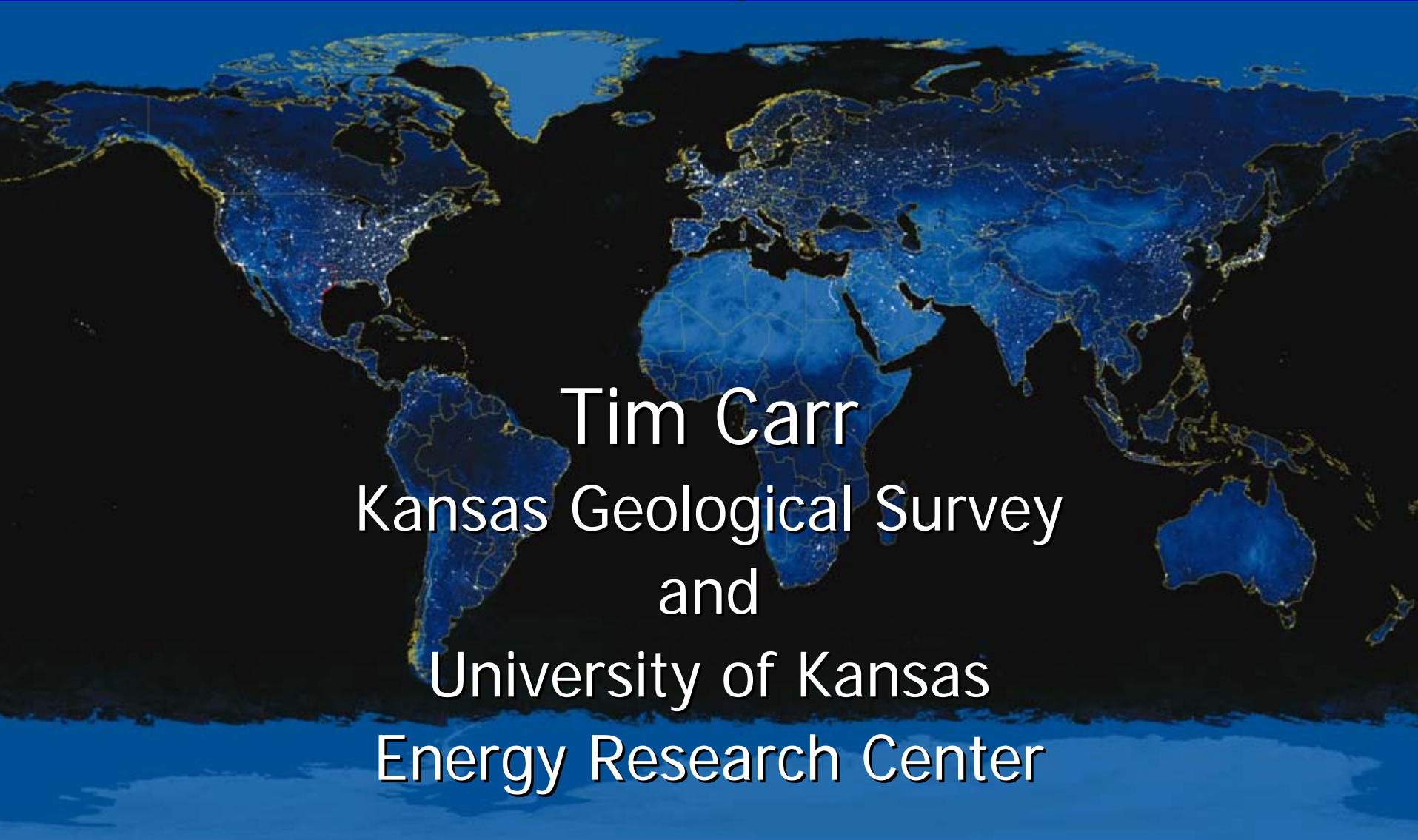


# Oil & Gas Production

---

## The Future is Bright



Tim Carr  
Kansas Geological Survey  
and  
University of Kansas  
Energy Research Center

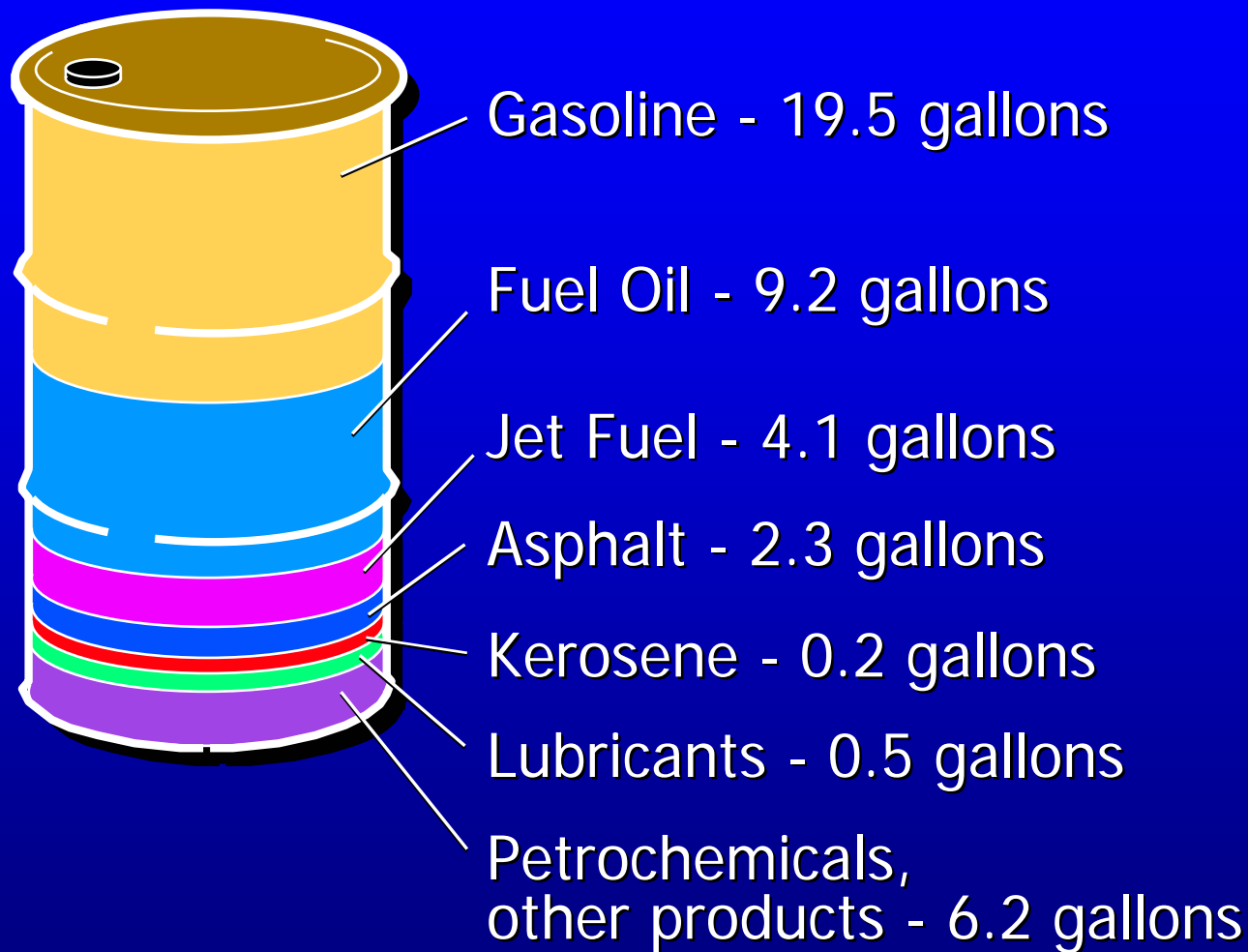
# Where I Am Coming From:

- Oil & Gas Background
  - Geologist & Geophysicist
  - Enhanced Recovery
  - Technological Approach
- Energy is the Basis of Civilization
- Resource is Adequate
  - Insufficient Investment
  - Geopolitical Questions
- Can Provide Energy & Protect the Environment
- Hydrocarbons Are Our Major Energy Source Through the Middle of this Century



# A Barrel of Crude Provides:

One Barrel =  
42 gallons



# Overview

---



In 2004

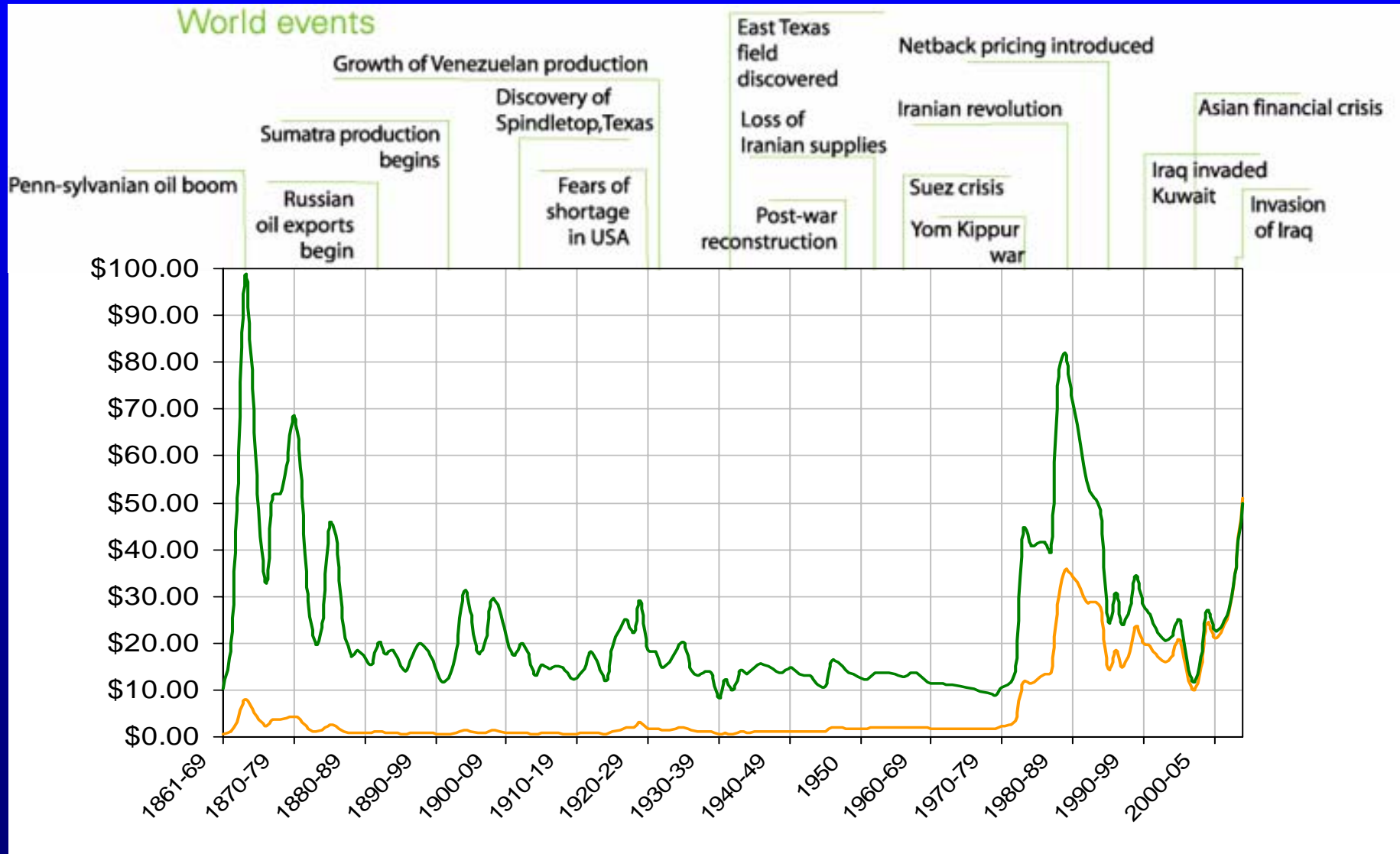
Economic Growth at 15 Year High  
China's Oil Consumption is

