

Fossil Fuels, Energy Efficiency, and Carbon Emissions: Carbon Emissions:

A Different Future?

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Presentation Outline

- Energy demand growth
- Global overview of fossil fuel reserves
- Changes in the global energy scene
- FutureGen: what is it?
- Carbon sequestration

Sources of Information

- BP Statistical Review, London (BP)
- Center for Strategic and International Studies (CSIS), Washington, D.C.
- U.S. Energy Information Administration (EIA)
- International Energy Agency, Paris (IEA)
- U.S. Geological Survey (USGS)
- Midwest Geological Sequestration Consortium
- Chevron Corporation

Key Observations

- The world is on an “energy express train” with respect to expanding use of conventional fossil fuels
- Developing countries are pursuing living standards and industrialization with impacts that are just beginning to be globally felt
- Coal is abundant, but we need to solve coal’s emissions and climate issues through new technology like IGCC and FutureGen
- Globally, we are adding 70 million people per year and 450 million additional vehicles are expected by 2030

World Energy Projections: 2020-2030*



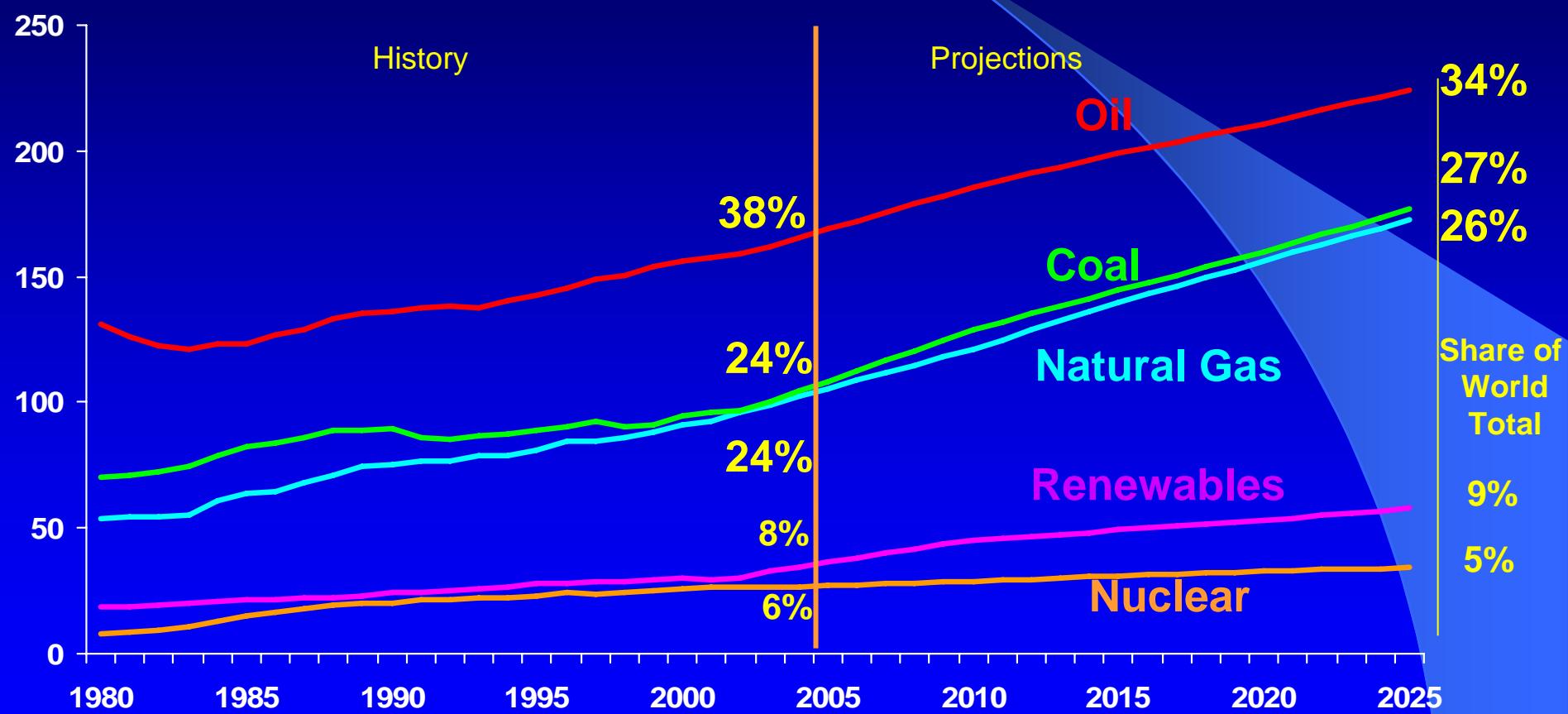
- Oil demand growth will reach 104 mmbd in 2020, and 118 mmbd in 2030, up from 84.5 mmbd in 2006*
- Coal demand will grow 47 percent from 4.8 bty to 7.0 bty by 2030
- In 2002, 1.6 of 6.1 billion people lacked electricity; in 2030 1.4 billion of 8.3 billion people may still lack electricity**

*EIA 2007, BP, 2006

**IEA, 2001, 2002

World Marketed Energy Use by Fuel, 1980-2025

(quadrillion Btu)

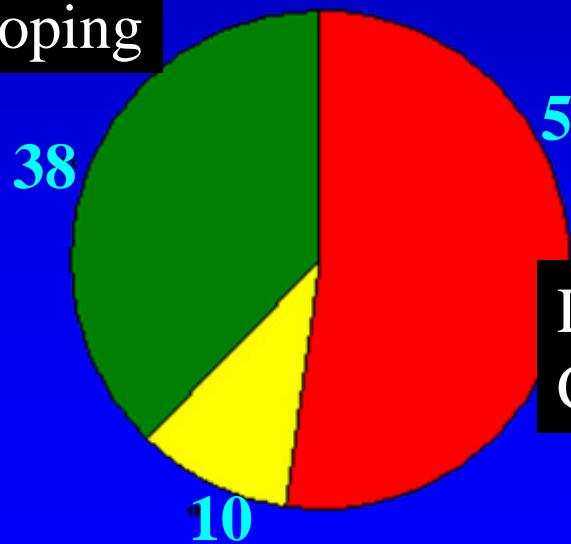


Regional Shares in World Energy Demand, percent (IEA, 2004)

2002
10,200 Mtoe

2030
16,325 Mtoe

Developing

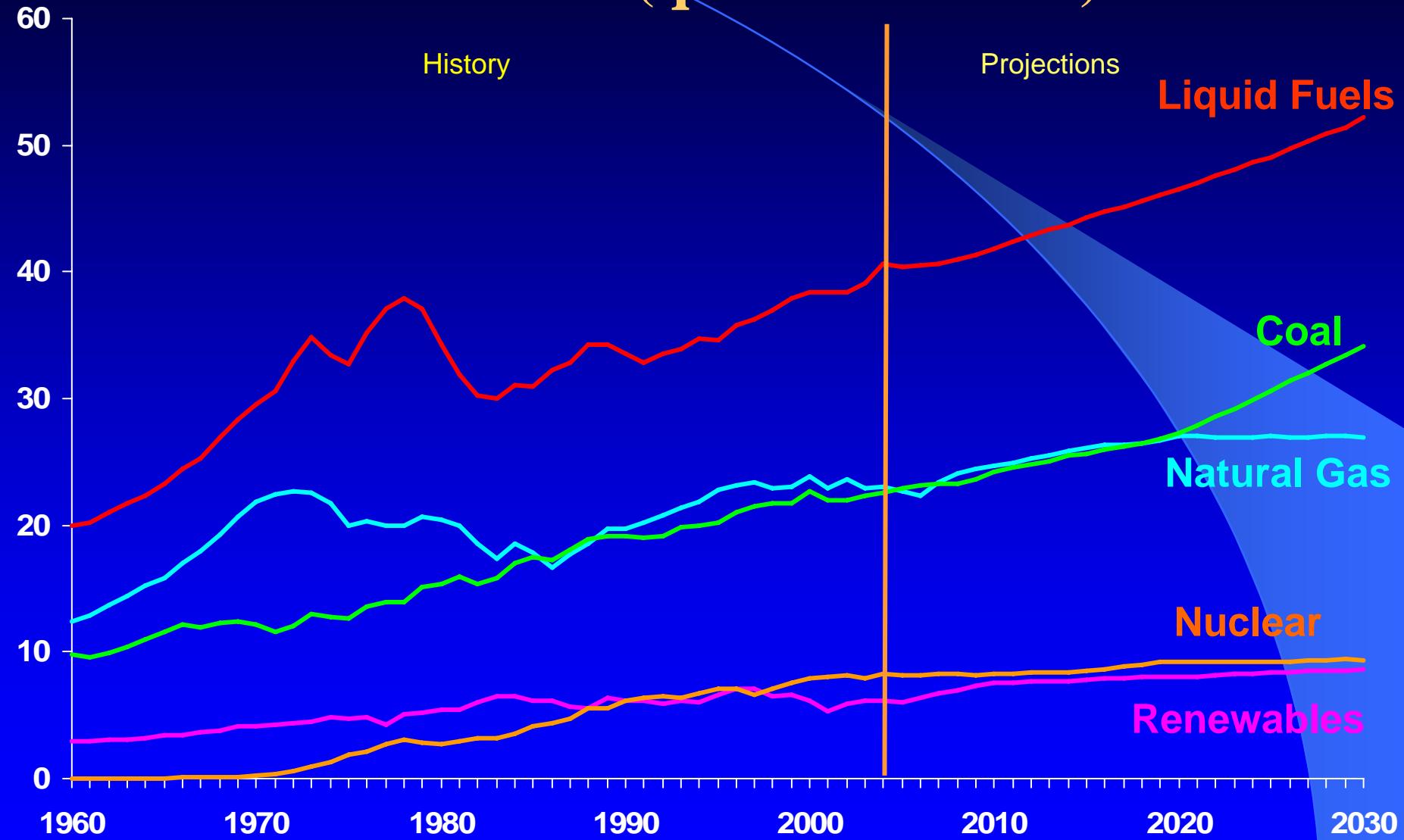


Developed
Countries



Transition Economies

U.S. Primary Energy Consumption by Fuel, 1960-2030 (quadrillion Btu)





World Oil Reserves (BP, 2004)

- Known world oil reserves will last 43 years at current rates of consumption
- The Middle East holds about 63 percent of proven reserves while North America holds about 6 percent

Proved Oil Reserves End 2005 (BP, 2006)

