

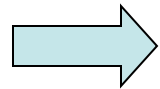
The Impending Decline of World Oil Production & What It Might Mean

Robert L. Hirsch, PhD
Senior Energy Advisor
Management Information Services, Inc. (MISI)
USAEE
December 17, 2010.

Messages

- In 2-5 years world oil production will begin to decline & will continue downhill.
- There will be no quick fixes. Oil shortages will increase annually until mitigation takes hold, more than a decade later.
- Annually declining world oil production will mean increasing economic distress.

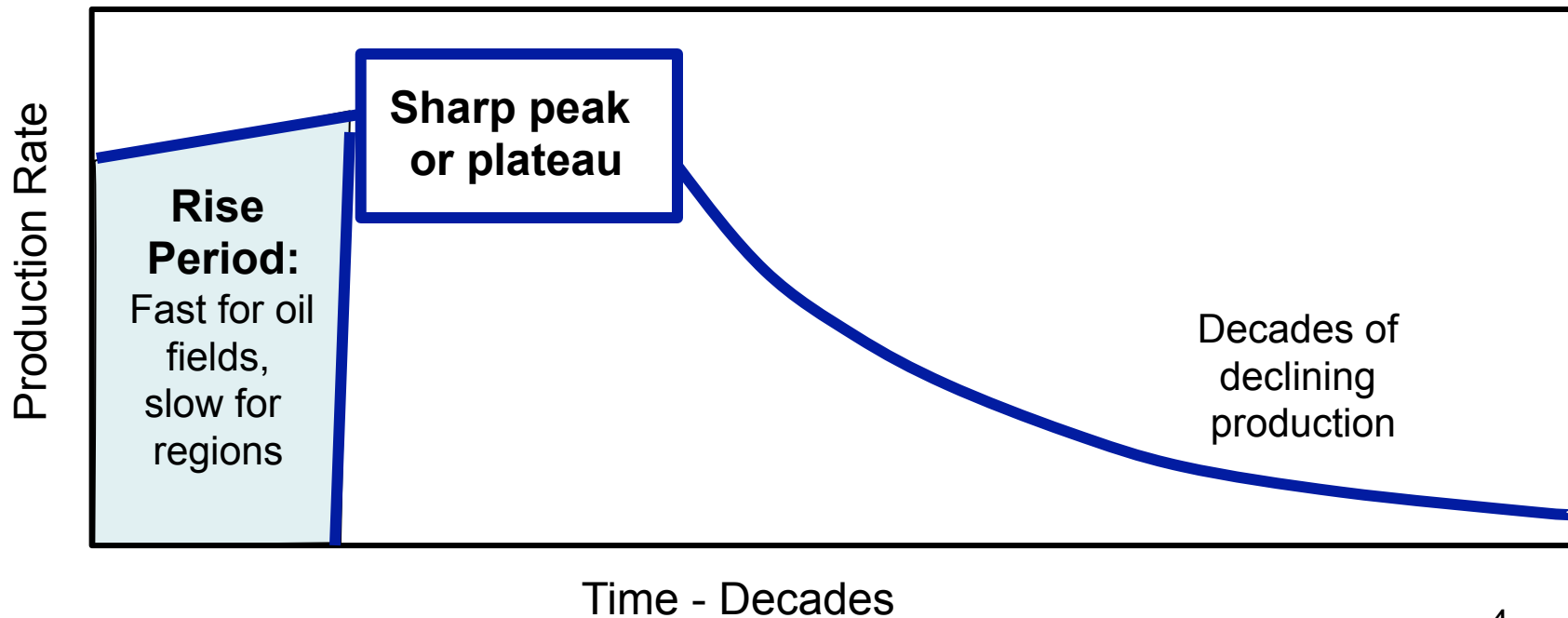
Topics



- **Some basics**
- **Forecasts**
- **Mitigation**
- **Economic impacts**
- **Take-away points**

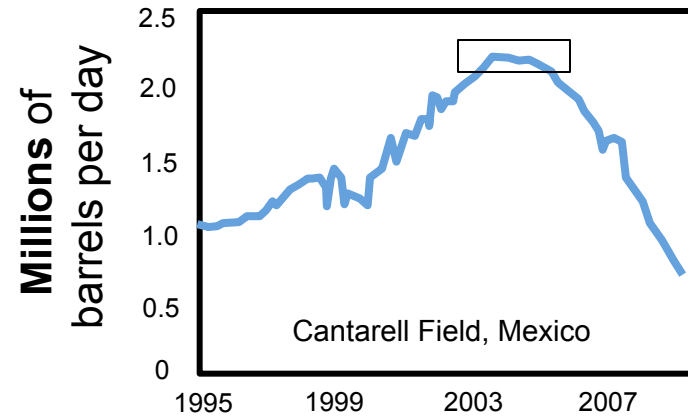
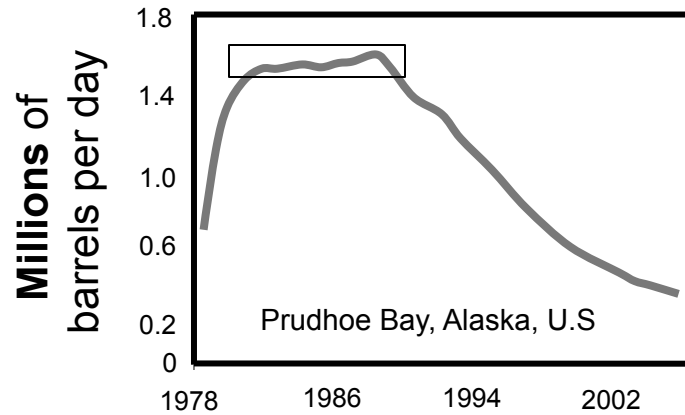
Basics

- Oil is a finite resource, which is being rapidly depleted.
- Oil production in oil fields, countries, & regions behave similarly, which is different than we are accustomed to outside the oil industry.

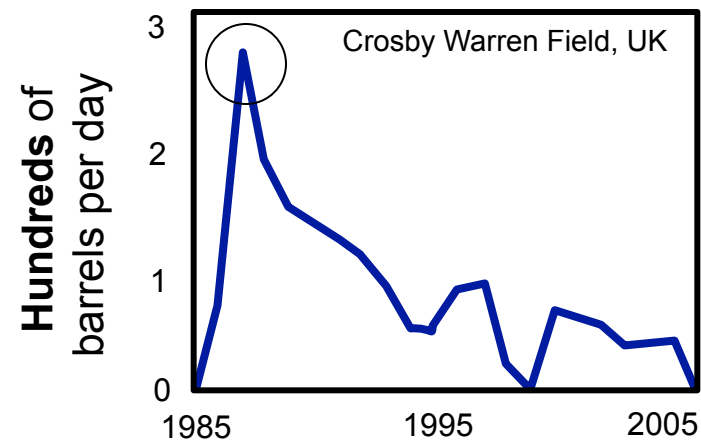
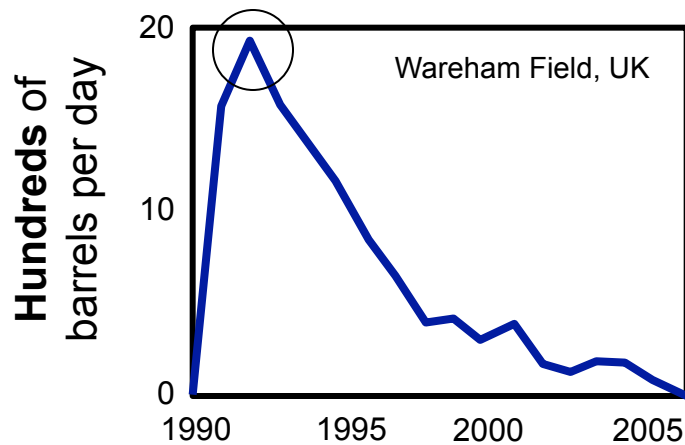


Some Oil Field Production Profiles

Plateau Production



Peaked Production



Large numbers can be misleading.

Ten billion barrels (10 B bbls)

of reserves can yield roughly

One million barrels / day (1 MM bpd)

of production at best for a decade or so.

The world now consumes ~ 85 MM bpd.

