

Peak oil and gas, and our energy dilemma

Forest Biomass Workshop

February 21, 2008

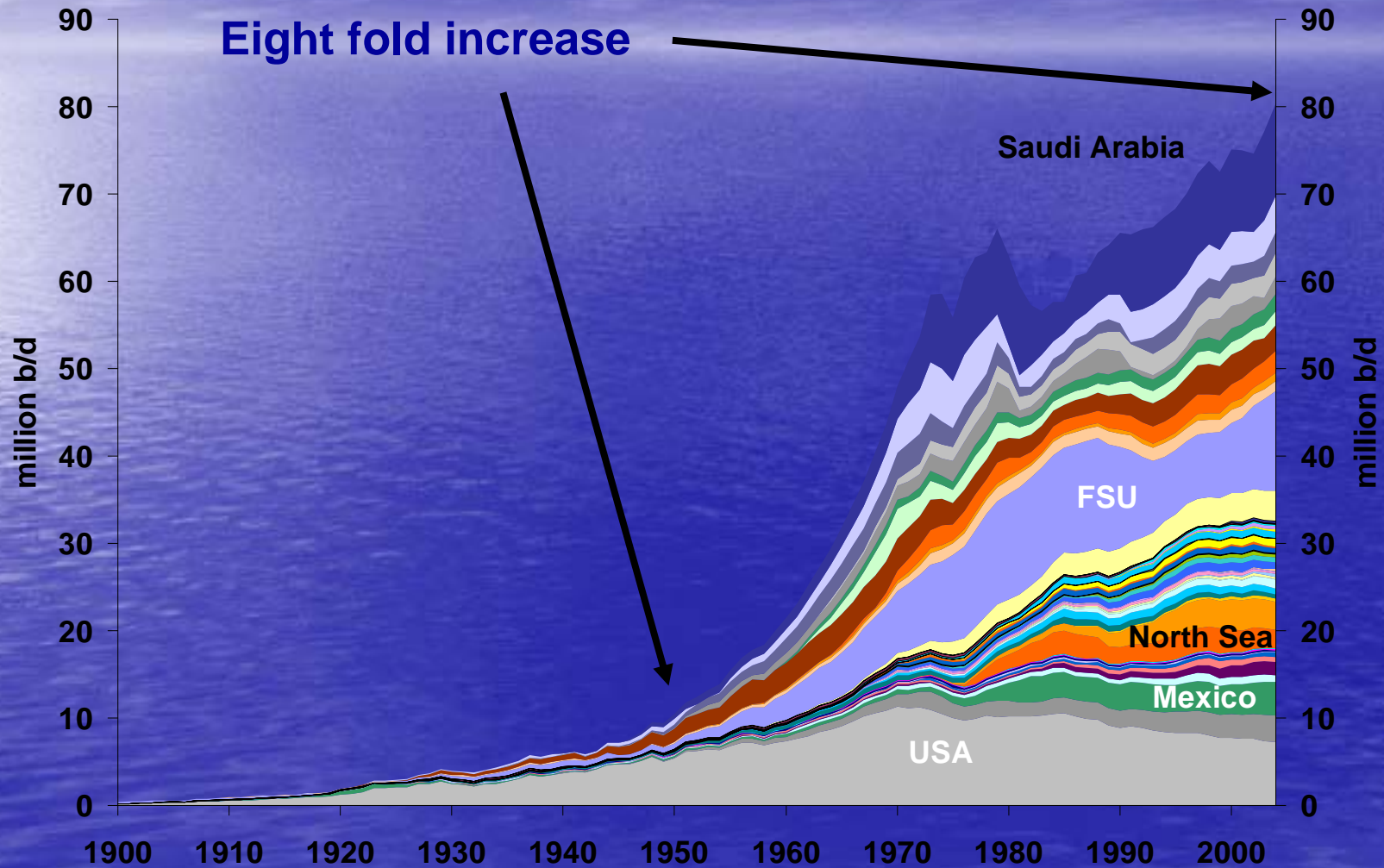
Steve Andrews

ASPO-USA



*Energy Action for a Healthy Economy
and a Clean Environment*

This trend isn't sustainable



Source: Dr. Peter Wells, NefTex (11/05)

Overview

- Natural gas context
- World oil context
- Responses to the problem
 - This is where you come in
 - To date, most responses aren't based in good science and steer incentives the wrong way



What will
politicians
do when oil
production
declines?
*Mayor of
Huntington
Beach*



There are two camps, two views about the peak oil and gas “theories”





CERA vision, natural gas style

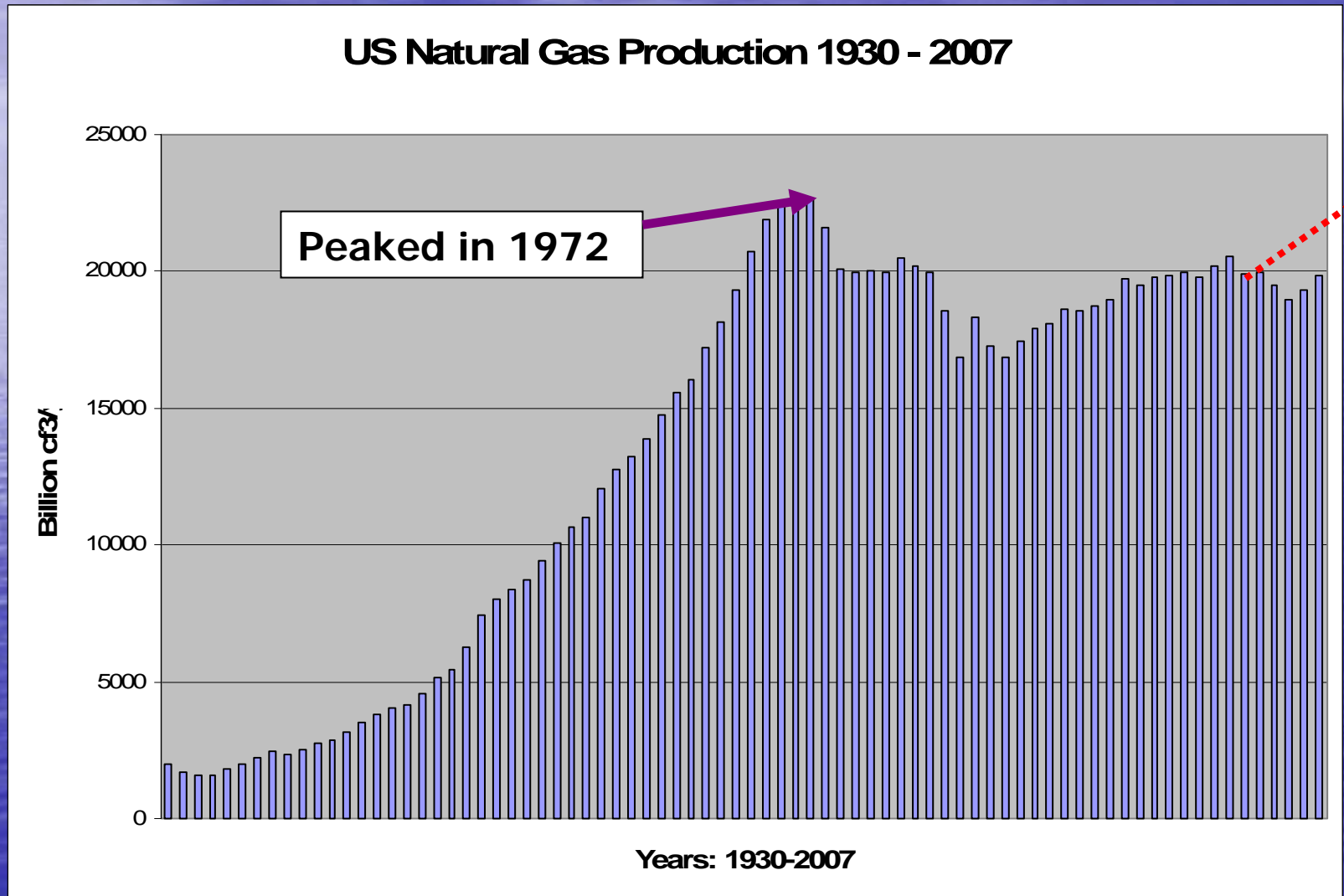
- 2002 projection: North American nat.gas production to increase 15% (by 2010)
- 2006 reality: North Am. Production flat





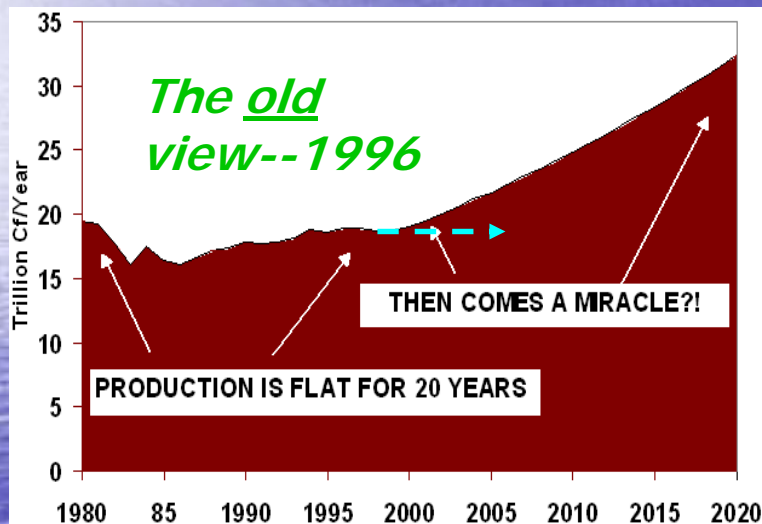
CERA[®]
An IHS Company

CERA-vision, by 2010 = +15%

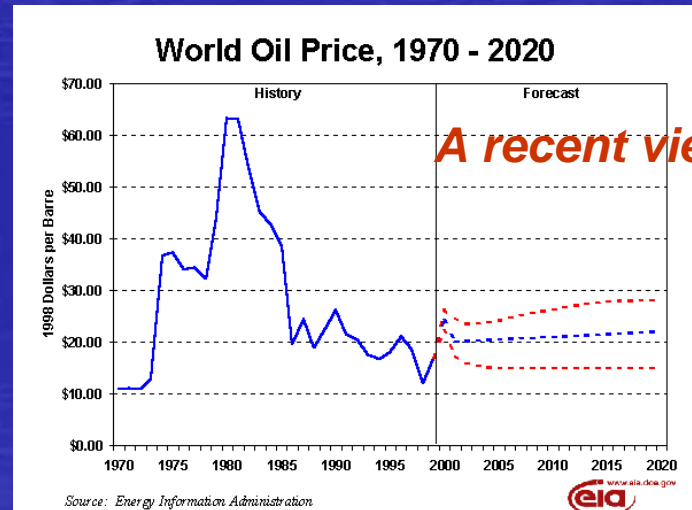
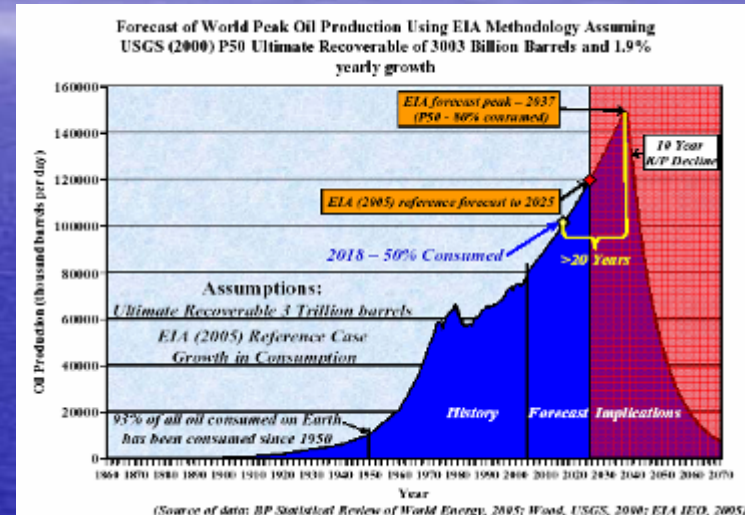