Proved reserves at end 2005
Thousand million barrels



Middle East
742.7

742.7

Asia Pacific
40.2

North America
59.5

S. & Cent. America
103.5

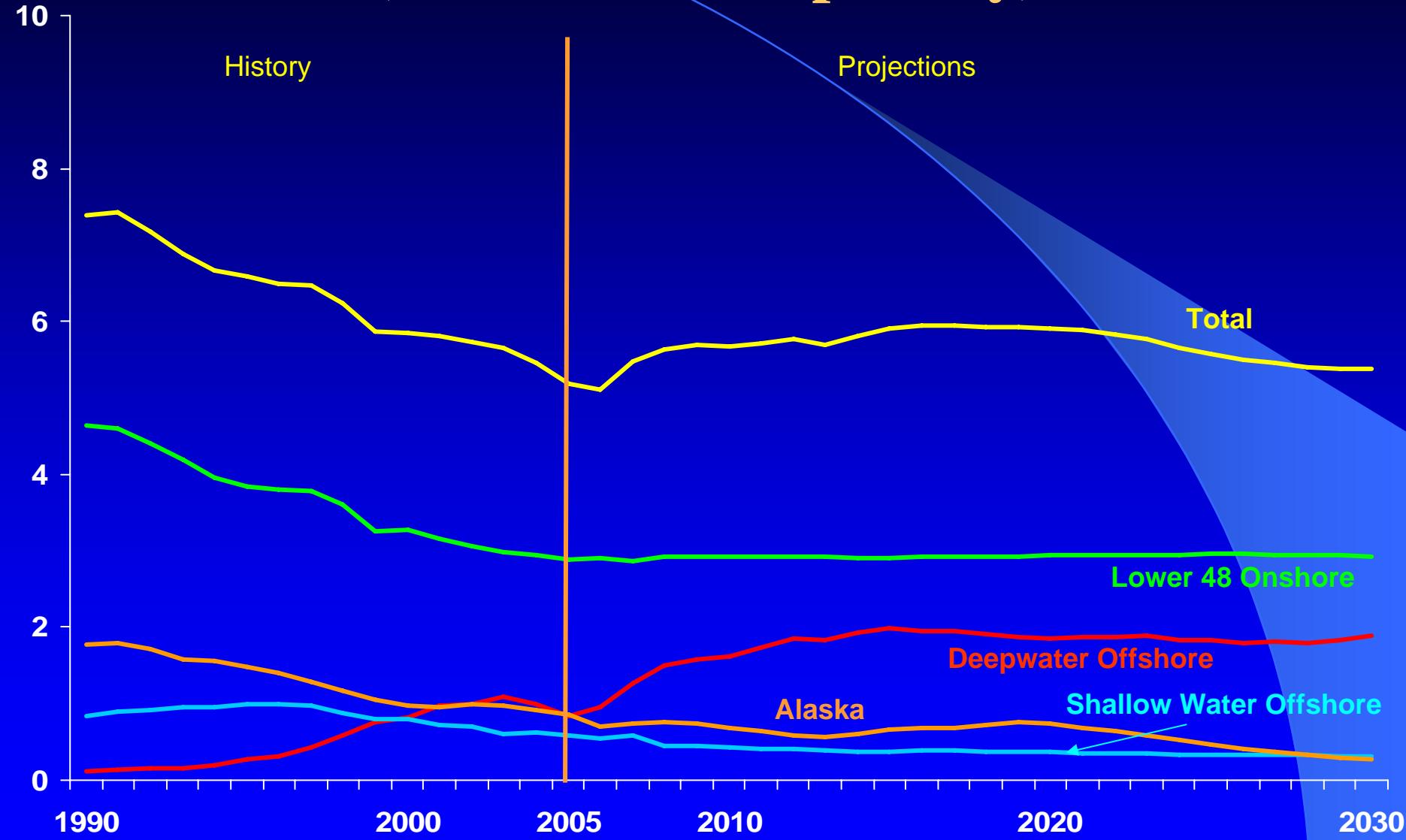
Africa
114.3

Europe & Eurasia
140.5

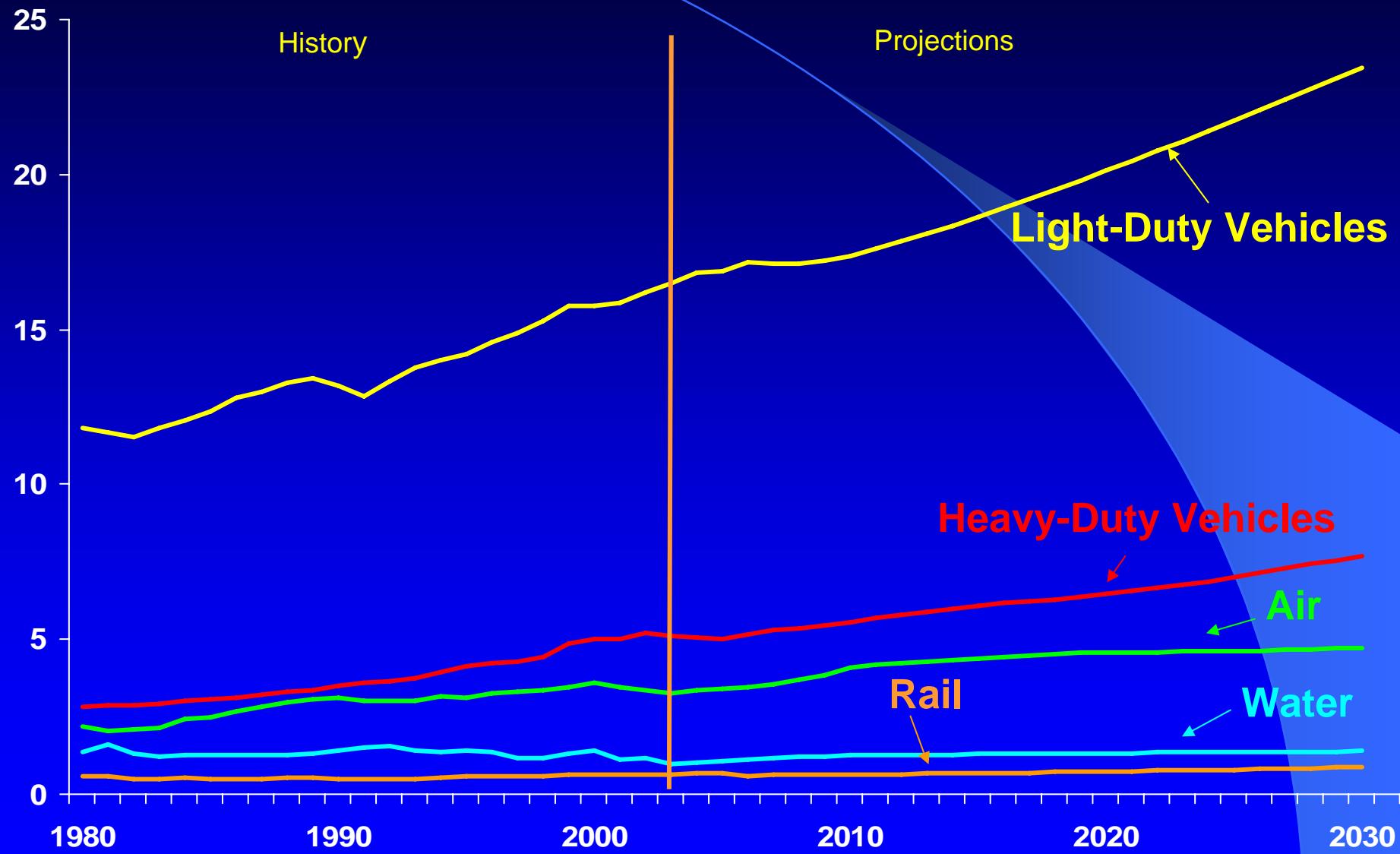
140.5

U.S. Crude Oil Production by Source, 1990-2030

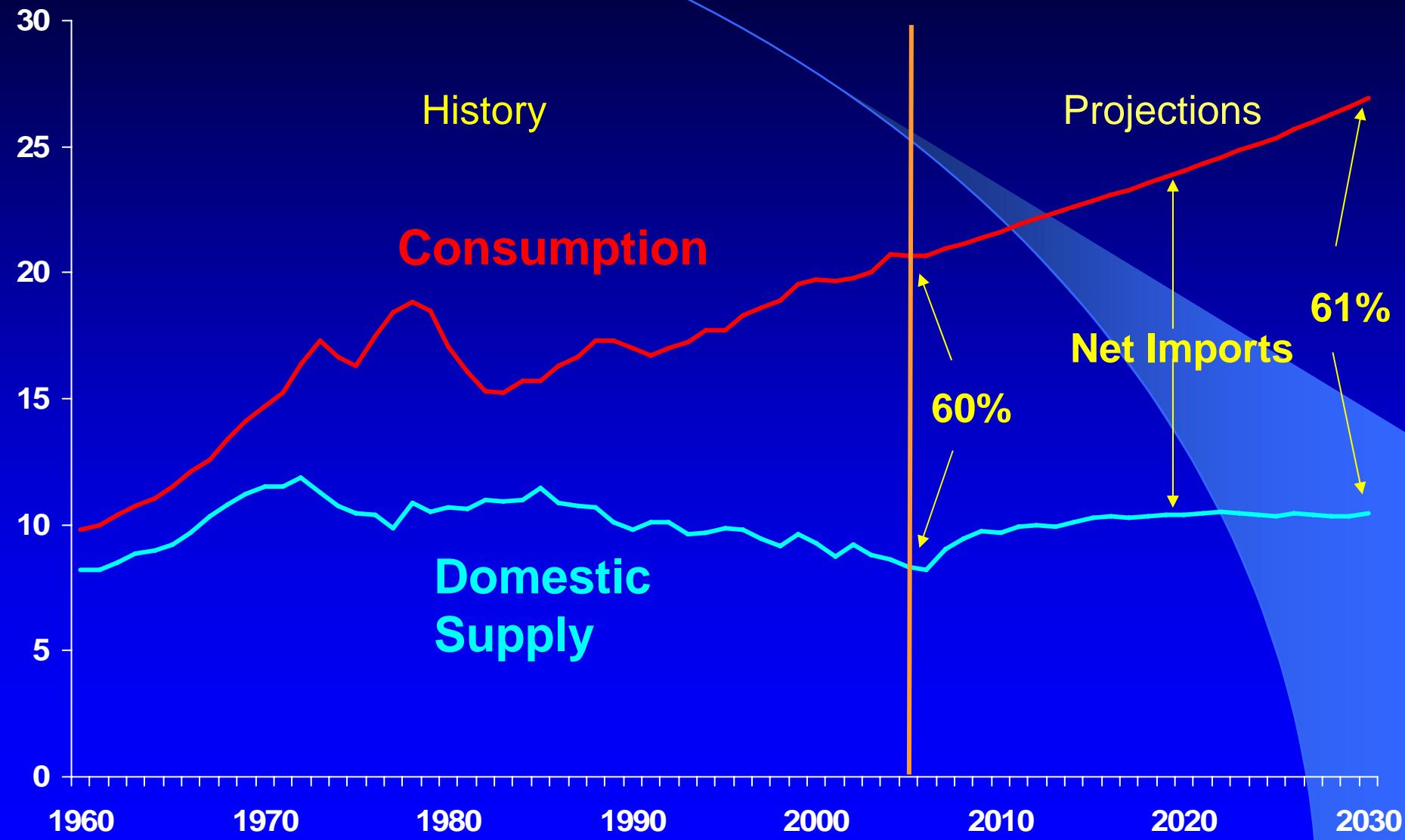
(million barrels per day)



