Building Technologies Office Program Peer Review

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Emerging Technologies Program

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Program Manager

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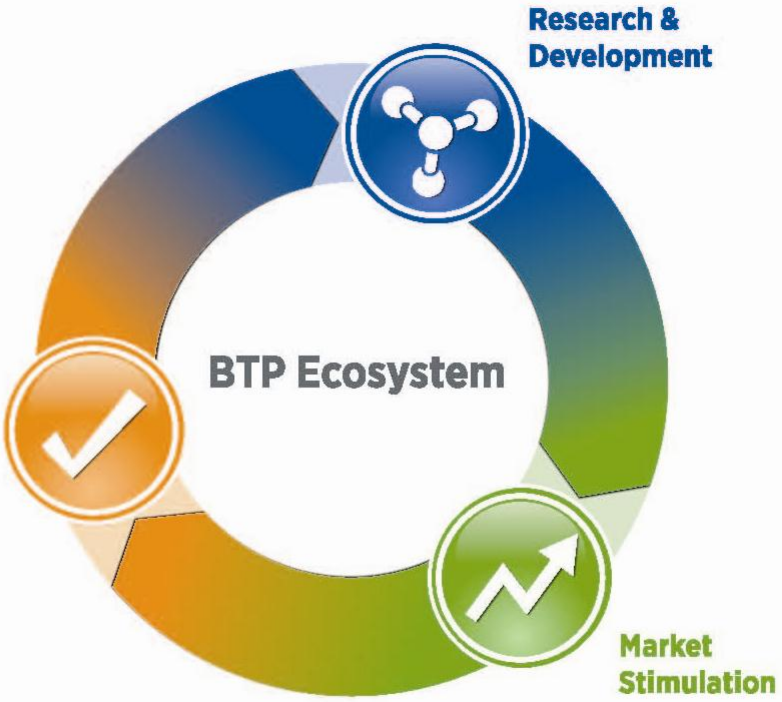
Research & Development

- Develop technology roadmaps
- Prioritize opportunities
- Solicit and select innovative technology solutions
- Collaborate with researchers
- Solve technical barriers and test innovations to prove effectiveness
- Measure and validate energy savings



ET Mission: Accelerate the research, development and commercialization of emerging, high impact building technologies that are five years or less to market ready.

DOE's Portfolio of Research in Advanced Technologies – Whole Building Approach

Advanced windows

Advanced refrigerator technology

Building energy models/calculators

Low global warming potential refrigerants

Heating, ventilating, air conditioning, water heating, and working fluids

Solid state lighting

Sensors and controls

Advanced heat pump technology:

