TUR
Toxics Use Reduction Planning

INDUSTRIAL / COMMERCIAL

ENERGY MANAGEMENT PLANNING
AND
GREEN HOUSE GAS CALCULATION

PRESENTED BY:

ROBERT S. CERIO

ENERGY RESOURCE MANAGER, BOC, CEM

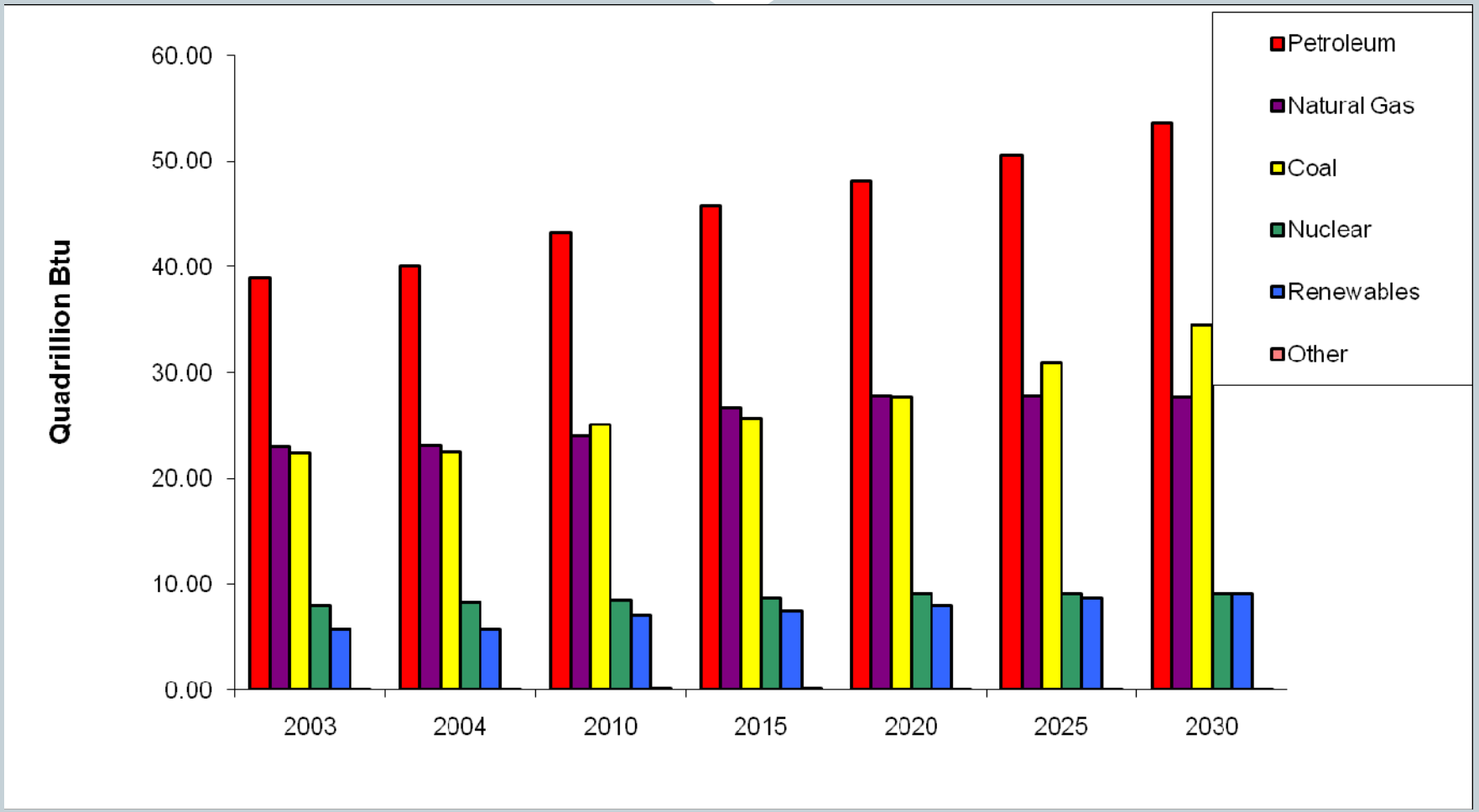
The History of Energy in the US

The past 100 years

- Muscle
- Wood
- Whale Oil
- Coal
- Petroleum
- Natural Gas
- Renewable Energy Resorces

The Forms of Energy We Use

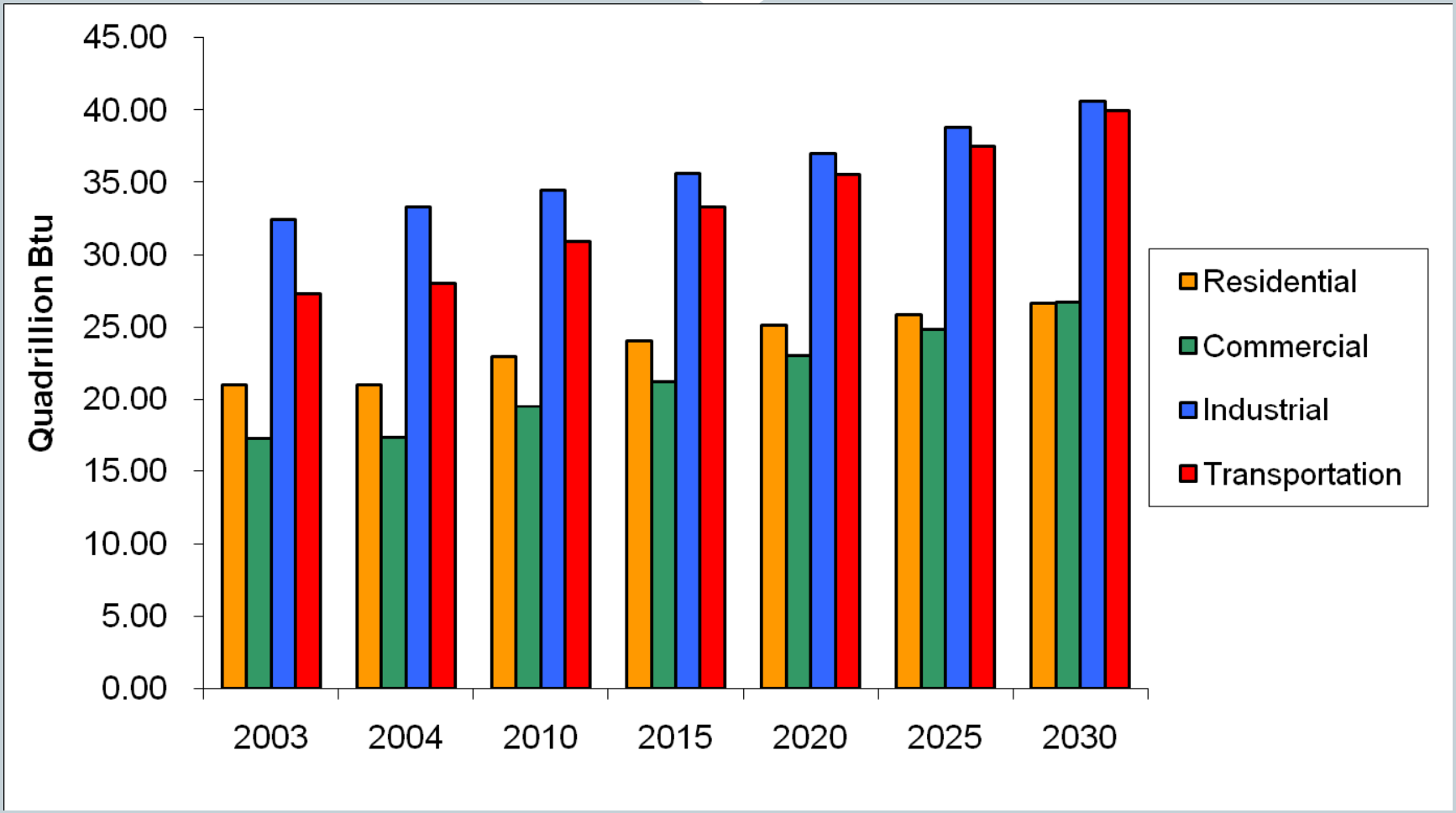
Us Energy Consumption by Resource



Source: Annual Energy Outlook 2006, Energy Information Administration.