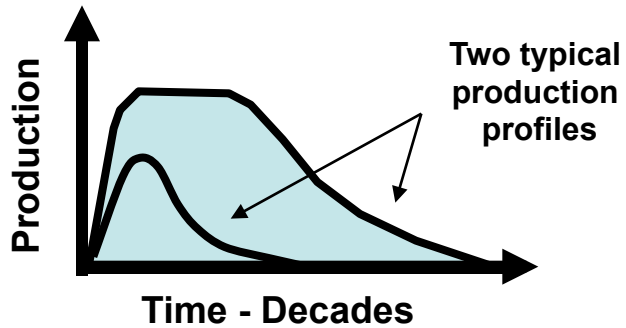
A 10 billion bbl oil field might provide ~ 1% of world needs before decline sets in.

Small numbers can be misleading.

5% decrease in U.S. oil supply → Recession (1973)

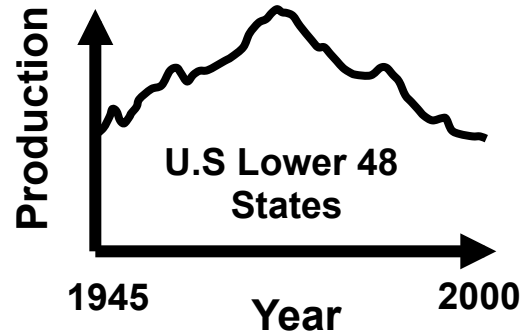
1% of world oil consumption is huge ~ 860,000 barrels/day

