World Oil Shortage Scenarios for Mitigation Planning

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Presentation to ASPO-USA
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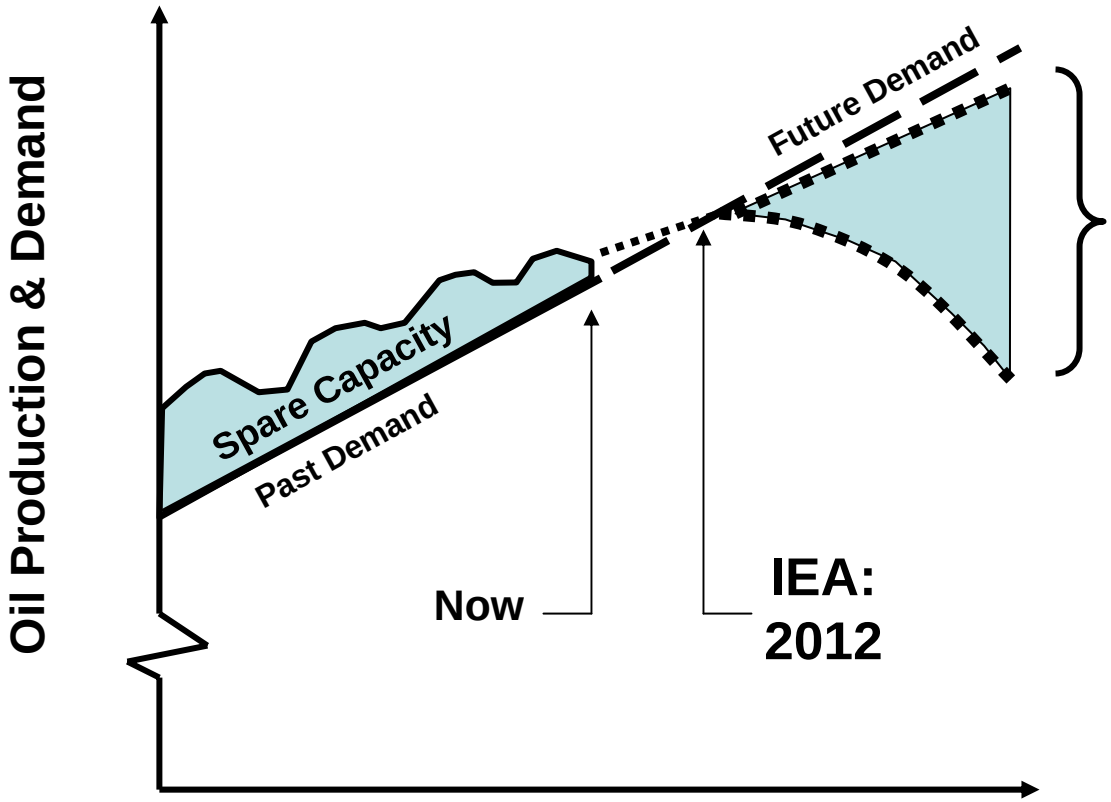
Introduction

- When world oil production capacity no longer keeps pace with world oil demand, oil shortages will develop.
- Oil shortages will result in escalating oil prices, negatively impacting economies.
- Mitigation will be needed: How much? How fast?
- This analysis develops

Mitigation requirement scenarios

World Spare Oil Production Capacity Will Not Meet Demand At Some Point

Notional picture



How large the ensuing shortages?

Background

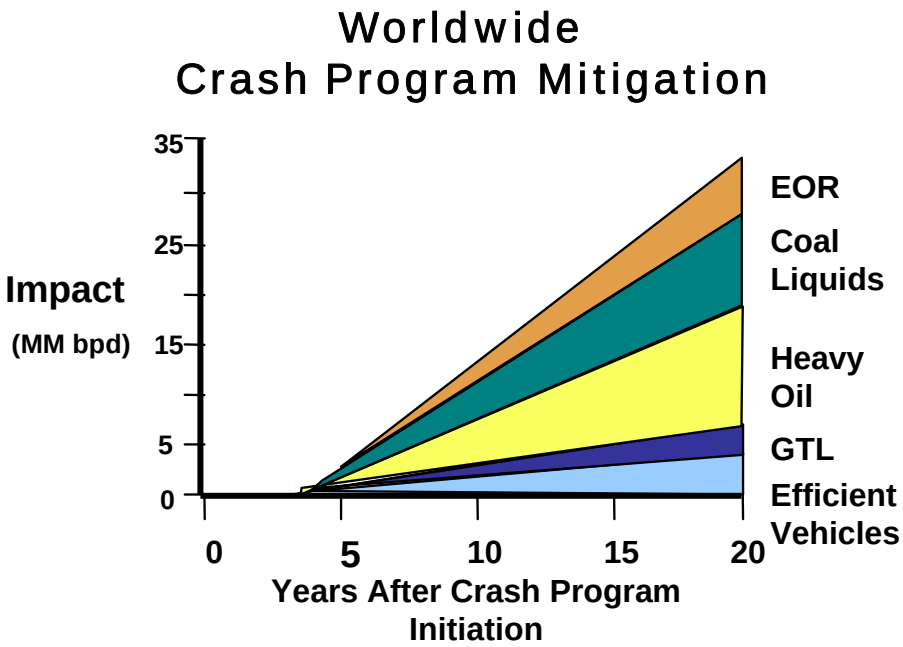
"… it only requires a relatively small amount of oil to be taken out of the system to have huge economic and security implications."

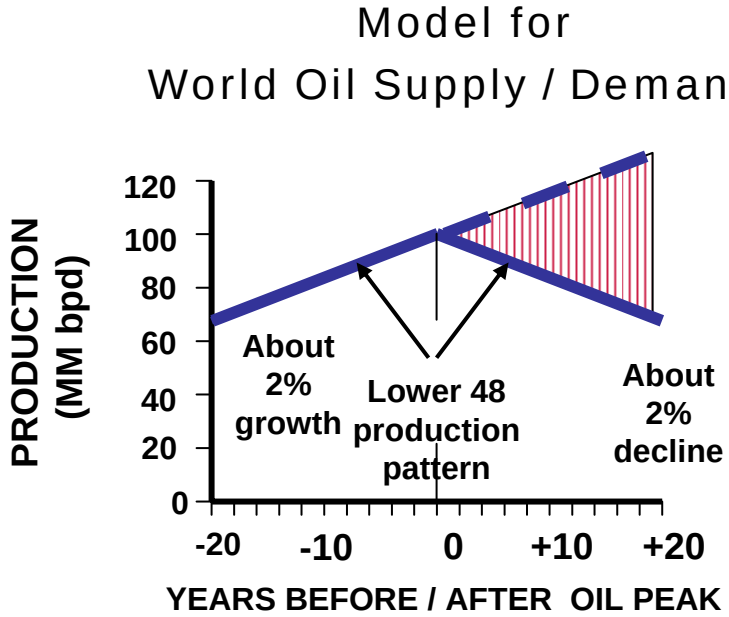
Robert M. Gates. Oil Shockwave. June 2005.

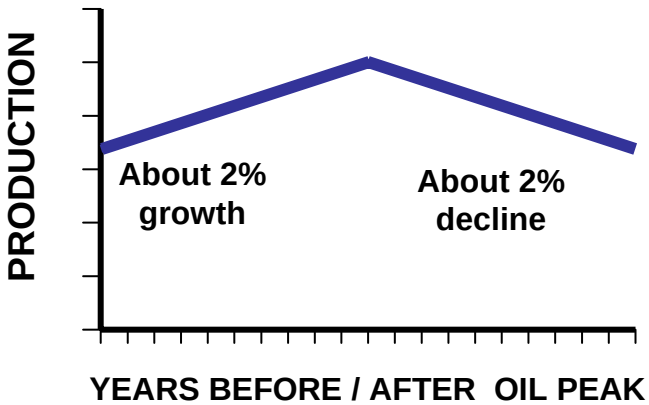
"The rate of decline after a peak is an important consideration because a decline that is more abrupt will likely have more adverse economic consequences than a decline that is less abrupt."

GAO-07-283. February 2007.

From the 2005 DOE Mitigation Study.....







Current analysis asks:

- **Likely patterns?**
- **Likely declines?**

Small is Huge

- **3% decrease in U.S. GDP → Recession (1973)**

- **1% of world oil consumption > 800,000 barrels/day**

- To **SAVE** 800,000 barrels/day: A **crash program** in vehicle fuel efficiency will require more than a decade.

- To **PRODUCE** 800,000 barrels/day of substitute fuel: A Coal-To-Liquids **crash program** will cost ~ $100 billion & require more than a decade.

Elements of the Study

- **Oil shortage impact on world GDP**
- **Analysis model**
- **Giant oil field decline rates**
- **Experience in North America & Europe**
- **Future oil production forecasts**
- **Resource nationalism**
- **Mitigation planning scenarios**

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Oil Supply & World GDP

- To estimate impacts, we need a relationship between oil supply shortages & world GDP change.

