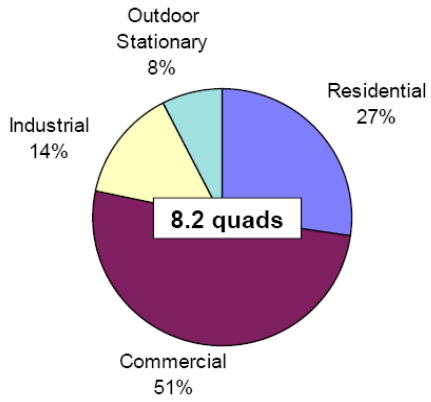
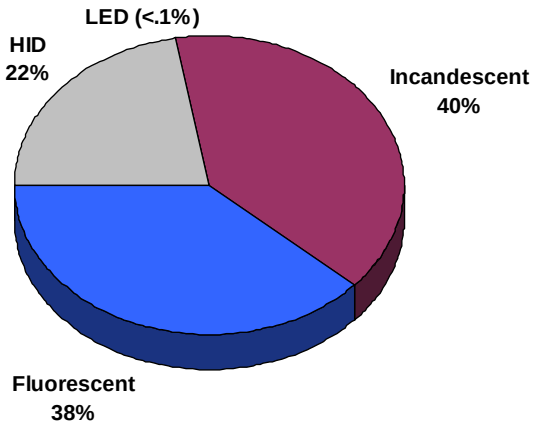
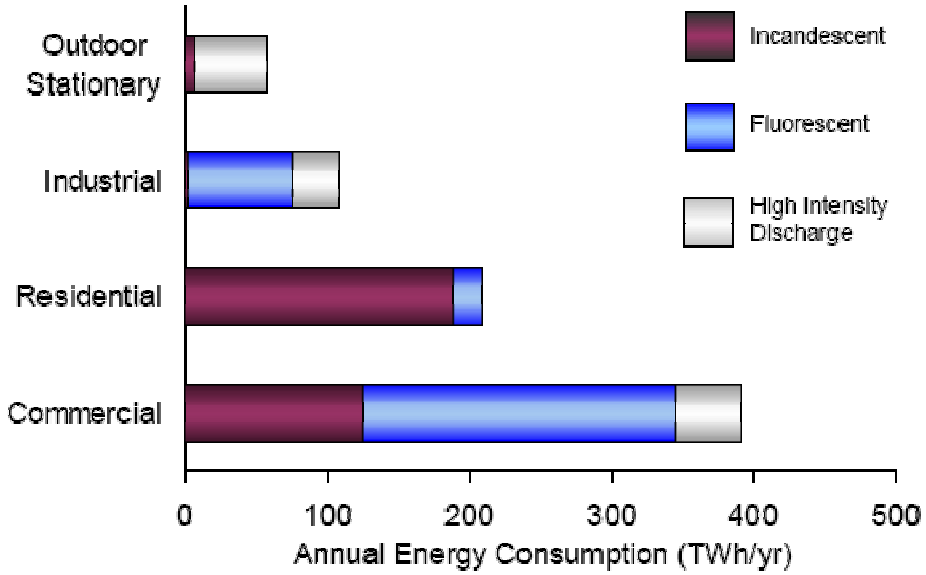
National Lighting Energy Consumption





