

Preparing Virginia for Liquid Fuel Shortages

Background, Timing & Ramifications

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Overview

- World oil production is either at or near maximum.
- Declining oil production will mean liquid fuel shortages that increase year-after year.
- Oil prices will escalate & economic damage will increase each year until effective mitigation takes hold, which will take much more than a decade.
- It's too late to avoid this world problem, but it's not too late to begin Virginia planning.

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The Situation

- **WHY THE PROBLEM?**
 - World conventional oil resources are finite.
 - Oil resources are being rapidly depleted.
- **WHEN WILL PEAKING OCCUR?**
 - Many think now or very soon.
 - The exact date is dwarfed by the need for urgent action.
- **WHY CAN'T THE PROBLEM BE FIXED QUICKLY?**
 - The scale of consumption worldwide is enormous.
 - Mitigation will involve many actions & take time.

Peaking = The world's first forced energy transition

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How We Use Oil

- Gasoline for our automobiles, SUVs & light trucks
- Diesel fuel for heavy trucks, trains, airplanes, ships, etc.
- Heating oil
- Lubrication
- Plastics
- Pharmaceuticals
- Building just about everything
- Etc.

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This Presentation

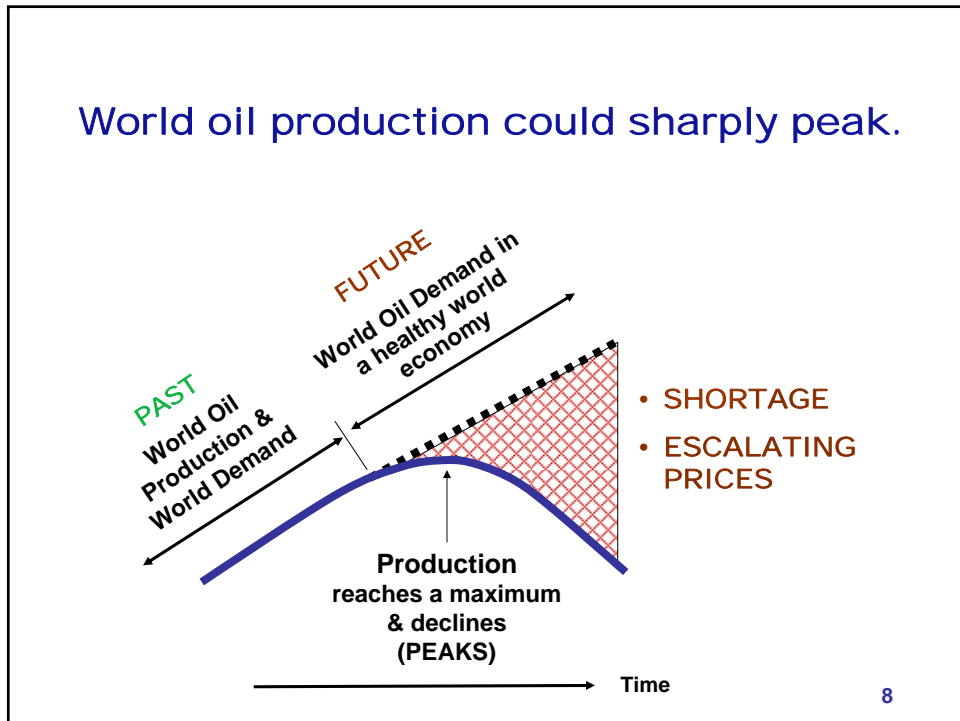
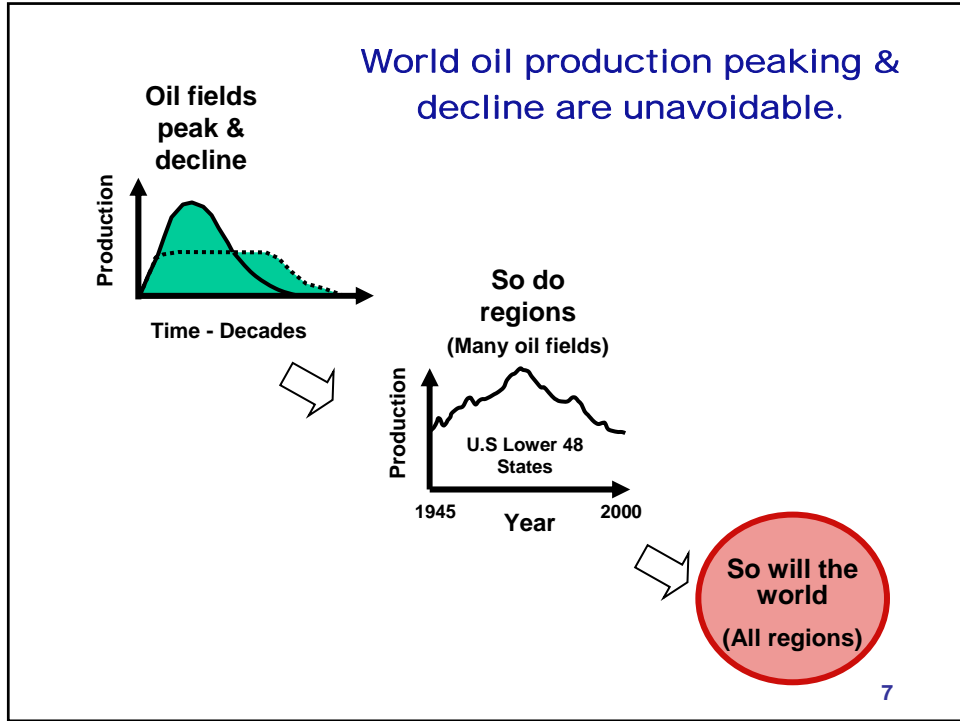
- **Background**
- **Some important basics**
- **Timing**
- **Mitigation**
- **Ramifications**
- **Final Remarks**

