

# **PEAKING OF WORLD OIL PRODUCTION**

## **How Do We Mitigate the Problem?**

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July 2005**

# The Situation

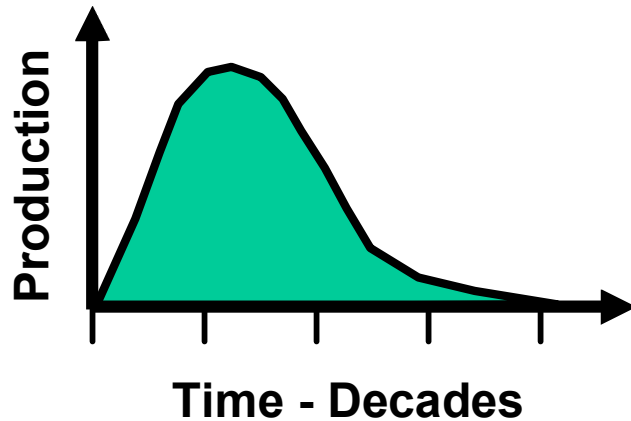
- **THE PROBLEM:** At some point, world conventional oil production will no longer meet demand.
- **WHY?** The resource is finite and being rapidly depleted.
- **WHEN WILL PEAKING OCCUR?** No one knows / Some think within 10 years, others later.
- **WHY CAN'T THE PROBLEM BE FIXED QUICKLY?**

The scale of change is enormous.

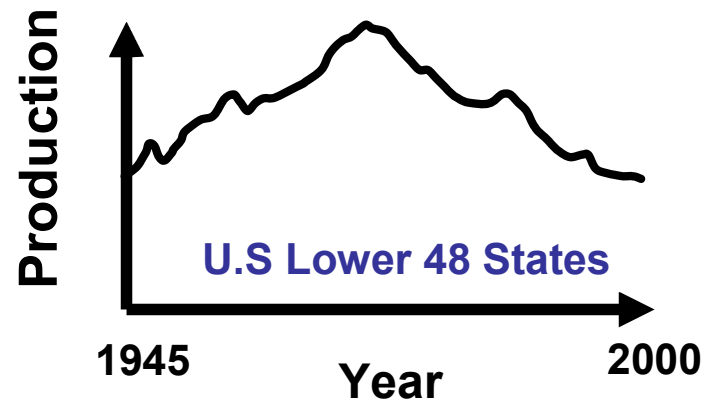
# **This Presentation**

- **The Problem**
- **Learning From Experience**
- **Transportation Fleets**
- **Mitigation Options**
- **Three Mitigation Scenarios**
- **Some Final Thoughts**

# Why will conventional oil production peak?



**Oil fields  
peak**



**Regions  
peak**

**The world  
(all regions)  
will peak.**

# Important Points

**Peaking is maximum production.**

**It is not running out; it is running down.**

**It's a liquid fuels problem.**

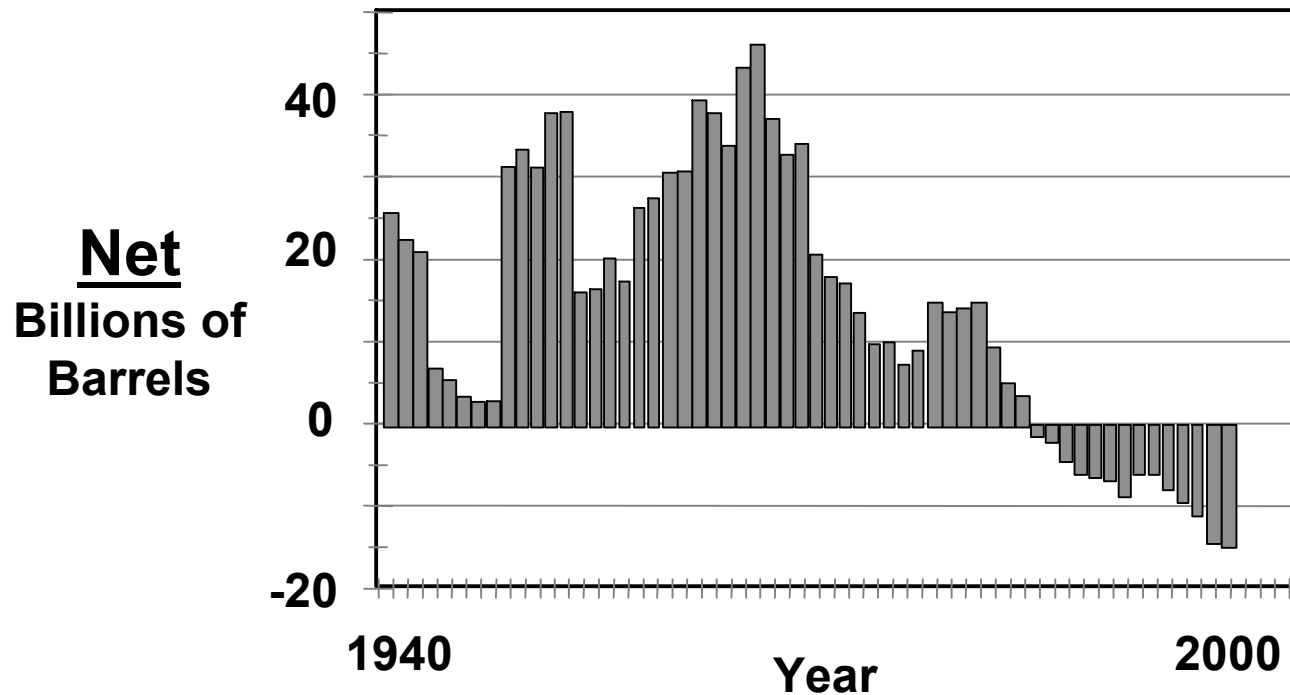
**It's the world's first forced energy transition.**