Source: US EIA data

Timing: US EIA's vision *also* appears clouded, now and in the past



Natural gas



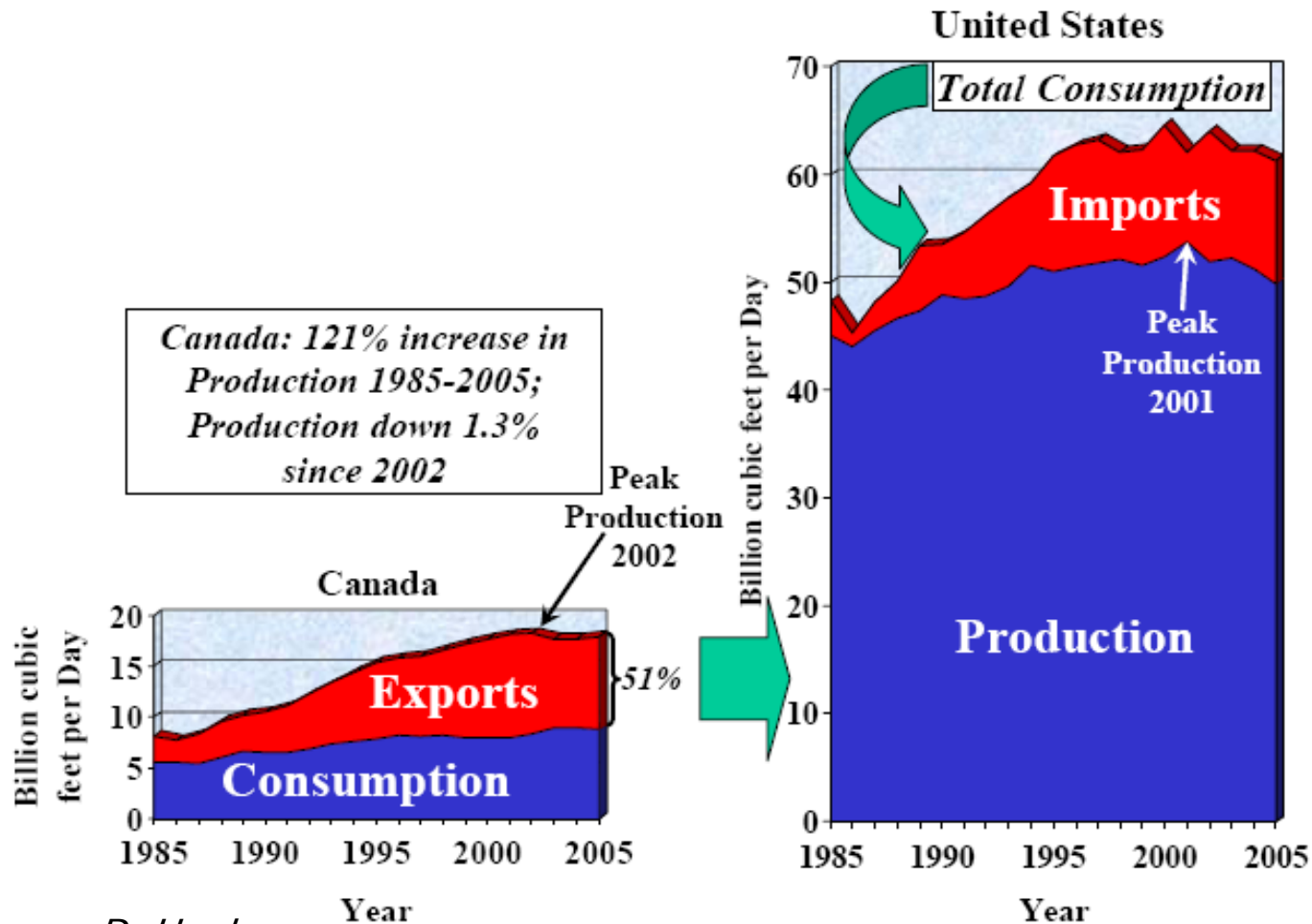


Can a miracle bail us out?



Biz-as-usual doesn't look sustainable

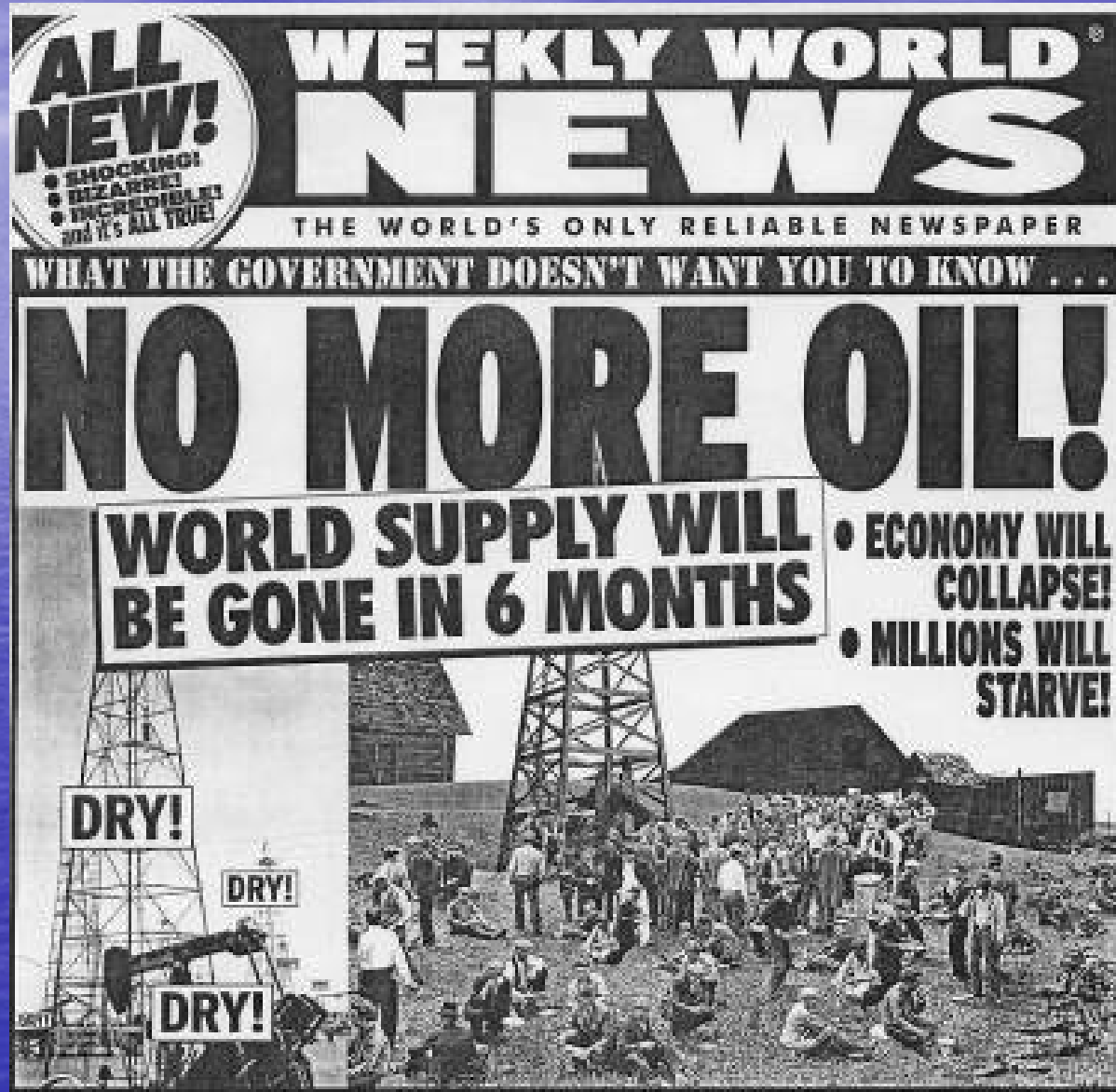
North American Gas Production and Movements: 1985-2005



Source : D. Hughes

(data from BP Statistical Review of World Energy, 2006)

