

Energy Efficiency & Human Behavior



David N. McNelis, Ph.D.

Director, Center for Sustainable
Energy, Environment and Economic
Development

University of North Carolina at
Chapel Hill

mcnelis@unc.edu

April 7, 2011



$$\text{CO}_2 = P \times S \times E \times C$$

Population **Demand
for
Services** **Electricity/
Service** **CO₂ / Unit
Electricity**



?

Conservation **Efficiency**

Energy conservation is any behavior that results in the use of less energy.

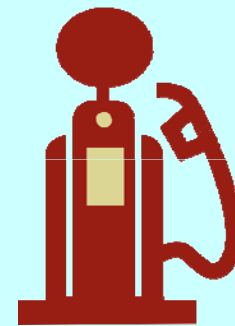
Energy efficiency is the use of technology that requires less energy to perform the same function.

Moderating Energy Consumption

- **Societal behavior modifications**
 - ◆ **Emphasis on conservation measures**
- **Adaptive policies and regulations**
- **Technological fixes and innovation**

Adaptive Policies and Regulations

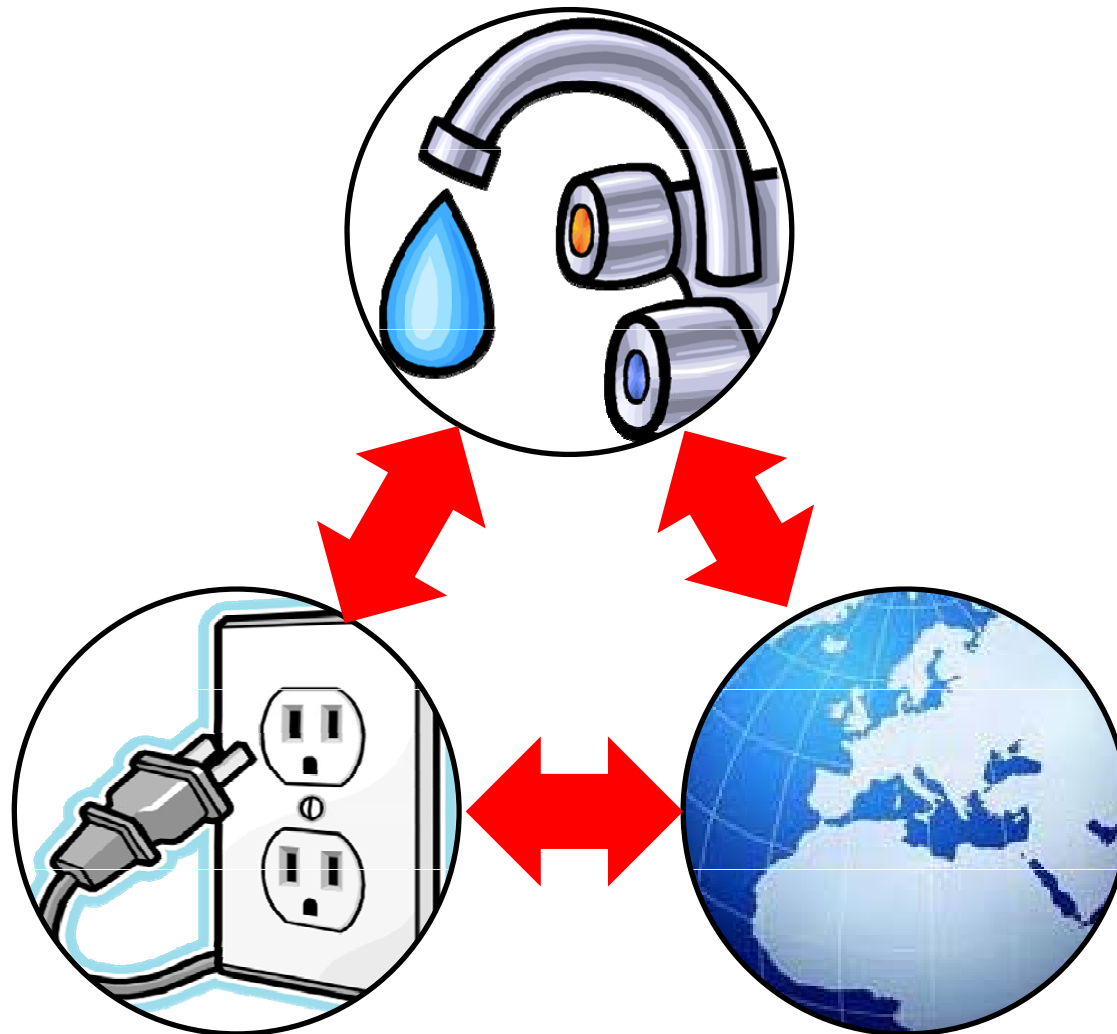
- **Renewable Portfolio Standards (RPS)**
- **CAFÉ Standards**
- **\$4.00/gallon gasoline**
- **Adapt to anticipated and unanticipated conditions**
- **Subsidies, tax incentives, loan guarantees.**

