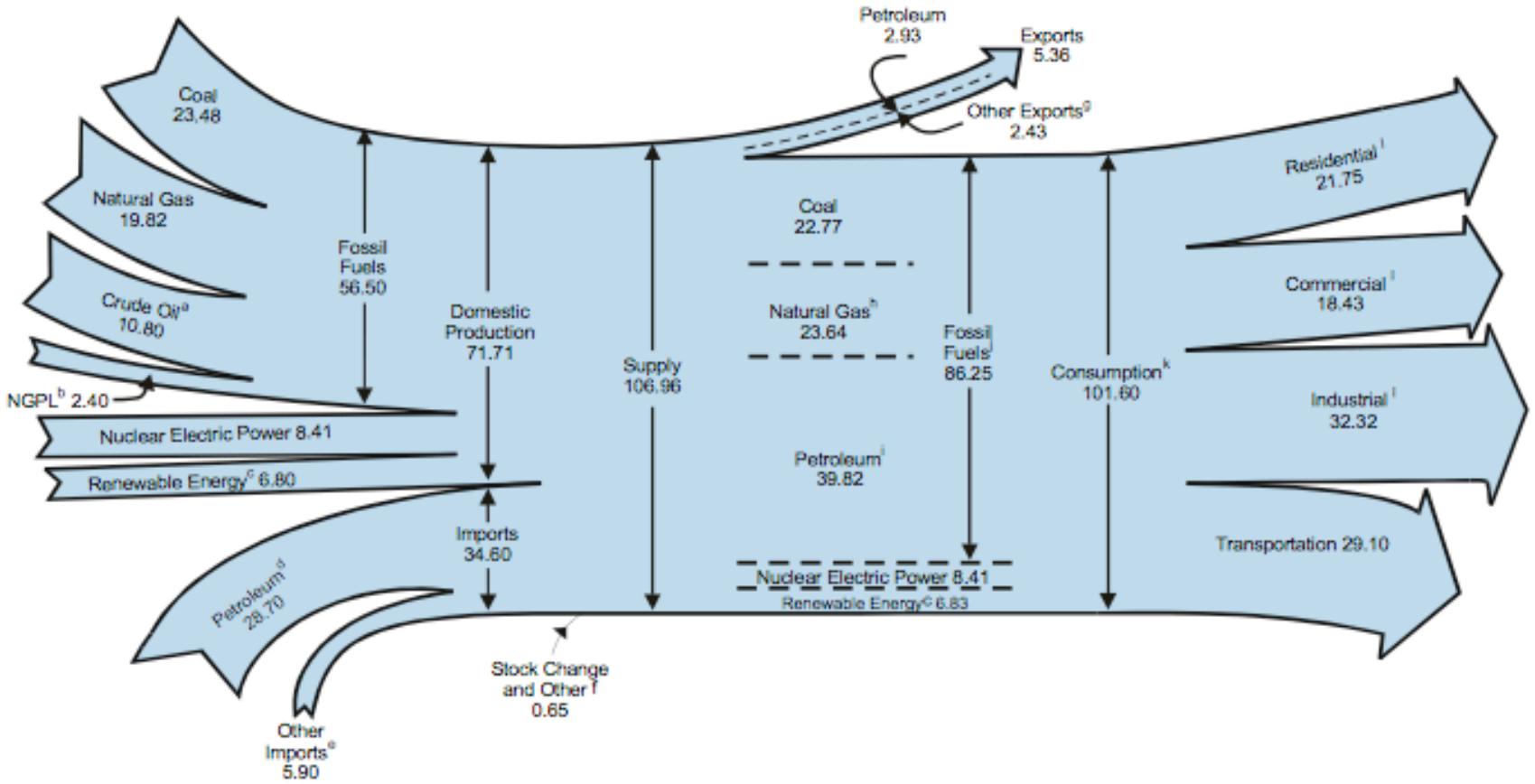