# Why worry now?

**Many experts are pessimistic.  
If ignored, economic consequences are dire.**

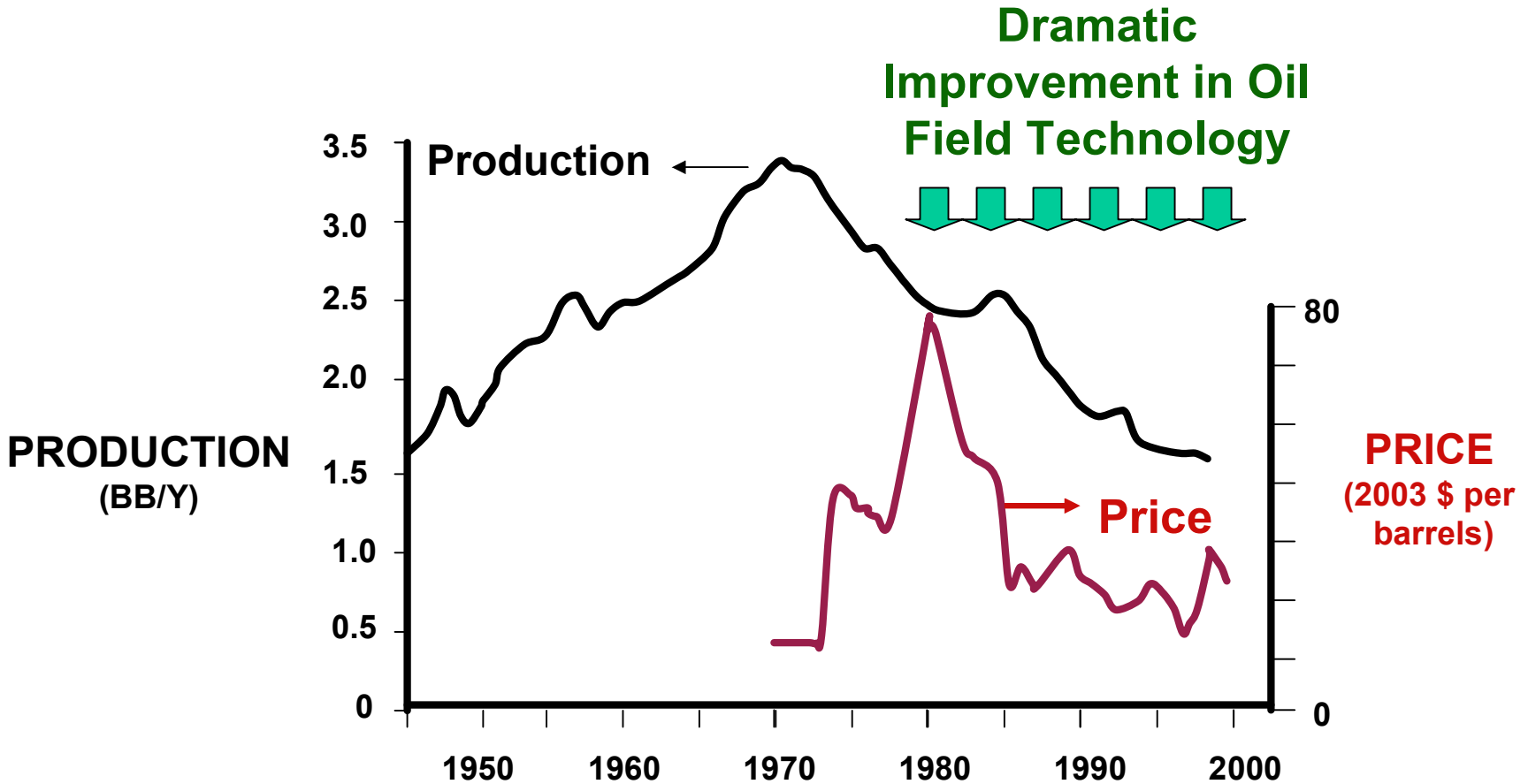
- It's a world problem / the oil market is a world market.
- World oil demand is huge & growing.
- Many countries have already passed peak production.
- World consumption is vastly outstripping discoveries.
- Advanced technology & high prices are not magic.

# Annual world oil consumption has been exceeding additions for a long time



We've been "eating our seed corn."

# Experience: U.S. Lower 48 States Oil Production

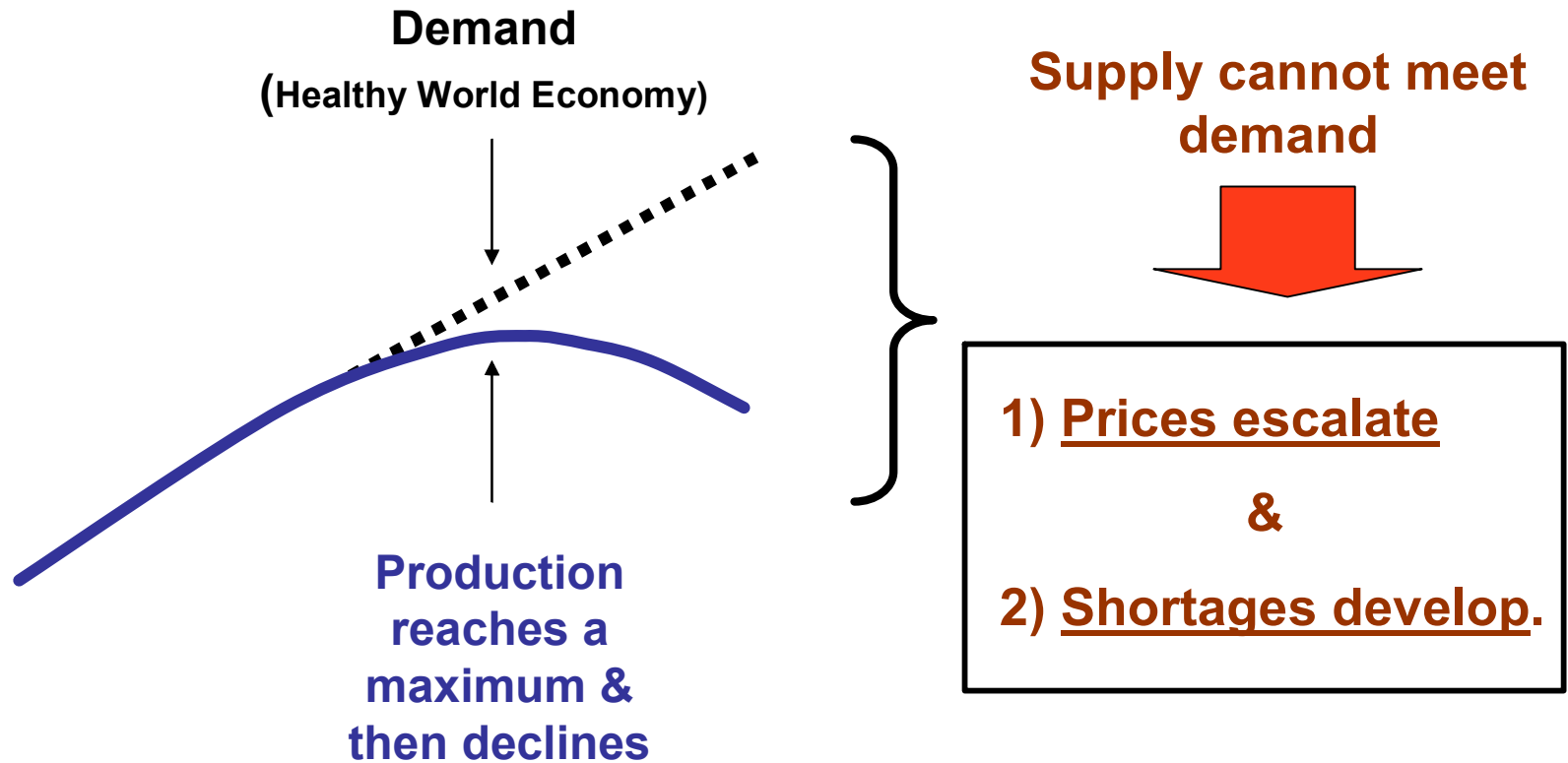


High prices & advanced technology did not reverse trends!

