1

MFE Lecture 4a Global Warming: The Human Factor

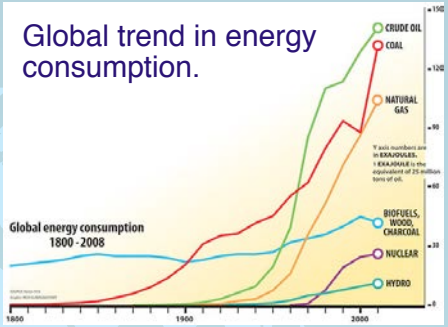
- Humans activity and GHG emissions
- Is our consumption of fossil fuels sustainable?
- Strategies to reduce GHG emissions
- Why is finance concerned with climate change?

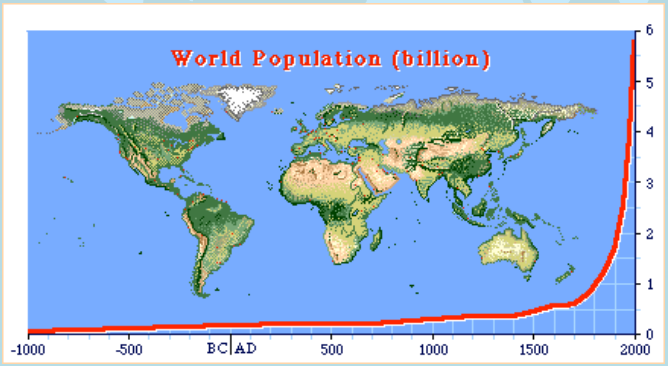
2

The Human Factor

Is Global Warming linked to population and industrialization?

Global trend in energy consumption.





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What is causing the CO_2 to increase in the Atmosphere?

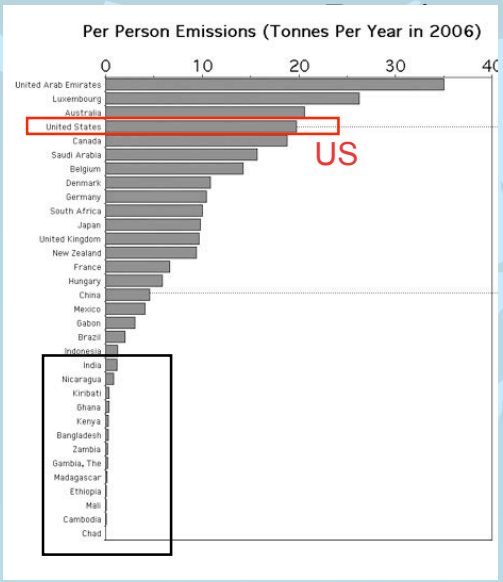
A: Fossil Fuel Burning: Coal, Oil and Natural Gas.

How do we know that?

- Circumstantial Evidence of timing of increase with rise of fossil fuel use.
- Smoking gun evidence of isotopic studies: ratio of C_{14} to C_{12}.

4

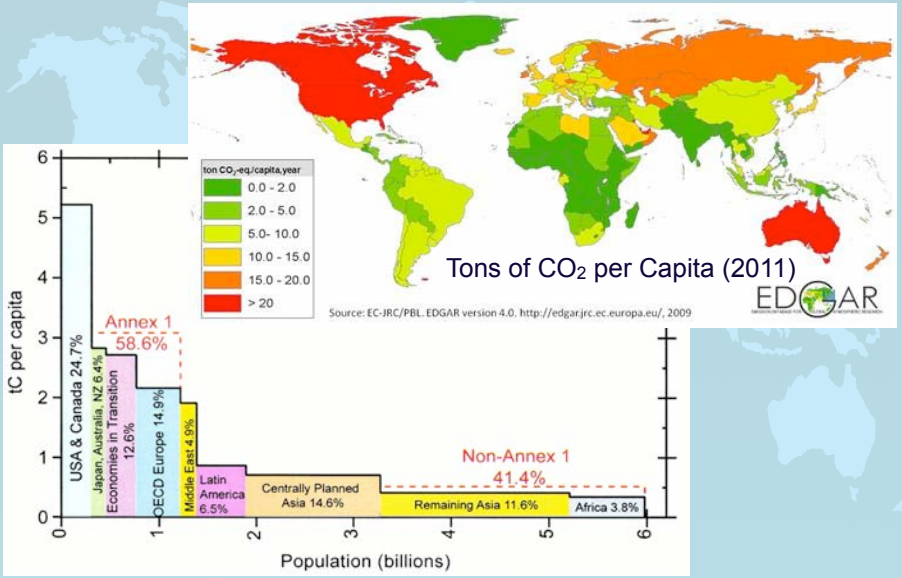
Carbon Dioxide Emission From Fossil Fuel



