

CERL Industry Workshop February 25-27, 2004

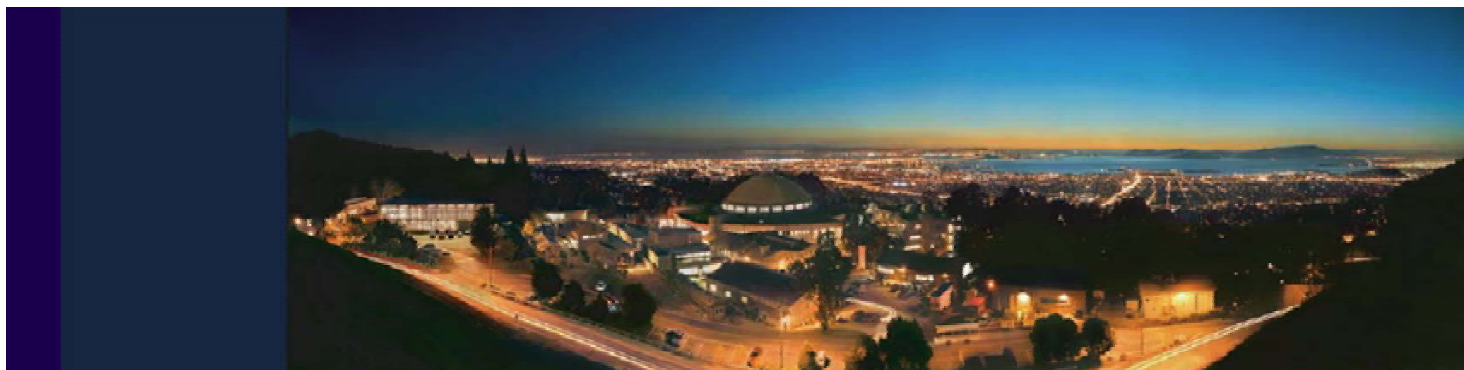


ENERGY ANALYSIS, BENCHMARKING, AND INDUSTRIAL INNOVATIONS METHODOLOGY

**Presented by
Don Foster, PE; Consultant –
Industrial Partnerships
Lawrence Berkeley National
Laboratory**

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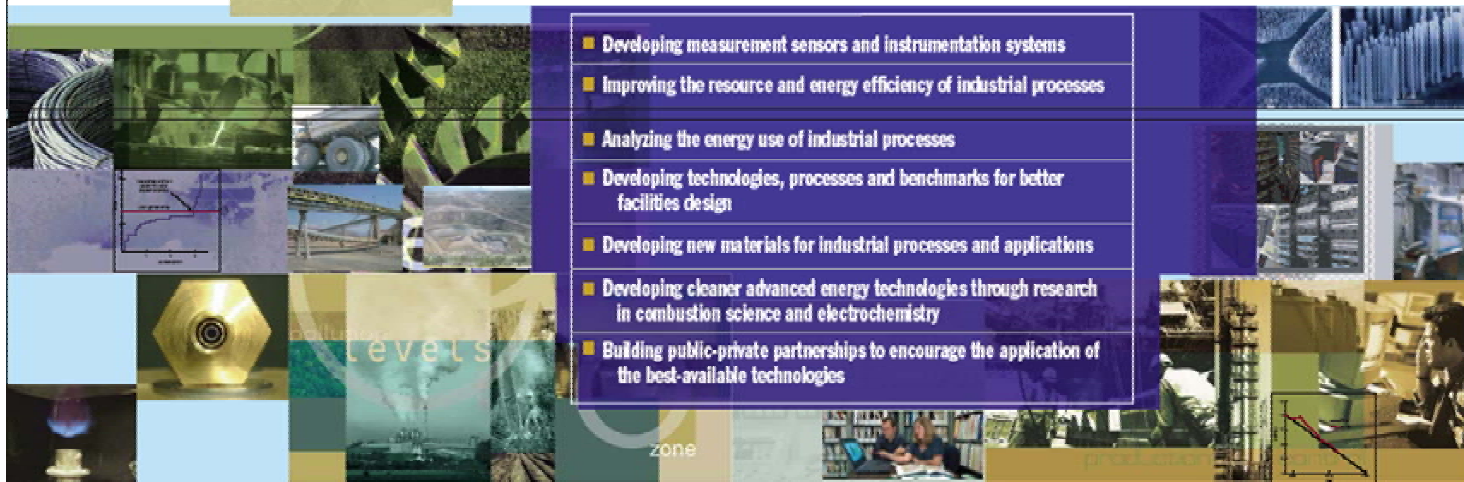
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Industrial Innovations:

Industrial research at **Lawrence Berkeley National Laboratory** covers a wide spectrum of practical applications. Berkeley Lab researchers work closely with representatives from many industries to **analyze and improve** industrial processes. Current research focuses on such areas as:

- Developing measurement sensors and instrumentation systems
- Improving the resource and energy efficiency of industrial processes
- Analyzing the energy use of industrial processes
- Developing technologies, processes and benchmarks for better facilities design
- Developing new materials for industrial processes and applications
- Developing cleaner advanced energy technologies through research in combustion science and electrochemistry
- Building public-private partnerships to encourage the application of the best-available technologies



<http://industrial-innov.lbl.gov/>





Energy Technology Research and Analysis

Industrial Innovations

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- Developing new materials for industrial processes and applications.
- Developing cleaner advanced energy technologies through research in combustion science and electrochemistry.
- Analyzing industrial impacts on air and water quality.
- Building public-private partnerships to encourage the application of the best-available technologies.





- Home
- Advanced Energy Technologies
- Air & Water Quality
- High Technology Buildings
- Industrial Energy Use Analysis
- Industrial Partnerships
- Measurement Sensor & Instrumentation Systems
- New Materials
- Contact Us
- Search

Home | [Berkeley Lab](#) | [Contact Us](#) | [Webmaster](#)

Industrial Innovations



- Improving the Resource and Energy Efficiency of Industrial Processes
- Analyzing the Energy Use of Industrial Processes
- Developing Technologies, processes and Benchmarks for Better Facilities Design

Industrial Innovations



- **Developing Measurement Sensors and Instrumentation Systems**
- **Developing New Materials for Industrial Processes and Applications**
- **Developing Cleaner Advanced Energy Technologies Through Research in Combustion Science and Electrochemistry**
- **Building Public-Private Partnerships to Encourage the Application of Best-available Technology**

Industrial Energy Use Analysis



Industrial Energy Use Analysis

Industry consumes more energy and produces more emissions than any other sector of the economy. Nevertheless, little is known about industrial use patterns. This is mainly because the industrial sector comprises a diverse network of producers, technologies, and processes. As a result, a wide range of knowledge is required to accurately assess industrial energy consumption and then evaluate how to reduce that sector's energy use and related emissions.

Berkeley Lab has specialists in all areas of industrial energy use analysis. Our staff of engineers, systems modeling experts, economists, and policy analysts explores the key questions facing decision-makers:

- What are the recent industrial energy use trends?
- What are the emerging industrial technologies that influence energy use? What is the market for these technologies?
- How can policies and programs properly address industrial energy concerns? What are the best evaluation tools to measure program success?
- What is the potential impact of energy efficiency policies and measures on the industrial sector?



[Links](#)



[Home](#)

[Advanced Energy Technologies](#)

[Air & Water Quality](#)

[High Technology Buildings](#)

[Industrial Energy Use Analysis](#)

[Industrial Partnerships](#)

[Measurement Sensor & Instrumentation Systems](#)

[New Materials](#)

[Contact Us](#)

[Search](#)

Industrial Energy Use Analysis



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BEST: An Integrated Tool for Industry



- BEST: Benchmark and Energy Savings Tool for Industry
- An Integrated Tool to:
 - **benchmark the performance of an industrial plant or facility**
 - **evaluate energy efficiency opportunities**
 - **track energy performance and improvement**
- Test version has been developed for the iron and steel industry
 - **tested and used by two integrated steel plants in China to set long-term energy-efficiency improvement targets**
- Under development for the California wine industry
- Future: pulp & paper, cement, mining (dependent on funding and funding sources)

Why BEST ?