**Oil fields peak or plateau
& then decline.**



**World oil production
decline is inevitable.**

**Countries peak
or plateau &
decline
(Many oil fields)**

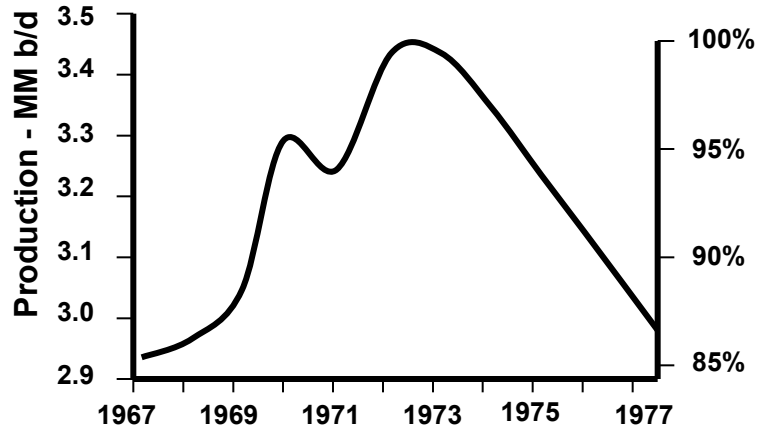


**The world
will peak or
plateau &
decline**

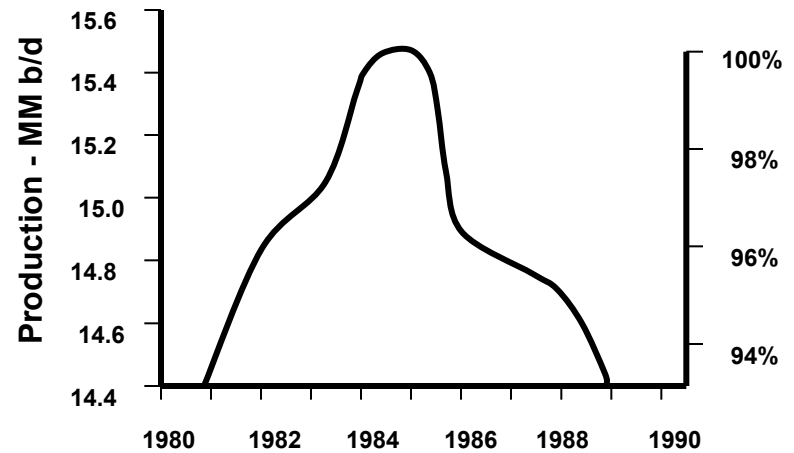


Examples of Sharp Regional Oil Peaking

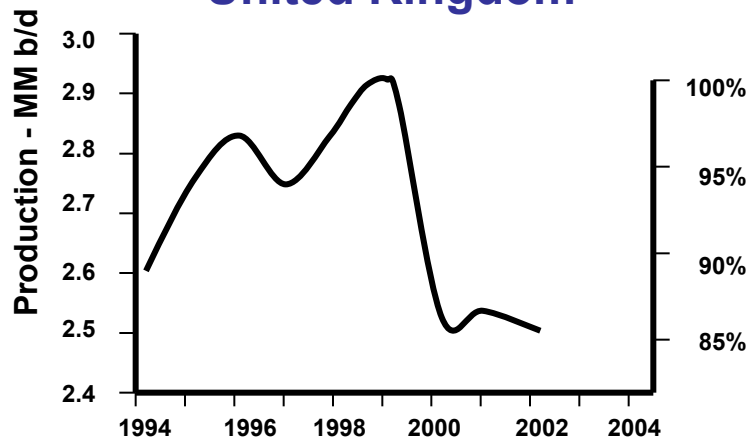
Texas



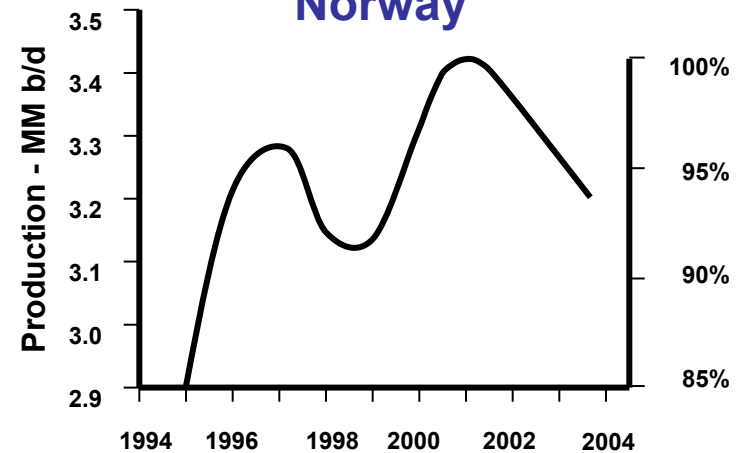
North America



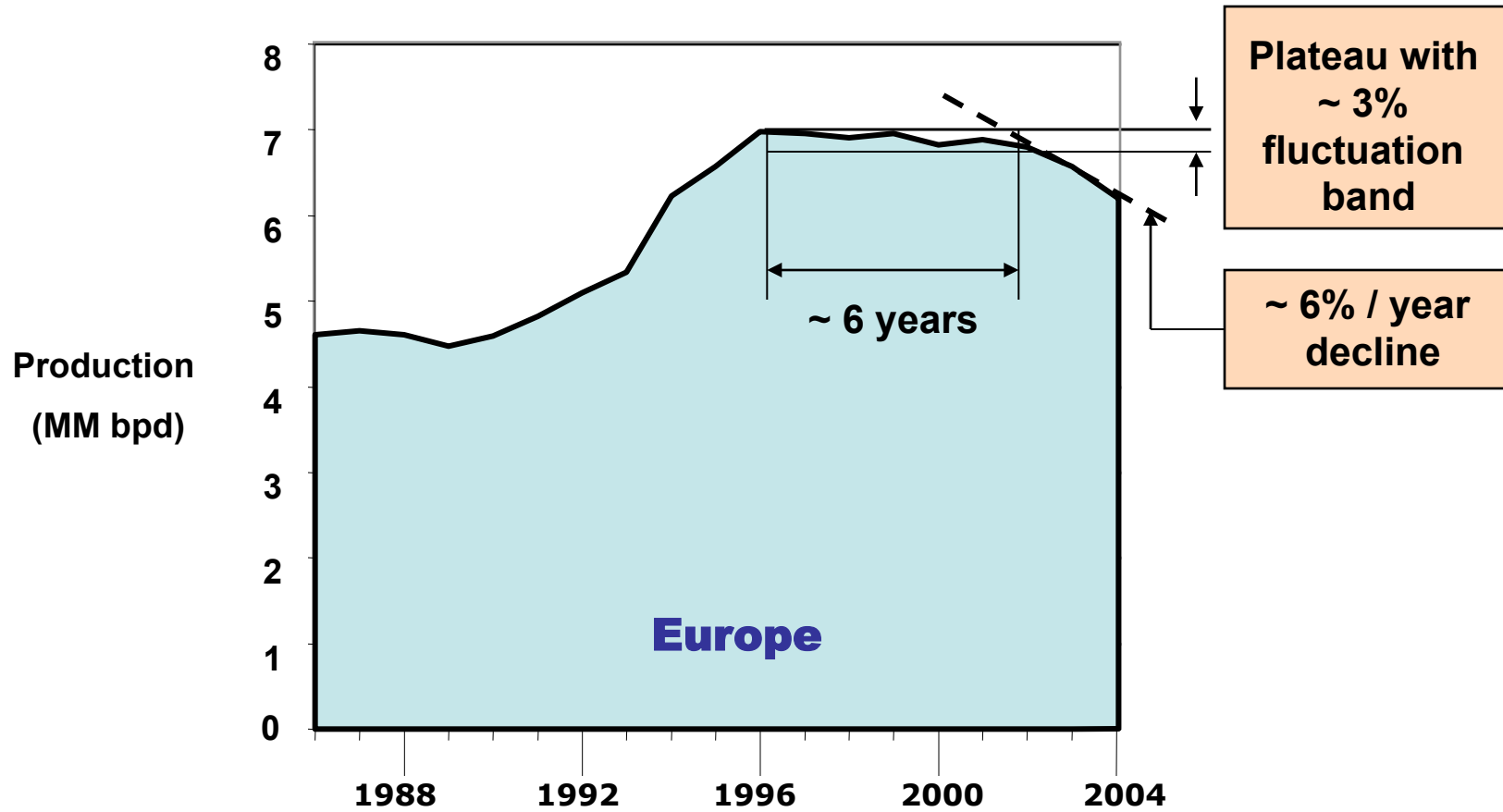
United Kingdom



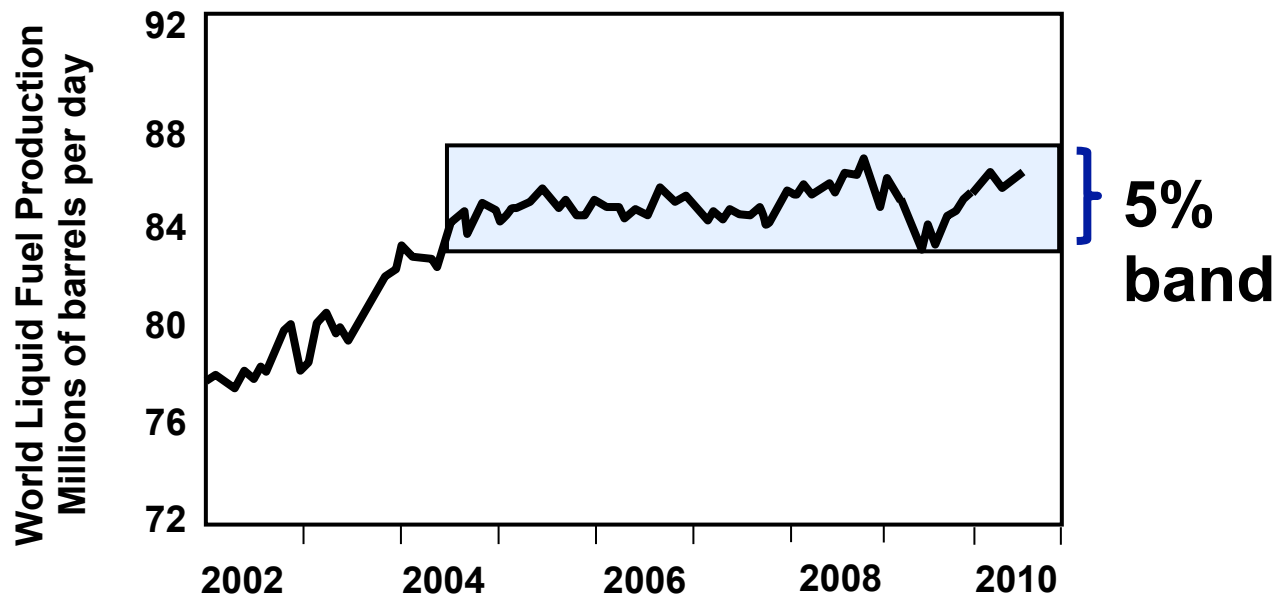
Norway



Sometimes production plateaus before decline.

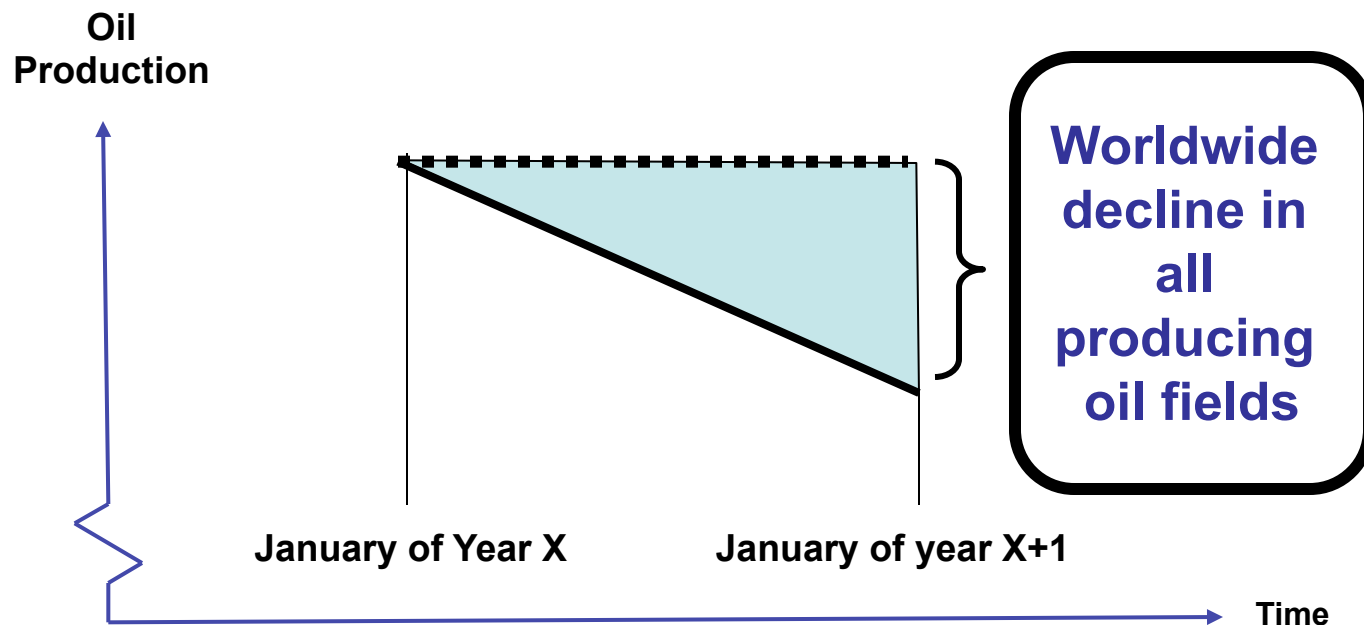


World oil production hit a plateau in mid 2004 & stayed in a narrow fluctuation range.



