The Quest

Part 2 - Securing the supply

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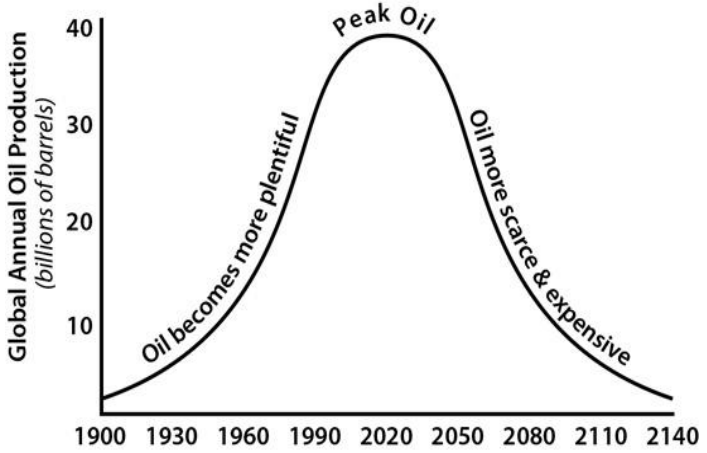
Overview

- Is the World Running Out of Oil?
- Unconventional
- The Security of Energy
- Shifting Sands in the Persian Gulf
- Gas on Water
- The Natural Gas Revolution

Is the World Running Out of Oil?
Chapter 11

Peak Oil



- A theory that argues that the world is near at the the point of **maximum** (oil) output.
- <u>Consequences:</u>
  - **Chaos** in the oil industry, in governments, and in national economies.
  - **War**, **Starvation**, **Economic recession**, possible human **extinction**
- Date of the peak keeps getting pushed back.
- Embodies an “end of technology/end of opportunity” perspective
  - No more significant innovation in oil production
- A more appropriate way to visualize future supply: as a **Plateau**

Aboveground Risks

- “Aboveground” refers to risks of **economies**, **politics**, and **militaries**.
- The International Energy Agency (IEA) estimates that new development will require as much as **$8 trillion** over the next quarter century.
- Youtube video

Running Out of Oil

- The modern oil industry was born in **1859** near the town of **Titusville** in NW Pennsylvania.
- The man who gave the world oil
- World has thought it was going to run out of oil **5** seperate times
- Primary market for oil in its first 40 years was for **Illumination**.
    - Replaced whale oil and other fluids used in oil lamps.
- State Geologists of Pennsylvania warned in 1885 that oil was a "**Temporary** and **vanishing** phenomenon".
    - Not long after, oil fields were discovered in Ohio, Kansas, Texas, and Oklahoma.
- New supplies arrived just in time for a new source of demand, the **Automobile**.

Running Out of Oil… Again

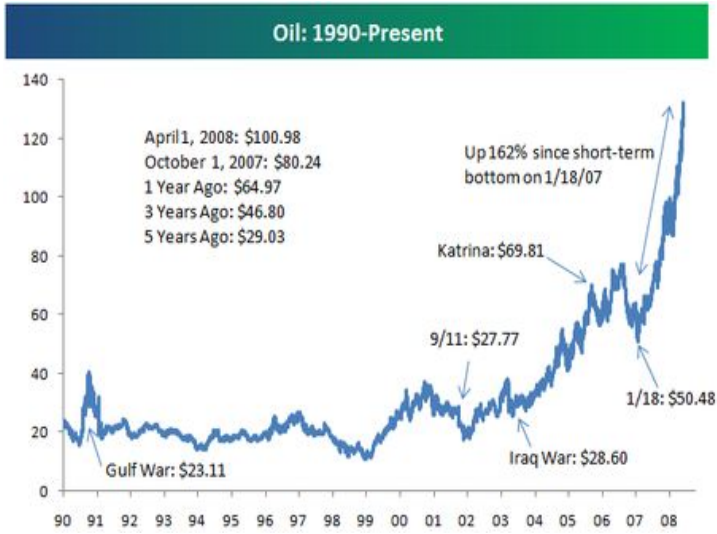
- As oil was being supplied to Europe to support the Allied forces in WW1, a **gasoline famine** struck the United States.
  - 1918 saw the **highest** gasoline prices ever recorded in the United States.
- "**Gasolineless Sundays**": People would abstain from driving in order to help relieve the shortage.
  - Gasoline shortage
- Oil was largely believed to have won the war for the Allies.
  - But for the **second** time, the world thought it was running out of oil.
- Securing new supplies became a strategic objective.
- By the end of the 1920's, instead of a permanent shortage, the markets began to **swim in oil**.
  - Seismic technology and East Texas oil field.

