



Residential  
Lighting  
June 5, 2008



## Session Topics

- Overview of Lighting Technology
- Multi-family Lighting Applications
- Existing Homes Applications
- New Energy Star Homes
- Mercury disposal information
- Emission Reductions

## Why is lighting important?

- Lighting accounts for up to 10% of residential energy costs – roughly \$11 Billion a year in power bills.
- Lighting is the most cost effective and easiest way for home owners to save energy and lower energy bills.
- As energy rates rise across the country, consumers are looking for ways to save that they can do themselves.

## Lighting Technologies

- Linear Fluorescent Lamps (4 foot)
  - Standard T8 Lamp Systems
  - High Performance T8 Systems
  - Lamp and Ballast Combinations
  - Lamp Properties
- Compact Fluorescent Lamps

## Lighting Terms

- Lumen – The amount of light delivered by a lamp. The higher the lumen rating, the greater the light output.
  - What does this mean in terms of lamp selection?
  - Selecting a standard T8 lamp is fine for most applications. If, one needs a little more light or a little less light, select a lamp with a higher or lower lumen rating.

## Lighting Terms

- Ballast factor - is the ratio of the lumens delivered by the ballast to the lumens delivered by the same lamp on a reference ballast.
  - The amount of light produced by a lamp and ballast combination is the lumen rating of the lamp times the ballast factor of the ballast.
  - Example: lamp with 2,800 lumen rating \* ballast factor of 0.88 = 2,464 lumen output.

## Lighting Terms

- Color Rendering Index (CRI) – Measures the ability of a light source to portray the true colors of objects.
  - The CRI scale is from 1 to 100, with 100 being the daylight standard. An incandescent lamp is considered to be close to 100.
- Color Temperature – Is the relative warmth or coolness of the color of the light. Measured in degrees Kelvin. The range is 3,000 to 6,500.

## Characteristics of Common Light Sources

| Light Source         | Efficiency Lumens/watt | Lamp Life     | Color Rendering Index |
|----------------------|------------------------|---------------|-----------------------|
| Incandescent         | 5-20                   | 750-1,000     | 100                   |
| Tungsten-Halogen     | 15-25                  | 2,000-4,000   | 100                   |
| Compact Fluorescent  | 20-55                  | 10,000        | 80-85                 |
| Tubular Fluorescent  | 60-100                 | 15,000-24,000 | 50-90                 |
| Mercury Vapor        | 25-50                  | Up to 24,000  | 15-30                 |
| Metal Halide         | 45-100                 | 10,000-20,000 | 60-90                 |
| High Pressure Sodium | 45-110                 | Up to 24,000  | 9-70                  |

## The Standard T-12 Lamp



T-12 Lamp is 1½ inches in diameter

Industry measures lamps by an eighths of an inch. A T-12 lamp is 12/8s of an inch.

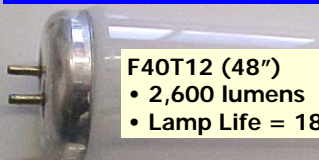
## T8 Lamp Technology



Lighting industry measures lamps by an eighths of an inch. A T8 lamp is 8/8s of an inch.

T8 Lamp is 1 inch in diameter.

## T12 lamps vs T8 lamps



**F40T12 (48")**  
 • 2,600 lumens  
 • Lamp Life = 18,000 hours



**F32T8 (48")**  
 • 2,800 lumens  
 • Lamp Life = up to 36,000 hours

## Ballasts Old & New

Old

Magnetic Ballast (60HZ)  
 • May Contain PCBs



New

Electronic Ballast (20,000HZ)  
 • Lower operating temperature  
 • No PCBs



## Reduce Your Utility Costs

- T-8 Lighting System is 25-40% more efficient than the T-12 Lighting System.
- Converting to a T-8 Lighting System typically has a 3 to 4 year return on investment. That's a 25% or more Return on Investment!