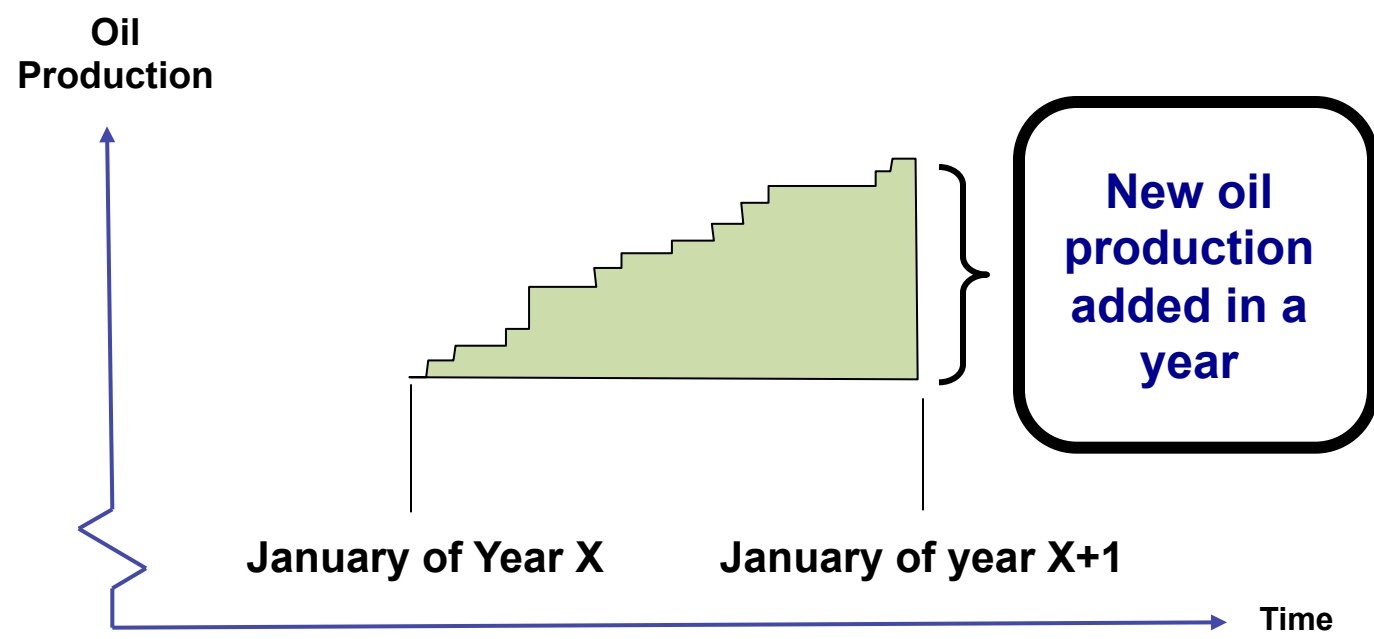
Who predicted this?

The majority of the world's oil fields are in decline, which means production from those fields is less at the end of a year than at the beginning.

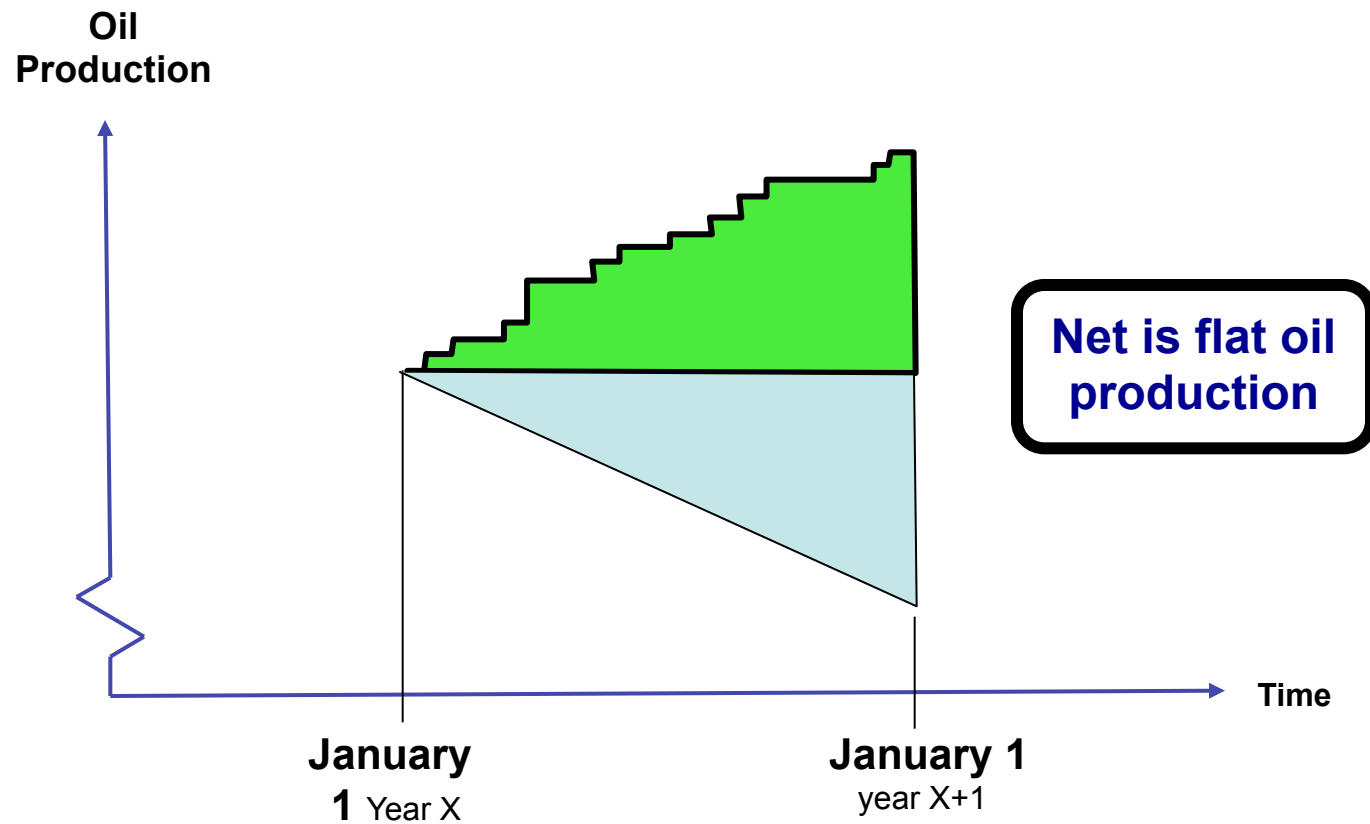


**IEA estimates the decline rate of existing world oil fields to be $> 5\%$.
At 85 MMbpd, that's a decline of > 4 MMbpd.**

Part of new oil production offsets decline in existing oil fields.

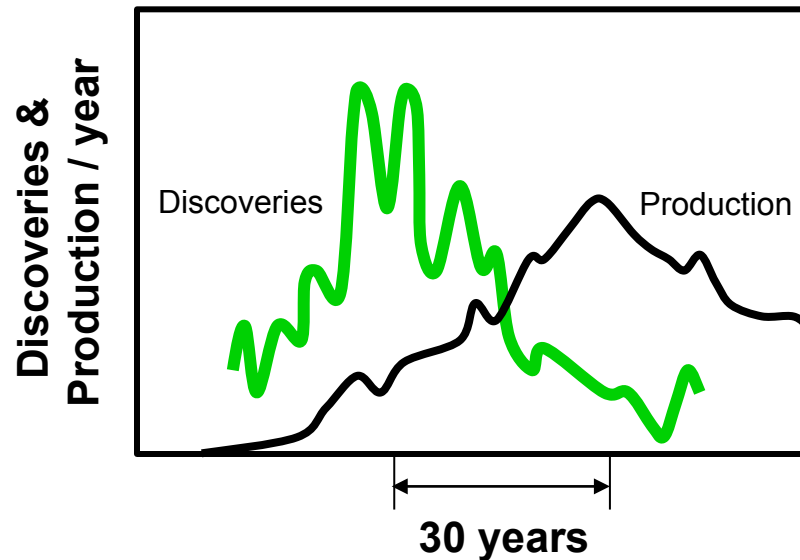


**Recently, new production has just made up
for declines in existing oil fields.**



Obviously, we have to find oil before we can produce it.

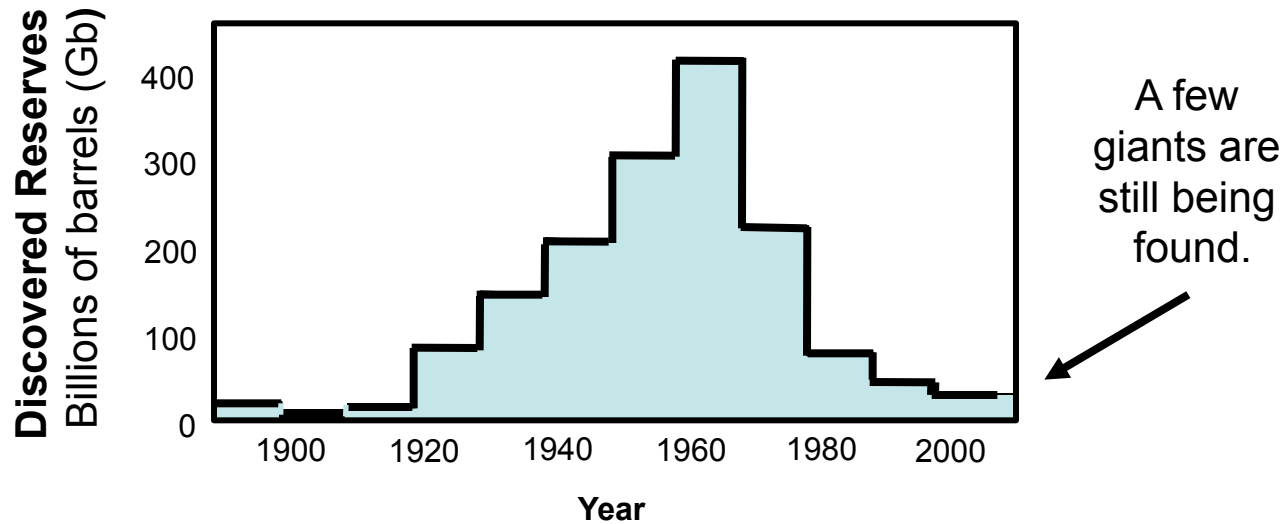
Oil Discoveries & Production in the U.S. Lower 48 States.
It's similar in other regions.



