

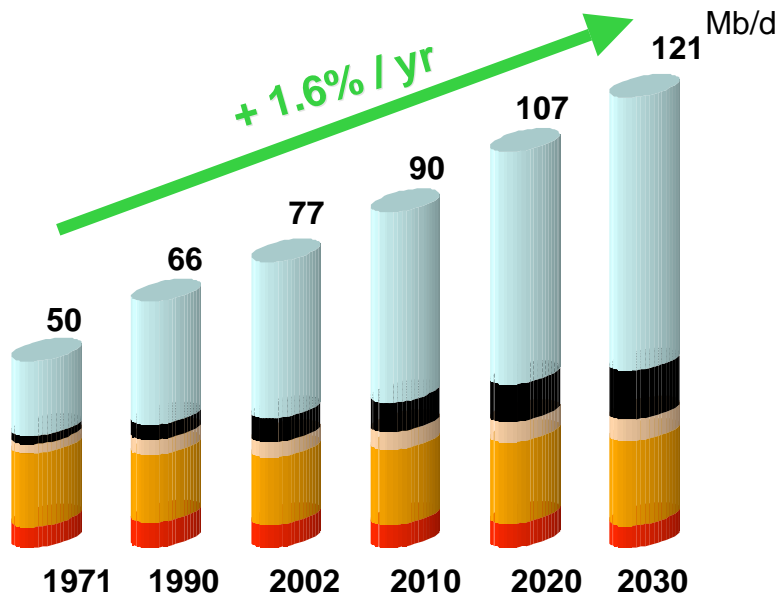
Petroleum Geoscience in the Coming Generation



