

Peak Oil and the End of Cheap-and-Easy-Oil

Challenges to the Global Community as it Faces the Most Difficult Transformation in the History of the Industrial Society

Manfred J. Zapka, Ph.D.

May 23, 2006

Rebuild Hawaii Quarterly Meeting, Honolulu, Hawaii

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Our Planet in crisis mode .. Top Challenges for the coming decades:



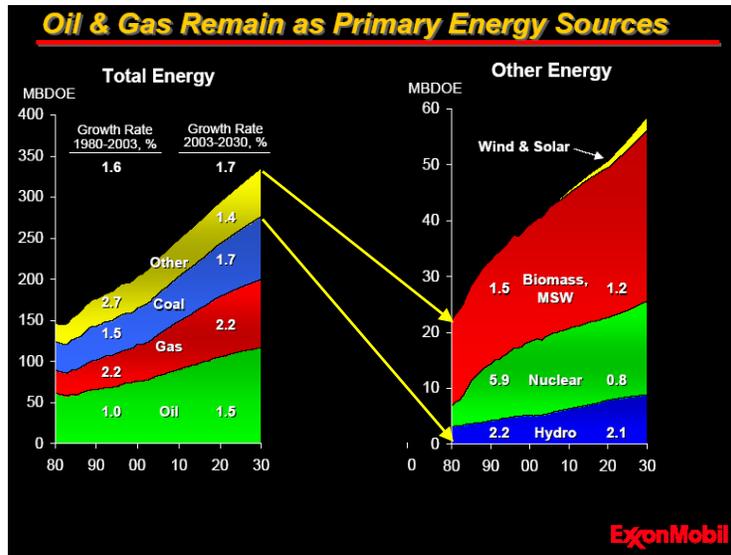
1. **Energy**
2. Global warming
3. Freshwater
4. Agriculture / defeating hunger
5. Environment degradation
6. Poverty
7. Military conflicts
8. Health systems
9. Education
10. Population

2003 6.5 billion people
2050 10 billion people

Energy is only one of several major challenges .. BUT the most **urgent** to solve



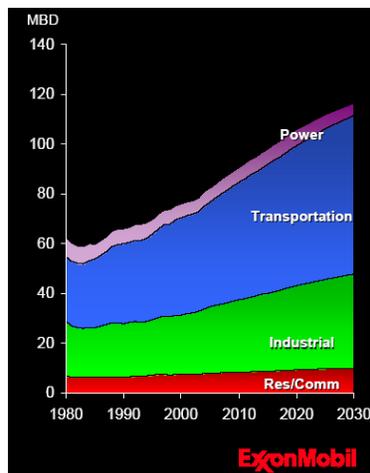
Energy demand continues to increase; Oil and Gas are leading



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Consider Oil: the most important and versatile form of modern energy, oil drives the global economy

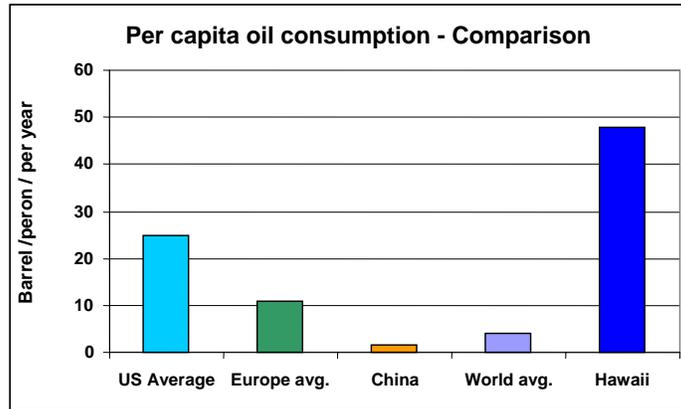


Oil production must increase to 115 MBD by 2030 up from 85 today ... to meet projected demand

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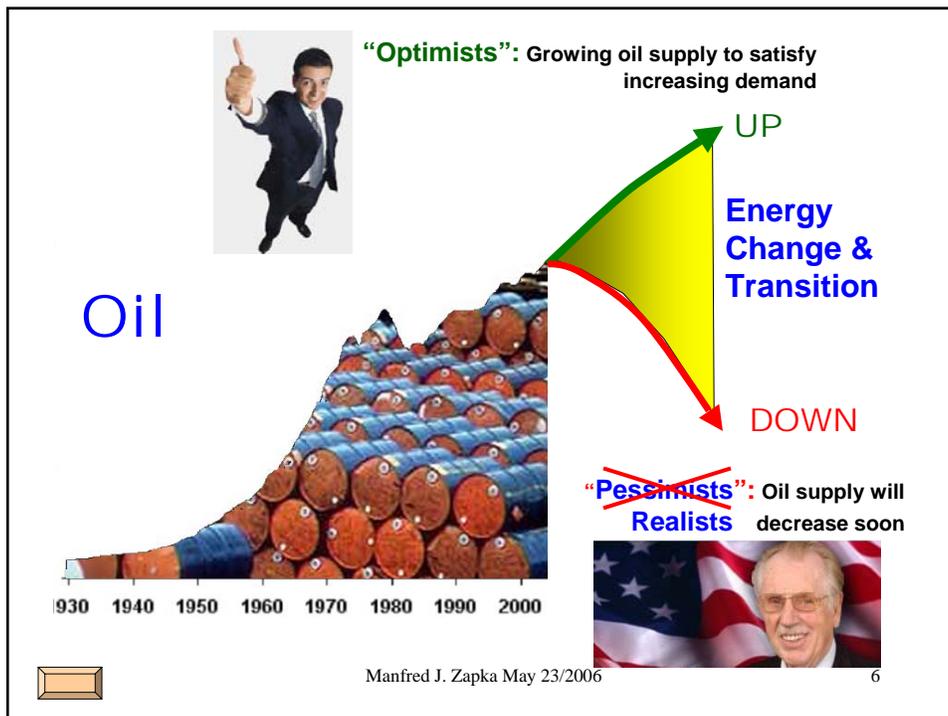
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Hawaii's very High oil dependence makes it very vulnerable



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**“Change towards Oil was evolutionary ...
Transition away from Oil will be revolutionary ...**

Hirsch Report DoE 2005

**Speed and Scope of Change will be
unprecedented**

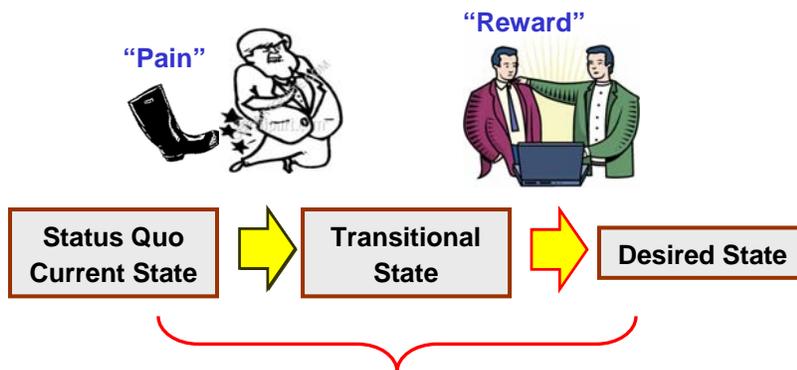
**Transition towards Energy Conservation and
less dependence on Oil**

**= Energy Change is different from classic
Change process**

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Classical Change process:



Process: Roles, communication, support, etc.