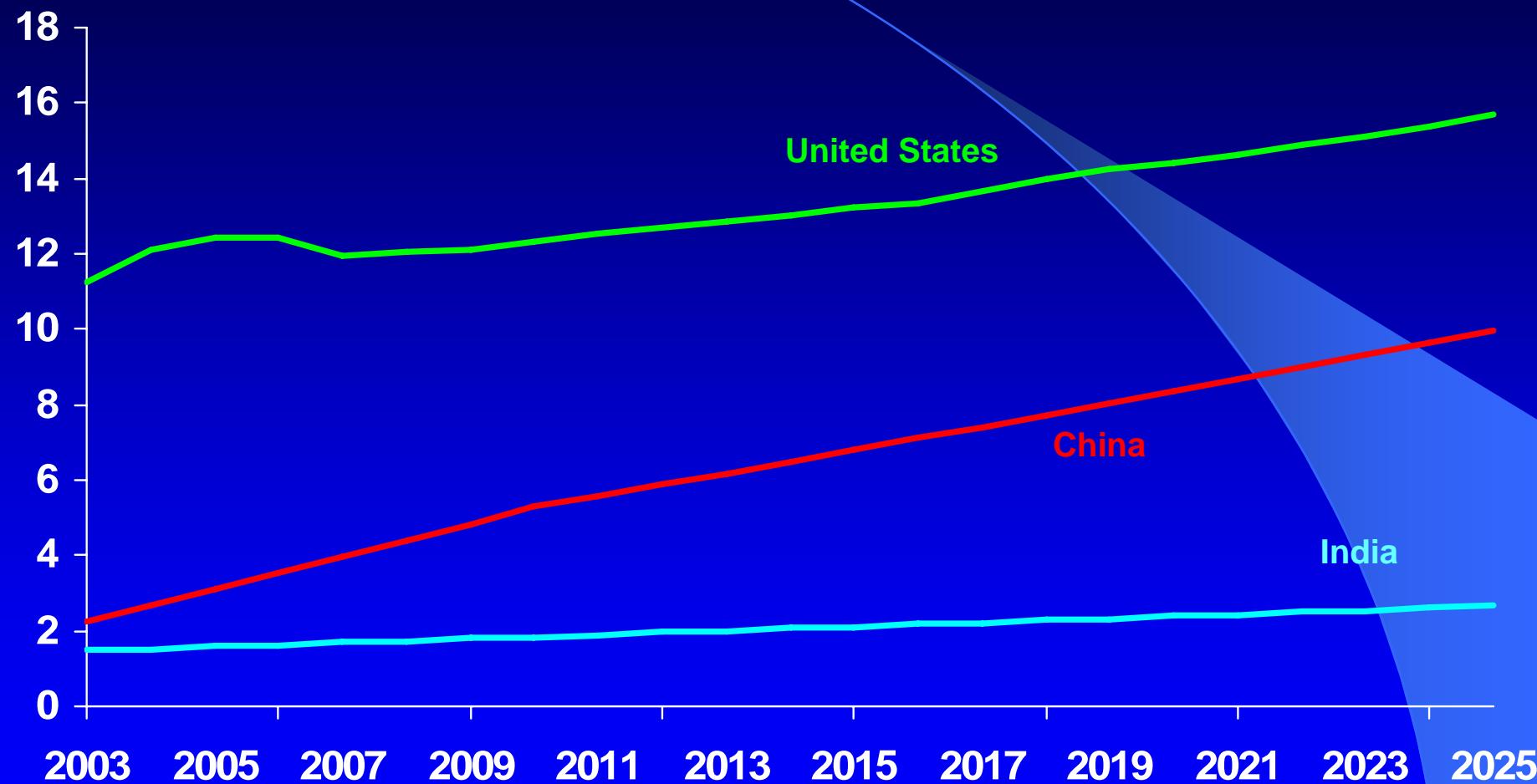
U.S. Transportation Energy Consumption by Mode, 1980-2030 (quadrillion Btu)



U.S. Petroleum Supply, Consumption, and Net Imports, 1960-2030 (million barrels/day)



Net Oil Imports in the United States, China, and India, 2003-2025 (million barrels/day)

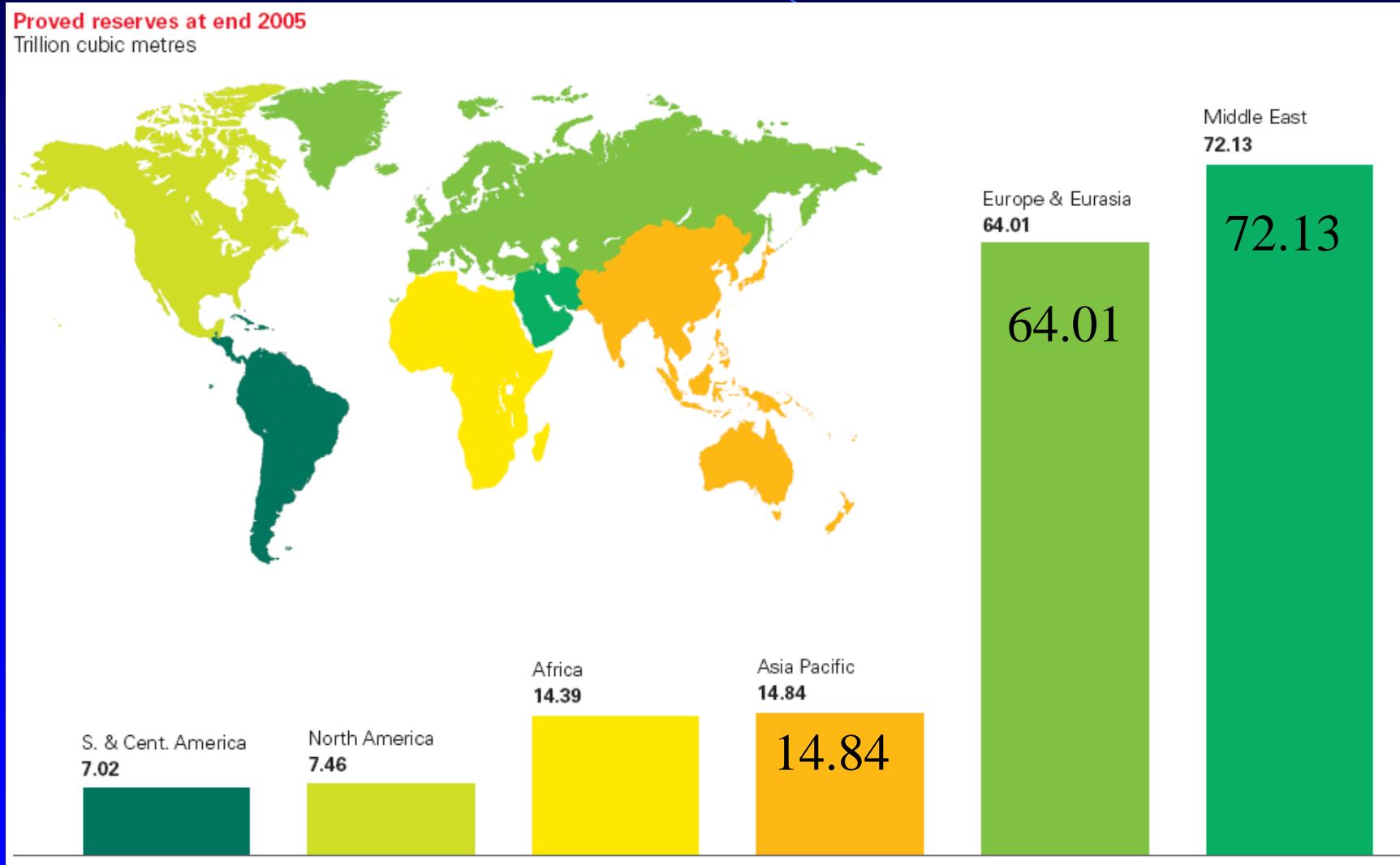




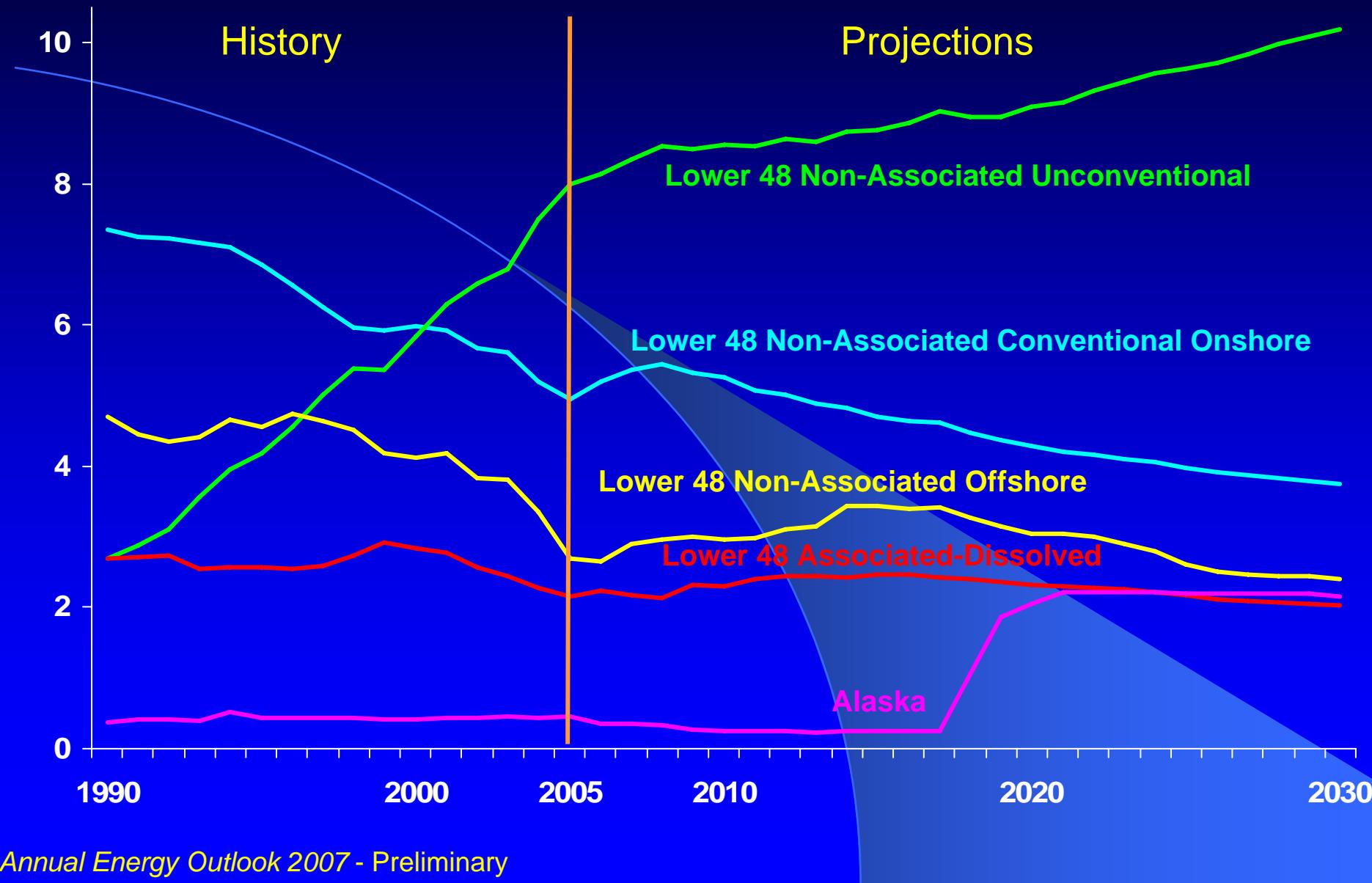
World Natural Gas Reserves (BP, 2004)

- Known world gas reserves will last 64 years at current rates of consumption
- The former Soviet Union has 8 times the gas reserves of North America and the Middle East has 7 times