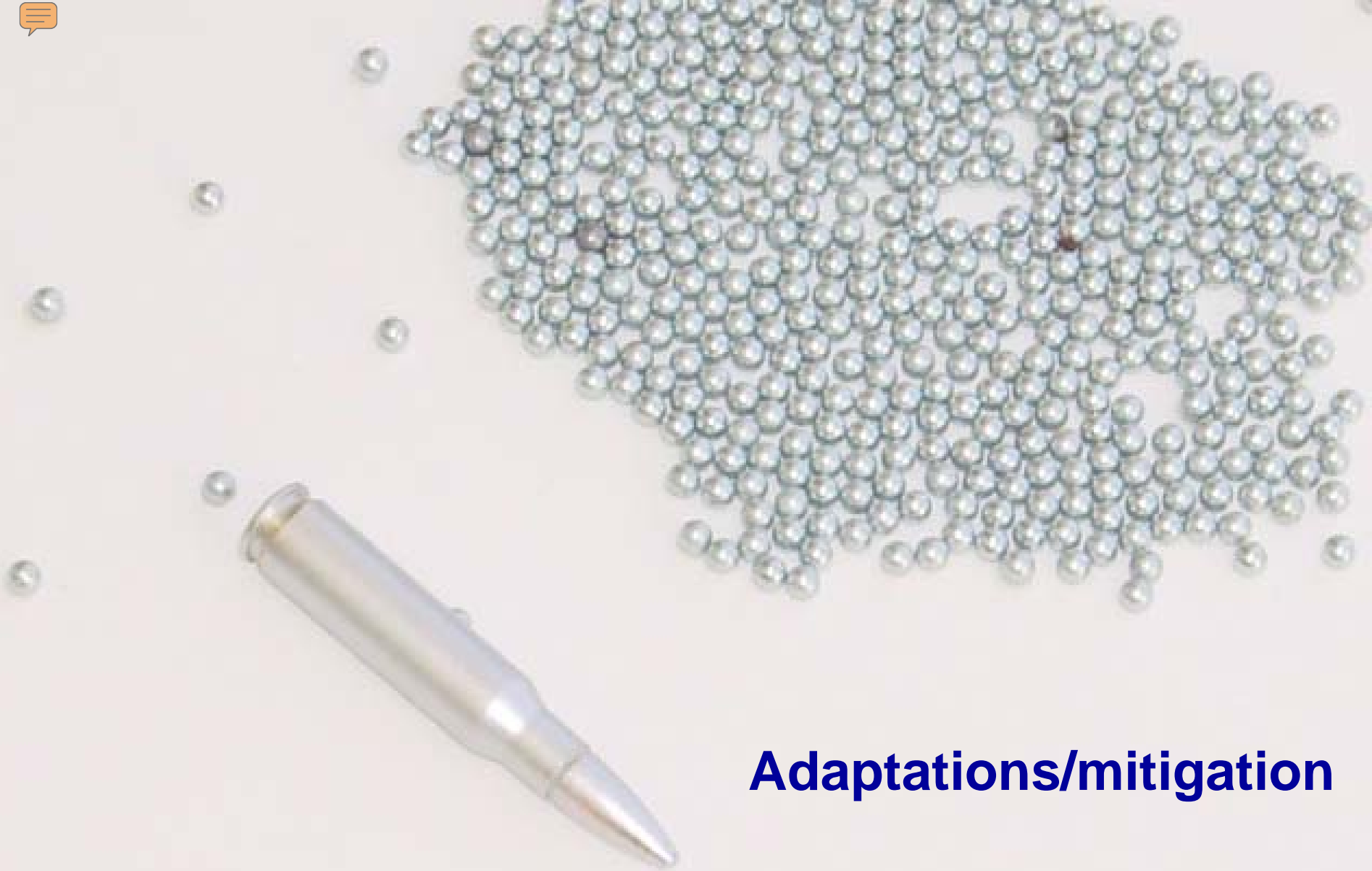
What peak oil *is* and *isn't*....





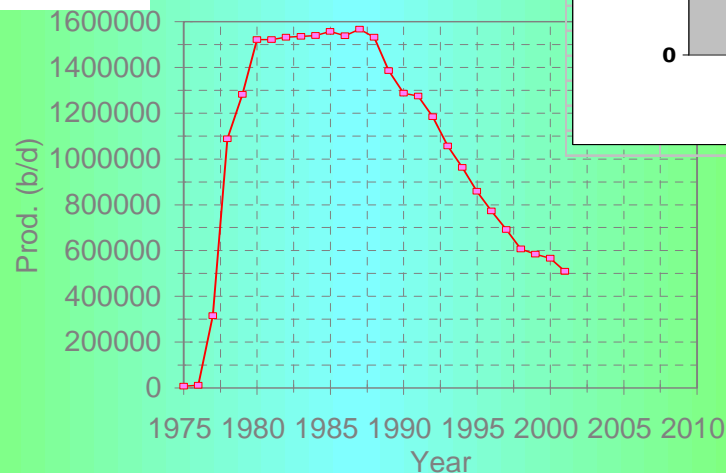
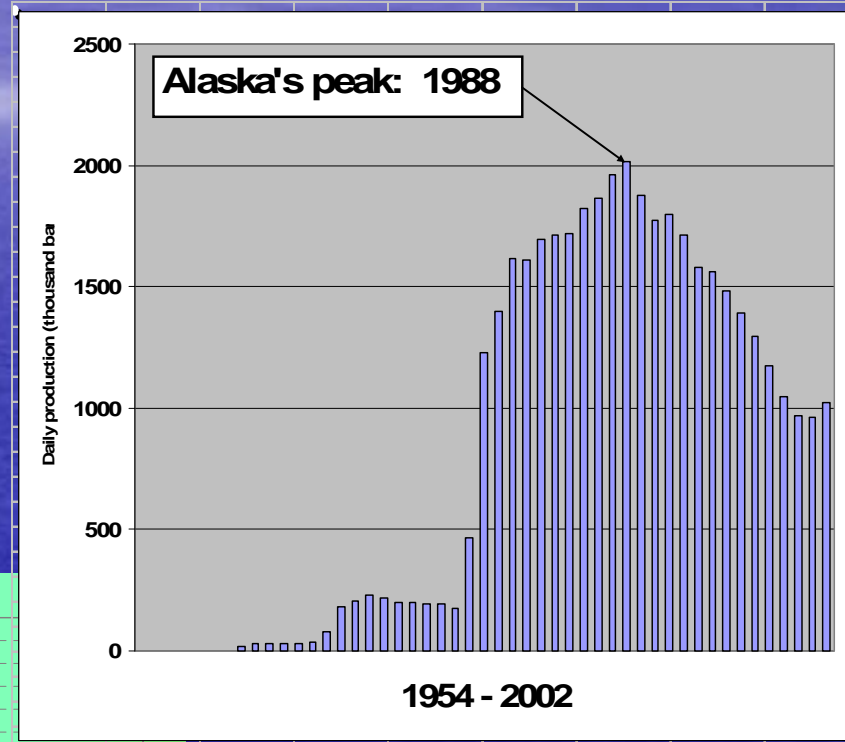
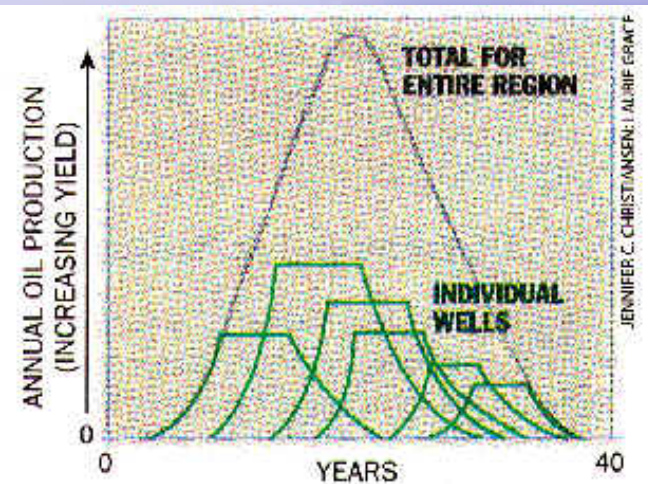
A common frame of reference

- *85 mmb/day – world's daily dose*
- *21 mmb/day – US*
- *14 mmb/day – US transport*
- 9.4 mmb/day – US gasoline
- 0.4 mmb/day ethanol from corn
- ...but 0.3 mmb/day gasoline equivalent



Adaptations/mitigation

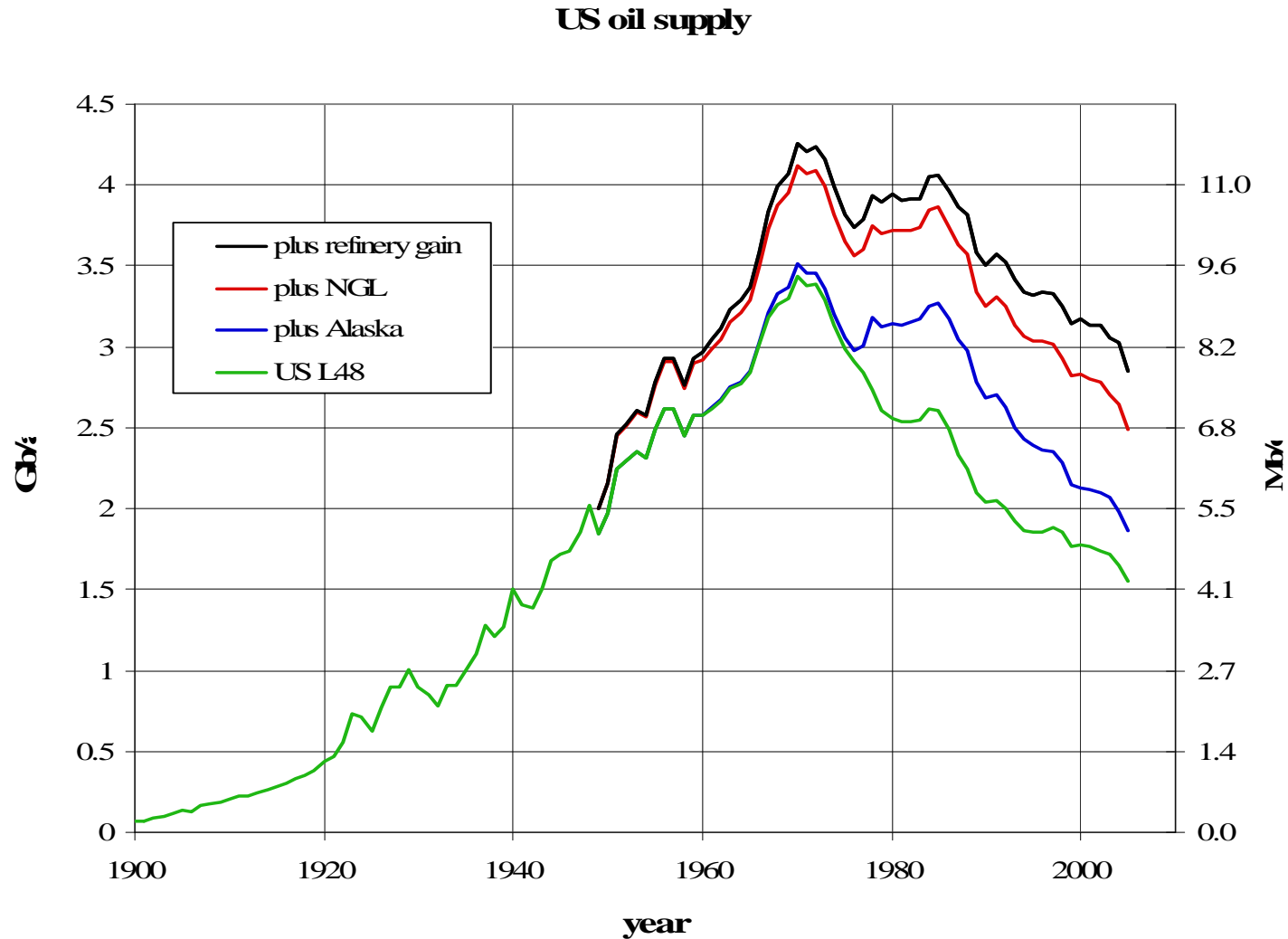
The peak oil basics: fields peak, then regions, then nations..



Prudhoe Bay extraction history

"We're going after the table scraps."

The first nation to hit peak oil; maybe 2/3s gone?

