Lawrence Berkeley National Laboratory
Environmental Energy Technologies Division
Overview

William J. Fisk
Acting Division Director
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
Berkeley Lab’s New Scientific Directions

- Solar to Chemical Energy
  Basic Energy Sciences
- Ultrafast Science
  Basic Energy Sciences
- Nano-Bio Frontier
  Basic Energy Sciences
- Quantitative Biology
  Biological and Environmental Research
- Matter and Energy in the Universe
  High Energy Physics
- New Energy Systems and Environmental Solutions
  Energy Efficiency and Environmental Research
- Scientific Computing
  Advanced Scientific Computing Research
## Energy Analysis Department

**123 staff & guests**

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<th>J.E. McMahon, Head</th>
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<tr>
<td>Electricity Markets &amp; Policy</td>
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<td>International Energy Studies</td>
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<td>End-Use Forecasting &amp; Market Assessment</td>
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Building Technologies Department
66 staff & guests

S.E. Selkowitz, Head

Windows & Daylighting
Commercial Building Systems
Lighting Systems
Simulations Research
Demand Response, Residential & Industrial Policy
Applications Team
Advanced Energy Technologies Department
95 staff & guests

R.E. Russo, Head

Electrochemical Technologies

Physical/Chemical Technologies

Combustions Technologies
Indoor Environment Department
63 total staff

Tom McKone, Head (acting)

Environmental Chemistry, Exposure, and Risk

Commercial Building Ventilation & Indoor Environmental Quality

Airflow & Pollutant Transport

Energy Performance of Buildings
Atmospheric Sciences Department
26 total staff (includes matrixed staff & guests)

N.J. Brown, Head

Atmospheric Processes Impacting Air Quality
Atmospheric Processes Impacting Global Climate
Emissions
Aerosol Sources and Exposures
Impacts of EETD’s Efficiency R&D
From National Academy of Sciences Report

Estimate of Economic Benefits

Lifetime Savings (Net) for Technologies*

$ Billions

2000 Dollars

48.5

25

20

15

10

5

0

DOE-2 Buildings Design Tool
Advanced Window Coatings
Electronic Fluorescent Ballast
Appliance Efficiency Standards

NAS estimate of economic benefits of EE R&D assigns $23 of $30 billion in savings to two LBNL-derived technologies (Table 3-4, page 64)

Additional $48 billion in savings from 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

Berkeley Lamp

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

“OFF” – 17 Watts
ON - 21 Watts

ATTENTION OFFICIALS
FAR Part 23.203 now requires energy efficient purchasing: 23.203 Energy-Efficient products.
1. If life-cycle cost effective, and available,
2. When acquiring energy efficient products, contracting officers may purchase ENERGY STAR® or other energy efficient DOE/FEMP designated products.

Energy Impacts (cont.)
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 an adverse health effects
UV Waterworks
- ~4M deaths/year from polluted drinking water
- Appropriate low-cost technology
- Initial commercialization

Scientific and Technology Underpinnings of Health Benefits from Improved Indoor Air Quality

<table>
<thead>
<tr>
<th>Reduced</th>
<th>Annual U.S. Health Benefits</th>
<th>Impacts (1996 $U.S.)</th>
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<tr>
<td>Respiratory disease</td>
<td>16-37M avoided illnesses</td>
<td>$6 - $14 billion</td>
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<tr>
<td>Allergies and asthma</td>
<td>8 - 25% decrease in symptoms in asthmatics and allergy sufferers</td>
<td>$1 - $4 billion</td>
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<tr>
<td>Sick building syndrome</td>
<td>20 - 50% reduction in symptoms</td>
<td>$10 - $30 billion</td>
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LBNL’s Contributions to Reduced Exposures to Indoor Pollutants
We have played leadership role in:
- Characterizing pollutant sources
- Identifying risk factors and health effects
- Evaluating and demonstrating control measures

Source: Fisk Annual Rev. E&E 2000
Examples of Current Directions
Switchable Electrochromic Windows:

- LBNL full-scale windows field test facility
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

10 µm
**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
**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
Getting to “Zero Net Energy” or “Carbon Neutral” Buildings

• Deployment: (5 - 30% savings)
  • Identify what works and deploy it widely
  • Applies to all buildings: new and existing
  • Mandatory programs: codes and standards
  • Voluntary programs: incentives

• Demonstrate Emerging Solutions (20 - 60% savings)
  • Find Underutilized, unproven technologies and systems
  • R&D to improve, optimize; Make them mainstream

• Breakthrough Innovations (50-80% savings plus on-site renewable power)
  • New, more effective, high performance options
  • Lower costs, Lower risk

• National Initiative Needed to Achieve this vision: $200M+/yr
Health Effects of Indoor Exposures

Background

• Most exposures to pollutants occur indoors

LBNL Initiative:
Create capability for assessing/reducing adverse health effects of indoor air quality

• Improved exposure assessment
• Epidemiologic analyses
• Intervention studies

Initial efforts
• Particles
• VOCs

Significance

• Establish priorities for mitigation research
• Enable energy efficiency in buildings without compromising health
• Ultimately provide basis to reassess impacts of outdoor air quality
Monitoring the Electricity Grid

• 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/