- Our only experience was 1973 & 1979, & there are many uncertainties, complications, and unknowns. Precision is impossible.

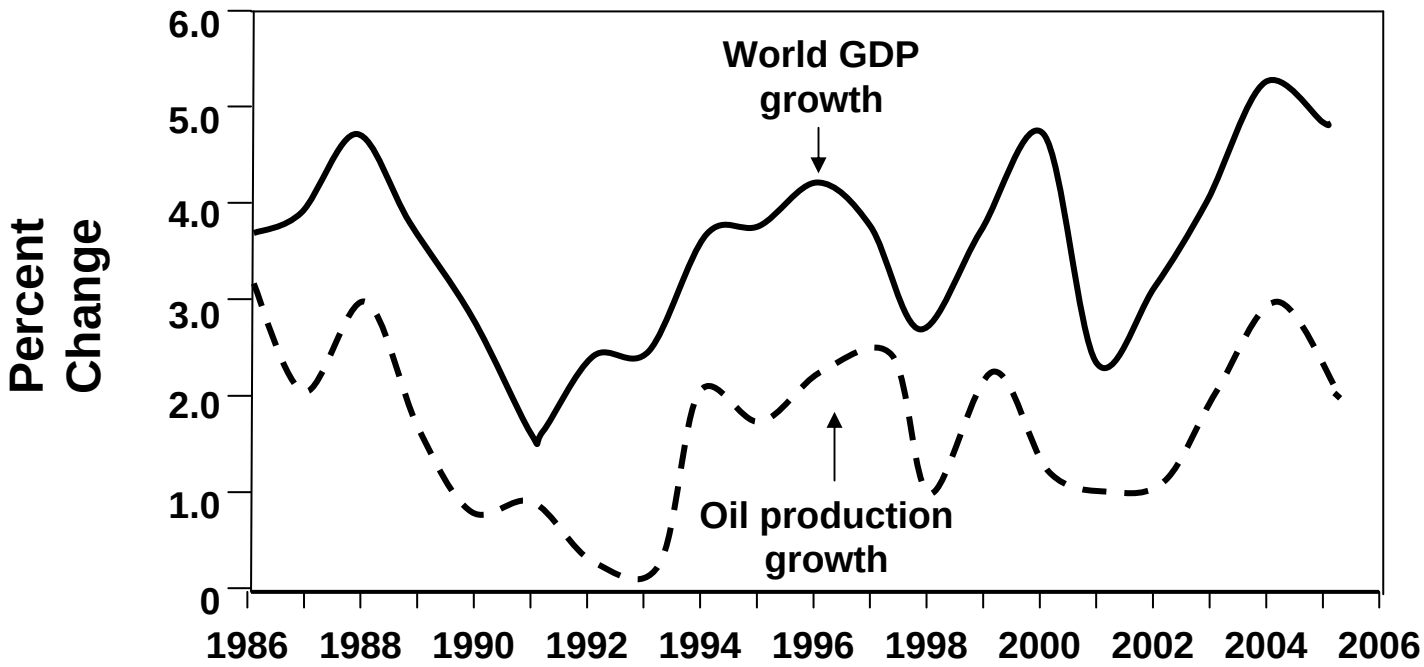
- Our rough estimate:

$$\frac{\textbf{\% Change in GDP}}{\textbf{\% Change in Oil Supply}} \sim 1$$

- This is an order of magnitude number.

10 is too large / 0.1 is too small.

World GDP Growth & World Oil Production Growth Have Tracked For Decades.



For 1995-2006, Deutsche Bank calculated:

$$\frac{\%\ \text{Change in World GDP}}{\%\ \text{Change in Oil Supply}} \sim 2.5$$

Order of magnitude of 1

U.S. GDP & Oil Shortages

BRIEF oil interruptions in 1973 & 1979 caused ….

+ Inflation
+ Unemployment
+ Recession
+ High interest rates

	1973 Embargo	**1979 Crisis**
U.S. GDP	- 3 %	- 3 %
Oil Supply	- 4 %	- 5 %
$\frac{\text{\% Change in U.S. GDP}}{\text{\% Change in Oil Supply}}$	**~ 0.7**	**~0.6**

$$\frac{\text{\% Change in U.S. GDP}}{\text{\% Change in Oil Supply}} \sim 1$$

Oil Shockwave

A scenario analysis of multiyear oil supply disruptions on the U.S. economy.

Findings:

- **4% global oil shortfall lead to an oil price to ~$160 / bbl.**
- **U.S. economy goes into recession / millions of jobs lost.**

If 1973 / 1979 were significant recessions @ 3% & 4% :

$$\frac{\text{\% Change in U.S. GDP}}{\text{\% Change in Oil Supply}} \sim 1$$

Participants: Carol Browner, **Robert Gates**, Richard Haass, General P.X. Kelley, Franklin Kramer, Don Nichols, Gene Sperling, Linda Stuntz & James Woolsey.

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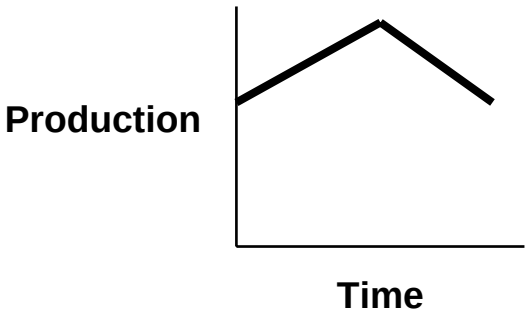
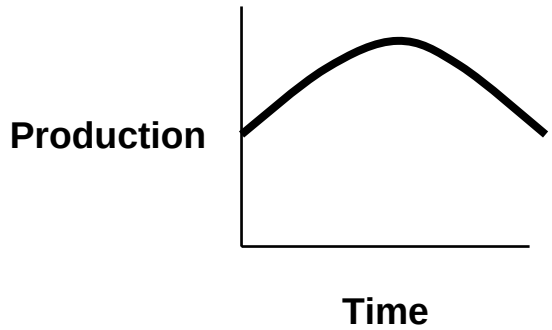
Possible Patterns For Future World Oil Production

