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Images Showing: All image sizes — Results **1** - **20** of about **37,200** for **larry page**. (**0.11** seconds)

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1/50 the number of hits,
< 1/10,000 the amount of $!

Larry

Serge

… So why am I here tonight, as a stand-in for Larry Page?

Feb. 5, 2007

Hi Steve,

Good to talk to you on the plane back from Davos. I noticed we are co-keynoting at AAAS. I'm speaking Saturday and you are on Friday night. If it is the same to you, it would be better for me to swap spots with you so …

Thanks,
--
-- Larry

Larry,

… As for the request, while I am willing to switch, there would be a lot of people who are arranging their schedules to hear you that would be greatly disappointed
to get me. ☺

Cheers,
Steve

[Larry]

If it is the same to you, I would love to switch. I'm sure people will be better off seeing you than me, and I'll get all the smart people who want to go to your talk ☺

Thanks, Larry

Dear Larry and Steve –

I checked overnight with those in AAAS management who might consider their oxen to have been gored, and my position that we should do whatever is necessary to pull off this switch was agreed to without dissent or fulmination …

Best,
John [Holdren]

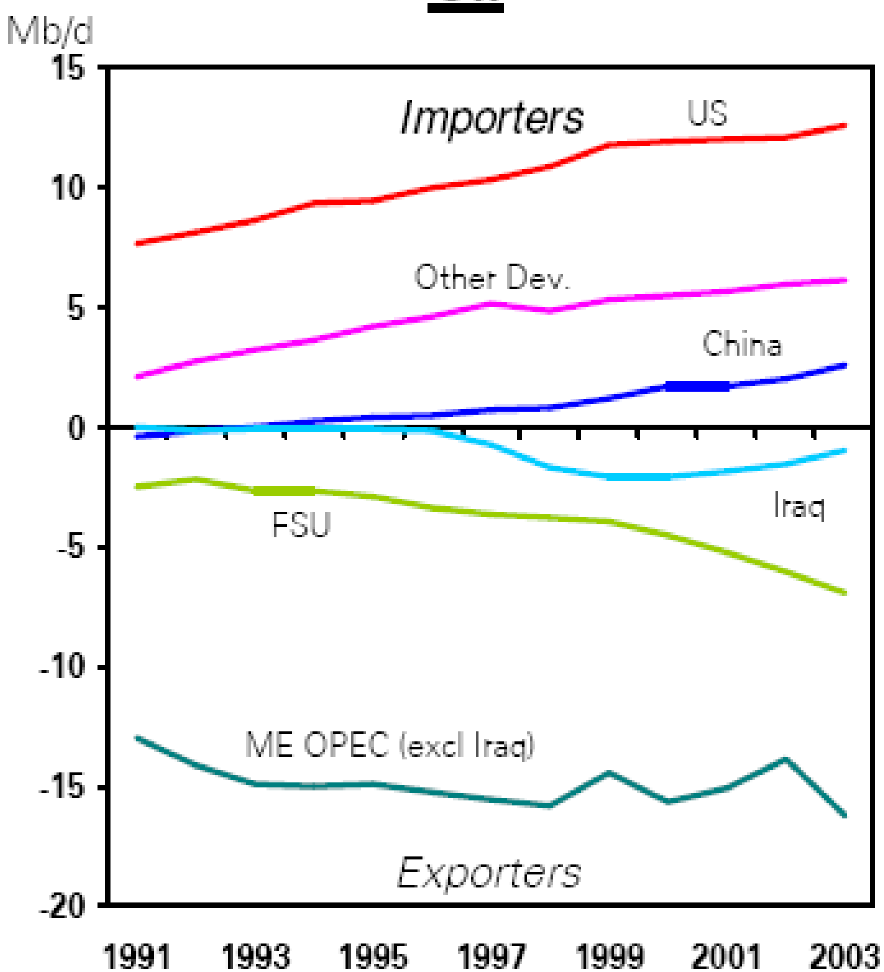
The energy problem and what we can do to solve it

AAAS Annual Meeting
San Francisco
15 - 19 February, 2007

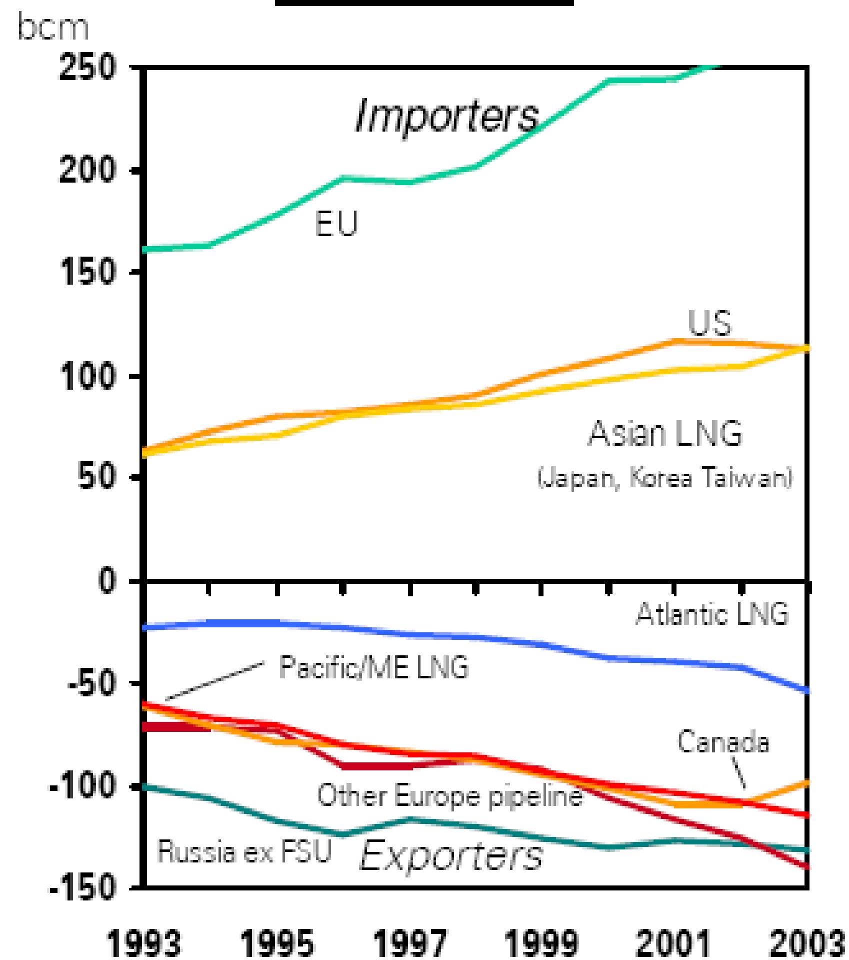
- National, international security and energy security
- Economic prosperity
- The Environment

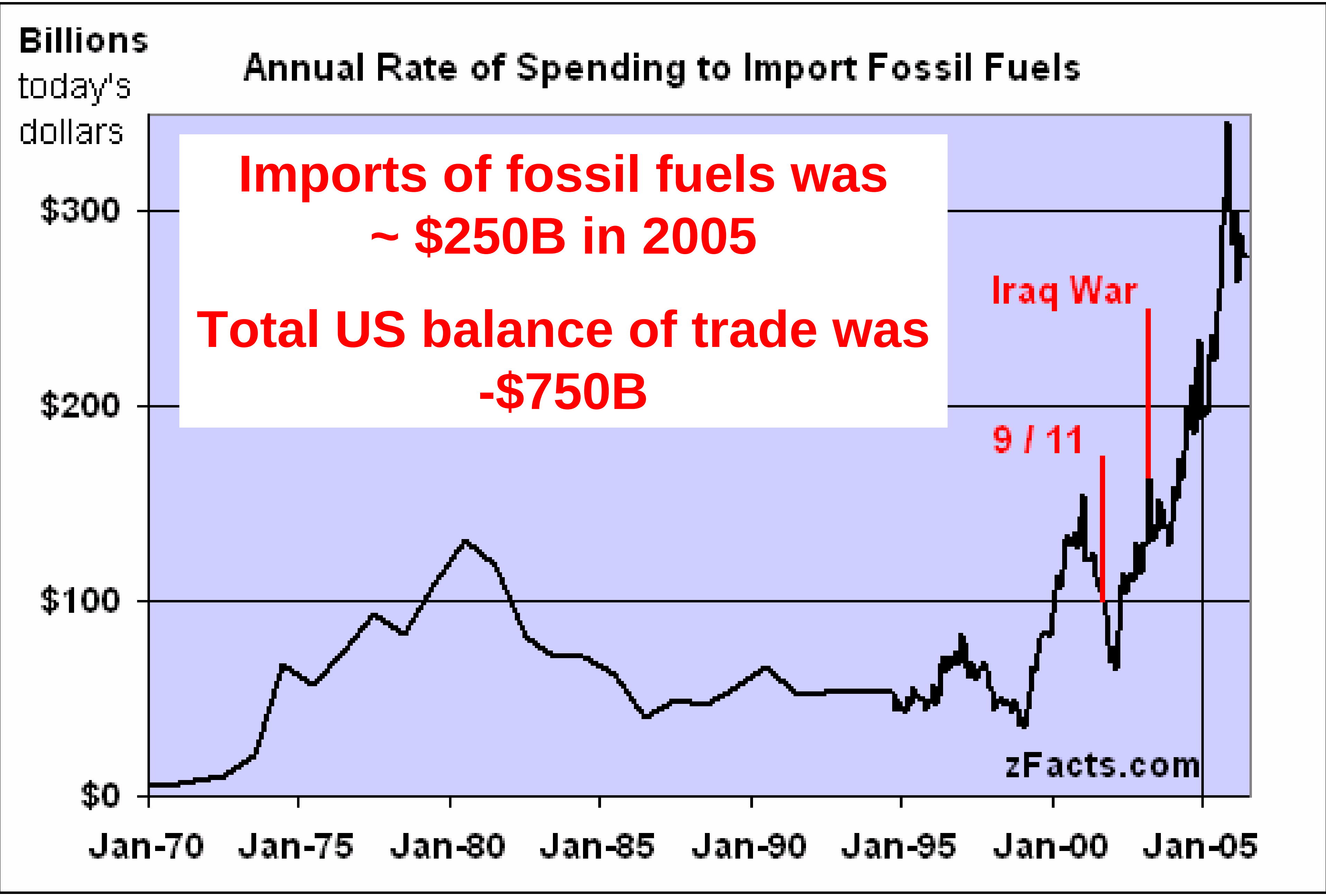
Energy security and energy dependency

Oil



Natural gas





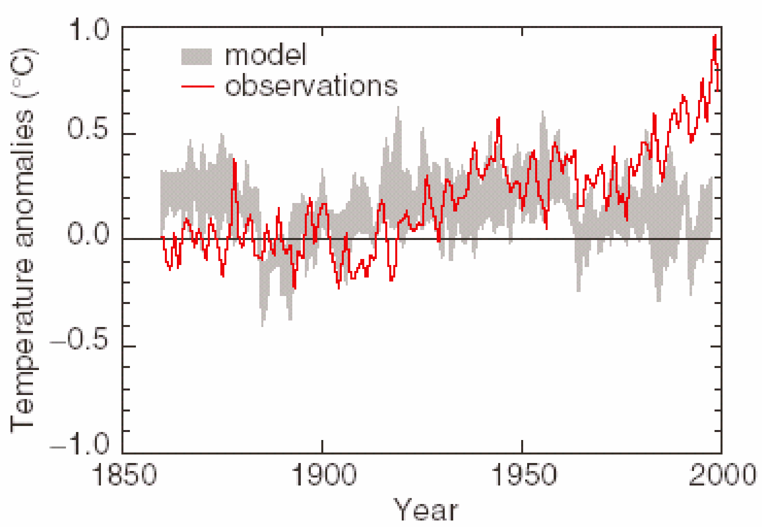
Billions today's dollars
Annual Rate of Spending to Import Fossil Fuels
Imports of fossil fuels was ~ $250B in 2005
Total US balance of trade was -$750B
Iraq War
9 / 11
$300
$200
$100
$0
Jan-70
Jan-75
Jan-80
Jan-85
Jan-90
Jan-95
Jan-00
Jan-05
zFacts.com

The Earth's climate is changing …

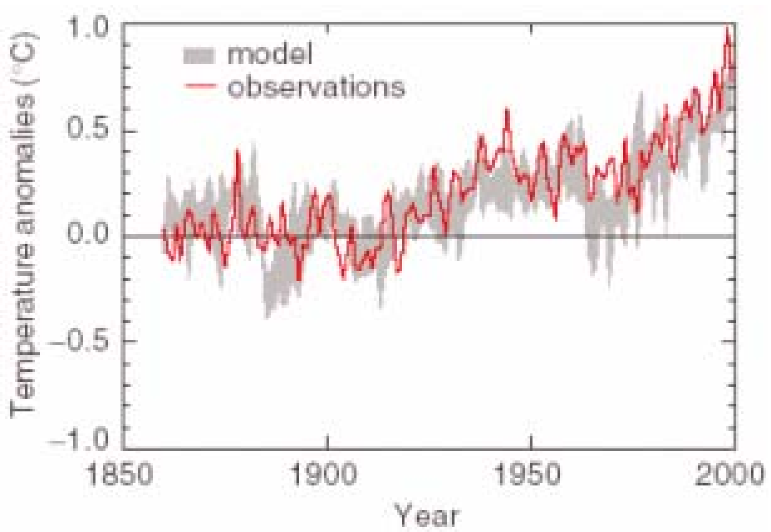
and there may be serious consequences.

Risk management is prudent and in our best long-term social and economic interests.

Temperature rise due to human emission of greenhouse gases



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



Climate change due to natural causes and human generated greenhouse gases

Emissions pathways, climate change, and impacts on California

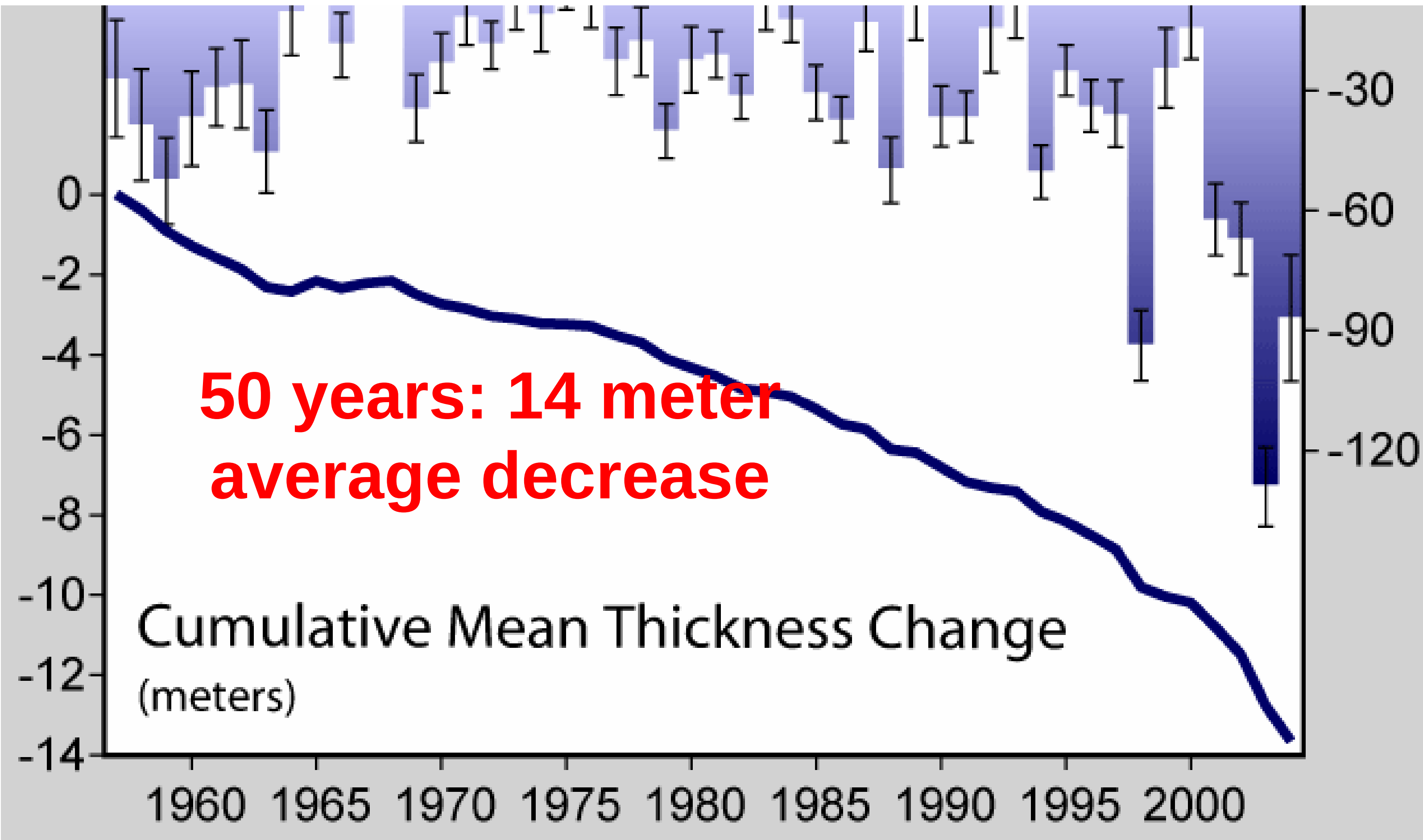
K. Hayhoea, et al., PNAS **101**, 12422 (2004)

Using two climate models that bracket most of the IPCC emissions scenarios:

	B1	A1 fi
Heat wave mortality:	**2-3x**	**5-7x**
Alpine/subalpine forests	**50–75%**	**75–90%**
Sierra snowpack	**30–70%**	**73–90%**

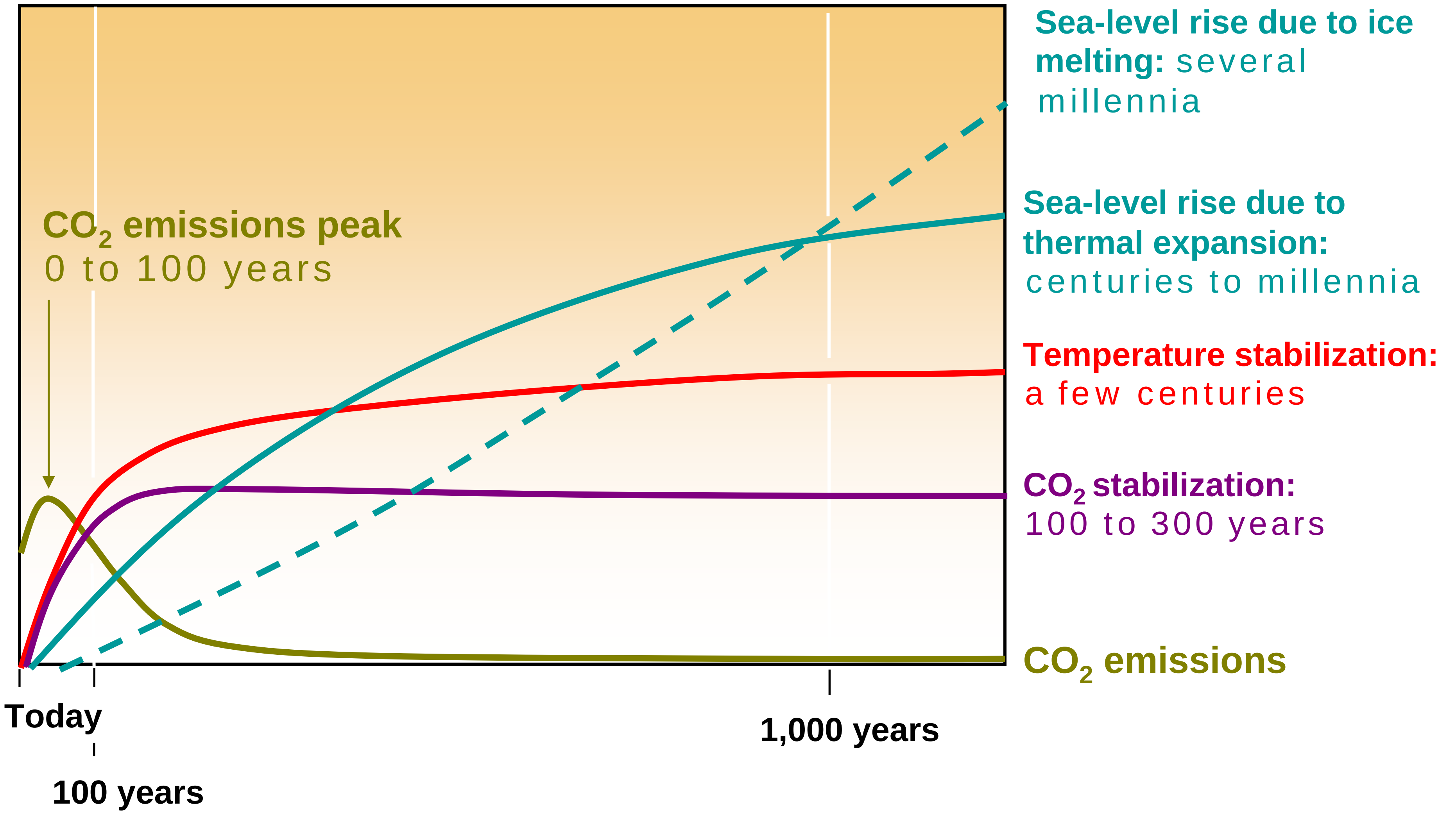
"…[this] could fundamentally disrupt California's water rights system."

Tibetan snow and glacial melt helps feed help feed ten of Asia's largest rivers, which bring freshwater to half of Earth's population.



