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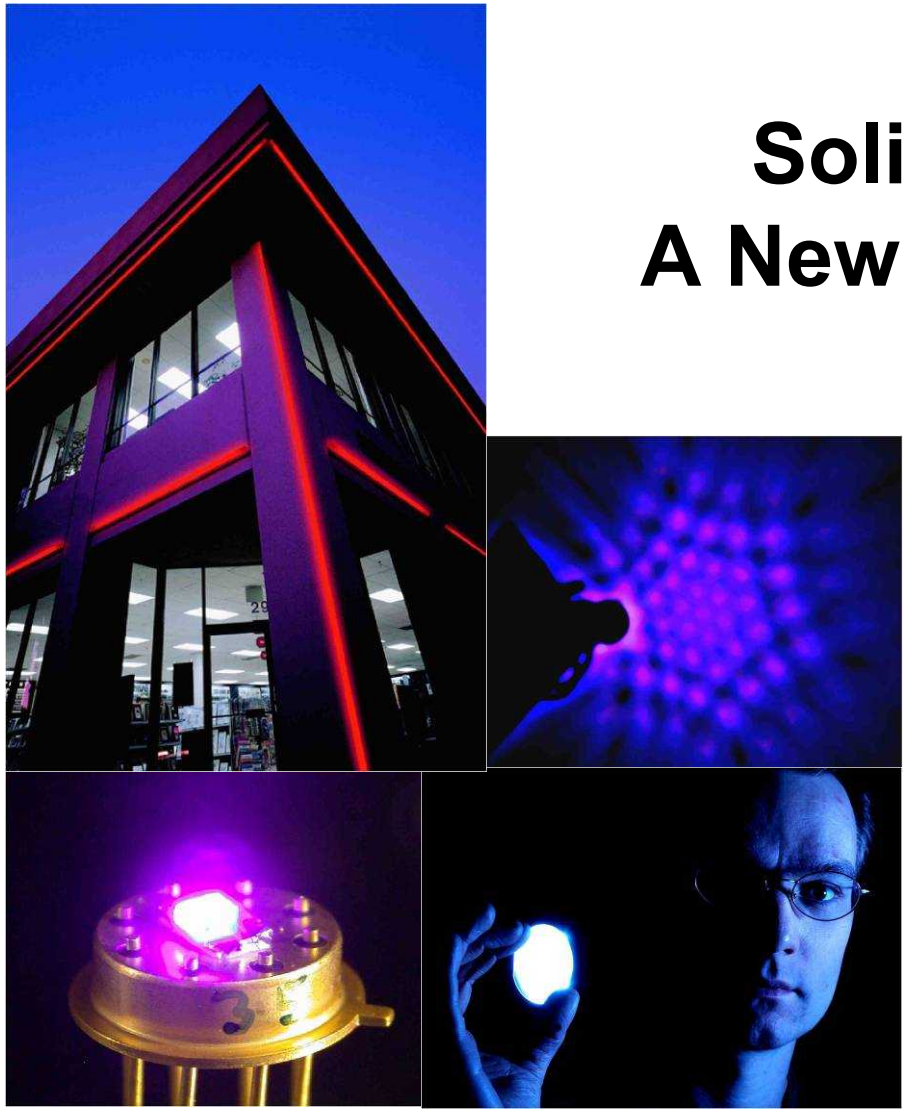