Running Out of Oil… Again & Again

- WW2 increased the global demand of oil.
  - 6 out of 7 billion barrels of oil used by the Allies, were **American.**
- After WW2 and for the 3rd time, the world feared an end to oil.
  - Fears were heightened when the “self-sufficient” United States became a net **importer** of petroleum.
- The global fear of running out of oil came to a halt when vast oil fields opened in the **Middle East** and technological advances led to an **oversupply**.
- In 1960, five oil exporting companies came together to form OPEC, in order to **protect** their revenues.

Running Out of Oil… Again & Again & Again

- In the 1970's, the fear of yet **another** oil shortage appeared.
  - Oil prices quadrupled due to war in the Middle East.
  - Government policies promoted greater fuel efficiency in automobiles and encouraged electricity companies to increase the use of coal and nuclear power.
  - Within half a decade this shortage turned into an enormous glut.
- In the late 1990's, the Asian financial crisis precipitated yet another price collapse.



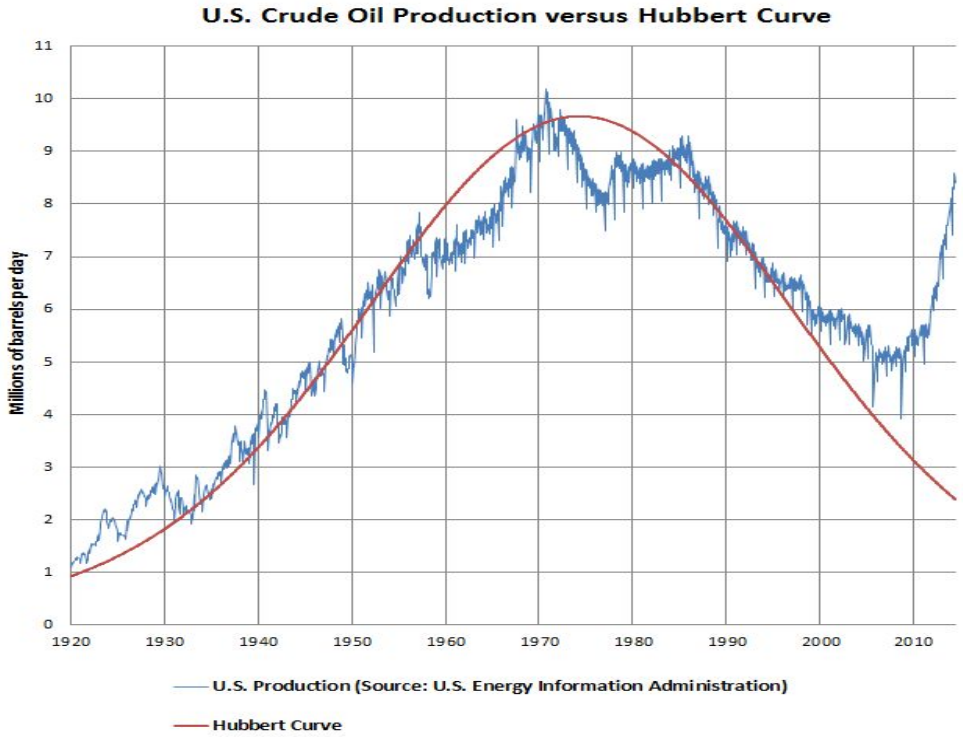
The Fifth Time

- Around the beginning of the 21st century, fear over running out of oil began to gain prominence, for the fifth time.
  - Accelerated demand from emerging economies. Ex) China
  - Climate Change: push to move away from carbon-based fuels
- Current Peak Theory: Relating the World's oil supply to beer
  - "The glass starts full and ends empty and the faster you drink it the quicker it's gone."
  - But this assumes someone knows how big the beer is.

