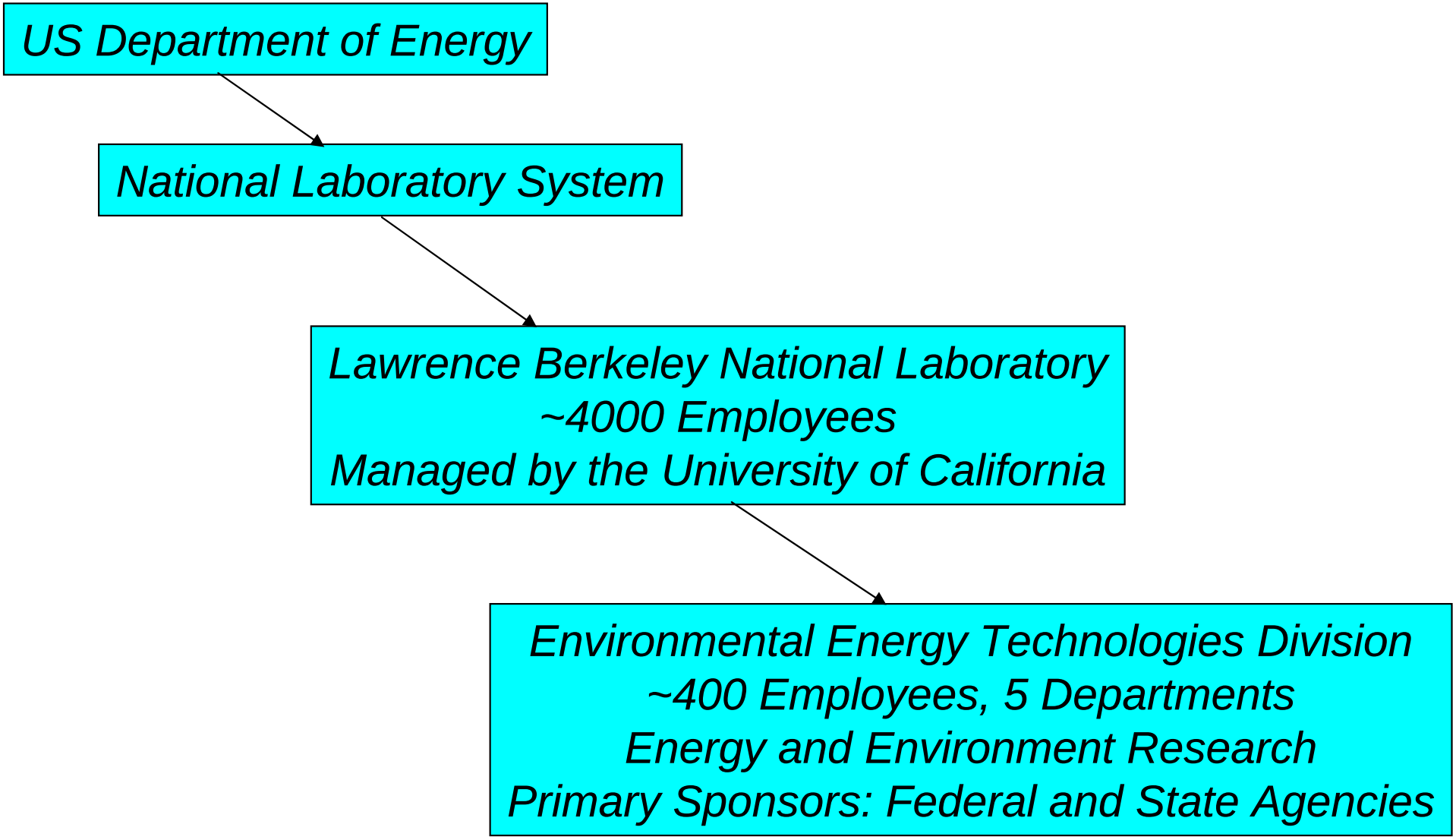
Lawrence Berkeley National Laboratory
Environmental Energy Technologies Division (EETD)

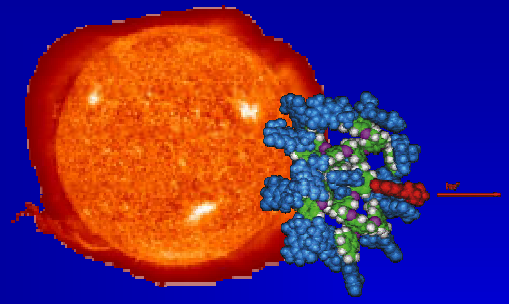
Saving Energy and Improving Environmental Quality

William J. Fisk
Acting Division Director

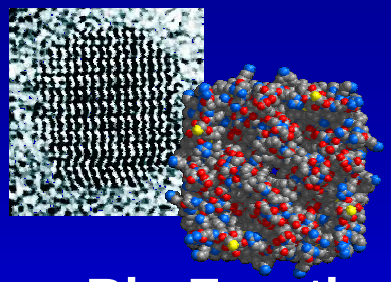
What is the Environmental Energy Technologies Division?



