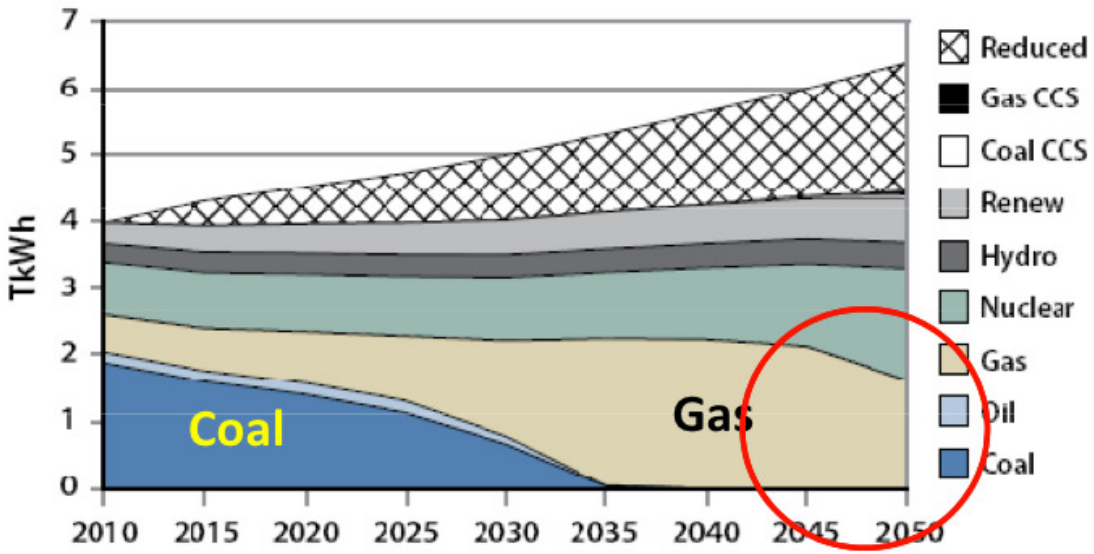
Carbon Management

Hussein Abdelhalim
Mark Artz

Major Carbon Emission Factors

- Electricity
  - Power generation
    - Fossil Fuels
    - Electricity and heating make up nearly 50% of carbon emissions at 3.6 gigatons carbon dioxide per year



Source: Moniz, Ernest J., et al. "The Future of Natural Gas: An Interdisciplinary Study." Massachusetts Institute of Technology, 2011.

Major Carbon Emission Factors

- Transportation
  - Production
    - Syngas
    - Tar Sands
  - Consumption
    - Vehicles
      - Cars, Planes

