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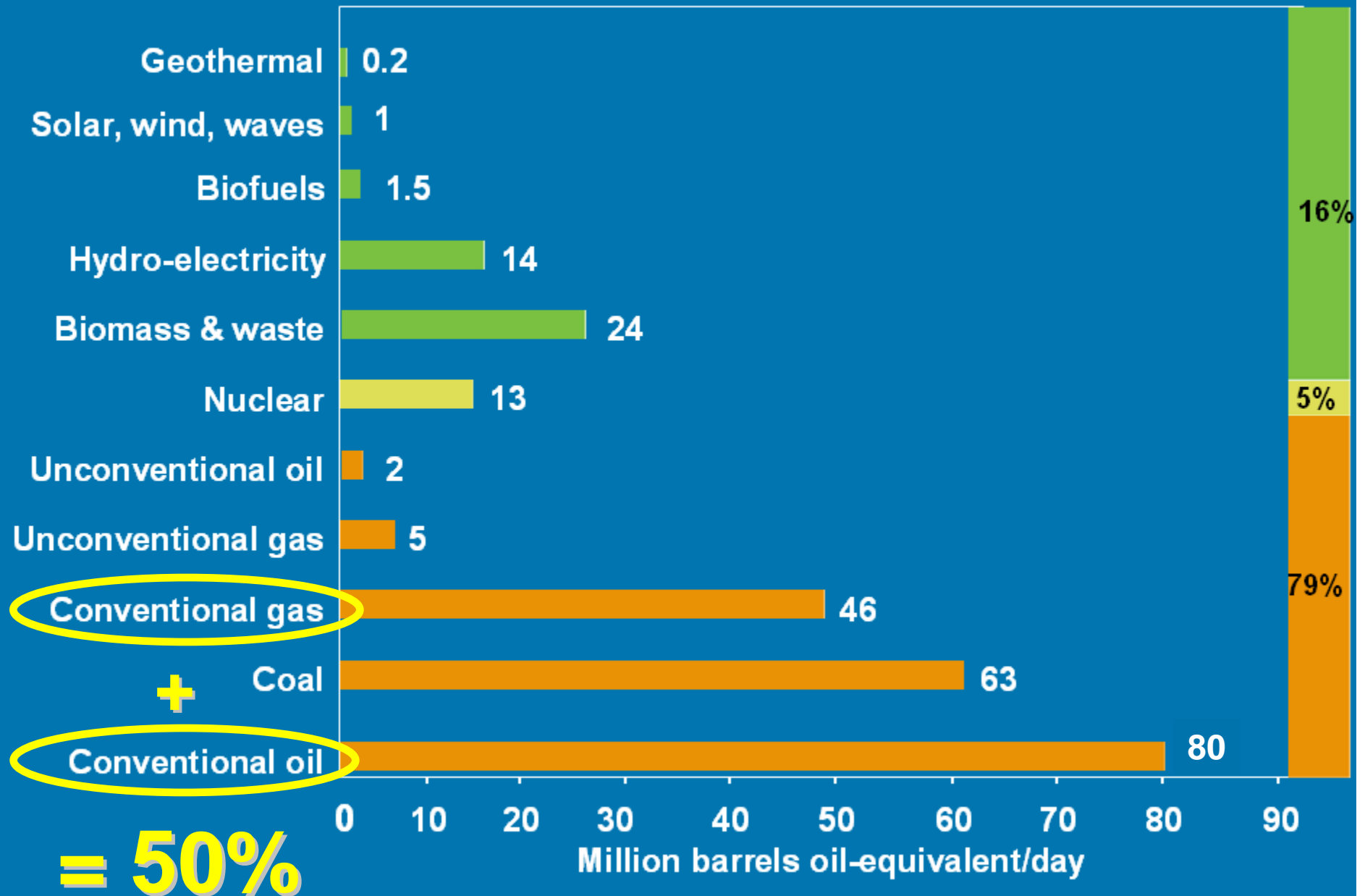
# World Oil & Gas Resources

**Ken Chew**  
**October 2, 2008**

**42<sup>ND</sup> ANNUAL IPLOCA CONVENTION**

**Athens, Greece**

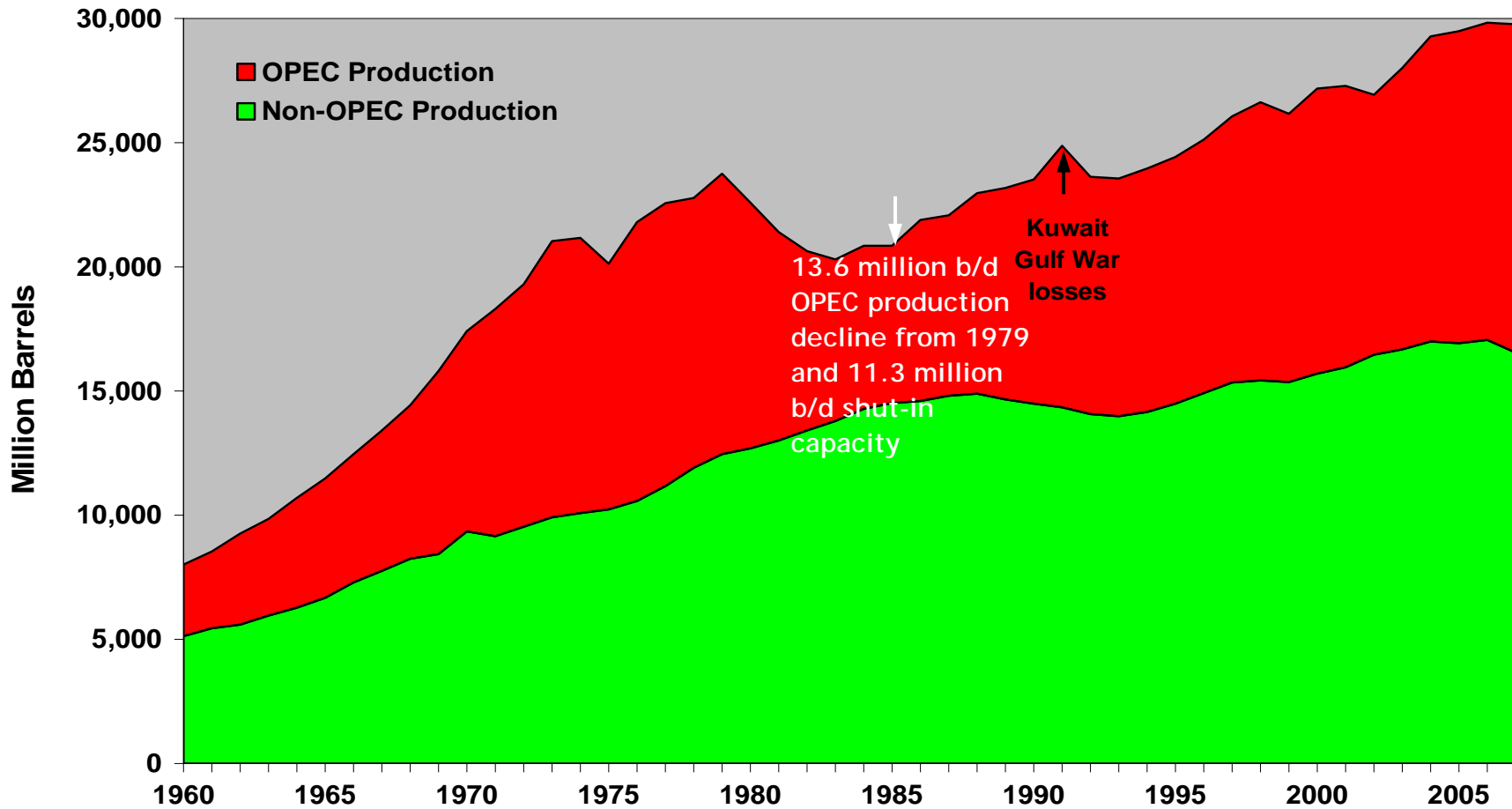
# World energy production 2007



# World Liquids Supply



**World Annual Liquids Production 1960-2007**  
(includes condensate, NGLs and oil sands)

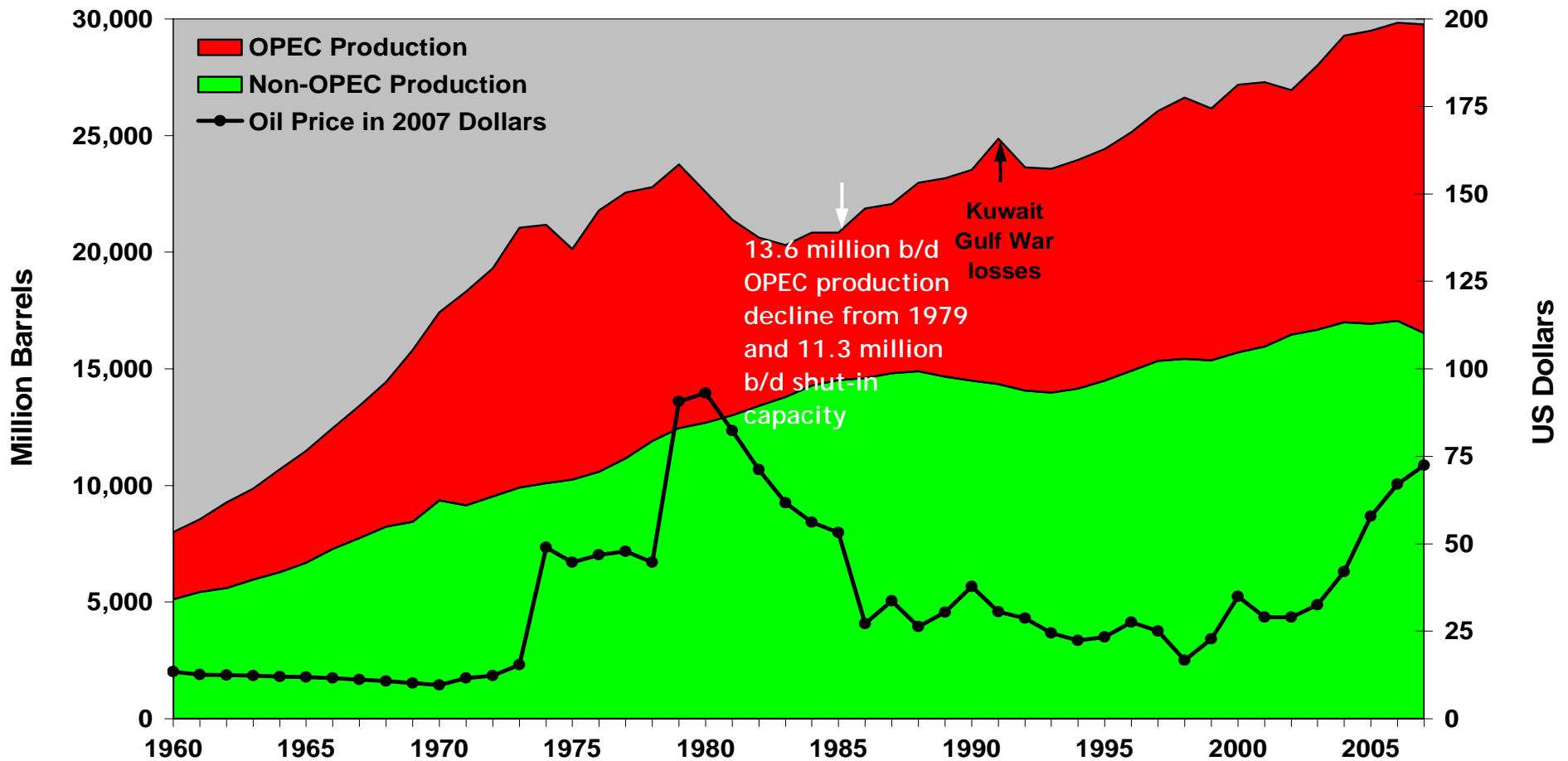


OPEC production includes Ecuador (1973-1992) and Gabon (1975-1994), and Angola (joined 2007); also includes OPEC NGLs