Yellow River
Indus Basin
Ganga-Brahmaputra-Meghna Basin
Yangtze River
MONGOLIA
Ulaanbaatar
GOBI DESERT
CHINA
INDIA
NEPAL
BHUTAN
BURMA
LAOS
THAILAND
VIETNAM
CAMBODIA
TAIWAN
PHILIPPINES
SRI LANKA
JAPAN
NORTH KOREA
SOUTH KOREA
TAKLA MAKAN DESERT
KUNLUN MOUNTAINS
HIMALAYAS
TIEN SHAN
ALTAY MTS.
DECCAN
Mt Everest
Beijing
Tianjin
Jinan
Taiyuan
Qingdao
Lanzhou
Xi'an
Zhengzhou
Nanjing
Shanghai
Wuhan
Hangzhou
Chengdu
Chongqing
Changsha
Nanchang
Guiyang
Kunming
Guangzhou
Taipei
Hanoi
Vientiane
Bangkok
Phnom Penh
Ho Chi Minh City
Manila
Lhasa
Kathmandu
Thimphu
Dhaka
Kolkata (Calcutta)
New Delhi
Lucknow
Kanpur
Jaipur
Lahore
Islamabad
Kabul
Tashkent
Bishkek
Almaty
Dushanbe
Kashi
Nagpur
Hyderabad
Bangalore
Chennai (Madras)
Jaffna
Colombo
Mandalay
Hue
Seoul
P'yongyang
Dalian
Shenyang
Changchun
Baotou
East China Sea
South China Sea
Andaman Sea
Gulf of Thailand
Laccadive Sea
Bandar Seri Begawan

CO_2 Concentration, Temperature, and Sea Level will rise long after Emissions are Reduced

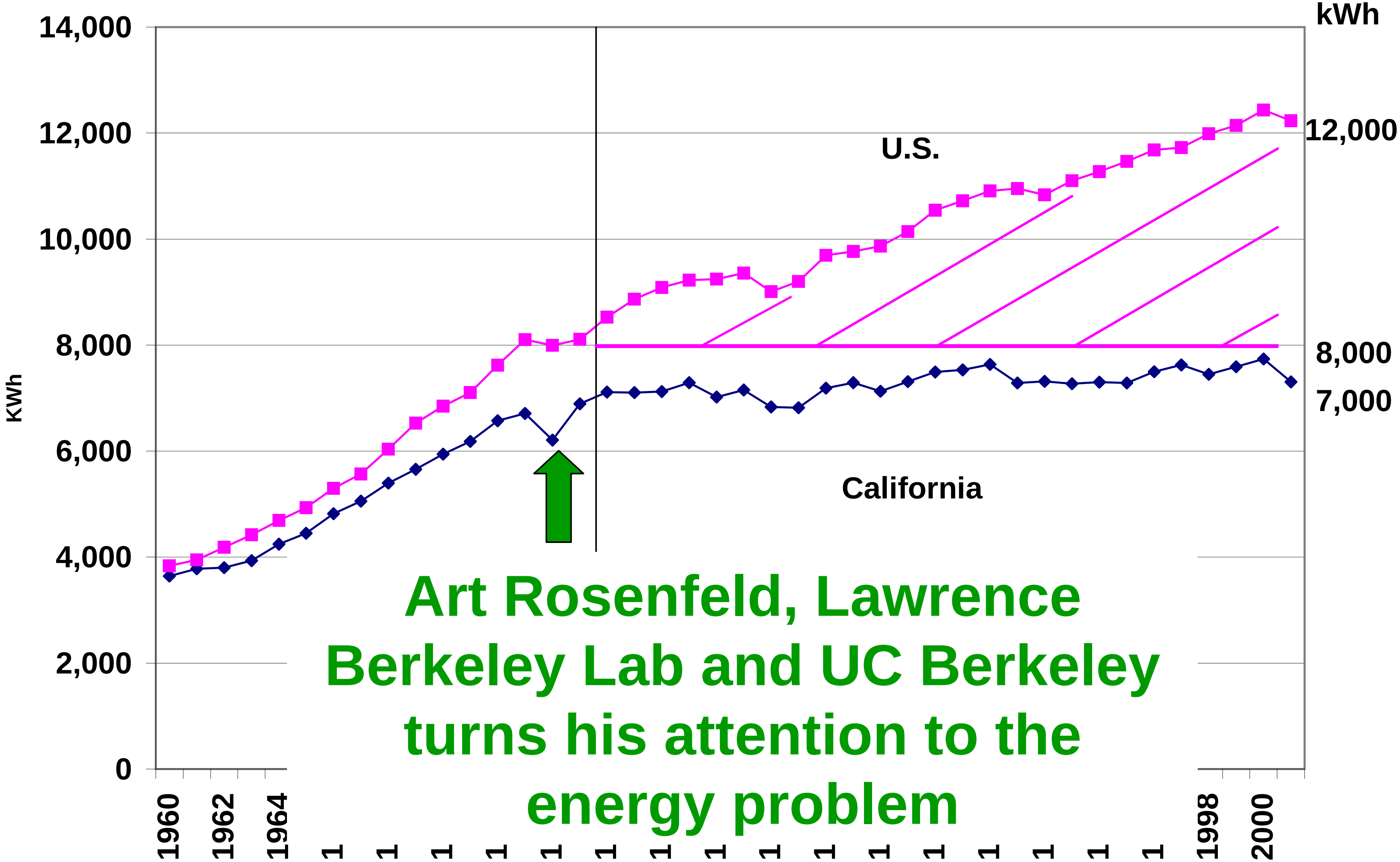


A dual strategy is needed to solve the energy problem:

1) Maximize energy efficiency and minimize energy use

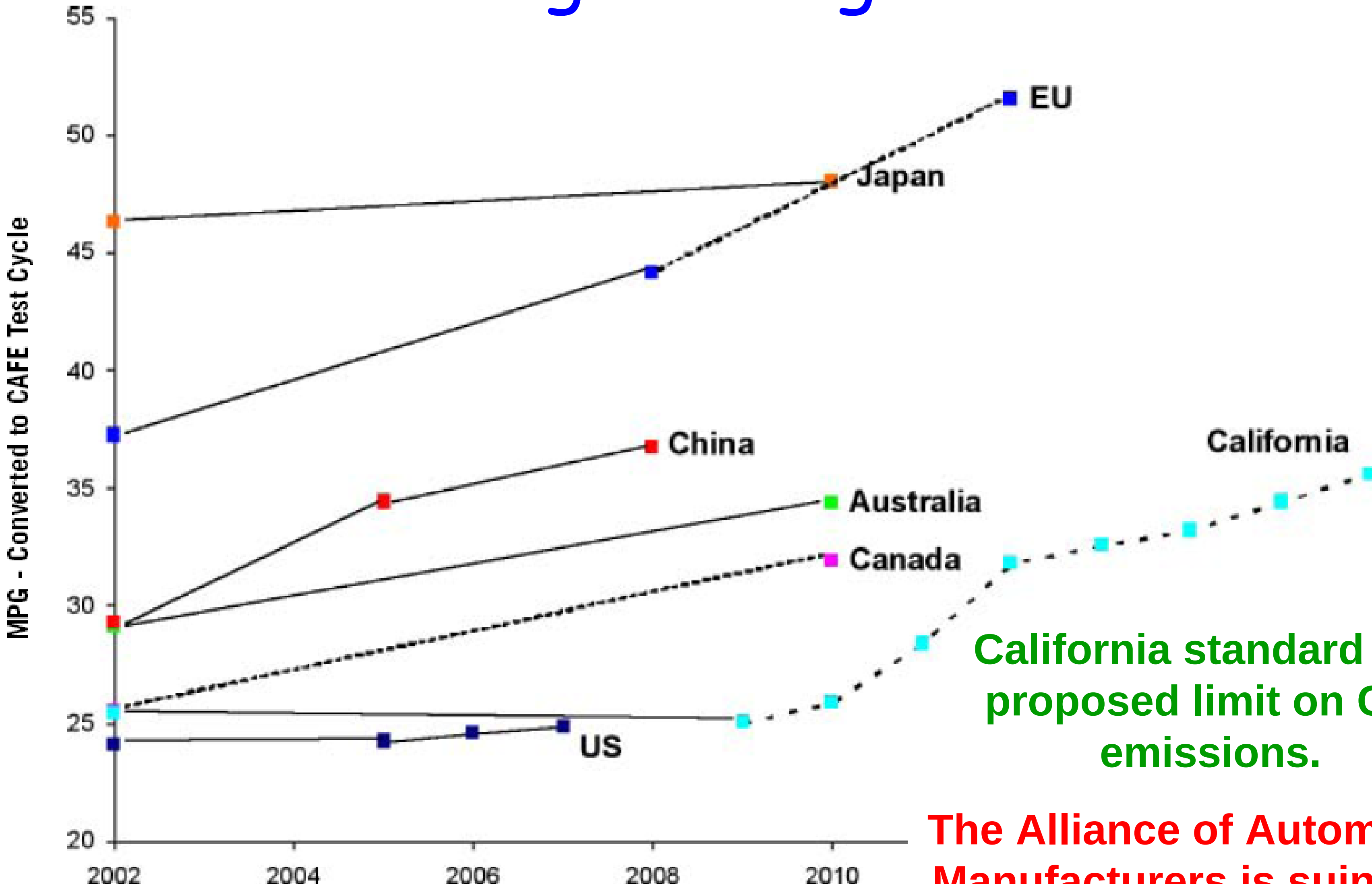
2) Develop new sources of clean energy

Electricity Consumption/person in the US and California



Art Rosenfeld, Lawrence Berkeley Lab and UC Berkeley turns his attention to the energy problem

Fleet average mileage standards

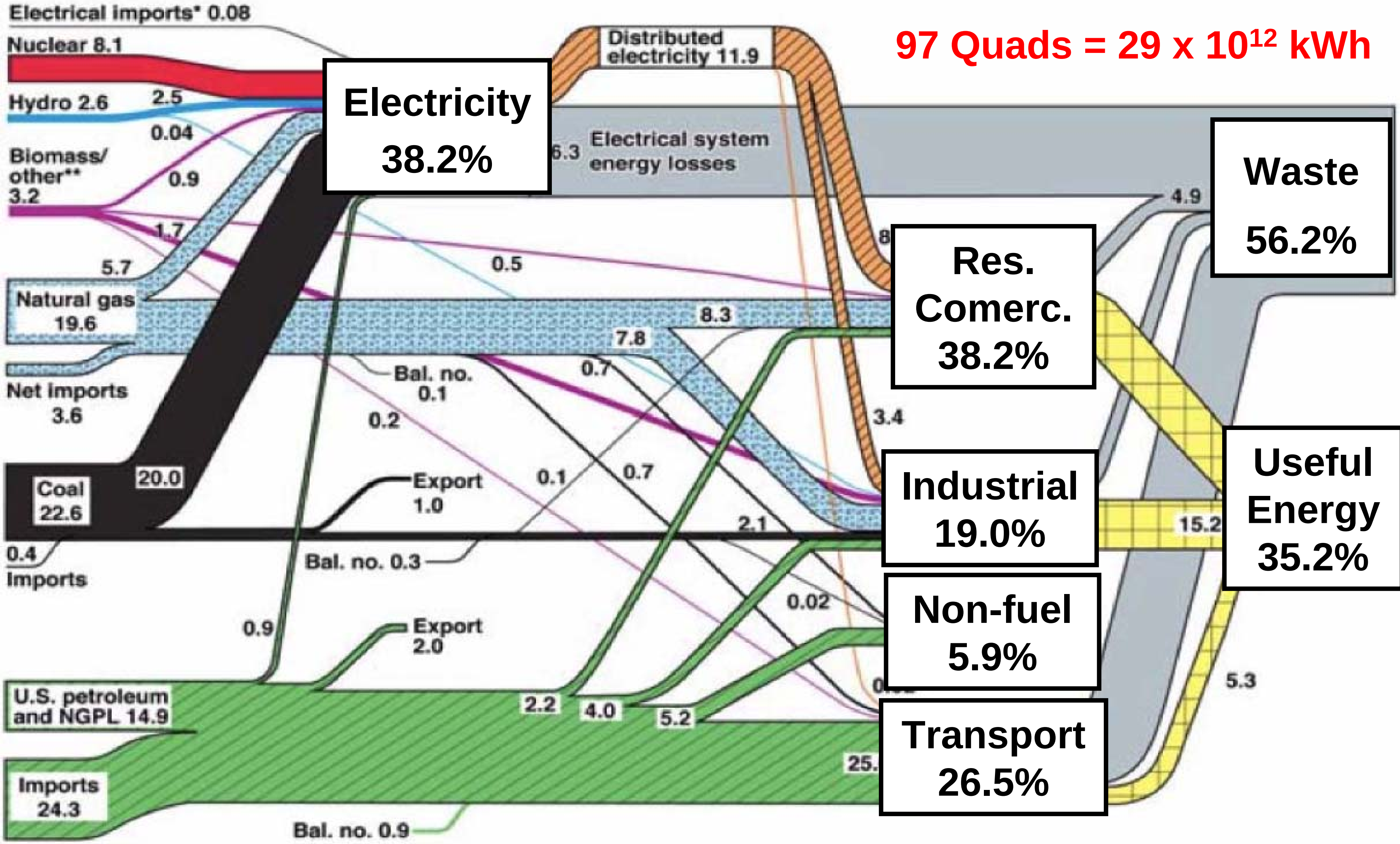


California standard is a proposed limit on CO_2 emissions.

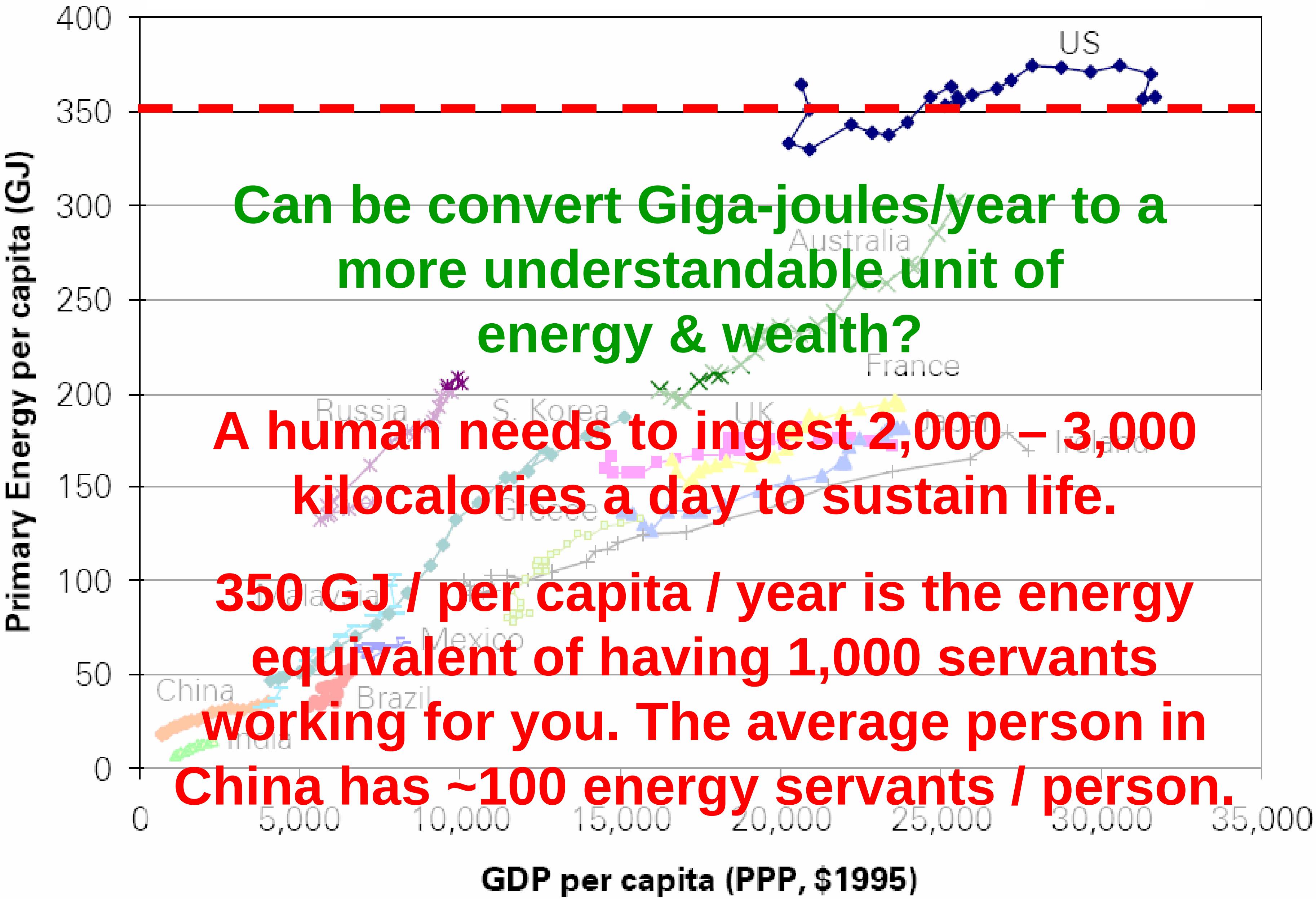
The Alliance of Automobile Manufacturers is suing CA

Notes: (1) dotted lines denote proposed standards
(2) MPG = miles per gallon

U.S. Energy Flow Trends – 2002
Net Primary Resource Consumption ~97 Quads



Energy demand vs. GDP per capita



Can be convert Giga-joules/year to a more understandable unit of energy & wealth?

A human needs to ingest 2,000 – 3,000 kilocalories a day to sustain life.

350 GJ / per capita / year is the energy equivalent of having 1,000 servants working for you. The average person in China has ~100 energy servants / person.

Source: UN and DOE EIA

Is it possible have the ***projected maximum*** world population at it live with a middle-class standard of OECD countries?

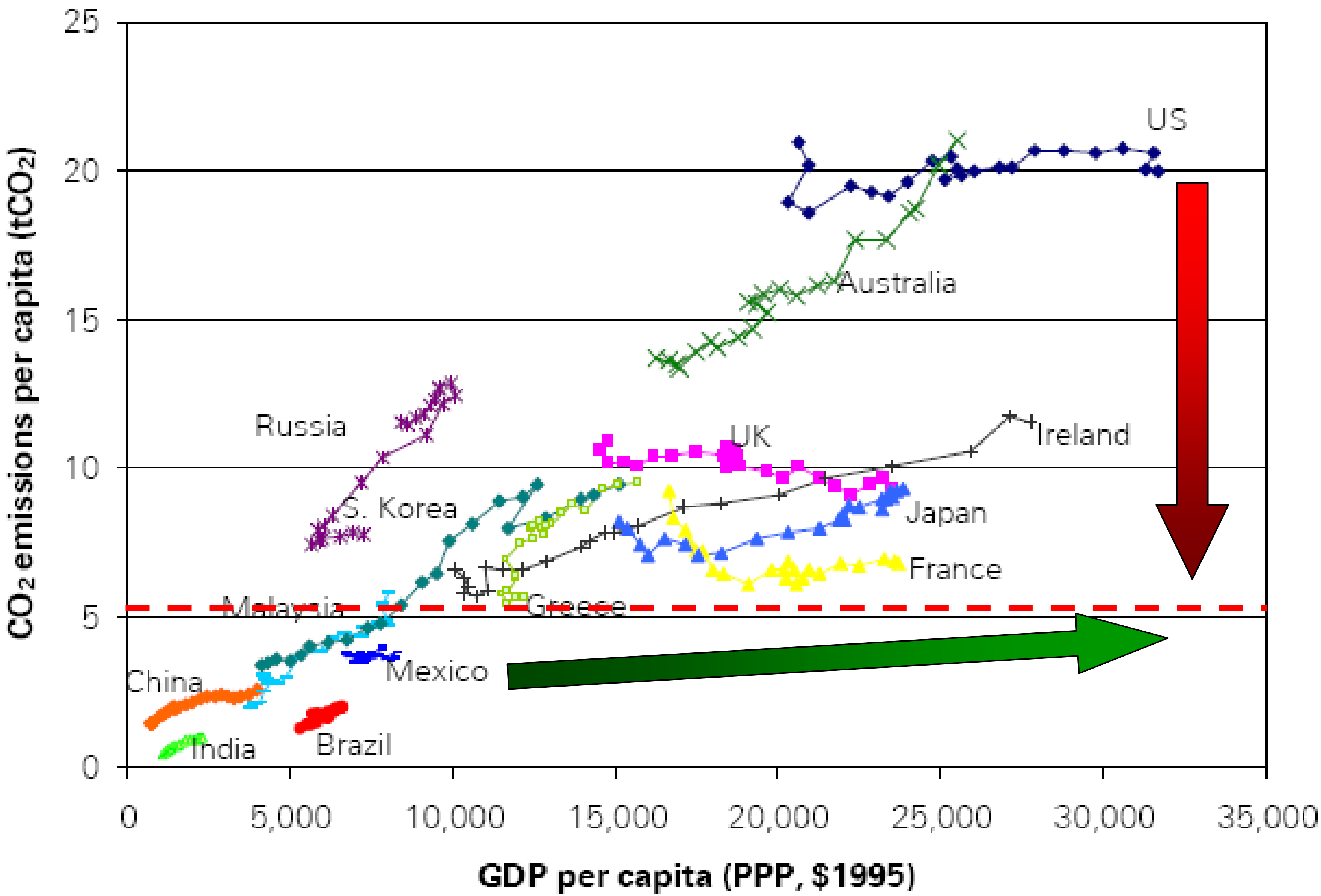
World population will peak at < 10^{10} people

US consumes ~10 -12 kW / person, EU ~ 5-6 kW

Suppose we learn to live with 3 - 4 kW/person
(~ 300 - 400 energy “servants”)
… or produce more energy “servants” that are carbon-neutral

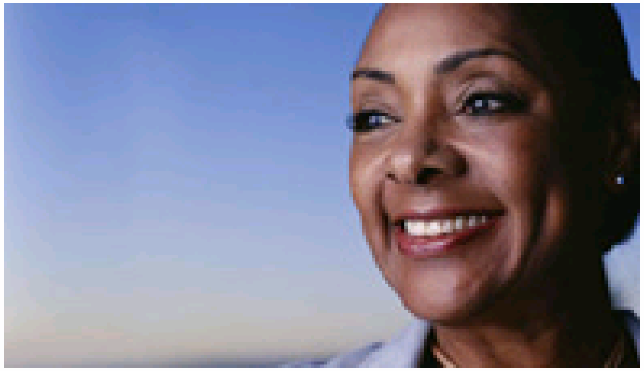
We will need to harness 0.04% of the solar power incident on the Earth

CO_2 emissions of selected countries



InterAcademy Council

About the IAC



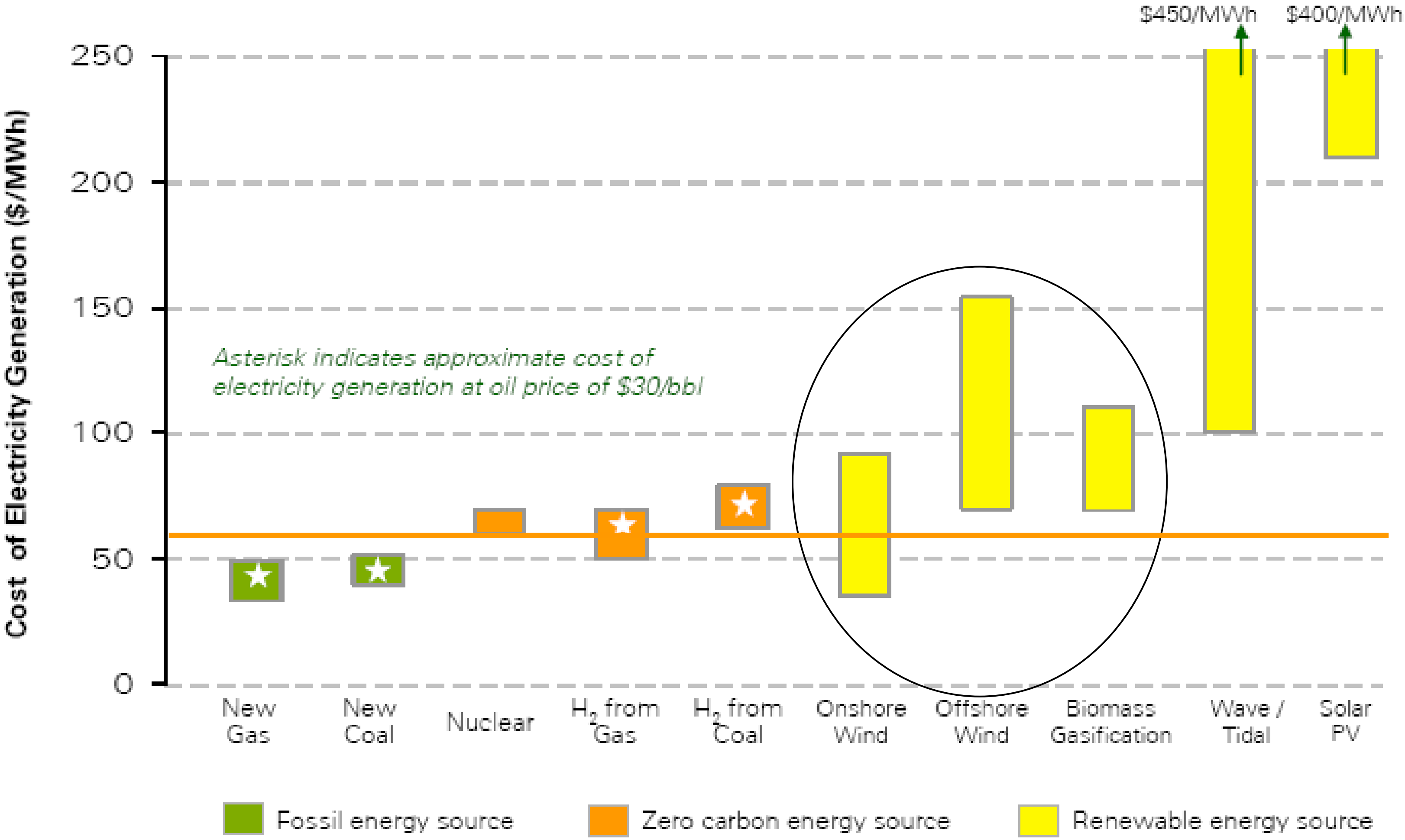
Transitioning to Sustainable Use of Energy

Is it possible to create a road map of energy research and policies that will allow us to achieve transitions to an affordable, sustainable clean energy supply?

