

# ENG 505 ENERGY SURETY AND SYSTEMS

## Energy Efficiency

*Jack Mizner, P.E., CEM, LEED AP*  
Sandia National Laboratories, New  
Mexico (USA)

**SANDIA REVIEW & APPROVAL NUMBER**



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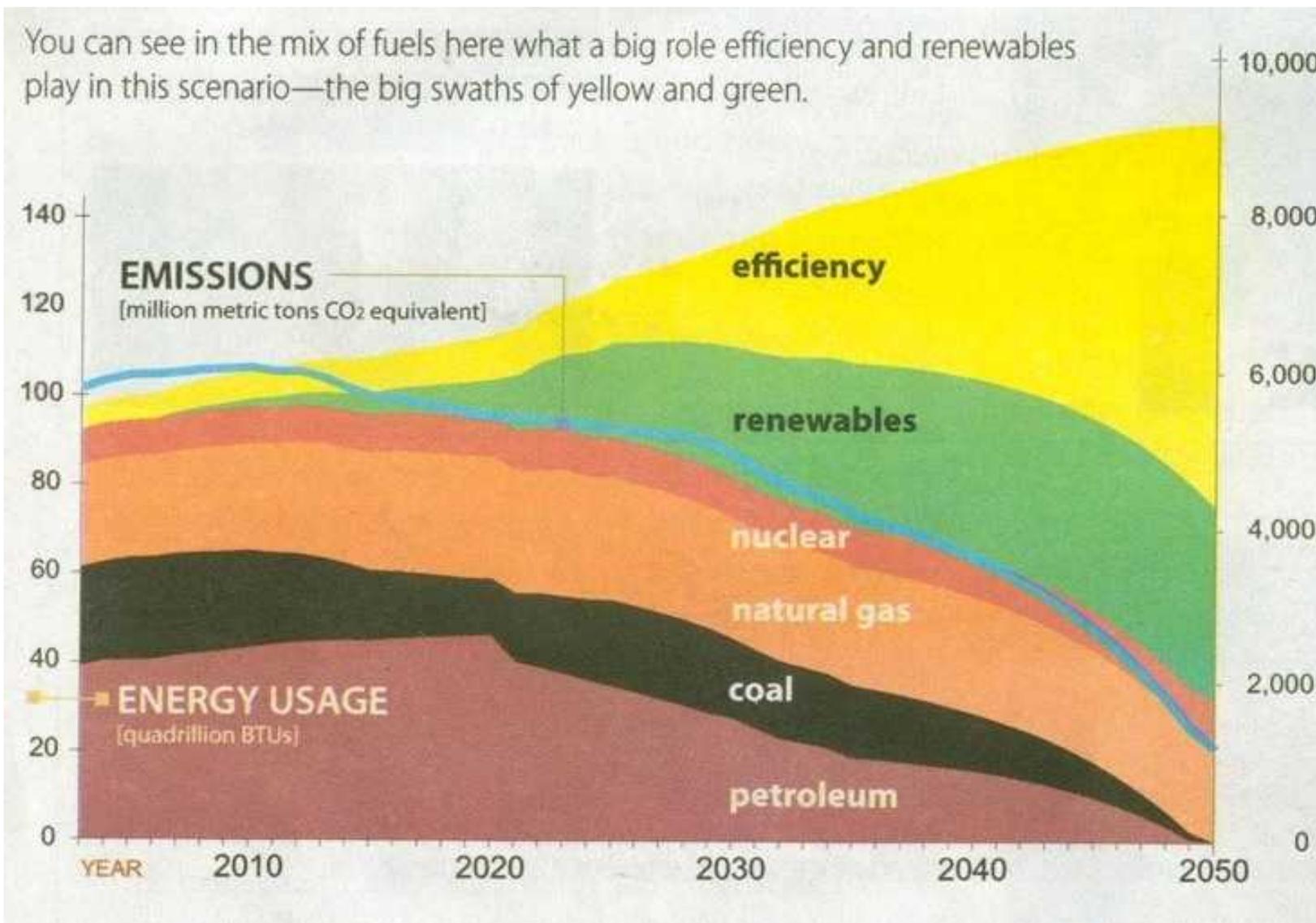
## **Jack Mizner, P.E., CEM, LEED AP**

- Sandia for 15 years
  - Currently manager 4853, accountable for energy management and sustainability
  - Past President, New Mexico Chapter of USGBC
  - Solar America Initiatives
  
- B.S. Biology, GA State, M.S. Ecology and Environmental Engineering, GA Tech

# Presentation Outline

- Global and national aspects of energy efficiency and energy intensity
- A Little History
- Efficiency Opportunities
- SNL Examples and Challenges
- What this presentation doesn't cover:
  - Efficiency in Manufacturing, Transportation & Transmission

# “Fifth Fuel”



# Definitions

- Energy Efficiency - energy inputs are reduced for a given level of service, or there are increased or enhanced services for a given amount of energy inputs.
- Energy intensity - the ratio of energy consumption to some measure of demand for energy services—what we call a demand indicator. For instance, mpg or BTU/SF.
- Energy conservation refers to efforts made to reduce energy consumption. Energy conservation can be achieved through increased efficient energy use, in conjunction with decreased energy consumption and/or reduced consumption from conventional energy sources.

# Facilities Manager's Hierarchy



From a Systems Perspective –  
Buildings/Homes/Campuses

Metrics:  
Consumption and  
Intensity

Management

Conservation

Intensity and Efficiency

## Sandia's Energy Strategy

- Use less
- Use what you have more efficiently
- Use “clean energy”
- Tell people about it