- Air source heat pumps
- Ground source heat pumps
- Heat exchangers

Building Envelope: Next generation attic and roof systems

Building Energy End-Use & Emerging Technologies (ET) Funding

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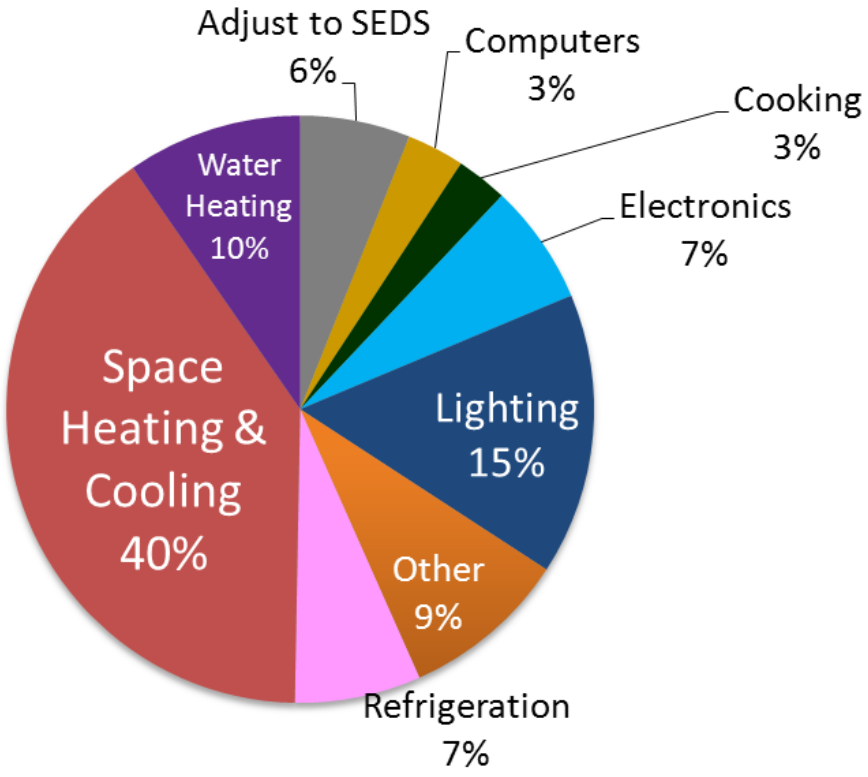
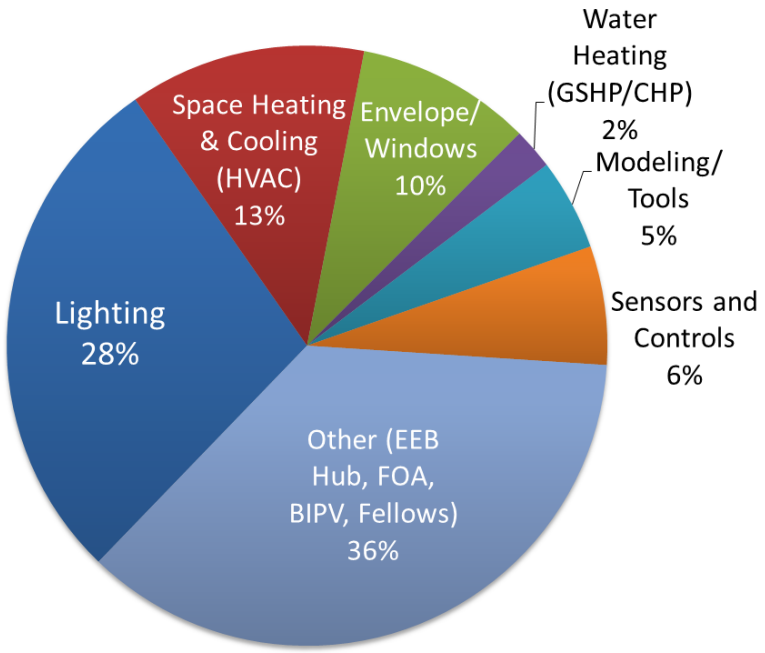
2010 Commercial & Residential Primary Energy End-Use, (Quadrillion Btu)



DOE-BTP Emerging Technologies FY13 Investments



Total Emerging Technologies FY13 budget is $84.1 million

Building Energy Data Book, http://buildingsdatabook.eren.doe.gov/

How Do We Make Decisions About Technology Development?

- Our internal "Prioritization Tool," described in another presentation
- Stakeholder engagement through workshops and roadmaps, e.g.,
  - Building Energy Storage (May or June, 2013)
  - Building-Integrated Solar Technologies (Apr 2013)
  - Separate Sensible & Latent Air Conditioning (Apr 2013)
  - Envelope & Windows (Apr 2013)
  - Sensors & Controls (Jan 2013)
  - Ground-Source Heat Pumps (Oct 2012)
  - Solid-State Lighting Manufacturing (Aug 2012)
- "Pull" from the deployment and standards/codes programs

Representative Building Emerging Technology Activities

EnergyPlus Whole-Building Energy Model

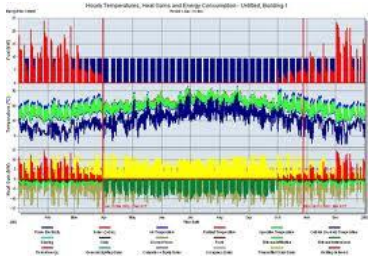
Performers: LBNL, NREL, PNNL, ORNL, subs

Contact PIs: B. Griffith, P. Haves

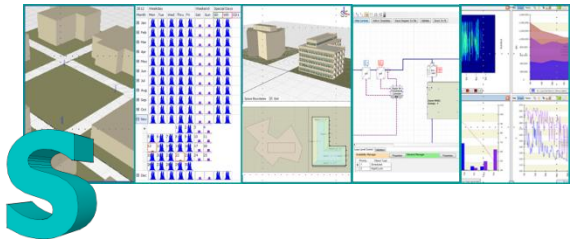
Why Important: Whole-building energy modeling supports performance driven integrated design of new buildings and retrofits, fault-detection and commissioning, dynamic control and demand response, asset ratings and labels, tax credit qualification, energy-efficiency standard development and compliance, and policy analysis. EnergyPlus is the industry leading engine.