# World Liquids Supply



## World Annual Liquids Production 1960-2007 (includes condensate, NGLs and oil sands)

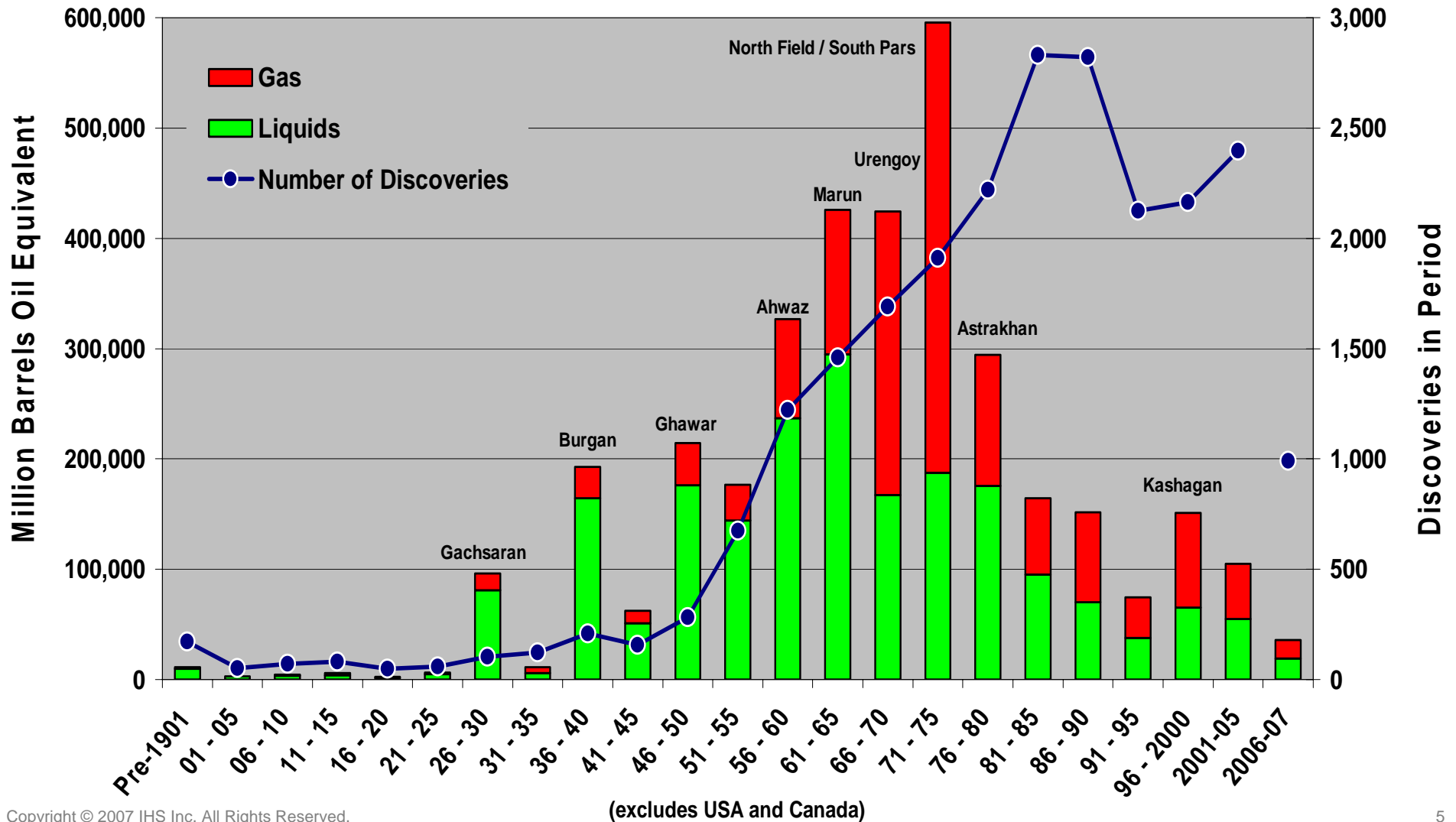


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## Discovery Trends

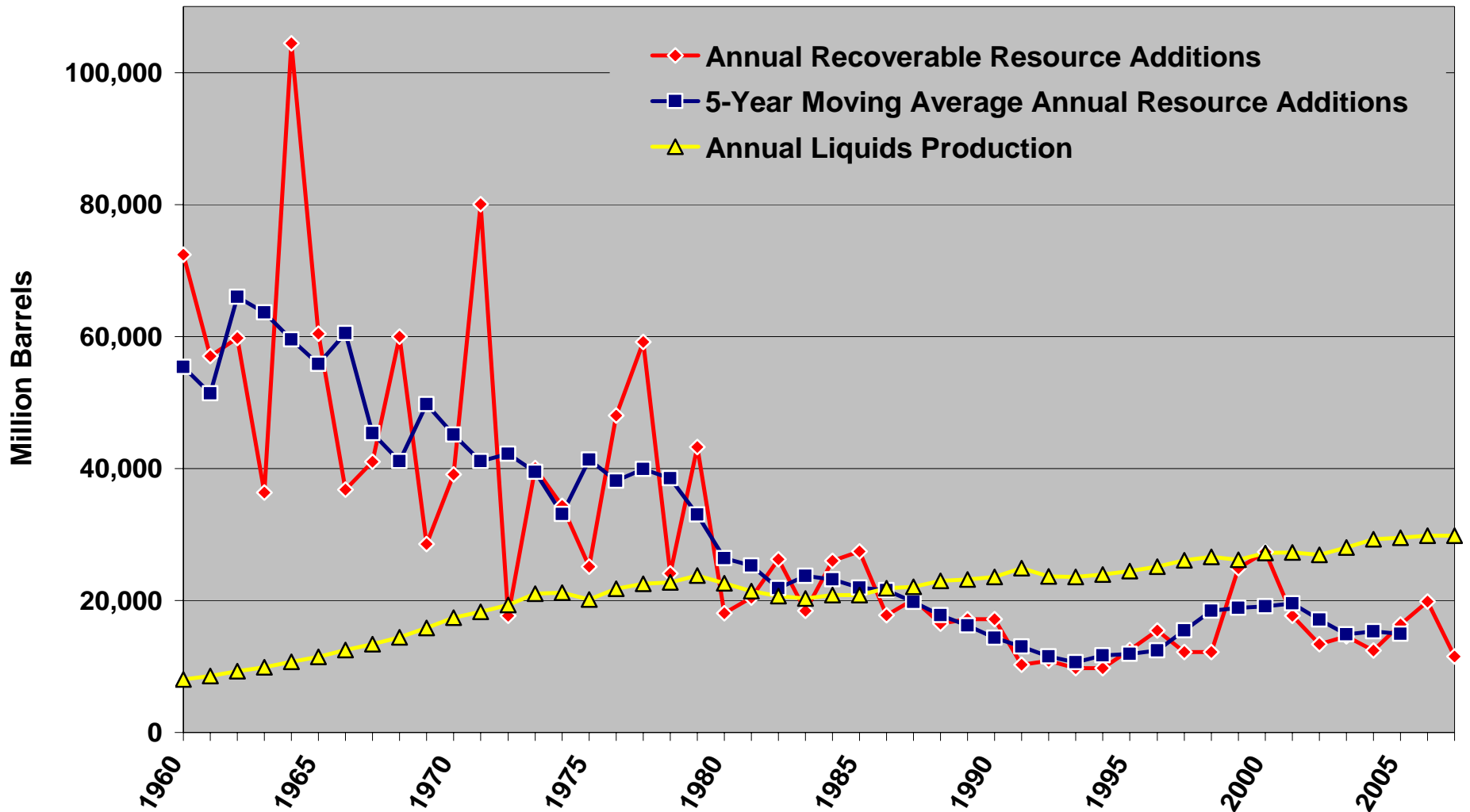
Total Discovered Resources to End-2007 versus Number of Discoveries