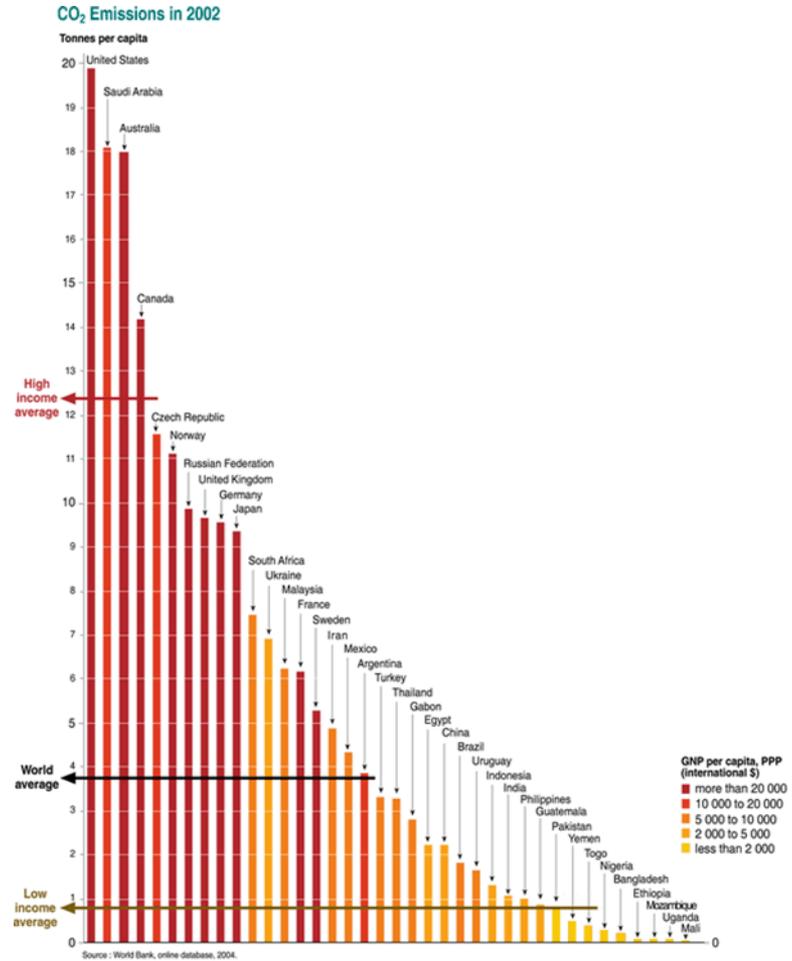
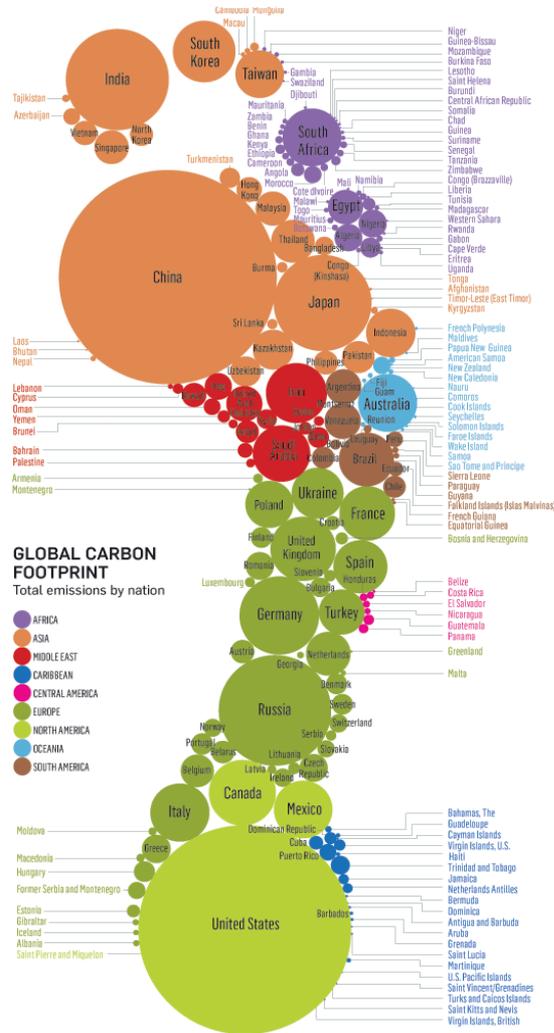
# Background

- Annual national energy bill is over \$700 billion per year
  - Transportation, industry, buildings each consume approx. one-third
- Federal government: “largest energy consumer in the US” – *FEMP web site*
- Buildings are major users of electricity and energy:
  - 76% of electric use in U.S. (per Architecture2030.org)
  - As well as 50% of non-electric generation-related natural gas
- Motor-driven systems use more than half of all electricity consumed in the U.S.
  - Improvements through more efficient motors; variable speed drives; improvements in loads (pumps, fans, compressors)
- Lighting consumes up to 34% of electrical use in commercial/residential sector, about 20% overall

# Energy Efficiency in the Modern U.S. – Some Policy History

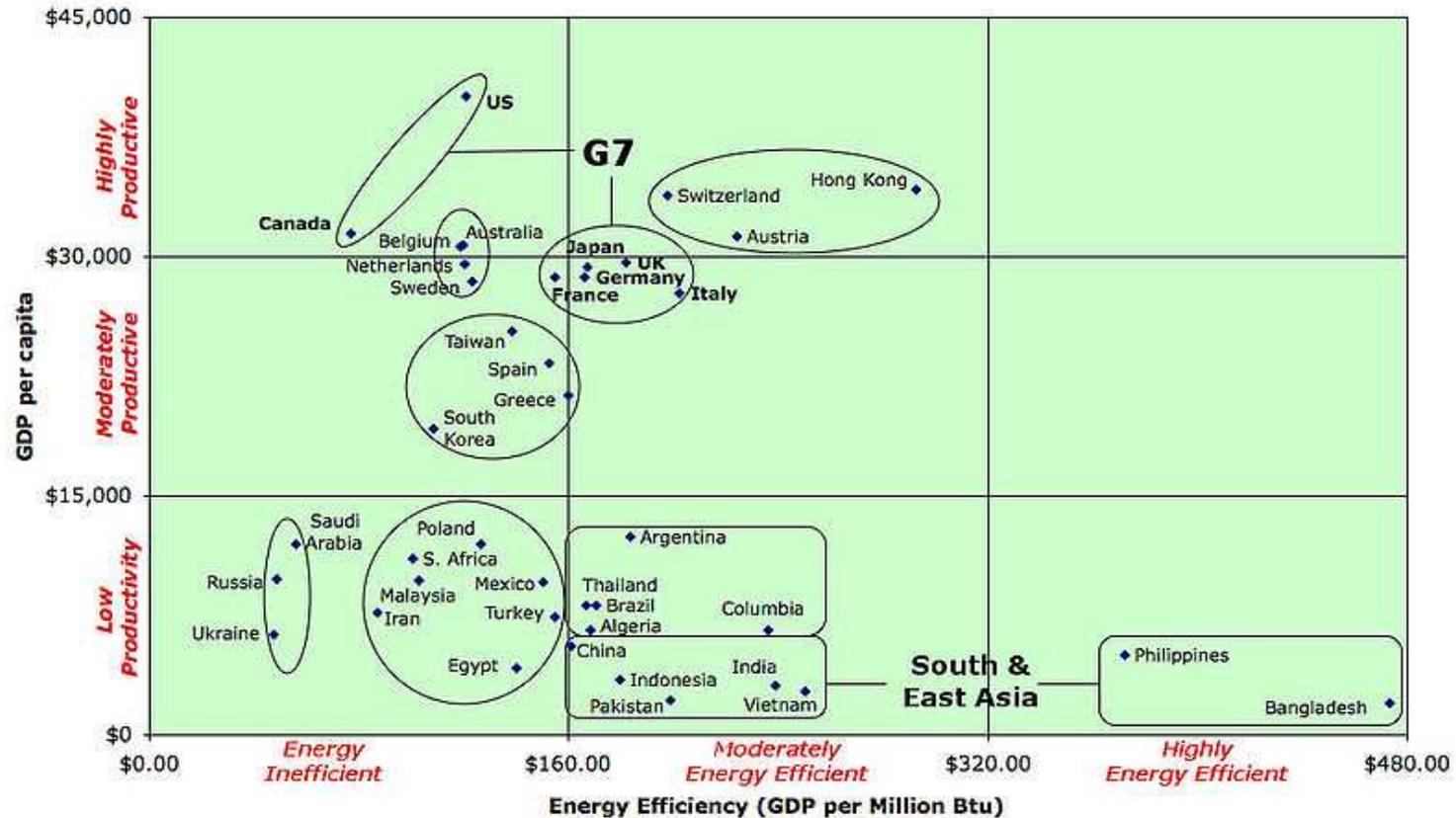
- 1973: “Wake-up Call” – Arab Oil Embargo & resulting oil supply crisis
- 1975: Energy Policy and Conservation Act
  - First automotive fuel efficiency standards (doubling over 10 years)
  - State Energy Conservation Programs
- 1986: Oil prices fell from \$30/bbl to \$10/bbl
- 1992: Energy Policy Act (EPACT) re-focused on efficiency:
  - Standards for homes and office buildings
  - New standards for lighting, motors, utility transformers, heating and cooling equipment
  - FEMP: mandated reduction in federal building energy use to 20% below 1985 levels by 2000. (A follow-on E.O. in 1999 raised that to 30% below 1985 by 2005.)
  - Energy Star rating for appliances launched
- 2005: President Bush signs EPACT2005 at SNL
  - Standards for 15 new products
  - More aggressive targets for Federal agencies, e.g., 2%/year reduction
  - Energy Star ratings upgraded
- 2007: Energy Independence and Security Act (EISA)
  - Increased energy intensity reduction to 3% per year
- 2008: Oil Prices rocketed to \$147/bbl, plummeted to \$40
- 2009: American Recovery and Reinvestment Act