Co-chairs: Jose Goldemberg, Brazil
Steven Chu, USA

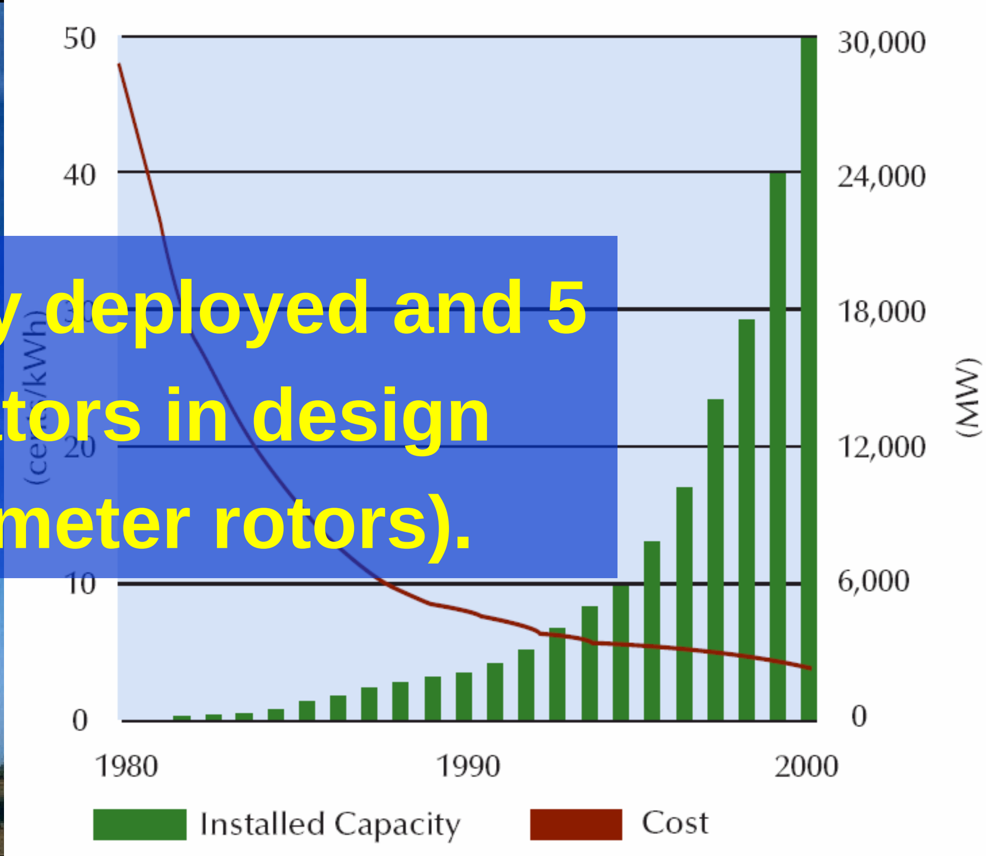
2005 costs of electricity generation for conventional, renewable and alternative options

A 25% increase in



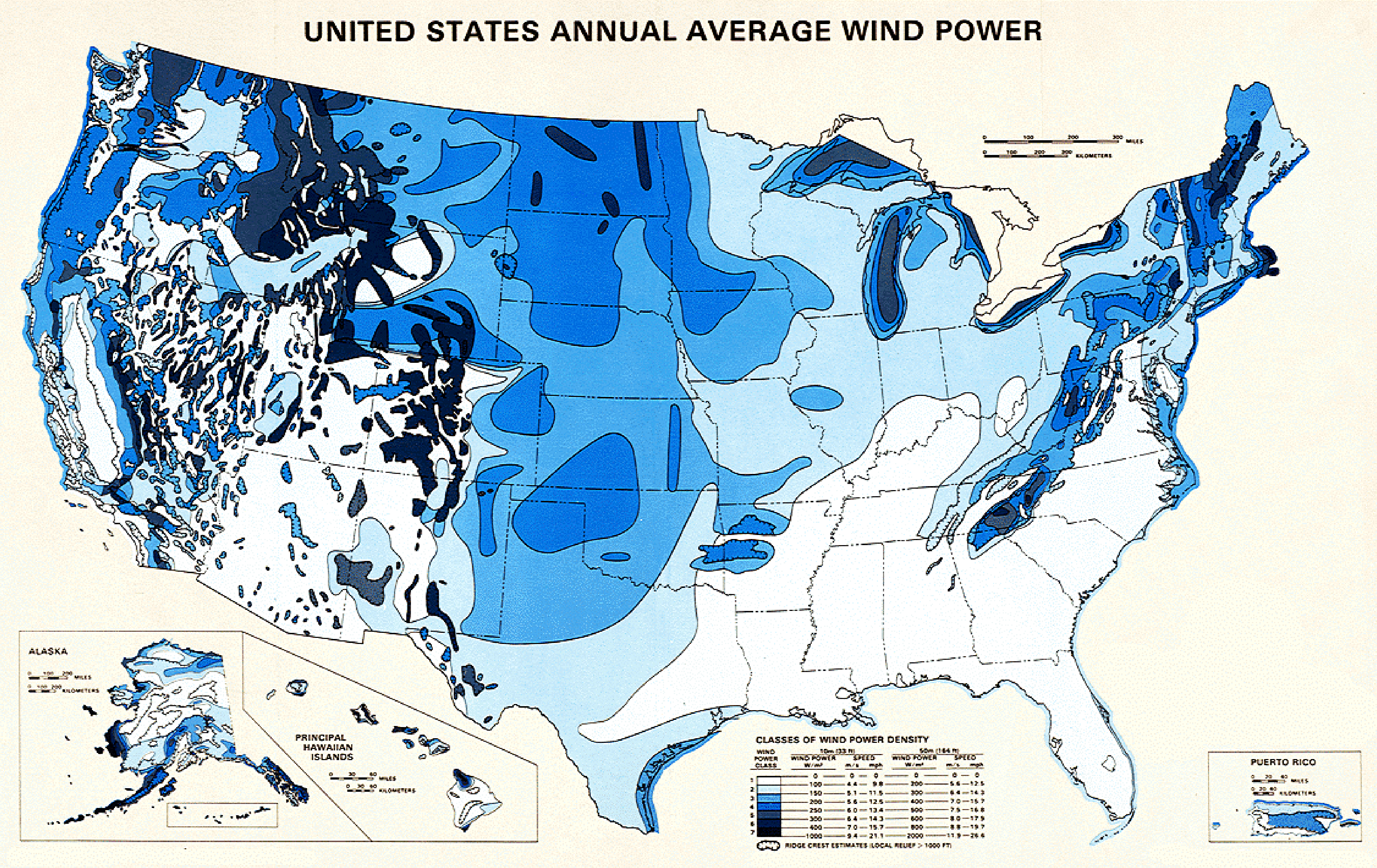
Source: BP Analysis, NCI

Modest but **stable** fiscal incentives were essential to stimulate long term development of power generation from wind

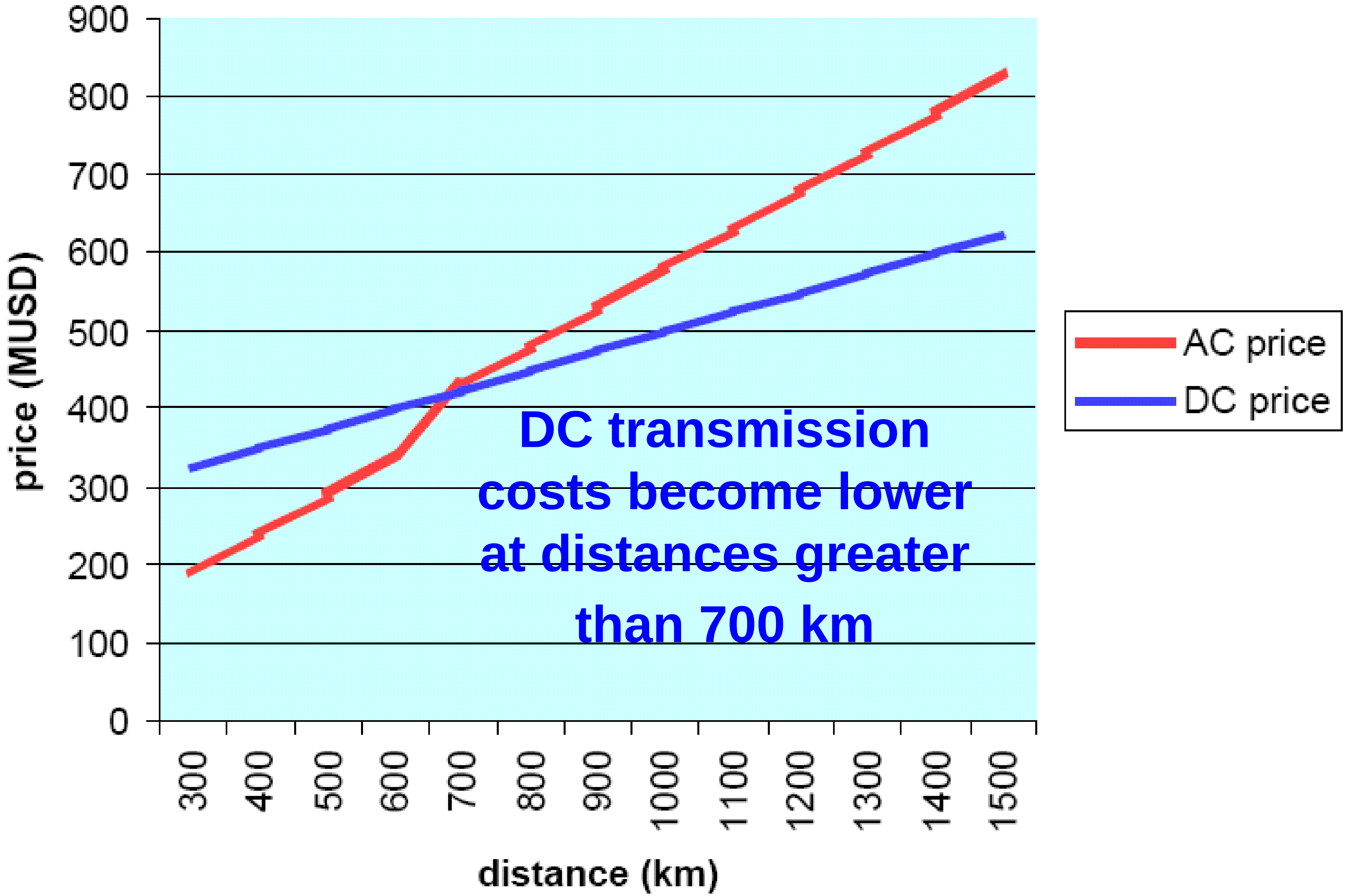


3 MW capacity deployed and 5 MW generators in design (126 m diameter rotors).

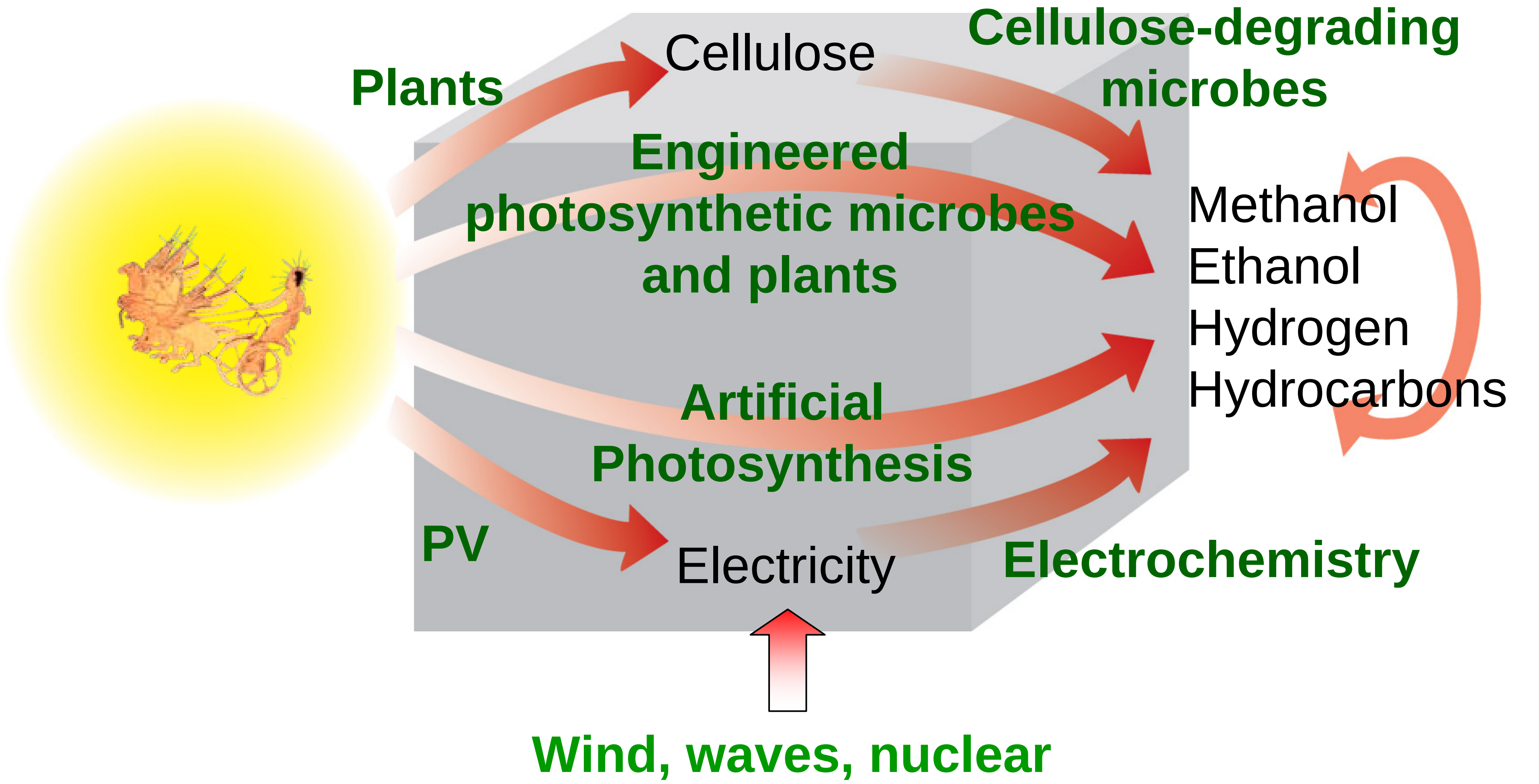
Wind sites in the US



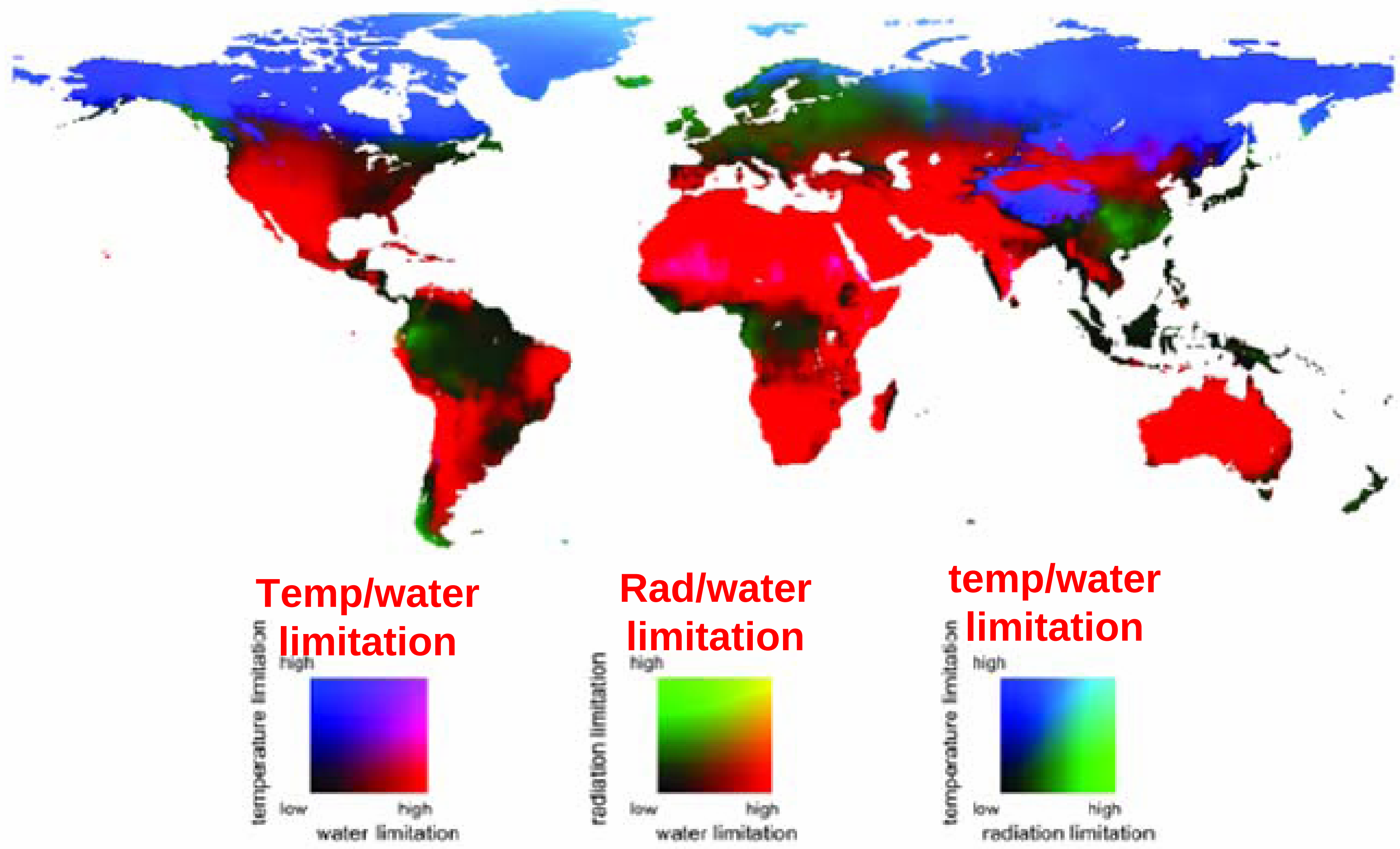
We need an efficient, national transmission line network



Helios: Lawrence Berkeley Laboratory and UC Berkeley's attack on the energy problem



Limiting factors for plant productivity

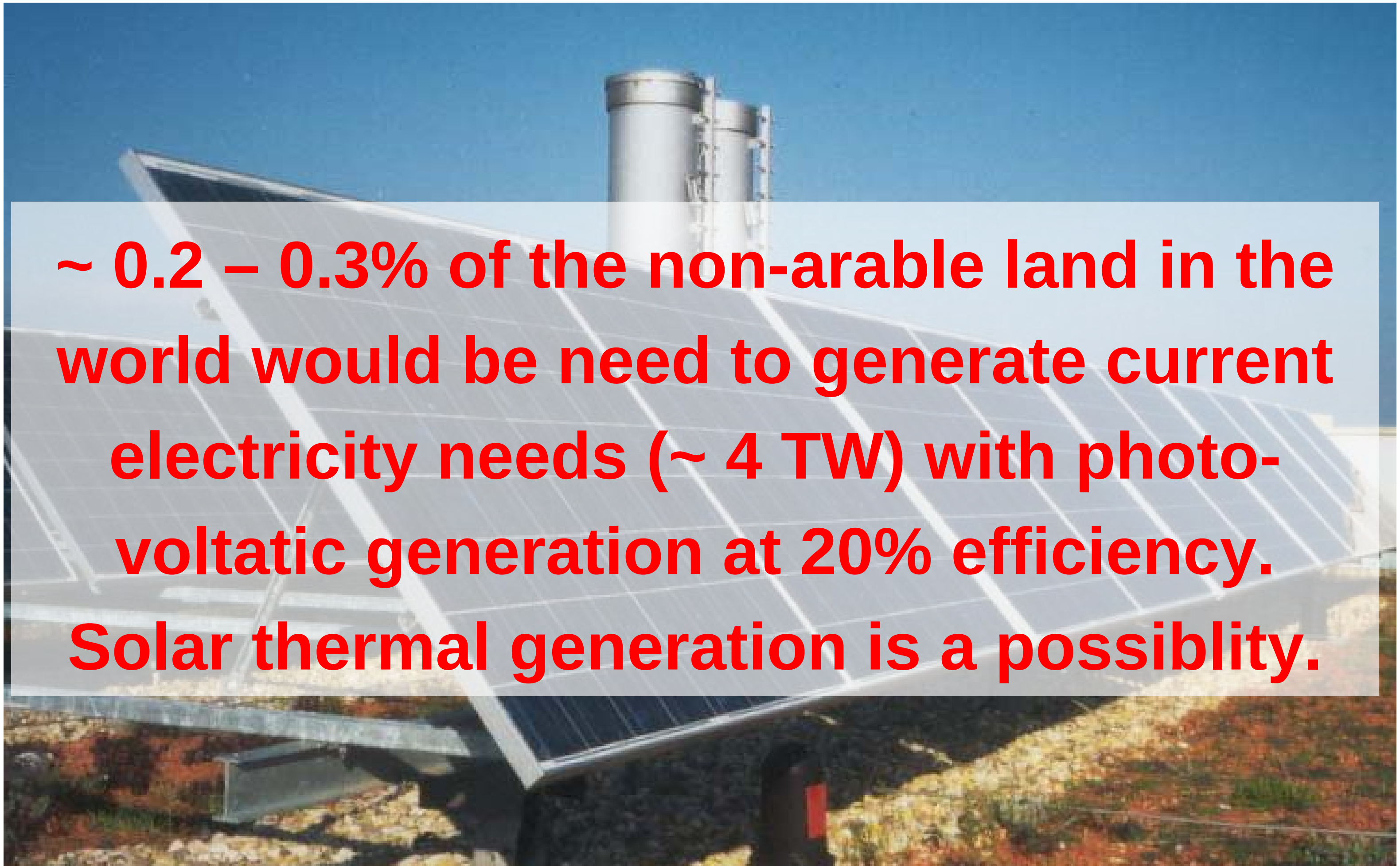


Baldocchi et al. 2004 SCOPE 62

Area requirements to satisfy all US electricity at 15% efficiency

J.A. Turner, *Science* **285** 1999, p. 687.

- Reduction of costs by a factor of ~ 3 is needed for roof-top deployment without subsidy.
- A new class of solar cells at ~ 1/10th current cost is needed for wide-spread deployment.



~ 0.2 – 0.3% of the non-arable land in the world would be need to generate current electricity needs (~ 4 TW) with photo-voltatic generation at 20% efficiency. Solar thermal generation is a possiblity.

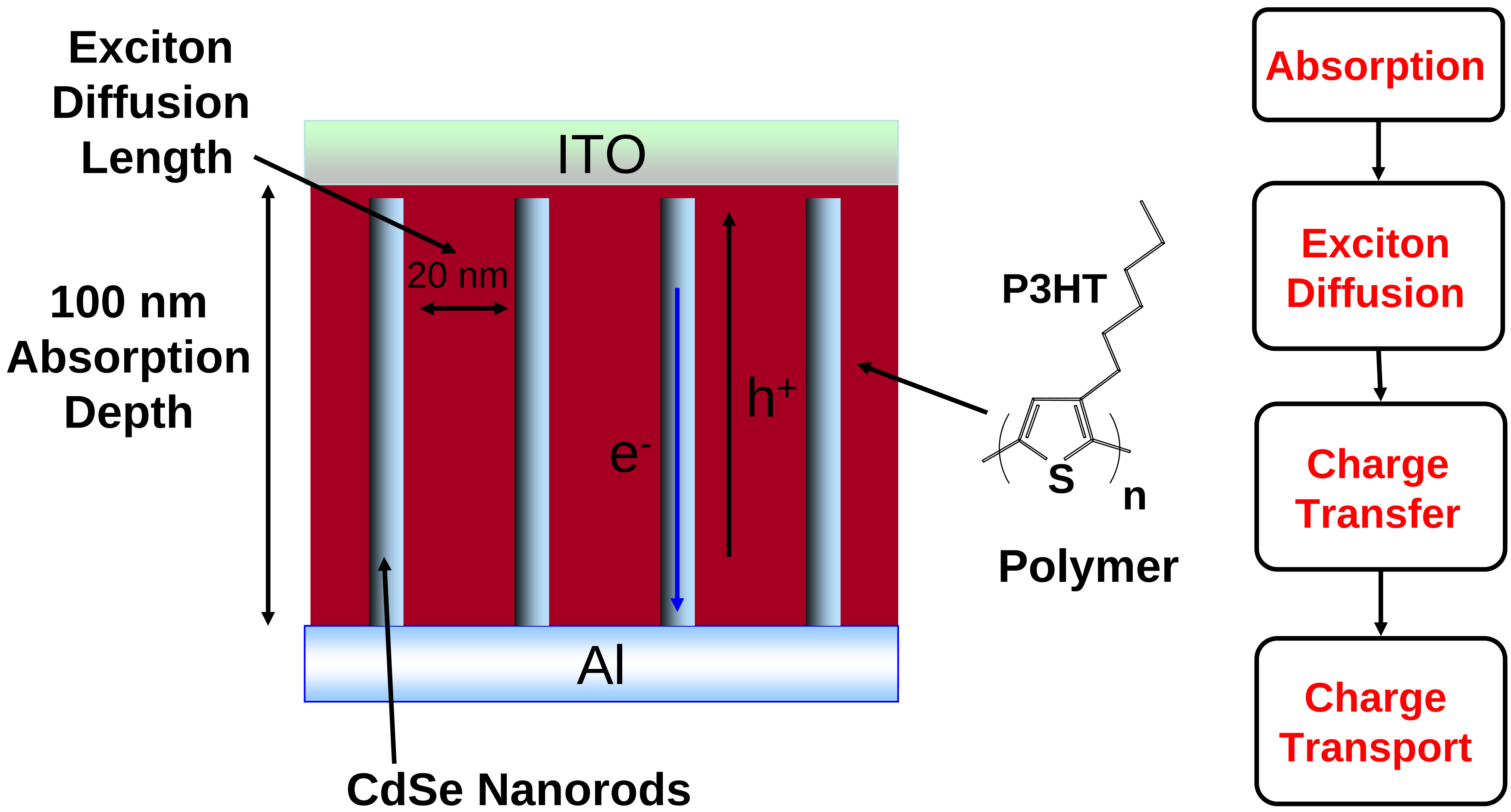
The Molecular Foundry

Foundry Director, Carolyn Bertozzi

Paul Alivisatos, Associate Lab Director, Physical Science

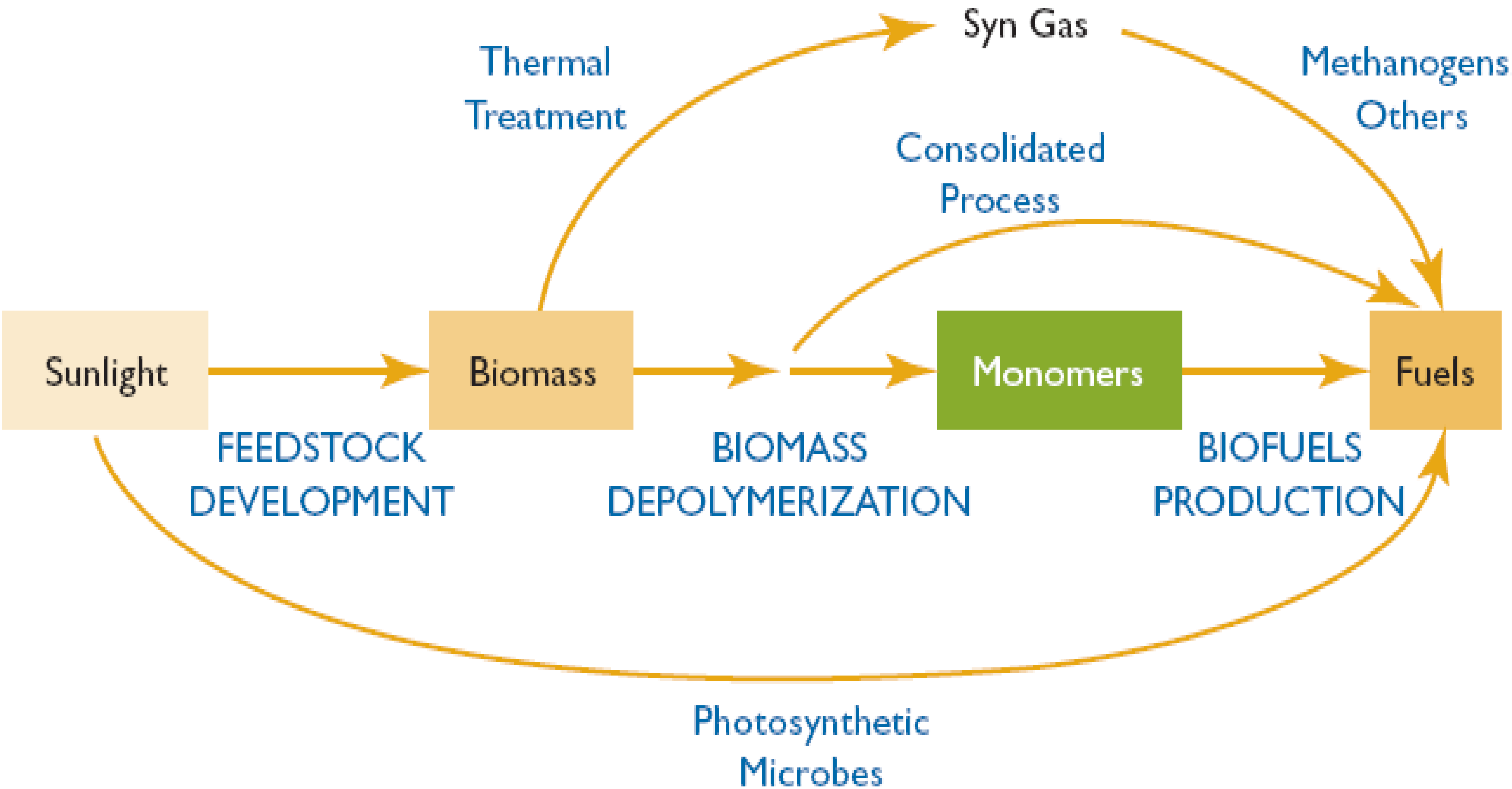
Limiting sizes for distributed junction nano-solar cells

(Creation of electrons and holes by one nano-structure; charge transport to electrodes with another.)