Solid-State Lighting: A New, Green Technology

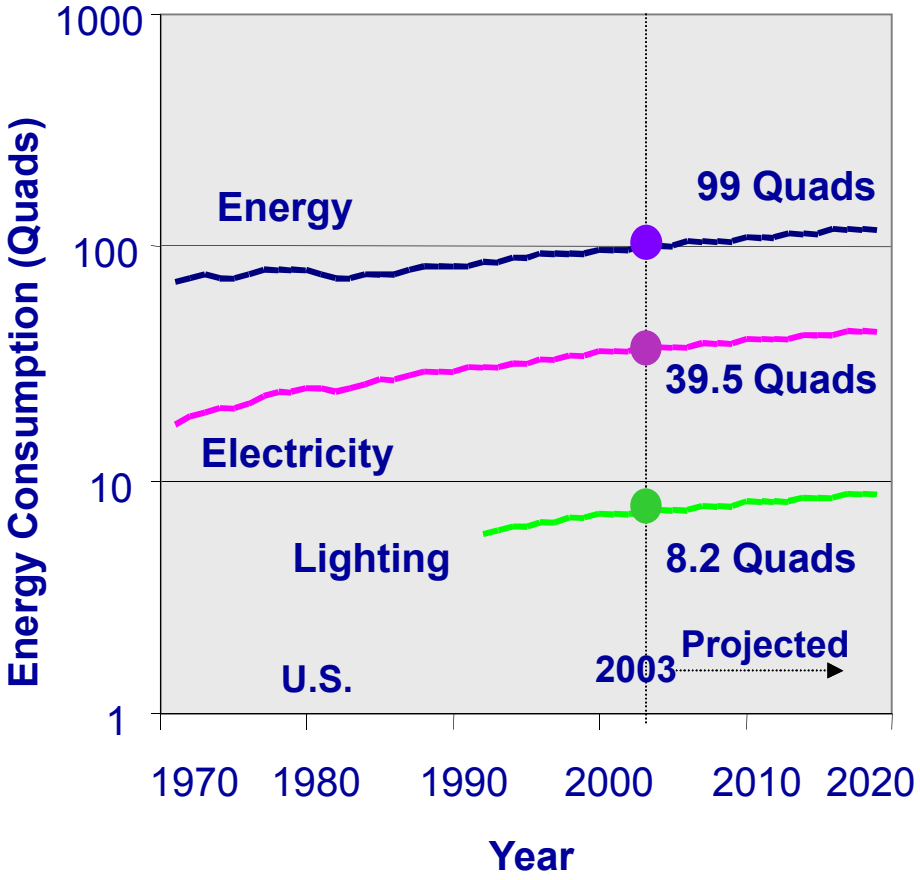
Mike Coltrin
Sandia National Labs.

SSLS EFRC

Sandia National Laboratories is a multi-program laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000. This work is supported by Sandia's Solid-State Lighting Science Energy Frontier Research Center, sponsored by the Department of Energy Office of Science.

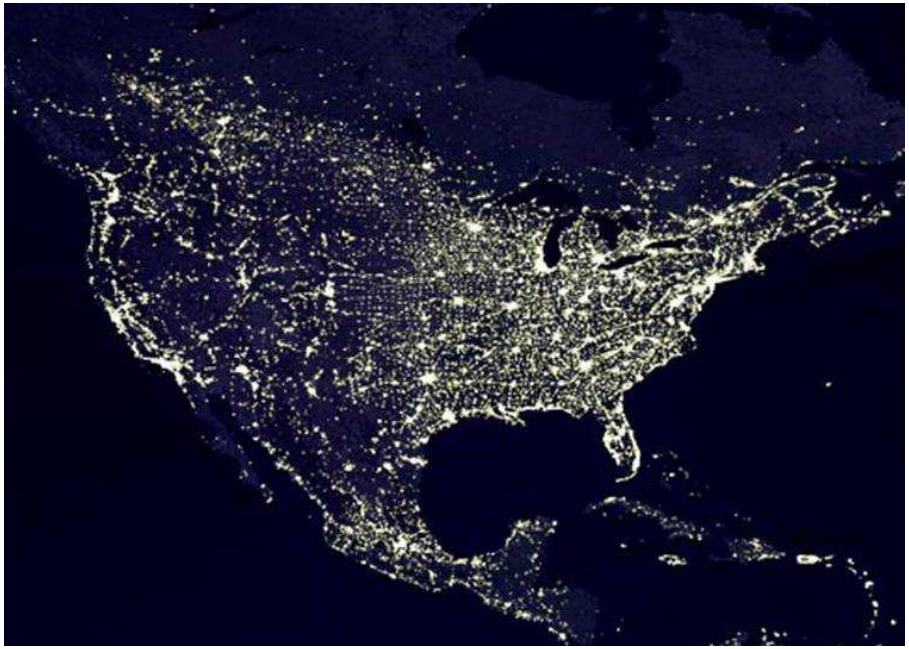
Lighting is a large fraction of energy consumption and is low efficiency

- ~22% of electricity consumption is for general illumination
- Lighting is a highly attractive target for reducing energy consumption!