## The Key Issue

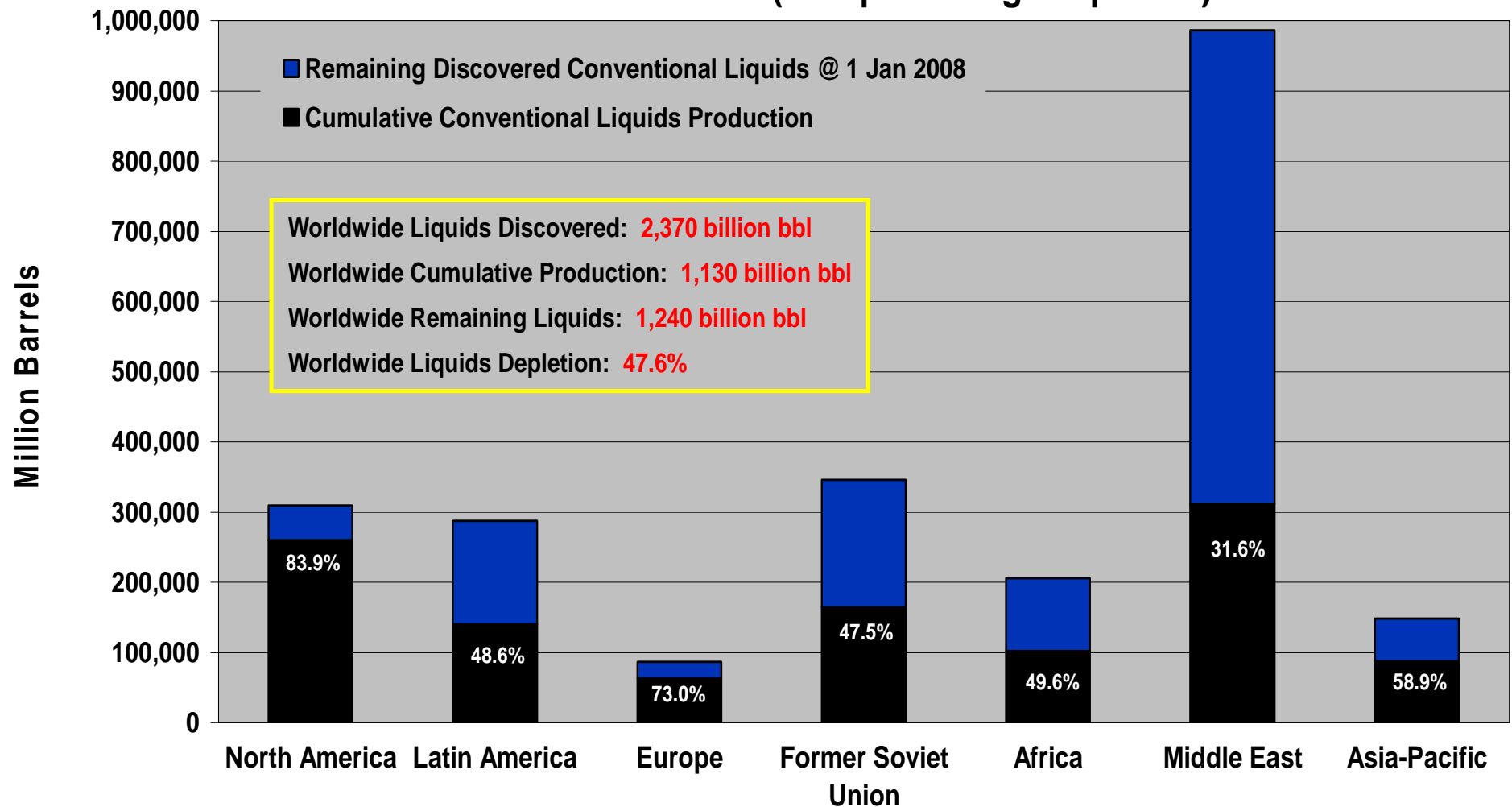
### Annual Liquids Discovered versus Annual Liquids Production



# Discovered & Remaining Recoverable World Liquids Resources



**Produced and Remaining Discovered Recoverable Conventional Liquids Resources at end-2007 (with percentage depletion)**





# Future Production

Discovered  
Resources

Resource  
Growth

Yet-to-Find

Unconventional  
Resources



## Remaining Recoverable World Liquids Resources (Low-end Estimate)



### Negative

- Some “stranded” accumulations will not be developed.

### Positives

- North American estimates are 1P (“proved”) reserves, not 2P (“proved plus probable”) resources.
- Only “developed” resources of oil sands / extra-heavy oil are included.
- No allowance is made for resource growth.
- No allowance is made for “yet-to-find” discoveries made after 31 Dec 2007.



## Resource Growth

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Also known as “reserves growth” or “field growth”, this term describes the increase in recoverable resources that commonly occurs over time, as oil and gas fields are developed and produced.

### Mechanisms

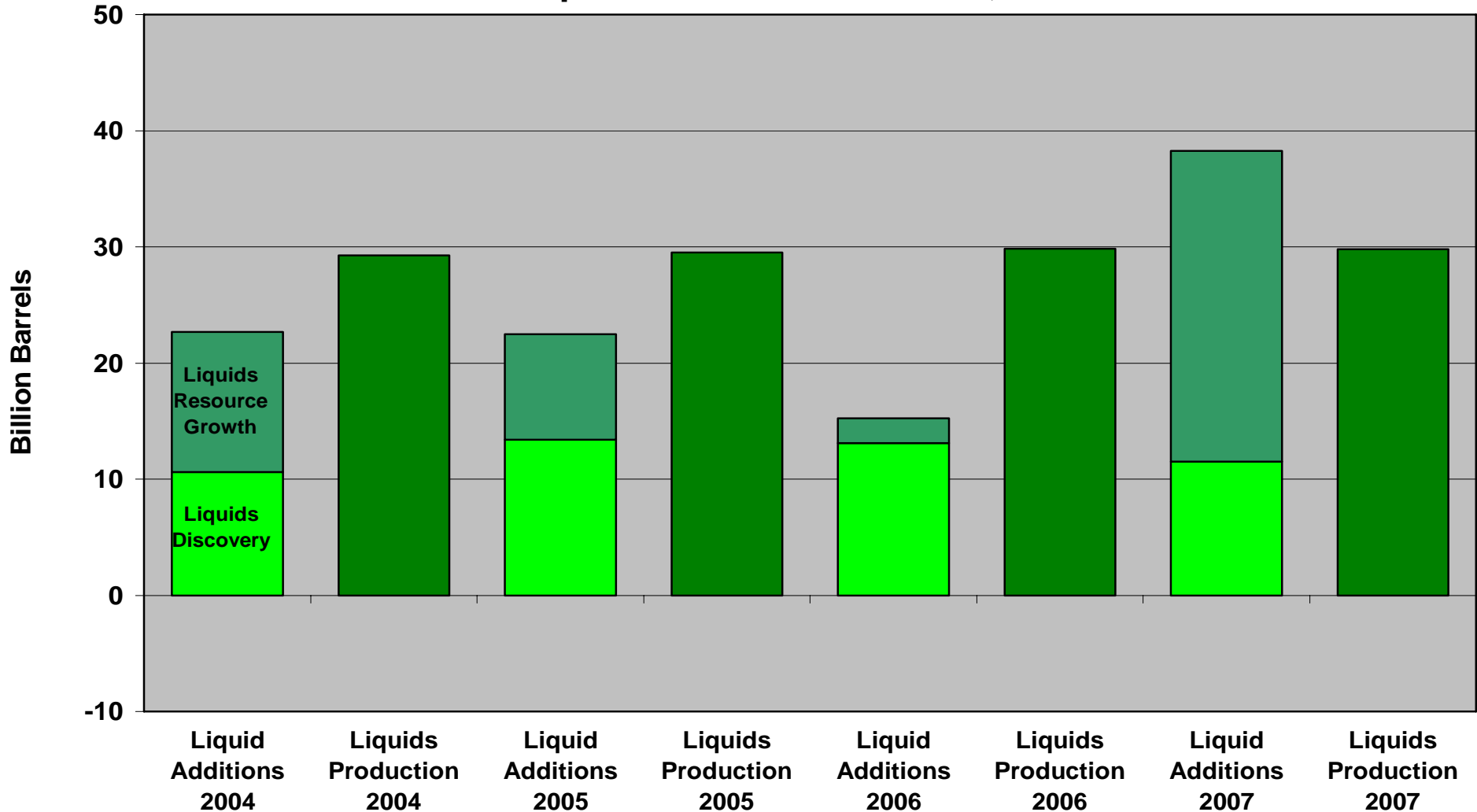
- New-pool discoveries: increases in-place
- Improved technology: increases recovery
- Commodity price: increases investment in IOR and infill drilling
- Field micro-management: allocation of investment

# World Recoverable Liquids Resources



## Discovery / Production Balance 2004 - 2007

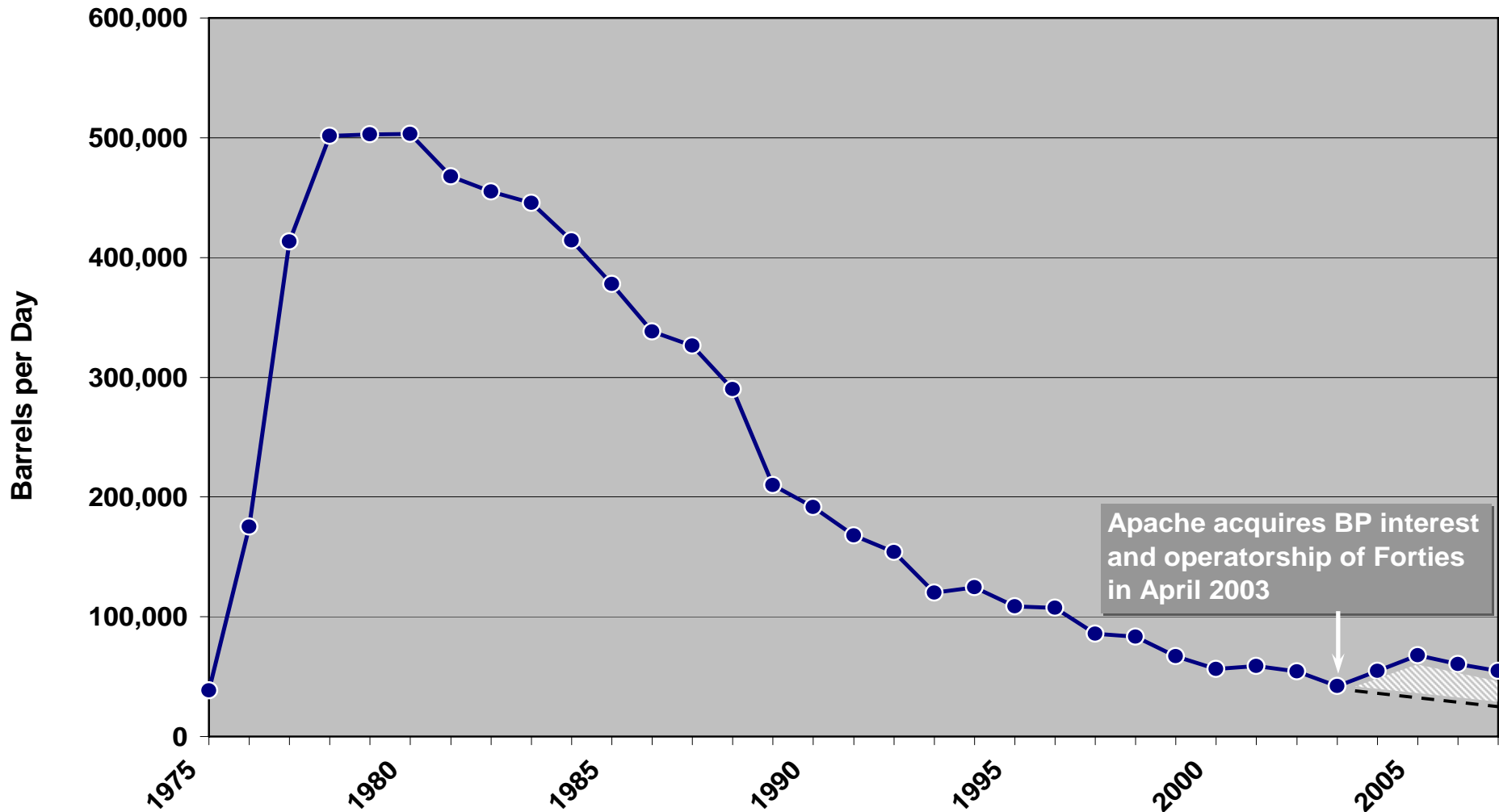
Recoverable Liquid Resource Additions, 2004 - 2007





