A Preview of New and Emerging Efficient Technologies

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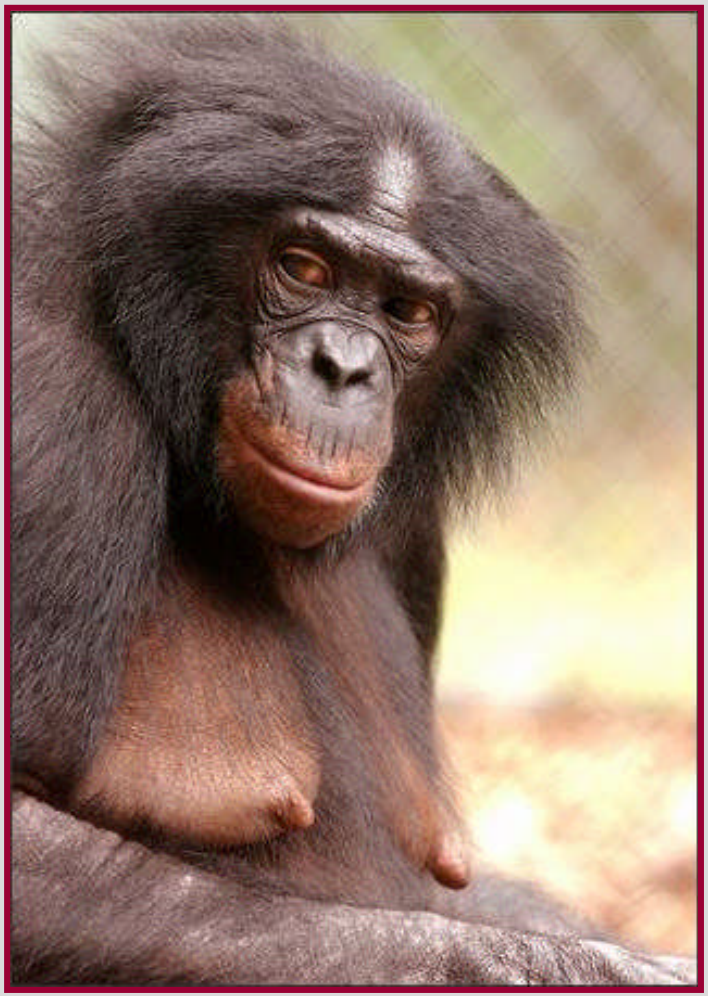
Battelle

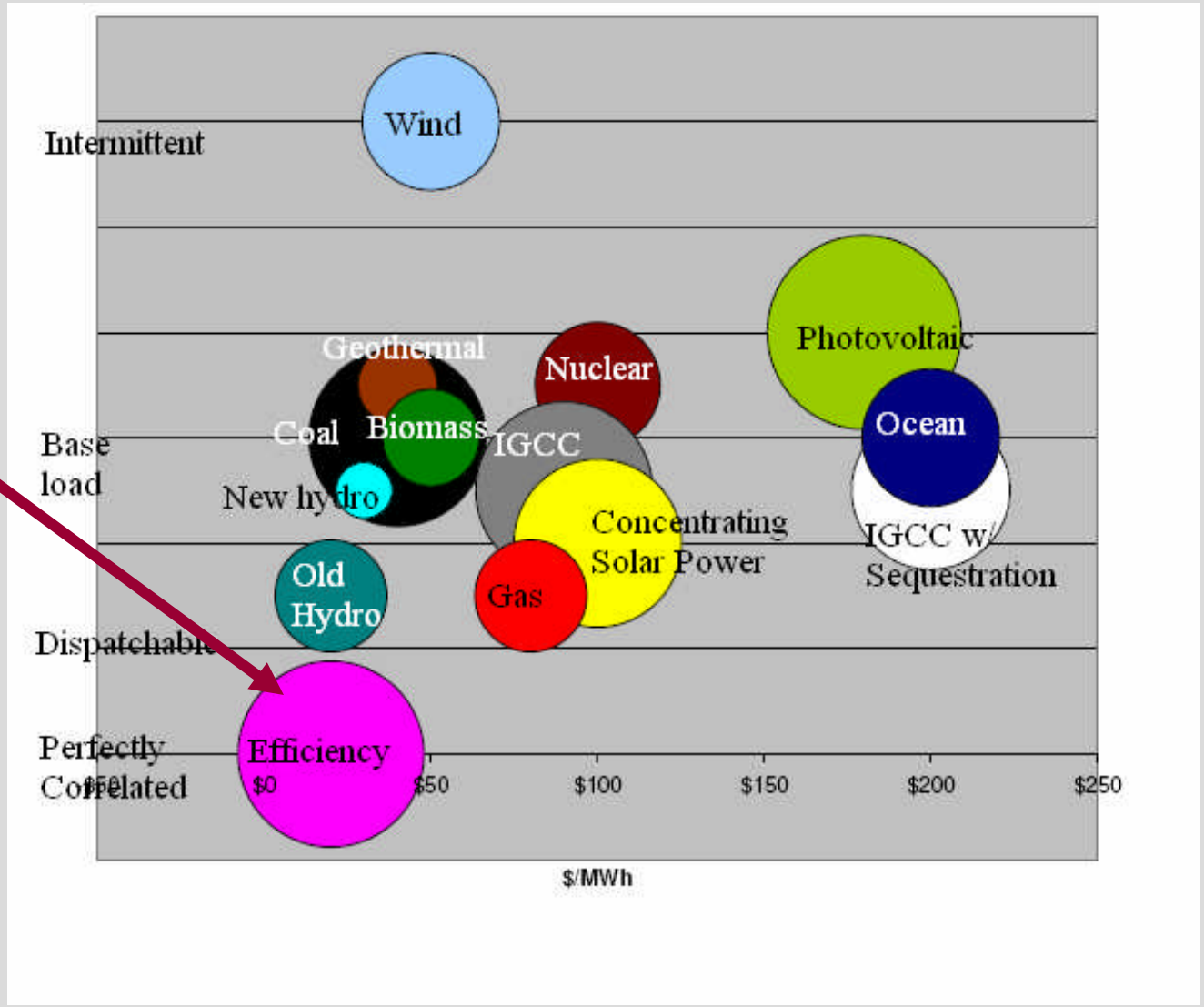
Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Focus of Presentation