increased 15%, 900,000 b/d

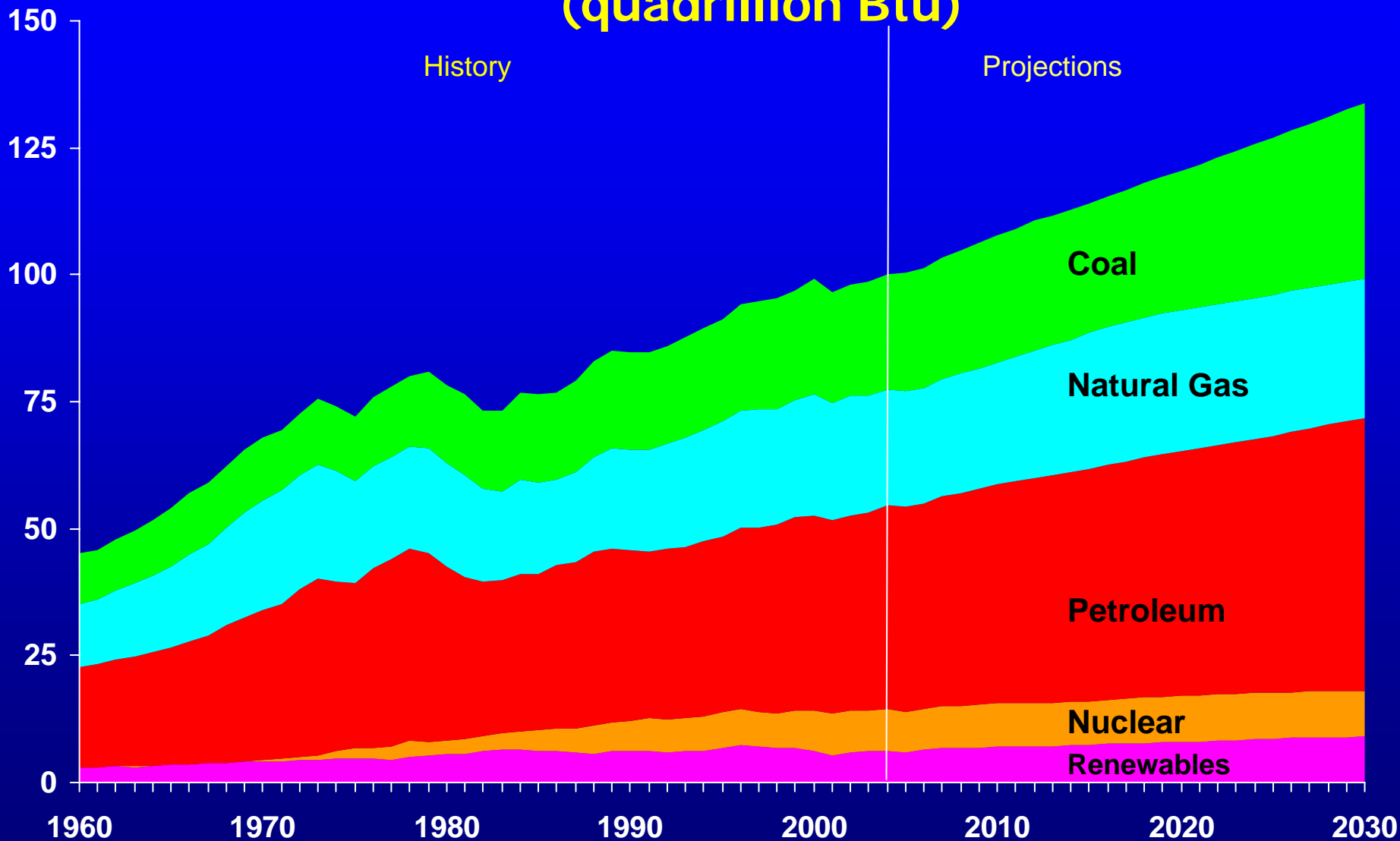
World Oil Consumption Increased  
2.5 million b/d

- Resource
  - Forecast and Price Trends
  - Changes in H/C Ratio
  - Future is NOT a Bell Curve
  - Future Production Requires Investment
    - 50% Per Decade
- Technology and People
  - Investment
- Geopolitics (Access)
- Environment

# Crude oil prices since 1861



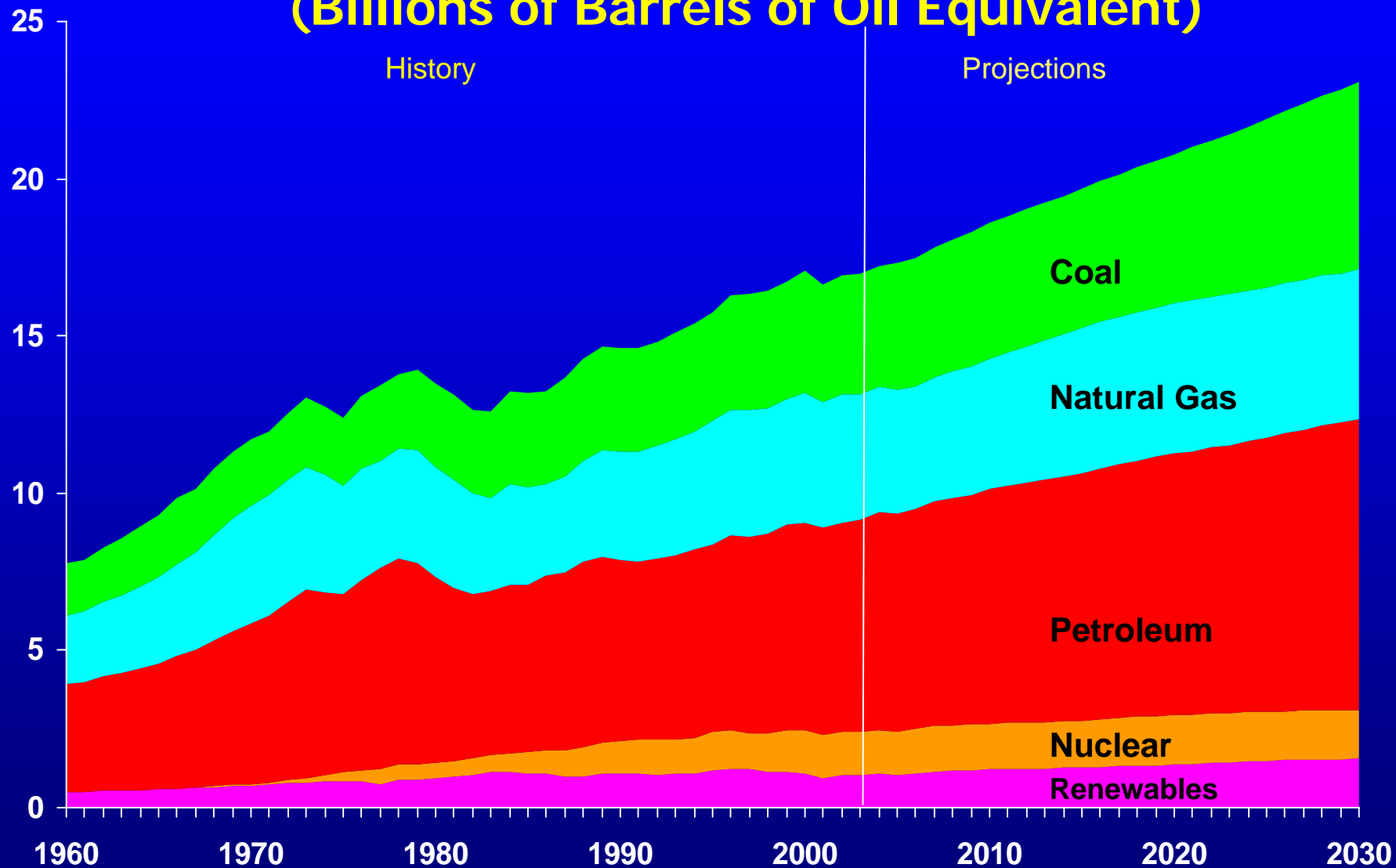
# U.S. Primary Energy Consumption by Fuel, 1960-2030 (quadrillion Btu)





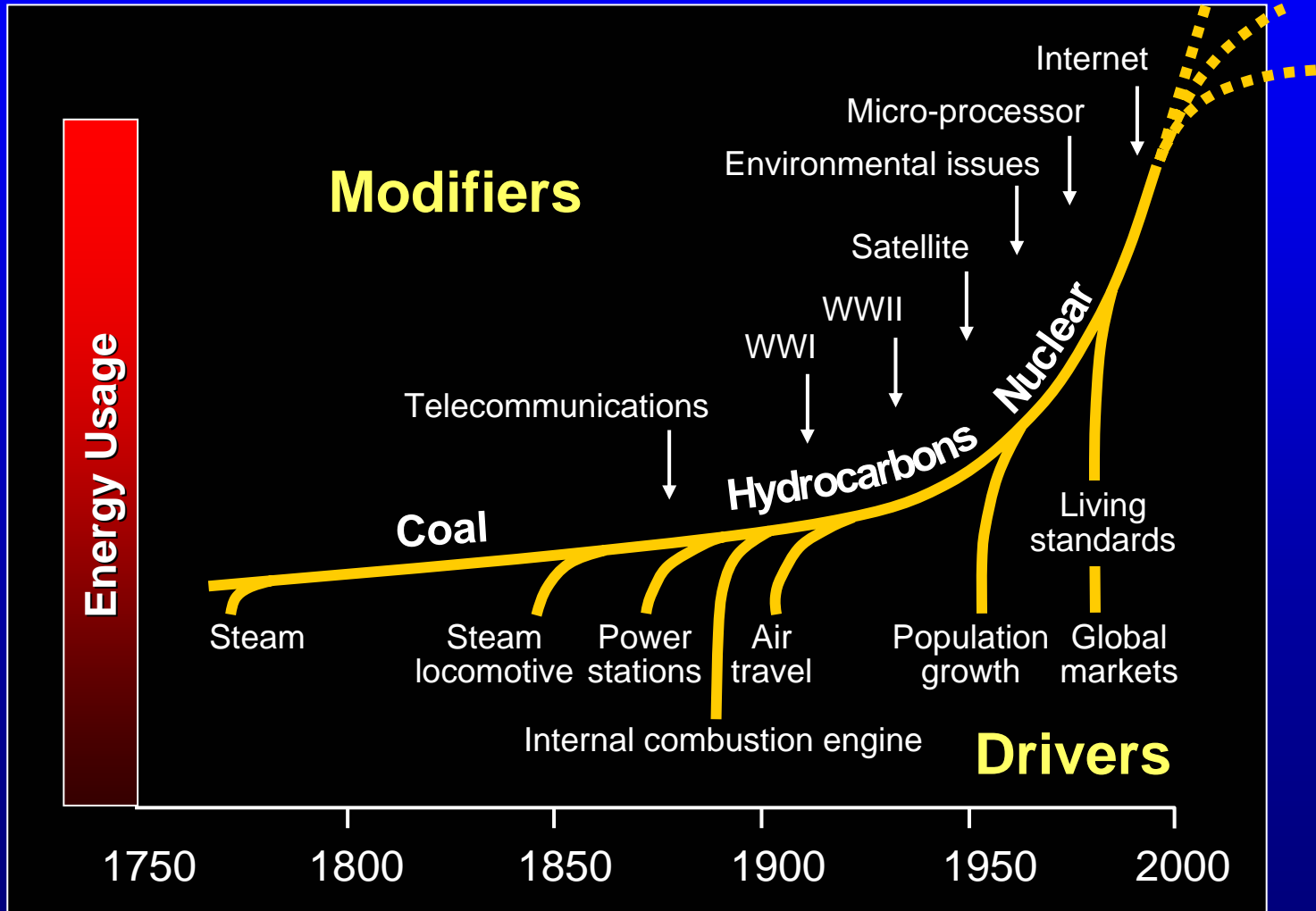
# U.S. Primary Energy Consumption by Fuel, 1960-2030

(Billions of Barrels of Oil Equivalent)