Lighting Energy Consumption by Major Sector and Light Source Type

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

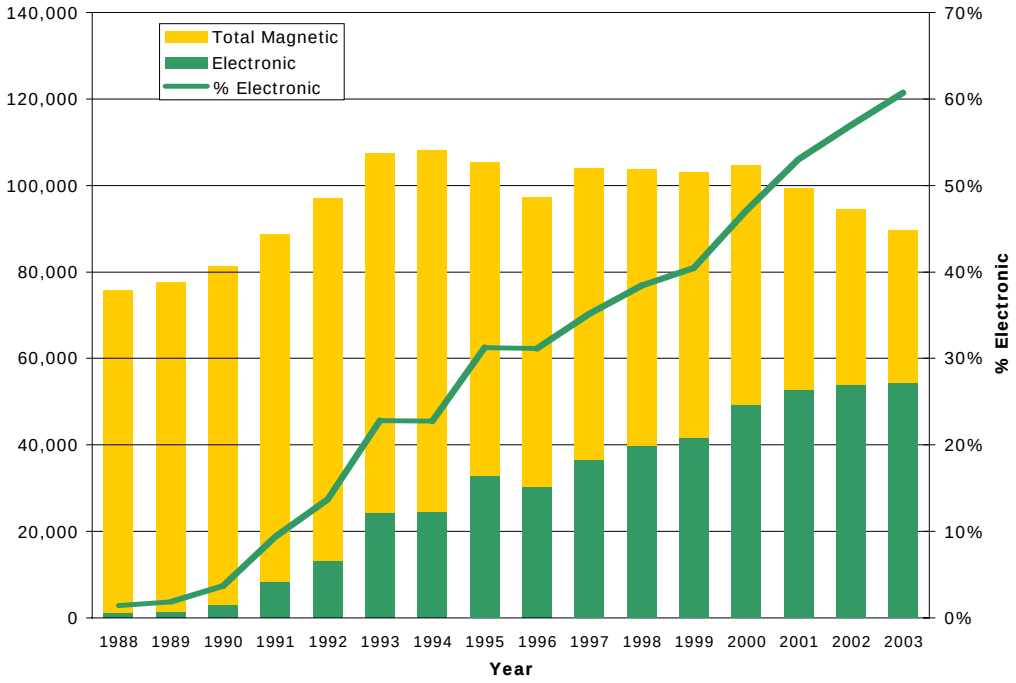


Breakdown of Lighting Energy

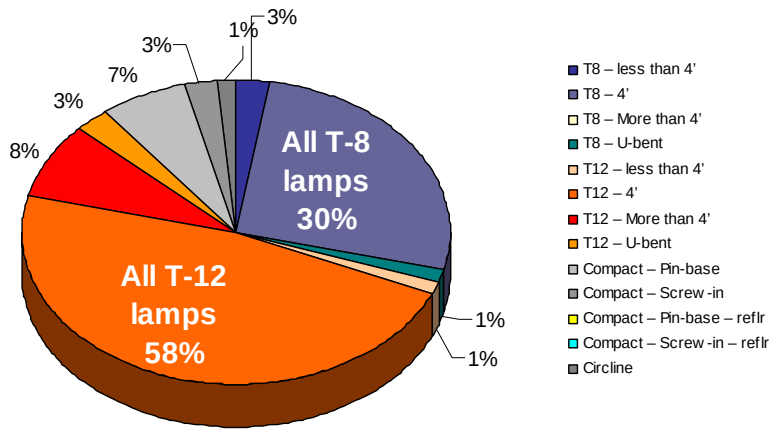
Source: Navigant Consulting, Inc., U.S. Lighting Market Characterization, Volume I: National Lighting Inventory and, Energy Consumption Estimate, Final Report for US DOE, 2002

Impact of Electronic Ballasts and T-8 Fluorescent Lamps on Lighting Consumption

Annual Shipment of Ballasts in US (1988 – 2003)



Fluorescent Lighting in Commercial Buildings (2001)



After 20 years, 50% of US lighting still uses inefficient magnetic ballasts

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

US Bureau of the Census

Controls and Communications

Wired Bus

- Analog (0-10 VDC)
- Digital (DALI)

Lighting ballast industry has selected DALI as its standardized wired digital protocol

Control over Powerline

Powerline Communications

No generally accepted powerline communications scheme

Radio Communications

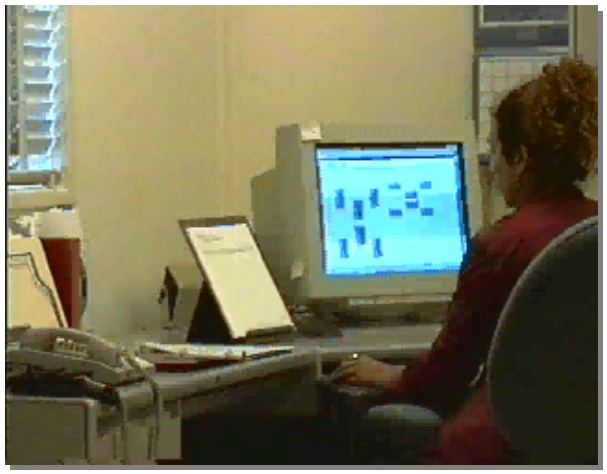
- WiFi
- ZigBee

ZigBee is leading contender for future wireless lighting and building control products

Lighting wastes energy because dimming lighting controls are not widely used

Major Lighting Control Strategies

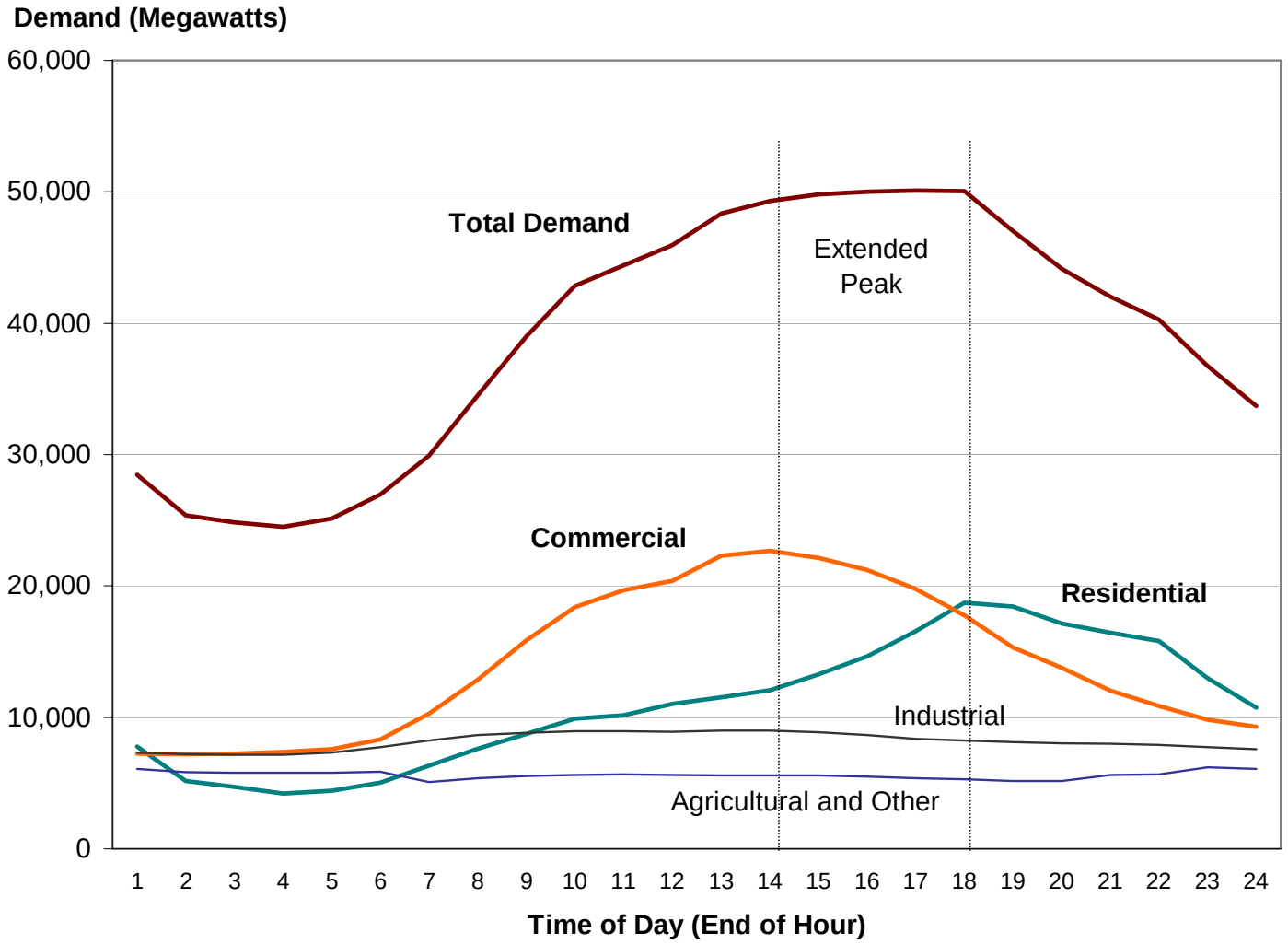
- Vacancy Detection or Scheduling
- Automatic Dimming with Daylight
- Tuning Strategies
  - Personal dimming controls
  - Institutional requirements
- Lumen Maintenance
- Demand Response



