

THE FUTURE OF THE GLOBAL OIL INDUSTRY

Presentation by
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New Canaan, Connecticut

United States Department of State
Washington, D.C.

The Issues.....

- ARE WE RUNNING OUT OF OIL?
- WHAT AND WHERE ARE THE WORLD'S FUTURE OIL RESERVES?
- WHAT ARE THE INDUSTRY CHALLENGES?
- WHAT TECHNOLOGY AND PROFESSIONAL SKILLS ARE REQUIRED TO MEET FUTURE DEMAND?
- FOREIGN POLICY IMPLICATIONS FOR THE USA



ACKNOWLEDGEMENTS

The author thanks the following organizations and companies for providing information and PowerPoint slides for this presentation:

American Association of Petroleum Geologists

American Geological Institute

Devon Energy

IHS Energy

John S. Herold, Inc.

Schlumberger, Inc.

Baker Hughes, Inc.

University of Texas - Dept. of Geological Sciences



POINTS OF



***THE WORLD CONSUMES
ABOUT 31 BILLION BARRELS***



GLOBAL ENERGY USE

*Oil & Natural Gas
as % of Total Energy Mix*

2005: 81%

2030: 59%

Source: EIA

**THIS IS THE GREATEST FACTOR
THAT IS DRIVING WORLD DEMAND**



DEMAND - ASIA ENTERS THE CONSUMER AGE



Night Energy Use Early 1970's



Night Energy Use 2005



Energy Consumption as an Indicator of the Wealth of Nations

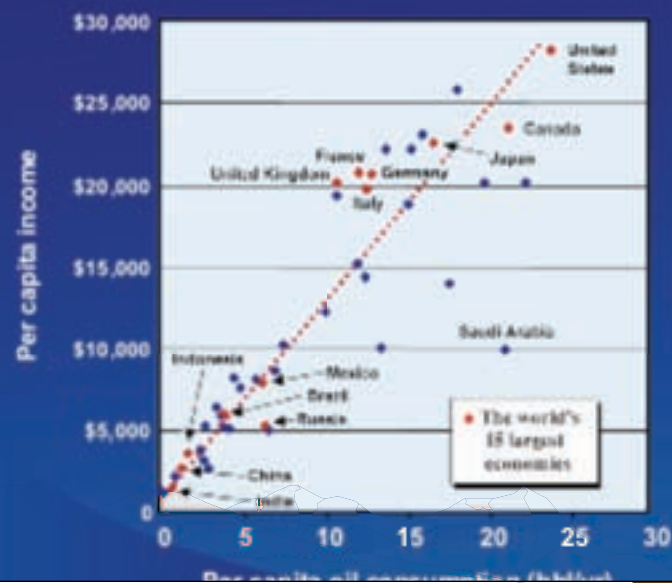
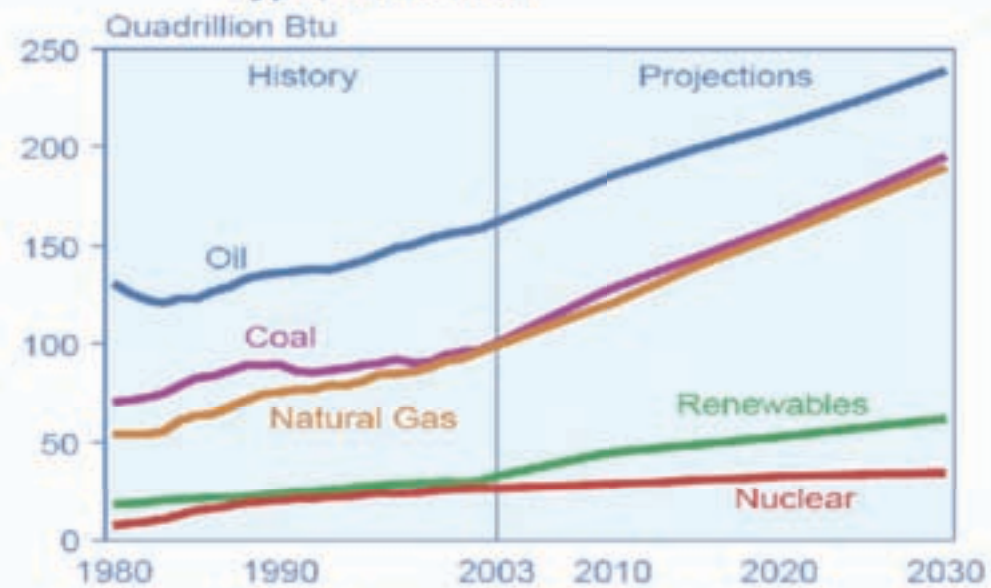


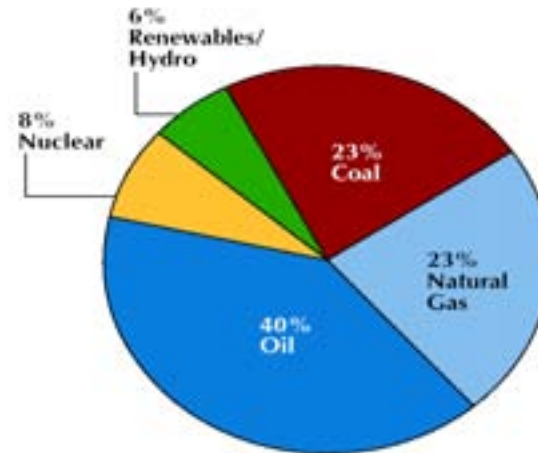
Figure 10. World Marketed Energy Use by Fuel Type, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, **Projections:** EIA, System for the Analysis of Global Energy Markets (2003).

Total Domestic Energy Use by Source

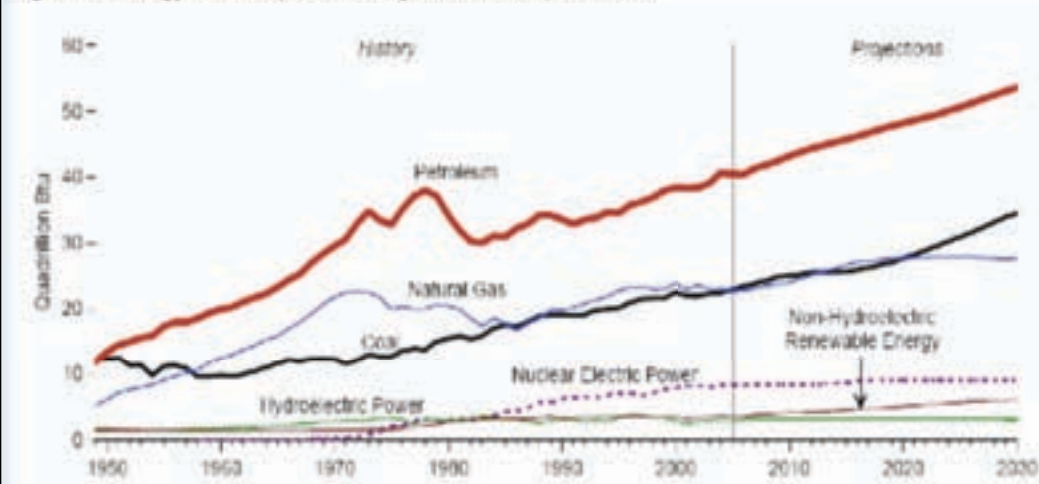
The U.S. relies upon fossil fuels to meet over 85% of its total energy needs (2003).



Data Source: Energy Information Administration, 2004

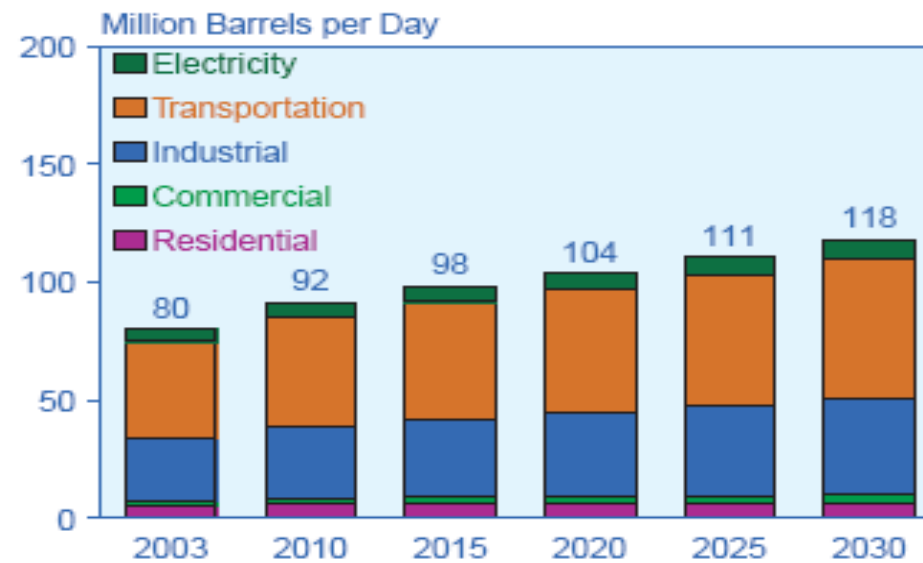
USA ENERGY USE BY TYPE

Figure 6. Energy Consumption History and Outlook, 1949-2030



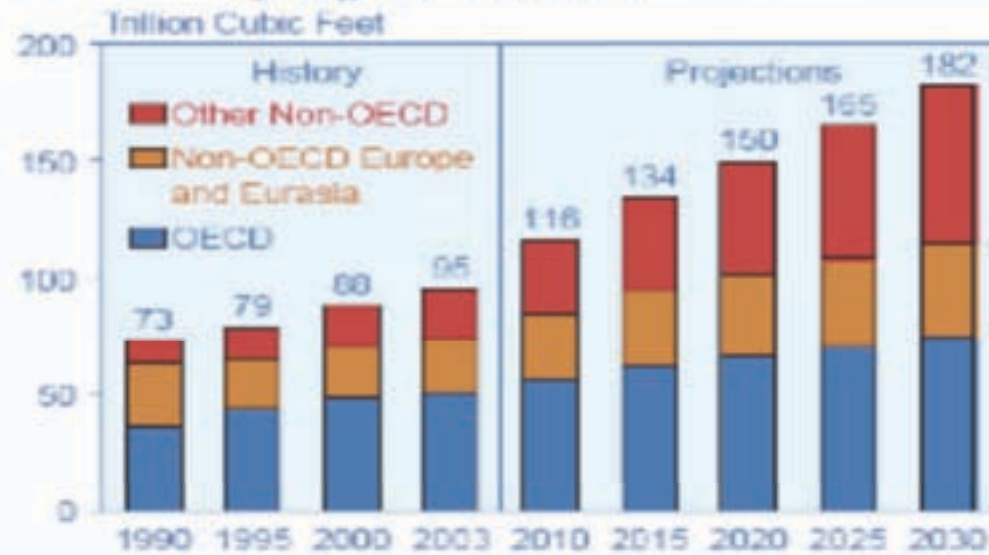
Source: EIA

Figure 26. World Oil Consumption by Sector, 2003-2030



Sources: 2003: Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. Projections: EIA, System for the Analysis of Global Energy Markets (2006).

Figure 34. World Natural Gas Consumption by Region, 1990-2030



Sources: History: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site: www.eia.doe.gov/iea/. Projections: EIA, *System for the Analysis of Global Energy Markets* (2005).

POINTS OF REFERENCE

- The USA currently consumes about 21 million Barrels of oil per day, or about 7.5 billion barrels/year.
- USA proved crude oil reserves are 21.3 billion barrels.
- USA imported 58% of its crude petroleum needs in 2005. Imports are expected to rise to 70% by 2025.

Source: EIA

USA CRUDE OIL PRODUCTION

YEAR	Million Barrels / Day
1970	9.63
2005	5.12

**Domestic production has declined
47% in 35 years**

Source: EIA



POINTS OF REFERENCE

- **The USA has less than 5% of the World's population, yet consumes about 25% of the world's oil and natural gas.**

The developing world has entered the consumer age.the USA has serious competition!