PETER R. ROSE, PRESIDENT

OIL & GAS

A changing environment for future production



A growing world oil demand driven by transport fuels

- Transport
- Petrochemicals
- Non-energy use
- Heating
- Electricity

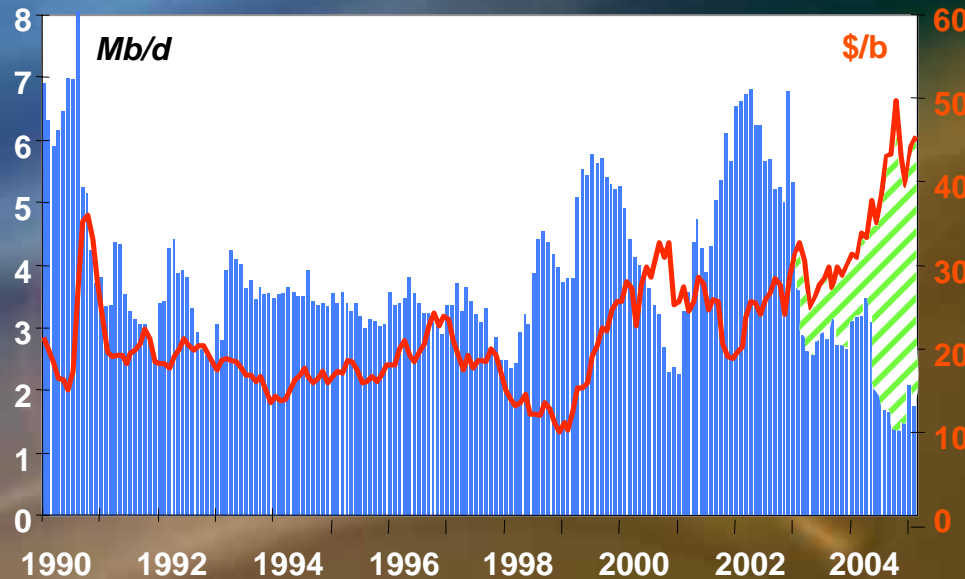


World oil demand Mb/d

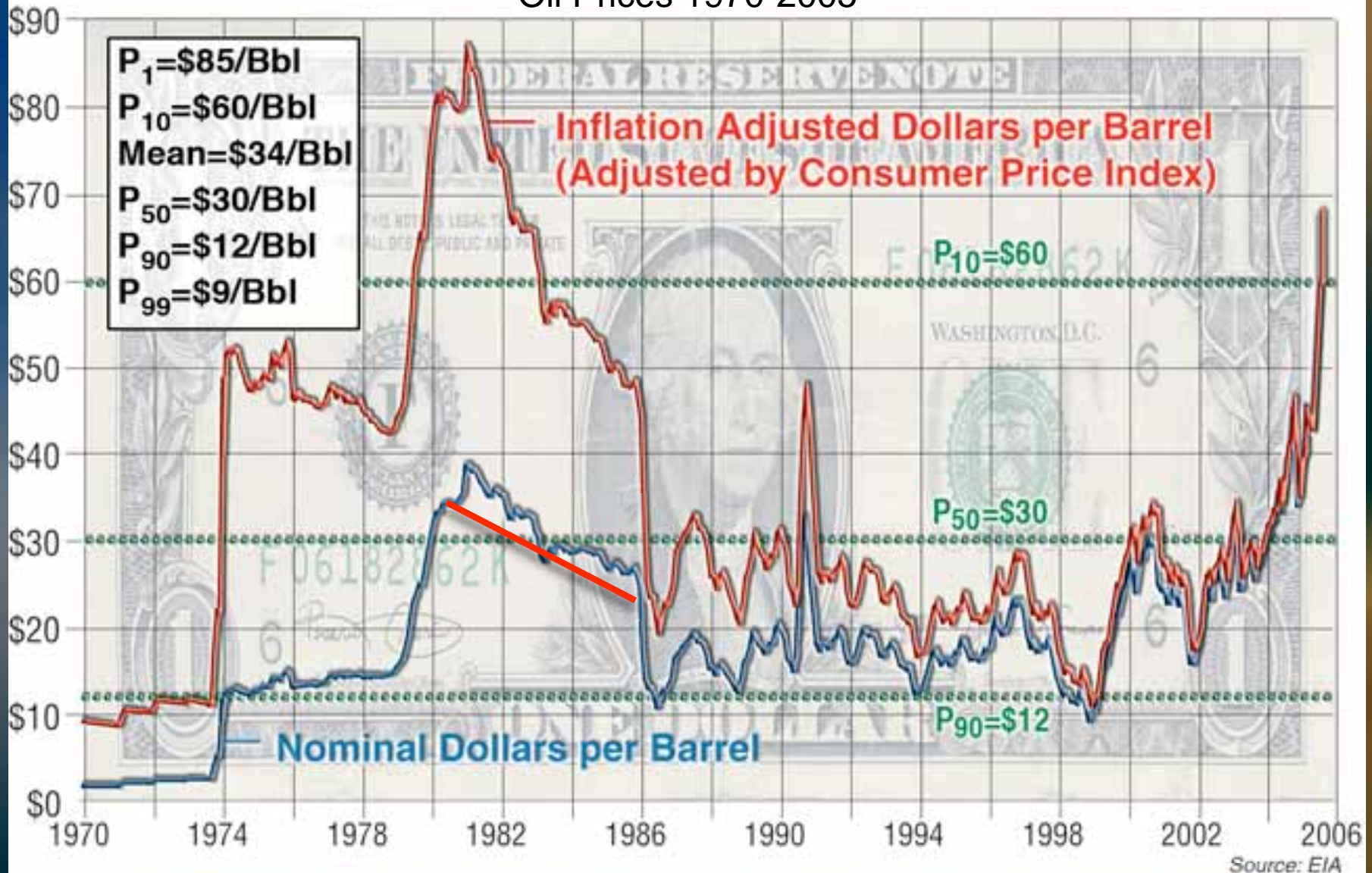
Oil price vs OPEC spare capacity

Reduction of spare capacities

Source : IEA, September 2005



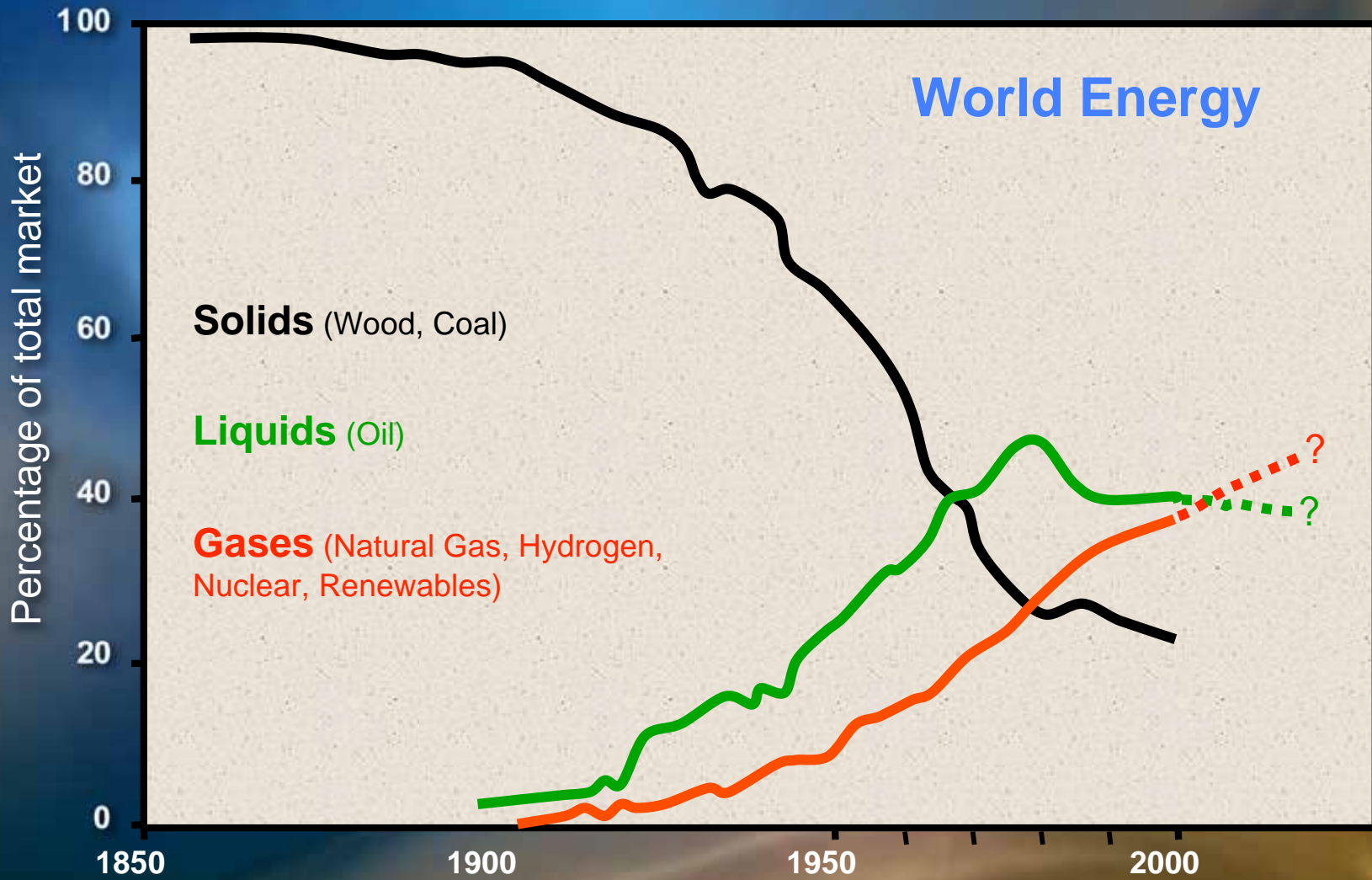
Oil Prices 1970-2005



CRUDE OIL A GLOBAL COMMODITY