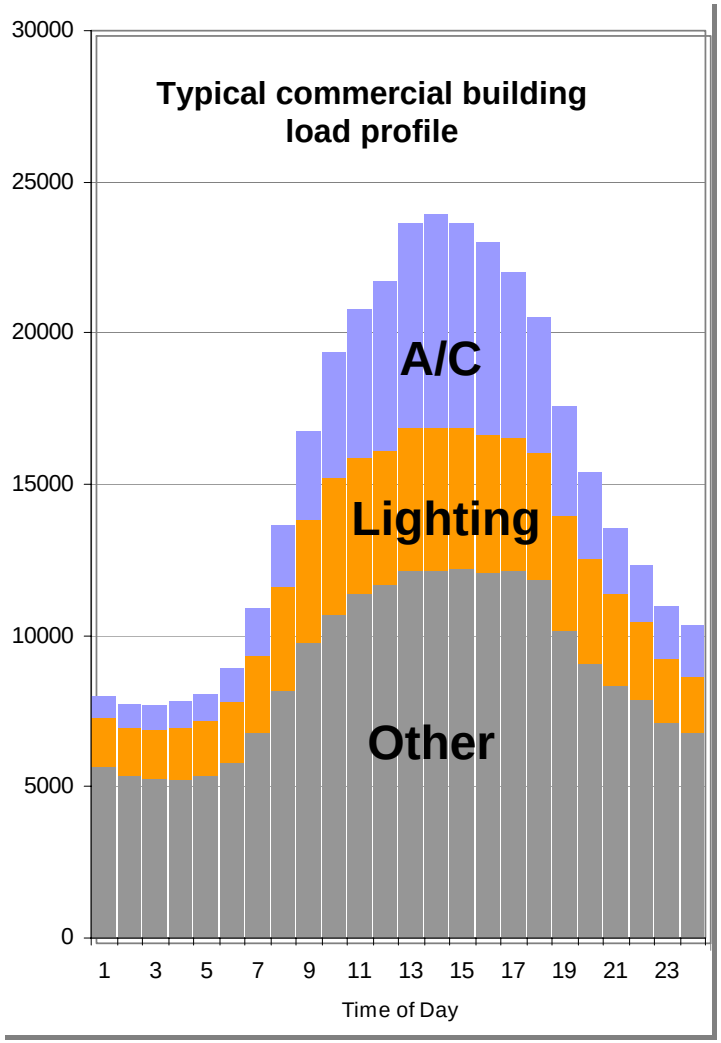
ALL lighting should be:

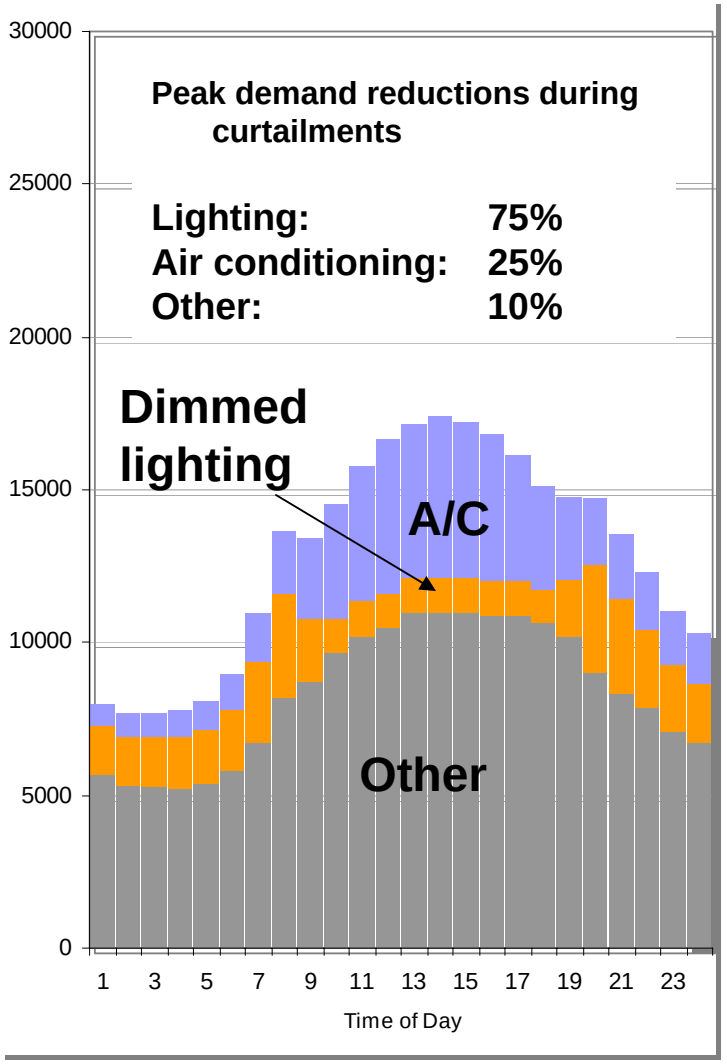
- Dimmable
- Addressable
- Affordable

Electricity Demand in California During 1999 Summer Peak

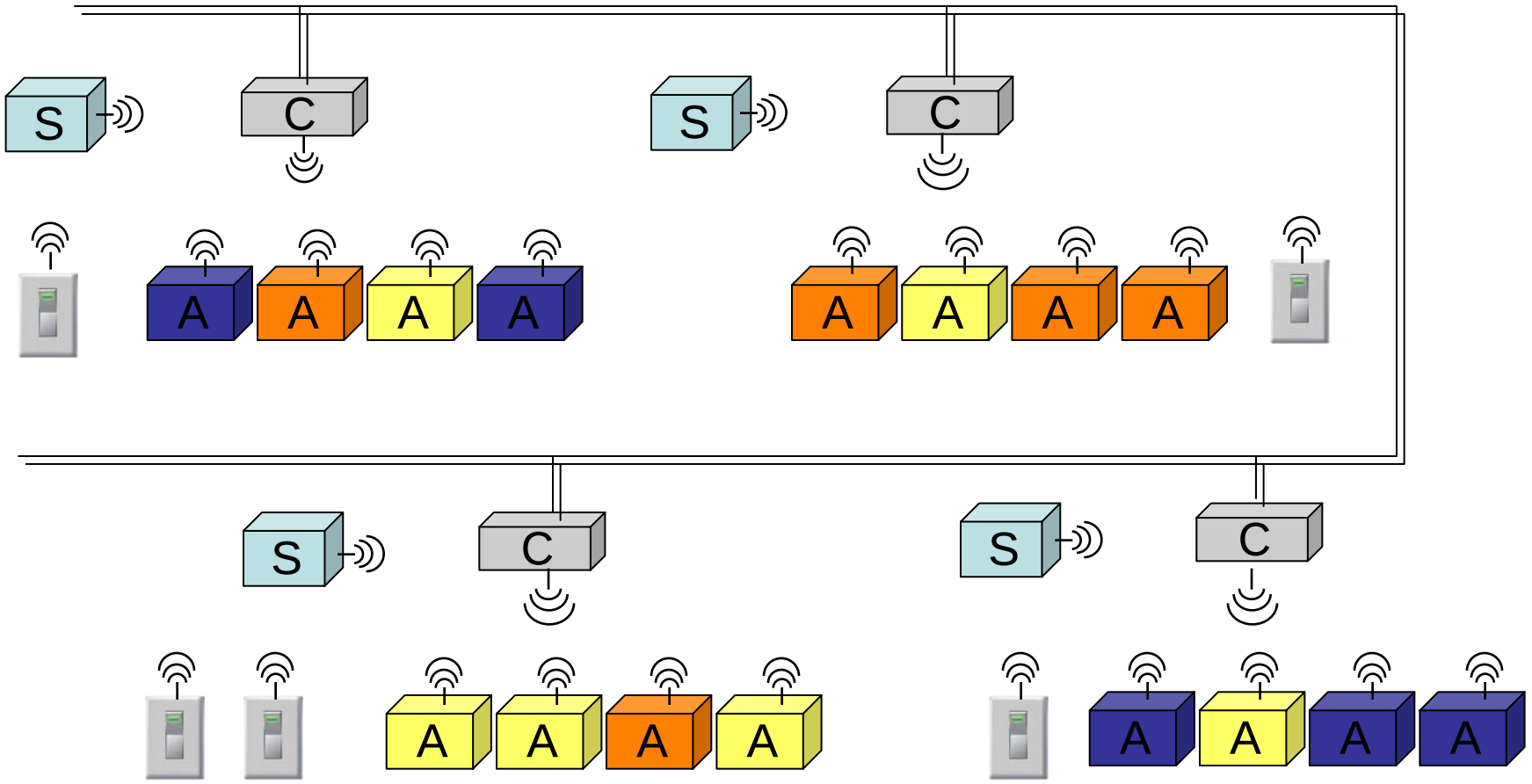


Dimming lighting during curtailments

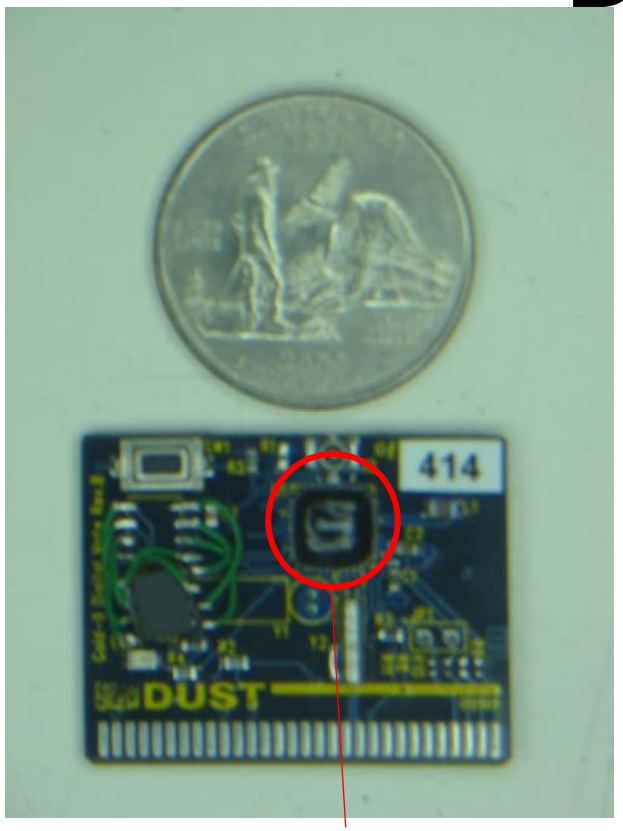