Efficiencies of energy technologies in buildings:

Heating:	70 - 80%
Elect. motors:	85 - 95%
Fluorescent:	**20-25%**
Incandescent:	**~5%**



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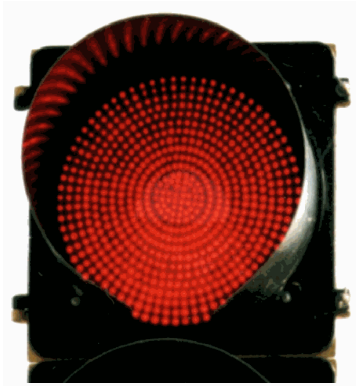
LEDs (Light-Emitting Diodes)

LEDs are widely adopted for monochrome applications

- Sophisticated semiconductor manufacturing needed
- Extremely bright, small area sources => fixture required



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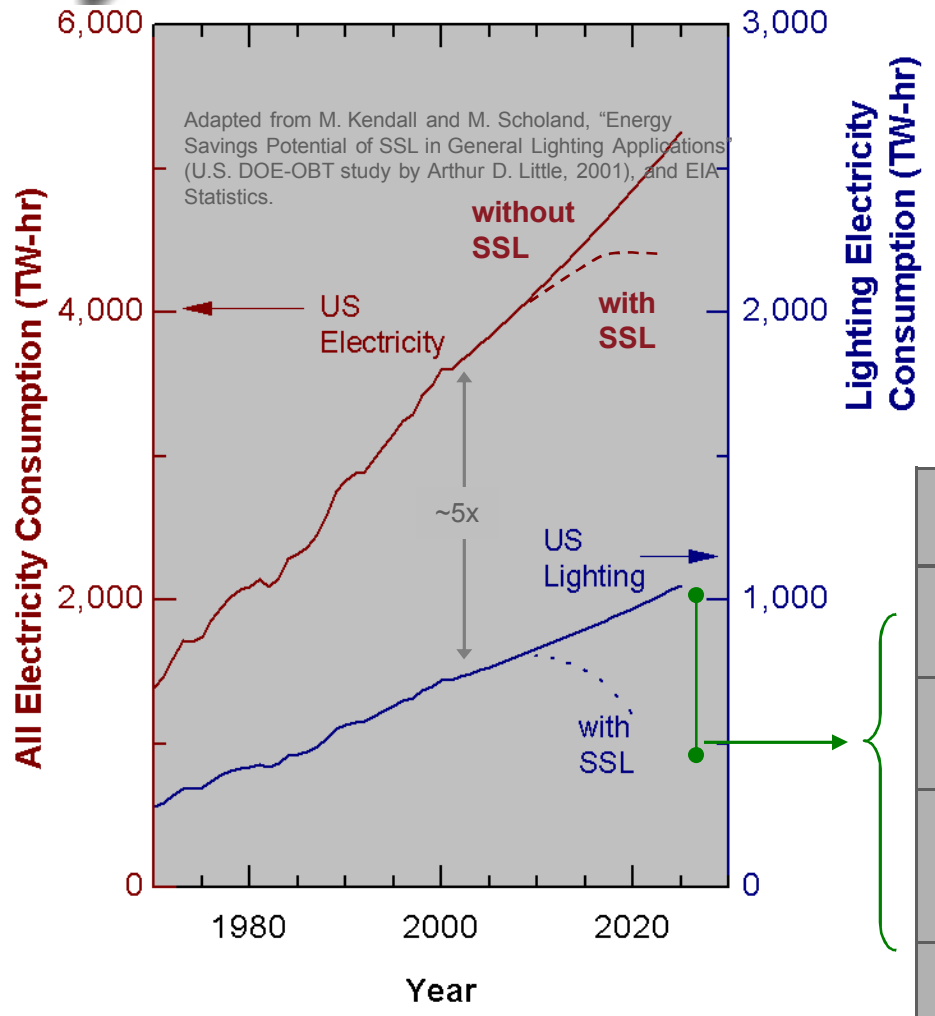
Potential SSL pay-offs are enormous: Goal is massive adoption of 50% efficient SSL



- **SSL has the potential, by 2025, to:**
  - **decrease electricity consumed by lighting by more than 50%**
  - **decrease total electricity consumption by 10%**

Projected Year 2025 Savings	US	World
Electricity used (TW-hr)	620/ year	~2,000 /year
$ spent on Electricity	42B/ year	~150B /year
Electricity generating capacity (GW)	75	~250
Carbon emissions (Mtons/year)	100	~350