**Despite High Oil-Price,
Increasing Costs &
Competition Reduce
E&P Profitability**

Energy Consumption Trends



U.S. Data: Annual Energy Review 1999 (EIA, 2000)
 World Data: International Energy Annual 1999 (EIA, 2000)

Year

Tinker, UTBEG, 2004

Global warming will generate growing pressure against oil and coal use:

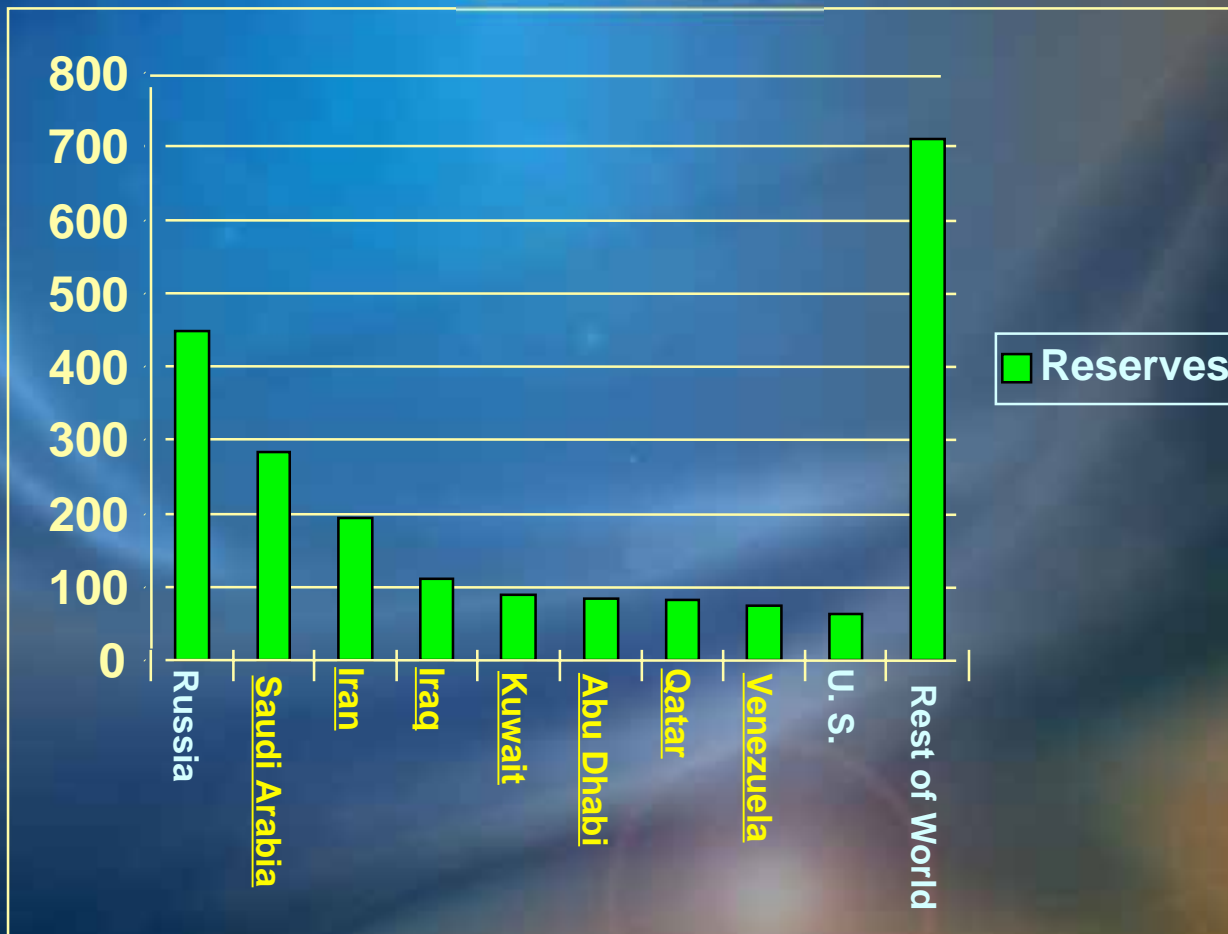
1. In West: increasing efficiency re motor fuel, new technologies = opportunities
2. In North America: increasing interference drives prices up, accelerates conservation