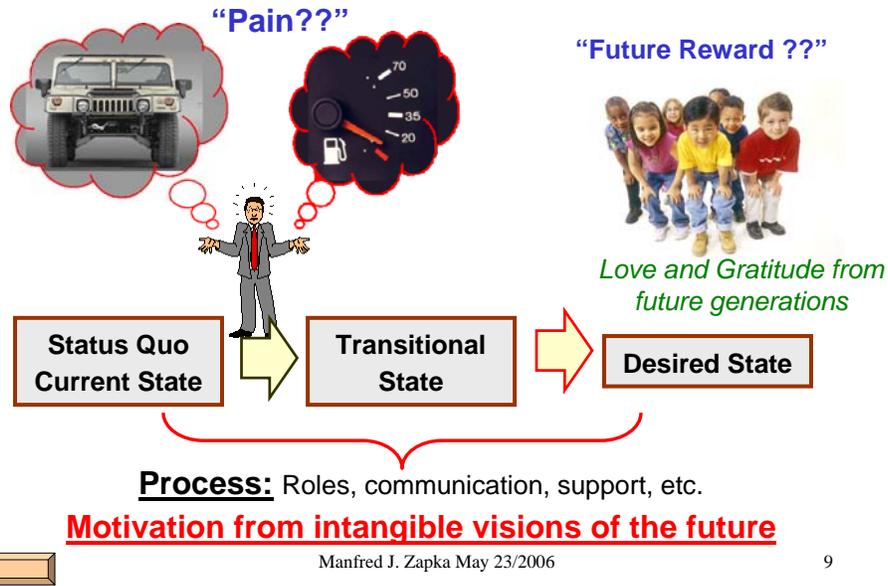
Motivation from tangible “Pain” and “Reward”



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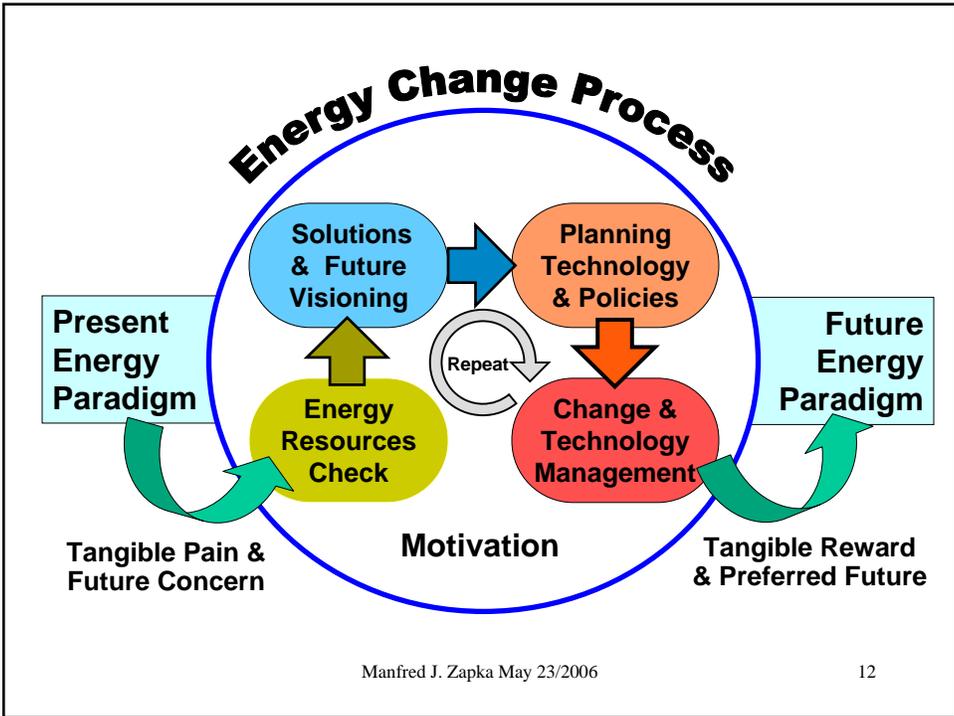
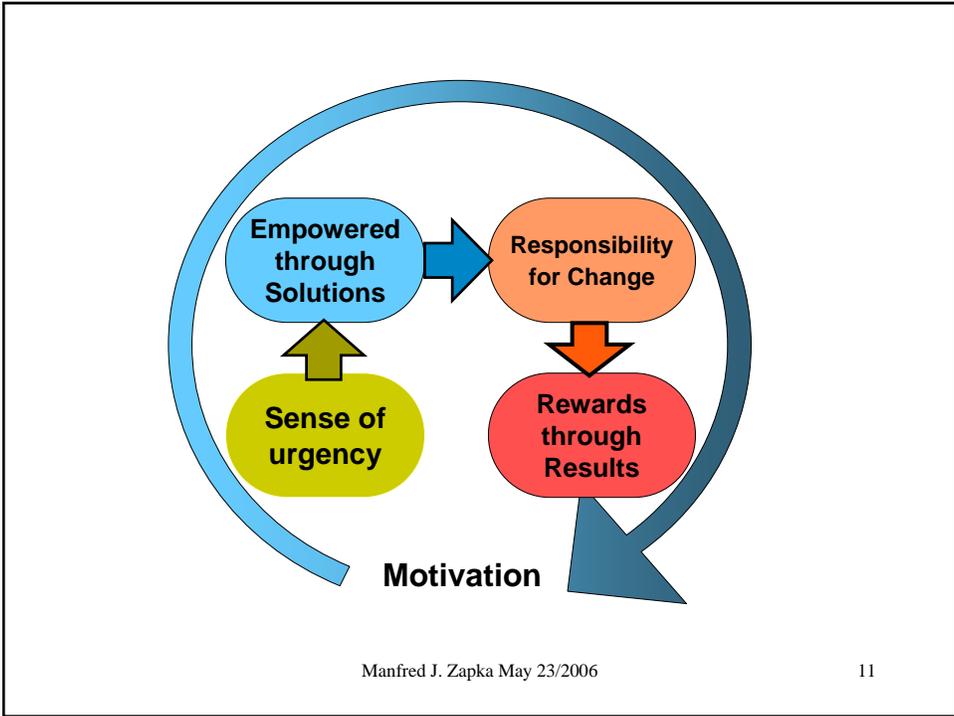
Challenges of Energy Change process:



Energy Change is different ... it requires:

- ❑ anticipation and future visioning
- ❑ good understanding about energy options and limitation
- ❑ forward looking governance
- ❑ sound solutions and avoidance of pitfalls
- ❑ and most of all ...

