Optimizing Clean and Efficient Energy Technologies through Tax and Fiscal Policy

INTERNATIONAL FORUM ON TAX AND FISCAL POLICIES TO PROMOTE CLEAN ENERGY DEVELOPMENT

The Great Hall of the People, Beijing, P.R. China

November 16-17, 2005

Advantages and limitations of free-market economies

- Free-markets provide powerful incentives for innovation (One works hardest for self-gain)
- They are more nimble than regulated economies

Question: How many free-market economists does it take to change a light bulb?

Answer: None. If it needed changing, free-market forces would have taken care of it.

The downsides of free-market economies

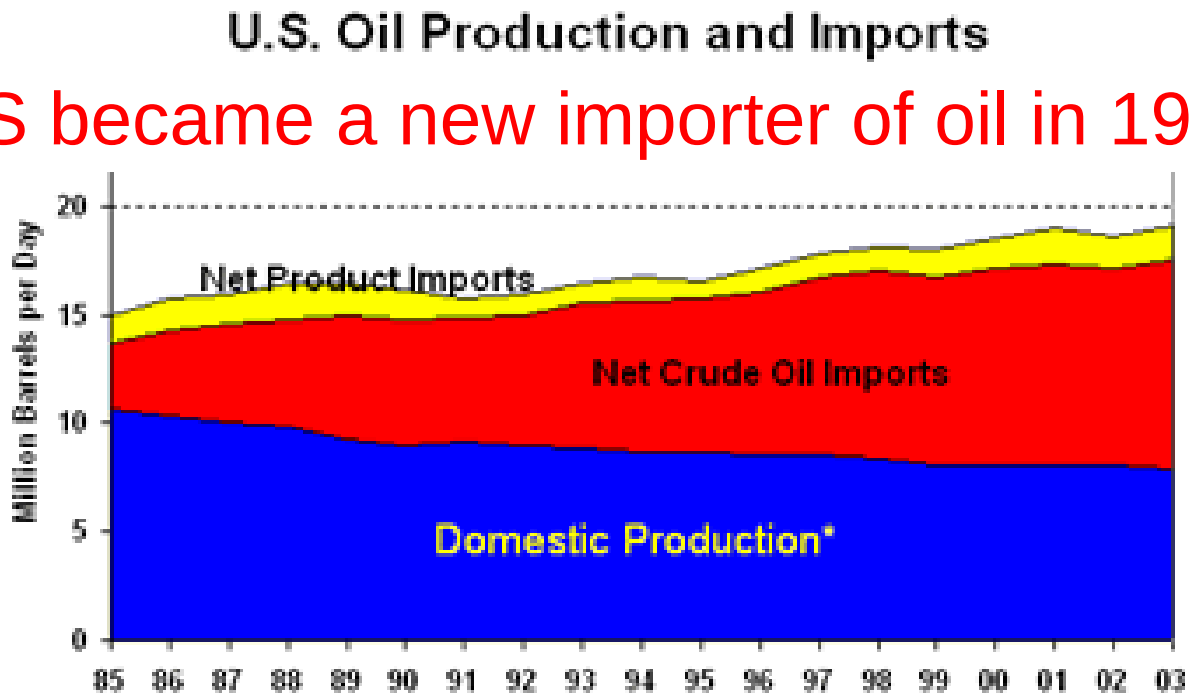
- Free markets do not always account for "externalities" (e.g. pollution, climate change)
- Public goods need to be supported by taxation (e.g. national security, roads and bridges)
- "Survival of the fittest" does not always mean "survival of the best". (e.g. unethical or predatory business practices). Regulation and transparent legal enforcement is needed
- Free markets do not respond well to long term problems or international/global issues. (e.g. international fishing, international pollution) Regulatory treaties? International Taxes?

The externalities related to energy

- Energy dependence costs
- Environmental costs

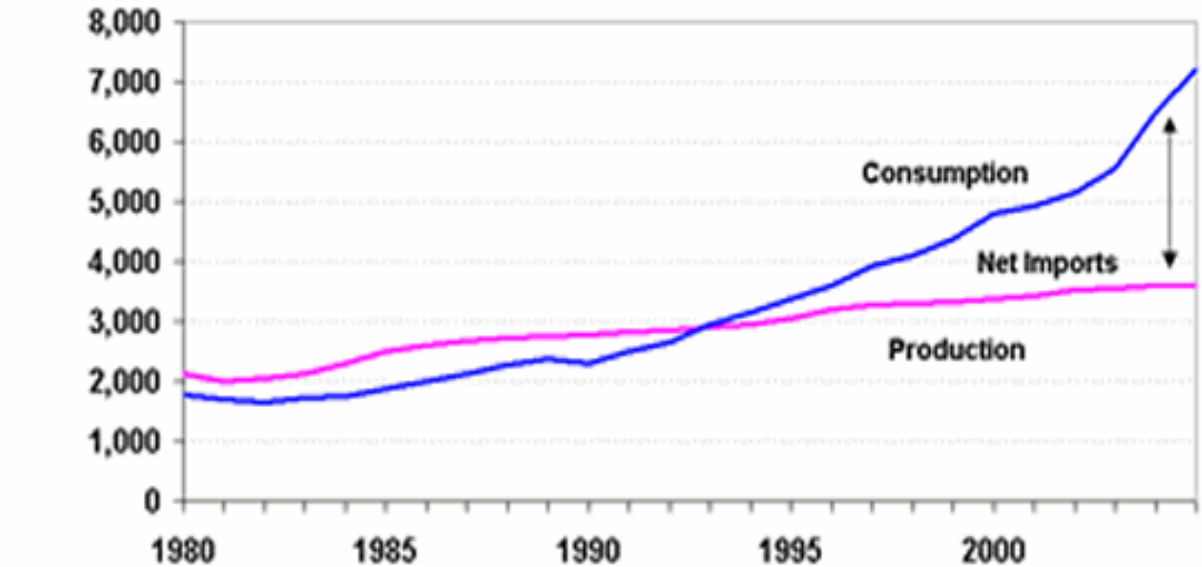
Polices that modify free-markets.

- Global incentives (carrots), dis-incentives (sticks), commands (regulation)
- Stimulating long term investments in research and development to commercialization