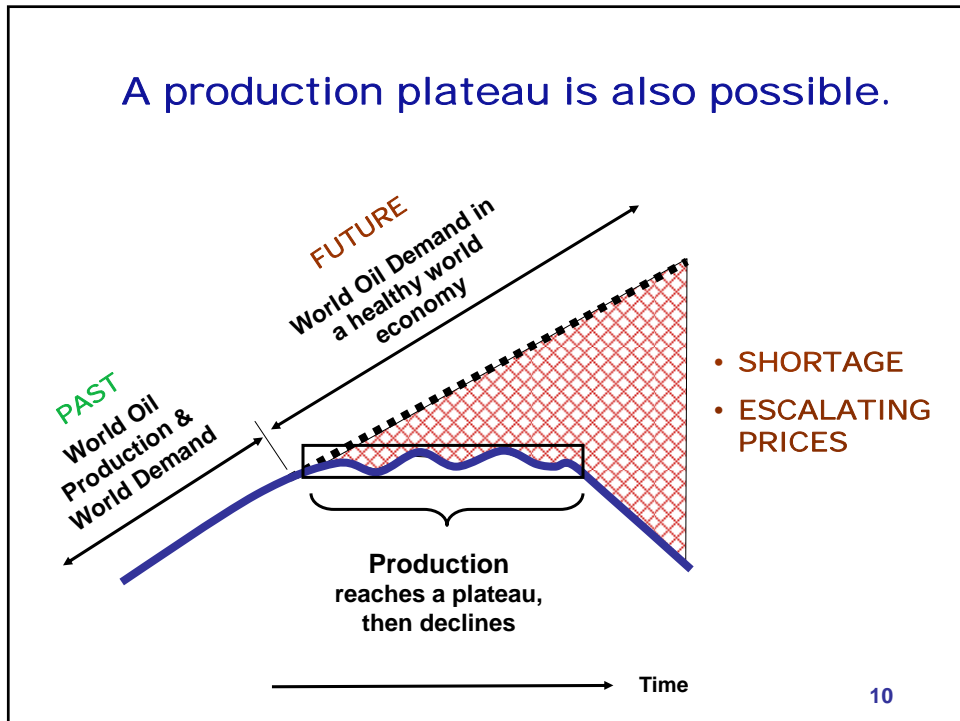
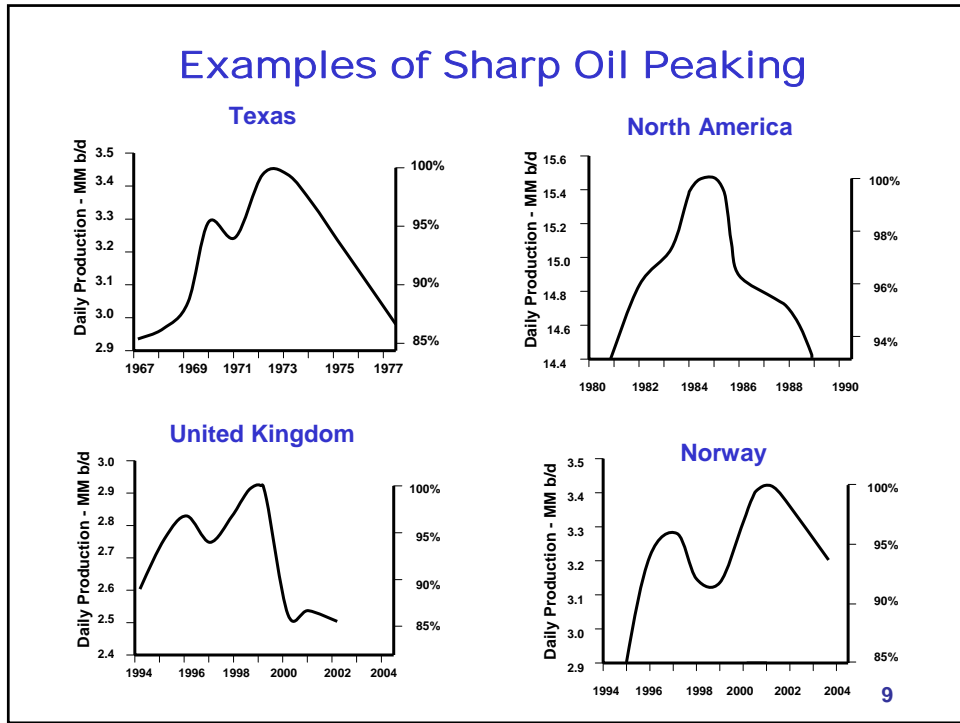
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Oil is essential.....