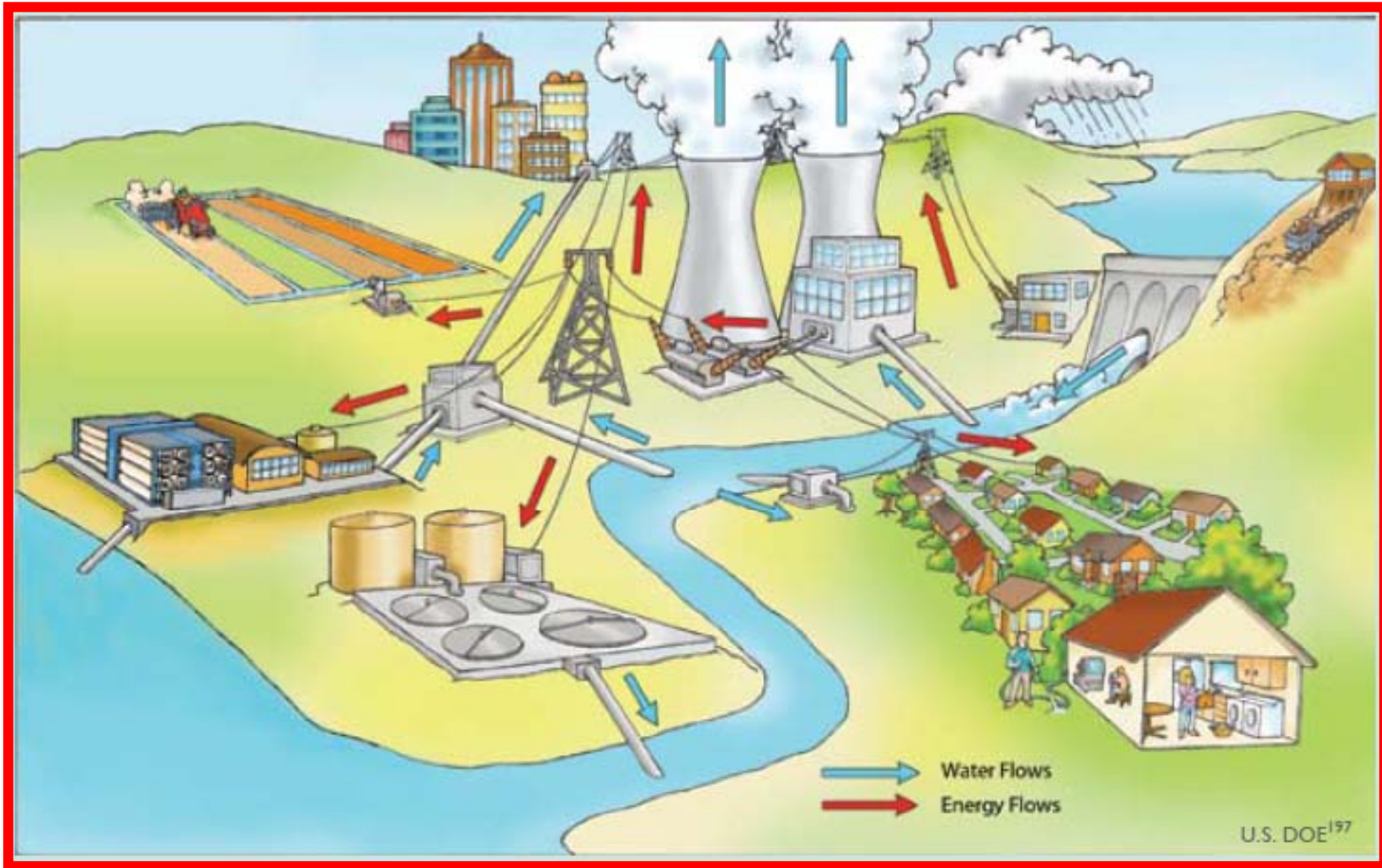


Technological Fixes/Innovation

- **Industrial ecology**
- **“Smart technology (e.g., grid, metering, appliances, household energy management systems)**
- **Colocation of complementary facilities**
- **Alternative sources of cooling water and cooling methods**
- **Technology transfer and outreach (foreign investments?)**

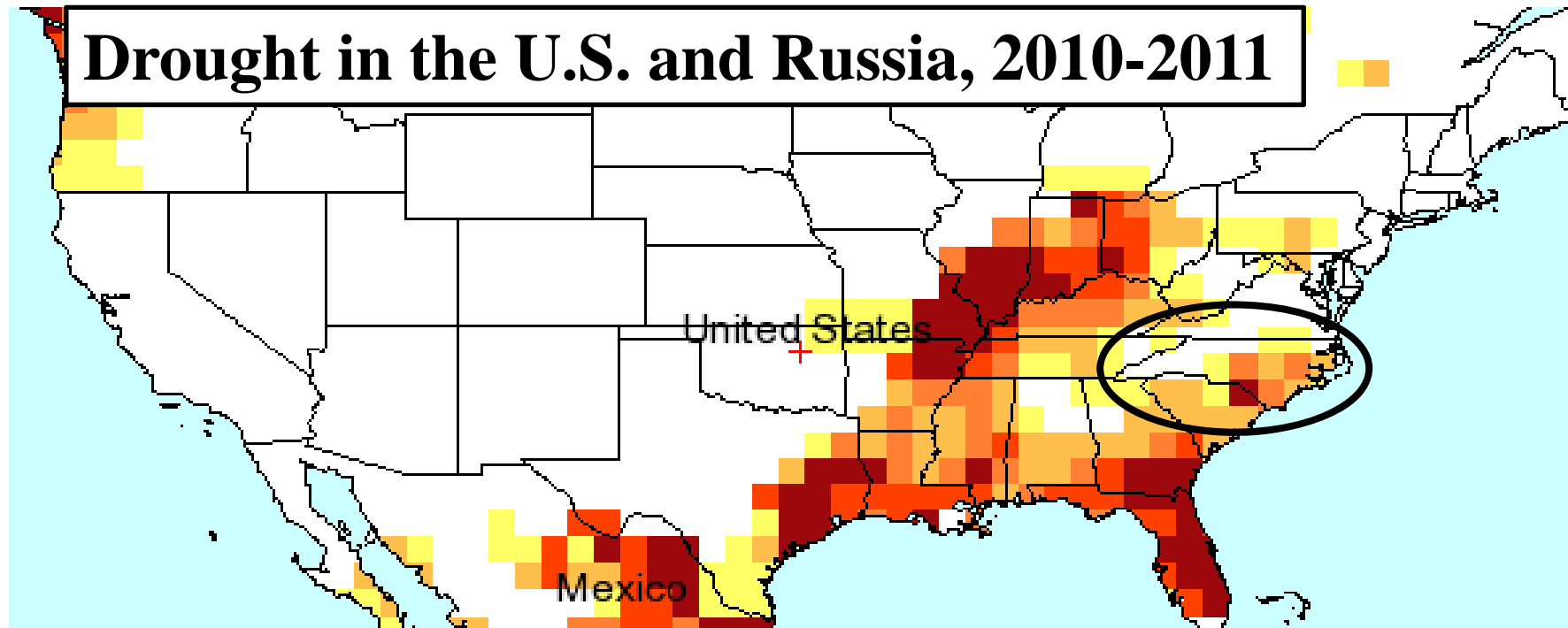
Interrelationship between Water, Energy, and Climate