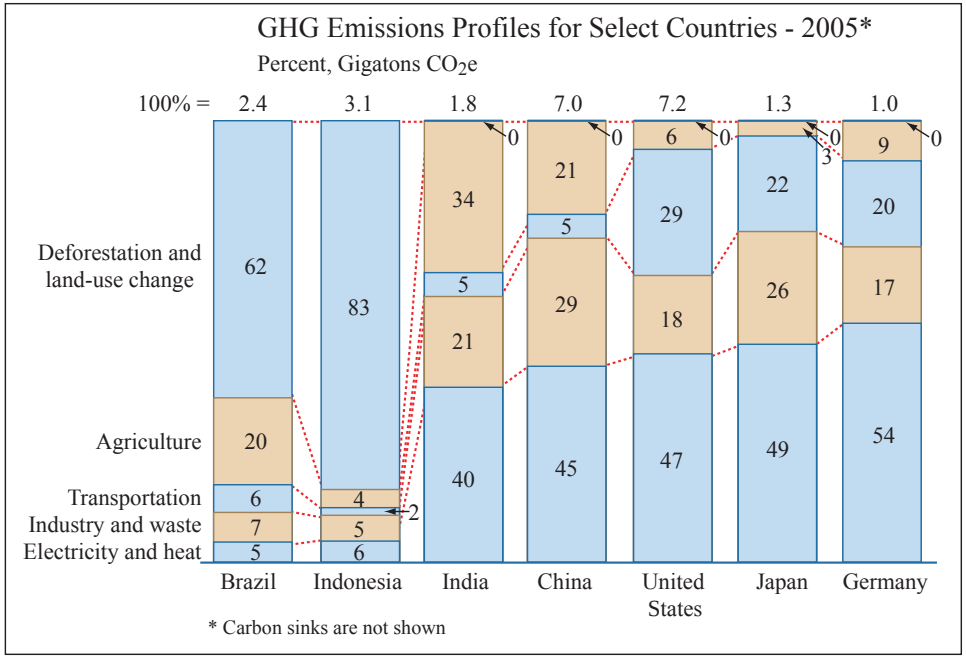


Image by MIT OpenCourseWare. Source: UNFCCC, WRI, IEA, EPA, McKinsey analysis. Adapted from Exhibit 3 in Creyts, Jon et al. "Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?" U.S. Greenhouse Gas Abatement Mapping Initiative, McKinsey & Company, December 2007.

- In the U.S. transportation accounts for nearly 30% of carbon emissions at 2 gigatons per year.

Discussion Areas

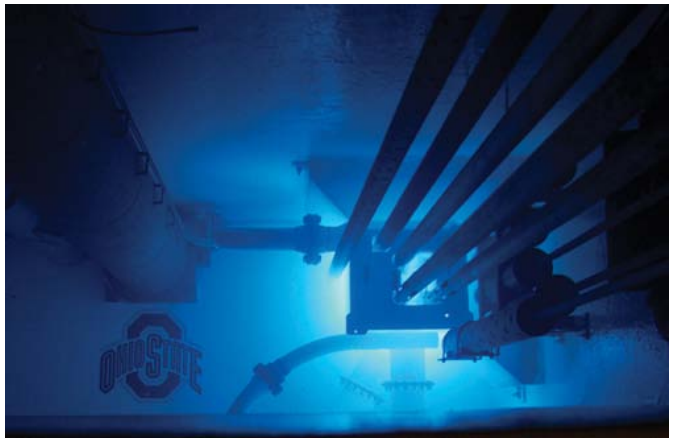
- Facilitate a class discussion on the following topics:
  - Electricity Generation
  - Driving Individual Behavioral Changes

Discussion Guidelines

- Applied loosely
  - No more than 3 comments per participant
  - Try to limit length of response to 3 minutes

Electricity Generation

- Wind
- Solar
- Geothermal
- Nuclear
- Hydroelectric



Photos by Martin Pettitt and Rory D on Flickr, Chmee2 and Eclipse.sx on Wikimedia Commons, and the U.S. Nuclear Regulatory Commission.

Question

- What incentives should we use to allow these technologies to compete with coal and other carbon emitting electricity production methods?

- Goal
  - Develop a global strategy to allow carbon free sources to compete.

Considerations

- Economic Impact
  - More costly electricity
    - Climate policy during a recession?
  - Loss of Natural Advantage
    - Countries with large coal reserves
      - U.S., China, India
  - Pressure to move to unregulated countries

Develop a Global Strategy

1. United States
   - Recession
   - Large coal reserves
2. France
   - 80% nuclear electricity
3. China
   - Large coal dependence
4. Illinois
   - Large coal reserves
5. Developing world
   - Cheap energy
6. Canada
   - Consumes large amounts of natural gas producing oil from tar sands
7. Sasol in South Africa
   - Syngas liquid fuel production
   - 71 million tons of carbon emissions

Class-Generated Ideas

1. United States
   - Kyoto Protocol
   - Commit to a global plan
   - Government incentives for renewable

2. France
   - Adoption of more nuclear facilities
   - Financing more facilities
   - Slowly add a few plants
   - Combination of financing and subsidizing

3. China
   - Keep coal cheap because of rising economic situation
   - Loose cap & trade
   - Subsidizing renewable by government

4. Illinois
   - Budget towards R&D towards clean coal technologies
   - Promote use of coal but mitigate its effect

5. Developing world
   - Want clean energy because most averse to temperature changes
   - Clean development mechanism of Kyoto Protocol
   - Direct investment of projects