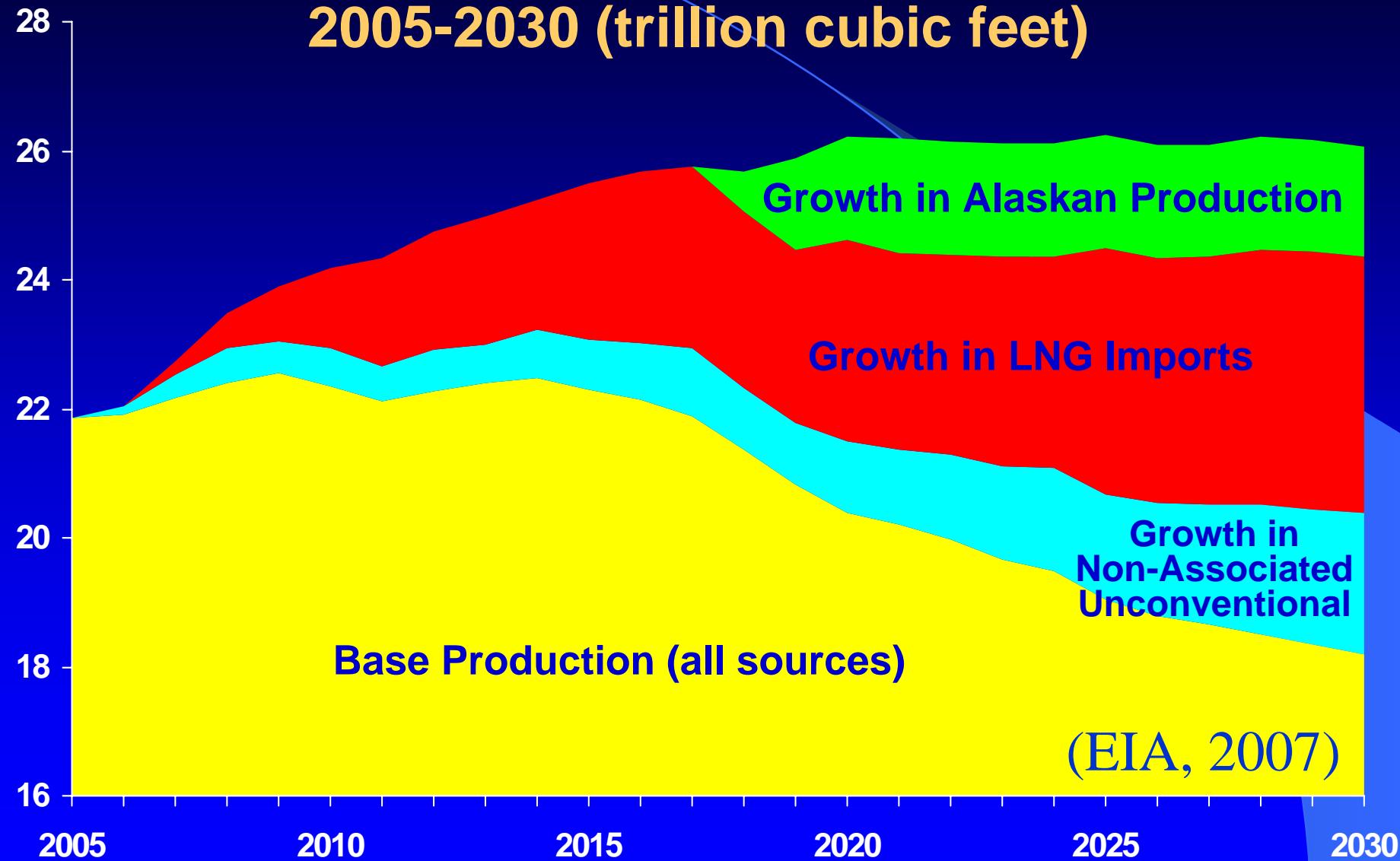
Proved Natural Gas Reserves End 2005 (BP, 2006)



U.S. Natural Gas Production by Source, 1990-2030 (trillion cubic feet)



Major Sources of Incremental U.S. Natural Gas Supply, 2005-2030 (trillion cubic feet)





World Coal Reserves (BP, 2005)

- Known world coal reserves will last 312 years at current rates of consumption
- Three areas of the world have “subequal”, major coal resources:
 - Asia Pacific 297 billion tons
 - North America: 254 billion tons
 - Europe and Eurasia: 287 billion tons

Proved Coal Reserves End 2005 (BP, 2006)

Proved reserves at end 2005

Thousand million tonnes (share of anthracite and bituminous coal is shown in brackets)



Middle East
0.4 (0.4)

S. & Cent. America
19.9 (7.7)

Africa
50.3 (50.2)

North America
254.4 (115.7)

254.4

Europe & Eurasia
287.1 (112.3)

287.1

Asia Pacific
296.9 (192.6)

296.9



Coal: An Old Fuel in Abundant Supply (BP, 2004)

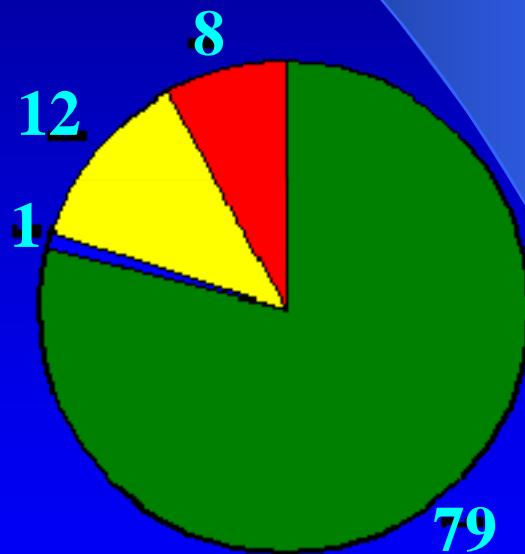
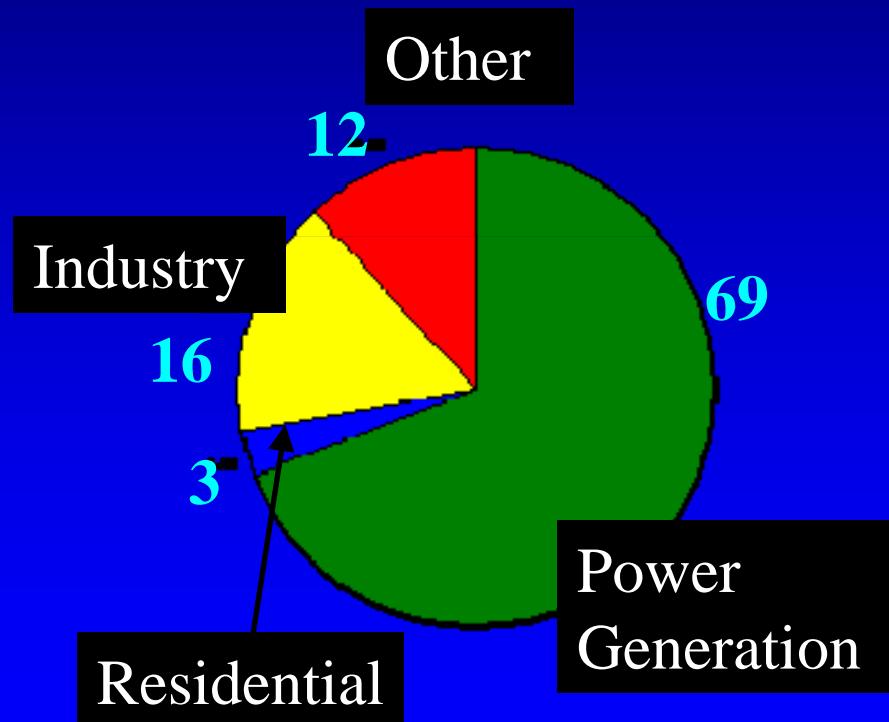
The United States:

- - holds 25 percent of world coal reserves
- - accounts for 22 percent of world production
- - accounts for 22 percent of world consumption
- (“balance” between reserves, production, and use)

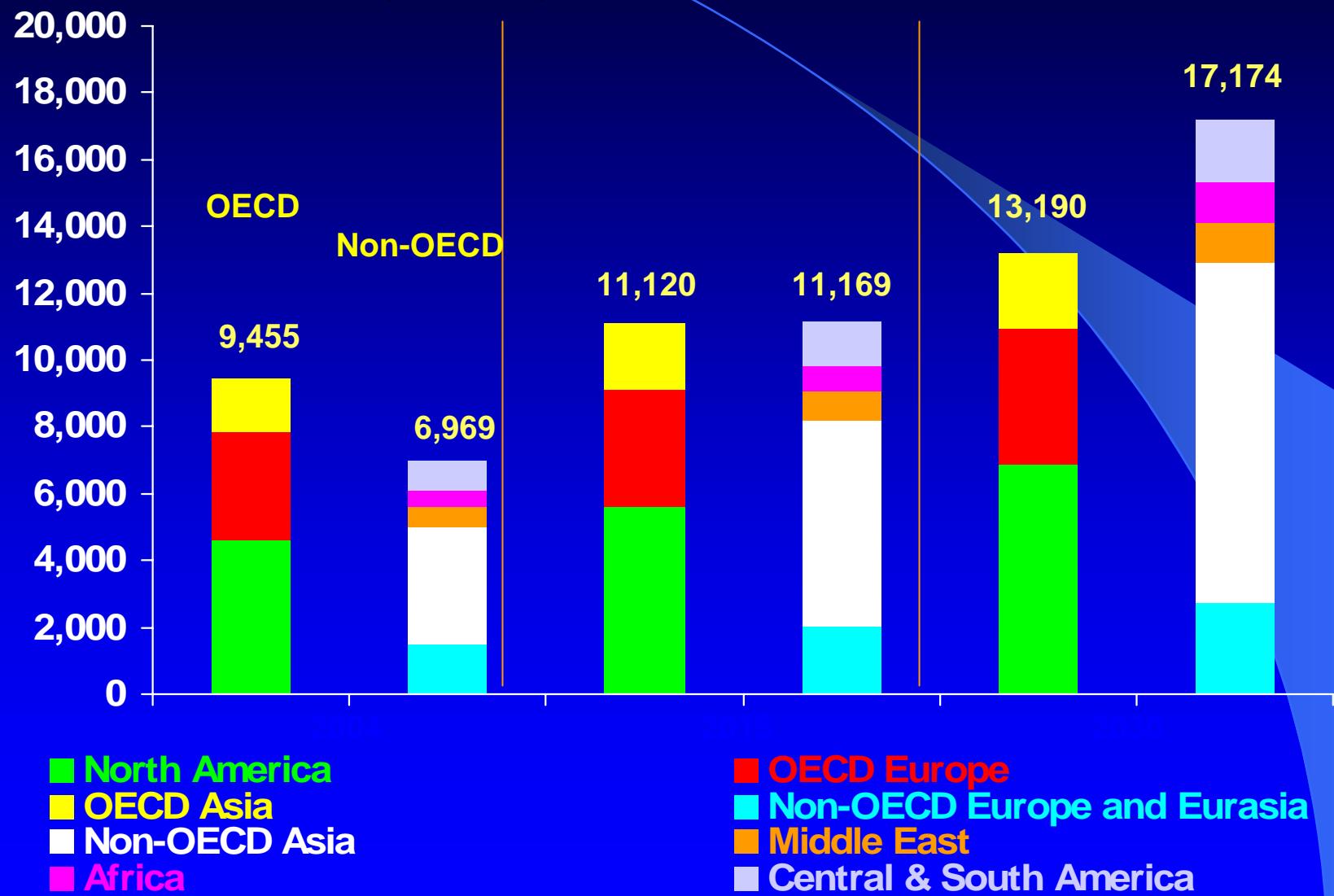
World Coal Demand by Sector, percent (IEA, 2004)