Intimate Connection between Energy and Water

Drought in the U.S. and Russia, 2010-2011



Drought Severity



Minor Drought



Moderate Drought



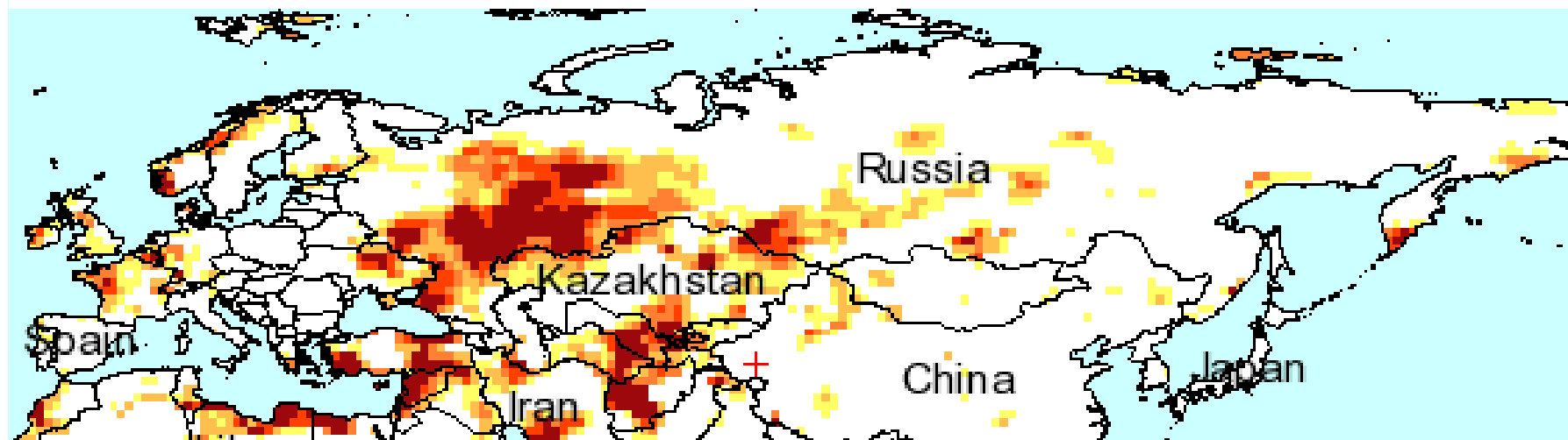
Severe Drought



Extreme Drought



Exceptional Drought



Total Consumptive Water Use (gal/kWh)

	Thermoelectric Site Water	Hydroelectric Site Water
NC	0.23	10.37
US	0.47	18.27

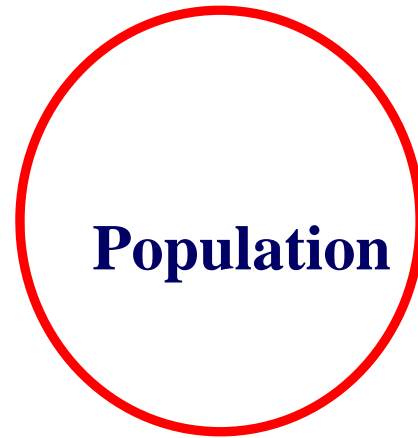
Virtual water content of products

1 cotton shirt	4000 litres
1 hamburger	2400 litres
1 cup of coffee	140 litres
1 glass of beer	75 litres
1 slice of bread	40 litres
1 sheet of A4-paper	10 litres