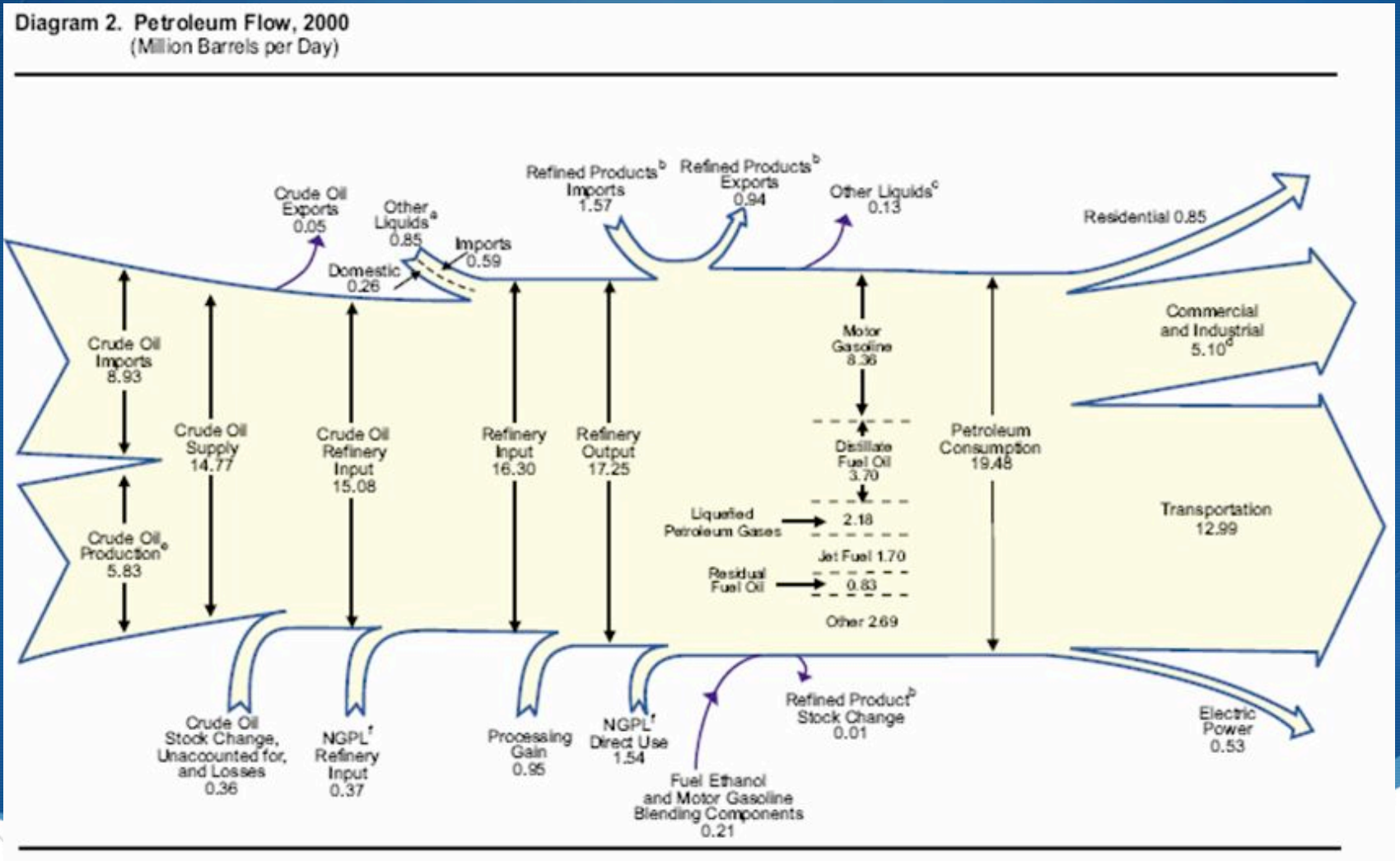
We know about Global Warming, Right?