## Reserves Growth in the Forties Field, UK


### Forties Field (UK) Annual Oil Production



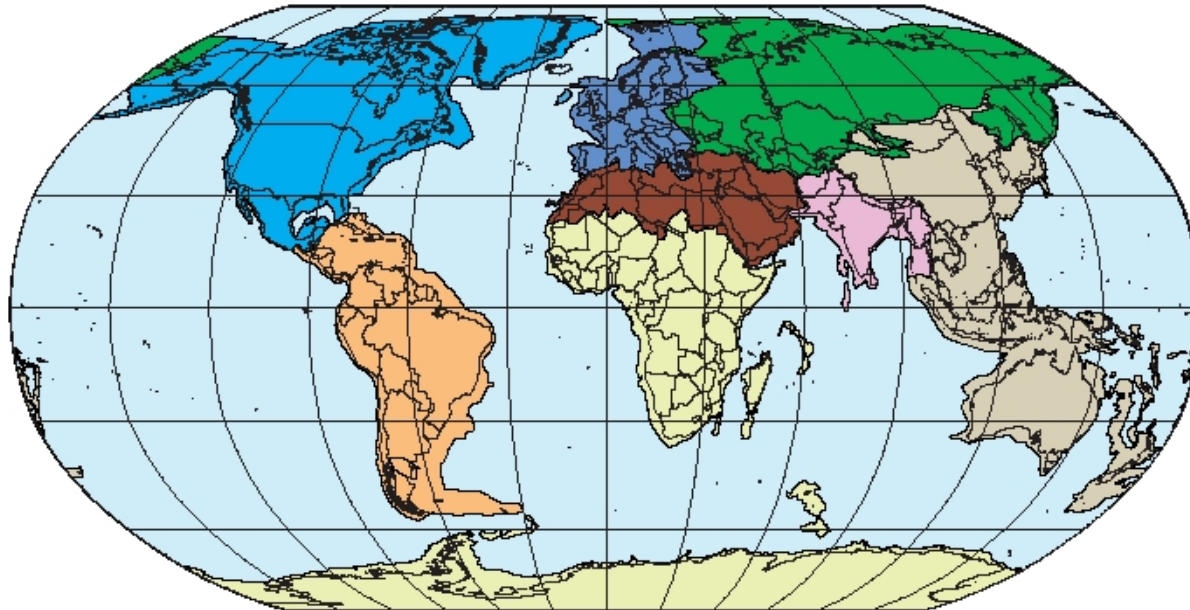
# World Recoverable Hydrocarbon Resources



## Undiscovered Hydrocarbons (“Yet-to-Find”)

 **U.S. GEOLOGICAL SURVEY WORLD PETROLEUM ASSESSMENT 2000—  
DESCRIPTION AND RESULTS**  
BY USGS WORLD ENERGY ASSESSMENT TEAM

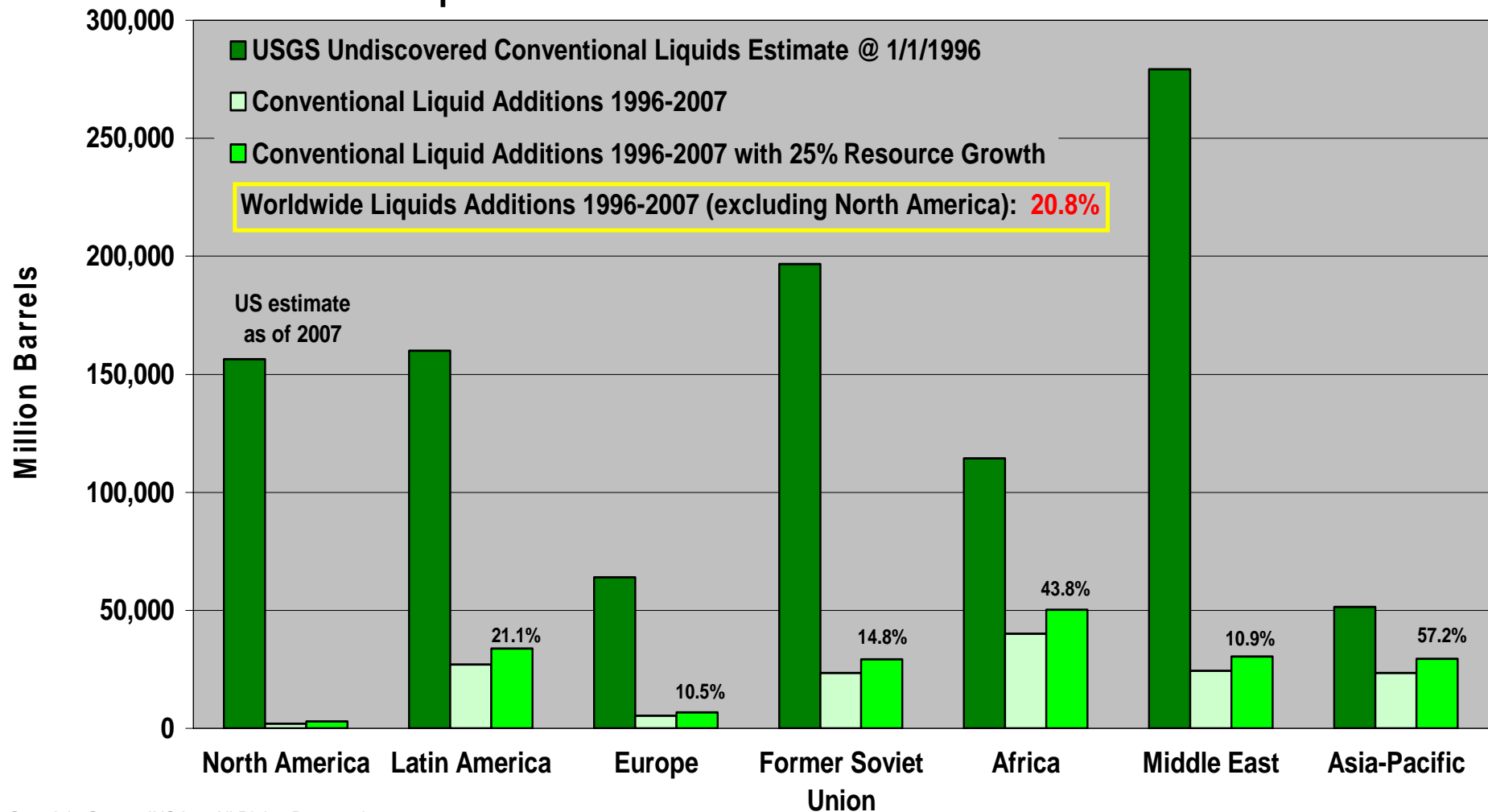
*Click anywhere to continue*



# Recently-discovered Recoverable Liquid Volumes vs Yet-to-Find



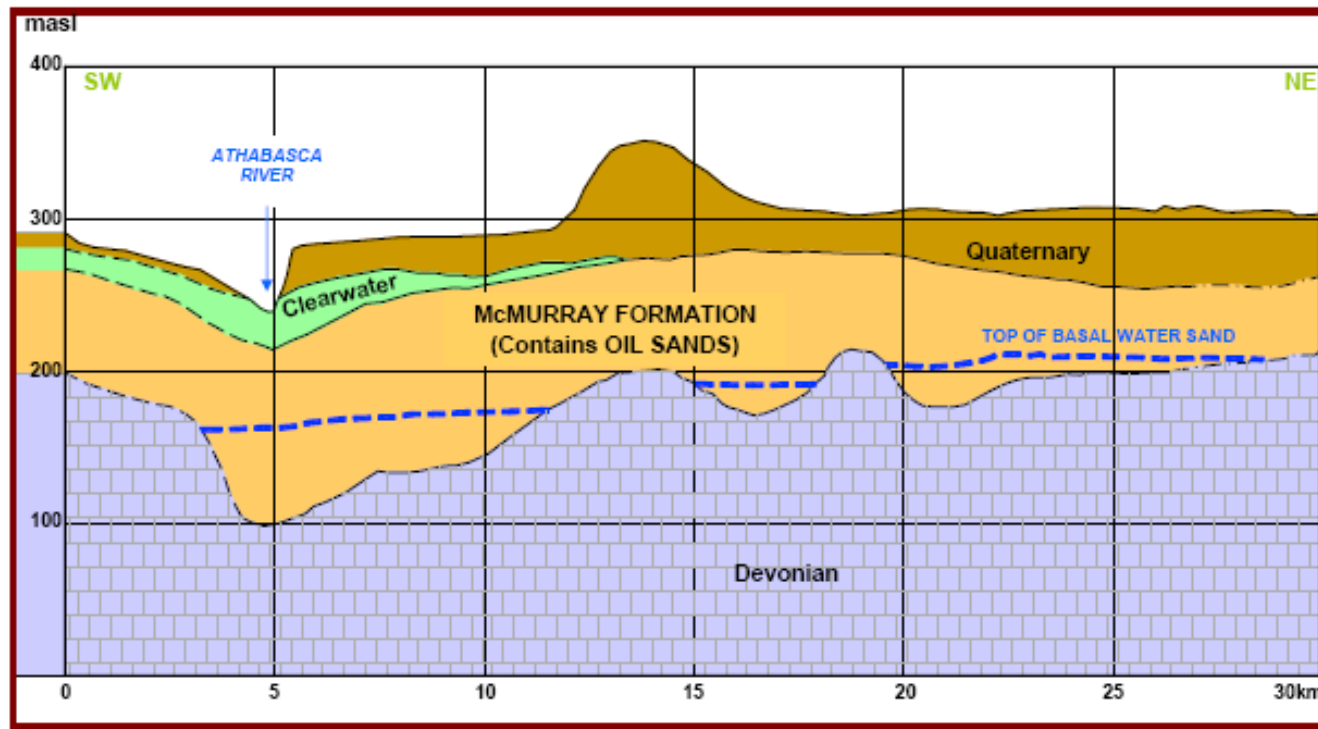
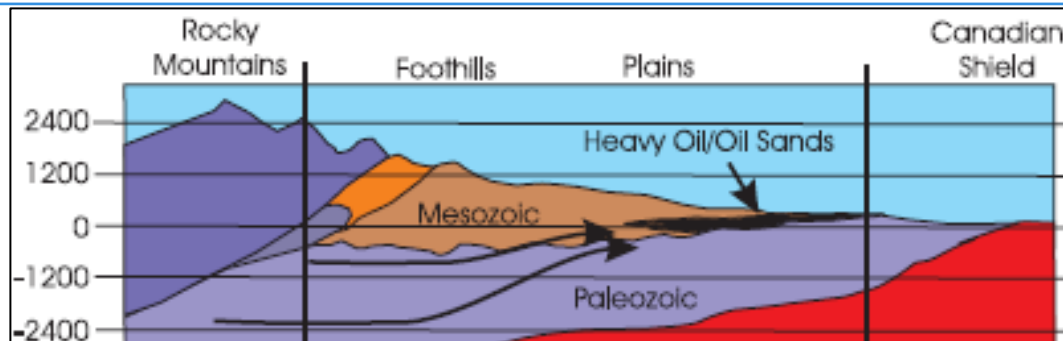
**USGS Estimate of Undiscovered Liquids at 1 Jan 1996 versus Recoverable Liquids Discovered between 1st Jan 1996 and 31st Dec 2007**