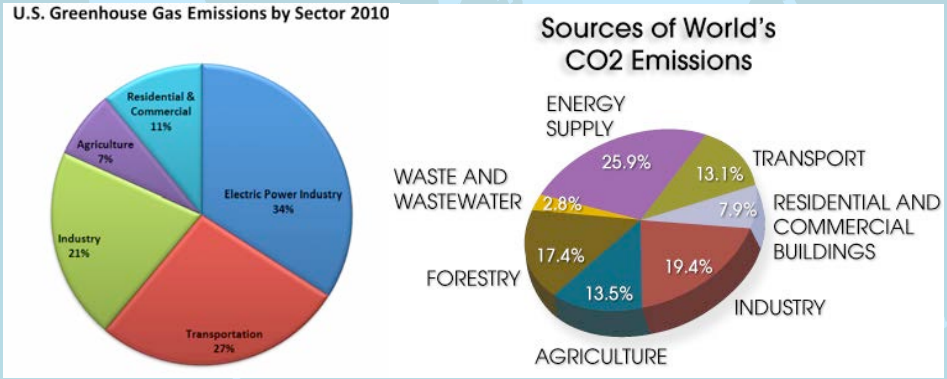
Who?

Source: Energy Information Agency, DOE

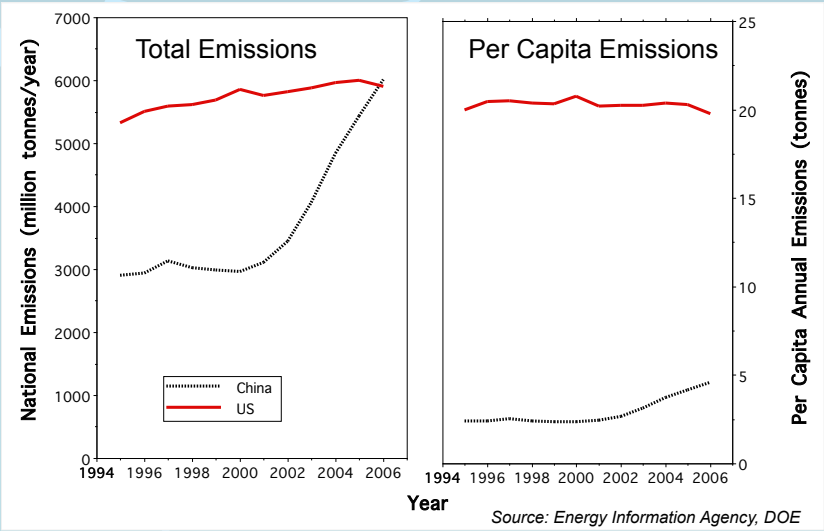
Greenhouse Gas Emitters



Why: Going, Doing, Making, Growing Food, Being Comfortable….. In short, just about everything.



Changes in Total and Per Capita Emissions of Carbon Dioxide From Fossil Fuel Burning in China and the USA

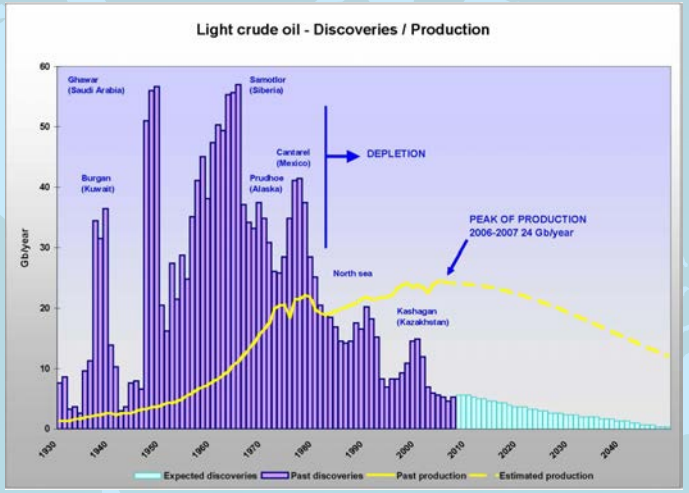


Last decade: China is getting richer, and emitting more CO_2 Kyoto Protocol?