Reel-to-reel mass production of solar cells?

Biomass fuel production

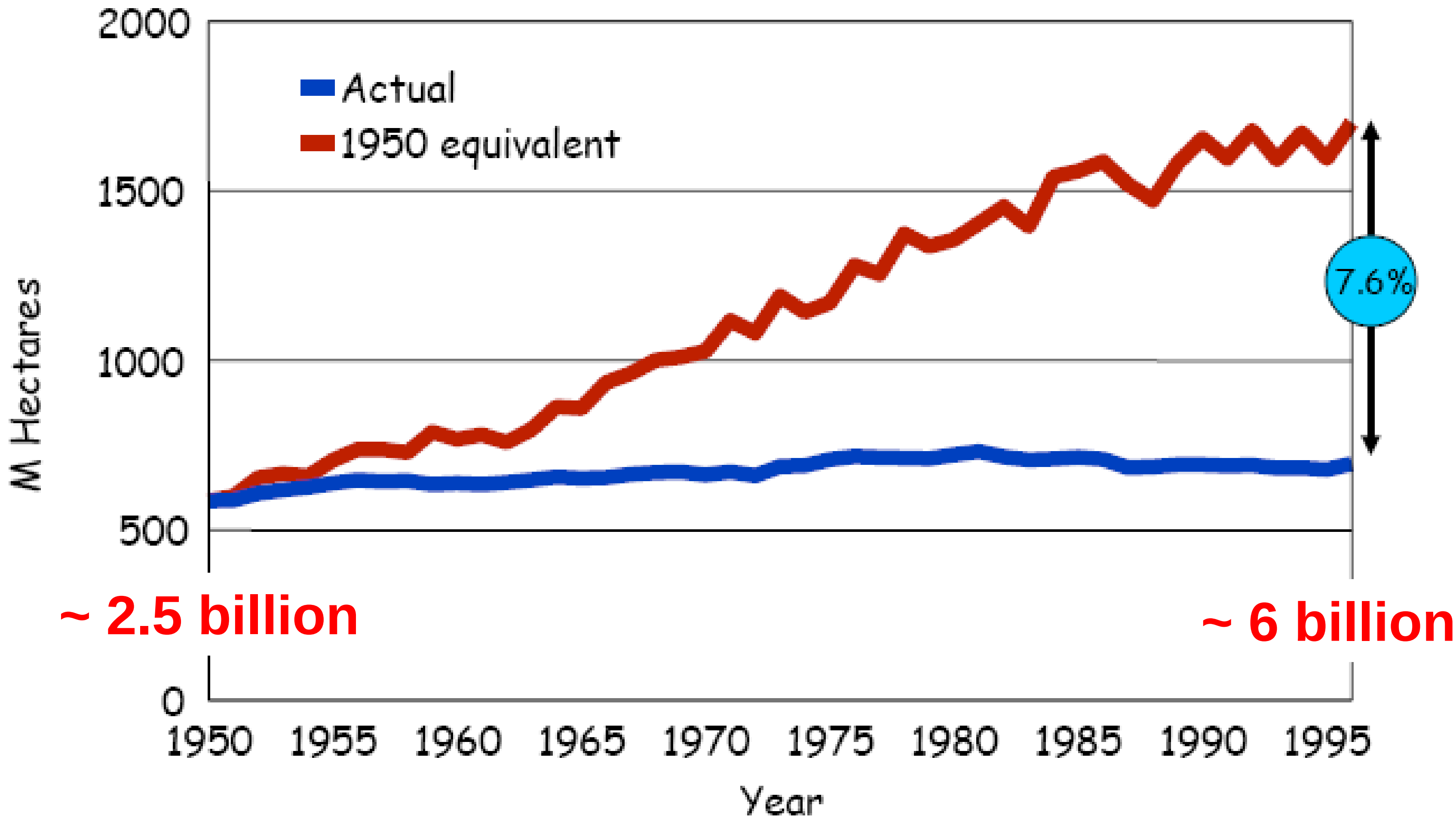


Univ. California, Berkeley,
Lawrence Berkeley National Lab
Univ. Illinois, Urbana-Champaign

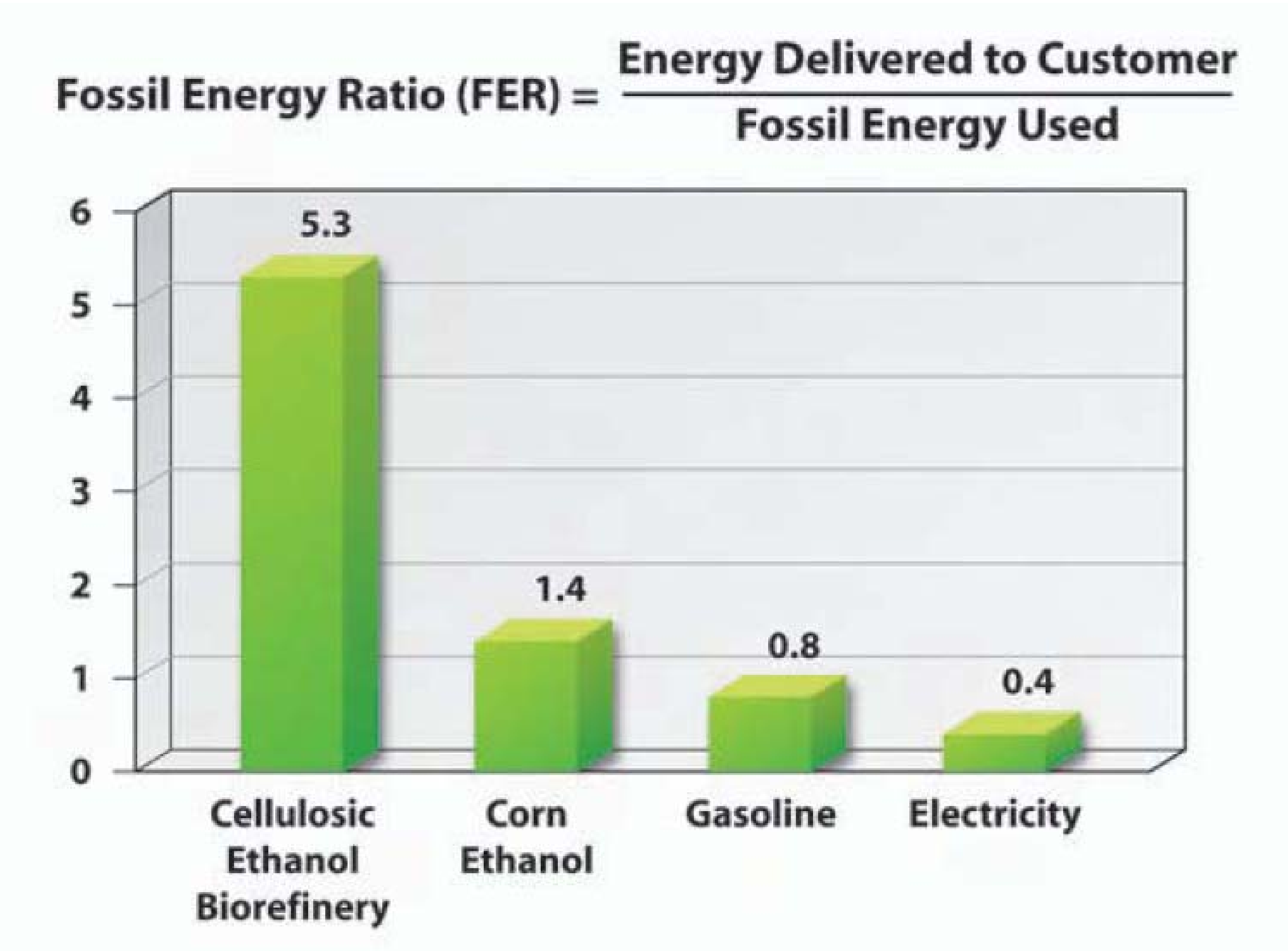
and

bp

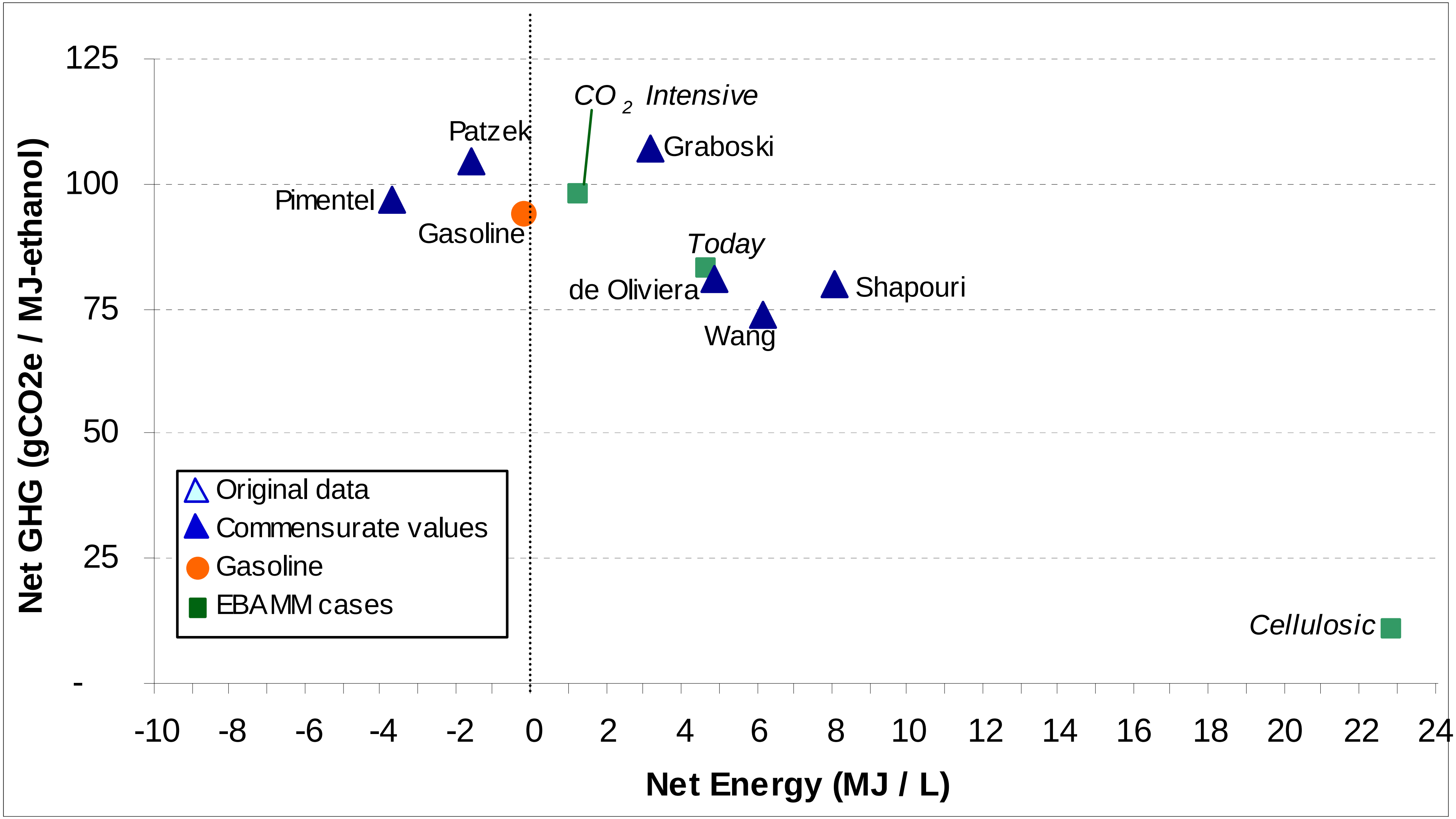
Hectares of Grain With and Without Yield Improvements



Data from Worldwatch database 1996, 1997


Fossil Energy Ratio (FER) = Energy Delivered to Customer / Fossil Energy Used
6
5
4
3
2
1
0
5.3
1.4
0.8
0.4
Cellulosic Ethanol Biorefinery
Corn Ethanol
Gasoline
Electricity

Greenhouse Gases



Alex Farrell, Dan Kammen, et. al., "Meta-analysis" of existing literature, Science 2006

- Miscanthus yields**:** **26** dry tons/acre demonstrated (Official DOE and USDA estimate uses **8** dry tons/acre)

- 100 M acres $\Rightarrow$ ~ 200 B gal / year of ethanol

- US consumption (2004) = 141 B gal of gasoline
  ~ 200 B gal of ethanol / year

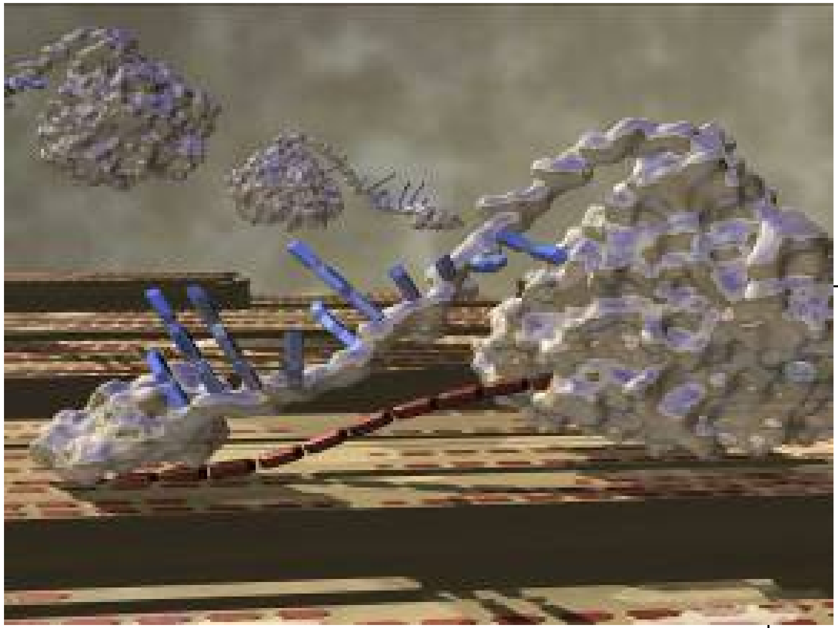
~ 2% conversion efficiency was demonstrated on non-irrigated, non-fertilized test field in Illinois.

Courtesy Steve Long, UIUC

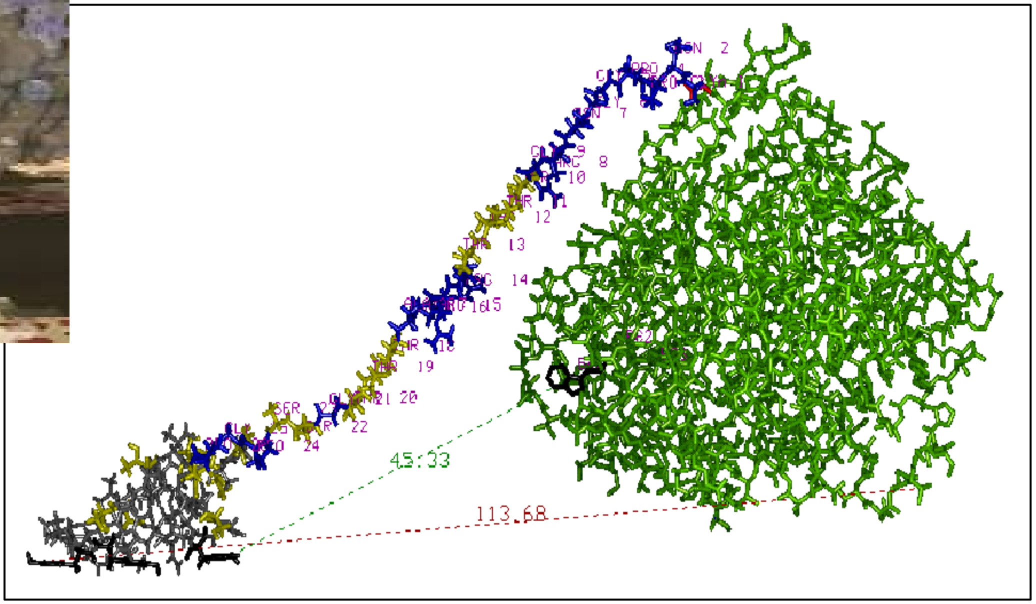
NREL has worked with Genencor & Novozymes for 4+ years

The RESULT:

20-30 fold reduction in cost contribution of enzymes

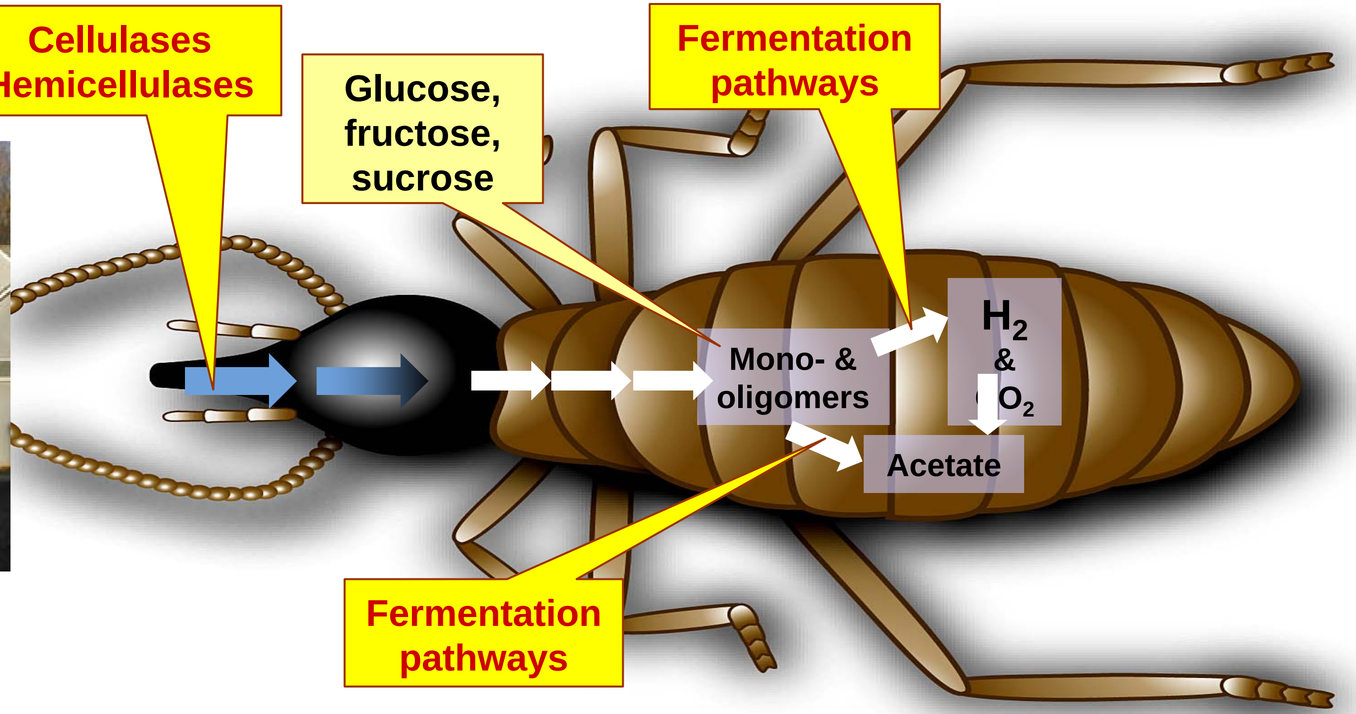


CBH1 from T. reesei



Termites have many specialized enzymes for efficiently digesting lignocellulosic material

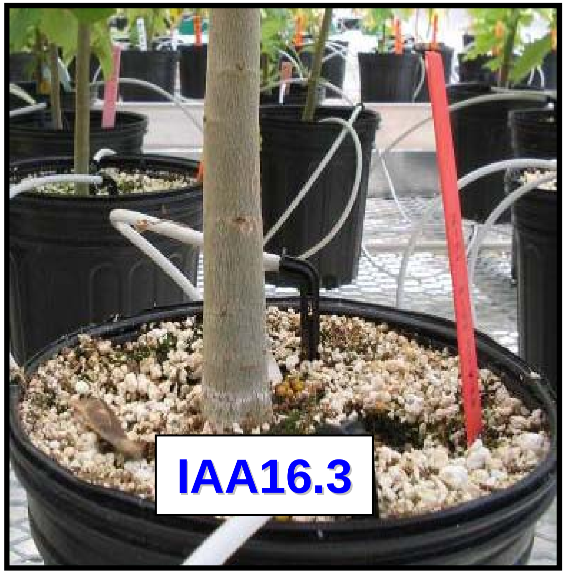
DOE JOINT GENOME INSTITUTE
US DEPARTMENT OF ENERGY
OFFICE OF SCIENCE



Poplar tree

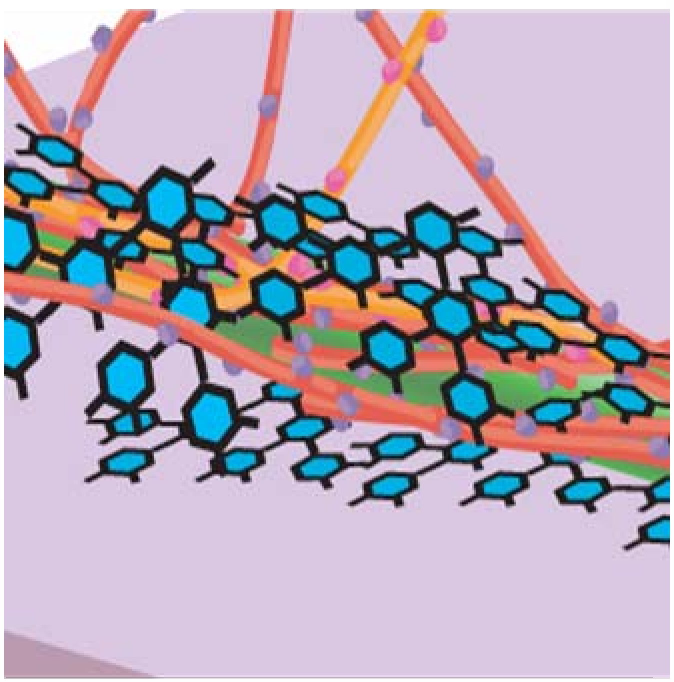
ornl OAK RIDGE NATIONAL LABORATORY · GenomeCanada · UPSC · UNIVERSITEIT GENT

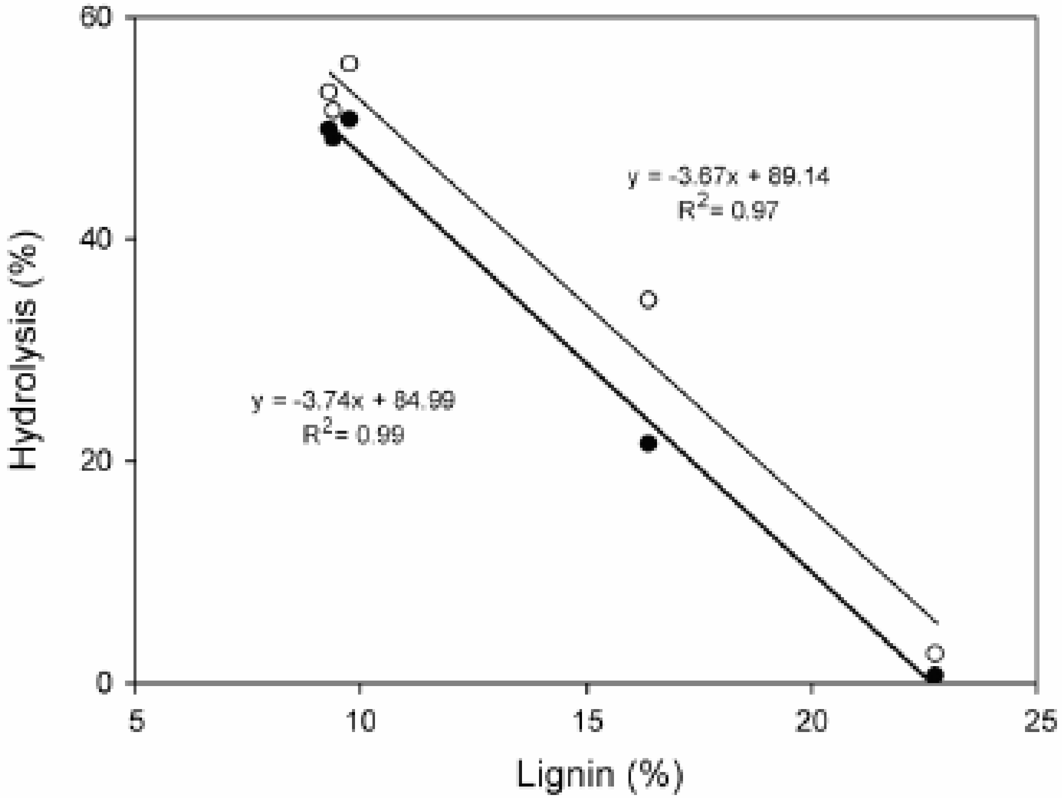
- ~ 45,000 genes
- Improve drought resistance and long term carbon sequestration
- Improve bio-mass production.