# Global Perspective



# Energy Efficiency vs. GDP

**GDP vs. Energy Efficiency  
(Top 40 Economies by GDP)**



# Efficient Products

Based on standard U.S. Government tests:

## ENERGYGUIDE

Refrigerator-Freezer  
With Automatic Defrost  
With Side-Mounted Freezer  
With Through-the-Door Ice Service

XYZ Corporation  
Model ABC-10  
Capacity: 23 Cubic Feet

Compare the Energy Use of this Refrigerator with Others Before You Buy.

This Model Uses 80 kWh/year

Energy use (kWh/year) range of all similar models:  
Uses Least Energy: 50  
Uses Most Energy: 100

Refrigerators using more energy cost more to operate. This model's estimated yearly operating cost is: \$65

Based on a 2008 U.S. Commercial and Industrial average cost of \$0.09 per kWh for electricity. Your actual operating cost will vary depending on your local utility rates and your use of the product.

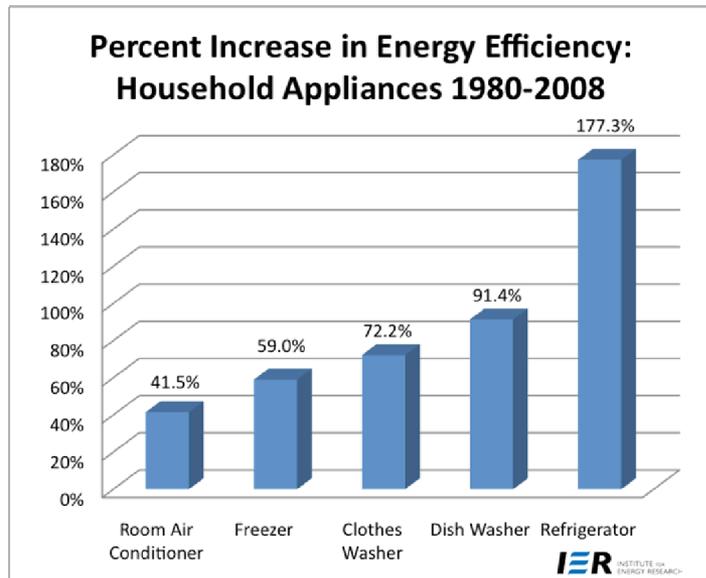
Manufacturer, model number and appliance type.

Information about features, capacity and size, so you can compare models.

Estimates of the appliance's annual energy use. The lower the number, the more energy-efficient the appliance, and the less it costs to run.

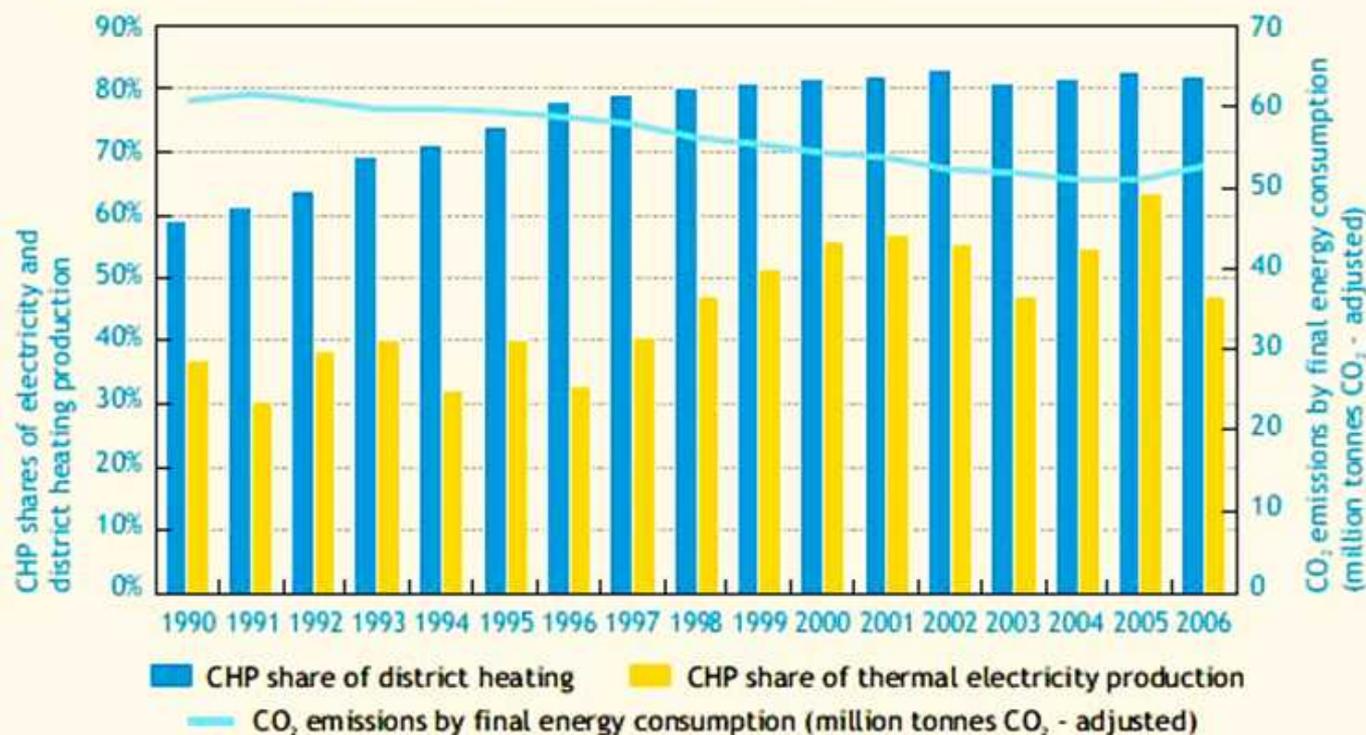
The range of ratings for similar models, from "uses least energy" to "uses most energy." This scale shows how a particular model measures up to the competition.