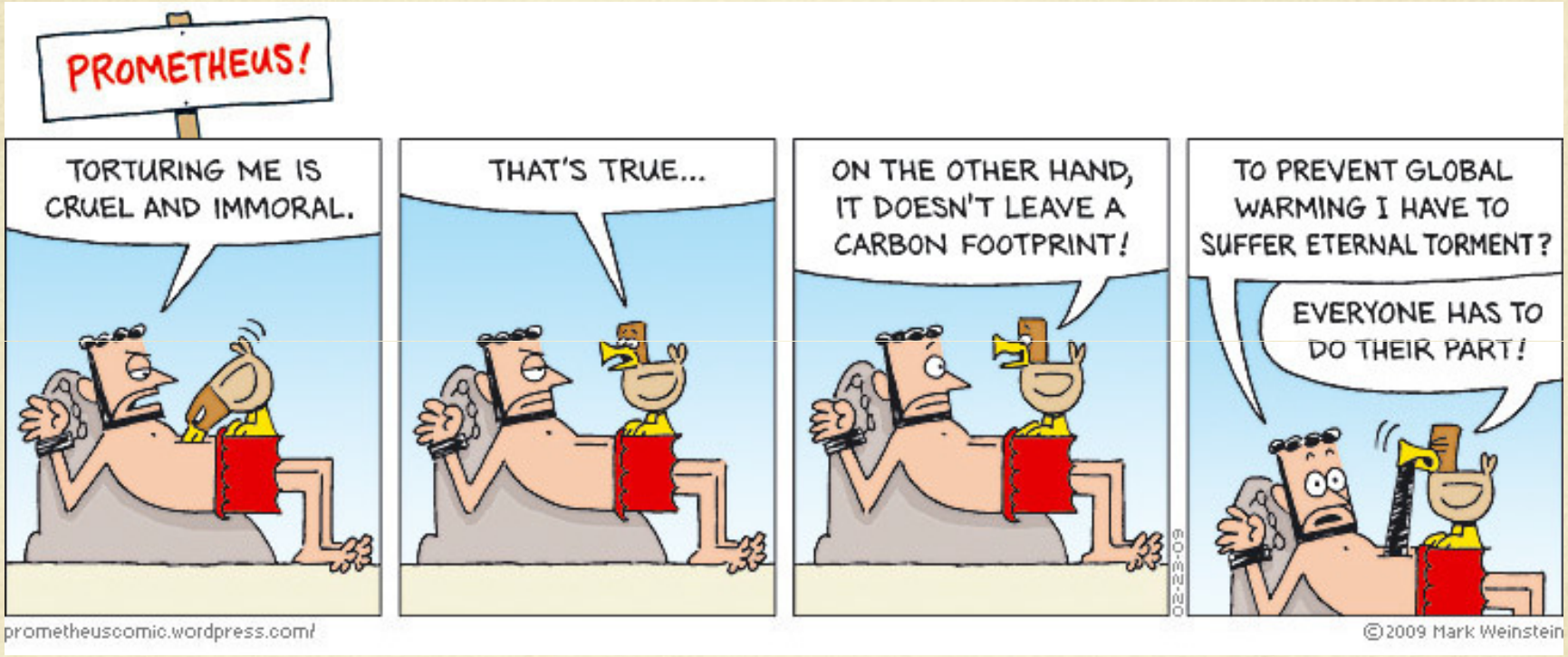
6. Canada
   - Look into nuclear and carbon sequestration to mitigate effects of carbon emissions

7. Sasol in South Africa
   - N/A

Overall Picture:

- Increased regulations: federal vs. local governments
- Time scale, triggers and involvement