# Energy Usage: 1750-2000

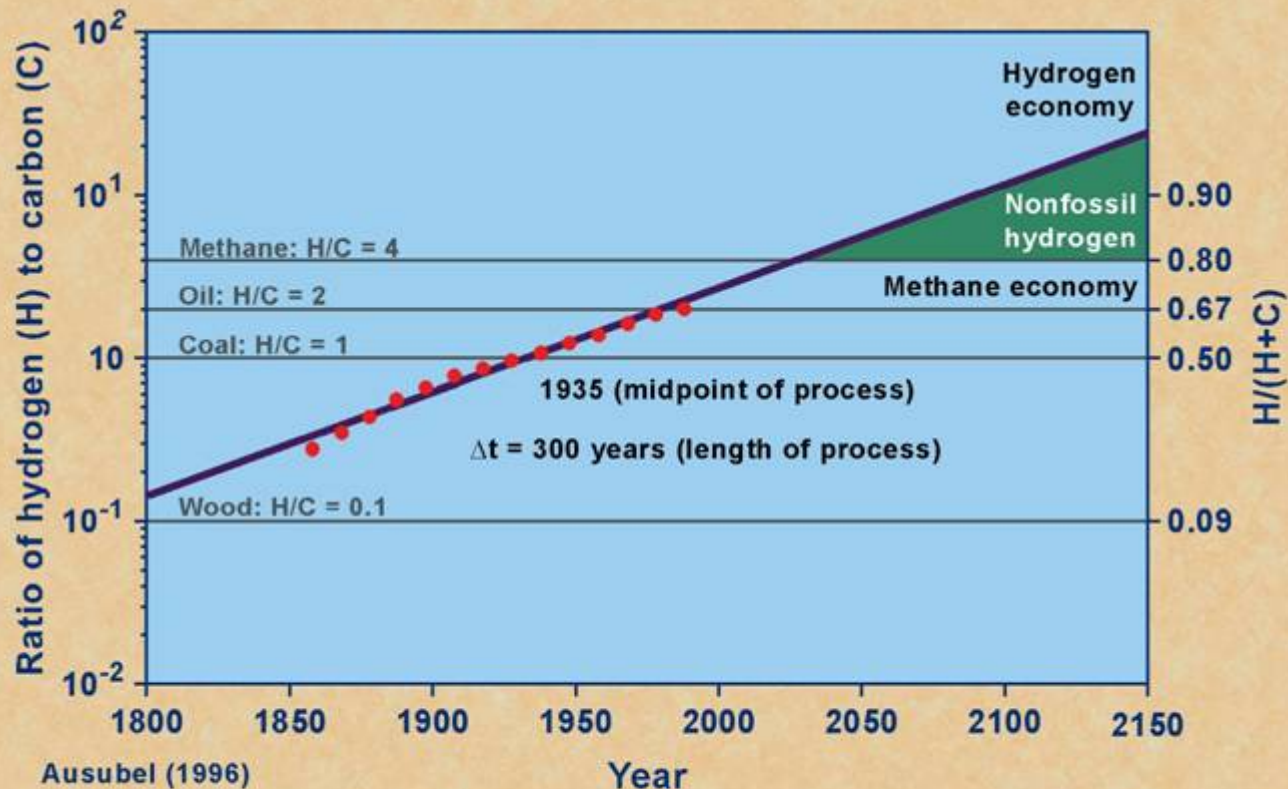
## An Energy Dependent Civilization





# Moving Greater H/C Energy Systems

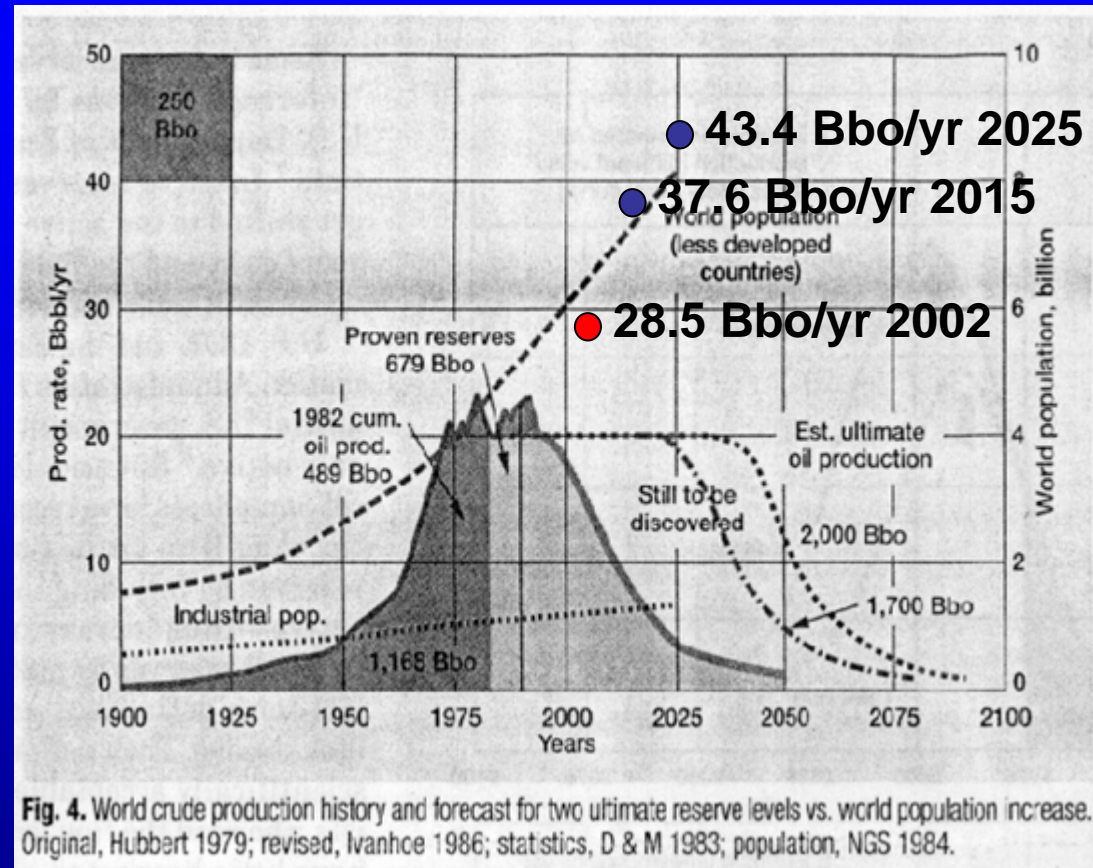
## RATIO OF HYDROGEN (H) TO CARBON (C) FOR GLOBAL PRIMARY ENERGY CONSUMPTION SINCE 1860 & PROJECTIONS FOR THE FUTURE



# Projected World Oil Supplies

Geologically-determined peak could have consequences up to and including “war, starvation, economic recession, even the extinction of homo sapiens” (Campbell in Ruppert 2002).

“Civilization as we know it is coming to an end soon. This is not the wacky proclamation of a doomsday cult, apocalypse bible prophecy sect, or conspiracy theory society. Rather, it is the scientific conclusion of the best paid, most widely-respected geologists, physicists and investment bankers in the world.”

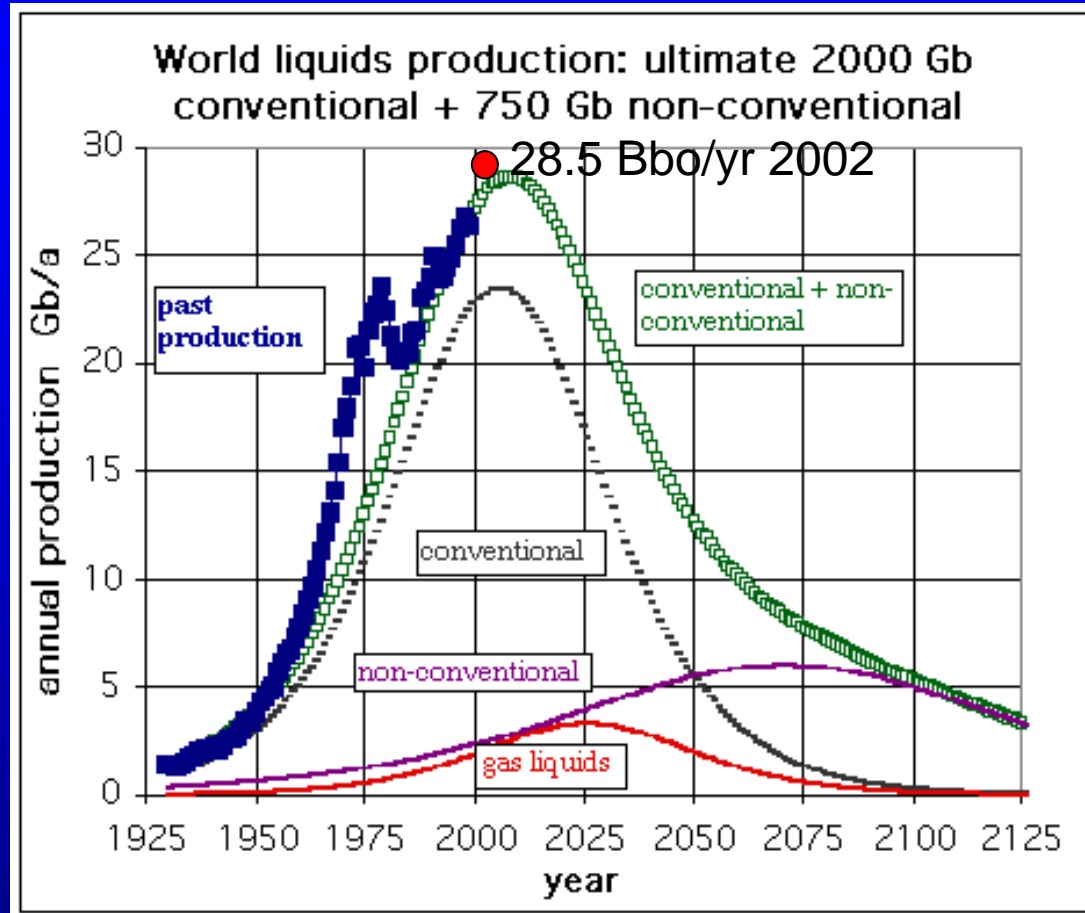


# Projected World Oil Supplies

A successful oilman remarked  
“I would never hire an exploration  
geologist who is not an optimist,  
or a petroleum engineer who is  
not a pessimist.”

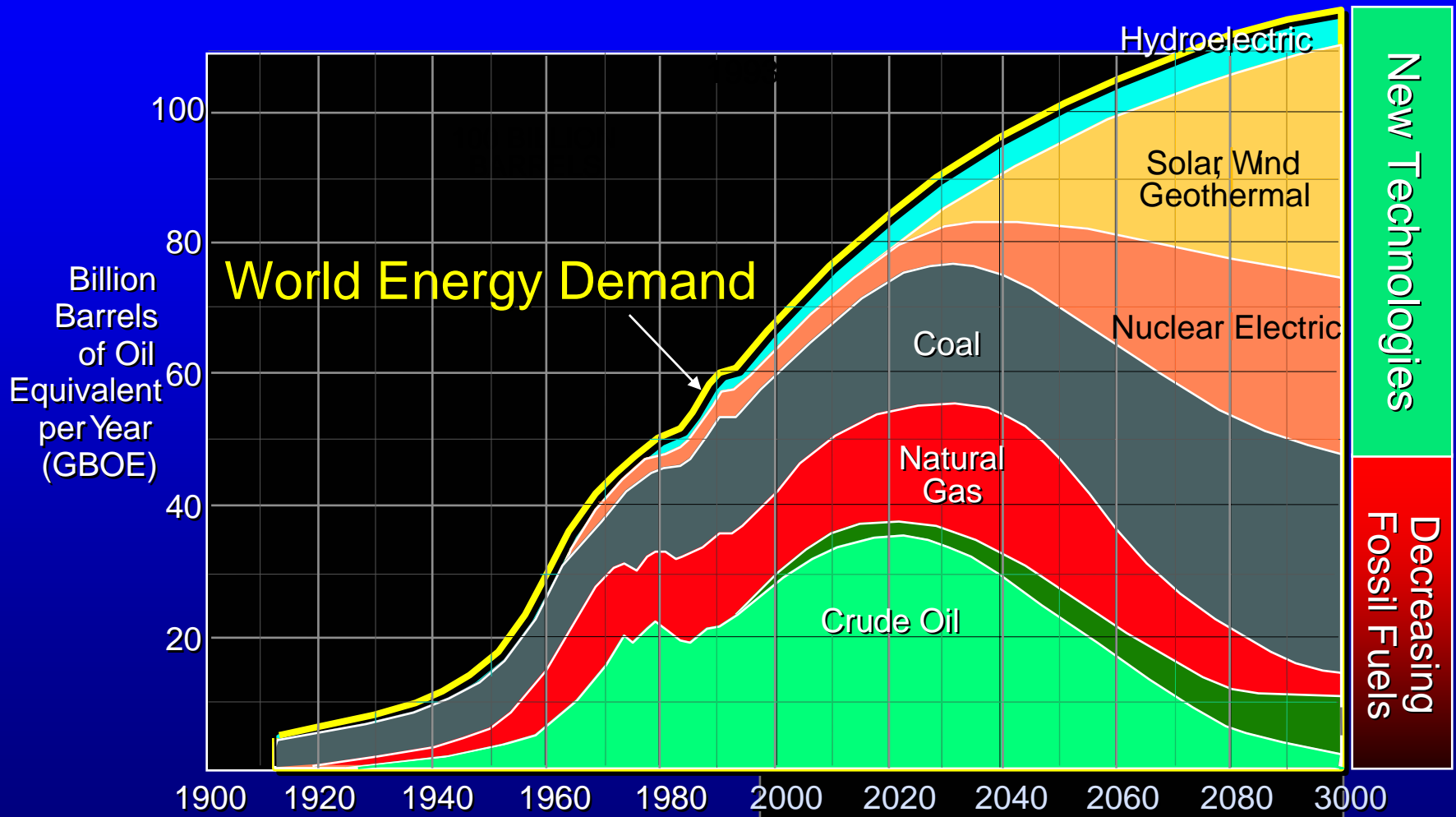
“There are 195 deepwater fields  
slated for development from  
2005 to 2009 with a total of  
37,279 MMBOE”

“If past history was all there as ...  
the richest people would be  
librarians” (Warren Buffet)