2002 4,791 million tons

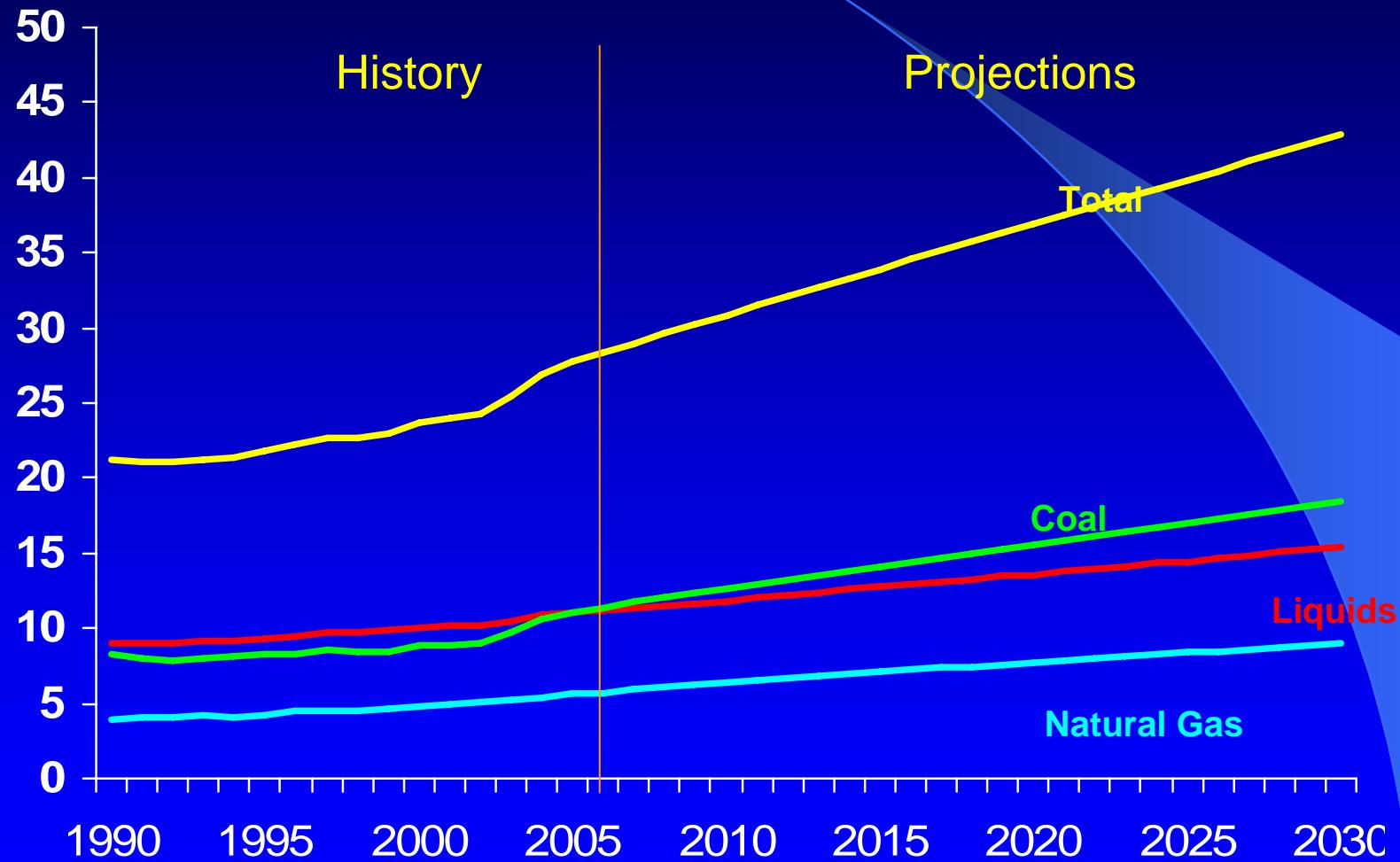
2030 7,029 million tons



World Net Electricity Generation, 2004, 2015, and 2030 (billion kilowatthours)



World Energy-Related Carbon Dioxide Emissions, 1990-2030 (billion metric tons)





APRIL 3, 2006

www.time.com AOL Keyword: TIME

SPECIAL REPORT GLOBAL WARMING

TIME

BE
WORRIED.
BE VERY
WORRIED.

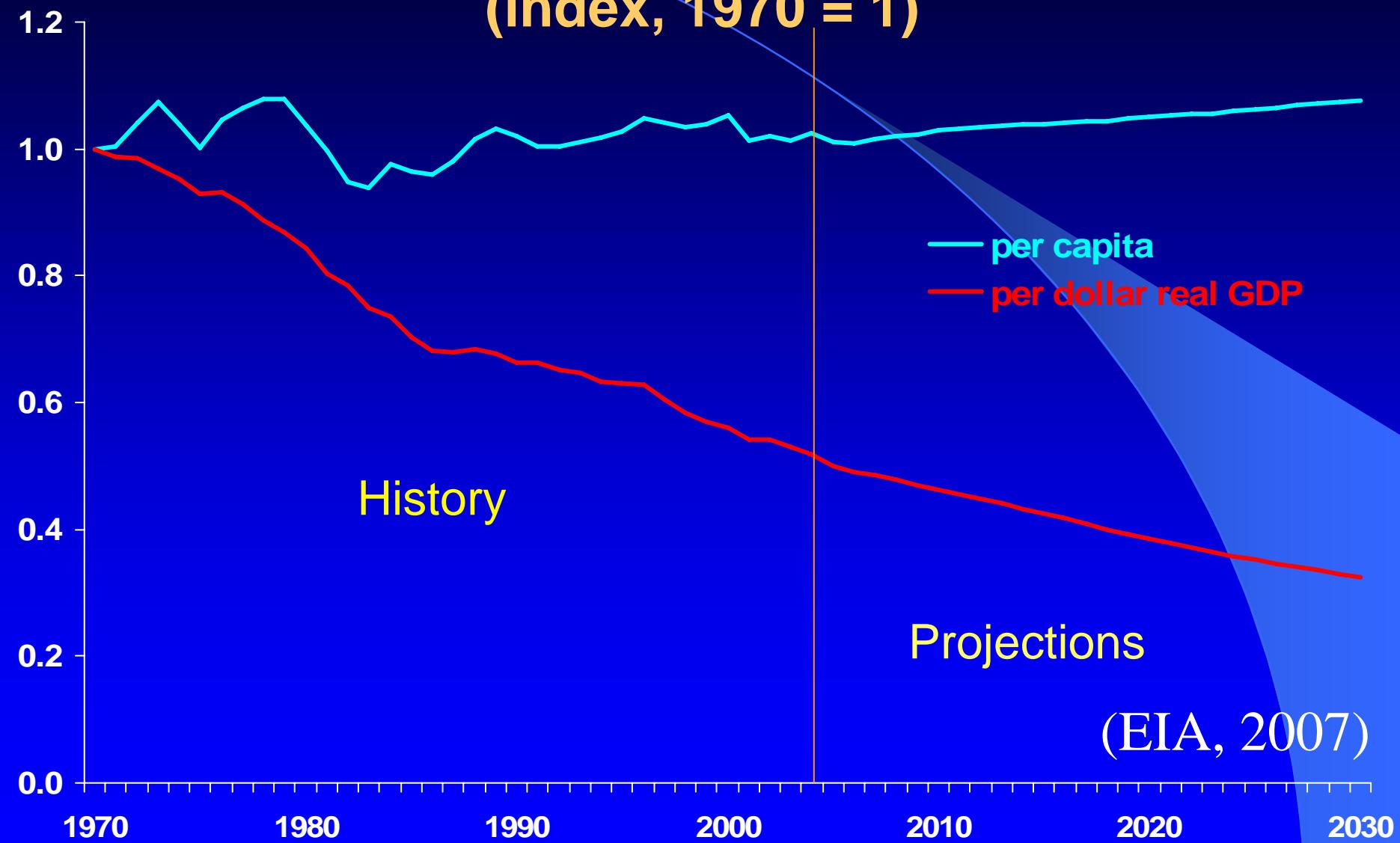
Climate change isn't some vague future problem—it's already damaging the planet at an alarming pace. Here's how it affects you, your kids and their kids as well

EARTH AT THE TIPPING POINT
HOW IT THREATENS YOUR HEALTH
HOW CHINA & INDIA CAN HELP
SAVE THE WORLD—OR DESTROY IT
THE CLIMATE CRUSADERS



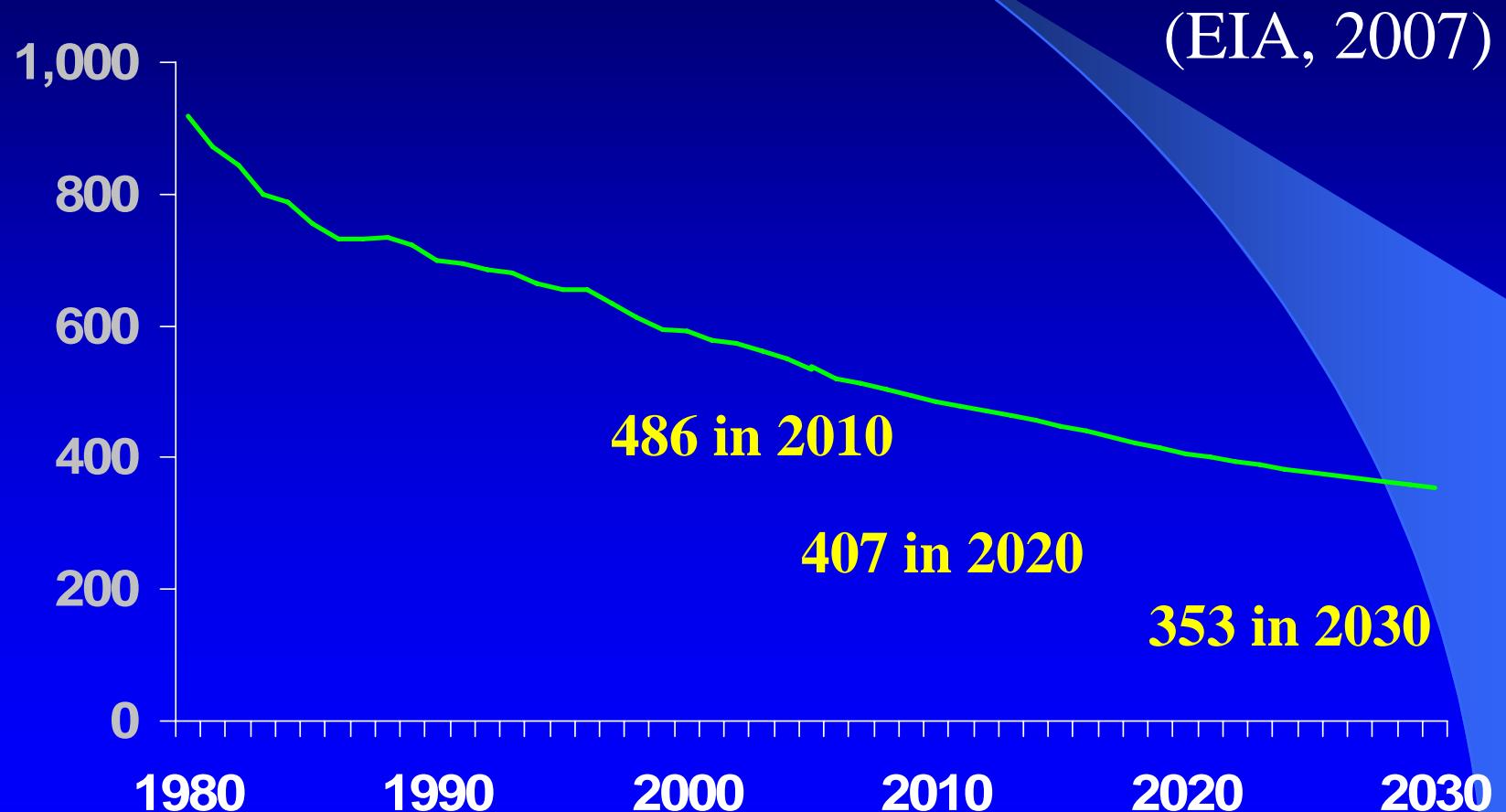
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U.S. Energy Use per Capita and per Dollar of Real Gross Domestic Product, 1970-2030 (index, 1970 = 1)