The King: M. King Hubbert

- Creator of the “Peak Oil” theory.
- One of the most renowned, yet controversial earth scientists of his time.
  - Taught at Columbia University
- Became active in the Technocracy movement
  - Democracy was a sham, scientists and engineers should take control of the government and the economy.
- Hubbert’s Peak: US oil production would come to a peak b/w 1965-1970.
  - It did hit a peak in 1970 and he became famous.
  - Due to the peak, US began importing oil rapidly leading to the 1973 Crisis.
- Predicted that Children born in 1965 would see the extinction of oil in their lifetime.

Hubbert's Peak



Why supplies continue to grow

- Hubbert underestimated the amount of oil that would be found and produced in the US. (Discovery of new oil fields)
- By 2010, US production was 4 times higher than Hubbert predicted.
  - 5.9 million barrels per day versus Hubbert's estimate, 1.5 million barrels per day.
- The Ghawar field, the Largest oil field in the world.
  - First well was drilled in 1948
  - Produces over 5 million barrels per day
- Peak oil supporters argue that the discovery rate of oil fields is declining.
  - Forget to account for reserves and additions.
  - 86% of oil reserves in the US are the result of revisions and additions.
- Some oil fields decline, but most reach a plateau.

How Much Oil?

- At the end of 2009, the world's proven oil reserves reached 1.5 trillion barrels.
  - Discoveries, revisions, and additions were sufficient enough to replace all oil produced.
- Replacing that oil produced is challenging and massively expensive.
- Prospects for the future?
  - Currently there are at least 5 trillion barrels of petroleum resources, of which 1.4 trillion are accessible.
- World production capacity should grow from 93 million barrels a day (2010) to 110 million barrels a day by 2030.
  - Will require further development of current and new project, which requires access to the resources.

Unconventional
Chapter 12

Unconventional

- Unconventional Sources of oil include:
  - Liquids with gas
  - Offshore drilling
  - Oil sands
  - Oil shales
  - Tight oil
  - Oil produced for coal.

Offshore Drilling

- Pioneered by H. L. William in Santa Barbara, California
  - Discovered oil beneath his ranch, decided to build piers on the seabed, and began drilling.
  - Not very successful
- Later proven successful by Kerr-Mcgee in October of 1947
  - In Gulf of Mexico after WW2
- 30% of total oil production (26 mbd) is produced offshore.
  - (2010) Global deepwater output: 6 mbd
  - (2020) Global deepwater output: 10 mbd
- Well blowout in Santa Barbara, 1969
  - Pitted environmental activists against offshore drilling.

The North Sea and Birth of Non-OPEC

- 9 months after Santa Barbara, Phillips Petroleum discovered the massive oil field, Ekofisk, in the North Sea.
  - Saw sufficient investments due to oil scarcity fears in the 1970's.
  - By 1985, The North Sea was producing 3.5 mbd
  - Became one of the pillars of what was known as "Non-OPEC"

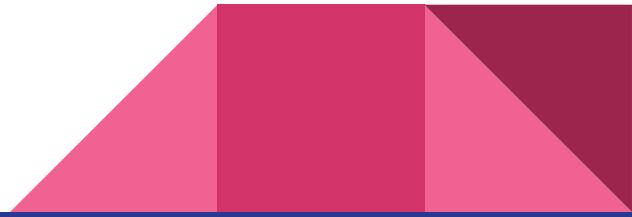
To The Frontier

- In 1992, Brazil's state owned oil company, Petrobras, broke the deepwater barrier by successfully placing the Marlim Platform 2,562 foot waters.
- In 1994, Shell Oil's Auger Platform, began producing in 2,864 foot waters.
    - Took an expenditure of $1.2 billion and 9 years of time to complete.
    - Regarded as a huge gamble within Shell.
    - Eventually Began producing over 100,000 barrels a day.
- By 2009, the shallow and deep waters of the Gulf of Mexico supplied the US with 30% of domestic oil production.