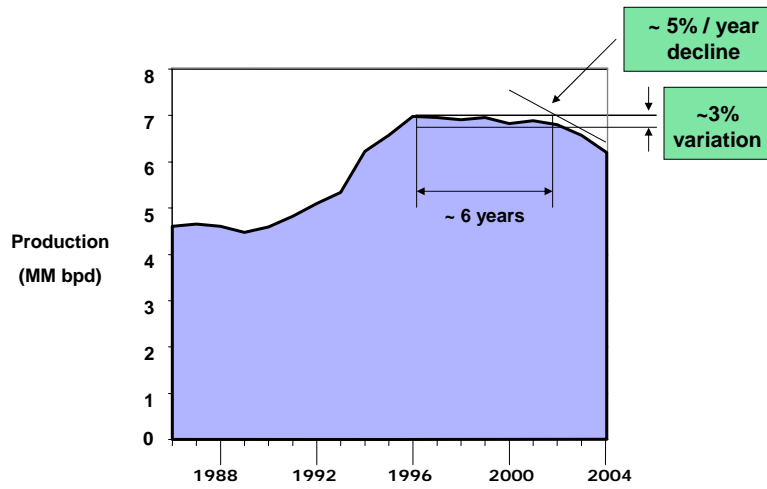
- World economic growth has been fueled proportionally by growing world oil production for decades.
- When world oil production declines, the resulting oil shortages & super high prices will lead to economic contraction, which will catapult oil decline mitigation to public priority #1.

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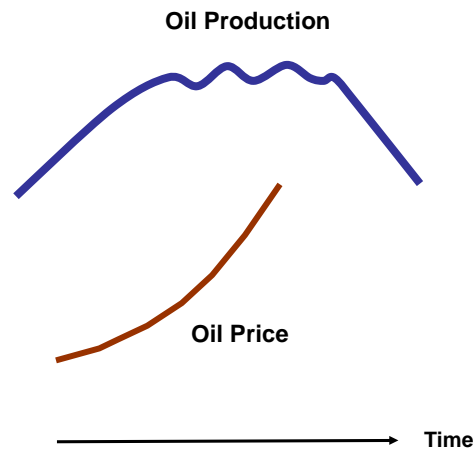