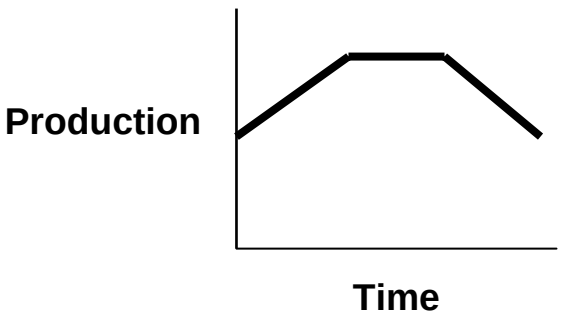
Sharp Break



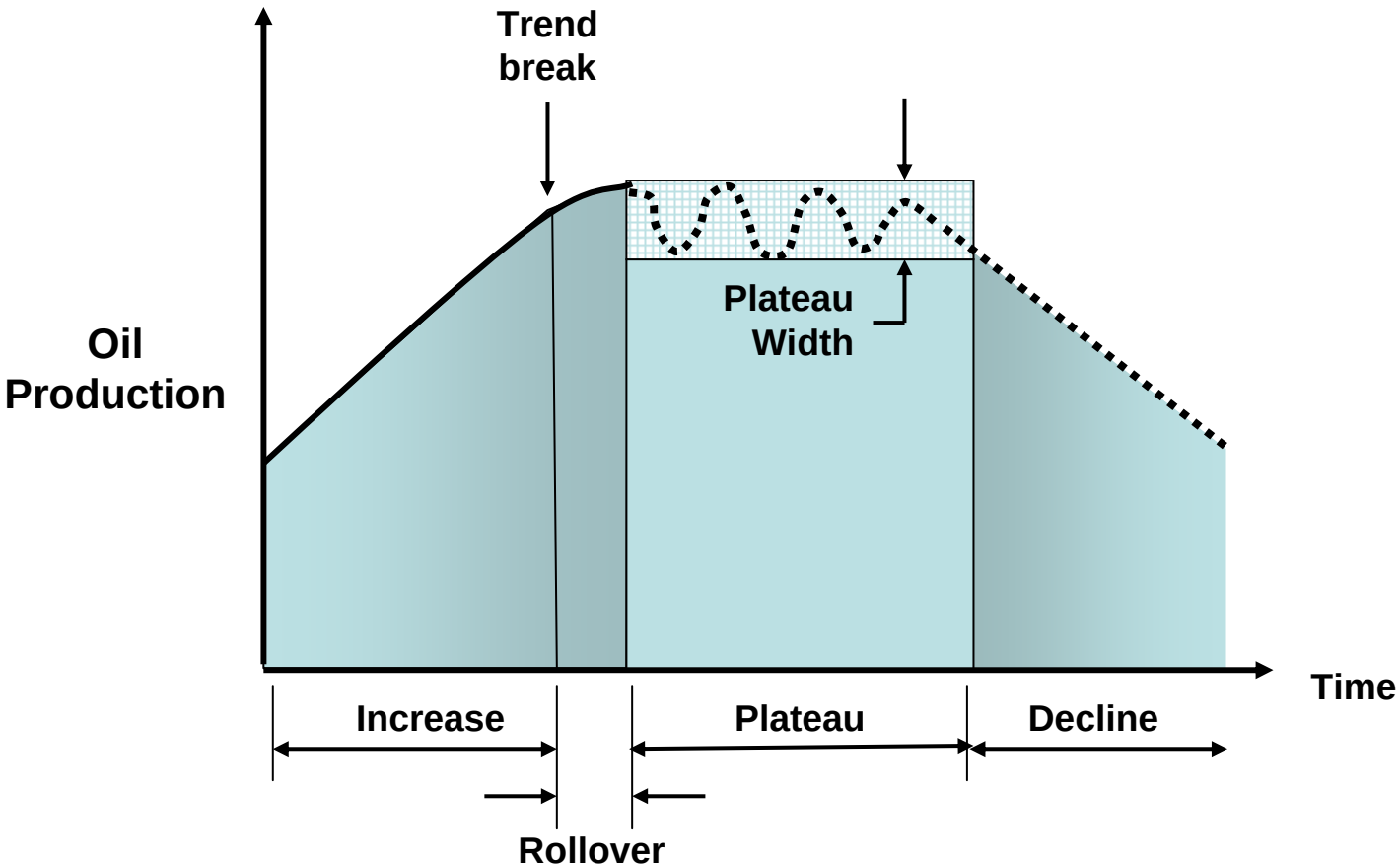
Rollover / Roll-Down



Plateau

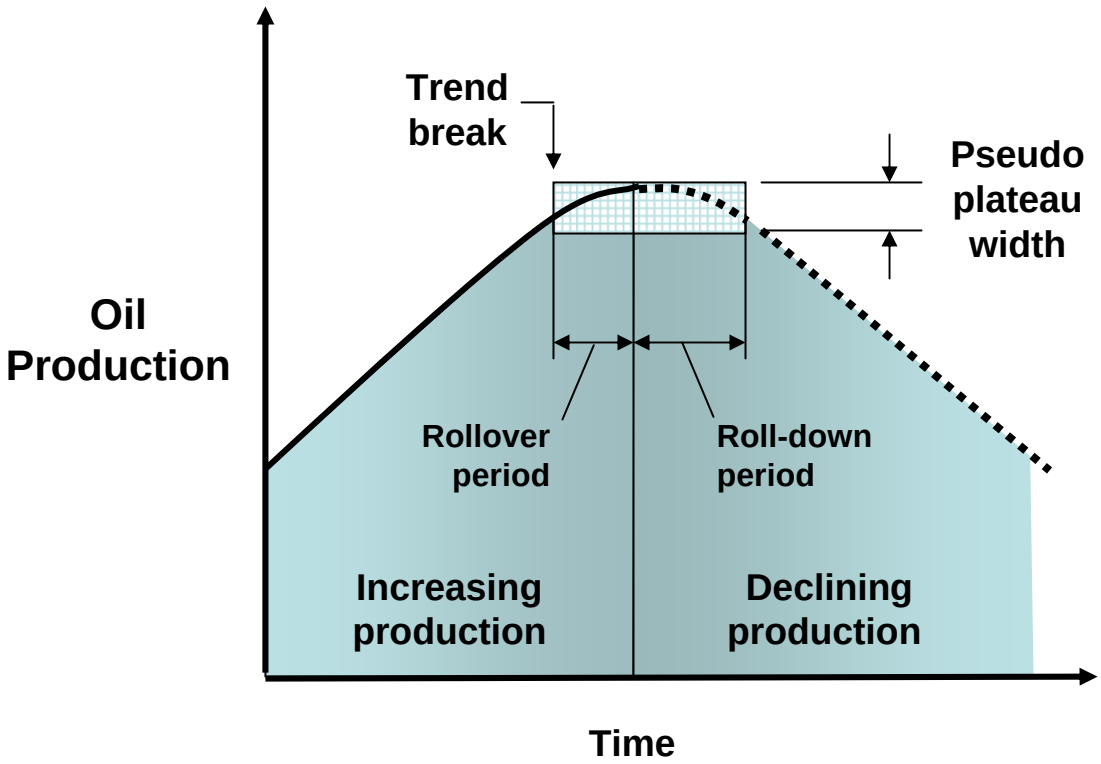


The General Model



The Limiting Case Without an Obvious Plateau

Call the Rollover + Roll-down Period a Pseudo Plateau



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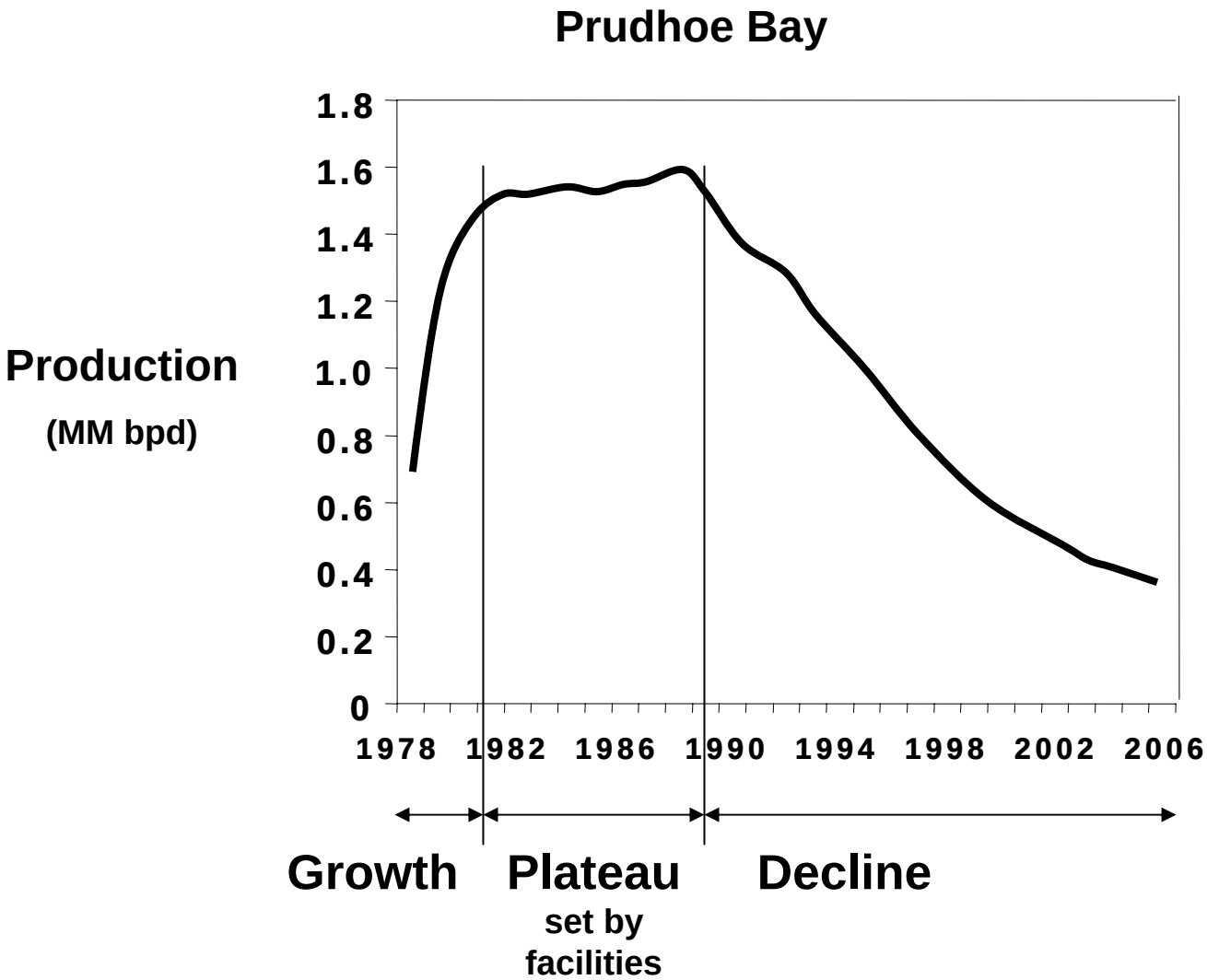
Giant Oil Field Production History



