What is the Environmental Energy Technologies Division?

US Department of Energy

National Laboratory System

Lawrence Berkeley National Laboratory
~4000 Employees
Managed by the University of California

Environmental Energy Technologies Division
~400 Employees, 5 Departments
Energy and Environment Research
Primary Sponsors: Federal and State Agencies
NAS estimate of economic benefits of EE R&D assigns $23 of $30 billion in savings to LBNL-derived technologies.

Additional $48 billion in savings from energy efficiency standards for 9 residential products:

- **Primary energy savings**
  - = 9% of 2025 residential energy use

- **Carbon reductions in 2025**
  - = 132 million metric tons CO₂/year
Improved Energy Technologies

- An energy-efficient and safe torchière lighting fixture
- Aerosol duct sealer
- Low-emission burner for heating and power
- Low energy fume hood
Energy Impacts (cont.)

China energy efficiency policies

Assisted China in:
- Transformation of refrigeration and lighting industries
- Appliance standards
- Building energy standards
- Iron & steel industry efficiency
- Motor systems

Intergovernmental Panel on Climate Change

- Significant contributions to reports

Reducing standby power losses
- U.S. executive order
- International 1-watt guideline

Electricity reliability
- Real time monitoring tools

Federal procurement
- Energy Efficiency in Federal Acquisition Regulations
- Federal Energy Management guidelines
Widely Used EETD-Developed Simulation Tools

- **DOE-2**
  - Building energy simulation program widely used for building design and energy performance compliance with standards

- **EnergyPlus**
  - Next generation of building energy simulation program with expanded capabilities and flexibility

- **Radiance**
  - Program for predicting and rendering lighting environments, used for lighting system design

- **Window**
  - WINDOW 5.2 is a publicly available computer program for calculating total window thermal performance indices

- **Home Energy Saver**
  - Web-based tool to guide selection of energy efficiency technologies by homeowners

- **CalTOX**
  - A risk assessment model that calculates chemical emissions and concentrations and the risk of adverse health effects
Understanding and Improving Indoor Air Quality (IAQ)

LBNL’s leadership role in IAQ Research

• Characterizing indoor pollutant sources
• Identifying risk factors and health effects
• Evaluating and demonstrating energy efficient technologies and practices for improving IAQ

Potential Health Improvements from Better IAQ

<table>
<thead>
<tr>
<th>Reduced</th>
<th>Annual U.S. Health Benefits</th>
<th>Impacts (1996 $U.S.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory disease</td>
<td>16-37M avoided illnesses</td>
<td>$6 - $14 billion</td>
</tr>
<tr>
<td>Allergies and asthma</td>
<td>8 - 25% decrease in symptoms in asthmatics and allergy sufferers</td>
<td>$1 - $4 billion</td>
</tr>
<tr>
<td>Sick building syndrome</td>
<td>20 - 50% reduction in symptoms</td>
<td>$10 - $30 billion</td>
</tr>
</tbody>
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Source: Fisk Annual Rev. E&E 2000
Affordable Energy-Efficient Provision of Clean Water for The Developing World

- 25% of the world’s population lacks access to safe water
- 60 million children suffer from stunted growth or development due to water borne disease
- 4 million deaths/year in developing world from polluted drinking water

UV Waterworks

- Appropriate low-cost technology provides water for less than $2 per person per year
- Now serving populations in Mexico, India, Philippines, Ghana, South Africa and elsewhere
Examples of EETD’s Ongoing Energy Research
Switchable Electrochromic Windows

- LBNL full-scale windows field test facility

• **Goal:**
  — Contribute unique expertise to development of solid state lighting technology

• **Significance:**
  — Lighting represents 30% of the total electric energy used within residential and commercial buildings.
  — **Solid state lighting could cut lighting energy use in half**

Luminous woven materials
High Power Lithium-Ion Batteries

Discovering causes of battery power loss in hybrid electric vehicles

• Hybrid EVs are entering the market, and lithium-ion is poised to become the preferred battery technology
  ➔ Higher power & energy, longer life, and similar cost, compared to Ni/MH