Laherre're, 2000

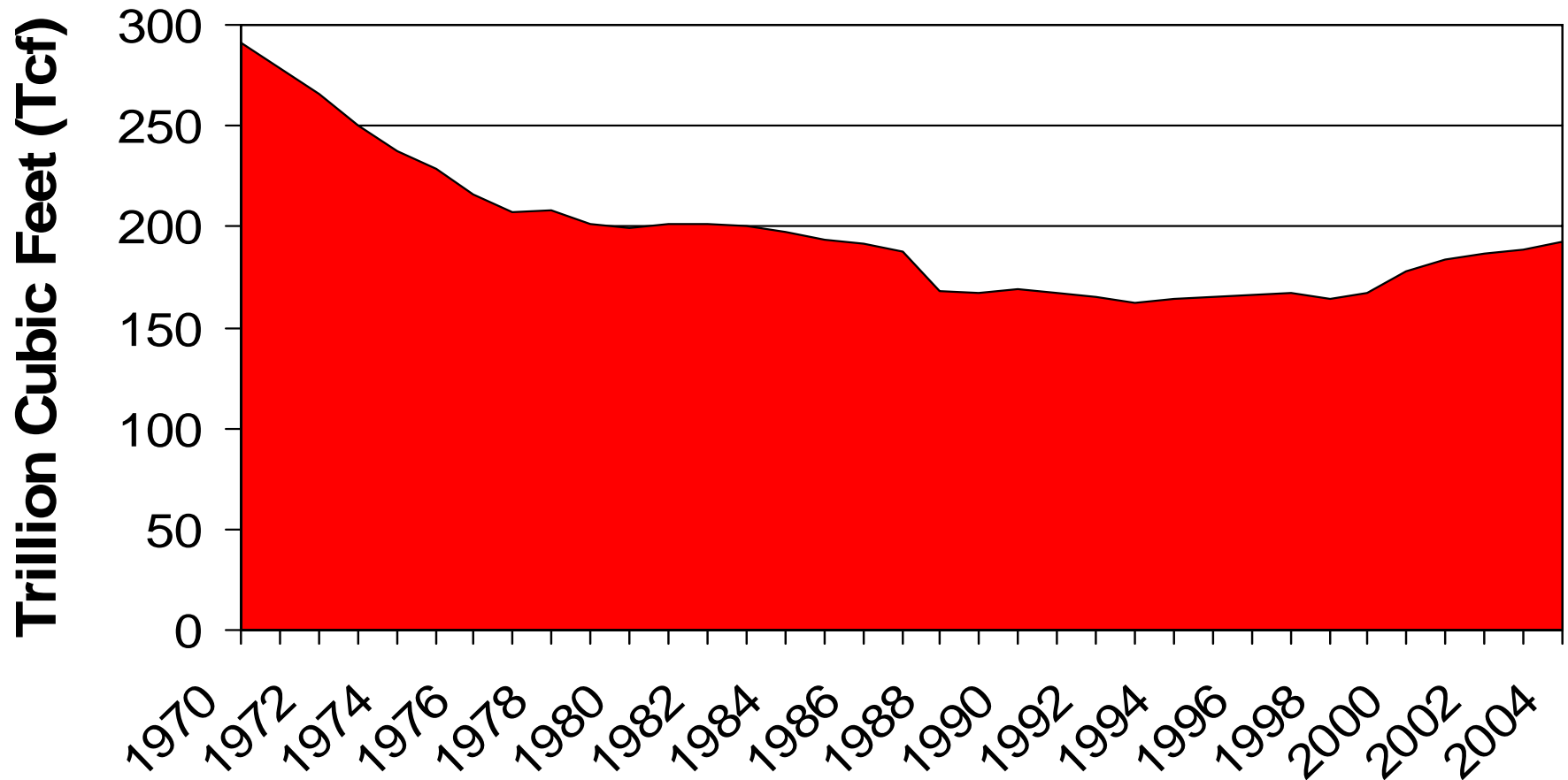
# Projected World Energy Supplies



after Edwards,  
AAPG 8/97

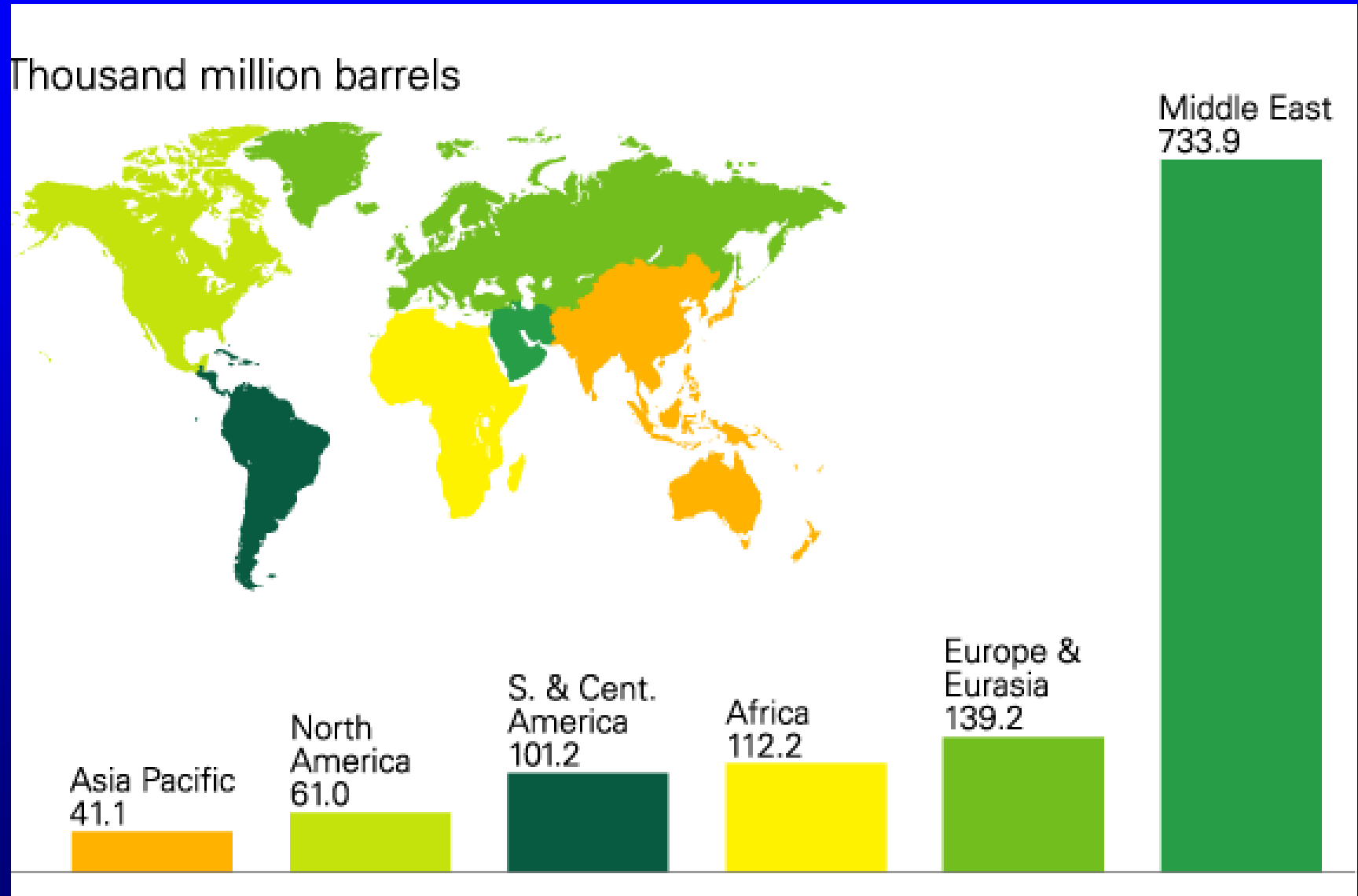
# Supply & Technology

## US Proved Reserves

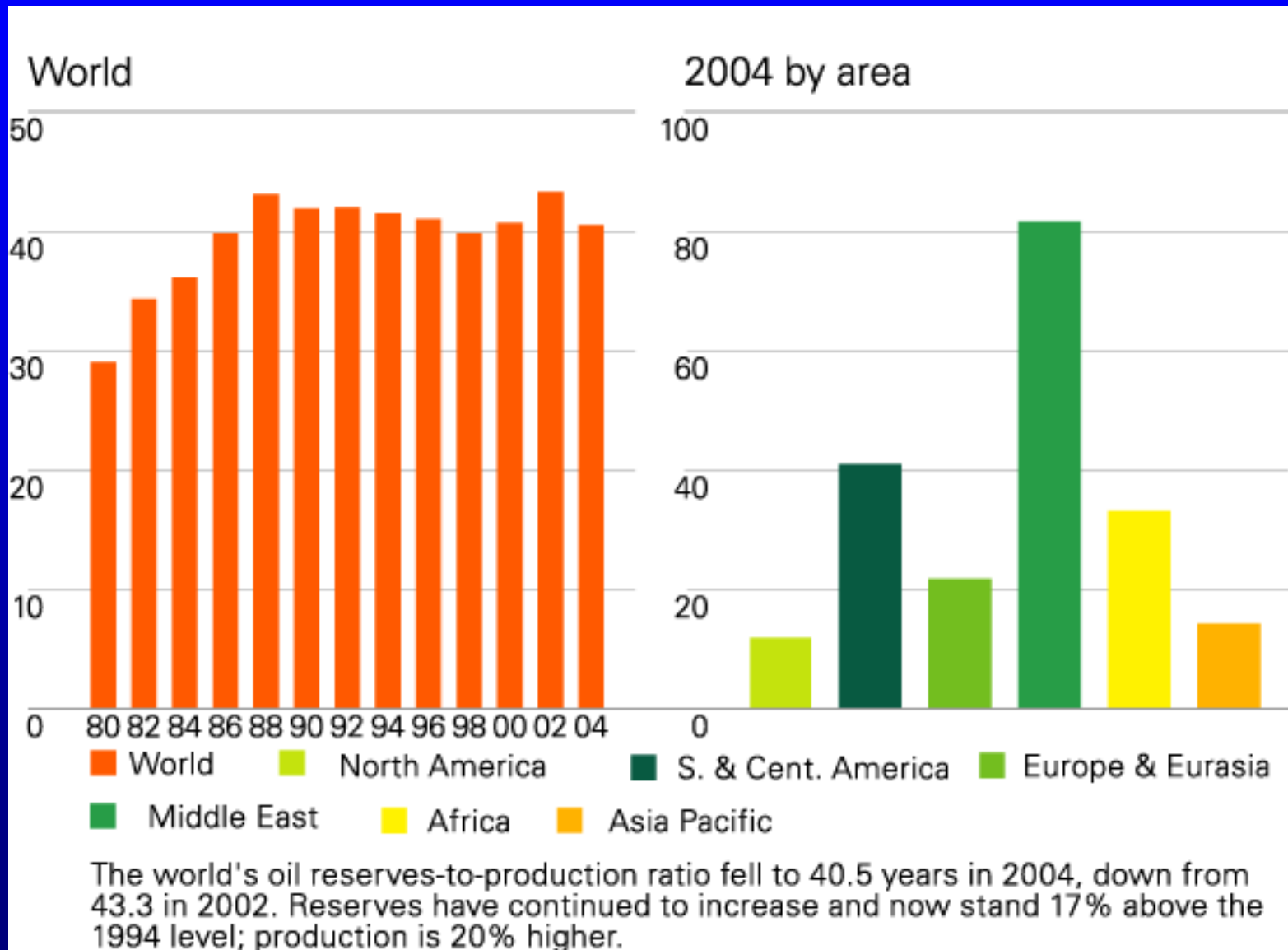


EIA, 2005

# Proved oil reserves at end 2004

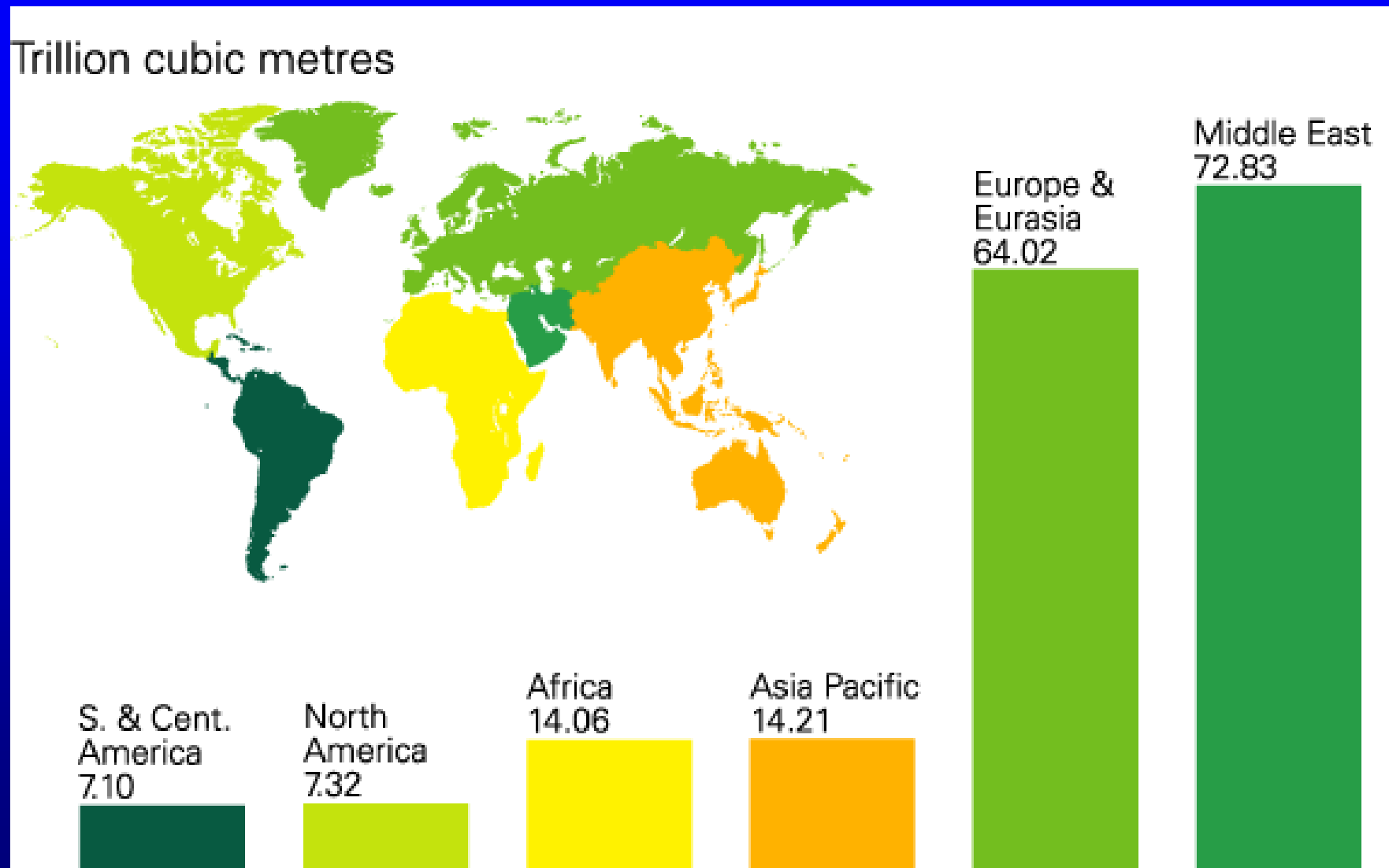


# Oil Reserves-to-Production (R/P) Ratios

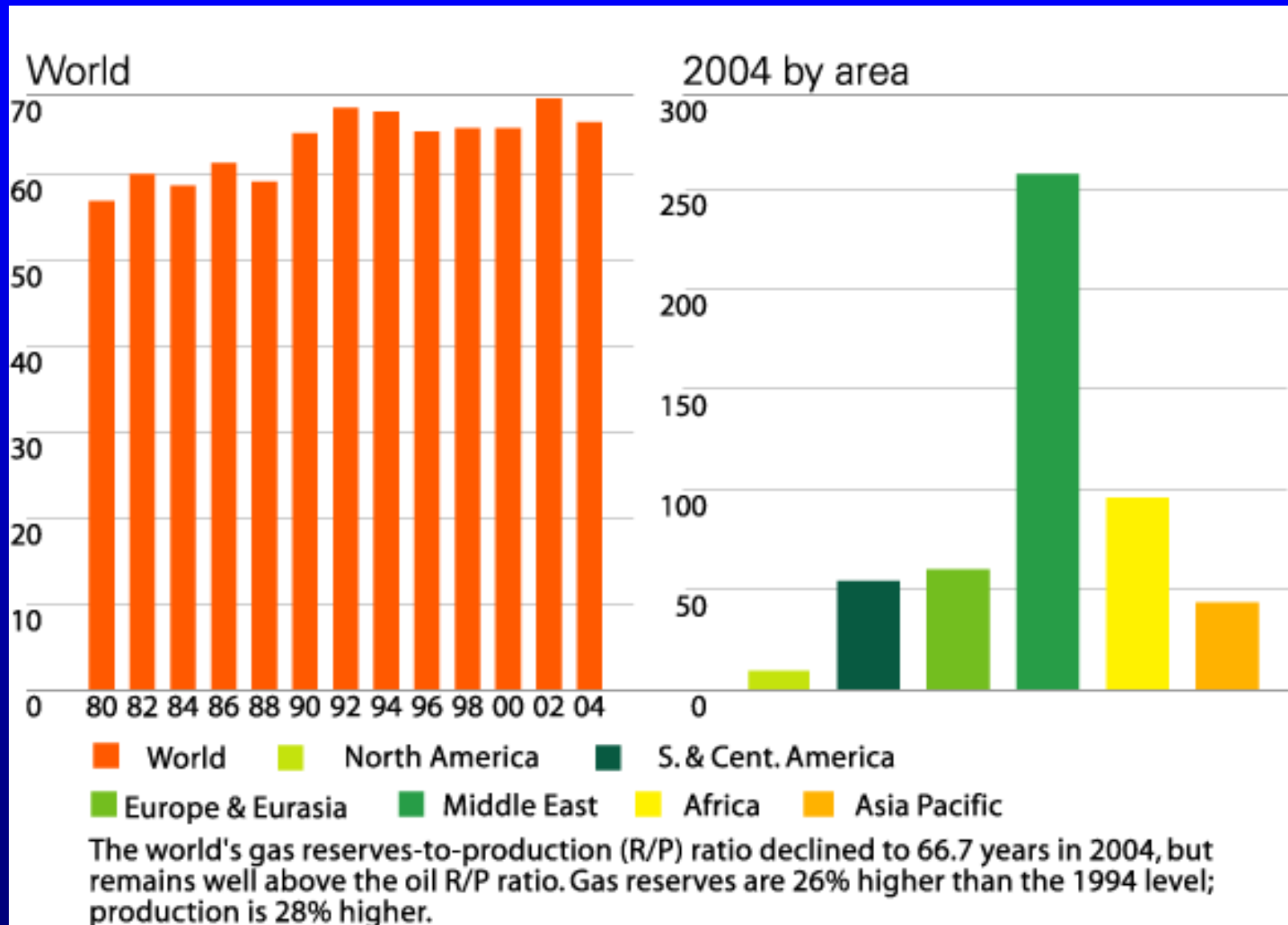




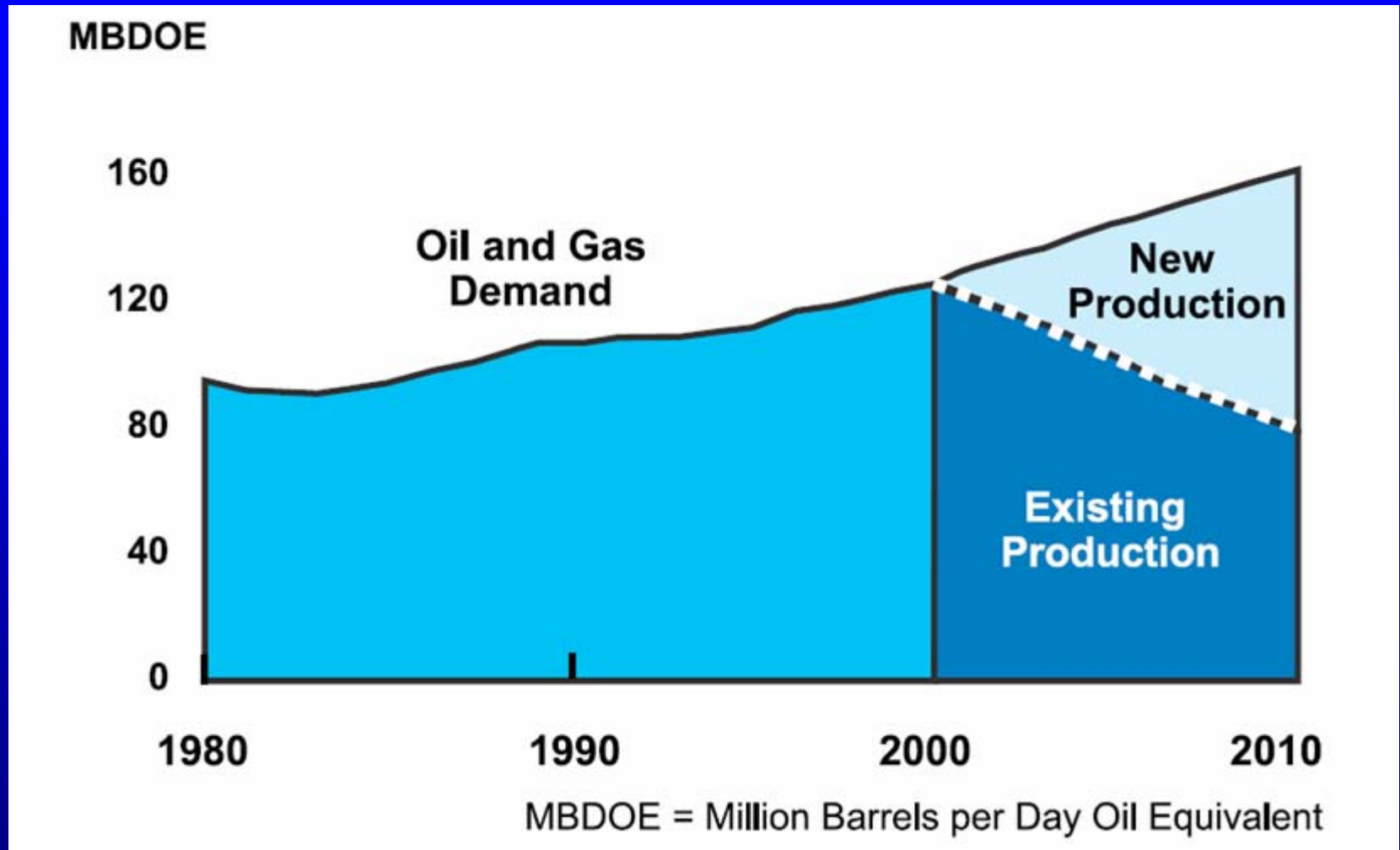
# Proved natural gas reserves at end 2004



# Natural Gas Reserves-to-Production

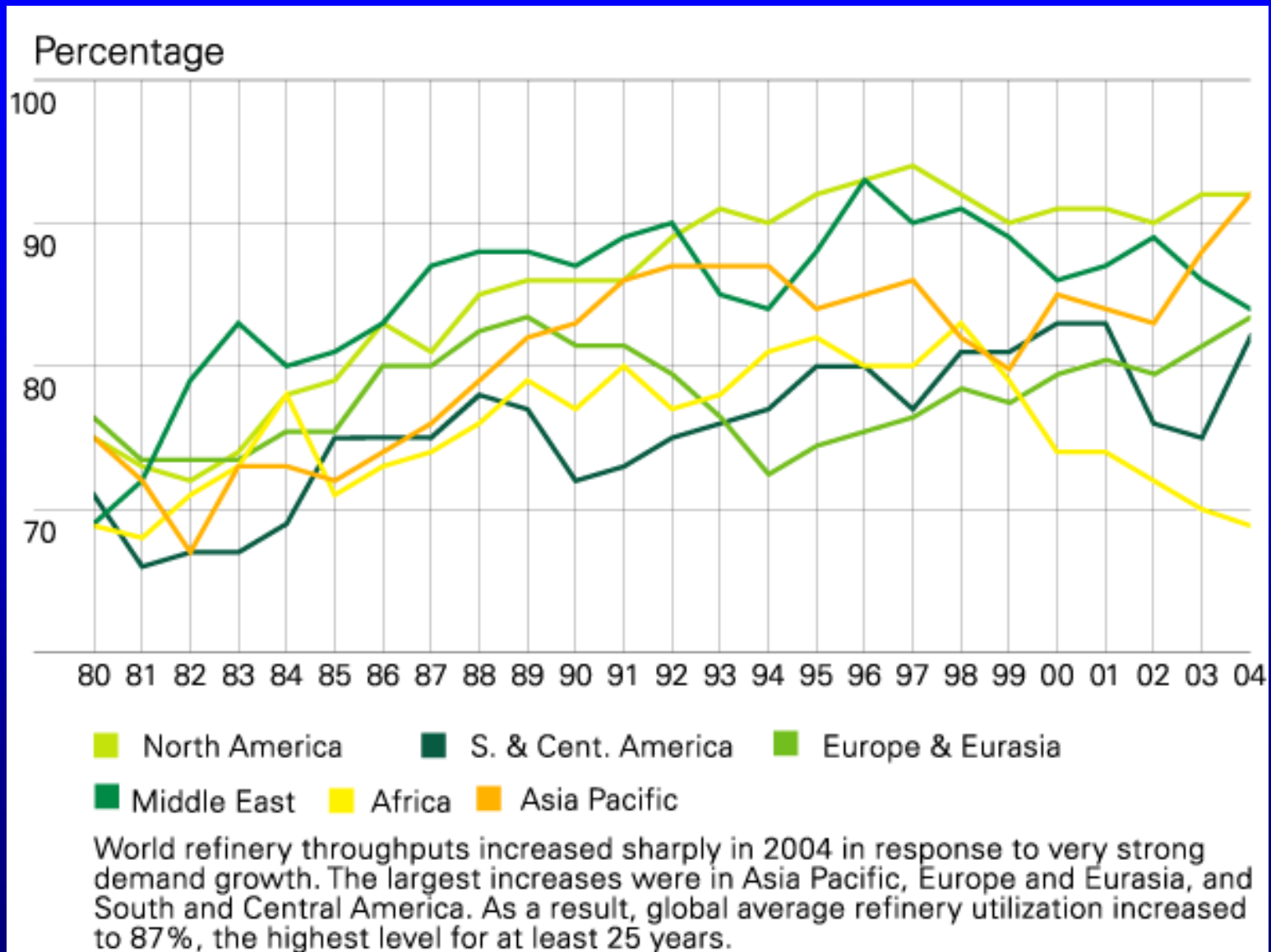


# Oil and Gas Requires Investment



Catch – About 50% of the daily volume in 10 years is not online.  
At present, requires approximately \$100 billion a year.

# Oil Refinery Utilization



# Requirements to Meet Demand

Today, 1.6 billion people – one quarter of the world population have no access to electricity.

In 2030, 1.4 billion people 17% of the world population will still not have electricity.

2.4 billion people rely on traditional biomass – wood, agricultural residues and dung – for cooking and heating.


- Evolution of Technology
- Available Expertise
- Geopolitics
  - Access
  - Investment Climate
