

Peak Oil: The Thing I'm Going to Talk About

Austin Quan

April 7, 2011

“Our principal constraints are cultural. During the last two centuries we have known nothing but exponential growth and in parallel we have evolved what amounts to an exponential-growth culture, a culture so heavily dependent upon the continuance of exponential growth for its stability that it is incapable of reckoning with problems of nongrowth.”

– M. King Hubbert

In case you took a nap...

- ▶ Oil is difficult and expensive to find and extract
- ▶ Oil comes in two main flavors:
 - ▶ Conventional: most current production, easier to extract, cleaner to produce, higher energy return, reserves are fading
 - ▶ Unconventional: dirtier and more energy intensive to produce, less popular, potentially huge pile of energy
- ▶ Estimating numbers for oil reserves is hard:
 - ▶ Multiple definitions for reserve
 - ▶ Countries report unaudited data, potentially biased by self-interest or politics
 - ▶ Estimating reserves is an inherently difficult task ("like trying to determine the entire shape of an elephant after just bumping into it a couple times in the dark")

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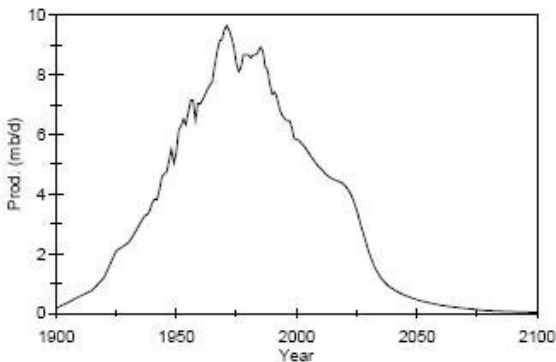
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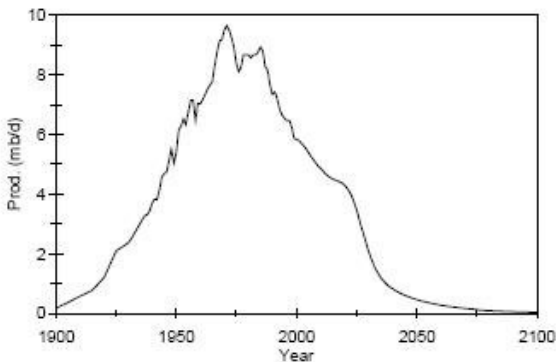
Peak Oil: “Not Your Mother’s Energy Crisis”

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- ▶ Peaking production could potentially severely limit growth, as it marks the point where *no additional demand can be satisfied*.



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Causes

No surprises here.

- ▶ Increases in demand: mostly transportation (69% of current consumption), 60% increase by 2020 (EIA)
- ▶ Global population growth, desire for higher standard of living
- ▶ Finite supply of resources, decreasing discovery rate

This is a liquid fuel problem. Automobiles, trucks, aircraft, trains, etc. have no ready alternative to liquid fuels at the present. Furthermore, rapid changeover of equipment to alternatives cannot be reasonably expected.

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Hubbert and His Curve

The Hubbert curve is used to describe oil production from location. Hubbert used it to accurately predict the production peak of the continental United States in 1965-1970. He further predicted that the world oil peak would occur in 1995 ('if current trends continue') and was not so right.

Cumulative production:

$$Q(t) = \frac{Q_{max}}{1 + \alpha e^{-\beta t}}$$

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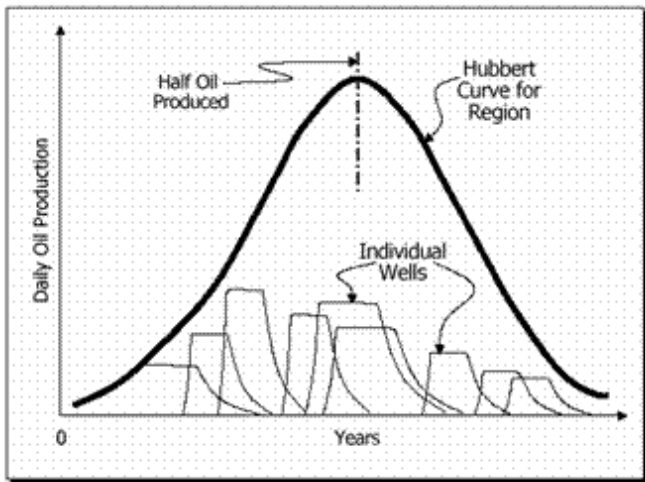
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HUBBERT CURVE

Regional Vs. Individual Wells



More Hubbert

Here are some of the general properties/assumptions of Hubbert theory:

1. Peak occurs roughly when half of the recoverable oil has been produced
2. Shape is roughly bell-shaped, though asymmetric (slower descent than ascent)
3. Production follows discovery at a constant time lag
4. The larger the region, the better the numbers fit the theory

It should also be noted that Hubbert theory generally is presented as a model of conventional oil.