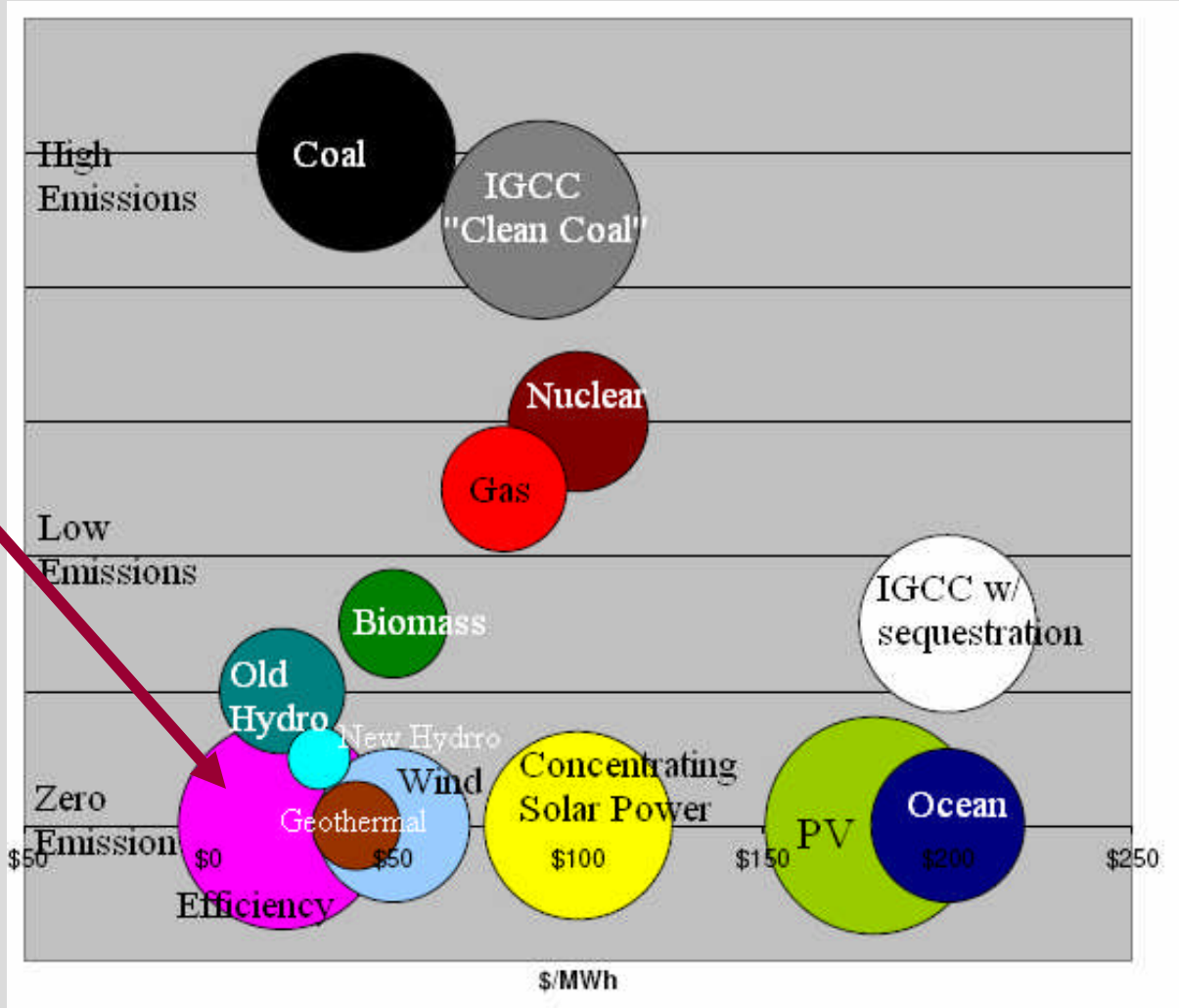
- Energy Efficiency
- HVAC & Appliances
- Lighting
- Watch Out!



Electricity Supply Availability and Costs



Electricity Supply Costs and Emissions



International Energy Agency (IEA) on Energy Efficiency

"Using energy-efficient equipment is the most cost-effective short-term path to greater energy security and lower greenhouse gas emissions to combat climate change. It reduces pressure on energy resources".

