

Slides for Peak Oil Speakers "Training for Trainers"

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Today's Approach

- "Peak oil" is complicated; the challenge is to make it understandable for your audience.
- It's critical to speak to the median of your audience. Each of us will do that differently.
- Here are two presentations & some positive slides for discussion.
- Talking about the slides will hopefully provide some ideas for your future use.

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The Decline of World Oil Production & Its Possible Impacts

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Management Information Services, Inc. (MISI)
GFF Conference
February 26-27, 2009

Overview

- World oil production is at or near maximum.
- When decline begins, shortages will develop & increase each year until mitigation takes more than a decade from now.
- Oil prices will escalate & economic damage will increase. There will be no quick fixes.
- As with any severe problem, there will be opportunities to contribute.

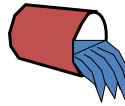
Orientation

Oil production is fundamentally different than inventory drawdown or emptying a bucket.

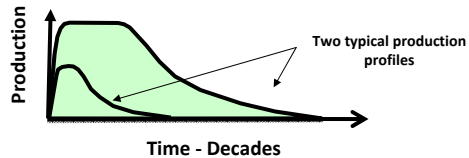
Inventory can be removed at almost any rate.



Liquids can be removed from a bucket at any rate.



Oil fields peak / plateau, & then decline.



Orientation

Large numbers can be misleading.

Ten billion barrels (10 B bbls)
of reserves yields roughly
One million barrels / day (1 MM bpd)
of production for a decade or so.

The world now consumes ~ 85 MM bpd.

Bringing a 10 B bbl oil field into full production can take roughly a decade.

Orientation

Small numbers can also be misleading.

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

1% of world oil consumption is huge ~ 850,000 barrels/day

But

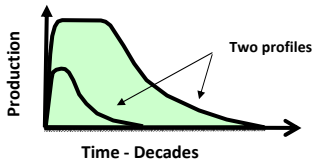
Percentage changes in oil production cannot be identified as a trend until years later.

Topics



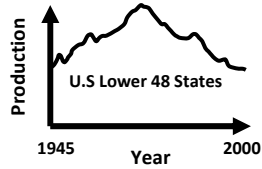
- Some background
- Timing
- Mitigation
- Economic impacts
- Take-away points

Oil fields peak / plateau & then decline.



Oil peaking & decline are unavoidable.

Countries peak / plateau & decline (Many oil fields)



The world will peak / plateau & decline (All countries)

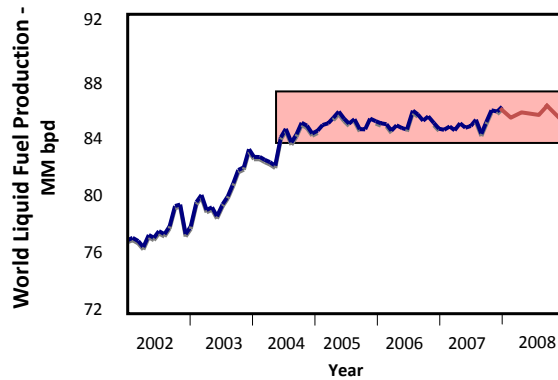
Royal Swedish Academy, October 2005:

54 of the 65 most important oil-producing countries are past peak.

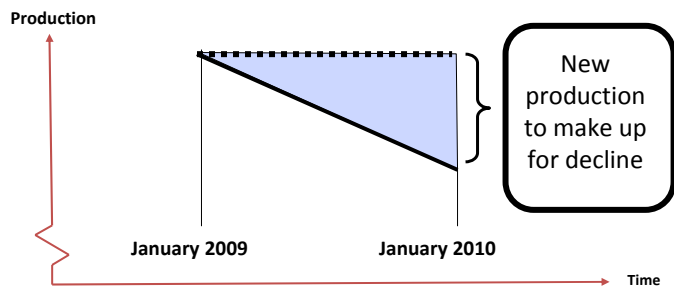
Add Mexico / maybe Russia

Oil is a finite, non-renewable resource that is being rapidly depleted.

World oil production started to stagnate in 2004 & has been on a plateau since then.



Maintaining flat world oil production requires steady make-up for oil fields that are in decline.