Highlights:

- Reference engine for California Title 24-2013
- Adopted by Trane for TRACE 800 product
- New user-interfaces: both commercial and free
- New open-source license
- New features in 7.2 (Oct 2012): detailed model for complex fenestration, variable-speed DX coils, equipment rating calculations, updated equipment sizing, ice storage model, expanded zone control options, speedups



DesignBuilder



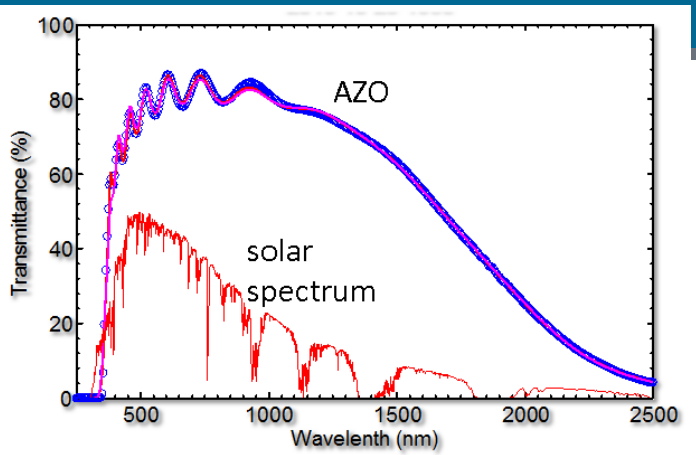
http://www.energyplus.gov/

Oct 2012

Windows & Building Envelope

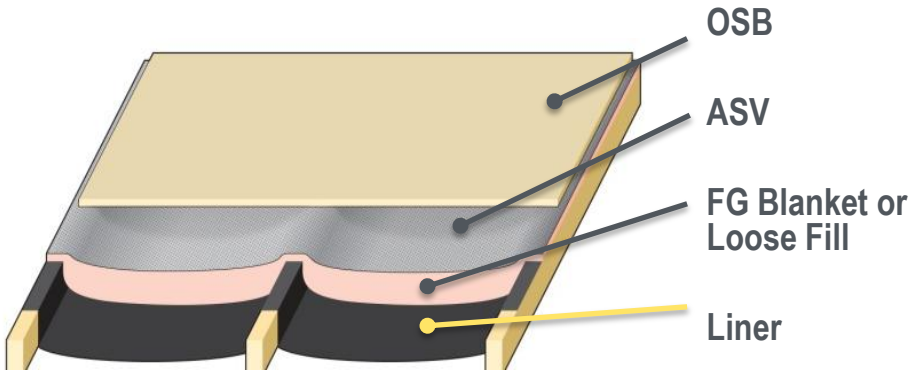
Windows

- Dynamic windows
- Highly insulating windows
- Advanced daylighting
- Window attachments



