CHEM 103: Chemistry in Context

Unit 3

Energy, Chemistry and Society

Unit 3.3

Alternative Energy Sources: Conservation

G&R 9

Energy Conservation / Efficiency

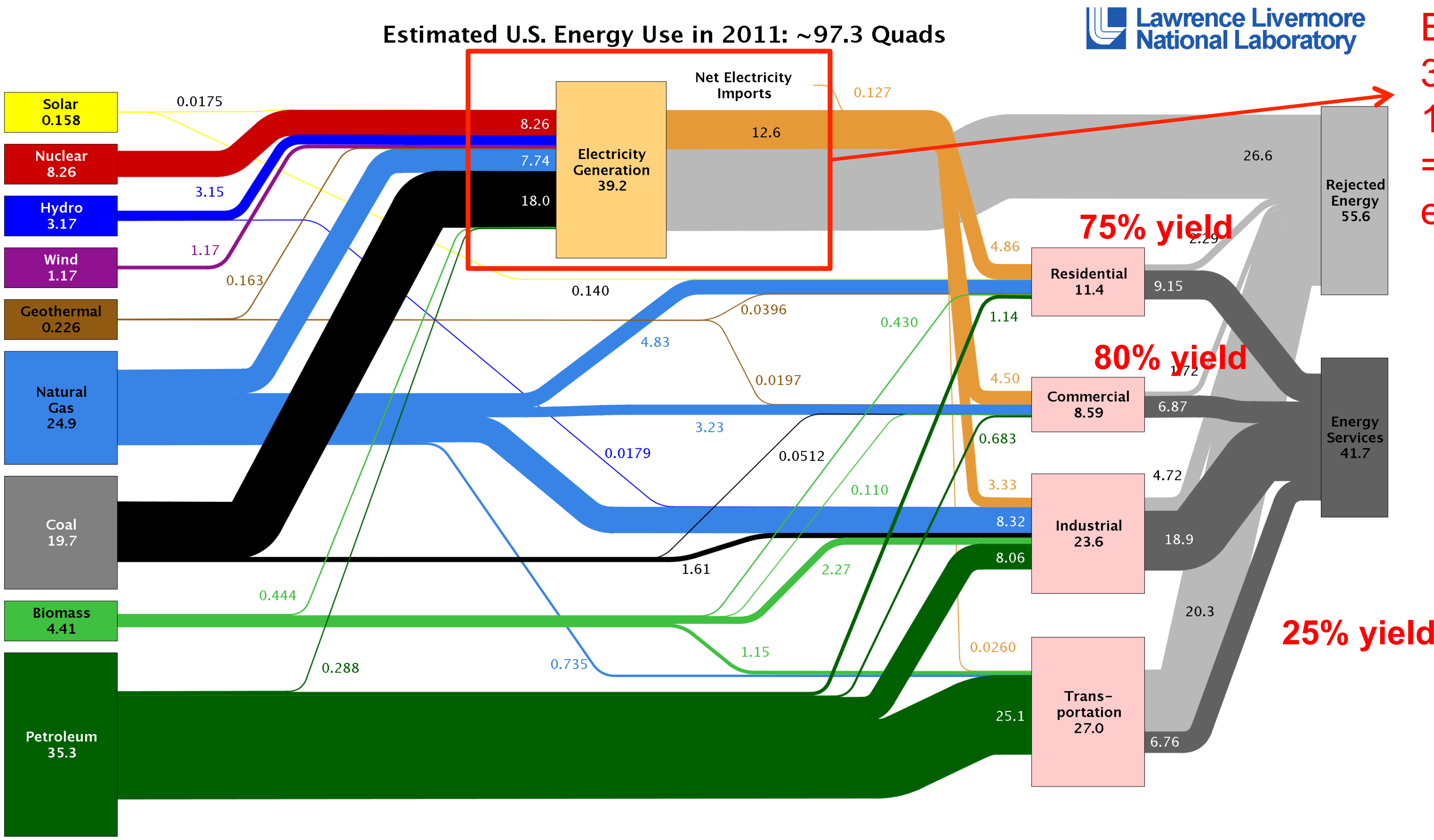
"Image" problem with conservation/efficiency:
like losing weight it's not fun

But…

"Increasing energy efficiency - technologically providing more desired service per unit of delivered energy consumed - is generally the largest, least expensive, most benign, most quickly deployable, least visible, least understood, and most neglected way to provide energy services"
(Energy End-Use Efficiency, Lovins, 2005)

"It is estimated that nearly 60% of carbon emission reductions achievable between now and 2030 will accrue from efficiency efforts" (Tracking Climate Change in the US, American Solar Energy Society, 2007)

Where Can We Improve Efficiency?



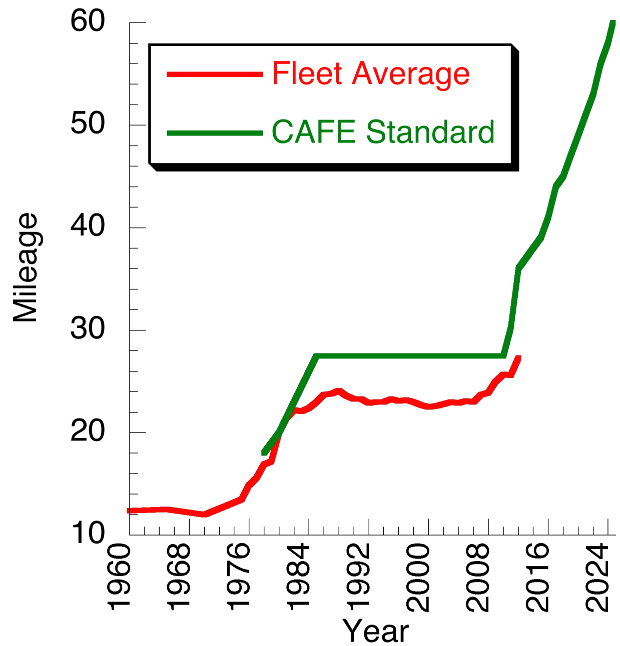
Source: LLNL 2012. Data is based on DOE/EIA-0384(2011), October, 2012. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports flows for non-thermal resources (i.e., hydro, wind and solar) in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 80% for the residential, commercial and industrial sectors, and as 25% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Electricity: 39.2 EJ in, 12.6 EJ out = 32% efficiency

Losses mainly in the form of heat

$$\text{efficiency} = 1 - \frac{T_{low}}{T_{high}}$$

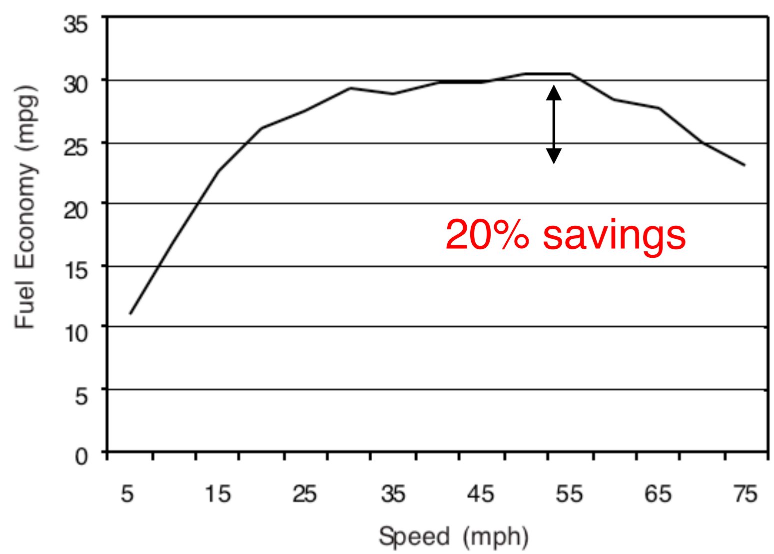
Automotive Fuel Efficiency



"New" Standard 55 MPG by 2025

(May '09 goal was: 39 MPG cars 30 MPG Light trucks)

At 48 mph, 54% of the energy required to move a car goes to aerodynamic drag. Drag increases with the square of the velocity http://www.fueleconomy.gov



www.fueleconomy.gov

1982 Honda CIVIC 1300 FE: 65 MPG commuting to Boulder

New materials: lighter vehicles with improved strength/safety (less weight less energy) (Chapter 9)

New batteries: greater energy density leads to greate distance & lighter weight (Chapter 8)

Fuel cells: lower Temp., less heat loss (Chapter 8)

Conservation

If the fleet-average MPG increases from 18 MPG to 55 MPG what would this do for our annual usage of petroleum in EJ (71% of our petroleum usage is for transportation)? How does this number compare to the other “renewable” energy options?