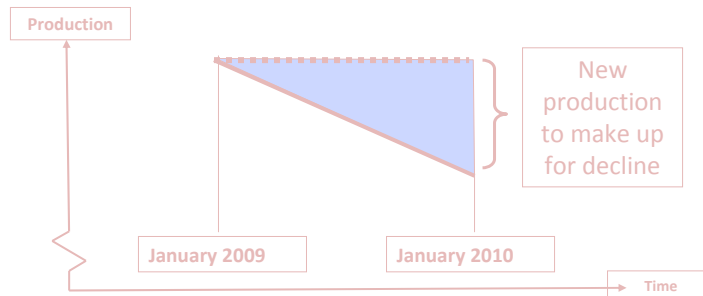


Decline Rate Estimates:

CERA ~ 4.5%

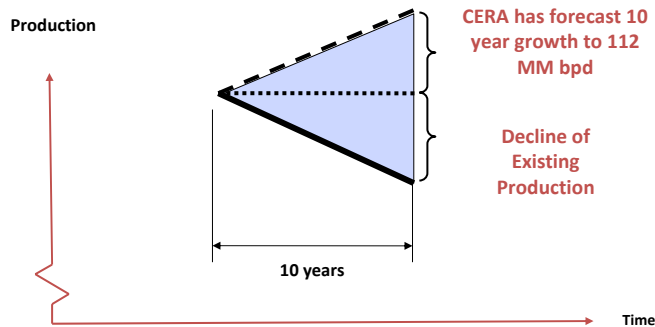
Others up to 8%

Maintaining flat world oil production requires steady make-up for oil fields that are in decline.



CERA's 4.5% ~ 3.8 Million Barrels per Day (MM bpd) brought into production each year just to maintain constant production.

World oil production expansion requires additional production.



To reach 112 MM bpd in 10 years at a 4.5% decline rate would require 75 MM bpd of new capacity = 8 new Saudi Arabia's. IMPOSSIBLE!

The world oil industry has been severely damaged by the recent dramatic decline in world oil prices.

Merrill Lynch believes “... the cumulative decline of global oil production from today could amount to 30 million barrels per day by 2015.”

Arnold, T. Oil output could fall by 30m bpd by 2015 – Merrill.
ArabianBusiness.com. February 6, 2009.

Topics

- Some background
-  Timing
- Mitigation
- Economic impacts
- Take-away points

Timing of World Oil Production Decline

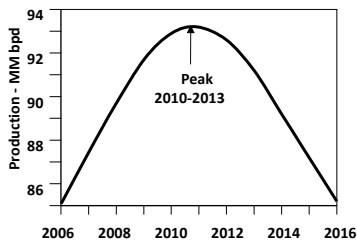
Now or Soon:

- IEA
- Chevron
- Shell
- Total Oil
- Statoil
- Hess Oil
- Toyota
- Jim Schlesinger
- Boone Pickens
- Matt Simmons
- Corps of Engineers
- CIBC (Canada)
- EWG (Germany)
- Many oil geologists

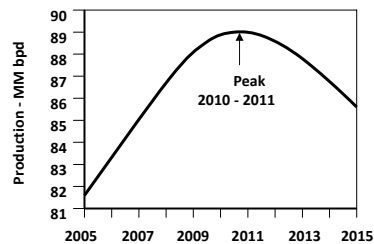
No imminent problem:

- OPEC
- EIA
- CERA
- BP
- ExxonMobil

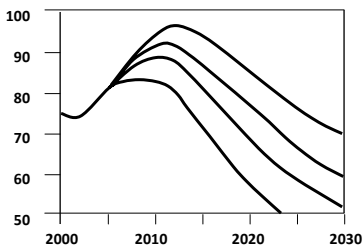
Various approaches forecast peaking soon.



Megaprojects - Skrebowski



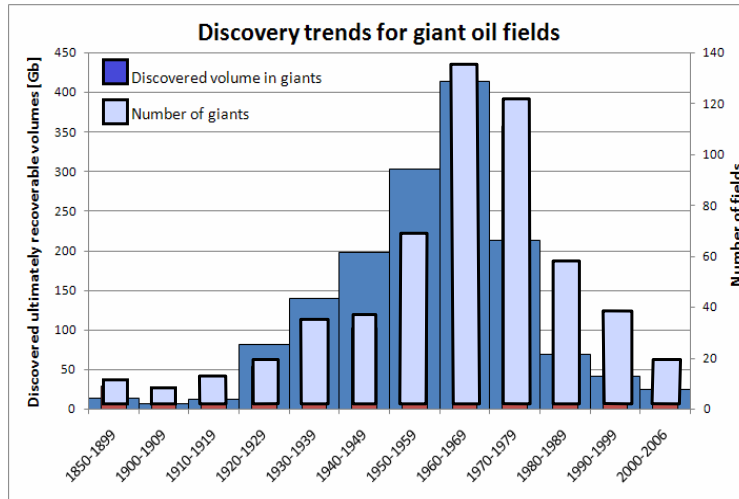
Country Studies - Campbell



Giant Fields - Robelius

Giant oil fields provide about 60% of world oil production but discoveries peaked decades ago.

Many giants are in decline; more will be soon.