ECT Fall Workshop
Dr. Krishan Kumar Bhatia
Mechanical Engineering
Rowan University

Diagram 1. Energy Flow, 2007
(Quadrillion Btu)

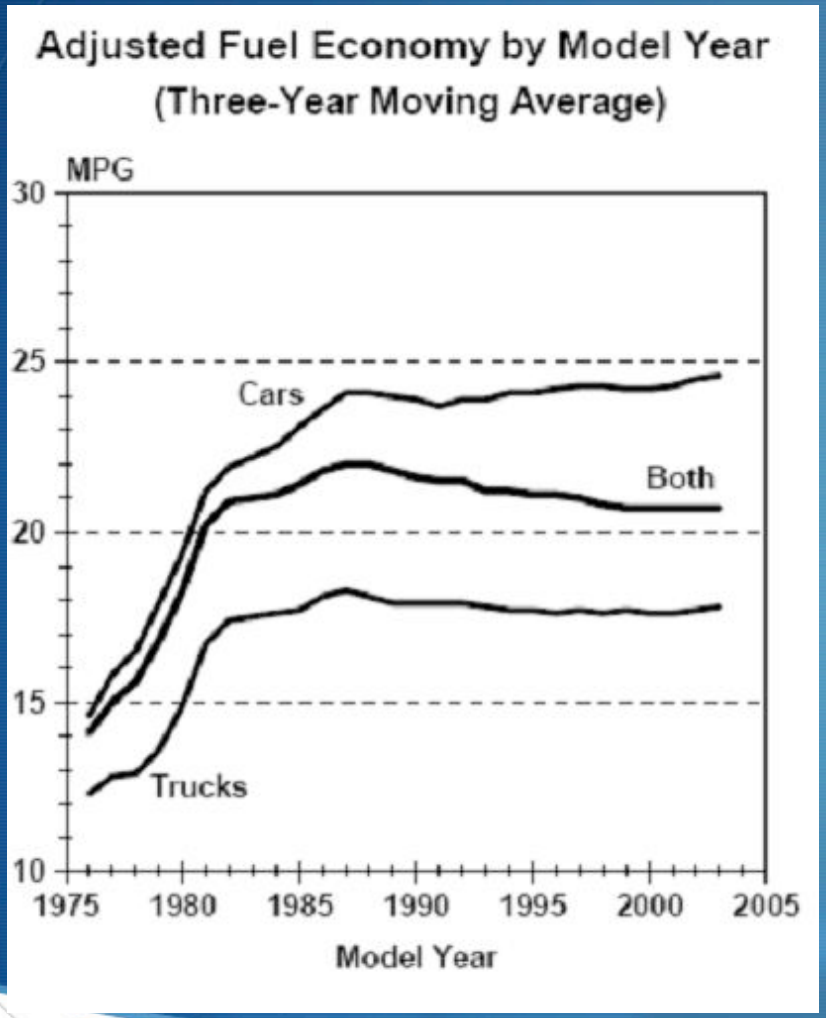