Driving Individual Behavioral Changes

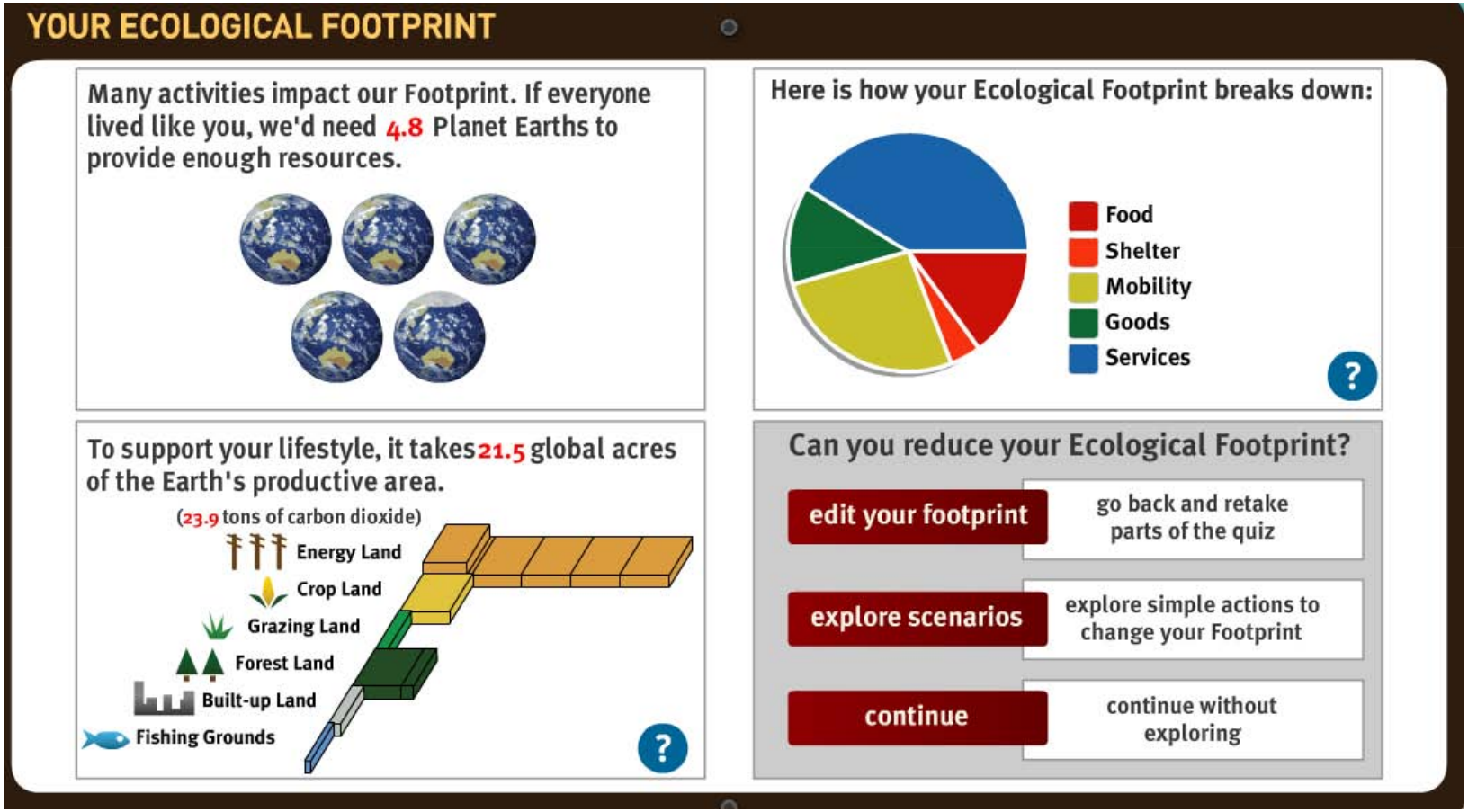


Courtesy of Mark Weinsten. Used with permission.