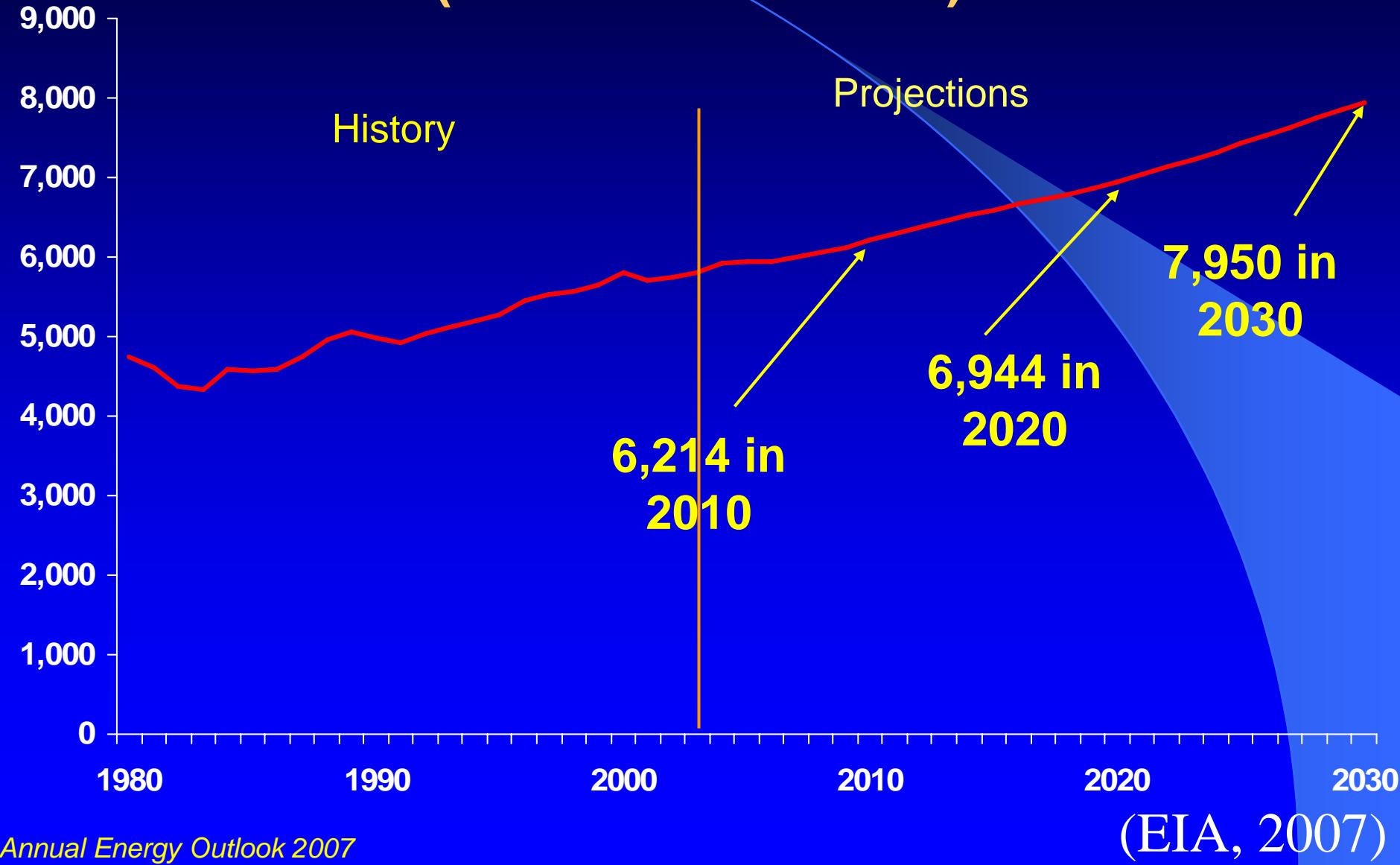


Carbon Dioxide Emission Intensity, 1980-2030

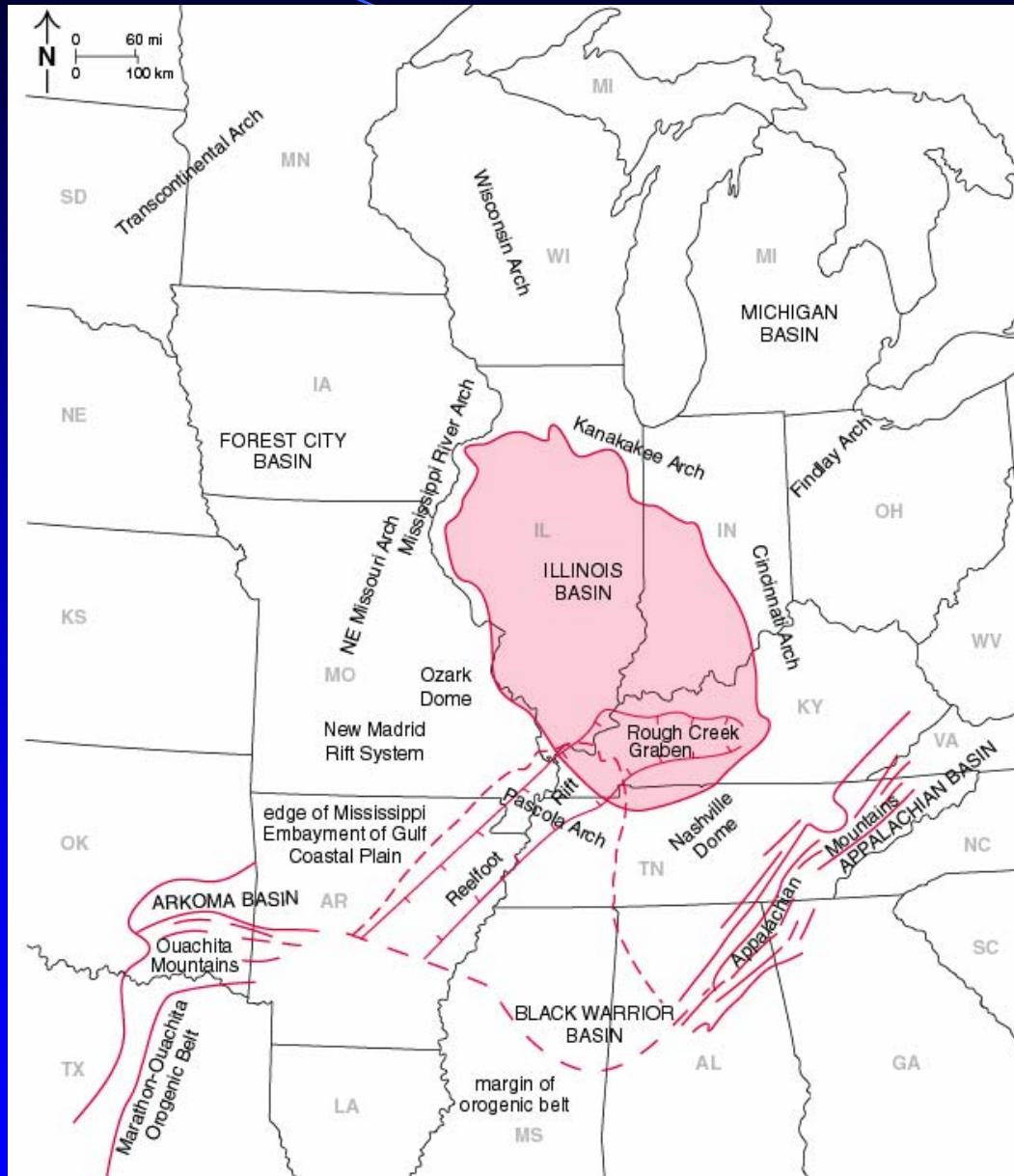
(metric tons per million 2000 dollars of GDP)



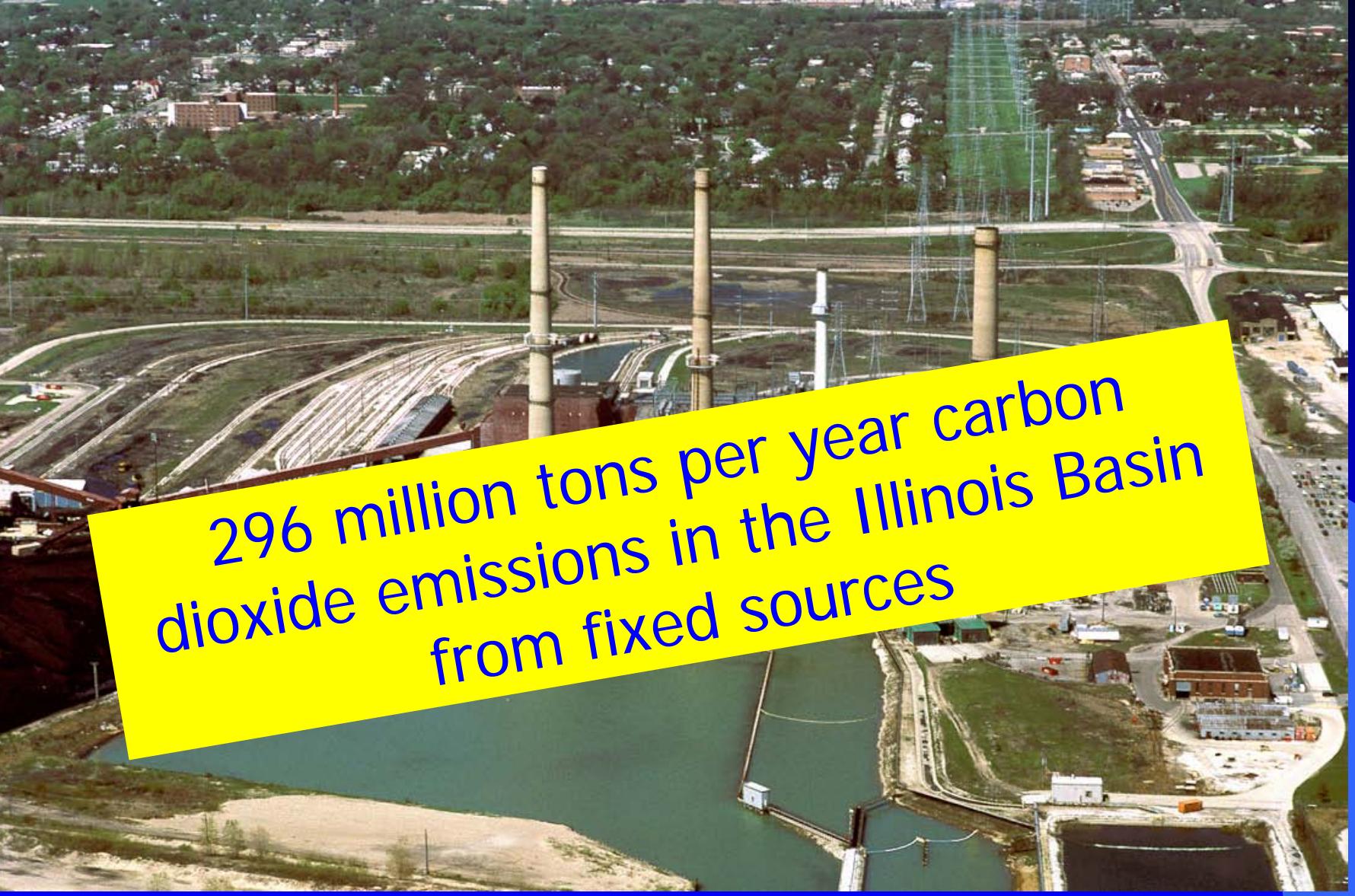
U.S. Energy-Related Carbon Dioxide Emissions, 1980-2030 (million metric tons)



Illinois Basin







296 million tons per year carbon
dioxide emissions in the Illinois Basin
from fixed sources