Deepwater Horizon

- Drilling platform leases by British Petroleum (BP)
  - 48 miles of the coast of Louisiana
- Just finished drilling the Macondo Well, which descended through 5,000 ft of water and nearly 13,000 ft of dense rock under the sea bed.
  - Only thing left to do was plug the well with cement so that it could be produced at a later date.
- At 7:55 PM on April 20th, 2010, oil and gas began to seep from the well.
- Blowout preventer was used but ultimately failed at sealing the well.
- At 9:49, the gas escaping the well caught a spark causing a tremendous explosion and setting the enormous rig on fire.
  - Killed 11/126 workers and sank 2 days later.
  - Video

The Security of Energy
Chapter 13



The Importance of Energy

- Electricity is essential for the internet age
- Oil is necessary for sea, land, and air transportation.
- In 1911, Winston Churchill decided to switch the Royal Navy's ships to oil power.
    - Increased mobility and fire rate during the arms race with Germany.
- Critics opposed because Britain had coal, not oil.

Vulnerability of Energy

- Hurricane Katrina and Rita struck the Gulf Coast in 2005.
    - Caused widespread damage to all infrastructure.
- The 2011 Japanese earthquake and tsunami took down electricity, communication, transportation, and rescue resources.
- Both of these events truly showed how vulnerable our modern world was to disruptions in energy supply

Energy Security

- Energy Security- the availability of a sufficient supply of energy at affordable prices.
- In 1973, President Nixon coined the phrase “Energy Independence” as part of a push to increase US domestic output.
- Today energy independence means two things:
  - Lack of imports
  - Security of the supply chain.

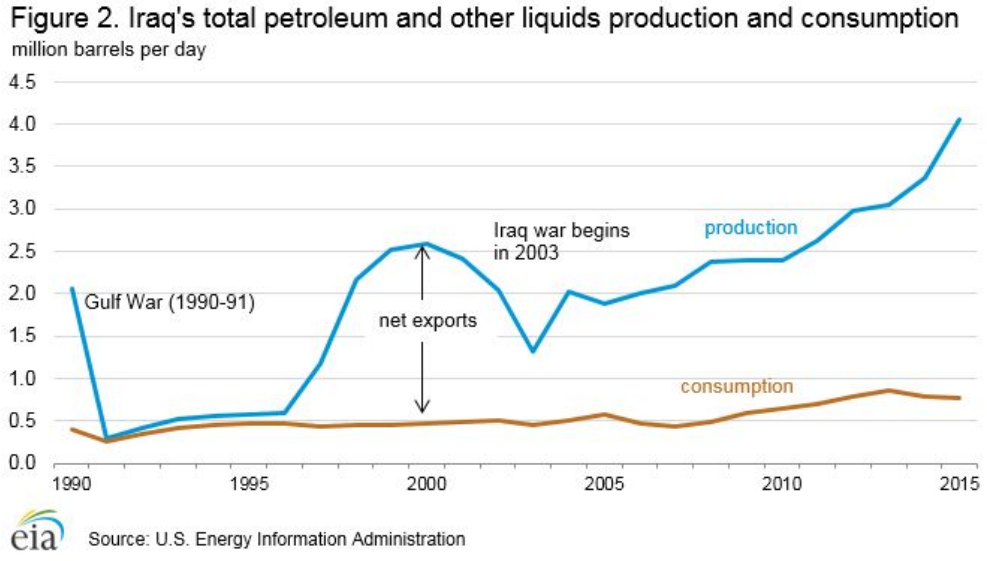
Shifting Sands in the Persian Gulf

- 25% of World Oil Output, 60% of Proven Reserves
- Al Qaeda, 1990 vs 2004
  - Critical Node, 2006 Abqaiq Attack
- Political Instability, and the Arab Spring