MOTIVATION to CHANGE



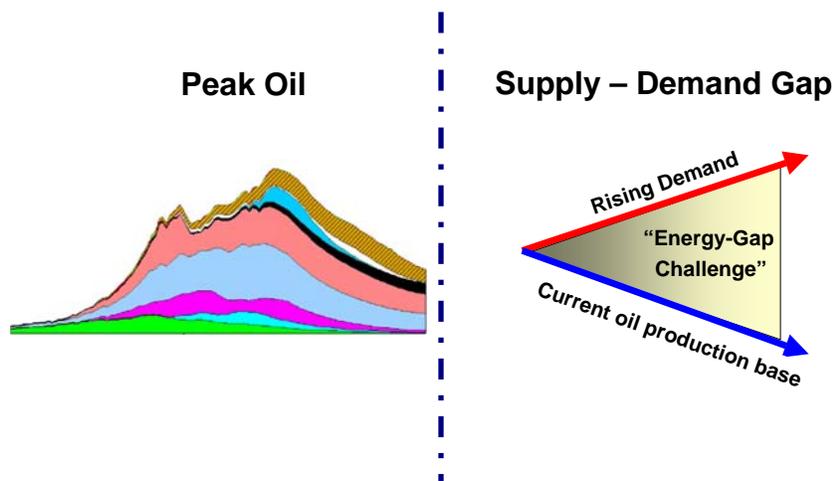
Lets look at the first step of Energy Change

Creating a sense of Urgency
through attaining knowledge about the
nature and scope of the coming fuel
Crunch

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Two models for challenges to future oil supply:



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What is Peak Oil

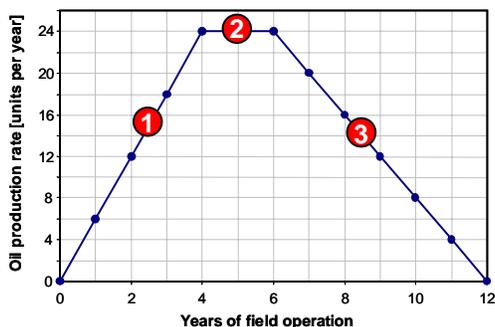
If oil is limited resource ...

- ❑ **Peak Oil is the maximum oil production**
- ❑ **Peak production is not a theory**, observed in all oil fields
- ❑ **Peak Oil is inevitable ... Date yet not known for sure**
- ❑ Peak Oil first reported by US geologist M. King Hubbert by correctly predicting US peak production in 1970

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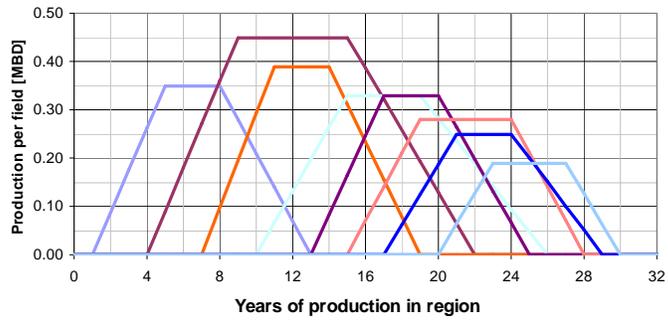
Production from single field



1	Increasing production rates: production rate increases; more infrastructure (wells, etc.) is added.
2	Reaching peak production rate: either a distinct maximum or a longer plateau
3	Decline of production: The internal field pressure decreases and less oil is driven through the rock formations toward the well head(s). advanced recovery techniques might be employed to increase the production rate above the natural decline.

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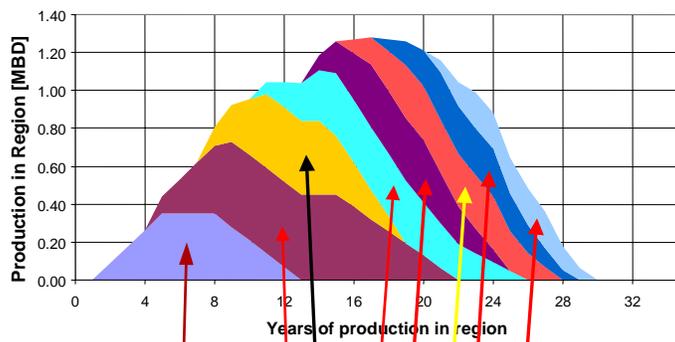
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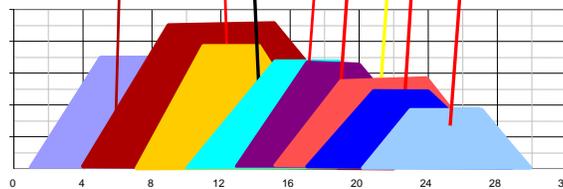
Example: Oil producing regions with eight oil fields; all contributing to production profile

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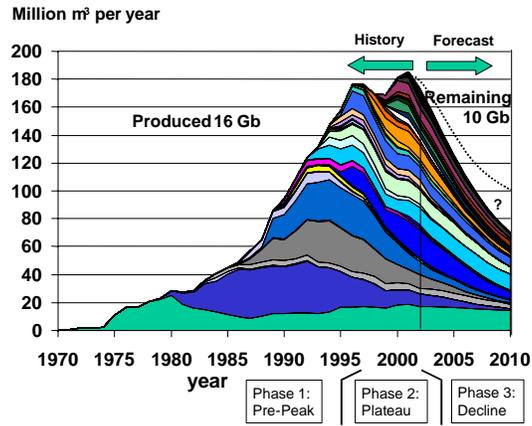


Start Animation



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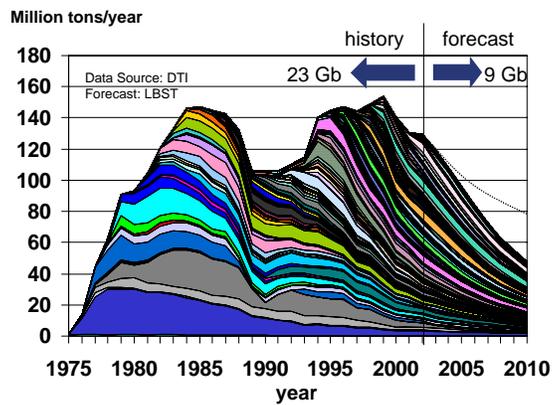
Peak oil for Norway



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Peak Oil for UK

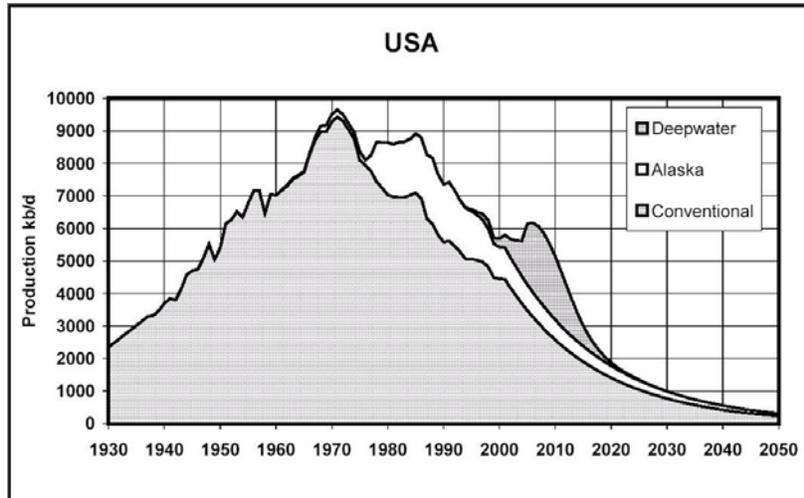


UK oil production profile

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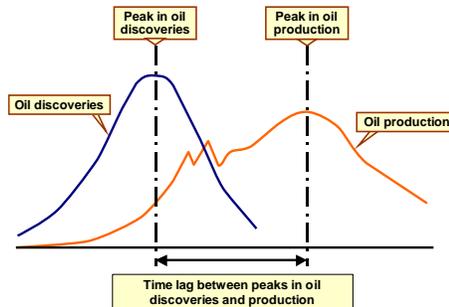
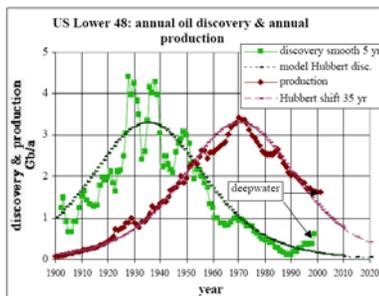
Peak oil for Countries or Provinces