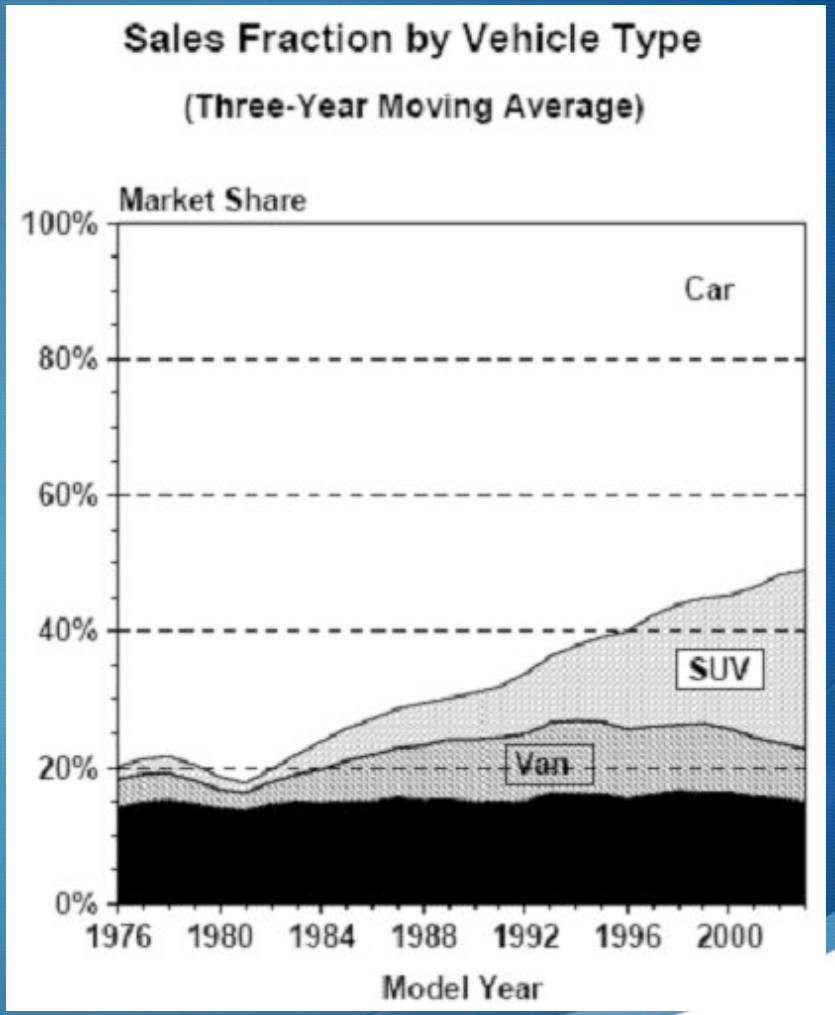
*Energy Information Administration/Annual Review 2007



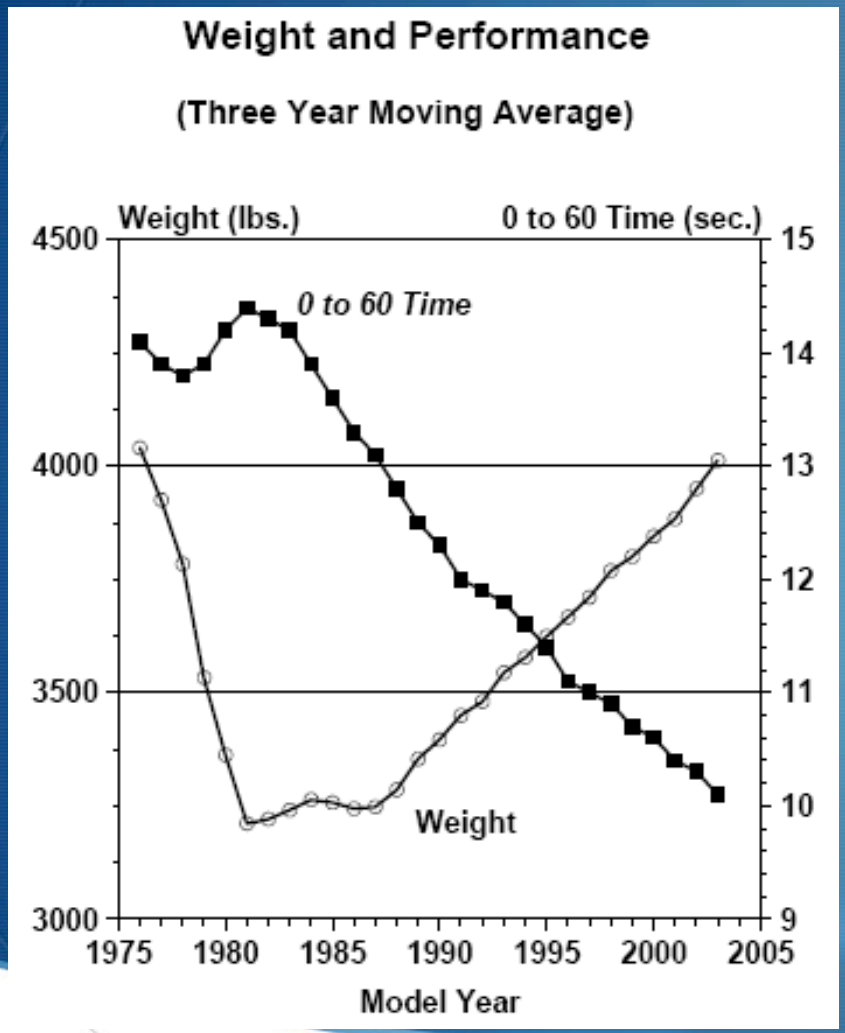
*Energy Information Administration/Annual Review 2000