- Price

# Technical Challenges

WHO estimates that 2.5 million women and young children die prematurely each year from fumes from biomass stoves. Shifting to LPG reduces health risk by  $> 100$

In sub-Saharan Africa only half the population has access to an improved water source (energy for pumps and purification)

In India, up to seven hours a day are devoted to collecting fuel for cooking.

- 
- Greater Depths
  - Deeper Water
  - Decreasing Quality
    - Reservoir
    - Hydrocarbon
  - Distance to Market
  - Price

# Energy Production is High-Tech Science

- Multiple Discipline Professionals evaluate “Mountains” of data to maximize reservoir recovery.
- The extraction process is based primarily on
  - management of the pressure and fluids
  - placement of wells to maximize efficiency.
- Historically,
  - Traditional “pumping” technologies extracted 20 percent of hydrocarbons in a reservoir
  - New Computer Models and technologies improve recovery to greater than 35 percent (75% Goal).
- This Science Continues to Improve with new breakthroughs



Jed Clampett also does not exist



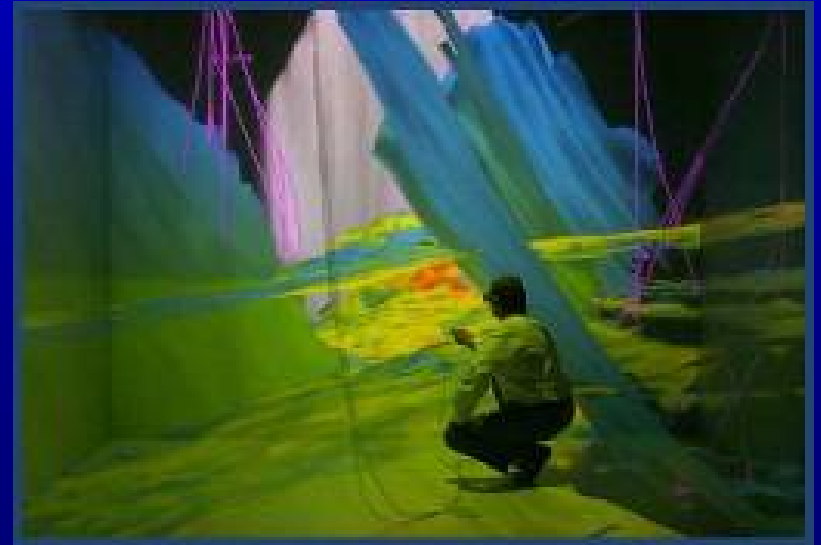
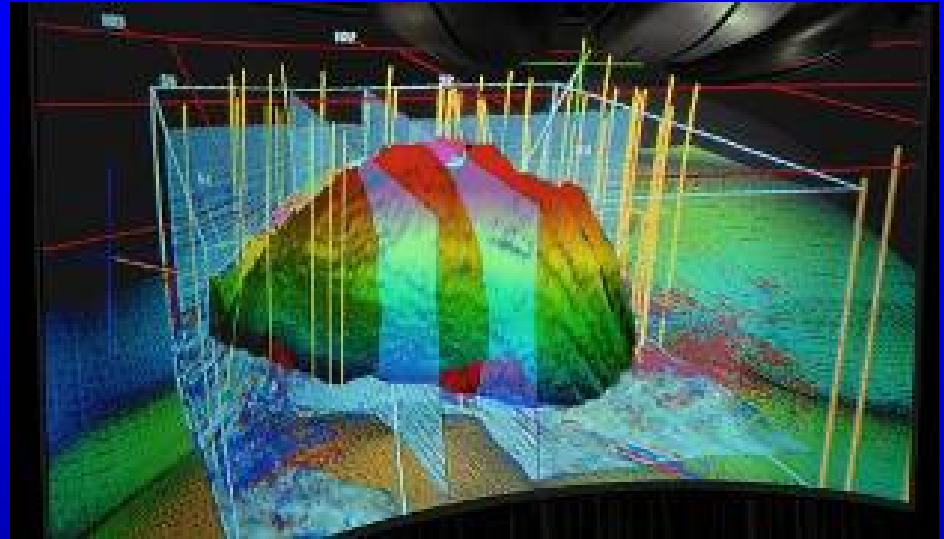
# Petroleum Technology Breakthroughs