Source: Arjen Hoekstra, University of Twente, Netherlands

$$\text{CO}_2 = \text{P} \times \text{S} \times \text{E} \times \text{C}$$



Demand
for
Services

Electricity/
Service

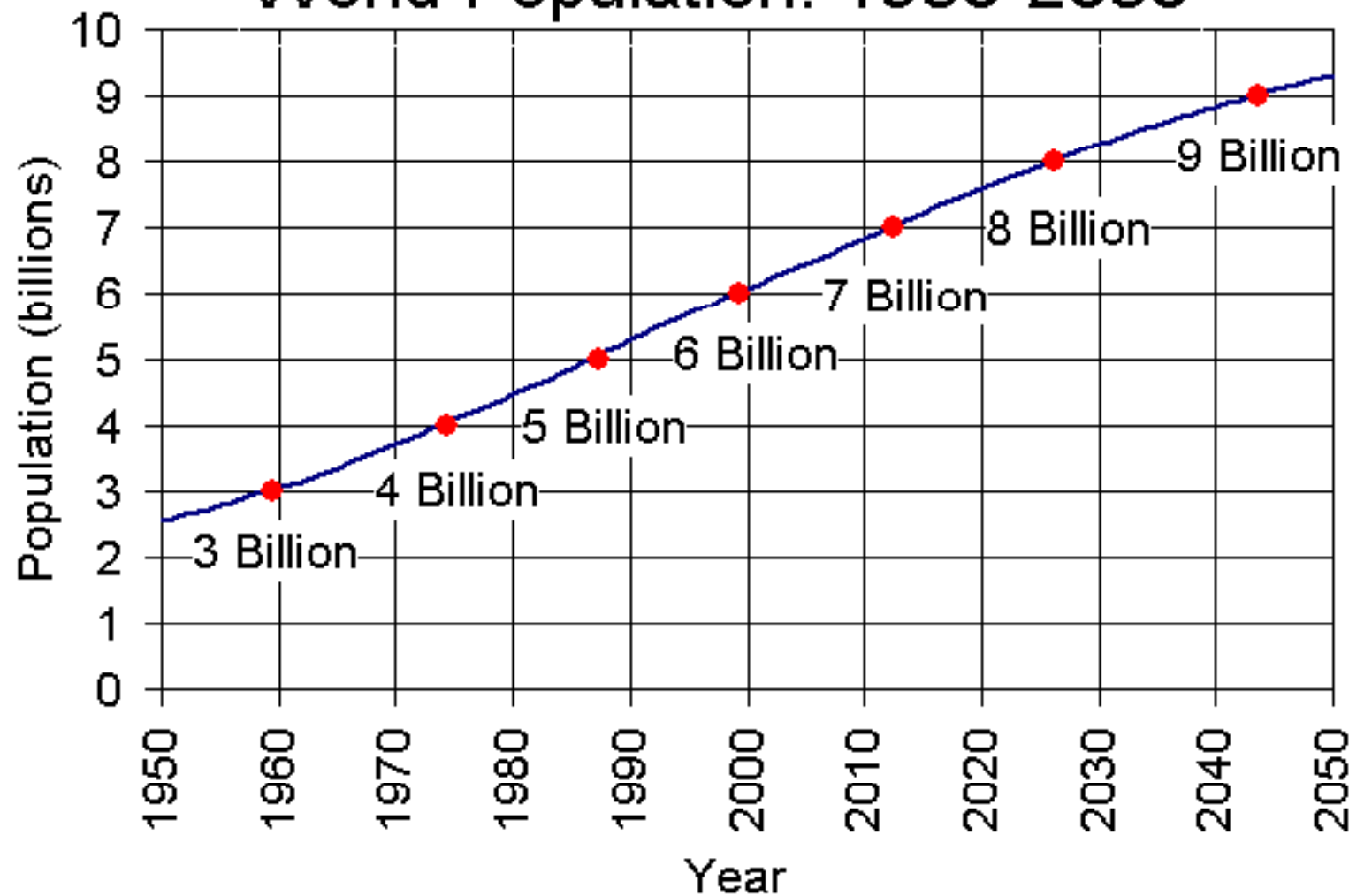
CO₂ / Unit
Electricity



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Conservation Efficiency

World Population: 1950-2050



Source: U.S. Census Bureau, International Data Base, June 2009 Update.

$$\text{CO}_2 = \text{P} \times \text{S} \times \text{E} \times \text{C}$$

Population

Demand
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Electricity/
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CO₂ / Unit
Electricity

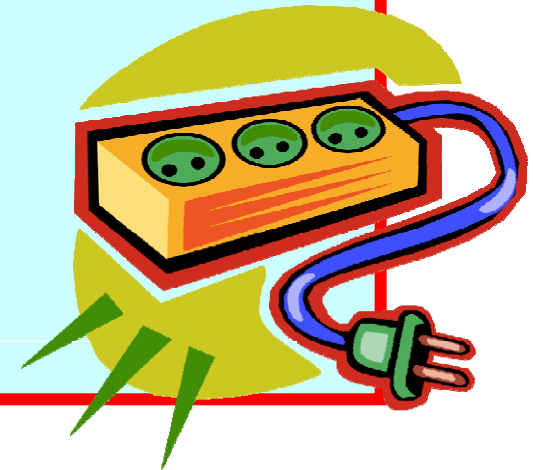


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Conservation Efficiency

Phantom Load Power Consumption Examples

Electrical device	Load (Watts)
Microwave	2-6
Answering machine	2-3
Cordless phone	2-4
CD player	3-8
TV	0-12
VCR	1-15
Oven clock	3-4
Security system	6-22
Cable box	8-15
Computer	0-2



$$\text{CO}_2 = \text{P} \times \text{S} \times \text{E} \times \text{C}$$

Population

Demand
for
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Electricity/
Service

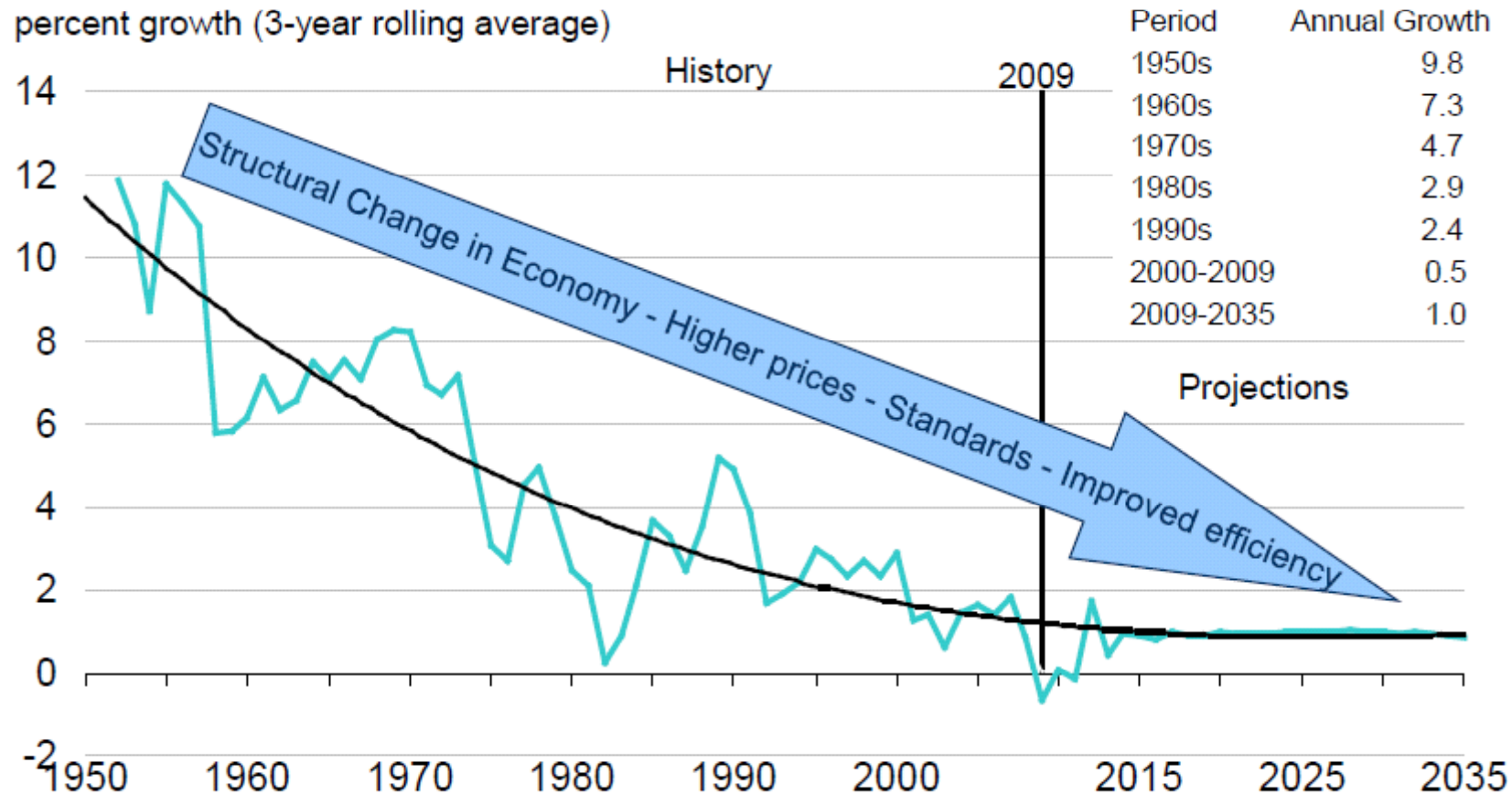
CO₂ / Unit
Electricity



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Conservation Efficiency

While projected electricity consumption grows by 30%, the rate of growth has slowed



Energy Efficiency

Roll Out

Weatherization

Low Energy Lighting

Smart Meters

Reduction of
Phantom Loads

...