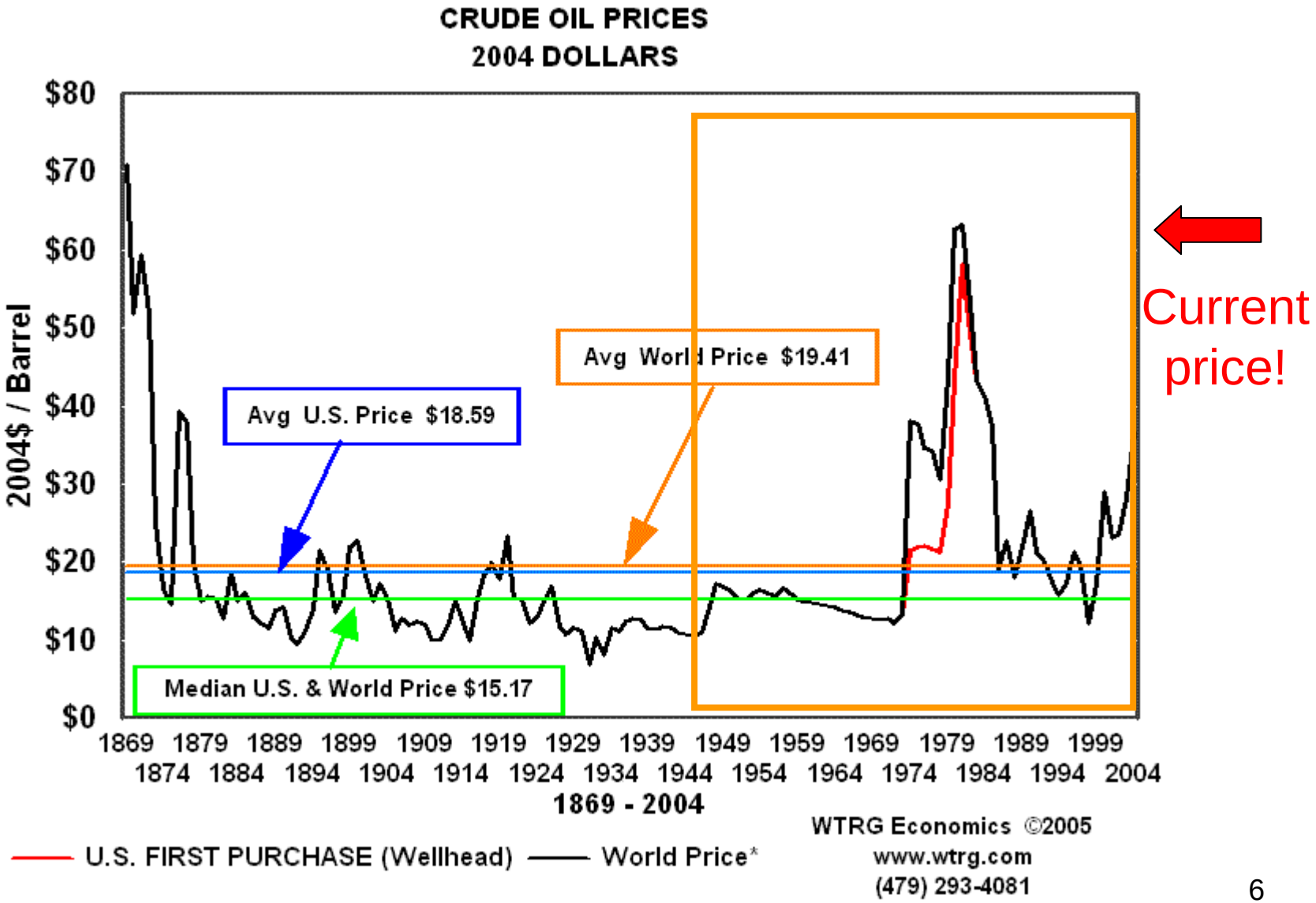


US became a new importer of oil in 1970

China oil consumption and production 1980 -2005

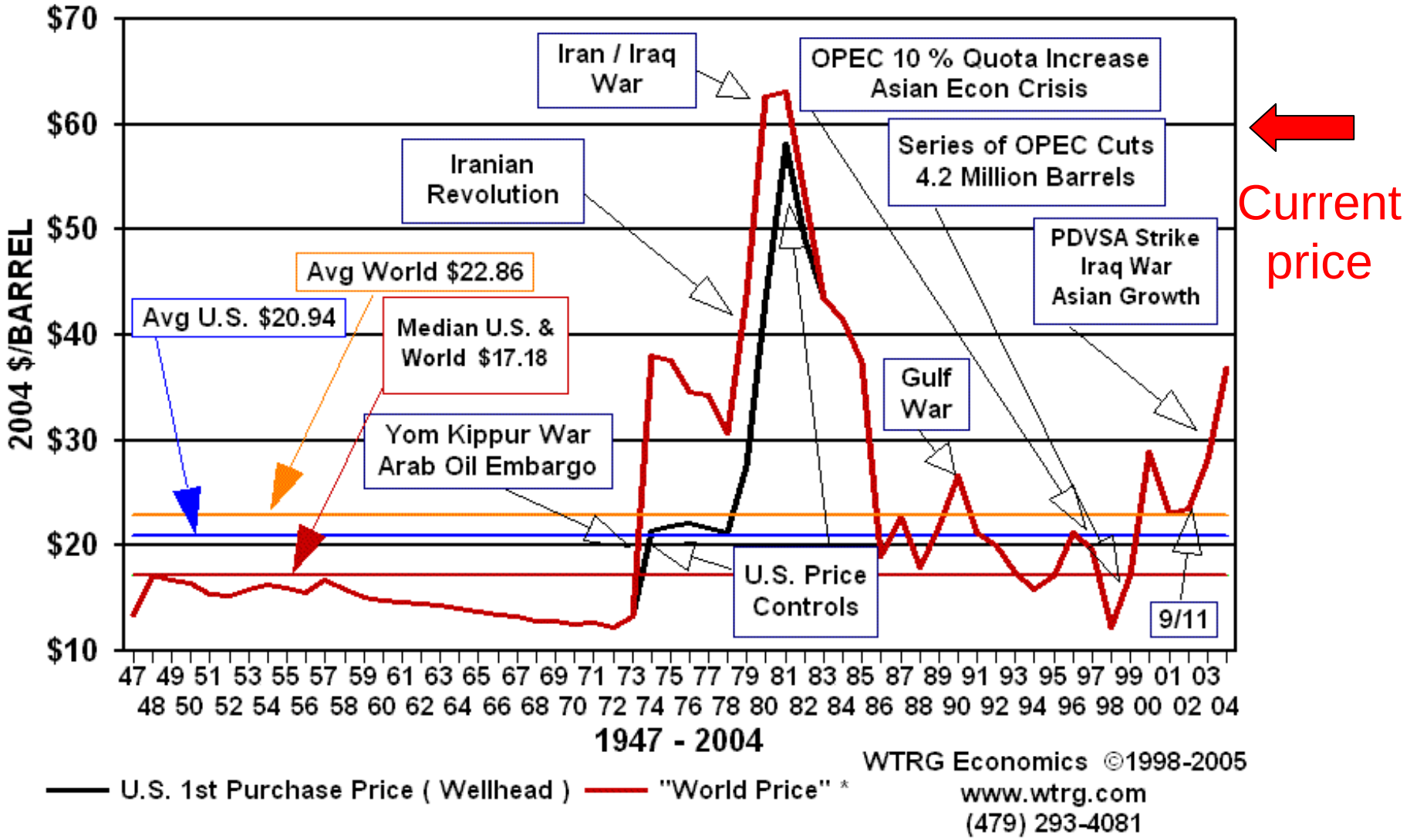


Uncertain cost of energy

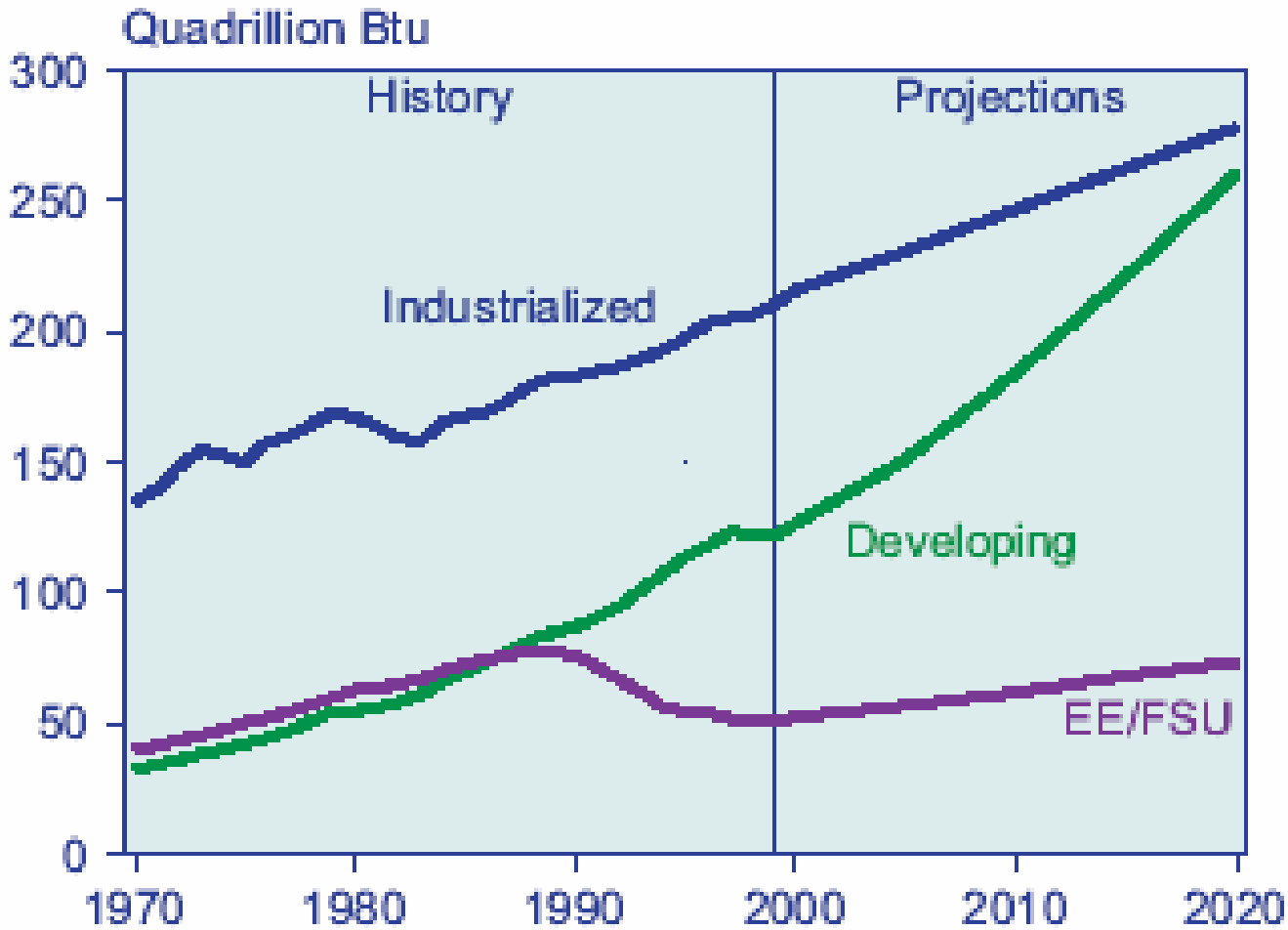


Current price!

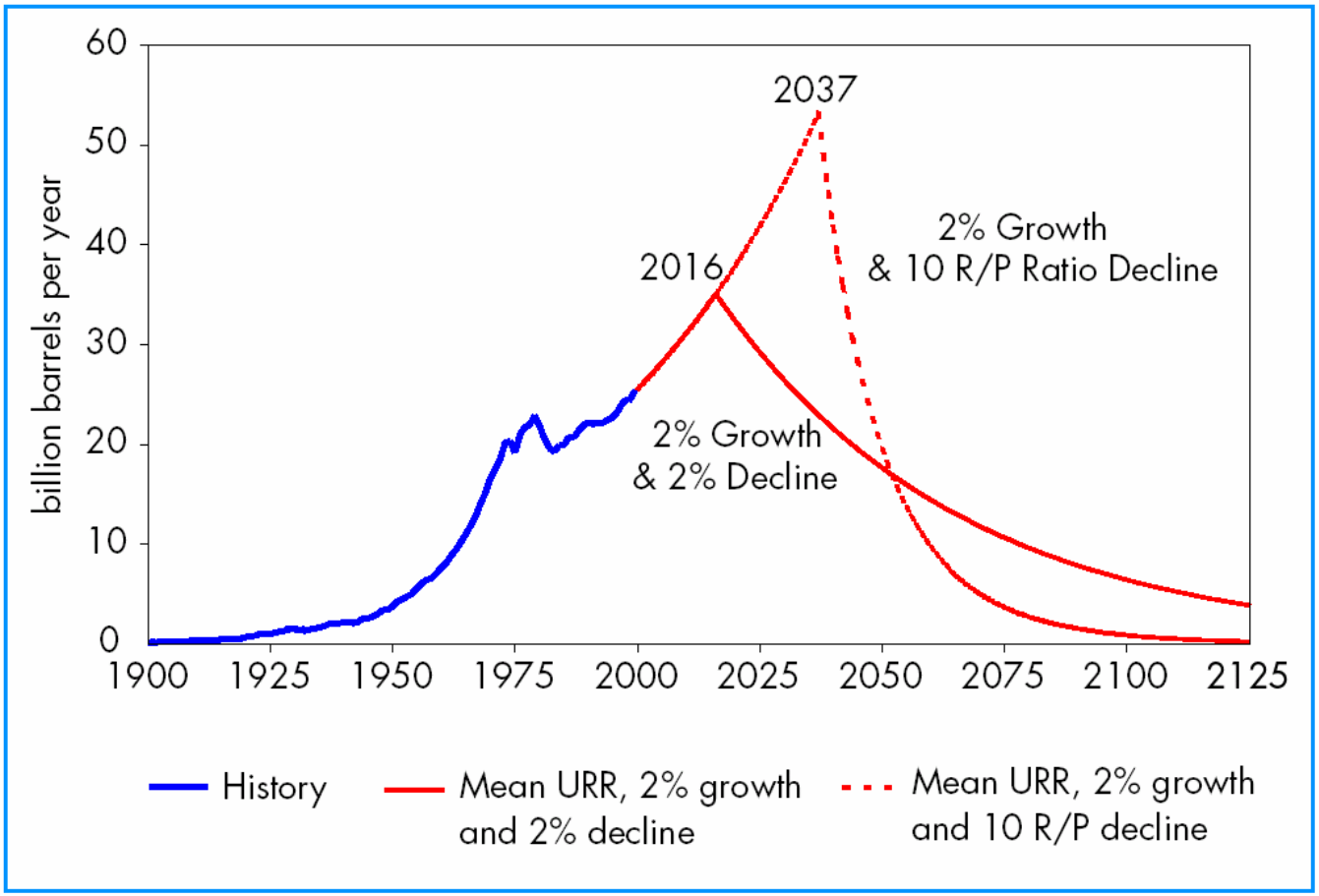
Factors affecting crude oil prices



World Energy Consumption from 1970-2020 is projected to triple: uncertain ***access*** to energy



"Hubbert Curves" with different assumptions of rate of decline using GSGS and DOE best estimates of ***total*** discovered and undiscovered global reserves



Source: *World Energy Outlook, 2001* by the International Energy Agency, a body of the Organization for Economic Co-operation and Development (OECD)

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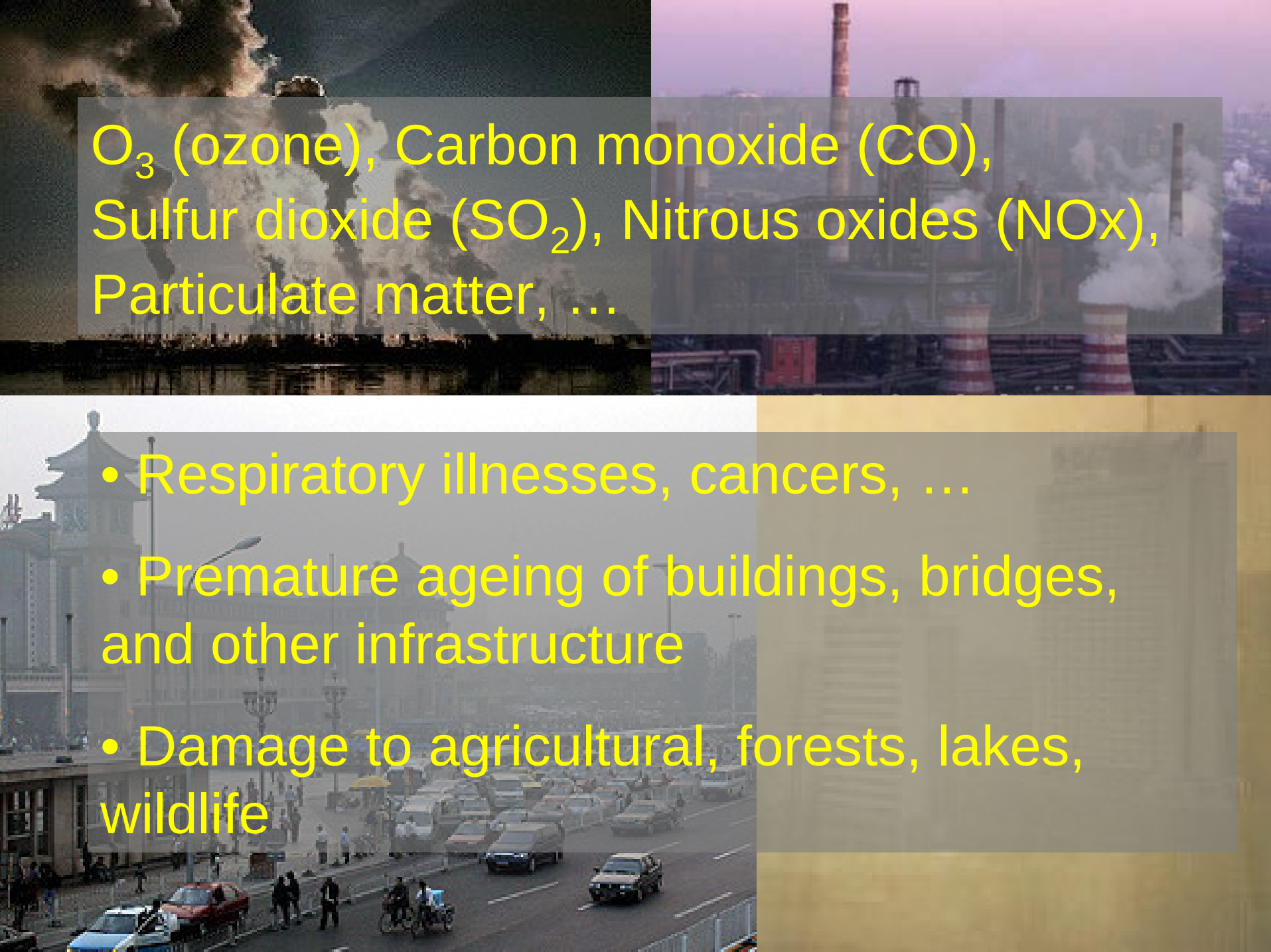
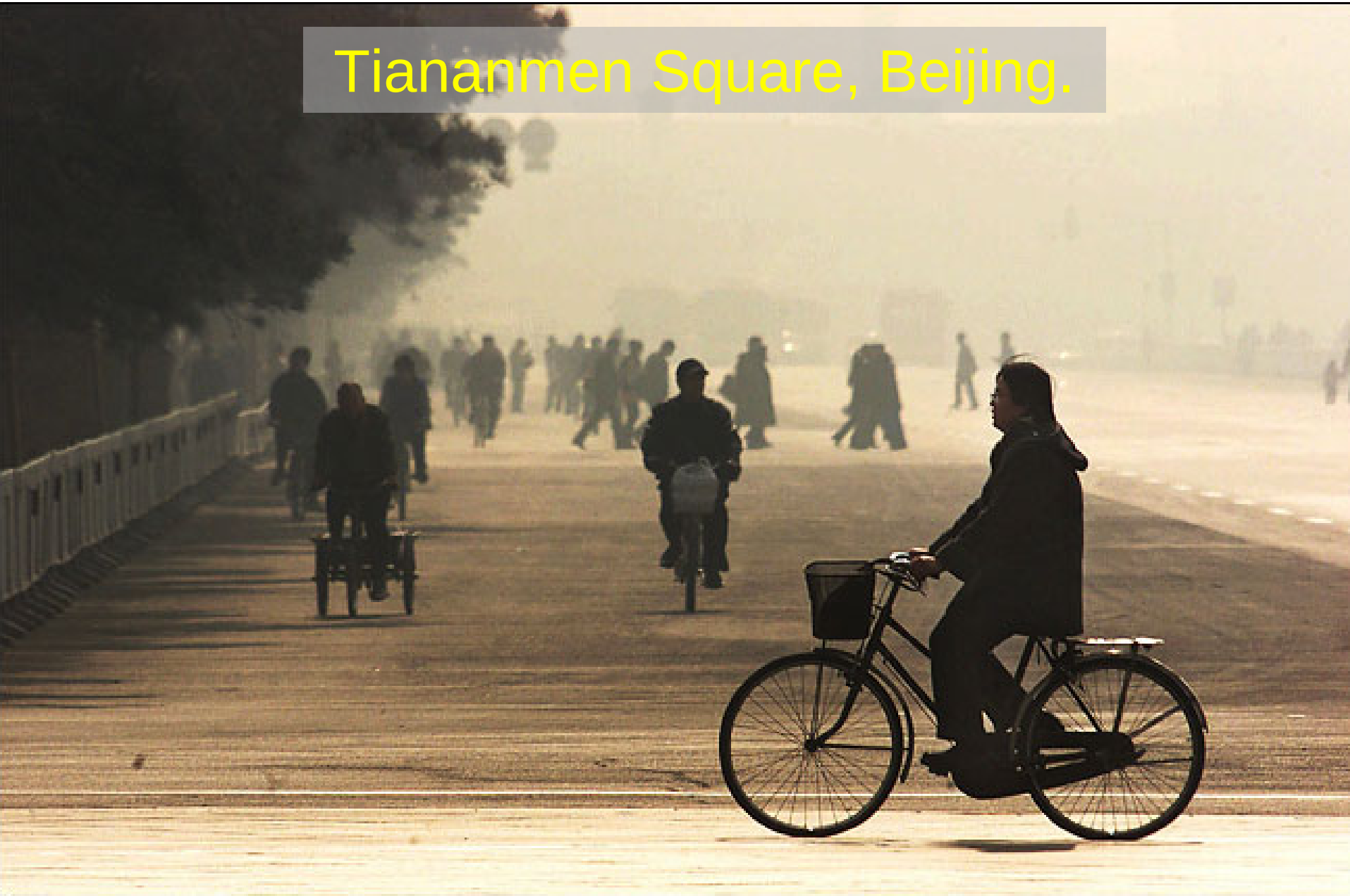
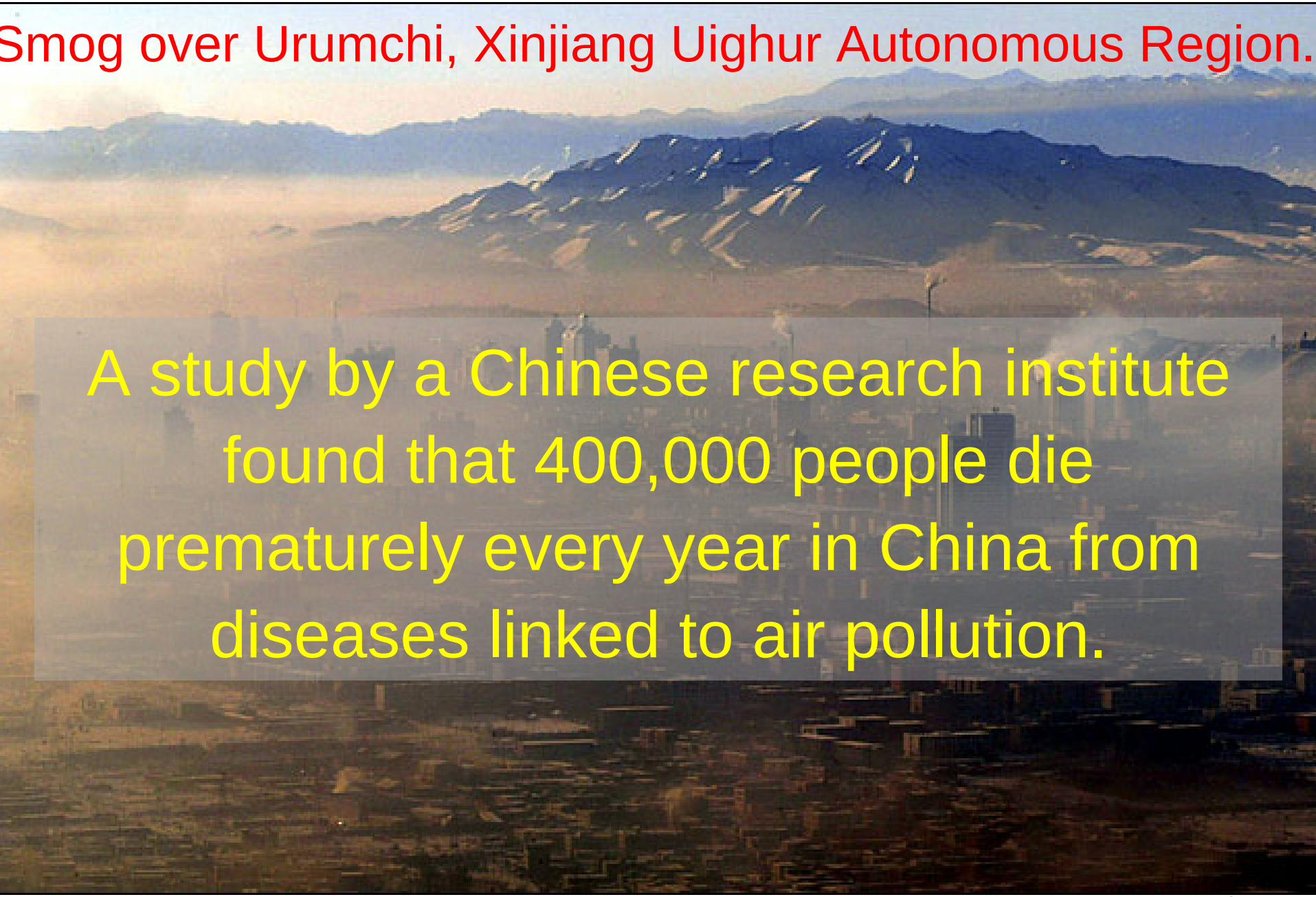