An estimate of the annual cost to run this model.



# Use Energy More Than Once

Figure 2.9 • Increase in CHP capacity and reduction of CO<sub>2</sub> emissions in Denmark



# The Value of Efficiency

- McKinsey Report Cites \$1.2 Trillion in Potential Savings From Energy Efficiency
- That investment would cut the country's projected energy use in 2020 by about 23 percent — a savings that would be “greater than the total of energy consumption of Canada,”
- Homes account for about 35 percent of the possible gains in end-use efficiency, according to McKinsey. The industrial sector accounts for 40 percent and the commercial sector for 25 percent.

# Total Portfolio: Energy Efficiency Solutions



Product Lifecycle  
 High value  
 Medium value  
 Low value

Sustainability Rating



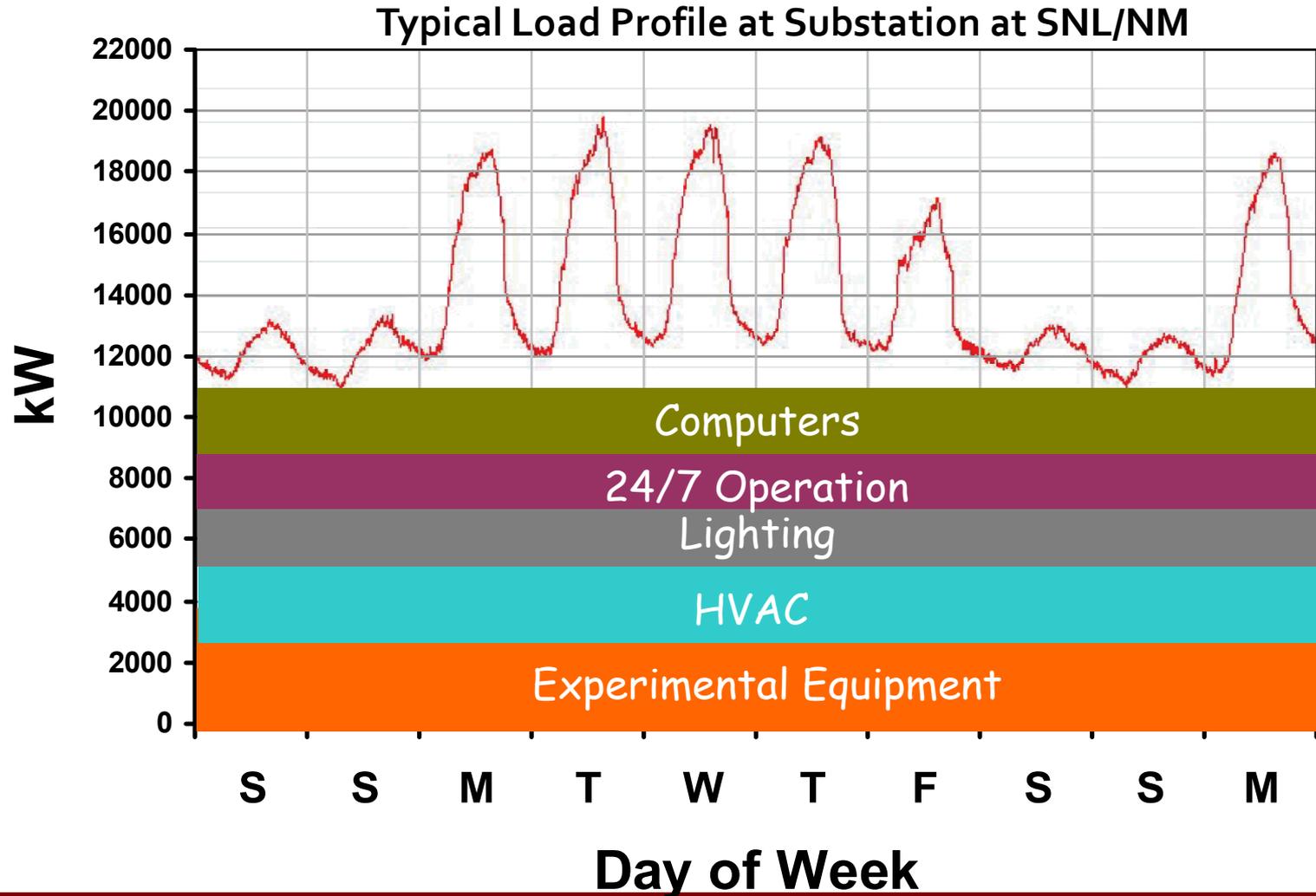
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# SNL Energy and Water Use Statistics