April 1, 2008. IEA Implementing Agreement for a Co-operating Programme on Efficient Electrical End-Use Equipment. www.iea-4e.org

Many Utilities are Rediscovering Energy Efficiency

Puget Sound Energy finds creative ways to manage load growth

New demand the size of Seattle to be added

Puget Sound Energy is launching new energy efficiency offerings and added incentives to help customers conserve power and natural gas.
Restructuring Today, April 3, 2008

EEI, EPRI believe efficiency could offset 7-11% of needed generation

Better energy efficiency in the power industry could cut the need for new generation by an extra 7% to 11% over the next 20-years
Electric Power Research Institute (EPRI) and the Edison Electric Institute (EEI) during an Edison Foundation conference, Keeping the Lights On: Our National Challenge

Nationwide Energy Efficiency - 2006

- 63 million MWh saved
  - Enough to power 5,000,000 homes for a year.
- 27,000 MW saved
  - Approximately 50 average-sized (500 MW) coal-fired power plants
- Energy efficiency programs costs were ~$1.2 billion
  - Average cost for energy efficiency: 2 cents/kWh
- Load management programs costs were $666 million

Source: www.eia.doe.gov

“Clean” Generation Options Can Sometimes Be a Bit “Messy”!

HVAC and Appliances

Magnetic Bearing High-Performance Electric Chiller

- **Turbocor** 80 ton chiller compressor
  - Oil-free magnetic bearings
  - Integral variable-frequency drive and micro-processor
  - First introduced as “new and emerging” in ~2004!
- Navy Techval Program demonstration has found simple pay backs between 4 and 8 years.
- 40% to 65% energy savings.
  - Example: San Diego 1.03kW/ton existing recip. vs. 0.55 kW/ton Tubrocore (~$180K installed cost)
- A cost-effective retrofit for a reciprocating chiller
  - Where electric rates are high
  - Where there is year round cooling load
- Carrier now offering a Turbocore compressor option.

Turbocore Chiller

80 ton Turbocor chiller compressor with magnetic bearings

Building HVAC Technology Option Set (TOS)

Option set evaluated for DOE Commercial Buildings Program. The set included:

- Peak-load shifting by means of active or passive thermal energy storage (TES).
- Dedicated outdoor air supply with enthalpy heat recovery from exhaust air.
- Radiant heating and cooling panels or floor system.
- Low-lift vapor compression cooling equipment.
- Advanced controls at the HVAC equipment and HVAC system (supervisory) levels.

Building HVAC Technology Option Set

Option set simulated in 3 medium-sized office buildings (new construction) in 5 climate zones.

- Technical HVAC energy savings potential of the option set ranges from 60% to 74% for temperate to hot and humid climates
- Energy savings of 30% to 70% in milder climates.
- The savings are calculated as a difference between the annual energy use (chiller, fans and pumps) for a building with a conventional HVAC system (VS fans and chiller) and the annual energy use for the same building with equipment and controls of the option set.
- Complete results can be found at http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17157.pdf (12/07)

GE “Hybrid Electric" Water Heater
[aka Heat Pump Water Heater]

- Water heater first uses a heat pump to bring the water up to the temperature of the ambient air. Then the electric water heater takes over, bringing the water up to 140°F.
- GE claims 50% more efficient than standard electric water heaters. A same size water heater uses ~4800 kWh/yr; the new GE water heater will use ~2300 kWh/yr.
- Because the new device uses a heat exchanger, it will make your furnace work harder during the winter. But in the summer, and in warm climates, it will actually help cool your house!

Dyson Airblade Hand-dryer

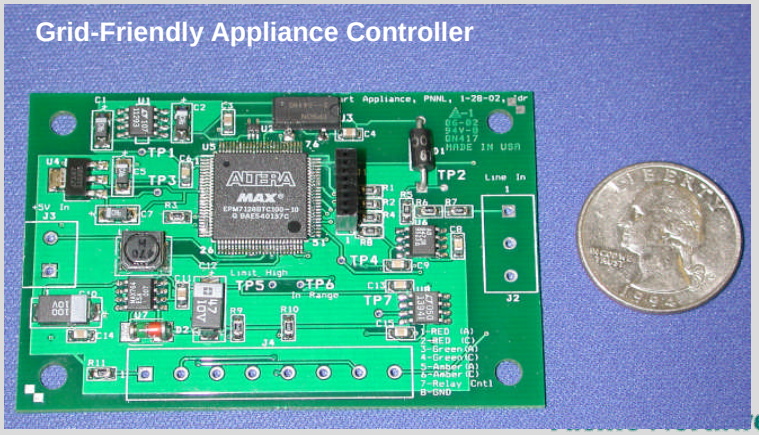
- Many people dislike air dryers because they are slow, noisy and power-sucking.
- Paper towels are an ongoing source of waste.
- The Dyson *Airblade* is up to 80% more efficient than conventional air dryers, using a fast (400 mph), thin (0.3mm) sheet of air to dry hands in about 12 seconds.
- Air is NOT heated but instead “wipes” water away.

http://www.dysonairblade.com/

Grid Friendly™ Appliance Controller

- Credit card-sized chip installed in appliances at factory
- Chip continually monitors power grid; when event-level fluctuations identified, appliance temporarily shut down for brief period (seconds to minutes) – with no inconvenience to consumer – until the grid stabilizes.
- Installed cost is ~$25/appliance
- Demonstration in Western Washington just completed.