---

1883	Anticlinal Theory	Concept of 'Where-to-Drill'
1900s	Rotary Drilling	Drill deeper
1914	Seismograph	1D Subsurface imaging
1924	Well Logging	Subsurface rock and fluid properties
1930s	Offshore Drilling	Access to new areas and basins
1960s	Digital Computer	2D Subsurface imaging data
1970s	Directional Drilling	Cost efficient reservoir management
1980s	3D Seismic	More precise subsurface imaging
1990s	3D Simulation 4-D Seismic	Predicting fluid movement
1990-2000s	Reservoir Creation	Heavy Oil (SAGD), Tight Gas, Shale Gas, Coalbed Methane, CO2 Flooding
2000s	Immersive Image Viewing / Network	Multi-discipline collaboration, Improved time to decision, success rate, risk assessment, ROI

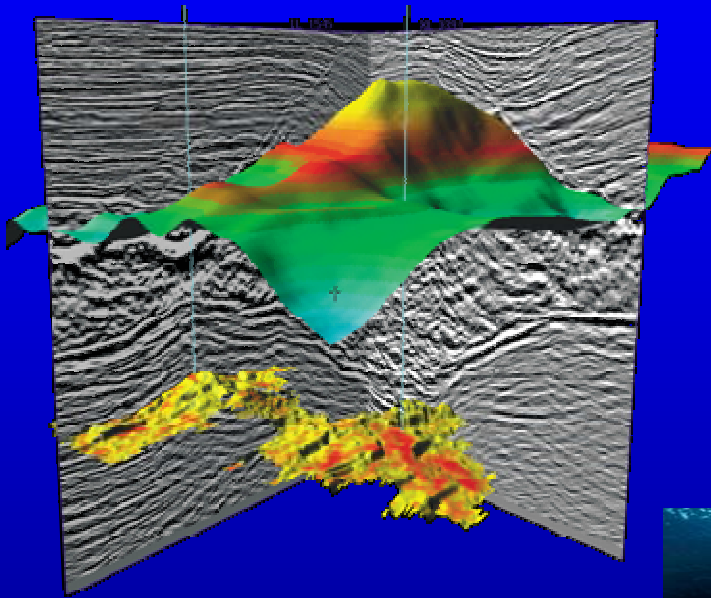
# Data Models for Energy Recovery

- Data Models are collected utilizing seismic readings.
- Computer Models are put in place to view these readings in a 3D Model
- Data is collected over time intervals for a 4D view of the data and changes over time
- Data sets are in Terabyte range with future projections in Petabyte range as information improves



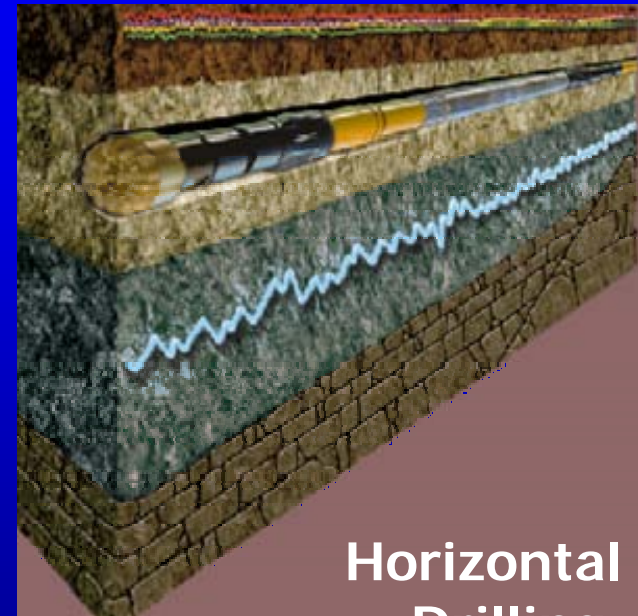
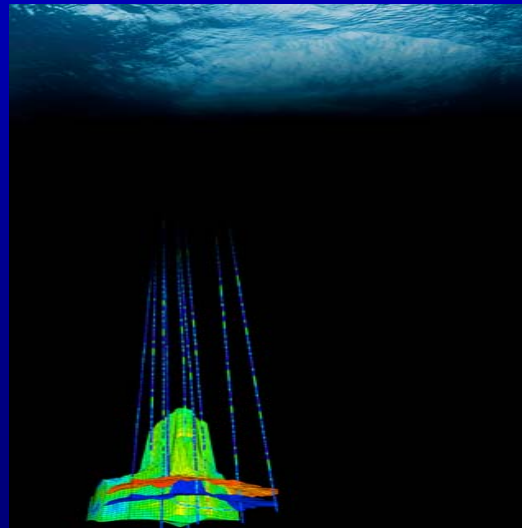
# Key Technologies

---



3D Seismic,  
Computer  
Assisted  
Exploration

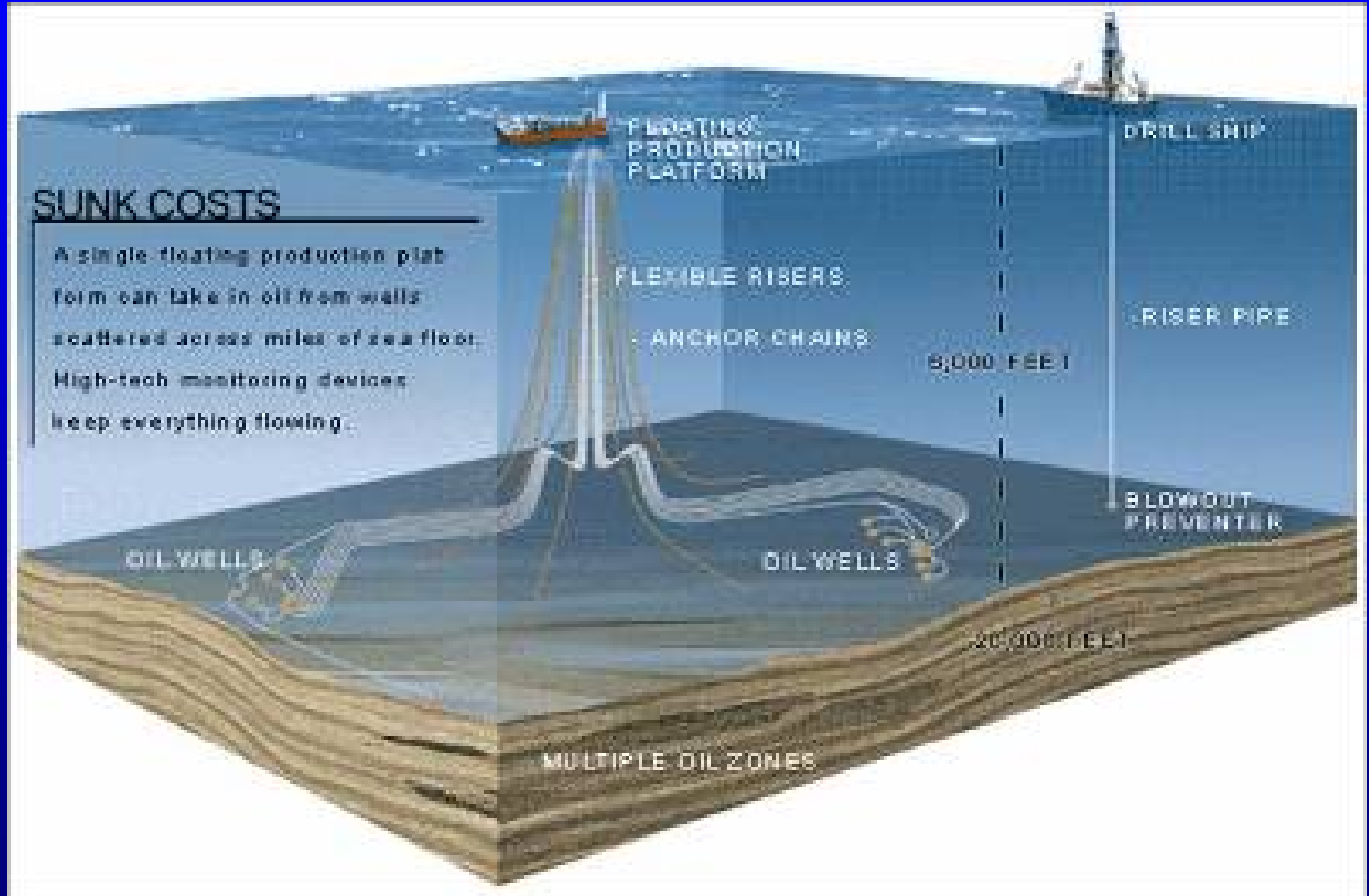
Deep-  
water,  
Sub-sea,  
FPSO



Horizontal  
Drilling,  
Geosteering, &  
Rotary Steering  
Systems

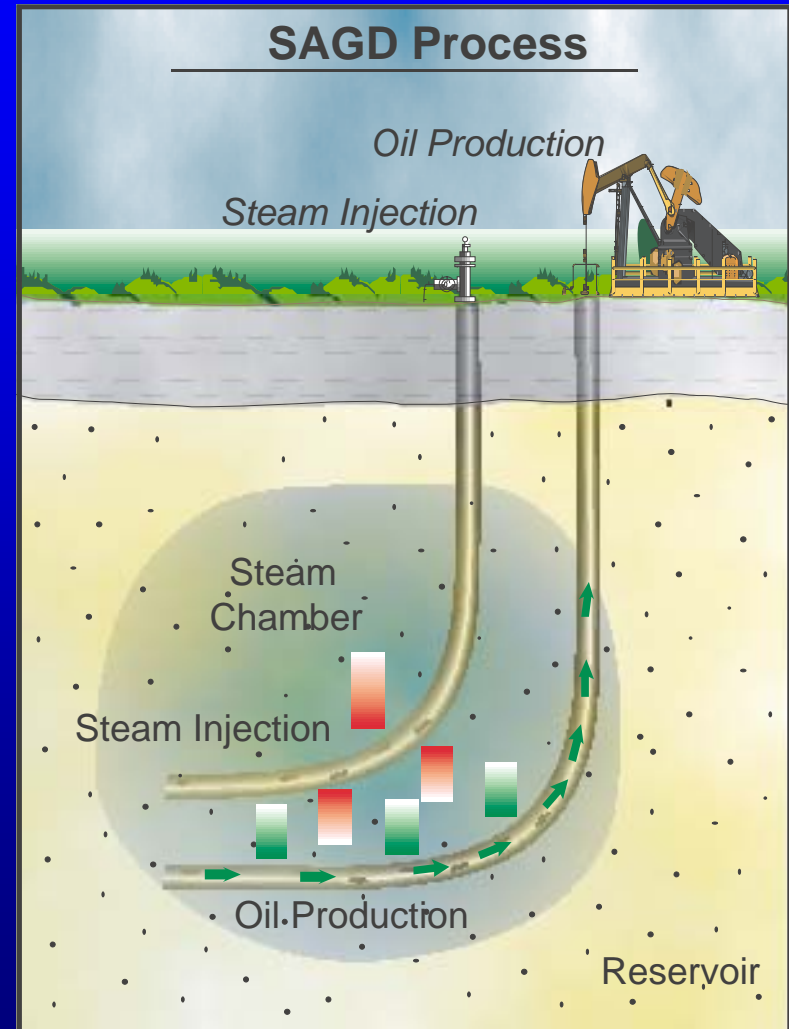
Source: Bates, 2002, GCAGS  
Baker Hughes

# Ultra-Deep Water



# Oil Sands - In Situ Deposits

- 80% of resource in situ
- too deep to mine
- current in situ production of 325,000 b/d bitumen + diluent for pipeline
- new technology developments:
  - cyclic steam stimulation
  - Steam Assisted Gravity drainage (SAGD)
  - VAPEX, MSAR