Next Generation Attics/Roofs

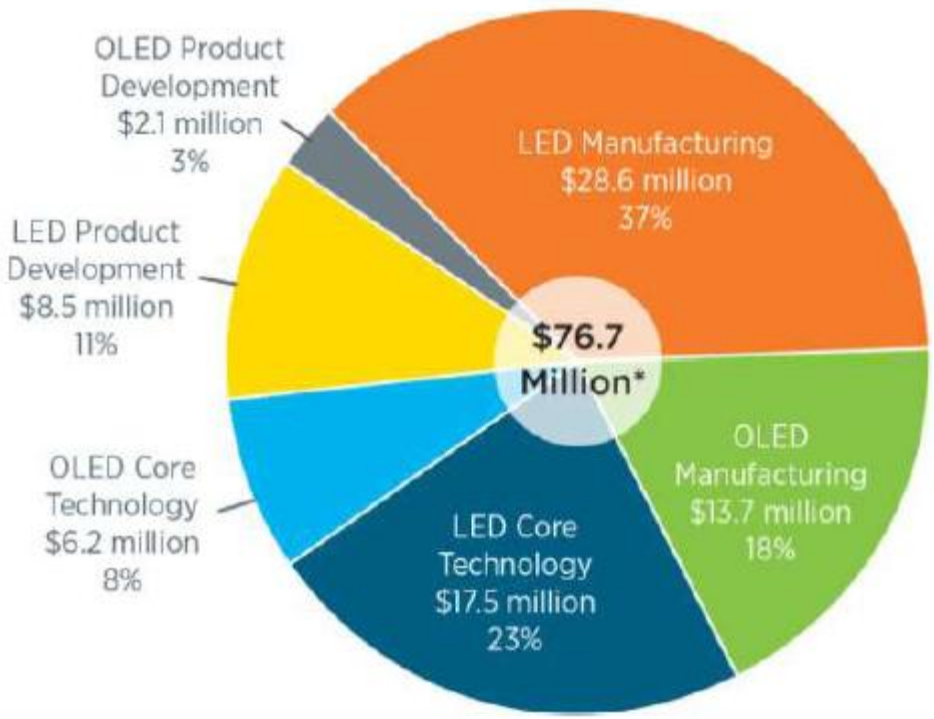
- Cool roofs
- Advanced attics



Insulation

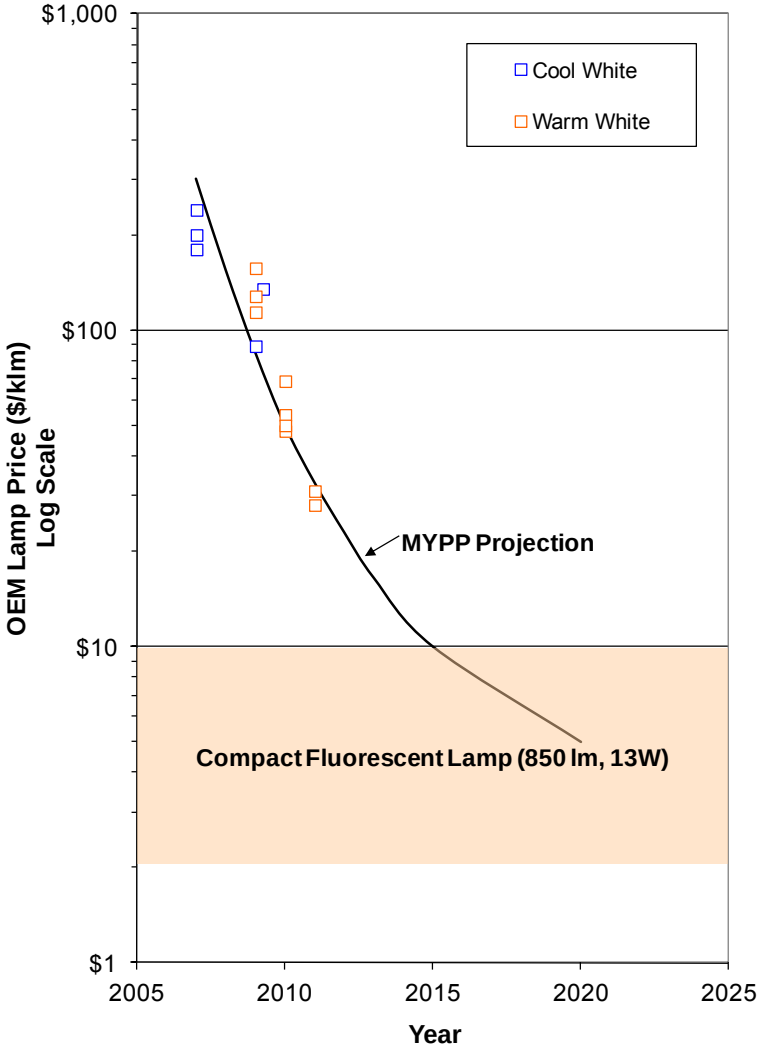
- Moisture transfer through foundations
- Air barriers
- Foam board insulation
- PCM standards development

Solid-State Lighting Program



Total funding for all active projects:
$51M DOE, $25.7M applicant share

http://www1.eere.energy.gov/buildings/lighting.html



http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_energy-savings-report_jan-2012.pdf

What Is the L Prize?

- Technology competition to spur innovation and exceptional performance in lighting products
- Created by Energy Independence and Security Act (EISA 2007) Sec. 655
- Three prize categories:
  - 60W Incandescent Replacement ($10 million)
    - Winner: Phillips (August, 2011)
  - PAR 38 Halogen ($5 million)
    - No entries received to date
  - Future focus: 21st Century Lamp ($5 million)
- Cash prizes authorized for each category, plus federal purchasing, utility programs