O_3 (ozone), Carbon monoxide (CO), Sulfur dioxide (SO_2), Nitrous oxides (NOx), Particulate matter, …

- Respiratory illnesses, cancers, …
- Premature ageing of buildings, bridges, and other infrastructure
- Damage to agricultural, forests, lakes, wildlife



Greg Baker/Associated Press

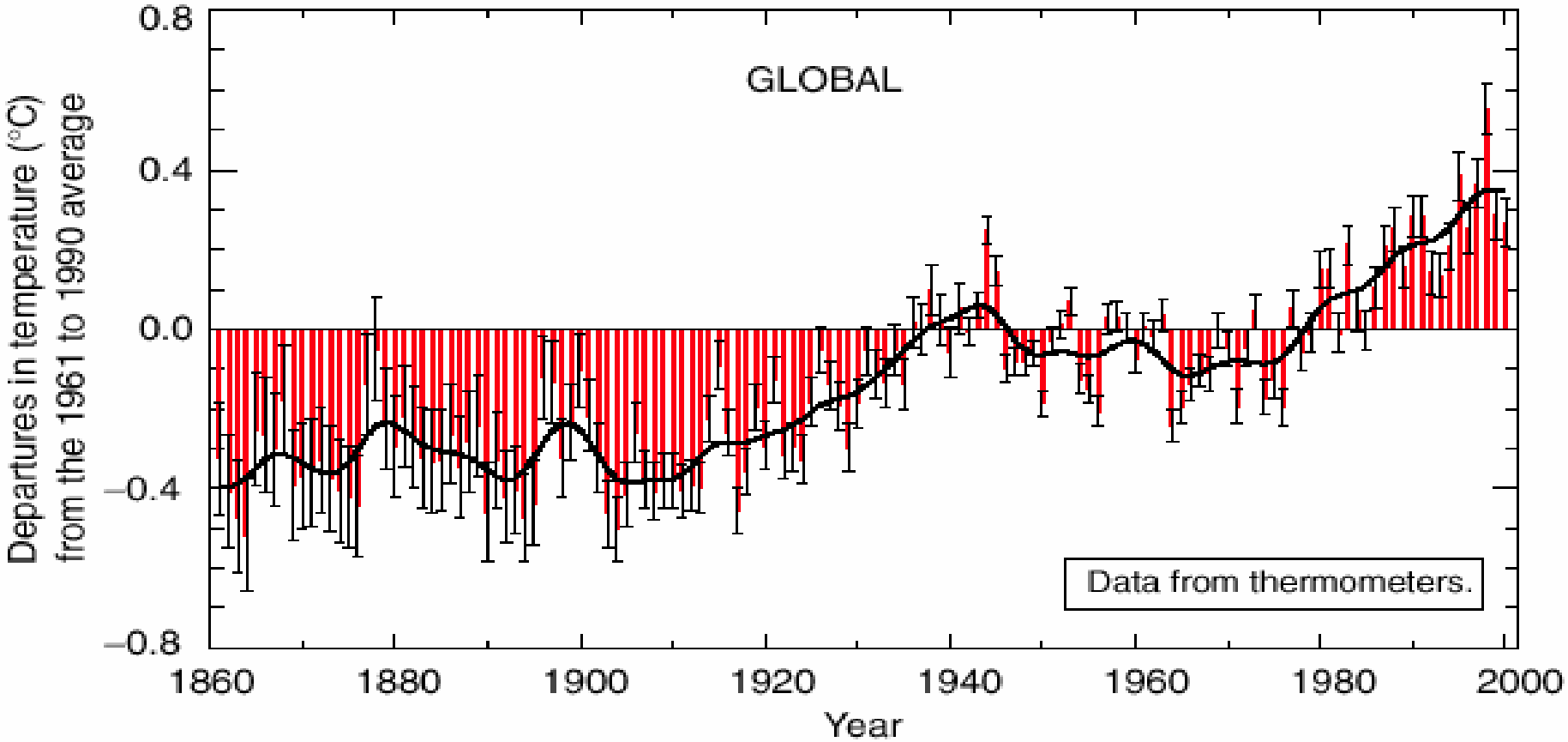


Song Yang/Imaginechina

A cement factory in Qianwei, Sichuan, China.

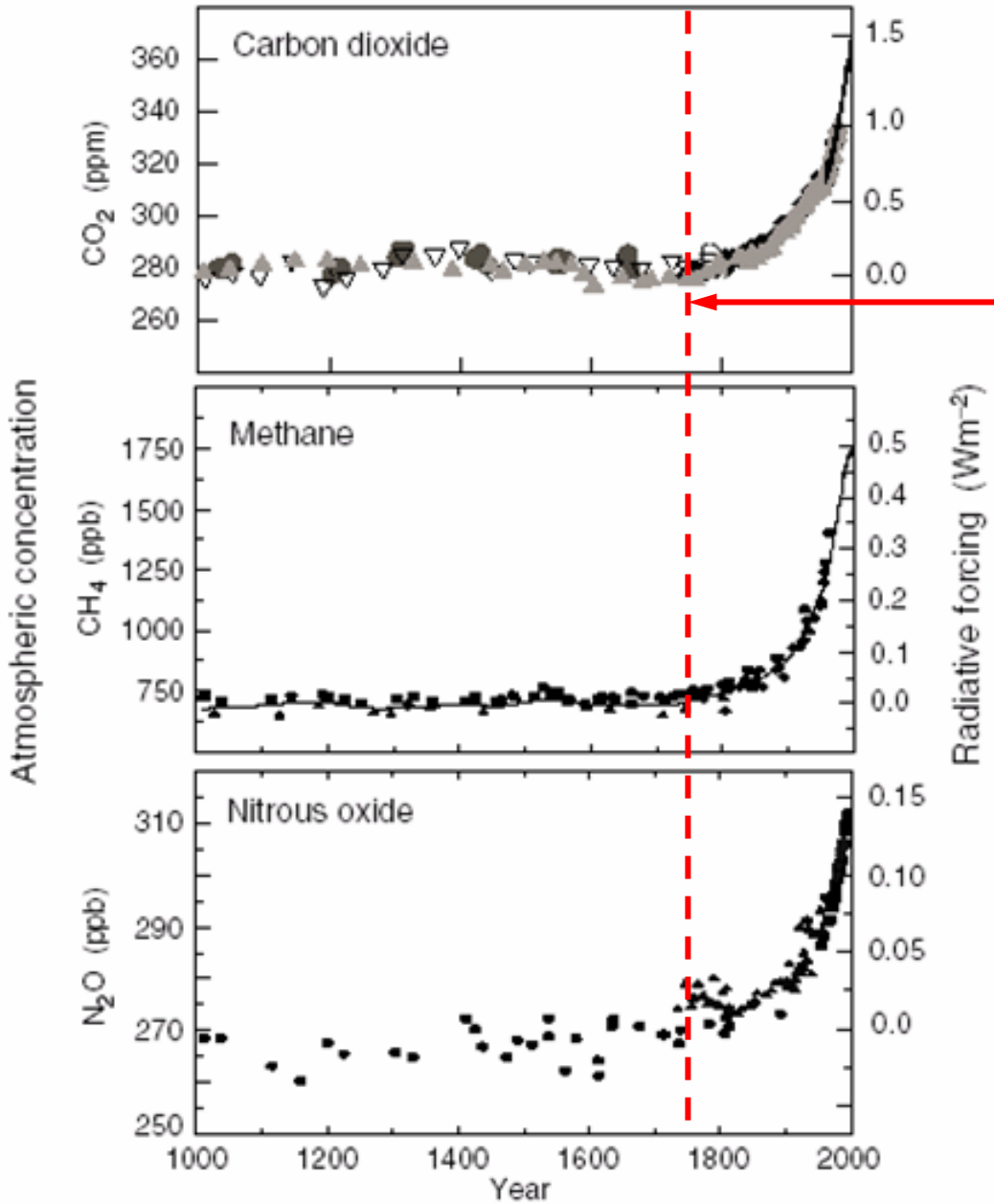
Liu Jin/Agence France-Presse - Getty Images

Average global temperature rise since 1860



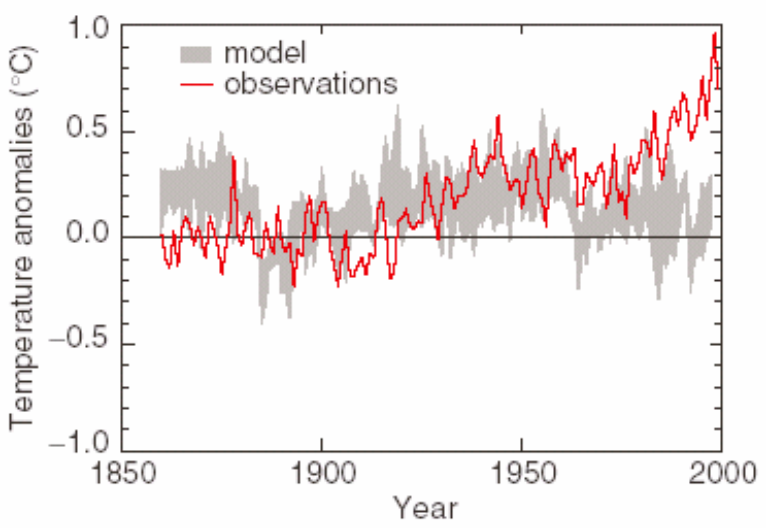
- 19 of the 20 warmest years since 1860 have all occurred since 1980.
- 1998 was the warmest year in the instrumental record and probably the warmest in 1,000 years.

Concentration of Greenhouse gases

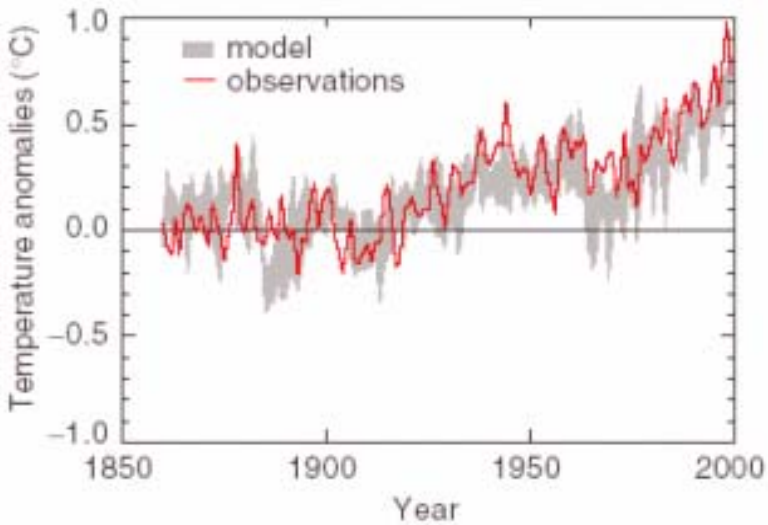


1750, the beginning of the industrial revolution

Can we predict the past?

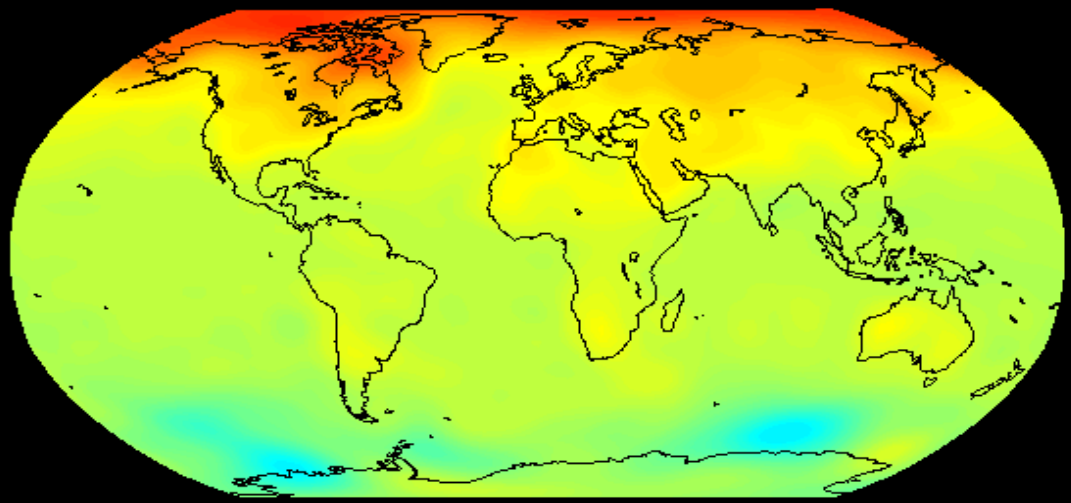


Climate change due to natural causes (solar variations, volcanoes, etc.)