# Liquids Resource Plays



## Canada: Alberta Oil Sands - Geology





### Liquids Resource Play Types

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- Bitumen in oil-sands (Alberta, Canada);
- Extra-heavy oil (Orinoco Belt, Venezuela);
- Fractured self-sourcing reservoirs (Bakken Shale, Williston Basin; Barnett Shale, Fort Worth Basin; Bazhenov Formation, West Siberia);

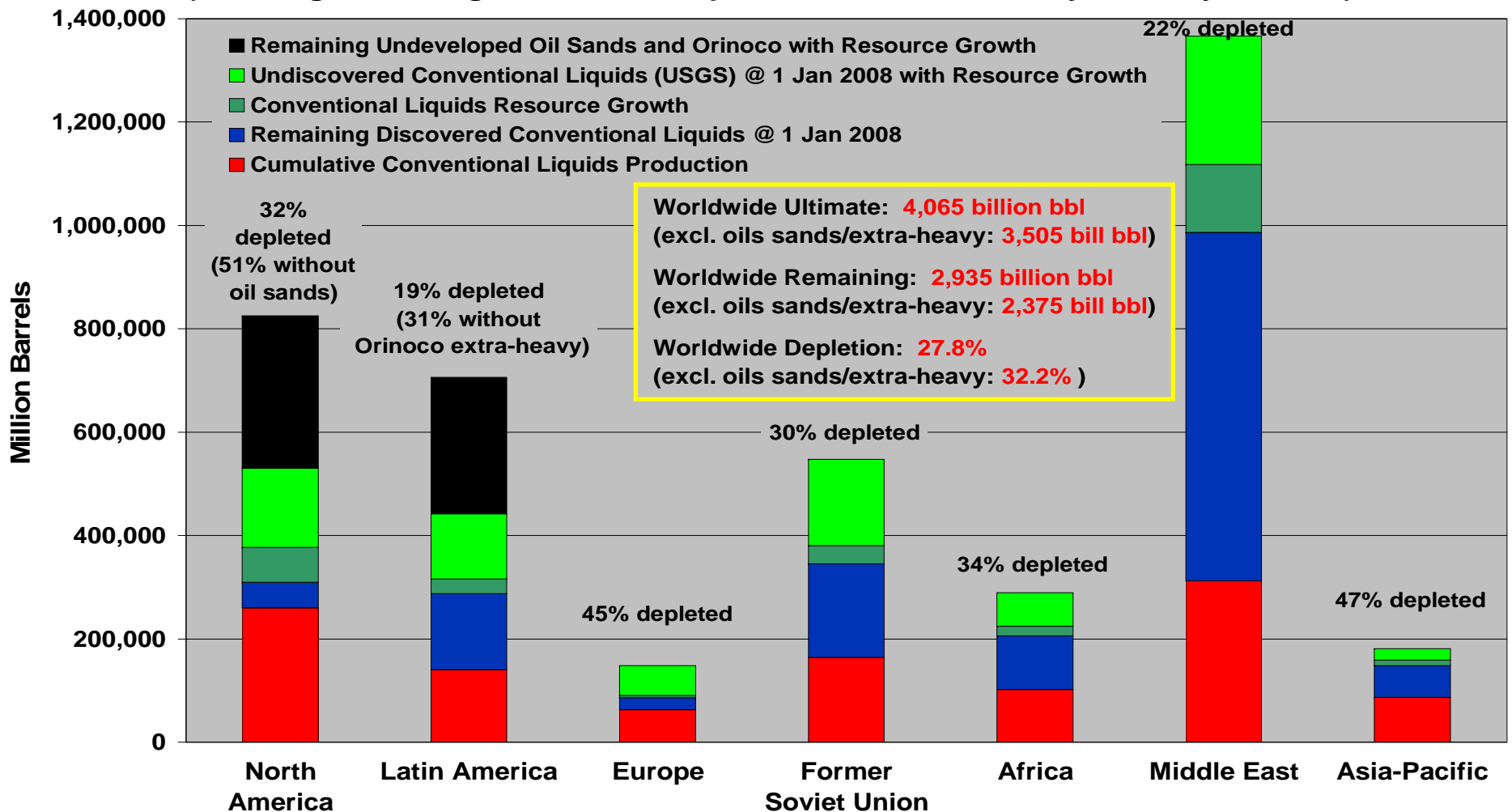
*also shale oil (USA; Estonia; Brazil; China; Queensland) and liquids from coal (South Africa; China) but strictly speaking these are conversion technologies.*



# World Recoverable Liquids Resources (High-end Estimate)



**Produced and Remaining Recoverable Liquids Resources at End-2007**  
(including resource growth, undeveloped oil sands / extra-heavy oil, and yet-to-find)

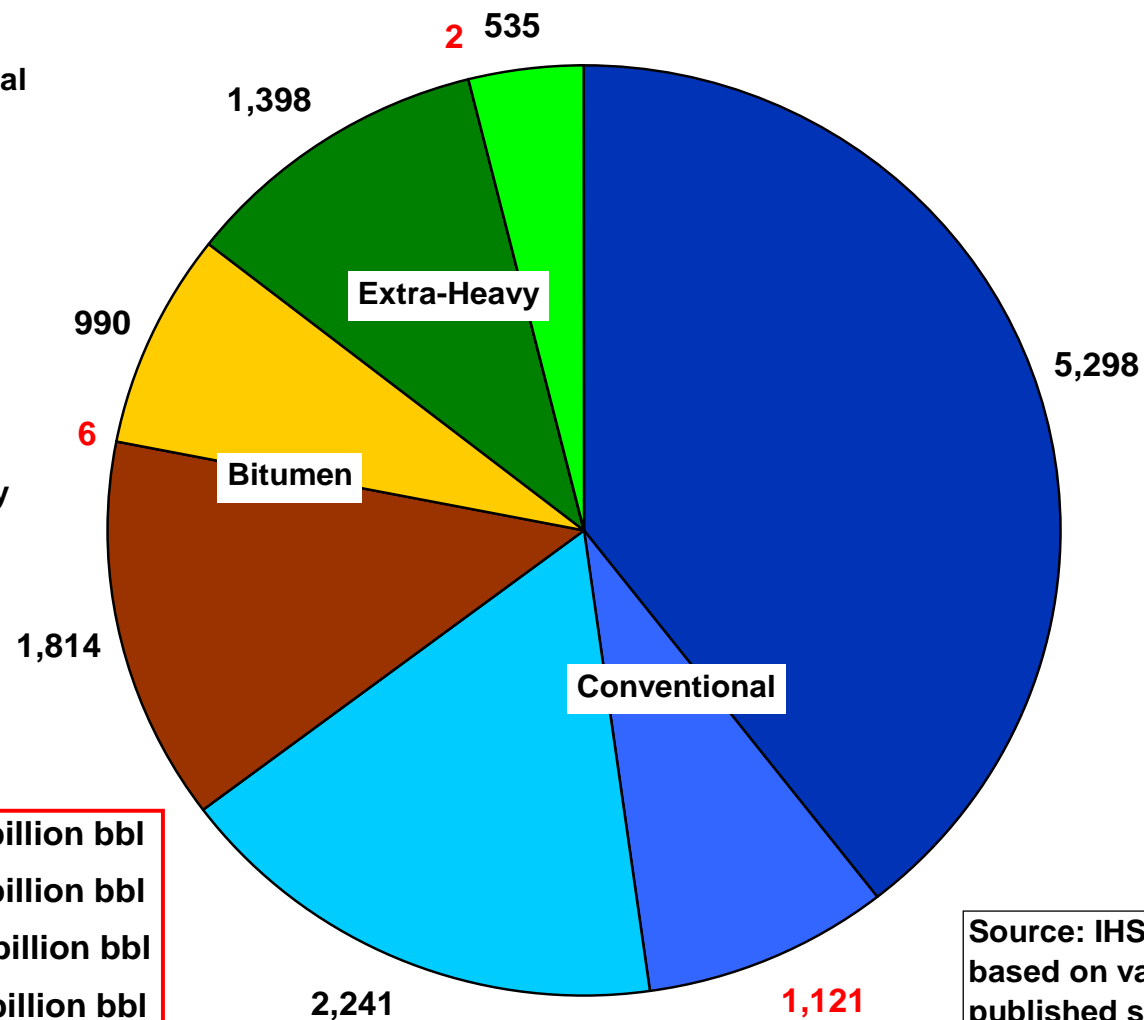


# Ultimate Liquids Resource



## Global Liquid Resources In-Place (billion bbl)

- Remaining Discovered Conventional
- Produced Conventional
- Undiscovered Conventional
- Remaining Discovered Bitumen
- Produced Bitumen
- Undiscovered Bitumen
- Remaining Discovered Extra-Heavy
- Produced Extra-Heavy
- Undiscovered Extra-Heavy