## Benefits of T-8 Lighting Systems

- Uses 25-40% less energy than a standard T-12 system.
- Produces less heat.
- Maintains its light output longer.
- Eliminates lamp flicker.
- Has better color rendering properties. Colors look truer.

## Calculating Energy Savings

### Existing 2-Lamp Lighting System

| Lamps/<br>Fixture | # of<br>Fixtures | Wattage<br>Rating | Divide by<br>1,000 | Operating<br>Hours<br>Hallways<br>24hrs/day | KWH<br>Usage | Operating<br>Cost<br>(9.0 cents/kWh) |
|-------------------|------------------|-------------------|--------------------|---|--------------|--------------------------------------|
| 2                 | 100              | 86                |                    | 8,760                                       | 75,336       | \$6,780                              |

### Retrofitted Lighting System

| Lamps/<br>Fixture | # of<br>Fixtures | Wattage<br>Rating | Divide by<br>1,000 | Operating<br>Hours<br>Hallways<br>24hrs/day | KWH<br>Usage | Operating<br>Cost<br>(9.0 cents/kWh) |
|-------------------|------------------|-------------------|--------------------|---|--------------|--------------------------------------|
| 2                 | 100              | 58                |                    | 8,760                                       | 50,808       | \$4,573                              |

## Calculating Energy Savings

- Old System Utility costs are \$6,762.
- New System Utility costs are \$4,560
- Annual Savings are \$2,202.
- This is a 33% savings. Or, in other words, a 33% return on investment!

## Estimated Costs to Retrofit

| Installation Cost per Fixture         |             |
|---------------------------------------|-------------|
| Ballast, Standard 2-lamp, T-8 Ballast | \$16        |
| Lamps(4ft. T-8 lamps at \$2.50 each)  | \$5         |
| Retrofit Kit                          | \$0         |
| Labor                                 | \$15        |
| Disposal                              | \$5         |
| Overhead & Profit                     | \$10        |
| <b>Total</b>                          | <b>\$51</b> |



**Philips Lighting Energy Advantage 25W T8 Fluorescent Lamp**

The Energy Advantage lamp is a 25 Watt T8 lamp. Draws approximately 7 watts less than a standard 32 watt T8 Lamp. Good choice for overlit areas.

## New Lighting Products



### New 28 watt Four Ft. T-8 Lamp

- Highly efficient T8 lamp and ballast system utilizing the new GE 28W T8 lamp and the GE UltraMax ballast product family.
- Up to 44% reduction in energy consumption.
- CRI > 82.
- TCLP-Compliance may reduce disposal costs.

## New Lighting Products



- 28 Watt, 4-foot SUPERSAVER, T-8 Lamp
- 12.5% Energy Savings over Standard T-8 Lamp
- 82 CRI
- Designed to Pass TCLP test

## High Performance Lamp & Ballast Combinations

- Go to Table in Handout

## Lighting Audit Tools



Ballast Checker by Advance Transformer



Kill A Watt by P3 International

## Lighting Audit Tools



## Why Compact Fluorescents?

- Use ¼ of the energy of an incandescent light.
- Save 75% of client's lighting costs.
- Environmental benefit - less energy used at power plants.
- Wide variety of CFL types afford same/better comfort as incandescent counterparts.
- Reduce cooling requirements.