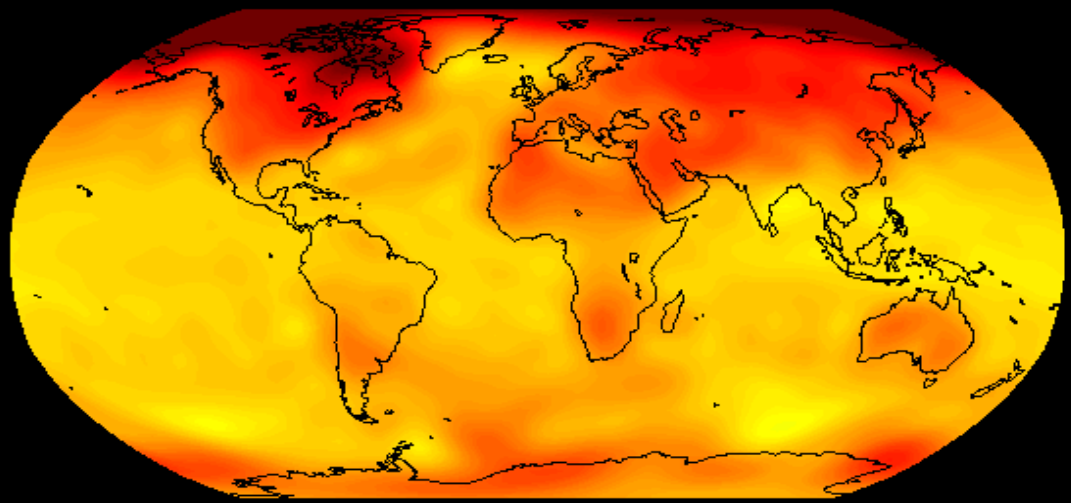


Climate change due to natural causes and human generated greenhouse gases

2 x CO_2



4 x CO_2



Computer simulations by the Princeton Geophysical Fluid Dynamics Lab for CO2 increases above pre-industrial revolution levels:

2x CO_2 : 5 – 8° F

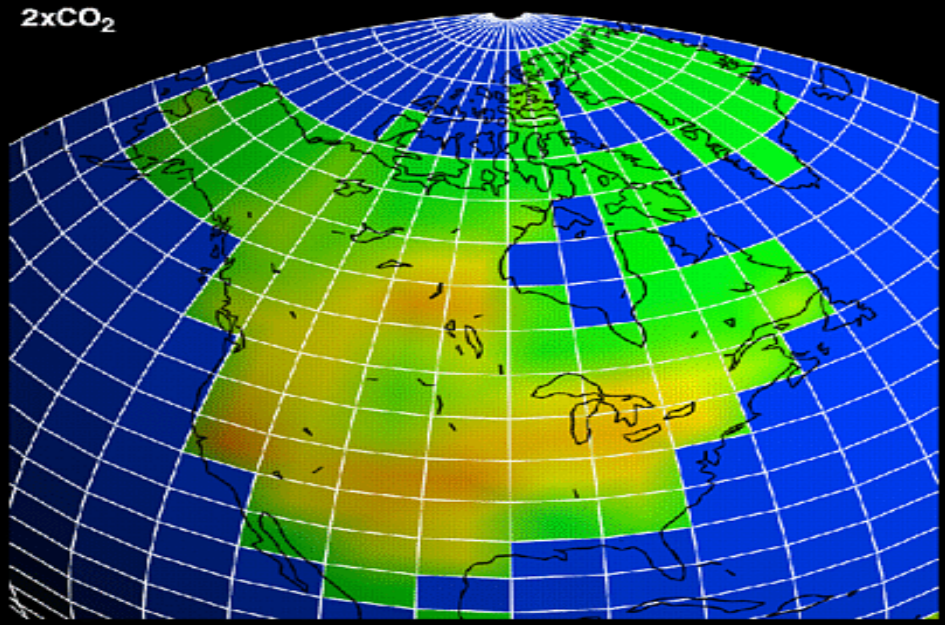
4x CO_2 : 15-25° F

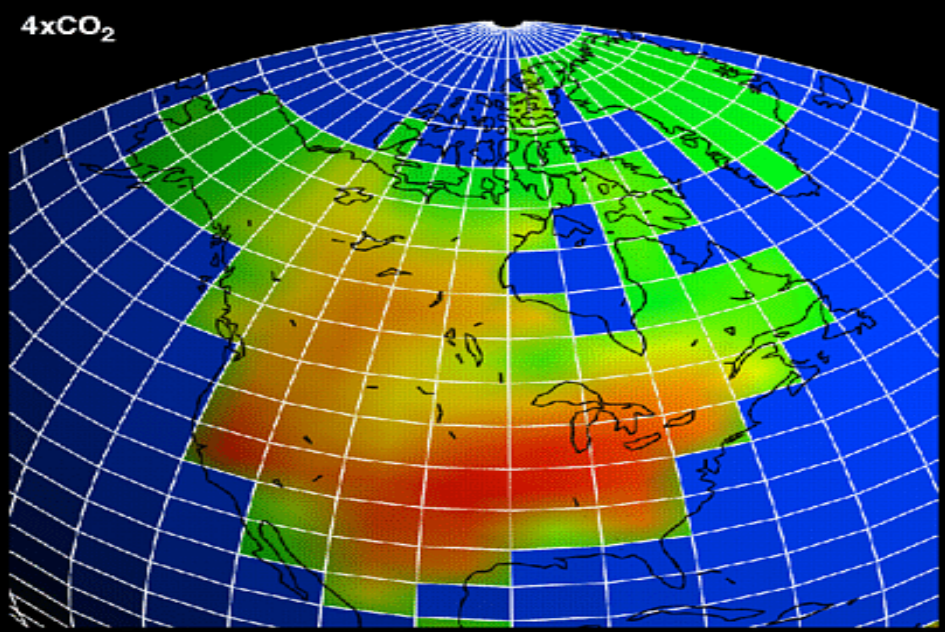
Pre-industrial:

~275 ppm

Today:

~380 ppm

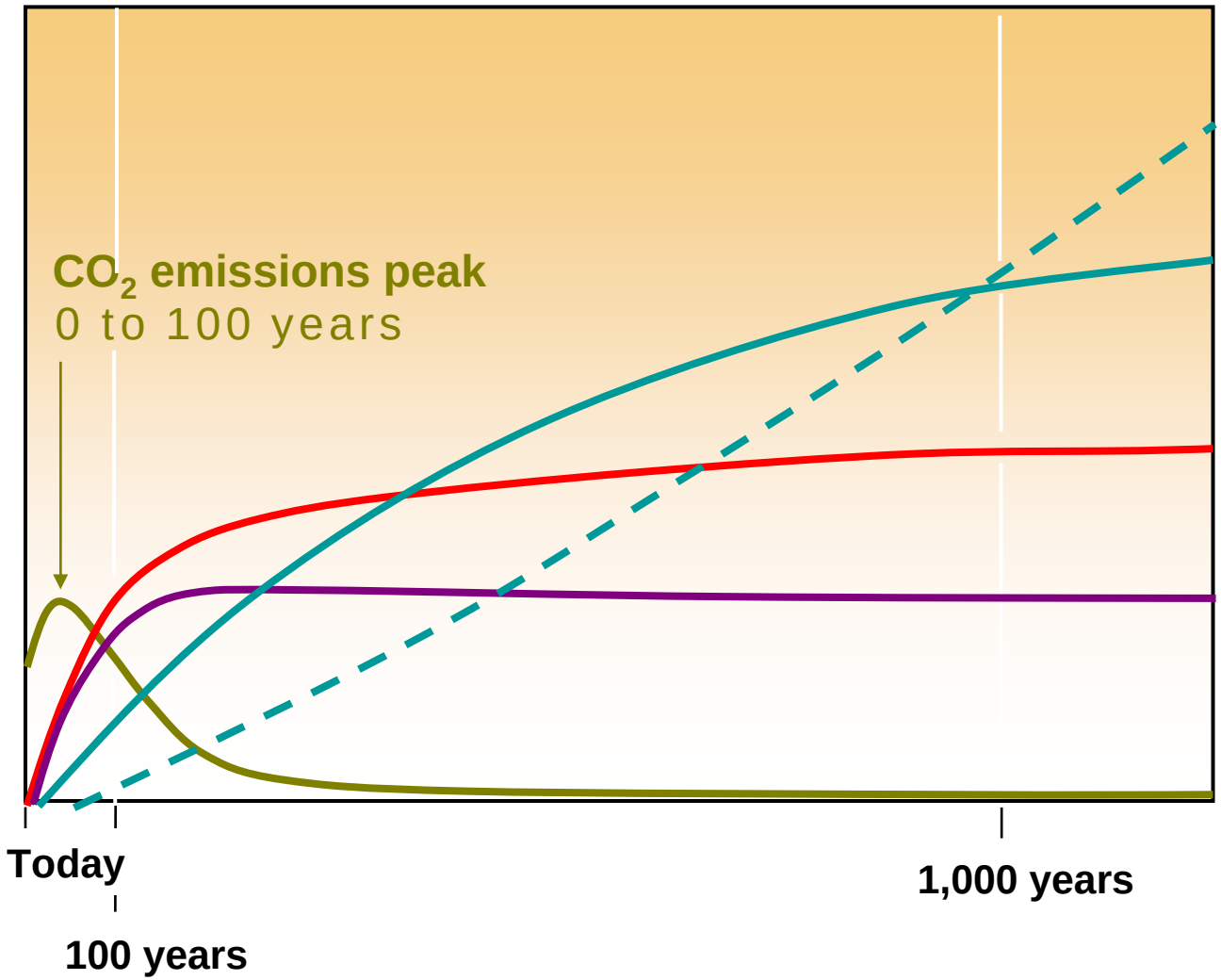




Summer soil moisture in N America under doubled & quadrupled CO_2 (from the Princeton GFDL model)

Mid-continent soil-moisture reductions reach 50-60% in the 4xCO_2 world.

CO_2 Concentration, Temperature, and Sea Level Continue to Rise Long after Emissions are Reduced



The externalities related to energy

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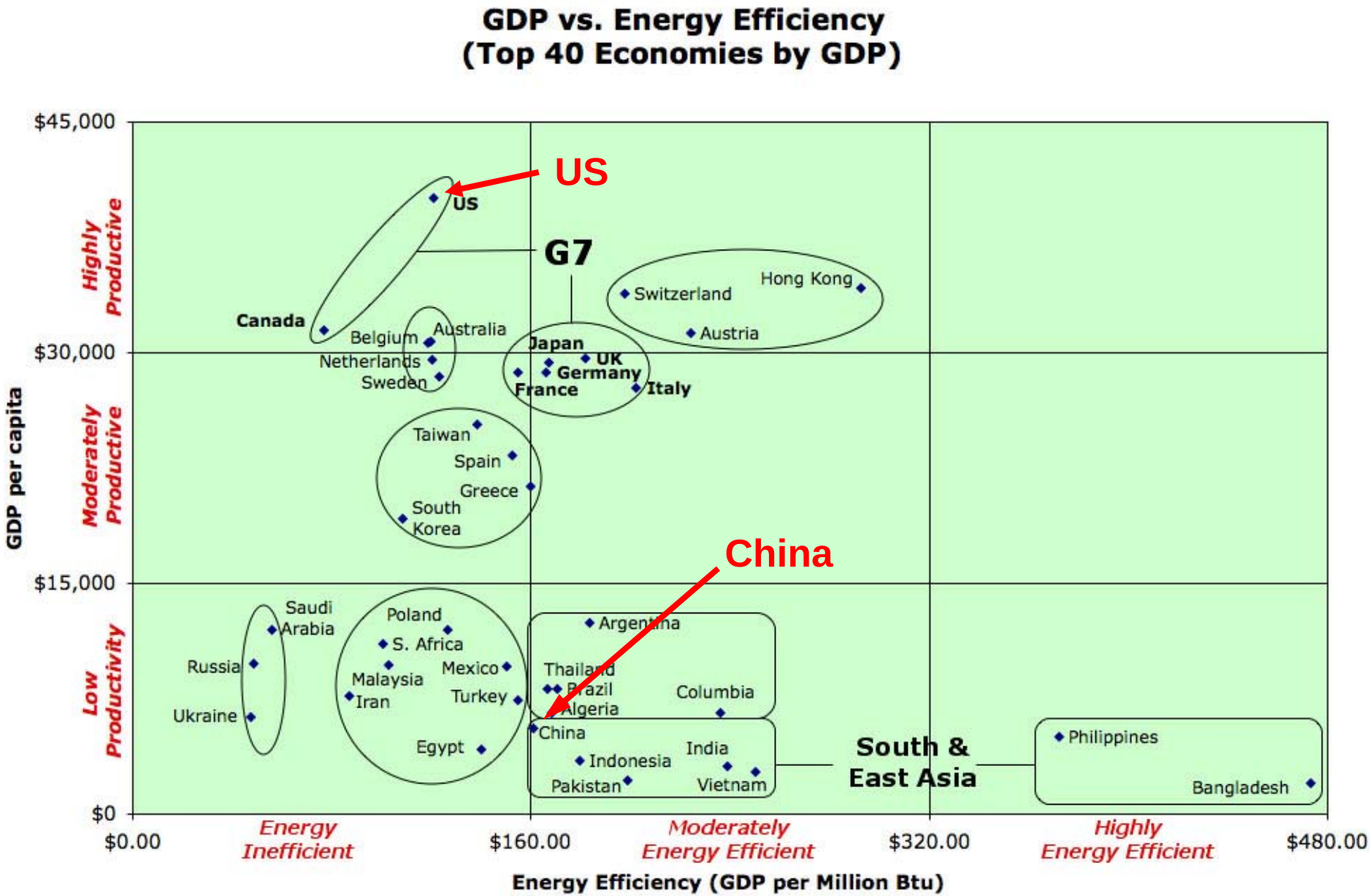
Polices that modify free-markets.