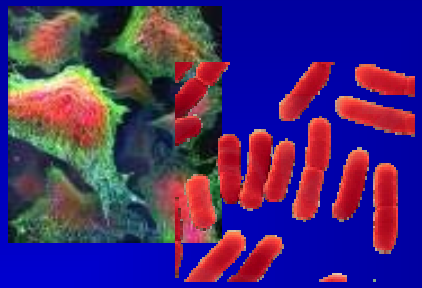
Berkeley Lab's New Scientific Directions



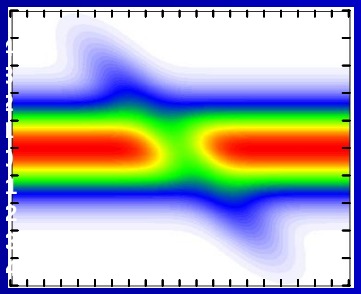
Solar to Chemical Energy
Basic Energy Sciences



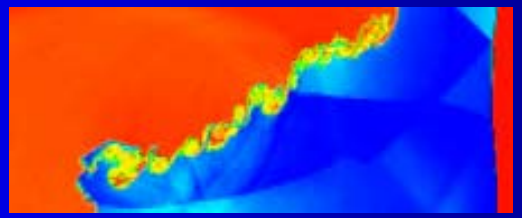
Nano-Bio Frontier
Basic Energy Sciences



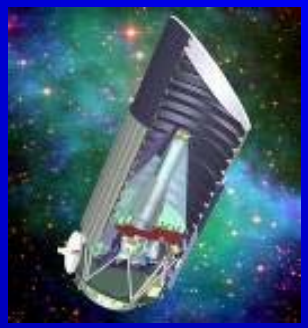
Quantitative Biology
Biological and Environmental Research



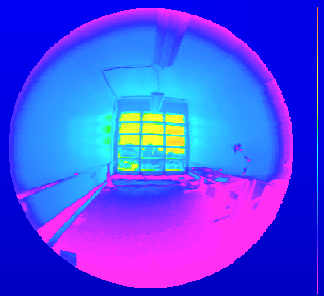
Ultrafast Science
Basic Energy Sciences



Scientific Computing
Advanced Scientific Computing Research



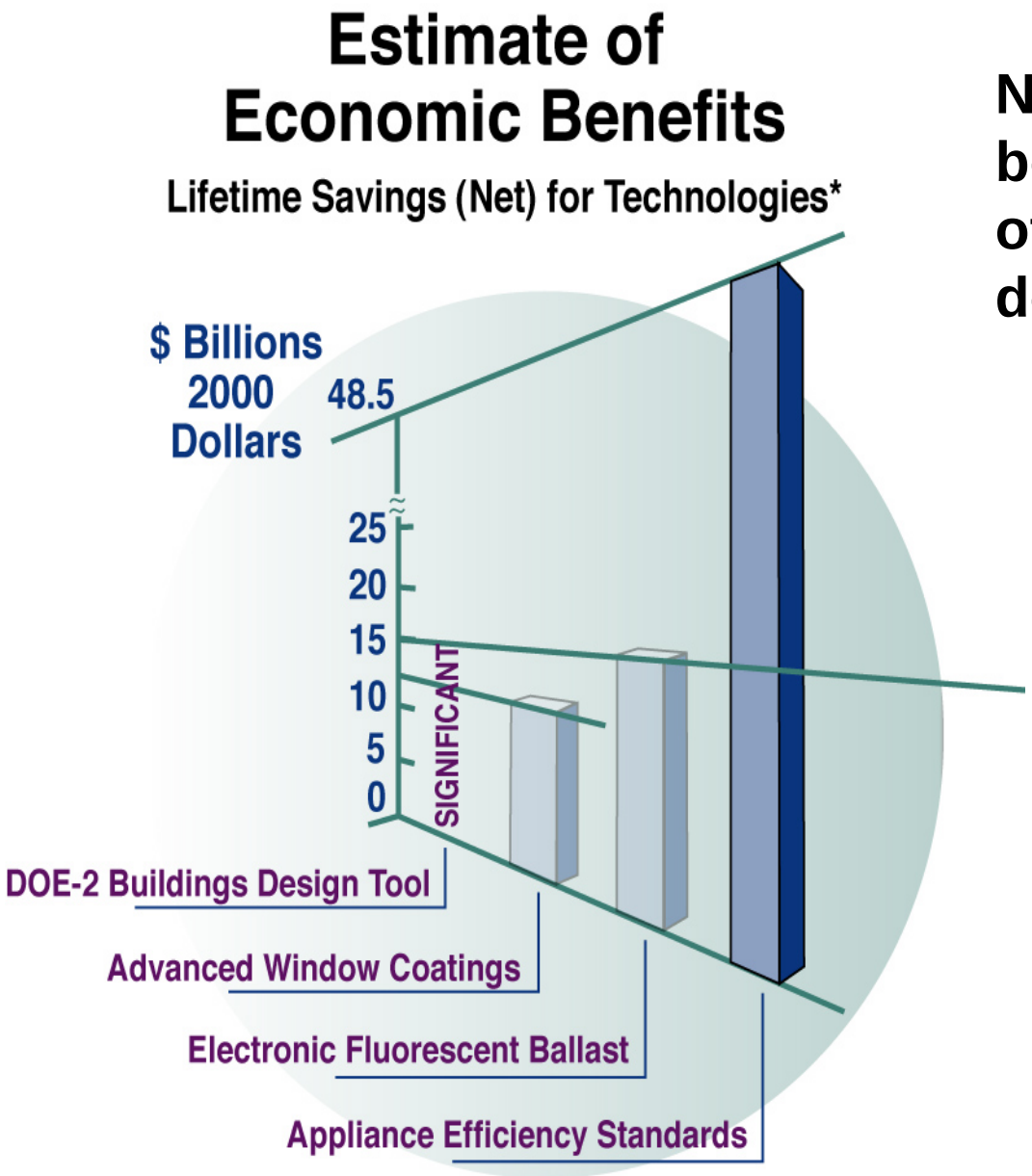
Matter and Energy in the Universe
High Energy Physics