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Time lag between peak in discovery and production

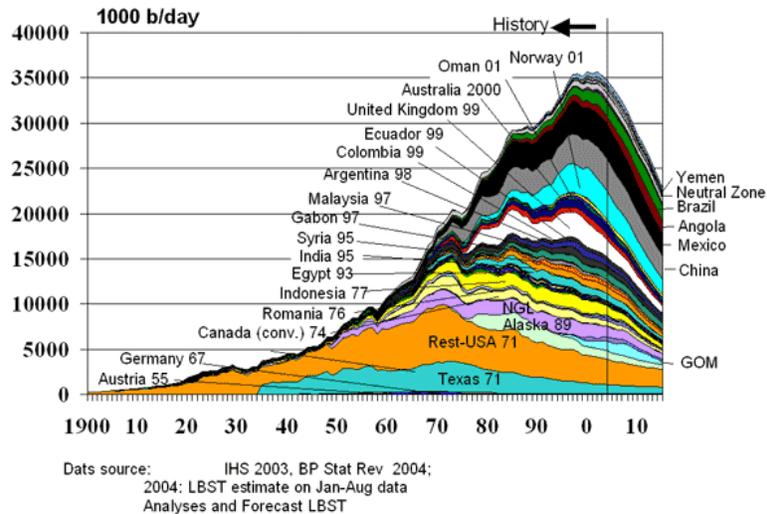


Oil has to be discovered before it can be produced

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Oil production of countries outside OPEC and FSU



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Peak Oil concept is basic .. But modeling and predicting date is complex

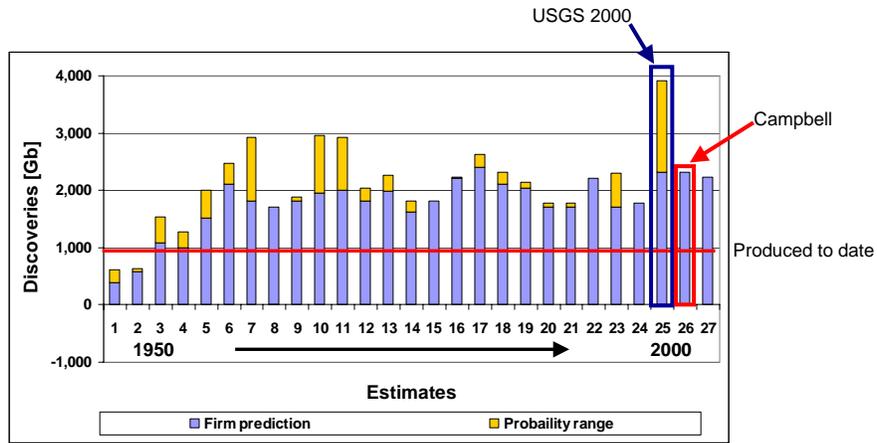
Main parameters:

- Ultimate Recoverable Oil (leading indicator)
- Proved Reserves
- Demand for oil structure
- Investment in exploration and production
- Down-well infrastructure bottlenecks (tanker capacity, refineries, drilling rigs, aging workforce)
- Natural disasters
- Conflicts / Terrorism
- State of world economy (recession, depression, or boom)

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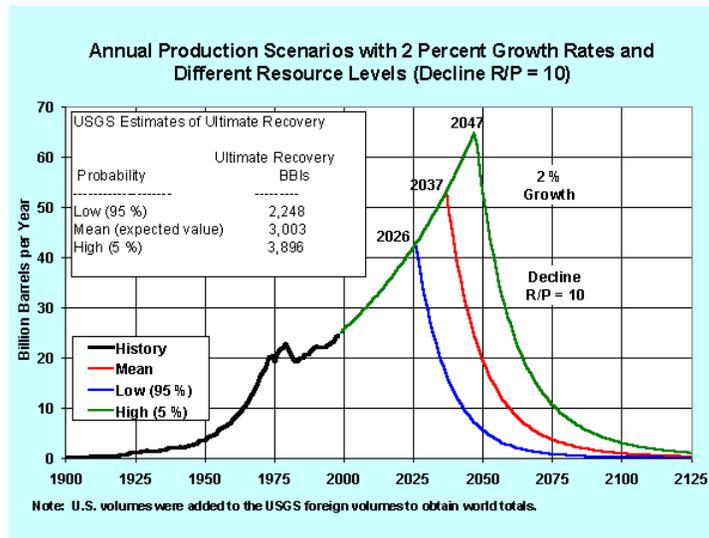
Overview of main predictions of Ultimate Recovery



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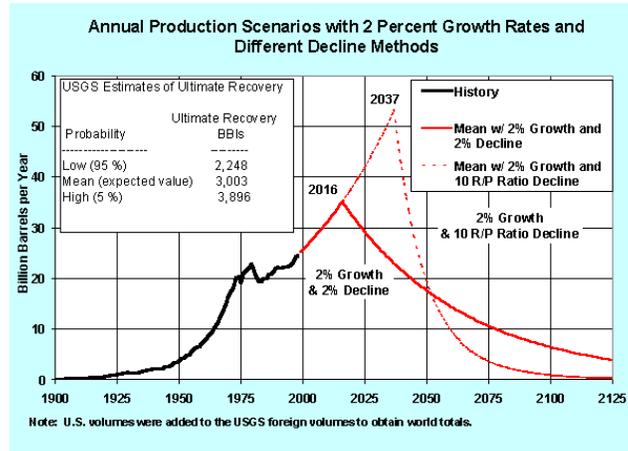
Peak Scenarios of US DoE, EIA



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Peak Scenarios of US DoE , EIA

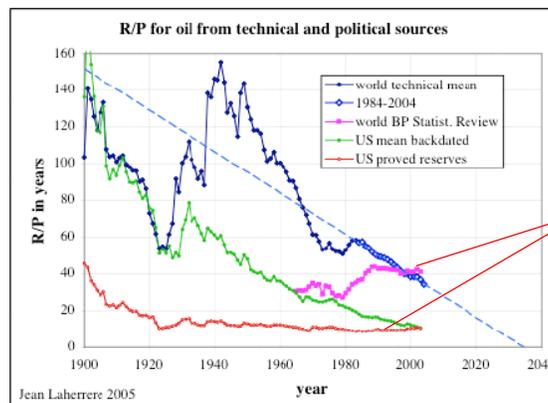


↑ ↑
2016 2037

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$R/P = \text{Reserves} / \text{Production rate} = \text{in years}$



R/P constant over past years or decades

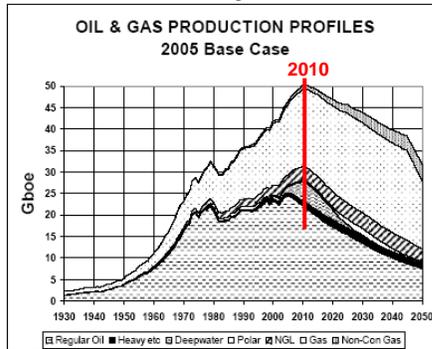
R/P is a very poor parameter but used by all!