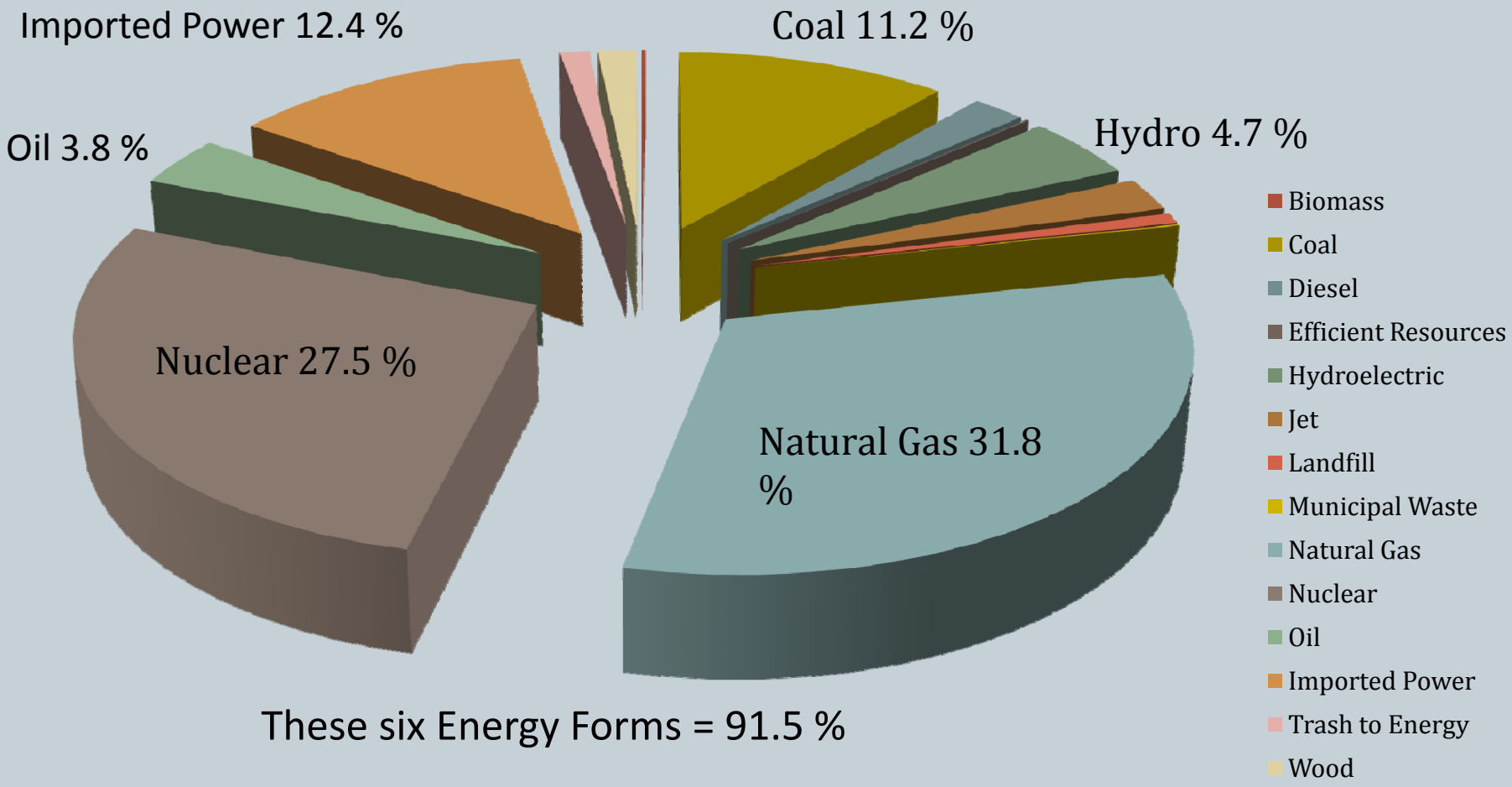
How We Use Our Energy

US Energy Consumption by Sector



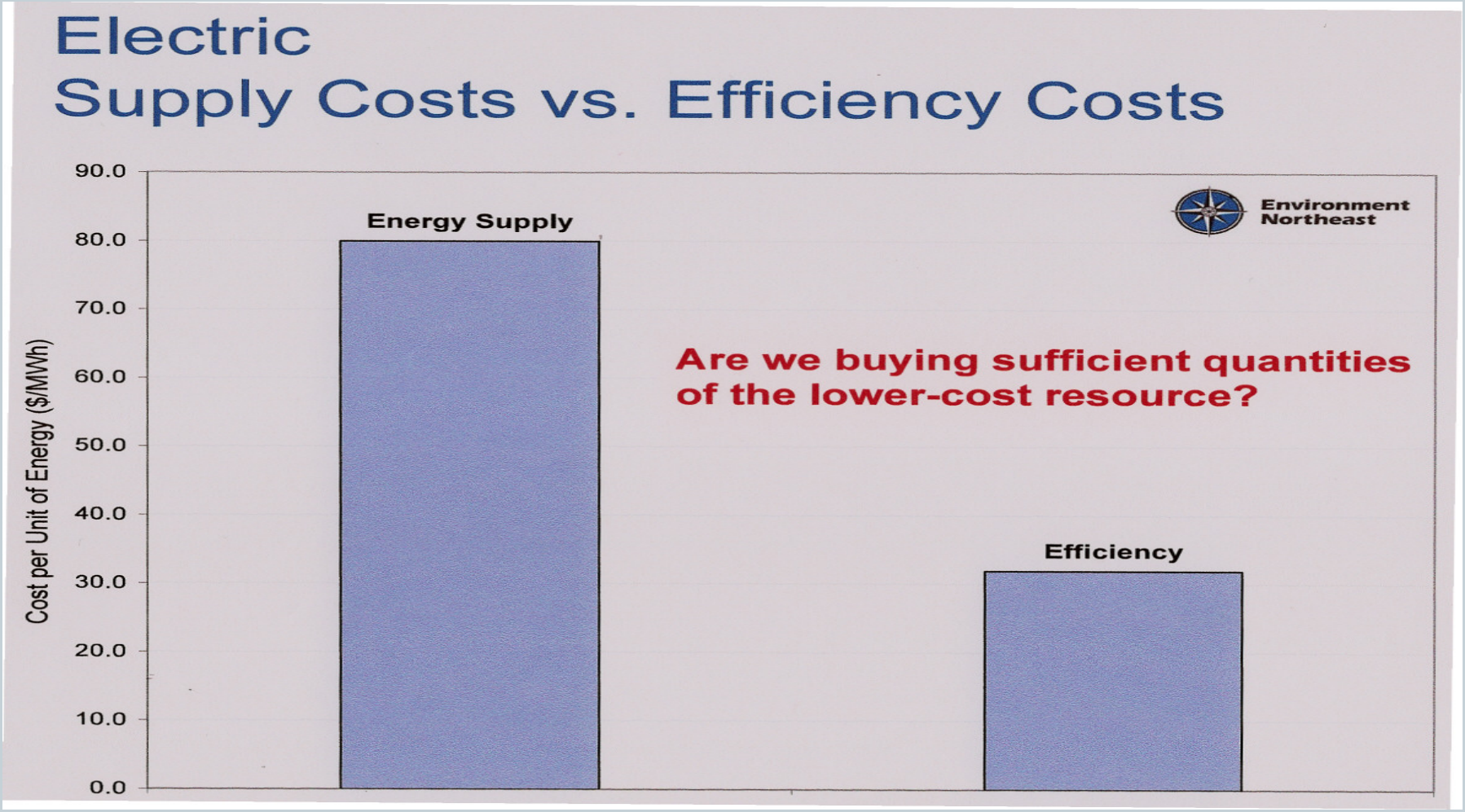
Source: Annual Energy Outlook 2006, Energy Information Administration.

Typical Electric Power Sources



These six Energy Forms = 91.5 %

Building New Supply Cost vs. Efficiency



Energy Fundamentals

Common Units of Measurement

- Electricity - kilowatt (kW); kilowatt-hour(kWh)
- Natural Gas - cubic foot, therm, Dth
- Fuel Oil - gallon
- LPG - gallon
- Water & Sewer – CF, HCF, Kgals.

More Energy Terms

- R-value and U-value:

R-value **is the <u>resistance</u> a material has to <u>heat flow</u>.**

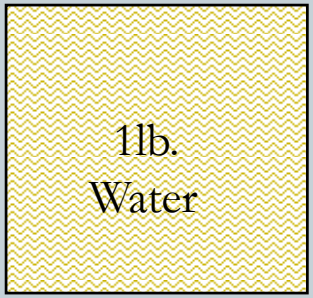
U-value **is a measure of a material's <u>conductivity of heat.</u>**

How they relate:

R-value = 1/ U-value

Energy Content

- British Thermal Unit, Btu
- *1 Btu = Heat required to raise the temperature of 1 pound of water by 1 degree F*



Raised 1 degree Fahrenheit

or

1 match

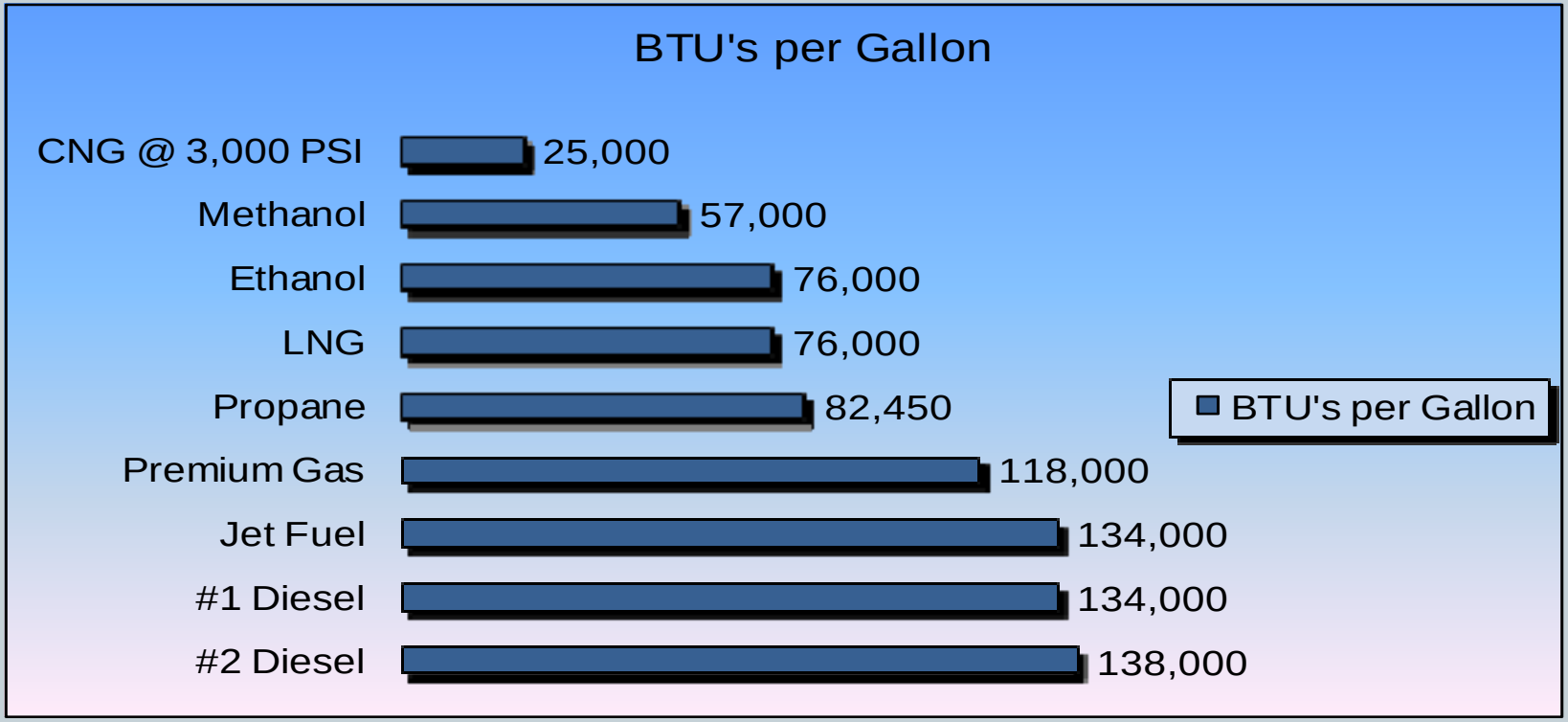
- Common thermal unit in most building energy analyses

Energy Thermal Values

- Natural Gas
  - 1 Cubic Foot = 950 to 1150 Btu
  - 1 CCF = 100 Cubic Feet
  - 1 MCF = 1,000 Cubic Feet
  - 1 Therm = 100,000 Btu
  - 1 CCF is approx 1 Therm
- Fuel Oil
  - Kerosene = 134,000 Btu/Gallon
  - Number 2 = 140,000 Btu/Gallon
  - Number 6 = 152,000 Btu/Gallon
- Propane
  - LPG = 91,600 to 95,000 Btu/Gallon
- Steam
  - 10 PSIG = 1000 Btu/Lb.
  - 100 PSIG = 1100 Btu/Lb.
- Coal
  - Lignite = 11,000 Btu/Lb.
  - Bituminous = 14,000 Btu/Lb.
- Electricity
  - 1 kW = 1000 Watts
  - 1 kWh = 3413 Btu
- Miscellaneous
  - Wood = 8,500 Btu/Lb
  - U_{235} = 75,000,000 Btu/gram