Option 4: Full Wireless

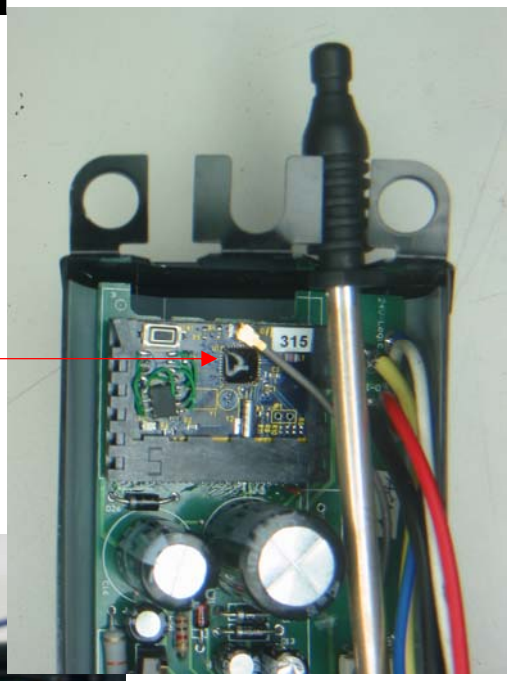


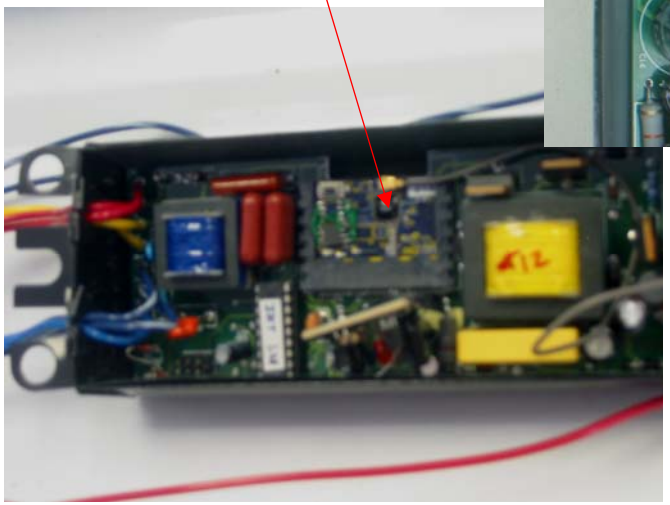
Single Chip Mote Feasibility Demonstrated



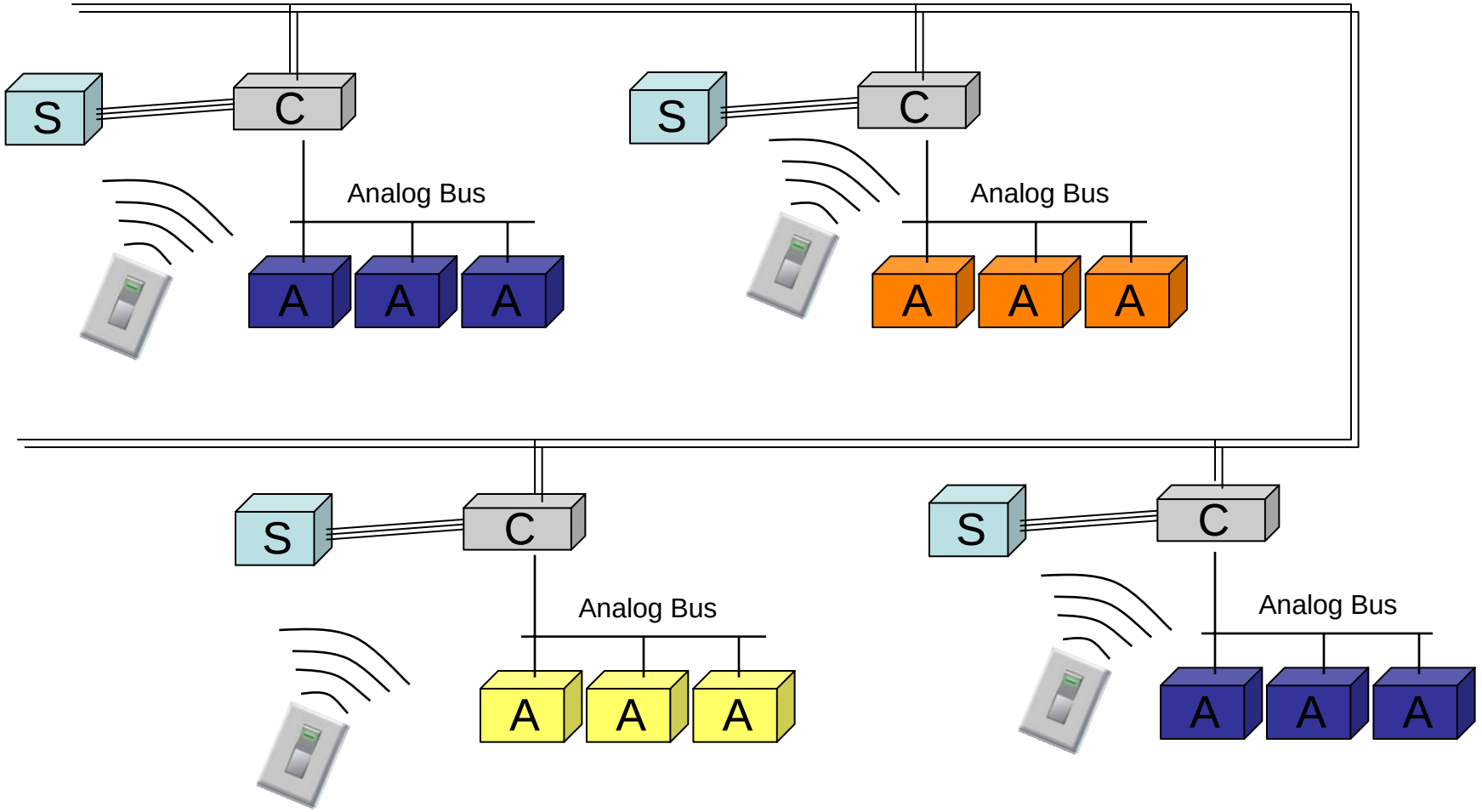
Single Chip mounted to a board for integration with lighting components