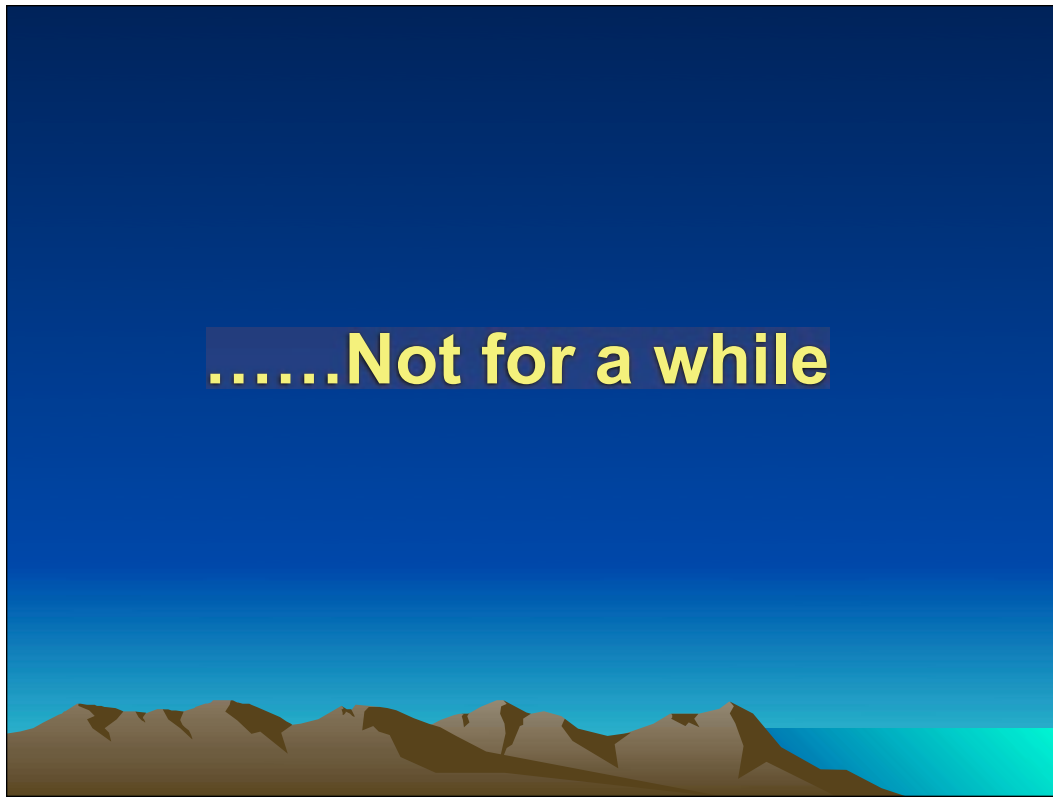


FUTURE PETROLEUM SUPPLY

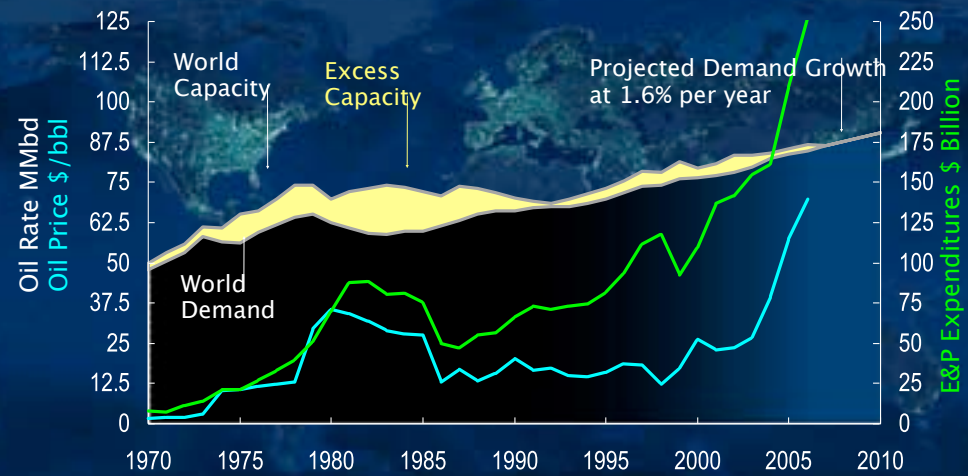
Are we running out of oil?



.....Not for a while



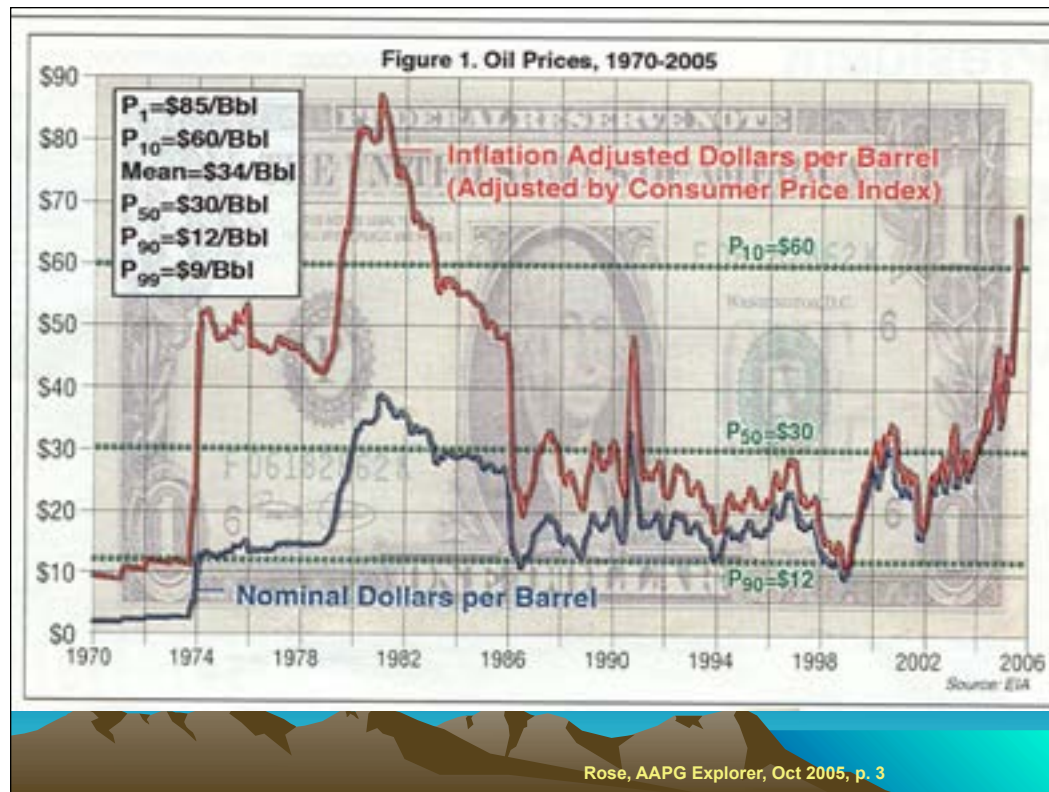
Oil Demand and E&P Expenditure – A Macro View



Source: Schlumberger, Inc based on data from BP Statistical Review, IEA Oil Market Annual Summary, OPEC Secretariat, Salomon Smith Barney. Data Revised June 2006.

**MINIMAL EXCESS CAPACITY
= HIGH COMMODITY PRICES**





Rose, AAPG Explorer, Oct 2005, p. 3

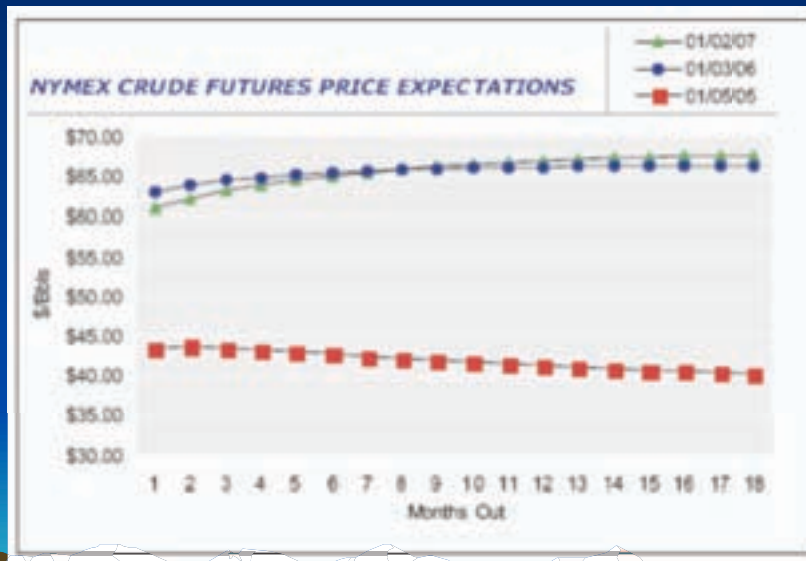
As shown by AAPG President Pete Rose in the Explorer, oil prices surged from \$12 in 1998 to a peak over \$67 in Sept 2005, up 500% in 7 years. Dr. Rose is a recognized industry expert in exploration risk and economic return, and he assembled this graph to put the recent upswing into perspective. Actual prices are shown in blue, and inflation adjusted prices are in red. Dr. Rose's statistical analysis of these data shows an average price of \$34/bbl and a P50 (50% probability) of \$30/bbl. But the past is not always a reliable guide for the future, so we will next look at some estimates of remaining world resources and the balance between supply and demand. But first...

Figure 32. World Oil Prices in Three Cases, 1980-2030



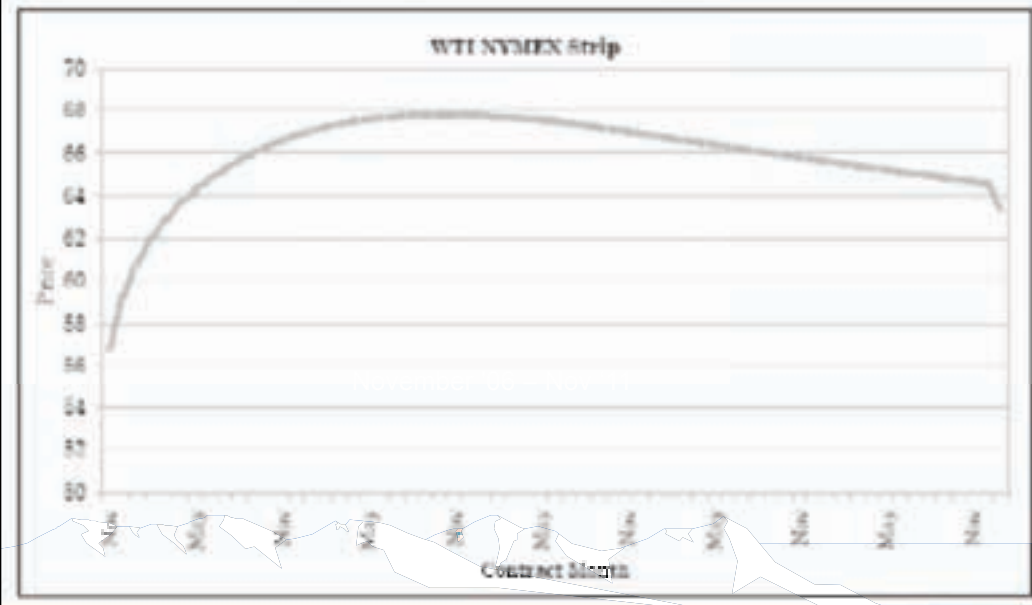
Sources: History: Energy Information Administration (EIA), *Annual Energy Review 2004*, DOE/EIA-0381(2004) (Washington, DC, August 2005), web site www.eia.doe.gov/emeu/aer/. Projections: EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006).

NYMEX WTI STRIP



Source: John S. Herold 1/02/07

NYMEX WTI STRIP NOVEMBER 2006-2011 AT 10-20-06



**SO WHERE IS THE
OIL & GAS ?**



ESTIMATES OF 21st CENTURY WORLD ENERGY SUPPLIES Billion Barrels Oil Equivalent

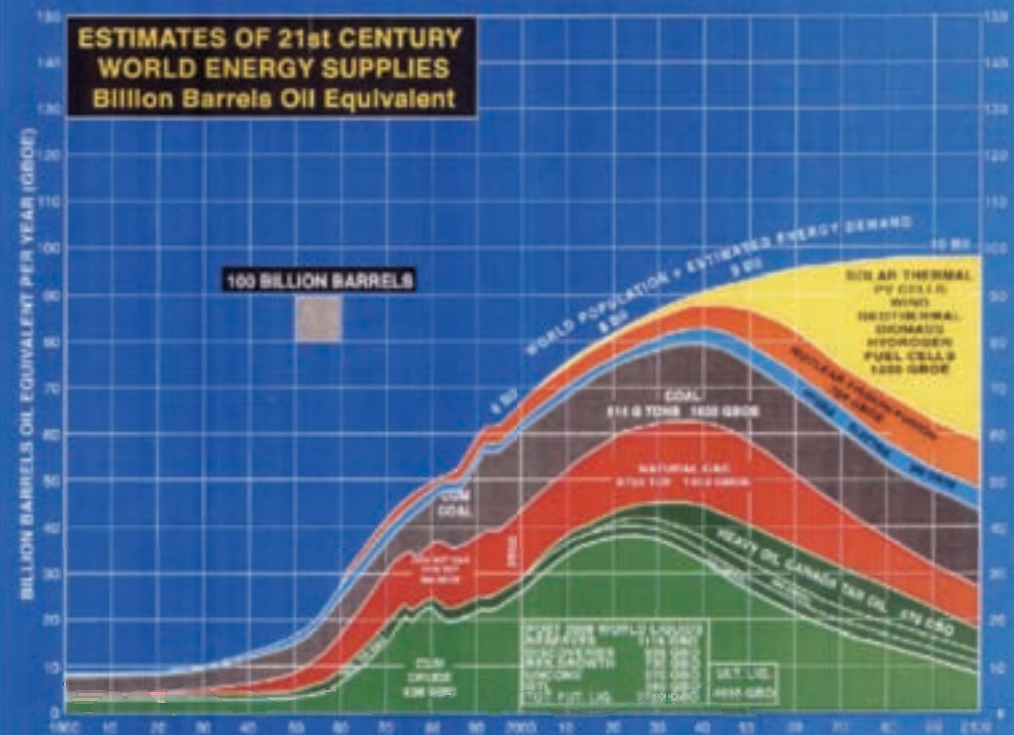


Figure 6 John D. Edwards, Department of Geological Sciences, University of Colorado - Boulder