- Incentives (tax credits), dis-incentives (taxes or caps), commands (regulation)
- Stimulating long term investments in research and development to commercialization

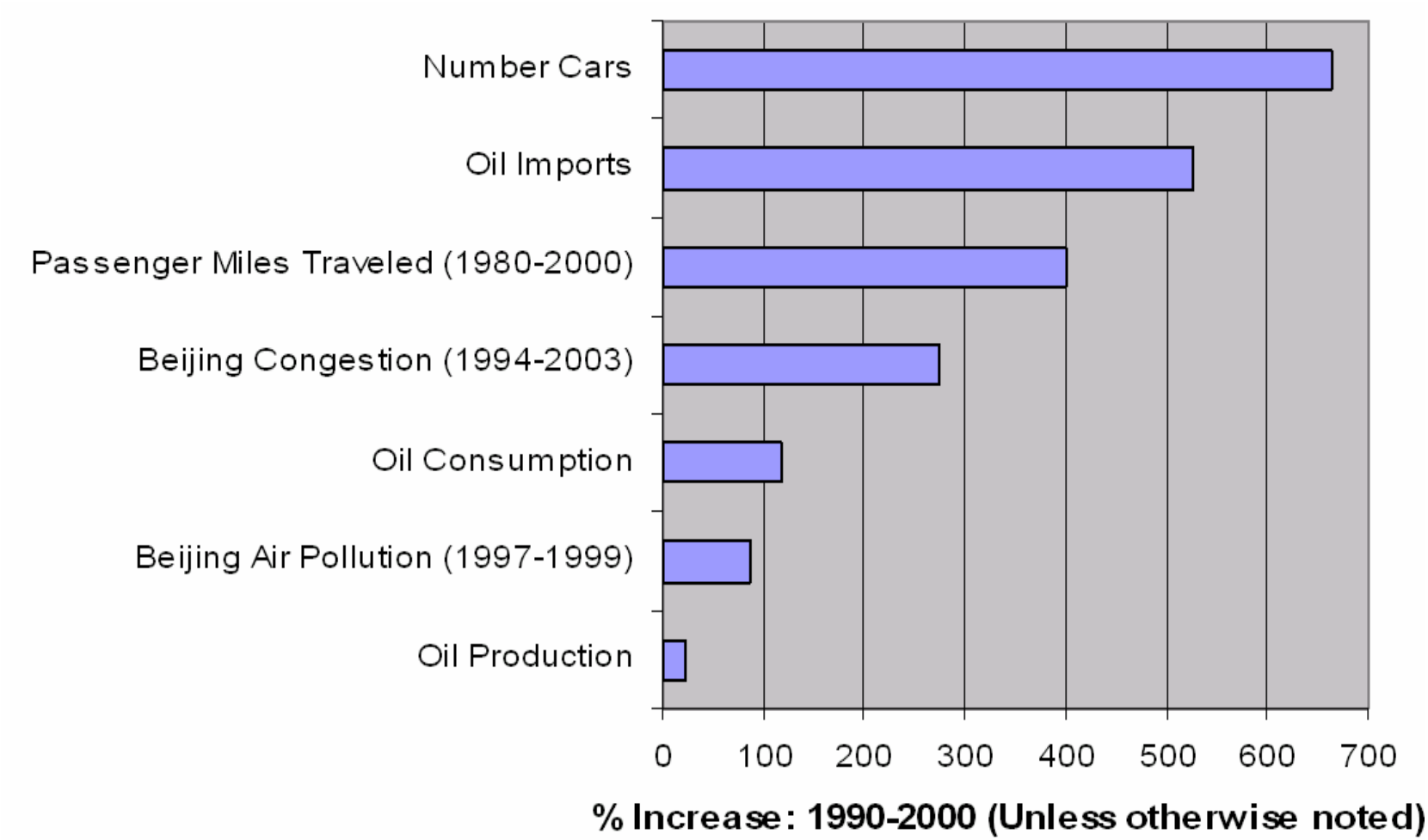
A dual strategy is needed:

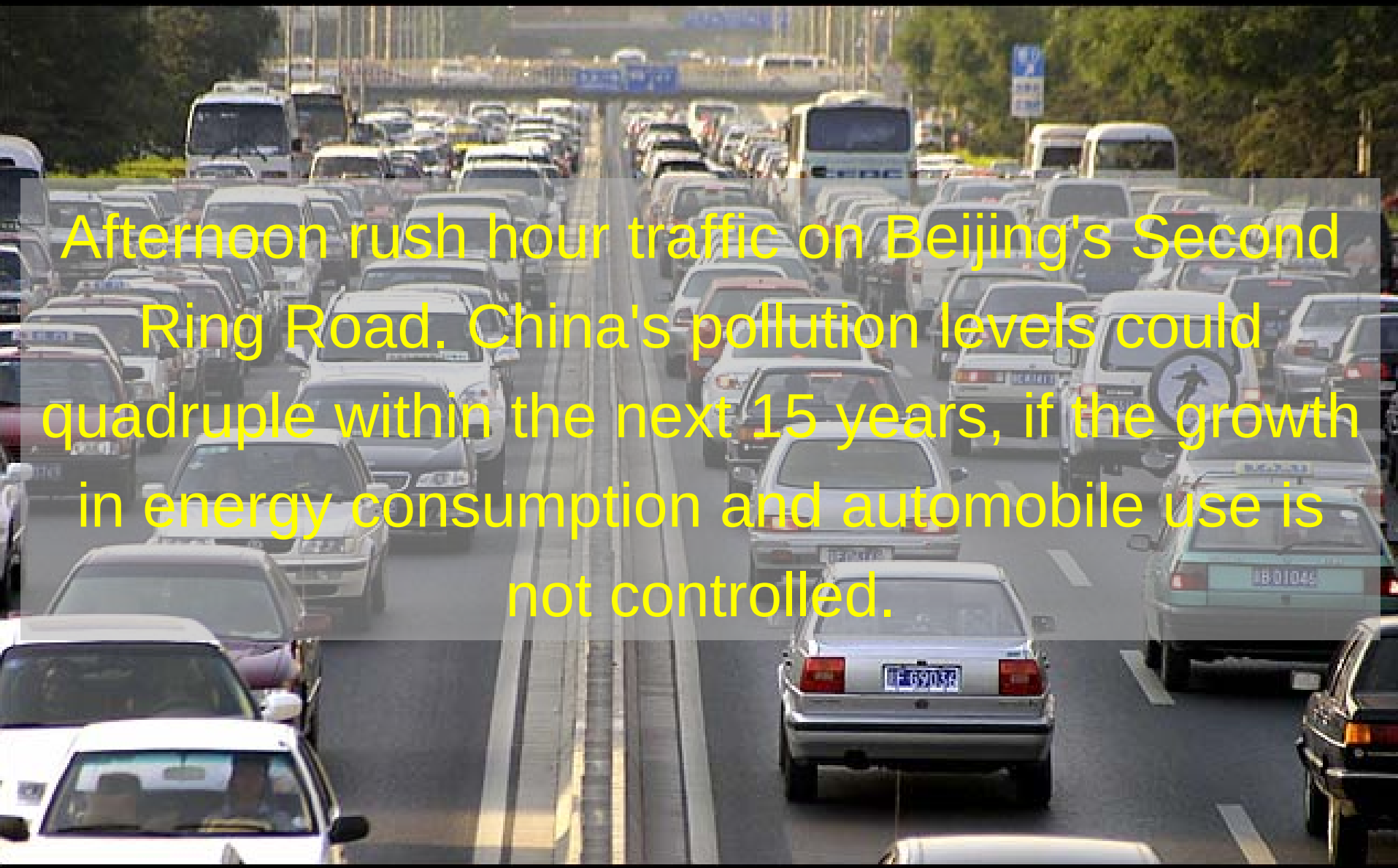
1) Conservation: maximize energy efficiency and minimize energy use, while insuring economic prosperity

2) Provide incentives to develop new sources of clean energy


GDP vs. Energy Efficiency
(Top 40 Economies by GDP)
$45,000
$30,000
$15,000
$0
GDP per capita
Highly Productive
Moderately Productive
Low Productivity
US
G7
China
South & East Asia
US
Canada
Belgium
Australia
Netherlands
Sweden
Japan
UK
Germany
France
Italy
Switzerland
Hong Kong
Austria
Taiwan
Spain
Greece
South Korea
Saudi Arabia
Russia
Ukraine
Poland
S. Africa
Mexico
Malaysia
Iran
Turkey
Egypt
Argentina
Thailand
Brazil
Algeria
Columbia
China
Indonesia
India
Pakistan
Vietnam
Philippines
Bangladesh
$0.00
$160.00
$320.00
$480.00
Energy Inefficient
Moderately Energy Efficient
Highly Energy Efficient
Energy Efficiency (GDP per Million Btu)

Externalities associated with China's transportation growth

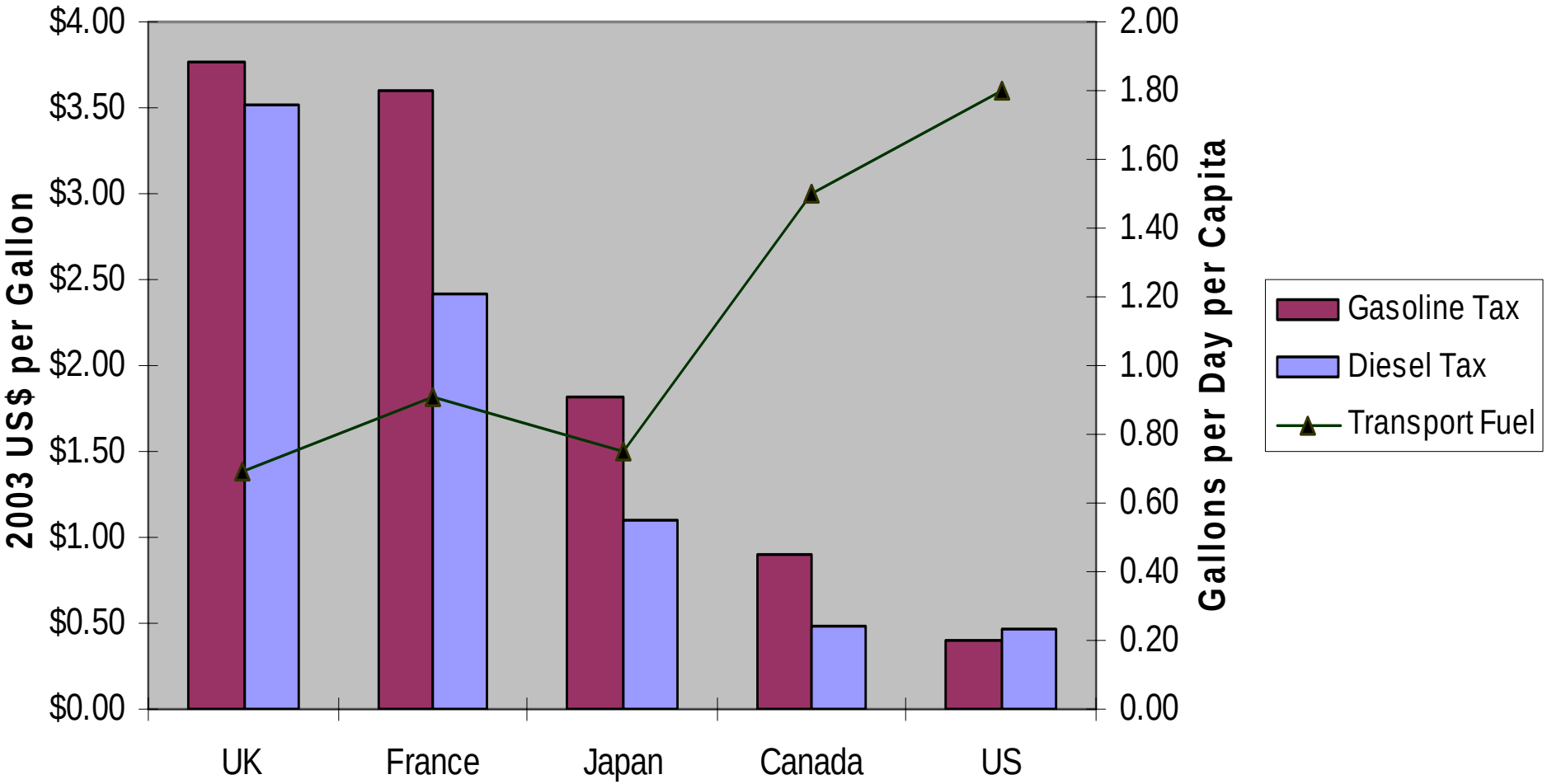




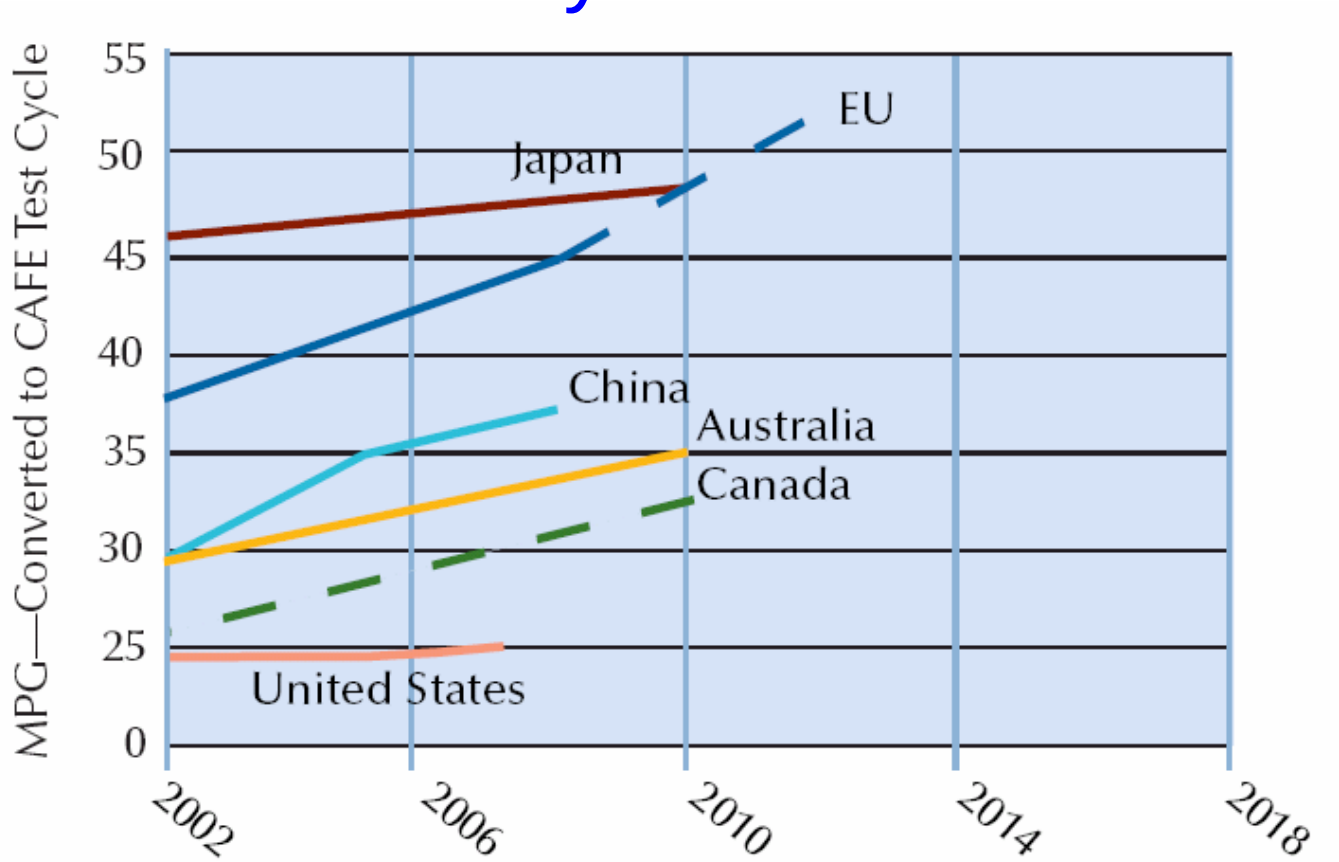
Afternoon rush hour traffic on Beijing's Second Ring Road. China's pollution levels could quadruple within the next 15 years, if the growth in energy consumption and automobile use is not controlled.