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Peak Scenarios of ASPO

The General Depletion Picture



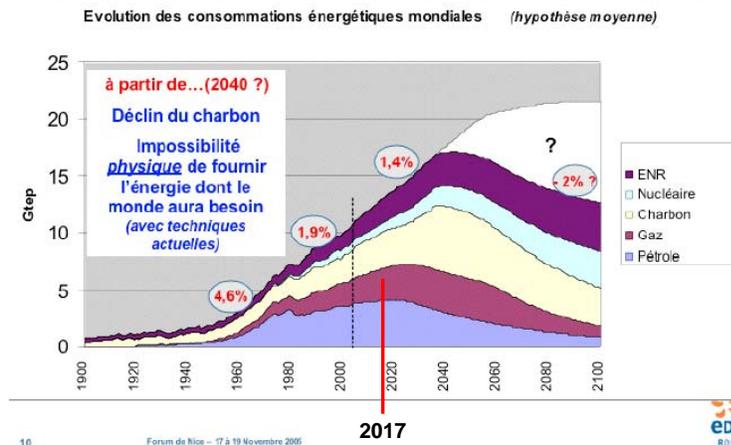
Regular Oil	1,850
Heavy, Deepwater, Polar, GL	550
All Liquids	2,400

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Peak Scenario for oil, gas, coal, nuclear by EDF, France

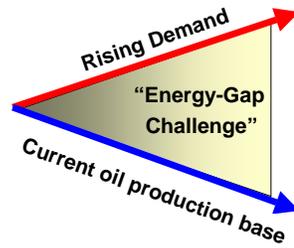
1. Perspectives mondiales : un scénario tendanciel possible



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Supply – Demand Gap

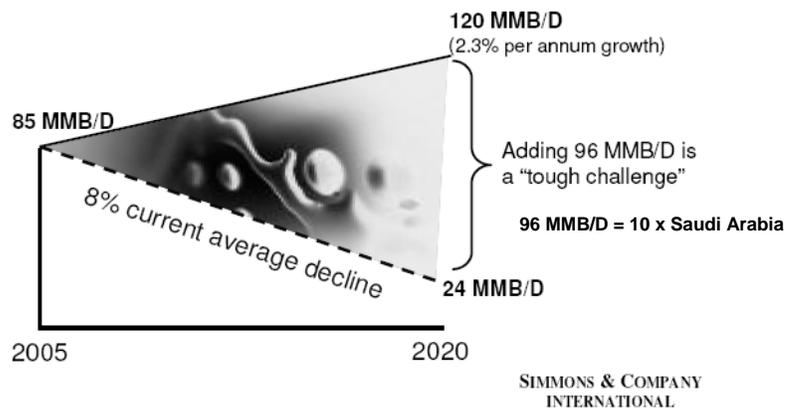


- Is used by the oil industry “mainstream experts” to indicate challenges to produce enough oil while current

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Estimate by Matt Simmons



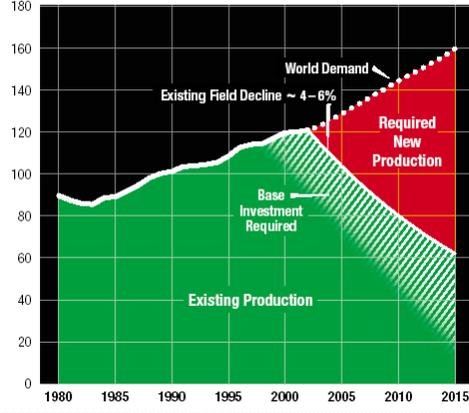
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Supplying Oil and Gas Demand Will Require Major Investment

Millions of Barrels per Day of Oil Equivalent (MBOOE)



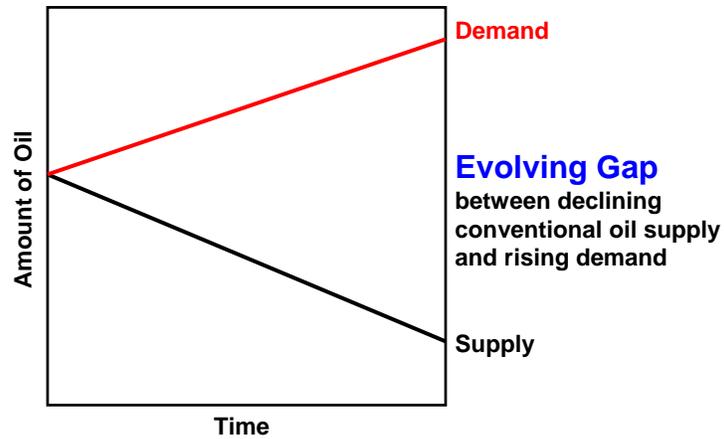
For example, we estimate that **world oil and gas production from existing fields is declining at an average rate of about 4 to 6 percent a year.**

In other words, by 2015, we will need to find, develop and produce a volume of new oil and gas that is equal to eight out of every 10 barrels being produced today. In addition, the **cost** associated with providing this additional oil and gas is expected to be **considerably more than what industry is now spending.**

“A revolutionary transformation” the President of ExxonMobil Exploration Company, Jon Thompson, 2002