60W Bulb Replacement Trends

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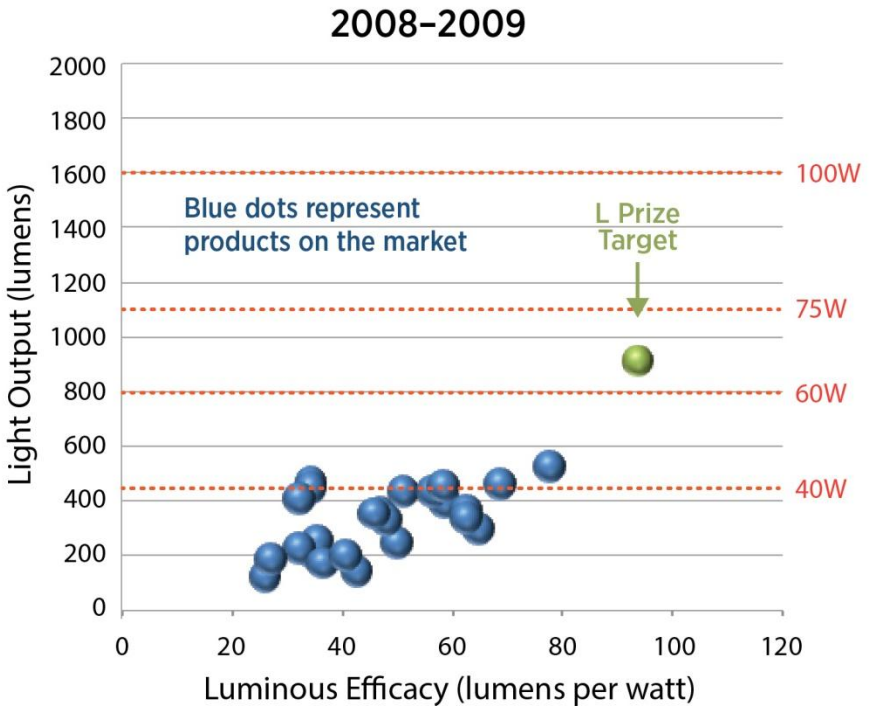
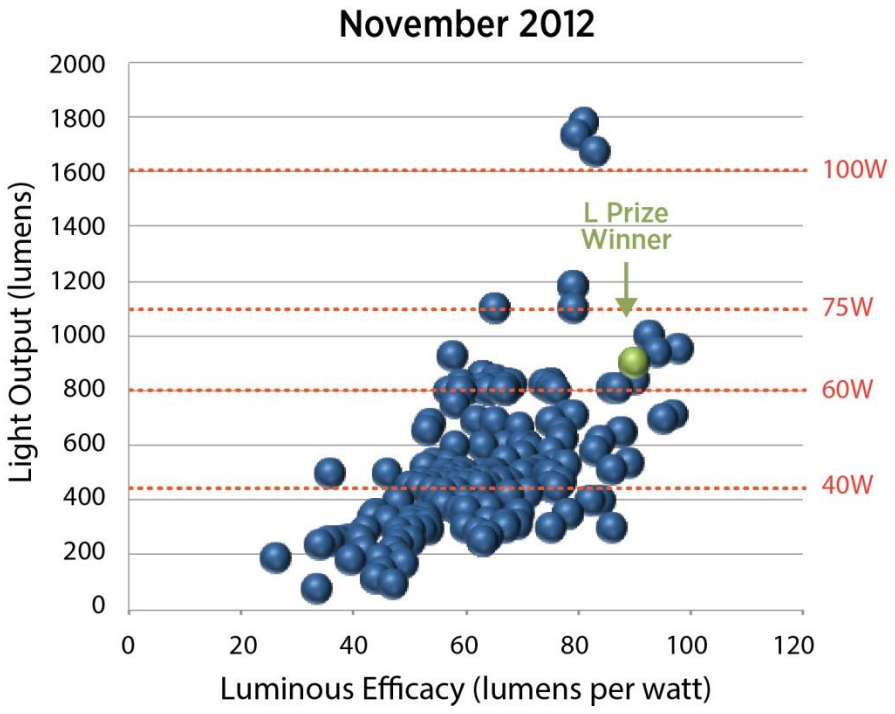