Associated Press photo

Taxation and fuel consumption



Higher cost of gas is correlated with fuel efficiency of automobiles



Control of automobile usage and efficiency requires both control by regulations and cost dis-incentives (tax on gas and large car purchases)

Traffic congestion in cities can not be solved by more roads alone. Note the relative congestion of light rail, buses and cars

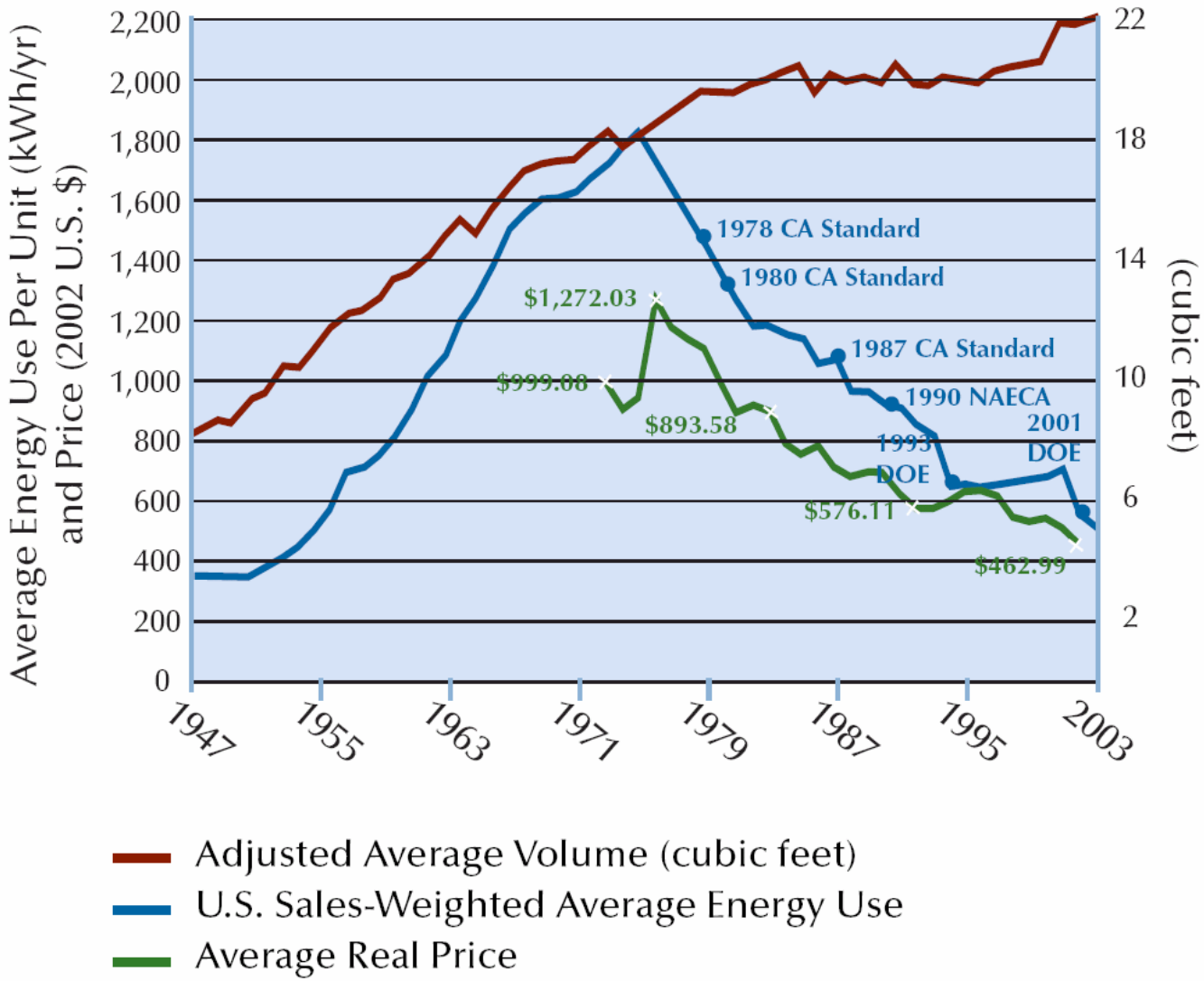
Three options to mass transit with large variations in cost.

Bus rapid transit

Subway

Light rail

Regulation stimulates technology: Refrigerator efficiency standards and performance. The *expectation* of efficiency standards also stimulated industry innovation



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California utility companies now urge and help their customers conserve electricity

Profit to utility companies was decoupled from the amount of energy sold.

- Initially, US electric utility industry were a regulated monopolies where rate-of-return on investments was set by regulatory agencies. Utility companies promoted the use of energy to maximize profits.

- Environmental regulations and disallowances of investments by state regulators of nuclear power generation created financial stresses in utility companies.

- "Least-cost Planning" is in place. Energy conservation decreases the need to build more power generating plants. Fair return of investment is guaranteed.

My concerns about the current California utility system

- Changes in the cost of fuel are passed through to the consumer

(Compromises incentives to the utilities companies to be more energy efficient)

- There are no incentives for utility companies to invest in long term research

- The electricity generation and distribution industry is becoming in danger of becoming more de-integrated.

Micro-economics forces to maximize profits might encourage companies to stimulate higher energy usage by selling more energy intensive “services”.

International Energy Agency (IEA) Carbon Emission forecast

Between 2003-2030:

New Coal Plants = 1.4 TW

New Natural Gas Plants = 1.9 TW

Carbon emission in the next 30 years will add 3x more CO_2 emission than the previous 250 years!

Energy from tar sands, shale oil, methane hydrates … will be as bad as coal for greenhouse gas emissions.

Limiting CO_2 is the biggest economic problem

- A carbon tax or carbon cap is needed
- Clear signals should be given that a tax or cap ***will occur*** so that companies can plan.
- Private (industrial) and public investments in renewable sources must be encouraged.
- Progressive changes in the carbon tax/cap should be initiated to stimulate research and development of alternative solutions.

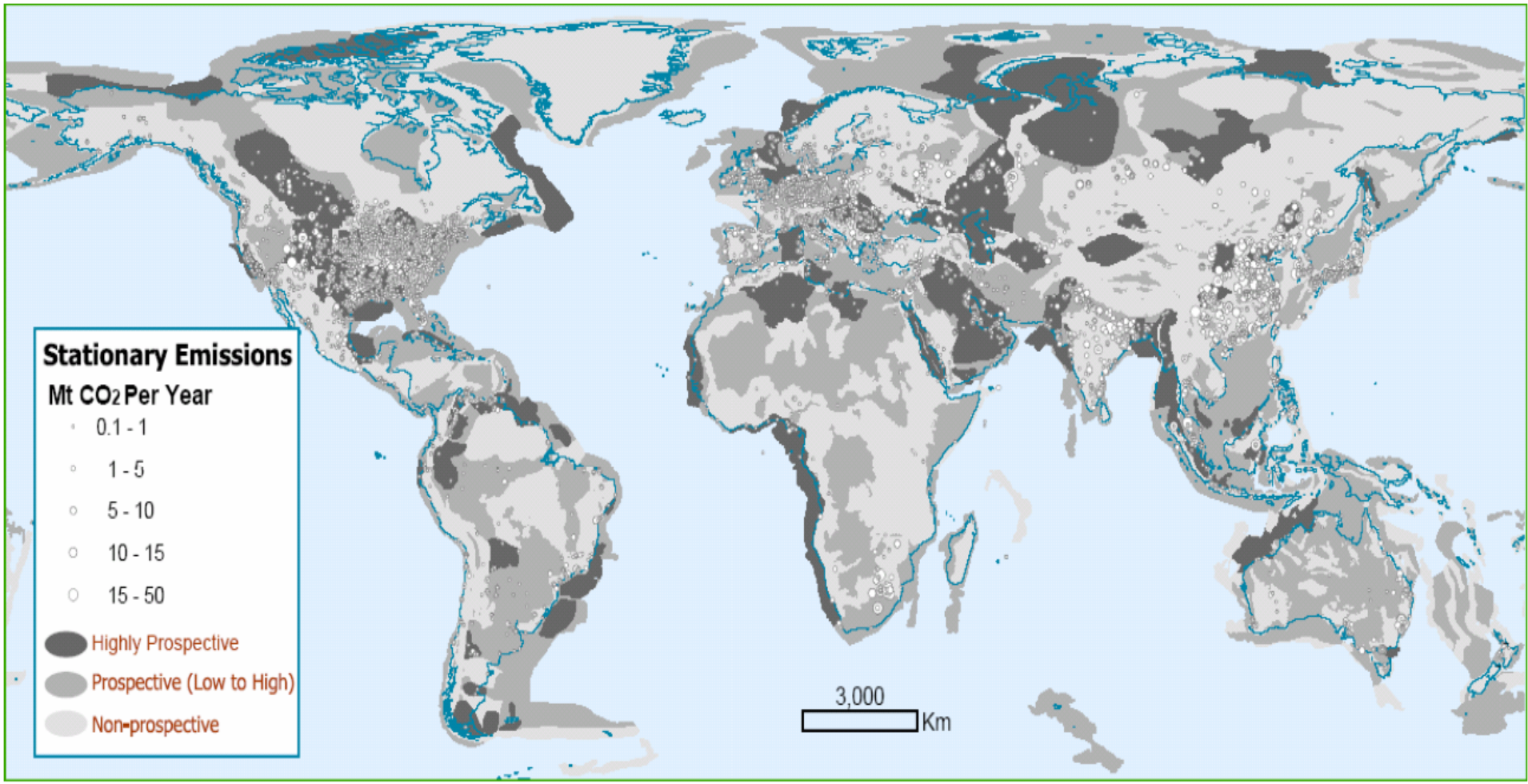
Carbon Sequestration needs more research

- Long term storage and environmental safety are yet to be proven.

- Cost is also an issue! Using present technology, sequestration costs are $100 - 300/ton of avoided carbon emissions.

- The US Department of Energy has a target to reduce the cost of carbon sequestration to $10 or less per net ton of avoided emissions by 2015.

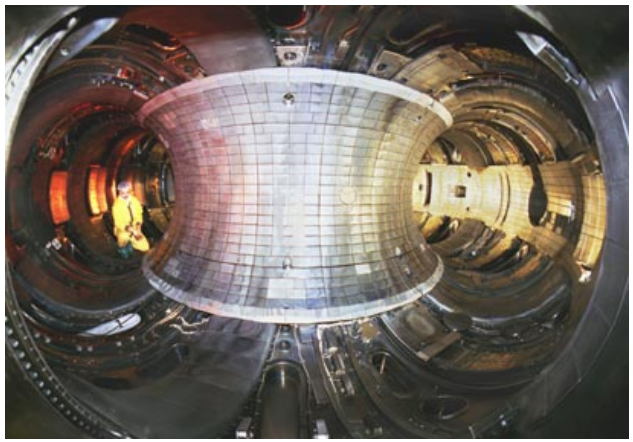
CO_2 emission sources and sedimentary basins with geological storage potential



Is large scale sequestration possible in China?

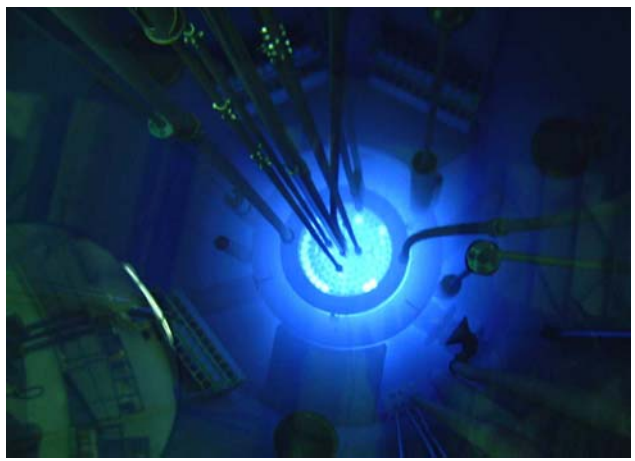
Potential Sources of Carbon Neutral Energy

1. Nuclear Fusion



Magnetic plasma confinement or inertial fusion. At least 40 - 50 years in the future