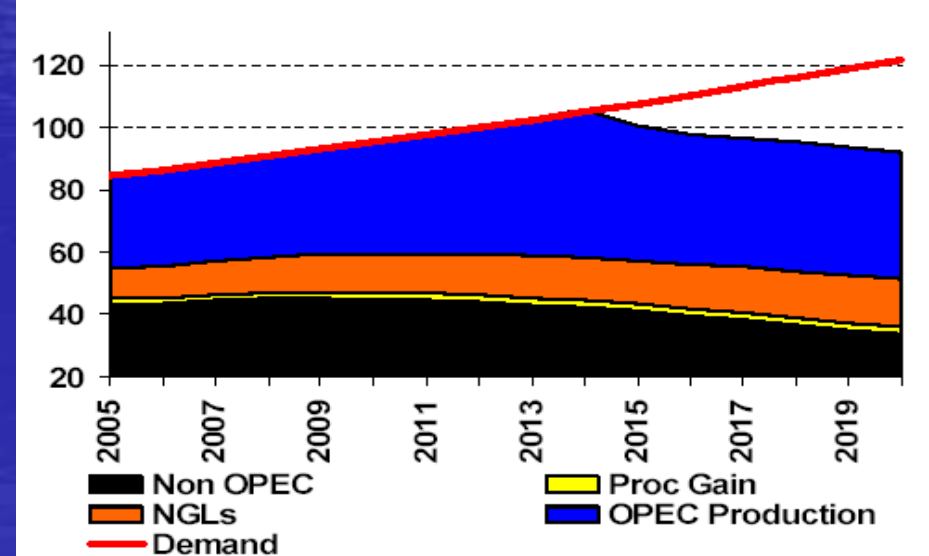
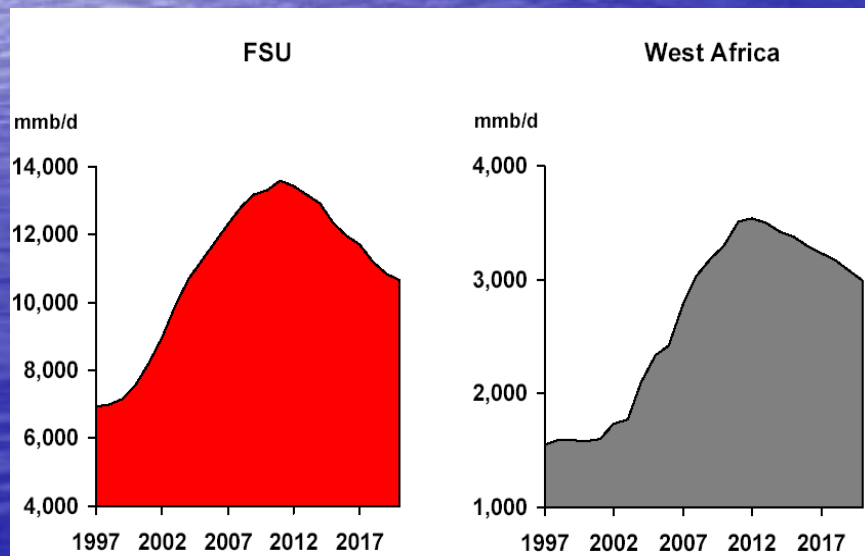
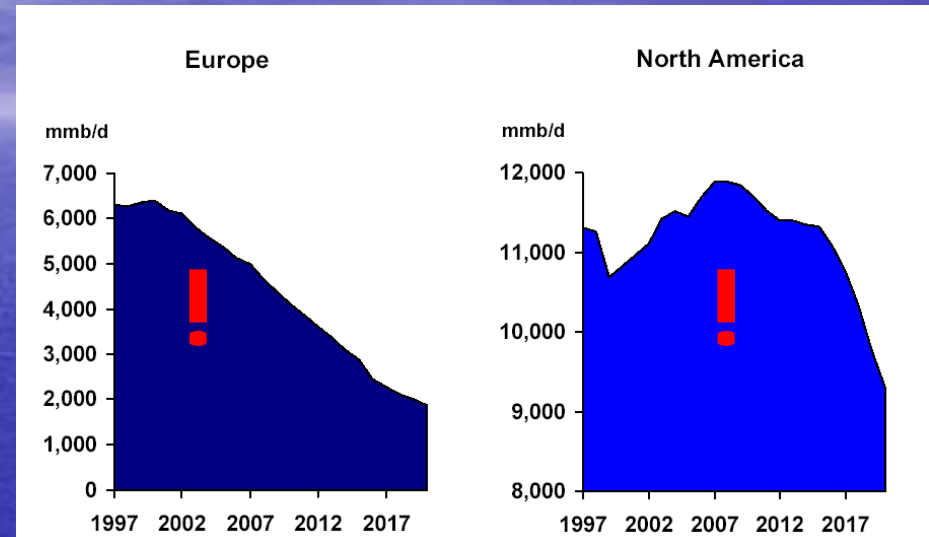
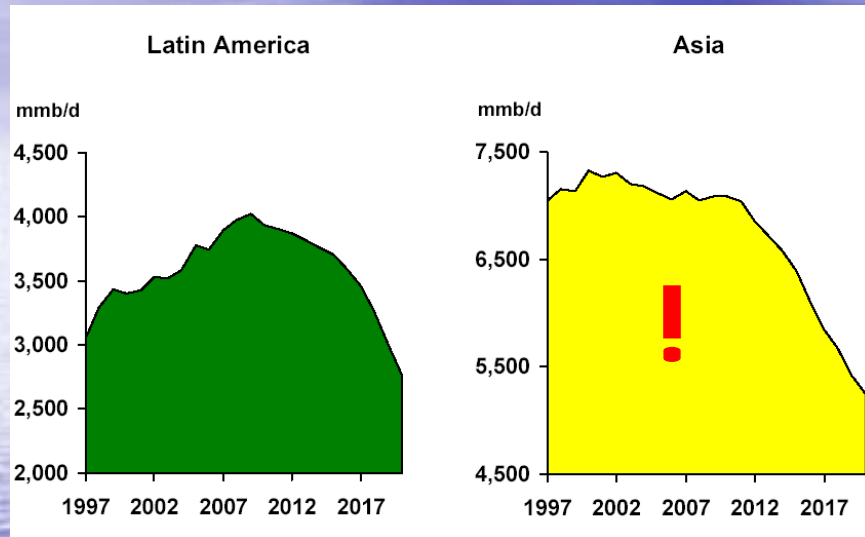


How do you communicate what
“2/3 of something gone” means?



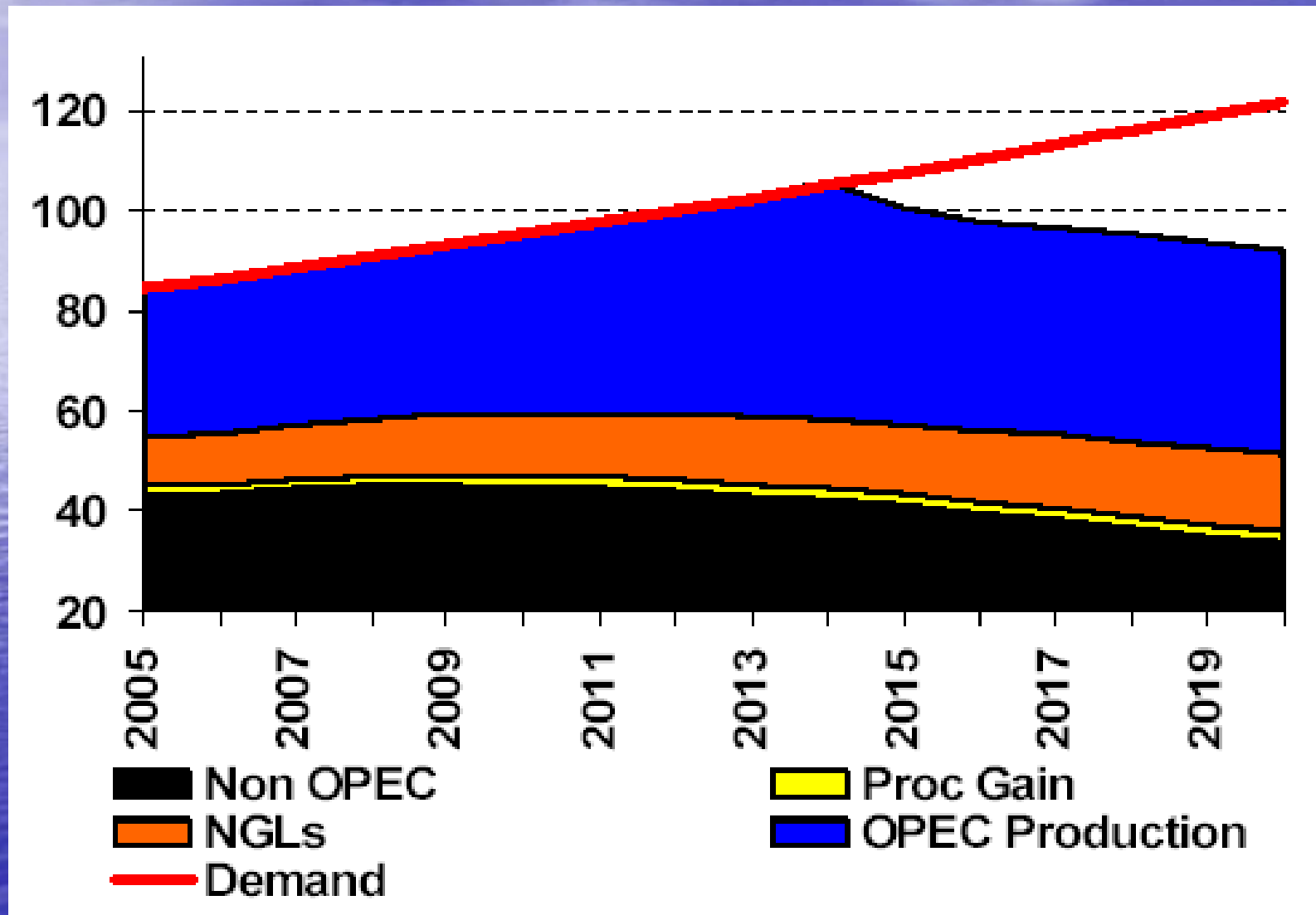
Eventually continents peak...and then the world peaks

[Source: PFC Energy, 2004]