# When will world conventional oil production peak?

<u>Forecast</u>	<u>Source</u>	
2006-2007	Bakhitari (Iran)	}
2007-2009	Simmons (U.S.)	
After 2007	Skrebowski (U.K.)	
2008	Campbell (Ireland)	
Before 2009	Deffeyes (U.S.)	
Before 2010	Goodstein (U.S.)	
		<b>5 years</b>
After 2010	World Energy Council	}
2012	Weng (China)	
2016	Doug-Westwood (U.K.)	
		<b>5-10 years</b>
After 2020	CERA (U.S.)	}
2031 or later	EIA (U.S.)	
		<b>&gt; 15 years</b>

# What's likely to happen at peaking?



# Learning from Experience

- **North American natural gas**
- **Peaking in various countries & regions**
- **Economic impacts in 1973 & 1979**

# Experience: North American Natural Gas

- **Experts overestimated North American natural gas reserves & future production as late as 2001.**
  - **National Petroleum Council** - 1999
  - DOE **EIA** - 1999
  - Cambridge Energy Research Associates (**CERA**) - 2001
- **U.S. natural gas production is now flat / in decline.**

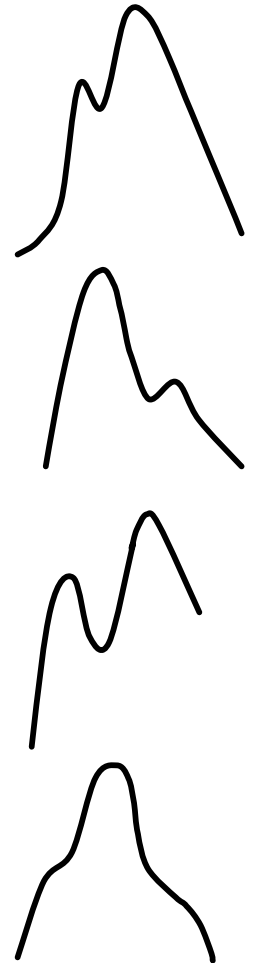
- **Natural gas & oil geology similar in many ways.**
- **If wrong on natural gas, what's the risk on oil?**

# Experience: Oil Has Already Peaked Sharply in Countries & Regions

The peaking that has already occurred:

1. Sudden onset
2. Very sharp peak

This could be true for the world.



# Experience: Notable Oil Interruptions

- Impacts of world oil production peaking are exemplified by the 1973 & 1979 oil interruptions.

+ Inflation

+ Unemployment

+ Recession

+ High interest rates

- 1973 & 1979 were relatively brief.
- World oil peaking impacts could last a decade or more.

**The world has never faced a problem like oil peaking.**

# The Scale of Things

- **U.S. 2003 consumption: ~20 MM bpd**
  - ~25% of world oil demand
  - ~Two thirds used in transportation
- **The U.S. transportation fleet**
  - + Very large
  - + Expensive
  - + Evolves slowly



# U.S. Transportation - 2003

	<b>Autos</b>	<b>Light Trucks</b>	<b>Heavy Trucks</b>	<b>Airplanes</b>
Share of transport fuel consumption	<b>39%</b>	<b>28%</b>	24%	9%
Fleet size - Millions	130	80	7	0.0085
New - Millions/Year	8.5	8.5	0.5	Small
Median life - Years	<b>17</b>	<b>16</b>	28	22

**Biggest / fastest savings**

## Cost to Replace Half of U.S. Fleets

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**Automobiles**

**\$1.3 trillion**

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**Light Trucks, SUVs, etc.**

**\$1 trillion**

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**Heavy Trucks, Buses, etc.**

**\$1.5 trillion**

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**Aircraft**

**\$.25 trillion**

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2003 \$

# Transportation Equipment Changes

Large efficiency improvements possible in some fleets, smaller in others,

**BUT**

**Change is slow & expensive.**

**Fuel must be provided for existing fleets.**

# Fixing the Problem

## Three Mitigation Scenarios for the World

- **Scenario I** - No action until peaking occurs
- **Scenario II** - Mitigation started 10 years before peaking
- **Scenario III** - Mitigation started 20 years before peaking

Assumption:

Immediate crash program implementation

**Optimistic limiting case**

# Mitigation Options We Considered

Commercial technologies ready for

**Implementation**

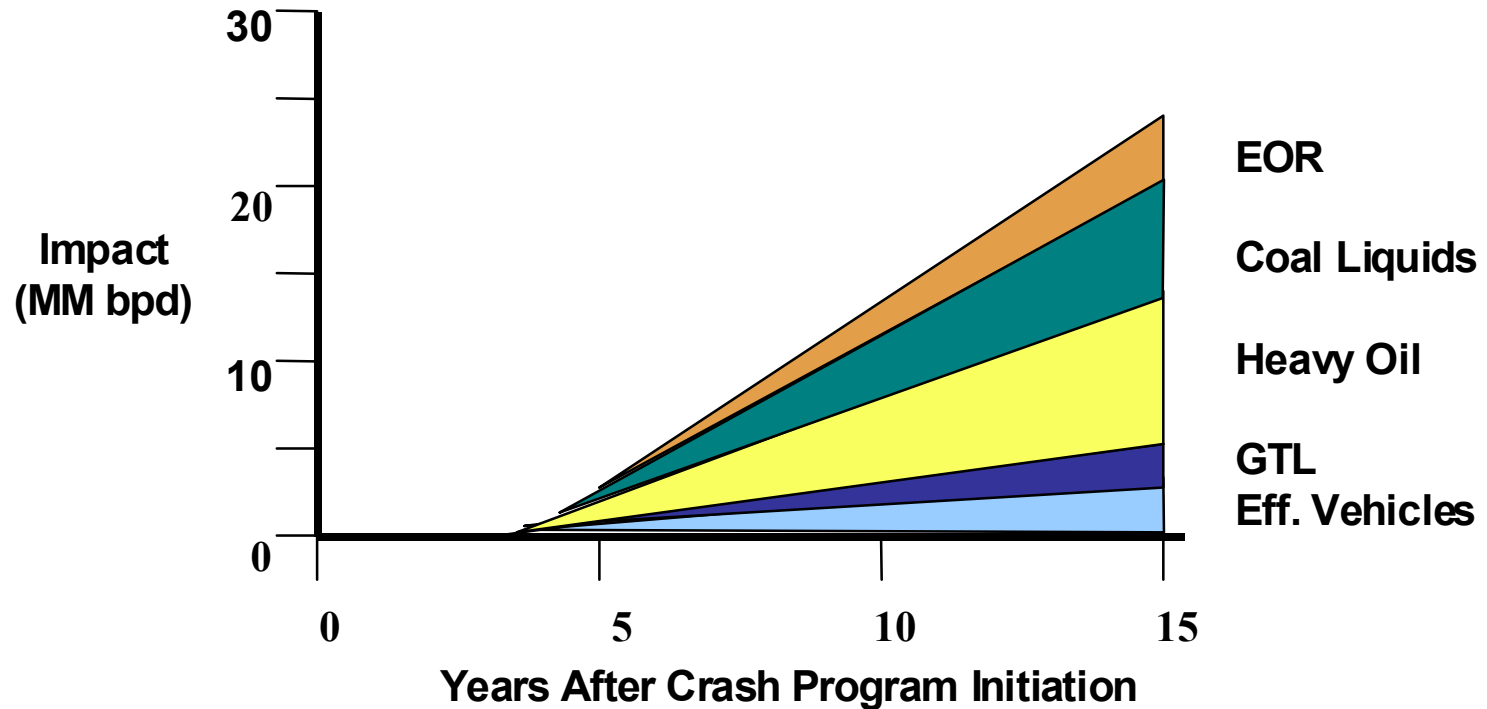
- Vehicle fuel Efficiency
- Gas-To-Liquids (GTL)
- Heavy oil / oil sands
- Coal Liquefaction
- Enhanced oil Recovery (EOR)