Develop

Smart Grid

Advanced Lighting

Coal Capture and
Sequestration

SMRs, PHEVs,
Desalination

...

Research

Thin Film Solar

High Conversion
Efficiency Solar

Energy Storage

Cellulosic Ethanol

...

Ways to Improve Efficiency

- **Buildings**
 - **Insulation**
 - **Eliminate air leaks**
 - **Air to air heat exchangers**
- **Appliances**
 - **Energy efficient appliances**
 - **High efficiency lighting**
- **Vehicles**
 - **Increase fuel economy**
 - **Efficient electric motors**



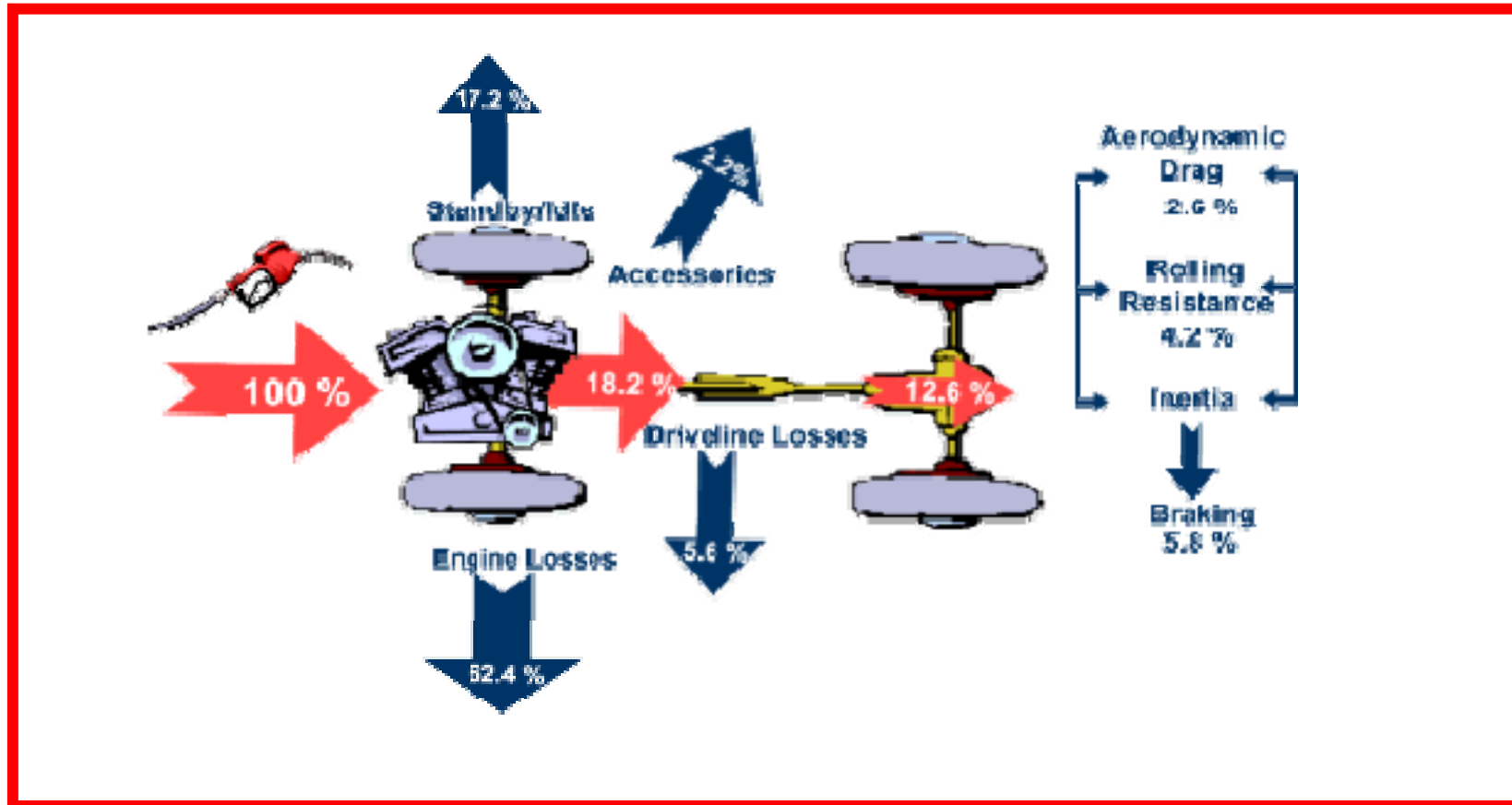
Buildings

Consume 1/3
of the Earth's
Resources

Use 2/3
of the Electricity

Create 1/3
of the Earth's
Pollution

Internal Combustion Automobile



Market penetration of new technologies for light duty vehicles. 2035 (percent)

