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.
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

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.
This Presentation

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

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.
World oil production peaking & decline are unavoidable.

So do regions (Many oil fields)

So will the world (All regions)

World oil production could sharply peak.

- SHORTAGE
- ESCALATING PRICES
A production plateau is also possible.

Examples of Sharp Oil Peaking

Texas

North America

United Kingdom

Norway

Examples of Sharp Oil Peaking

A production plateau is also possible.

PAST
World Oil Production & World Demand

FUTURE
World Oil Demand in a healthy world economy

• SHORTAGE
• ESCALATING PRICES

Production reaches a plateau, then declines

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

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

Example: U.S. Lower 48 States
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.

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).
Technology & price will NOT reverse decline.

U.S. Lower 48 States

The Problem

It’s **Liquids Supply**, not “energy.”

Peaking is **maximum production**. It’s not running out soon.
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- **Timing**
- 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.
World Maximum Oil Production Forecasts

- Pickens, T. Boone (Oil & gas investor) .................. 2005
- Deffeyes, K. (Retired professor & retired Shell) .......... 2005
- Westervelt, E.T. et al. (US Army Corps of Engrs) ...... At hand
- Bakhtiari, S. (Iranian National Oil Co. planner) ........ 2005
- Simmons, M. (Oil expert & businessman) ................ Very soon
- Bentley, R. (University energy analyst) .................. Around 2010
- Campbell, C. (Retired oil company geologist) ........ 2010-2011
- Skrebowski, C. (Editor of Petroleum Review) .......... 2010-2011
- Pang, X (China Petroleum Univ.) ......................... Around 2012
- Meling, L.M. (Statoil oil company geologist) .......... A challenge around 2011
- Volvo Trucks .............................................. Within a decade
- de Margerie, C. (Oil company executive) ............... Within a decade
- Husseini, S. (Retired Saudi Aramco) .................... 2015
- Merrill Lynch (Brokerage / Financial) .................. Around 2015
- West, J.R., PFC Energy (Consultants) ................. 2015-2020
- Maxwell, C.T., Weeden & Co. (Brokerage) .... 2020 or earlier
- Wood Mackenzie (Energy consulting) .................. Tight balance by 2020
- Shell (Oil company) ...................................... 2025
- ExxonMobil (Oil company) ................................ No sign of peaking
- CERA (Energy consulting) ................................ After 2030
- EIA ......................................................... After 2030
- International Energy Agency ............................. After 2030

~ Now

5 years

8-13 years

20+ years

Forecasting Oil & Gas Supply Is Difficult.

DOE EIA Natural Gas Forecasts With “Good” Data
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.**
It Takes a Long Time to Replace Massively Deployed End-Use Equipment

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

**Besides Taking Time, It’s Expensive**

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

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
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

Worldwide Crash Program Mitigation of Conventional Oil Production Peaking

Impact (MM bpd)

Years After Crash Program Initiation

Delay, then rapid growth
A Model for World Oil Supply / Demand

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

Extrapolated Oil Demand - Growing World Economy

Shortage
(60 MM bpd at year 20)

Scenario I: Mitigation at Peaking
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?

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.
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
  - + Unemployment
  - + Inflation
  - + High interest rates

**World oil peaking won’t be BRIEF.**

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:**

\[
\frac{\text{% Decline in GDP}}{\text{% Decline in Oil Supply}} \approx 1
\]
When it is no longer possible to add increasing amounts of world oil production, plateau production will end, and production will decline.

Now

Price rising to many $100s per barrel

World oil production dropping at 3-5% or more per year

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

GDP?

5% per year decline rate

Mitigation

Production - MM bpd
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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.
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.

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.
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!