New Energy Systems and Environmental Solutions
Energy Efficiency and Environmental Research

Prior Impacts of EETD's Efficiency R&D

From National Academy of Sciences Report



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 CO_2/year**

Improved Energy Technologies

An energy- efficient and safe torchiére lighting fixture

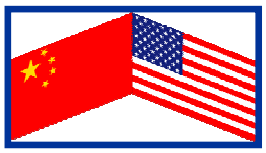
Berkeley Lamp

Aerosol duct sealer

Low- emission burner for heating and power

Low energy fume hood

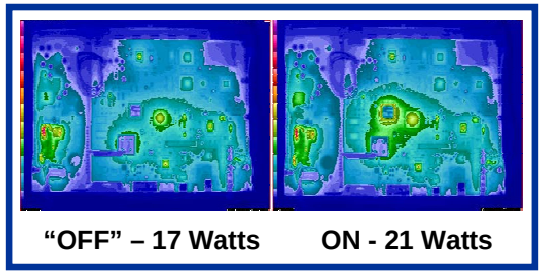
Energy Impacts (cont.)



China energy efficiency policies

Assisted China in:

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

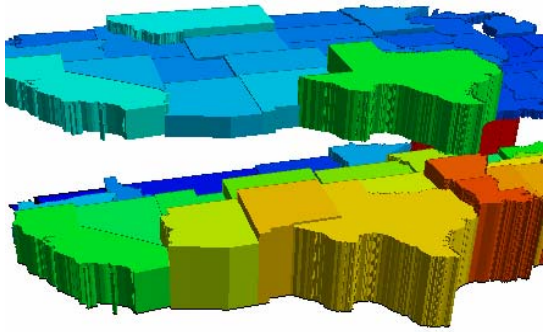


Reducing standby power losses

- U.S. executive order
- International 1-watt guideline

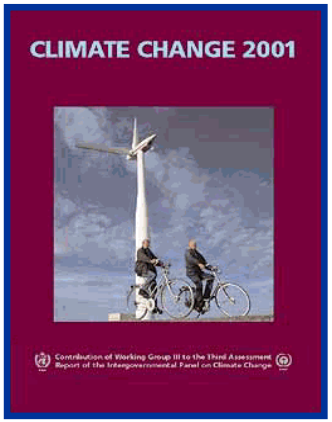
Electricity reliability

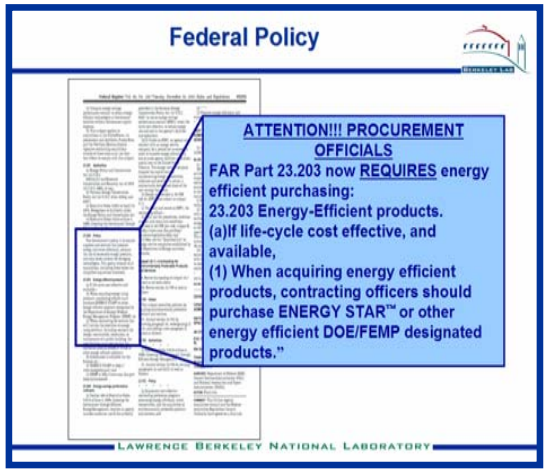
- Real time monitoring tools



Intergovernmental Panel on Climate Change

- Significant contributions to reports



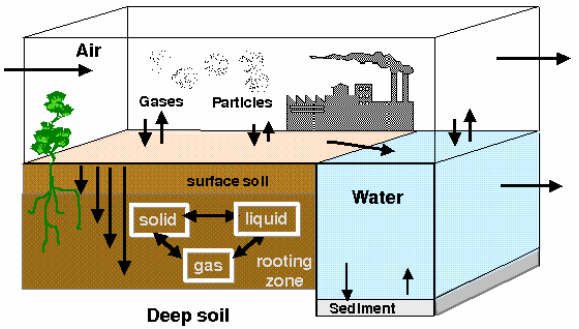


Federal procurement

- 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 an 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