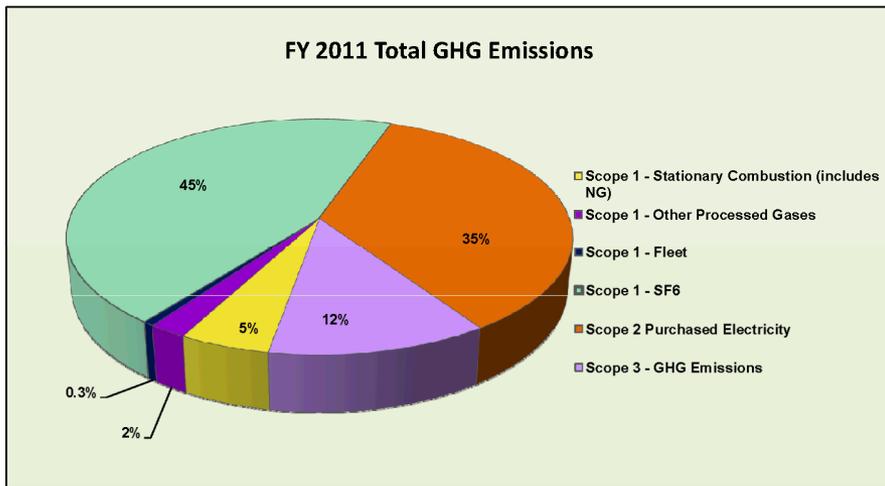
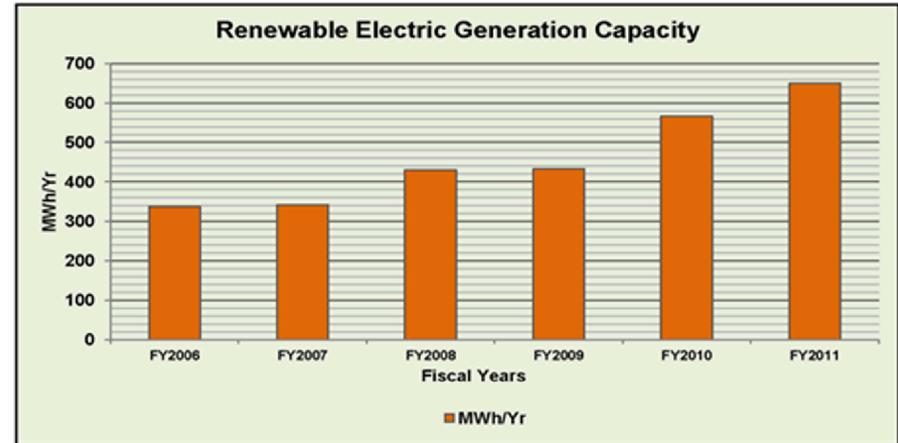
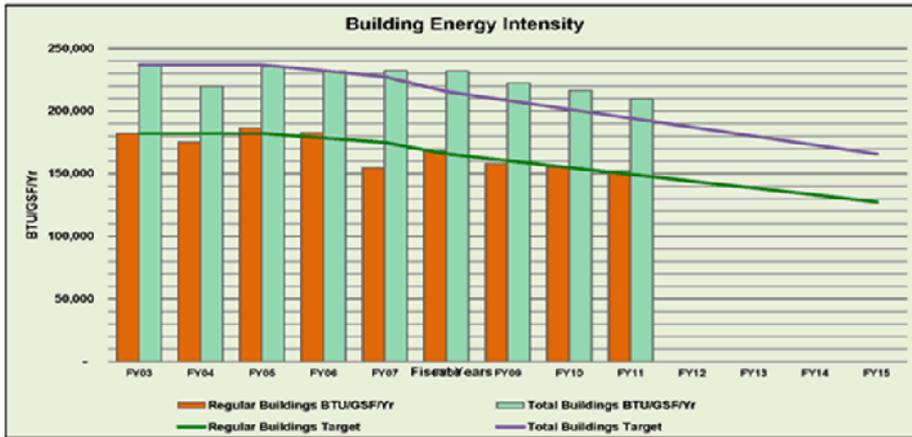
ENERGY STREAM	SNL/NM (BTUs)	SNL/CA (BTUs)
Electricity	873,963,723,792	128,526,628,000
Natural Gas	326,602,035,800	79,897,345,000
Other	16,528,662,788	
Total	1,220,343,192,300	208,423,973,000
# of SW Homes	13,560	2315

A city of 50,000 residents

# Greatest Opportunities



# Key Goals & Status



**GP Compliance: 10% by GSF; 3% by buildings**

# Direct/Indirect Free Cooling



**Cooling tower: Core of the system**

Large-scale free cooling using direct/indirect evaporative cooling techniques, installed at Buildings 962 & 963.

- Offsets a 100 kW electrical load
- Reduces energy use by 2,280 kWh/day
- Saves energy costs by roughly \$35,000/yr

Energy data gathered from October 2010 to March 2011 show the energy demand from refrigerant compressors in Buildings 962 and 963 was zero.

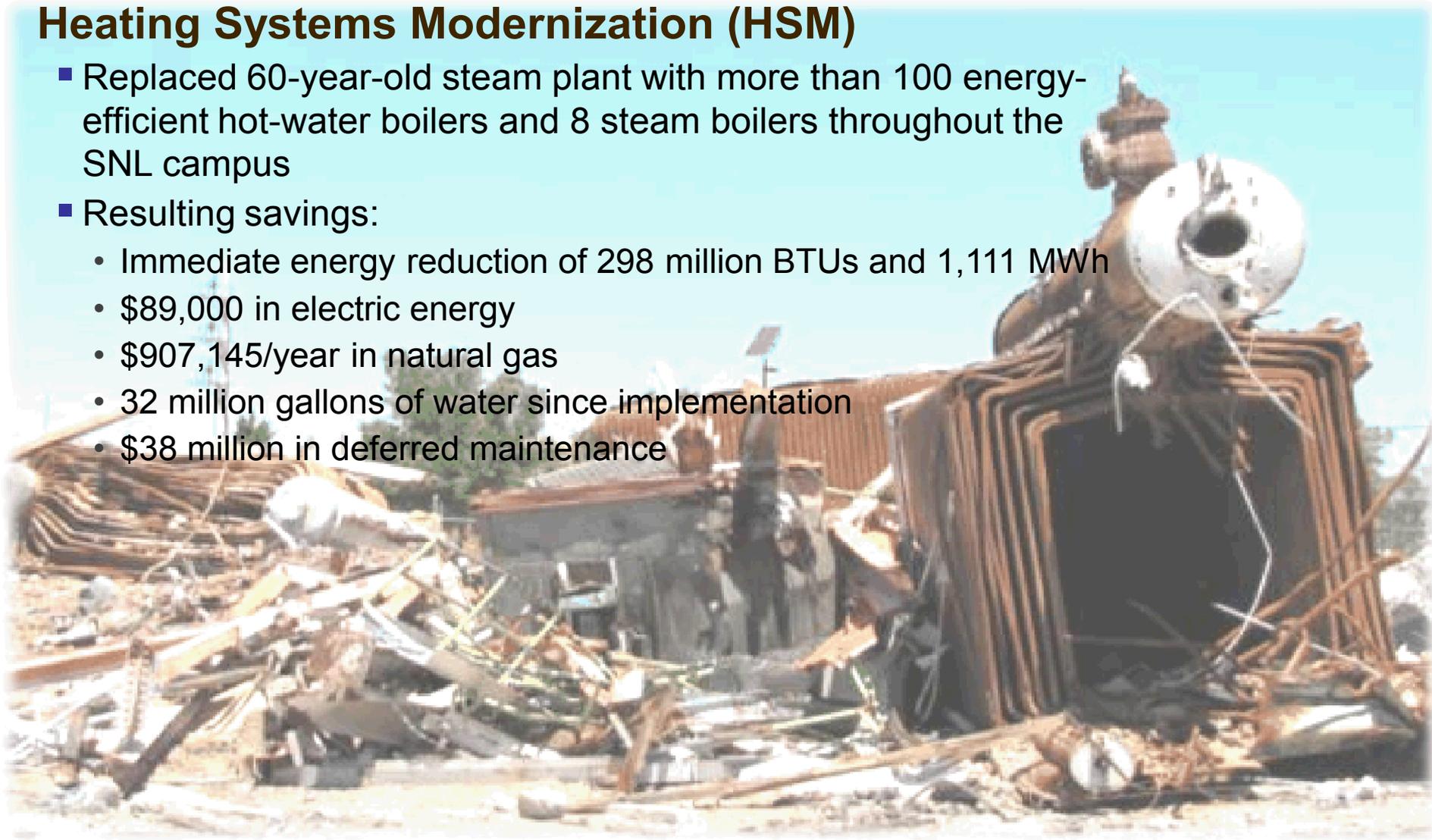


**Cold plate heat exchanger:**  
Uses the cold tower water that is produced in the winter to cool the chilled water in the building