DISTRIBUTION OF KNOWN RESERVES*

*Gas converted at
5.6BCF = 1MMBOE

2.1 TBBOE

B
B
O
E



- 67% OF KNOWN RESERVES ARE IN 9 COUNTRIES
- 43% OF KNOWN RESERVES ARE IN 7 MAJOR OPEC COUNTRIES

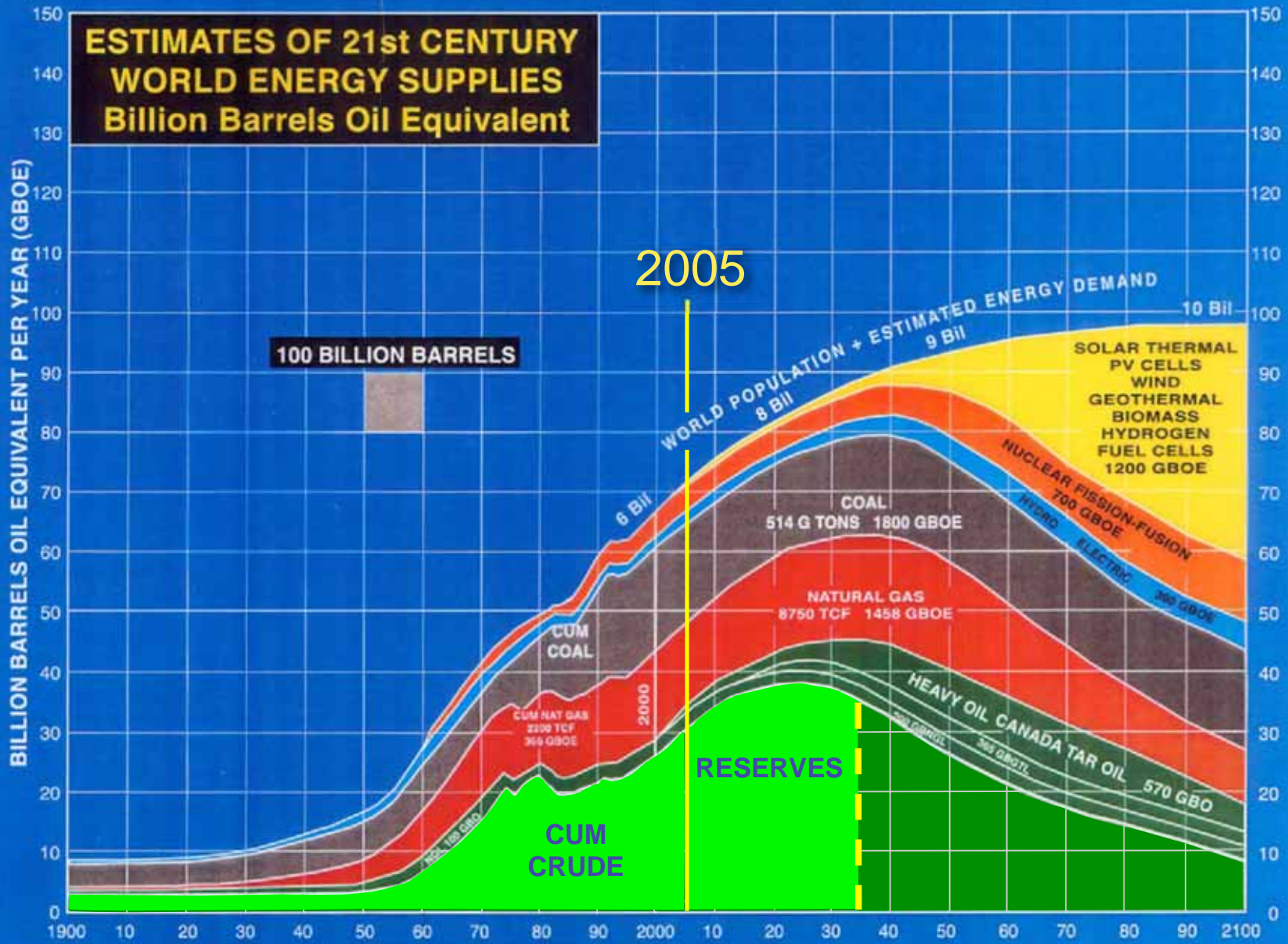


Figure 6

John D. Edwards, Department of Geological Sciences, University of Colorado - Boulder

Professional societies:

US needs to re-start national
effort toward energy
efficiency and conservation...