European Oil Production Plateaued, Then Declined



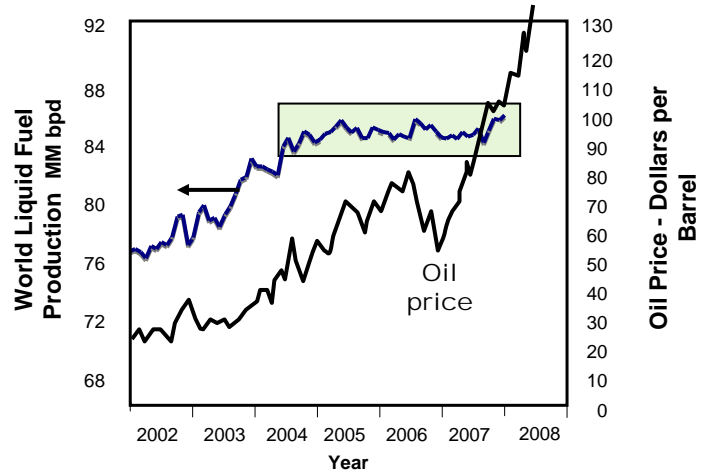
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If world production were to plateau, oil prices would rapidly increase.



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In fact, that's what's been happening.



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In Oil, Small is Huge

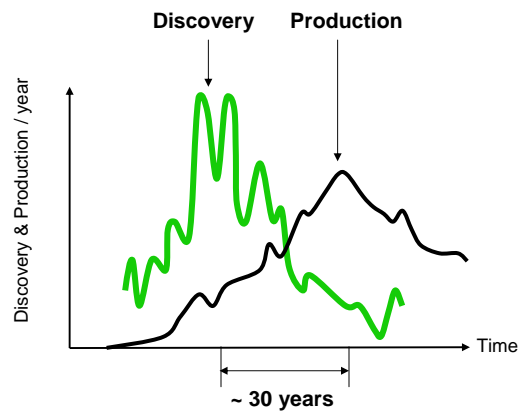
1% of world oil consumption > 800,000 barrels/day

4 - 6% U.S. oil shortages → Recessions (1973 & 1979)

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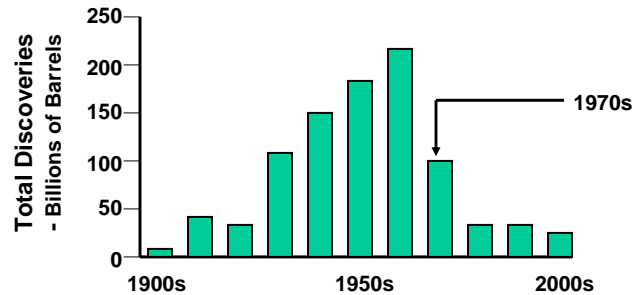
Note the Obvious:
In order to produce oil, it must first be discovered.

Example: U.S. Lower 48 States



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Giant Oil Field Reserve Additions Have Dropped Every Decade Since the 1960s



- Oil prices jumped in the 1970s.
- Q: Why did discoveries drop?
- A: There was less to find.

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The Royal Swedish Academy of Sciences

14 October 2005

54 of the 65

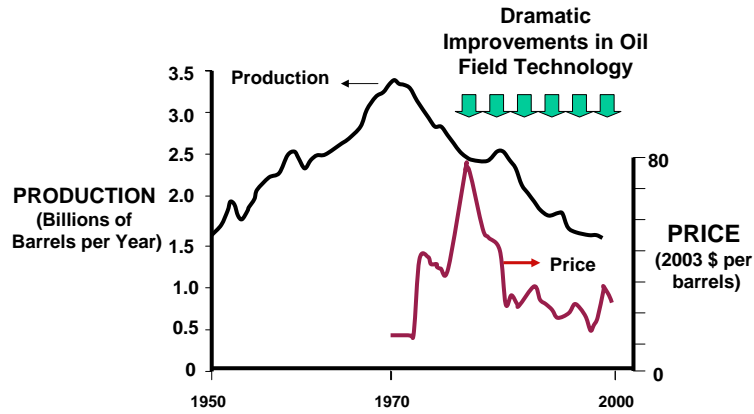
most important oil-producing countries have declining production (past peak)...

(The) rate of discoveries of new reserves is less than a third of the present rate of consumption (in the world).

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Technology & price will NOT reverse decline.

U.S. Lower 48 States

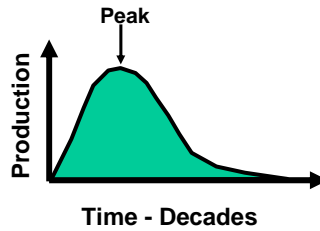


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The Problem

It's Liquids Supply,
not "energy."