# Heating System Modernization

## Heating Systems Modernization (HSM)

- Replaced 60-year-old steam plant with more than 100 energy-efficient hot-water boilers and 8 steam boilers throughout the SNL campus
- Resulting savings:
  - Immediate energy reduction of 298 million BTUs and 1,111 MWh
  - \$89,000 in electric energy
  - \$907,145/year in natural gas
  - 32 million gallons of water since implementation
  - \$38 million in deferred maintenance



# Fume Exhaust/By-Pass Drives



## Building 1090 Fume Exhaust System Modification

- Originally connected to a constant-volume exhaust system
- Redesigned to use a variable-volume system, with optimized ducting

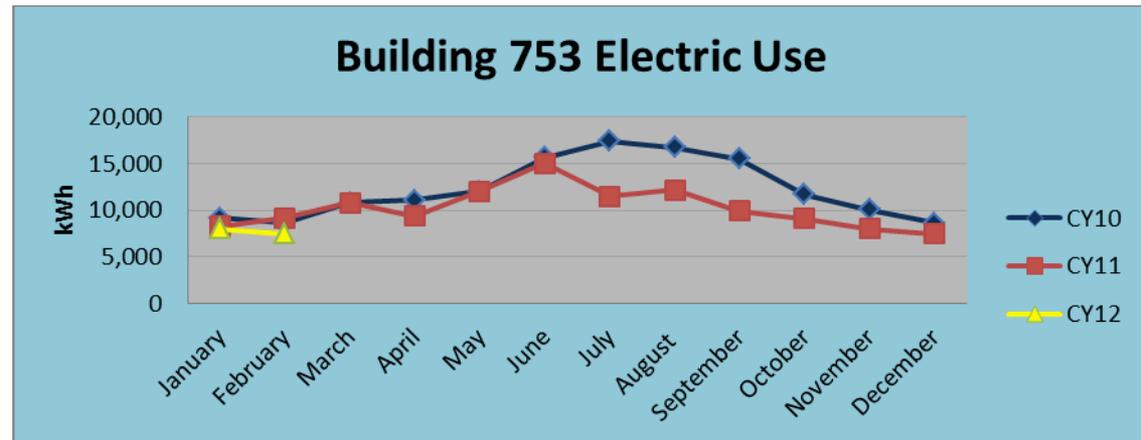
## Energy Savings

- Combined energy savings from exhaust fans: \$4,000/yr
- Lab Exhaust Fan EF-1: approx. 38,544 kWh/yr
- Lab Exhaust Fan EF-2:
  - 15 HP motor - energy reduced from 1.76 kW to 0.57 kW/yr, a 61% reduction
- Total kWh energy savings: approximately 10,424 kWh/yr

# Occupancy Sensors



Building 753 Project Costs and Payback	
Project Cost	\$15,800
Estimated Annual Savings	\$3,620
Simple Payback	4.36 years

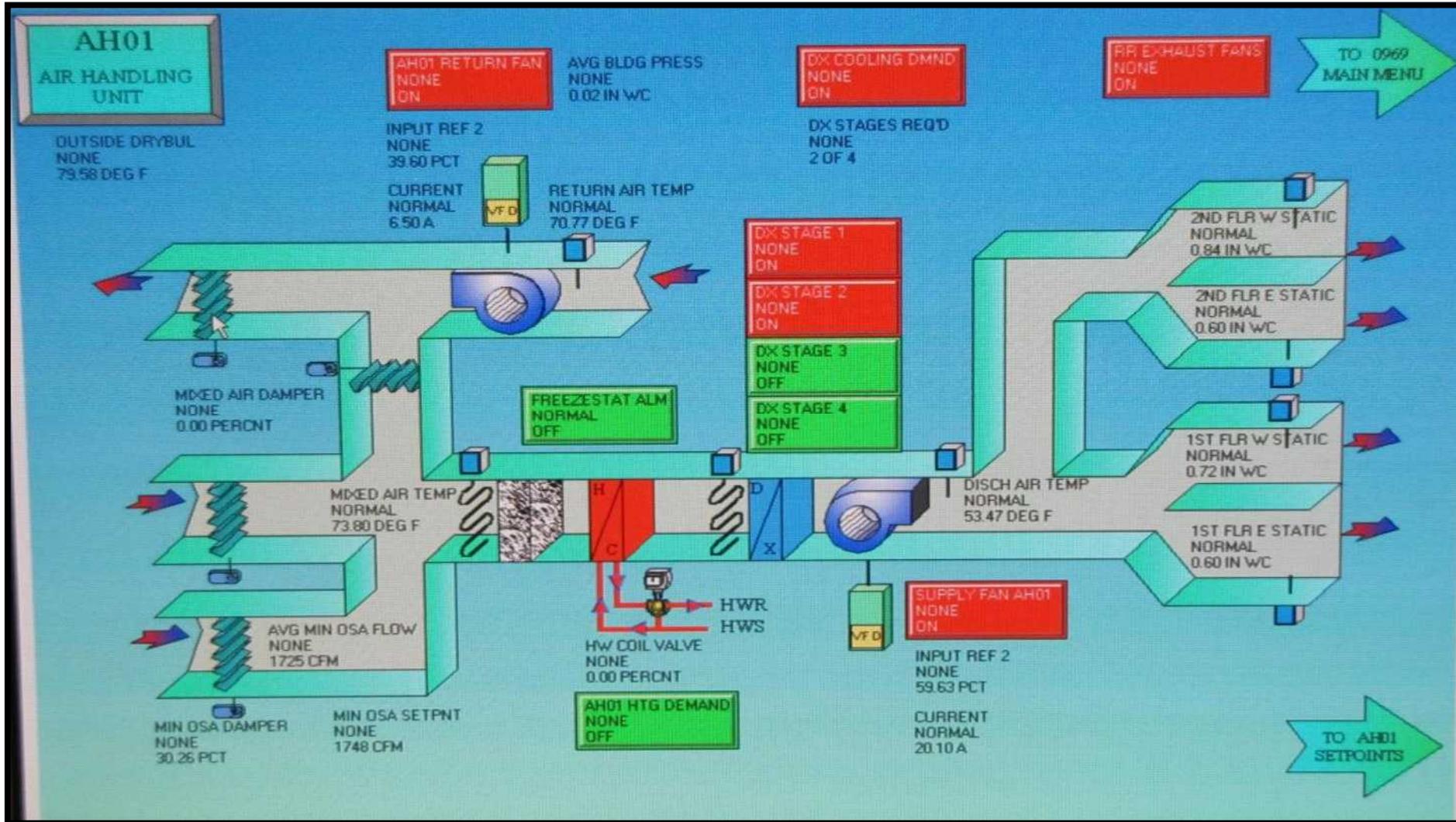


## FMOC Plan:

- Install sensors in SNL facilities in offices and common areas.
- Integrate installation of lighting and HVAC sensors.