*1 MBPD ~ 2 Quad BTUs





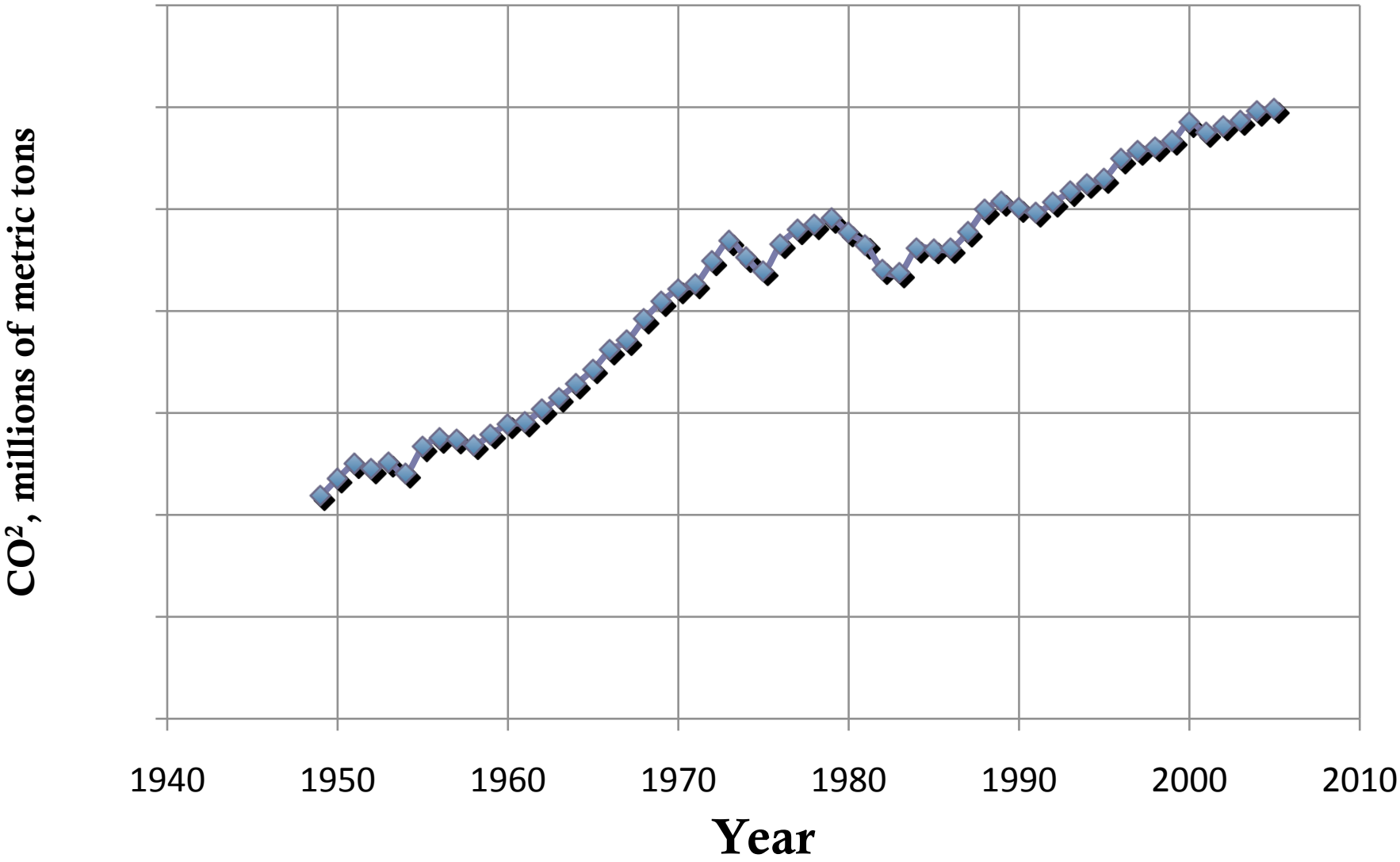
*EPA 420-R-04-001



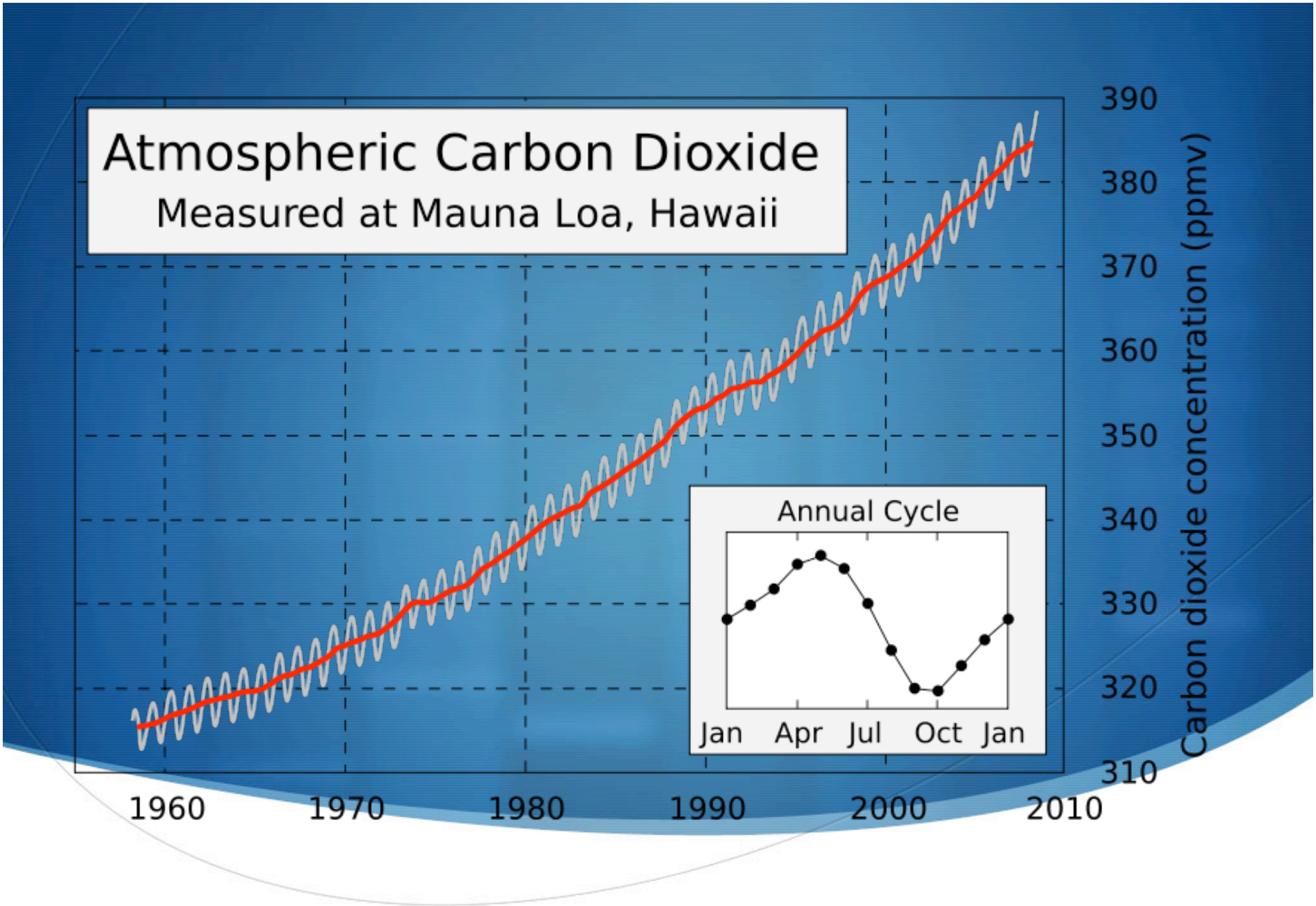
*EPA 420-R-04-001