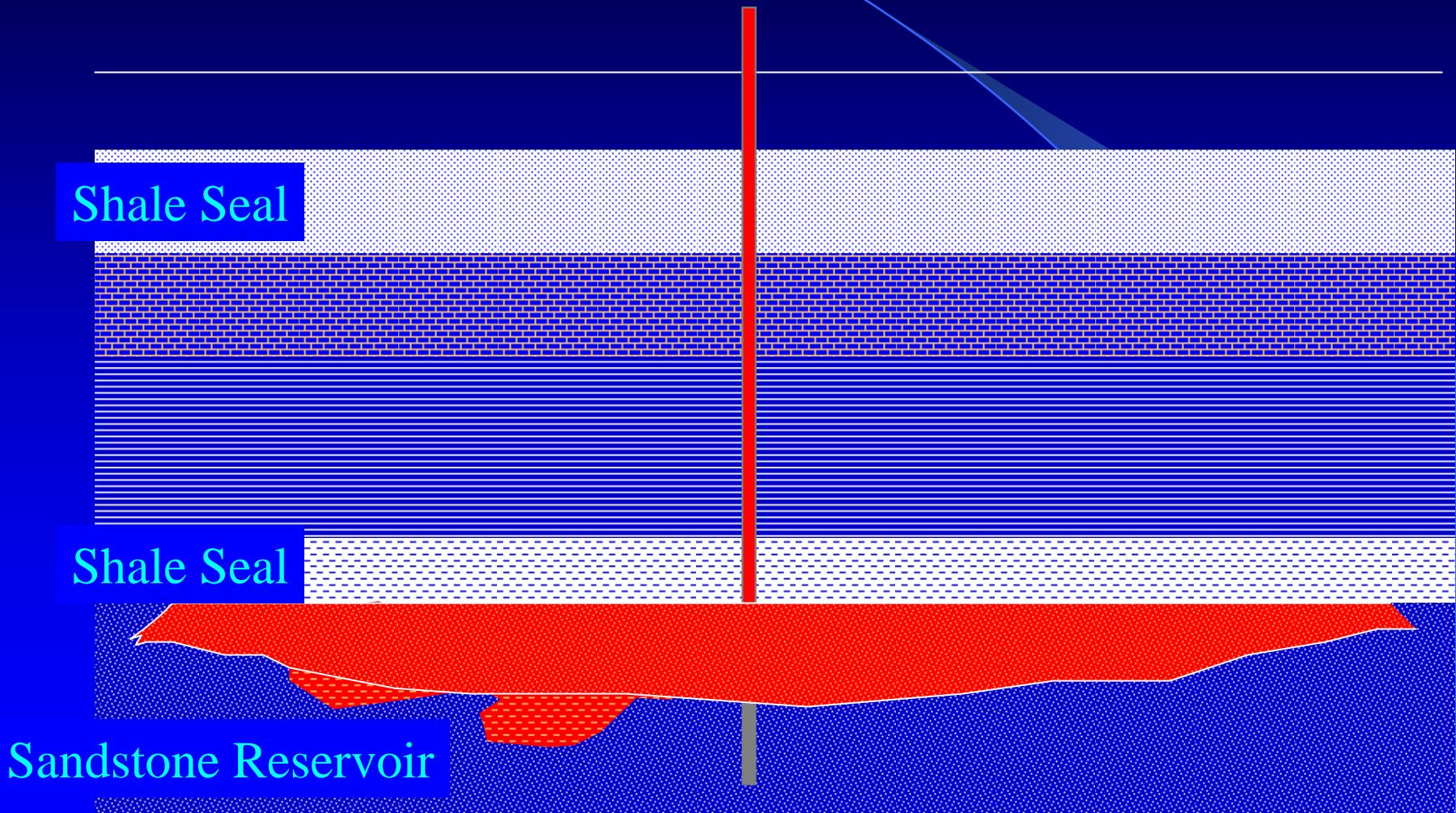
~40,548 20-ton truckloads of liquid CO₂/day

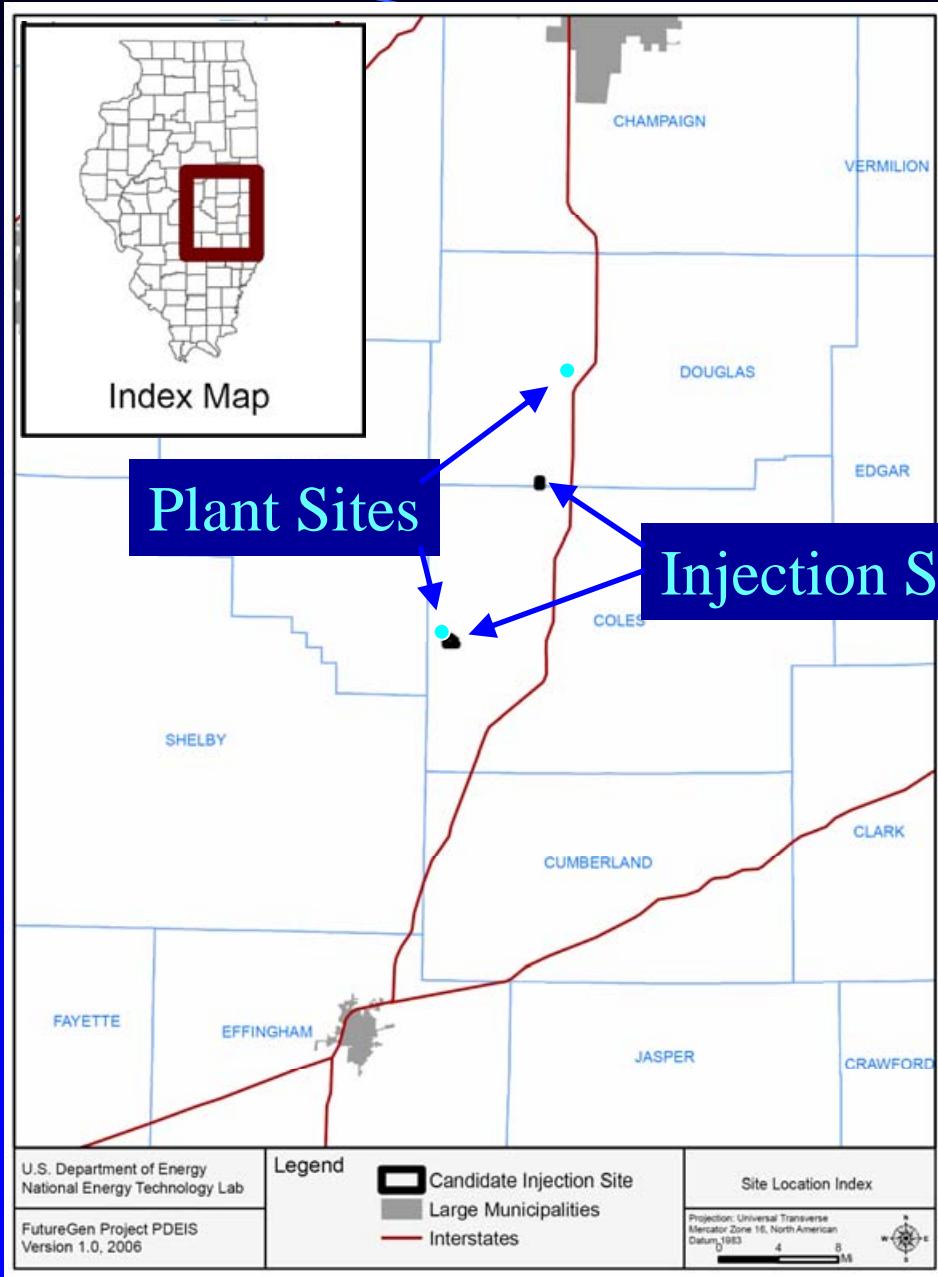


FutureGen: Near-Zero Emission Coal-Fired Electric Generation

- *FutureGen* is a multifaceted demonstration of coal gasification, electricity generation, hydrogen production, *and carbon sequestration*
- Sequestration = CO₂ capture + transport + storage
- Illinois offers storage = geological sequestration potential over a wide area of the Illinois Basin