**Figure 29. World Proved Oil Reserves
by Geographic Region as of
January 1, 2006**

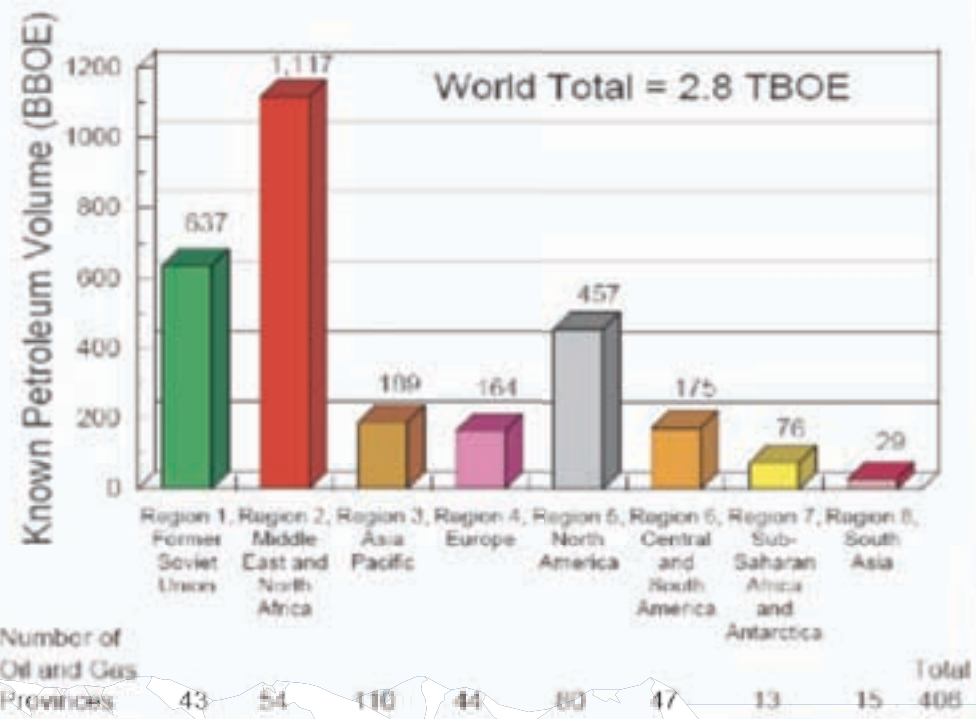


Source: "Worldwide Liquid Reserves and Production," *Oil & Gas Journal*, Vol. 103, No. 47 (December 19, 2005), pp. 24-25.

**Figure 37. World Natural Gas Reserves
by Geographic Region as of
January 1, 2006**

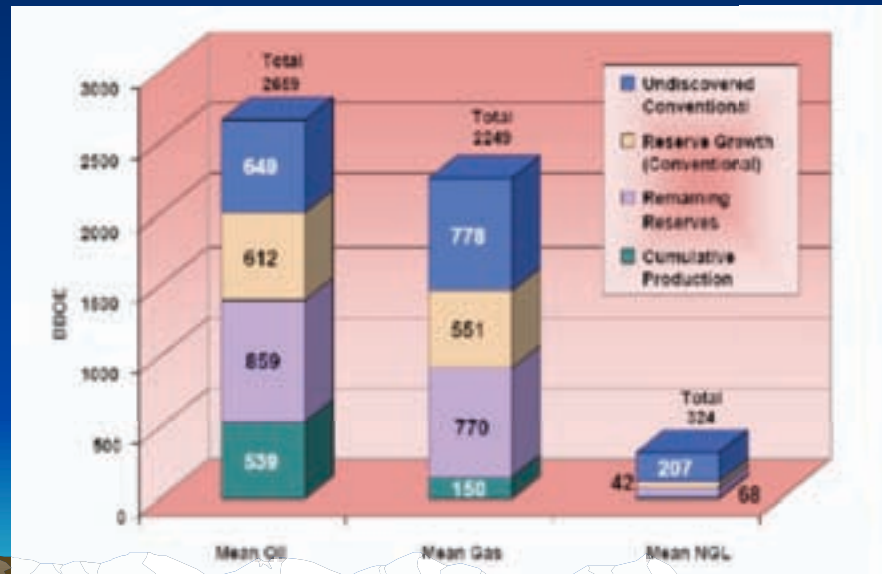


Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 103, No. 47 (December 19, 2005), pp. 24-25.



Source: USGS Open File Report 97-463

REMAINING RESOURCES



Source: USGS World Petroleum Assessment 2000

FUTURE PETROLEUM RESOURCES

**USGS 2000 World Petroleum Assessment
Mean Estimate of Undiscovered Resources**

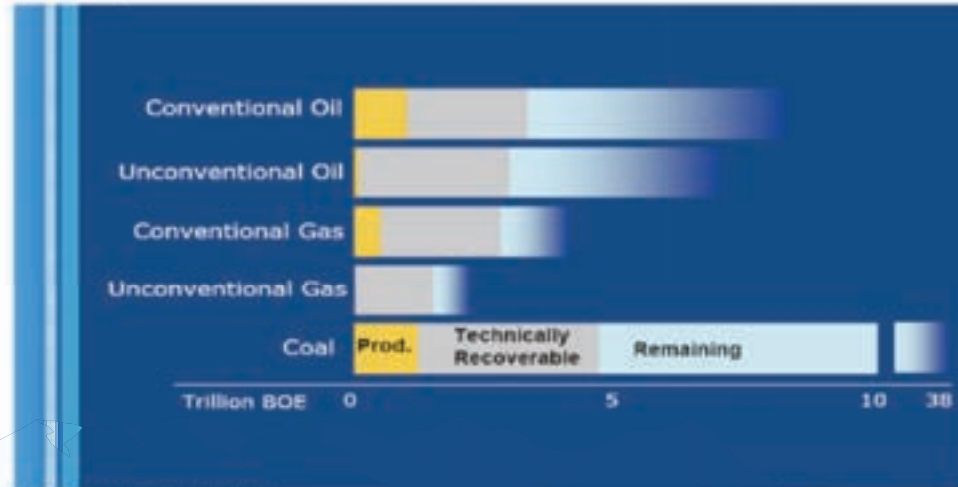
***World: 724 Billion BO
5,196 TCF Natural Gas***

***USA: 75.6 billion BO
526.9 TCF Natural Gas***



WHAT REMAINS?

No Apparent Shortage of Hydrocarbon Molecules

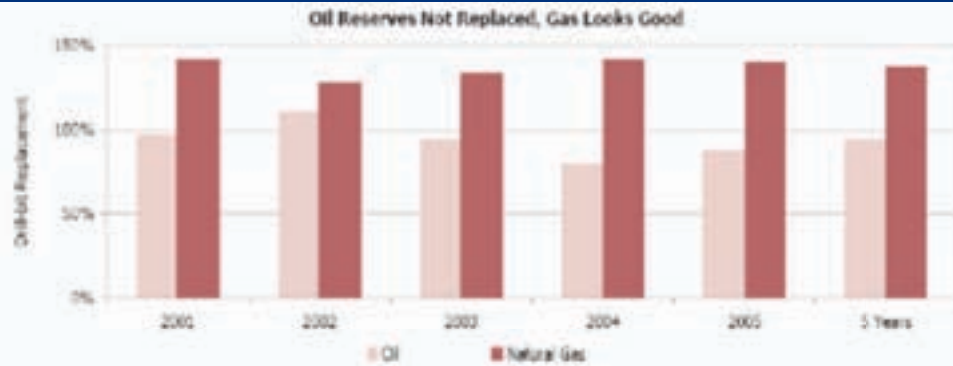


© 2004 Chevron Corporation Strategic Planning

Source: EIA, UN

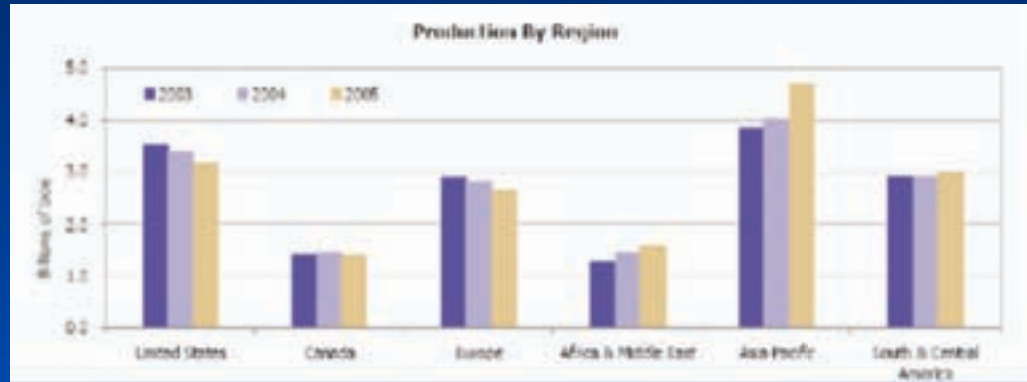
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ARE WE REPLACING GLOBAL RESERVES?



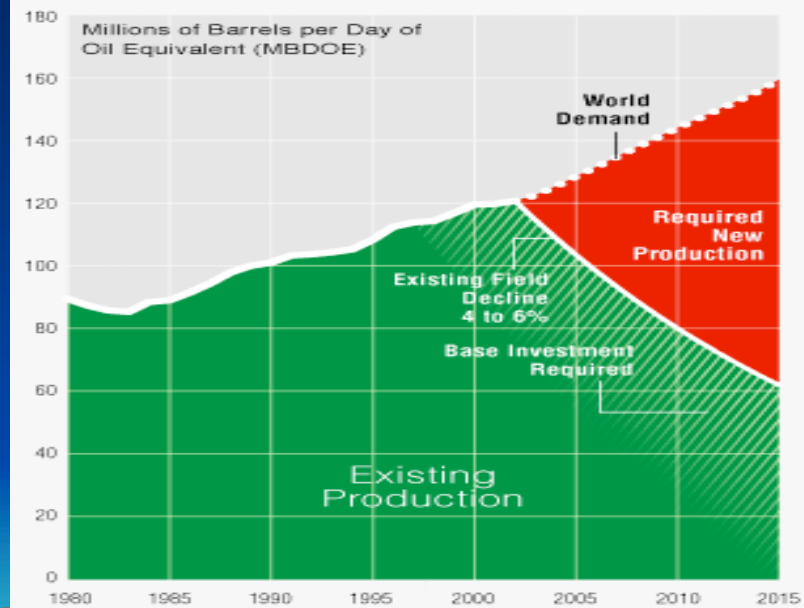
Source: J.S. Herold 2006 Global Upstream Performance Review
study of 205 largest E&P companies

HOW ARE THE REGIONS DOING?