Climate and Energy Policy

- The International Energy Agency issued a warning stating that; "Current global trends in energy supply and consumption are patently unsustainable — environmentally, economically, and socially.
- One of the most fundamentally unsustainable facts of our economy is that each year, almost two trillion dollars are spent overseas, $324 billion more than other countries spend in the US. Oil imports, primarily from Saudi Arabia and Venezuela, make up approximately half of the import trade imbalance.
- Renowned investor Warren Buffett has observed "The U.S trade deficit is a bigger threat to the domestic economy than either the federal budget deficit or consumer debt..."

Oil Discovery v Production



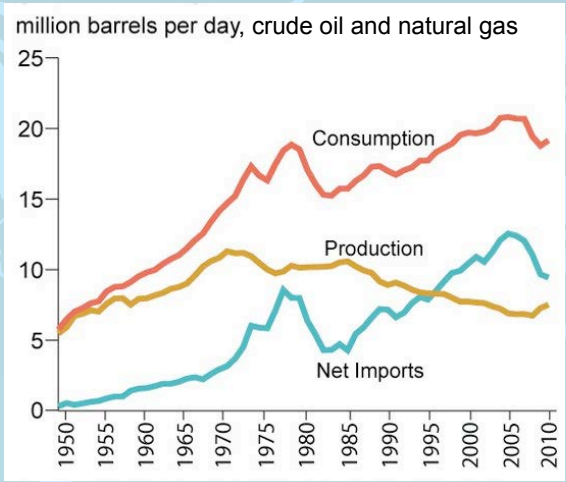
We now are discovering fewer than 8 billion barrels annually compared with the 28 billion barrels we consume.

Oil Producers

Saudi Arabia	10,584
Russia	9,285
United States	7,241
Iran	4,081
Mexico	3,824
China	3,490
Norway	3,188
Canada	3,085
Venezuela	2,980
United Arab Emirates	2,667
Nigeria	2,508
Kuwait	2,424
United Kingdom	2,029
Iraq	2,027
Algeria	1,933
Libya	1,607
Brazil	1,542
Kazakhstan	1,295
Indonesia	1,126
Angola	991