# Options Not Included

<u>Option</u>	<u>Reasoning</u>
– Nuclear	..... <u>ELECTRICITY, NOT LIQUIDS</u>
– Wind	
– Solar	
– Hydrogen.....	Neither ready nor economic
– Biomass.....	Not economic
– Shale Oil.....	Not commercial

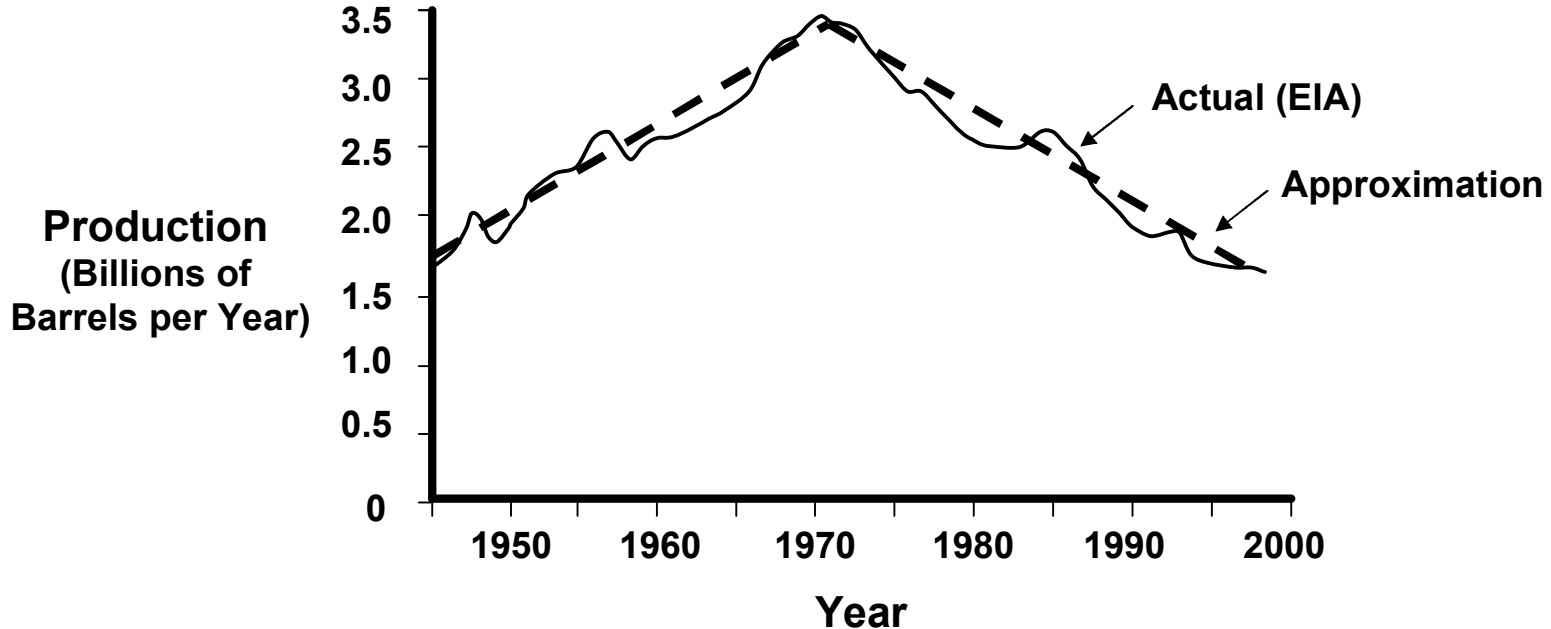
# Best Possible Mitigation Contributions

## Delayed Wedge Approximations



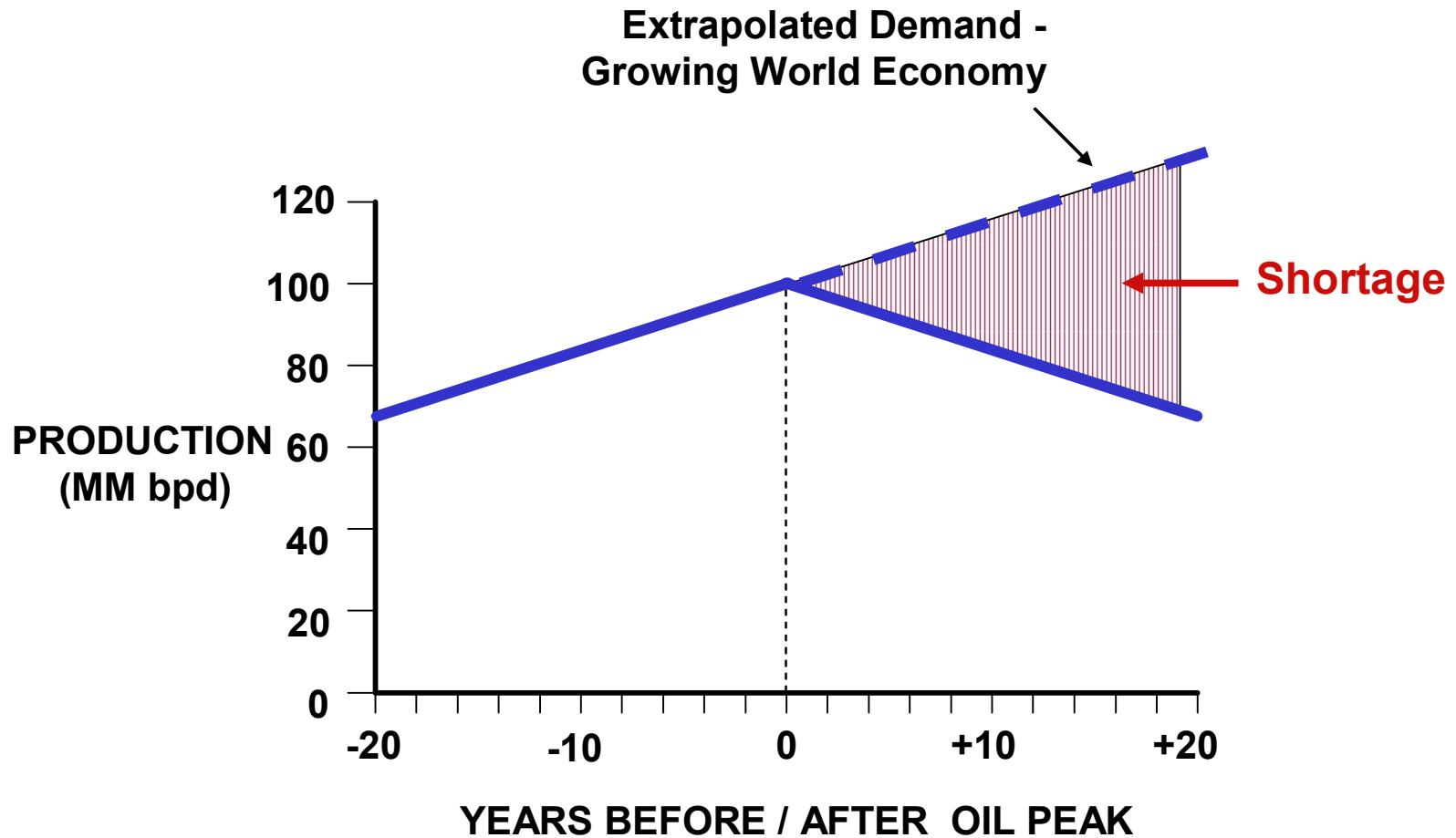
- Delay, then rapid growth.
- Roughly 25 MM bpd at 15 years after crash program start.