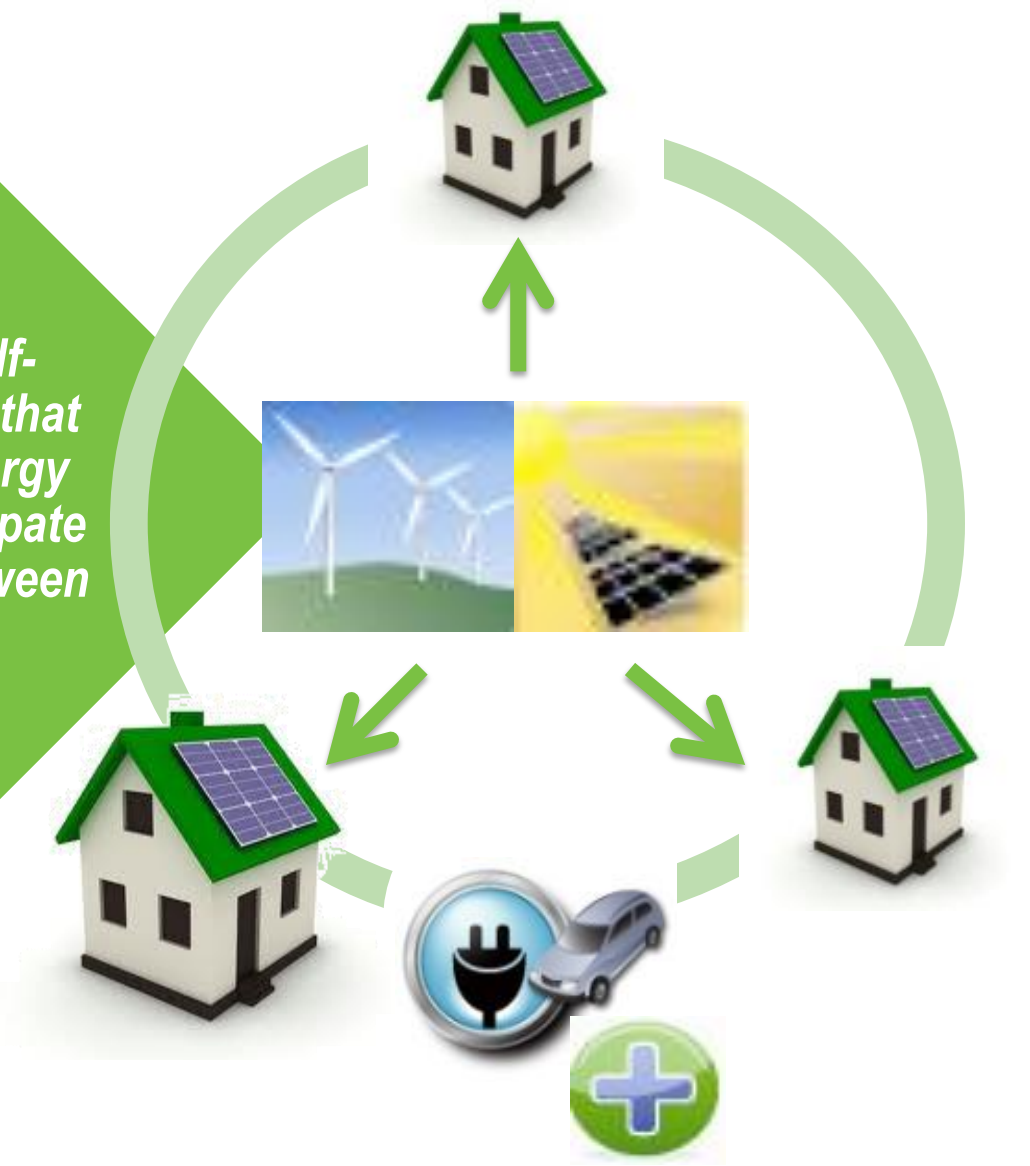
Source: CALiPER 2008–2009 results for 12 LED lamps and data from 12 LED Lighting Facts labels.



Source: LED Lighting Facts analysis

BTO Sensors & Controls Vision

Buildings will be self-configuring, self-commissioning and self-learning such that they optimize operation, maximize energy savings cost effectively and can participate in transactions within the building, between buildings and with the grid



A low cost, wireless "peel and stick" sensor

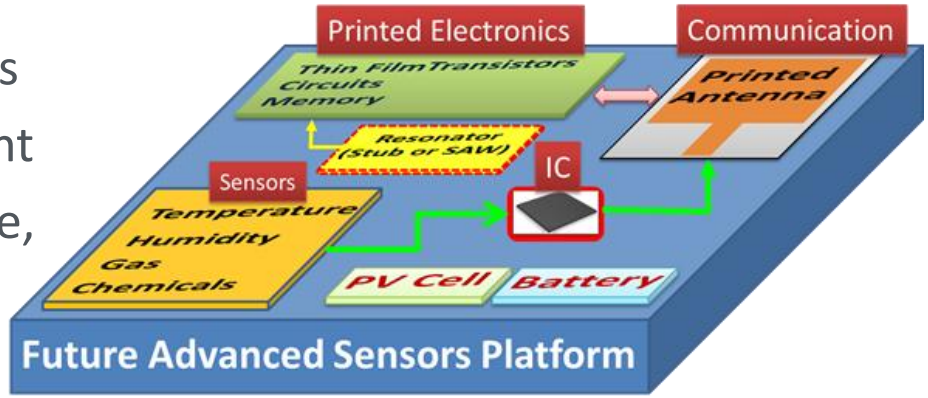
Opportunity: Cheap and wireless sensors will enable enhanced building controls; requirement for future transaction platform