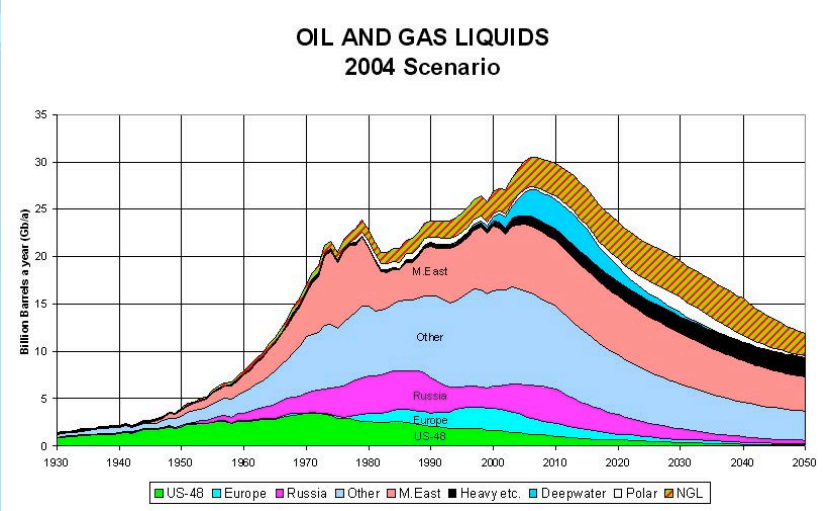
Oil producers in 1000 barrels per day

US Oil Production and Consumption



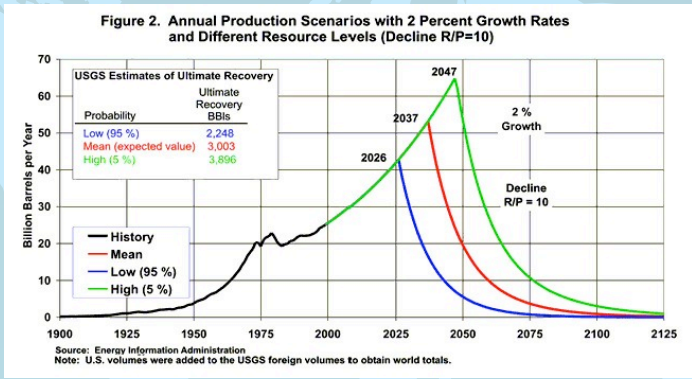
US consumption exceeds production. An increasingly hostile group of Middle Eastern nations are in control.

Global Oil Past and Projected Production



Experts agree, oil prices will rise significantly in the future as production begins to drop.

Global Oil Past and Projected Production



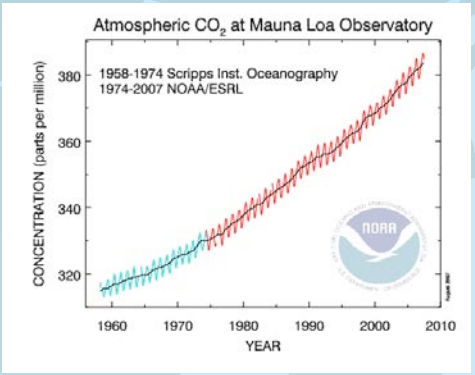
Pessimistic view vs the optimistic view.

Or optimistic view vs the pessimistic view.

Mackay River, Boreal Forest and Tar Sands Mine

Boreal Forests and wetlands surrounding the Tar Sands are among the most carbon rich terrestrial ecosystem on Earth, with about as much carbon as tropical rainforests. Referred to by the Tar Sands industry as "overburden," these forests are scraped off and the wetlands dredged, to be replaced by tar mines like the one above.
From: Canada's Tar Sands and the True Cost of Oil. Photography by Garth Lenz.

Climate And Bathtubs: A Poorly-Understood Principle

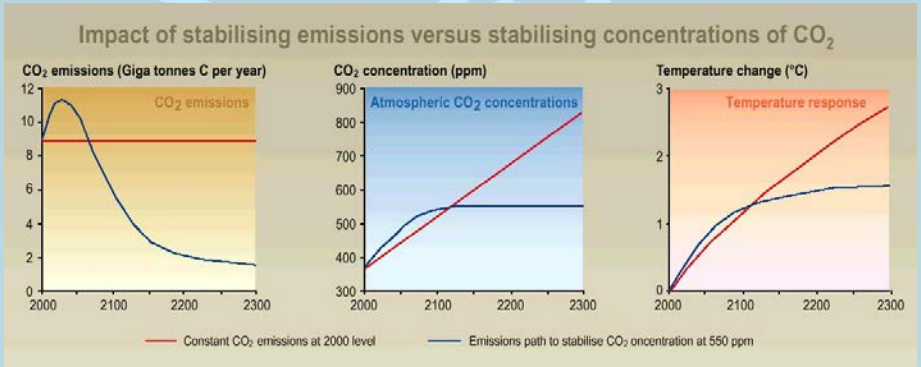


Stabilization of CO_2 would require 50% emissions reductions (for a few decades) and then 80%

Geoengineering? Cool the planet? Real and 'artificial' trees?