- Why Benchmarking?
 - Companies often have the perception that they are highly energy-efficient
 - Benchmarking provides a tool to test this perception using accepted benchmark values for technology
 - Benchmarking addresses the specific product and feedstock mix at the plant
 - Experience with benchmarking programs worldwide has shown increased attention for energy-efficiency and performance
- Why an integrated energy-assessment tool?
 - Allows low-cost and easy evaluation of energy-efficiency improvement potential and provides a menu of opportunities
 - Reduces transaction costs for information collection, preliminary evaluation, and strategic energy management

BEST Features



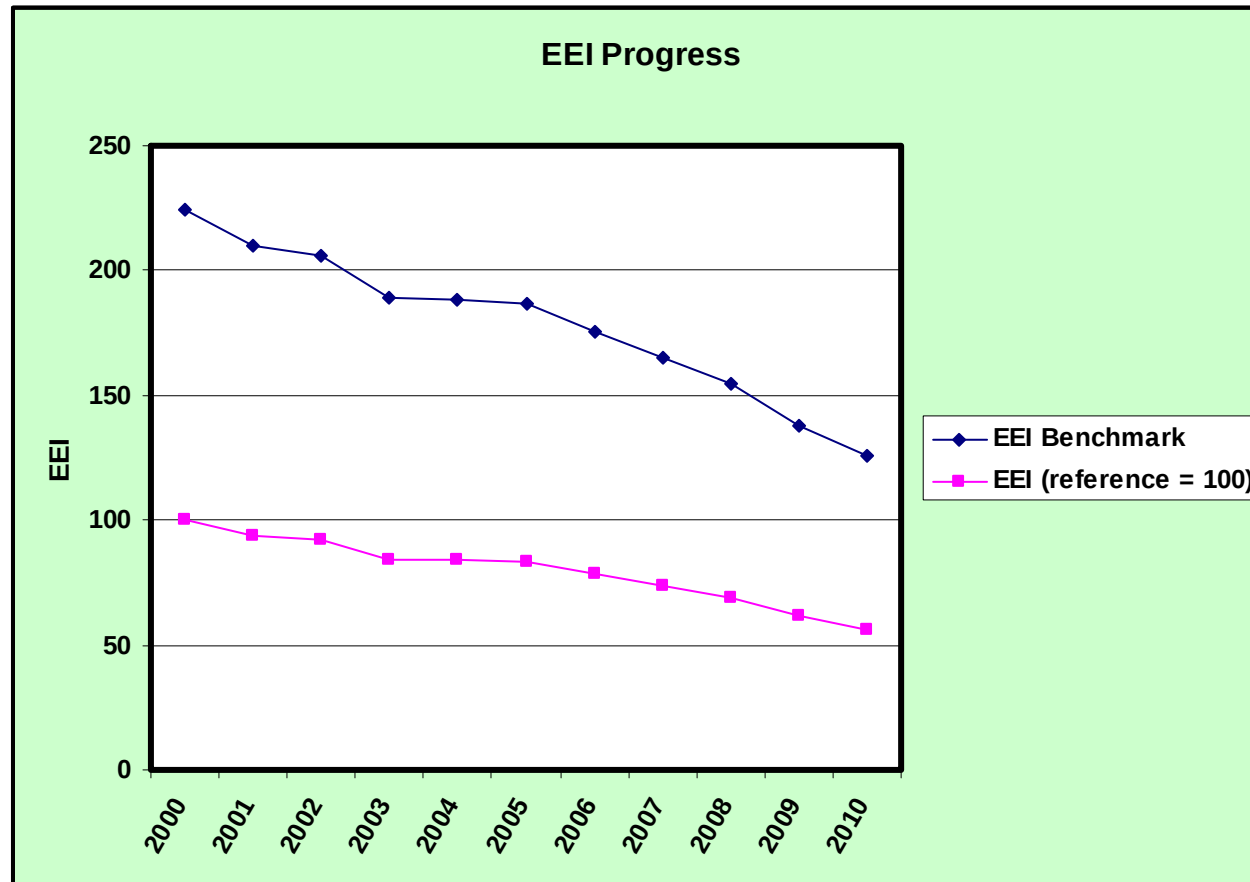
- Benchmark plant by process
 - **Plant energy intensity calculated by process**
 - **Plant energy intensity benchmarked to industry “best practice”**
(EcoTech plant by process)
- Benchmark entire plant to industry “best practice”
- Energy-efficiency options by process
 - **Documentation of plant’s current situation**
 - **Assessment of plant’s energy-efficiency potential**
- Annual monitoring of progress relative to potential
- Annual energy consumption input - datasheet
 - **energy use by process, by fuel**
 - **can be designed based on existing data collection methods used by the industry**