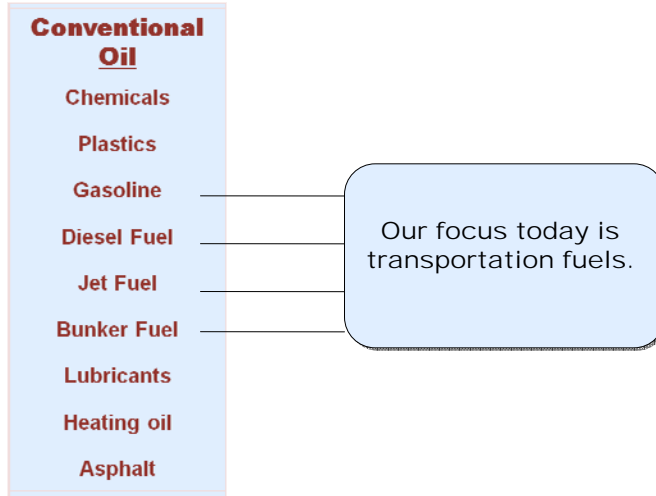
Mikael Höök, Global Energy Systems, Uppsala University

Topics

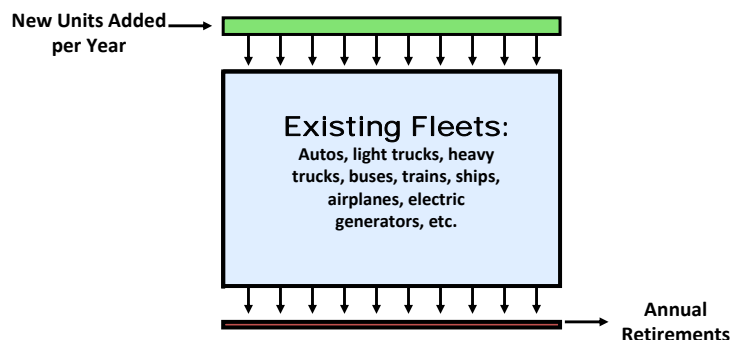
- Some background
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Oil provides a variety of important hydrocarbon products besides fuels.



Liquid Fueled Capital Stock Dynamics



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

Mitigation Options

High near-term value:

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

Liquid fuels & hydrocarbon products

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

- Nuclear
- Wind
- Solar

Electricity, not liquid fuels

It's not just "energy."

Hydrocarbon Products from Various Sources

Conventional Oil	Enhanced Oil Recovery	Oil Sands (Canada)	Gas-To-Liquids	Coal-To-Liquids (indirect)
Chemicals	✓	✓	✓	✓
Plastics	✓	✓	✓	✓
Gasoline	✓	✓	✓	✓
Diesel Fuel	✓	✓	✓	✓
Jet Fuel	✓	✓	✓	✓
Lubricants	✓	✓	✓	✓
Heating oil	✓	✓	✓	✓
Bunker Fuel	✓	✓		
Asphalt		✓		

Hydrocarbon Products or Substitutes from Renewables

Note: None are now economically viable without government.

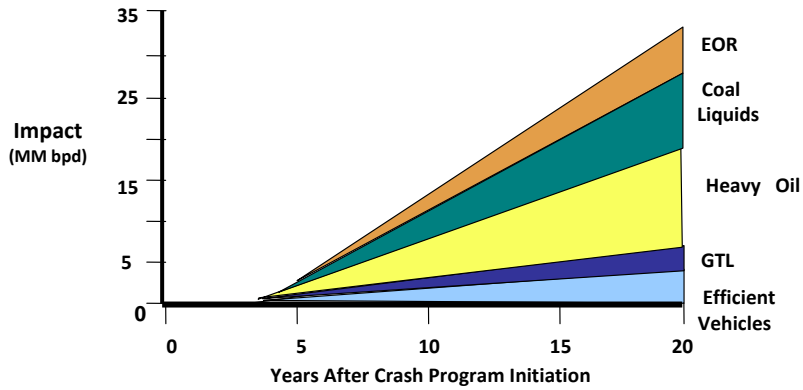
Conventional Oil	Corn Ethanol	Biodiesel	Cellulosic Liquids	Wind	Solar
Chemicals			✓		
Plastics			✓		
Gasoline	✓		✓		
Diesel Fuel		✓	✓		
Jet Fuel		✓	✓		
Lubricants			✓		
Heating oil			✓	✓	✓
Bunker Fuel			✓		
Asphalt					

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)

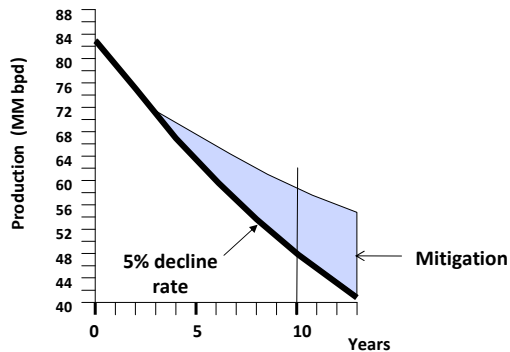
Why these? There're liquid fuels & ready for
IMPLEMENTATION /DEPLOYMENT

Worldwide Crash Program Mitigation of Conventional Oil Production Peaking



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

World Liquid Fuels Shortages After the Onset of Production Decline



Shortage in 10 years:
24 MM bpd (~ 30%)

“...we could hope and pray that Hirsch is wrong about the 20-year lead time...”