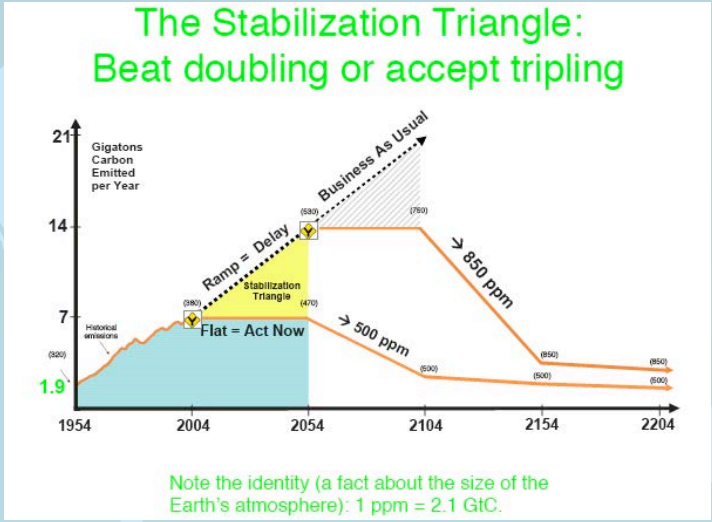
5/6 of the people now emit 5x less per person than 1/6

Climate and Bathtubs: A Poorly-Understood Principle



Note: We are not doing either of these two. Our emissions are continuing to ramp up.

How Far Will We Go?



The longer we wait to act, the more climate change we will be locked into.

Image: Socolow and Pacala

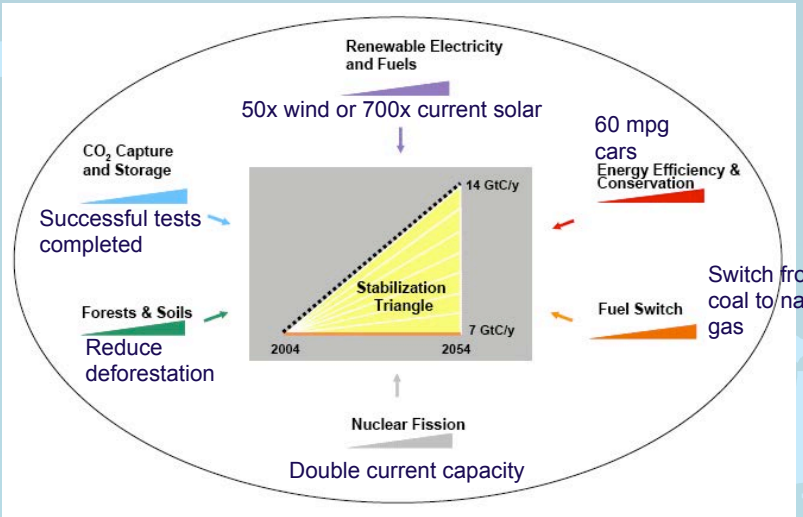
CO_2 Stabilization is Possible, But…

Essential Requirements

1. Quick Coal Phase-Out Necessary
   All coal emissions halted in 20 years
2. No Unconventional Fossil Fuels
   Tar sands, Oil shale, Methane hydrates
3. Don't Pursue Last Drops of Oil
   Polar regions, Deep ocean, Pristine land

The Tar Sands were the inspiration for Avatar's Edmonton-born art director's vision of the mining operation on Pandora.

Some Possible Future Choices: Just Illustrations



There are no silver bullets but there is much silver buckshot. Technology matters.

Energy Conservation

- Promote mass transit where appropriate.
- Promote electric car technology.
- Expand use of natural gas (cleaner fuel).
- Improve quality of gas lines, especially in Eastern Europe.
- Recover methane from landfills.
- Promote co-generation technologies - e.g., recovery of waste heat; produce electricity as a by-product of production.
- Improve manufacturing techniques - e.g., electronic inventories; automated manufacturing where inventories are eliminated.
- Promote alternative energy-wind and solar power - local energy sources eliminate transmission loss.
- Strengthen efficiency standards throughout the economy. Improve building codes: insulation, improve lighting and appliance efficiencies, promote use of passive solar.

Strategies to Control Warming

- Stabilize world population
- Initiate a no-coal world energy strategy
- Vastly enhance renewable energy dependence
- Institute strong energy conservation
- Develop treaties strongly controlling greenhouse gases
- Initiate CO_2 sequestration
- Discover counter-greenhouse technologies

What's Really Happening

1. Tar Sands Agreement with Canada
   Pipeline planned to transport oil
2. New Coal-fired Power Plants
   Rationalized by 'Clean Coal' mirage
3. Mountaintop Removal Continues
   Diminishes wind potential of mountains
4. Oil & Gas Extraction Expands
   Arctic, offshore, public lands