When: add regions and the world peaks



Source: PFC Energy



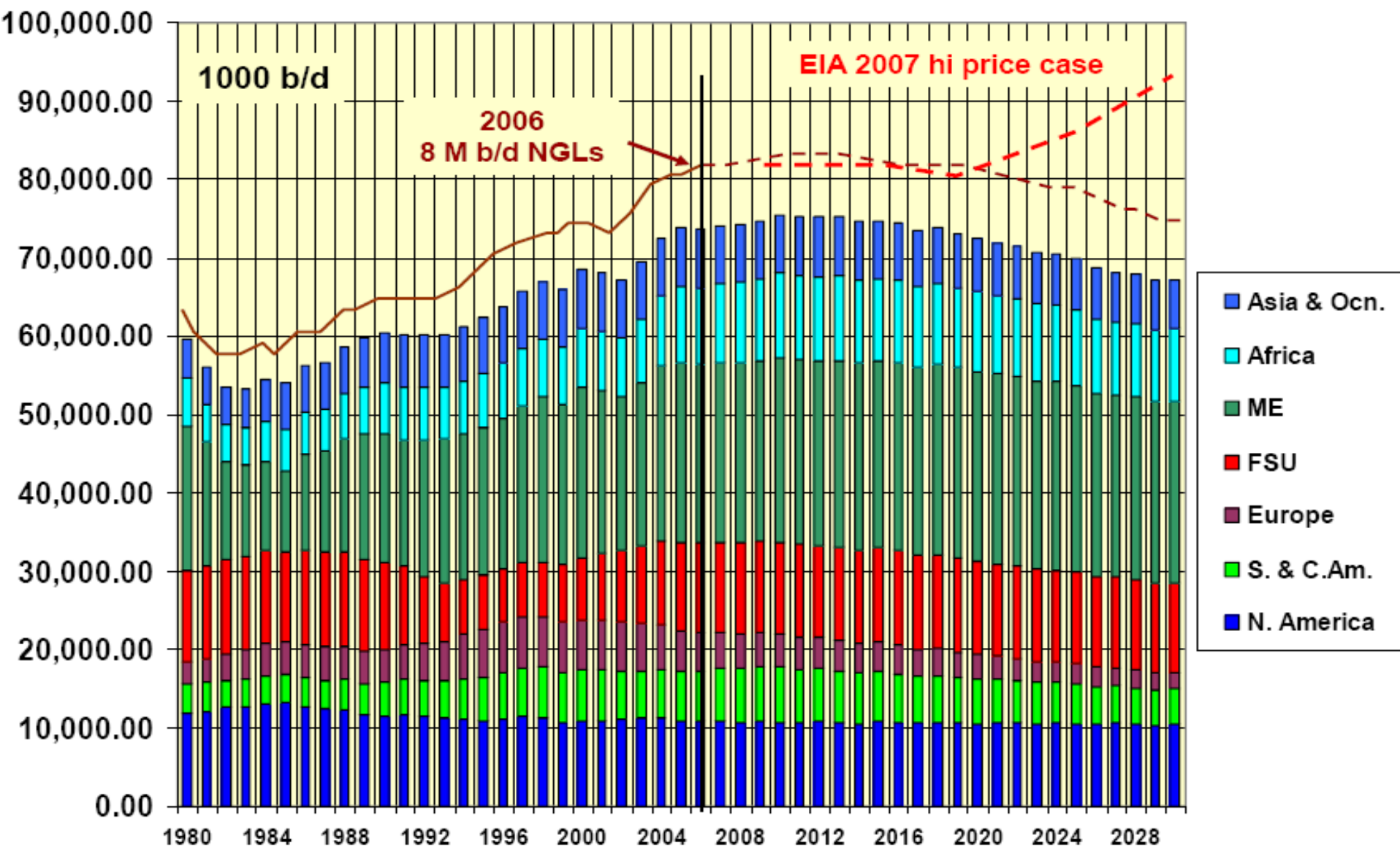
Serious disagreement about the "when" question

- **Matt Simmons, chairman Simmons&Co**
- Dr. James Schlesinger, former Energy S.
- **Sadad al Husseini, Saudi Aramco (ret.)**
- **Tom Petrie, Merrill-Lynch/Petrie**
- E.T. Westervelt et al, Corps of Engineers
- John Hess, CEO Hess Corp.
- **James Mulva, CEO ConocoPhillips**
- **Christophe de Margerie, Total (FR)**
- **Shoki Ghanem, Libya's oil minister**
- **IFP**
- Toyota; Volvo Trucks
- Charley Maxwell, Weeden & Co.
- **Marshall Adkins, Raymond James Assoc.**
- **Prof. X Pang, China's Petroleum University**
- T. Boone Pickens
- **Bob Hirsch, The Hirsch report to DOE**





The total outlook: a 15 year production plateau . . .



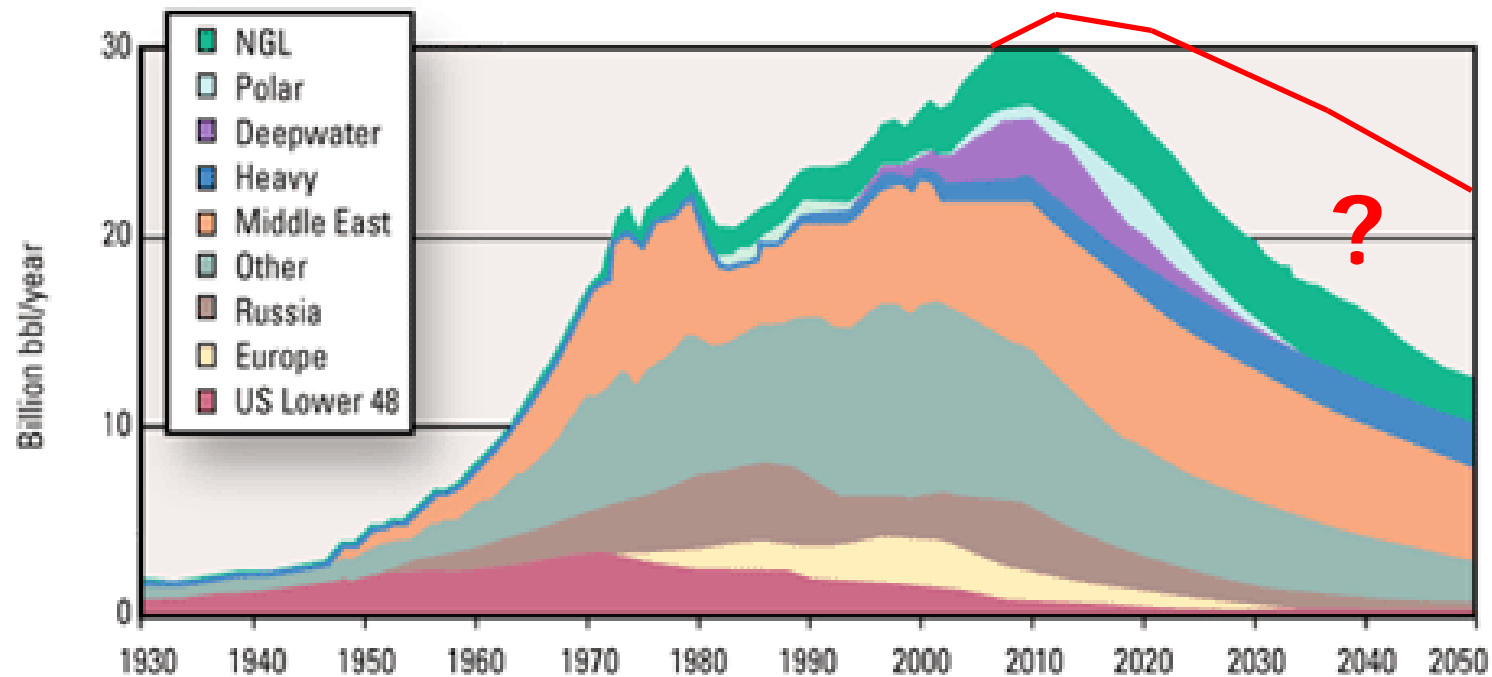
Source: Dr. Sadad Al Husseini, Saudi Aramco, head of exploration and production divisions (retired during 2004); from Oil & Money Conf. talk 10/07



Timing: peak oil happens, 75% probability **between now and 2015**

OIL, NGL PRODUCTION OUTLOOK

Fig. 2

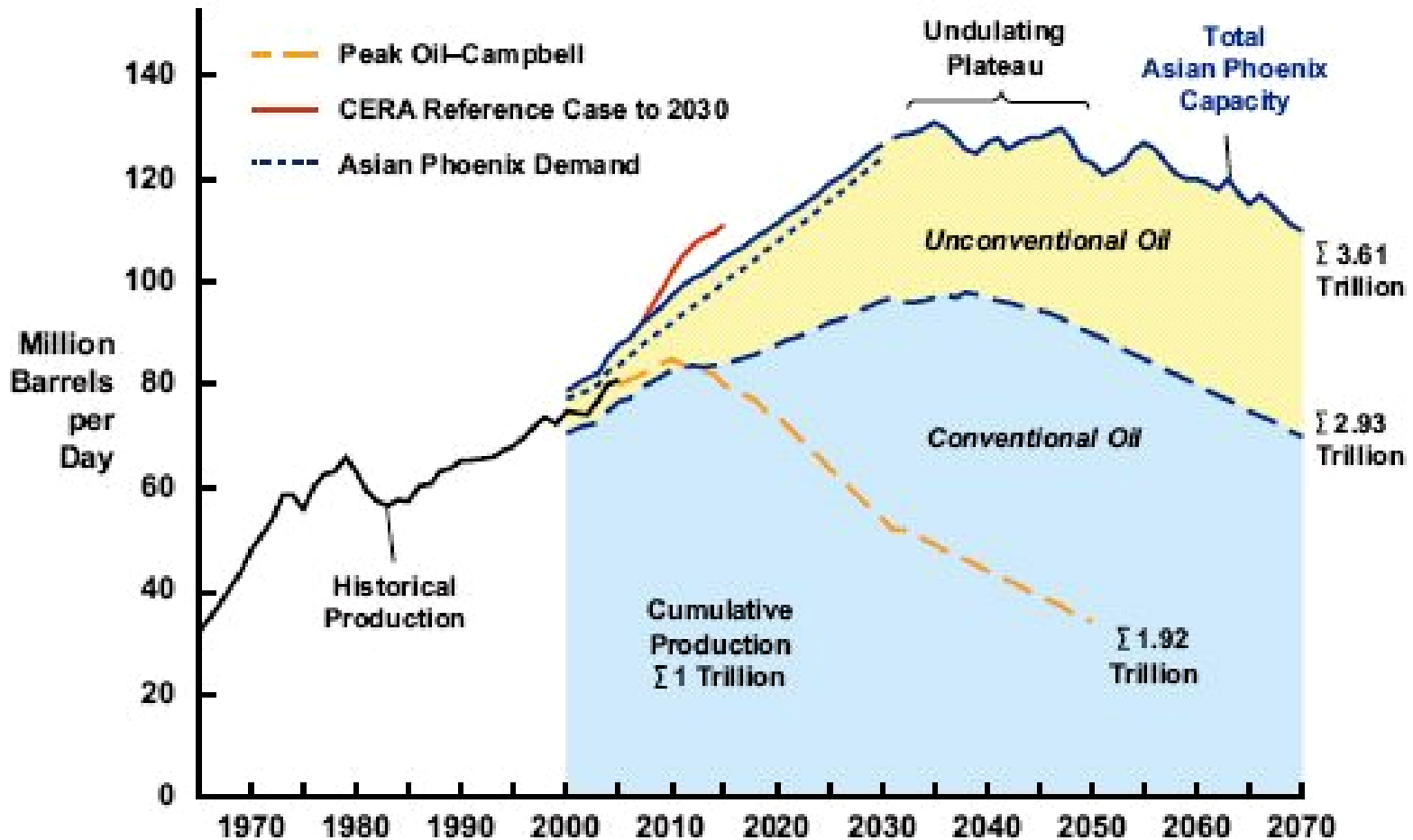


The ASPO production scenario anticipates that regular oil production will be on average flat to 2010 because of recurring recessions and price spikes. Heavy oil production is expected to grow gradually in what is effectively a mining process. Deepwater oil, which is likely to be confined to a relatively small number of areas having the right geology, is expected to peak a year or two later, followed by polar oil, mainly from Siberia. Natural gas liquids track the growing production of gas to plateau and eventual decline