THE
ARAB
SPRING
HISTORY

Shifting Sands in the Persian Gulf

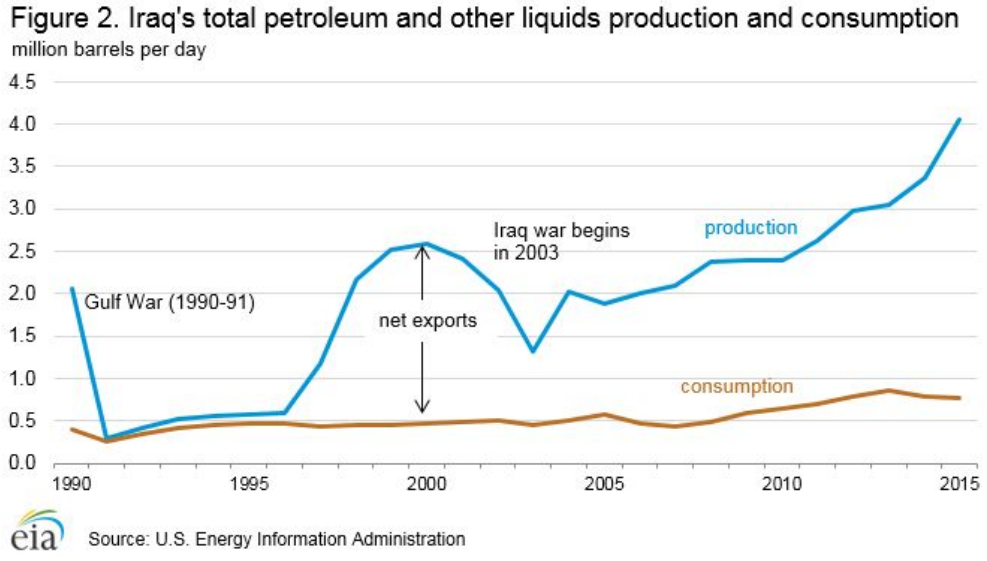
- Potential of Iraq
- Strait of Hormuz
- Iran, Terrorism, and the Revolutionary Guard
- Nuclear Iran
  - 1950-Energy
  - 1980-Weapons




IRAN
THE STRAIT OF HORMUZ
Vox
ATLAS

Shifting Sands in the Persian Gulf

- Potential of Iraq
- Strait of Hormuz
- Iran, Terrorism, and the Revolutionary Guard
- Nuclear Iran
  - 1950-Energy
  - 1980-Weapons



LNG

Gas on Water

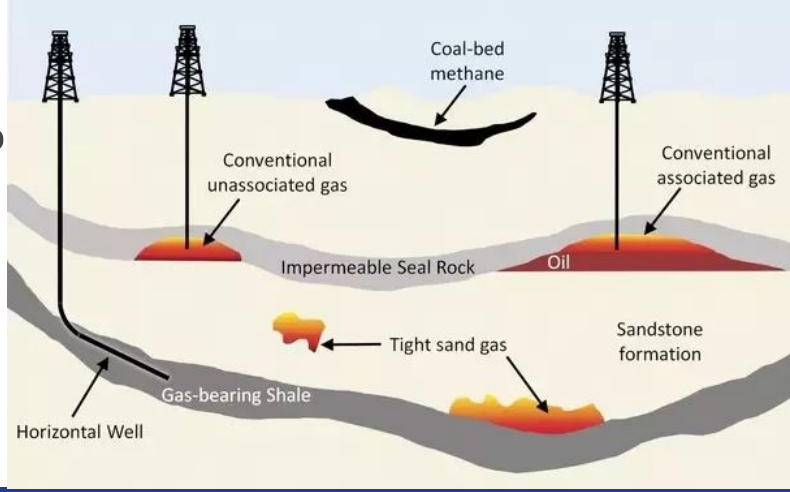
- The growth of Liquid Natural Gas (LNG)
  - 1939-US Long Term Storage
  - 1944-Failure Causes 129 Deaths
  - 1960s-LNG Transport from Algeria to Europe
  - 1965-Cheap Natural Gas Hits Europe
- Long Term Contracts in Southeast Asia

Gas on Water

- WWII natural gas use grows in the US to 25% in 1970
- Politics and Economics
  - 1978-“Fuel Non-Use Act” Natural Gas as a Luxury
  - Low Cost Natural Gas outcompetes LNG in US
  - 1990s-Prohibitions Lifted, LNG Makes a Comeback
- Qatar Builds an International Market
  - Short Term Contracts
  - 2007 and 2011 Emergencies in Japan