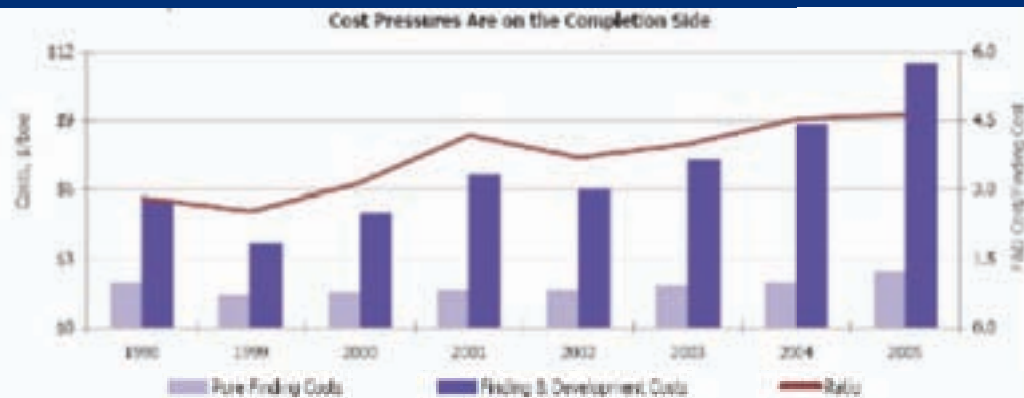
Source: J.S. Herold 2006 Global Upstream Performance Review
study of 205 largest E&P companies

Supplying Oil and Gas Demand Will Require Major Investment



Source: ExxonMobil Website 11-04

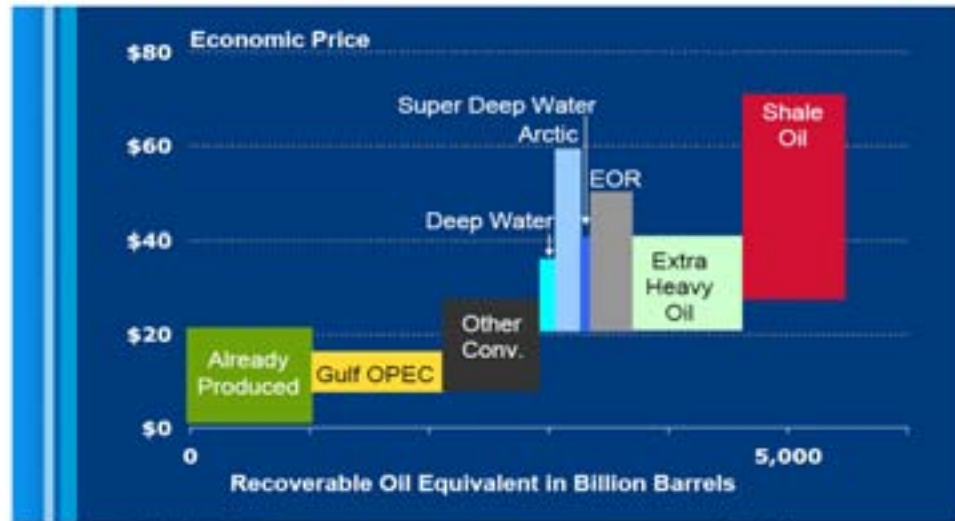
IT'S GETTING EXPENSIVE!



Source: J.S. Herold 2006 Global Upstream Performance Review
study of 205 largest E&P companies

AT WHAT PRICE?

Working to Capture New Value Opportunities



© 2008 Chevron Corporate Strategic Planning

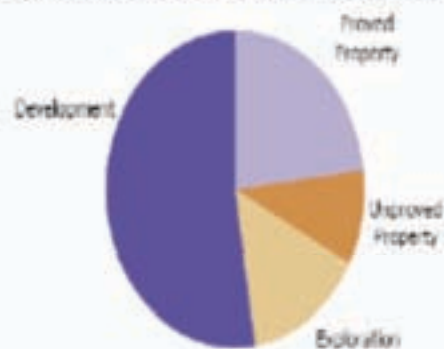
Source: IEA

2

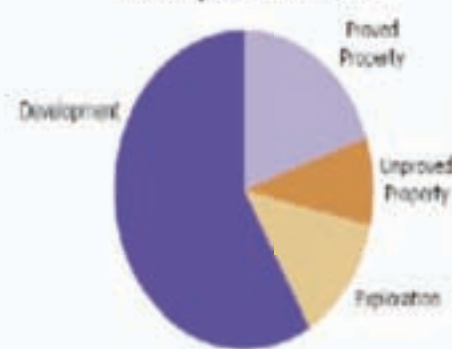
WHERE DOES THE MONEY GO?

\$277 Billion Upstream Capital

Exploration Gets 15% of Capital Investment in 2001



But Drops to 13% in 2005



Source: J.S. Herold 2006 Global Upstream Performance Review
study of 205 largest E&P companies

WHERE IS THE MONEY BEING MADE?



Two-Thirds Of Known Conventional

- **West Siberia**
- **Mesopotamian Foredeep**
- **Greater Ghawar Uplift**
- **Zagros Fold Belt**
- **Rub Al Khali**
- **Qatar Arch**
- **Volga-Ural Region**
- **North Sea Graben**
- **Western Gulf of Mexico**
- **West Texas Permian Basin**
- **Maracaibo Basin**
- **Niger Delta**

Source: USGS Open File Report 97-463

WHERE WILL WE FIND THE NEW RESERVES?

The best place to look is where we know oil to exist The 12 basins on the previous slide!

Plus.....

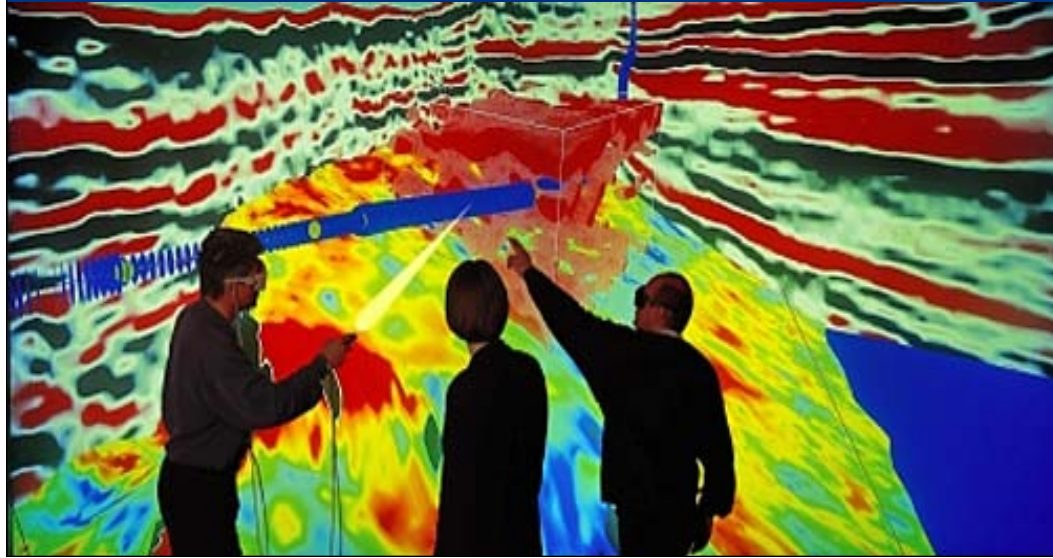
- Deep water at the mouths of the world's great river systems- *Mississippi, Mackenzie, Niger, Congo, Orinoco, Amazon, Ganges, Lena.*
- *Deep water offshore Mexico, NW Shelf Australia.*
- *Hostile environments offshore the Arctic rim, Greenland and Labrador, East Siberia*



**THERE ARE ABUNDANT
REMAINING PETROLEUM**



TECHNOLOGY + GOOD GEOLOGY REQUIRED!



GEOSCIENCE SKILLS

- **Digital database manipulation**
- **Work-station skills**
- **Good visualization skills**
- **Stratigraphy**
- **Petrography**
- **Geochemistry**
- **Structural analysis**
- **High-resolution log analysis**



NON-ROCK SKILLS

- *Creative – “think outside the box”*
- *Good communication skills*
- *A team player with multi-task capabilities*
- *Economics – including risk analysis*
- *An understanding of geo-politics*
- *Cultural sensitivity*
- *A foreign language*
- *Environmental sensitivity*
- *Professional ethics*



TECHNOLOGIES

1990's

Primarily Conventional objectives

Digital databases

3-D Seismic

2000's

Unconventional resources important

Horizontal, multi-lateral well bores

Measurement while drilling

Thin-bed evaluation

Seismic reprocessing with new algorithms

High resolution gravity and magnetics

4-D seismic



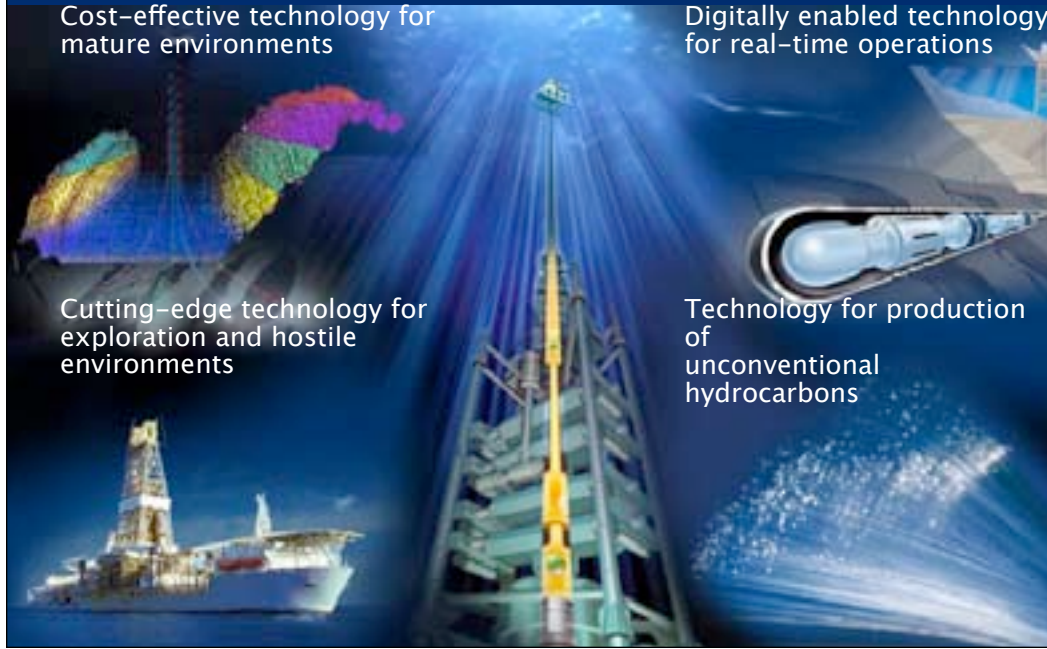
Schlumberger Technology Needs and Drivers

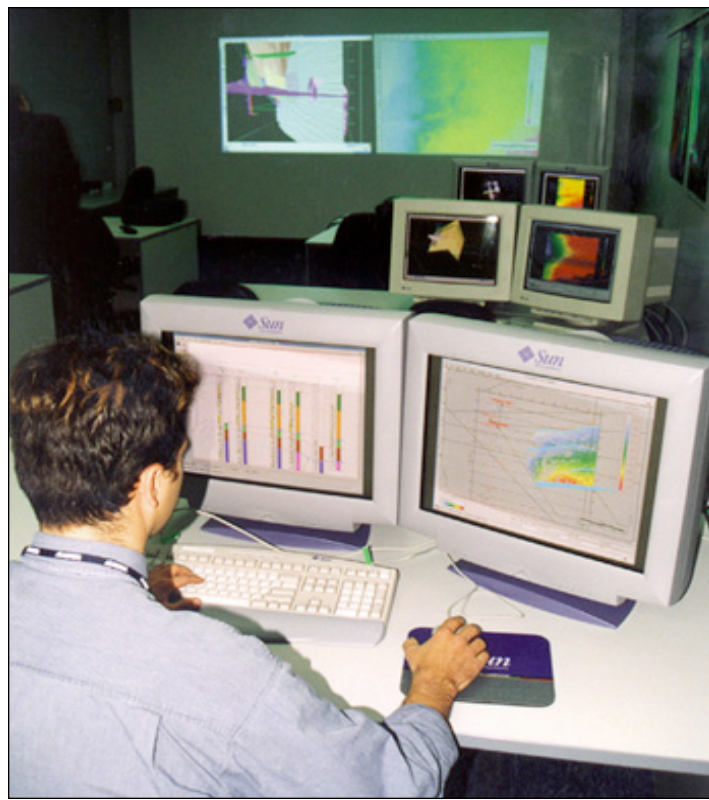
Cost-effective technology for
mature environments

Digitally enabled technology
for real-time operations

Cutting-edge technology for
exploration and hostile
environments

Technology for production
of
unconventional
hydrocarbons





**Synergistic
Technologies:
Integrated Workstation
Applications
&
Visualisation Capabilities**

**NCPGG / Schlumberger Joint
Training and Research Centre
(Univ Adelaide)**

Sub-salt Imaging

New acquisition techniques
New processing algorithms

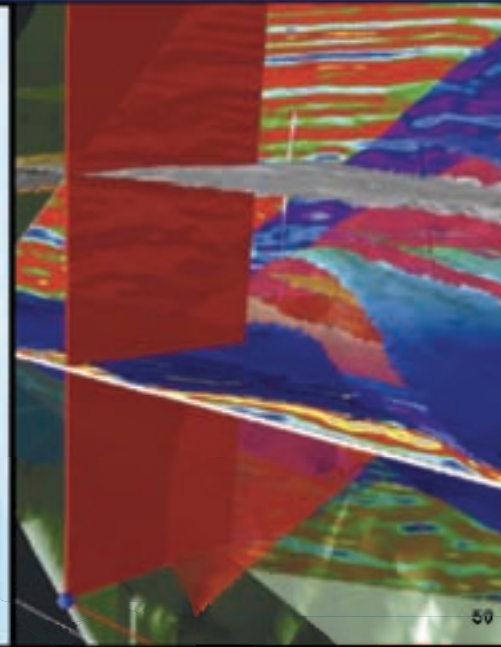
3-D Volume Interpretation

Rapid assessment of prospectivity

Multi-Disciplinary Well Planning

Advanced Drilling Techniques

Salt and sub-salt environments
High pressured environment



50



- Understand the rocks:
 - Type kerogen
 - Thermal history
 - Lithology and heterogeneity
 - Porosity & permeability
- Estimate oil and gas in place
- Understand structural setting - stress fields – fractures
- Pilot project to determine best practices:
 - Drilling
 - Completions
 - Well types and spacing
- Continuous process improvement