Relative Energy Potential of Liquid Fuels

- All internal combustion engines operate on the heat produced by the combustion of the fuel.
- The higher the British Thermal Unit "BTU" value per gallon, the less fuel is required to produce the required heat or power.
- ***Diesel produces 5.52 times as much energy as CNG and is more efficient.***



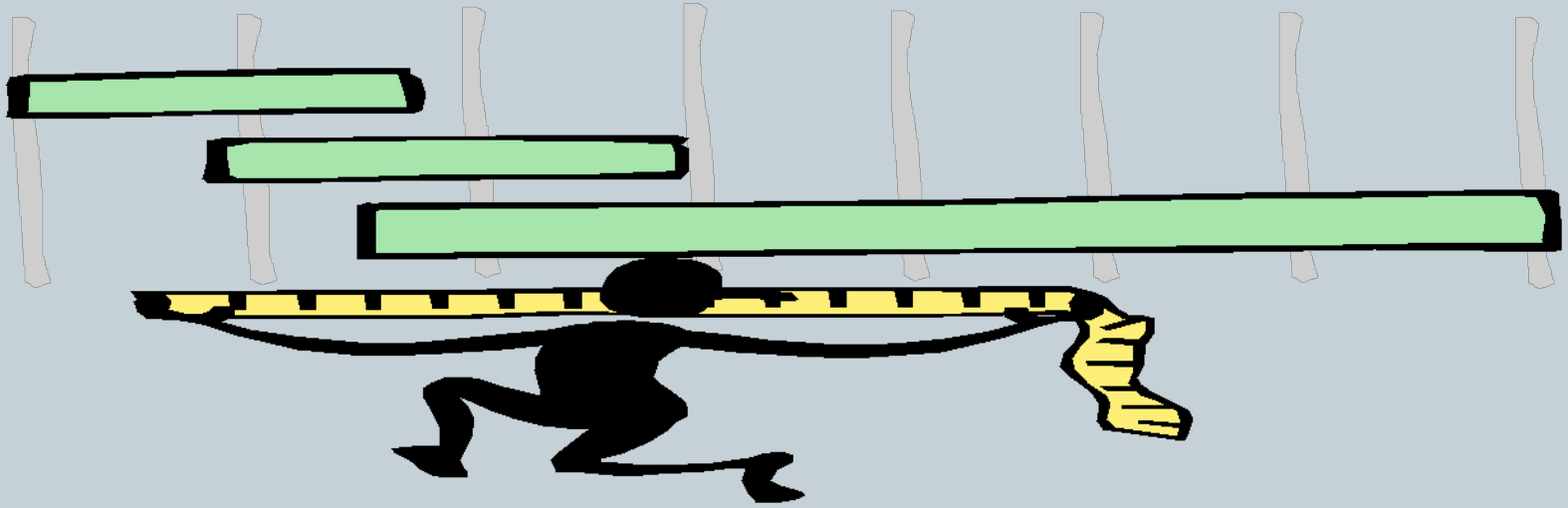
An Energy Management Plan, What is it ?

A must have tool !

- **It is a means of measuring and tracking utilities !**
- **People oriented non retrofit program.**
- **An educated approach to utility use & procurement**
- **Achievable by any organization**
- **The plan typically yields a 10% utility savings**
- **It is Accountability**

“You can’t manage what you have not measured.”

“The foundation of sound and sustainable energy management plan”



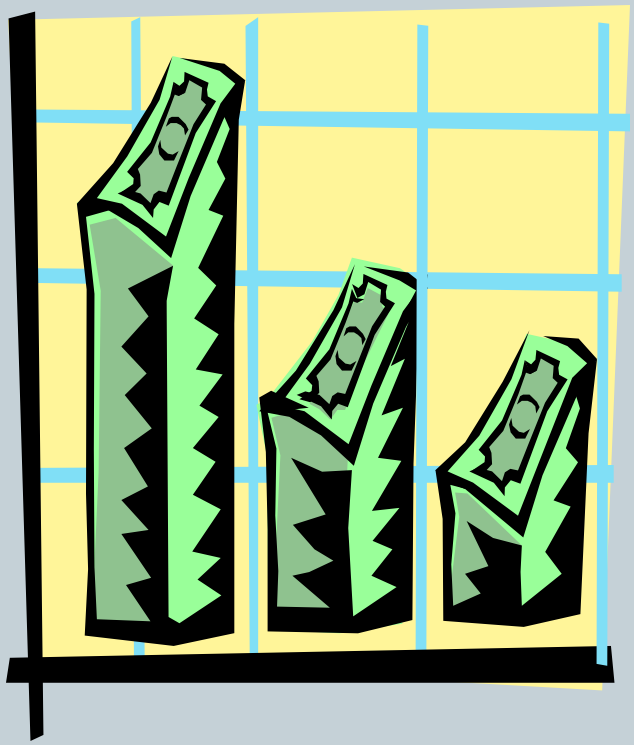
What can you manage and control?

- You have no control over cost
- You do have control over consumption

Why Do You Need A Plan

It allows you to see were, when & how

- You use energy
- How efficient you are
- Identifies areas of concern
- The basis for repairs
- Utility budget forecasting
- Project Planning & Commissioning
- Grant Opportunities
- Renewable Energy Projects
- Environmental Impact



Areas To Be Addressed

- **The Team and Goals**
- **Initiative, Policy & Guideline**
- **Accountability Tools**
- **Reduce Consumption and Increase Savings**
- **Utility Purchasing**
- **Retrofit , Construction Planning & Commissioning**
- **Alternative Energy Resources**
- **Grant Opportunities**
- **Educational Component**
- **Putting it all together**
- **Environmental Impact**

The Team & Goals

- Knowledgeable
- Compatible
- Motivated individuals
- Shared set of goals

Initiative - Organization Wide

- Support from the top down
- Committees, corporate, superintendent, administration, faculty , staff, employees and students
- Outside partnerships and support

Partnerships & Support Groups

- State Office of Energy Resources
- State Department of Administration
- State Association of School Committees
- State League of Cities and Towns
- United States Department Of Energy, USDOE
- Energy Smart Schools
- Trade Associations
- State Local Utility – Electric & Natural Gas
- Northwest Energy Efficiency Council, NEEC
- Northeast Energy Efficiency Partnerships, NEEP
- Regional ISO
- National Oil Heat Research Alliance, NORA
- National Renewable Energy Laboratory, NREL
- Northeast Sustainable Energy Alliance, NESEA

Accountability

Utility bill Tracking and Bench Marking

- Tracking
  - Cost
  - Consumption
  - Use Trends
  - Weather
  - History
  - Budget Projection
- Access, Excel, Energy Cap Pro, Utility Tracker
- Energy Star-Portfolio Manager or Com Check

www.energystar.gov.

Utility Tracking

Track all utilities within a facility

- Electric
- Natural Gas & Propane
- Oil s– Liquid Fuels - not a typical utility bill ?
- Water
- Sewer
- Compressed Air
- Chilled Water

Understanding Your Utility Bill

- Identify all of your utilities –

  Perform a building survey and list all utilities & meters

- Reading and understanding the bill

  Use – consumption

  Demand – rate of consumption

  Taxes

  Energy Fee

  SBF & Energy Conservation Funds

  Other Charges

Understanding Your Bill

Utility Bills and Rate Structures

Sample Electric Bill

BOC PEOPLE'S UTILITY DISTRICT

ACCOUNT NUMBER: 3767
NAME: BOC 102
METER NUMBER: 29908279
FOR SERVICE AT: BLACK CANYON RD SP

PREVIOUS BALANCE	29,345.76
PAYMENTS	29,345.76 CR
BALANCE FORWARD	0.00

SERVICE DATES	DAYS	PREVIOUS METER READ	CURRENT METER READ	MULT	UNITS USED	AMOUNT
1/1 - 1/31	30	9000	15000	80	480000	
KW / DEMAND			4.2	80	336.000	927.36

ENERGY CHARGE	1.840	CENTS PER KWH X	480000	=	8,832.00
DISTRIBUTION	3.400	CENTS PER KWH X	480000	=	16,320.00
SUBTOTAL					26,079.36
PRIMARY METERING DISCOUNT					(648.00)
MOUNTHLY BASIC SERVICE					28.00
BPA ADJ. OF ENERGY RELATED CHARGES @ 41%					3,999.55
REACTIVE CHARGE			PF .8700		92.74
SCHEDULE-LARGE COMMERCIAL > 500 KW 3PH			48T		29,551.65

Utility Bills and Rate Structures

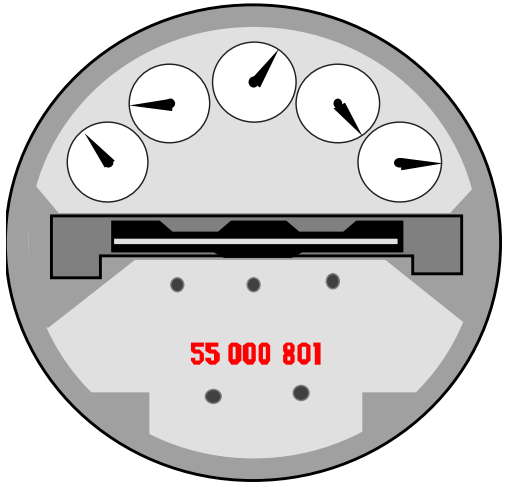
- Consumption vs. Demand
- Typical Bills
  - Electric
  - Local
- Electric Billing Components
- Rate Structures

Understanding how you are billed for energy is fundamental to learning how you can reduce your energy use

Utility Bills and Rate Structures

- Consumption vs. Demand
  - Energy Consumption

    Total electrical energy consumed in a given time period.
    - Measured in kilowatt-hours (kWh)
  - Energy Demand
    - *Rate of electrical energy consumption in a given time period.*
    - Measured in kilowatts (kW)