Peaking is maximum production.
It's not running out soon.



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- One forecasting approach
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Where People & Organizations Stand

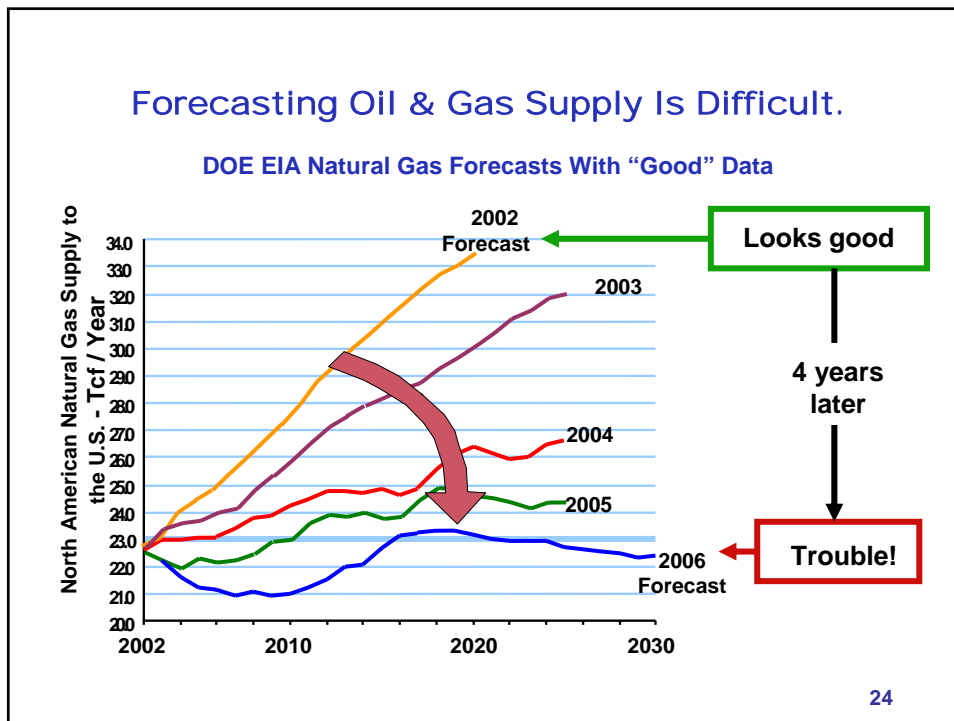
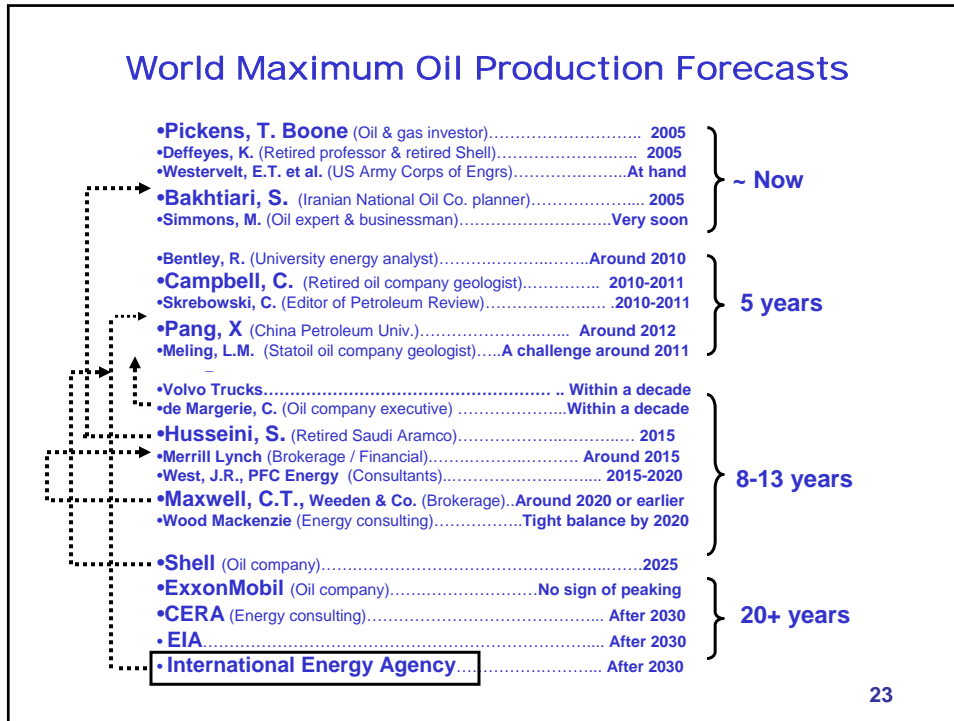
Sounding the warning / alarm:

IEA, Chevron, Shell, Jim Schlesinger, Boone Pickens, Matt Simmons, The Corps of Engineers, Total Oil, Volvo Trucks, the Chinese, Statoil, Hess Oil, and a number of retired oil company geologists.

Denying an imminent problem:

OPEC, EIA, CERA, ExxonMobil, fewer & fewer others.

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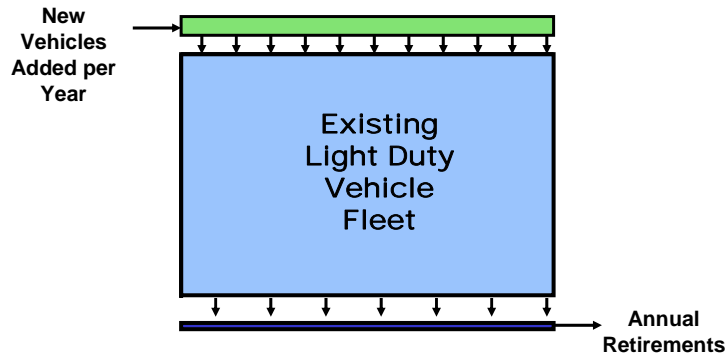
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Mitigation Is An Essential Bridge to Sustainability

- We must mitigate because it will require decades to massively modify or replace large fractions of the world's liquid fuel consuming end-use equipment.....We can't just shut down.
- Climate clash: Climate change is the priority, but peaking is expected to be harsh and to overshadow. Big readjustment!
- Reality: Mitigation & progress on climate change & sustainable energy will coexist for decades.

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It Takes a Long Time to Replace Massively Deployed End-Use Equipment



- Now ~ 900 million vehicles worldwide.
- Adding ~ 50 million vehicles per year.

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Besides Taking Time, It's Expensive

U.S. Fleets	Size	Median Lifetime (Years)	Cost to Replace Half the Fleet (2006 \$)
Automobiles	140 million	17	\$1.6 trillion
Light Trucks, SUVs, etc.	90 million	16	\$1.3 trillion
Heavy Trucks, Buses, etc.	7.5 million	28	\$1.7 trillion
Aircraft	8,500	22	\$0.3 trillion

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Mitigation Study

A 2005 analysis for the U.S. DOE

**ASSUMED CRASH PROGRAM
IMPLEMENTATION:
THE MOST OPTIMISTIC
CASE**

Scenario I - No action until peaking occurs

Scenario II - Mitigation starts 10 years before peaking

Scenario III - Mitigation starts 20 years before peaking

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Options

High near term value:

- Conservation
- Energy efficiency (LDVs)
- Drilling offshore & ANWR
- Enhanced oil recovery
- Heavy oil / oil sands
- Gas-To-Liquids
- Coal-To-Liquids

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

- Nuclear
 - Wind
 - Solar
- } Electric / Not Liquid Fuels

Not yet commercial

- Cellulosic biomass, shale oil, or hydrogen

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Mitigation Options Considered

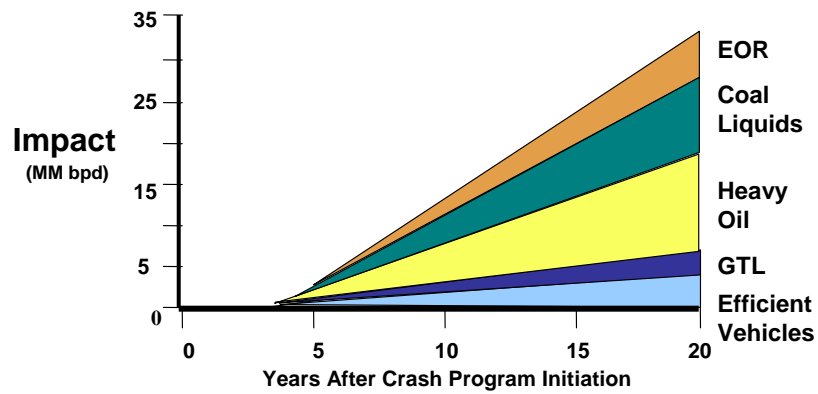
- Vehicle Fuel Efficiency
- Heavy oil / oil sands
- Coal Liquefaction
- Gas-To-Liquids (GTL)
- Enhanced Oil Recovery (EOR)