The effect of lignin on enzyme recovery of sugars in miscanthus

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

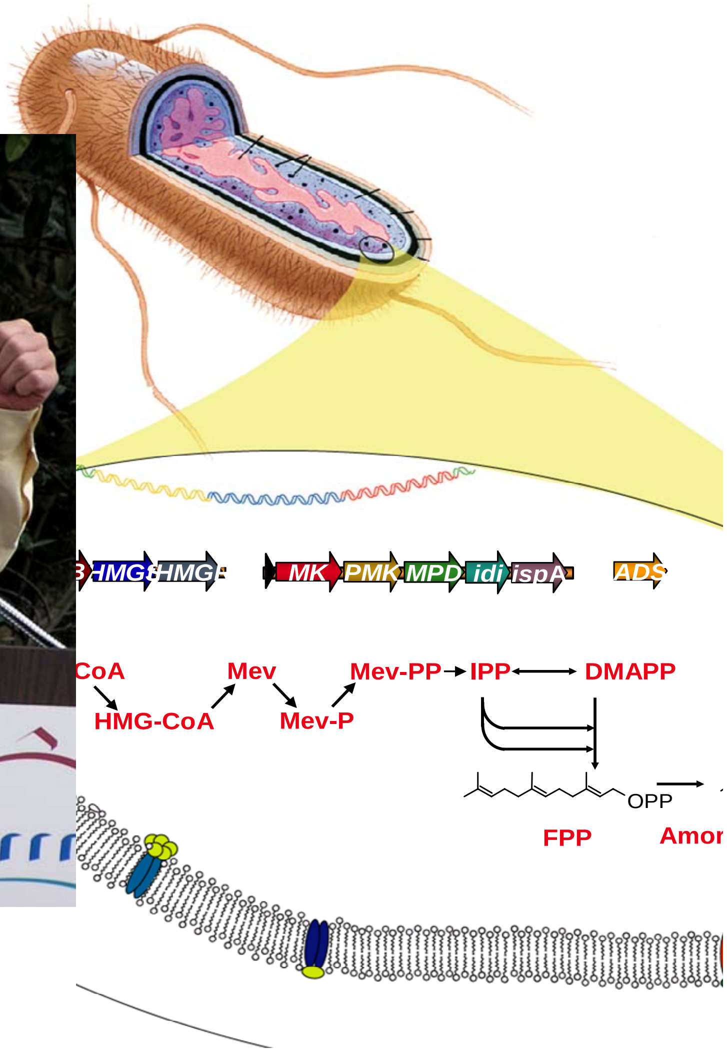




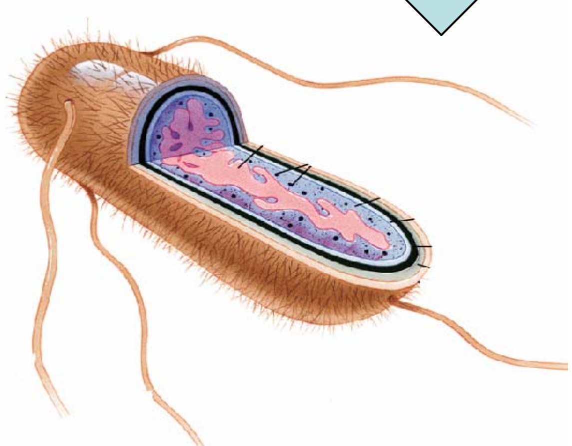
Production of artemisinin in bacteria

Jay Keasling

Director of Physical Biosciences Division



Research, Development & Delivery



Keasling Laboratory

Amyris Biotechnologies

Institute for OneWorld Health

Cost 20¢ /cure

The Helios Project

Helios Fund raising:

$500 M / 10 yr	BP
$70 M	State of California
$30-60 M	UC General Revenue Bond Authority
$15 M	Private Donations already pledged
$1+1+2M	Private Donations 2007 scientific program
$ 3 M	Renewable Energy Chair

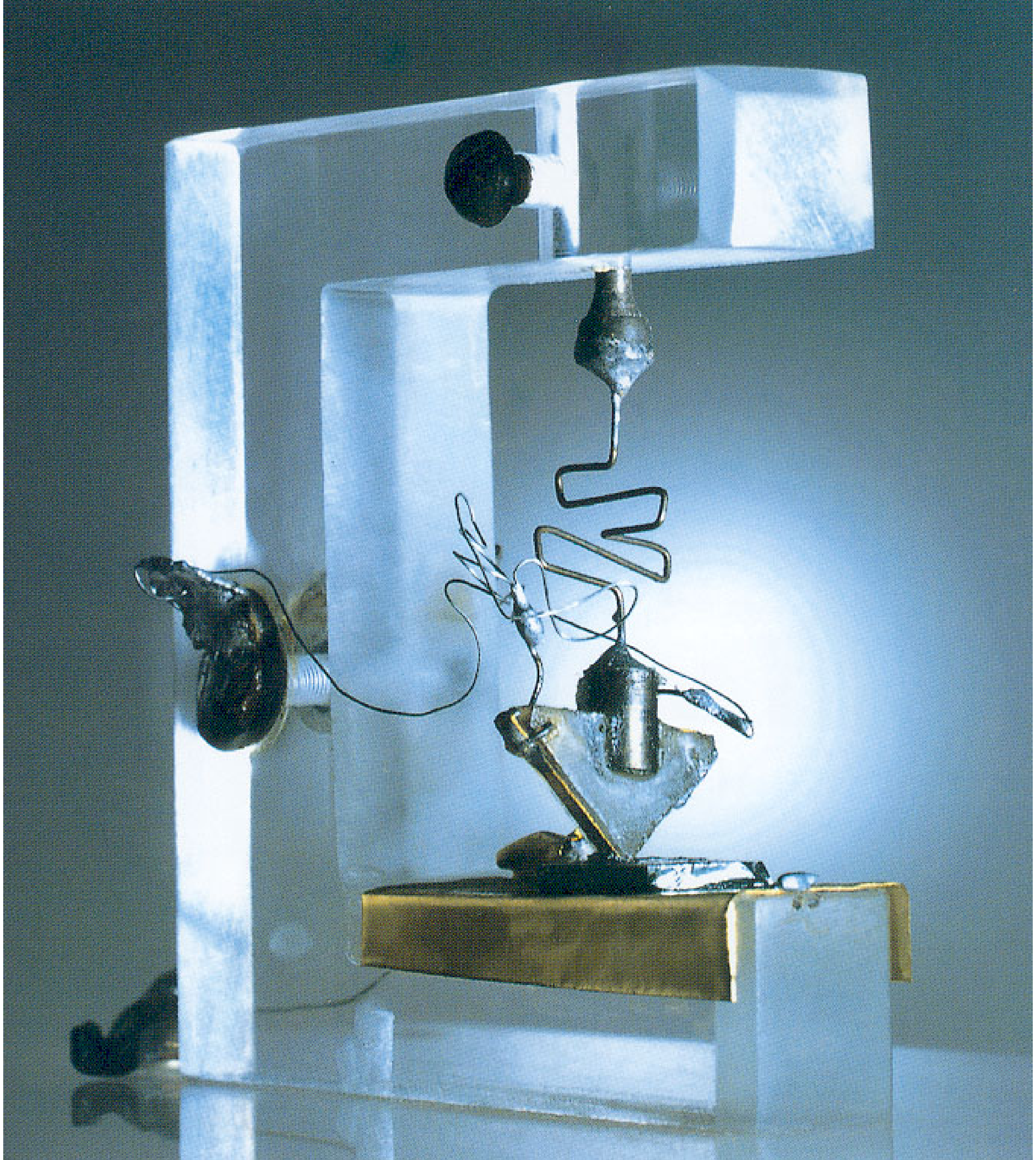
$160 M Building

$125 M/ 5 yr?	Department of Energy (biology)
$ ~5-15 M/yr ?	Department of Energy (materials science)
$XX M?	Private Foundations
$XXX M?	Other

Los Alamos
1942 -1945

Bell Laboratories (Murray Hill, NJ)

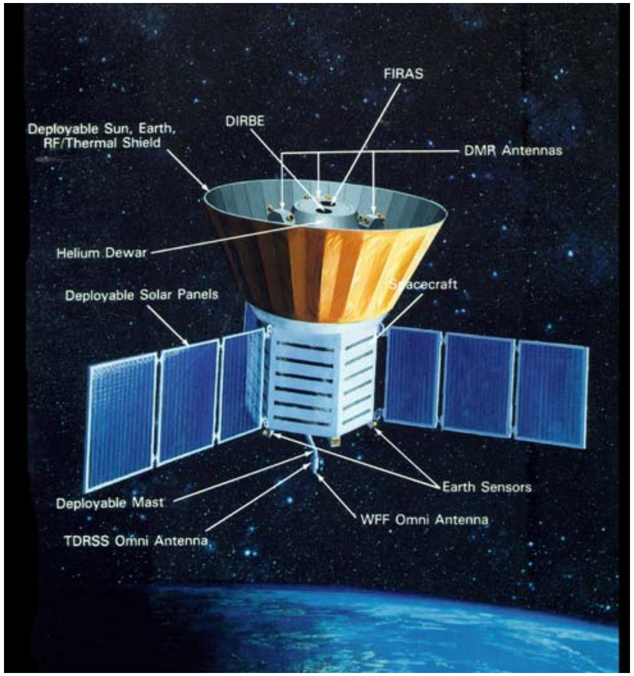
15 scientists who worked at AT&T Bell laboratories received Nobel Prizes.



E.O. Lawrence introduced the idea of "team science"

Ernest Lawrence, Robert Serber, Luis Alverez, Edwin McMillian, Robert Oppenheimer, Robert R. Wilson, …

The tradition of E.O. Lawrence continues ...



COBE: Cosmic Background Explorer

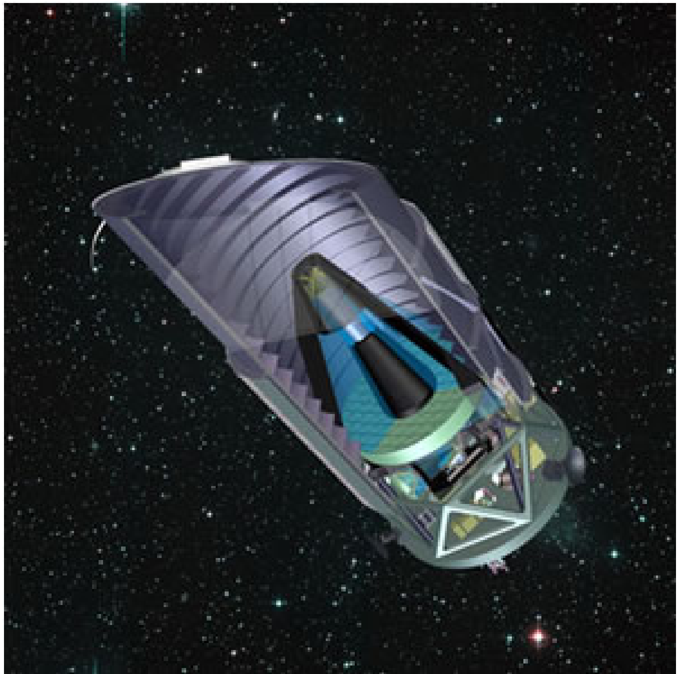
2006 Nobel Prize in Physics

George Smoot (LBNL & UCB) and John Mather (Goddard)

Dark Energy

Saul Perlmutter (LBNL and UCB)

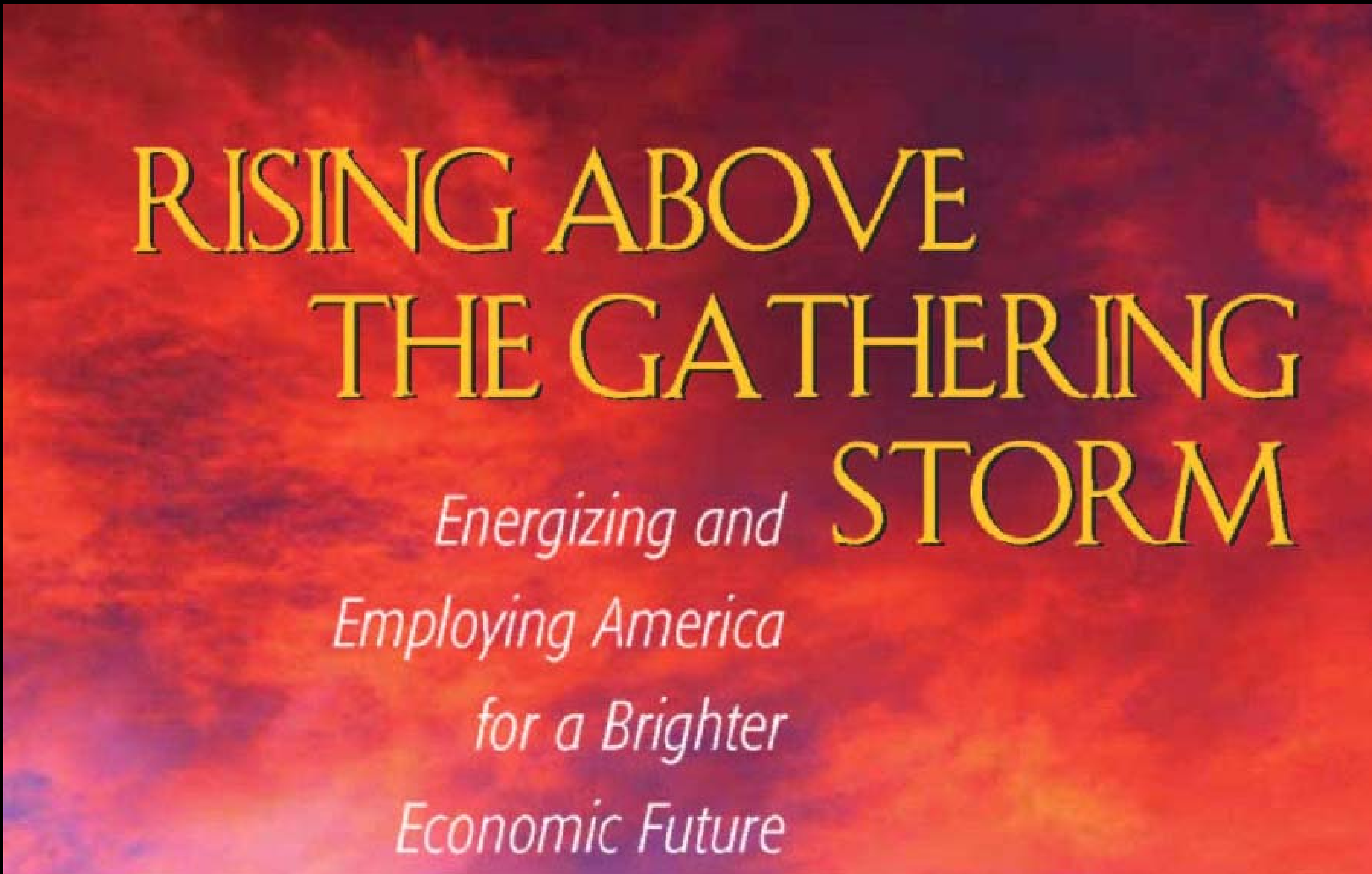
(2006 Run Run Shaw Prize, Fretinelli Prize)

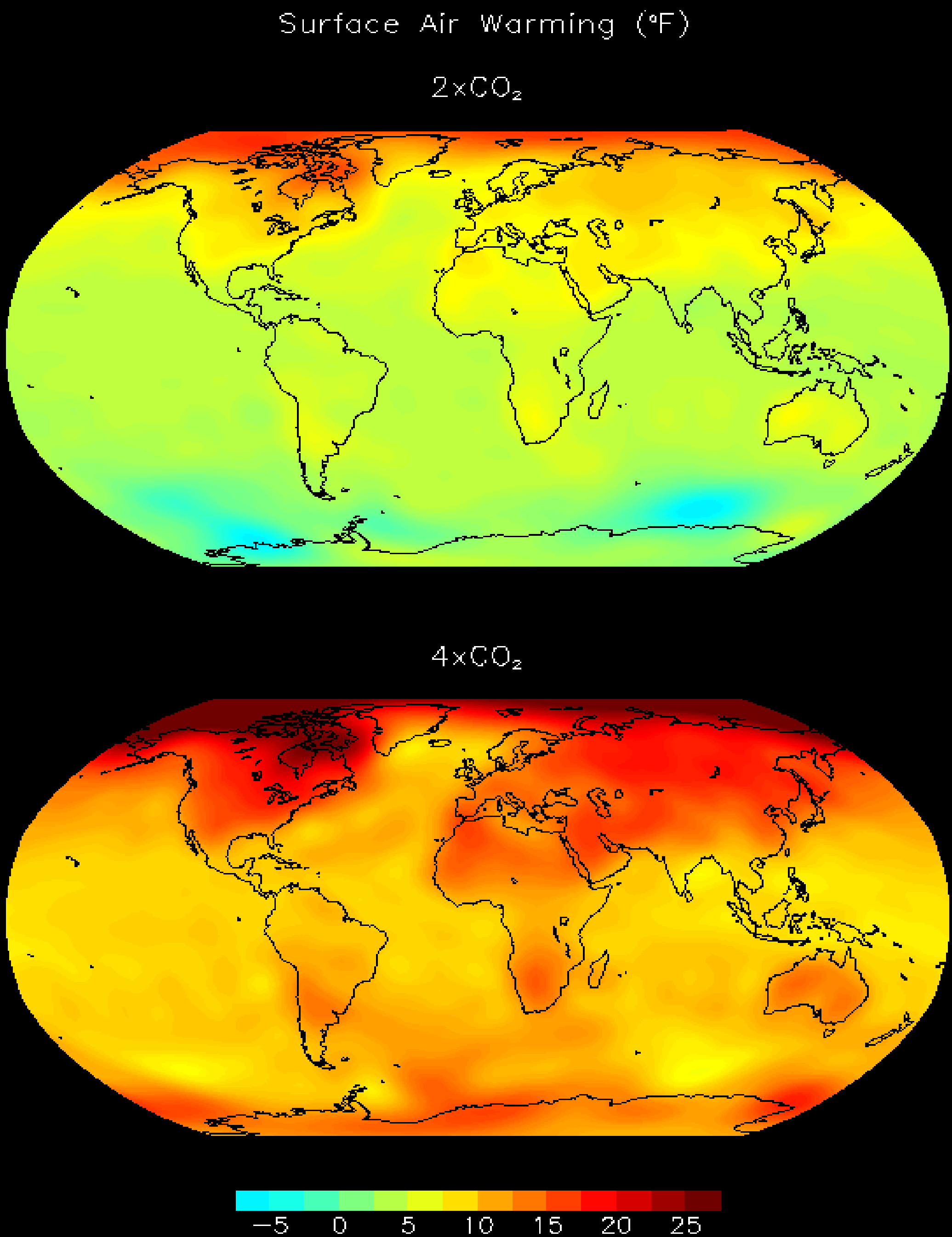


Organizational culture

- Individual genius was nurtured, but individuals were also encouraged to quickly form teams to rapidly exploit ideas.
- The scientific direction was guided by collective wisdom and “managed” by top scientists with intimate, expert knowledge.
- Bold approaches were encouraged; some failure was expected, but there was an emphasis on recognizing failure quickly, and moving on to other opportunities.