Utility Bill Tracking

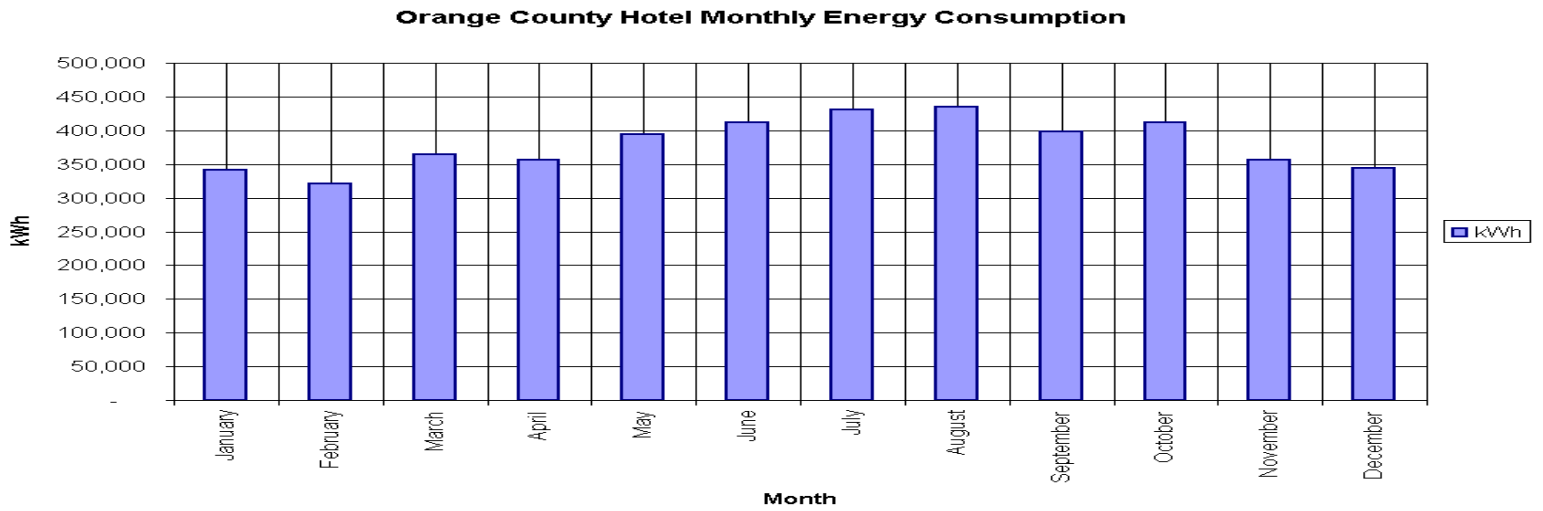
Fiscal Year 2007											
Act. Number	Mt. #	Billing Start	Period End	Days	Consmpt KWH	Demnd KW	Total Cost	$ / Unit $ / KWH	$ / Day Dollars	Consmpt / Day KWH
E-2466	7298	12/12/06	1/12/07	31	64200	221.4	8,103.65	0.126	261.41	2070.97
E-2466	7298	1/12/07	2/12/07	31	38000	205.2	4,915.02	0.129	158.55	1225.81
E-2466	7298	2/12/07	3/13/07	29	41800	199.8	5,297.65	0.127	182.68	1441.38
E-2466	7298	3/13/07	4/13/07	31	75600	219.6	8,923.84	0.118	287.87	2438.71
E-2466	7298	4/13/07	5/10/07	27	69200	277.2	8,438.88	0.122	312.55	2562.96
E-2466	7298	5/10/07	6/11/07	32	67000	307.8	8,307.67	0.124	259.61	2093.75
Totals				**181**	**355800**	**238.5**	**$ 43,986.71**	**$0.124**	**$243.78**	**1972.26**

Consumption Profile

Building Data Analysis

Data Presentation

- Consumption Profiles

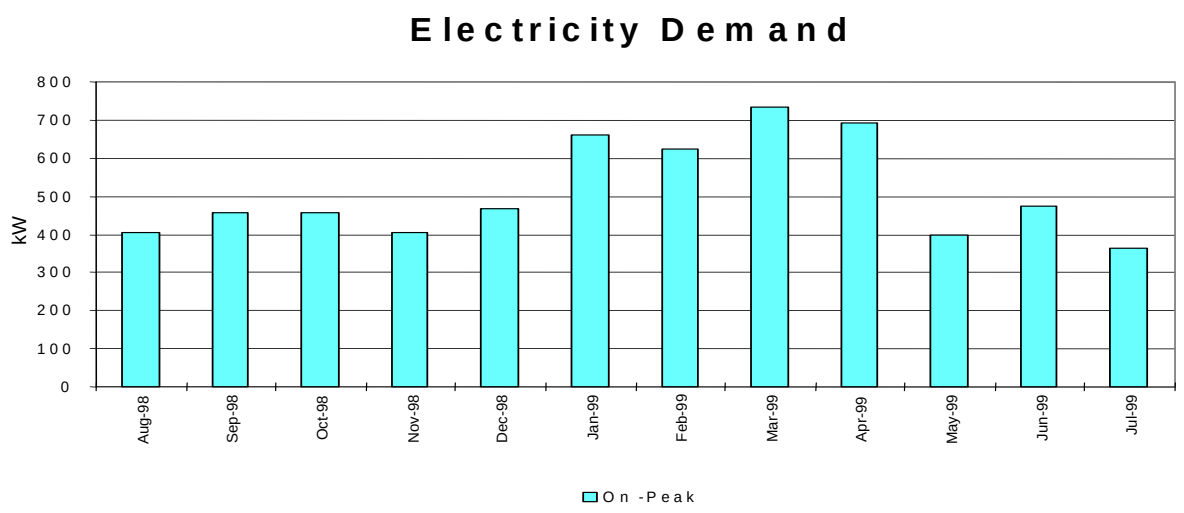


Demand Profile

Building Data Analysis

Data Presentation

- Demand Profile



Energy Tracking & Bench Marking Software

Energy Use & Cost

- Energy Costs ***up-up-up*** (2nd to salaries)
- Up to 30% is waste energy–system inefficiencies
- Low-cost measures can reduce by +10%

- Oversized Systems
- Improper installation
- Poor maintenance

Energy Auditing and Tracking

- **Benchmarking**
  Training & Support (LDC/ NEEC)
  Identify Improvements (Energy Audit)
  Goal Setting/Action Plan (Set Investment Priorities)
  Goal implementation (Verify & Track Progress)

- **Energy Audit**
  - EPA Energy Star **Portfolio Manager**
    Manage Energy & Water
    Rate Building's Energy Performance

Rating Use

www.energystar.gov.

- 1-50% = **INVEST** in new equipment
- 50-75% = **ADJUST** low-cost measures
- 75-100% = **MAINTAIN** operations

Calculating the Value of Energy Efficiency

Putting it all together

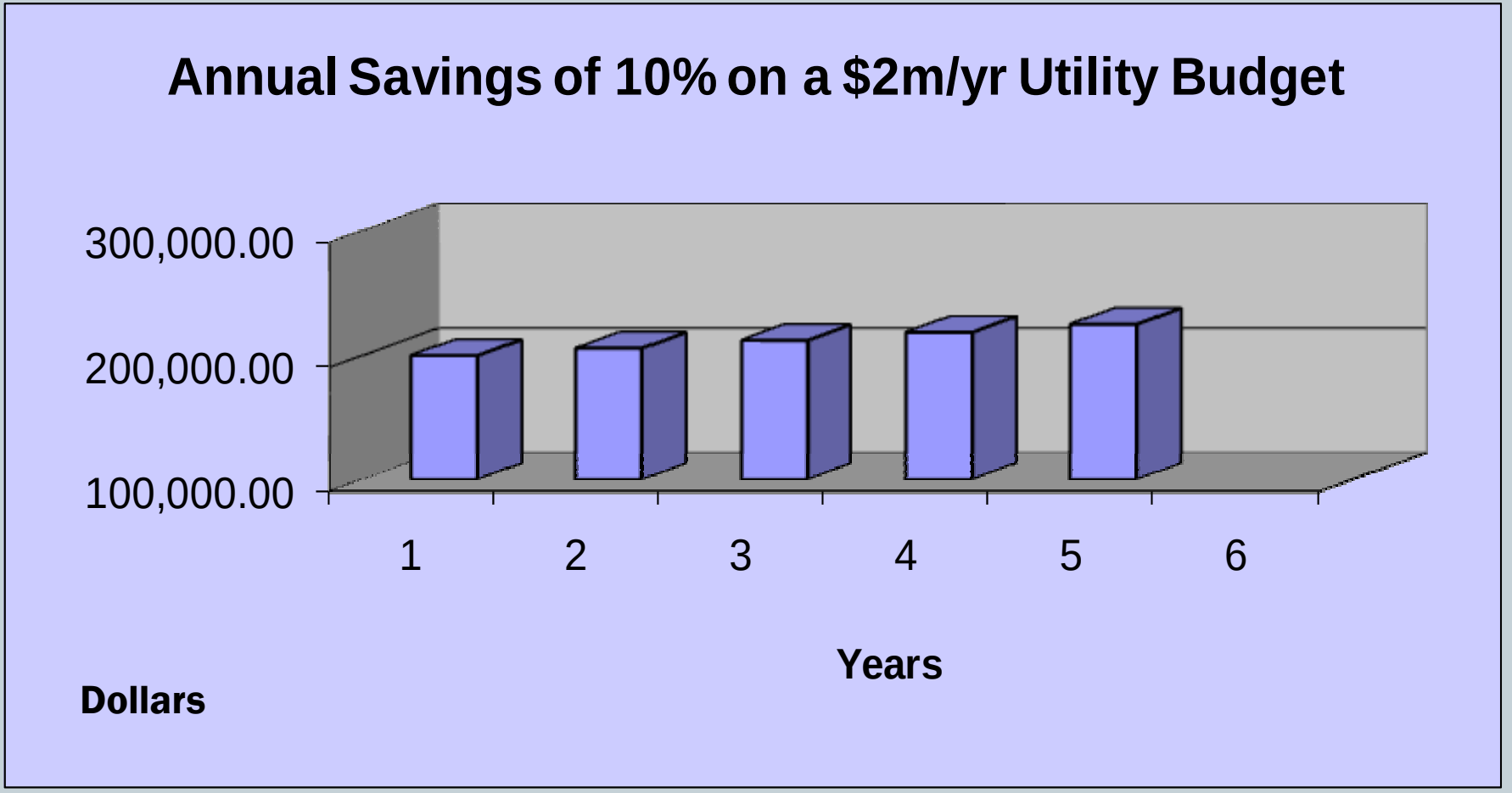
- Energy Accountability
- How to Audit and Interpret the data
- True Savings vs. Cost Avoidance
- ROI, NOI and Life Cost Analysis