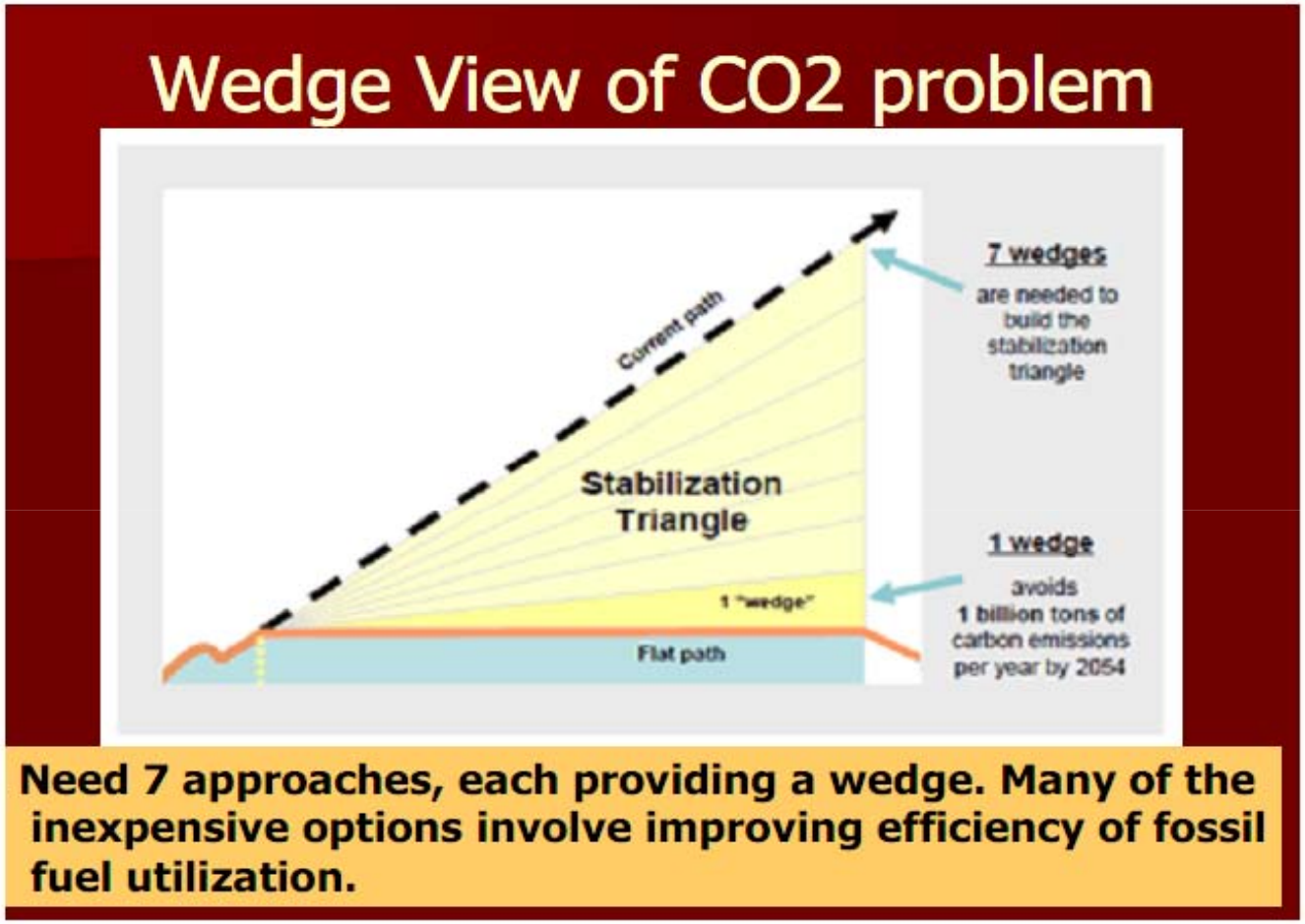
Source: http://prometheuscomic.wordpress.com/2009/02/23/cap-and-trade-off/

Individual CO2 Emission Contribution

- Recall Carbon Footprint Quiz from Homework 2
  - ➢Average annual contribution is 18 to 24 tons of CO2 per person



Source: Homework 2 Solutions, Alex Shih



Graph by Carbon Mitigations Initiative, Princeton University.