National Academies Report   Chair: Norm Augustine





Computer simulations by the Princeton Geophysical Fluid Dynamics Lab:

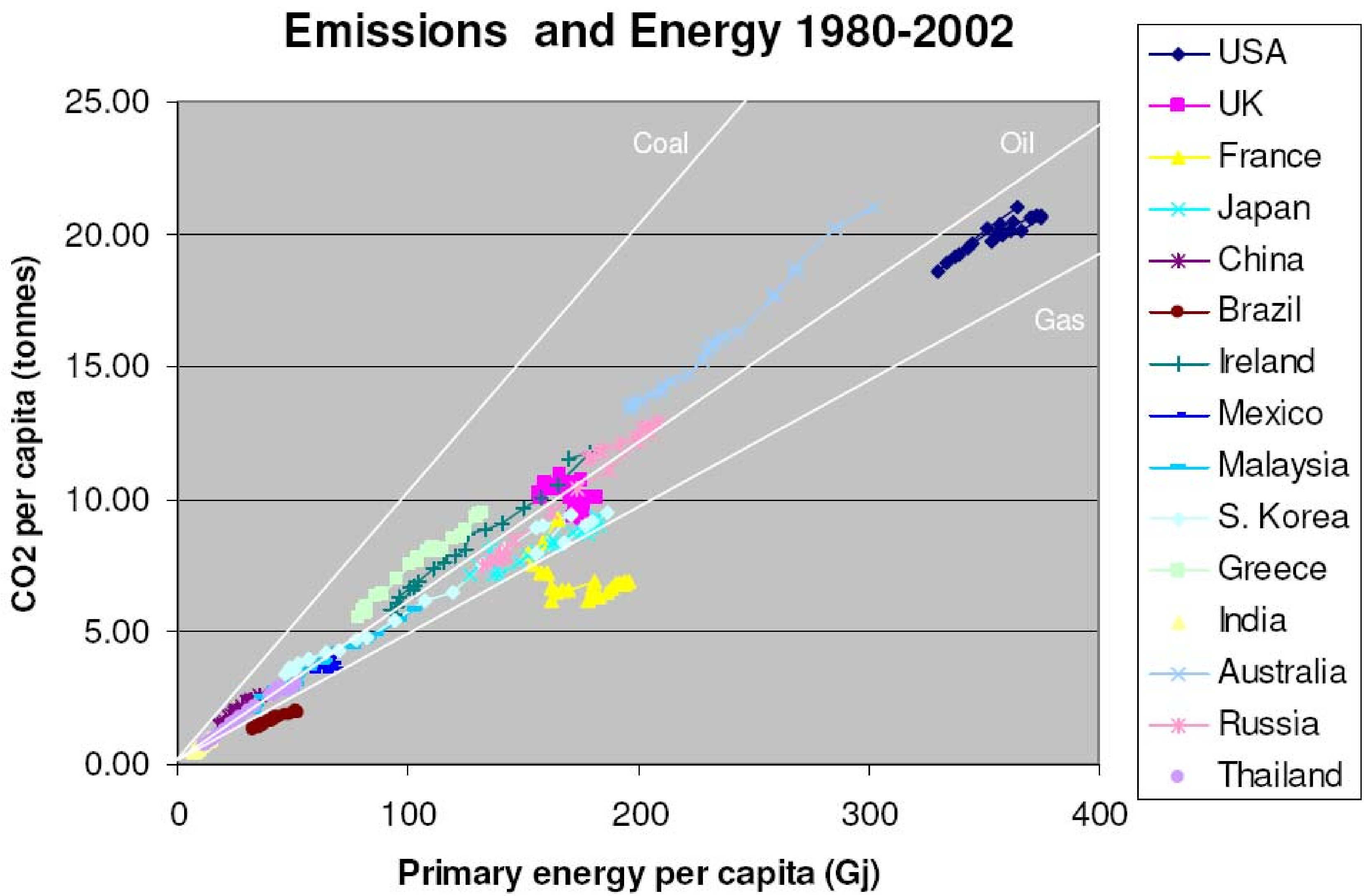
2x increase in CO_2 from the pre-industrial level

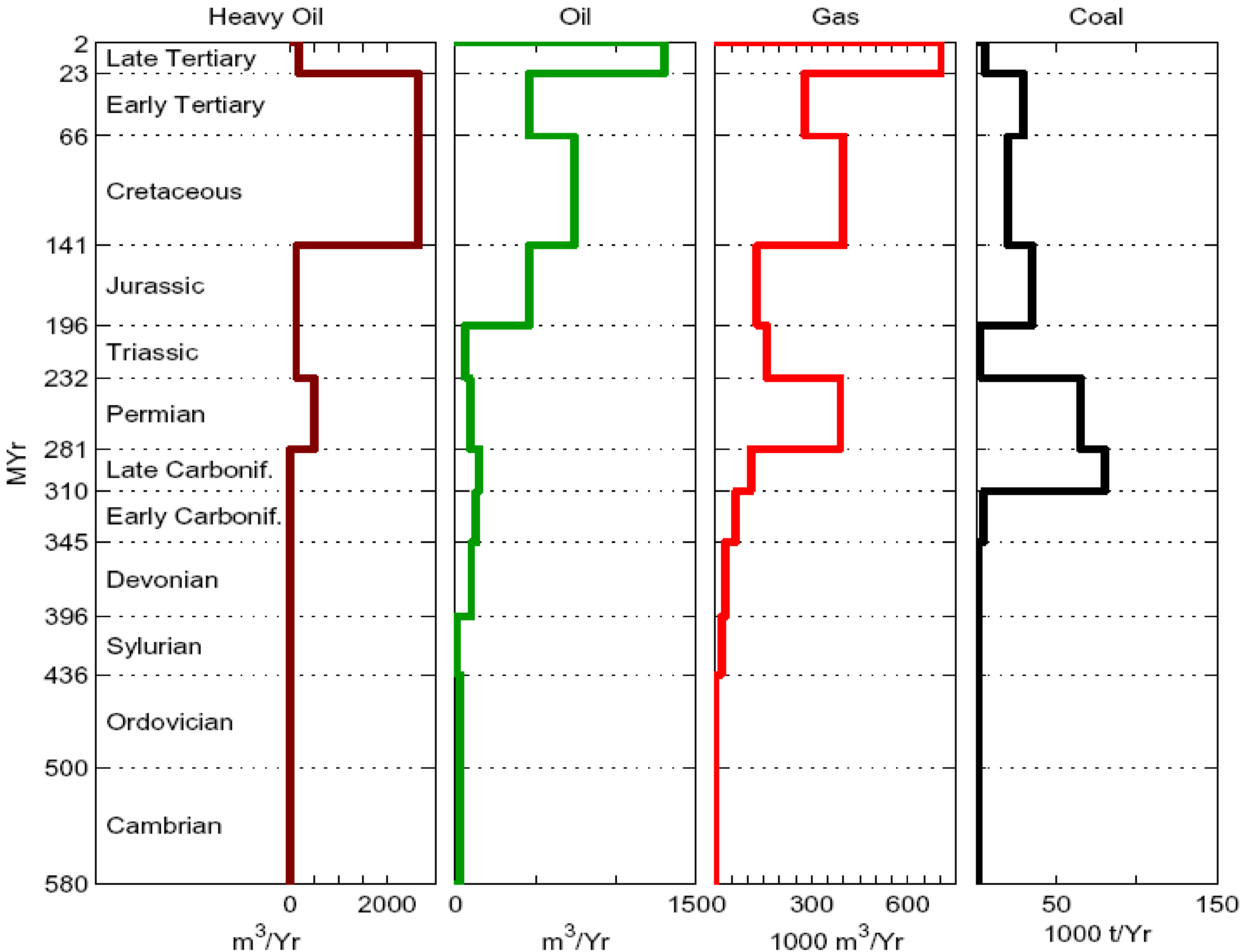
⇒ 5 -12 °F increase

4x increase in CO_2

⇒ 15-23°F!

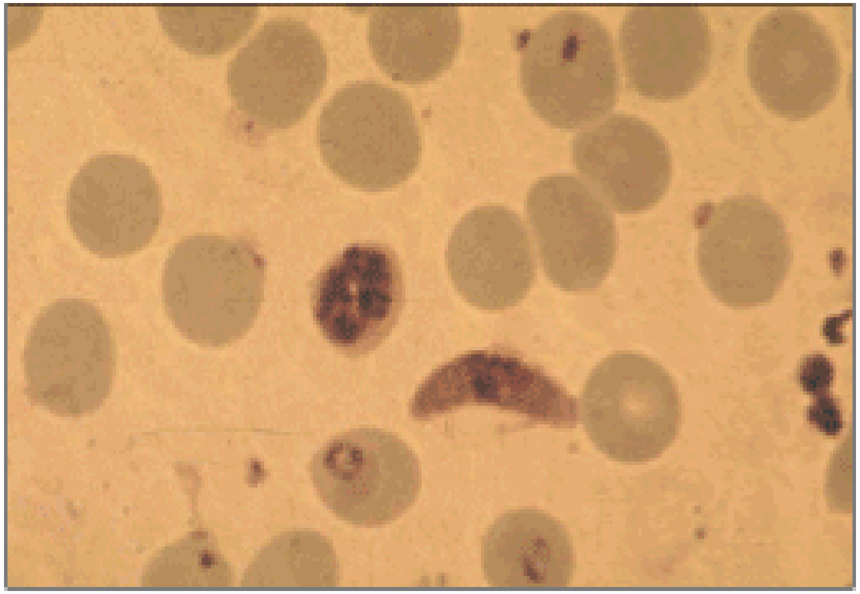
CO_2 emissions depends on the energy source



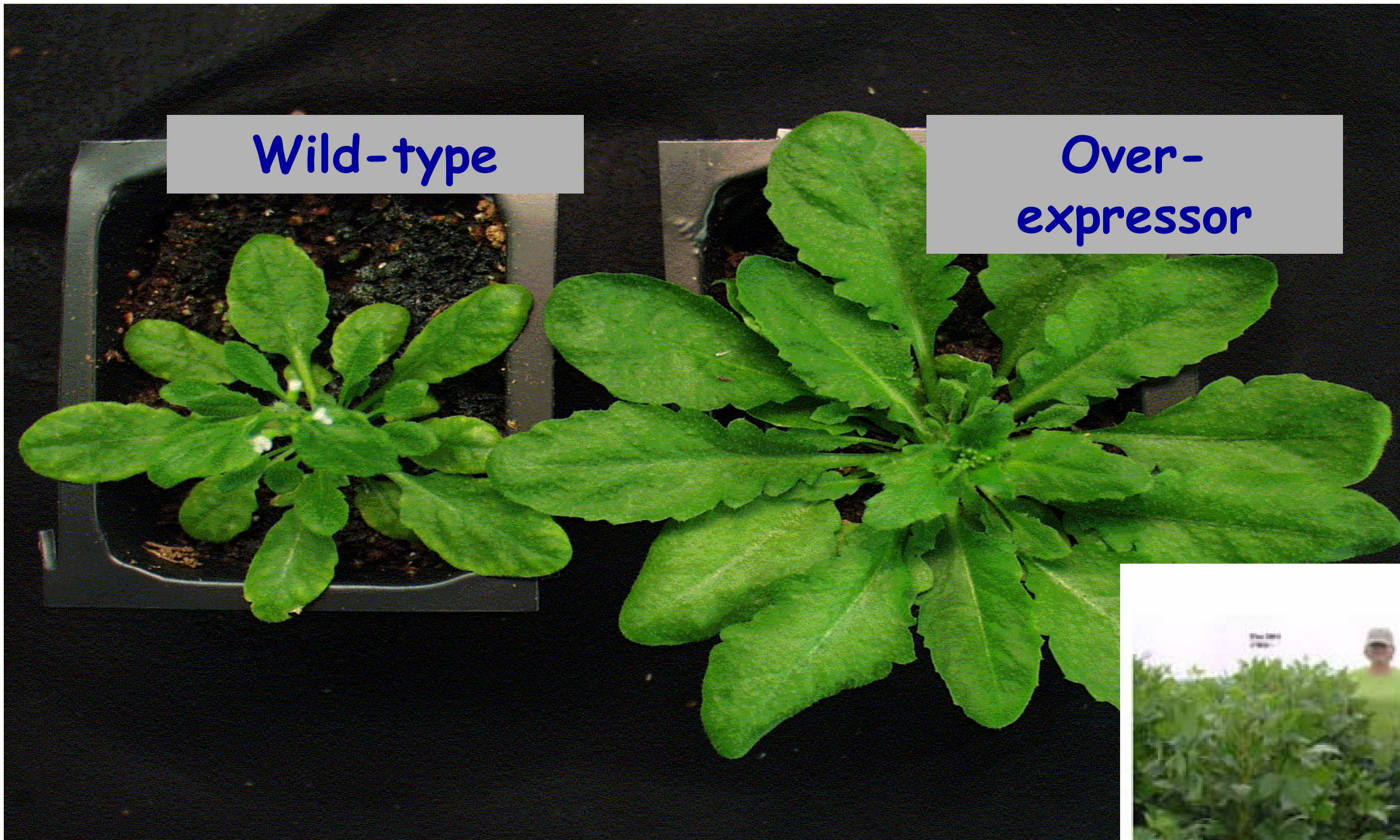

Heavy Oil
Oil
Gas
Coal
MYr
2
23
66
141
196
232
281
310
345
396
436
500
580
Late Tertiary
Early Tertiary
Cretaceous
Jurassic
Triassic
Permian
Late Carbonif.
Early Carbonif.
Devonian
Sylurian
Ordovician
Cambrian
0
2000
m³/Yr
0
1500
m³/Yr
0
300
600
1000 m³/Yr
50
150
1000 t/Yr

Malaria

- Caused by *Plasmodium*, a single-cell protozoan
  - Transmitted by Anopheles mosquito
  - Destroys red blood cells
  - *Plasmodium* in South America and Southeast Asia is largely resistant to chloroquine – based drugs



Enhanced plant size caused by increased expression of a transcription factor



Courtesy of Mendel Biotechnology
And Monsanto Co

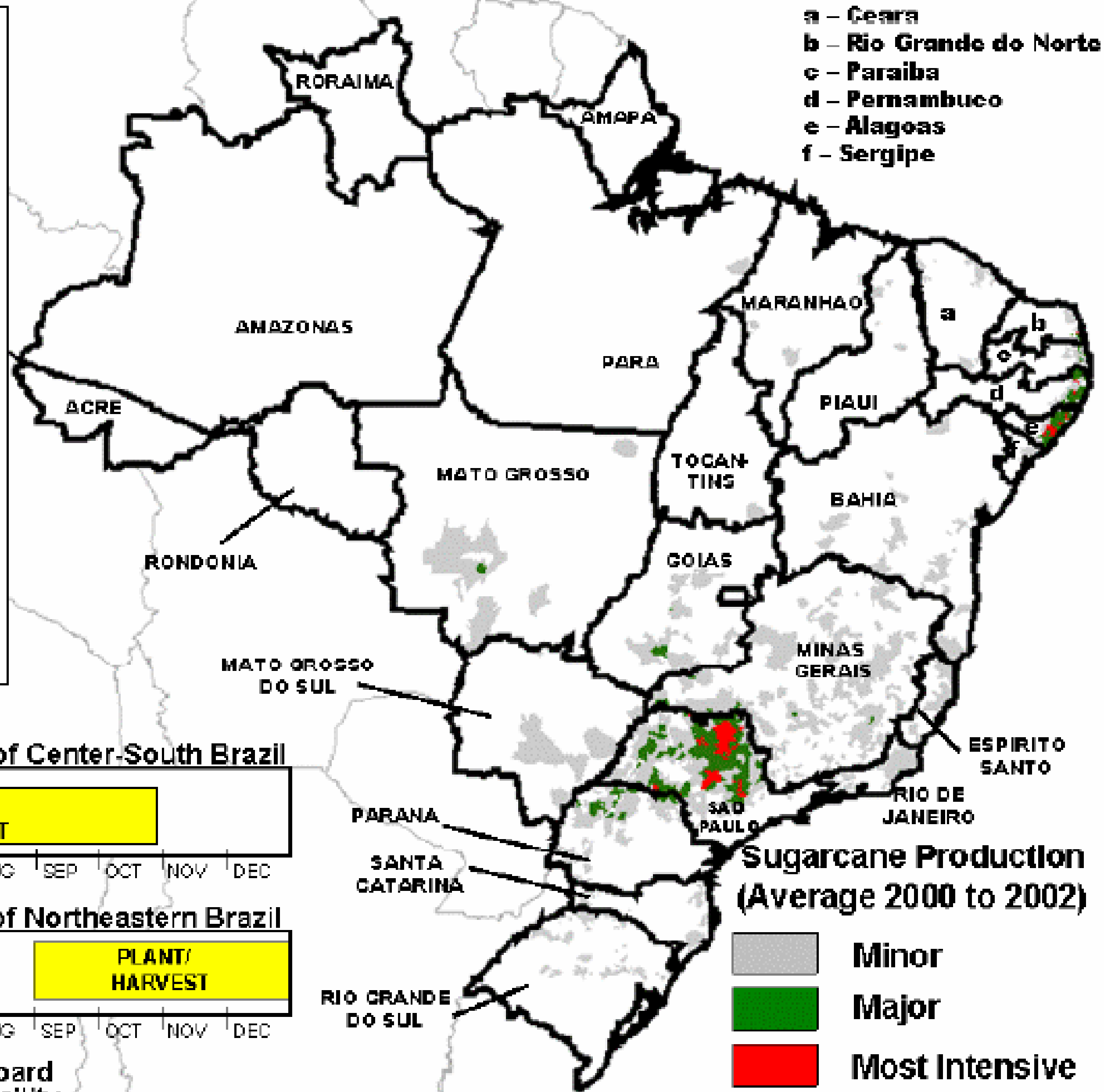
Brazil Sugarcane

*** State-Level Production (as % of total)**

State	%
Sao Paulo	58
Alagoas	8
Parana	8
Minas Gerais	5
Pernambuco	5
Mato Grosso	3
Goias	3
Mato Grosso do Sul	2
Rio De Janeiro	2
Other States	6

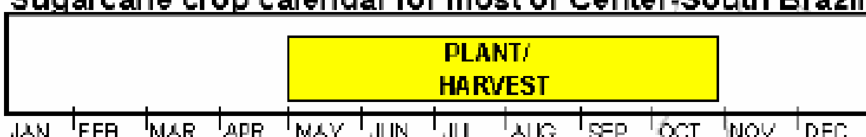
•1999/2000 to 2001/02 Average

Source: IBGE Brazil



Source: IBGE Brazil

Sugarcane crop calendar for most of Center-South Brazil



Sugarcane crop calendar for most of Northeastern Brazil

USDA World Agricultural Outlook Board
Joint Agricultural Weather Facility

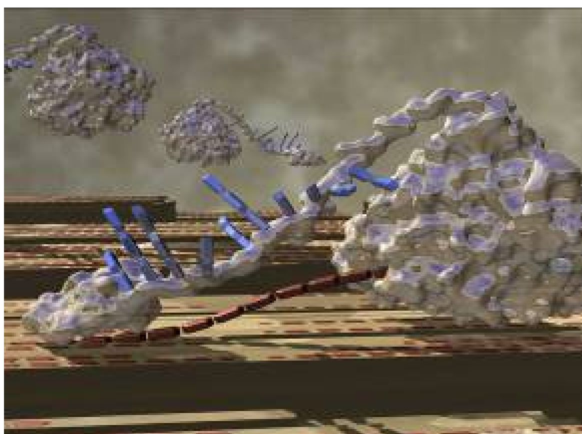
Advantages of perennial plants:

- No tilliage after first planting
- Long-lived roots establish beneficial interactions with root symbionts that facilitate acquisition of mineral nutrients.
- Some perennials withdraw a substantial fraction of mineral nutrients from above-ground portions of the plant at the end of the season but before harvest.
- Perennials have lower fertilizer runoff than annuals. (Switchgrass has ~ 1/8 nitrogen runoff and 1/100 the soil erosion of corn.)
- Diversity by growing several intermixed species of perennials is more feasible.

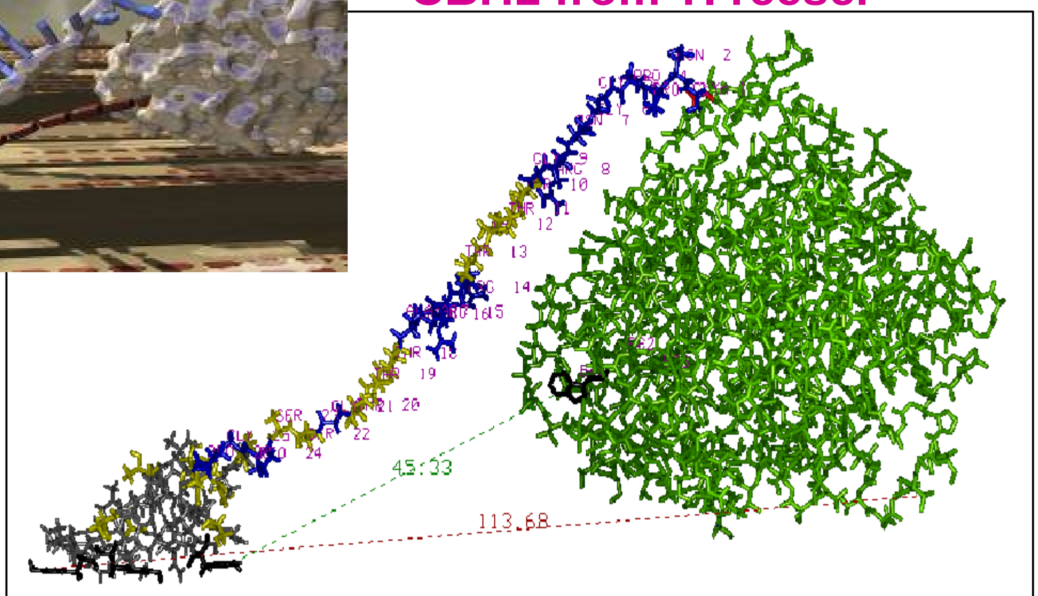
NREL has worked with Genencor & Novozymes for 4+ years

- Focusing on enzyme biochemistry, cost, and specific activity
- Investigating the interaction of biomass pre-treatment and enzymatic hydrolysis

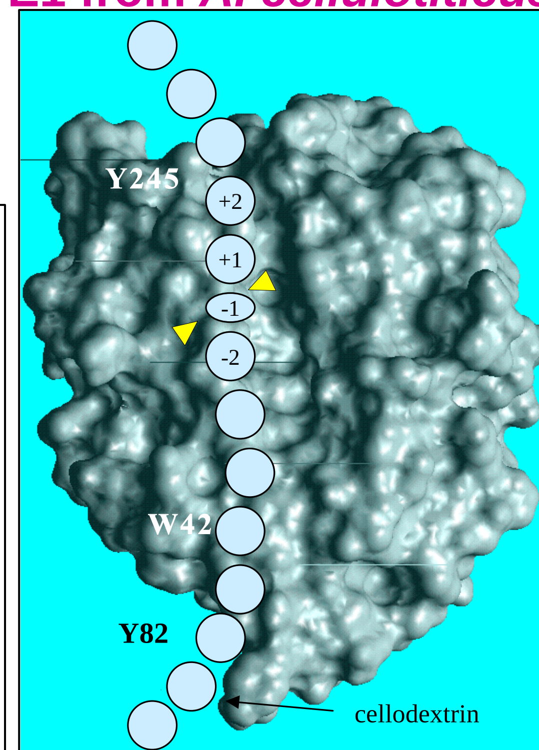
The RESULT: 20-30 fold reduction in cost contribution of enzymes ($/gal EtOH)

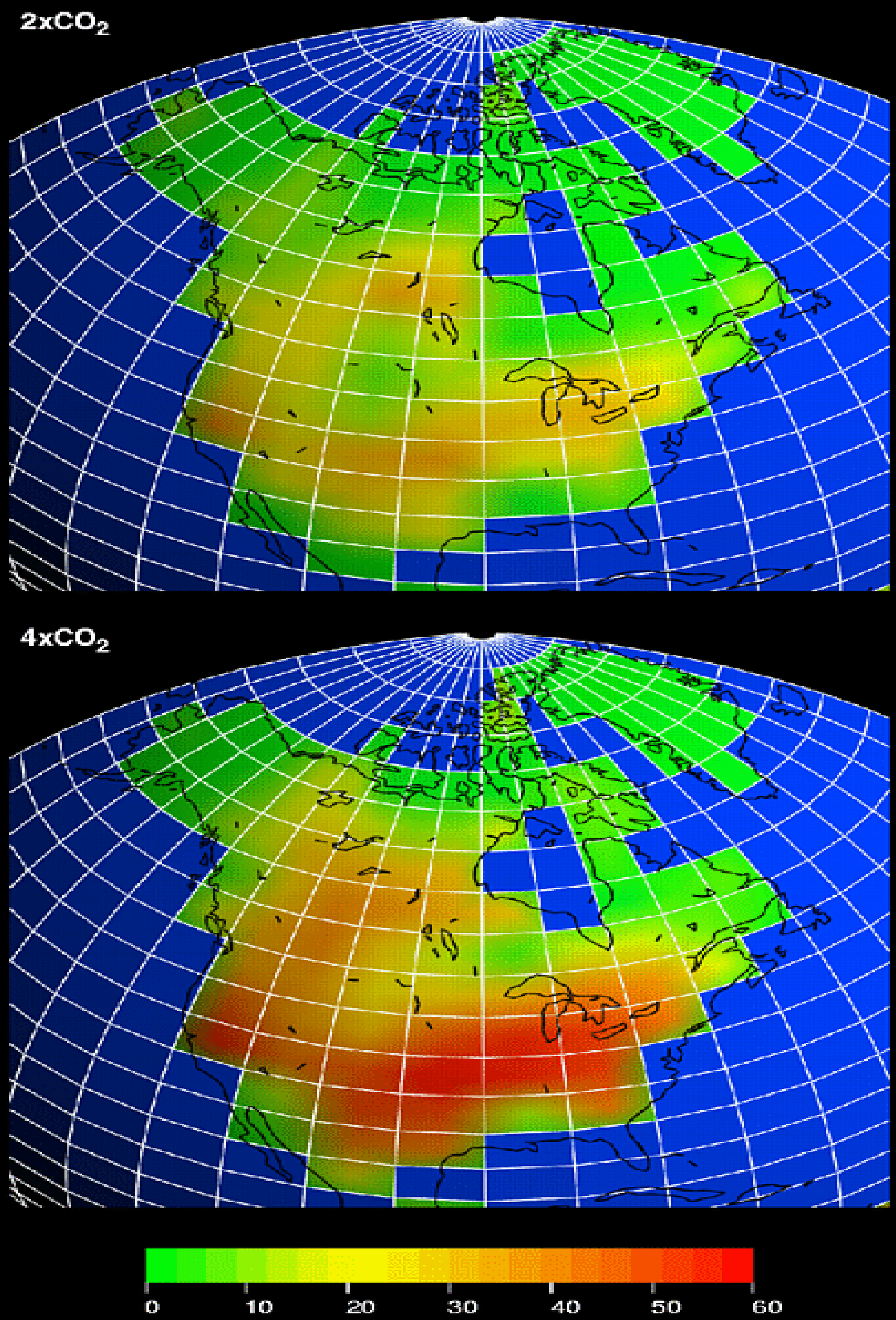


CBH1 from T. reesei



E1 from *A. cellulotiticus*

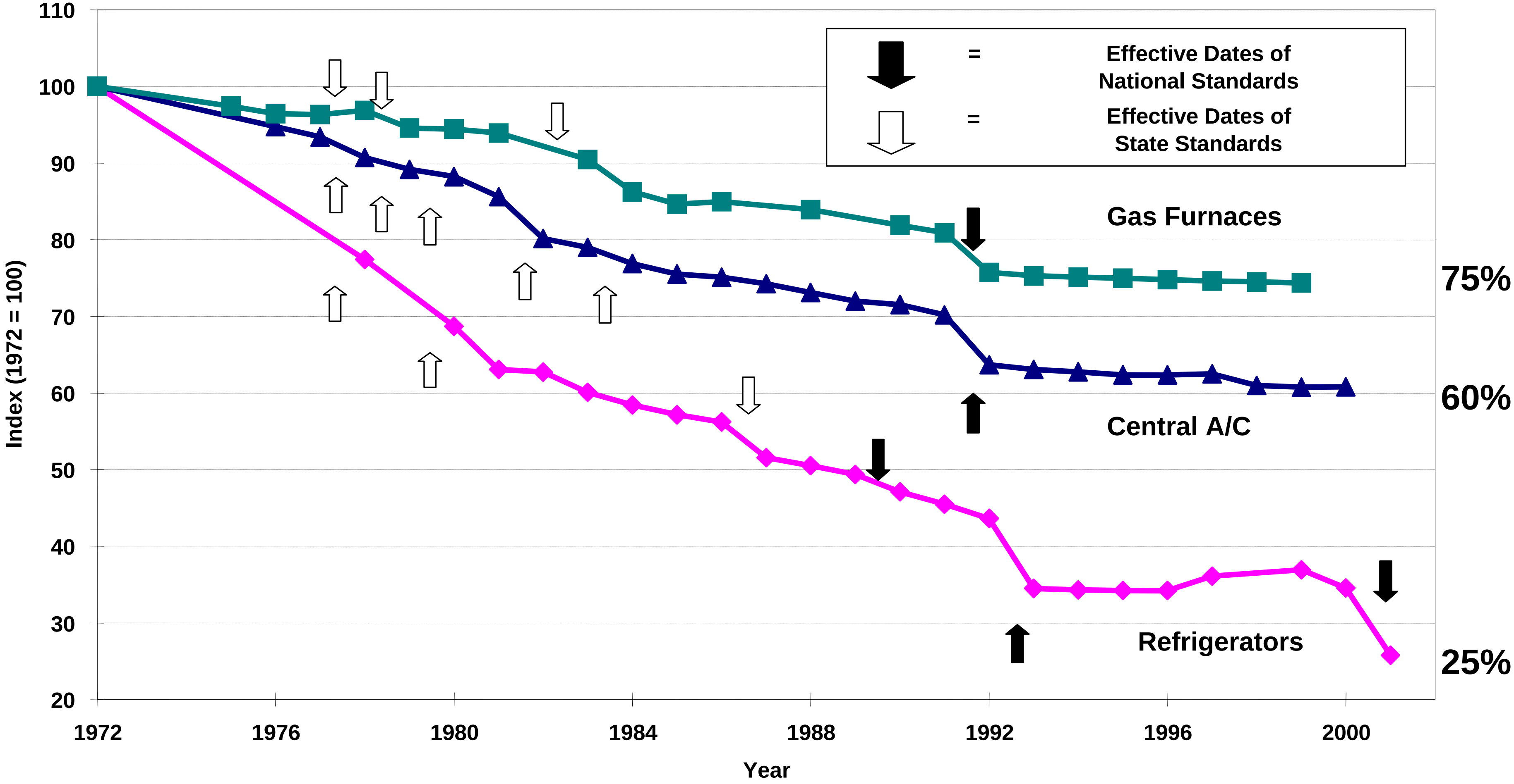




Summer soil moisture in N America under doubled & quadrupled CO_2 (from the Princeton GFDL model)

