to Tested Systems

Studied in Detail

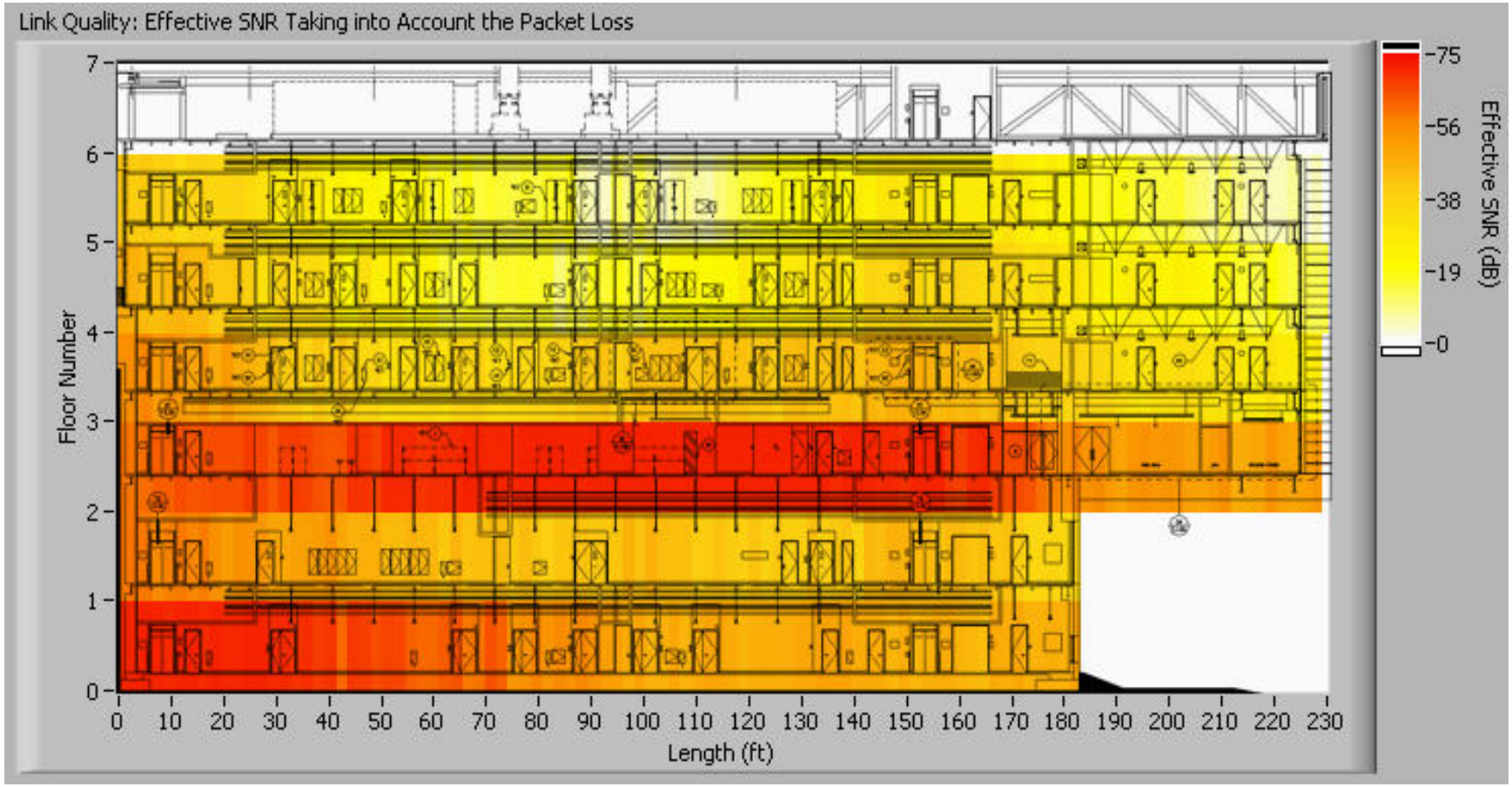
2.4 GHz Transmitter at 63 mW (Ground Floor)



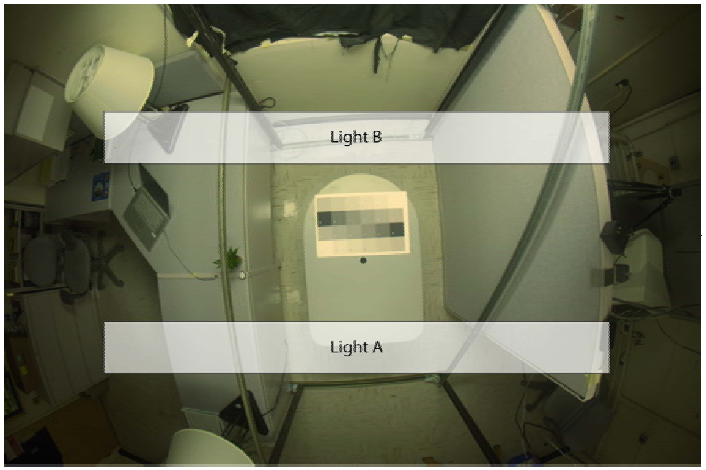
2.4 GHz Transmitter at 63 mW (Second Floor)