# Use the U.S. Lower - 48 States Pattern for World Oil Peaking



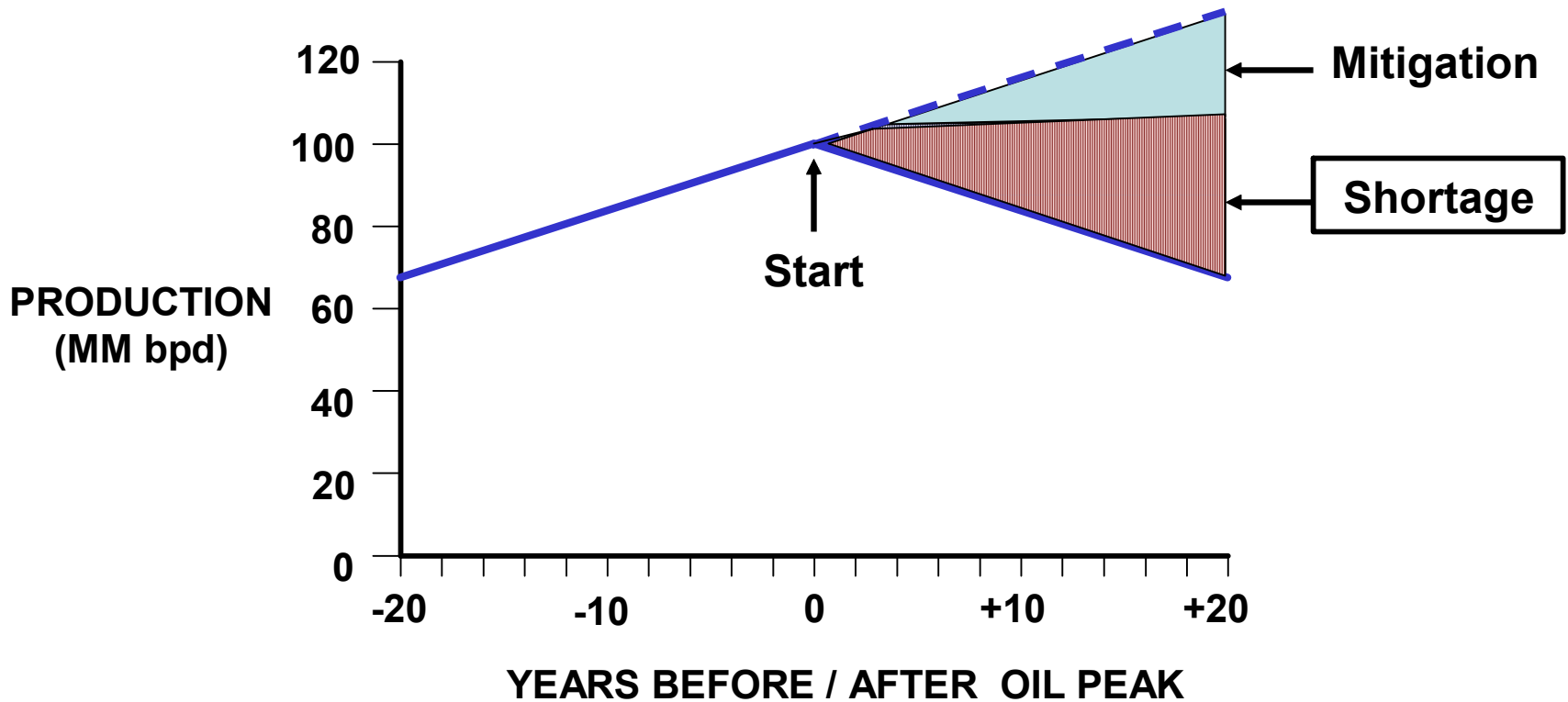
**A huge, complex & geologically varied oil province & a 50 year history.**