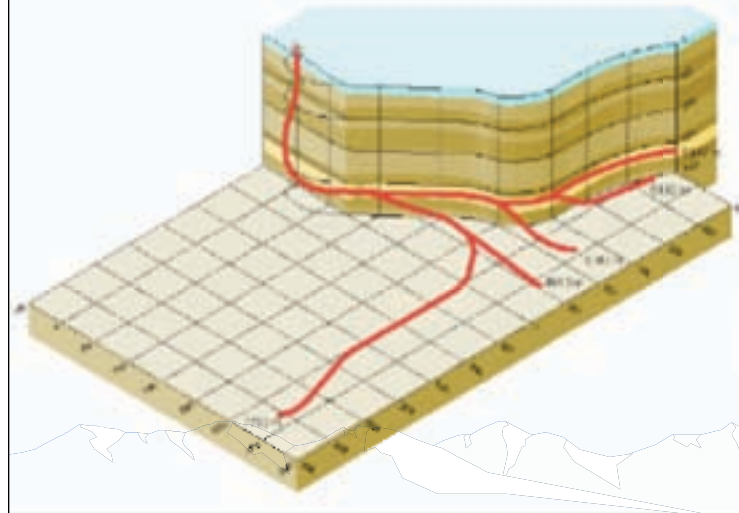
Technology Drivers For Baker Hughes

- More difficult drilling and operating environments
 - Operators need more precise HPHT equipment to evaluate wells in extreme conditions
- Increased geological uncertainty
 - Operators need more precise and detailed data to evaluate increasingly complex reservoirs
- Need for better reservoir characterization
 - Operators need more accurate reservoir and fluid composition data to maximize production and minimize costs
- Focus on reduced cost, efficiency and performance
 - Record day rates and limited availability of rigs places premium on reliability and efficiency
- Need to maximize production from existing reservoirs

Source: Baker Hughes

NEW TECHNOLOGIES REQUIRE PRECISE GEOLOGY

North Sea
"Starfish Well"



44,000' of horizontal
multi-lateral wellbore
drilled in upper 2' of
28' thick oil rim at
Troll Field in
Norwegian North Sea

Source: Baker Hughes

NEW TECHNOLOGIES REQUIRE PRECISE GEOLOGY

Measure and Compare

Location

UK Offshore, July 2004

Problem / Objective

Unswep heavy oil target directly beneath platform

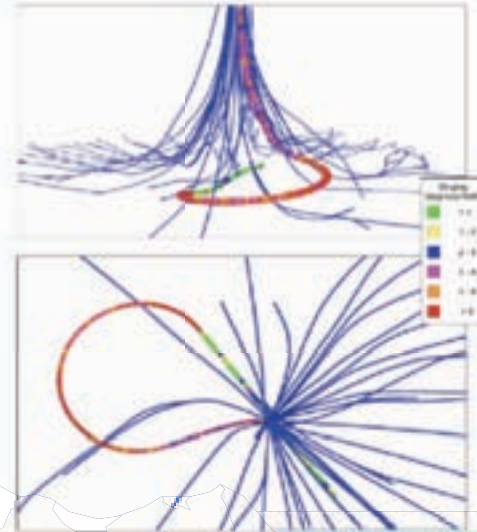
Solution

AutoTrak G3.0 system

CoPilot

Results

Highly complex well drilled as required and delivered on plan



Source: Baker Hughes

LONG REACH TECHNOLOGIES MINIMIZE ENVIRONMENTAL IMPACTS

– Precise Geology a Must!

Measure and Compare

Location

Sakhalin Island

Problem / Objective

Drill world class extended reach wells

Solution

AutoTrak G3.0, APLS

Results

Industry's 4th & 6th longest ERD wells

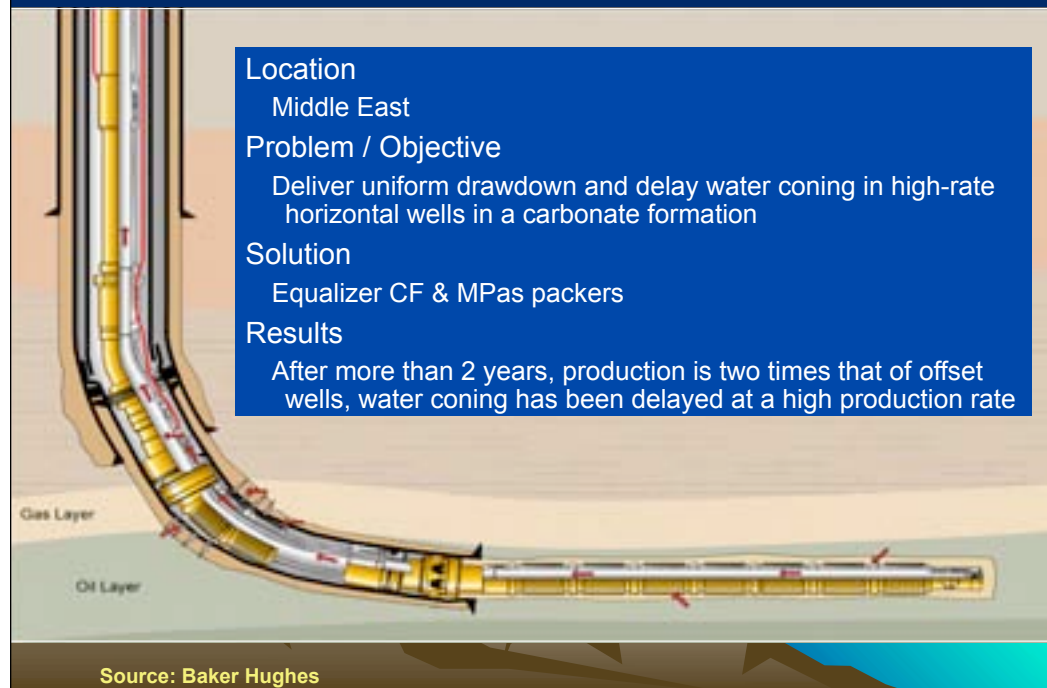
Obtained continuous log through each well

Exceptional MWD decoding

Excellent acoustic LWD data on Chayvo 4



.....More Precise Geology in Carbonates



The first of these is the Equalizer production management system.

This system optimizes production in high-rate horizontal wells, while delivering uniform drawdown and delaying water encroachment.

In one application for a major operator in the Middle East we have installed the Equalizer system in 8 wells in five fields ranging from offshore sandstone to onshore carbonate fields.

The senior management of this company told me that the production rate from these wells has been sustained at double the rate of offset wells!

The Equalizer provides a viable alternative to more complex and costly solutions and we expect significant growth in the use of this technology.

***LEADING EDGE GEOPHYSICAL AND
OPERATING TECHNOLOGIES
+ GOOD GEOLOGY
= MULTI-BILLION BARREL NEW TREND***

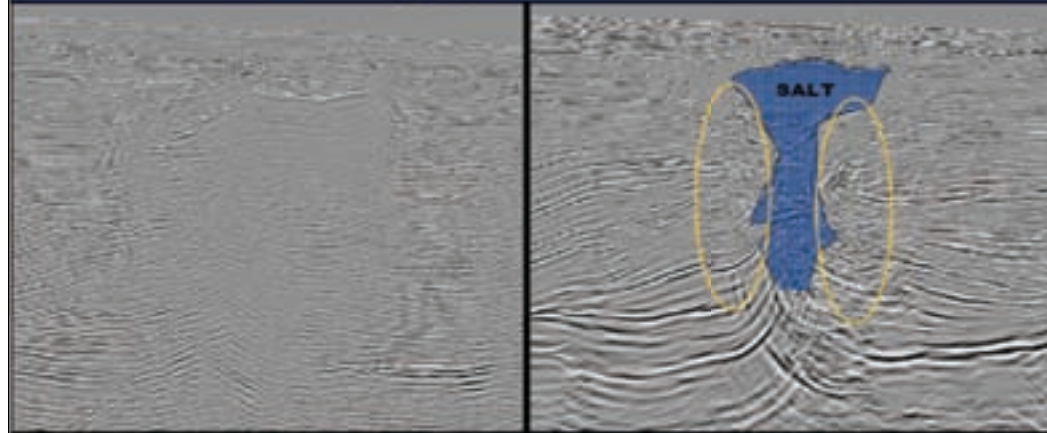
***DEEP TERTIARY PLAY
IN THE GULF OF MEXICO***



LEADING EDGE TECHNOLOGIES + GOOD GEOLOGY = NEW DISCOVERIES

Sub-Salt Seismic Imaging

devon



Time Migration

Depth Migration

Data Courtesy of TGS NORPC Geophysical Company

61

Shallow Salt Cover

devon



Deep GOM Tertiary: New multi-billion Barrel Play

Gulf Production by Reservoir Age

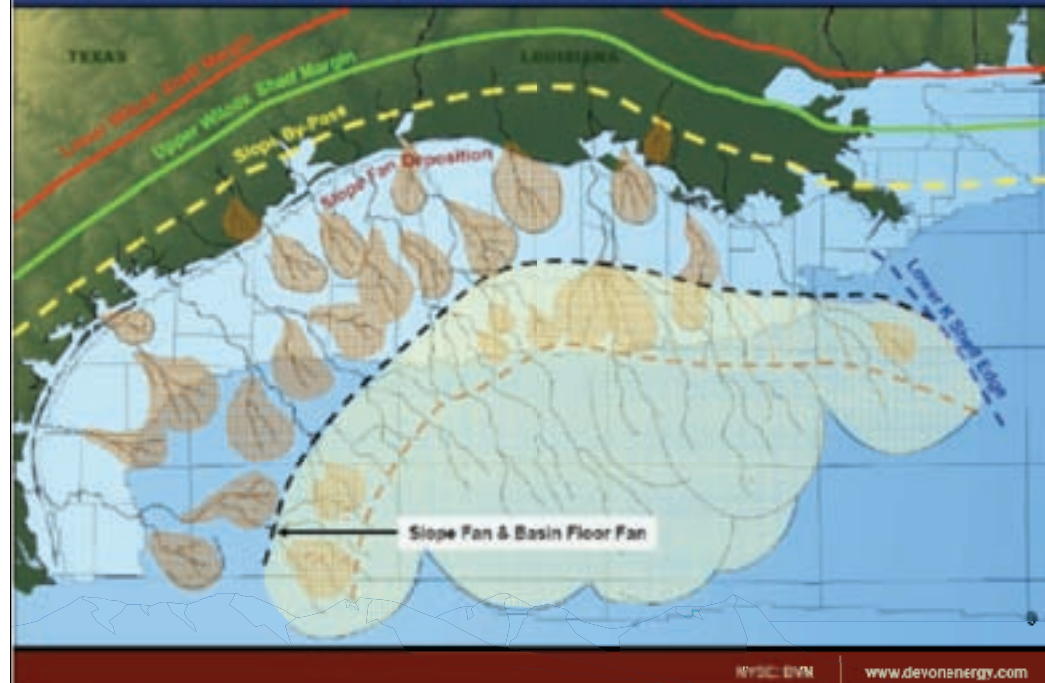
devon

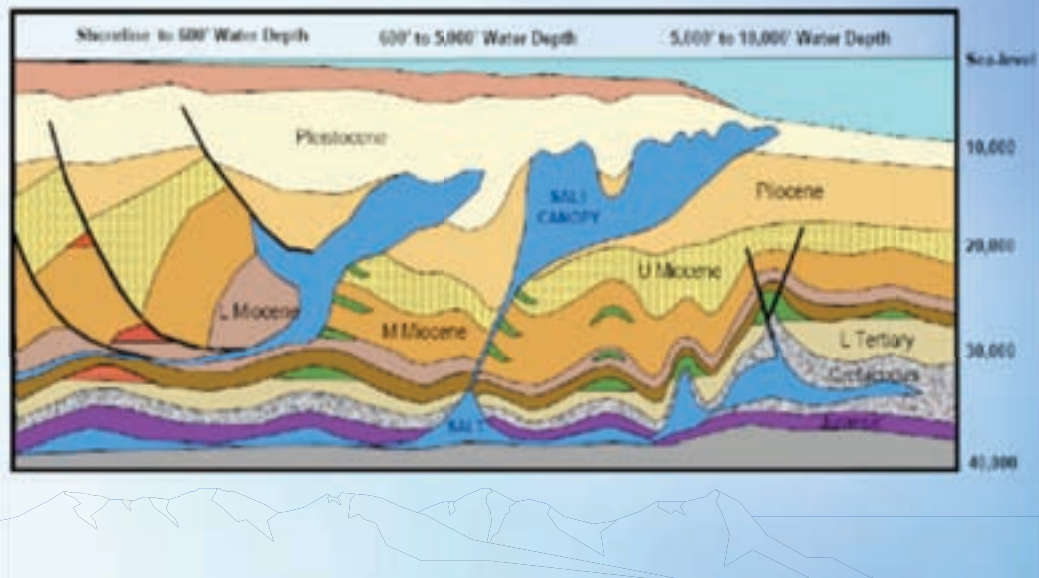
Age of Rock (Millions of years)	Cum. MMBOE*	%		
Present - 2	13,759	33	Pleistocene	Tertiary
2 - 5	10,755	25	Pliocene	
5 - 24	17,236	41	Miocene	
24 - 34	49	0	Oligocene	
34 - 55	0	0	Eocene	
55 - 65	0	0	Paleocene	
65 - 144	49	0	Cretaceous	
144 - 206	235	1	Jurassic	

*BIS Federal Offshore data as of February 2000. Conversion factor: 6 Mcf = 1 barrel.