Tripling the mileage would cut the energy usage by 2/3

World Reserves	
Coal	20,200 EJ
Natural Gas	7,170 EJ
Oil	10,200 EJ
US use:	
Coal	20.8 EJ
Natural Gas	26.3 EJ
Oil	37.2 EJ
Nuclear	8.7 EJ
Biofuels	16.7 EJ
Wind	36 EJ
Solar	38 EJ
MPG	17.8

$$26.5\ \text{EJ} \times \frac{18}{55} = 8.7\ \text{EJ}$$

26.5 EJ - 8.7 EJ = 17.8 EJ saved

1.055 EJ= 1 Quad

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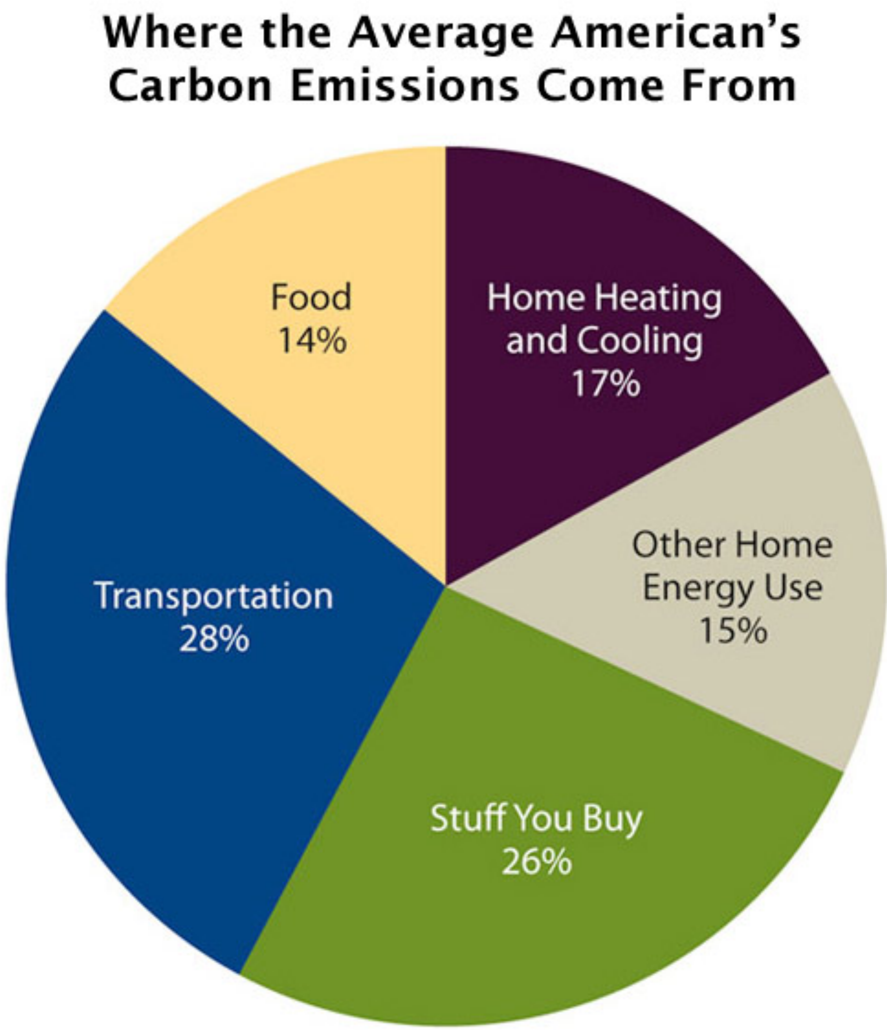
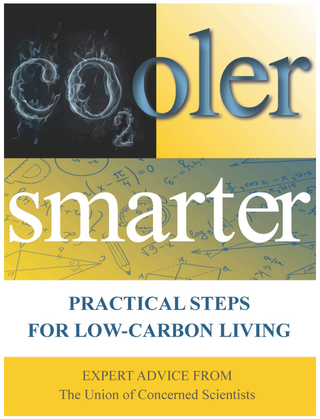
What can we do?



http://coolersmarter.org



Transportation

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Where the Average American's Carbon Emissions Come From

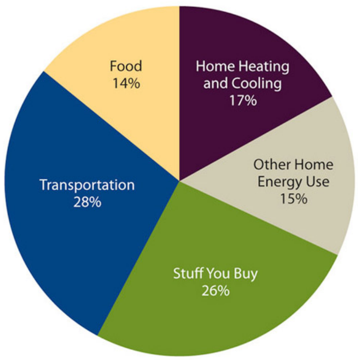
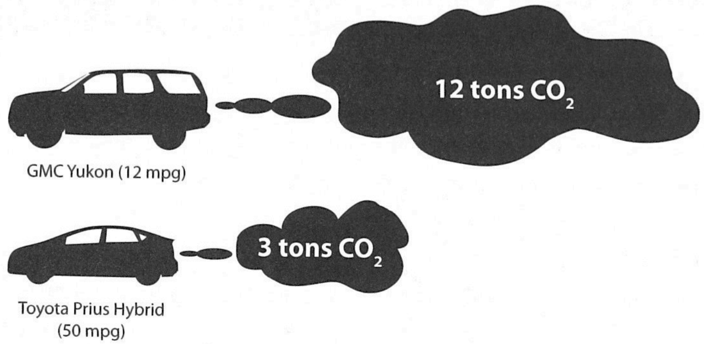


Figure 4.2. Vehicle Emission Comparison



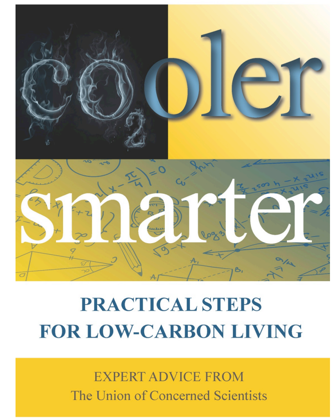


Figure 4.4. CO_2 Emissions per 100 passenger miles

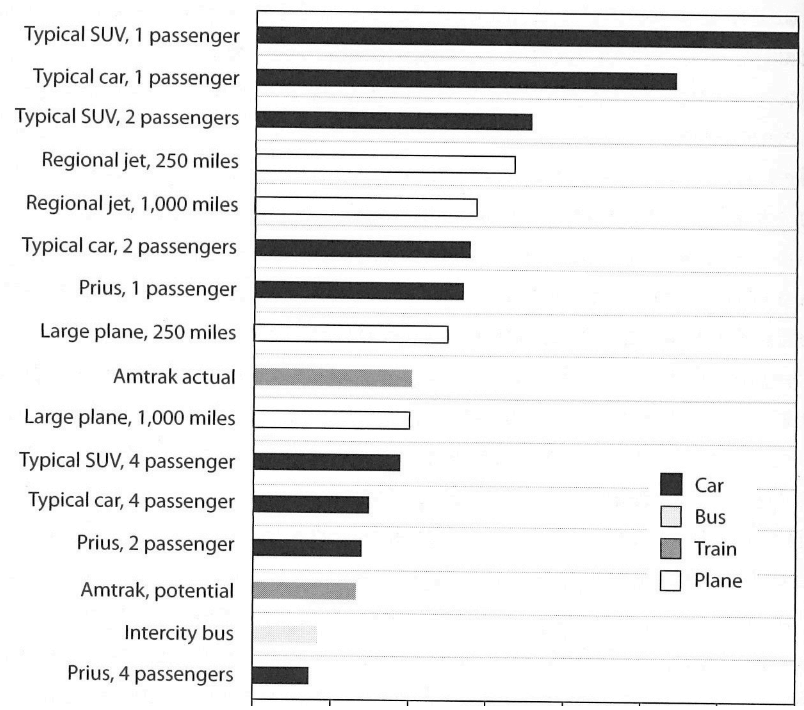
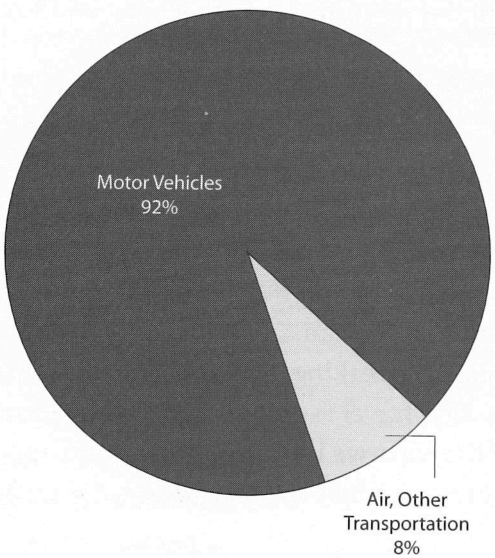


Figure 4.5. Breakdown of Transportation Emissions



Heating

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Where the Average American's Carbon Emissions Come From