Problem: Communicating sensors are too expensive

Solution: Low cost, wireless sensors that are fully printable "peel and stick" and cost $1-$10/node vs. $150-$300/node

FY13 goals (metrics): Prototype multi-sensor platform

- Comprised of new high performance materials using a unique low temperature thin film integration platform
- Performance specifications:
  - Transmission rate: every 80 seconds
  - Power harvesting from ambient light
  - Parameters measured: Temperature, humidity, light intensity
  - Range: 50 feet (tested), expected range (2K-3K feet)
  - RF frequency: 315 MHz



HVAC, Water Heating, & Appliances Program: Heat Pumps

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HVAC Integrated Heat Pump (IHP) Technologies:

- Ground Source –IHP (variable speed), 55% to 65% energy savings
- Air Source (AS)-IHP (2-speed), 40% to 45% energy savings
- AS-IHP (variable speed), 45% to 55% energy savings
- Multifunction Natural Gas-driven HP (10 to 17.5 kW), 70% peak demand savings; 40% source energy savings

HVAC Heat Pump (HP) Technologies, non-IHP:

- Next Generation Roof Top Unit (RTU) (70 kW), 25% energy savings vs. ASHRAE 90.1 RTU
- Next Generation Window AC 30% energy savings
- Cold Climate HP (10 to 17.5 kW), 50% to 70% energy savings at low ambient

Water Heating Heat Pump (HP), non-IHP:

- Electric Heat Pump Water Heater (HPWH) with low-GWP (CO_2), 15% energy savings
  Absorption HPWH, 45% energy savings

Heat Pump (HP) Appliances:

- HP Dryer, 40% energy savings

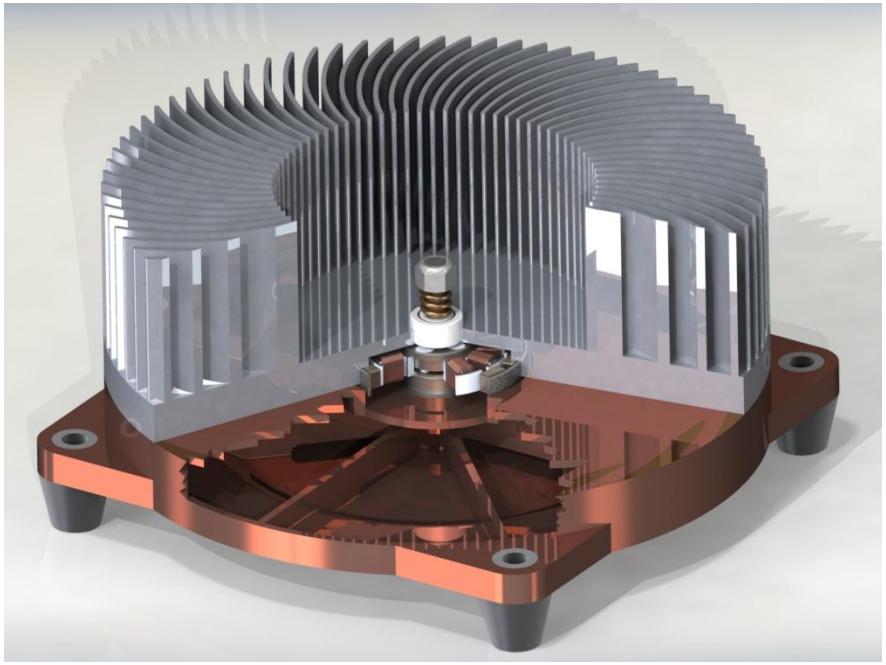
Air Bearing Heat Exchanger Technology

Performer: Sandia National Labs (Livermore, CA)

Contact PI: Dr. Jeff Koplow

Importance: 30% of electricity usage is accounted for cooling and 20% by lighting. A breakthrough in air cooled heat exchanger technology could increase HVAC efficiency by an estimated 30% and lighting efficiency by 50% (by solving the LED thermal management problem). The Sandia cooler achieves breakthrough cooling performance via a radically different device architecture.

Sandia Cooler video viewed 360,000 times:
www.youtube.com/watch?v=JWQZNXEKkaU



Version 5 "technology platform" device

Greatly improved heat-sink impeller design:

R_{xfer} (v4) = 0.09 C/W. R_{xfer} (v5) = 0.03 C/W!