www.gridwise.pnl.gov

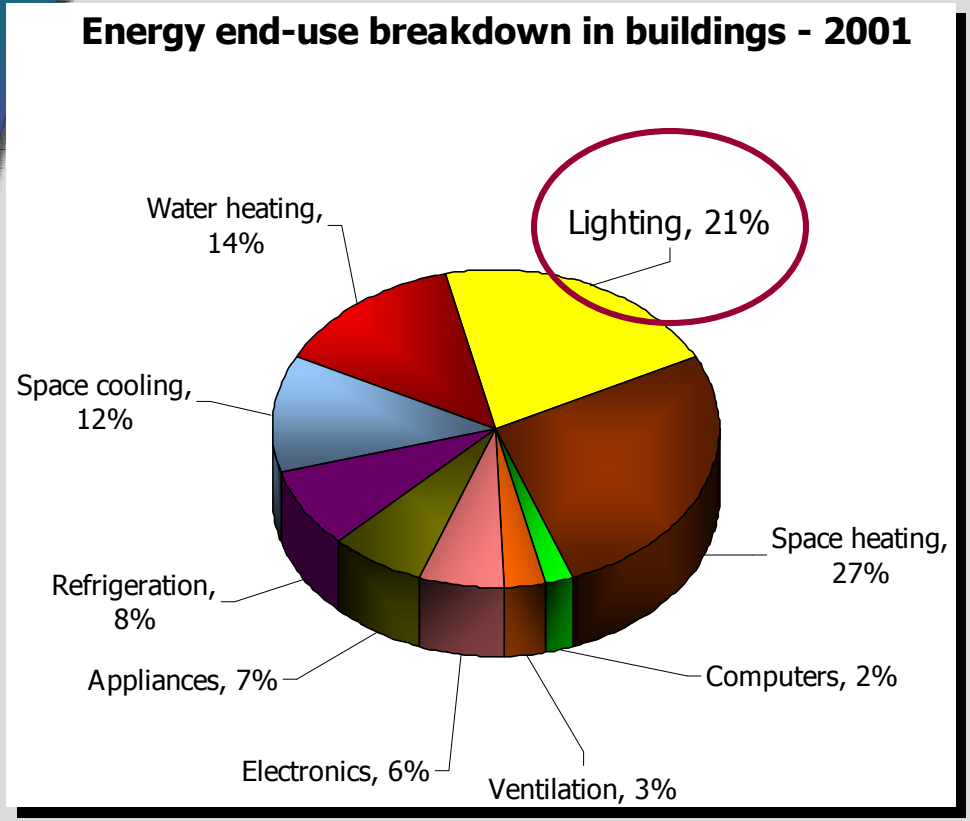


Commercial Front-Load Washer

- Whirlpool/Maytag is replacing the venerable MAH21 commercial machine with the ‘MAH22’.
- Whirlpool/Maytag indicates this new machine will meet *CEE Tier 3*, but no formal submittal to CEE has taken place.
- Awaiting confirmation……

Lighting Technologies

Why Focus on Lighting?



U.S. DOE 2003 Program Core Databook

- Lighting is 21% of all energy used in buildings
- Lighting % continues to increase
- Lighting contributes significantly to electric demand
- Significant savings potential in efficiency lighting technologies

CFL Screw-in Reflector (R) Lamp
DOE Procurement

- The purpose of this project is to increase the availability and use of highly energy-efficient reflector compact fluorescent lamps (R-CFLs) for use in insulated ceiling rated airtight (ICAT) fixtures. Specifically, the procurement calls for R-CFLs that are:
  - Short enough to fit into recessed downlight fixtures
  - Deliver adequate light with a beam spread that is similar to equivalent wide flood-type incandescent R-lamps
  - Maintain light output levels and life span in high-temperature environment
  - ENERGY STAR compliant
  - Available at an affordable price

CFL Screw-in Reflector (R) Lamp
DOE Technology Procurement Project

Current Reflector Lamp Products Available

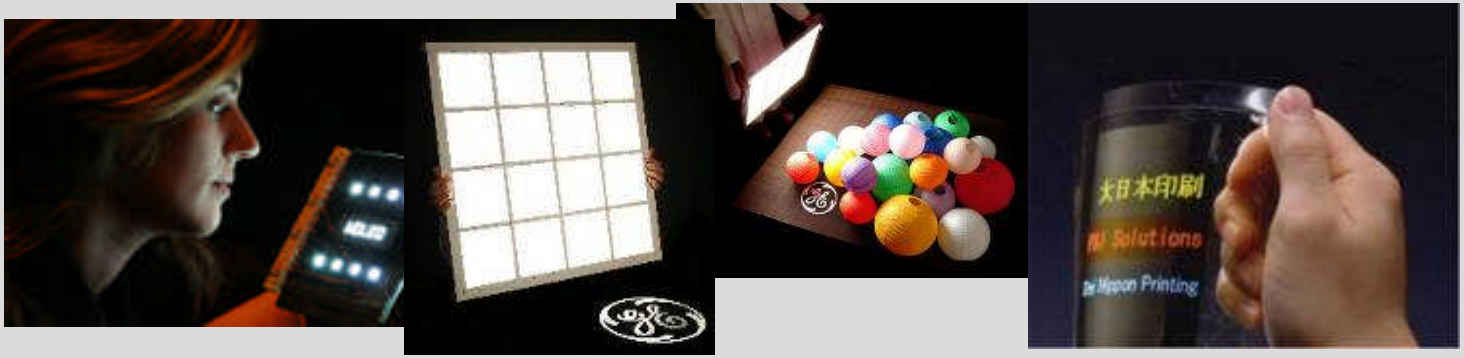
- 4 manufacturers (GE/Feit/Philips/Sylvania)
- R30, BR30 and PAR38 sizes
- 15 – 26 Watts with 630 – 1300 lumens
- 6,000 – 10,000 rated life
- 1 dimmable product (GE 15 Watt)
- Available at several retail and internet stores.

Project has concluded unless picked up by a consortium desiring additional products (such as additional dimming products).