Especially Motor Fuels!

- Globalization of E&P workforce;
- Increased overseas opportunities for US geoscientists



West Texas Exploration in 1940's?



NOT!

The March of E&P Technology

1850s Drilling for oil (cable tools)

1860s **Anticlinal theory**

1870s Surface mapping

1890s Rotary drilling

1910s Use of geologists

Torsion balance

Sedimentary petrology/petrography

1920s **Refraction seismic**

Micropaleontology

Reflection seismic

Magnetometer

1930s Electric logs

Drill-stem testing

Coring

Stratigraphic trap concept

Aerial photography

1940s **Gamma-ray neutron logs**

Offshore drilling

1950s Hydraulic fracturing

Sonic log

Density log

1960s **CDP Seismic**

Discounted cash-flow analysis

Petroleum geochemistry and source rocks

1970s Seismic amplitude anomalies ("Bright spots")

Exploration economics

Calgary

Bahrain

Doha

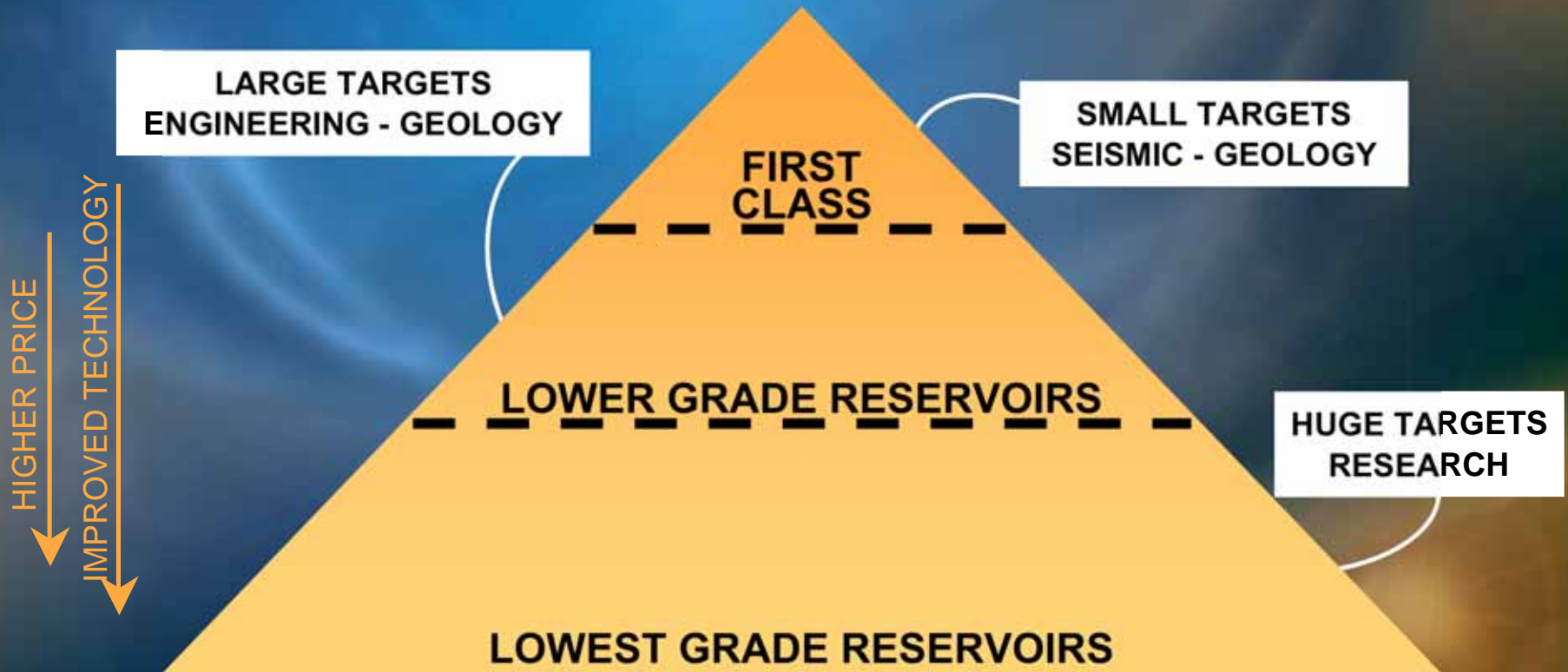
Paris

Houston

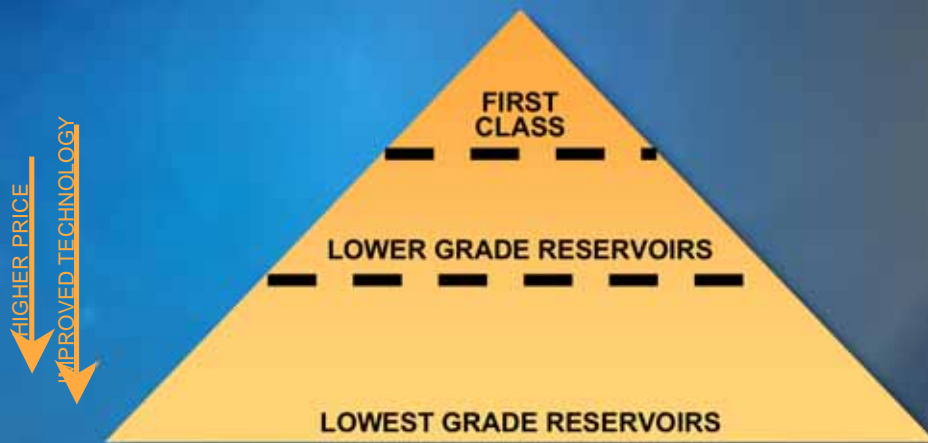
London



RESOURCE TRIANGLE



RESOURCE TRIANGLE



MULTIDISCIPLINARY TEAMS

Geology

Geophysics

Petrophysics

Risk Analysts

Economists

Engineers

- **Drilling**

- **Reservoirs**

- **Completions**

Project Managers

HISTORICAL SCOPE OF PETROLEUM GEOSCIENTISTS

1900 - 1950:

Explore New Geography, Technologies

1950 - 2000:

Explore partly known Terranes, partly known Technologies

2000 - 2050:

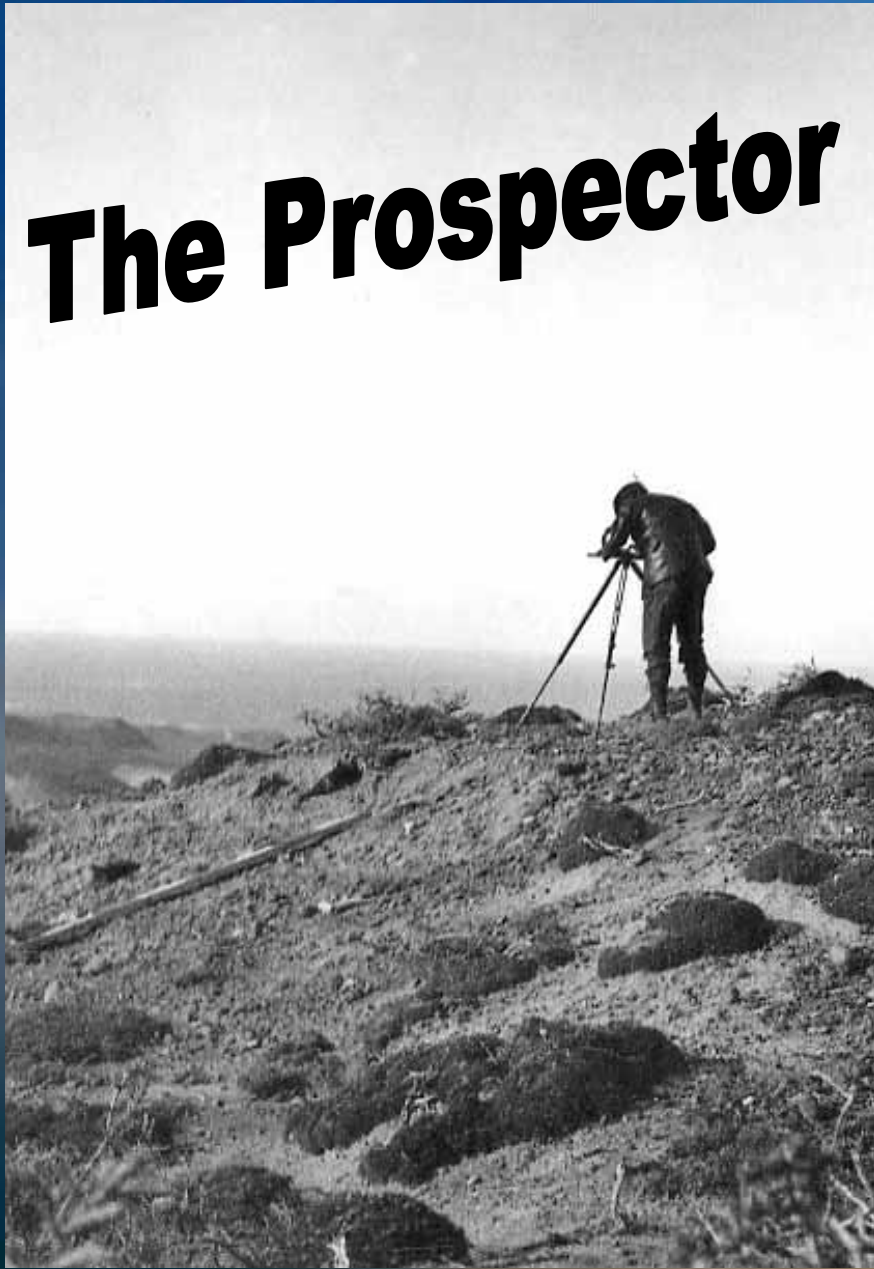
Integrated Intellectual, Technological, Interdisciplinary Frontiers