George Monbiot. *The Guardian*, December 15, 2008.

“Well, I too, and probably everyone else hope and pray that Hirsch is wrong, but the probability (regrettably) is near zero.”

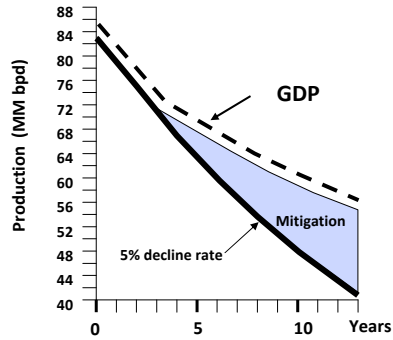
James R. Schlesinger, First Secretary of Energy. December 16, 2008.

Topics

- Some background
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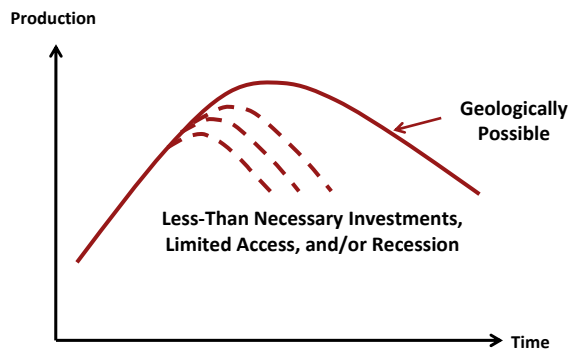


Possible Future World GDP Change



The GDP could track oil shortages & decline ~30% over the 10 years after the onset of decline.

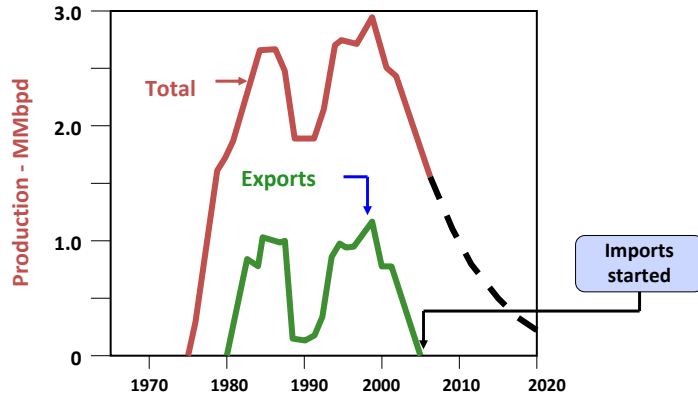
Conceptual Difference Between What Is Geologically Possible In World Conventional Oil Production & Above-Ground Effects



No one can say how this will play out.
The risks of a bad outcome are significant.

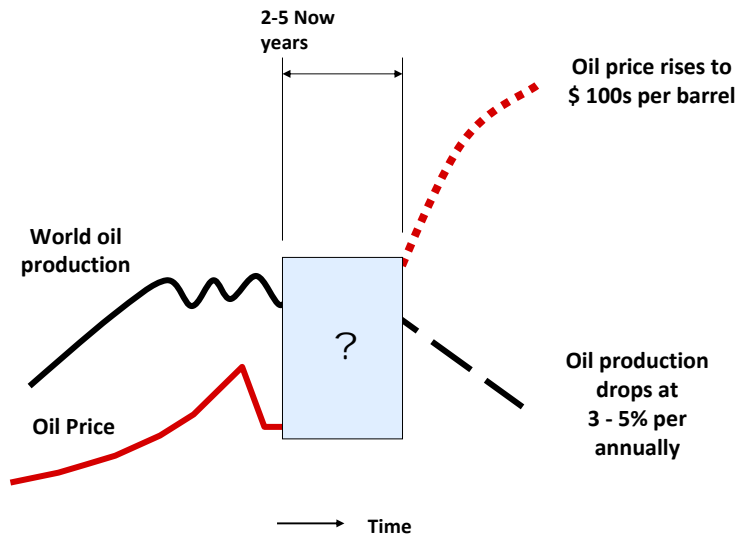
Production & Exports

The United Kingdom Example



Healthy exporters can become importers relatively quickly.