# Assumed World Oil Supply / Demand Pattern

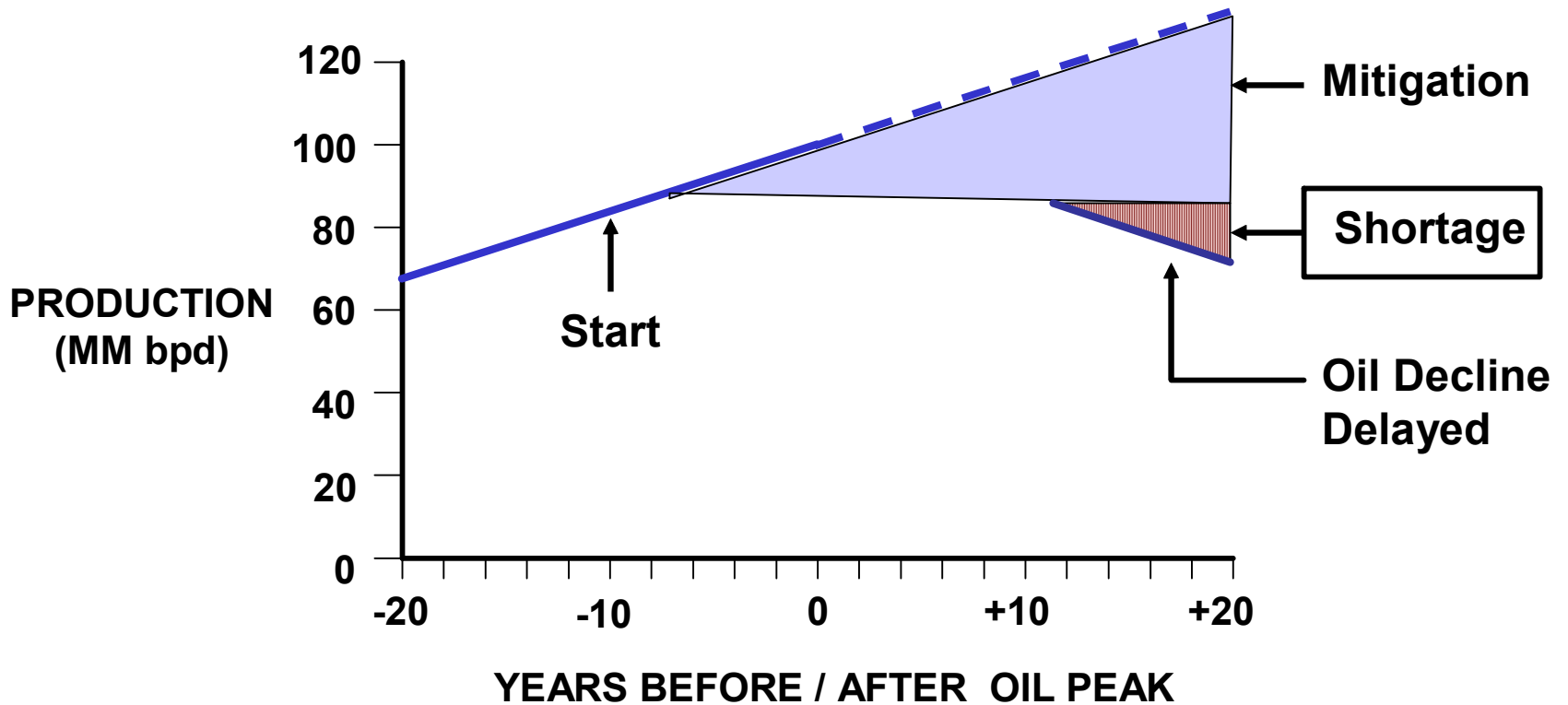


Date of peaking not specified

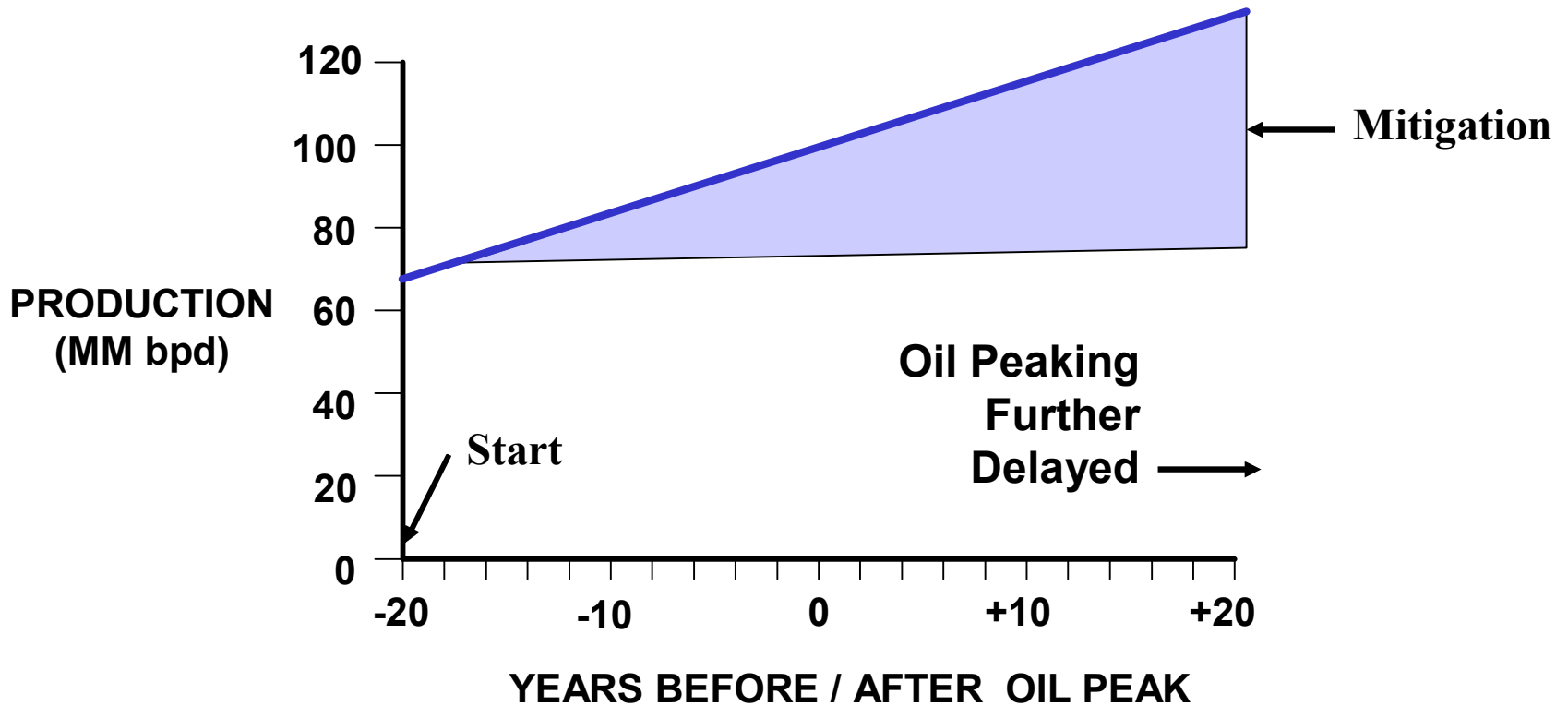
# Scenario I: Start Mitigation @ Peaking



# Scenario II: Start Mitigation 10 Years Before Peaking



# Scenario II: Start Mitigation 20 Years Before Peaking



# Conclusions from Scenario Analysis

Remember: Immediate crash program implementation

Scenario	Result
<b>Wait for peaking</b>	<b>Oil shortages largest, longest lasting</b>
<b>Start 10 years early</b>	<b>Delays peaking; still shortages</b>
<b>Start 20 years early</b>	<b>Avoids the problem; smooth transition</b>