Reduced	Annual U.S. Health Benefits	Impacts (1996 $U.S.)
Respiratory disease	16-37M avoided illnesses	$6 - $14 billion
Allergies and asthma	8 - 25% decrease in symptoms in asthmatics and allergy sufferers	$1 - $4 billion
Sick building syndrome	20 - 50% reduction in symptoms	$10 - $30 billion

Source: Fisk Annual Rev. E&E 2000

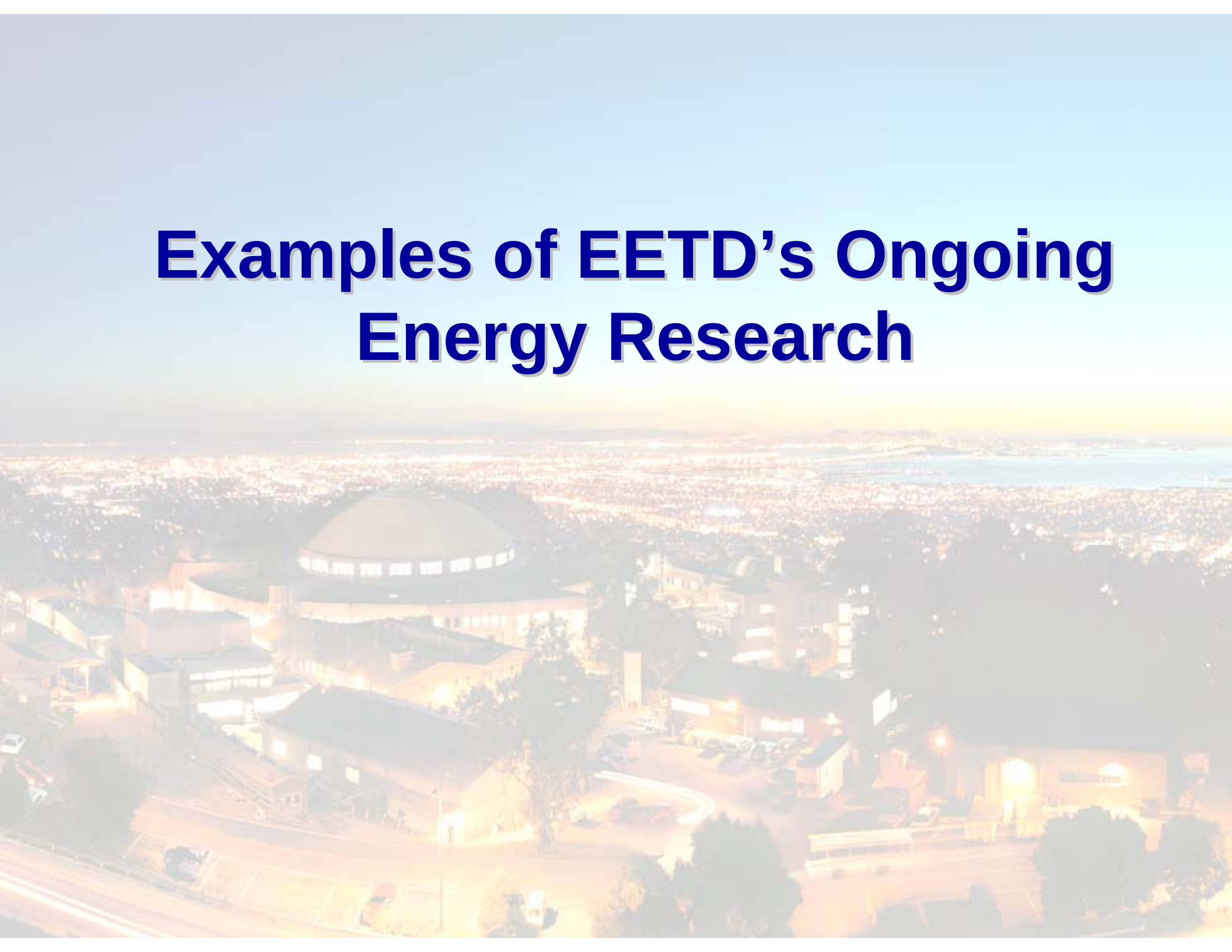
Affordable Energy-Efficient Provision of Clean Water for The Developing World