Lower Tertiary Wilcox Depositional Model

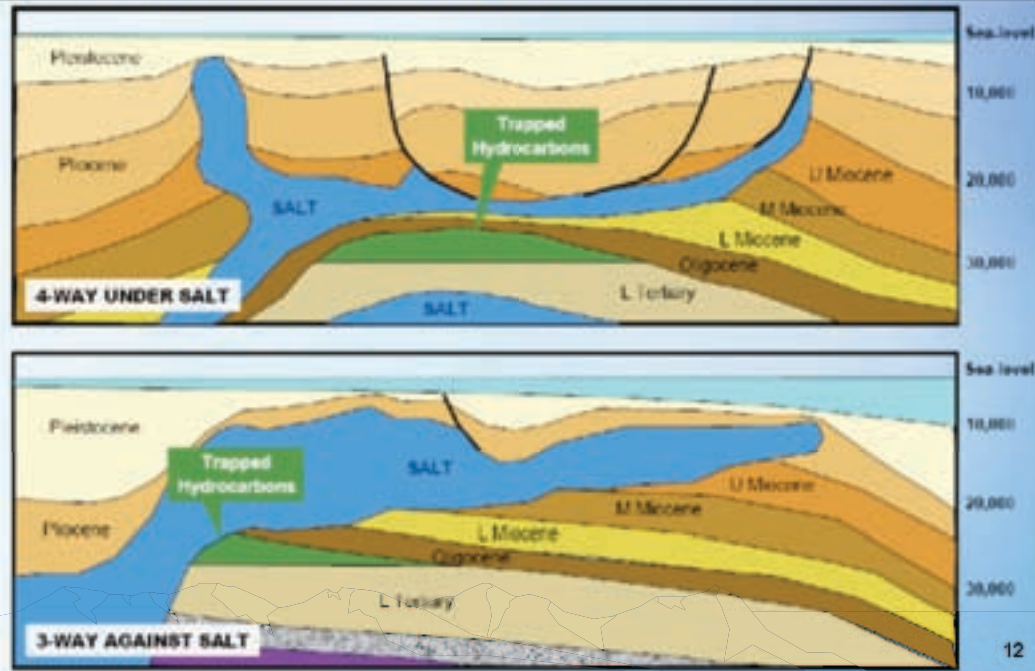
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Lower Tertiary Sub-Salt Plays

devon



Lower Tertiary Trend

Industry Results to Date

devon



● Industry Discovery

● Industry Non-Commercial

○ Results Unannounced

➤ 12 announced discoveries out of 19 wells drilled

➤ Trend data for Alaminos Canyon, Keathley Canyon and Walker Ridge only

➤ Additional penetrations along trend to the northeast

ULTRA-DEEP GOM – “Jack” Discovery

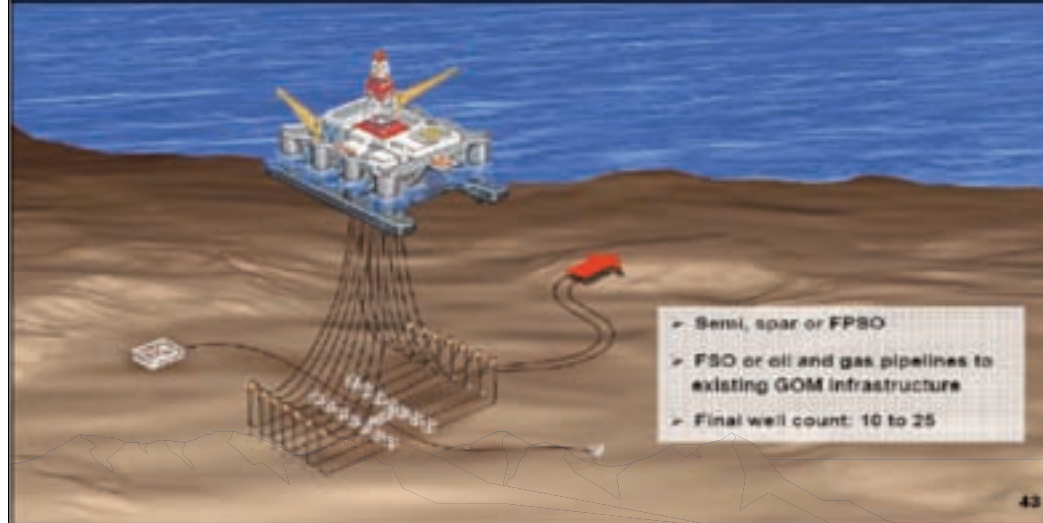
Drilled to 29,000' in 6,965' Water



ULTRA-DEEP WATER PRODUCTION CONCEPT

Large Field Development Option

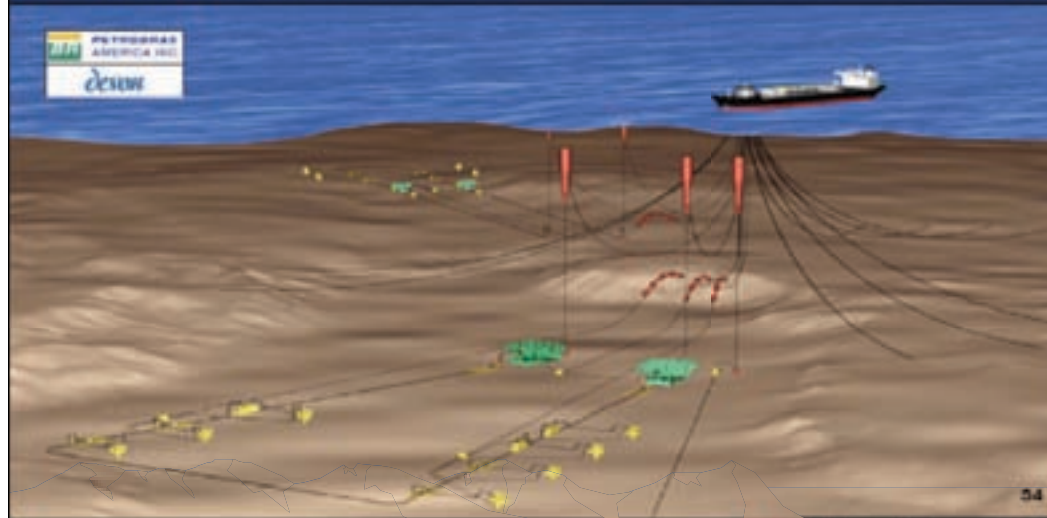
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ULTRA DEEP-WATER PRODUCTION CONCEPT

Cascade Development Concept – Phase 2
Multiple Sub-Sea Wells & FPSO

devon



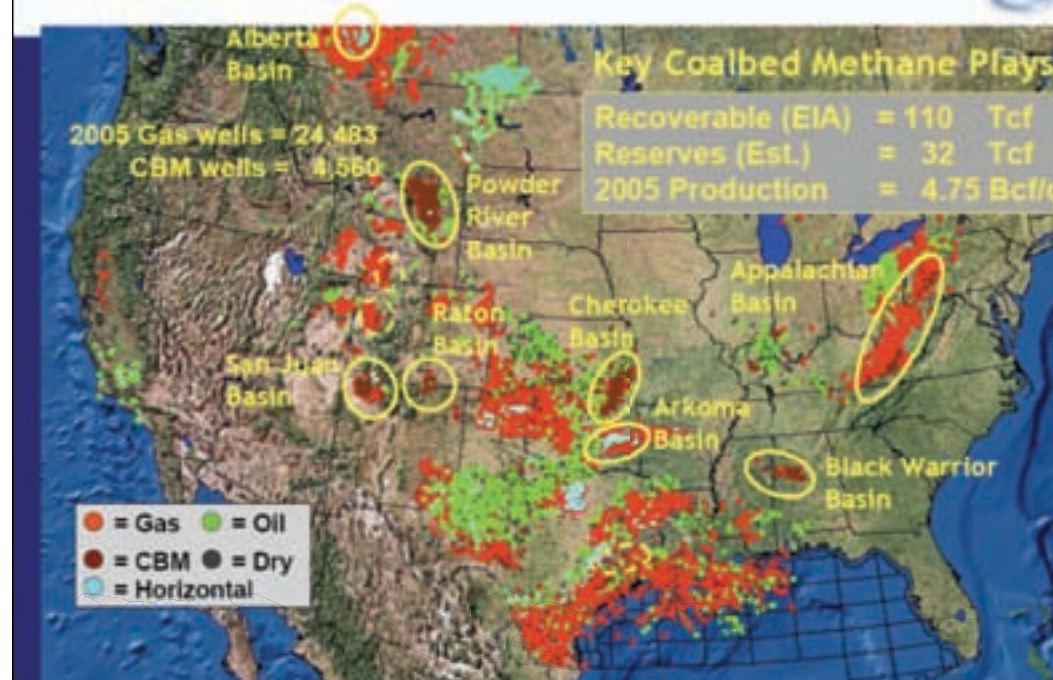
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NYSE: DYN