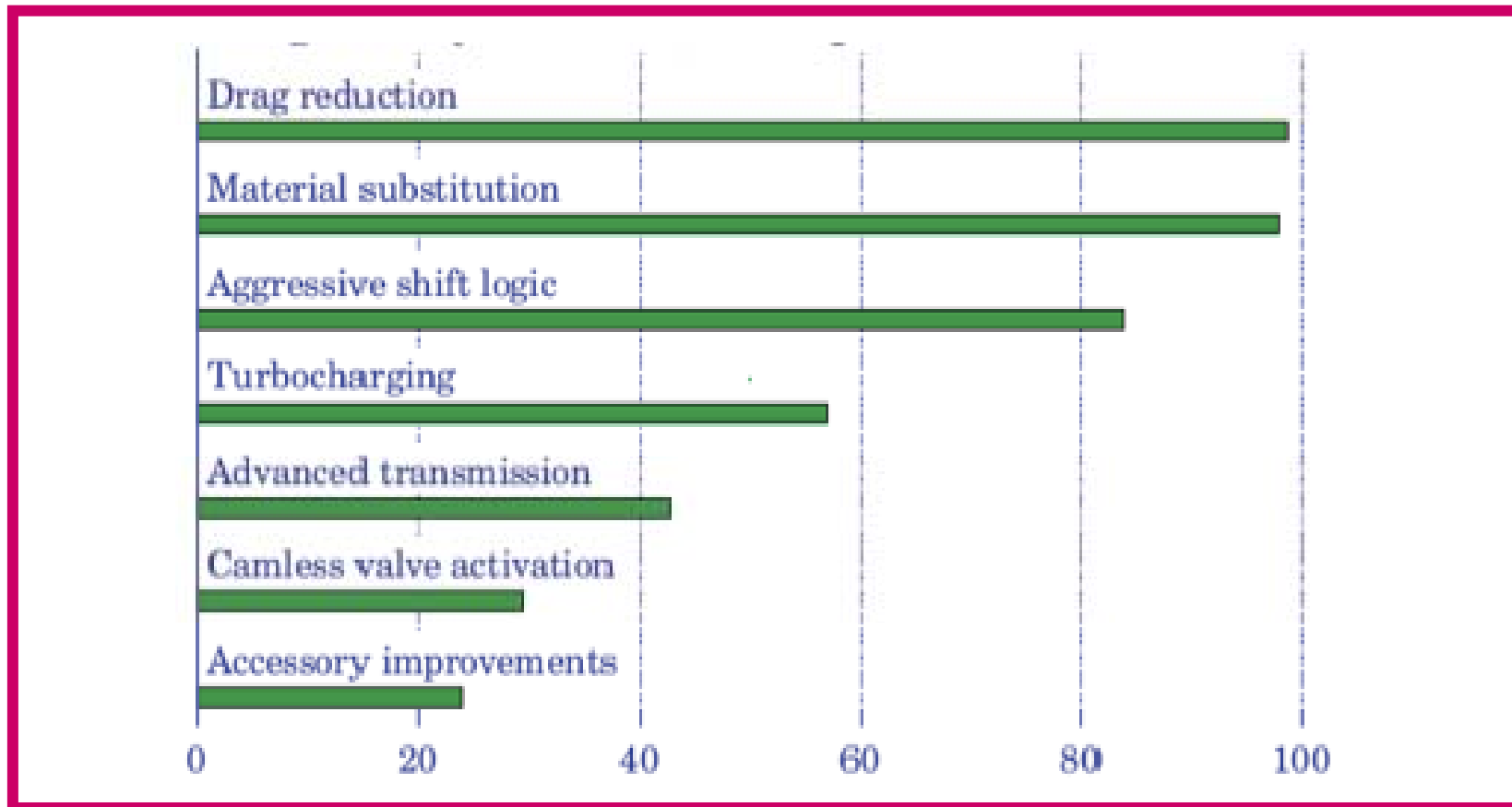
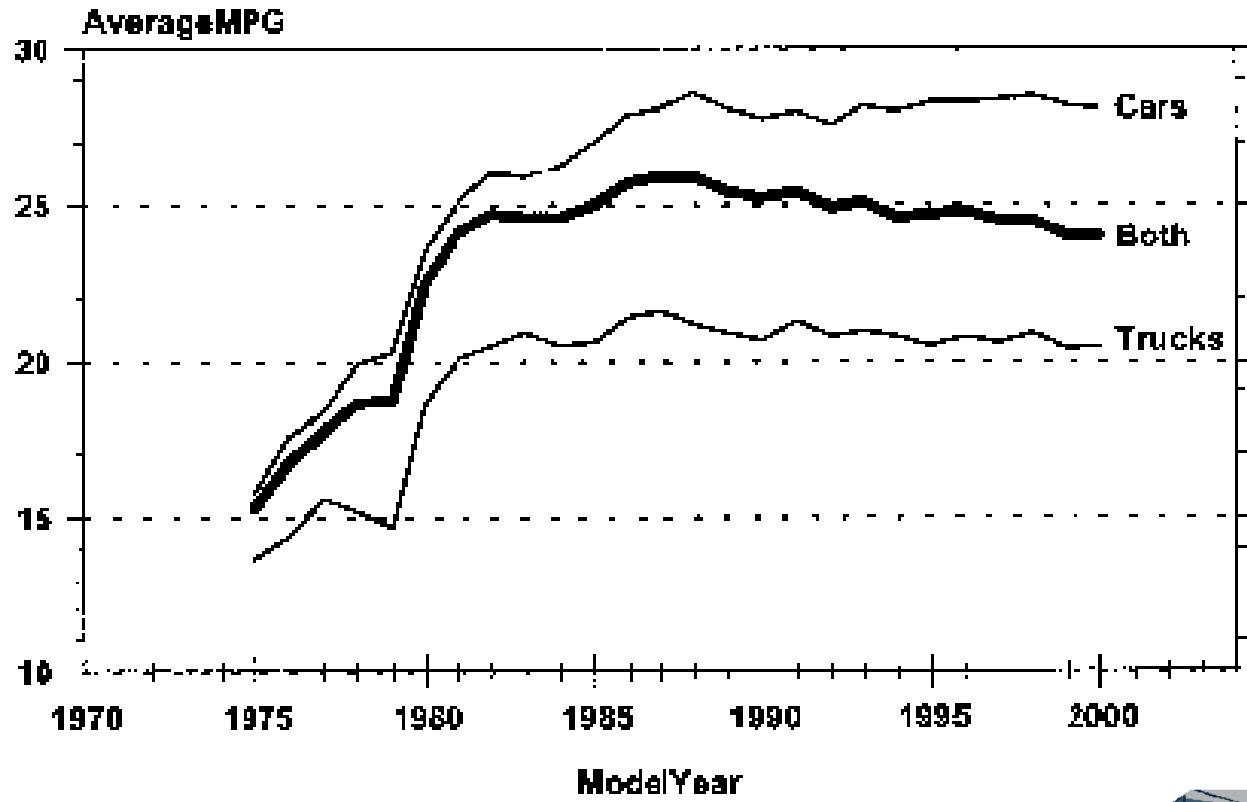
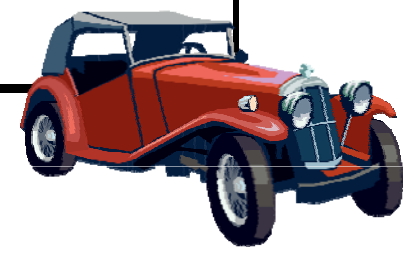