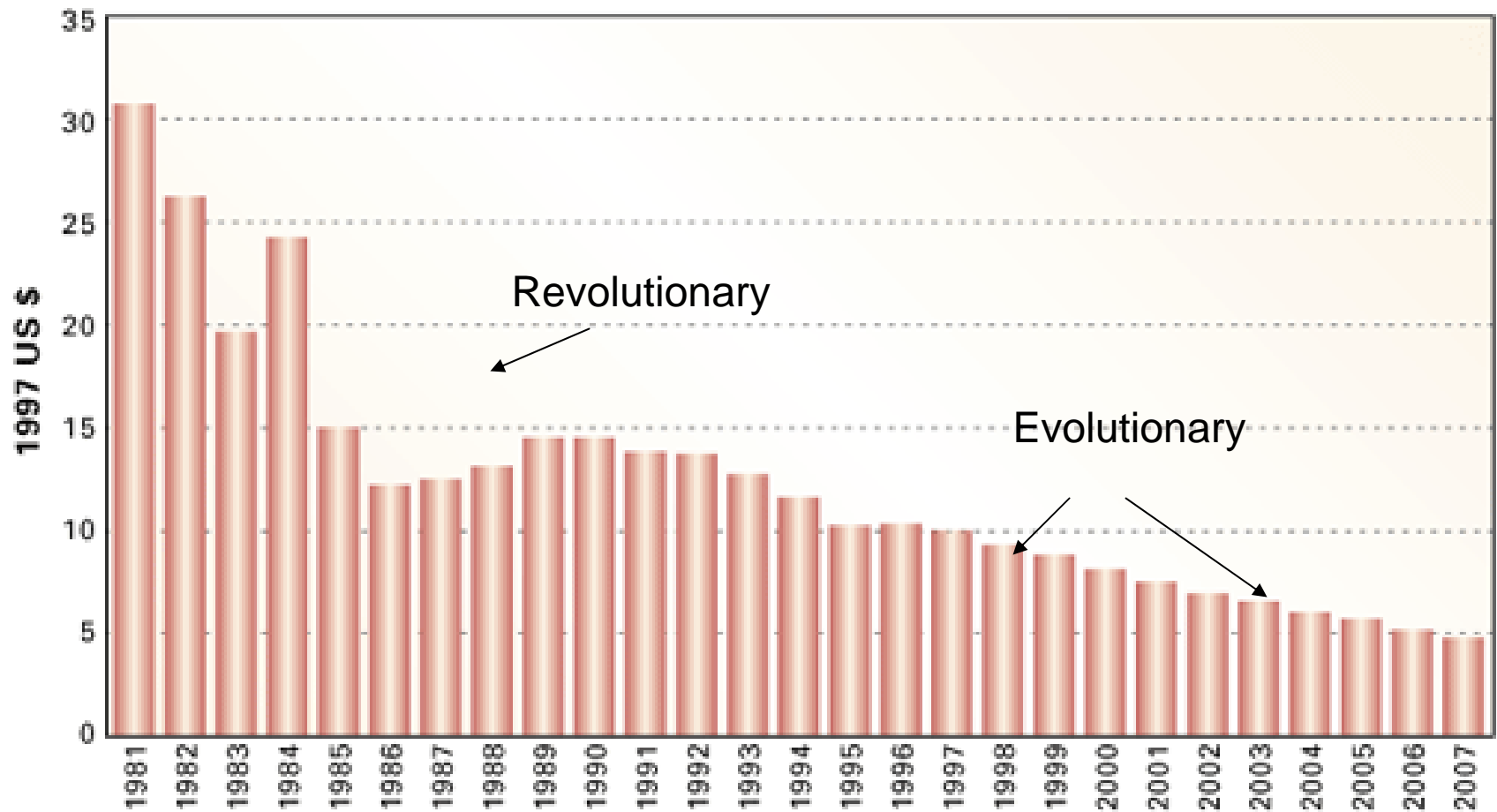


Source: PetroCanada

# Oil Sand Cost Trends

## HOW CANADIAN OIL SANDS COSTS ARE DECLINING

Fig. 7



Source: Syncrude Ltd.