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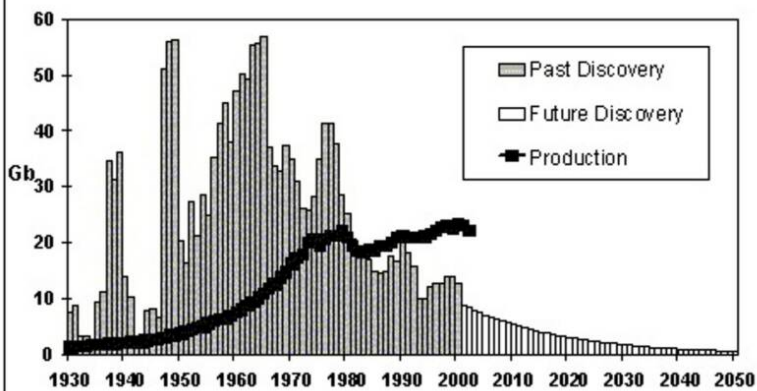
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The Growing Gap



Impacts of Peak Oil

Primary effects:

- ▶ Severe increase to the cost of oil → damaging to economies that rely on cheap oil, like the US
- ▶ No capacity for additional demand → products and services produced by oil becomes scarcer, leading to lower living standards

We can look at interruptions to the oil price have done in the past (oil crises in the 1970's):

- ▶ Inflation
- ▶ Unemployment
- ▶ Recession
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When?

The predictive power of our models to date is 'dismal'.

- ▶ There are other factors besides geological ones that impact production → economic, institutional
- ▶ Consumers and producers do not behave as economic theory classically predicts
- ▶ Production can be very specific to location
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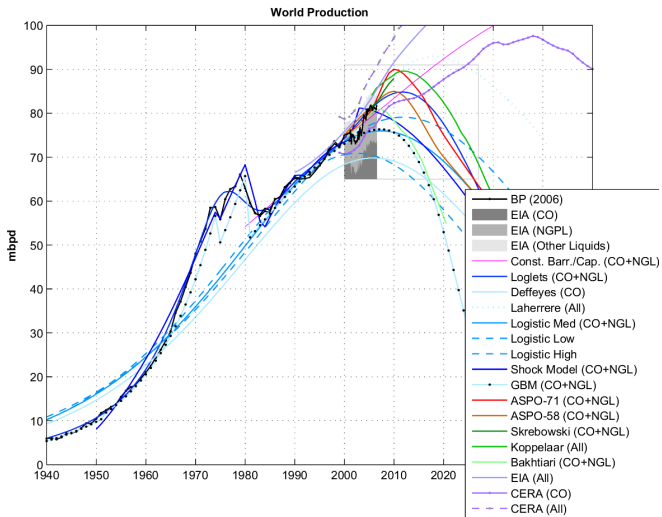
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Some Estimates

Forecast	Source
2006-2007	Bakhitari (Iran)
2007-2009	Simmons (US)
After 2007	Skrebowski (UK)
2008	Campbell (Ireland)
Before 2009	Deffeyes (US)
Before 2010	Goodstein (US)
After 2010	World Energy Council
2012	Weng (China)
2016	Doug-Westwood (UK)
After 2020	CERA (US)
2031 or later	EIA (US)

You be the judge...