Energy Efficiency Options



- Begin with assessment of plant's current situation
- Select from an extensive menu of energy-efficiency technologies and measures that could be implemented
 - Process-related
 - Cross-cutting: includes motor systems, boilers, steam distribution, cogeneration, and general measures
- For each option, BEST provides:
 - Typical energy savings per ton product (iron, steel)
 - Relative cost of implementation (high, medium, low)
 - Other benefits such as reduced emissions, reduced water use, increased productivity, etc.
- Once options for implementation are selected, BEST calculates potential EEI for plant

Annual Monitoring of Progress Relative to Potential



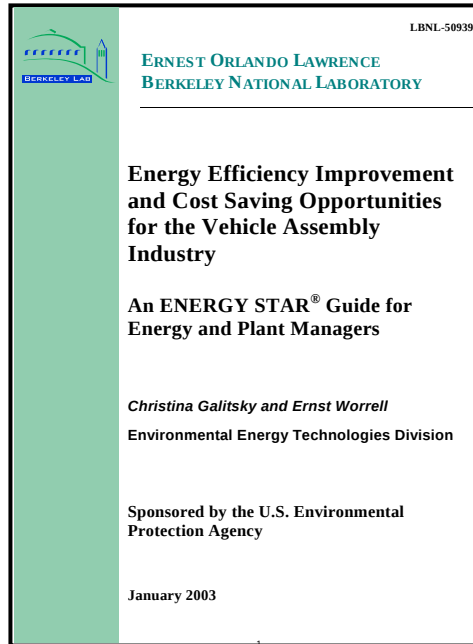
BEST Wineries

- Development of Integrated Benchmarking and Assessment Tool in Wineries for:
 - benchmark energy intensity and water intensity in winery
 - include an assessment of energy-efficiency and water-efficiency opportunities
 - integrate water-efficiency effects on energy efficiency
 - be applicable for smaller and larger wineries
- Wineries are second largest energy user in California food industry
- Funded by California Energy Commission
- Partnered with Fetzer Vineyards, a leader in sustainable practices in the Wine Industry

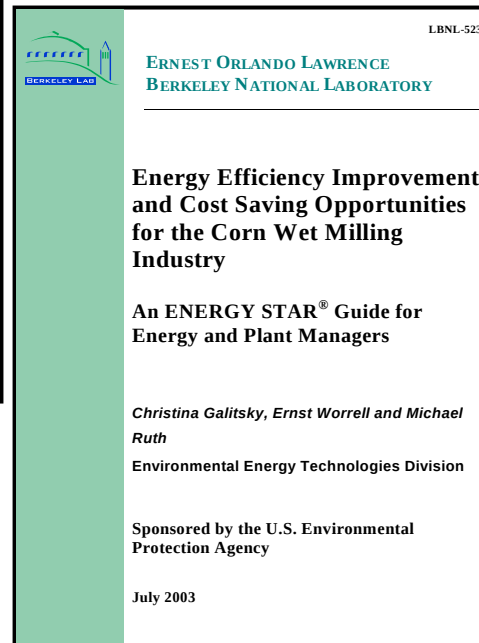


FETZER®
VINEYARDS

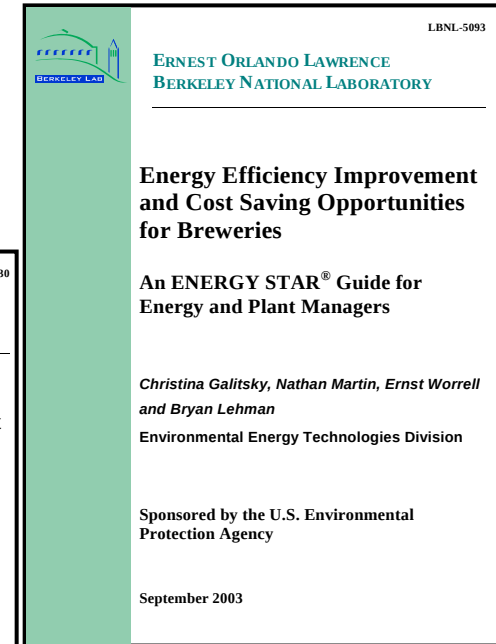
Current Energy Guides



**Vehicle Assembly
Motor**



Corn Wet Milling



Breweries

more under development: cement, petroleum refining, pharmaceuticals,

High Technology Buildings



High Technology Buildings

(Cleanrooms, Data Centers, Laboratories)

High technology buildings are among the most energy-intensive buildings used in the industrial sector. They include cleanrooms, used in the manufacture of semiconductors, pharmaceuticals and other products that require nearly particle-free environments; data centers, which house servers for Internet communications; and laboratories buildings, which may be in use 24 hours a day, and have very high heating, ventilation and air conditioning requirements.