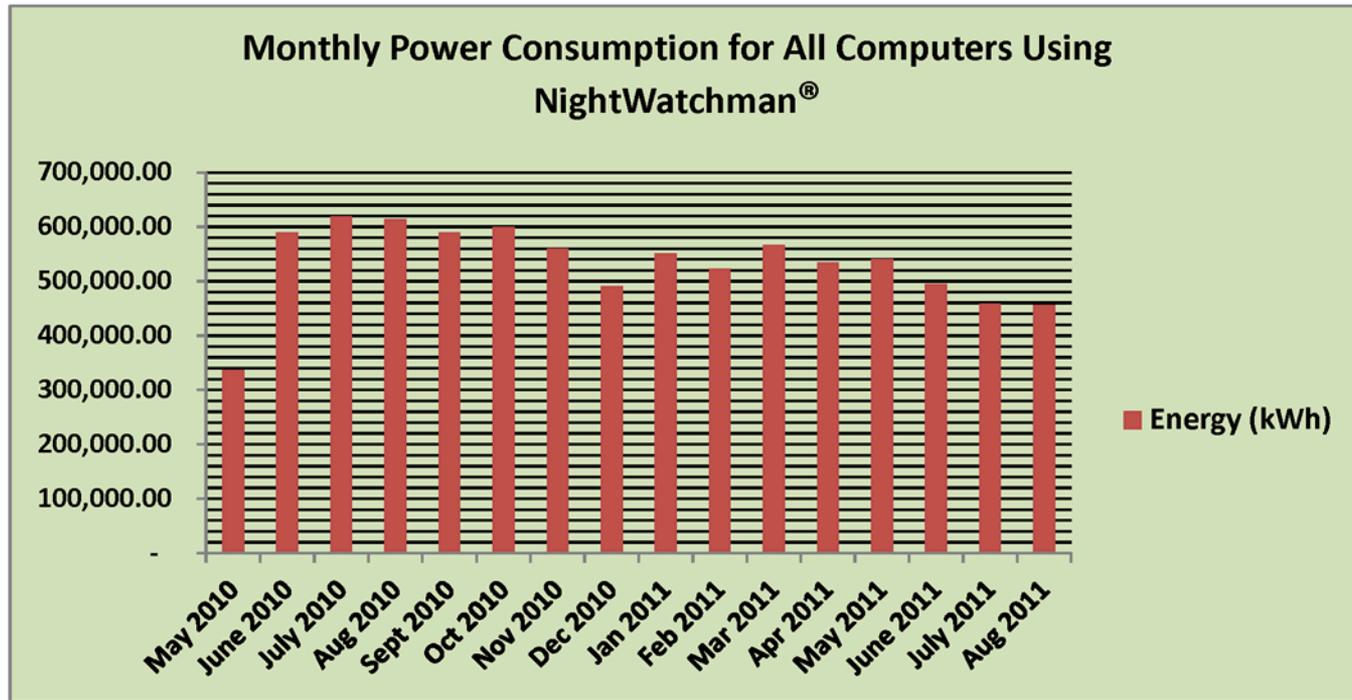


# Energy Management



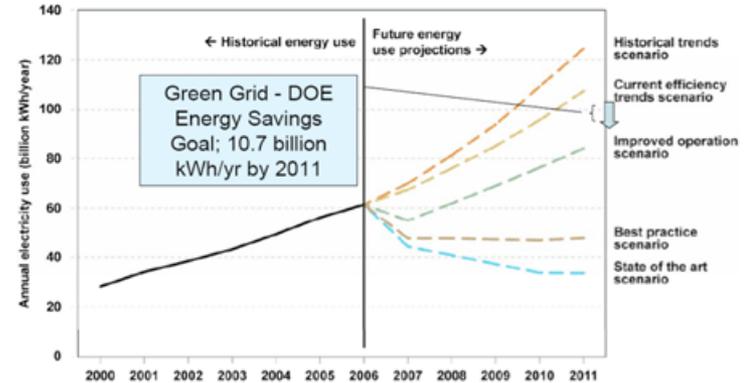
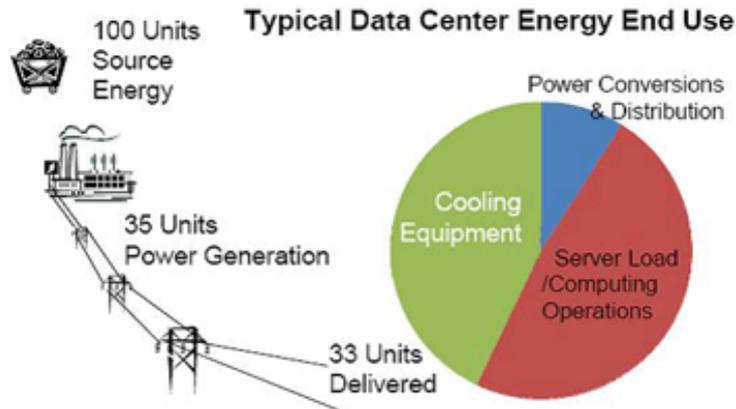
Building Automation Control

# NightWatchman



	2010	2011	Savings
June	589,233	494,342	94,891
July	618,864	458,577	160,287
August	614,390	456,939	157,451

# The Effect of the Information Age



- Data Centers are the fastest growing use of electricity
- SNL Data Centers use approximately 3 million BTU/GSF/yr. A typical U.S. office building is about 90,000 Btu/GSF/yr.
- Data Servers are getting more efficient (denser) – bytes/kW, but there are more of them, and they require more energy for HVAC.