The peak of discoveries was followed by a peak in production about 30 years later.

World Giant Oil Field Discoveries

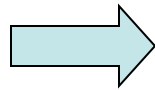
- 10 year averages
- Giant fields provide 60% of all conventional oil.



We're living on past discoveries.

Topics

- **Some basics**
- **Forecasts**
- **Mitigation**
- **Economic impacts**
- **Take-away points**

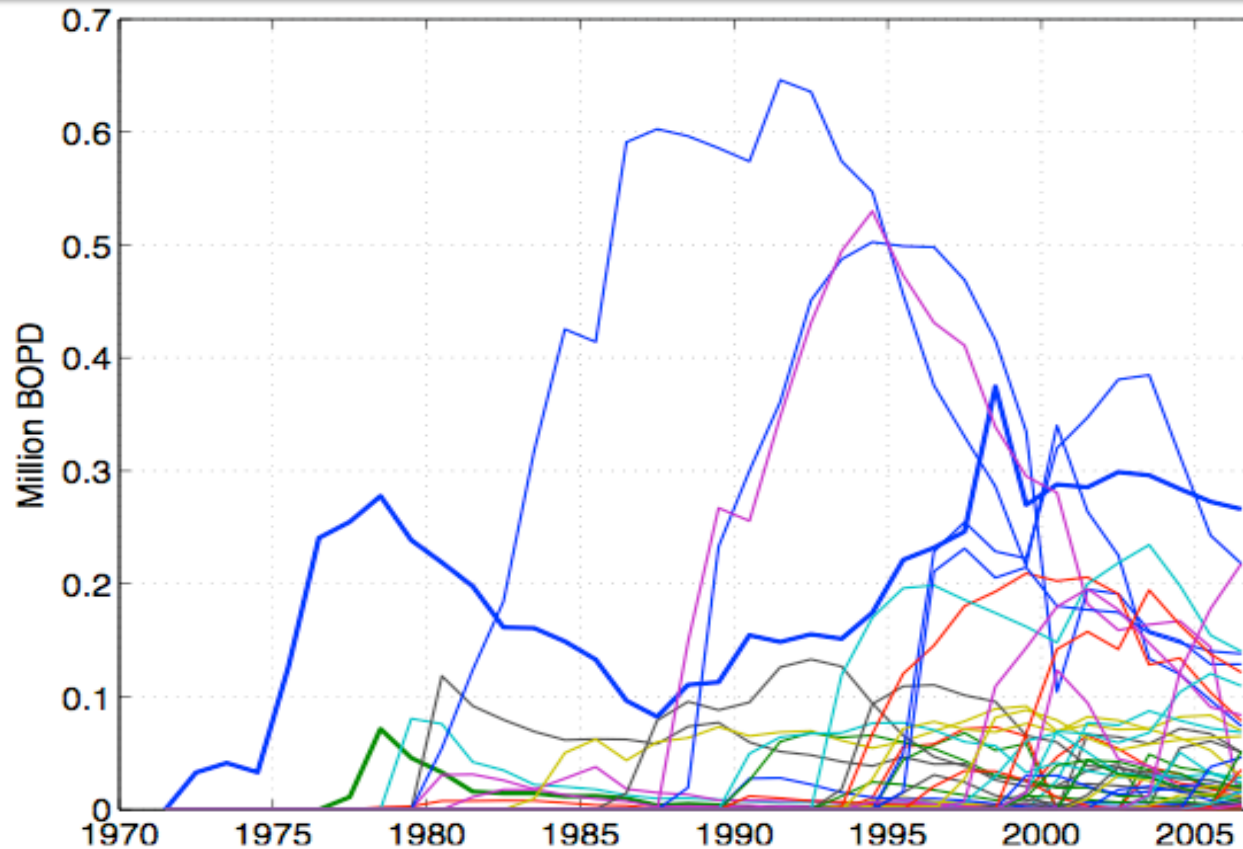


Methods for Analyzing & Forecasting Future World Oil Production

- **Hubbert approaches**
- **Creaming curves**
- **Detailed oil field studies**
- **Detailed country analyses**
- **Megaproject studies**
- **Expert opinion**

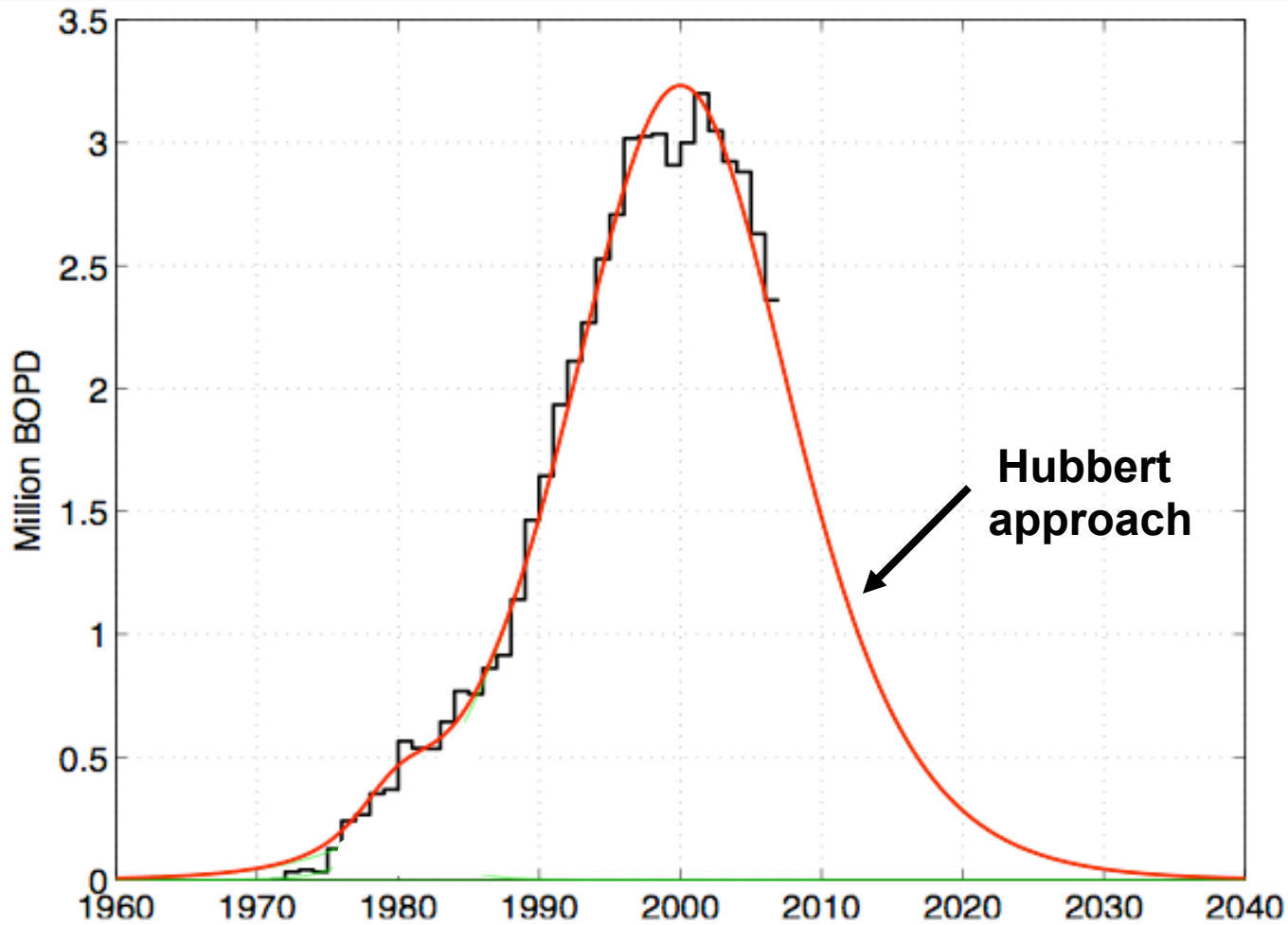
A number of approaches yield roughly similar forecasts.