How It Might Play Out



Take-Away Points

- World oil production decline is UNAVOIDABLE.
- It's a complex problem, not just "ENERGY."
- Mitigation requires IMPLEMENTATION of many options.
 - ✓ MASSIVE
 - ✓ TIME-CONSUMING
 - ✓ EXTREMELY EXPENSIVE
 - ✓ COMPARATIVELY SLOW
- MAJOR ECONOMIC HARDSHIP is unavoidable.
- For many of you there will be opportunities.

World Oil Production: Trouble Sooner

Robert L. Hirsch, Ph.D.
Senior Energy Advisor
Management Information Services Inc. (MISI)
May 14, 2009.

These slides are too wordy; they were meant for reading.

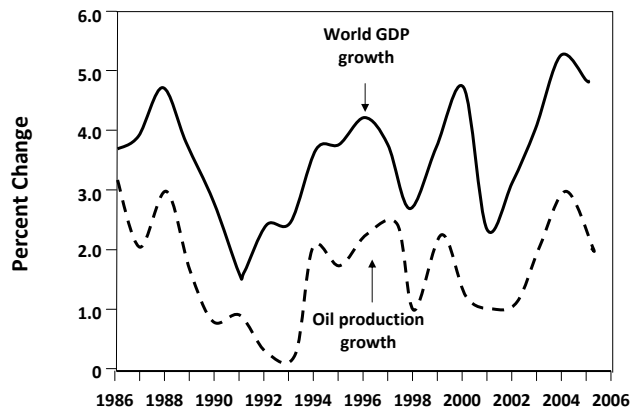
Overview

- Oil supplies and GDPs are coupled in normal times & when sudden oil shortages occur.
- World oil production has been on a plateau since 2004, because new oil production did not exceed declines in older oil fields.
- Before the current economic recession, a number of organizations & analysts believed that geological factors had already or would soon lead to a world oil production decline.
- Recently, investment in world oil production capacity has been significantly reduced due to the economic recession .
- The combination of geological limitations and underinvestment points to declining world oil production within a matter of a few years.
- Declining world oil production will drag down world GDP, causing an ever deepening recession until mitigation takes hold, more than a decade thereafter.
- Accordingly, an oil shortage-driven recession may follow soon after the end of the current economic recession, limiting the potential of the recovery.

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Data

**Oil is fundamental to economic well-being.
World GDP growth & world oil production
growth have tracked each other for decades.**



Oil production data is from EIA, April 2007 International Petroleum Monthly, May 8, 2007.
GDP Market Exchange Rate data is from the IMF World Economic Outlook Database, April 2007.

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Data

The two oil shocks of the 1970s suddenly & sharply reduced U.S. GDP

1973 Embargo	1979 Crisis	
U.S. Oil Supply Drop	- 4 %	- 5 %
U.S. GDP Drop	- 3 %	- 3 %
<u>% Change in U.S. GDP</u>	~ 0.8	~ 0.6
% Change in U.S. Oil Supply		

$$\frac{\% \text{ Change in U.S. GDP}}{\% \text{ Change in U.S. Oil Supply}} \sim 0.6 - 0.8$$

Note: These two events provide our only significant, sudden oil shortage experiences over the last half century.

Speculation

So GDPs are tightly connected to oil supply during both normal times & shocks.

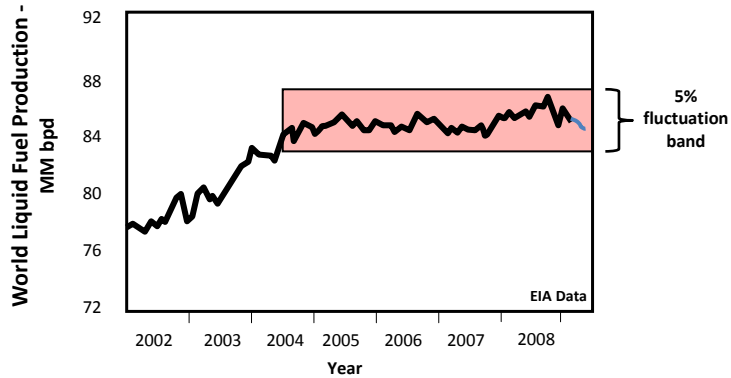
- An accurate correlation between oil supply & GDPs is impossible, because there are too many variables involved.
- Many influences other than oil supply can impact GDPs, & declining world GDP can cause declining oil demand, as recently demonstrated.
- Nevertheless, from the U.S. experience & various studies, it is believed reasonable to consider that world oil shortages could drag down world GDP roughly to the extent that occurred in the U.S. during the 1973 & 1979 oil shocks:

$$\frac{\% \text{ Change in World GDP}}{\% \text{ Change in Oil Supply}} \sim 0.6 - 0.8$$

- Next, consider recent world oil production experience.....