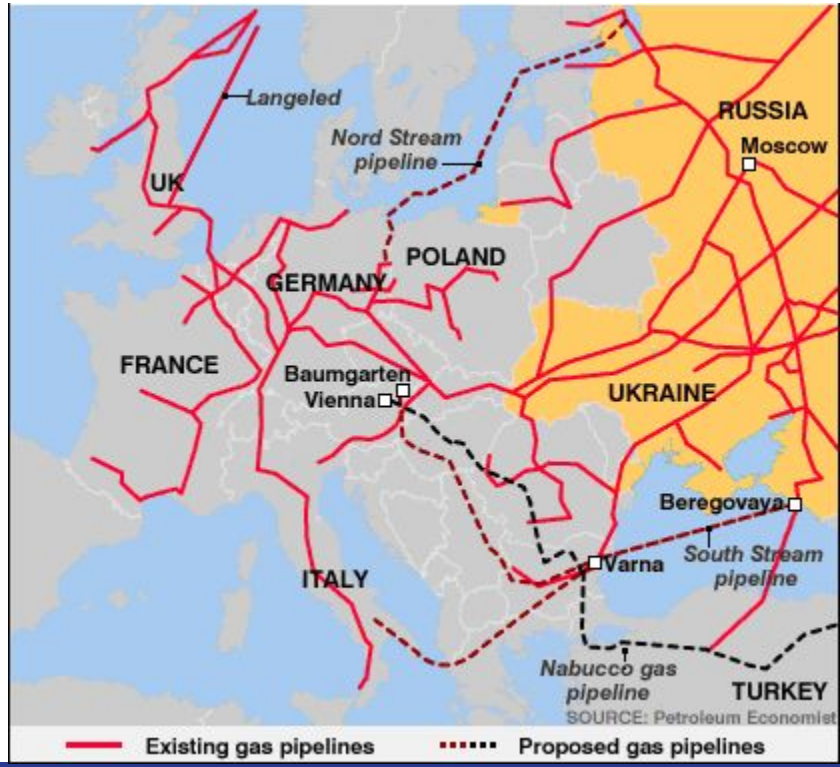
The Natural Gas Revolution

- George Mitchell and the 1980's Search for TX Shale Gas
- 2002-Light Sand Fracking and Horizontal Drilling
- 2007-Unconventional Gas Revolution hits AR, LA, NY, PA
- Shale Percent of All Natural Gas
  - 2000:1% 2011:25% 2030:50%
- 100+ Years of Shale Natural Gas
- Renewables and LNG
- The Global Gas Market



The Natural Gas Revolution

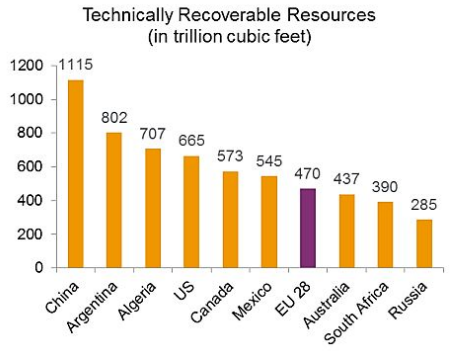
- 1980s-Soviet Natural Gas in Europe
  - US Embargo Ignored
  - 1991-Soviet Union Collapse
- State Owned Gazprom
  - 80% of Output
  - 15% of State Budget
- 2006-Ukraine vs Russia



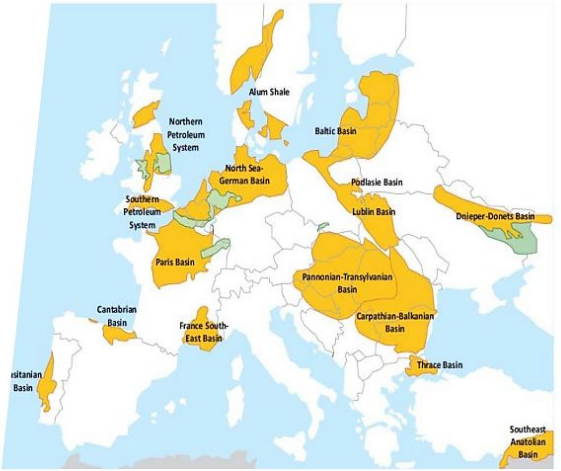
The Natural Gas Revolution

- Diversification
  - The Fourth Corridor
    - Turkmenistan
    - Azerbaijan
    - Iraq
  - European Shale?

Europe's shale gas resources are within the Top 10 worldwide



Main shale gas resource areas in Europe



Summary

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Questions?