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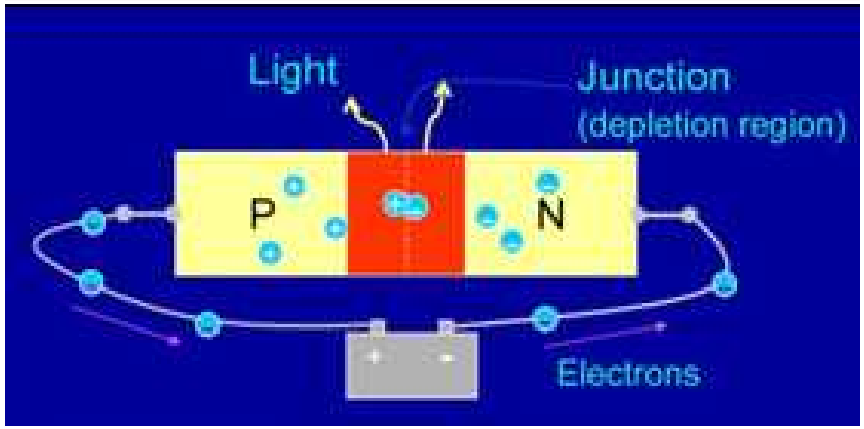
How LEDs work



- An LED is a chip of semiconducting material treated to create a structure called a p-n (positive-negative) junction.

- Current flows from the p-side or anode to the n-side, or cathode. Charge-carriers (electrons and electron holes) flow into the junction.

- When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon (light).

- Depending on the composition of the semiconducting material, different colors of light are emitted.

More than simply energy savings!

- **Directional light emission** – directing light where it is needed.
- **Size advantage** – can be very compact and low-profile.
- **Breakage resistance** – no breakable glass or filaments.
- **Cold temperature operation** – performance improves in the cold.
- **Instant on** – no "warm up" time.
- **Rapid cycling capability** – lifetime not affected by frequent switching.
- **Controllability** – electronic control to change light levels / color characteristics
- **No IR or UV emissions** - do not emit infrared or ultraviolet radiation.

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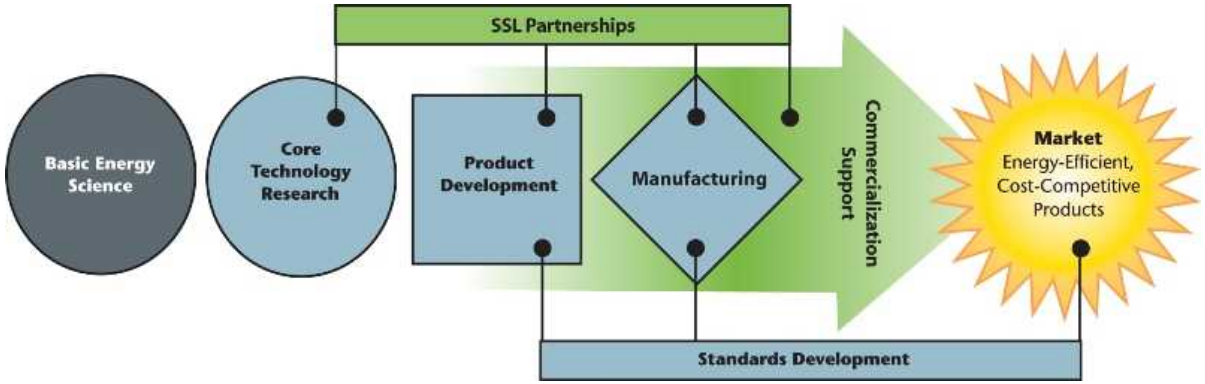
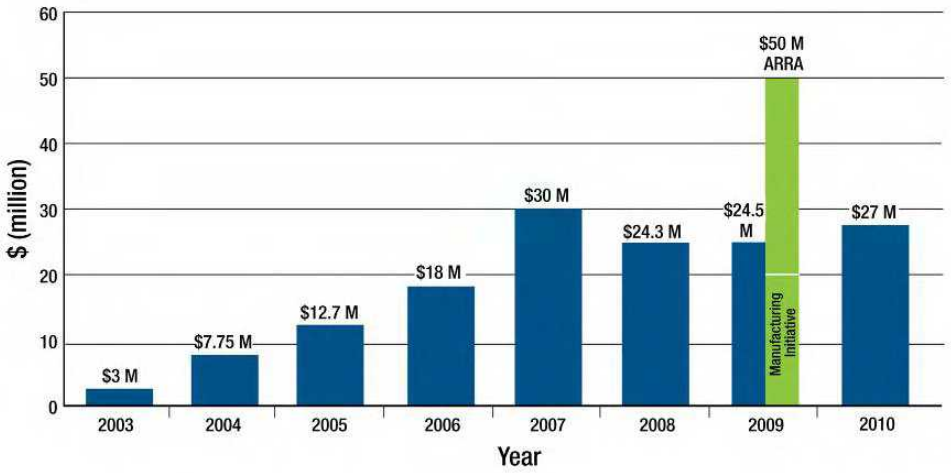
Department of Energy Solid-State Lighting programs