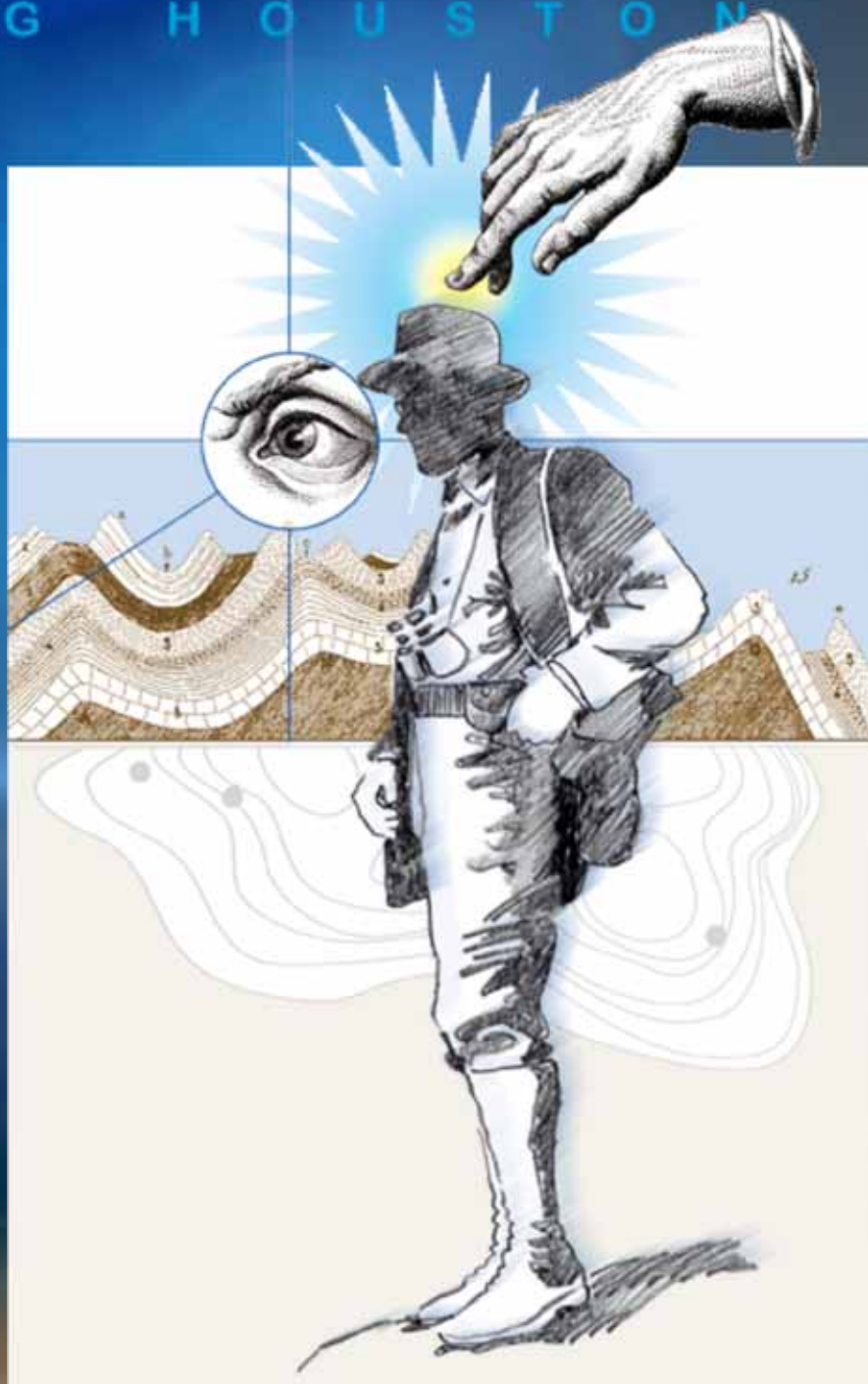
KEYS TO 21ST CENTURY E&P SUCCESS

- Entry-level workforce
(numbers, qualified)
- Technical efficiency &
Business discipline
- Available capital



The Prospector Myth





BECAUSE EXPLORATION IS DOMINATED BY

- SUBJECTIVITY
- UNCERTAINTY

*... it invites the
Exercise of Intuition!*

So Explorers Tend to Overvalue
their Prospects!