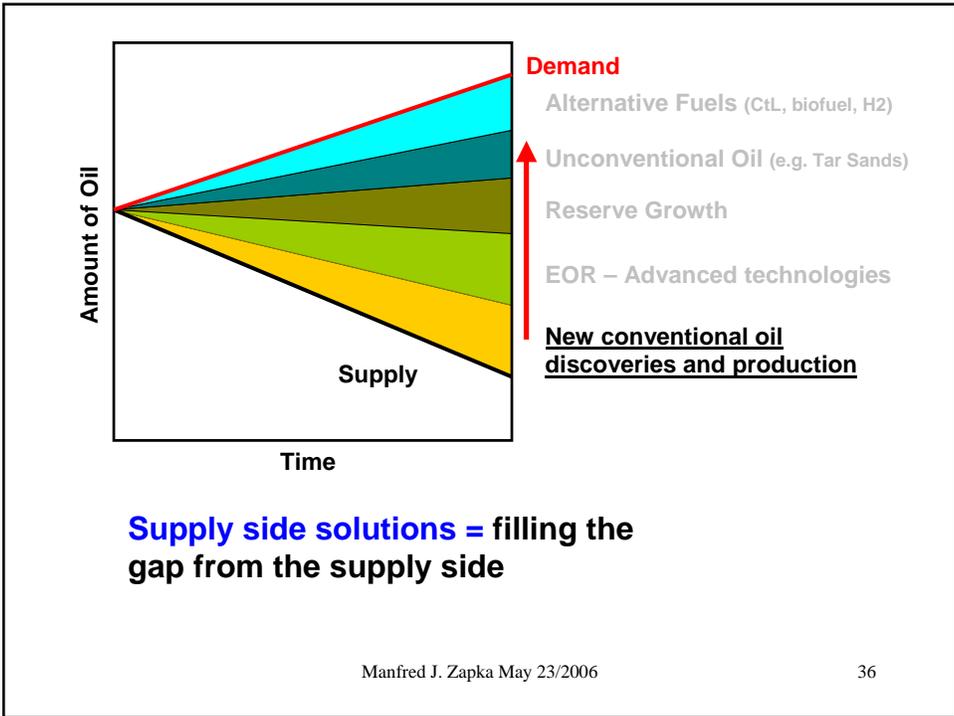
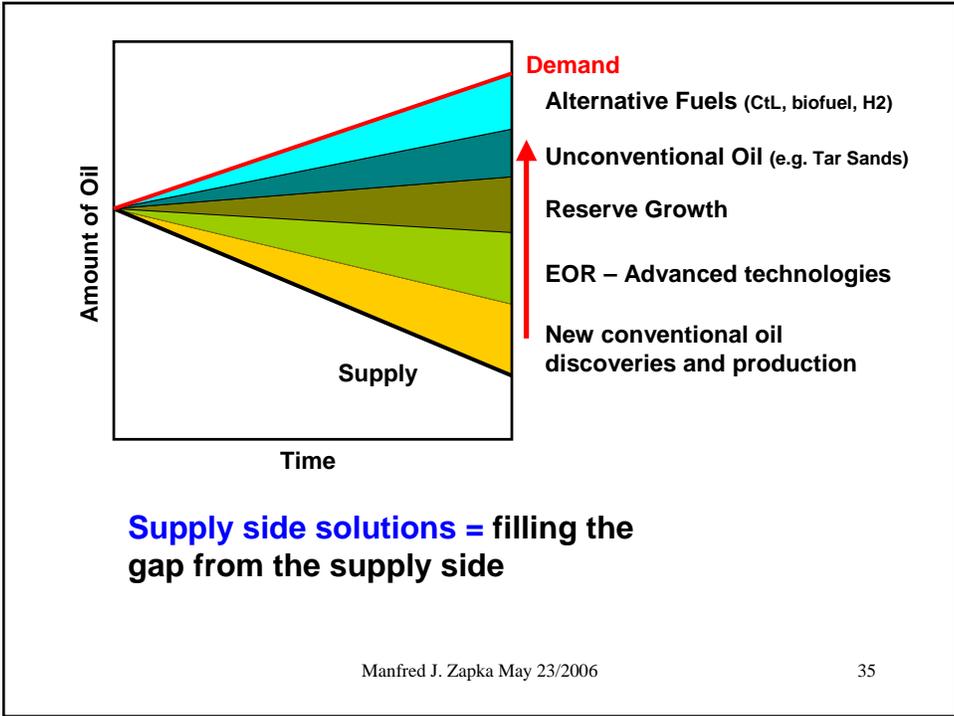
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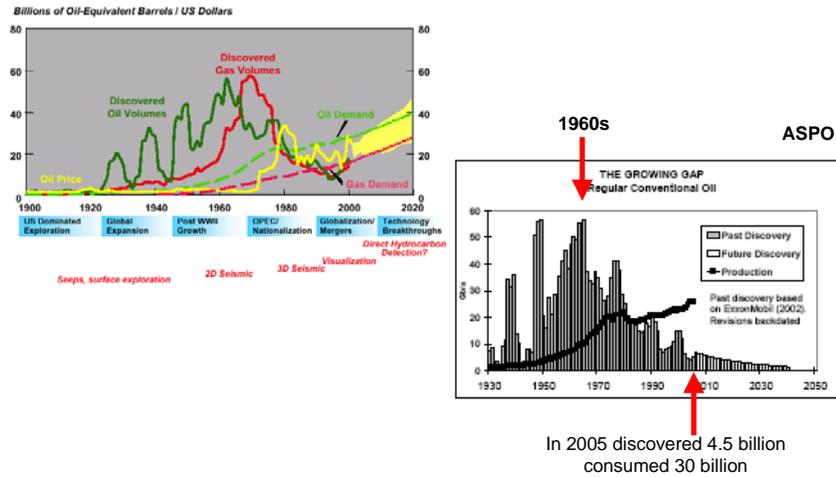
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Potential for New Discoveries

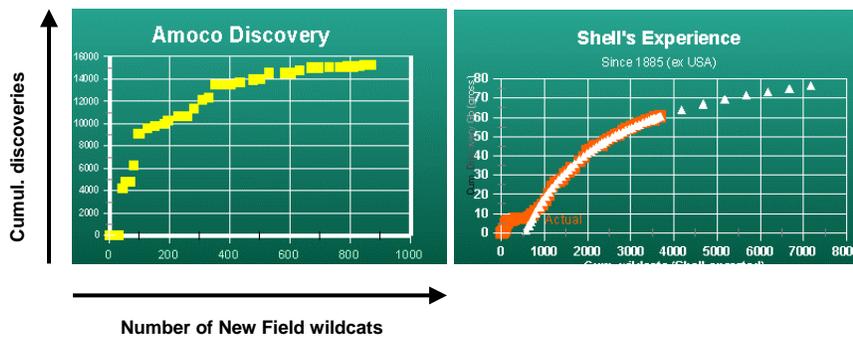
World Annual Oil discovery – EXXON 2002



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Creaming curves for Shell and Amoco

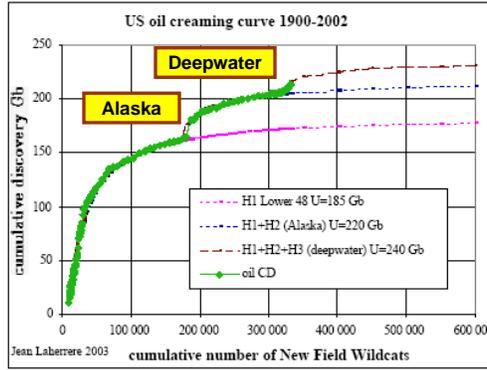


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Creaming curves = cumulative discovery versus cumulative number of exploratory wells