Wireless Control by single-chip mote demonstrated in ACM & Ballast

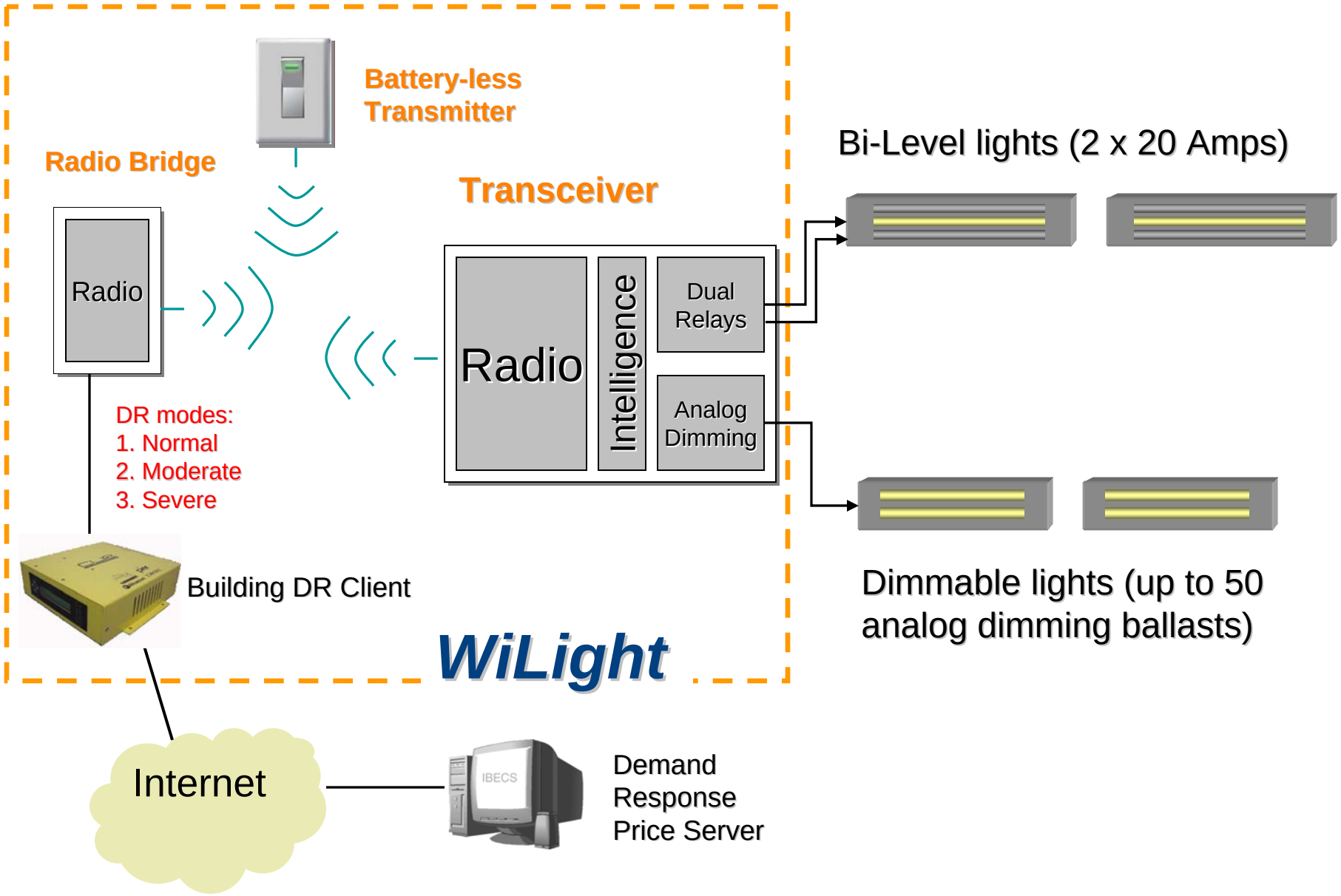




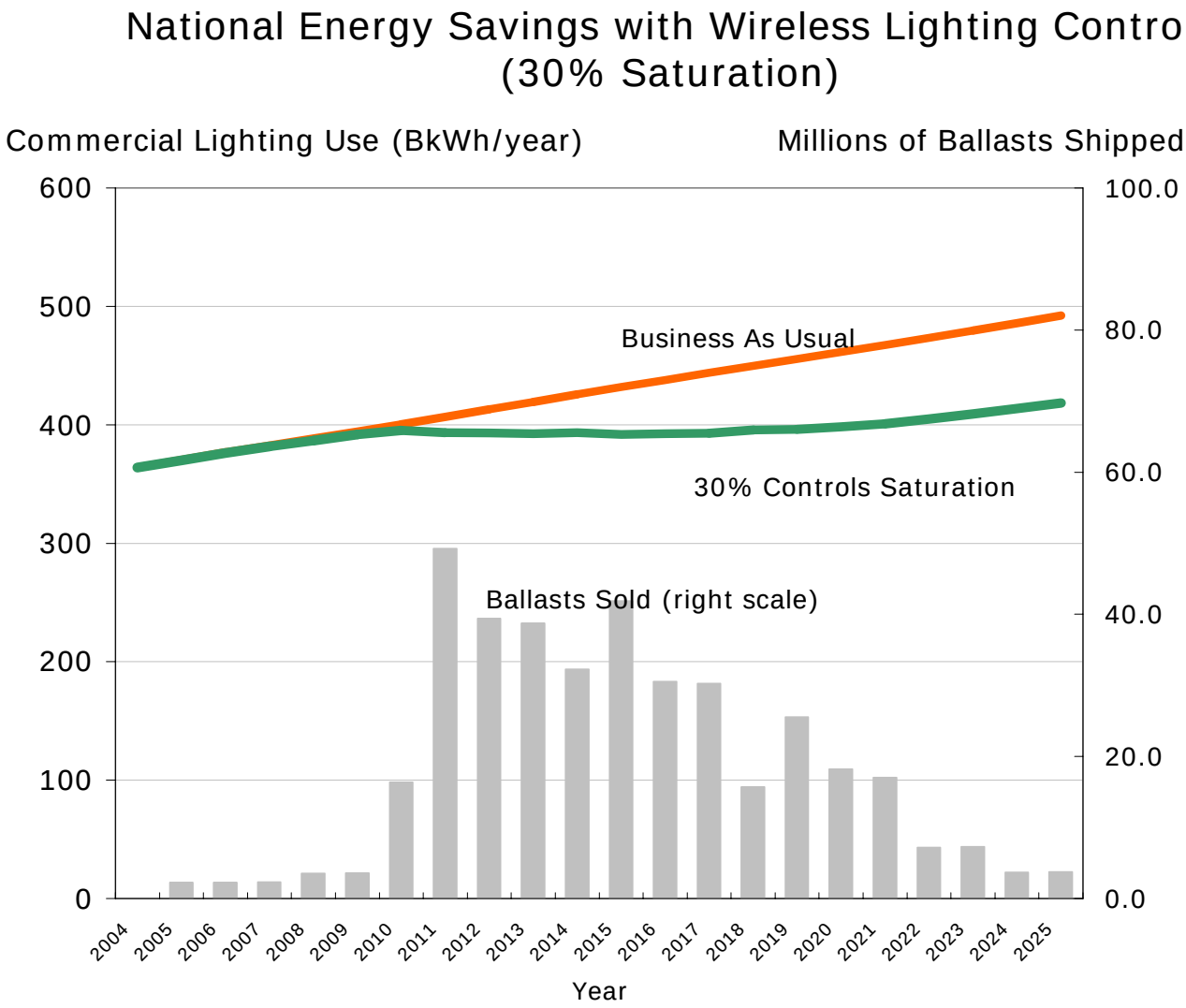
A Hybrid Option: Analog Control (0-10 VDC bus) Accessible with Wireless Transmitters



WiLight: A Novel Application of Energy-Scavenging Wireless Communications



Energy Implications and Economic Impact of Converting to Wireless Lighting Controls