CERA: unofficial leader of the Optimist Club

Undulating Plateau versus Peak Oil



Source: Cambridge Energy Research Associates.
60907-9



10 reasons for peak oil sooner rather than later

1. Geologic *and* non-geologic factors

- M. King Hubbert (1956)—for the big picture
 - There *are* geologic limits
- Numerous other constraints against expanding production



2. Oil is geographically concentrated, and large producers are flagging

Top 21 countries (84%): decreasing

Chart 78: United States Production 1930 - 2006

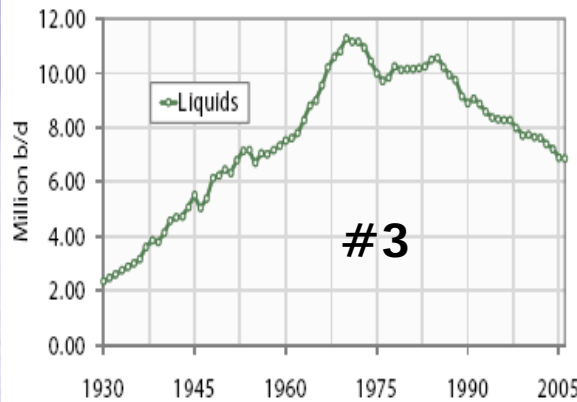


Chart 82: Mexico Production 1930 - 2006

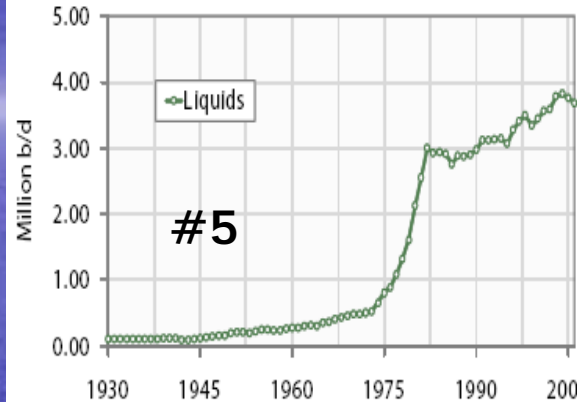


Chart 92: Venezuela Production 1930 - 2006

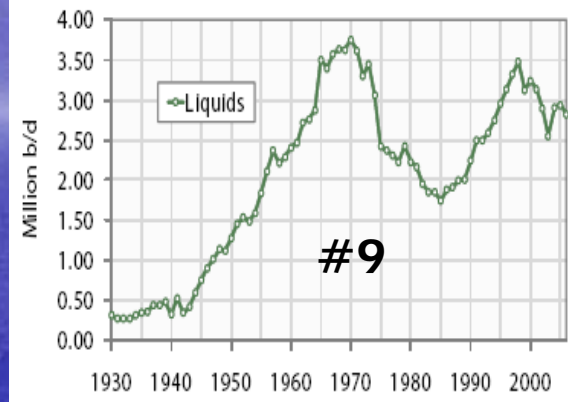


Chart 45: Norway Production 1970 - 2006

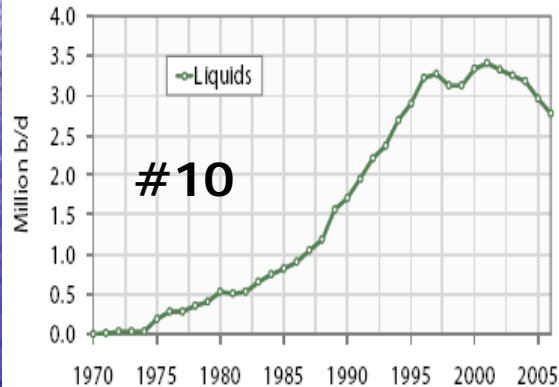


Chart 47: United Kingdom Production 1970 - 2006

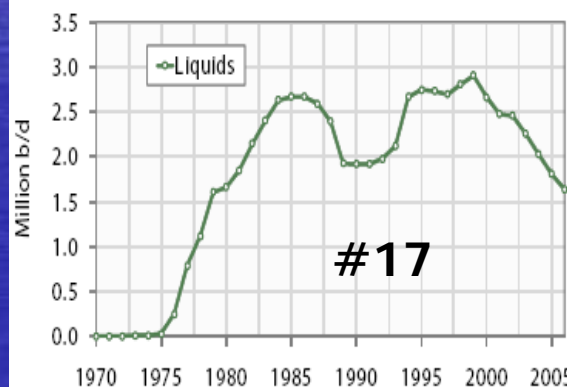
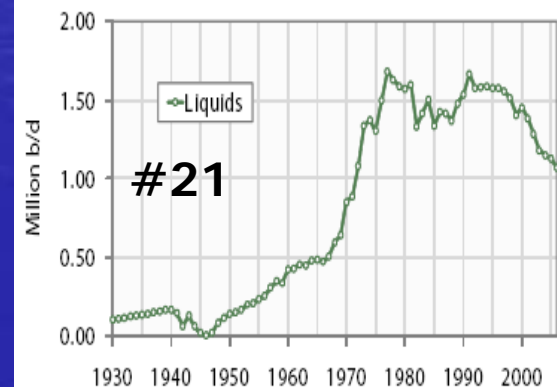


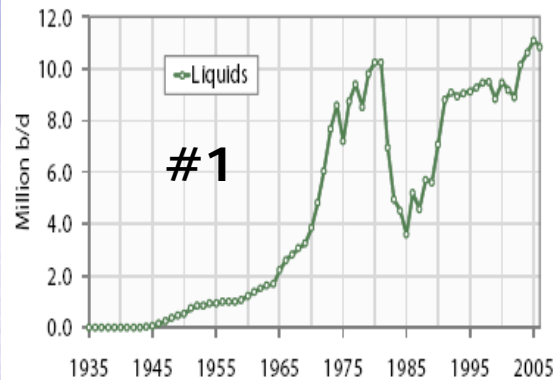
Chart 97: Indonesia Production 1930 - 2006



When half of the 21 are in decline, oil production growth is over

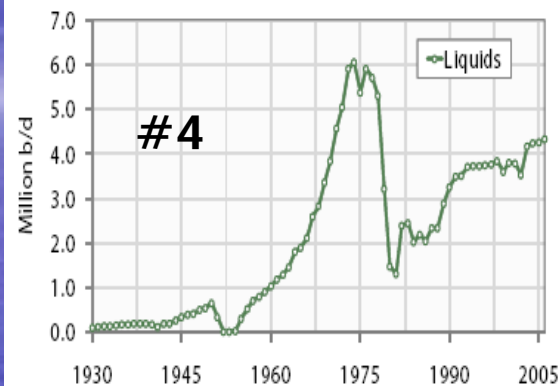
Top 21 countries: volatile or flat

Chart 31: Saudi Arabia Production 1935 - 2006



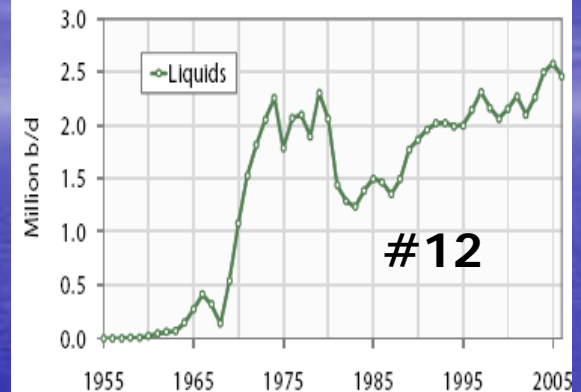
Source: ASPO Ireland & BP Statistical Review

Chart 27: Iran Production 1930 - 2006



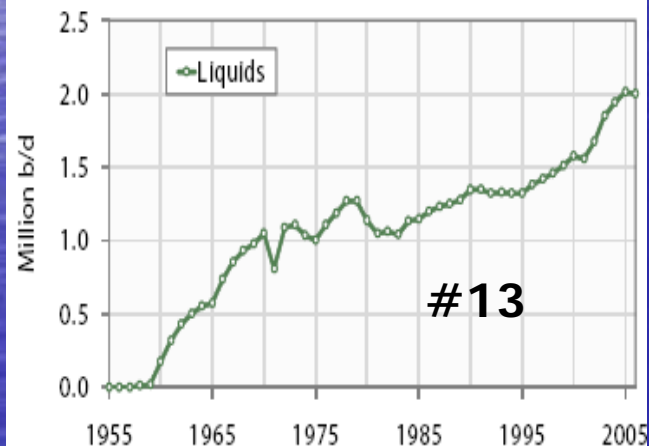
Source: ASPO Ireland & BP Statistical Review

Chart 55: Nigeria Production 1955 - 2006



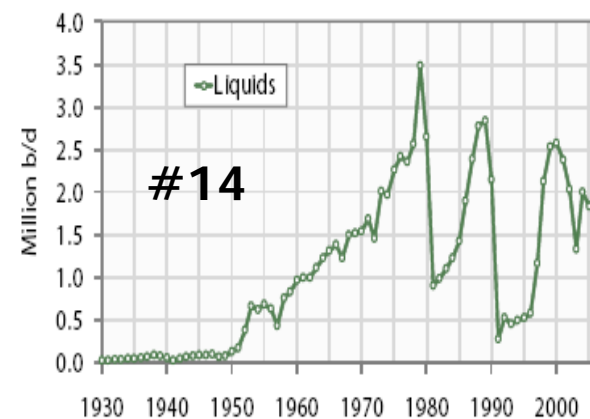
Source: ASPO Ireland & BP Statistical Review