An Example of the Complexity: Production History of 65 Norwegian North Sea Oil Fields



Patzek, T. University of Texas. 2010.

**Overall, the sum total often fits a simple curve:
Norwegian North Sea Oil Production**



Expecting World Oil Production Peaking and/or Decline Now or Soon

Statements & positions vary.

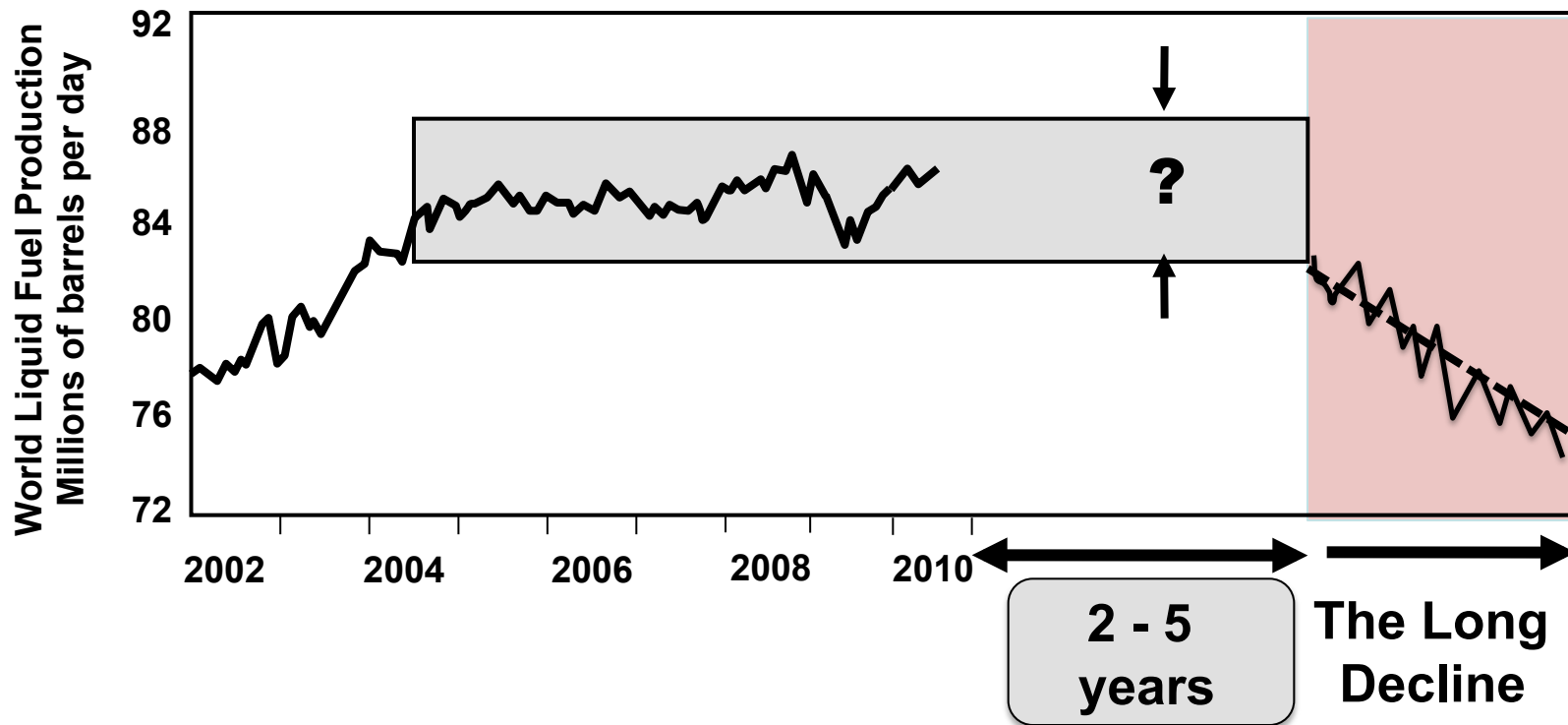
- IEA
- Chevron
- Shell
- Total Oil
- Statoil
- Hess Oil
- Toyota
- Volvo
- Corps of Engrs
- CIBC (Canada)
- James Schlesinger
- Boone Pickens
- Matt Simmons
- Department of Defense
- Raymond James
- EWG (Germany)
- U.K. Industry Oil Study Group
- ASPO Organizations
- Many retired oil company engineers & geologists

**Well-known deniers include EIA, OPEC, CERA,
BP, & ExxonMobil.**

A Sampling of Recent Warnings

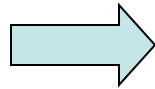
- “... an imminent peak and sharp decline in oil production could cause a worldwide recession.” U.S. GAO – 2007
- “A global peak is inevitable. The timing is uncertain, but the window is rapidly narrowing.” UK Energy Research Centre - 2009
- “The availability of oil worldwide has already peaked.” Guenther Oettinger, the European Union's energy chief. 2010
- “The next five years will see us face ... the oil crunch.” UK Industry Taskforce on Peak Oil and Energy Security – 2009
- “By 2012, surplus oil production capacity could entirely disappear, and as early as 2015, the shortfall in output could reach nearly 10 MBD.” U.S. Dept. of Defense – 2008 & 2010.

We believe that world oil production will likely stay on its current plateau & enter decline in 2 - 5 years.



Topics

- **Some basics**
- **Forecasts**
- **Mitigation**
- **Economic impacts**
- **Take-away points**



Administrative Mitigation

- **Rationing**
- **Forced carpooling**
- **Forced telecommuting**
- **Etc.**

Significant federal, state, & local government decision-making & policing required.

Physical Mitigation Options

High Near-Term Value:

- Energy efficiency (LDVs)
- Enhanced oil recovery
- Heavy oil / oil sands
- Gas-To-Liquids
- Coal-To-Liquids

Liquid fuels

Not of near-term value - Electricity cannot operate existing liquid fuel machinery

- Nuclear
- Wind
- Solar

**Electricity,
not liquid
fuels**

**It's a liquid fuel problem,
not "energy."**

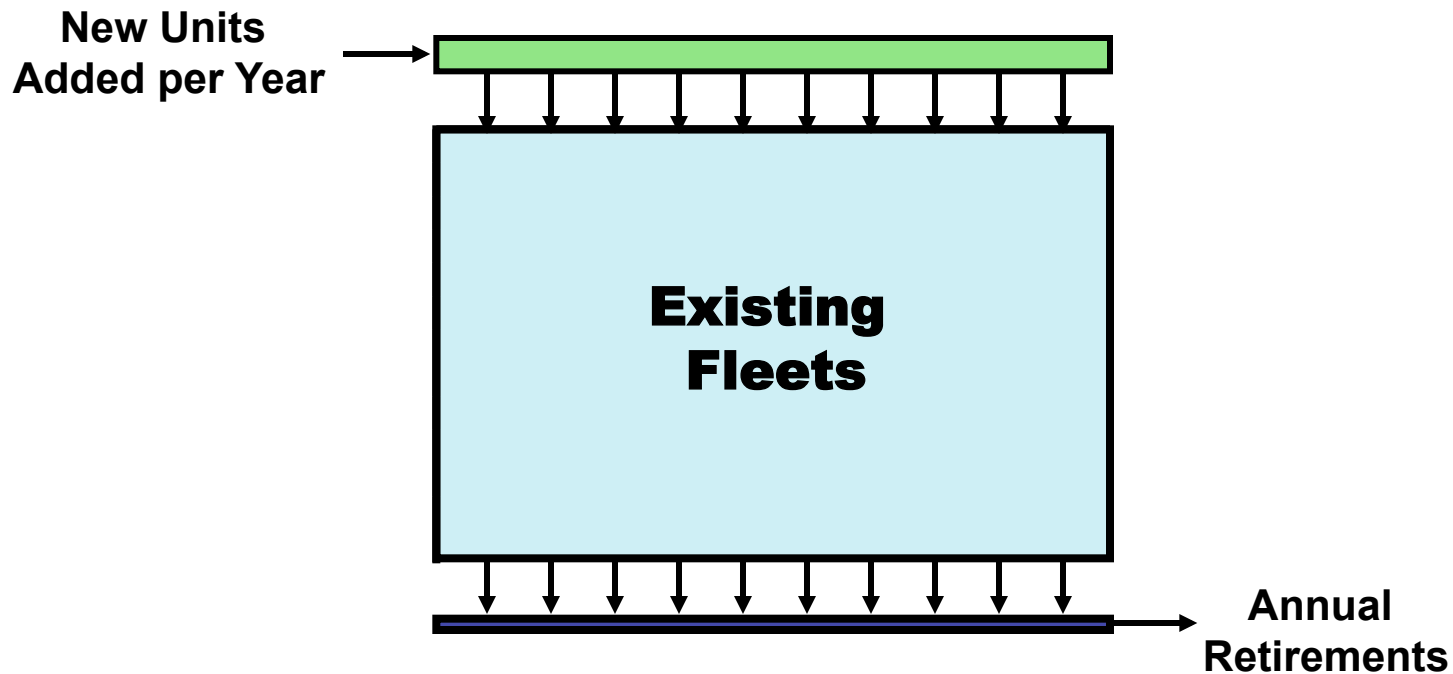
Physical Options Considered in Our 2005 DOE Study of Worldwide Crash Program Mitigation