Cumulative Benefits: Installing Wireless Lighting Controls in 30% of Commercial Buildings by 2025

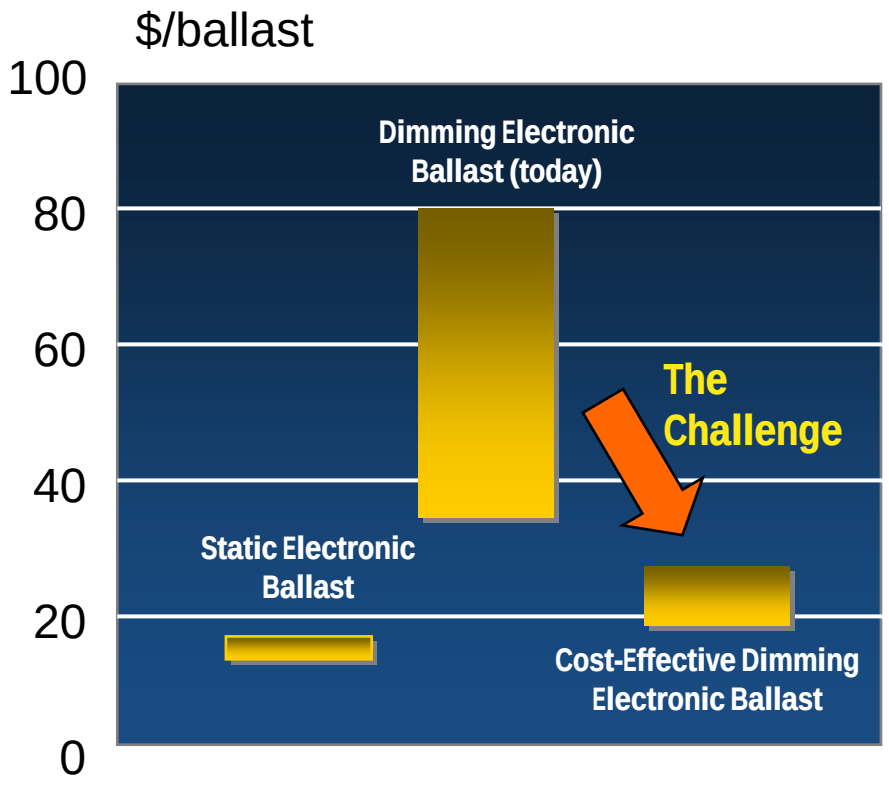
Energy	**695 Billion kWh Energy Saved** **$52 Billion in Energy Cost Savings**
Environmental	**139 MMTCe Carbon Avoided** **Equivalent 93 Million Cars Removed**
Economic & Industrial	**400 Million Dimming Ballasts Sold** **$10 Billion Market Value**