Chart 49: Algeria Production 1955 - 2006



Source: ASPO Ireland & BP Statistical Review

Chart 35: Iraq Production 1930 - 2006



Source: ASPO Ireland & BP Statistical Review

Top 21 countries: increasing

Chart 68: Russia Production 1955 - 2006

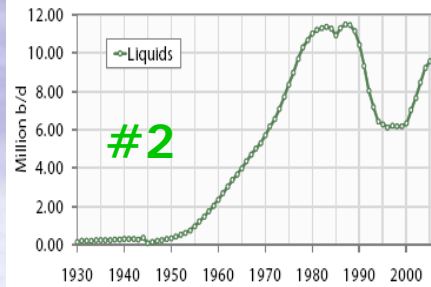


Chart 70: China Production 1950 - 2006

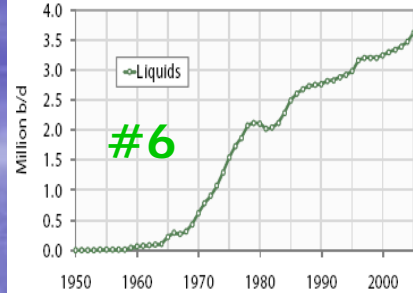


Chart 80: Canada Production 1945 - 2006

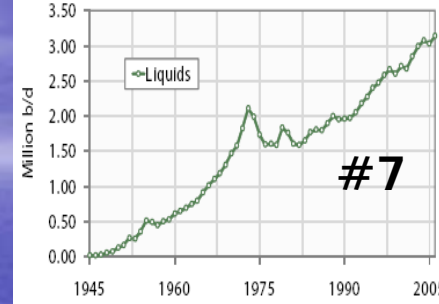


Chart 33: UAE Production 1960 - 2006

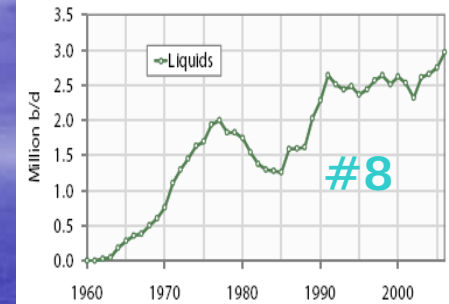


Chart 25: Kuwait Production 1945 - 2006

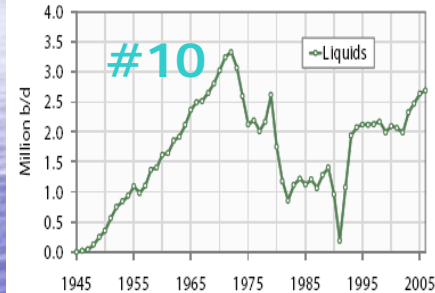


Chart 53: Libya Production 1970 - 2006

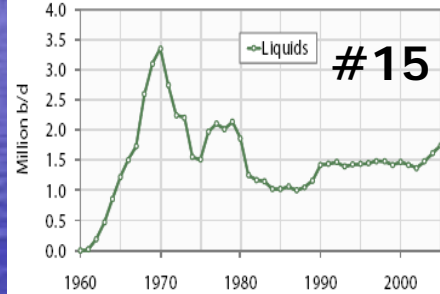


Chart 86: Brazil Production 1955 - 2006

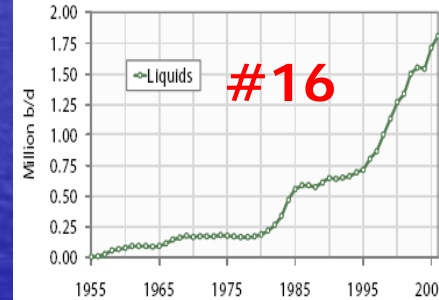


Chart 66: Kazakhstan Production 1940 - 2006

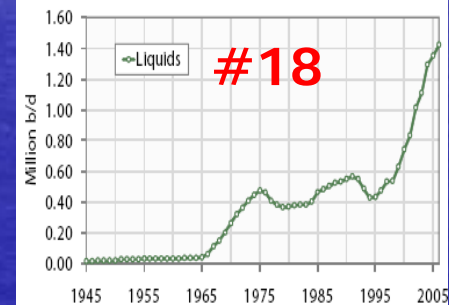


Chart 51: Angola Production 1960 - 2006

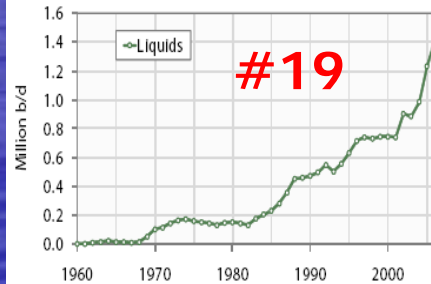
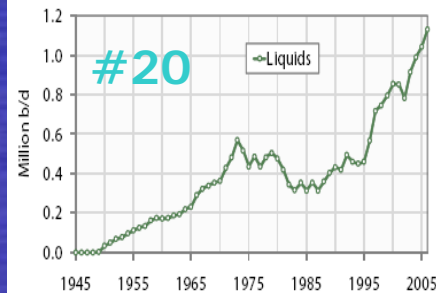


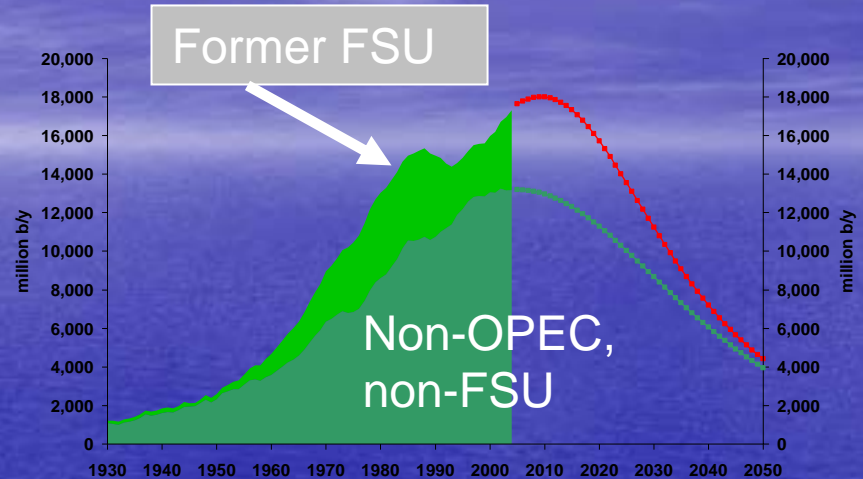
Chart 29: Qatar Production 1945 - 2006





3. Non-OPEC to peak soon

- Everyone agreed at National Academy of Sciences peak oil workshop (Oct 20-21, 2005)



4. Most oil in Middle East; risks abound

- Their resource for expanding production is there, but *they are rethinking the needs of their grandkids*





5. Production from *non-Gulf* OPEC won't do the job

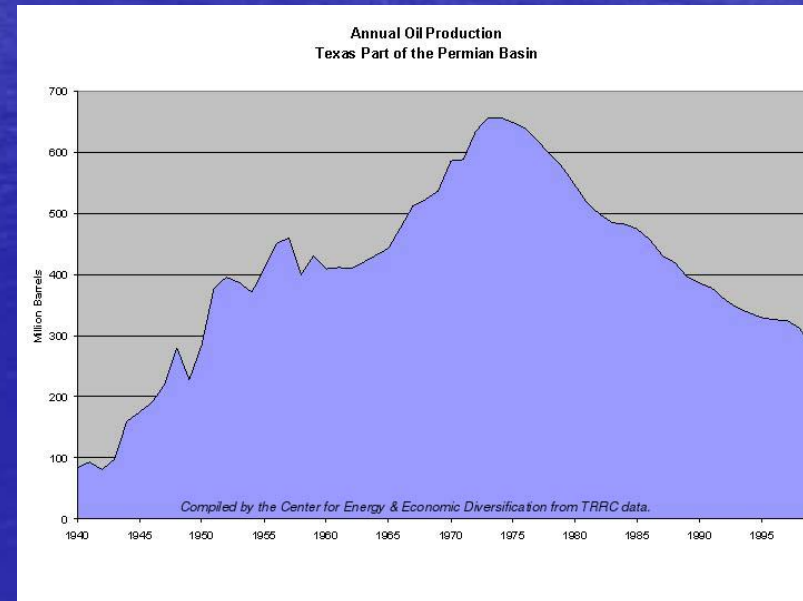
- Venezuela, Nigeria, Indonesia = declining
- Angola can't do it alone



6. Relentless depletion

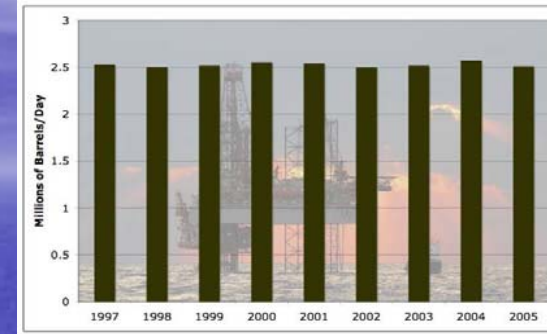
- If world average decline rate is 5%, we lose 4.2 million barrels/day per year
- If true, we'll need 27 mbd new by 2015 just to offset depletion

NOT “running out”



7. National Oil Companies hold the cards

- Roughly 80% of the world's oil
- World energy power flex – Russia
- Project delays now *increasingly* the norm



8. Discovery rates falling

- **The big easy oil is gone (Chevron)**
- Discovering less than we are producing every year since the mid-1980s

9. Domestic consumption in exporting countries will play a growing role

- 2007 Russian consumption increased faster than production increased, so exports dropped (prelim.)
- Iran, Mexico, Venezuela in worse situation