## Why are CFLs so Efficient?

(Think MPG)



- 60W Incandescent =  $\frac{900 \text{ lumens}}{60\text{W}}$  = 15LPW
- 15W CFL =  $\frac{900 \text{ lumens}}{15\text{W}}$  = 60LPW

## Cost Comparison - Incandescent vs CFL

| Bulb Type           | Wattage | Bulb Cost | Annual Energy Cost | Total Cost 1 Year | Total cost 2 years | Total cost 4 years |
|---------------------|---------|-----------|--------------------|-------------------|--------------------|--------------------|
| Incandescent        | 60      | \$0.50    | \$6.57             | \$7.07            | \$13.64            | \$26.78            |
| Compact Fluorescent | 15      | \$3.00    | \$1.64             | \$4.64            | \$6.28             | \$9.56             |
| Savings             | 45      | n/a       | \$4.93             | \$2.43            | \$7.36             | \$17.22            |

Assumptions: 3 hours a day every day and 10 cents a kwh

## Tips on Shopping for CFLs

- CFLS available in 2700K CCT (“soft white”) – same as an incandescent.
- CFLS also available in higher CCT (“daylight”), giving you more light. (3,000, 3,100 & 3,500)
- You can up the CCT without upping the wattage.
- Even if you up the wattage, you are still saving 75% than its incandescent counterpart.

## Bulb Disposal & Mercury

Fluorescent tubes & CFLS account for 1% of mercury (Hg) released in to the US annually. 87% of US emissions are from coal burning power plants & incinerators. Energy savings from CFLS results in a net reduction of Hg releases through less coal use.

Check with your local solid waste agency for proper disposal suggestions.

[www.earth911.org](http://www.earth911.org)

[www.lamprecycle.org](http://www.lamprecycle.org)

## US EPA Energy Star Fact Sheet on CFLs and Mercury

[http://www.energystar.gov/ia/partners/promotions/change\\_light/downloads/Fact\\_Sheet\\_Mercury.pdf](http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf)

## Mercury Disposal Information

- Go to Handout

## Multi-Family Housing Applications

- Kitchen light fixtures
- Bathroom light fixtures (existing homes)
- Hallway fixtures
- Exterior lighting

## Two lamp T12 Wrap Around

Kitchen Fixture



Typically, this fixture over a kitchen oven has a 15, 25 or 40 watt incandescent lamp.



Compact Fluorescent lamp in a kitchen light fixture (7 to 13 watts). It can also double as an efficient night light.

## Recessed Fixtures

- Convert to Compact Fluorescent Lamps



Incandescent bulbs can be replaced with compact fluorescent lamps.

## Compact Fluorescent Lamps

- 20 Watt Compact Fluorescent Lamp produces the same amount of light as a 60 Watt Incandescent Lamp



## Compact Fluorescent Globe



## What's Wrong Here?



## Better Solution



## Convert Exit Signs to LEDs



\* Operating cost is based on \$0.10 per kWh

Advice: Buy new sign instead of retrofitting old.  
Bonus, new battery backup.



### LED Exit Sign



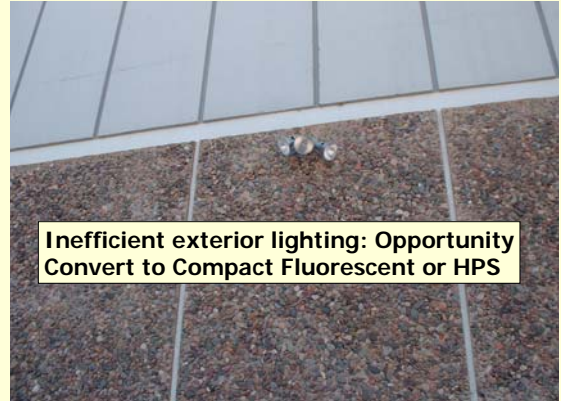
### Green means Go!