- **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

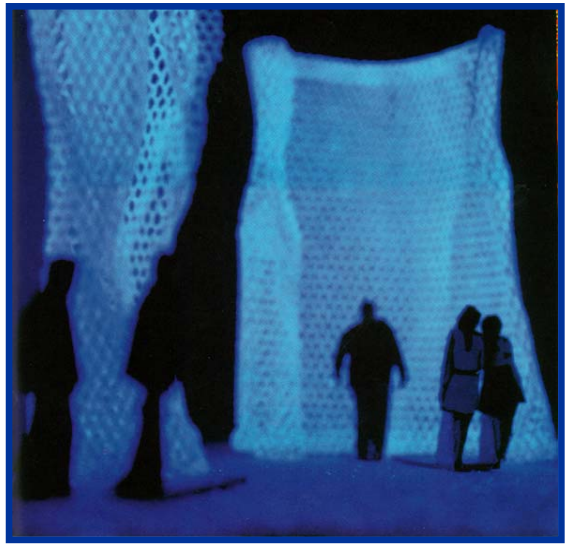


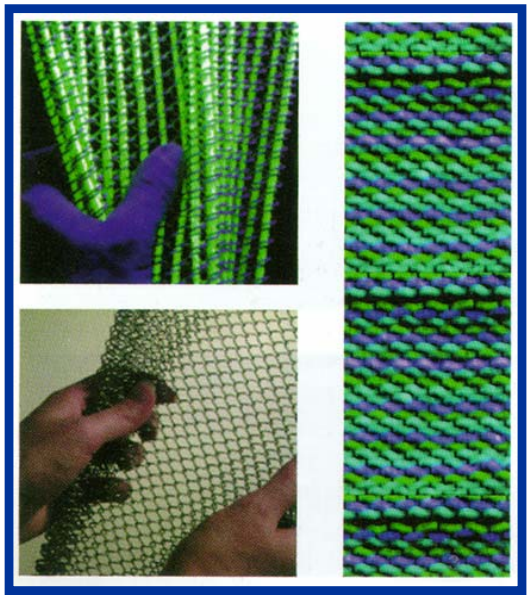
Switchable Electrochromic Windows

- **LBNL full-scale windows field test facility**

Solid State Lighting: The Next Generation of Energy Efficient Lighting Products

- **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

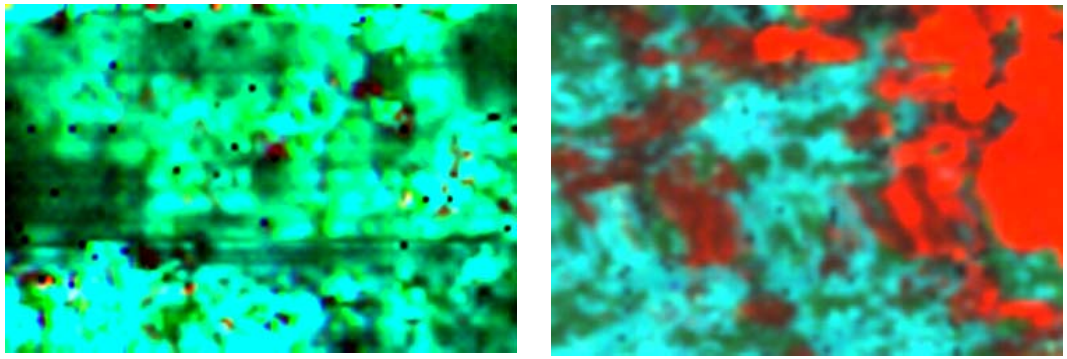
Discovering causes of battery power loss in hybrid electric vehicles

- **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**



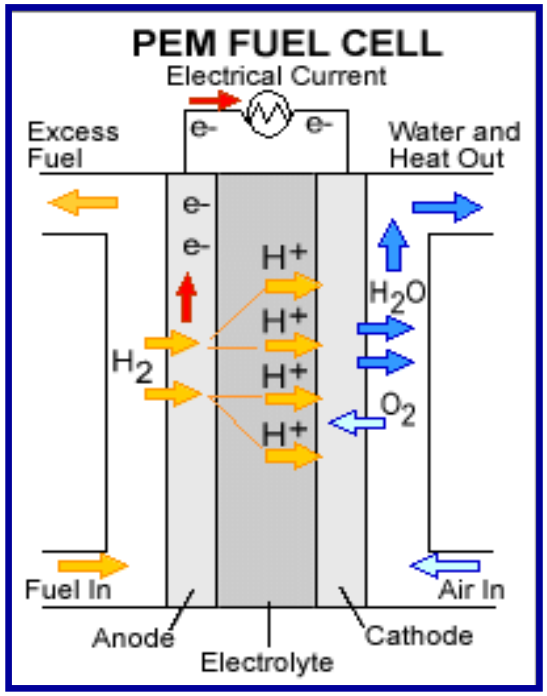
- ◆ $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$
- ◆ graphite
- ◆ acetylene black