A spectrum of funding from the most basic research through market introduction.

Sustained funding, including a new manufacturing initiative.



For more info: http://www.ssl.energy.gov

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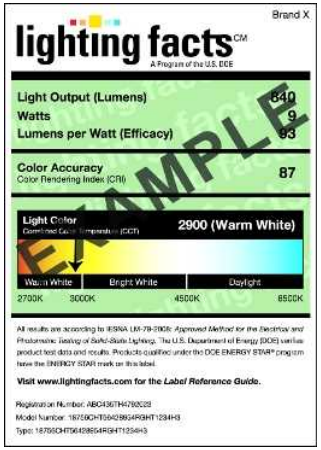
DOE EERE activities to help launch successful SSL products



Quick / simple summary of product performance data as measured by new industry standards.

DOE GATEWAY Demonstrations showcase high-performance LED products for general illumination in a variety of commercial and residential applications.

ENERGY STAR

Establishes the industry-wide criteria that manufacturers can use to promote qualifying products.

L PRIZE

Challenges industry to develop replacement technologies for two of today's most widely used and inefficient products: 60W incandescent lamps and PAR 38 halogen lamps.

CALiPER

Reliable, unbiased product performance information to foster the developing market for high-performance SSL.

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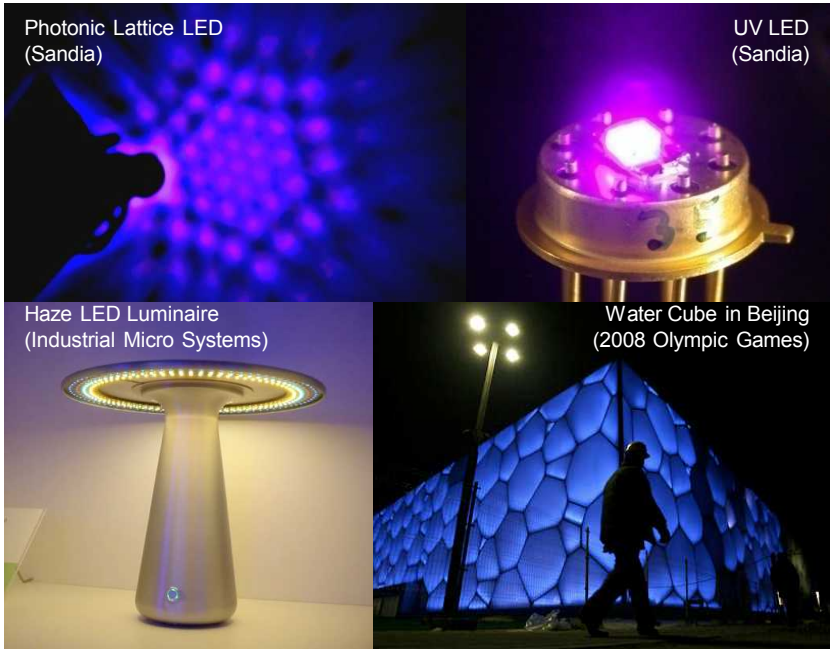
U.S. DEPARTMENT OF ENERGY

EFRC for Solid-State Lighting Science

Goal: Improve the energy-efficiency in the way we light our homes and offices, which currently accounts for 20% of the nation's electrical energy use. Solid-State Lighting (SSL) has the potential to cut that energy consumption in half – or even more.