- **Vehicle Fuel Efficiency**
- **Heavy oil / oil sands**
- **Coal Liquefaction**
- **Gas-To-Liquids (GTL)**
- **Enhanced Oil Recovery (EOR)**

Why these? There're LIQUID FUELS & READY.

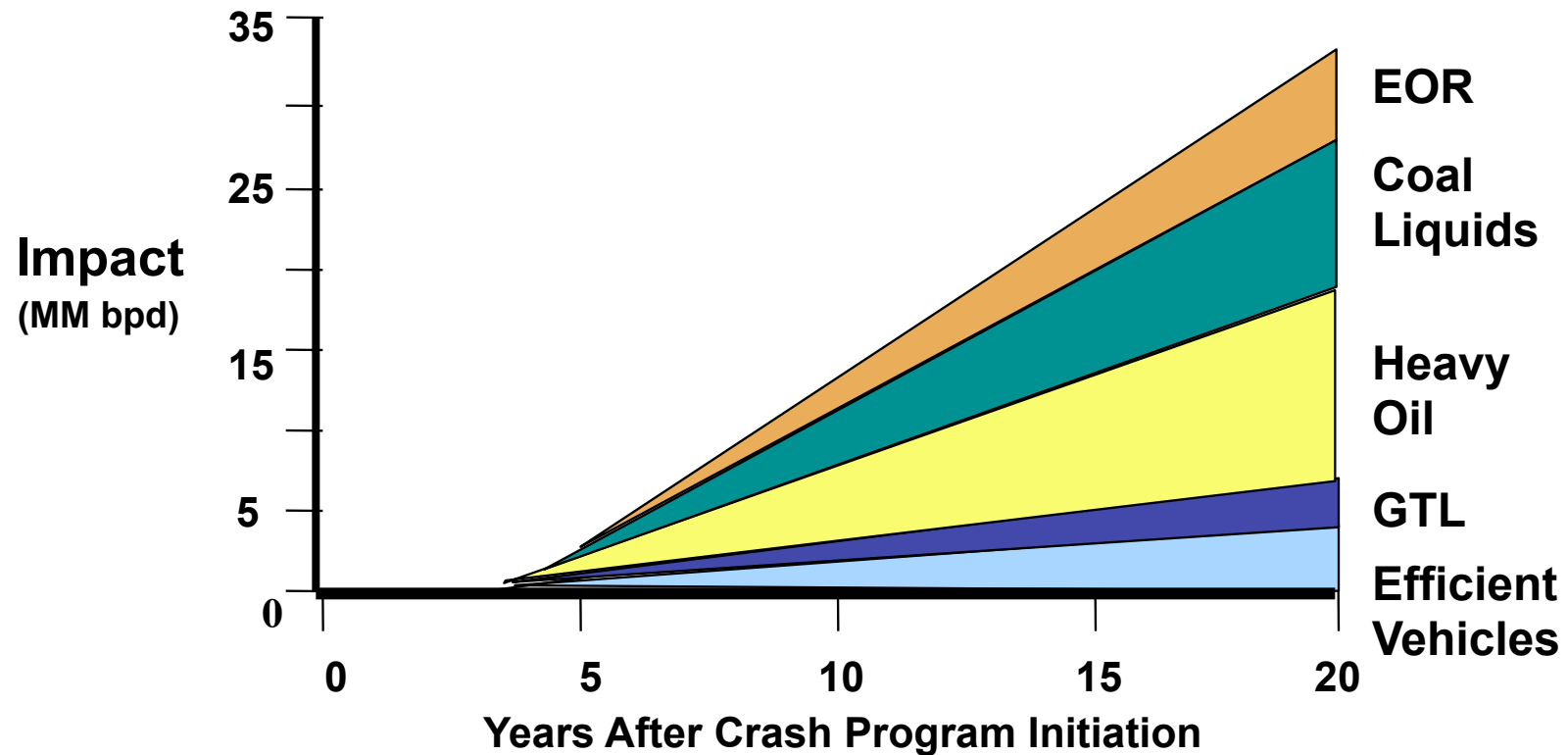
IMPLEMENTATION / DEPLOYMENT is essential to effective mitigation.

Liquid Fueled Capital Stock Dynamics



Replacing liquid fuel-consuming equipment will be a massive, time consuming & expensive undertaking.

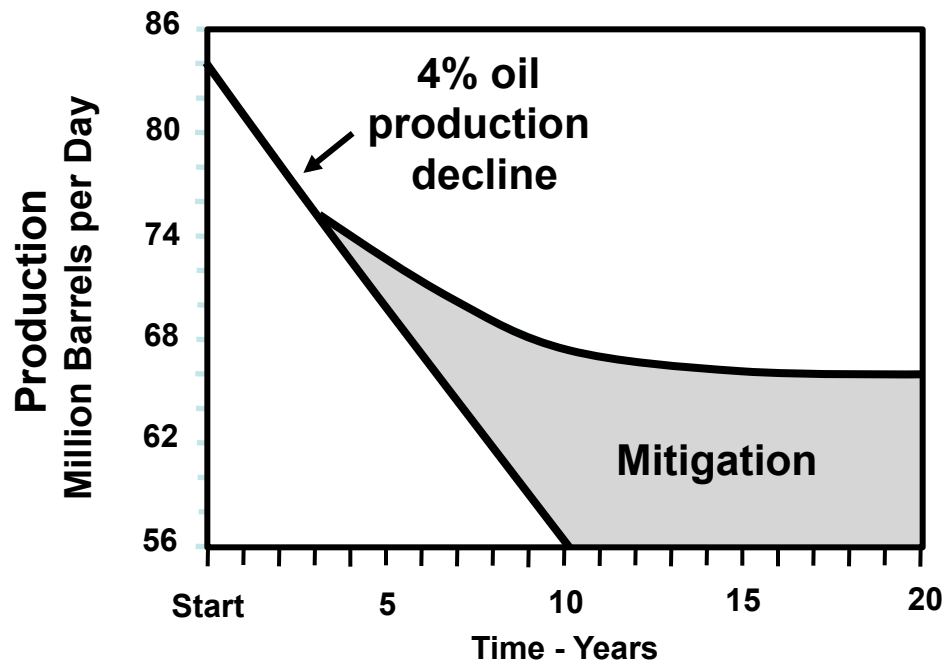
Worldwide Crash Program Mitigation of Conventional Oil Production Peaking



Physical mitigation will involve a time lag, followed by a buildup.

Our best case mitigation does not overtake expected world oil production decline for over a decade.

Decline has a big head start.