Decline Rates in Selected Giant Oil Fields

Field & Location	URR	Actual Annual Decline Rate
Abaktun, Mexico	3.1 Gb	16%
Beryl, UK	1.5 Gb	14%
Forties, UK	2.6 Gb	8%
Gullfaks, Norway	2.2 Gb	11%
Kuparuk, Alaska	2.6 Gb	8%
Ninian, UK	1.2 Gb	11%
Prudhoe Bay, Alaska	13 Gb	10%
Oseberg, Norway	2.2 Gb	13%
Statfjord, Norway	3.6 Gb	14%
Yibal, Oman	2.1 Gb	15%

8 - 16%

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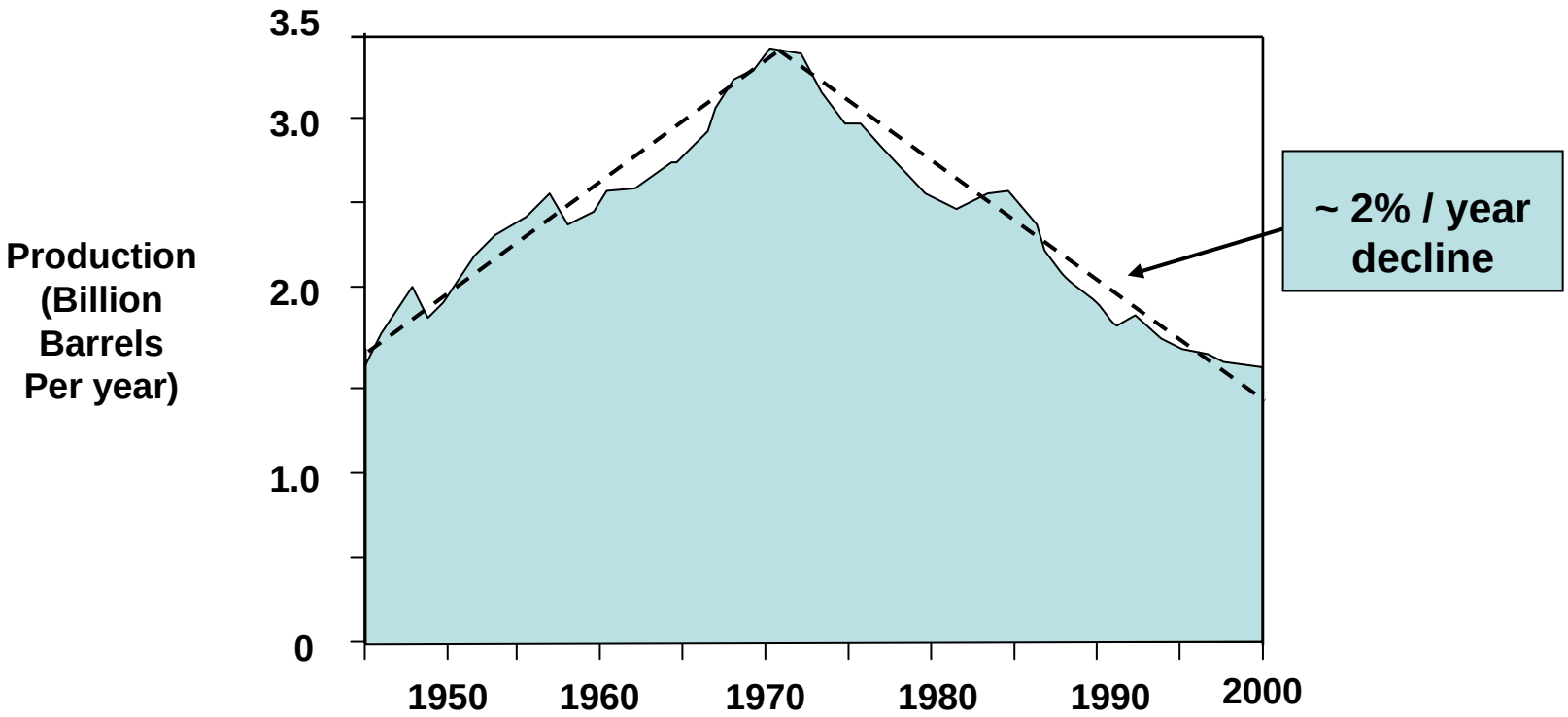
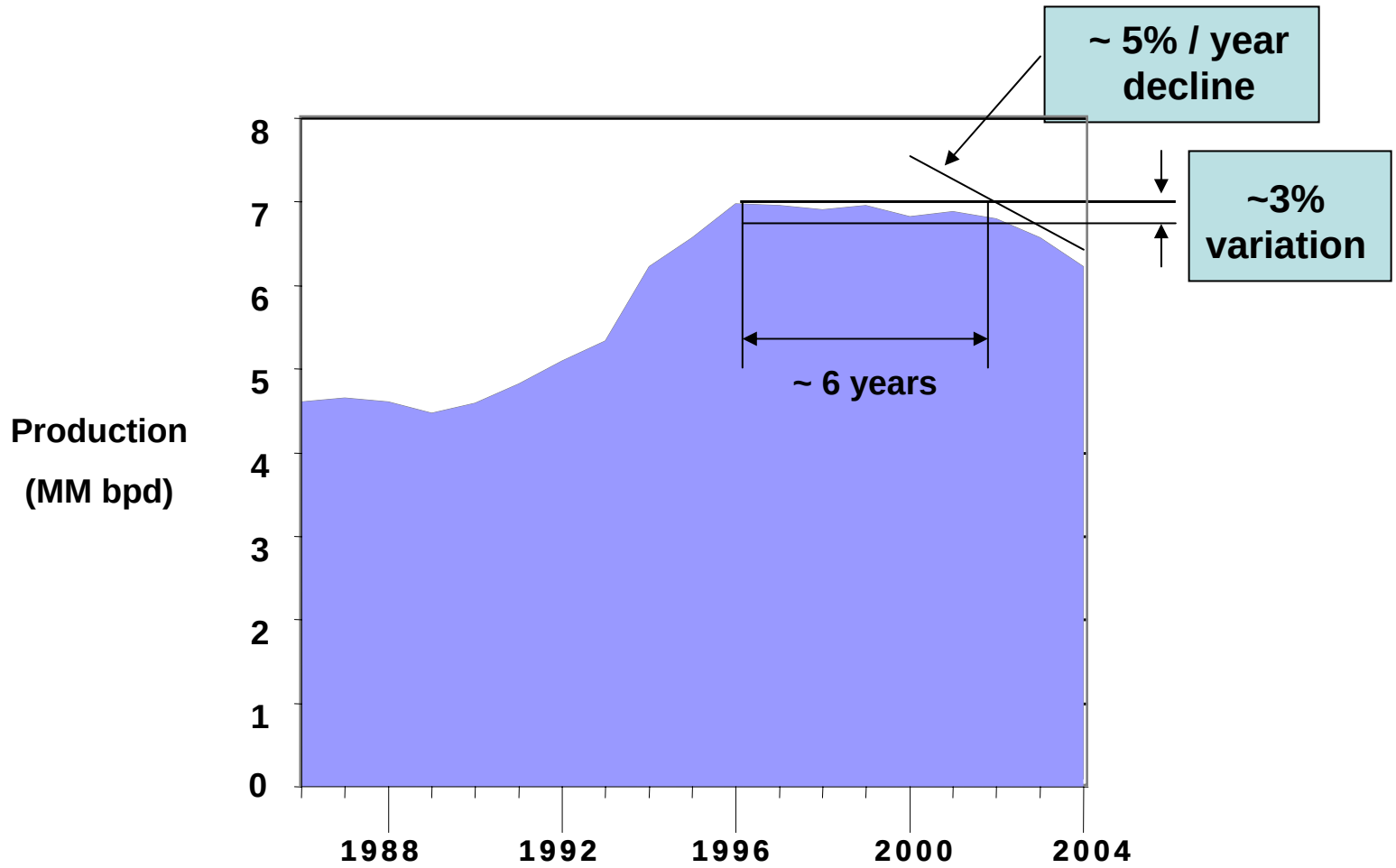
Oil Production in the U.S. Lower 48 States