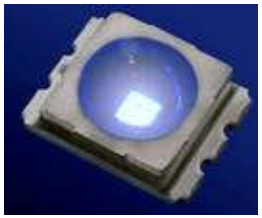
www.pnl.gov/rlamps

Solid State Lighting (SSL)

Organic Light Emitting Diodes (OLEDs)



Light Emitting Diodes (LEDs)



©Cree

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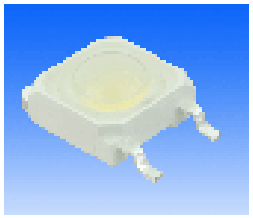


©Nichia

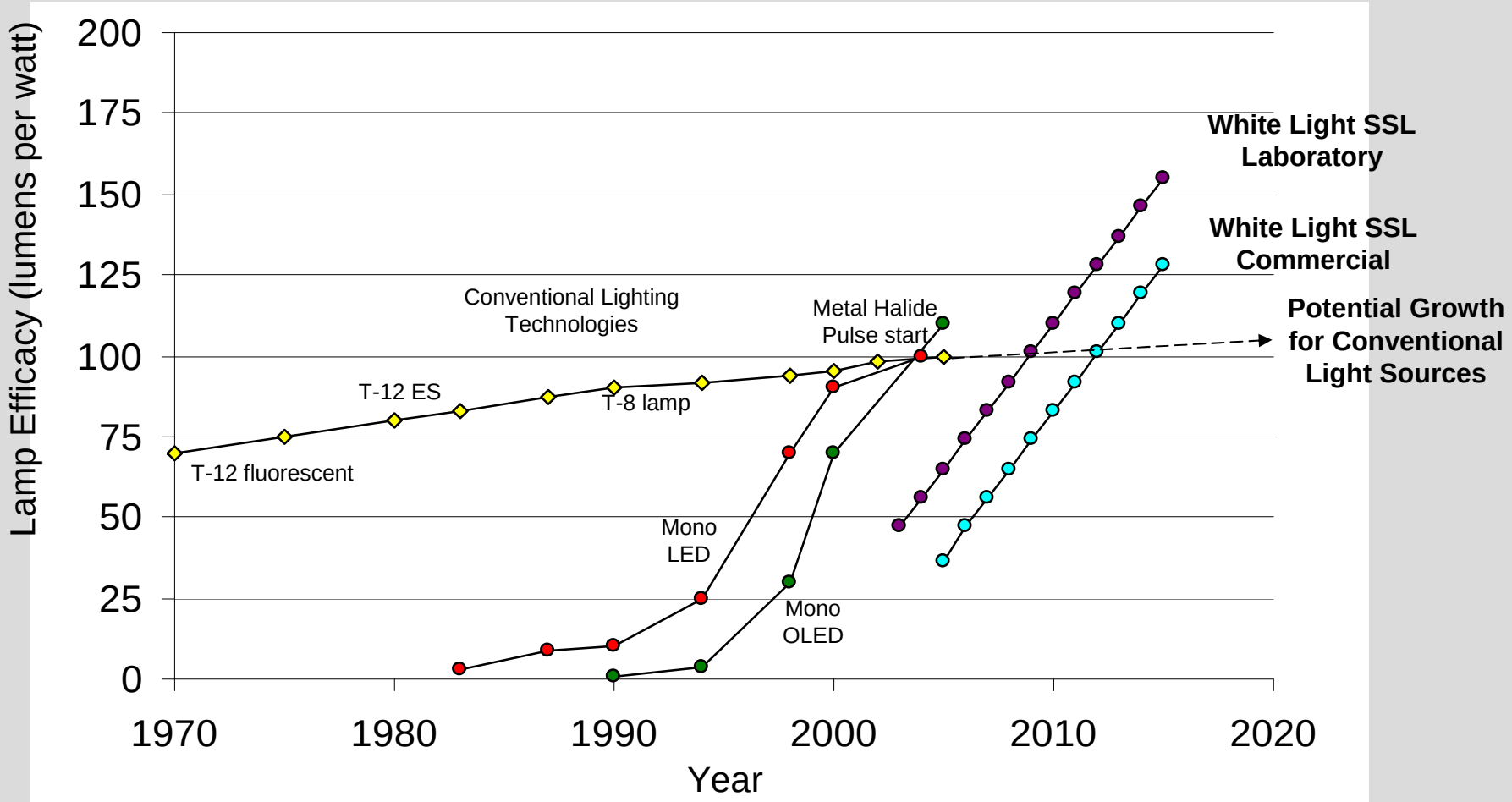
"…it's [LED lighting] a revolutionary technology that's going to completely reshape the lighting business."

M, George Craford, Chief Technology Officer

Philips Lumileds-Lighting Co.