CO₂ Injection: Caprock/Seal Integrity

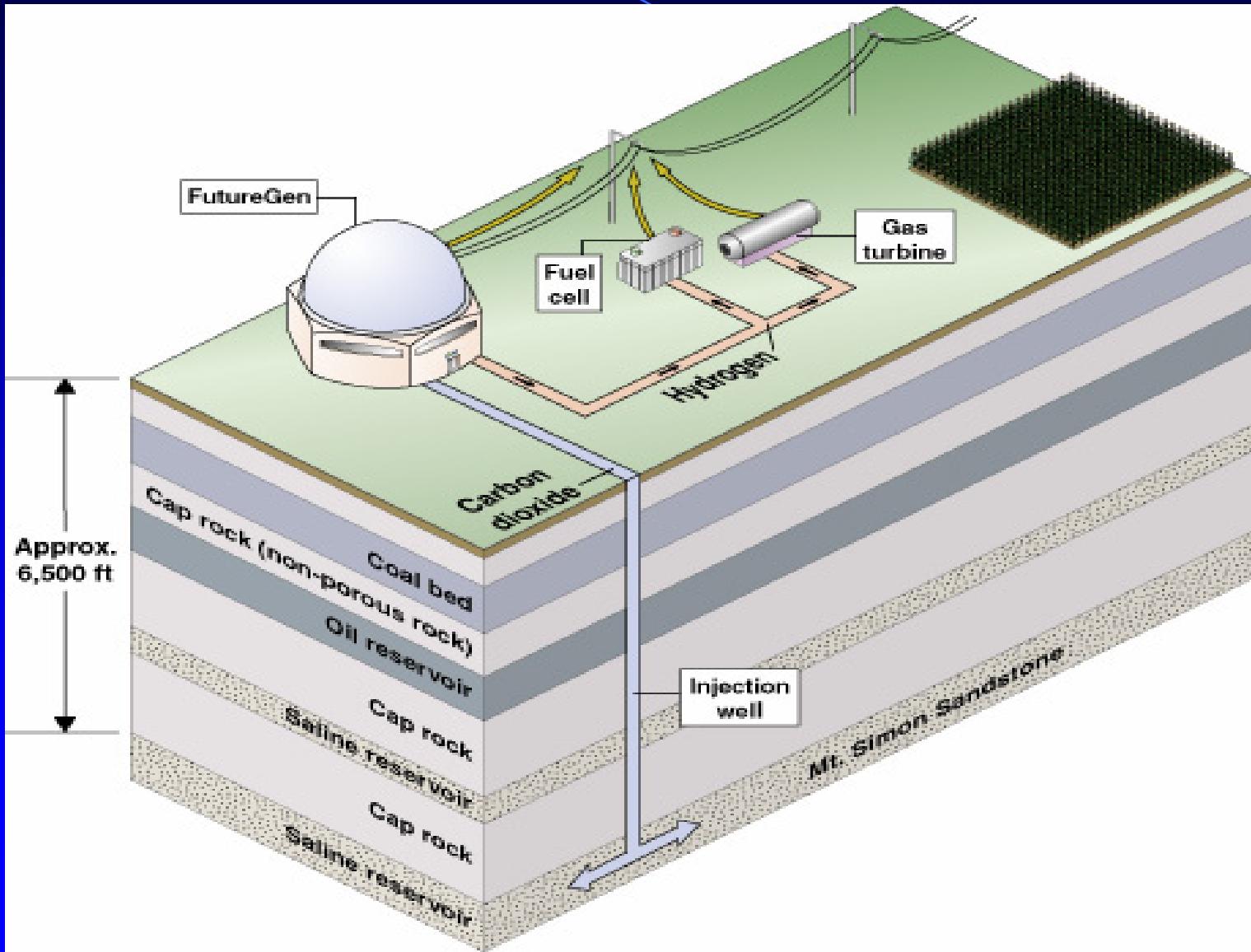


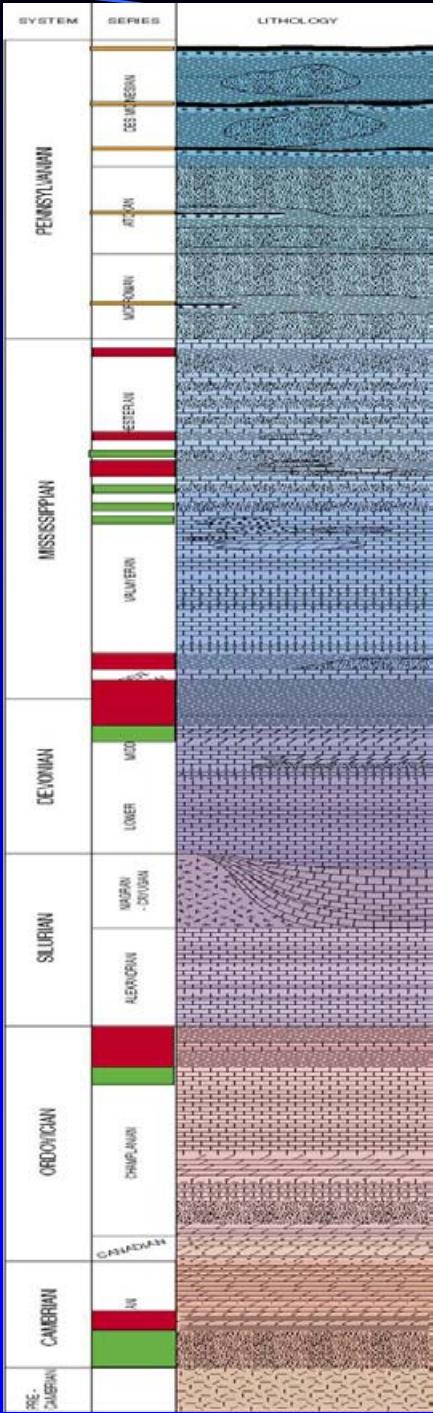


Mattoon and Tuscola FutureGen Sites

- Predominantly farm land
- Outstanding community support for FutureGen
- Familiarity with industrial facilities and coal mining or quarrying
- Excellent sequestration option on site or 10 mi via pipeline

Sequestration at Mattoon and Tuscola





Pennsylvanian coal seams

adsorption on coal

Mississippian sandstone and carbonate oil reservoirs

CO₂ EOR in mature fields

New Albany Shale

adsorption on shale

Maquoketa Shale

St. Peter Sandstone

Eau Claire Shale

Mt. Simon Sandstone

Potential Seal

Potential Sink

Coal Bed
Potential Sink
and Seal

major saline reservoirs

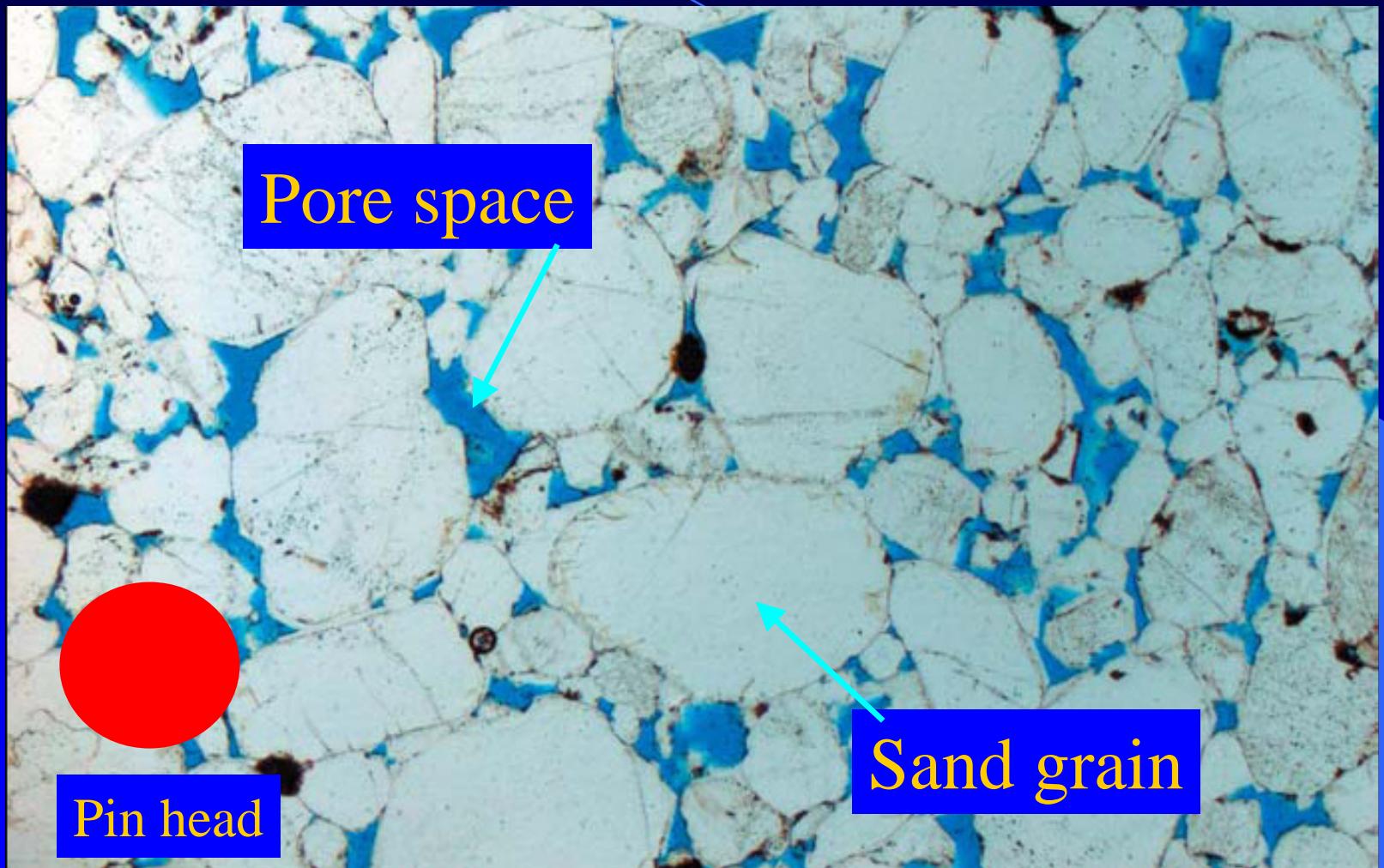
from Leetaru, 2004

Mt. Simon Sandstone Reservoir



- Mt. Simon Sandstone is used for natural gas storage in Champaign County, IL at 4,000 to 4,200 ft
- Mt. Simon core has been recovered from a few deep exploration wells, such as this sample from near Salem, IL at 8,467 drilled in 1966

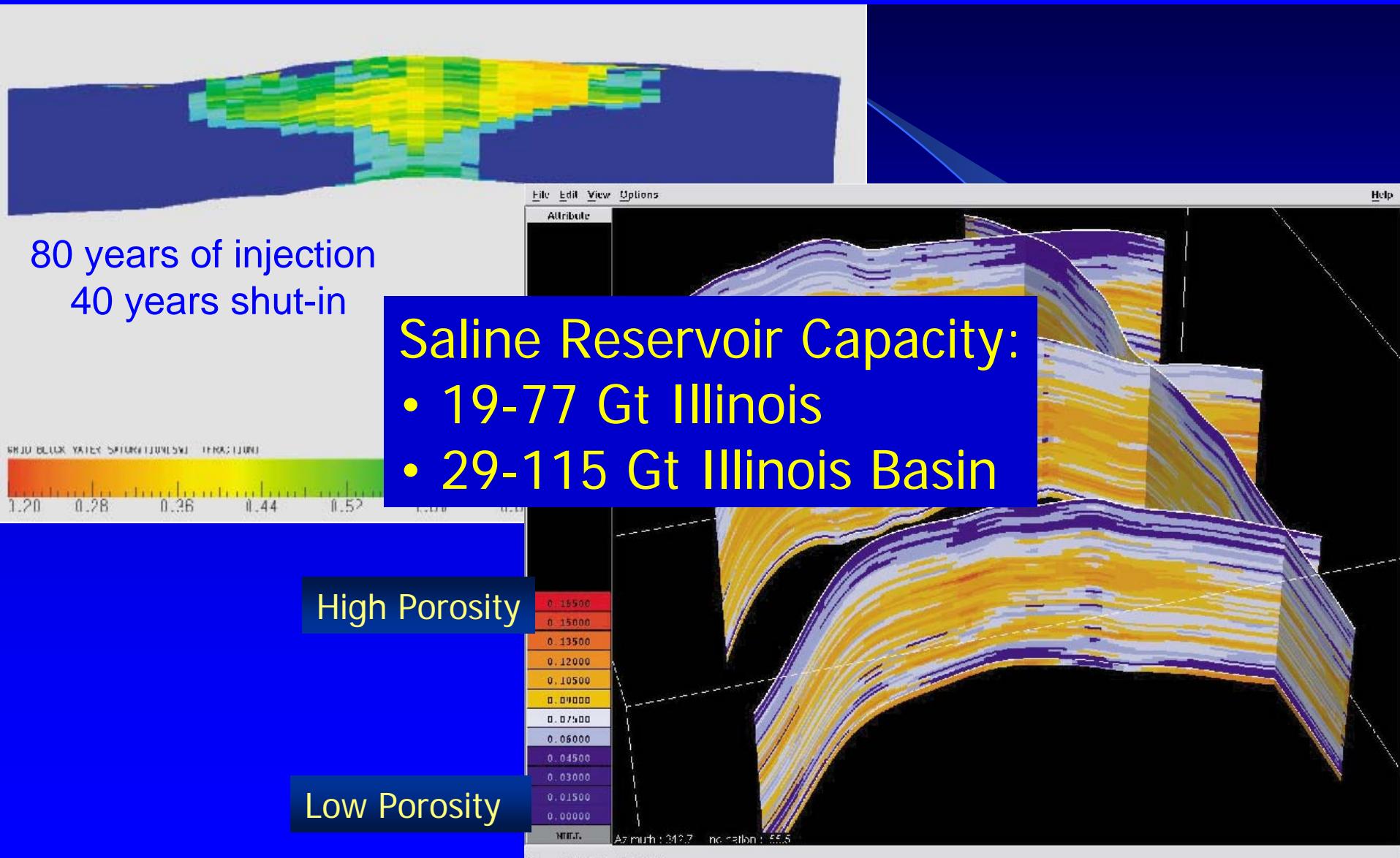
CO_2 Storage in Sandstone Reservoir Pore Space



Reservoir Caprock (shale seal)



Mt. Simon after 120 Years



FutureGen for Illinois: Current Status

- FutureGen Industrial Alliance formally announced September 13, 2005
- Alliance led by 10 coal and utility companies
- July 25, 2006: Two Illinois sites and two Texas sites finalists from among 12 sites in 7 states
- NEPA Environmental Impact Statement public meetings in June 07
- Final results of NEPA due Fall 07
- Alliance makes final selection ~ Dec 07-Jan 08
- Illinois' effort led by the Department of Commerce and Economic Opportunity and its Office of Coal Development

Illinois Seeking FutureGen and Facilitating IGCC, Carbon Sequestration, and CO₂ EOR

- Illinois Office of Coal Development leading Illinois' FutureGen team; IN and PA formally endorse Illinois sites
- IL SB 1704 provides liability protection for the Alliance and establishes monitoring responsibility at ISGS
- Illinois Office of Coal Development supporting IGCC projects with grants, bonding, and cofunding Midwest Geological Sequestration Consortium, a DOE regional sequestration partnership
- Illinois working across state agencies to attract more IGCC projects that use abundant Illinois coal and are optimized for carbon sequestration
- Illinois seeking public-private partnership to develop a CO₂ pipeline backbone to deliver CO₂ from these projects to Illinois oil fields



www.isgs.uiuc.edu



www.sequestration.org