A sharp break profile



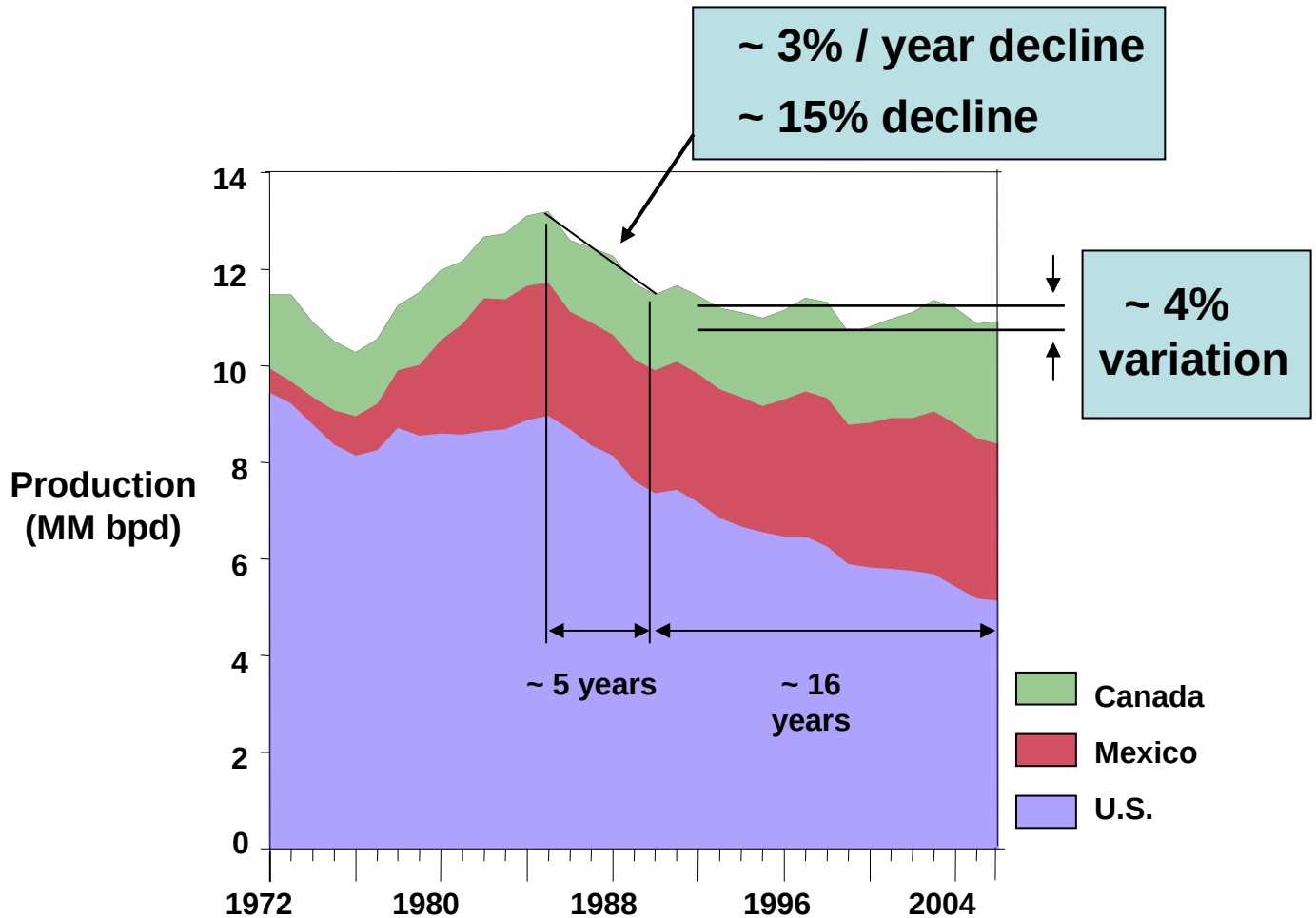
European Oil Production

Plateau & decline



North American Liquid Fuels Production

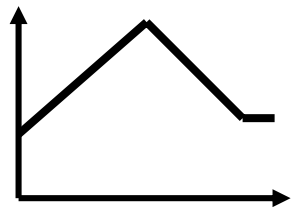
Sharp break, decline & plateau



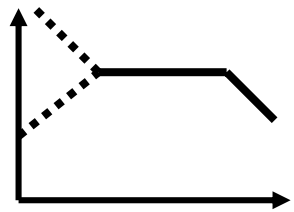
Summary of

North American & European Oil Production

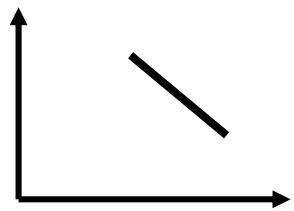
- Sharp break & 5 year decline at ~3%:
  ~ 15 % total (North Am.)



- Plateau widths of **3 - 4%,** length of plateaus of **6** & **16 years**



- Decline phase: **3 - 5% per year**



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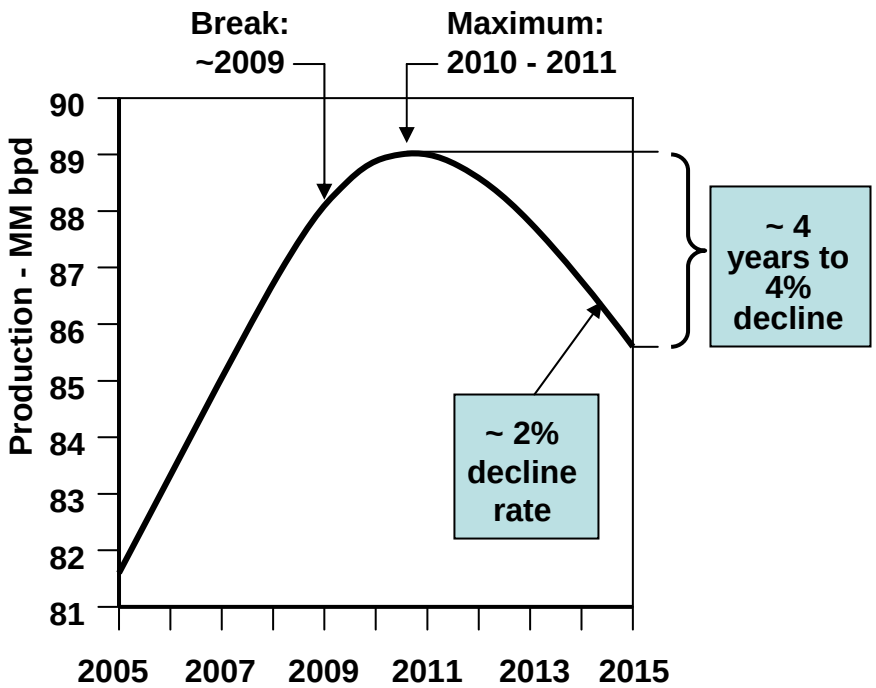
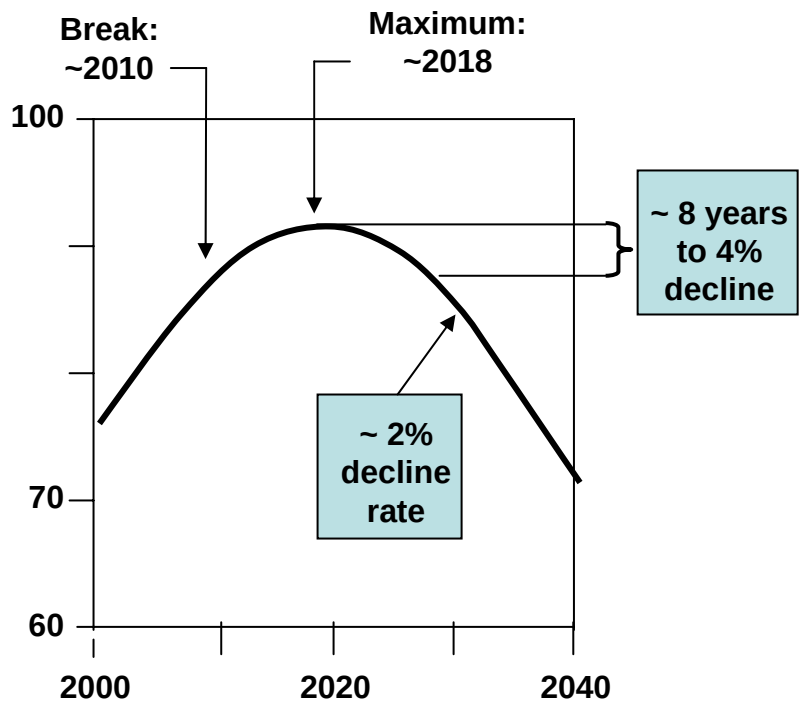
Forecasts of Future World Oil Production