Why these? There're liquid fuels & ready for

Deployment

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Worldwide Crash Program Mitigation of Conventional Oil Production Peaking

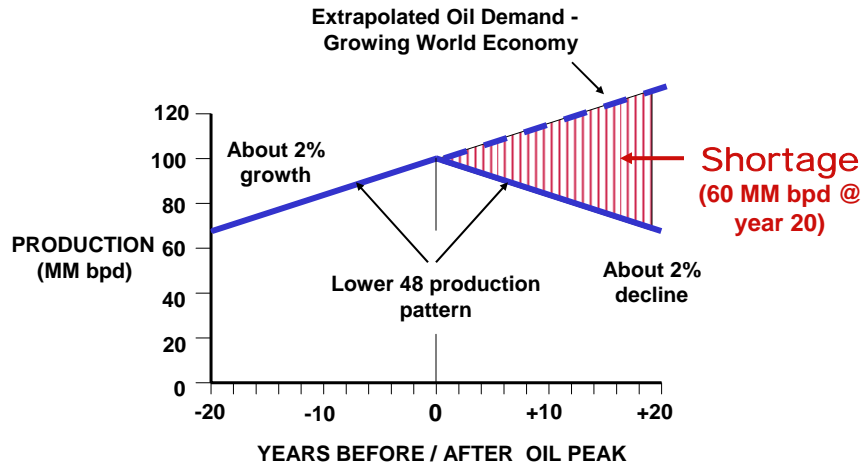


Delay, then rapid growth

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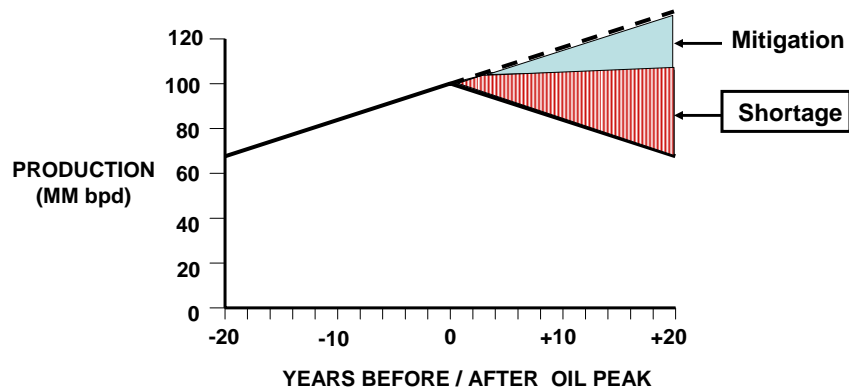
A Model for World Oil Supply / Demand

Center on the unknown date for peaking & Assume 100 MM bpd at peak.



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Scenario I: Mitigation at Peaking



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Scenario Results For A Worldwide Mitigation Crash Program

The Most Optimistic Case

I. Wait for peaking



Very Bad

II. Start 10 years early



SERIOUS TROUBLE

III. Start 20 years early

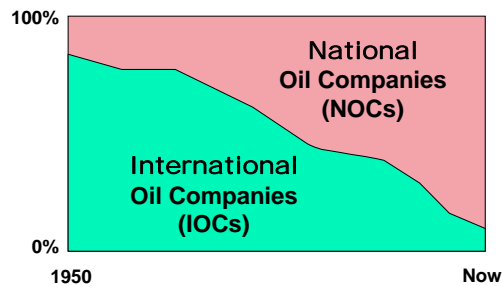


NO PROBLEM?

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The Shift In World Oil Market Control

Notional picture



MAJOR PLAYERS NOW: Saudi Aramco, NIOC, Pemex, Petrobras, Lukoil, PDVSA, PetroChina, etc.

DIMINISHED PLAYERS: ExxonMobil, Chevron, Shell, BP, ConocoPhillips, etc.