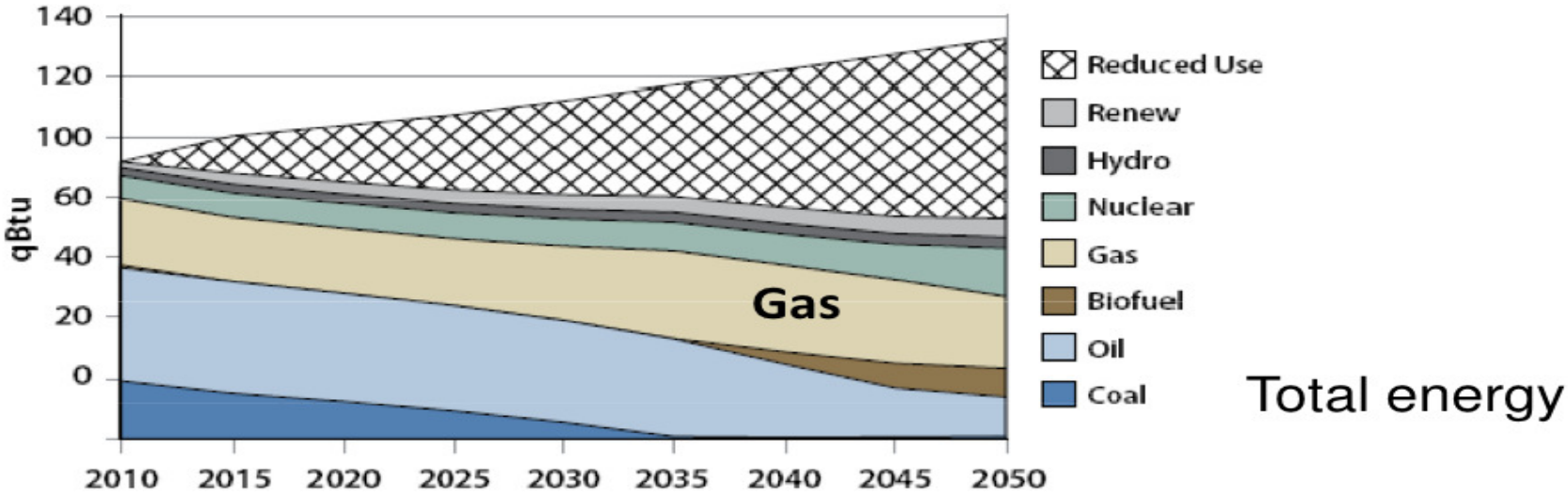
A portfolio of options are needed!

↑

Source: Lecture 17, Prof. Green

Question

- What incentives should be used to encourage individuals and businesses to reduce their carbon footprint?
- Goal
  - Develop a portfolio of options that will drive individual behavioral changes to reducing carbon emissions.



Source: Moniz, Ernest J., et al. "The Future of Natural Gas: An Interdisciplinary Study." Massachusetts Institute of Technology, 2011.

Considerations

- Major contributors to large amounts of carbon produced by individuals
  - Transportation
    - If your car gets 25 mpg and you reduce your annual driving from 12,000 miles to 10,000 miles, you will save 1800 pounds of CO2.
    - If your new car gets 40 mpg instead of 25, you will reduce carbon emissions by 3300 pounds.
  - Home appliances, heating, and cooling
    - If you live in a cold climate and you super-insulate your walls and ceilings, you can save 5.5 tons of CO2 per year.

Source: www.powerscorecard.org/reduce_energy.cfm

Develop a Global Strategy

1. How should cities encourage their residents to use public transit?
2. How should the government encourage its citizens to purchase hybrid vehicles and other appliances/electronics that reduce carbon emissions?
3. How should consumers become more educated on home energy conservation?
4. What are some actions we can take today to reduce carbon emissions that have personal financial incentives?
5. Can a government impose an individual carbon rationing system that is fair? If so, how would it work?
6. What incentives should governments give to large corporations for their energy conservation practices?
7. Discuss other options and strategies not presented here.

Class-Generated Ideas

1. How should cities encourage their residents to use public transit?
    - Price increases
        - Parking
        - Fuel
    - Decrease public transportation costs
    - Public transportation reliability
        - ETA
    - Range of stops
    - Driving restrictions
    - Population distributions
    - Parking centers for public transportation

2. How should the government encourage its citizens to purchase hybrid vehicles and other appliances/electronics that reduce carbon emissions?
    - Stricter emission standards
    - Reduced import tariffs for hybrids

3. How should consumers become more educated on home energy conservation?
    - Standard for comparison
        - Independent

4. What are some actions we can take today to reduce carbon emissions that have personal financial incentives?
    - Timers and thermostats
    - Off vs. stand-by

5. Can a government impose an individual carbon rationing system that is fair? If so, how would it work?
    - Effectively higher taxes
    - Cost association

6. What incentives should governments give to large corporations for their energy conservation practices?
    - Rewards, instead of penalties, for energy conservation (i.e. lower tax bracket)
    - Cost association

7. Discuss other options and strategies not presented here.
    - Stricter building codes to adhere to at the beginning
    - Other GHGs like fluorocarbons (i.e. HFCs and CFCs)

22.081J / 2.650J / 10.291J / 1.818J / 2.65J / 10.391J / 11.371J / 22.811J / ESD.166J
Introduction to Sustainable Energy
Fall 2010