Cleanrooms

Facilities operators and engineers in the semiconductor industry can reduce energy consumption by half, save water used in processing, and conserve expensive and hazardous chemicals by applying state-of-the-art resource-efficiency techniques and measures to their silicon production and semiconductor fabrication facilities.

Data Centers

Current research on data centers focuses on: identifying benchmark and best practices; researching improved efficiency of uninterruptible power supplies and computer power supplies; developing a self-benchmarking protocol; improving the interface of building systems and computer equipment; demonstrating air management in an operating data center; and promoting technology transfer with utilities and industrial associations.

Laboratories

Methods of conserving energy through new designs for implementation in high-tech industries are detailed in the Design Guide for Energy-Efficient Research.

[Links](#)



[Home](#)

[Advanced Energy Technologies](#)

[Air & Water Quality](#)

[High Technology Buildings](#)

[Industrial Energy Use Analysis](#)

[Industrial Partnerships](#)

[Measurement Sensor & Instrumentation Systems](#)

[New Materials](#)

[Contact Us](#)

[Search](#)

HIGH TECHNOLOGY INDUSTRIAL BUILDINGS



- ENERGY PLUS TOOLS
- MOST ENERGY-INTENSIVE FACILITIES
- EXAMPLES INCLUDE CLEANROOMS, DATA CENTERS AND LABORATORIES
- HIGH PERFORMANCE BERKELEY FUME HOOD
- AEROSOL DUCT SEALING TECHNOLOGY

Opportunities Are Real

LBNL Example:

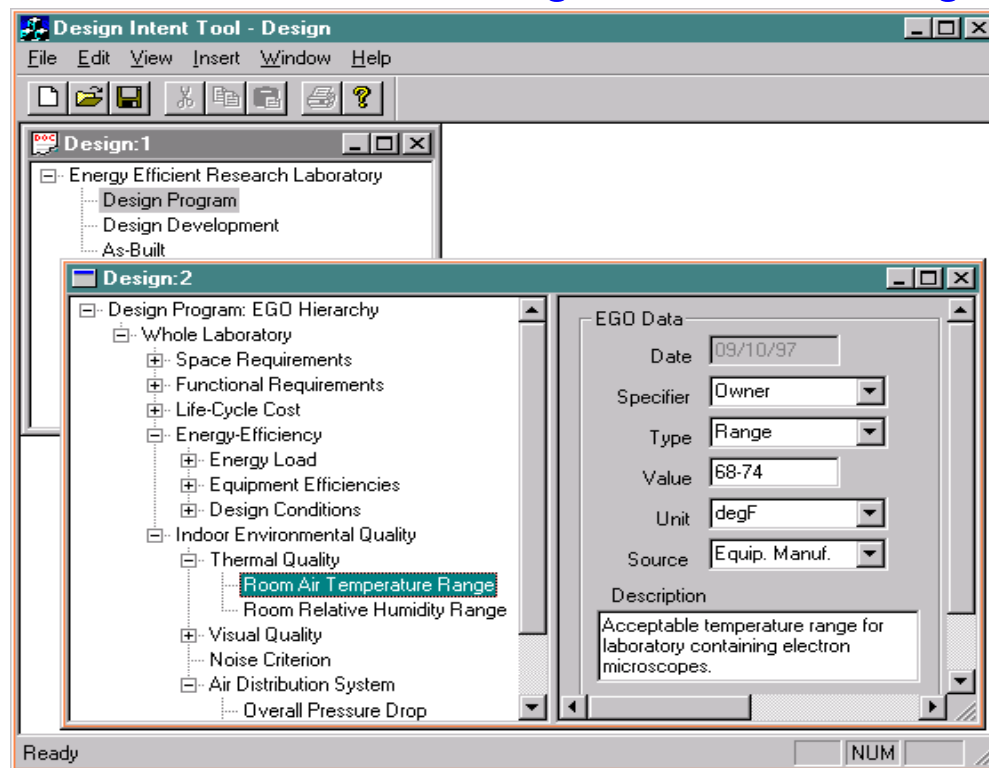
- 40% reduction in energy use per square foot from 1985 baseline
- \$4 million/year more research based on 1985 energy prices
- Improved worker productivity
- Safer environment
- Improved reliability



Information Technology: Design Intent Documentation Tool

Objective:

Capture design intent information & performance expectations for use throughout the building's life-cycle.