# Environmental Impact Tarr Farm, Pennsylvania

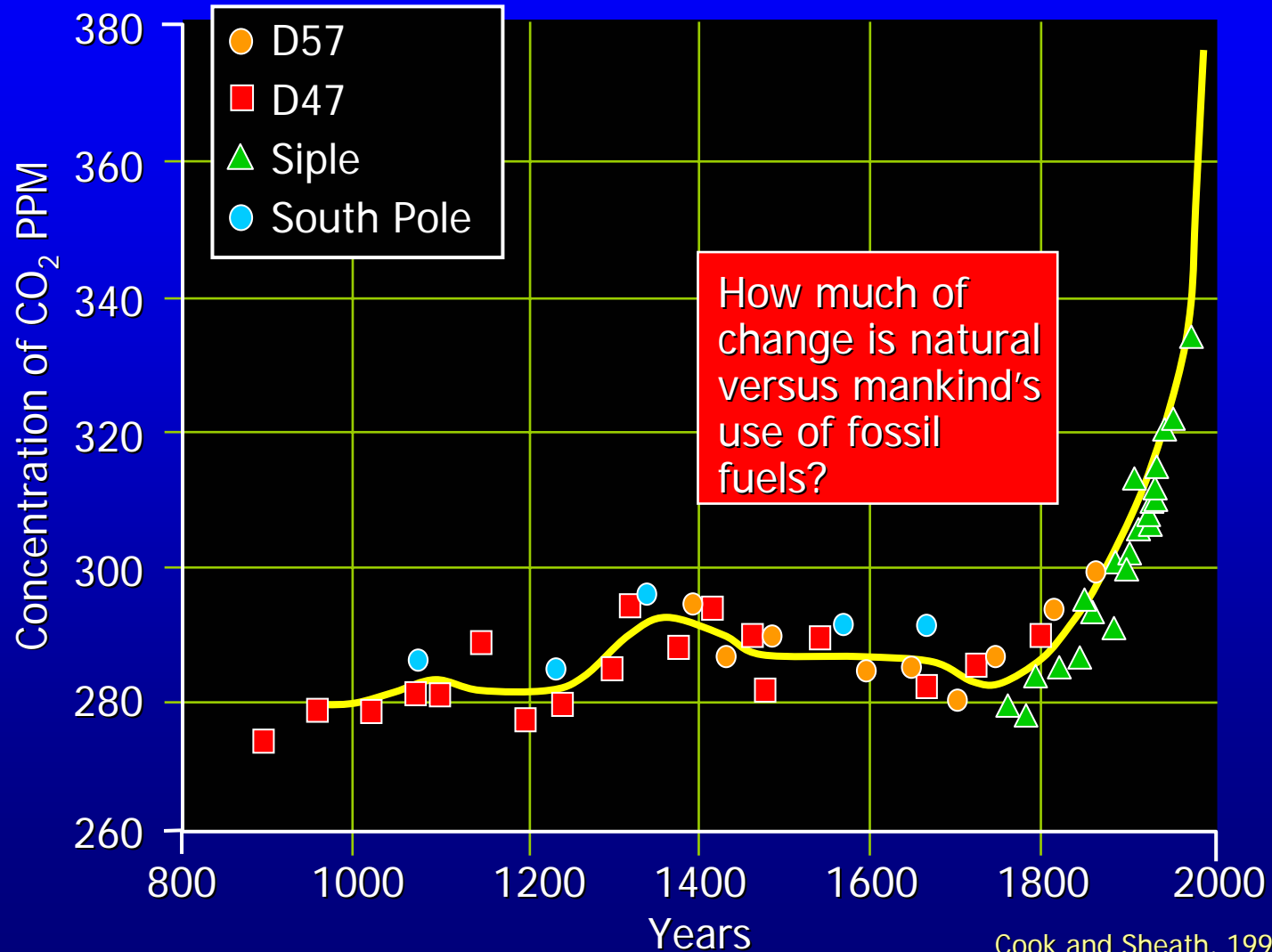


Same View in 1991



# Atmospheric Concentration of CO<sub>2</sub>

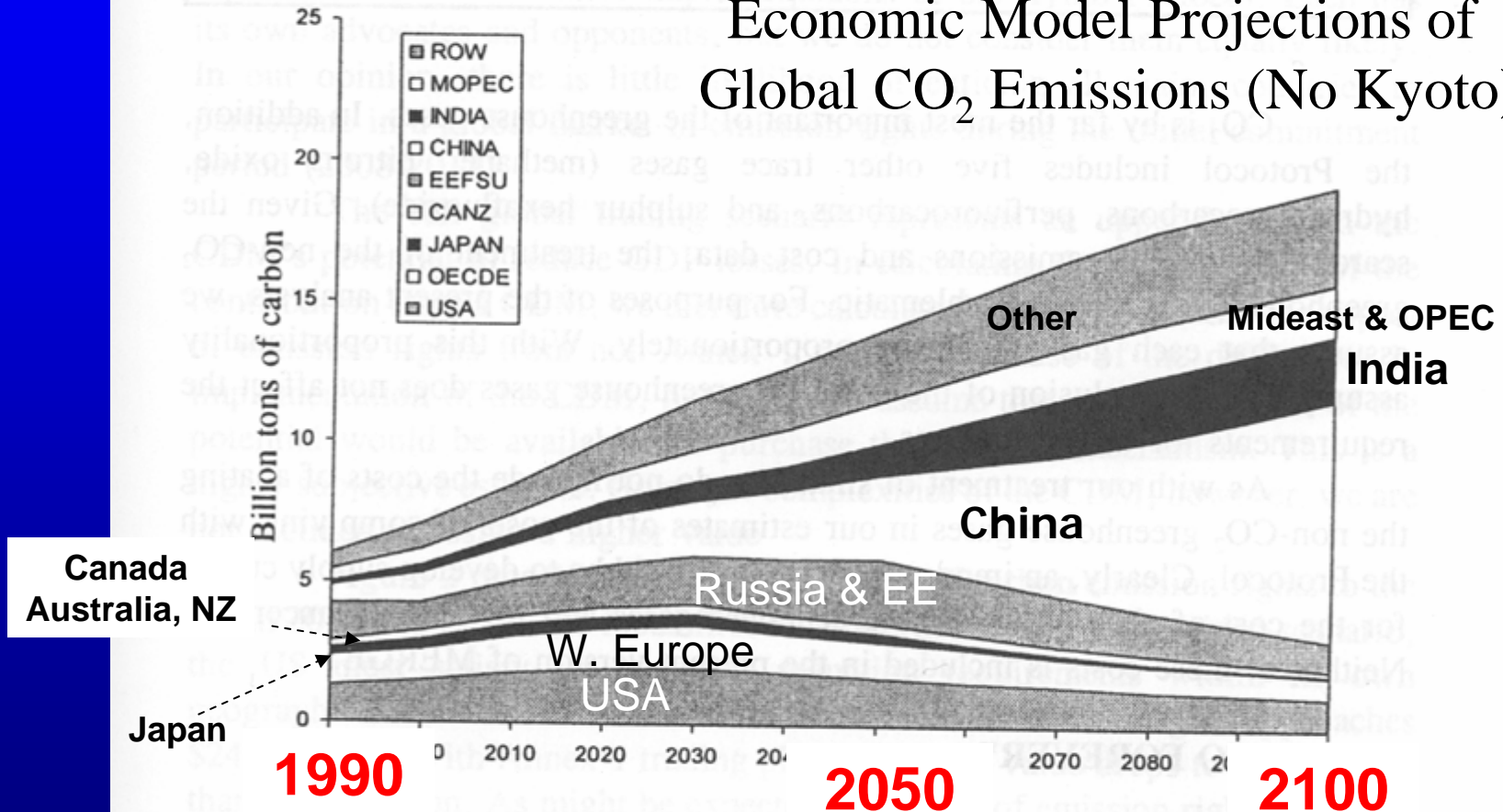
## 1000 Year History



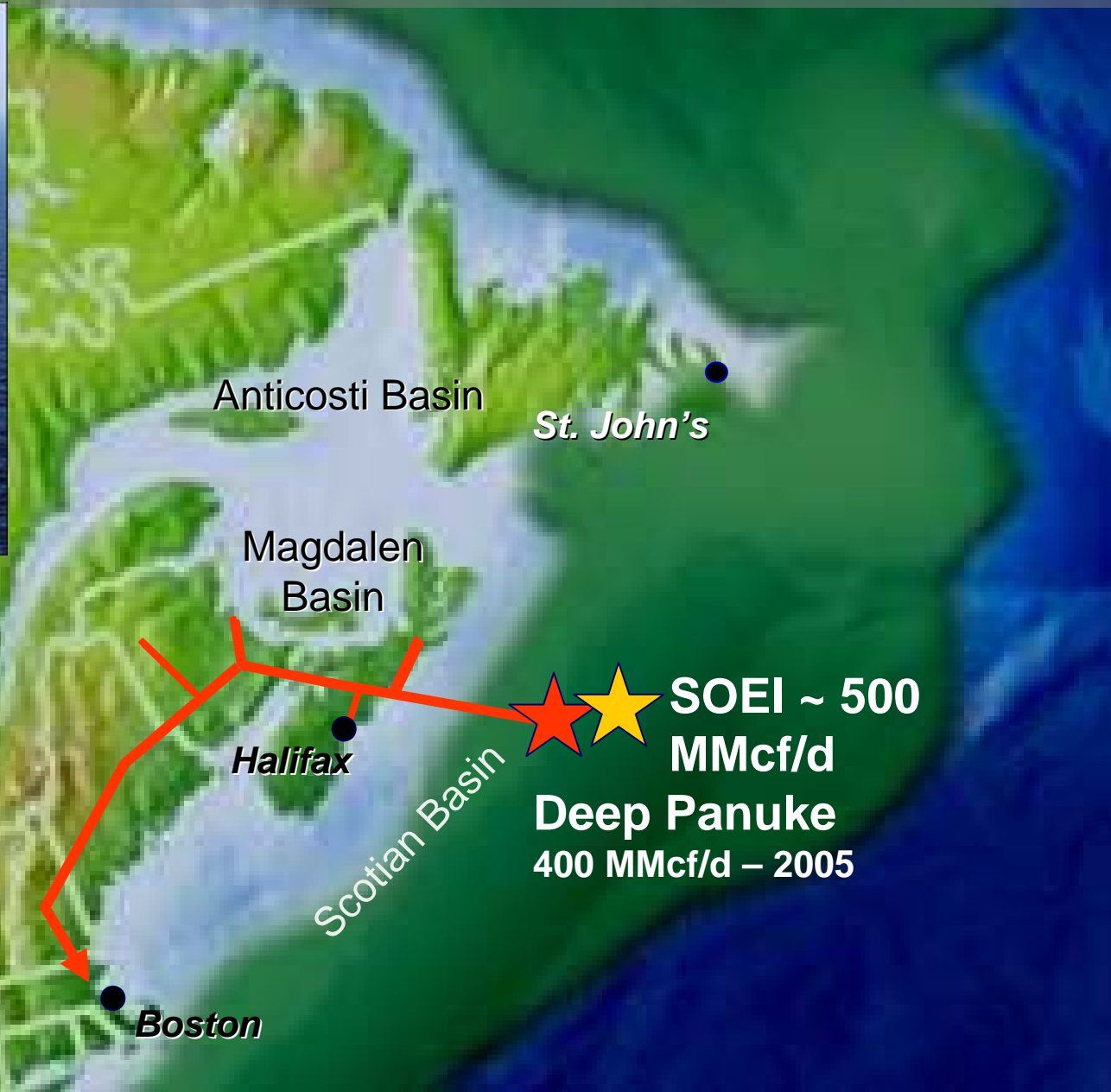
# CO<sub>2</sub> Emissions – Real Issue

Figure 1. Regional Carbon Emissions - Reference Case

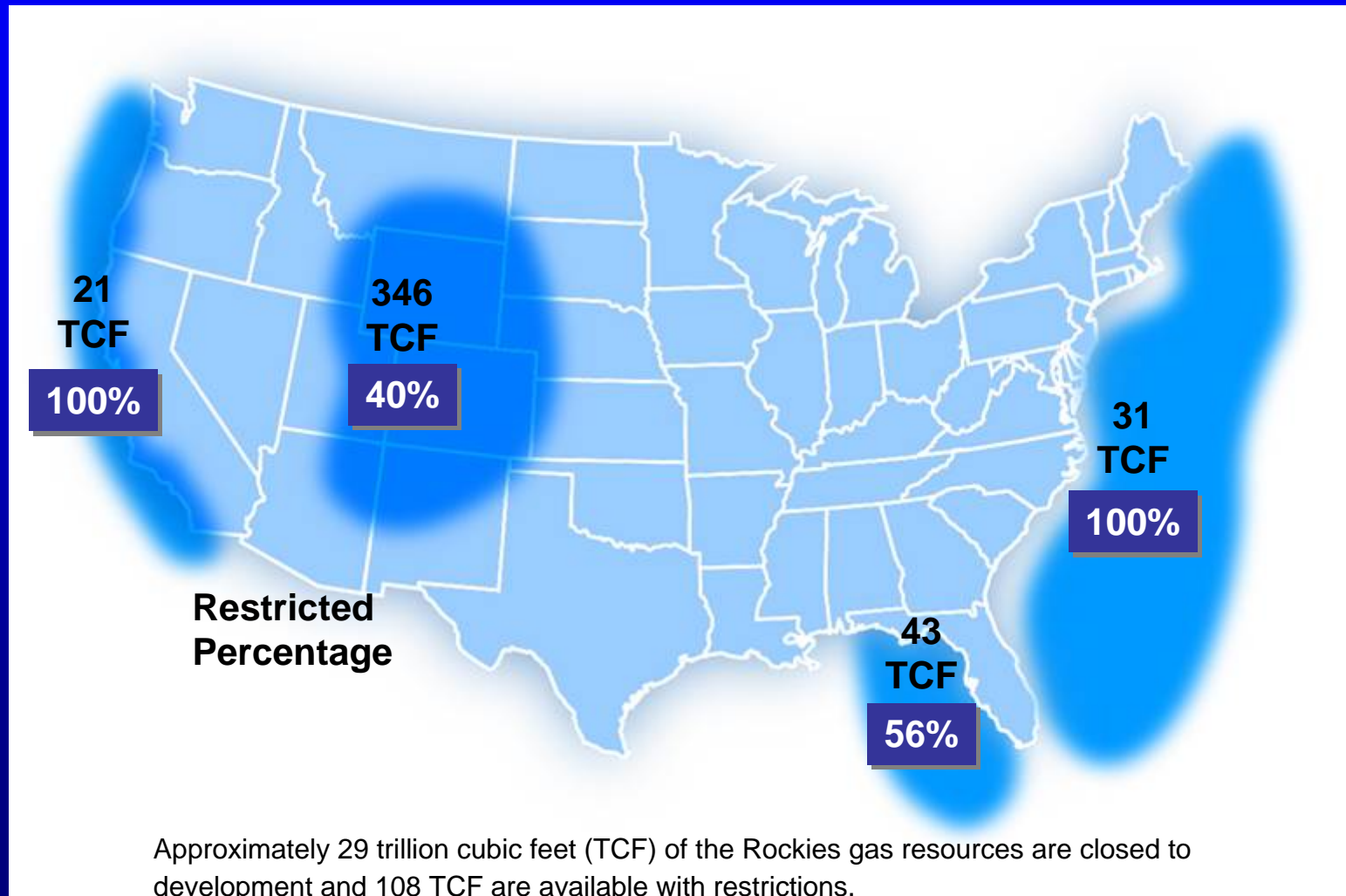
Economic Model Projections of  
Global CO<sub>2</sub> Emissions (No Kyoto)



# Geopolitics and Atlantic Gas Access

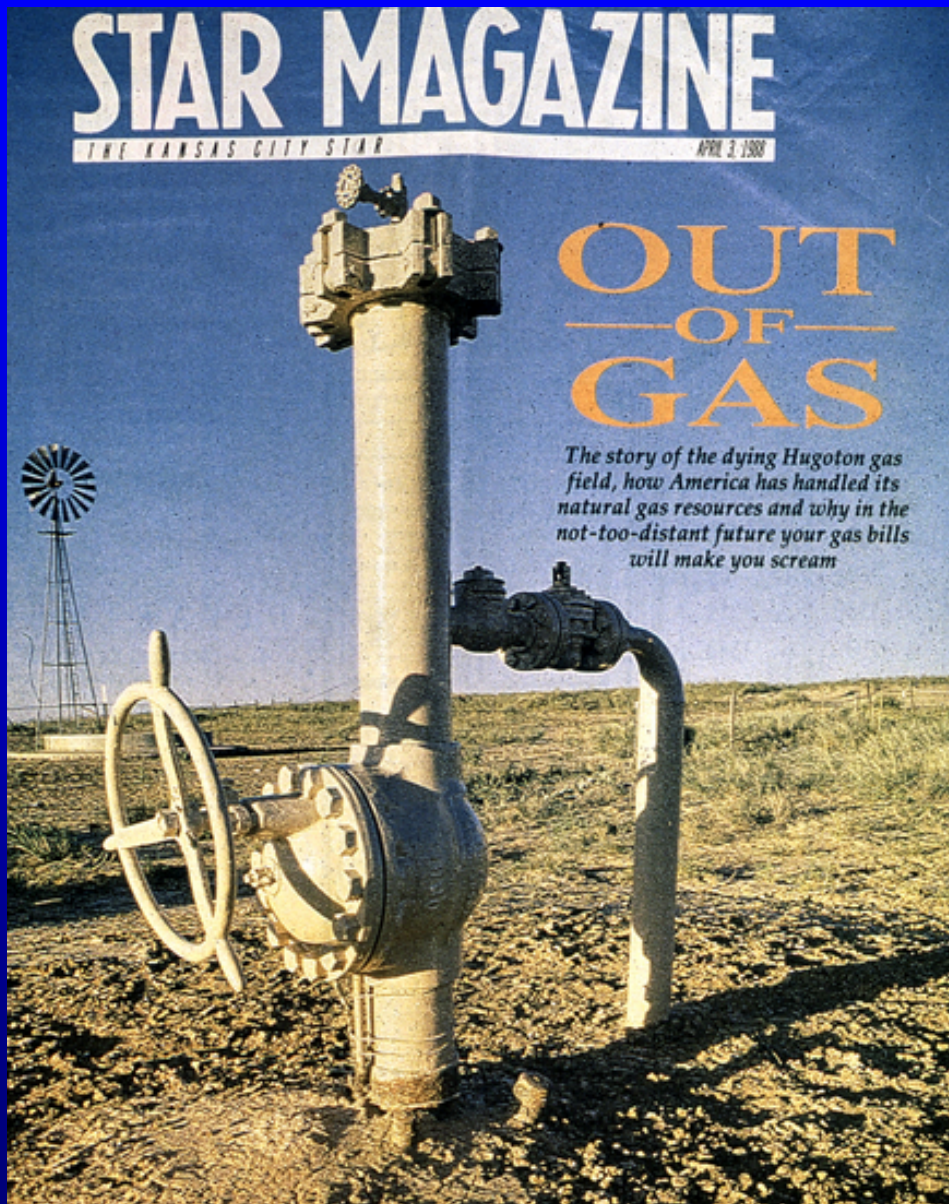


# Geopolitical Decision: Restricted Access to Gas Resource Base

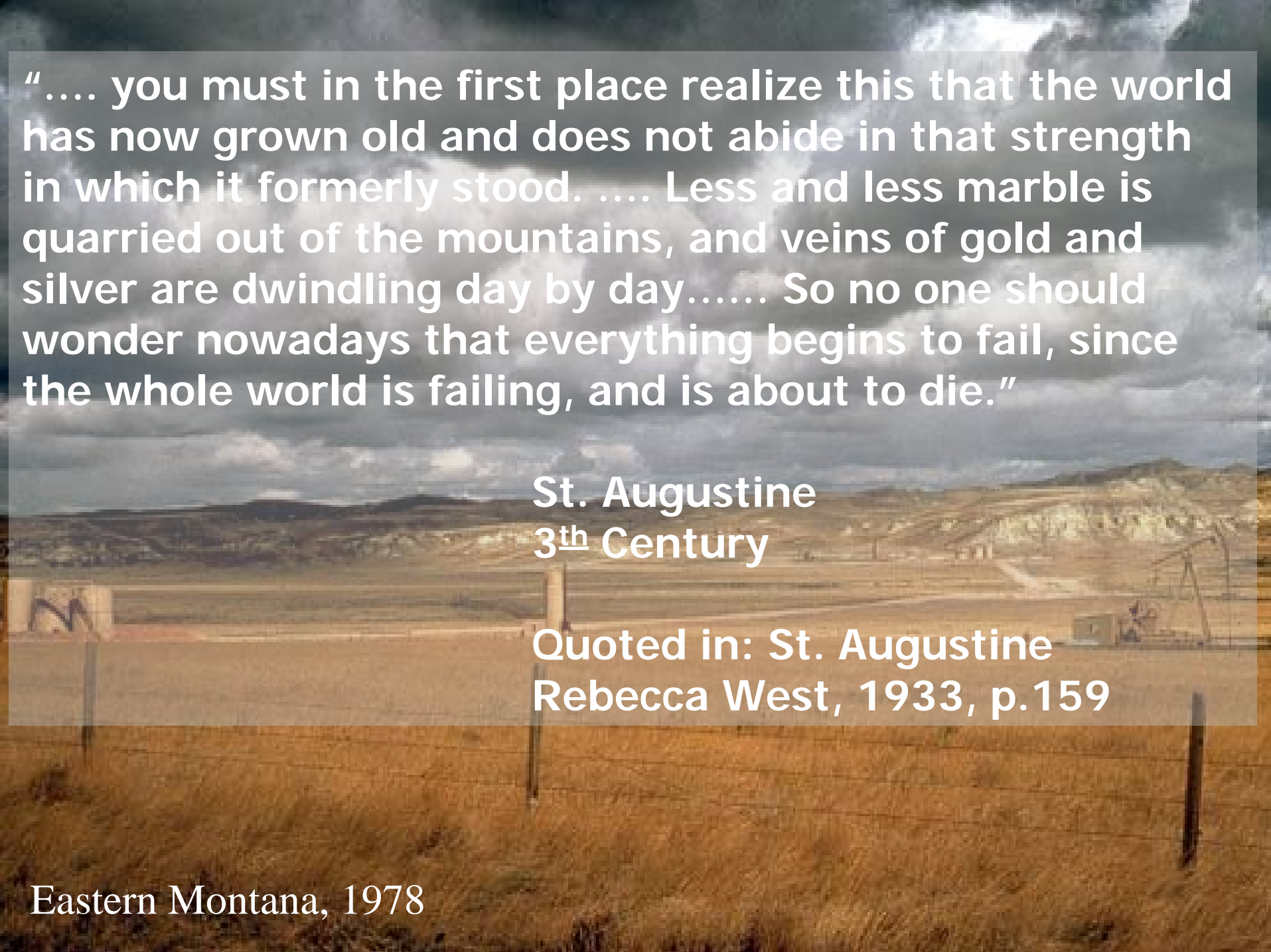




# Urban Legends (Energy)



- CONVENTIONAL OIL & GAS NEAR A PEAK
- TAR SANDS AND OTHER UNCONVENTIONAL RESOURCES ARE TOO DIRTY OR COSTLY TO BE PRODUCED
- ENERGY OUTPUT FROM ETHANOL IS NEGATIVE
- ENVIRONMENTAL IMPACT FROM OIL AND GAS PRODUCTION AND USE CAN NOT BE MITIGATED
- EASY OIL IS GONE, COSTS ARE RISING
- GEOLOGISTS ARE YOUNG AND HANDSOME



".... you must in the first place realize this that the world has now grown old and does not abide in that strength in which it formerly stood. .... Less and less marble is quarried out of the mountains, and veins of gold and silver are dwindling day by day..... So no one should wonder nowadays that everything begins to fail, since the whole world is failing, and is about to die."

St. Augustine  
3<sup>th</sup> Century

Quoted in: St. Augustine  
Rebecca West, 1933, p.159

Eastern Montana, 1978