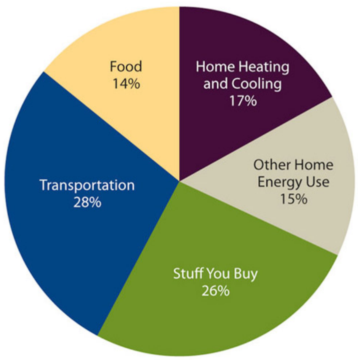


Figure 5.2. Household Heating Systems in the United States, by Type

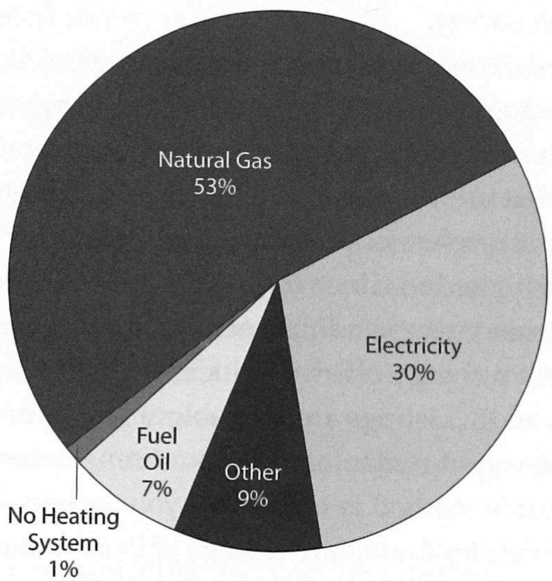
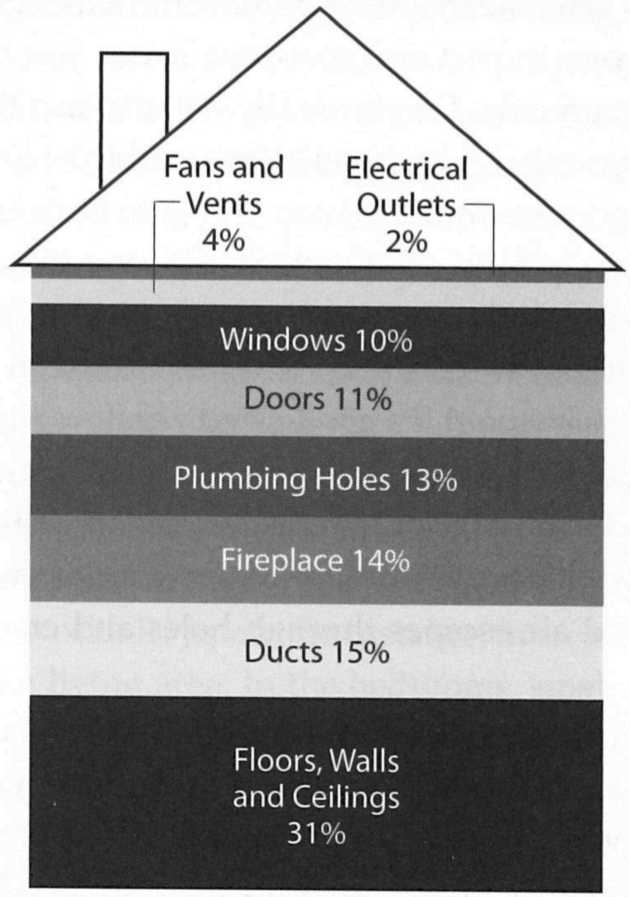
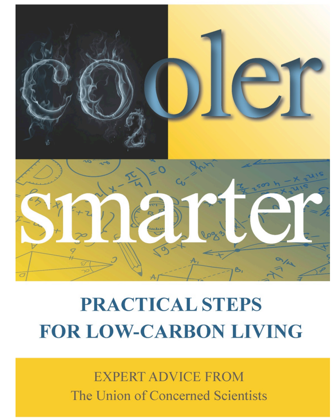


Figure 5.3. Where Air Escapes from Your Home





Electricity

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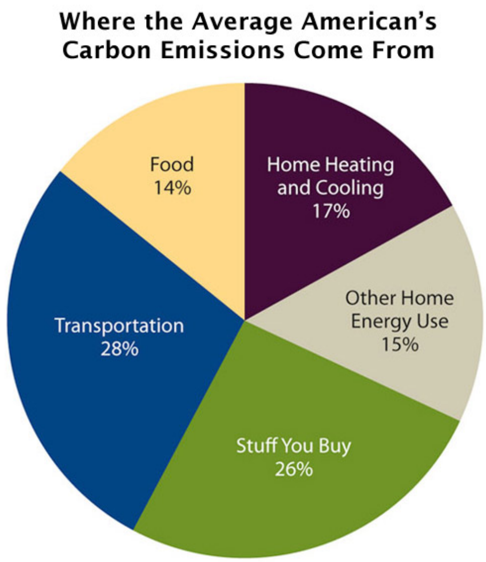
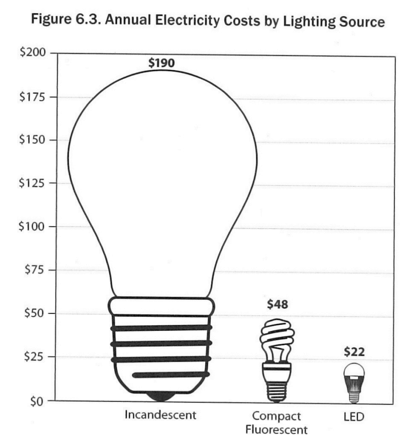
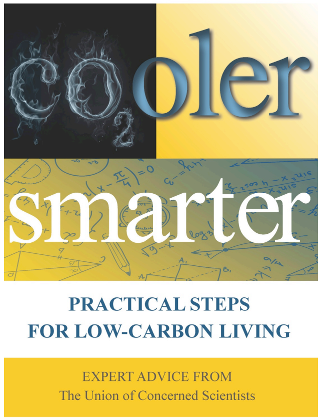
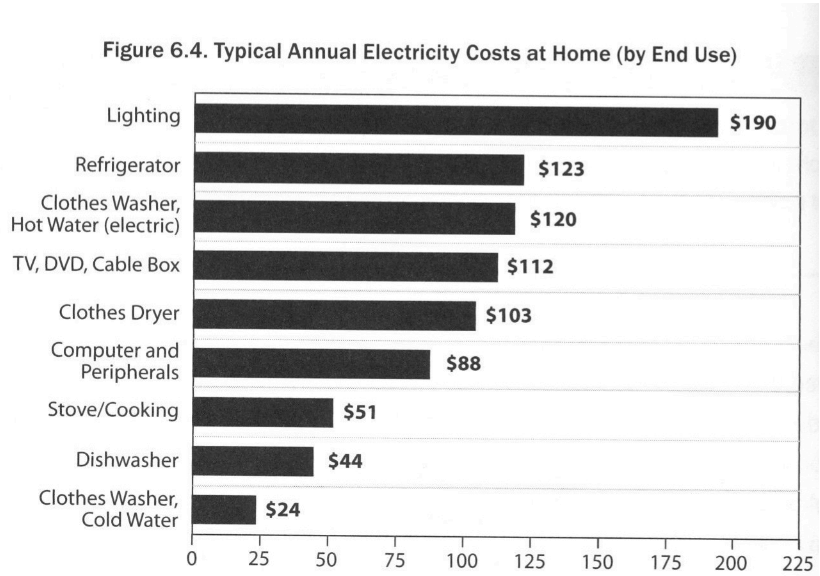
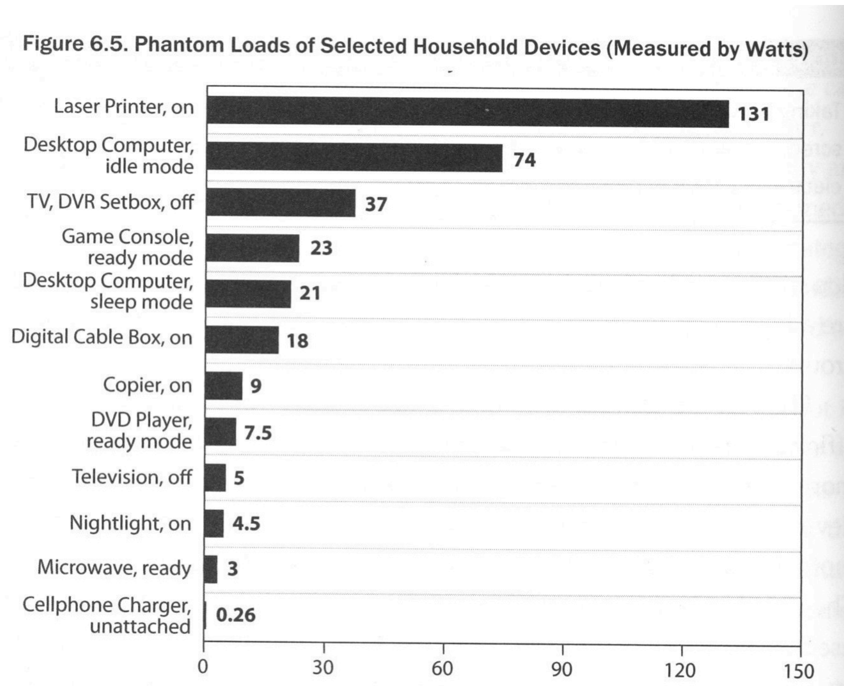