10 μm

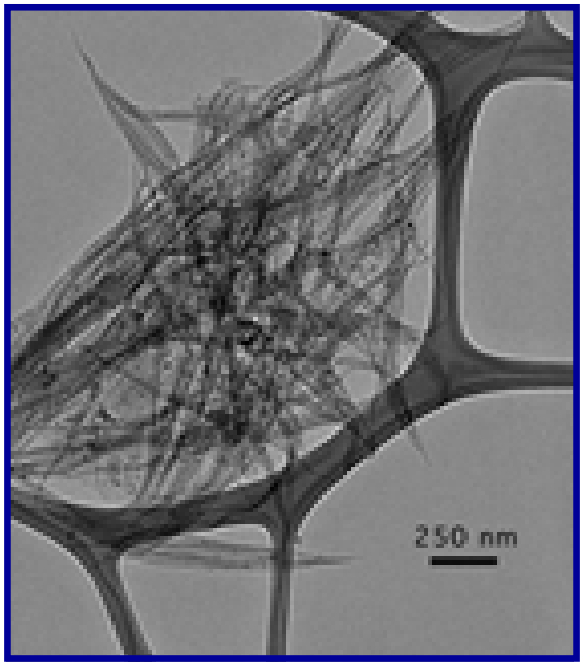
- **Color-coded images reveal how electrode surface chemistry changes during battery tests**
  - ➔ **Loss of conductive carbon contributes to unwanted battery power loss**

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

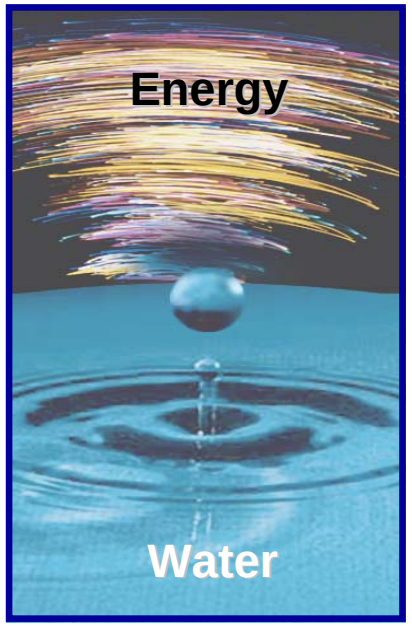
- **The buildings sector accounts for about 40% of total U.S. energy consumption**
- **Approximately half of that is from commercial buildings.**
- **The commercial sector is the fastest growing energy end-use sector**

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

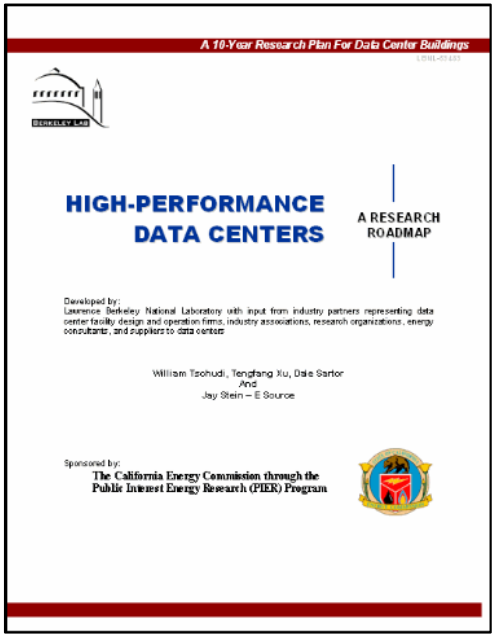
Energy Demands at Data Centers and Super Computer Centers are Growing Rapidly

- Google warns “Power could cost more than servers”
- LBNL’s supercomputer center expects 7 fold increase in electricity demand over 10 years