Creaming curve for US

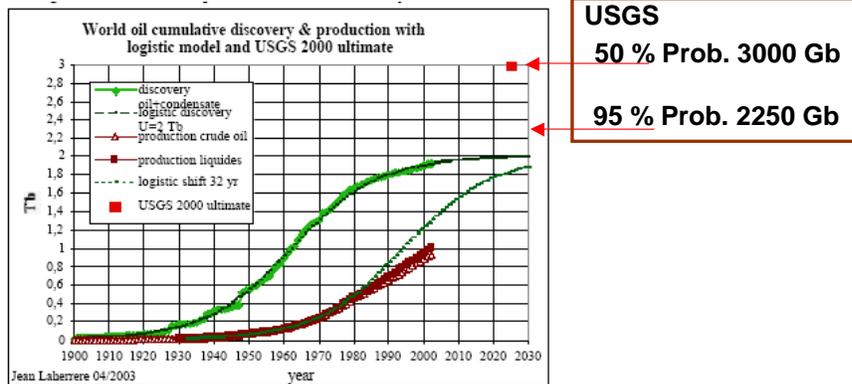


Comparison

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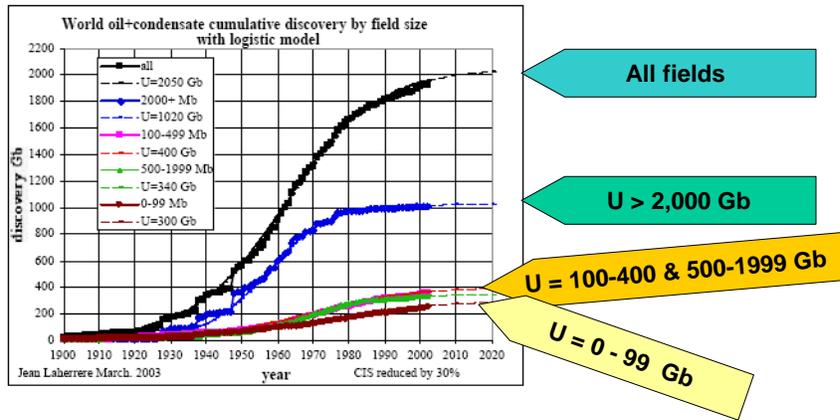
Cumulative discovery and production curve



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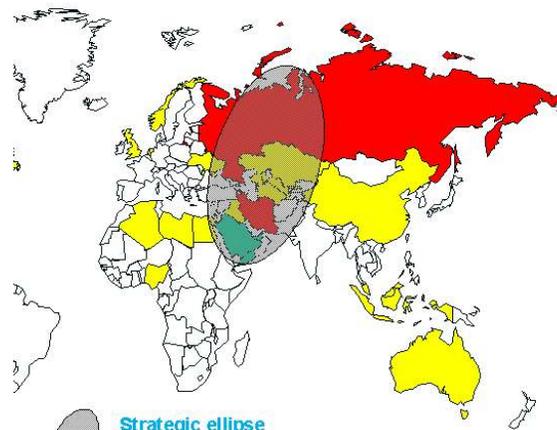
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Giant oil fields are very important, because of cost effective production; about 360 Major fields contain about 75% of all the reserves; of ~ 45,000 active oil fields worldwide



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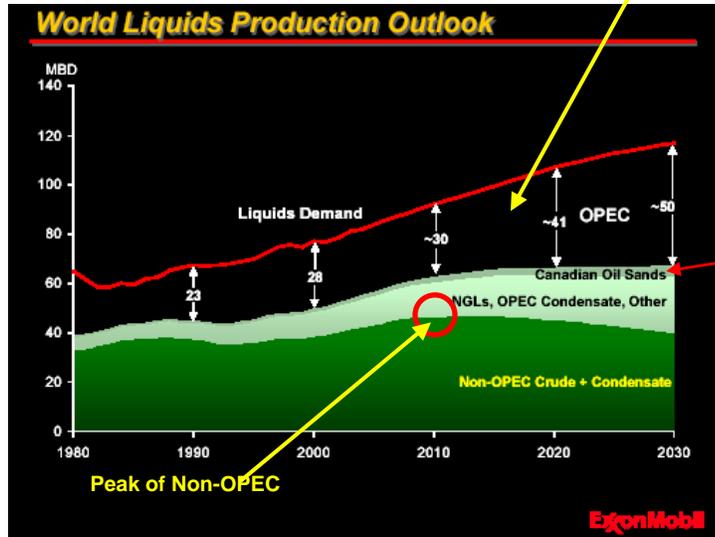
Strategic ellipse
with about 70 % of world oil reserves
and about 65 % of world natural gas reserves

BGR

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OPEC is called to increase production by great amount; can they do it??