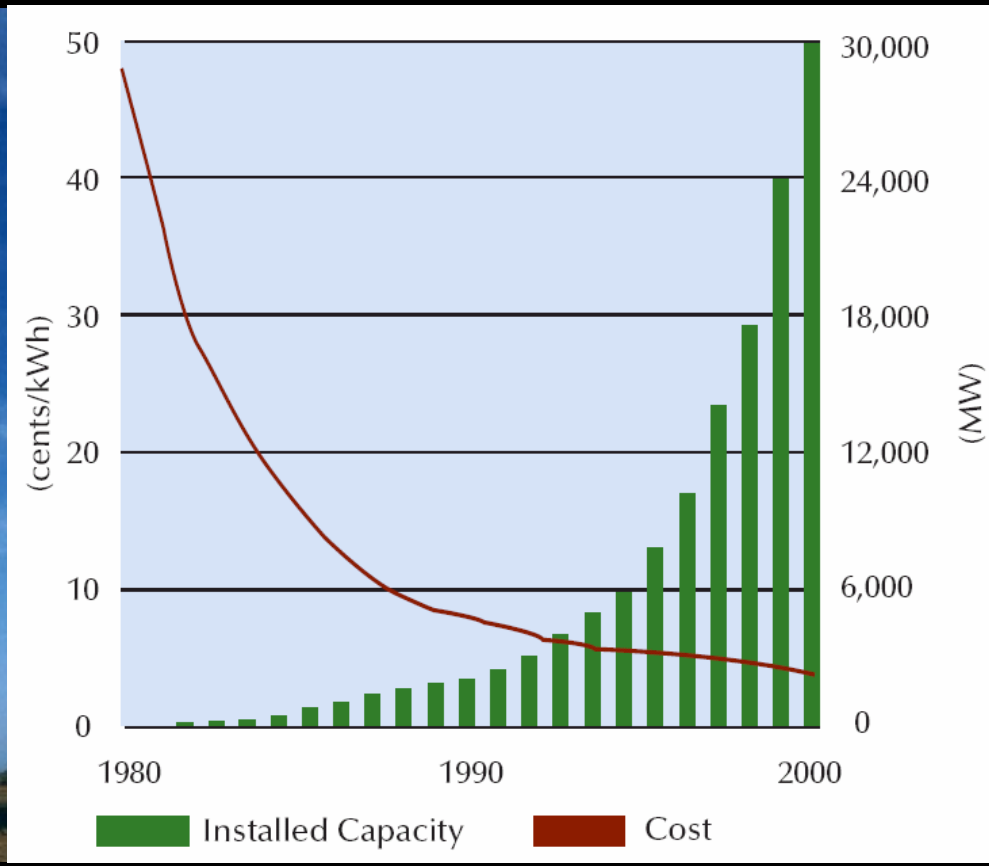
2. Nuclear Fission



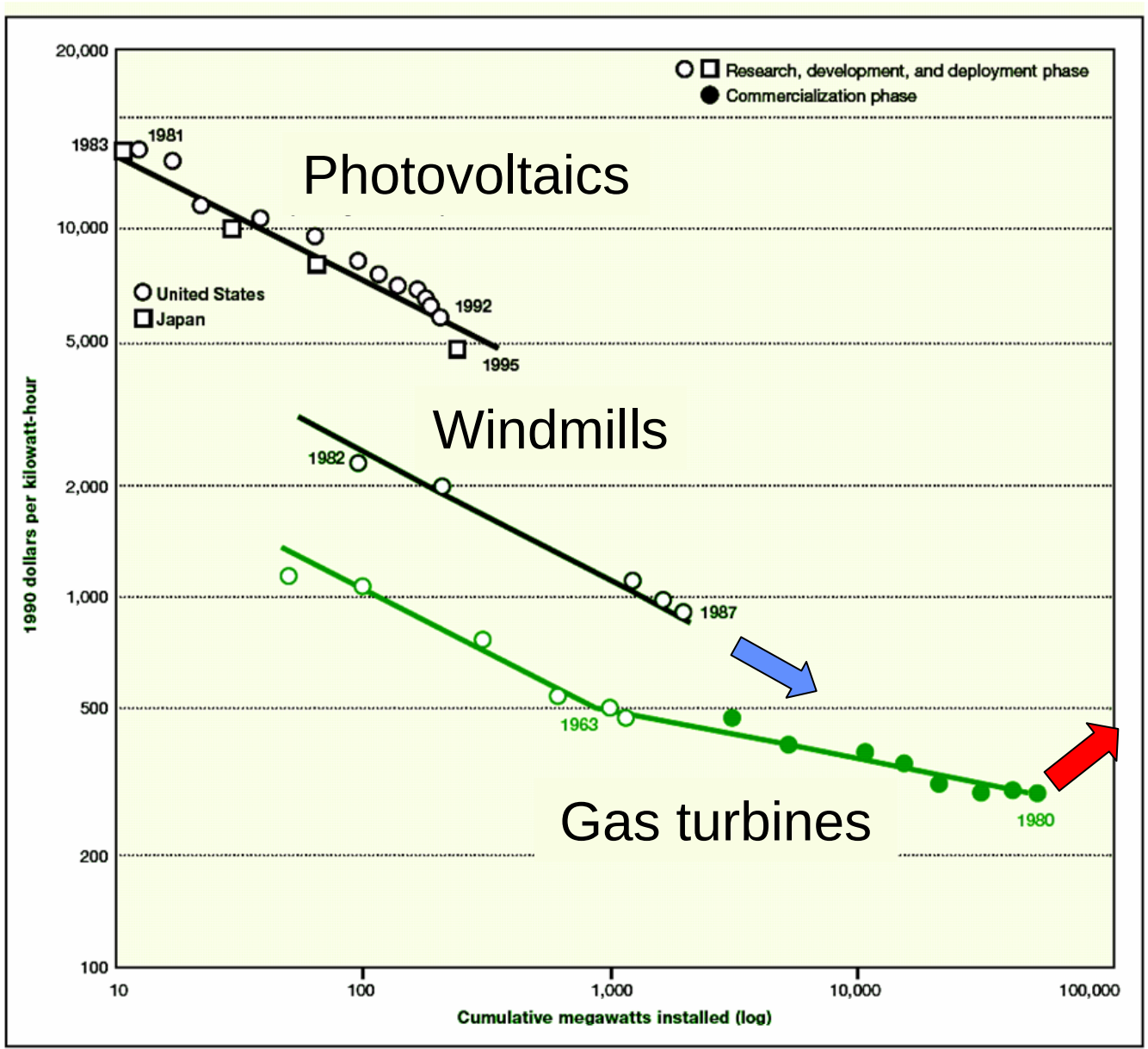
Waste and Nuclear Proliferation

3 TW = One new GW reactor every week for the next 50 years)

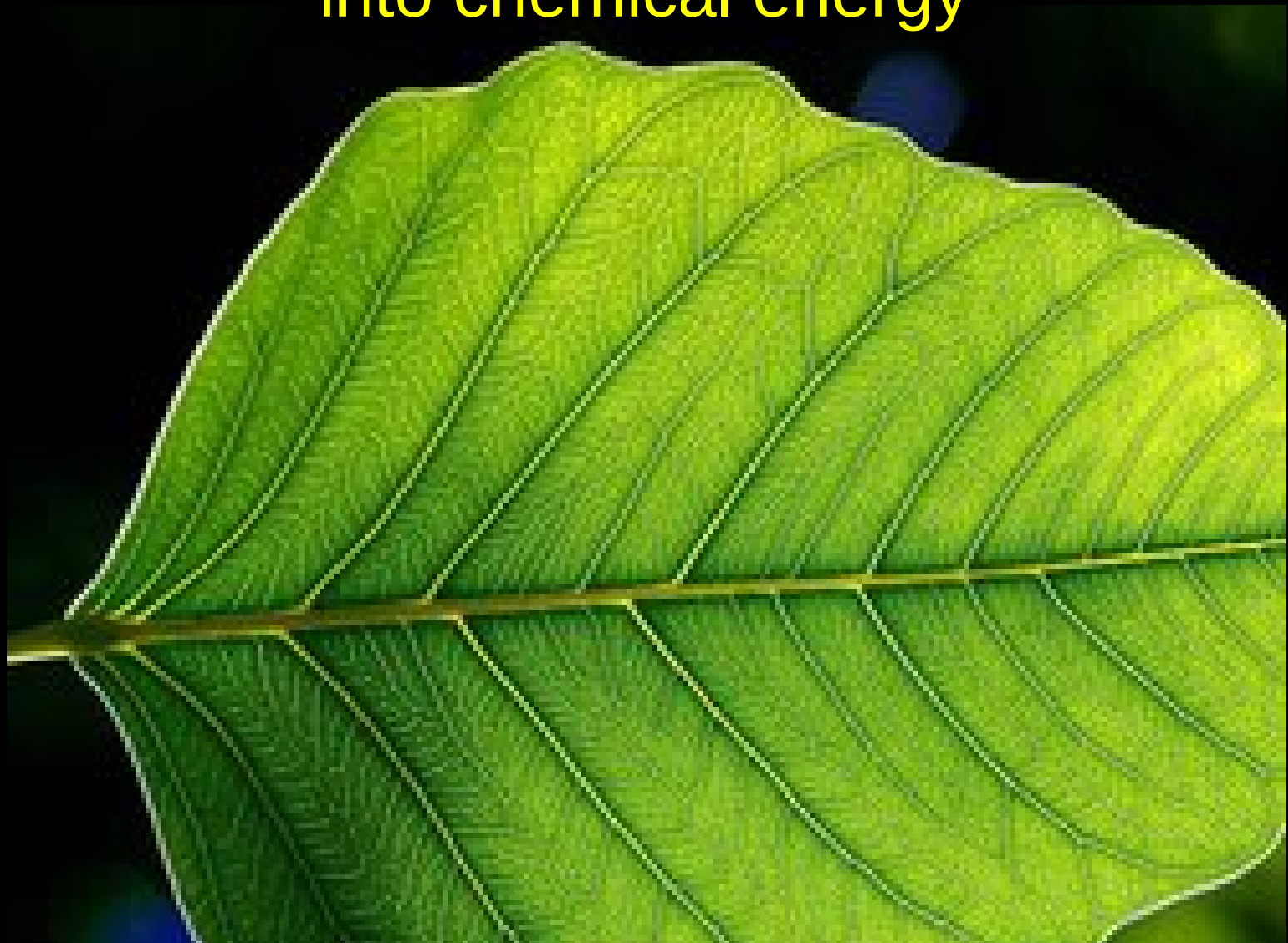
Tax incentives and rebates were essential to stimulate continued development of power generation from wind



Cost of electricity generation
(1990 dollars/kilowatt hour)



Photosynthesis: Nature has found a way to convert sunlight, CO_2, water and nutrients into chemical energy



The majority of a plant is structural material

Cellulose	40-60% Percent Dry Weight
Hemicellulose	20-40%
Lignin	10-25%

Sunlight

CO_2, H_2O,

Nutrients

→ Biomass →

Chemical energy

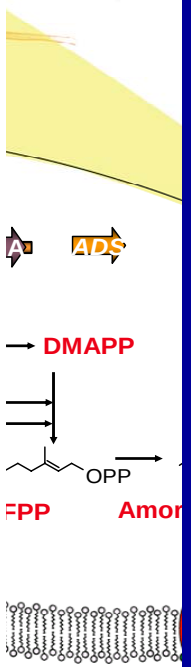
Self-fertilizing, drought and pest resistant

Improved conversion of cellulose into chemical fuel

Synthetic Biology:

Production of artemisinin in bacteria Jay Keasling

Can synthetic organisms be engineered to produce ethanol, methanol or methane from cellulose or directly from sunlight?



and International

National Concerns

1) National security which is intimately tied to energy security

2) Economic prosperity

3) The environment

Sustainable, CO_2 neutral energy

End

• The US phone system (AT&T) was a vertically integrated monopoly. Phone service was reliable and of moderate cost.

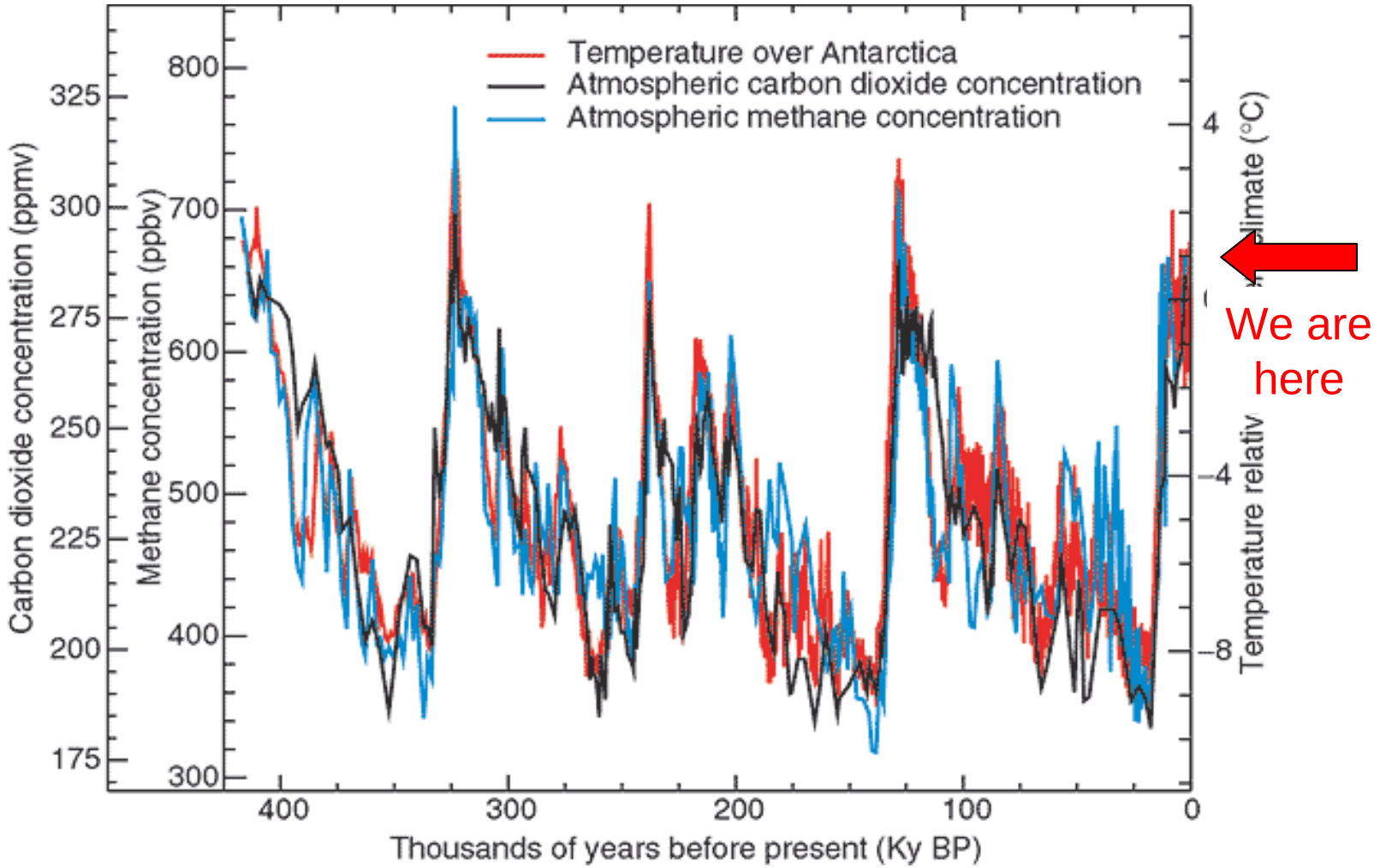
• Others wanted access to this market, claiming that competition would drive down prices.