NERSC IBM Bassi SuperComputers
XBD200510-00348-13

Research areas

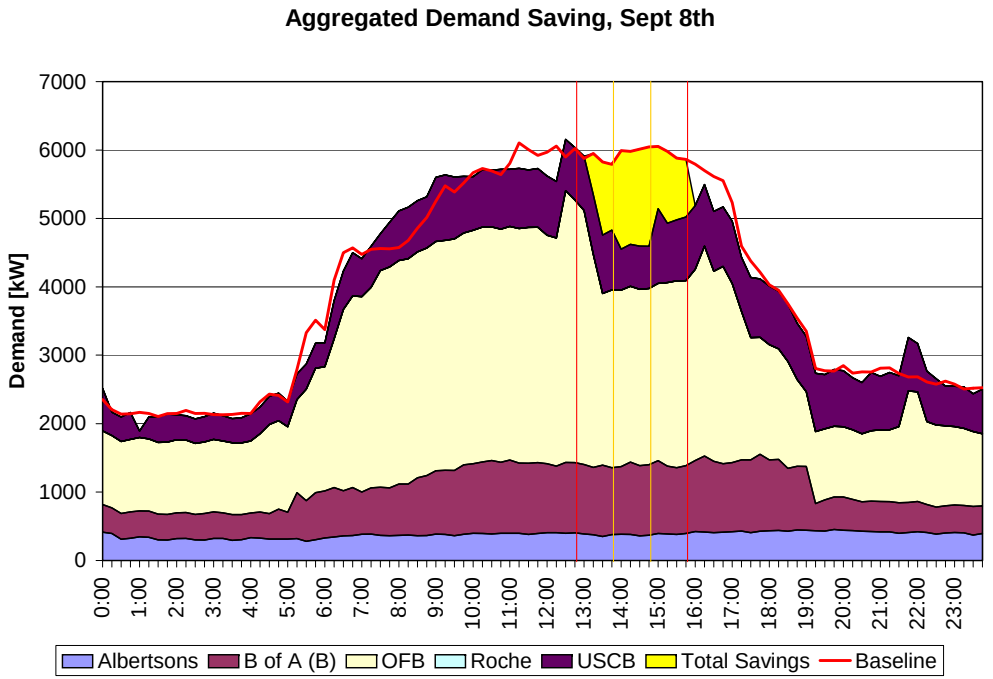
- Understanding how energy is used in data centers
- Efficient power supplies
- Efficient computer cooling strategies
- Real time monitoring and control
- Use of outdoor air for free cooling
- Power efficient algorithms

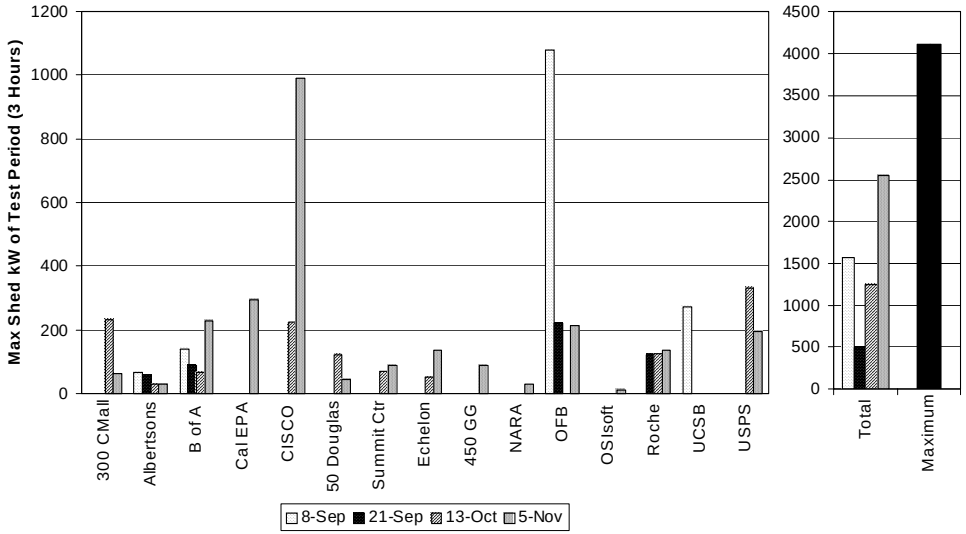


Fully Automated Electricity Demand Response

LBNL's Demand Response Center

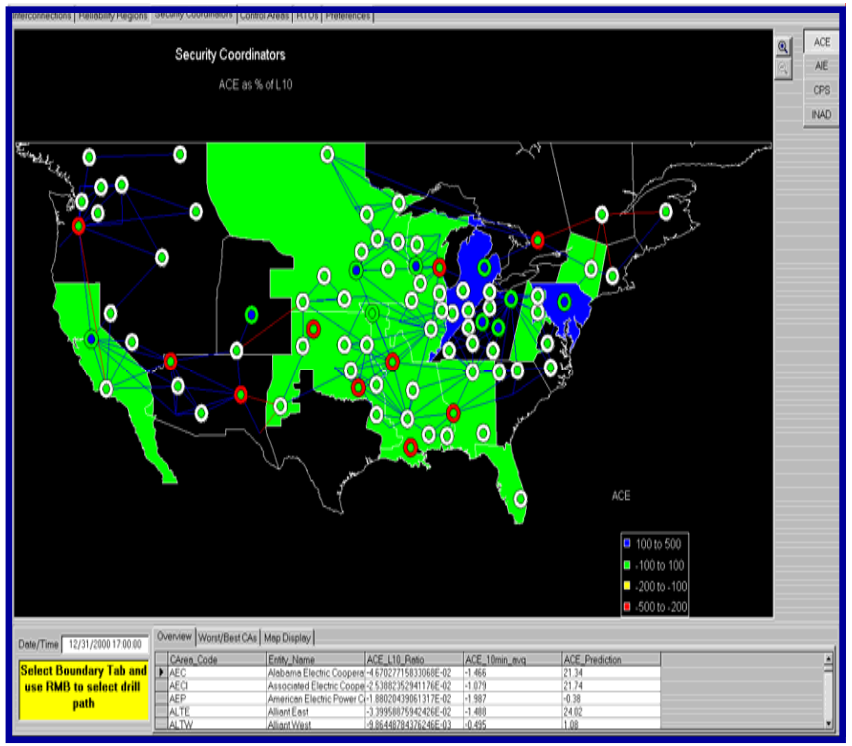
- **Demonstrates large electricity sheds can take place without complaints**
- **Demonstrates range of strategies to produce electricity sheds and capabilities needed**
- **Provides knowledge and experience needed for related policies and building codes**