Typical Utility Cost Distribution

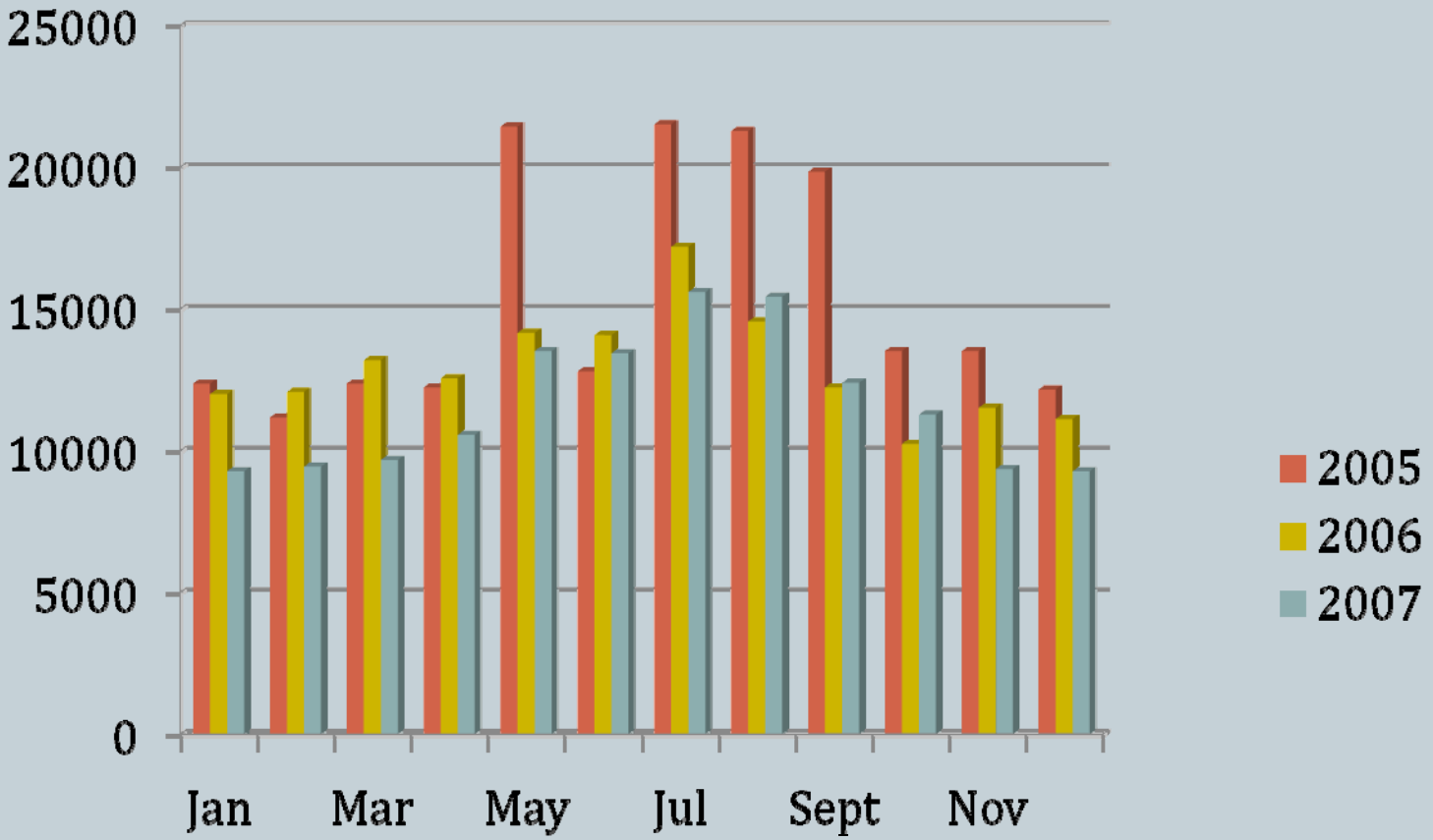
- **Typically the cost of Utilities Represents the Second or Third Largest Budget Line Item**
- **The Pie Chart Represents a Typical 2 Million Dollar Annual Utility Budget Break Down**

Dual Fuel Account
$2,015000.00 per year

Potential Cost Savings Over 5 Years at 10 % = $ 1,007,500.00



Monthly Electrical Consumption



Corporate Electric Consumption

Reducing Consumption & Increasing Savings

- Trim building operating conditions & times
- To coincide with occupied & unoccupied times
- Maintain comfort in occupied areas
- Minimize energy waste
- Utility data monitoring
- Aggregate energy purchasing
- New construction oversight – build Green
- Grant programs
- Alternative energy resources
- Life cycle cost analysis

Energy Conservation Basics

- Simple Payback

  = (Cost – Rebate) / Savings /month = ROI

- Total Annual Savings, true savings and cost avoidance = NOI

Energy Terms

Defining Basic Energy Terms

- **Conservation:** measures taken to reduce using energy consuming systems in order to reduce cost.
- **Efficiency:** installing systems that use less energy.
- **Load Management:** controlling your electric or gas demand during on peak periods.
- **Demand Side Management:** reducing electric or gas loads to help preserve system reliability (and get paid for it).

Small Investment Big Savings

- Measurement & Verification
- Energy Efficiency Measures
- Orientation
- Insulation & Weatherization – infiltration, R-value, U-value
- HVAC Efficiency - EER, SEER
- O & M Procedures
- Filtration
- Lighting & Appliances – Energy Star

Energy Conservation

- Steps for Efficient Operation
- Determine Current Performance
  - Evaluate Collected Data
  - Benchmark Building www.energystar.gov
  - Set Goals
- Determine Potential Performance
  - Prioritize Areas of Energy Saving Opportunities
    - Operational Strategies
    - Low Cost/No Cost
    - Capital Improvement

Energy Conservation Analysis

Life Cycle Financial Analysis:

Tale of TWO LIGHT BULBS:

Standard Bulb:

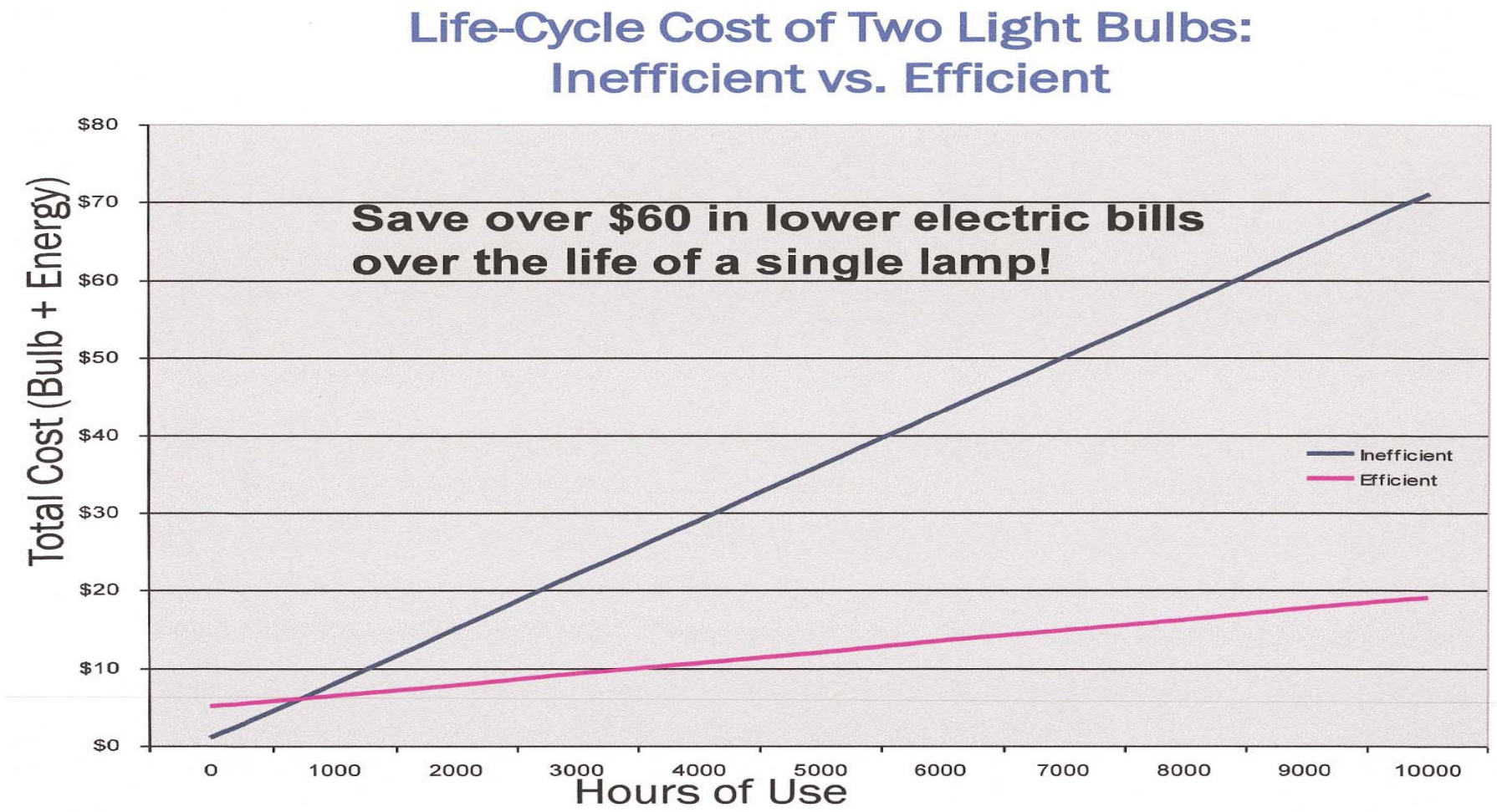
- **Short life: 900 hours**
- **Uses more electricity: 75 W**
- **Costs $1 for one bulb**

Energy Efficient Bulb:

- **Longer life: 10,000 hours**
- **Uses less electricity: 14 W**
- **Costs $4 for one bulb**

At 15 cents per Kilowatt-hour…

Life Cycle Cost Analysis



Energy Efficiency Ratings

- One measure of fossil fuel efficiency is Annual Fuel Utilization Efficiency (AFUE)
- Equipment is rated in (SEER) Seasonal Energy Efficiency Ratio.
- EER = Rated cooling capacity in Btu / Electrical demand in Watts
- standing pilot ~ 70% AFUE
- new furnaces must be 78% or higher
- high efficiency furnaces are 90% and greater (ARI reference)

Renewable & Alternative Energy Resources

Passive Solar

Solar PV

Solar Thermal

Wind

Radiant

Geothermal

CHP

Bio-mass

Transportation

Biomass Energy Resources

- Coal
- Wood Chip
- Methane Recovery
- Ethanol
- Biodiesel
- Synthetic-Gas
- Synthetic-Diesel