Research plan: Investigate conversion of electricity to light using radically new designs, such as luminescent nanowires, quantum dots, and hybrid architectures; study energy conversion processes in structures whose sizes are even smaller than the wavelength of light; understand and eliminate defects in SSL semiconductor materials that presently limit the energy efficiency.

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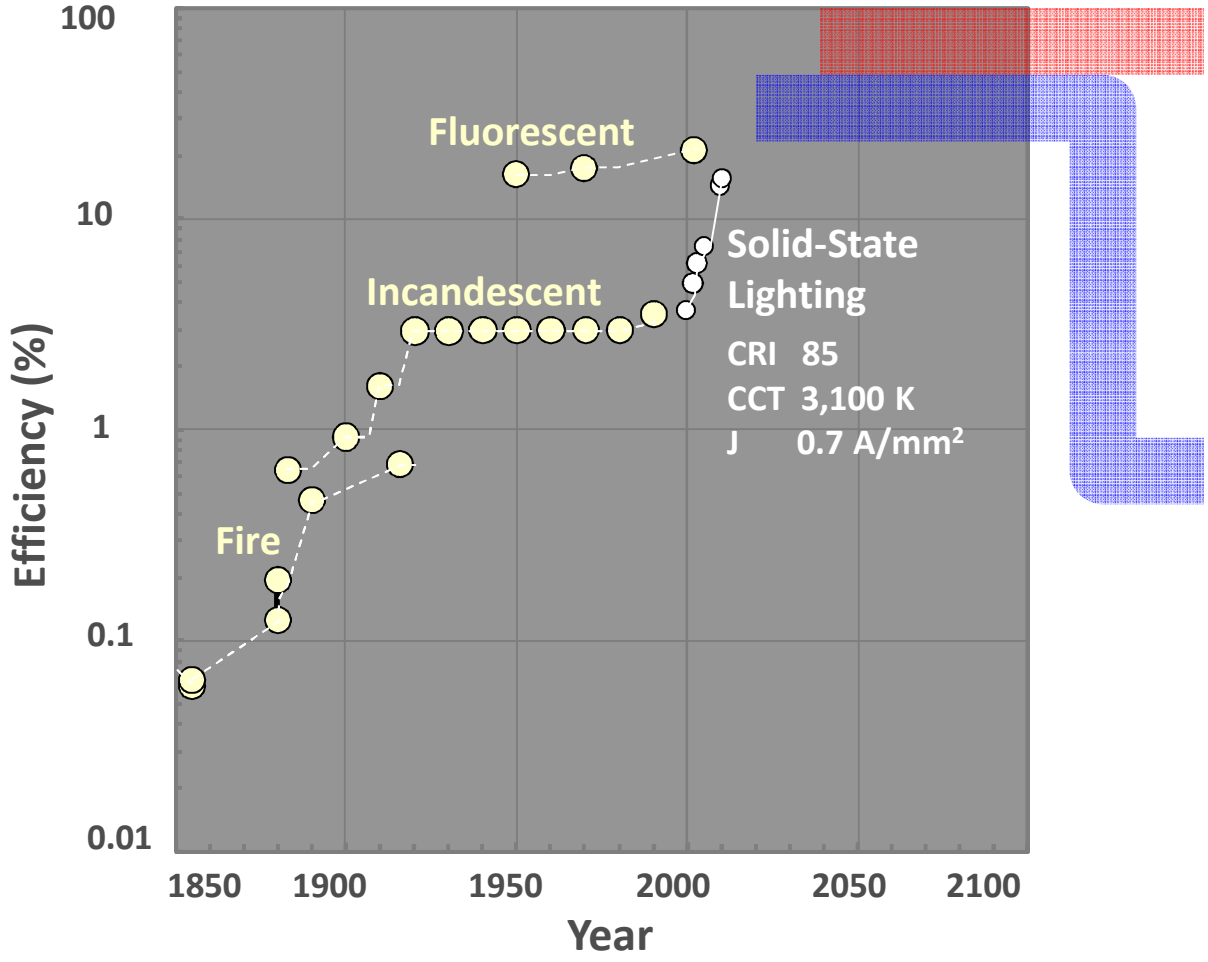
For more info: http://ssls.sandia.gov