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

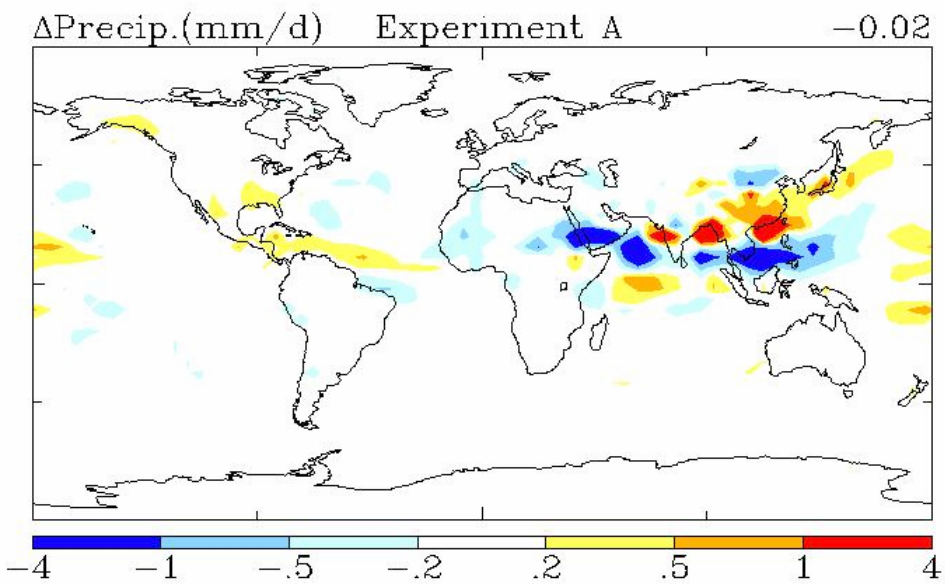


* Achievements by the Consortium for Electricity Reliability Technology Solutions (CERTS) led by LBNL

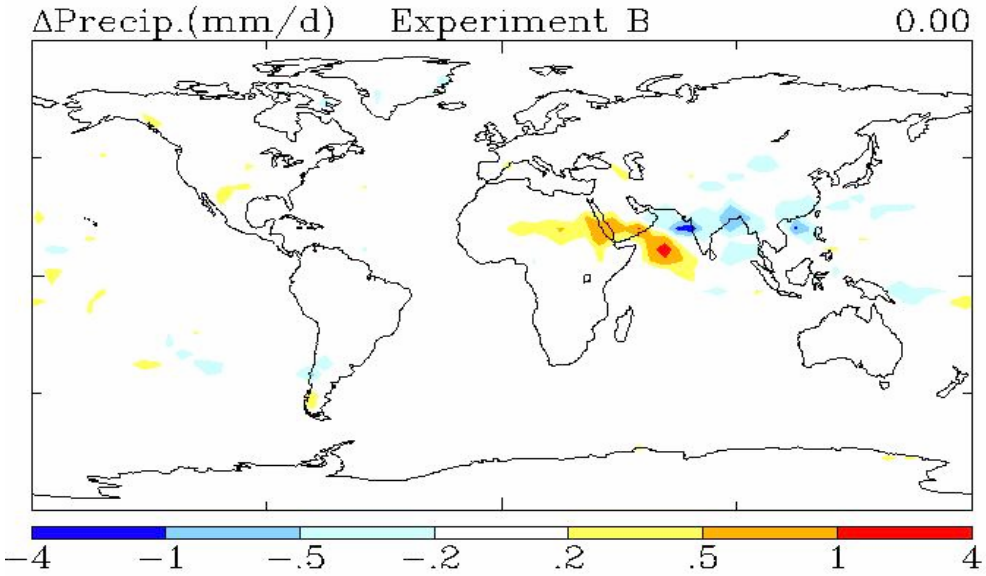
Climate Effects of Aerosols

- **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
Δ Precipitation mm/d



Without black carbon
Δ Precipitation mm/d



For More Information

http://eetd.lbl.gov/