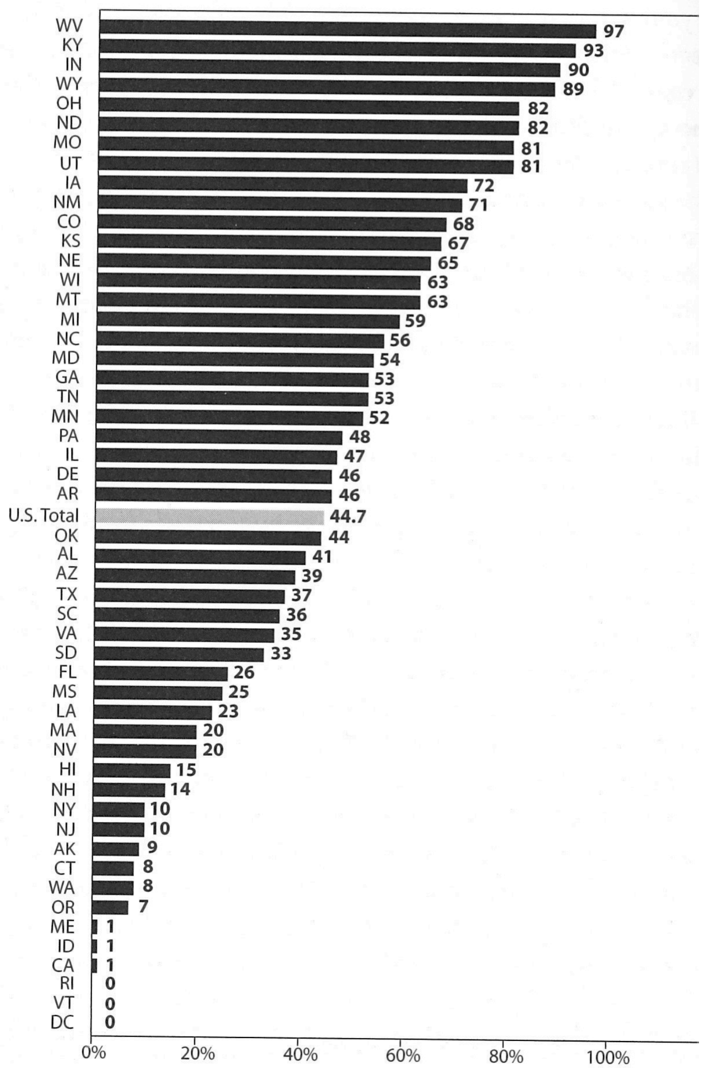


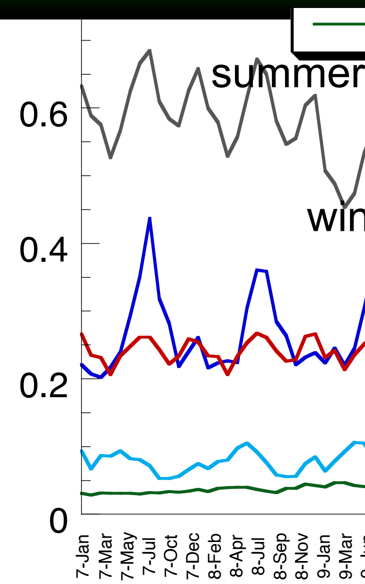




US Electricity

Figure 6.6. Percentage of Electricity from Coal (State by State)

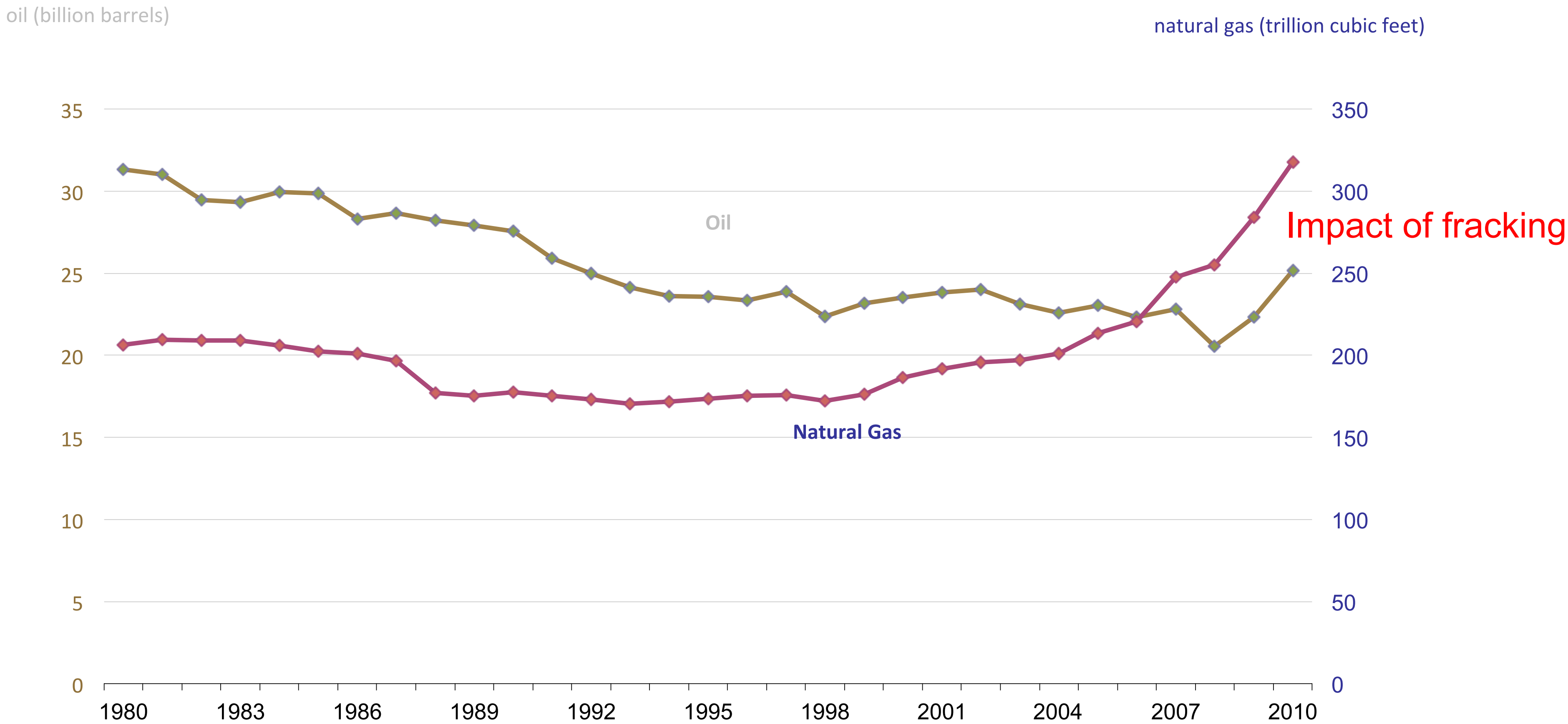




Annual usage by adding monthly numbers

We’re seeing a changeover due to natural gas pricing & coal regulation

US Proved Reserves



Source: U.S. Energy Information Administration

Food

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Figure 7.2. Comparison of Global Warming Emissions by Food Type (by Pound or Pint)

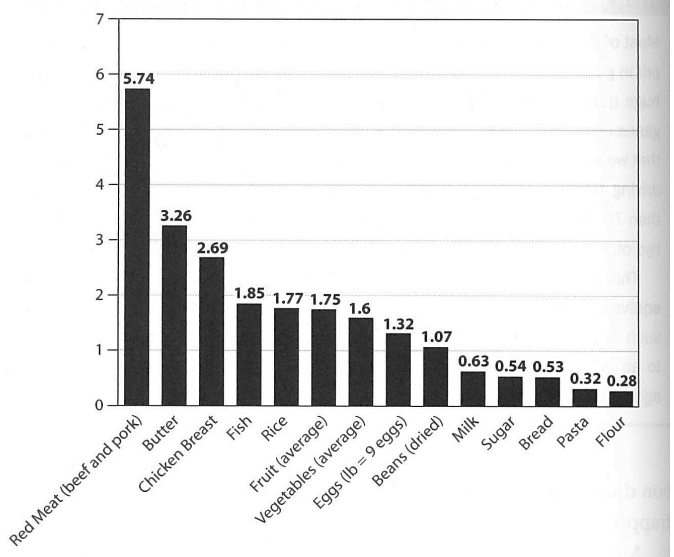
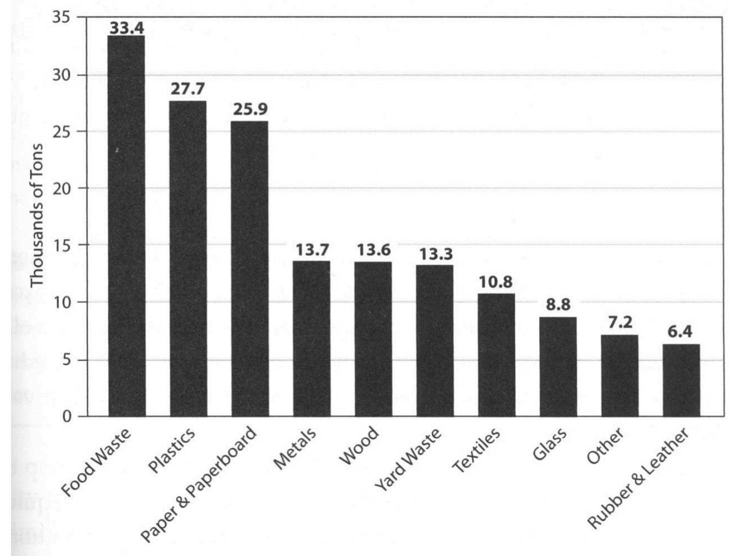