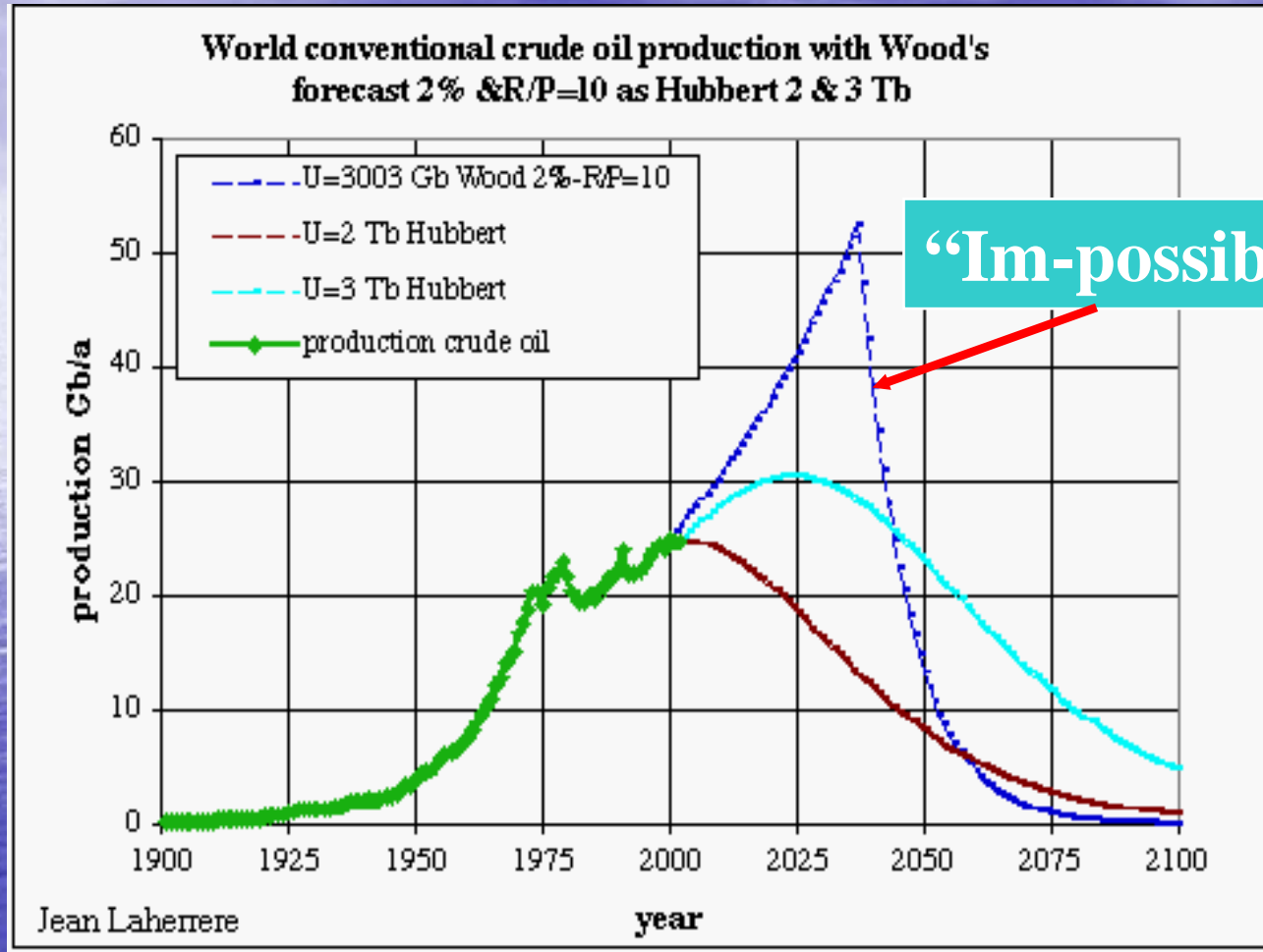
Peak exports *before* peak oil?

Chart 18: World Liquids Exports Estimate Jan. 2002 - Sept. 2007

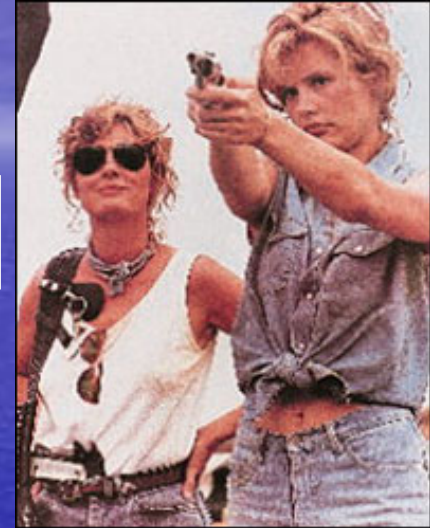


Source: derived from the IEA, EIA and JODI Database

Bad data = bad decisions



“Im-possible”



The US Energy Information Admin. is the least responsible player in this debate, because either they won't tell truth to power or they're incompetent



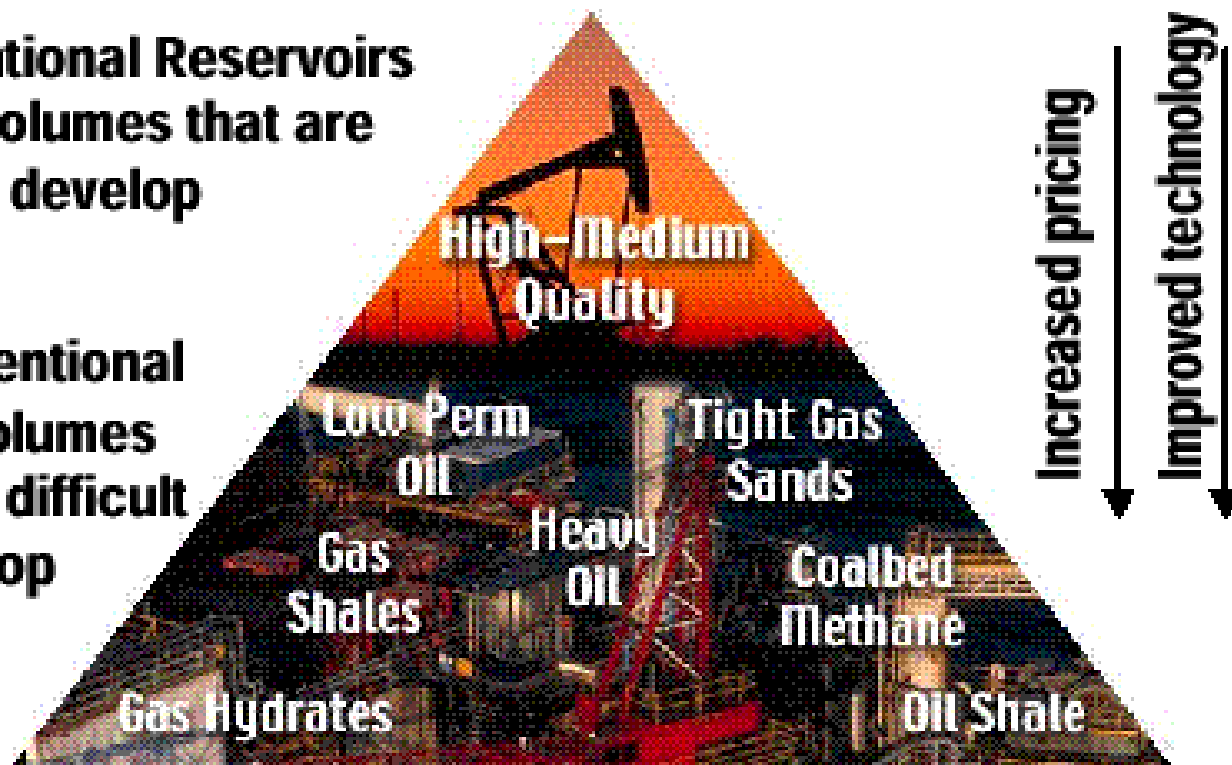
10. Unconventional petroleum resources won't impact peak

- Not all barrels are equal (“oil shale” is way different from tar sands, conventional oil)
- Development is uncertain, expensive, technically arduous and slow
- Other issues
 - Timing of flow--mostly post-peak?
 - Rates of flow—can *slow* but not *offset* declines
 - Carbon/environmental footprint
 - Demand for power, other infrastructure
 - Net energy

Resource Triangle

Conventional Reservoirs
Small volumes that are
easy to develop

Unconventional
Large volumes
that are difficult
to develop



1. Rates of production are slower (solids vs. fluids)
2. "Net-energy production" is drastically lower

Timing and a peak in world oil production by 2015 or so: how fast can substitutes arrive?



- Efficiency (US): 1.0 – 1.5 mmb/day by 2015
- Oil from sands: 0.5 – 1.2 mmb/day more by 2015
- Gas-to-liquids: 0.3 to 0.4 mmb/day (foreign source)
- Ethanol (US corn): up to 0.35 mmb/day more
- Coal-to-liquids US: 0.1 to 0.3 mmb/day
- Biodiesel US: 0 to 0.1 mmb/day
- Electricity* US: for PHEVs: 0 to 0.2 mmb/d
- Oil from shale US: 0 to 0.1 mmb/day
- Hydrogen: zero (25 fueling stations today)
- **Mode shifting US: 1 to 2 mmb/day**

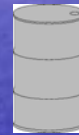
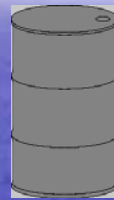
*Sources: S. Andrews' estimates, based on public info; * = plug-in hybrids*



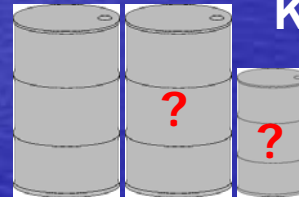
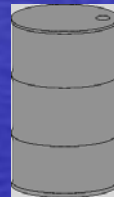
Energy balance (EROI) is really important

Input

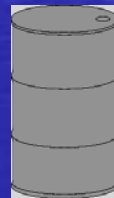
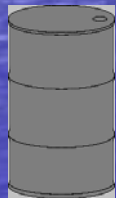
Output



Ethanol from corn



Kerogen from marlstone;
oil from tar sands SAGD



U. S. oil industry today

*Impacts and
form matter*





Net Energy; also known as “Energy Returned on Energy Invested”

- Texas oil 1930: 100 to 1
- US oil 1970: 30 to 1
- Wind today: 18 to 1
- US oil today: 15 to 1
- Ethanol (Brazil) 8 to 1
- Coal to liquids, gas to liquids: 5-1 (est.)
- Oil sands SAGD: 3 to 1 (mining = higher EROEI)
- Oil shale: 3.5 (Shell's fig.) to 2.0 to 1
- Ethanol from corn 1.5 to 1 (ave. gov't figures)
- Electricity from coal: 0.35 to 1
- Solar (6 to 1?), nukyalur? cellulosic ethanol? H2?

Many of these have ranges. Wind and solar vary with location. Ethanol from corn varies from irrigated to non-irrigated crops. Primary source: Cutler Cleveland, Boston Univ.

Leave you on an up note; you folks *can* do what we didn't.



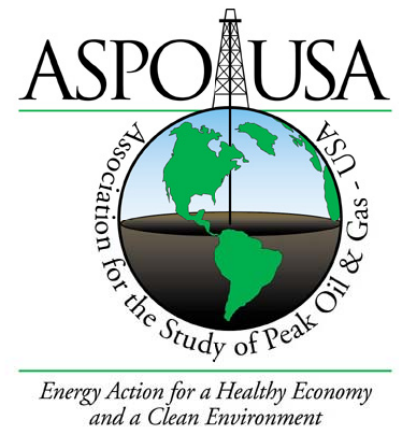
sbandrews@att.net

www.aspo-usa.com

Peak Oil News (daily; free)

Peak Oil Weekly (weekly; free)

ASPO-Sacramento conf (Sept 21-23)



ASPO-USA's Blueprint for Action

- Education (describe the problem; get better data; BBs vs. bullets; smarter land-use planning, etc.)
- Efficiency
- Electrification of transportation
- Change price signals and incentives (e.g. feebates)
 - Use science-based analysis during selection
 - Do the hard math on “oil shale,” CTL, GTL, etc.
- Renewables
- EOR
- Cellulosic ethanol: prove this up fast, or else...
- *We have* to talk about role of population growth

Renewables *must* be the future

- ...by definition
- But timing/scale a challenge
- Is electricity from renewable energy yet offsetting new load to the grid?
- After that, *then* liquid fuels displacement (for the transportation sector)
- Must be paired with smarter mass transit
 - E.g., lanes or trains to the hills