Campbell

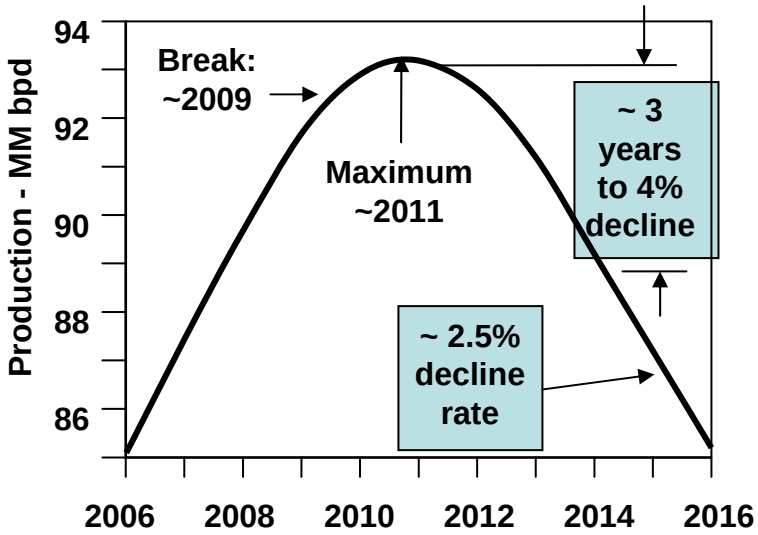


Laharrere

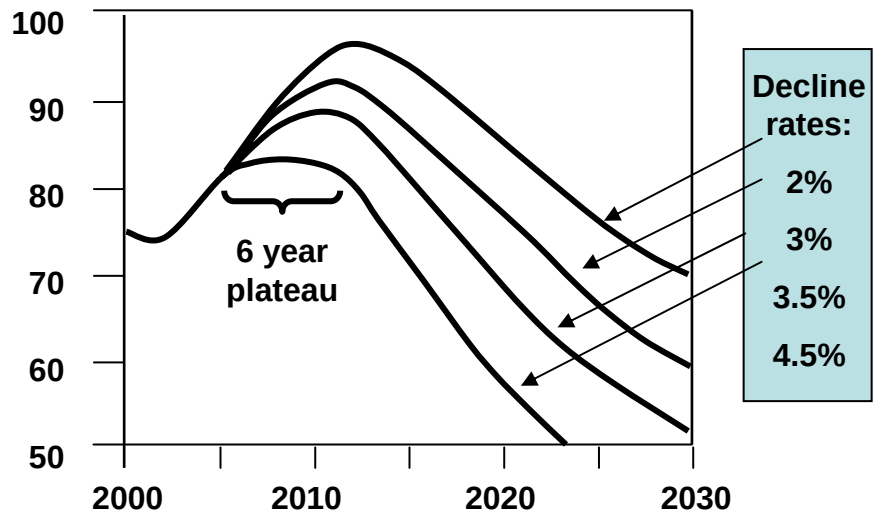


A 4% rollover / roll-down period was assumed as a quasi-plateau = A relatively moderate recession.

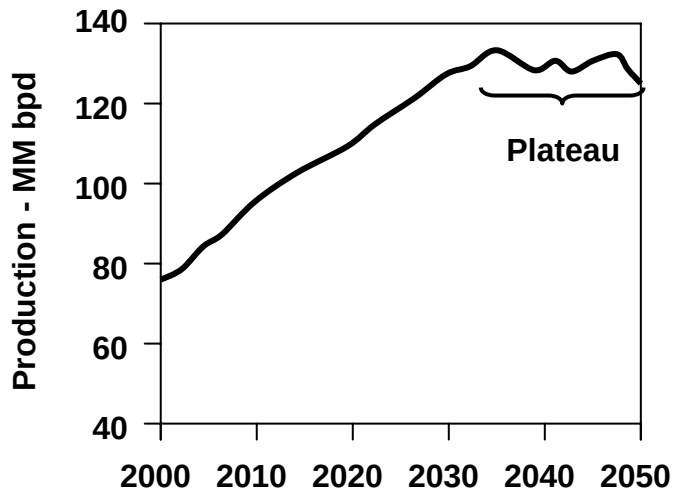
Europe was ~ 3% & North America was ~ 4%



Skrebowski



Robelius



CERA

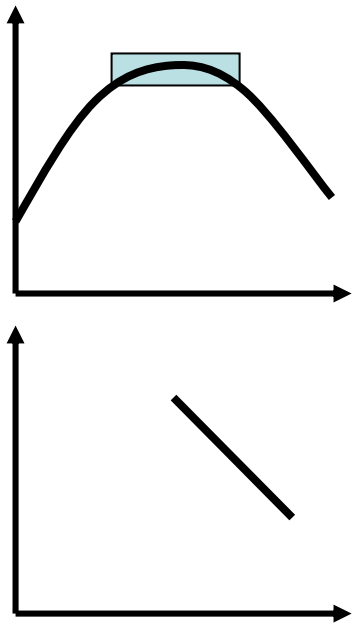
Characteristics of Production Forecasts

Forecaster	Pseudo Plateau Period (4% width)	Final Decline Rates
Campbell	~ 6 years	~ 2%
Laherrere	~ 15 years	~ 2%
Skrebowski	~ 5 years	~ 2.5%
Robelius	Varied	2 - 5%
CERA	Plateau expected	Not forecast

Summary of Oil Forecasts

- Pseudo plateaus (~4%) lasting **2 - 15 years**

- Declines: **2 - 5% per year**



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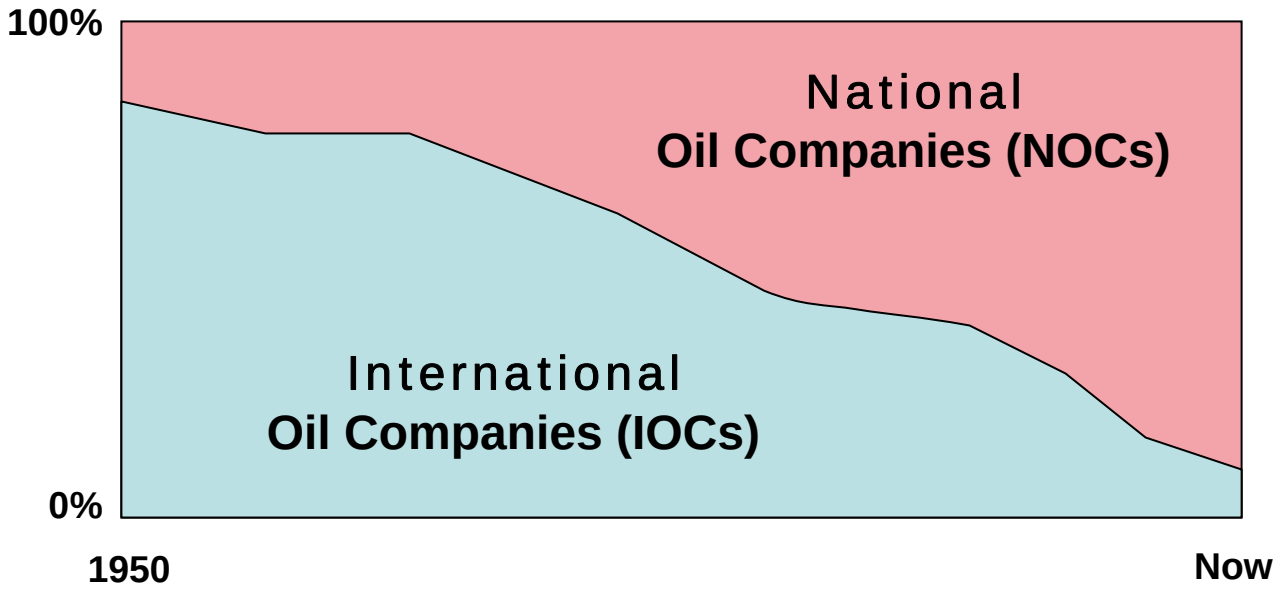
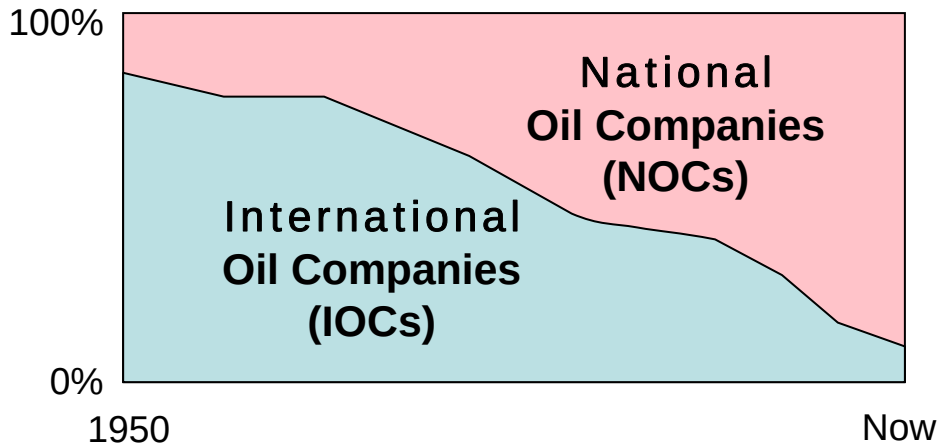
World Oil Market Control --The Power Shift

Notional picture



MAJOR PLAYERS NOW: **Saudi Aramco, NIOC, Pemex, Petrobras, Lukoil, PDVSA, PetroChina, etc.**
Diminished Players ("Baby Oil"): **ExxonMobil, Chevron, Shell, BP, ConocoPhillips, etc.**

World Oil Market Control --The Power Shift



Profit-Oriented Stakeholders

Well-managed, technologically strong, efficient, transparent, long time horizons, financially strong, growth-oriented, etc.