Transportation

- Choosing the right vehicle
  - Gas
  - Diesel
  - CNG
  - Electric
  - Fuel cell
  - Gas / Electric Hybrid
  - Diesel / Electric Hybrid

Utility Purchasing

- Electricity - Deregulated Market
- Natural Gas - Deregulated Market
- Heating Fuels - Purchase Futures
- Transportation Fuels – Purchase Futures
- Water and Sewer – Private, Municipal, Regional

Purchasing Strategy

- State or Local Associations
- Organization Buyer Groups
- State Central Services Purchasing
- State League of Cities and Towns
- Other Collaborative Purchasing Groups
- Professional Organization

Retrofit & Construction Planning

- Cost Evaluation
- Analyze Incentive Programs
- Analyze and Calculate Savings
- Calculate ROI & NOI
- Avoid the lowest first cost pit fall
- Life cycle cost analysis
- Commission all new construction

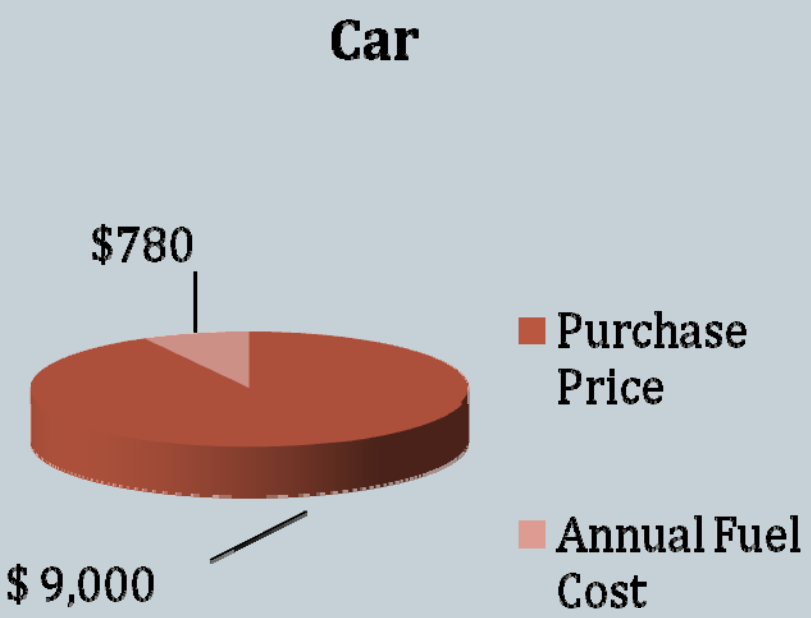
Simple Payback = (Cost – Rebate) / Savings

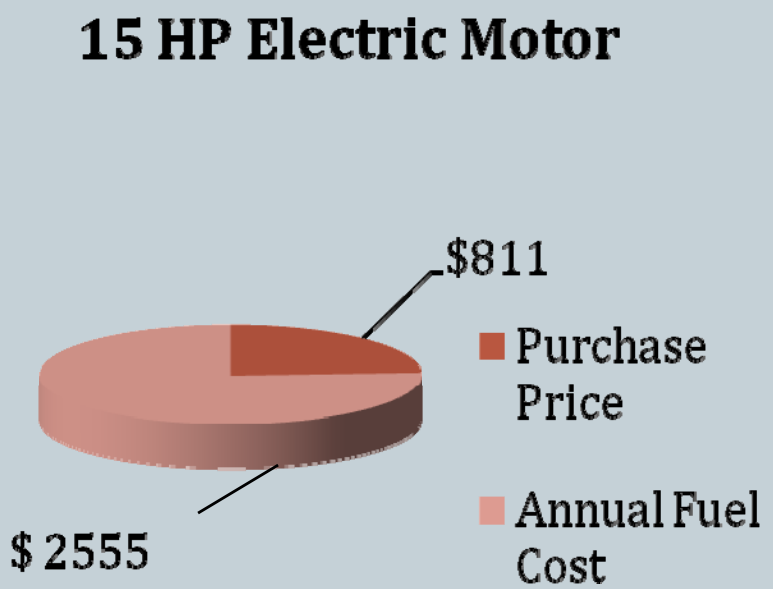
Grant Opportunities & Resources

- ARRA Funding
- LDC - Systems Benefit Fund
- State Energy Office
- Regional ISO
- Rebuild America
- Energy Smart Buildings
- Million Solar Roofs
- DOE – Renewable Energy Resources
- Northeast Bio-Mass Council
- National Renewable Energy Laboratory
- North East Sustainable Energy Alliance
- Green Building Council

Life Cycle Cost Analysis

A Car vs. Electric Motor



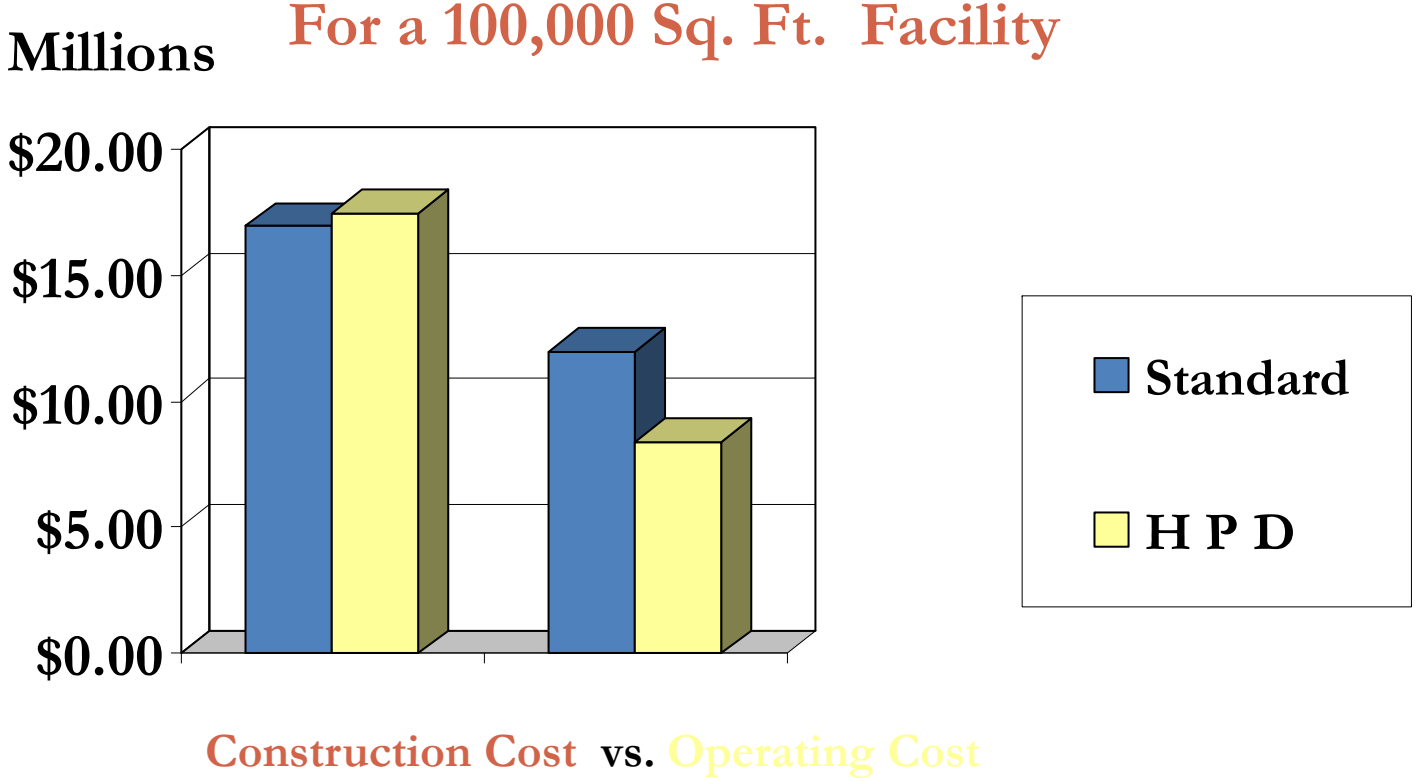


Life Cycle Cost Analysis

Standard Design vs. High Performance Design

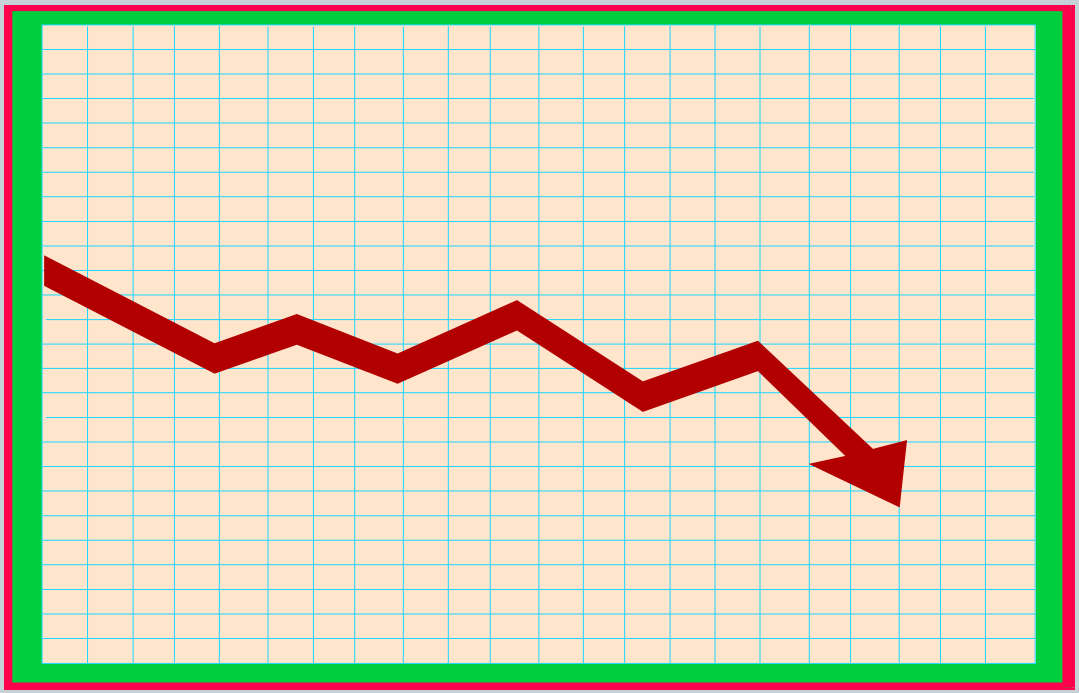
Construction Cost vs. Operating Cost Over 30 Years