Data

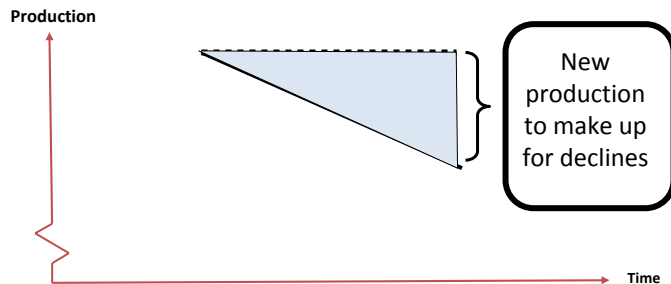
World oil production stopped growing in 2004 & has been on a fluctuating plateau since then.



Between 2004 & 2008, GDPs continued to rise in spite of world oil supply stagnation. The mismatch caused oil prices to escalate dramatically until economic recession broke the spiral.

Calculations

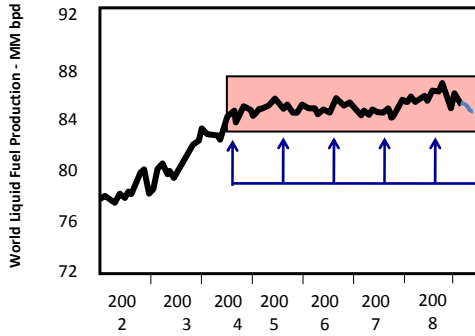
Maintaining flat world oil production requires new production to make-up for losses from the many oil fields worldwide whose production is declining.



Decline Rate Estimates: IEA, CERA, Hook, Exxon, others...4-8% per year

Calculation

A 5% per year on-going decline requires roughly 4 Million barrels per day (MM bpd) of new production each year to just maintain constant production.



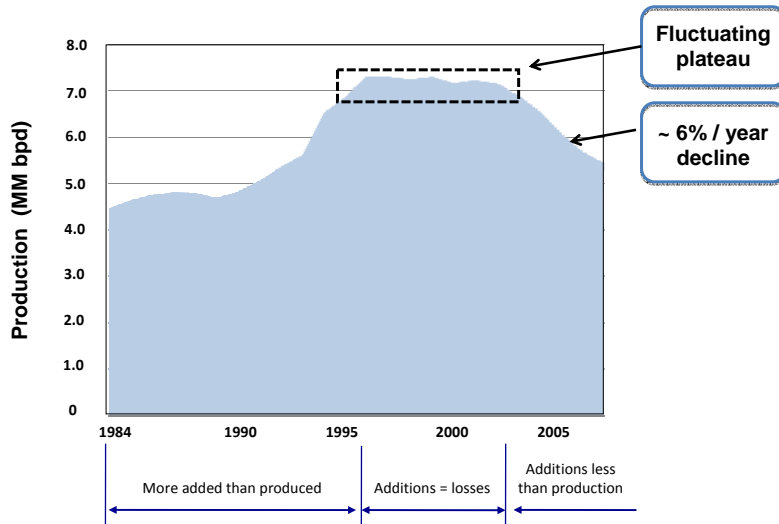
Since 2004, world production gains balanced losses. Those gains required huge investments.

The cost for just maintaining that relatively constant production over the 5 year period is estimated to be about \$1.5 trillion

total
Simmons, M. Society of Petroleum Engineers Presentation. April 21, 2009.

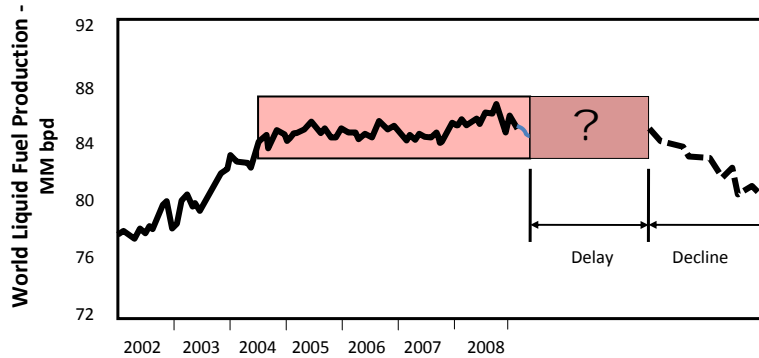
Data

Next, consider European oil production, which increased, plateaued, & then declined.



Speculation

World oil production rose, then plateaued. If it follows the European pattern, the result might look like this.....



Based on geological factors, many of the estimates of future world oil production indicated the onset of decline within a matter of years. But the world recession led to large reductions in recent oil field investments, which will impact future world oil production.

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Some of the Organizations & People Expecting World Oil Production Peaking and/or Decline Based on Geological Studies

A few believe that the peak has already occurred; others have suggested that it could occur within a matter of years.