Motor noise eliminated. Assembly ruggedized.

v5 base plate incorporates planar vapor chamber.

Multiple copies to facilitate technology transfer.

Oct 2012

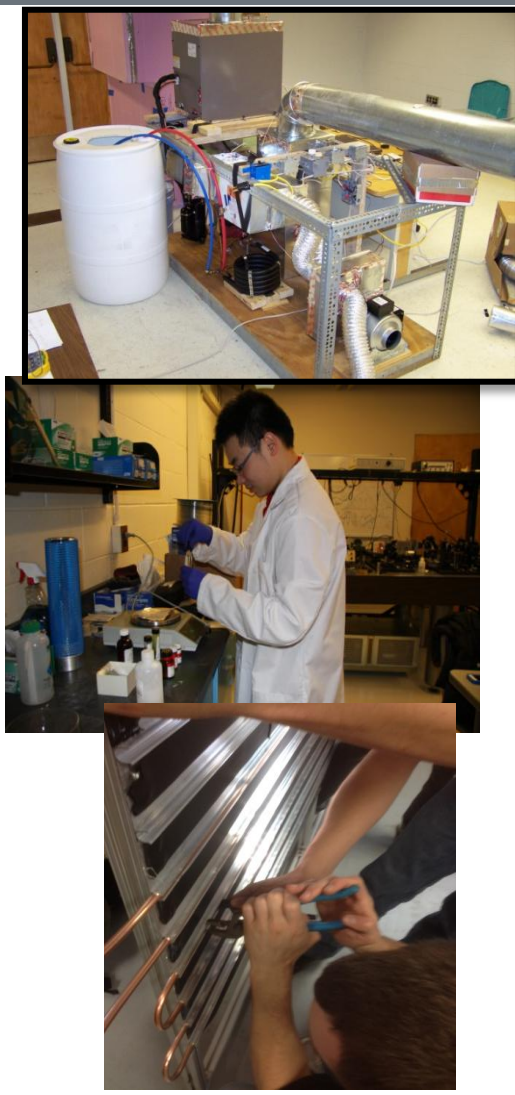
Max Tech and Beyond Ultra-Low Energy Use Appliance Design Competition

Performer: **LBNL** PI: Karina Garbesi PM: Stacy Pratt

Goal: To support faculty-led university student teams in the prototyping of ultra efficient residential and commercial appliances while developing and inspiring a next generation of engineers, equipped to aggressively reduce the nation's carbon emissions.

2013 Selected Teams:

- University of Maryland: *High Efficient Clothes Dryers*
- Ohio State University: *HAWC (Hybrid Air/Water Conditioner) 2.0*
- Cal Poly Pomona: *Smart Solar PV Battery Refrigerator Controller*
- UC Berkeley: *User-Centric and Self-Commissioning Predictive-Model-Based Lighting Retrofit System*
- SUNY @ Stony Brook: *Dramatic Reduction in Residential and Commercial Refrigeration Energy Usage using a Two-Phase Thermosyphon*
- University of Nevada: *An Automatic Efficiency Optimizer for Fractional-Horsepower AC Motors*
- Tufts University: *LED Energy Saving Showerhead*
- Santa Clara University: *Phase Change Material in Automated Window Shades*



http://maxtechandbeyond.lbl.gov/

BTP's Research and Development…
the Ripple Effect

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Research CRADAs' effects on the Marketplace

HPWH = Heat Pump Water Heater

Challengers appear, set off by BTO R&D

Looking Forward

- Larger share of our budget will be competitively awarded through Funding Opportunity Announcements (FOAs)
  - Engage a broader group of researchers: industry, academia, small business, national labs
  - Current FOA #1: *Building Technologies Innovations Program* (DE-FOA-0000823), required Letters of Intent due 3/18/13, required Concept Papers due 4/1/13, full applications due 5/28/13
  - Current FOA #2: *"Turn Key" Open Source Software Solutions for Energy Management of Small to Medium-Sized Buildings* (DE-FOA-0000822), required Concept Papers due 4/22/13, full applications due 6/24/13
- Comprehensive Emerging Technologies Roadmap will be published and updated regularly

Emerging Technologies

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Program Manager

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Technology Managers

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- James Brodrick
- Bahman Habibzadeh
- George Hernandez
- Richard Karney
- Amir Roth
- Marc LaFrance (on detail)
- Karma Sawyer (detail)

Technical Project Officer

- Leon Fabick (GO)

Jim Payne (GO