Figure 7.3. Municpal Solid Waste Discarded (by Material) in 2009



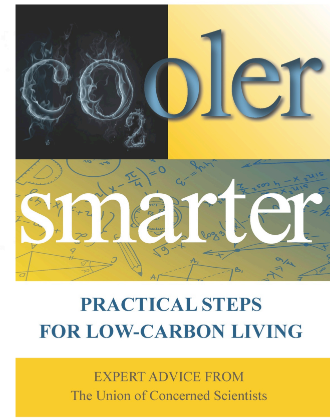


Figure 7.4. Supply Chain Food Miles by Food Group

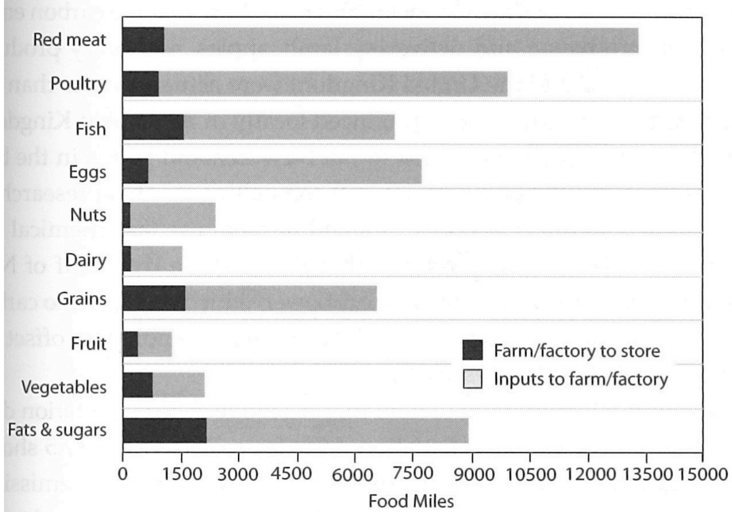
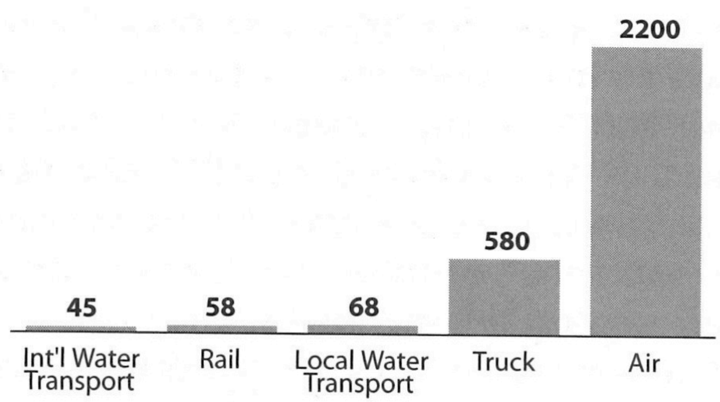


Figure 7.5. Emissions by Mode of Transport (pounds of CO_2e per 1,000 ton-miles)



Recycling

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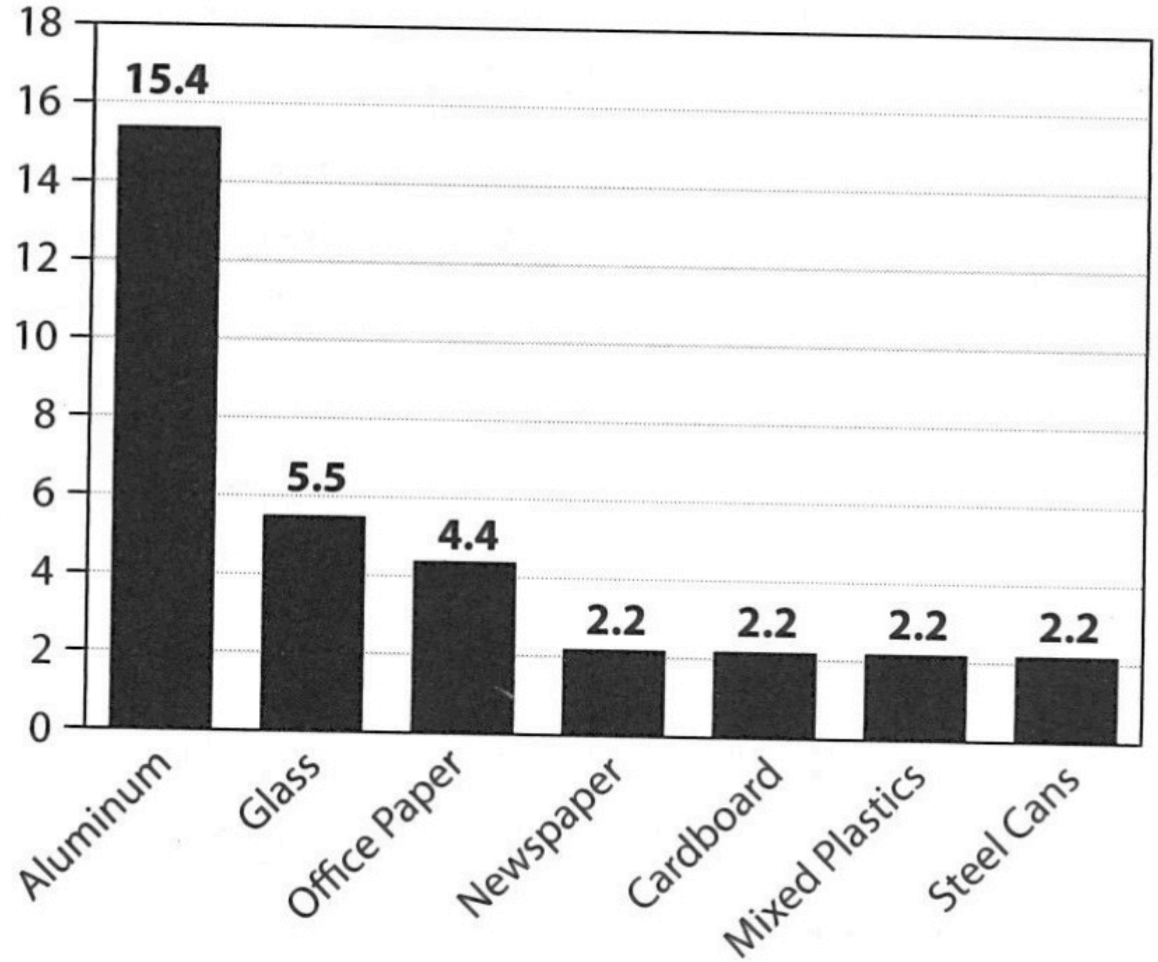
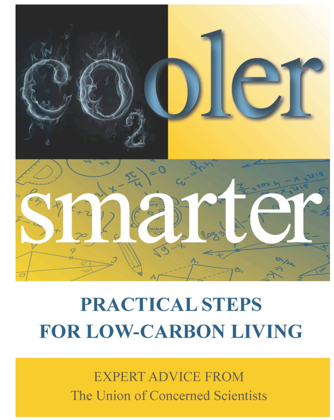


Figure 8.3. Pounds of CO_2e Emissions Saved Per Pound of Recycling



Energy Conservation / Efficiency

Suggestions from *Cooler Smarter* (2012) from The Union of Concerned Scientists

#1 Use a more fuel efficient car

(Doubling your gas mileage uses less energy and produces less carbon)

Or drive less (carpool, take the bus, “trip-chain”, ride your bike, walk)

Or drive slower (optimal MPG comes at about 65 MPH)

#2 Reduce heating and cooling costs

(Turn the thermostat down/up, insulate your house, get a higher efficiency furnace/AC, use a smart thermostat)

#3 Switch from incandescent lights for home lighting

(Use fluorescent (75% less energy) or LED (88% less energy) if you were using 60W light bulbs–even more if they were 100W)

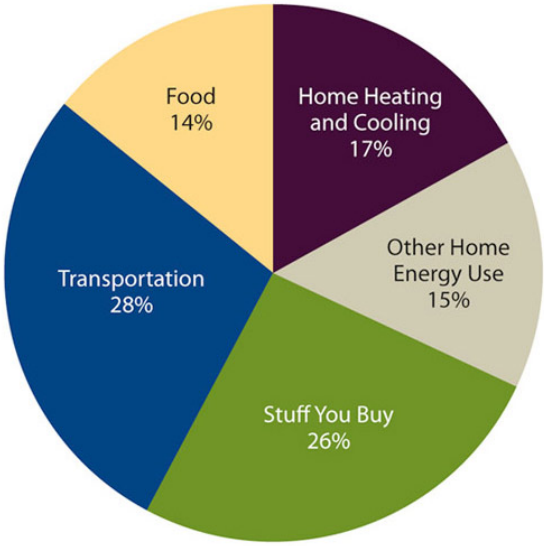
#4 Turn off the extra refrigerator when it’s not in use / turn off the laser printer (Buy more energy efficient appliances.)

#5 Eat less red meat (beef and pork)

(More energy required and 5x the carbon footprint than beans and grains.)

#6 Buy less stuff (Buy stuff with less packaging.)

Where the Average American’s Carbon Emissions Come From



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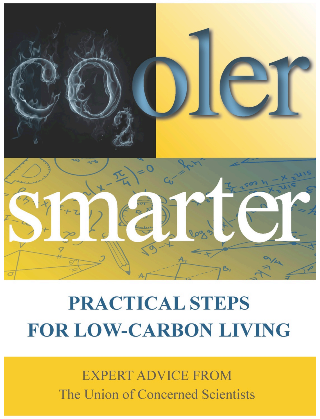


Don’t sweat the small stuff

Paper vs. plastic hardly matters

Buying local food doesn’t matter that much in terms of energy and carbon (83% of energy costs are in production and not transportation–most food is shipped via truck, railroad, or boat) although there may be other good reasons to buy local.

YOU’LL SAVE MONEY TOO!

