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

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


Fluorescent Lighting in Commercial Buildings (2001)

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


US Bureau of the Census
Controls and Communications

Wired Bus

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

Control over Powerline

- Powerline Communications

Radio Communications

- WiFi
- ZigBee

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

No generally accepted powerline communications scheme.

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

![Graph showing electricity demand with different categories: Total Demand, Extended Peak, Commercial, Residential, Industrial, Agricultural and Other.](image-url)
Dimming lighting during curtailments

Typical commercial building load profile

Peak demand reductions during curtailments
- Lighting: 75%
- Air conditioning: 25%
- Other: 10%

Dimmed lighting
Single Chip Mote Feasibility Demonstrated

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

Single Chip mounted to a board for integration with lighting components
A Hybrid Option: Analog Control (0-10 VDC bus) Accessible with Wireless Transmitters
WiLight: A Novel Application of Energy-Scavenging Wireless Communications

- Battery-less Transmitter
- Bi-Level lights (2 x 20 Amps)
- Dimmable lights (up to 50 analog dimming ballasts)

Radio Bridge

Radio

DR modes:
1. Normal
2. Moderate
3. Severe

Transceiver

Building DR Client

WiLight

Internet

Demand Response Price Server

WiLight

Radio Bridge
Energy Implications and Economic Impact of Converting to Wireless Lighting Controls

National Energy Savings with Wireless Lighting Controls (30% Saturation)

Commercial Lighting Use (BkWh/year) vs. Millions of Ballasts Shipped

- **Business As Usual**
- **30% Controls Saturation**

Ballasts Sold (right scale)

Year:
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025
**Cumulative Benefits: Installing Wireless Lighting Controls in 30% of Commercial Buildings by 2025**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy</strong></td>
<td>695 Billion kWh Energy Saved</td>
</tr>
<tr>
<td></td>
<td>$52 Billion in Energy Cost Savings</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>139 MMTCe Carbon Avoided</td>
</tr>
<tr>
<td></td>
<td>Equivalent 93 Million Cars Removed</td>
</tr>
<tr>
<td><strong>Economic &amp; Industrial</strong></td>
<td>400 Million Dimming Ballasts Sold</td>
</tr>
<tr>
<td></td>
<td>$10 Billion Market Value</td>
</tr>
</tbody>
</table>
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

New technology

Savings

35 BkWh in Energy
$2.6 Billion Cost Savings

7 MMT Carbon avoided
4.5 million cars removed
Modernizing Our Homes

Old technology

New technologies

Savings

55 BkWh in Energy
$4 Billion Cost Savings

11 MMT Carbon avoided
7.3 million cars removed
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

Billion kilowatt-hours

Roadways
Stores
Homes
Offices

2007
2017

633
513

242
207

251
196

48
38

92
72

500
600
700
800