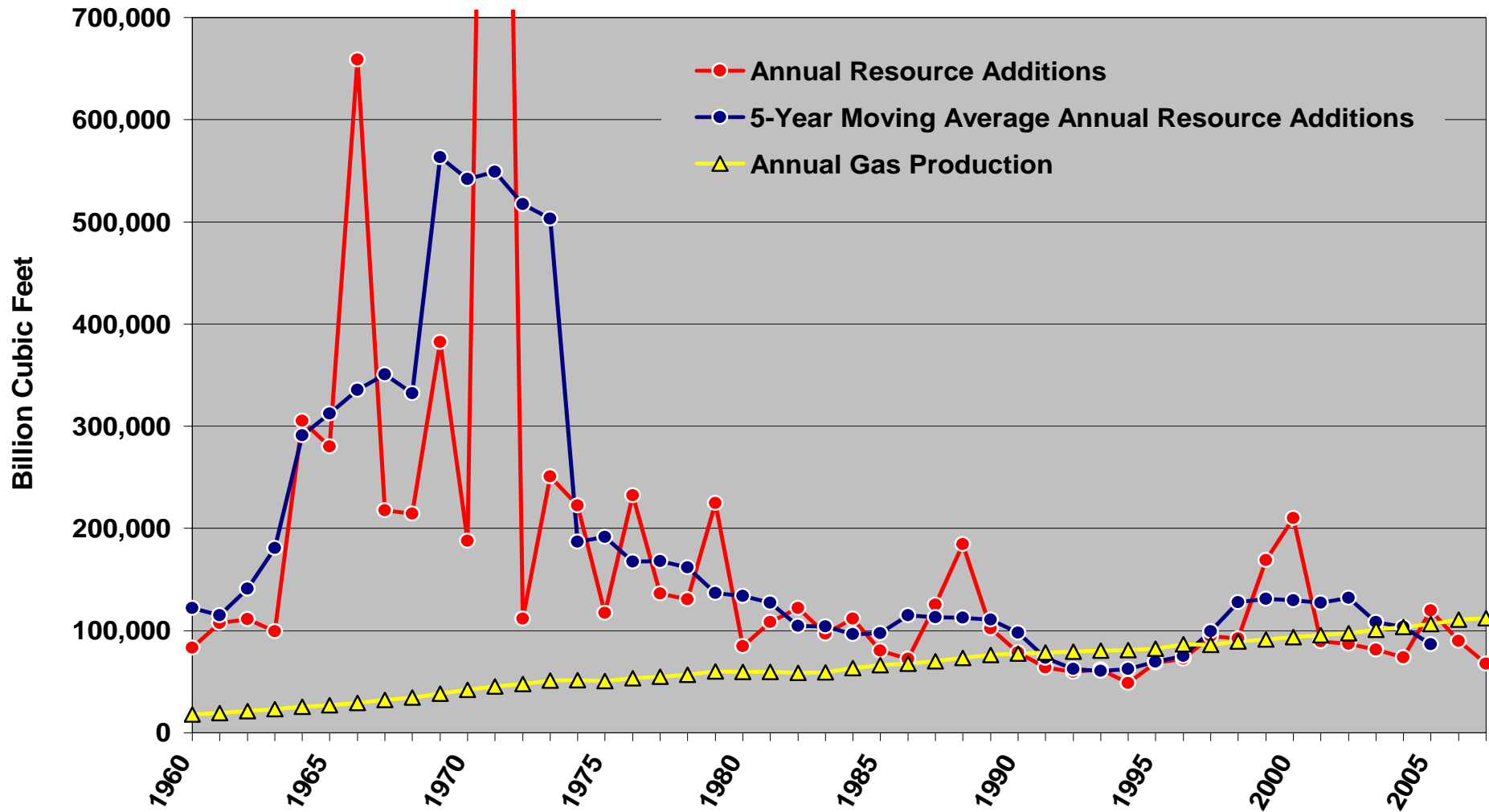
<b>Total Discovered:</b>	<b>9,640 billion bbl</b>
<b>Total Undisc / Inferred:</b>	<b>3,765 billion bbl</b>
<b>Ultimate Resource:</b>	<b>13,405 billion bbl</b>
<b>Total Produced (end-2007):</b>	<b>1,129 billion bbl</b>

Source: IHS estimate based on various published sources

# World Natural Gas Resources



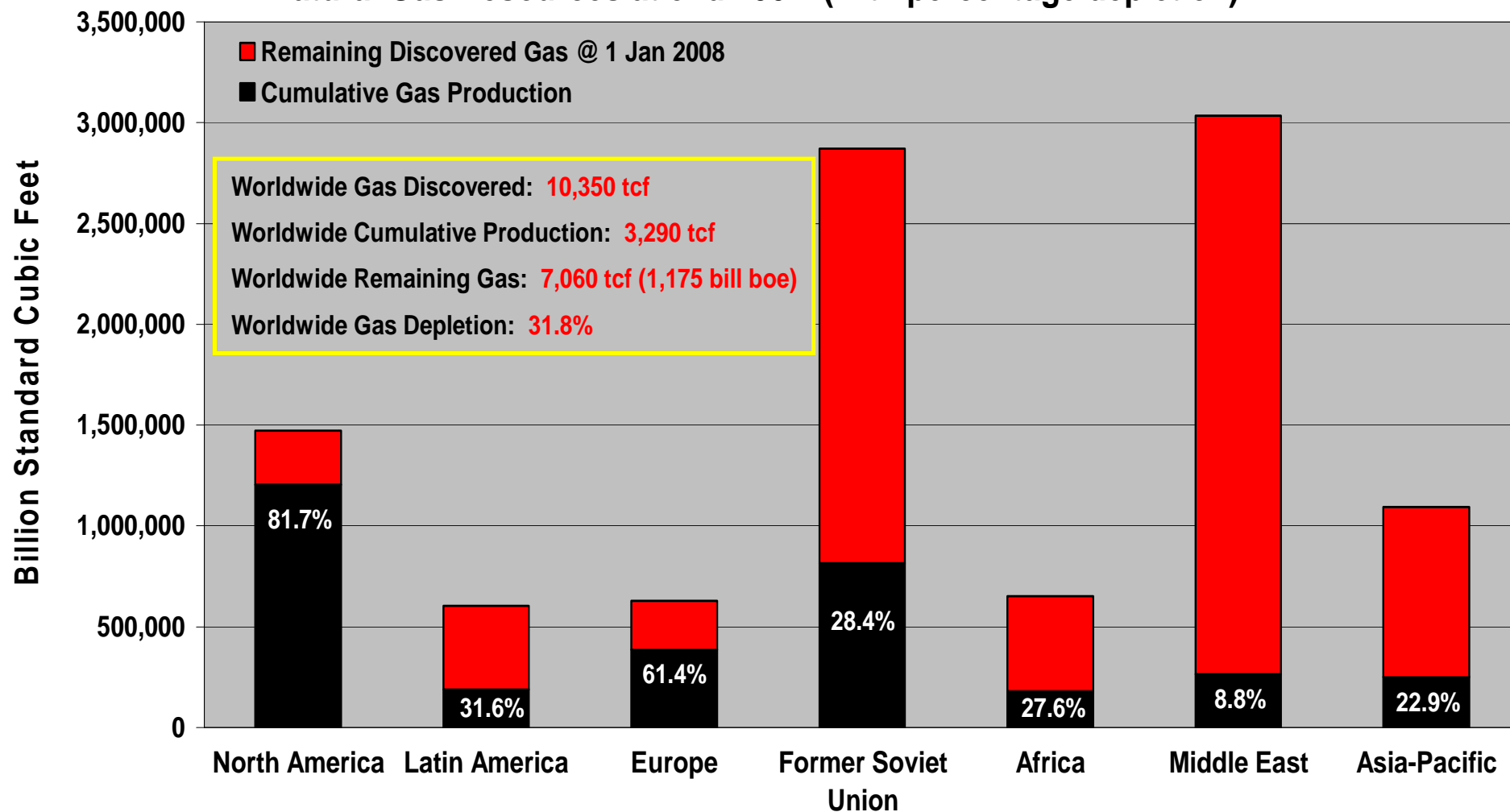
## Annual Gas Discovered versus Annual Gas Production



# Discovered and Remaining Recoverable World Gas Resources (Low-end Estimate)



Produced and Remaining Discovered Recoverable Conventional Natural Gas Resources at end 2007 (with percentage depletion)