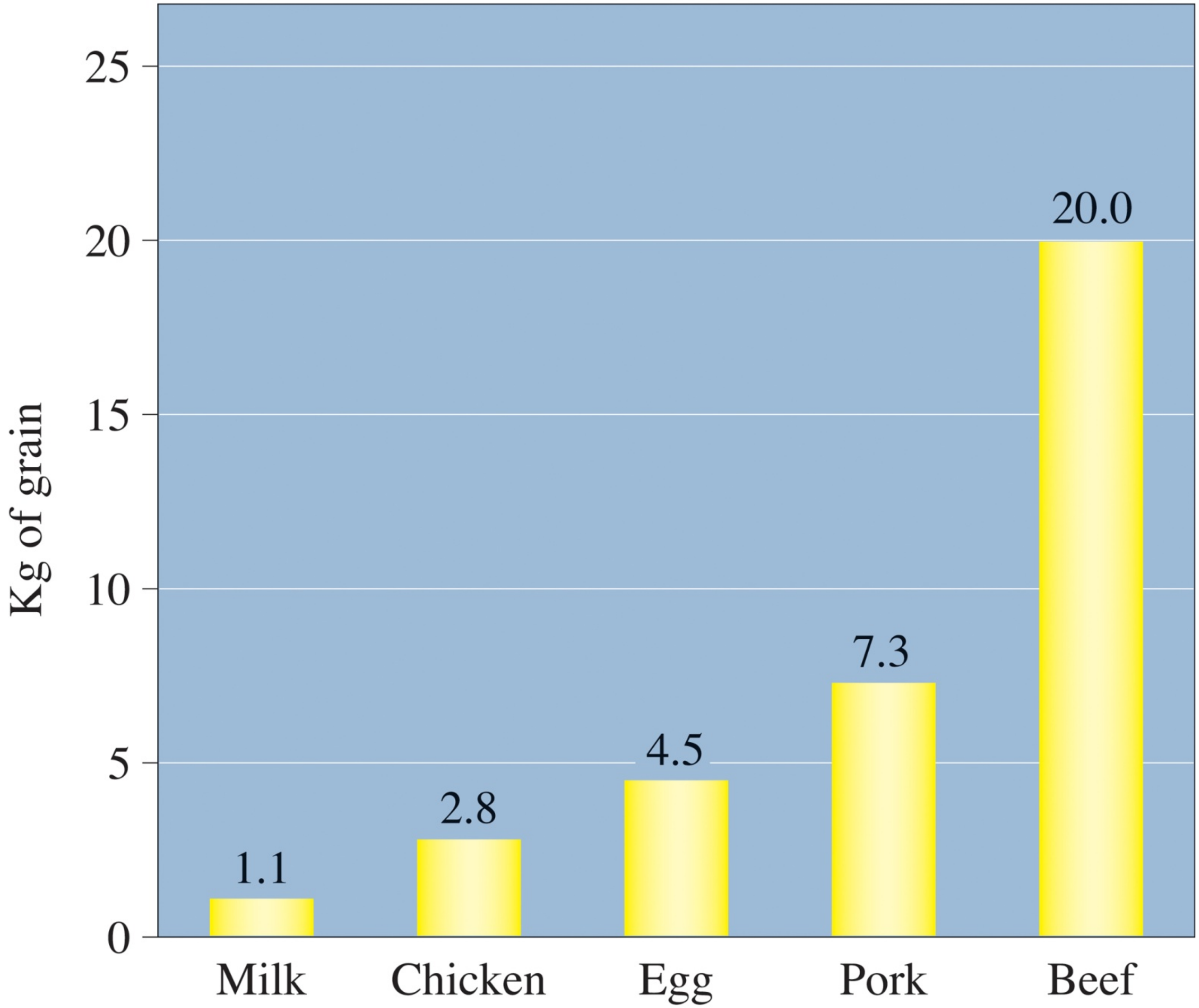
Eating Local

Table 11.10 **Reasons to "Eat Local"**

1. **Eating local means more for the local economy.** A dollar spent locally generates twice as much income for the local economy. When businesses are not owned locally, money leaves the community at every transaction.
2. **Locally grown produce is fresher and tastes better.** Produce at your local farmer's market often has been picked within 24 hours of your purchase. This freshness not only affects the taste of your food, but also the nutritional value. Ever tried a tomato that was picked within 24 hours? 'Nuff said.
3. **Locally grown fruits and vegetables have longer to ripen.** Because the produce is handled less, locally grown fruit does not have to stand up to the rigors of shipping. You will get peaches so ripe that they fall apart as you eat them, and melons that were allowed to ripen until the last possible minute on the vine.
4. **Eating local is better for air quality and pollution than eating organic.** In a March 2005 study published in *Food Policy*, researchers found that the miles that organic food may travel to our plate can outweigh the benefit of buying organic. Consider buying local organic food.
5. **Buying local food keeps us in touch with the seasons.** By eating with the seasons, our foods are at their peak taste, are the most abundant, and are the least expensive.
6. **Supporting local providers supports responsible land development.** When you buy locally, you give those with local open space—farms and pastures—an economic reason to stay open and undeveloped.

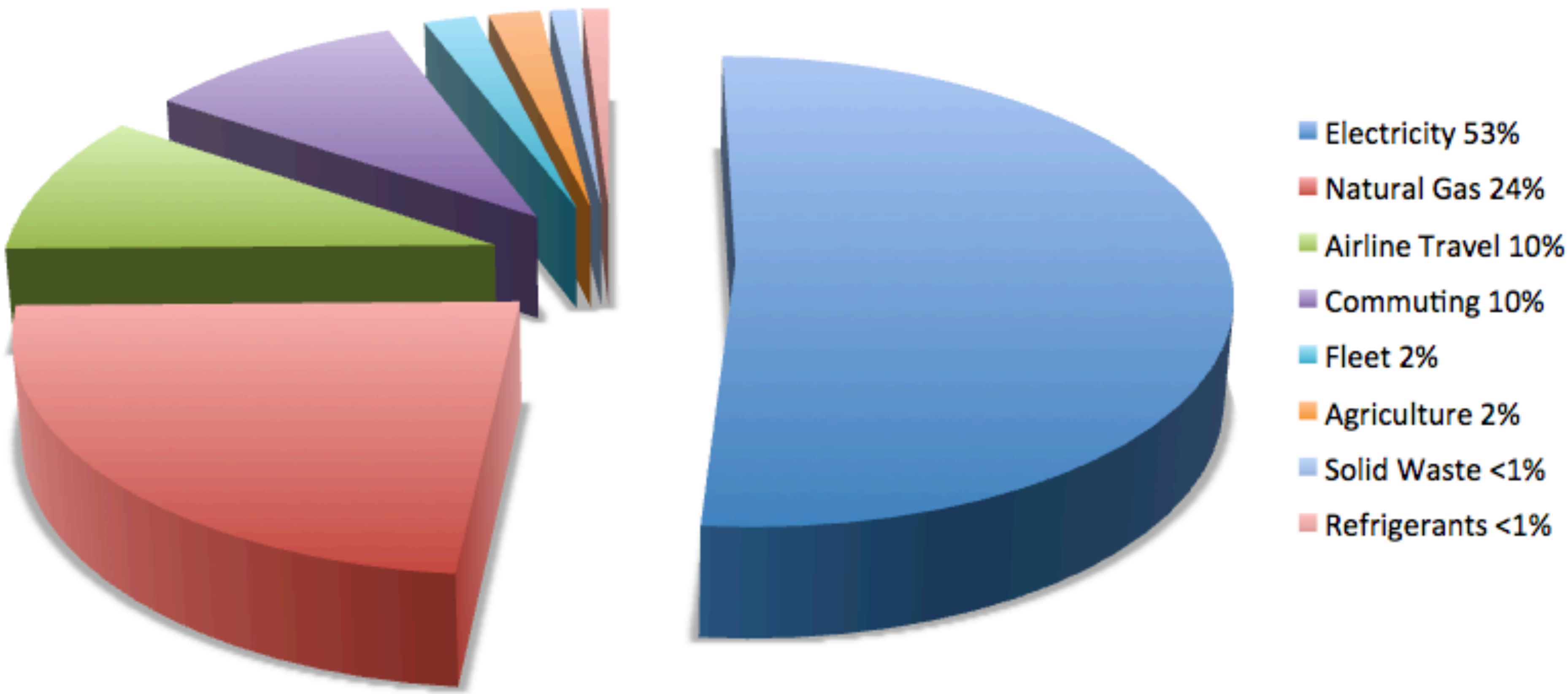
Source: Adapted from "10 Reasons to Eat Local Food," Jennifer Maizer, EatLocalChallenge.com, 2009.

