Trends in Carbon Energy: What Can We Expect?
There are many forecasts about energy and emissions...

Possible

Hopeful

Terrible

History and Present Trends offer some crucial insights
How Important are Fossil Fuels for Emissions?

(Source of GHGs)

- CO$_2$: fossil fuel combustion; deforestation
- Methane: agriculture; coal mines; gas leakage
- Nitrous oxide: vehicle exhaust; fertilizer

Fossil fuels ~ 75% of all GHG emissions worldwide, U.S. – 84%; India, China – 85%-90%
Which Fuels?

80% of emissions from Oil & Coal

Oil for transportation
Coal used for electricity

Emissions are forecasted to grow—Why?

Global Population Trends
Developing Countries a HUGE market for future energy

Thus, also a HUGE potential source of emissions…
Global Trends in Energy Demand

- Oil, gas, and coal will remain crucial sources of energy for human civilization, next several decades.

- Renewables (wind, solar, etc.) growing rapidly—but start from low base.

In most forecasts, 

Fossil fuels account for almost 90% of the growth in energy demand between now and 2030.
Global Energy Consumption by Region

Future of Energy Use is in the Developing World

International Energy Outlook 2005
Developing World Wants What We Have…
cars, electricity, consumer goods, technology, better nutrition, health care, longer life span

Most of all—electricity: essential for modern civilized life
DCs are now entering the electrical age
But there are still 2.1 billion people in the world, mainly Asia/Africa, without access to electricity
What Energy Sources is the Developing World Using?

International Energy Outlook 2005
It is perhaps ironic that in an age where the pace of technological change is almost overwhelming, the world will remain dependent, for 2000-2020 at least, on essentially the same forms of energy—oil, coal, and natural gas—that fueled the 20th century.
What does this mean for emissions?
Future of Emissions is also with the DCs

In ~20 yrs, developing world will surpass advanced nations in CO₂ emissions
These are sobering aspects

Let’s look at some more…
Kyoto Protocol:
The First Global Attempt to Deal with Climate Change

Purpose: to cap GHG emissions, help stabilize global climate.

Industrial nations legally bound to reduce emissions an average of 5% below 1990 levels

Developing countries have no emissions obligations

- They claim: “ACs caused problem, they should take the lead in fixing it…We won’t weaken, slow our development for their errors.”

- Kyoto inscribes geopolitical problems between North & South
Geopolitical Realities…

North/South Issues:

- Legacy of colonialism: distrust and dependency
- South: weak states, large foreign debt
- Rapidly developing states: desperate for energy resources to fuel their economies; competing with North

Political symbolisms

- South: “Respect,” sovereignty, imperialism
- North: Free trade (U.S.), human rights, transparency

Lesson: Geopolitics can be “re-written” into global treaties
Which countries contribute most to the emissions problem?

It depends on how you measure…
Three most common ways…

**Total**

1998 CO2 Emissions from the Combustion and Flaring of Fossil Fuels (Million Metric Tons of CO2 per Year)

- **USA** = 24% World Total
- **China** = 12%

**Per Capita**

1998 CO2 Emissions per Capita (Tons CO2 per Person)

- Advanced countries look “bad”
- Developing countries “good”

**Per $GDP**

1998 CO2 Emissions per $GDP (Tons of CO2 per $1,000 GDP)

- Developing countries “bad”
- Advanced countries “good”
What does this mean?

Politics Again…

Per Capita: Developing Countries prefer

DCs have less technology, less energy-intensive lifestyles;

ACs advanced lifestyles inevitably use more energy; look “wasteful” (trailer in Phoenix uses more than hut in Bhopal)

Per $GDP: US prefers

ACs have more efficient economies, updated technology, look “better”, not wasteful (coal plant in China has 25% efficiency; in US/EU = 35-40%)
The Bush Plan

Goal: 18% decrease in Carbon/$GDP by 2012

Reality: 17% decrease per decade since 1980

How ambitious is Bush plan?

Meanwhile, US emissions continue to increase by 1.7% per yr
If the problem is truly Global...

What measure do you think is most appropriate?
What are the Major Ways to Lower Emissions?

Changes in energy consumption

- Switch to less carbon-intensive fuels (gas, biofuels, nuclear pwr)
- Improve efficiency of energy use (appliances, auto fuel efficiency)
- New technologies
  - Renewable energy (solar, wind, etc.)
  - Develop new sources (H₂, nuclear fusion)
  - Clean(er) coal technology (power generation)

Alternative energy mainly focused on power generation, largely leaves out question of….
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A Few Realities
What’s in a Barrel of Oil?

~77% is used for vehicle fuel (48% for gasoline)
From the 1.25 g of Feedstock (3% of the Original Crude) We Get…

Air Bags, Antihistamines, Antiseptics, Artificial Hearts, Aspirin, Audiocassettes, Baby Strollers, Balloons, Bandages, Blenders, Cameras, Candles, CD Players, CDs, Clothing (rayon, nylon, etc.), Computers, Containers, Cosmetics, Crayons, Credit Cards, Dentures, Deodorant, Diapers, Digital Clocks, Dinnerware, DVDs, Dyes, Eyeglass Frames, Fertilizers, Food Storage Bags, Footballs, Foul Weather Gear, Furniture, Garbage Bags, Gloves, Glues, Golf Balls, Hair Dryers, Hang Gliders, Heart Valve Replacements, House Paint, Infant Seats, Ink, Life Jackets, Lipstick, Luggage, Medical Equipment, Nylon Rope, Outdoor Equipment, Pacemakers, Pantyhose, Patio Screens, Perfumes, Photographic Film, Photographs, Piano Keys, Roller Blades, Roofing, Safety Glass, Shampoo, Shaving Cream, Shower Curtains, Soft Contact Lenses, All Manner of Sports Equipment, Sunglasses, Surfboards, Surgical Equipment, Syringes, Telephones, Tents, Toothpaste, All Manner of Toys, Umbrellas, Vitamin Capsules… to name a few
Like it or not...Petroleum is one of the most crucial raw materials on which modern society is based...
Future Generations May Well look back and say…

You burned it all??!!
At this point in history, we have **no real substitutes** for oil in global transport...

We are working on some (e.g. hydrogen), but they are still decades away.

Biofuels, e.g. Ethanol can be good substitutes, but...

- Less energy content: 25% less mpg
- Require significant energy to produce
- Can’t be produced in the needed volumes

Biofuels are transitional fuel, not a full alternative
The most highly traded commodity on Earth
World Total = 1,278 Billion Barrels

66% of Global Reserves in Persian Gulf

Where is oil demand growing most rapidly?
- In DCs + US

Where must oil supply grow most rapidly?
- In unstable, autocratic DCs

Oil & Gas Journal, "Worldwide Look at Reserves and Production,“ Vol. 102, No. 47 (December 20, 2004).
A Final Sobering Truth…

Advanced nations have built societies of unprecedented wealth and freedom on the back of a resource now controlled by unstable, often hostile and corrupt regimes—regimes that have come to power due, in no small part, to the ill-fated policies of those same advanced nations.
The Long View...

Consumption of fossil fuels

Time

billion tonnes coal equivalent

25
20
15
10
5
0

1000
0
1000
A.D.
2000
3000
4000
B.C.
And A Vision of the Future…Hopeful

Patterns of energy use are not fixed and immutable
They can change, even rapidly: crisis, policy, economics
“Whoever tells the truth, sooner or later will be caught doing it…”

Oscar Wilde