Innovation, Feb/Mar 2008

Accelerated R&D for White Light SSL



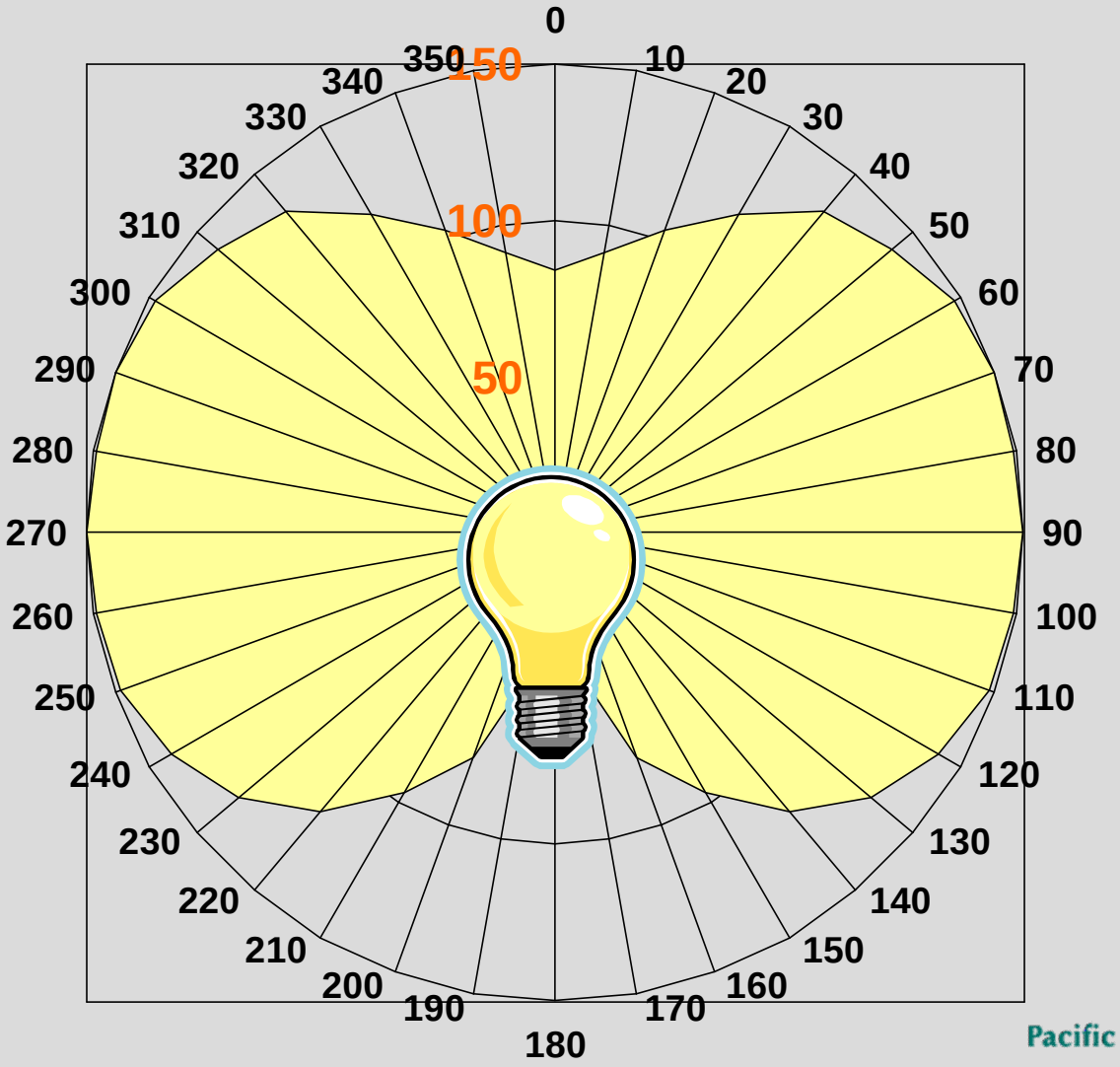
SSL Laboratory and Commercial Curves, revised May 2006

LED Myth
LEDs are more efficient that fluorescents

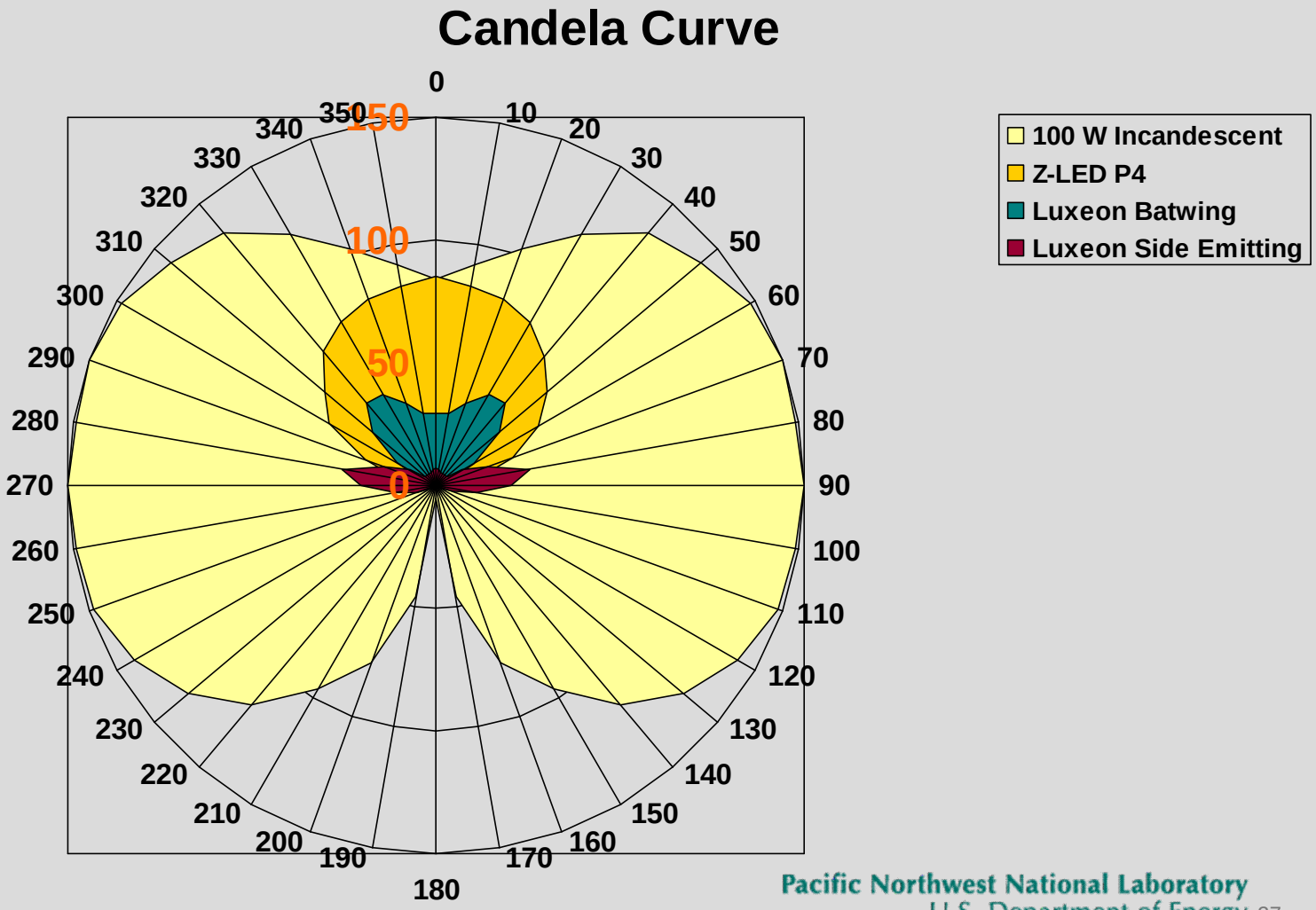
- *"Nichia delivers 92 lm/W at 350 mA"*
  Nov 2006
- "*Philips Lumileds shatters 350 mA performance records with 115 lm/W LED*"
  Jan 2007 (R&D result)
- *"Cree achieves 1000 lumens from a single LED" [52 – 72 lm/W]*
  Sep 7, 2007 (R&D result)
- *"Seoul Semiconductor to launch 420 lumen LED next quarter" [52 lm/W]*
  Sep 19, 2007