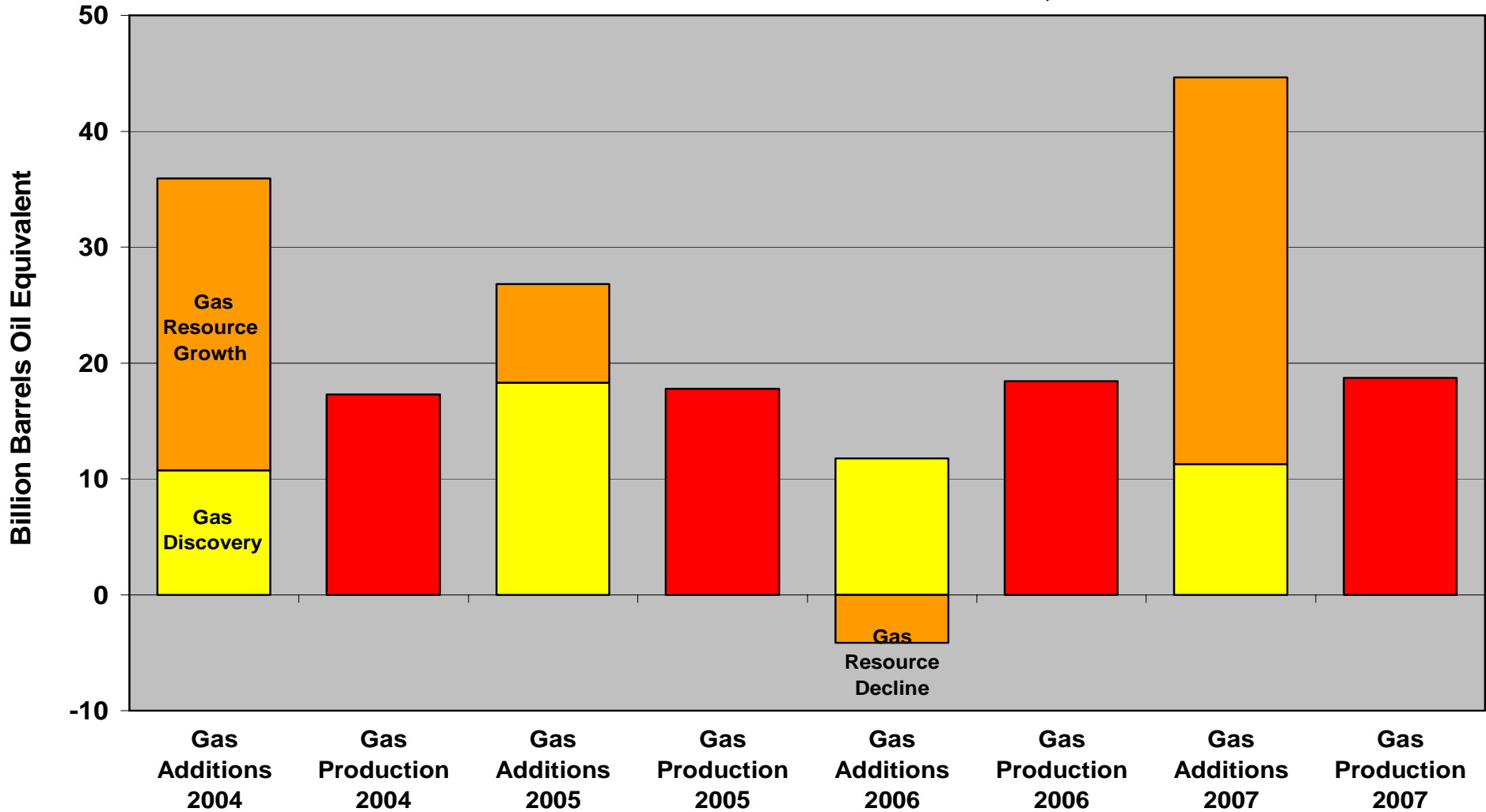


# World Recoverable Natural Gas Resources



## Discovery / Production Balance 2004 - 2007

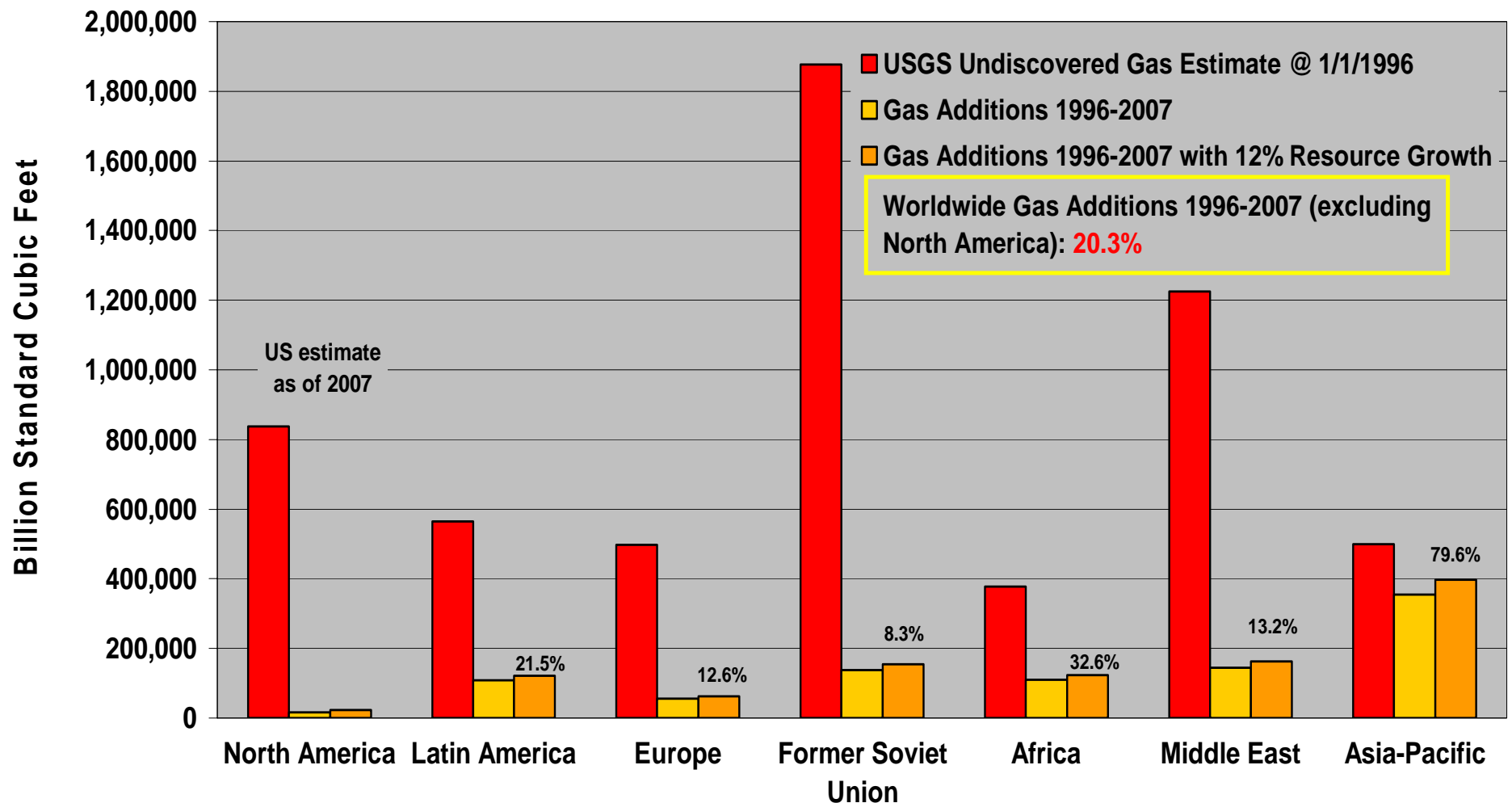
Recoverable Natural Gas Resource Additions, 2004 - 2007



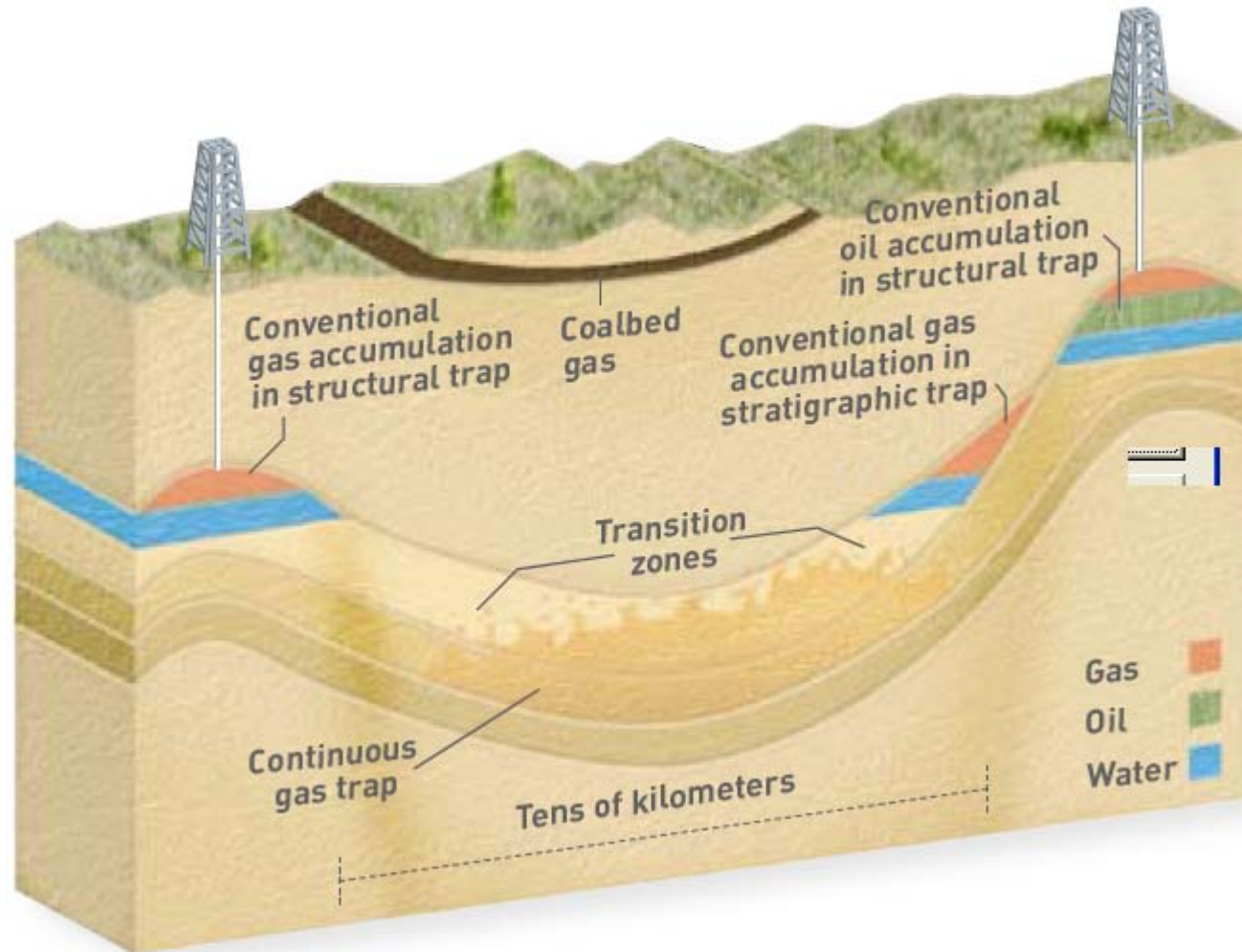
# Recently-discovered Recoverable Gas Volumes *versus* Yet-to-Find



**USGS Estimate of Undiscovered Gas at 1 Jan 1996 versus Recoverable Gas Discovered between 1st Jan 1996 and 31st Dec 2007**



# Gas Resource Plays



Source: Total



### Gas Resource Play Types

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- Coal Bed Gas (“CBM”; “CSG”; Natural Gas from Coal)
- Anomalously-Pressured Basin-Centre Gas (also known as “deep gas” or “tight sand gas”)
- Tight Self-Sourcing Lithologies (shale; chalk)  

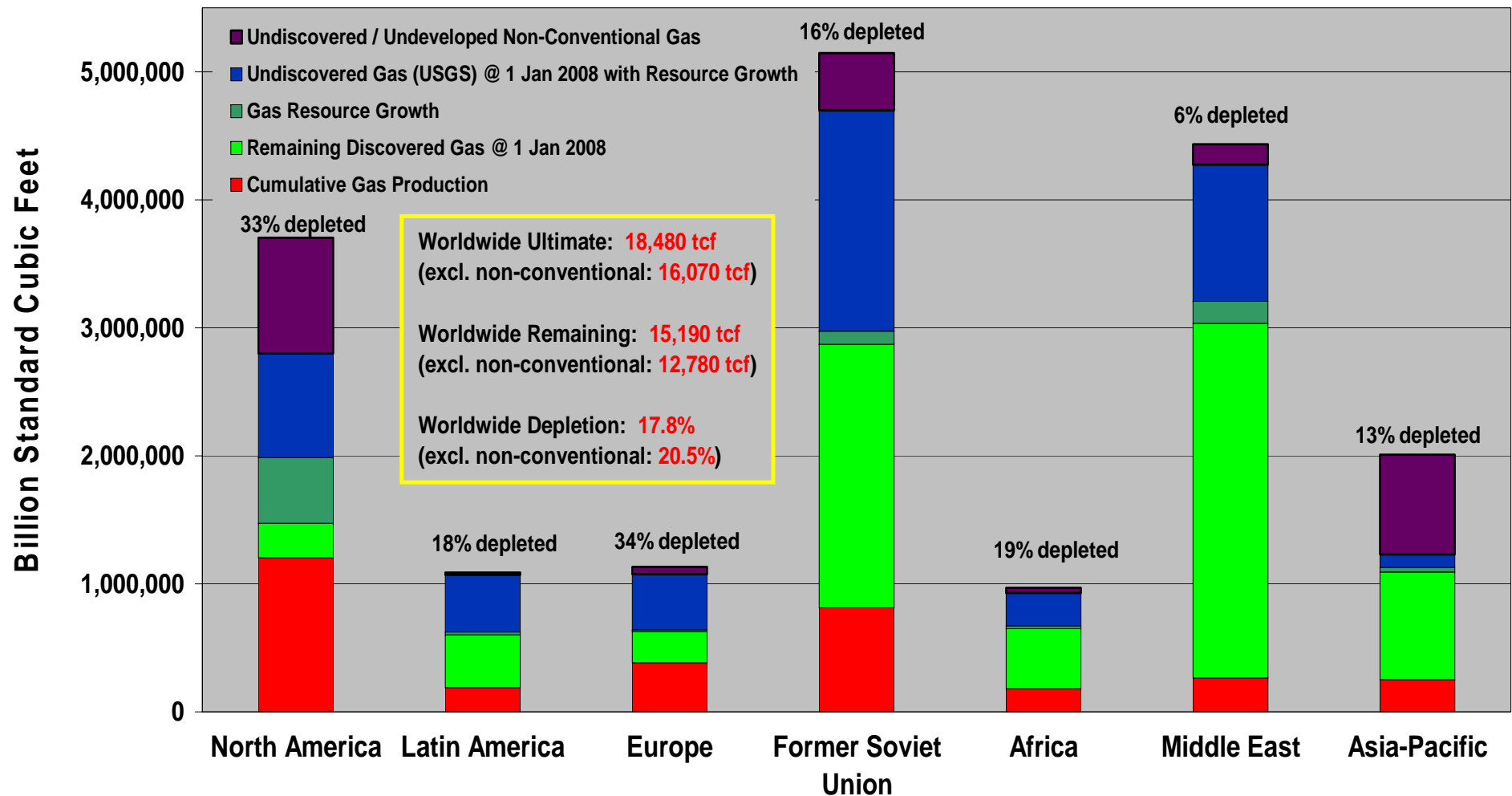
and in the future
- Gas Hydrates (clathrates: methane trapped in lattice of ice)