• EETD researchers are addressing key issues to advance lithium-ion technology

Microscopic images of electrodes

- Fresh cathode
- Failed cathode

- Color-coded images reveal how electrode surface chemistry changes during battery tests
  ➔ Loss of conductive carbon contributes to unwanted battery power loss

- $\text{LiNi}_{0.8}\text{Co}_{0.15}\text{Al}_{0.05}\text{O}_2$
- graphite
- acetylene black
Fuel Cells for Transportation

Applications

- Proton-exchange membrane fuel cells are favored for future transportation
  - Benign emissions, non-petroleum fuel, good performance, rapid refueling
  - Require lower cost, greater durability, hydrogen storage, infrastructure, and production

- Research Areas:
  - Novel catalyst layer: microstructures to reduce Pt loading (cost issue)
  - Nanostructured membranes
  - New diagnostic methods to help develop advanced hydride materials
  - Modeling of fuel cell components
Zero-Energy Commercial Buildings

Background

- The buildings sector accounts for about 40% of total U.S. energy consumption
- Approximately half of that is from commercial buildings.
- The commercial sector is the fastest growing energy end-use sector

Goals

- EETD is partnering with Alliance to Save Energy, AIA, ASHRAE, World Business Council for Sustainable Development to define and propose a major initiative to:
  - Stimulate measurement and disclosure of the energy performance of buildings
  - Develop and demonstrate scaleable and replicable building energy system solution packages
  - Develop a strategy for sector-wide building transformation
Water and Energy

- **Goals:** identify cost-effective ways to:
  - Increase energy efficiency of water delivery
  - Reduce waste of water

- **Significance:**
  - 7% of world energy is for delivering water
    - 50-60% of some municipal electricity bills is for water
  - U.S. freshwater withdrawals:
    - 38% thermoelectric power (recycled and reused)
    - 39% irrigation
    - 19% commercial, industrial, residential
  - **Serious and growing water availability problems** – in U.S. and worldwide
    - As in energy efficiency, technology can play a major role in reducing water use; behavior may be more important for water
Reducing Data Center Energy Consumption

Energy Demands at Data Centers and Super Computer Centers are Growing Rapidly

• Google warns “Power could cost more than servers”

• LBNL’s supercomputer center expects 7 fold increase in electricity demand over 10 years

Research areas

• Understanding how energy is used in data centers

• Efficient power supplies

• Efficient computer cooling strategies

• Real time monitoring and control

• Use of outdoor air for free cooling

• Power efficient algorithms
Fully Automated Electricity Demand Response

LBNL’s Demand Response Center

• Demonstrates large electricity sheds can take place without complaints
• Demonstrates range of strategies to produce electricity sheds and capabilities needed
• Provides knowledge and experience needed for related policies and building codes
Monitoring the Electricity Grid to Reduce Failures

• **Background:**
  — Massive amounts of real time data collected about electricity flows on U.S. transmission grids

• **Problem:**
  — Operators of electricity grid were unable to analyze the data in close to real time

• **Achievements**
  — Created *visualization tool* to analyze and display data in real time
  — Tool being adopted by all 23 National Electricity Reliability Council Coordinators (covering nation) and by several Independent System Operators

*Achievements by the Consortium for Electricity Reliability Technology Solutions (CERTS) led by LBNL*
Climate Effects of Aerosols

- Using the Goddard Institute for Space Studies climate model
- Simulations revealed that the heating effects of black carbon result in lower level heating, changes in vertical motions, circulation, and thus cloud cover and rainfall. (Menon et al. Science, 2002)
- Results show that the regional climate effects of BC particles can be quite significant.

### With black carbon
\[ \Delta \text{Precipitation mm/d} \]

### Without black carbon
\[ \Delta \text{Precipitation mm/d} \]
For More Information

http://eetd.lbl.gov/