Can LEDs Replicate Incandescent Light?

Candela Curve

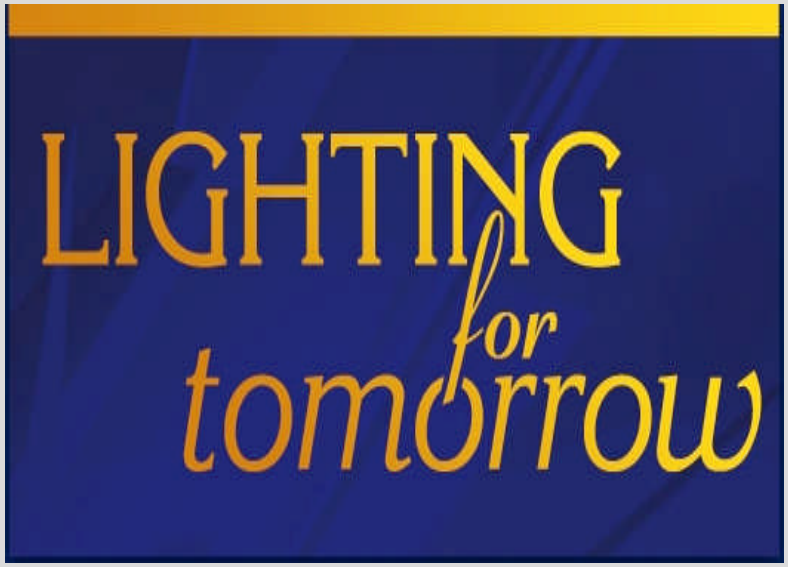


Perhaps We Are Asking the Wrong ??



2007 SSL Competition

New Products



american lighting association

CEE
Together We Can Change National Markets

2007 SSL Competition

- Niche applications
  - Undercabinet and in-cabinet
  - Portable desk/task
  - Outdoor porch, path, step
  - Recessed downlights
- LED luminous efficacy – minimum requirements
  - 40 lm/W for < 5000K
  - 50 lm/W for 5000K +

LIGHTING for tomorrow

2007 Grand Prize Winner

LR6 by LLF Inc. (new and retrofit can light)

-11 Watts, ~650 lumens, 60 lm/W (system)

-2700K, 94 CRI

Winner – Undercabinet

PLS Undercabinet by Finelite

8 Watts, 344 lumens, 43 lm/W

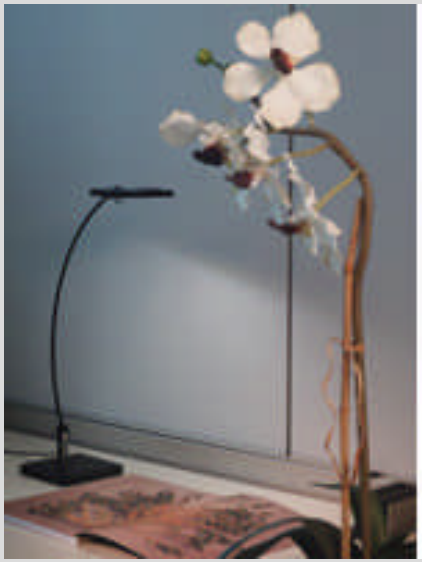
3500K, 71 CRI

Winner – Portable Desk/Task

PLS Task by Finelite

10 watts, 430 lumens, 43 lm/W

3500K, 71 CRI



Winner – Outdoor

Strata by Progress Lighting

- **5 Watts, 125 lumens**
- **25 lm/W**
- **3200K, 70 CRI**

Honorable Mention

Wall sconces by Justice Design Group

ENERGY STAR for SSL

- Excludes OLEDs… for now
- Limits coverage to LED systems for “white light” general illumination only
- Both commercial and residential
- Luminaire efficacy key metric
- Establish 2-category specification:
  - Category A: prescriptive specifications for near-term lighting applications
  - Category B: performance specification for all applications (long-term)
- In-Situ testing required
- Effective date: September 30, 2008

www.netl.doe.gov/ssl

Category A: Niche Applications

1. Undercabinet Kitchen
2. Undercabinet Shelf-mounted Task
3. Portable Desk/Task
4. Recessed Downlights (Res./Com.)
5. Outdoor Wall-mounted Porch
6. Outdoor Step
7. Outdoor Pathway