MEASURING E&P VENTURES

- E&P Ventures Must Be Measured
- Requires estimating under uncertainty
- Portfolio performance requires objectivity and consistency

MEASURING OUR PROJECTS: TWO OPTIONS

- Consign evaluation responsibility to others (gate-keepers)
- Geoscientists accept evaluation
 - responsibility

PROFESSIONAL RESPONSIBILITIES OF PETROLEUM GEOSCIENTISTS

- Find profitable oil and gas accumulations **Fun Part!**
- Measure opportunities consistently w/o bias **Business Part!**

DETACHMENT IS REQUIRED TO MEASURE YOUR OWN PROSPECTS!

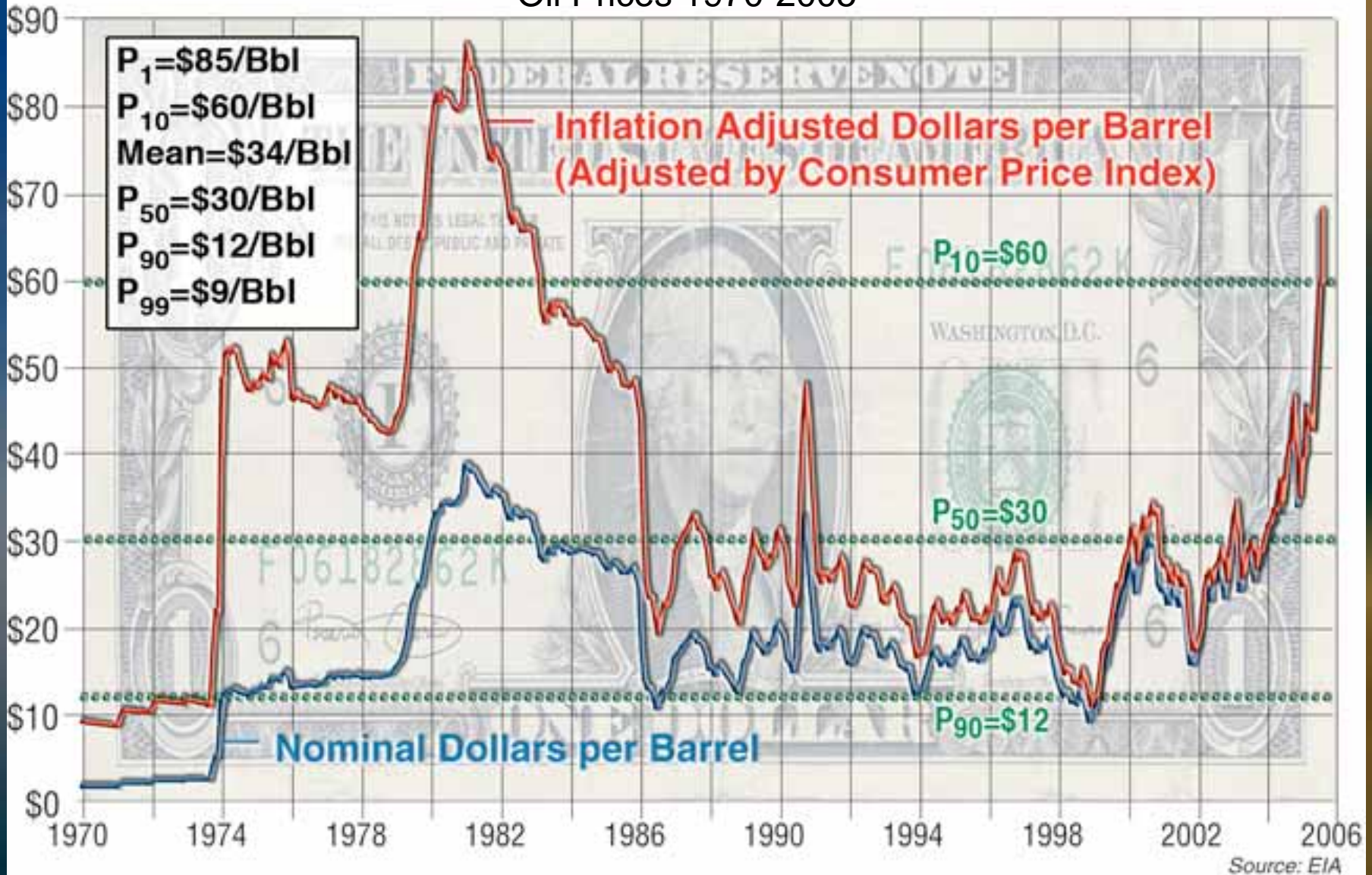


- Professionalism
- Project Teams

E&P PORTFOLIO PERFORMANCE IMPROVING

- Seismic Advances
- Risk Analysis Methods
- Professional Emphasis
- More Efficient Use of Investment Capital

Oil Prices 1970-2005



CRUDE OIL A GLOBAL COMMODITY



HORATIUS AT THE BRIDGE



Geoscience in the Coming Generation



Onward!