Grain needed to generate food

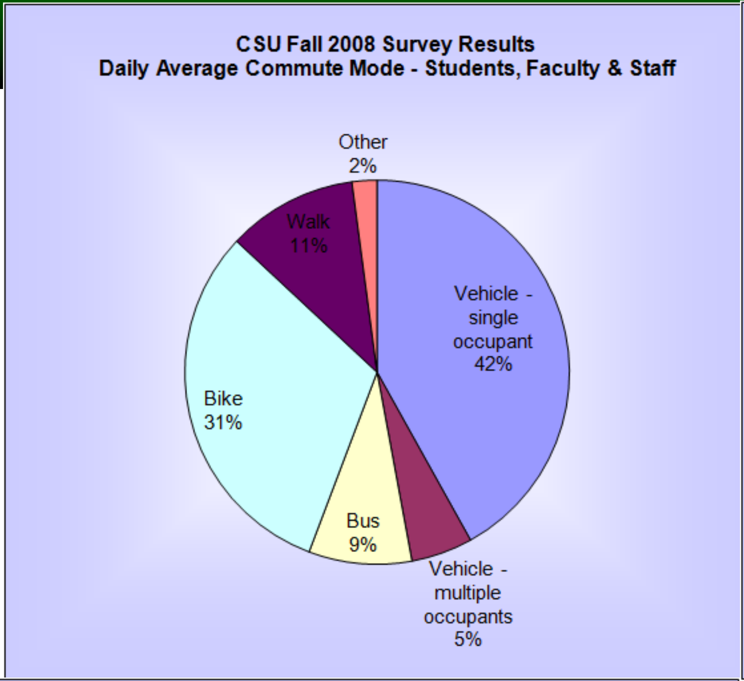


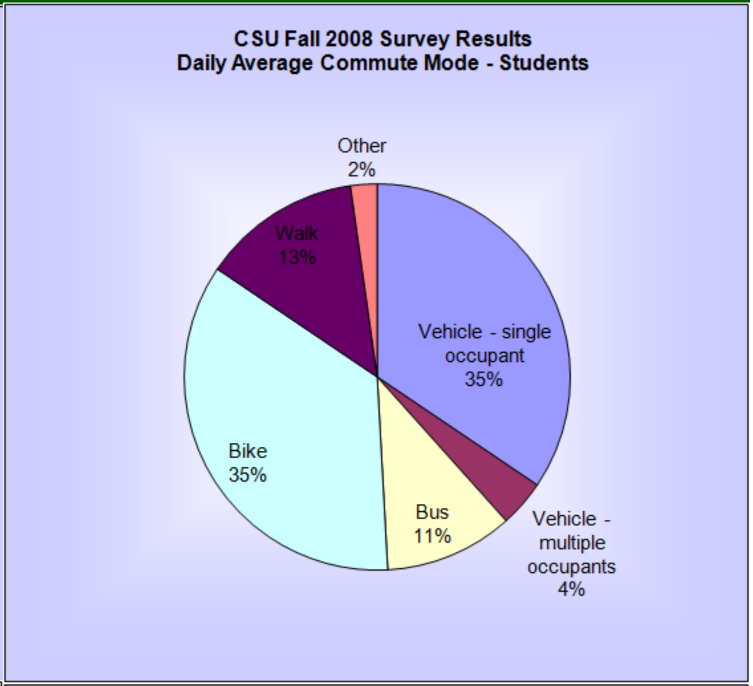
(a)