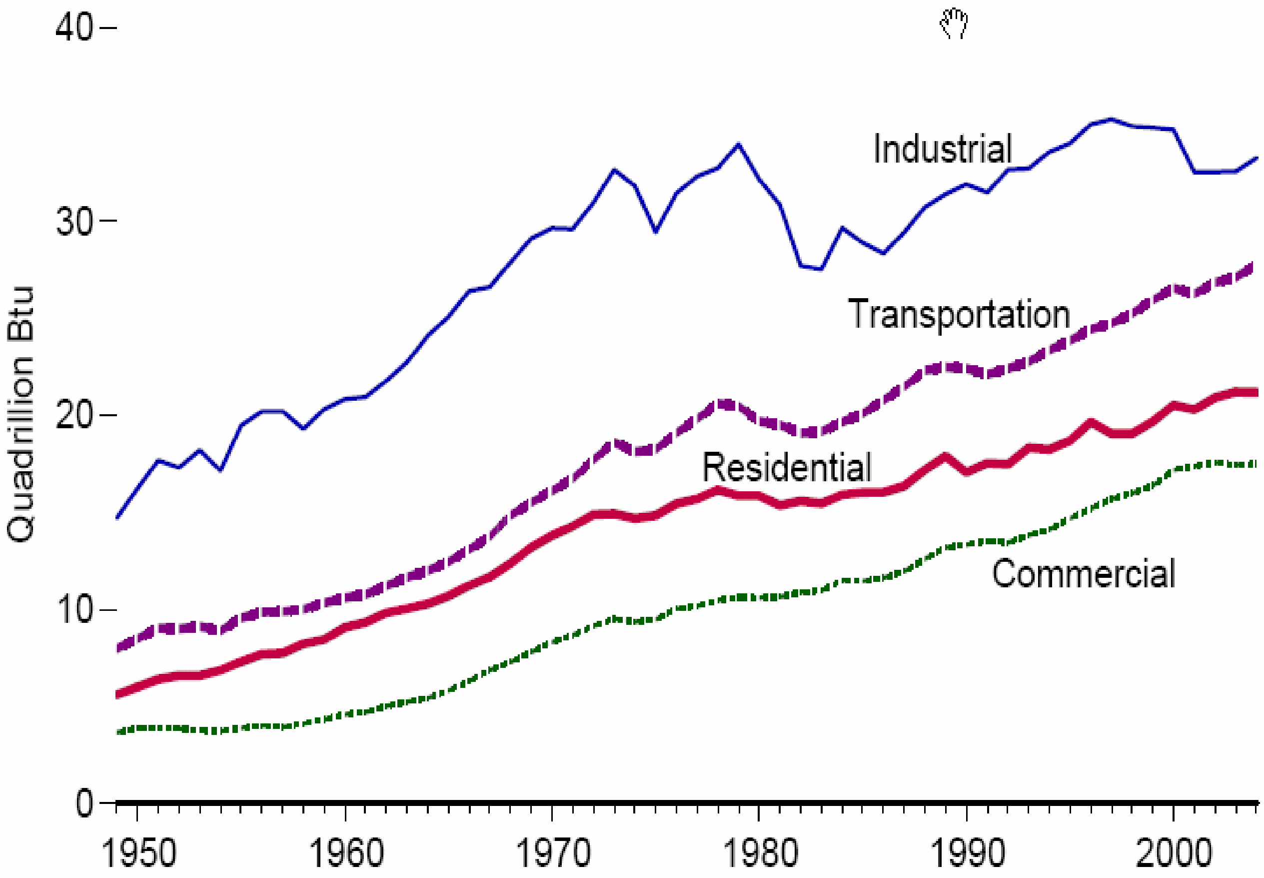
Mid-continent soil-moisture reductions reach 50-60% in the 4xCO_2 world.

Impact of Standards on Efficiency of 3 Appliances



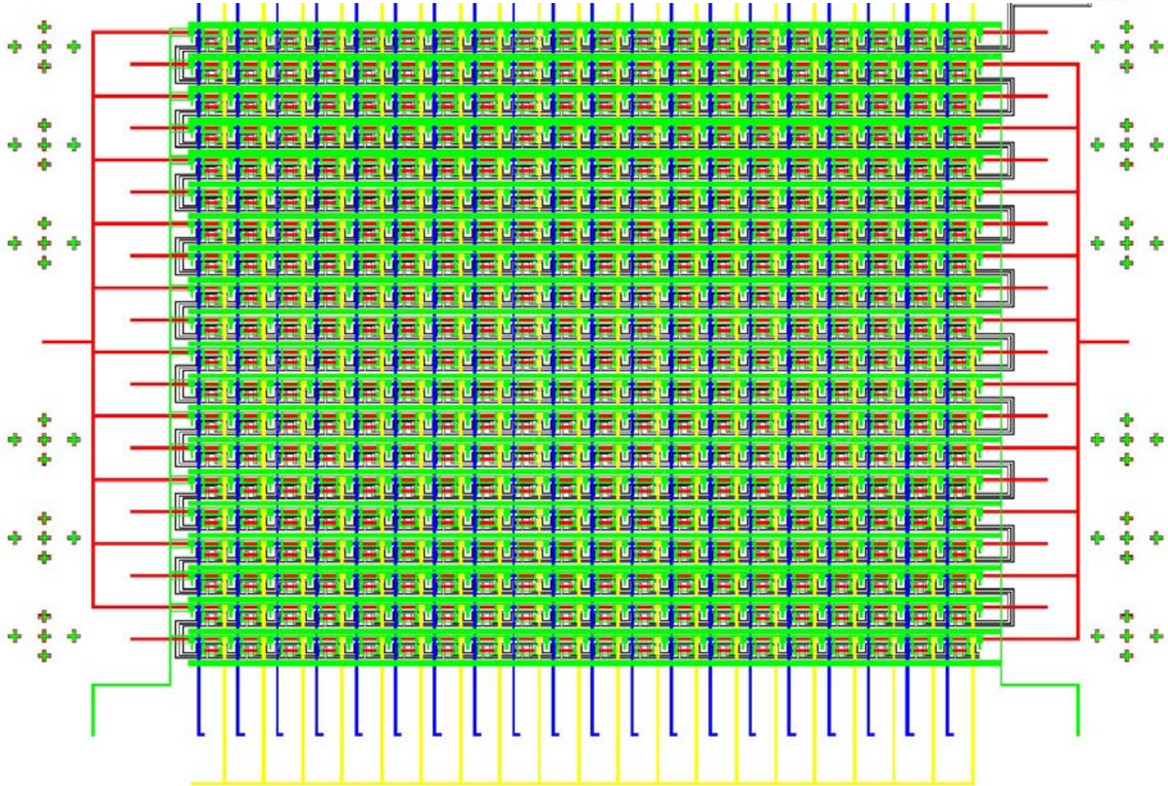
Source: S. Nadel, ACEEE, in ECEEE 2003 Summer Study, www.eceee.org

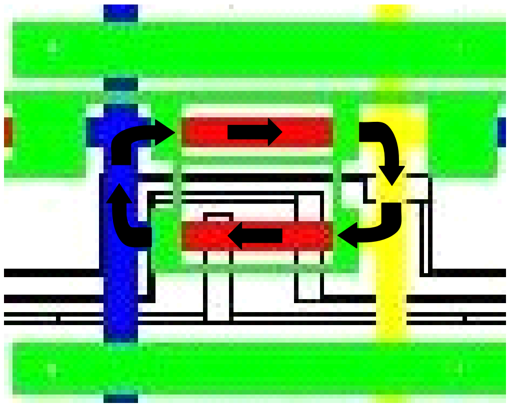
Total end-use energy consumption 1949 – 2004



Micro-fluidic technology can be used to optimize organisms with “directed evolution”

Matrix Polymerase Chain Reaction (PCR)





Red: Primer Input (Multiplexed by N)

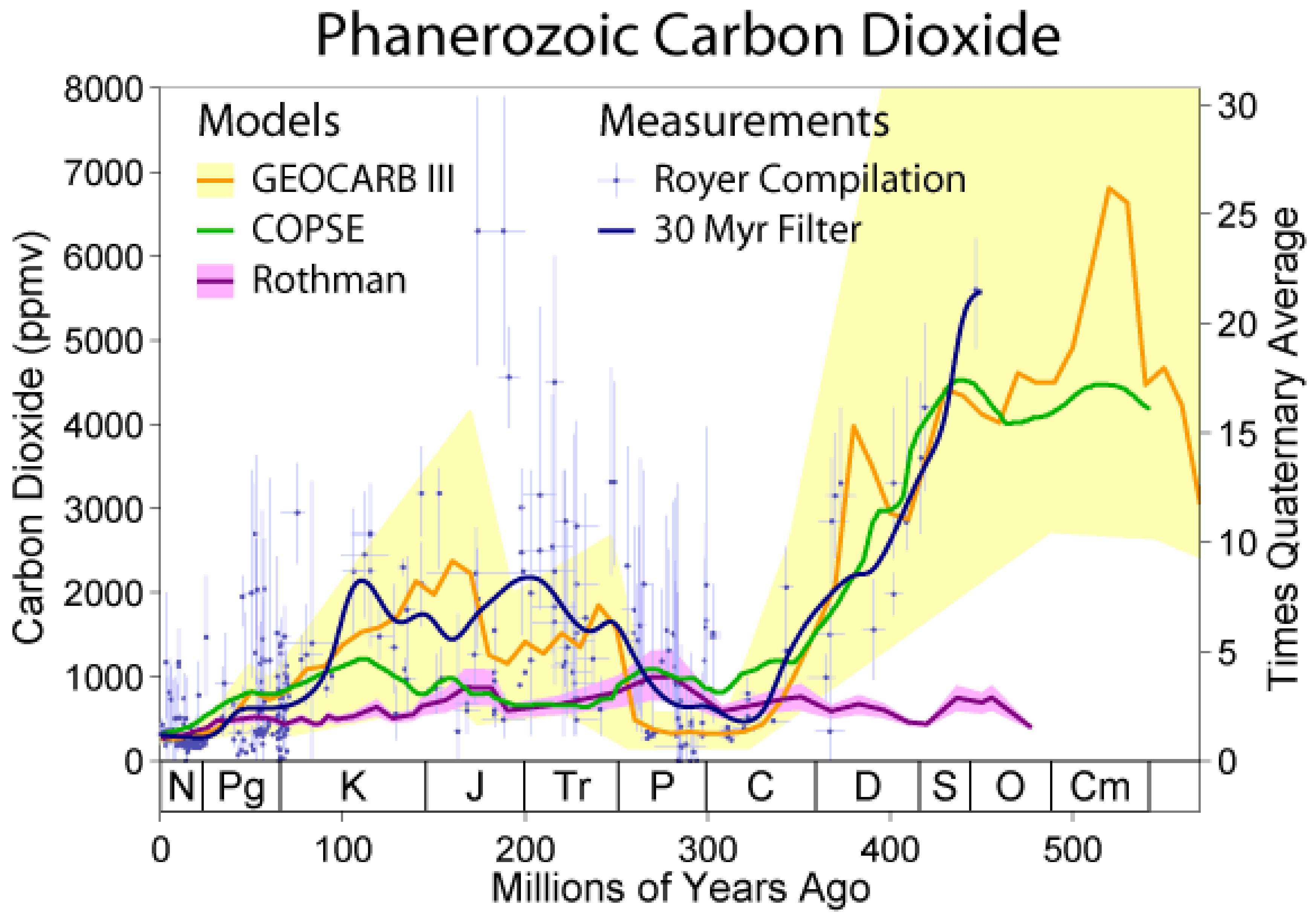
Blue: Template Input (Multiplexed by N)

Yellow: Taq Input (Multiplexed by N^2)

N^2 independent PCR reactions performed with 2N+1 inputs!

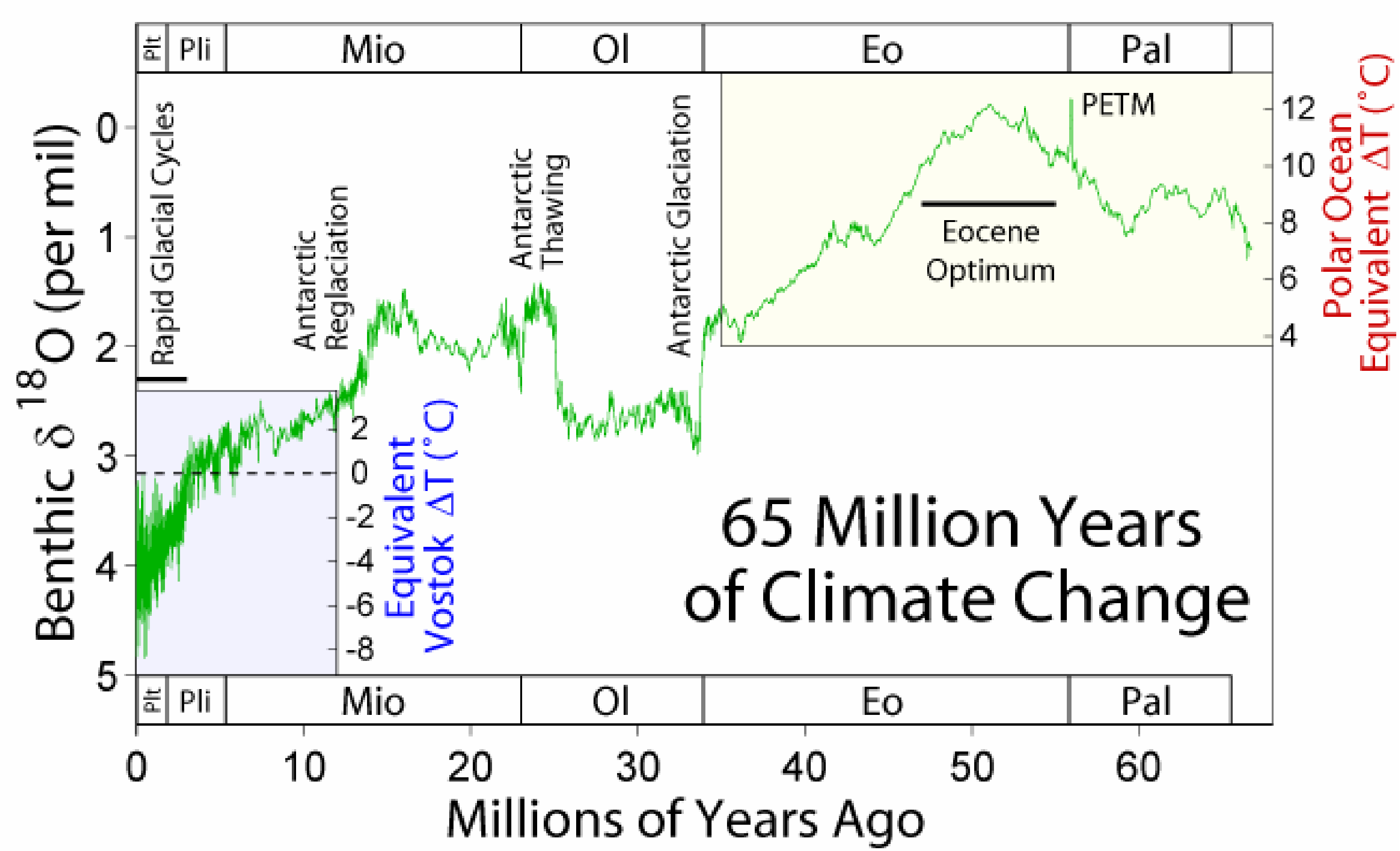
Efficiency

Energy for the Future



Phanerozoic Carbon Dioxide
Models
GEOCARB III
COPSE
Rothman
Measurements
Royer Compilation
30 Myr Filter
Carbon Dioxide (ppmv)
Times Quaternary Average
0
1000
2000
3000
4000
5000
6000
7000
8000
0
5
10
15
20
25
30
N
Pg
K
J
Tr
P
C
D
S
O
Cm
0
100
200
300
400
500
Millions of Years Ago

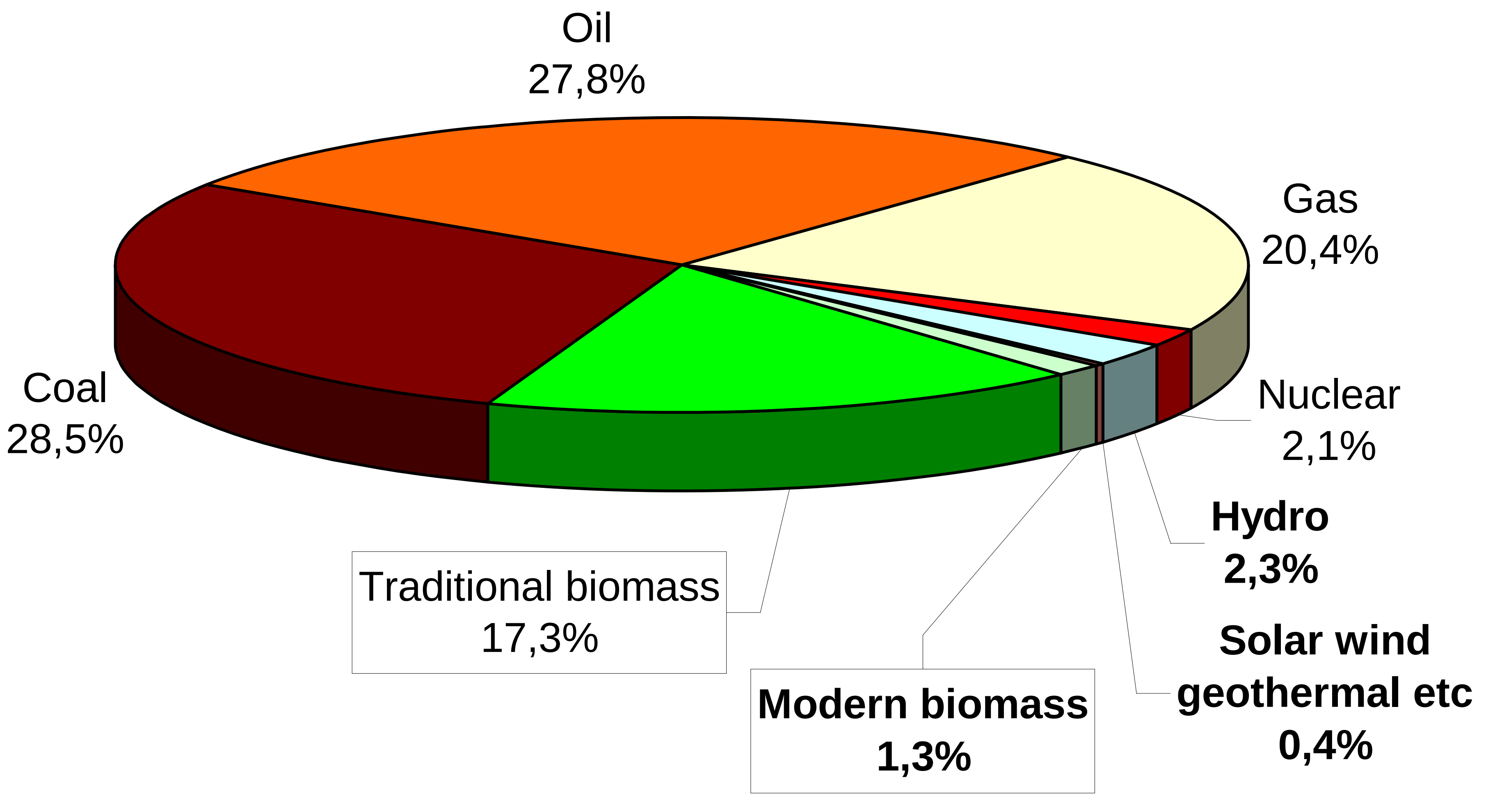
Paleocene-Eocene Thermal Maximum (PETM)



Climate change during the last 65 million years. The PETM and is likely to be understated by a factor of 2 or more due to coarse sampling and averaging in this data set.