# World Production Decline Could More Rapid Than 2%

ExxonMobil..... 4-6%  
Schlumberger (Gould)..... 8%

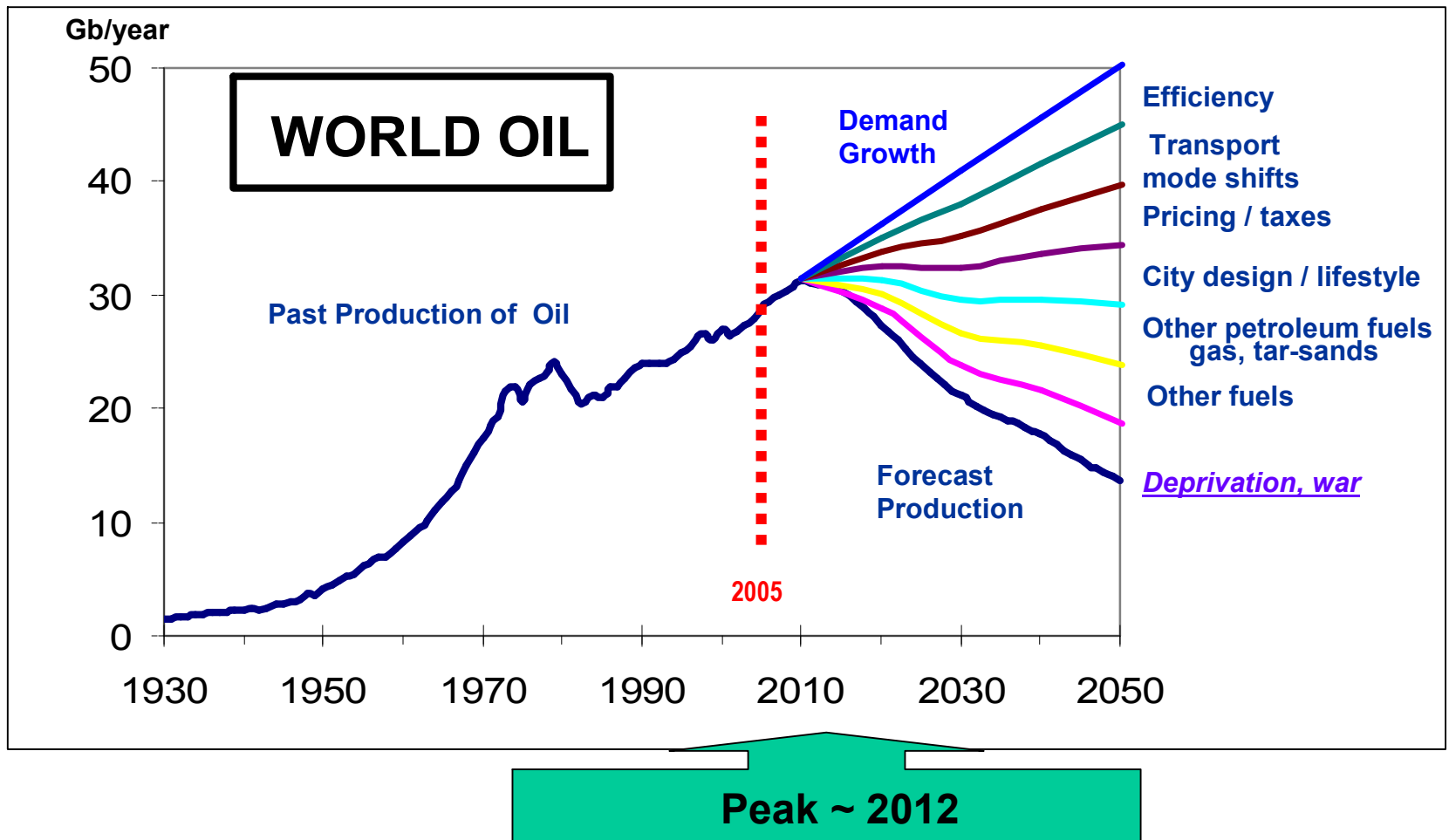
Modeled 2 MM bpd

4-8 MM bpd annual declines

# Forecasts of World Conventional Oil Production Peaking

	<u>Forecast</u>	<u>Source</u>	
<b>Now</b> →	2006-2007	Bakhitari (Iran)	} <b>“Soon”</b>
	2007-2009	Simmons (U.S.)	
	After 2007	Skrebowski (U.K.)	
	2008	Campbell (Ireland)	
	Before 2009	Deffeyes (U.S.)	
	Before 2010	Goodstein (U.S.)	
	After 2010	World Energy Council	
	2012	Weng (China)	
<b>Now + 10 years</b> →	2016	Doug.-Westwood	
<b>Now + 20 years</b> →	After 2020	CERA (U.S.)	
	2031 or later	EIA (U.S.)	

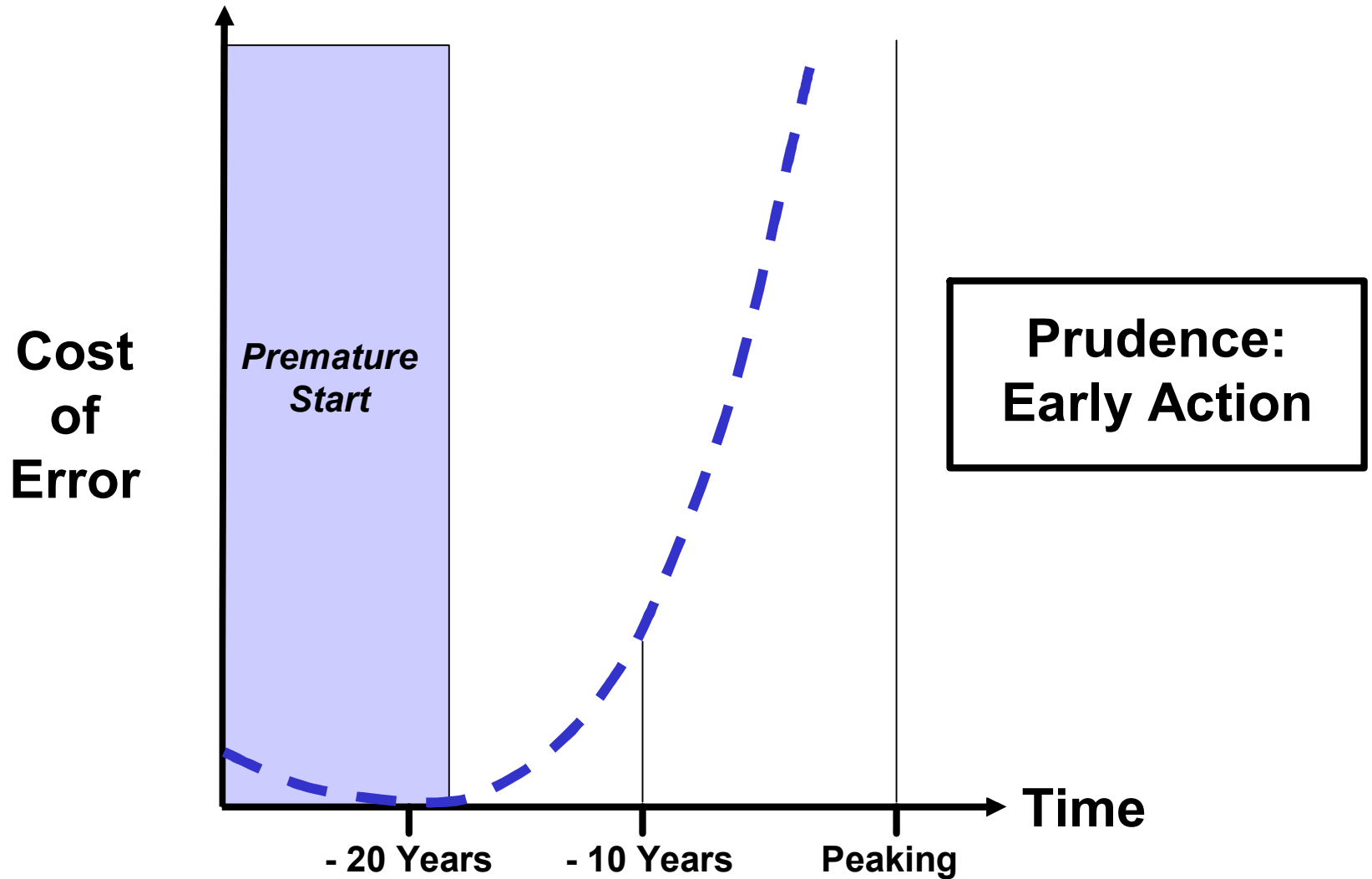
# A Chinese View on Peak Oil



**“The Chinese government is well aware of peak oil.”**

Pang Xiongqi, China University of Petroleum in Beijing

# With an uncertain peaking date, what to do?



# Summary & Conclusions

- There's unprecedented trouble ahead in world oil.
  - It's unavoidable but it can be mitigated.
  - Timing is uncertain.
  - Warning could be very short .
- It's not “energy; it's liquid fuels problem.
- Technologies are available to mitigate.