- IEA
- Chevron
- Shell
- Total Oil
- Statoil
- Hess Oil
- Toyota
- Volvo
- James Schlesinger
- Boone Pickens
- Matt Simmons
- Corps of Engineers
- CIBC (Canada)
- Raymond James & Associates
- EWG (Germany)
- ASPO Organizations
- Many retired oil geologists

Forecasts & positions vary considerably. Exact determinations are impossible.

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Recent Recession Impacts - I

“Oil and gas explorers postponing or scrapping deep water drilling projects are potentially reducing crude supplies by as much as 2.4 million barrels a day in 2011, Morgan Stanley said.”

Sethuraman, D. DEEP WATER OIL DRILLING SCALED BACK, MAY TIGHTEN CRUDE SUPPLIES. Bloomberg. March 20, 2009.

“The International Energy Agency estimates that about \$100 billion of worldwide oil production capacity expansion projects have been cancelled or postponed over the past half year. According to Barclays Capital, oil companies have cut worldwide exploration and production spending by 18 percent so far this year. Deutsche Bank estimates that U.S. energy exploration-and-production spending will drop \$22.5 billion this year, a 40-percent, year-on-year decline.”

Markey, M. Topic Report: E&P Capital Expenditure Cutbacks. Topic Reports. Apache Corp. March 16, 2009

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Recent Recession Impacts - II

[CIBC World Markets chief economist Jeff Rubin] “expects a world oil demand recovery to 86.7 million b/d in 2010, mostly in the developing world, but oil supply at 84.8 million b/d, resulting in a gap of 1.9 million b/d.”

Cattaneo, C. The Patch: Peak supply vs. peak demand. Financial Post. January 25, 2009.

“The world will never be able to produce more than 89m barrels a day of oil according to Christophe de Margerie, CEO of Total. He said he had revised his forecast for 2015 oil production downward by at least 4 million barrels a day because of the impact of the current economic crisis and the collapse in oil prices.”

Financial Times 16 February 2009

“The International Energy Agency (IEA) ... warns that the credit crisis and project cancellations will lead to no spare crude oil capacity by 2013.”

Markey, M. Topic Report: E&P Capital Expenditure Cutbacks. Topic Reports. Apache Corp. March 16, 2009

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OPEC and Saudi Warn of Underinvestment

“Crude oil prices of about \$45 a barrel will prevent companies and countries from investing in new oil fields, threatening the world’s future fuel supply, according to OPEC Secretary General Abdalla El-Badri..... **The decline in prices has already forced OPEC nations to delay 35 of 150 projects meant to increase global oil supply capacity**, he said.”

Pals, F., Chmaytelli, M. OPEC'S EL-BADRI SAYS \$45 OIL THREATENS FUTURE SUPPLY. Bloomberg. March 18, 2009.

“Saudi Arabia's oil minister warned of a possible "catastrophic" energy supply crunch without prompt investment. “.... **such a supply crunch would be catastrophic**,” Ali Al-Naimi said yesterday. ‘**The painful result would be felt sooner rather than later. It would effectively take the wheels off an already derailed economy.**’”

SAUDI WARNS OF 'CATASTROPHIC' ENERGY CRUNCH. Reuters. March 19, 2009

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Observations

Underinvestment means less new future production,
which means
world production capacity will shrink,
which means
less production capacity when demand resumes.

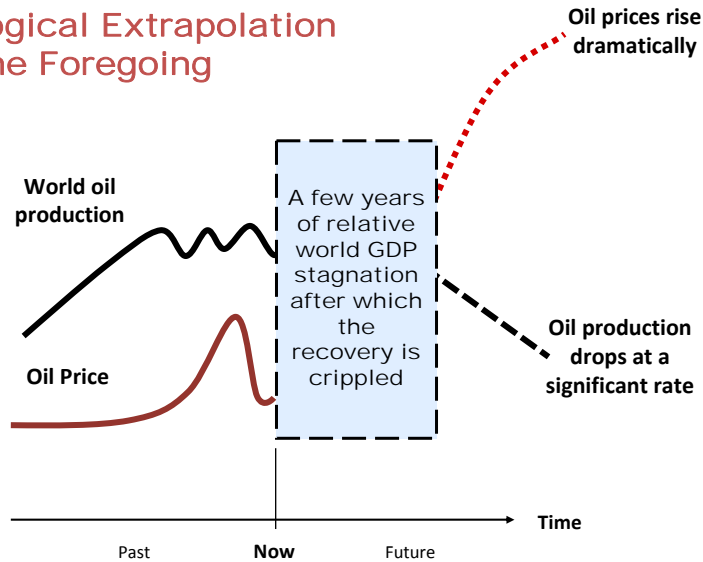
Two of the scenarios that might evolve:

- I. Underinvestment effects merge into geologically-driven world oil production decline & GDPs decline sooner.
- II. Underinvestment effects abate before geologically-driven world oil production decline begins & GDPs decline a few years later.