### Parking Canopies Long Hours of Operation



Inefficient exterior lighting: Opportunity  
Convert to Compact Fluorescent or HPS



Inefficient exterior lighting: Opportunity  
Convert to Compact Fluorescent or HPS



### Existing Homes

- Kitchen Fixtures
- Bathroom fixtures
- Table Lamps



American Fluorescent close-to-ceiling fixture



Good Earth ceiling fixture



Montclair Four-Lamp Wall/Bath



Jasco ceiling fixture

### Bathroom light bar with CFLs



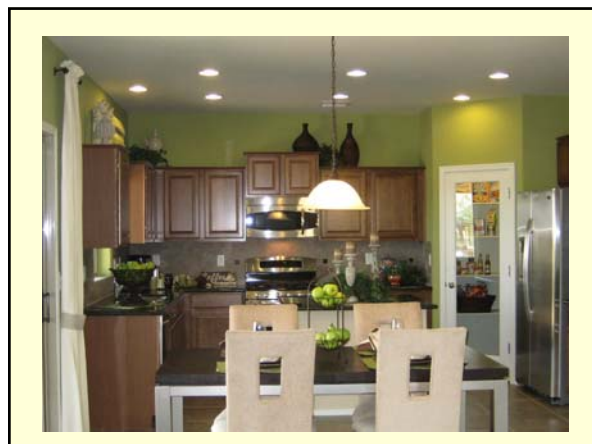
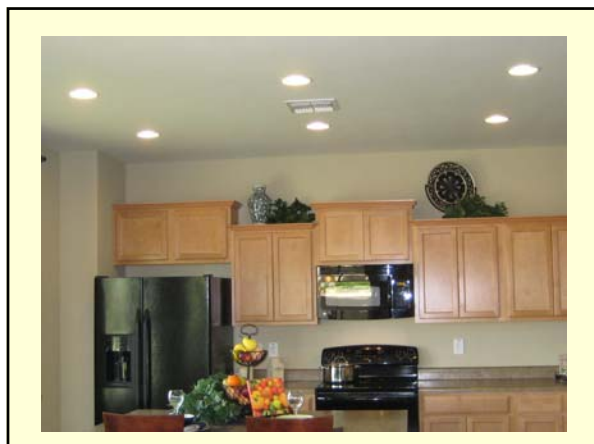
### More CFLs



### ENERGY STAR Qualified Homes

- Energy Star Requirement:
  - Five or more ENERGY STAR qualified appliances, light fixtures, ceiling fans equipped with lighting fixtures, and/or ventilation fans.
    - ENERGY STAR qualified lighting fixtures shall not be counted if installed in storage rooms (closets, pantries, sheds), or garages.

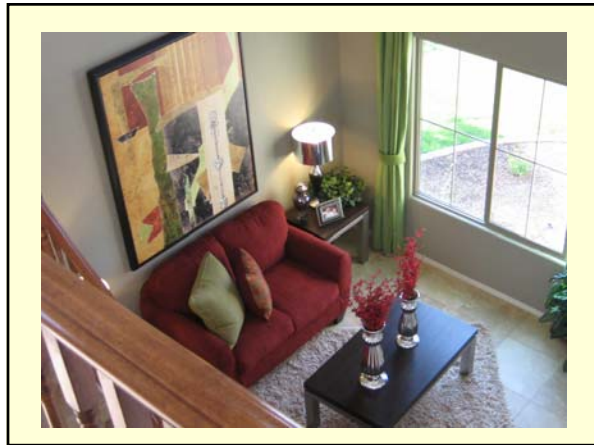
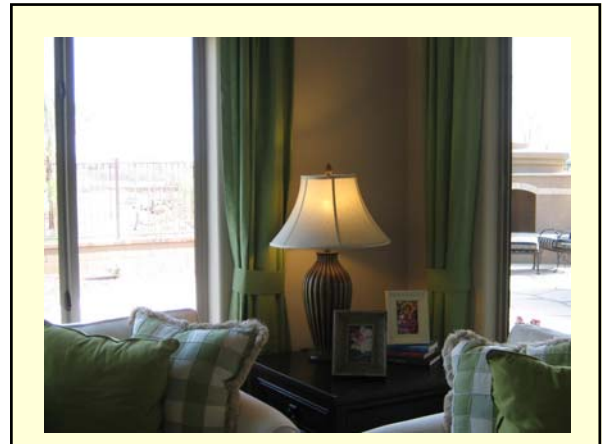
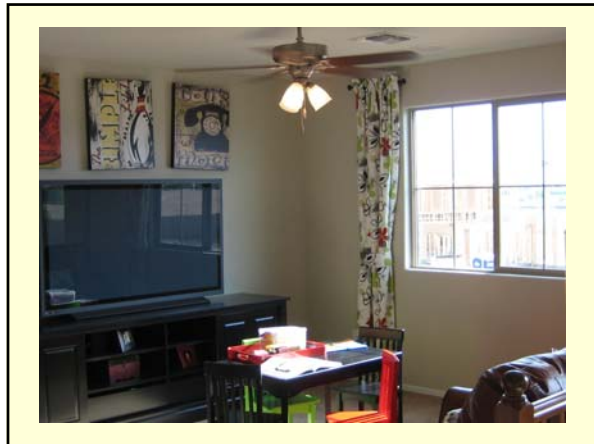