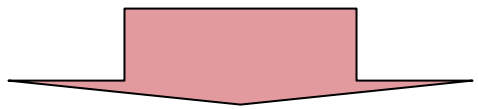
Political Stakeholders

Cash output important. Some have poor management, low reinvestment, short time horizons, financially weak, etc.

Peak Oil & Exporter Strategies

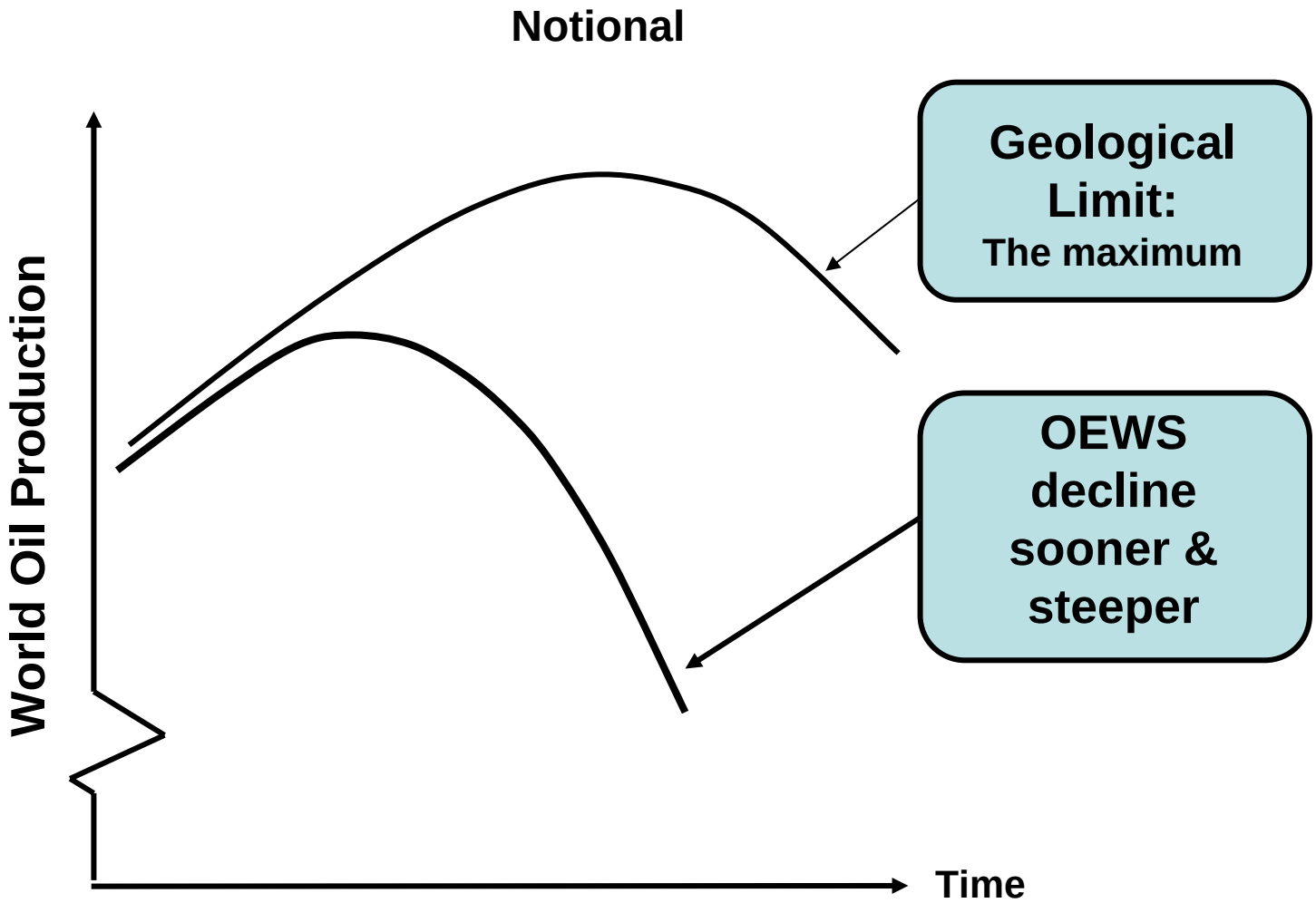
- Peak oil not yet real to most people & countries
- When realized (likely sudden), panic could cause shortages & oil prices to rise rapidly (1973 & 1979)
- For oil exporters: Another large windfall

- **Some exporters will likely reduce exports.**
  - Less need for income due to their new windfall
  - Internal oil consumption rising
  - Realization that national oil resources are finite
  - Conserving for the future makes good sense



Oil Exporter Withholding Scenario

Oil Exporter Withholding Scenario (OEWS)



IEA: There's Trouble

- "The recent apparent surge in oil and gas investment is illusory, because costs have soared. Real investment in 2005 was barely higher than in 2000."
- "This energy future is not only unsustainable, it is doomed to failure," because of underinvestment.
- **"... we are on course for an energy system that will evolve from crisis to crisis…"**
- **Excess capacity and demand converge in 2012 (Peaking).**

It's the NOCs.

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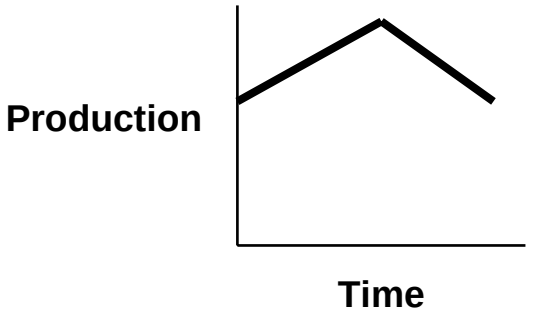
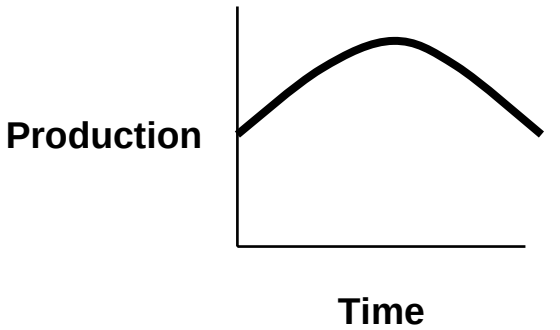
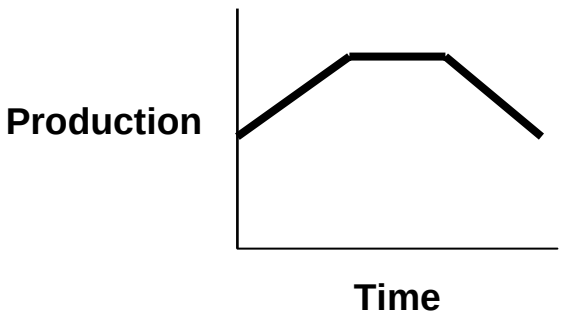
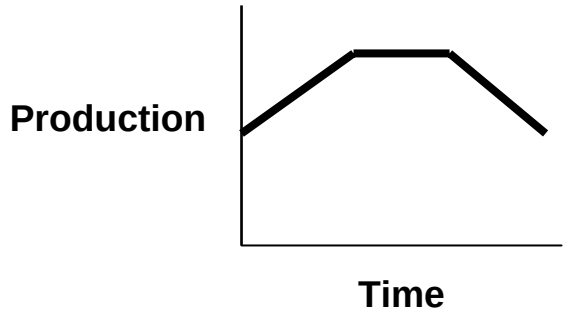
Original Patterns