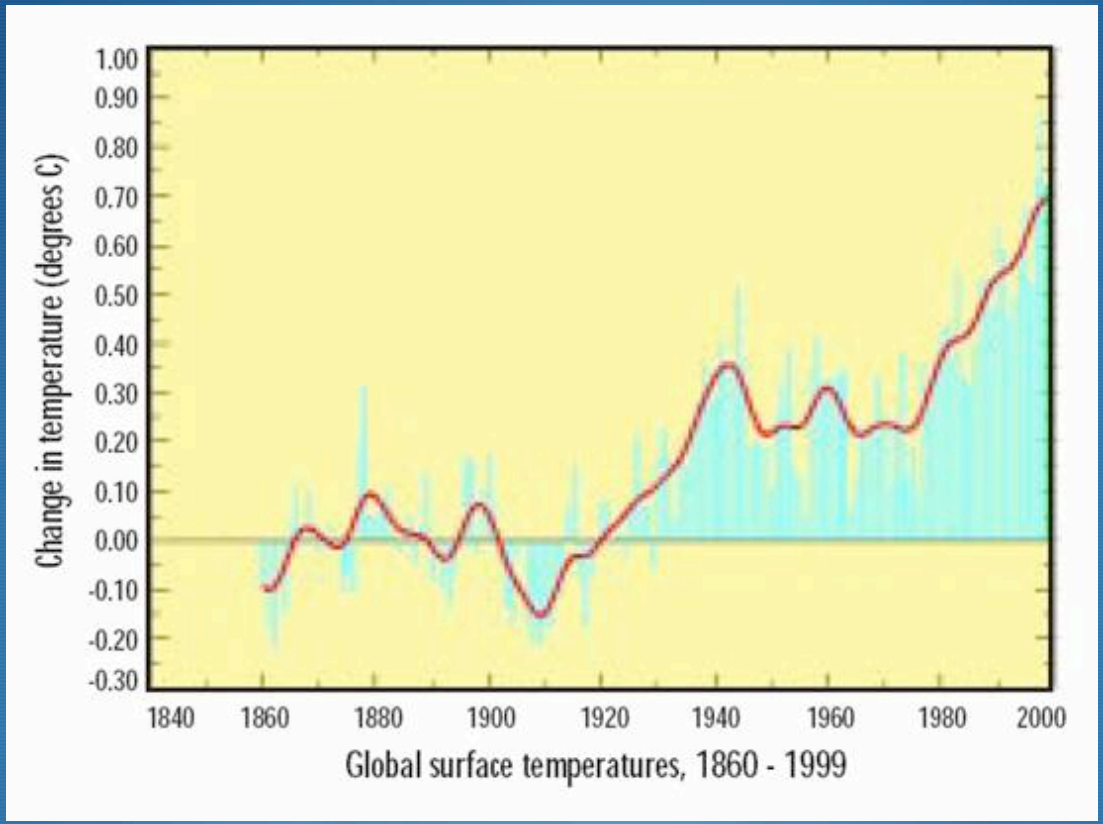
"Thus, avoiding the SUV trend and simply keeping the mix of cars and light trucks at the level it was in 1989 would have saved 75 times more energy per year than what has been saved by recycling plastic and four times more energy than what has been saved each year by recycling aluminum."