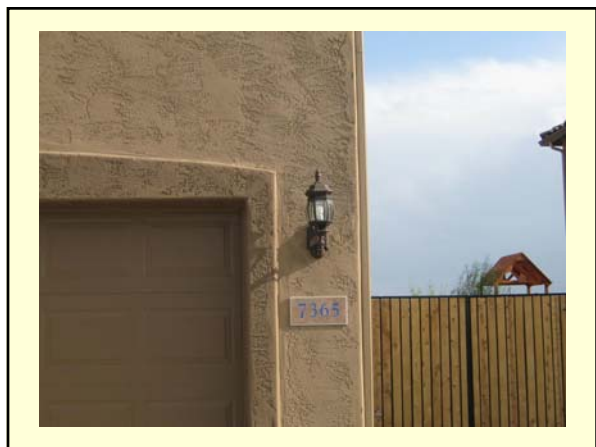


### Insulated Contact Rated Cans

- It is not always enough to be IC Rated.
  - For cold climates, it is also very important to have an airtight rating for the can to avoid moisture problems in the ceiling.
  - For hot, dry climates, still important to have an airtight can to avoid air traveling between conditioned and unconditioned spaces.
  - Do not plug holes on cans, it can void the safety rating. See Handout from IECC.







Thank you!  
Contact information:

- Jim Westberg
  - Energy Office
  - Arizona Department of Commerce
- [jimw@azcommerce.com](mailto:jimw@azcommerce.com)  
602-771-1145

## Calculating Emission Reductions



## Session Questions

- What is a Carbon Footprint?
- How is it Calculated?
- What's Happening?
- What Can you Do?



## Carbon Footprint Defined

- A carbon footprint is the total amount of CO<sub>2</sub> and other greenhouse gases, emitted over the full life cycle of a product or service. It is expressed as grams of CO<sub>2</sub> equivalents.
- So, What does this Mean?



## Carbon Footprint - Individual

- What you do and what you use adds up to the amount of carbon dioxide - a greenhouse gas - you create.
- Do you drive? What do you drive? How much do you drive?
- Other travel – air travel, by bus, by train
- Where you live – How energy efficient is your home? How large? How many people?
- Products you buy – how far do they travel?



## Emissions & Generation Resource Integrated Database (eGRID)

- eGRID is a comprehensive inventory of environmental attributes of electric power systems.
- Based on available plant-specific data for all U.S. electricity generating plants
- Contains air emissions data for nitrogen oxides, sulfur dioxide, carbon dioxide, and mercury
- <http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html>

## Average Power Plant Emissions for Arizona

|         | State annual CO <sub>2</sub> output emission rate (lb/MWh) | State annual SO <sub>2</sub> output emission rate (lb/MWh) | State annual NO <sub>x</sub> output emission rate (lb/MWh) | State annual mercury output emission rate (lb/GWh) |
|---------|--|--|--|--|
| Arizona | 1218.9   | 1.232  | 1.77   | 0.0143   |
|         | State annual CO <sub>2</sub> output emission rate (lb/kWh) | State annual SO <sub>2</sub> output emission rate (lb/kWh) | State annual NO <sub>x</sub> output emission rate (lb/kWh) | State annual mercury output emission rate (lb/MWh) |
| Arizona | 1.2189   | 0.00123  | 0.00177  | 0.0000143  |