Category A: Undercounter Lighting

Philips SSL Solutions

Osram

Category A: Portable Desk/Task Lighting

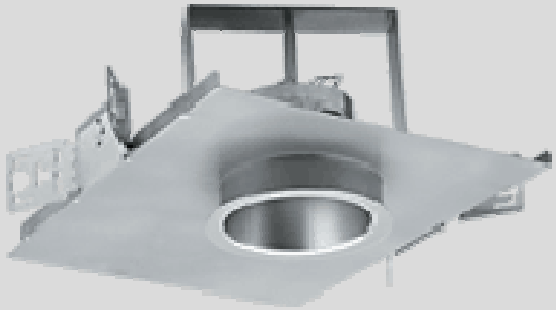
6 Watt LED Desk Lamp

Halley LED Desk Lamp

Category A: Recessed Downlights

Renaissance

Progress

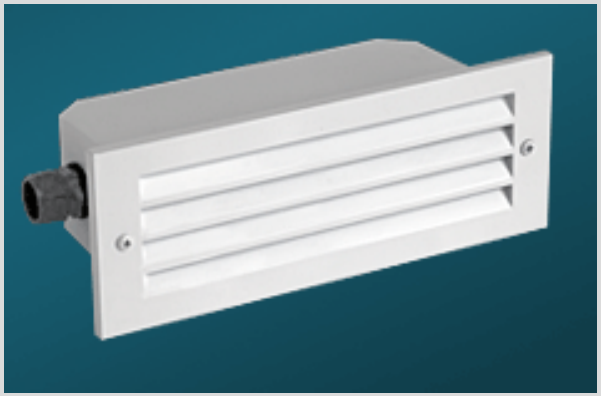


Prescolite

Category A: Outdoor Porch

“Lakeland” by Progress Lighting

Category A: Outdoor Step



Category A: Outdoor Pathway

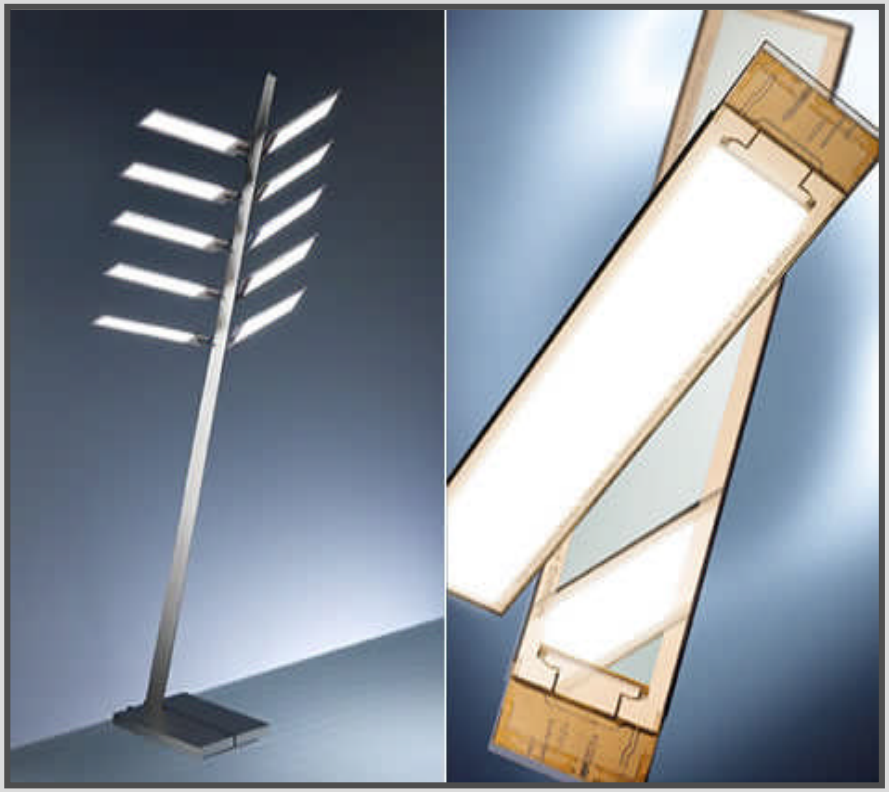
Category B: Efficacy Based Performance

- Aggressive efficacy requirement: 70 lm/W
- Simpler; no total flux or zonal lumen requirements.
- Allows for non-directional lighting applications.
- Manufacturers able to qualify under Category B approximately three (3) years after the effective date.
- Serves as future target for manufacturers.

Contact Jeff McCullough for Any and All Questions!!!
509-375-6317

OLED Desk Lamp

- Osram lamp used ten l32 x 33 millimeter OLED panels to form lamp.
- They neither require reflectors directing the light into the right direction nor large sockets.
- OLEDs are more advanced and expensive than LEDs, but potentially more efficient.



Watch Out!

There are a lot of technologies that look appropriate, but they are clearly not…….

Here is one example that looks like it's ES when in fact it is anything but.

And, there is some stuff you simply cannot make up!