Environmental Science & Policy
6 (2003) 175–179
Friedland et al.


CO², millions of metric tons
1940
1950
1960
1970
1980
1990
2000
2010
Year

- US Average CO_2 Emissions – 20 tons/person/year
- World Average CO_2 Emissions – 4.5 tons/person/year
- Rowan Average CO_2 Emissions – 4 tons/student/year
  - Just for direct University activities (not including your car, purchases, food, etc)


Atmospheric Carbon Dioxide
Measured at Mauna Loa, Hawaii
Annual Cycle
Jan
Apr
Jul
Oct
Jan
1960
1970
1980
1990
2000
2010
310
320
330
340
350
360
370
380
390
Carbon dioxide concentration (ppmv)



- CO_2 varied between 200 and 300 ppm (last 160,000 year)
- CO_2 has increased from 280 ppm to 385 ppm in a single century
- Predicted to rise to 600 ppm by 2100

*Green Power, Los Alamos National Lab, LA-UR-99-3231

Aside from greenhouse gas emissions….

- Vehicle traffic causes half of all urban smog and 90% of the carbon monoxide emissions in the US.*
- Complications arising from air pollution kills twice the number of Americans that die in auto accidents, and triple the number of homicide victims.*
- In 2001, you were 24 times more likely to die from air pollution than from a terrorist attack.

*General Motors Corporation

The Debate: Energy Use

- Transportation/Energy Costs?
- Foreign Oil Dependency?
- Environment (i.e. Global Warming)?
- Is Our Current Lifestyle Sustainable?
  - (5% world population emitting 22% of the greenhouse gases)

Effects by 2100…

- Cat 5 Hurricane rise from 11% to 37%
  - Knutson and Tuleya, NOAA (2004)
- 0.4 m rise in sea level (what will this do to Florida, Bangladesh, etc)
- Complete loss of summer Arctic Ice Sheet
- Mass Extinction - ½ of all global species by 2050
  - Battachatya et al (2004), Ulansey (2007)
- 70% of biologists believe we are in the beginning stages of a human caused mass global extinction.

Effects by 2100…

- Rising temps and majority species loss will lead to increased desertification
  - Desertification up to Paris? (Lovelock, 2006)
  - Already 20% of worlds populations does not have access to safe drinking water

Topics to cover with students

- Scientific conversation has shifted
- Do we understand the environmental effects of global warming?
- What about the political effects of global warming?
- Are we destroying biodiversity?

Wind Energy Activity: Supplemental Slides

Sample Power Calculations

- Power via Kinetic Energy in the air = ½ * Density of air * Air Velocity ^{3} * Area of Turbine
- Example Calculation for a small classroom turbine
  - Density of air = 1.2 kg/m^3
  - Air velocity = 5 m/s (about 11 mph)
  - Turbine Area = 1 m^2 (can get this from pi * turbine radius^2)
  - Power = 75 Watts
- Most small wind turbine can capture between 5 and 10% of this energy.

Sample Power Calculations

- Example Calculation for a large turbine (like the ones at Atlantic City Utility Authority)
  - Density of air = 1.2 kg/m^3
  - Air velocity = 10 m/s (about 22.5 mph)
  - Turbine Area = 4071 m^2 (can get this from pi * turbine $radius^2$…for the A/C turbines, this radius is 36 meters)
  - Power = 2,442,600 Watts
- Most large wind turbine can capture about 40% of this available power in the wind.
- A typical house consumes on average about 1,000 watts of power.

Useful Wind Energy Links

- Good diagram of a wind turbine generator and internals
- http://www1.eere.energy.gov/windandhydro/wind_animation.html

- Wind Maps
- http://www.windpoweringamerica.gov/wind_maps.asp

- Great Resource for Teachers on Wind Energy:
- http://www.windpoweringamerica.gov/schools_teaching_materials.asp