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Peak Oil & Exporter Behaviors

- When peak oil is broadly understood, panic could lead to rapid oil shortages & prices rises. It happened in 1973 & 1979.
- For oil exporters: Another large windfall
- Some exporters will likely reduce exports.
 - New windfall = Less need for income
 - Realization that national oil resources are finite
 - Conserving for the future makes good sense



Expect Oil Exporter Withholding

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How Did Oil Shortages Impact?

- The **1973 & 1979 BRIEF** oil interruptions caused....

+ Recession	+ Inflation
+ Unemployment	+ High interest rates

World oil peaking won't be BRIEF.

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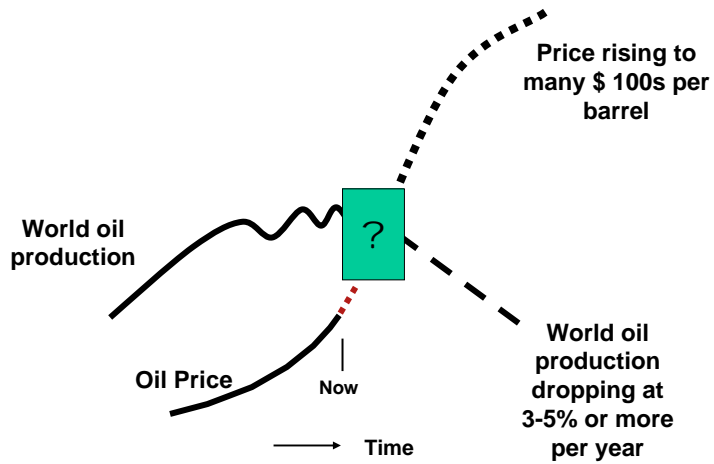
A Possible Relationship Between World Oil Shortage & World GDP

- Only experience: 1973 & 1979.
- Since then, many differences, complications, and unknowns, precision is impossible.
- Rough estimate using multiple sources:

$$\frac{\% \text{ Decline in GDP}}{\% \text{ Decline in Oil Supply}} \sim 1$$

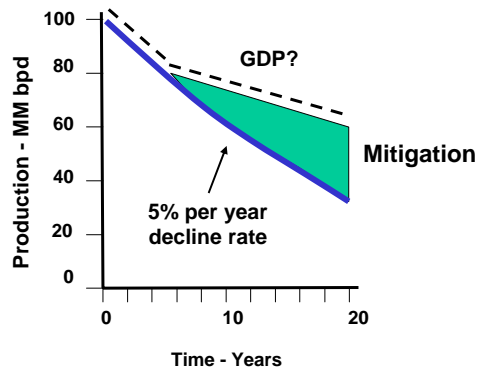
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When it is no longer possible to add increasing amounts of world oil production, plateau production will end, and production will decline.



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Potential Impact On World GDP of a 5% World Oil Production Decline



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The Approaching Shock

- **Peak oil is percolating up in awareness**
 - + Growing numbers of items in the media
 - + Recognized in the Administration
 - + Growing interest on Wall Street
 - + Google Peak Oil -- 4 million items

 **It could break into active public consciousness at any time.** 

- **When peak oil hits, aspects of the 1973 & 1979 oil shocks are likely:**
 - + Public panic
 - + Hoarding & instant shortages
 - + Major negative reactions on Wall Street
 - + Recession, unemployment, inflation, etc.

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Government Intervention Will Be Required

- Economic & social implications of oil peaking would otherwise be much more chaotic.
- **The 1970s and 1980s experience offer important guides** on what's desirable & undesirable.
- Government will have to provide support, incentives, facilitation, & protection.

**Presidential leadership will be critical.
States will face daunting problems.
Industry must implement.**

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What Can Virginia Do?

- **Educate yourselves - Difficult & painful!**
- **Develop short and long-range plans**
 - + Plan to work together & to compromise.
 - + Permitting in 3 weeks versus 3 years
 - + Etc.
- **Plan for deepening recessions / decreased revenues.**
- **Educate the public.**
- **Remember ying & yang - There will be opportunities.**

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In Conclusion

- Oil peaking / maximum will happen; timing is uncertain.
- Based on likely rates of change, it's too late to avoid serious economic damage.

Facing the problem squarely is the first step.

Rapid, decisive actions will be required.

Difficult compromises will be needed.

Deployment of technologies will be essential.

We'll manage but it will be a huge challenge!

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