Crossroads in Alberta Tar Sands

Problem & Solution

1. Fossil Fuels are Cheapest Energy
   - Subsidized & We Do Not Pay Costs
   - Solution: Rising Price on Carbon
2. Regulations also Required
   - Efficiency of Vehicles, Buildings,e.g.
   - Carbon Price Provides Enforcement
3. Technology Development Needed
   - Driven by Certainty of Carbon Price
   - Government Role Limited

Average daily solar radiation for Oahu

Fee & Dividend

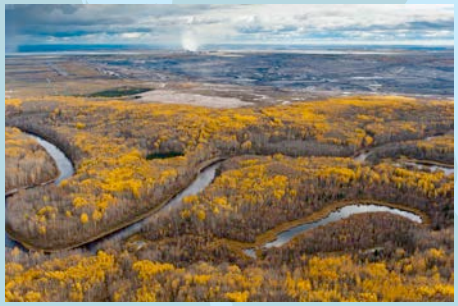
1. Fee Applied at First Sale/Port of Entry
   - Covers all Oil, Gas, Coal – No Leakage
2. Fee Specified: No Speculation, No Volatility
   - No Wall Street Millionaires at Public Expense
3. Other Merits
   - Only Potentially Global Approach
   - Simple, Honest, Can be Implemented Quickly
   - Market Chooses Technology Winners
   - Most Efficient & Largest Carbon Reductions

Fee & Dividend Addresses

1. Stimulates Economy
   - Puts Money in Public's Hands– A Lot!
2. Energy: Stimulates Innovation
   - Fastest Route to Clean Energy Future
3. Climate
   - Only Internationally Viable Approach
   - Zero Chance of China/India Accepting a Cap
   - Would Result in Most Coal & Unconventional Fossil Fuels, and some Oil, left in the Ground

Tar Sands Oil not Needed

If carbon price rises $10 per ton CO_2, after 10 years the U.S. carbon emissions will have decreased approximately 30 percent. That is equivalent to 13 Keystone pipelines.



With a proposed 5-fold expansion of the Tar Sands, an area the size of Florida might be industrialized within as little as two decades.

Adaptation: Strategies to Live With Warming

- Improve irrigation efficiency
- Develop new sources of irrigation water
- Stop deforestation – increase forestry – plant trees
- Conserve soil – prevent erosion
- Grow salt tolerant food plants and expand aqua culture
- Plan for increased ocean height

In Hawaii

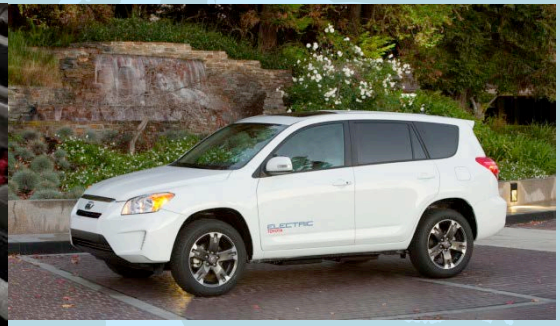
- Gasoline in Hawaii is not only expensive, the oil consumed represents an export of cash from our economy that literally just goes up in smoke.
- Ethanol from sugar cane: Cultivation requires significant fossil fuels, reduction in soil fertility, water consumption high, competition with food production.
- Hawaii's pre-1985 sugar production on 180,000 acres could have produced enough ethanol to cut current gasoline consumption by only 15% percent.
- Wind energy. The trade winds provide reliable source of energy. Wind farms must located in areas of enhanced winds, but with a minimum of terrain-induced turbulence, which causes wind turbines to wear out faster.
- Solar energy sources. Photovoltaic cells are becoming more efficient and economical. Hawaii has great solar resource.
- Geothermal energy sources
- Wave and tidal energy sources

Residential Solar Power

Plug-in Electric

family car plugs into the solar panel roof.

Electric Toyota Rav/Tesla



- Powerful electric motor with Lithium-ion (Li-ion) battery pack
- Zero emission vehicle (ZEV)
- Class-leading driving range, acceleration, and top speed
- Real world driving range of ~ 100 miles

Chevy Volt, Nissan Leaf, Mitsubishi MiEV, Tesla Model S

These models are currently in production.

Questions?