Undeveloped (non-OECD) use of Energy (2003)

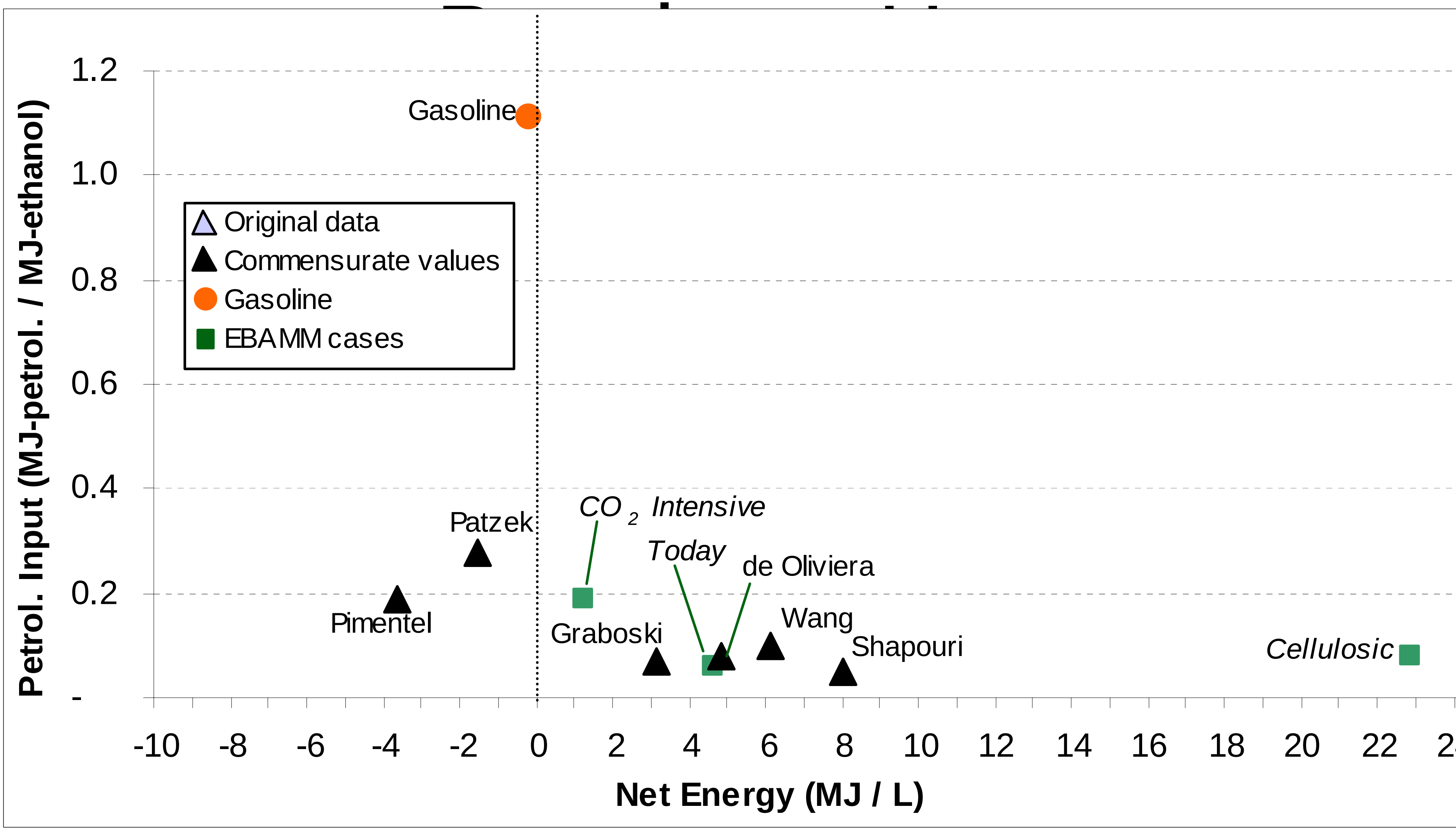
IEA, 2005



Total Surface Area by Land Cover/Use and Year in Millions of Acres, with Margins of Error

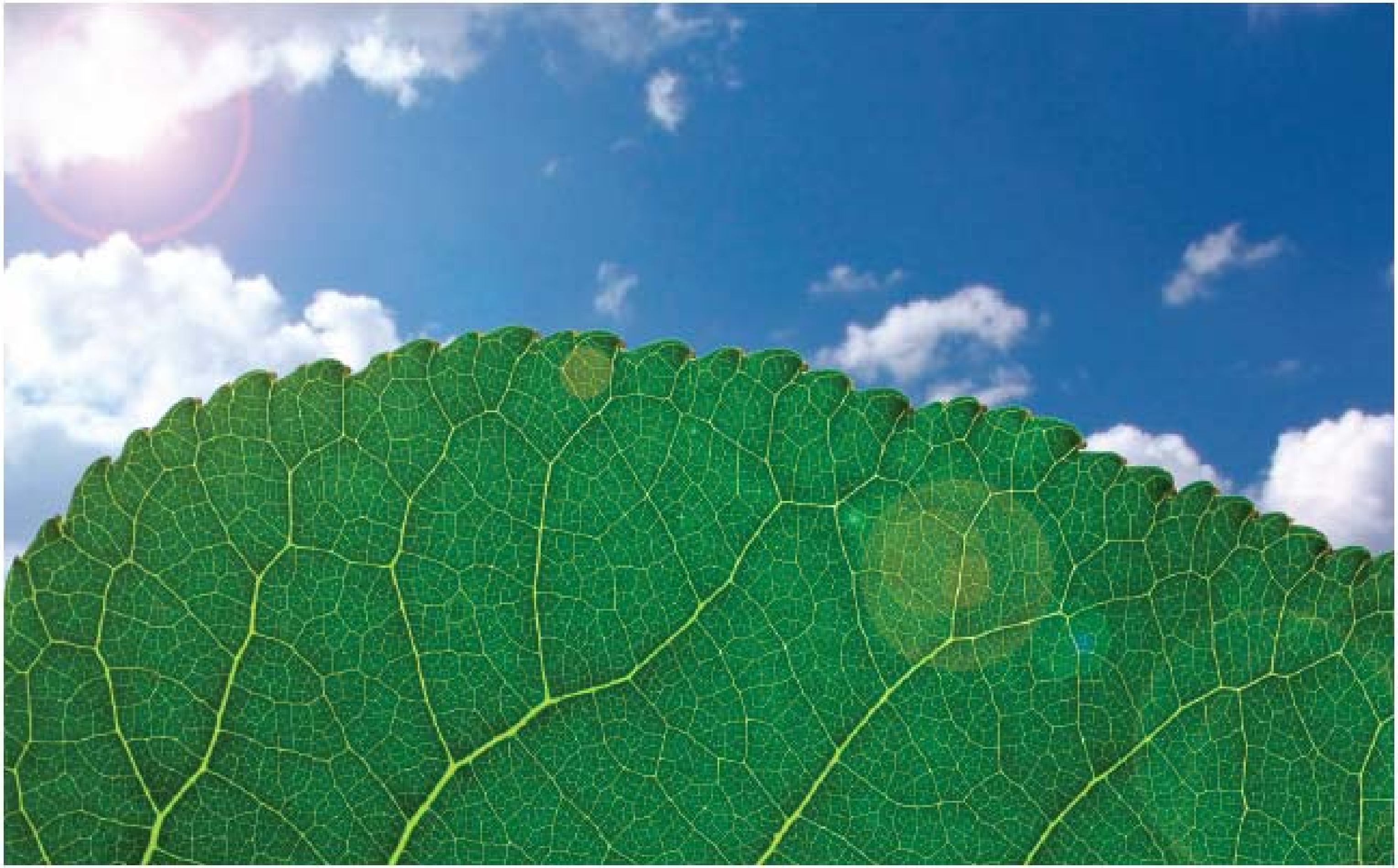
Year	Cropland*	CRP Land*	Pastureland	Rangeland
1982	419.9 ± 2.1	0.0 ± 0.0	131.1 ± 1.4	415.5 ± 3.5
1992	381.3 ± 2.0	34.0 ± 0.2	125.2 ± 1.3	406.8 ± 3.3
1997	376.4 ± 2.0	32.7 ± 0.0	119.5 ± 1.2	404.9 ± 3.3
2001	369.5 ± 2.0	31.8 ± 0.3	119.2 ± 1.8	404.9 ± 3.4
2003	367.9 ± 2.4	31.5 ± 0.3	117.0 ± 1.8	405.1 ± 3.5

Source: US Dept of Agriculture



Alex Farrell, Dan Kammen, et. al.,
“Meta-analysis” of existing literature, Science 2006

Energy Biosciences Institute



University of California, Berkeley

Lawrence Berkeley National Laboratory

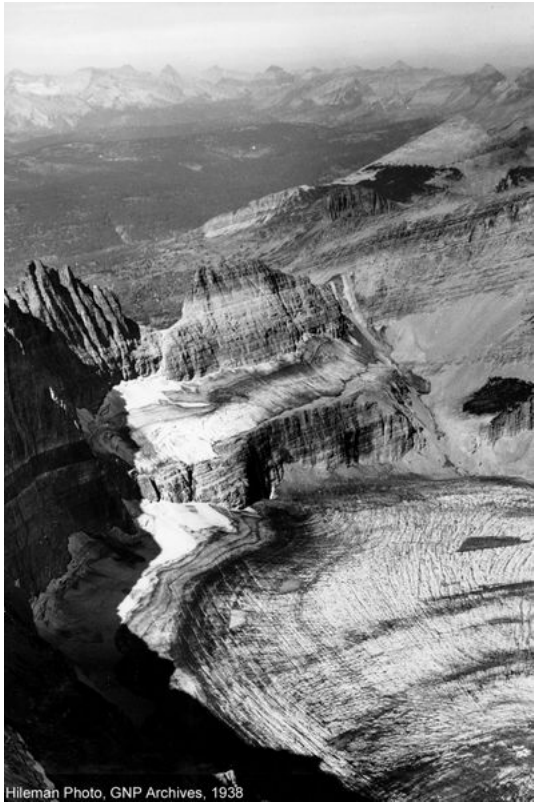
University of Illinois at Urbana-Champaign

Significant climate change could lead to:

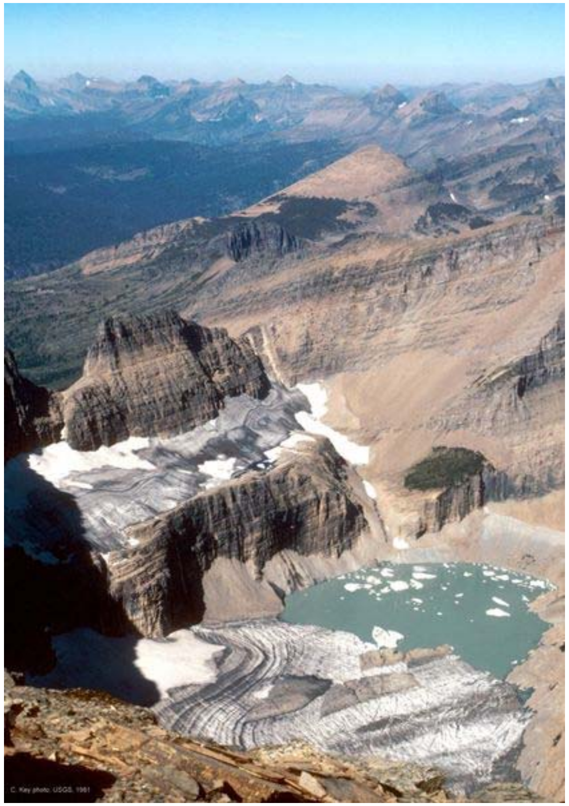
- Increased damage from storms, floods, wildfires
- Property losses and population displacement from sea-level rise
- Productivity of farms, forests, & fisheries
- Increased species extinction
- Change in the geography of disease

Grinnell Glacier, Glacier National Park, Montana

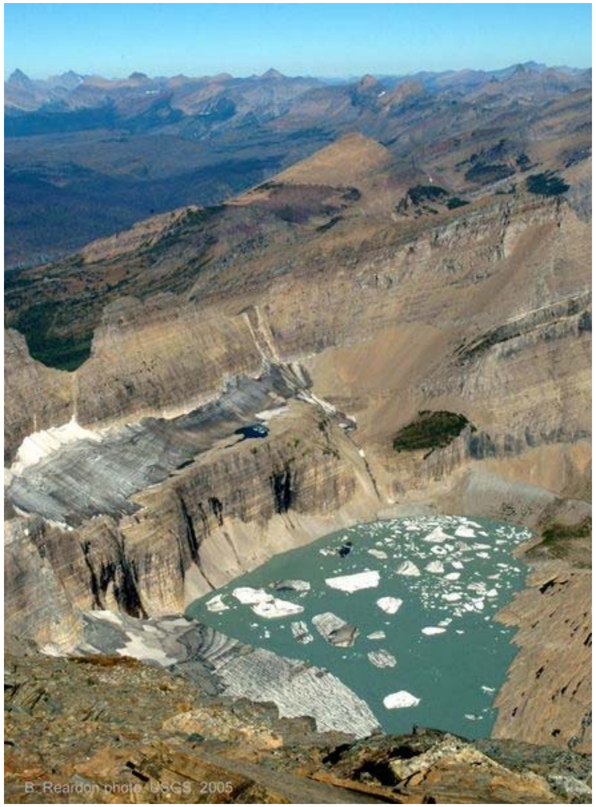
(Recession has been 1.1 Km since the end of the little ice age circa 1850)



1938



1981



2005

The Energy problem means different things to different people

- ~ 1.6 billion people do not have access to electricity.
- In rural areas, women and children can spend ***1-2 hours a day*** foraging for biomass for cooking and heating.
- Indoor air pollution from primitive cooking methods and kerosene lighting is estimated to kill ~1.5 million people a year.

Sunlight to energy via Bio-mass

Sunlight, CO_2, H_2O, Nutrients → Biomass → Chemical energy

More efficient use of water, sunlight, nutrients.

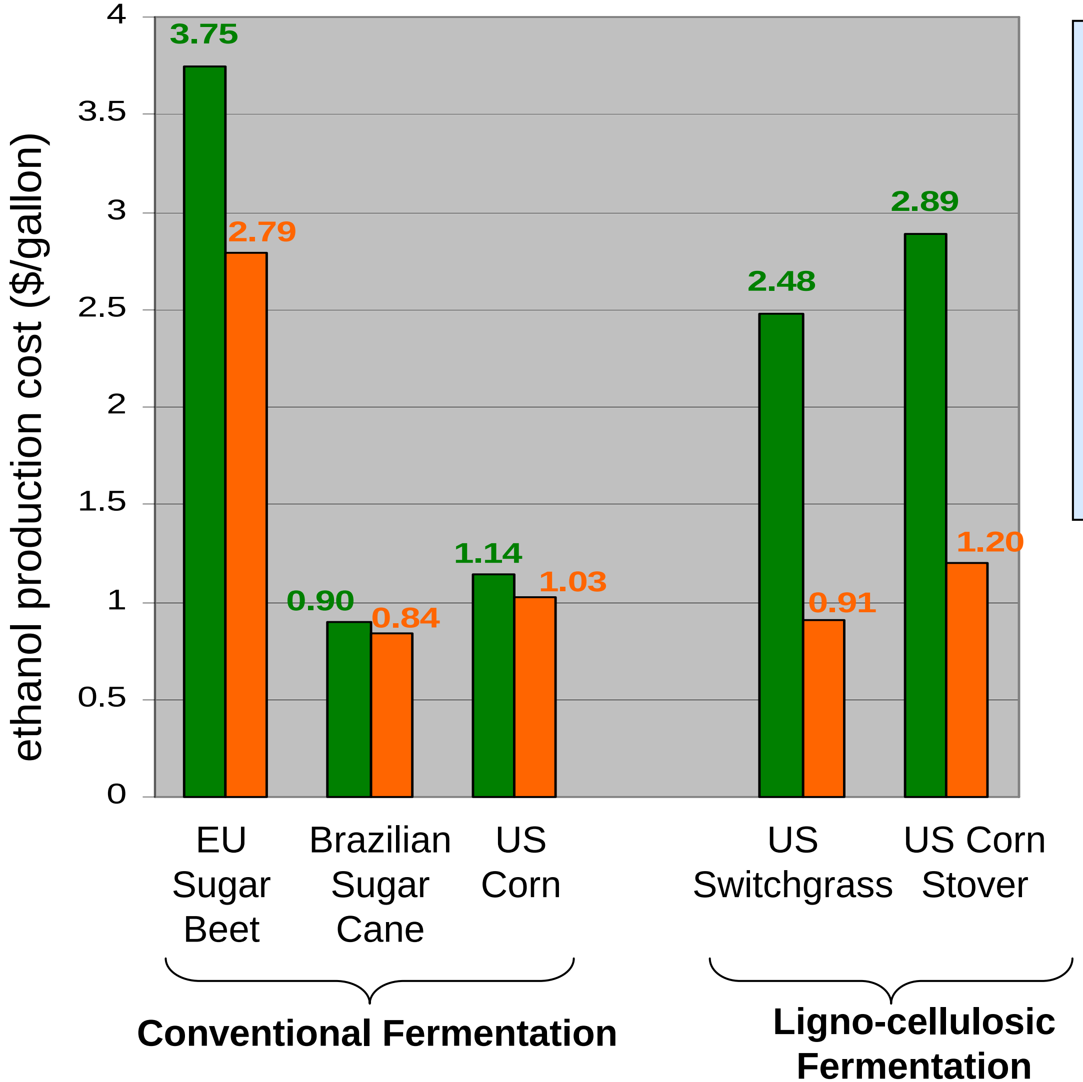
Drought and pest resistant

Improved conversion of cellulose into fuel.
New organisms for biomass conversion.

Plant growth fixes CO_2
Burning the fuel generates CO_2

current and projected production costs of bio-gasoline components

Courtesy Steve Koonin, BP Chief Scientist



- Ligno-cellulosic biomass is the key to materiality and sustainability of biofuels in long term
- Currently uneconomic – 1/2 pilot plants operating
- Technology advances will dramatically reduce costs

Key:

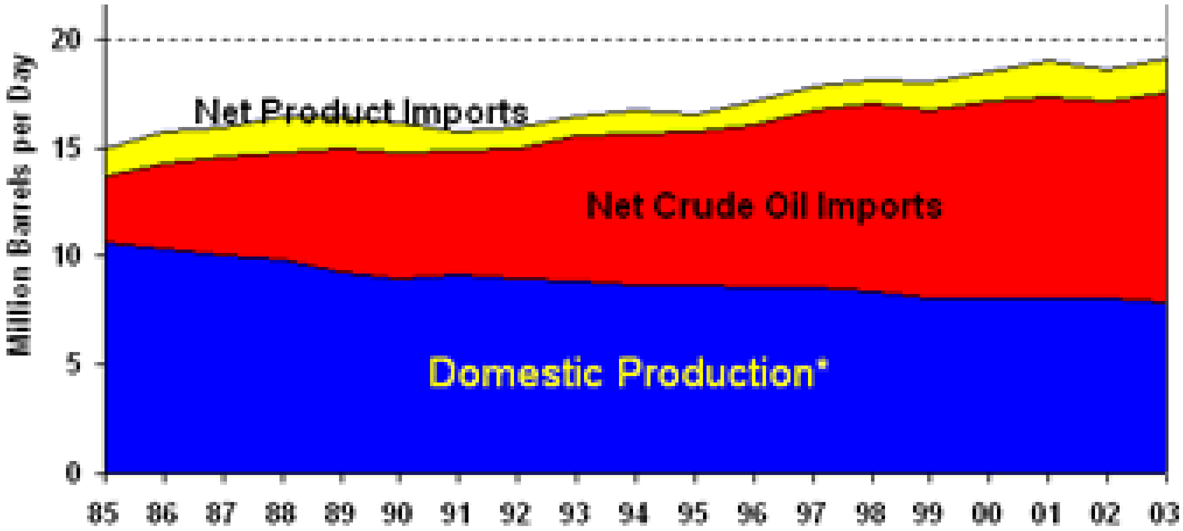
Base case

10 year plausible technology stretch

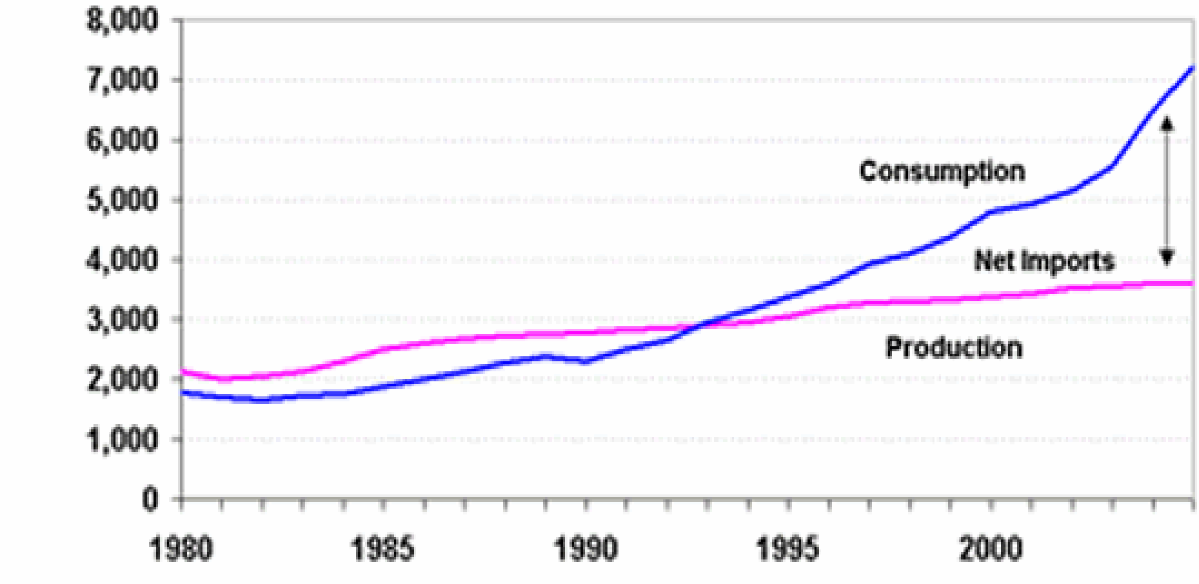
Source: BP Analysis, NREL, CERES, NCGA

U.S. Oil Production and Imports

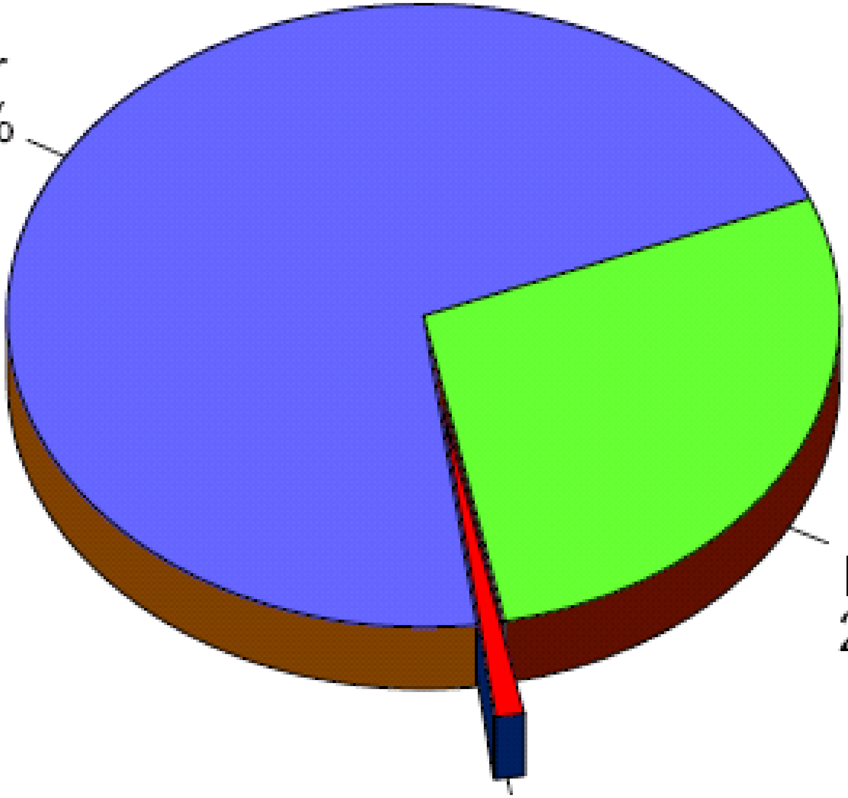
US became a net importer of oil in 1970



China oil consumption and production 1980 -2005



~ 100,000 TW of energy is received from the sun

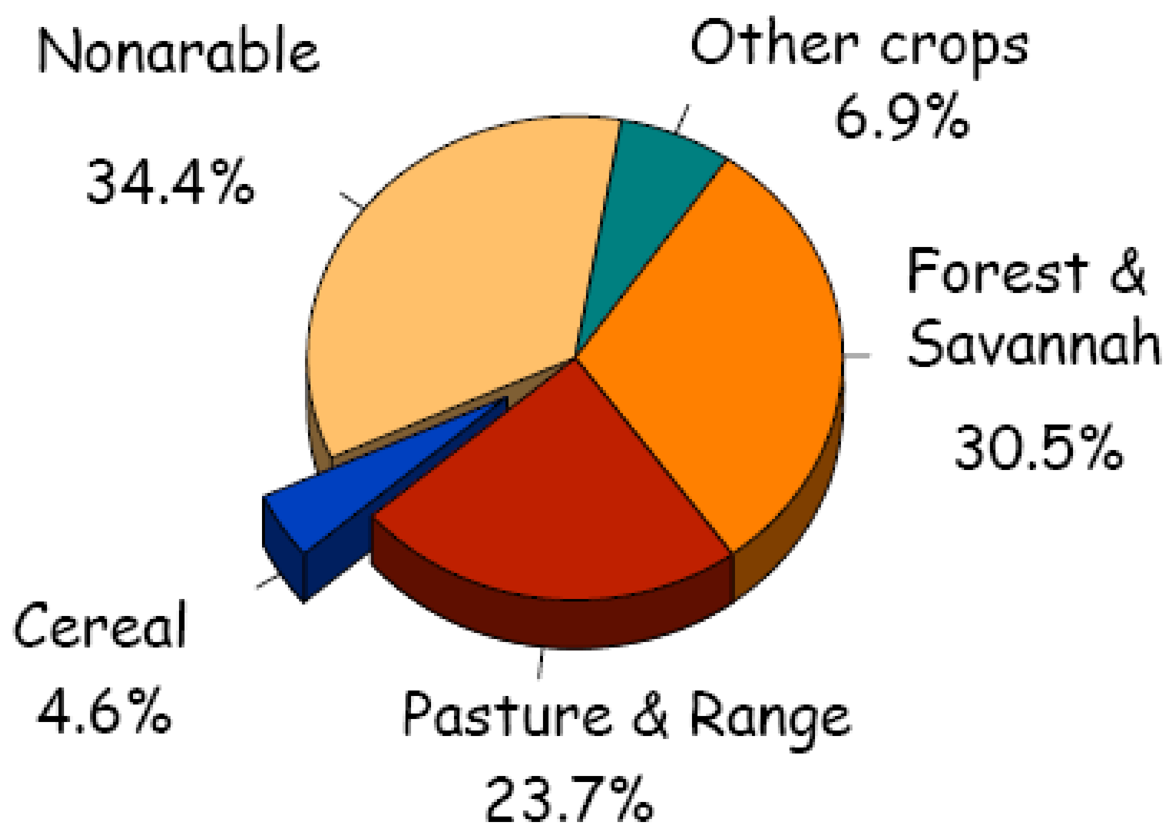


Amount of land needed to capture 13 TW:

20% efficiency (photovoltaic) = 0.23%
1% efficiency (bio-mass) = 4.6%

~13 B ha of land in the Earth

- 1.5 B ha for crops
- 3.5 B ha for pastureland
- 0.5 B ha are "built up"
- 7.5 B ha are forest land or "other"



Projected Population Growth