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Speculation

A Logical Extrapolation of the Foregoing



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Governments can turn to two types of oil shortage mitigation – Administrative & Physical.

Administrative options for rapid implementation include.....

- Rationing
- Speed limits
- Telecommuting
- Carpooling
- Limiting air travel
- Other

All useful but likely limited compared to the magnitude of expected shortages

Physical mitigation options ready for implementation include.....

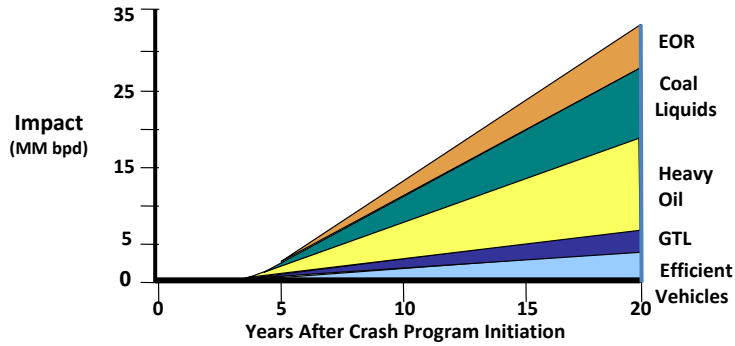
- More efficient motor vehicles
- Enhanced oil recovery
- Coal-to-Liquids
- Heavy oil & oil sands
- Natural Gas-To-Liquids

All ready for deployment and capable of large scale impact

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Calculations

At some point the world is likely to initiate a major program of physical mitigation to counter oil shortages. Under a crash program scenario -- the best possible, it will take much more than 2-4 years to significantly impact growing world oil shortages.



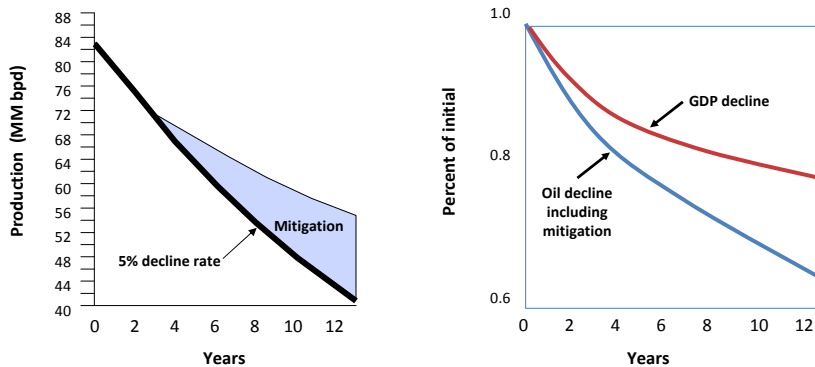
There will be a time lag, followed by a buildup.

Hirsch, R.L. et al. Peaking of World Oil Production: Impacts, Mitigation, & Risk Management. DOE NETL. February 2005.

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Speculation

If the world oil production decline rate is 5% & world GDP decline is of the order of 60% of oil decline, then world GDP would decline significantly in spite of crash program mitigation.



A 15 – 20 % world GDP decline in 10 years is conceivable.

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Conclusions

- Many of the geological, production, & investment trends are very troubling.
- If world oil production decline begins in a matter of a few years, the result would be a new, lengthy oil shortage-driven recession, following on the heels of the current economic recession.
- Since the risks of severe economic damage are so severe, these matters deserve objective in-depth study.

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One Approach To Being Positive.....

World Energy in 2050

Vision

- Major changes, higher prices, & more sustainability
- Most vehicles: Plug-in hybrids, electric, & hydrogen
- Liquid fuel consumption declining
- Electric power largely from nuclear & renewables
- Energy efficiency in all sectors

Resource Situation

- Conventional oil production will be roughly 50% of 2008 level.
- Natural gas production will be roughly 50% of 2030 level.

The 2008 - 2050 transition will be
Extremely Challenging

WorldLiquid Fuels in 2050

• **Structural energy efficiency** }

Save

- **Remaining oil production**
- **Coal-to-Liquids**
- **Enhanced Oil Recovery**
- **Oil Sands / Heavy oil**
- **Shale oil**
- **Gas-to-Liquids**
- **Cellulose**

Sources of
liquid fuels

“Training the Trainers” Conclusions

- These were my ideas & what I felt was reasonable for the audiences I was addressing. Yours will likely differ.
- The story is inherently frightening to anyone that gets it. Try to find positives.
- Feel free to use any of these slides with or w/o attribution.
- Good luck!