Consider the following facts:

- ▶ According to the International Energy Agency (IEA), production of crude oil peaked in 2006
- ▶ The Energy Information Administration (EIA) estimates that petroleum-based fuel demand dropped 7.1% in 2008, *the greatest decline since 1950*
- ▶ Oil field discoveries peaked in 1965 (ASPO), but have remained relatively constant over the past decade
- ▶ Production is in decline in 33 of the world's 48 largest oil-producing countries
- ▶ OPEC warns that oil supply will not be adequate to satisfy the demand in 15-20 years
- ▶ A review of 500 studies concludes that a peak before 2030 appears likely, and there is a significant risk of a peak before 2020

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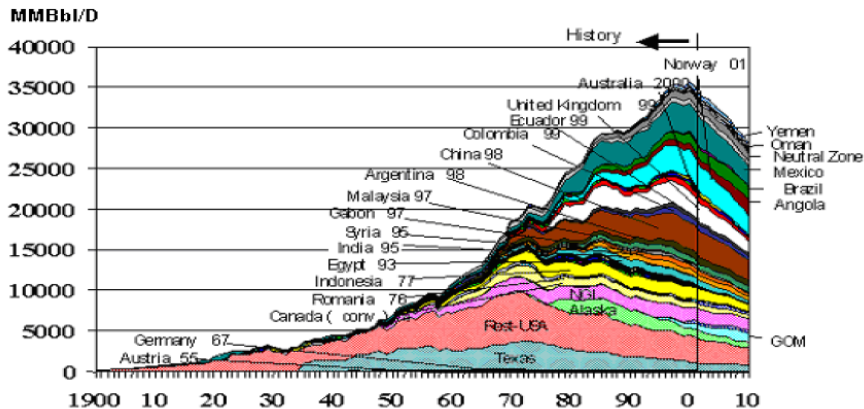
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Non-OPEC, non-FSU Oil Production Has Peaked and is Declining



Experience has shown...

By studying countries/regions that have already experienced peaking oil production, we can learn several things:

- ▶ A peak in production has not been obvious one year prior to the event → *we will only have short-term warning*
- ▶ Generally speaking, peaks are sharp, not gently varying or flat topped
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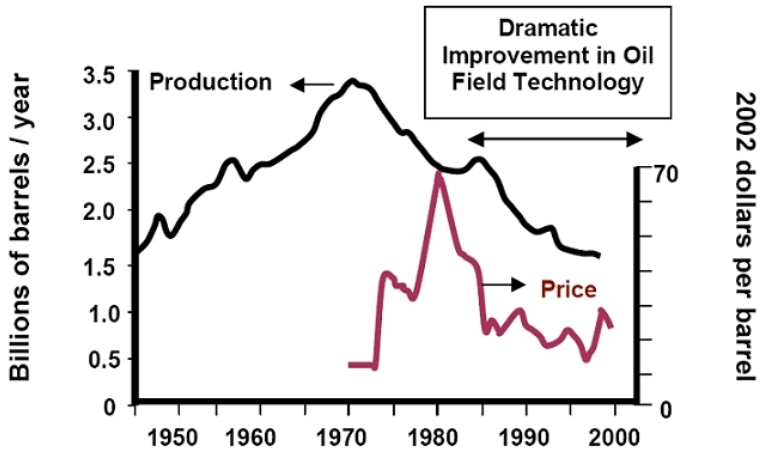
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Mitigation, or are we screwed?

“It became abundantly clear early in this study that effective mitigation will be dependent on the implementation of mega-projects and mega-changes at the maximum possible rate”

– The Hirsch Report, 2005

- ▶ Fuel efficient transportation: public transportation, carpooling, electric vehicles, hybrid vehicles
- ▶ Heavy oil/oil sands
- ▶ Coal liquefaction
- ▶ Enhanced oil recovery
- ▶ Gas-to-liquids
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Mitigation, cont.

Three scenarios considered in the Hirsch Report:

1. We don't take action until we hit the peak → economic upheaval, social chaos, a two decade liquid fuel deficit
2. Initiate action 10 years prior to the peak → helps considerably, but still a decade long shortfall after the event
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Successful mitigation can be achieved using current technology, if we start early.

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Cost to Replace Half of US Fleets (Hirsch, 2005)

Vehicle Type	Cost
Automobiles	\$1.3 trillion
Light trucks, SUVs, etc.	\$1 trillion
Heavy trucks, buses, etc	\$1.5 trillion
Aircraft	\$0.25 trillion

Recap

- ▶ Peak oil, in some form or another, will happen soon, and the economic consequences could be severe.
- ▶ Experience has shown that the peak will occur with little warning. Predictions for when it will happen vary.
- ▶ This is very specifically a liquid fuels and transportation problem, not an energy problem.
- ▶ Effective mitigation is possible using current technology, given enough lead time (10-20 years).

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