# Energy Efficiency Resources

Source	URL address	Comments
National Action Plan for Energy Efficiency (NAPEE)	<a href="http://www.oe.energy.gov/eeactionplan.htm">http://www.oe.energy.gov/eeactionplan.htm</a>	The NAPEE is a private-public initiative begun in the fall of 2005 to create a sustainable, aggressive national commitment to energy efficiency
American Council for an Energy Efficient Economy	<a href="http://www.aceee.org">www.aceee.org</a>	Policy and government programs, along with consumer information regarding a wide range of home appliances.
U.S. EPA Energy Star Program	<a href="http://www.energystar.gov/">http://www.energystar.gov/</a>	Info on Energy Star appliance ratings; many other consumer and health-related efficiency efforts
Southwest Energy Efficiency Project (SWEEP)	<a href="http://www.swenergy.org">www.swenergy.org</a>	State-by-state info (incl. NM) on efficiency potential. Look for "The New Mother Lode" report.
Rocky Mountain Institute	<a href="http://www.rmi.org">www.rmi.org</a>	Search site for "Electric Productivity Gap"
Architecture 2030 Challenge	<a href="http://www.architecture2030.com/">http://www.architecture2030.com/</a>	Challenges the design&build community to achieve carbon neutral buildings by 2030
DSIREE (database)	<a href="http://www.dsireusa.org/">http://www.dsireusa.org/</a>	Database for State Incentives for Renewable Energy and Efficiency – click on link to Federal incentives
Federal Energy Management Program	<a href="http://www.eere.energy.gov/femp/">www.eere.energy.gov/femp/</a>	Training, technology, and government case-studies for energy efficiency – primarily buildings
Alliance to Save Energy	<a href="http://www.ase.org">www.ase.org</a>	Wealth of policy and consumer information, both domestically and internationally.
Energy Information Administration	<a href="http://www.eia.doe.gov/emeu/efficiency">www.eia.doe.gov/emeu/efficiency</a>	"The First Stop for Information on Energy-Efficiency and the Relationship of Energy to Greenhouse-Gas Emissions."
DOE Office of Industrial Technologies	<a href="http://www.eere.energy.gov/industry">www.eere.energy.gov/industry</a>	Spectrum of technology programs for improved efficiency of industrial processes within several sectors.
US Clean Heat & Power Association	<a href="http://www.uschpa.org/">http://www.uschpa.org/</a>	Good primers and fact sheets on Combined Heat & Power status, potential, technologies
World Energy Council	<a href="http://www.worldenergy.org">www.worldenergy.org</a>	Global indicators and benchmarks on various energy issues.



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**Department of Energy Awards \$43 Million to Spur Offshore Wind Energy**

(Submitted to the DOE Energy Efficiency and Renewable Energy web site on September 9, 2011)

U.S. Energy Secretary Steven Chu today announced \$43 million over the next five years to speed technical innovations, lower costs, and shorten the timeline for deploying offshore wind energy systems. The 41 projects across 20 states will advance wind turbine design loads and hardware, improve information about U.S. offshore wind resources, and accelerate the deployment of offshore wind by reducing market barriers such as supply chain development, permitting, and interconnection. Read more [click here](#).

**Free Water Smart and Drip Irrigation Classes Albuquerque Bernalillo County Water Utility Authority**

Achieve improved landscape water efficiency for your home or business. Determine water needs at your site and best ways to provide water to your plants. Learn about irrigation controllers, spray and rotor heads, and drip system use. Available online and additional education resources are identified. First-time participants in this one-hour class earn a \$20 credit on their water bill. Read more [click here](#).

**DOE Awards Nearly \$7M for Fuel Cell and Hydrogen Storage Research**

(Posted on the DOE Energy Efficiency & Renewable Energy Web site on August 10, 2011)

**Welcome to the SNL Energy & Sustainability Site**

Sandia National Laboratories (SNL), a key facility within the U.S. Department of Energy, has long been recognized for its innovative science-based technologies, research and development activities, and collaborative partnerships in support of national security and energy policy. Energy management and resource sustainability are crucial components in all solutions pertaining to the complex issues we face as individuals living and working in one of the most energy-consuming countries.

Department 4853, Strategic Partnerships, has developed this web site to engage the SNL workforce in the timely conversation about energy and sustainability. We will share frequent updates on Sandia Corporation's ongoing efforts to reduce site energy consumption and greenhouse gases, provide building energy-use profiles, and offer energy-saving tips. We invite you to check the Energy & Sustainability web site often and to join the conversation. Working together, we can each be a part of the solution to one of the most critical issues of our times.

*Jack Miner, P.E., LEED AP*

**Building 1090 Energy Audit and Fume-Exhaust System Modification**

Building 1090 Energy Consumption				
	2010 kWh	2011 kWh	Reduction kWh	% Reduction
January	49,750	33,684	16,066	33
February	46,604	29,774	16,830	36
March	53,734	39,481	14,253	27
April	58,406	45,864	12,542	22
May	69,115	51,818	17,297	25
Average monthly savings			15,530	
Estimated savings for 2011 (12 months)			185,136	

During a fiscal year (FY) 2010 energy and water audit of Building 1090 at Sandia National Laboratories (SNL) in New Mexico, energy-consumption data showed that usage was higher than average for a lab facility. The fume-exhaust system proved to be the cause of the inordinately high energy consumption.

Building 1090 houses Industrial Hygiene and Radiation Protection (4121). Personnel in this building use hazardous chemicals, and the building contains pressurized gas in bottles and the nitrogen and argon systems. Chemical fumes must be vented through an exhaust system.

In early FY2010, the laboratory fume hoods were connected to a constant-speed exhaust system, and energy consumption was unacceptably high. With support from the line organization, the Facilities Management and Operations Center (FMOC) redesigned the exhaust system to include a variable-speed system and replaced most of the existing ductwork in the building with larger diameter ducting to reduce flow restrictions. The project work was accomplished over several months, from the latter part of 1990s through the winter shutdown in late December.

The building 1090 exhaust fans are linked into the SNL Building Automated Control System (known as the Facilities Control System, or FCS, in the FMOC), which is used to monitor and control building mechanical systems. Recent energy-consumption data shows that the fume-exhaust modification, combined with an energy audit, have significantly reduced energy use.

This successful project was identified during a regular SNL building audit. It exemplifies the value of the SNL energy audit process, which stems from a U.S. Department of Energy (DOE) requirement that the top 75 percent of energy users at DOE facilities be audited. By participating in these audits, SNL Operations Teams continue to identify projects and opportunities to reduce site energy and water consumption and meet sustainability goals.

**"Free Cooling" Installed at Technical Area IV Buildings**



**How Much Do You Know About Renewable Energy?**



What are the leading renewable energy sources and their environmental impacts, amount of electricity generated from renewable energy sources, country leading the way in renewable energy use? U.S. policies aimed at increasing renewable energy use, future generation of renewable energy, and more. You can learn more about renewable energy by viewing a short video developed by the U.S. Energy Information Administration (EIA) [click here](#).

**Building Occupancy Sensors**



**Consider this:** Lighting can account for as much as 30 percent of the total energy consumption in a typical office building, similar to the facility in which you work.

**And this:** Occupancy sensors have been shown to reduce total facility lighting loads by as much as 40 percent.

**Next, do the math:** Reduced lighting loads = energy savings = cost savings

**What is Sandia Labs' plan to implement the audit?**

Facilities Management and Operations Center plans also to install occupancy sensors in SNL facilities, starting with offices and common areas. As more funding becomes available, Center also will investigate the feasibility of installing sensors in facility hallways. In some buildings, occupancy sensors will also be connected to heating, ventilation, and air conditioning (HVAC) systems.

**Benefits summary:**

- Reduced space charge back costs
- Reduced greenhouse gases
- Reduced site energy consumption

**Test Your Energy IQ**



Think you know how to go green at work? Test your knowledge of energy use by taking this 10-question quiz.

*Energy Efficiency*

THANK YOU!

QUESTION & ANSWER SESSION

Presenter(s) contact Information”

Jack Mizner

- [jhmizne@sandia.gov](mailto:jhmizne@sandia.gov)
- 845-3576