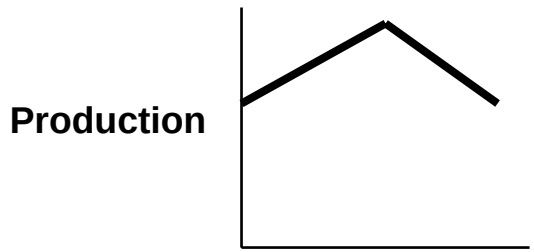




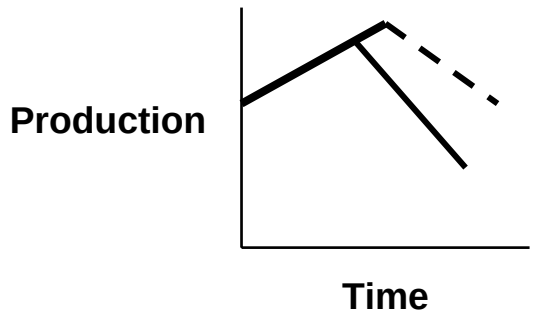
Three Planning Scenarios



Best
Plateau



Meddling
Sharp like North America

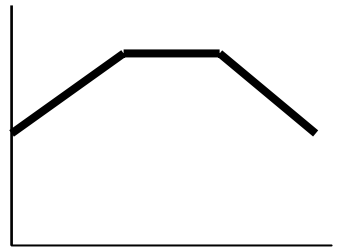


Worst
Sharp plus Exporter Withholding

Scenarios for Maximum World Oil Production

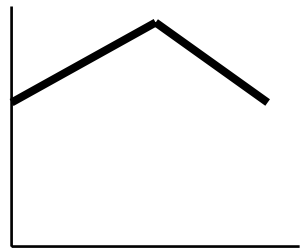
I. BEST CASE - Plateau of 2 - 15 years

Then a decline of **2-5% per year.**



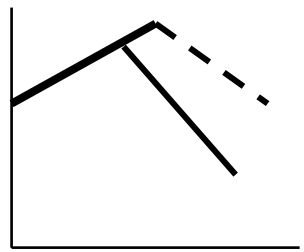
II. MIDDLING CASE - Sharp Peak

Then a decline of **2-5% per year.**



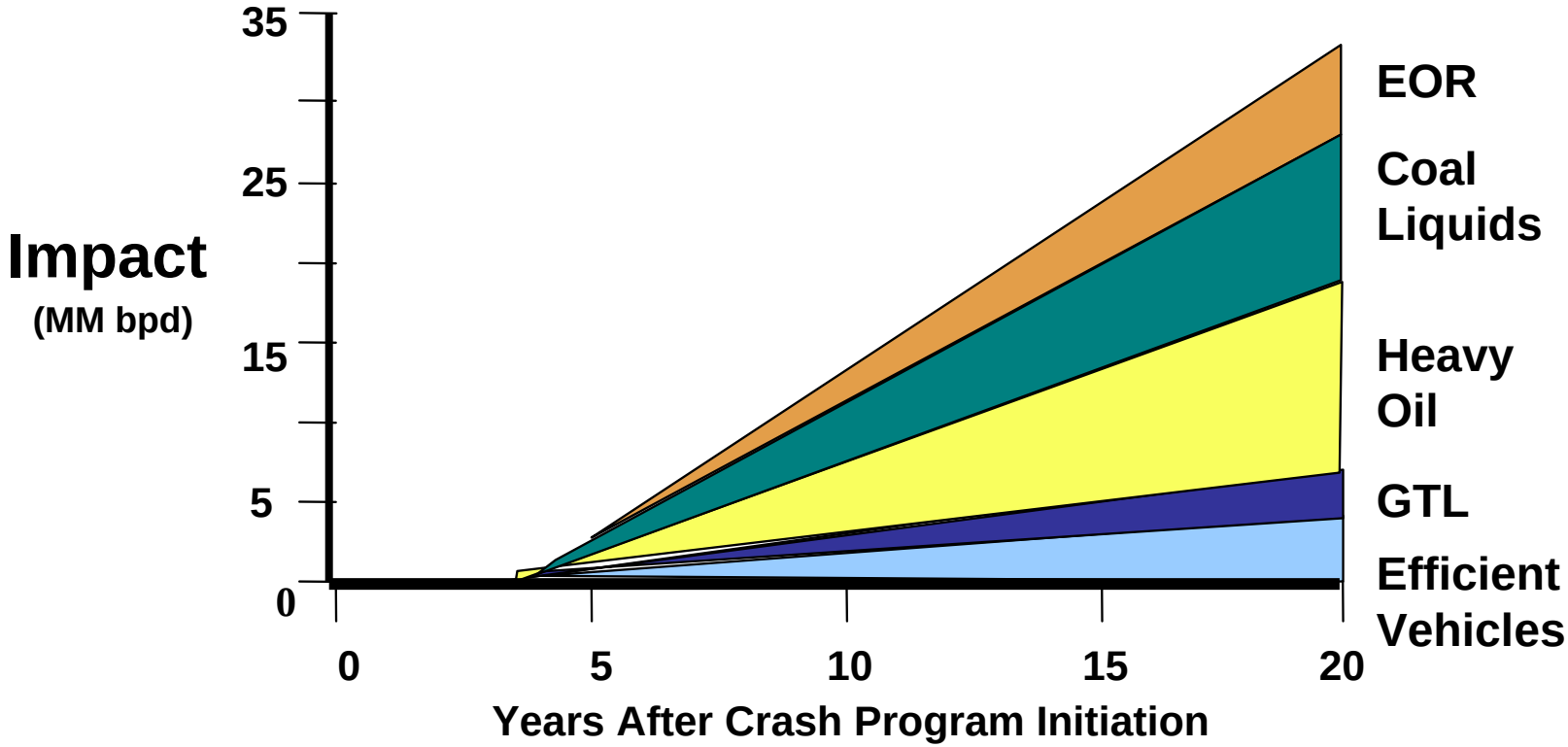
III. WORST CASE - Oil Exporter Withholding

Then a decline **greater than 2-5% per year.**



Worldwide Crash Program Mitigation of Conventional Oil Production Peaking

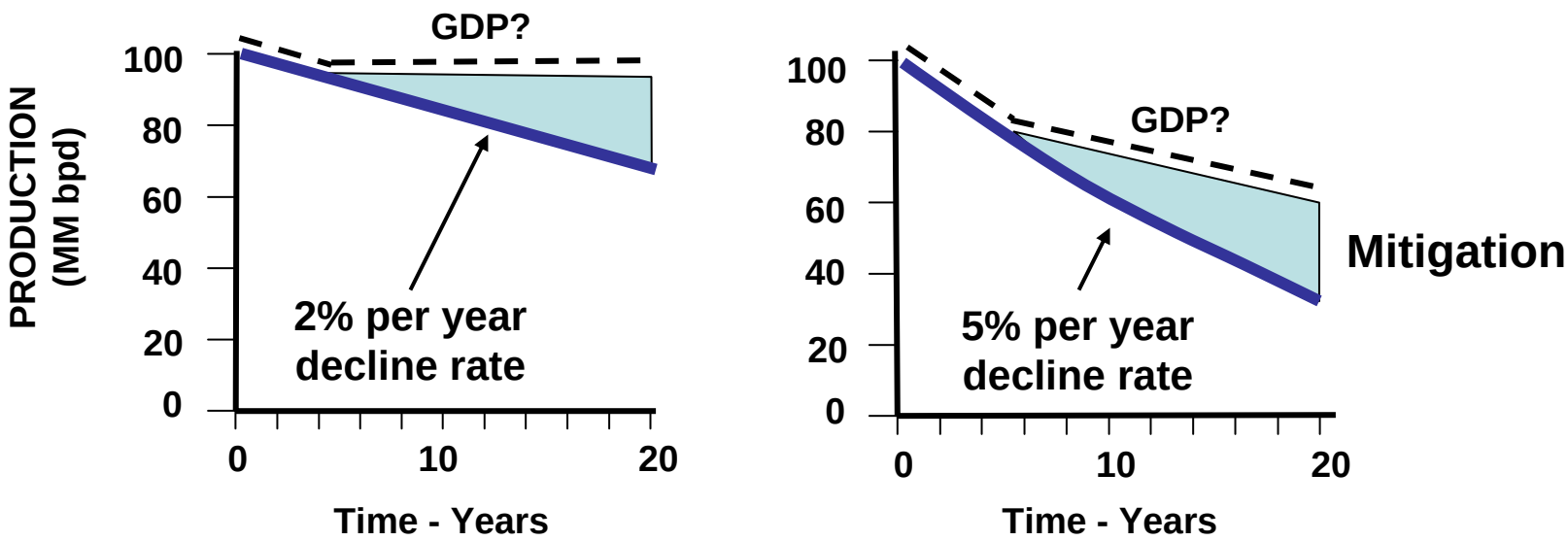
2005 NETL Study.



- **Delay, then rapid growth.**
- **Can mitigation overtake oil decline?**

Crash Program Mitigation Starting the Year of Decline

Assumes a 100 MMbpd start.



Summary

- **Small percentages represent huge impacts.**
- **% World oil shortage ~ % Decline in world GDP**
- **Regional oil production maximums can be sharp or plateau followed by decline.**
- **Resource nationalism has dramatically changed world oil.**

Three world mitigation planning scenarios:

- **Best** - Plateau of 2 - 15 years / 2-5% per year decline
- **Middling** - Sharp peak / 2-5% per year decline
- **Worst** - Steeper decline from exporter withholding.

Peak Oil:

The more you think about it, the uglier it gets.

2007 Houston World Oil Conference

Proceedings

- Conference Program
- Conference DVD
- Video Highlights
- Peak Oil Review
- ASPO-USA