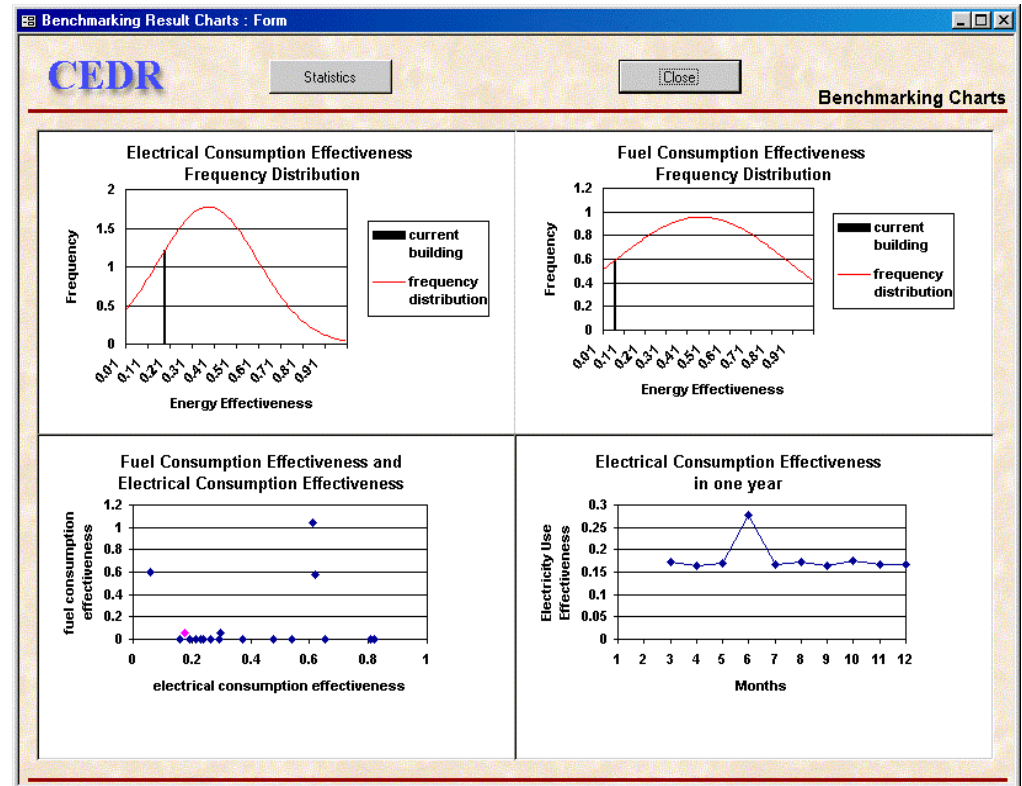


Benchmarking Protocol and Tools

Objective:

Provide feedback to designers and operators of actual building loads and performance (reduce oversizing)

- Performance Metrics
- Database
- Feedback Mechanisms



Laboratories for the 21st Century Design Tool Kit

- An Internet-accessible compendium containing the following tools:
 - Guides to energy efficient laboratory design.
 - Design intent tool.
 - (Future) national database with performance metrics for laboratory energy use.
 - Case Studies
 - Links to other related Web sites



Measurement Sensor and Instrumentation Systems



Measurement Sensor and Instrumentation Systems



Every industry and field of scientific research uses sensors, measurement technology, and process control systems. These instruments help keep people safe and healthy, improve or maintain product quality and services, and regulate processes to regulate the flow of resources including energy.

Drawing on Berkeley Lab's unique capabilities and facilities in physics, chemistry, engineering, biology, and environmental science, scientists of our Industrial Innovations team develop leading-edge measurement systems and sensor technologies.

Focus areas include:

- Acoustic sensors for monitoring and process control.
- Biological and chemical sensors for environmental and medical applications.
- Laser-based and other optical technologies.
- Magnetic and radio frequency sensors for industrial processes.
- Photonic sensors for process control, chemical, and medical applications.
- Semiconductor-based detectors for radiation detection.
- Spectroscopy.
- High-flux heat exchangers using microchannel technology.