# The Scale of Oil Production

- In the time that I took for this presentation, humankind withdrew roughly a million barrels of oil from the earth.
- At current world oil production, it would take roughly half a minute to fill this room with oil.



# OPEC Backing Down?

October 2004

**“Resource base is adequate to meet growth for decades to come.”**

OPEC Research Director. 10/26/04

July 2005

**“Saudi ... (OPEC) will be unable to meet projected ... demand in 10 to 15 years.”**

Financial Times. 7/7/05

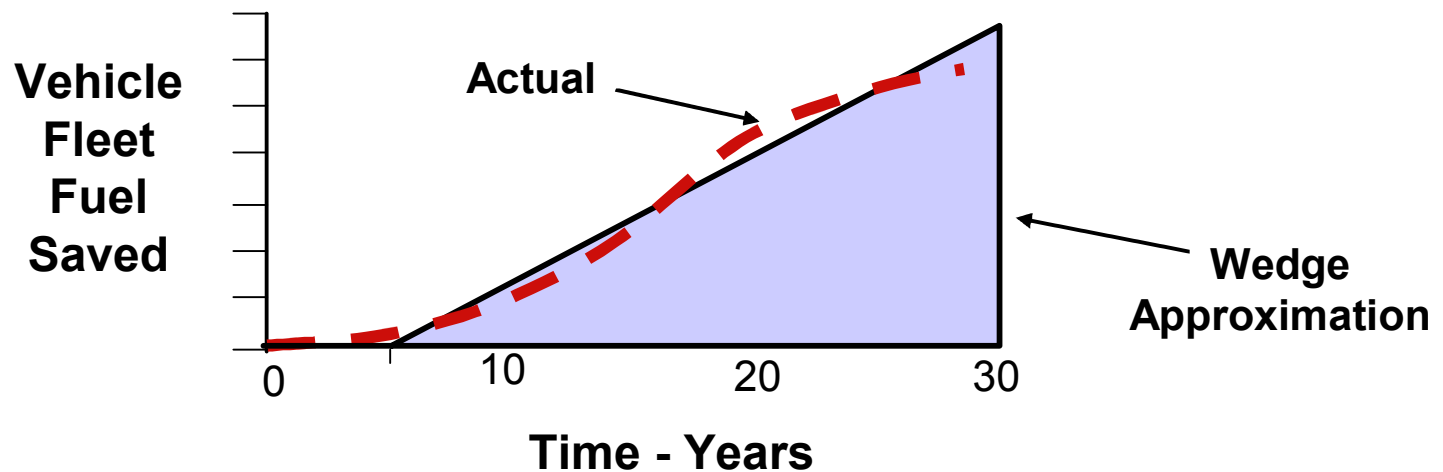
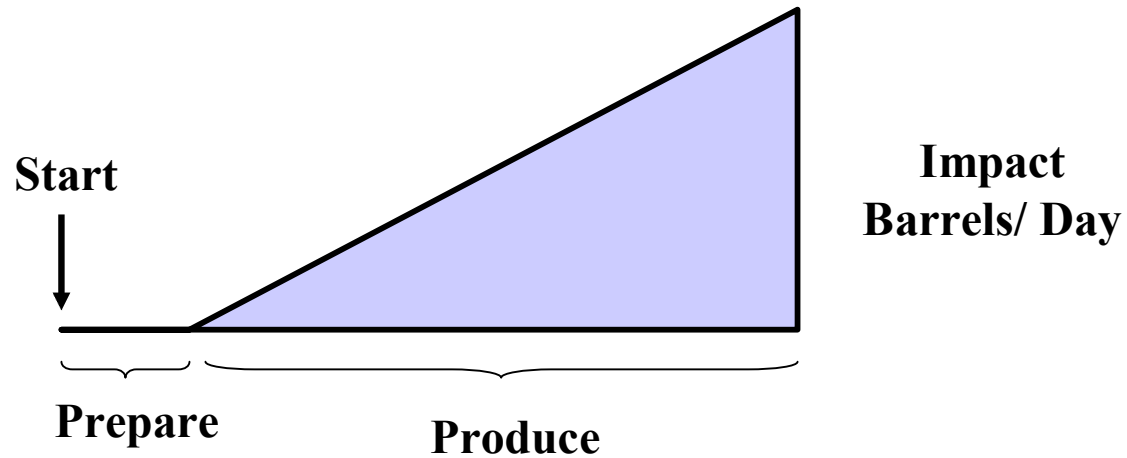
**No Scenario III?**

# Backup Slides






# Assumptions Underlying Estimates

- **VEHICLE FUEL EFFICIENCY** -- 30%, then 50% LDV improvements
- **GAS-TO LIQUIDS** -- 2x recent GTL projections (LNG competes)
- **HEAVY OIL/OIL SANDS** -- 2-2.5x recent projections
- **COAL-TO-LIQUIDS** -- Five new 100,000 bpd plants/year
- **ENHANCED OIL RECOVERY (EOR)** -- Paced by CO2 availability

# Wedges Used to Model Mitigation



# Estimated Crash Program Contributions

<u>Mitigation Option</u>	<b>Preparation Delay</b> <u>(Years)</u>	<b>Impact 10 Years Later</b> <u>(MM bpd)</u>
– <b>Vehicle Efficiency</b>	3	 2
– <b>Gas-To-Liquids</b>	3	 2
– <b>Heavy Oils / Oil Sands</b>	3	 8
– <b>Coal Liquids</b>	4	 5
– <b>Enhanced Oil Recovery</b>	5	 3

# SOME ISSUES

- Many peak oil forecasts assume countries will produce at their maximum rates. What about **political turmoil, mismanagement, & self-interest?**
- **Skilled workers & industrial capacity** worldwide are in short supply for current needs, let alone the level of effort described herein.
- Massive commercial crash programs are rare. **Startup will almost certainly be much slower** than assumed here.
- **Some countries may delay**, others will proceed rapidly with mitigation. **China may have started.**
- It is not clear how **environmental protection** will fare if there is widespread joblessness, high inflation & severe recession.