SSL: Two Future Scenarios



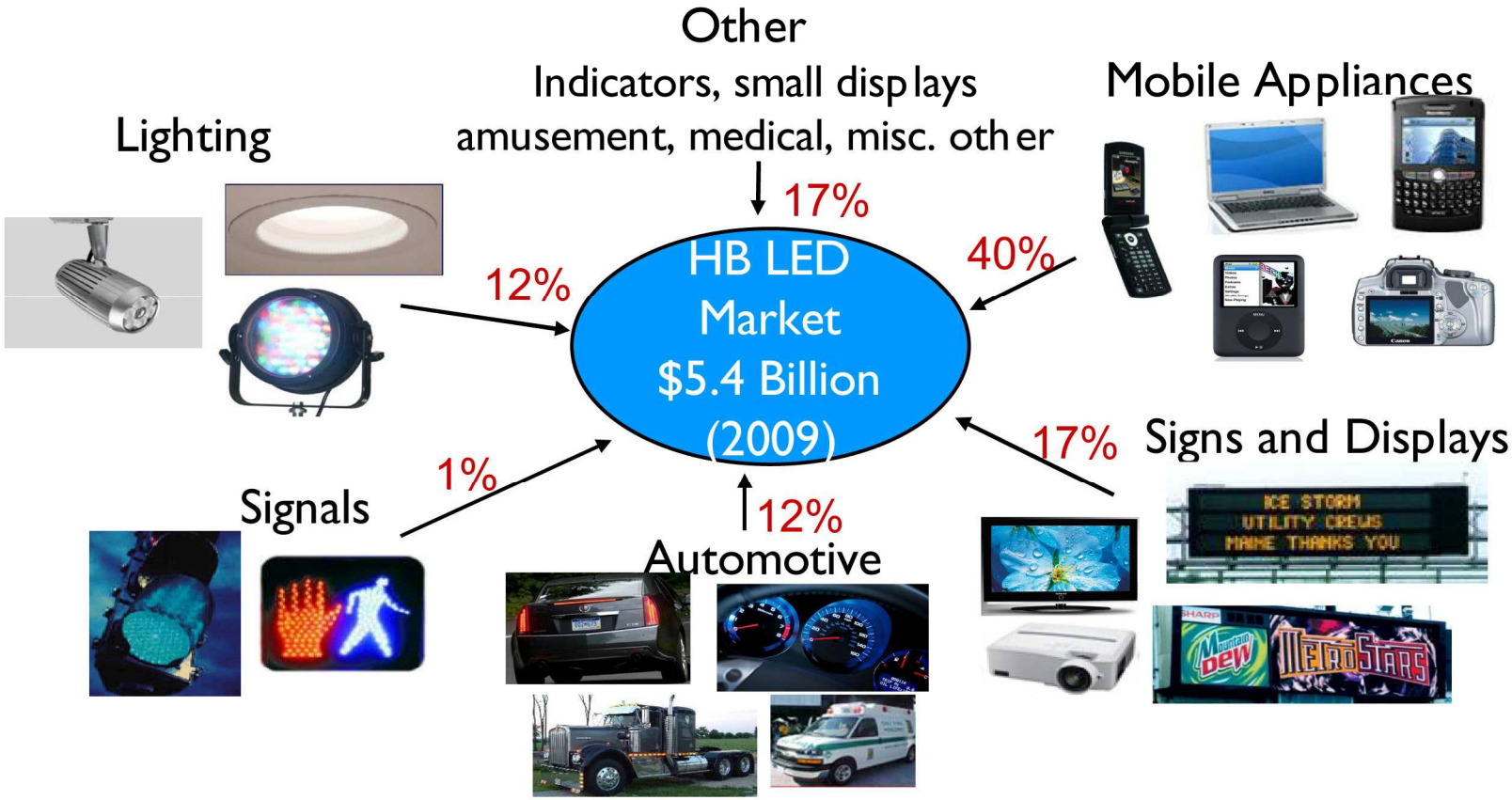
SSLS EFRC: 50-100%

Enables the highest savings in energy consumption and gains in human productivity (but not obvious how to achieve)

EERE Programs: 25-50%

Enables penetration of traditional lighting (will almost certainly happen)

2009 Market for LEDs: $5.4 B
Lighting World-Wide: $75B (~1/2 million jobs)



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