[Industrial Sensor Development at Berkeley Lab](#)
[Laser Ultrasonics and Laser Ablation](#)
[Other Links](#)



[Home](#)

[Advanced Energy Technologies](#)

[Air & Water Quality](#)

[High Technology Buildings](#)

[Industrial Energy Use Analysis](#)

[Industrial Partnerships](#)

[Measurement Sensor & Instrumentation Systems](#)

[New Materials](#)

[Contact Us](#)

[Search](#)

[Go](#)

Industrial Sensor Development



Industrial Innovations
Energy Technology Research and Analysis



**Industrial Sensor Development
at Lawrence Berkeley National Laboratory**

The nation's industries, as never before, need industrial process sensors to help them stay at the forefront of innovation in an increasingly competitive world. Sensor-based control of industrial processes can help companies:

- Decrease production costs;
- Reduce waste of raw materials on manufacturing lines;
- Lower downtime of manufacturing processes caused by equipment maintenance;
- Increase the energy efficiency of manufacturing processes;
- Detect equipment failure early, before it becomes a major liability;
- Improve the environment by minimizing waste products;
- Enhance the safety of workers by providing warning of hazards.

Lawrence Berkeley National Laboratory's industrial sensor development experts have a wide range of expertise in sensor technologies that are critical to efficient industrial process monitoring and control, including:

Physical Properties

Thermal Properties

Chemical Properties

Gas Properties

Nuclear Radiation

Nano- and Fine Particle Measurement

These technologies are applicable to a broad range of industrial manufacturing or materials processing application:

- Petrochemicals and refining,
- pulp and paper, other forest products,
- process heating,
- natural gas and energy conversion,
- iron and steel, metal casting, and aluminum,
- ceramics, glass, plastic and composites;
- general manufacturing,
- mining and cement processing,
- chemicals and pharmaceuticals,
- telecommunications, computers and electronics.



Home
Contact Us
Webmaster
Search

Home | [Berkeley Lab](#) | [Contact Us](#) | [Webmaster](#)

New Materials



New Materials

Researchers throughout Berkeley Lab are developing new materials for use in the broadest imaginable range of industrial applications, as well as everyday applications from building materials to biomedicine. A new and growing area of research at Berkeley Lab focuses on nanotechnology.

The examples of energy-efficient new materials that follow were developed or studied at Berkeley Lab.



Gas-Filled Panels

Gas-Filled Panels, or GFPs, use thin polymer films and low-conductivity gas to create a device with extraordinary thermal insulation properties. GFPs are essentially hermetic plastic bags that can take on a variety of shapes and sizes. Inside the outer barrier is a cellular structure called a baffle. Argon gas filling provides an effective thermal resistance level of R-7 per inch, krypton gas provides R-12.5 per inch, and xenon gas provides R-20 per inch.



- Energy use of domestic refrigerator/freezers is directly influenced by the overall thermal performance of the cabinet and doors. An advanced thermal insulation technology can improve the efficiency of appliances such as refrigerators.
- Insulation materials are critical in buildings designed for low energy use and good thermal comfort. Increasing the thermal resistance, or R-value, of the insulation is an effective strategy to lower heating costs when thermal loads are dominated by the building envelope.
- Thermal insulation will be increasingly important in the future development of cars because significant improvements in gas mileage can be achieved by downsizing the heating, ventilation, and air conditioning equipment.
- Waste reduction and higher thermal performance compared to close-cell foam is possible using Gas-Filled Panels. The panels feature low mass and low volume.



[Home](#)

[Advanced Energy Technologies](#)

[Air & Water Quality](#)

[High Technology Buildings](#)

[Industrial Energy Use Analysis](#)

[Industrial Partnerships](#)

[Measurement Sensor & Instrumentation Systems](#)

[New Materials](#)

[Contact Us](#)

[Search](#)

[Go](#)

LBNL'S BROAD ENERGY ANALYSIS, BENCHMARKING, AND INDUSTRIAL INNOVATIONS METHODOLOGY



- **Experienced Team of Scientists, and Engineers With Un-bias Approach To Problem Solving**
- **Current Applying These Techniques To a Diverse Set of Industrial Applications**
- **Working With a Number of Partners and Users**

In Summary



**LBNL Would Like To
Work With Your Group
On Your Energy
Efficiency
Opportunities**