www.devonenergy.com

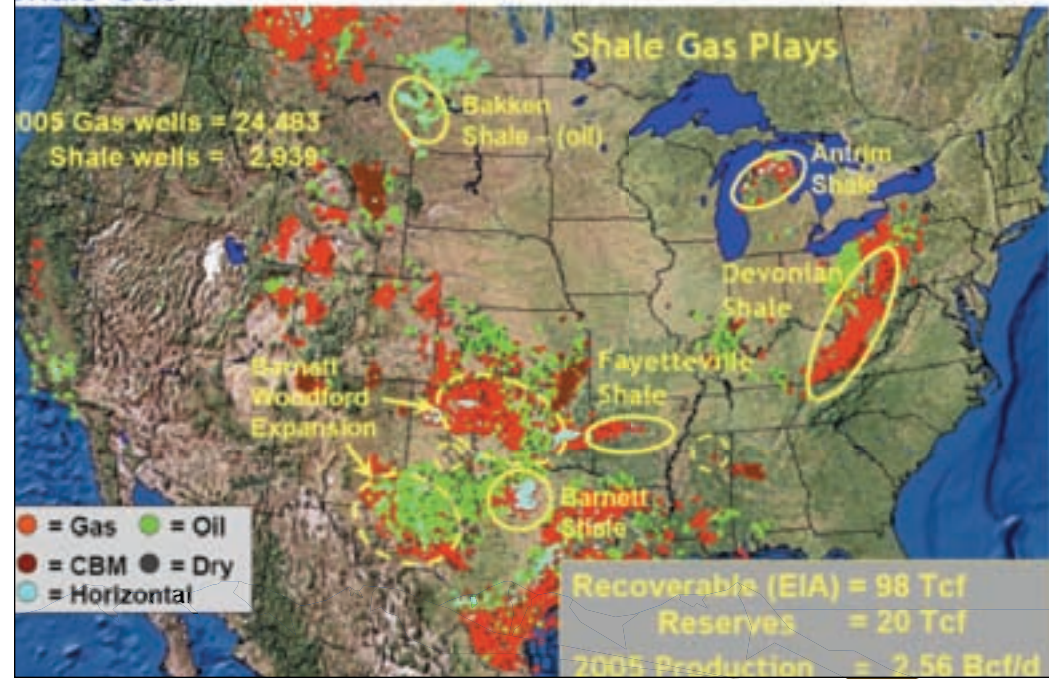


US. 2005 Drilling Coalbed Methane



US. 2005 Drilling

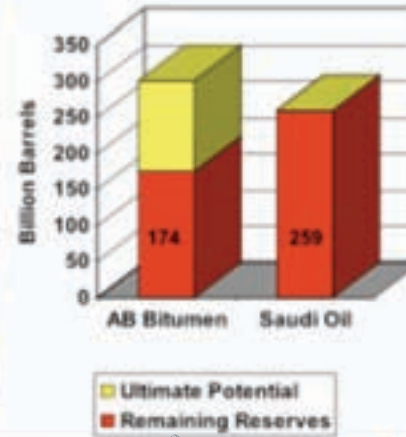
Shale Gas



Suncor Energy

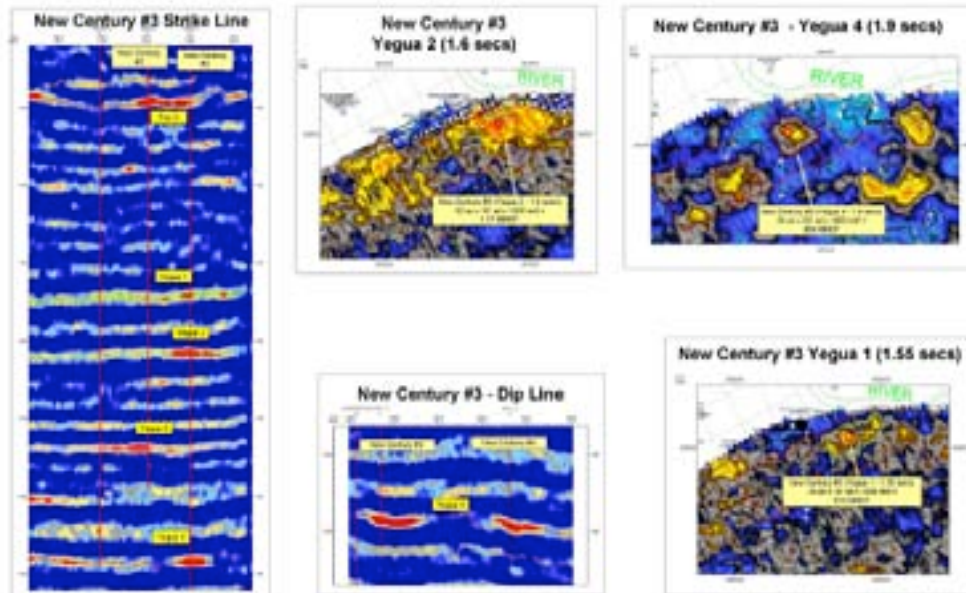


Huge Reserves



Source: Alberta Energy and Utilities Board; Oil & Gas Journal

Onshore USA-New Technologies in Mature Provinces The 1-2 BCF Prize



Courtesy of New Century Exploration, Houston, TX

THE FUTURE OF THE GLOBAL OIL INDUSTRY

**There are huge remaining oil and gas
resources discovered, and yet to be
discovered, but..... there are**

**Significant challenges for
balancing supply and demand**





INFRASTRUCTURE



Supply- Political Uncertainty



Dateline.....Caracas, Venezuela

WAR PREMIUM @ \$10/bbl



Dateline.....Iraq, October 2006



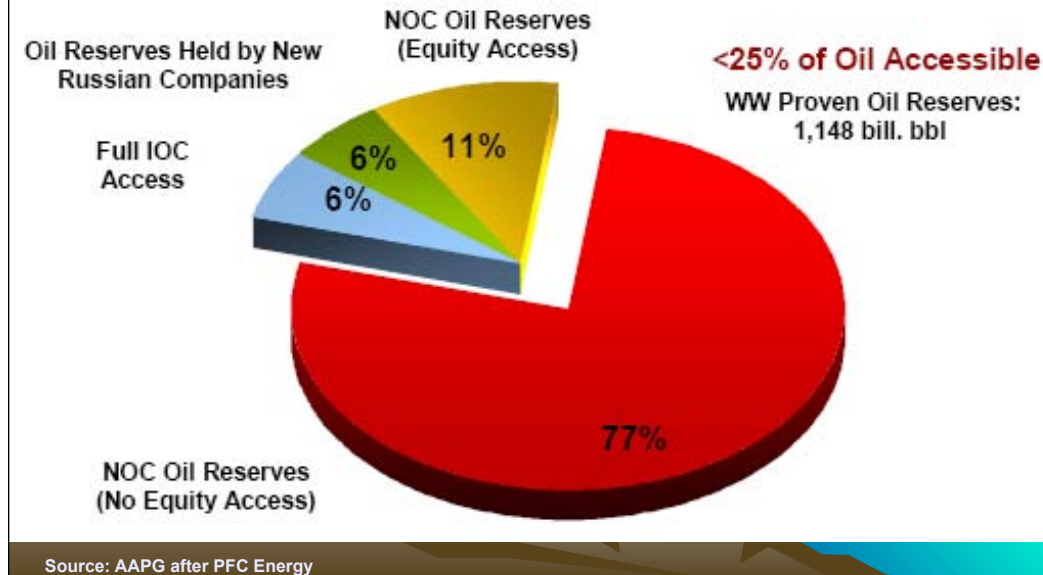
Supply/demand - The Weather



Hurricane Katrina Knocked out 700,000 BO and 3.6 Bcf per day Gulf production



Control of Proven Oil Reserves



Clearly, national oil companies (NOCs, e.g. Petrobras, Pemex, Pertamina, PDVSA, Nigerian Nat'l Petroleum Co., Petronas, etc.) control most of the world's discovered (as well as undiscovered) reserves.

- Thus western companies must continue to find ways to partner with them, and this may be critical to future growth.
- Russian Oil Companies are the next largest holder of reserves behind NOCs, and several majors have been working on joint ventures there

Exploration has been slow for the last 20 years, major petroleum supplies are located distant from consuming nations, and resources are largely controlled by national oil companies. It is therefore not surprising...

CHALLENGES....

Beyond the Rocks

- **Hostile Operating Environments**
- **Geopolitical Environments**
- **Regulatory Environments**
- **Commodity Price Volatility**
- **Capital & Operating Cost Volatility**
- **Lack of trained professionals may delay projects**



GLOBAL CHALLENGES

And.... The declining value of the US\$

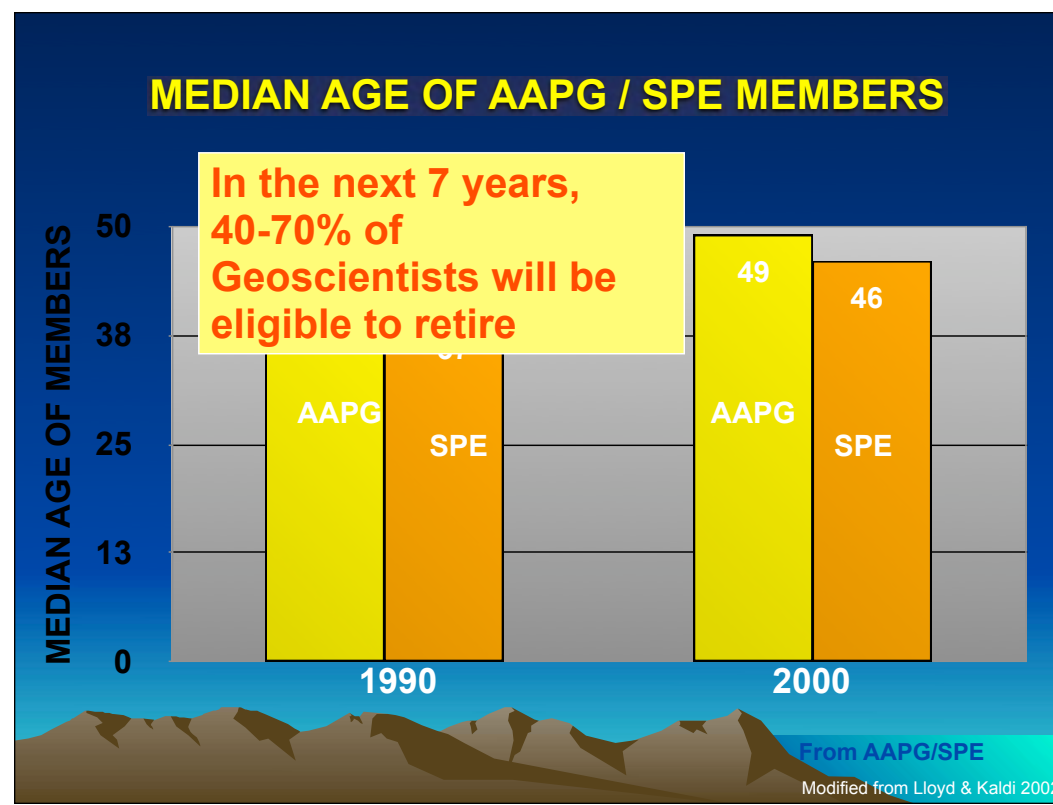
***What will happen to the US economy if
OPEC demands
oil payments in Euros?***



Challenges to Growth in Supply As Viewed by Schlumberger

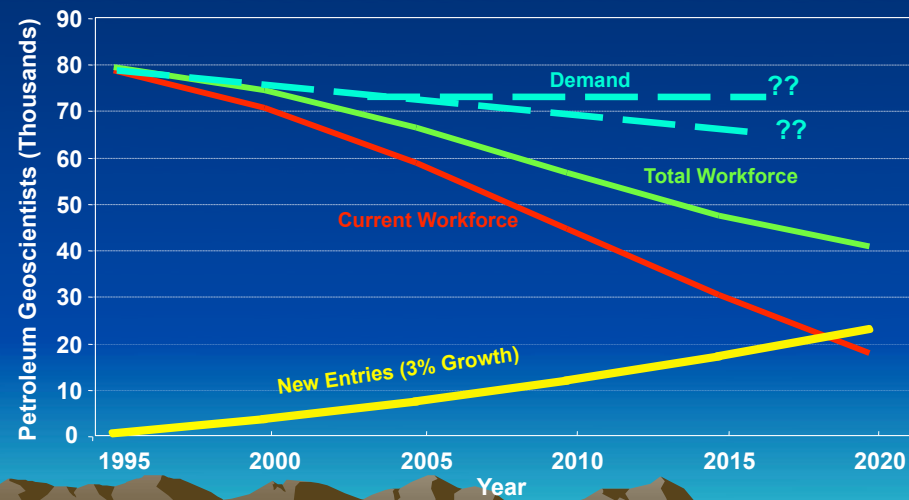
- Investment levels remain insufficient for industry needs
- Decline rates gain in significance
- New exploration areas present issues of access and risk
- Investors view commodity prices levels in the short term

Source: Schlumberger, Inc.



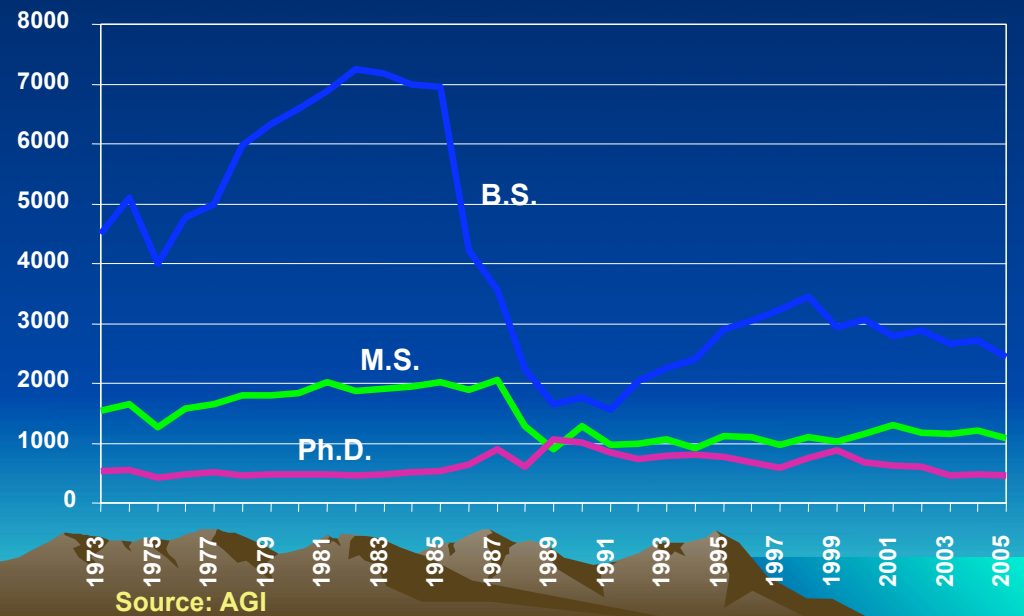
The industry clearly needs to add staff now, before the experienced supervisors and mentors retire.