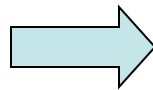


The Bottom Line

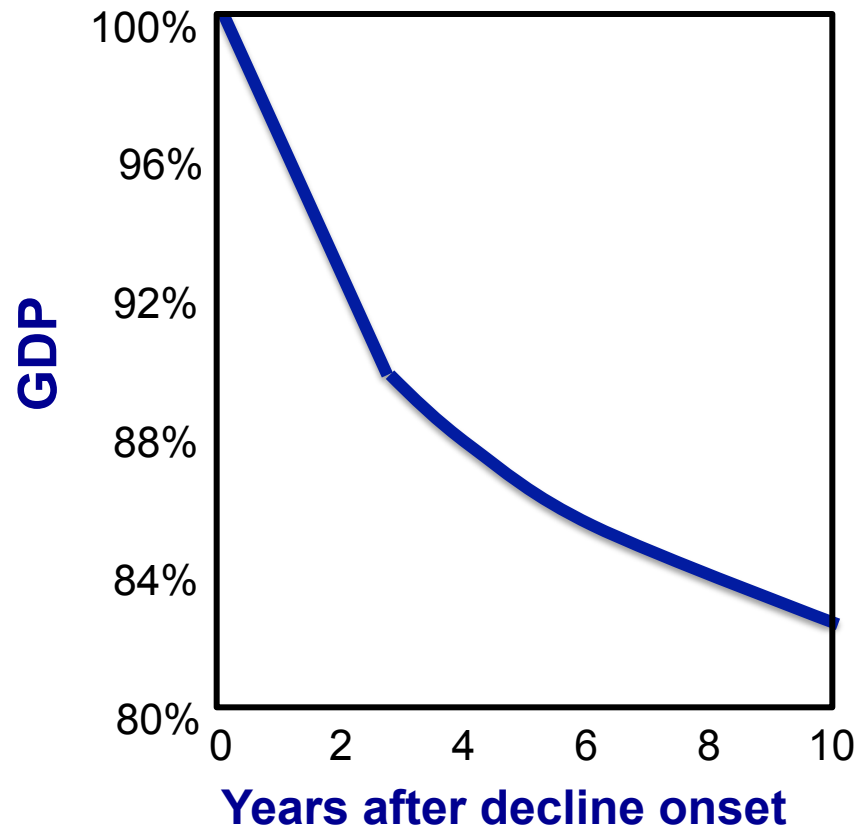
- The problem runs away from our best mitigation efforts for a long time at likely production decline rates.
- There will be growing world liquid fuels shortages for much more than a decade.

Topics

- **Some basics**
- **Forecasts**
- **Mitigation**
- **Economic impacts**
- **Take-away points**



In the U.S. in 1973 & 1979, the oil shortage percentages were about equal to the decline in U.S. GDP. If the 1:1 ratio holds after world oil production decline, world GDP decline might look like this in the best case crash program mitigation.



We expect public shock realization.

The experiences of 1973 & 1979 give insights for when the shock of world oil production decline becomes widely realized.

- A sudden awakening - panic, disorientation, & insecurity
- Immediate fuel shortages, as people top off their gasoline tanks & hoard
- Large increases in fuel prices due to much higher oil prices
- Difficult commuting due to high gasoline prices & growing shortages
- Stock markets declines due to fear, panic, & weakening economies.
- Declining real estate prices in areas far from work or public/mass transportation. Vacation & entertainment areas hard hit.

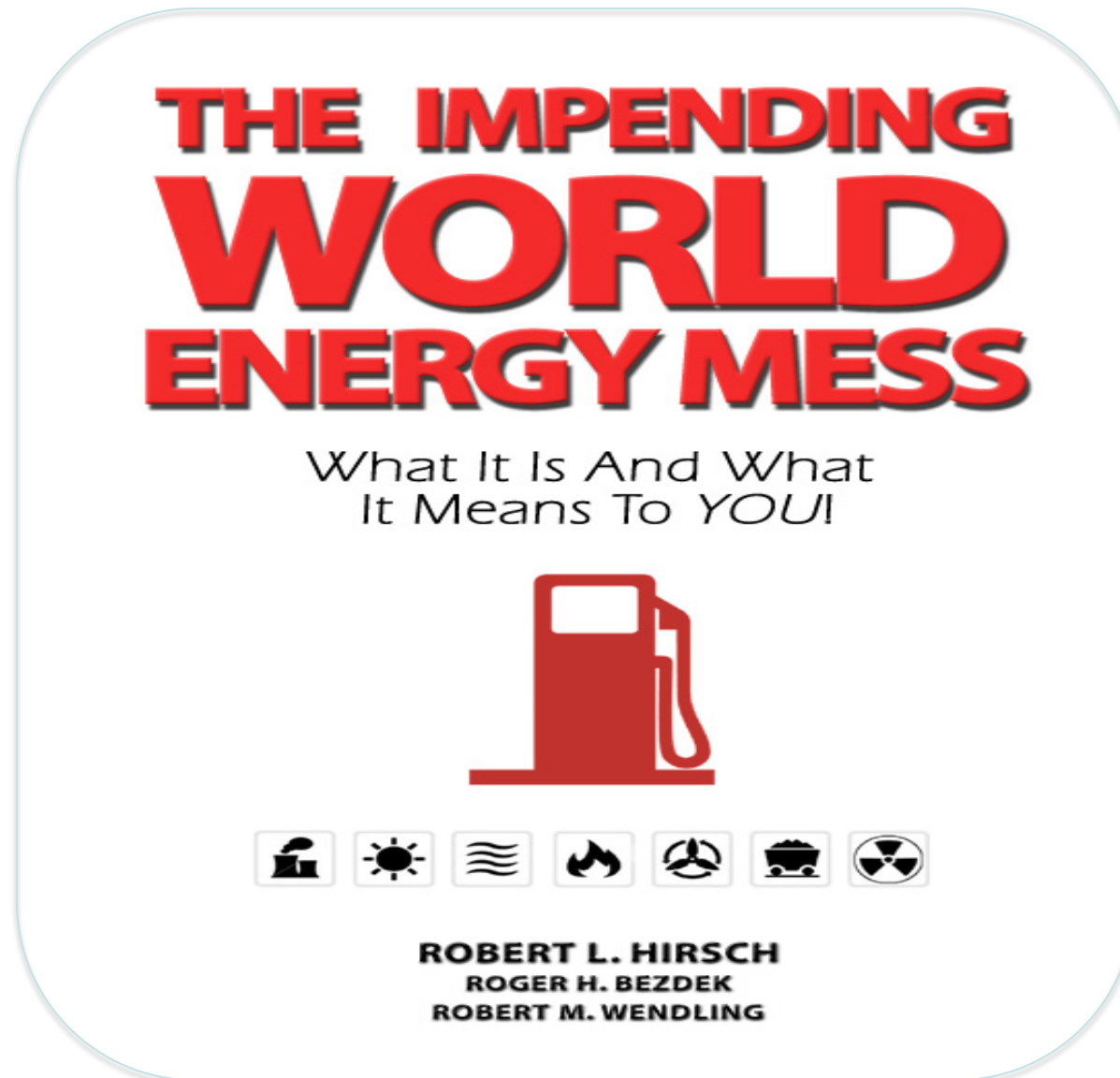
More 

**The experiences of 1973 & 1979 give insights for when the shock of world oil production decline becomes widely realized.
Continued.....**

- Annually deepening recession until effective mitigation takes hold
- Increasing inflation due to much higher oil prices & shortages
- Growing unemployment due to business cutbacks.
- Declining world trade

**“It will be the same this time,”
but it will last much, much longer.**

Our Book



Provides detail & references for individual study.

Summary

- Oil is a finite resource, which is being rapidly depleted. Oil production behaves differently than things we are used to.
- World oil production decline is inevitable.
- World oil production hit a plateau in mid 2004 & stayed in a narrow fluctuation range. Maintaining flat world oil production requires significant new oil production to make up for oil fields that are in decline.
- The peak in giant oil fields occurred in the 1960s and has been in steep decline ever since. Giants provide 60% of world oil.
- A number of techniques yield roughly similar oil production forecasts. Many forecast near-term decline; others tell us not to worry.
- After world oil production decline begins there will be no quick fixes. Practical mitigation requires IMPLEMENTATION / DEPLOYMENT of existing technologies.
- Growing world oil production declines will mean increasing economic distress.

In Conclusion

- Production decline could start in 2-5 years, but a public realization shock could happen at any time.
- You might wish to minimize your personal vulnerabilities.
- There will **OPPORTUNITIES** for many of you to contribute.

We will beat the oil decline problem & emerge much stronger & more pragmatic.