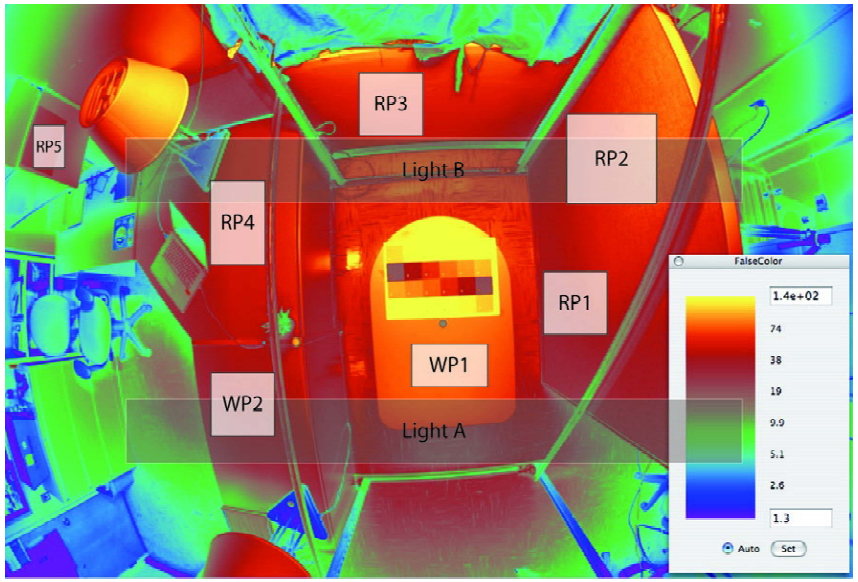


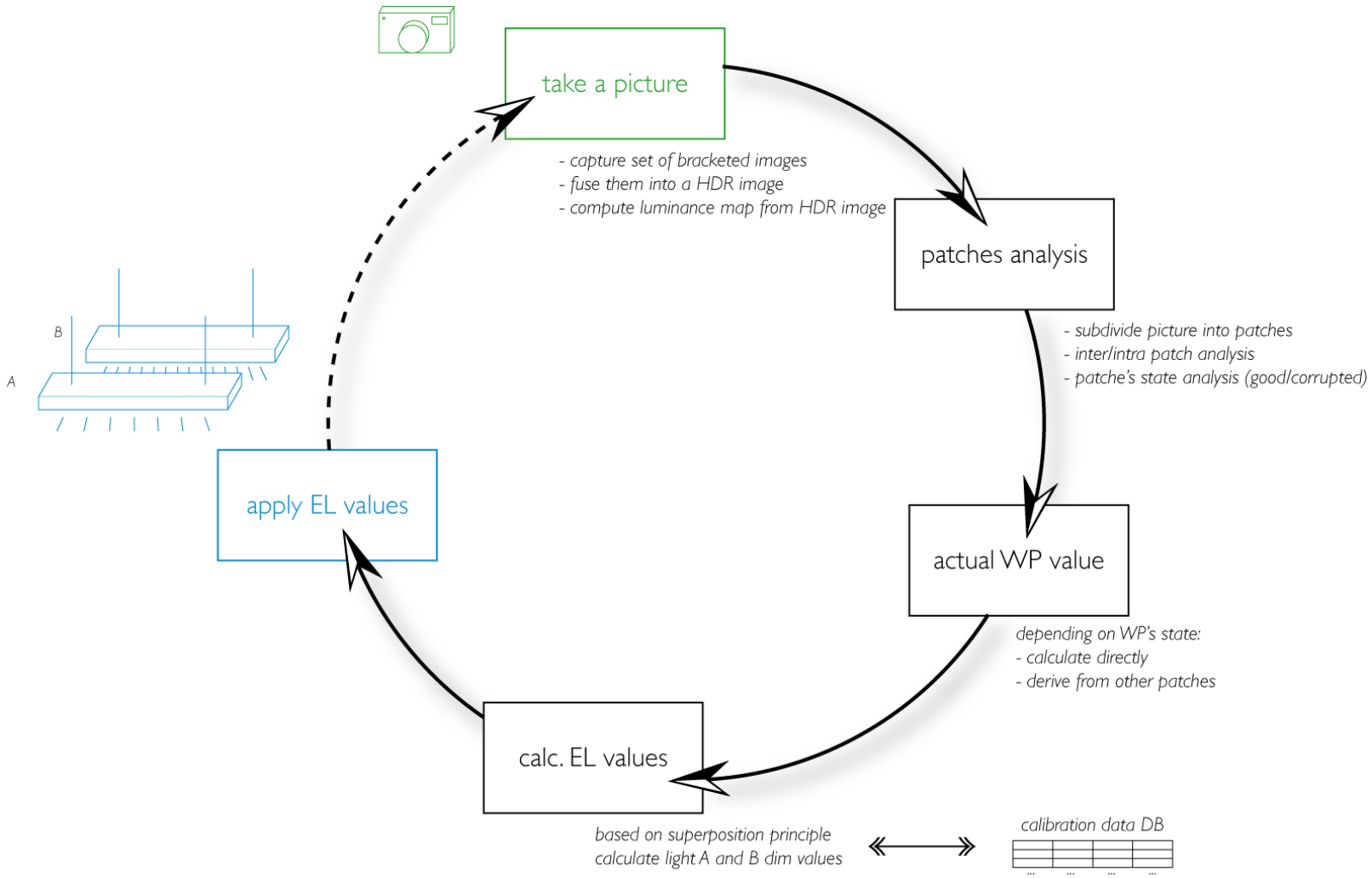
2.4 GHz Transmitters at 63 mW (Ground and Second Floor)



Advanced Optical Sensing





- CMOS detector-based
- Algorithm development
- Robustness
- Integration with window shades

Algorithm Testing