Petroleum Geoscientist Demand Geologists, Geophysicists, and Engineers

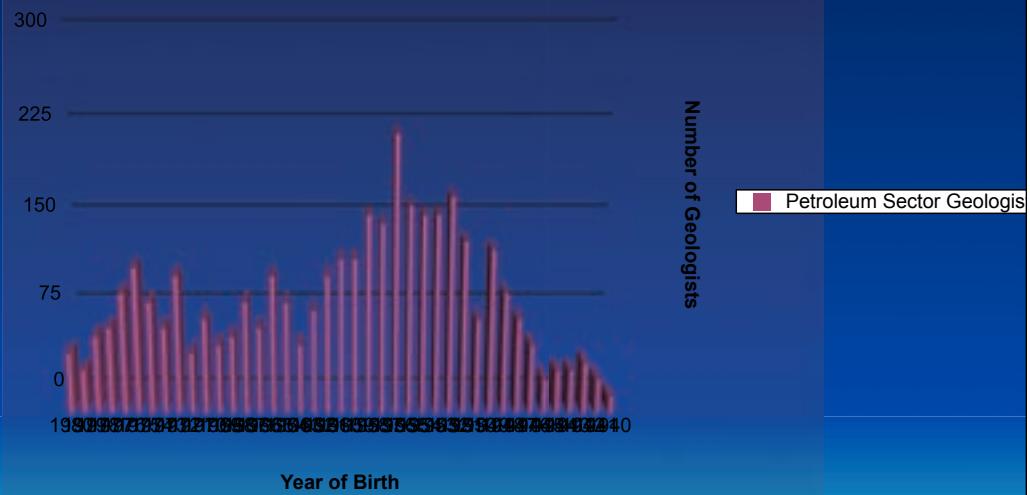


Source: AGI

Newly Minted USA Geoscientists



Current Age Distribution of Petroleum Geologists



Age Demographic of Canada's Petroleum Geologists
by Year of Birth

WORKFORCE HURDLES

**The oil industry has a terrible reputation
among academics and students in
North America and Europe.**

**How can negative perceptions
be overcome?**

This is not a problem in Asia!



Enrollment at University of Texas vs. Price of Oil



Source: University of Texas 2006

GLOBAL GEOSCIENCE WORKFORCE

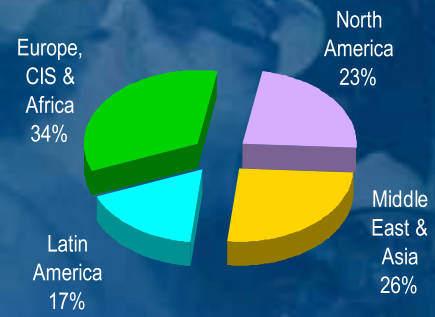
Latin American, Middle Eastern, Former Soviet, and Asian geoscience graduates are now the competition for North American and European graduates in a global economy.



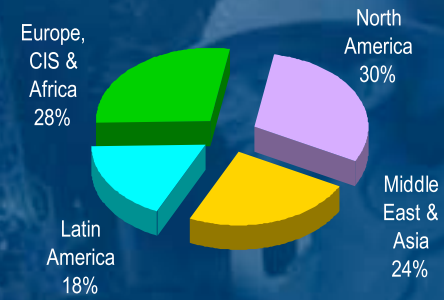
SCHLUMBERGER

Global Reach and Culture

Nationality



Revenue



Source: Schlumberger Company Data 2004

EXPLORATION AND PRODUCTION TRENDS.....



The Future: North America

Declining onshore conventional oil and gas productivity and prospect size

Exploration Opportunities

Deep Gulf of Mexico

Deep Rockies USA & Canada

Alaska - (ANWR has huge potential!)

Canadian Arctic

Deep onshore frontiers

Atlantic and Pacific Continental margins



The Future: North America

Focus on unconventional energy resources

- *tight gas reservoirs*
- *CBM*
- *shale gas*
- *Oil sands*
- *coal to liquids,*
- *oil shale (?)*
- *natural gas hydrates (maybe?)*



The Future: North America

Regulatory restrictions -

*Balancing environmental concerns
with energy demand and economic
security*

Conservation –

driven by commodity price

Alternate Energies -

driven by price and technology



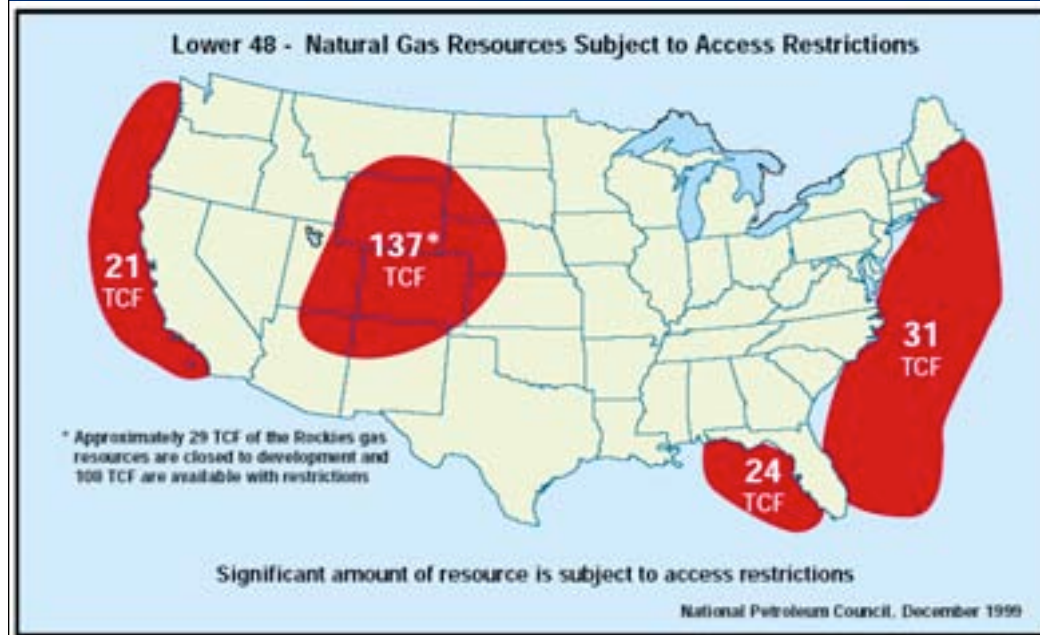
OUT OF BOUNDS IN THE USA!

Jurassic Abenaki Reef Trend



Source: CNSOPB

CAN'T EXPLORE HERE!



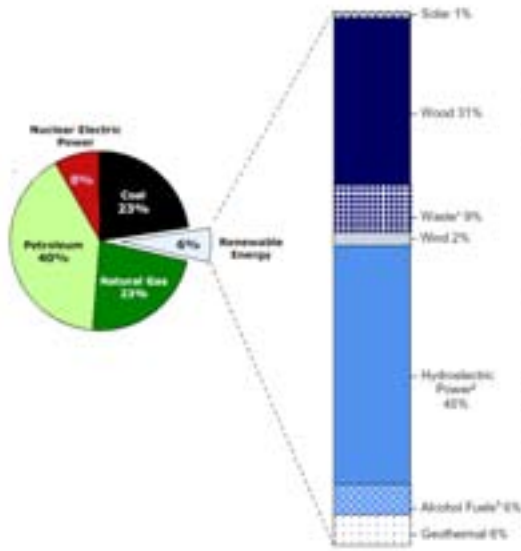
EDUCATING THE PUBLIC

Public Perception
vs.
Reality
&
Political Expectations

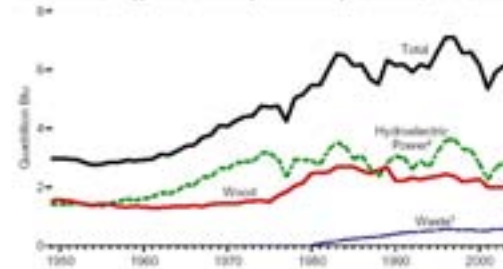


What about renewables?

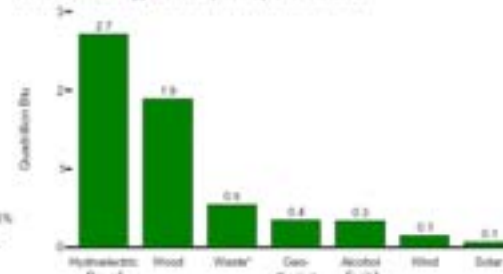
Renewable Energy as Share of Total Energy, 2005



Renewable Energy Total Consumption and Major Sources, 1949-2005

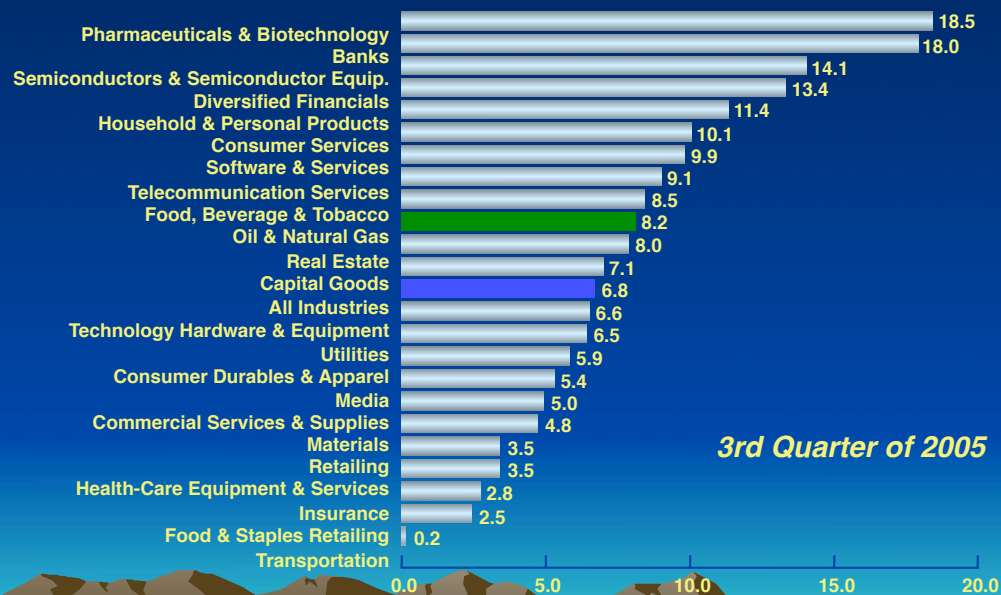


Renewable Energy Consumption by Source, 2005



Some promising technologies, but need more work!

How Do Oil Industry Earnings Compare to Other Industries?



Source: Company filings as reported by Oil Daily for the oil and gas industry, and by Pricewaterhouse Coopers LLP from data compiled by Standard and Poor's Compustat for all other industries

EDUCATING THE PUBLIC

Petroleum Extraction And Environmental Concerns

*.....The oil industry has
a credibility problem*



EDUCATING THE PUBLIC

Ending the Addiction to Cheap Energy

*This is a huge challenge!
..... And politicians make hay by
whipping the petroleum industry.*



The Future - International

- **Significant conventional exploration potential**
- **Significant by-passed oil potential**
- **Huge unconventional resource potential**



The Future - International

- **A global economy**
work force, goods and services
- **Highly competitive**
exploration licenses, crude demand
- **Geopolitical hurdles**
- *Middle East wars, national conflicts*
- **Environmental hurdles**
Kyoto, global warming
- **Resurgence of national oil companies**



USA FOREIGN POLICY IMPLICATIONS

The USA will remain dependent on foreign oil supplies to meet demand during our lifetimes.....(and probably to the end of the 21st Century).

So, what do we do?



USA FOREIGN POLICY IMPLICATIONS

Goal #1

*The USA must preserve access to
global petroleum resources to assure
continued economic prosperity.*



USA FOREIGN POLICY IMPLICATIONS

Fact #1

The Middle East is key to future
Global petroleum supply.

Issues:

Is the war in Iraq really about who controls the oil?

Can the USA afford to have hostile governments in power that might use the "oil weapon"?

Will hostile governments sell oil into the world markets anyway?

USA FOREIGN POLICY IMPLICATIONS

Fact #2

NOC'S are "tightening the screws" and taking
back control of their petroleum resources
i.e. – Russia, Venezuela, Bolivia, Algeria

Issues:

Sanctity of contracts?

Does this matter? Will it impact supply and price?

How do we deal with this?

Any policy leverage?



USA FOREIGN POLICY IMPLICATIONS

Fact #3

The IOC's now face serious and "unfair" competition for new license areas and asset sales from the NOC's and emerging private/public Arab-Asian oil companies

Issues:

Does this matter?

Will it impact supply?

Is there a basis for complaints on "restraint of trade"?



CONCLUSIONS

- *Significant remaining global petroleum resources
(....but not much in the USA!)*
- *Leading edge technologies in the hands of bright
and creative geoscientists required.*
- *Question of: capital*
 - access to exploration areas*
 - energy infrastructure*
 - geopolitics*
 - regulatory environments*



CONCLUSIONS

- *Commodity prices will be volatile, but will remain high.*
- *Oil @ \$50-\$75*
- *Price will drive supply and overcome technical and business risks*
- *Demand driven by half the world now entering the modern “consumer class”*
...there is no turning back!



CONCLUSIONS

Uninterrupted USA Domestic Petroleum Supply will depend on.....

A Domestic Energy Policy that realistically balances resource supply and demand with environmental concerns, and promotes conservation and alternate energies.



CONCLUSIONS

**Uninterrupted USA Domestic Supply
will depend on.....**

***A Foreign Policy that adapts to changing
international geopolitical and economic
realities***



CONCLUSIONS

WE CAN DO IT!

*But..... in the end, the global markets
will dictate commodity prices,
and ultimately high prices will
force changes in policy.*



The Future.....



Source: AAPG-John Kaldi