FIGURE 1
FUEL ECONOMY OF U.S. VEHICLES BY MODEL YEAR

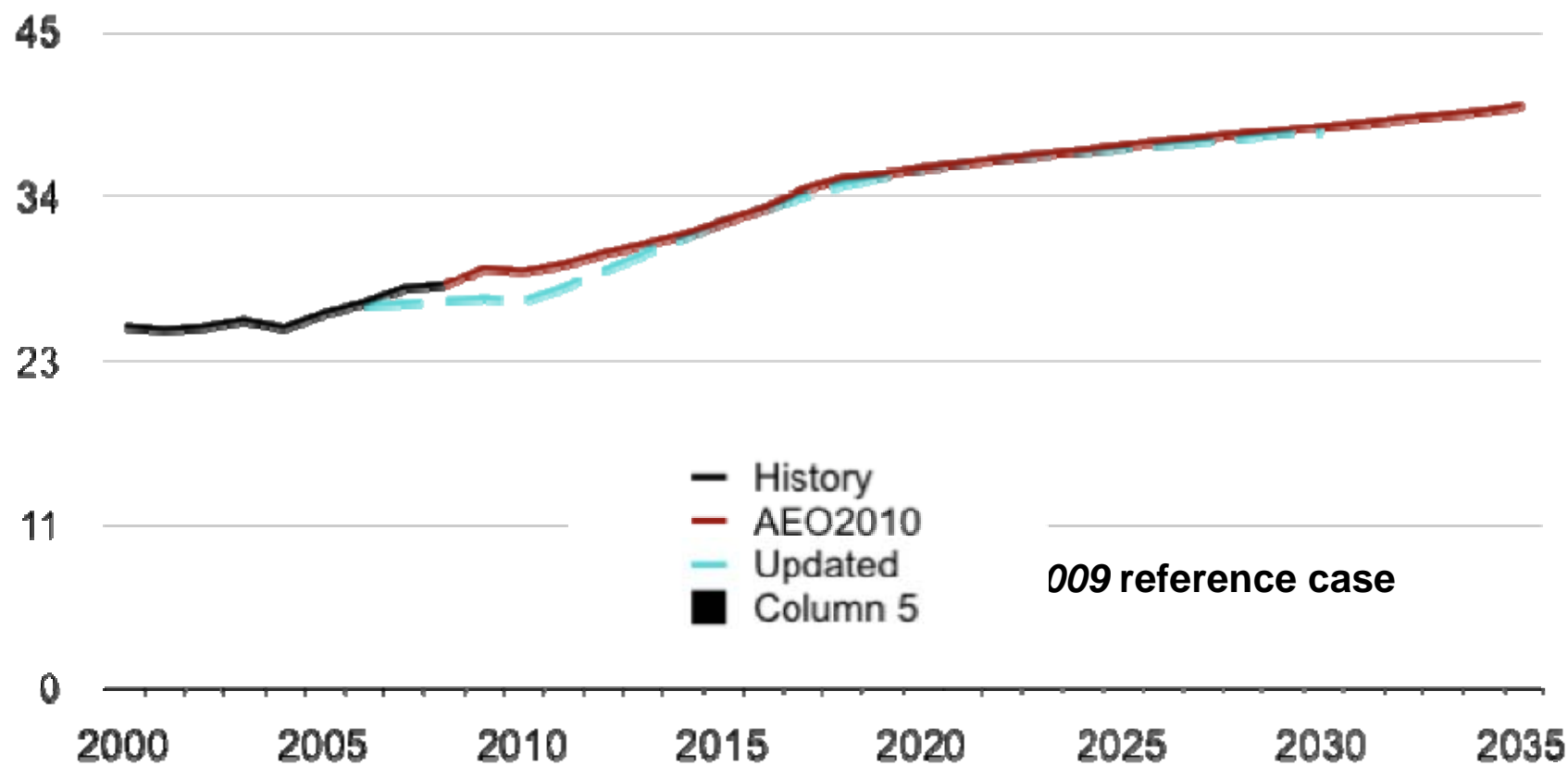


SOURCE: EPA



New light duty vehicle efficiency reaches 40 mpg by 2035

miles per gallon



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Population

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Conservation

Efficiency

?

Energy Options

- **Carbon Capture and Sequestration**
- **Nuclear (including SMRs and FBRs)**
- **Renewables (Wind, Concentrating Solar Power, Solar PV, Solar Thermal)**
- **Renewables (Hydro, Geothermal, Biofuels)**
- **Conservation and Efficiency**

Energy Efficiency

**First,
Best, and
Least Cost Option**

Energy Efficiency Programs at the University of North Carolina

- **Student Activity Funds**
- **Bus Service**
- **Public Lectures**
- **Science Teacher Workshops**
- **Leed Certification**



National Champions!