Key Barriers to Advanced Lighting Controls

- Not cost-effective to add control wiring to existing buildings
- Delivering robust lighting control systems is challenge to industry
- *Commissioning* not properly understood
- Dimming inherently more complicated than non-dimming
- Quantifying the energy cost savings from lighting controls is inexact

Challenges Ahead

- Sustainable drop in the cost of dimming



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

Modernizing Our Homes

Old technology

Savings

55 BkWh in Energy
$4 Billion Cost Savings

11 MMT Carbon avoided
7.3 million cars removed

New technologies

Standards for Eliminating the Incandescent Light Bulb

Wattage Limit per Lumen Range *OR*

Lumens per watt per Lumen Range

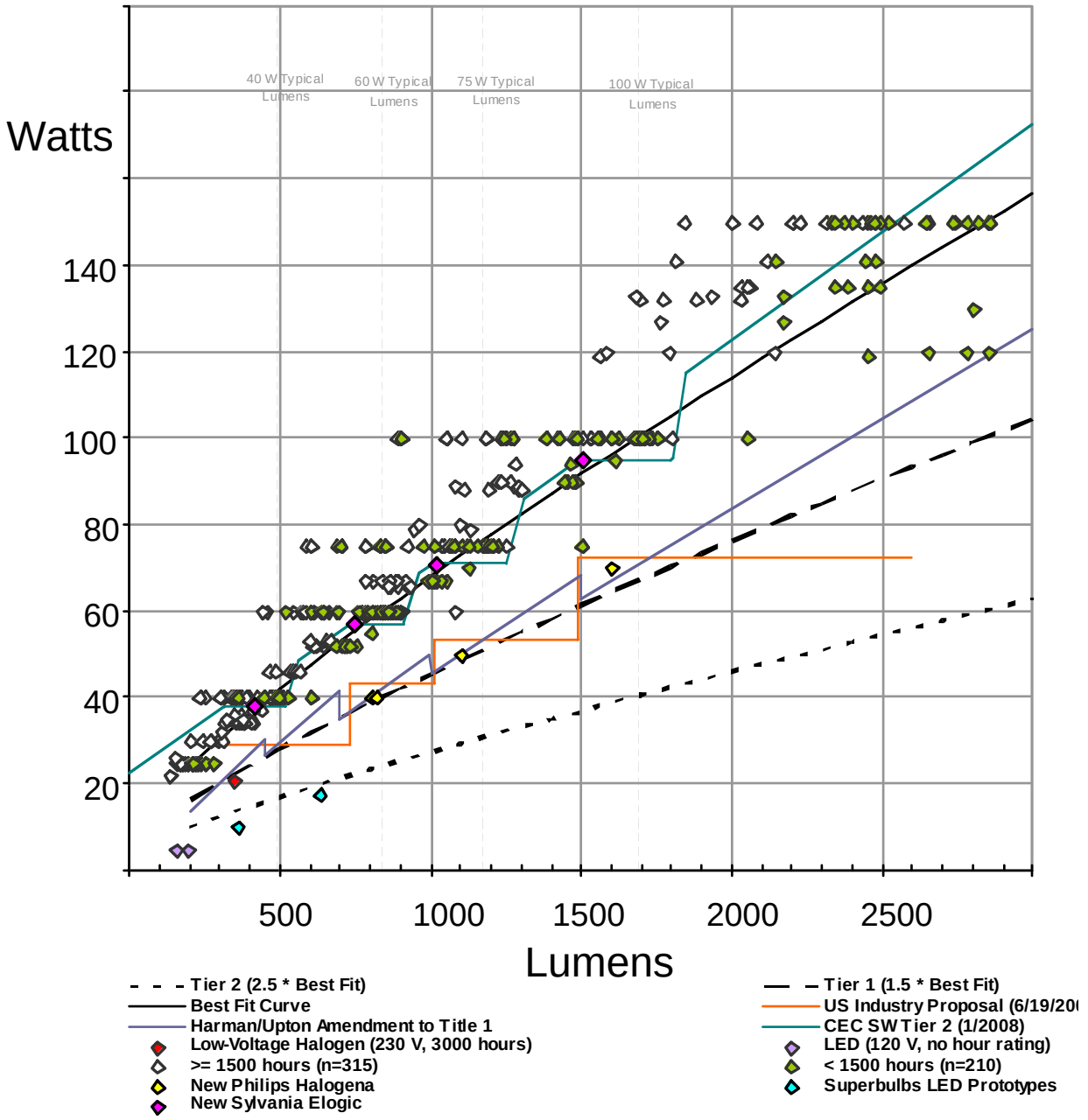
Lumen Ranges: 40, **60**, **75**, **100**, 150 watts

National Implementation Schedule:

1. July 2012: 100 watt

CA only can start early

65 Twh saved annually by 2017



Modernizing Our Nation's Lighting