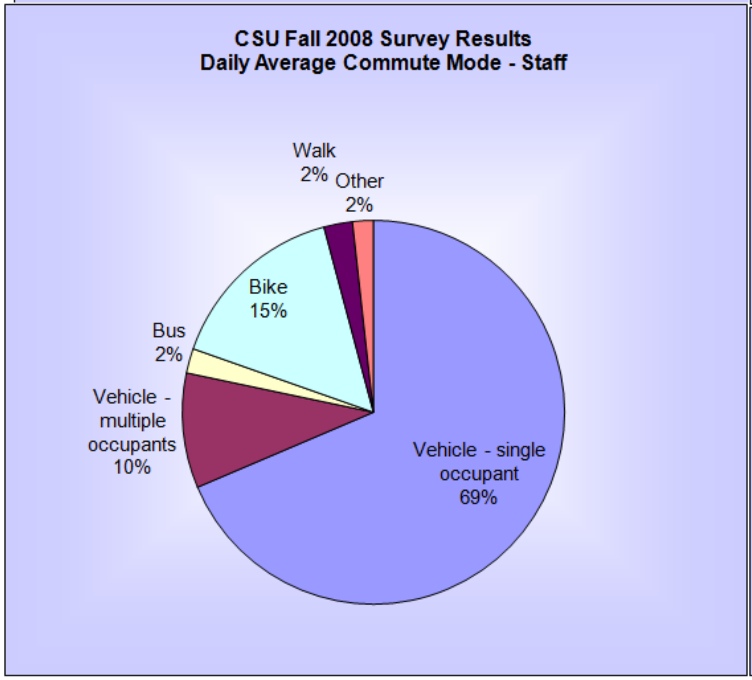
CSU's GHG Footprint – FY12

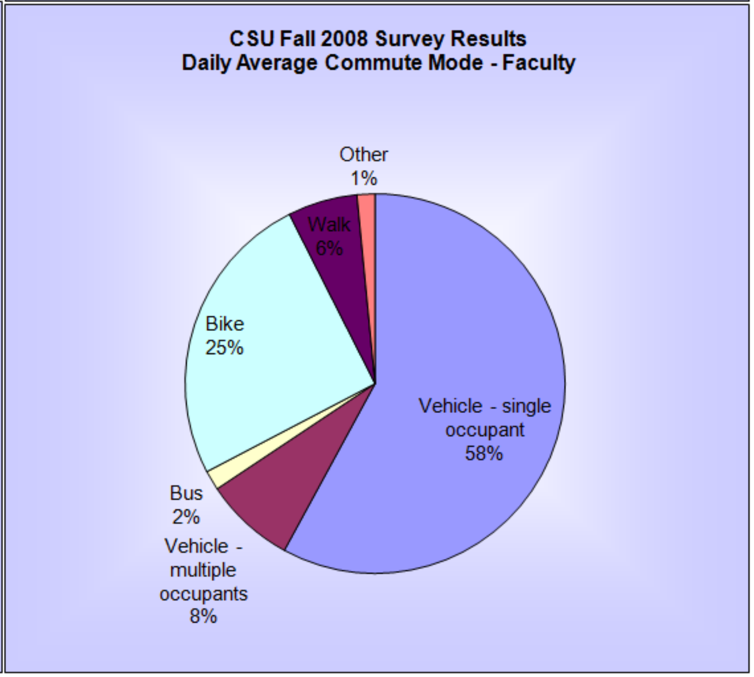


CSU Commuting

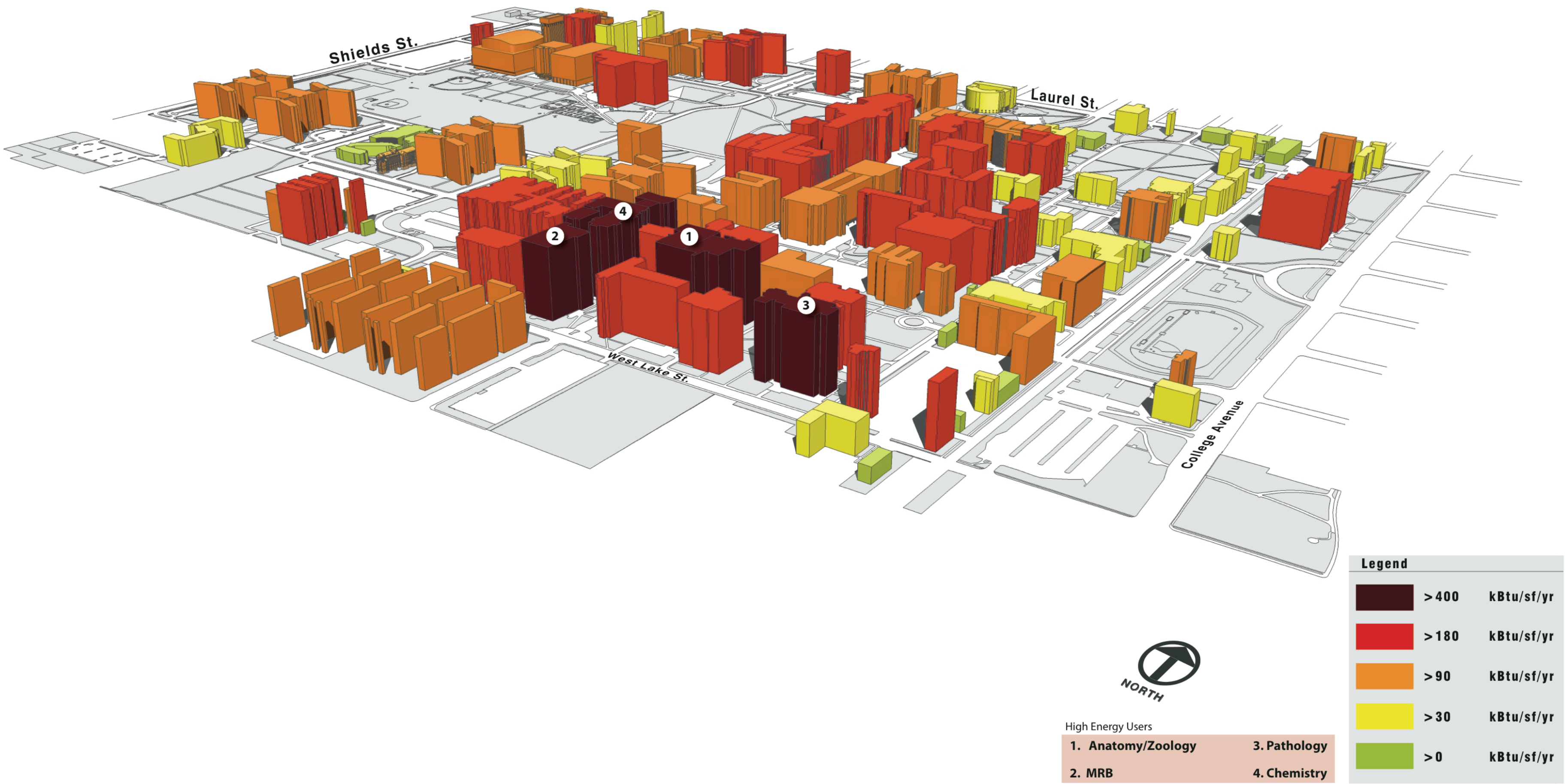








Energy Use

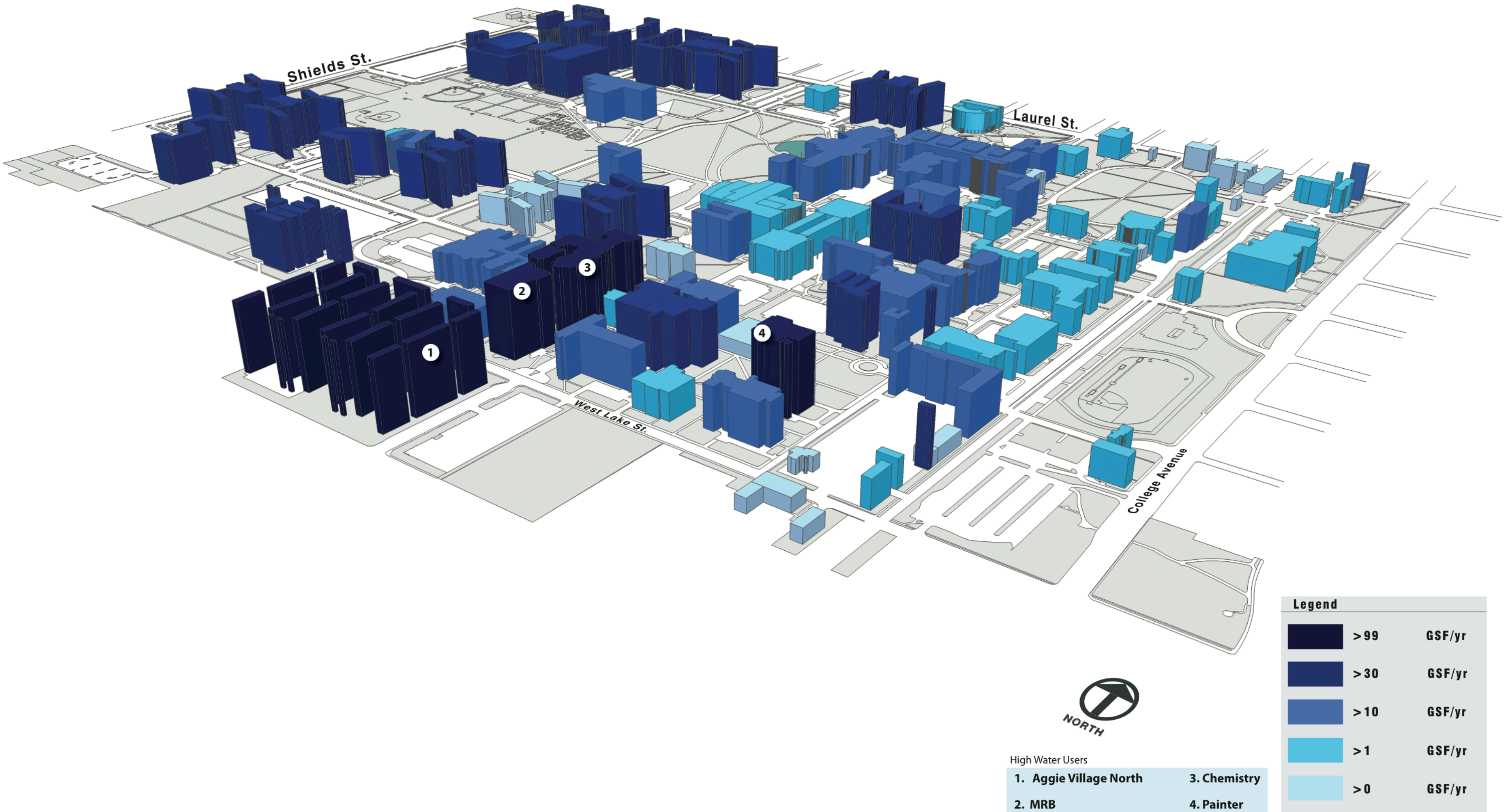


Main Campus Energy Intensity Model

Fiscal Year 2008

Colorado State University

Water Use

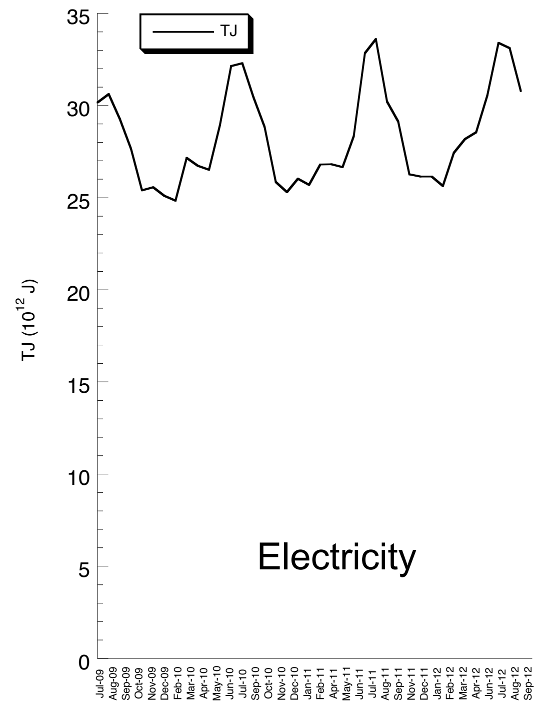


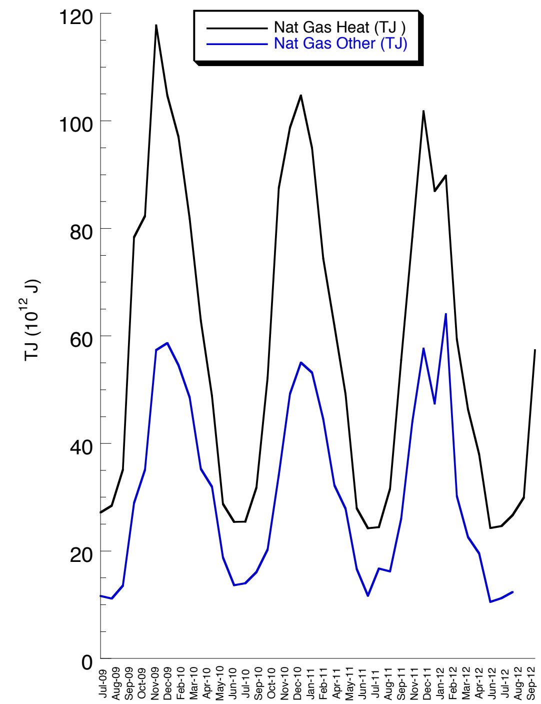
Main Campus Water Usage Model

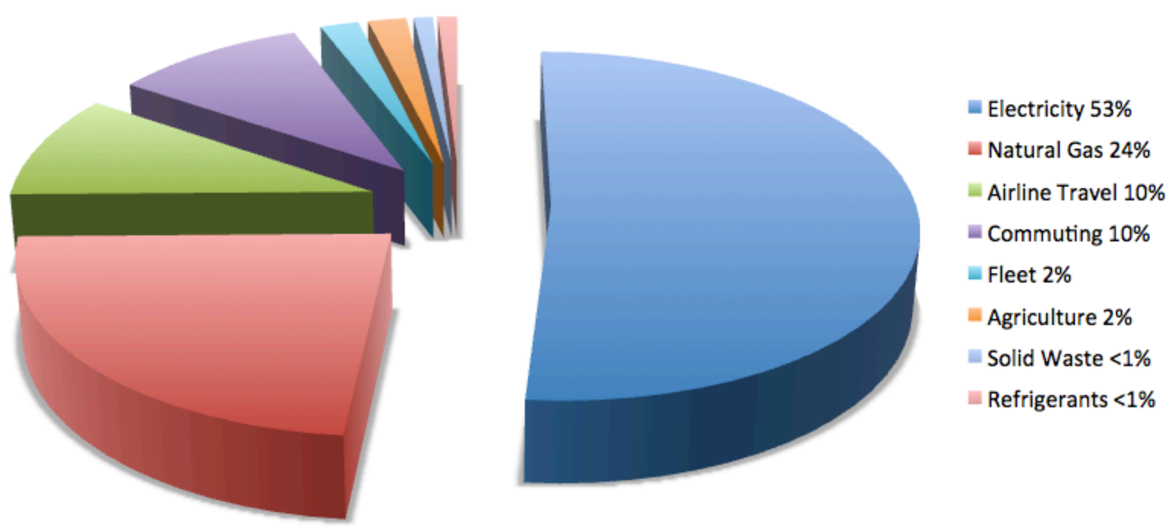
Fiscal Year 2008

Colorado State University

CSU Usage


TJ
TJ (10^12 J)
35
30
25
20
15
10
5
0
Electricity


Nat Gas Heat (TJ)
Nat Gas Other (TJ)
TJ (10^12 J)
120
100
80
60
40
20
0


Electricity 53%
Natural Gas 24%
Airline Travel 10%
Commuting 10%
Fleet 2%
Agriculture 2%
Solid Waste <1%
Refrigerants <1%