**Energy Star National
Building Competition**



Morrison Hall Per Floor Consumption

Kilowatt-hours of electricity consumed today



UNC

DIVISION OF STUDENT AFFAIRS

COMPARISONS

Per Floor Consumption

This grouping includes floors 2 through 10 in Morrison Hall

Period: Mar 16 (Today)



TOTAL KILOWATT-HOURS

655

Per Wing Consumption

Wing A Per Floor Consumption

Wing B Per Floor Consumption

Floor 2	67.2 kWh
Floor 3	65.0 kWh
Floor 4	88.5 kWh
Floor 5	65.1 kWh
Floor 6	67.2 kWh
Floor 7	74.7 kWh
Floor 8	85.8 kWh
Floor 9	65.0 kWh
Floor 10	76.8 kWh

History

Unit equivalent



Introduction



Comparisons

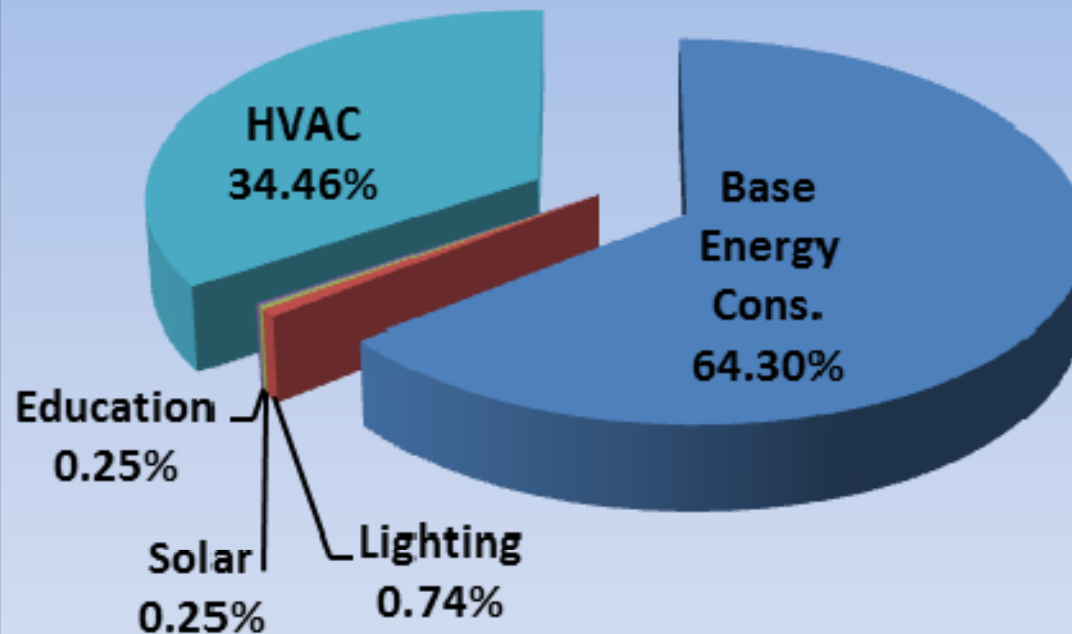


Electricity



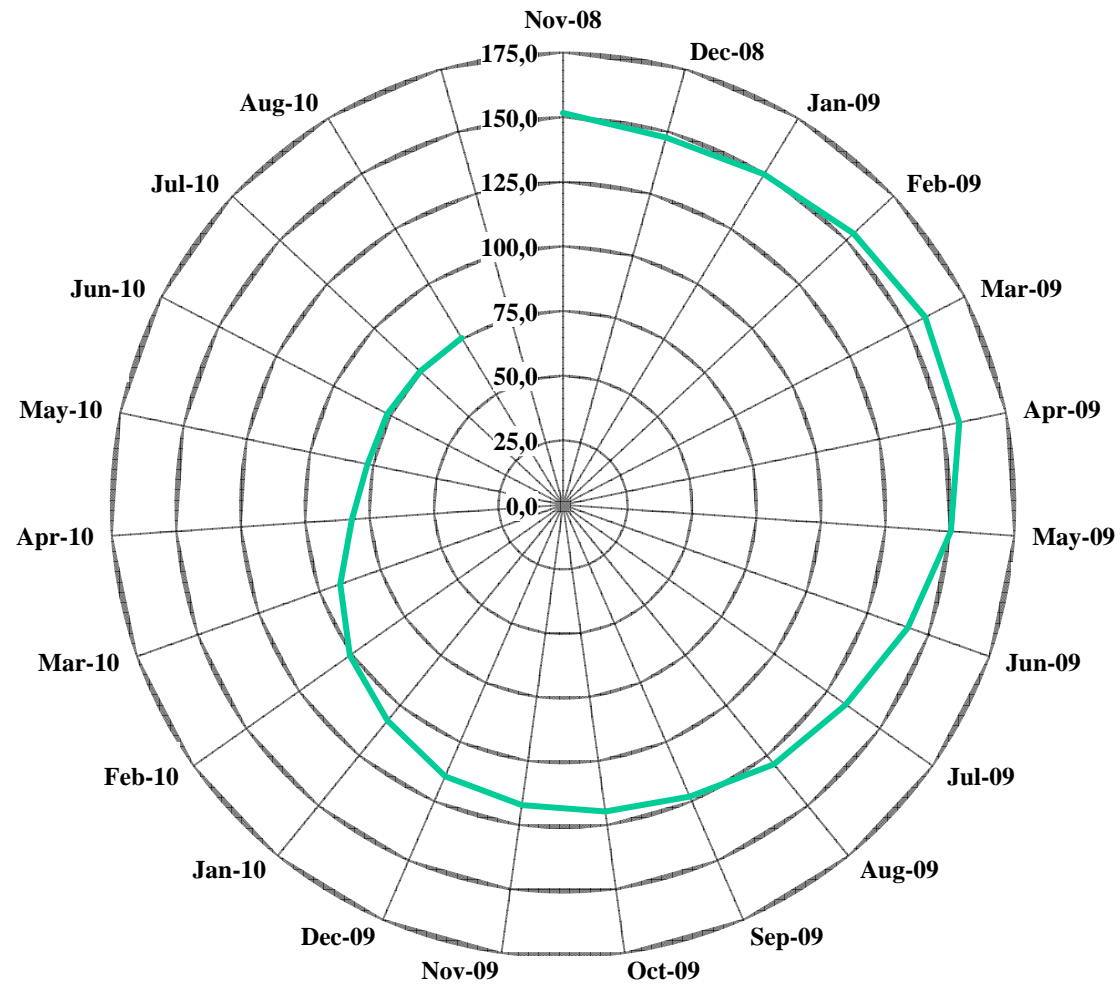
Solar thermal

Morrison Energy Reductions September 2009 - August 2010



This chart shows the energy consumption for the contest year and the estimated contribution of each of the four focus areas. The total energy reduction was over 35%.

Weather Normalized Annual EUI (kBtu/Sq. Ft.)



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