# World Recoverable Natural Gas Resources (High-end Estimate)



**Produced and Remaining Recoverable Natural Gas Resources at End-2007  
(Including Reserves Growth and Conventional and Non-Conventional Yet-to-Find)**

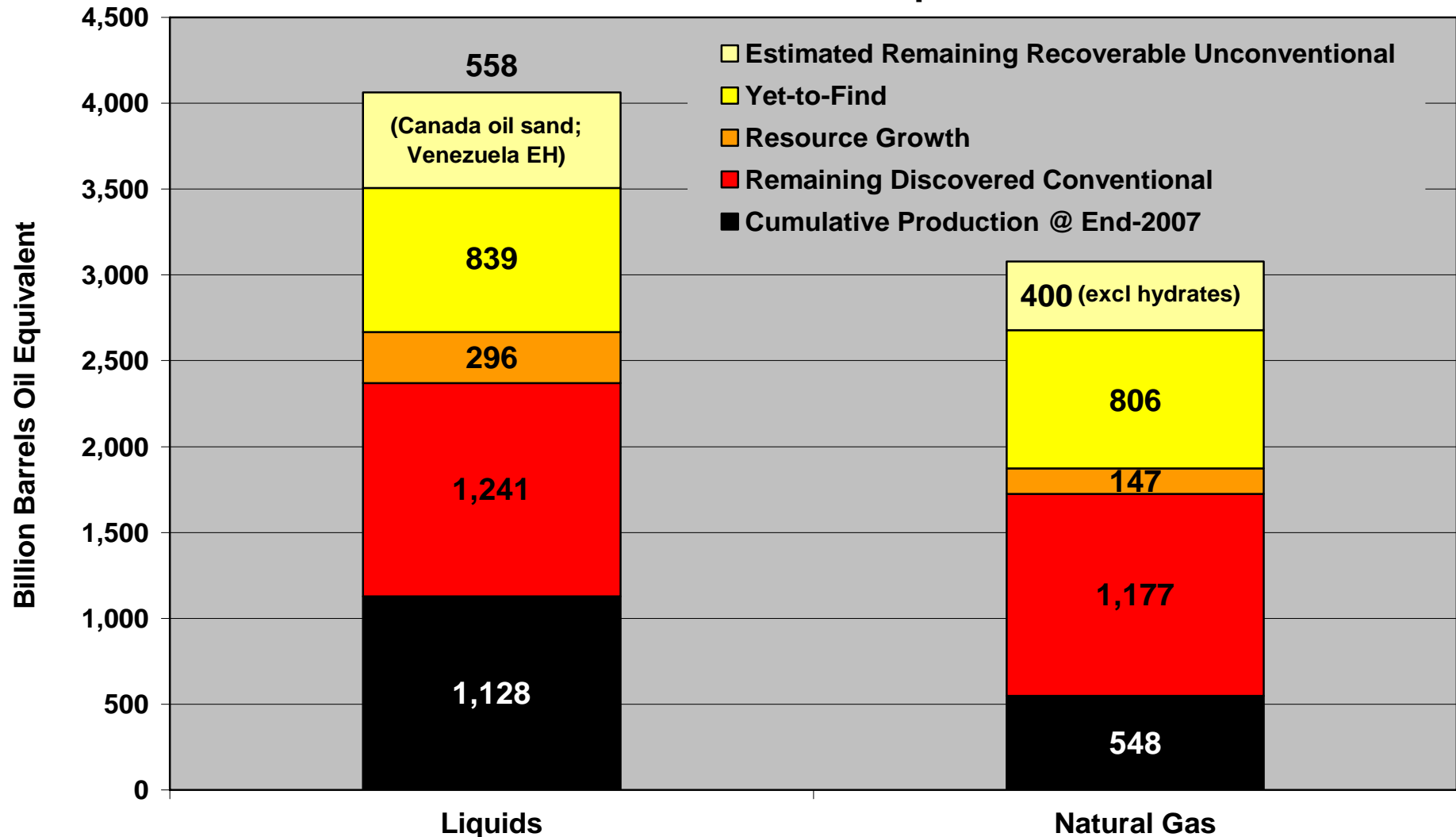


# Ultimate Recoverable Hydrocarbon Resources



## Summary

### Estimated Ultimate Recoverable World Liquid and Gas Resources



# Remaining Recoverable World Hydrocarbon Resources (High-end Estimates)



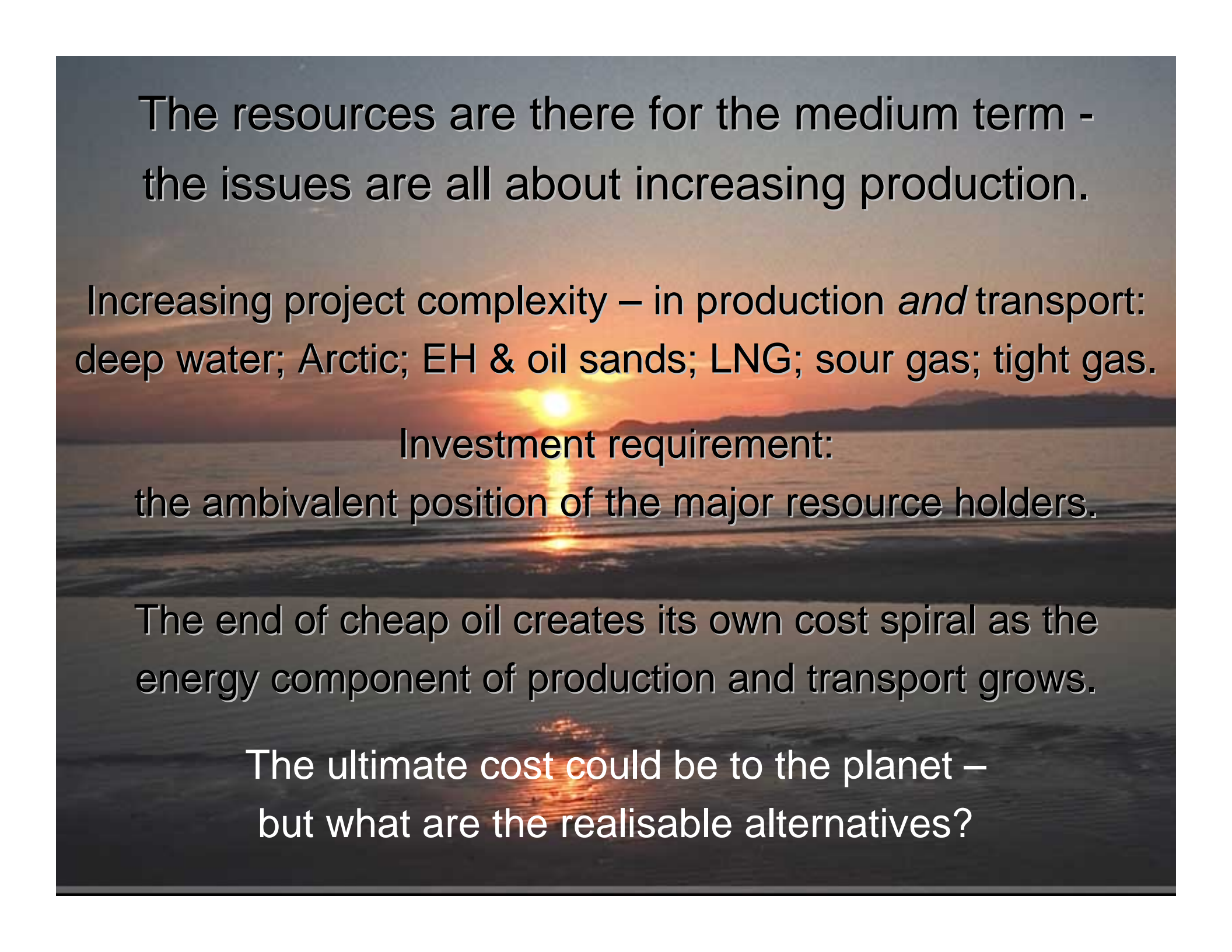
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## Positives

- USGS World Petroleum Assessment 2000 does not encompass all prospective petroleum provinces.
- IHS estimates of the gains from resource growth are considerably more conservative than those of the USGS.

## Negatives

- Undiscovered resources remain speculative until discovered.
- Unlikely that undiscovered potential can be found and developed within the time frame required to meet forecast demand growth through 2030.

A sunset over a body of water with mountains in the distance. The sun is low on the horizon, casting a golden glow across the sky and reflecting on the water. The mountains are silhouetted against the bright sky.

The resources are there for the medium term -  
the issues are all about increasing production.

Increasing project complexity – in production *and* transport:  
deep water; Arctic; EH & oil sands; LNG; sour gas; tight gas.

Investment requirement:  
the ambivalent position of the major resource holders.

The end of cheap oil creates its own cost spiral as the  
energy component of production and transport grows.

The ultimate cost could be to the planet –  
but what are the realisable alternatives?