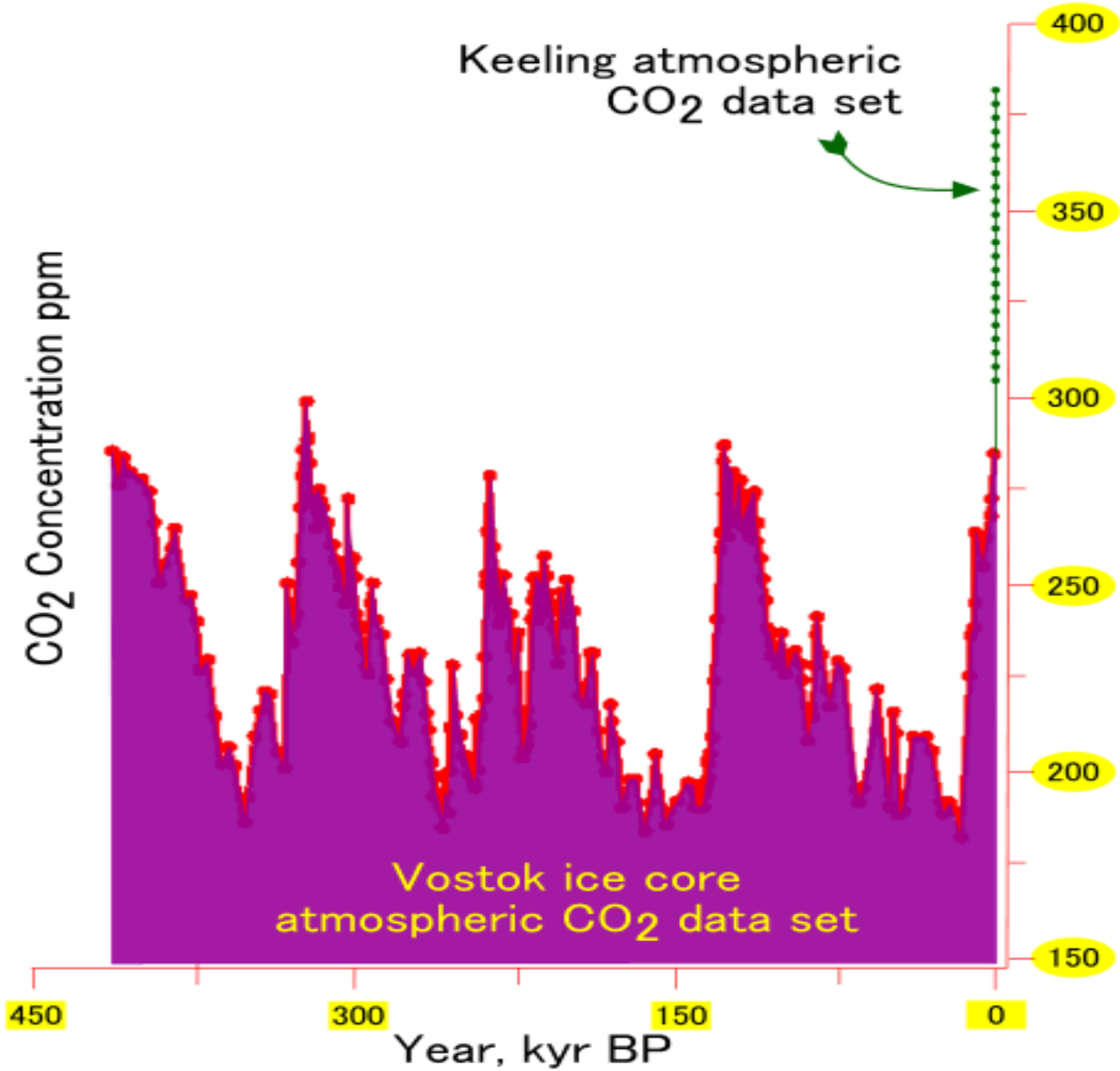
• 20 years later our total phone bills are much higher due to competition to promote higher usage (text messaging, photograph transmission over phone data channels, …

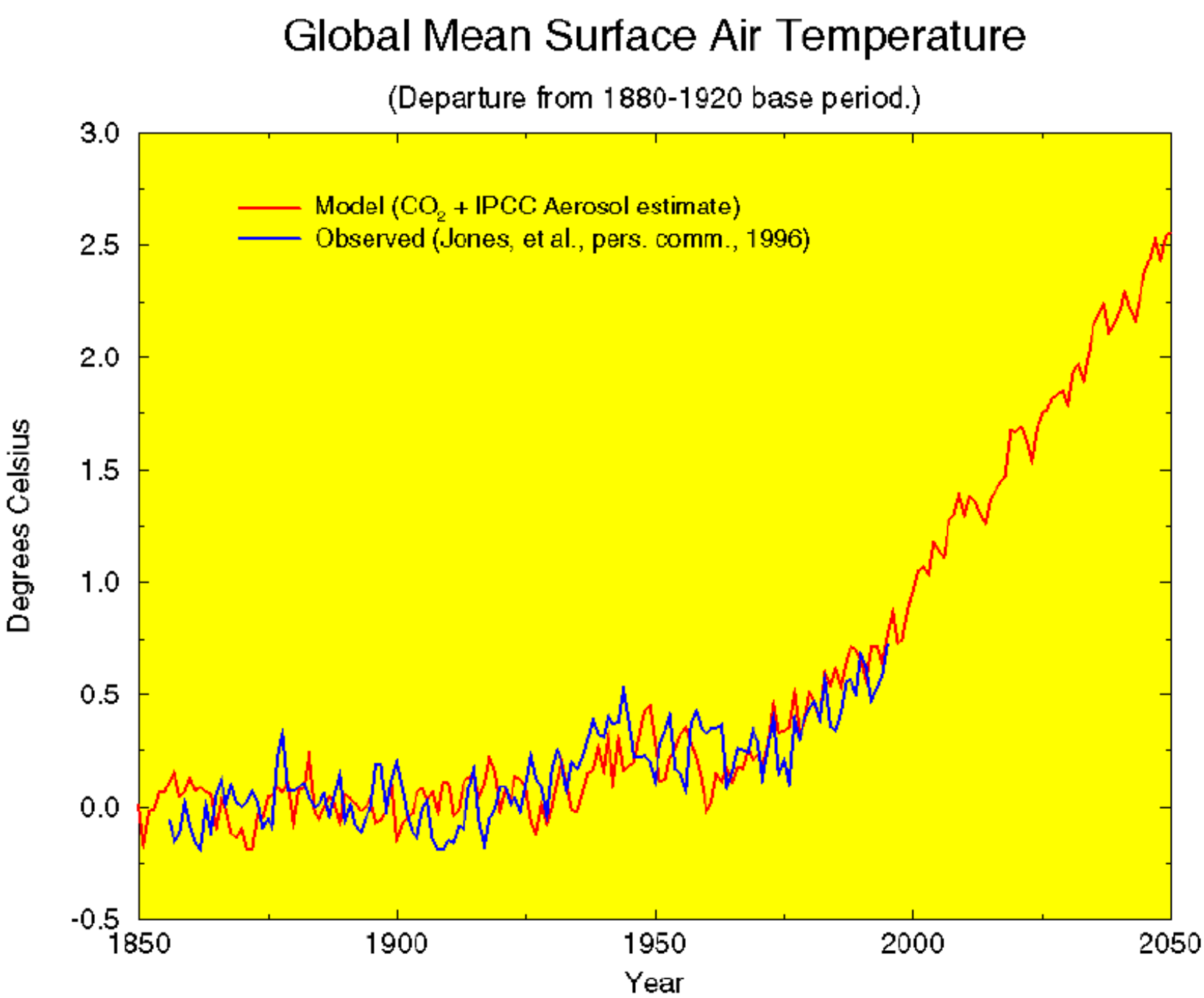
Telecom companies are reluctant to invest in long-term research

Temperature over the last 420,000 years

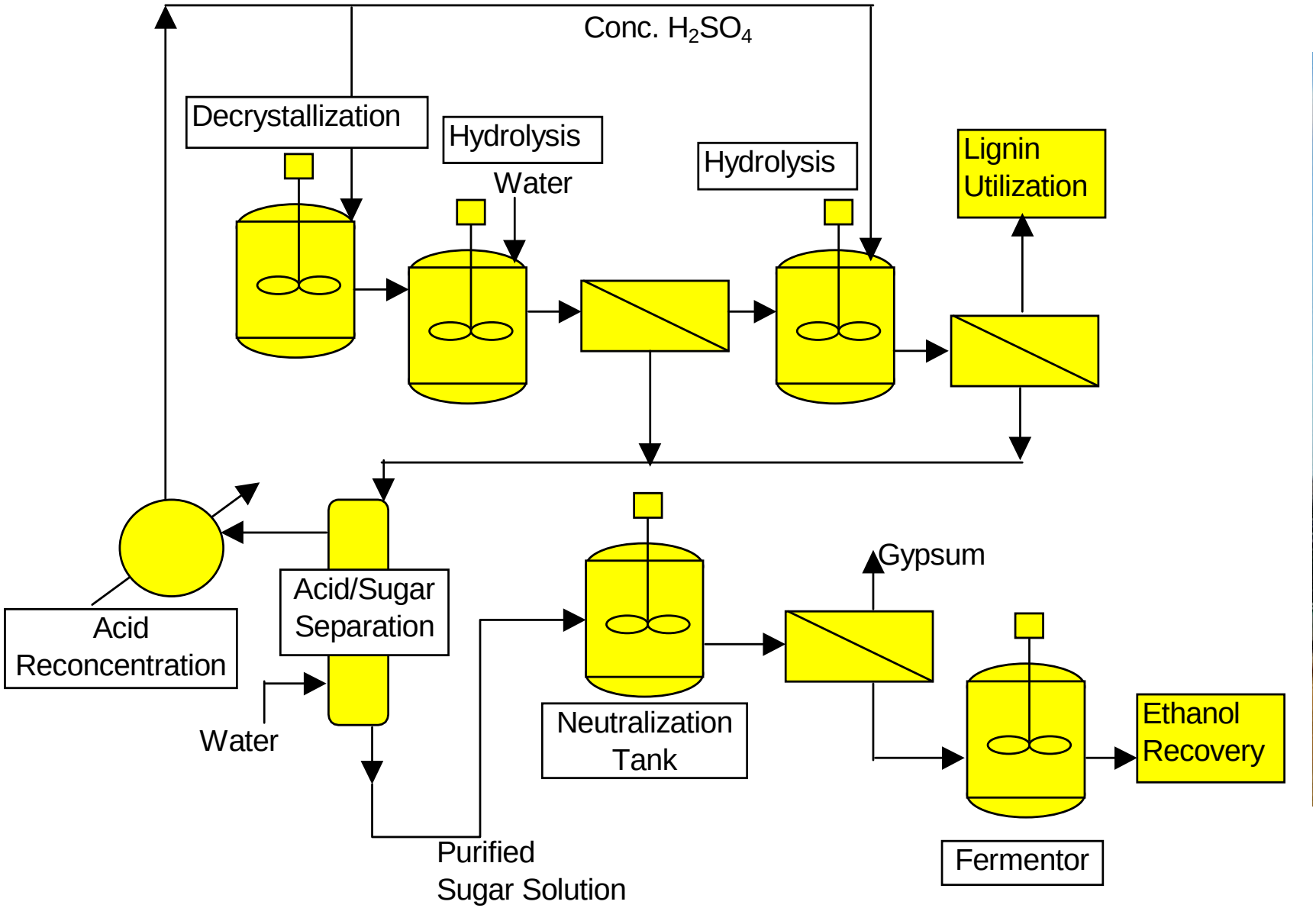
Source: Working Group I of the Intergovernmental Panel on Climate Change




Keeling atmospheric
CO2 data set
CO2 Concentration ppm
400
350
300
250
200
150
Vostok ice core
atmospheric CO2 data set
450
300
150
0
Year, kyr BP


Global Mean Surface Air Temperature
(Departure from 1880-1920 base period.)
Model (CO_2 + IPCC Aerosol estimate)
Observed (Jones, et al., pers. comm., 1996)
Degrees Celsius
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
1850
1900
1950
2000
2050
Year

Commercial ethanol production from cellulose



There are dangers in dividing “public good” services such as transportation and energy suppliers into micro-business sectors.

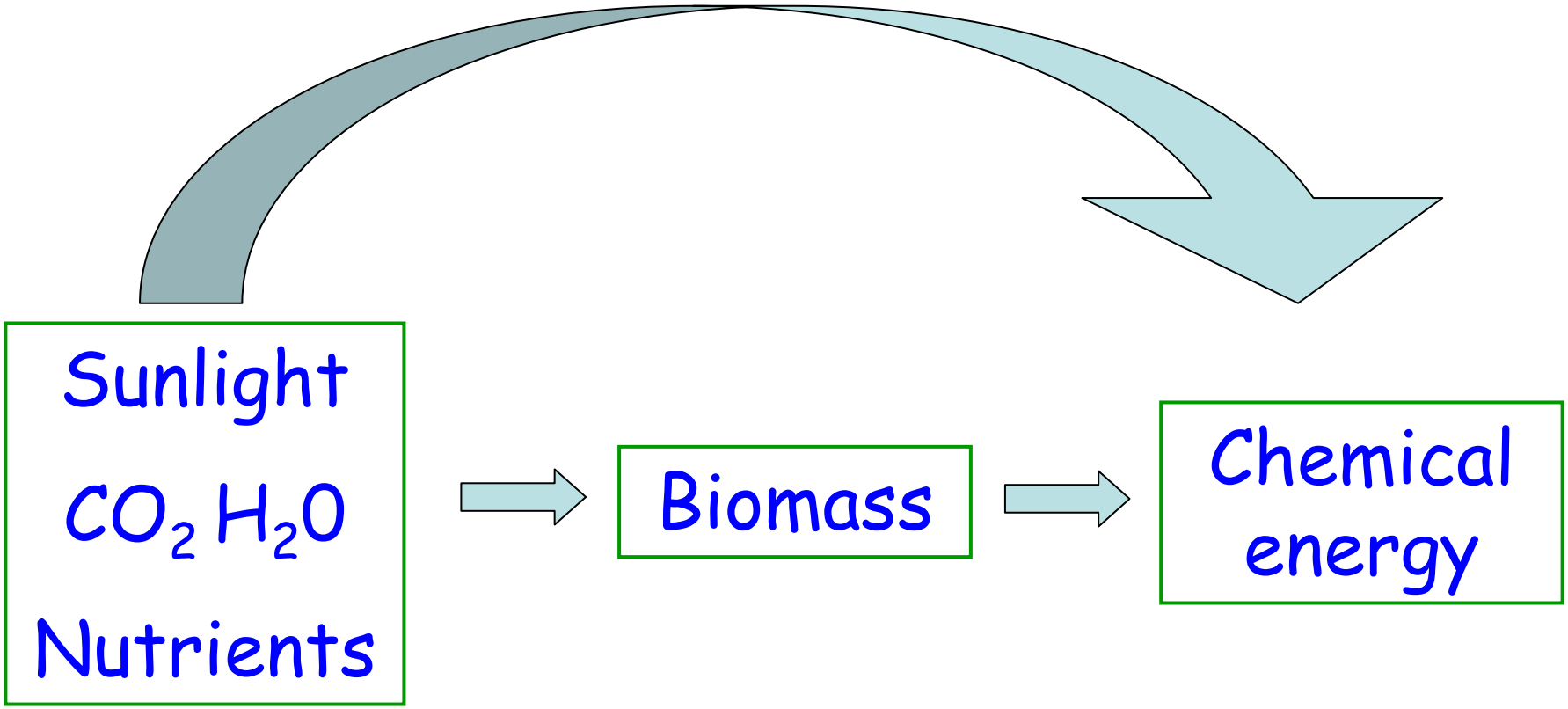
- A vertically integrated transportation system (monopoly) would provide incentives to optimize factors such as the cost of transportation energy, road construction, car use and efficiency, and mass transit.

- My predictions:

  Marketing bigger cars as **safer** cars would stop.

  Investments in mass transit would increase.

Can we modify existing organisms or design new ones to directly produce energy?



A diversified portfolio of investments is needed

A solution may lie at the interface of biology and the physical sciences at the nano-scale

Microbulbifer degradans

A group of microorganisms that degrades of a significant portion of the 50+ billion tons of cellulose