For a 100,000 Sq. Ft. Facility



Putting It All Together

- Use the data to plot savings
- Use the data to project cost avoidance



The Hudson Companies

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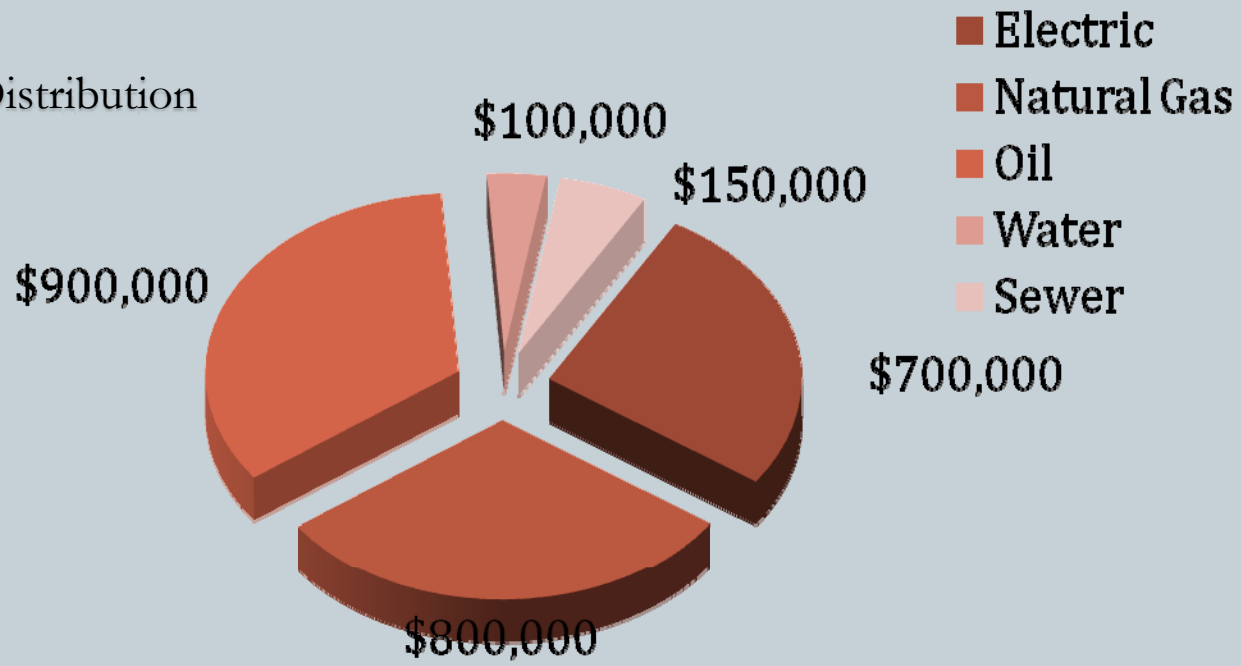
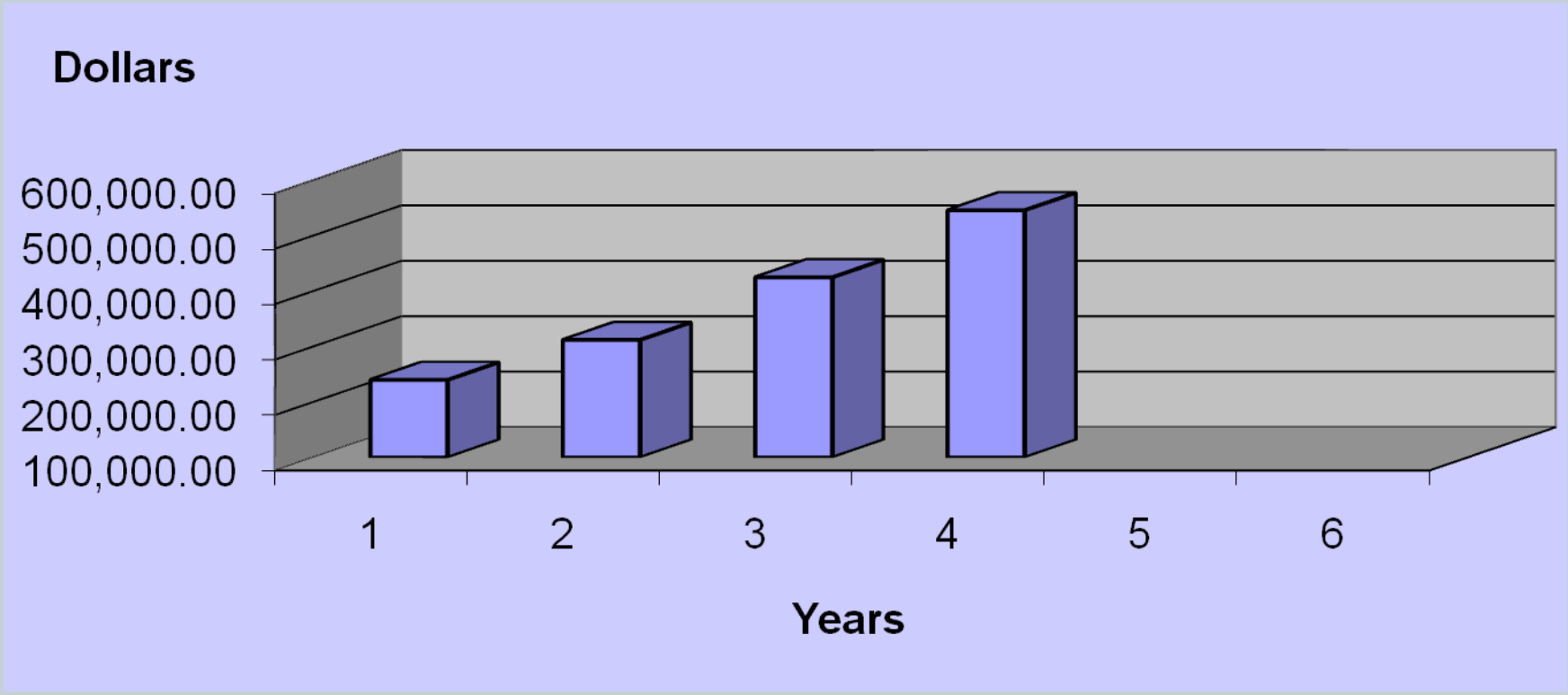
Typical Utility Cost Distribution