## Compact Fluorescent Example

- Scenario: Implement plan for facility wide replacing of 10 units of 60 watt incandescent lamps with 15 watt CFL lamps.
- Assume:
  - 4 hours of use daily (no change in use)
  - Emissions calculated on an annual basis
  - Investment in higher upfront cost EE measures would not have otherwise occurred
  - Using eGRID average emission factor for Arizona

## Compact Fluorescent Example

- Emissions Impact:
  - 365 days x 4 hrs/day = 1,460 hours per year
  - 1,460 hours x 45w (watt savings/lamp/hr) = 65,700 watt-hours/year
  - Convert to kWh: 65,700 / 1,000 = 65.7 kWh/year
  - 65.7 kWh/year x 10 lamps = 657 kWh saving
  - 657 kWh x 1.218 lb CO<sub>2</sub>/kWh = 800 lbs of CO<sub>2</sub>

## Summary

- Change ten 60 watt incandescent lamps to ten 15 watt compact fluorescent lamps
- Operate 4 hours/day 365 a year
- Result is reduction of 800 lbs CO<sub>2</sub>.
- 800 lbs CO<sub>2</sub> equivalent to:
  - 9.3 trees
  - 0.044 homes
  - 0.047 cars

## Emissions of Energy Resources

| Energy Resource | Unit of Energy | Lbs. CO <sub>2</sub> | Source of calculation   |
|-----------------|----------------|----------------------|---|
| Natural Gas     | 1 therm        | 11.7 lbs per therm   | <a href="http://www.naturalgas.org/environment/naturalgas.asp">http://www.naturalgas.org/environment/naturalgas.asp</a>             |
| Propane         | 1 gallon       | 12.7 lbs. per gallon | <a href="http://www.climatetrust.org/solicitations_2007_Metrics.php">http://www.climatetrust.org/solicitations_2007_Metrics.php</a> |
| Gasoline        | 1 gallon       | 19.6 lbs. per gallon | <a href="http://www.climatetrust.org/solicitations_2007_Metrics.php">http://www.climatetrust.org/solicitations_2007_Metrics.php</a> |
|                 |                |                      |   |

## Greenhouse Gas Equivalencies Calculator

- EPA's Clean Energy Home Page
  - <http://www.epa.gov/cleanenergy/index.html>
- EPA's Energy Resources Calculator
  - <http://www.epa.gov/cleanenergy/energy-resources/calculator.html>

## Emission Reduction Equivalents

| Energy reduction | CO <sub>2</sub> Emissions Reductions | Approximate Equivalents   |
|------------------|--------------------------------------|---------------------------|
| 10,000 kwh       | 17,140 lbs.                          | Electricity for 1 home/yr |
| 10,000 kwh       | 17,140 lbs.                          | Energy use 0.69 home/yr   |
| 10,000 kwh       | 17,140 lbs.                          | 882 gallons gasoline      |
| 10,000 kwh       | 17,140 lbs.                          | 199 trees                 |
| 10,000 kwh       | 17,140 lbs.                          | 1.4 passenger vehicles    |
| 1,000 therms     | 11,023 lbs.                          | 0.92 passenger vehicles   |
| 1,000 therms     | 11,023 lbs.                          | 128 trees                 |

Using National Emissions Rates, not an individual state rate.

Thank you!  
Contact information:

- Jim Westberg
- Energy Office
- Arizona Department of Commerce
  - [jimw@azcommerce.com](mailto:jimw@azcommerce.com)
  - 602-771-1145