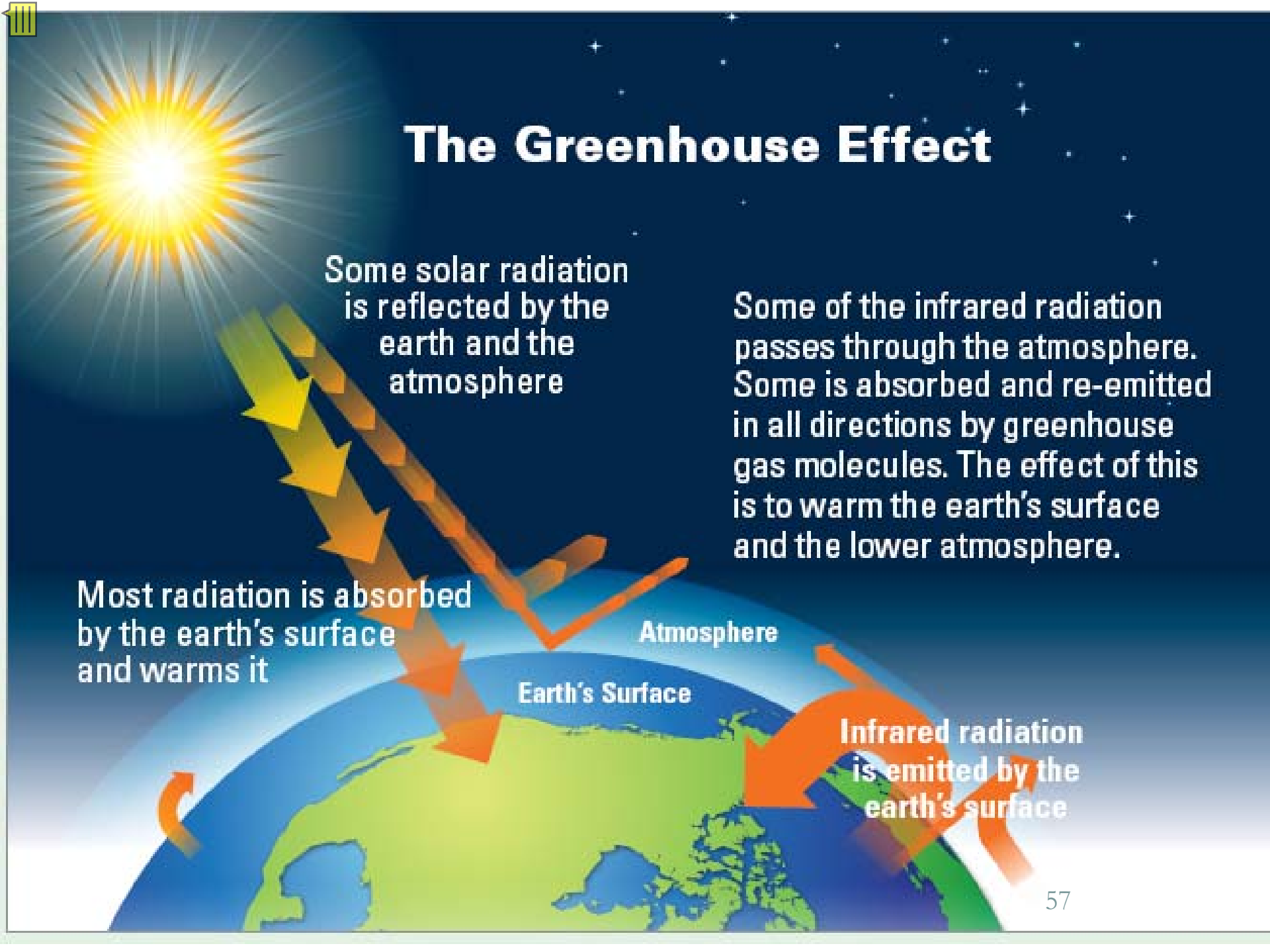


The Hudson Companies 2005-2008
$2,650,000.00 Annual Utility Budget

Cost Savings Over 4 Years



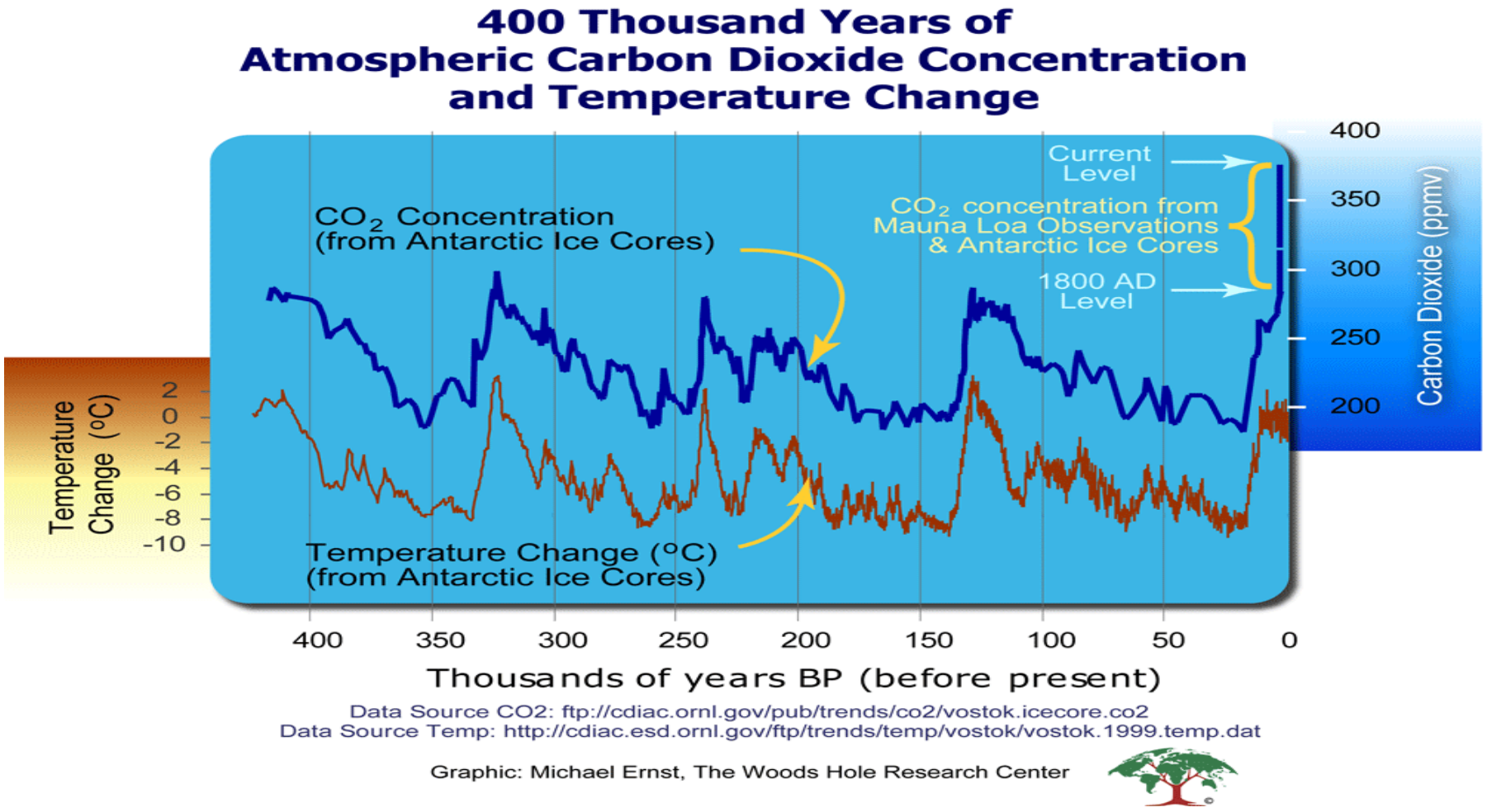
$1,523,000.00 Total Savings


The Greenhouse Effect
Some solar radiation is reflected by the earth and the atmosphere
Some of the infrared radiation passes through the atmosphere. Some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the earth's surface and the lower atmosphere.
Most radiation is absorbed by the earth's surface and warms it
Atmosphere
Earth's Surface
Infrared radiation is emitted by the earth's surface

Impacts


Climate Change Impacts
Health Impacts
Heat-related deaths
Infectious diseases
Air quality-respiratory illnesses
Temperature
Precipitation
Sea Level Rise
Wildlife
Loss of diversity
Species range shifts
Agriculture
Crop yields
Irrigation demand
Pest management
Forest Impacts
Health, composition and productivity
Water Resources
Changes in precipitation, water quality, and water supply
Coastal Areas
Erosion and inundation of coastal lands
Cost of protecting vulnerable lands

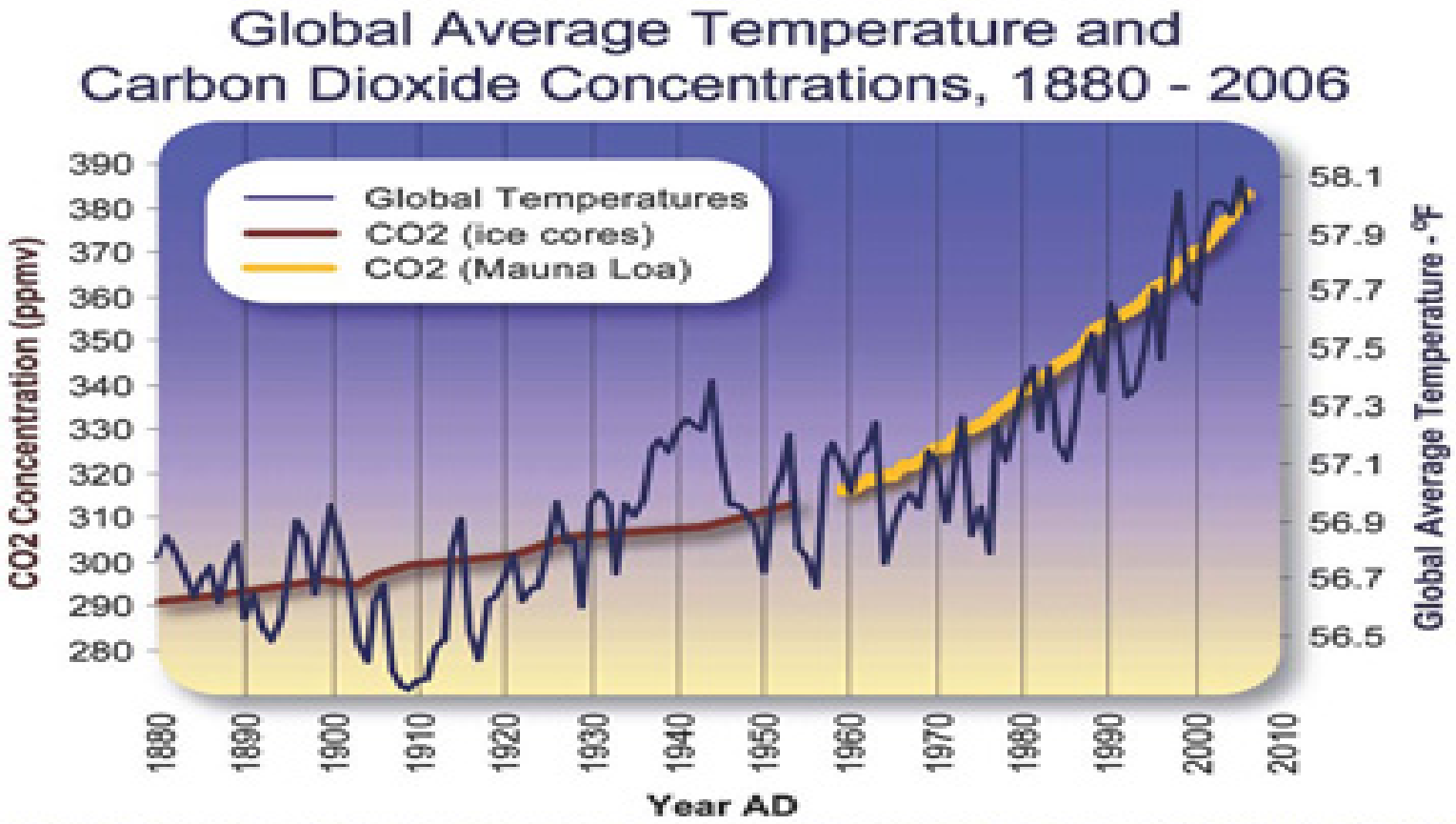
The Effects of CO2 over 400 thousand years and its effect on Global Temperature



Data Source CO2: ftp://cdiac.ornl.gov/pub/trends/co2/vostok.icecore.co2
Data Source Temp: http://cdiac.esd.ornl.gov/ftp/trends/temp/vostok/vostok.1999.temp.dat

Graphic: Michael Ernst, The Woods Hole Research Center

CO2 Concentration over the last 130 years and its Effect on Global Temperature



Data Source Temperature: ftp://ftp.nodc.noaa.gov/pub/data/anomalies/annual.land_and_ocean.90S.90N.df_1901-2000mean.dat
Data Source CO2 (Siple Ice Cores): http://cdiac.esd.ornl.gov/ftp/trends/co2/siple2.013
Data Source CO2 (Mauna Loa): http://cdiac.esd.ornl.gov/ftp/trends/co2/maunaloa.co2
& http://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/co2_mm_mlo.dat

Graphic Design: Michael Ernst, The Woods Hole Research Center

Environmental Impact

The United States Environmental Protection Agency Estimates that every kilowatt-hour (kWh) of electricity use avoided prevents the emission of the following:

1.5 pounds of carbon dioxide

5.8 grams of sulfur dioxide

2.5 grams of nitrogen oxides

A facility that uses 1,000,000 kWh, and saving 10 % per year equals a 10,000 kWh.

<u>These savings are equal to the removal of:</u>

15,000 pounds of carbon dioxide emissions

128 pounds of sulfur dioxide

55 pounds of nitrogen oxide

OR

2 automobiles removed from highways annually

1 acre of trees being planted

Heating Conversion (Btu's / 3412) = kWh

Emissions Calculators

- EPA – Office Carbon Footprint Tool - EXCEL
  http://www.epa.gov/epawaste/partnerships/wastewise/carboncalc.htm
- EPA – GHG Equivalencies Calculator
  http://www.epa.gov/cleanenergy/energy-resources/calculator.html
- EPA – CHP Emissions Calculator
  http://www.epa.gov/chp/basic/calculator.html

Questions and Answers

Reminders

Education , Education , Education

- Track utility data
- Organization wide energy conservation awareness
- Minimize consumption & reduce energy waste
- Maintain comfort in occupied areas
- Save Dollars
- Reduce Environmental Impact

Contact Information

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Robert S. Cerio. BOC, CEM – Energy Resource Manager
Ocean State Energy Resources
RSCerio@cox.net

NEEC, Northwest Energy Efficiency Council
www.neec.net www.theBOCinfo/NE

NEEP, Northeast Energy Efficiency Partnerships
www.neep.org www.neep.org/boc/index.html.