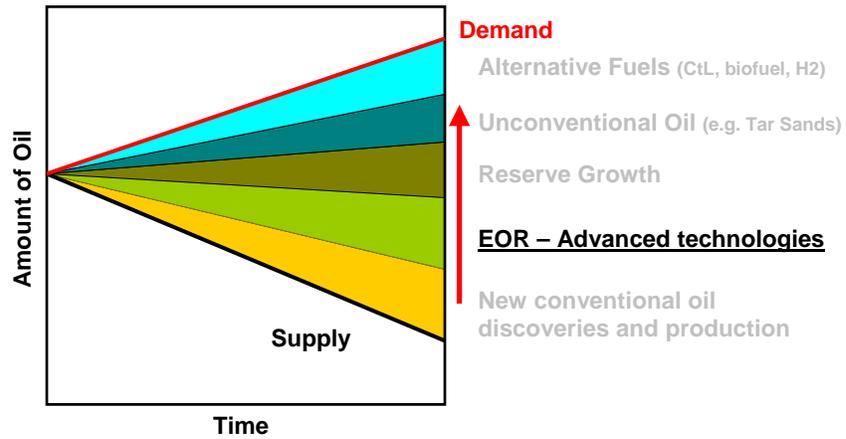


OPEC has to increase by >70%

EXXON projection of Canadian Oil Sands; about 4-5 MBD

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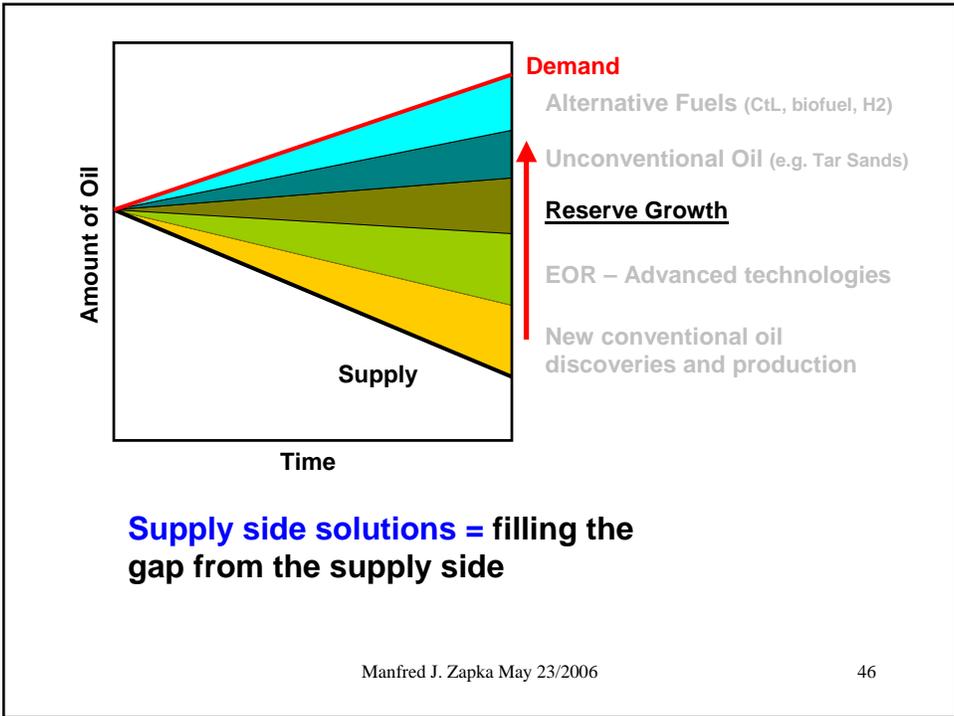
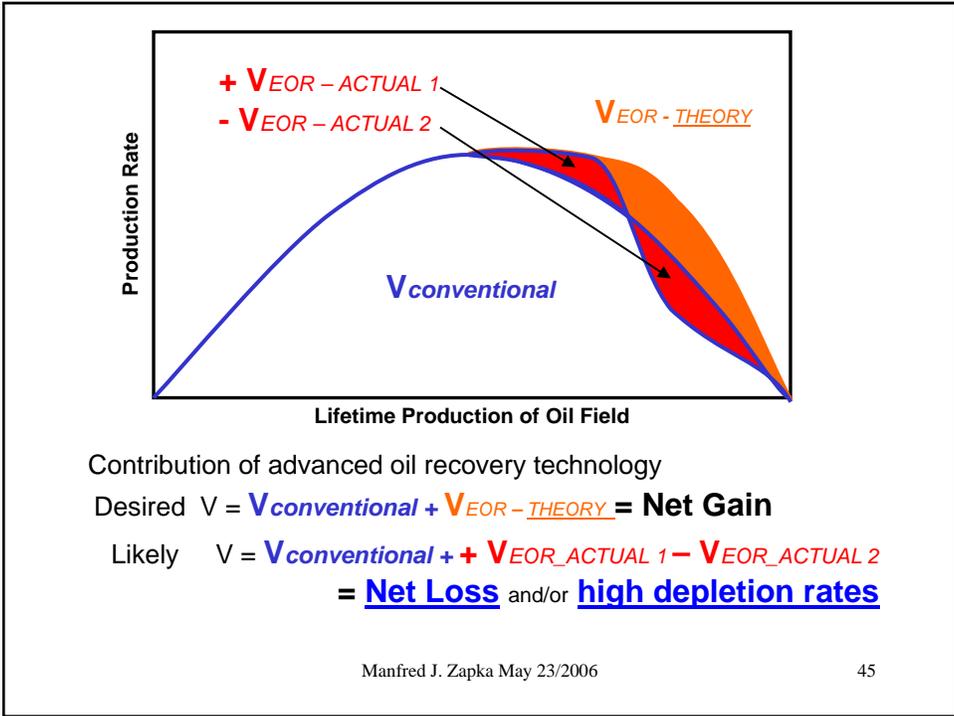
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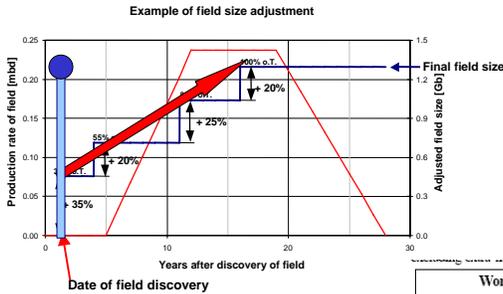
Supply side solutions = filling the gap from the supply side

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Reserve Growth - Backdating



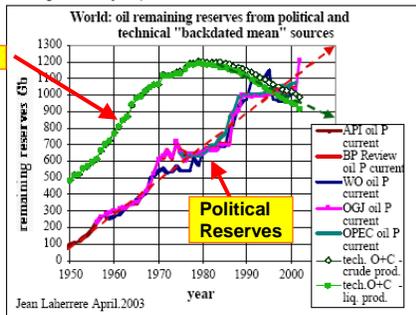
Zero or Negative Reserve Growth more frequently

Technical Reserves

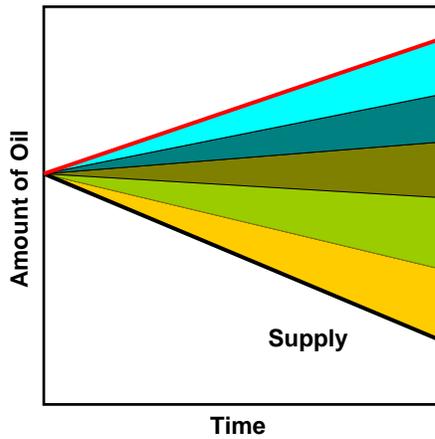
Important to correctly backdate the discoveries

“Political” versus “Technical” reserves

Backdating required by SEC for asset reporting purposes (only proven reserves) no technical rational



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Demand

Alternative Fuels (CtL, biofuel, H2)

Unconventional Oil (e.g. Tar Sands)

Reserve Growth

EOR - Advanced technologies

New conventional oil discoveries and production

Supply side solutions = filling the gap from the supply side

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Oil "Production"



Oil from Tar Sand



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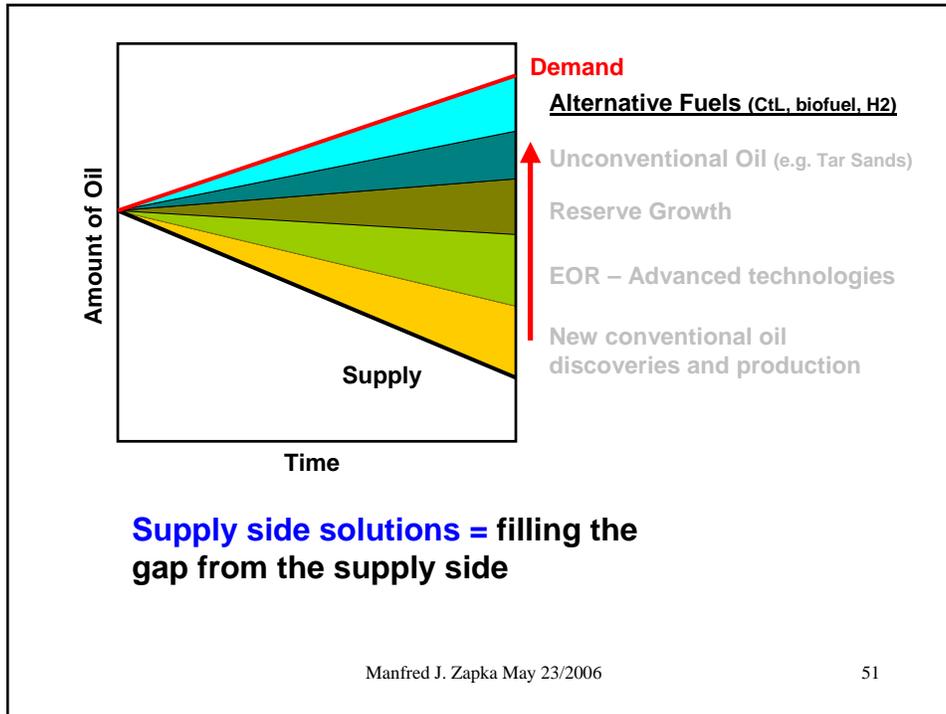
Important issue: Energy Net Gain

Energy Invested over Energy Recovered (EIOER)

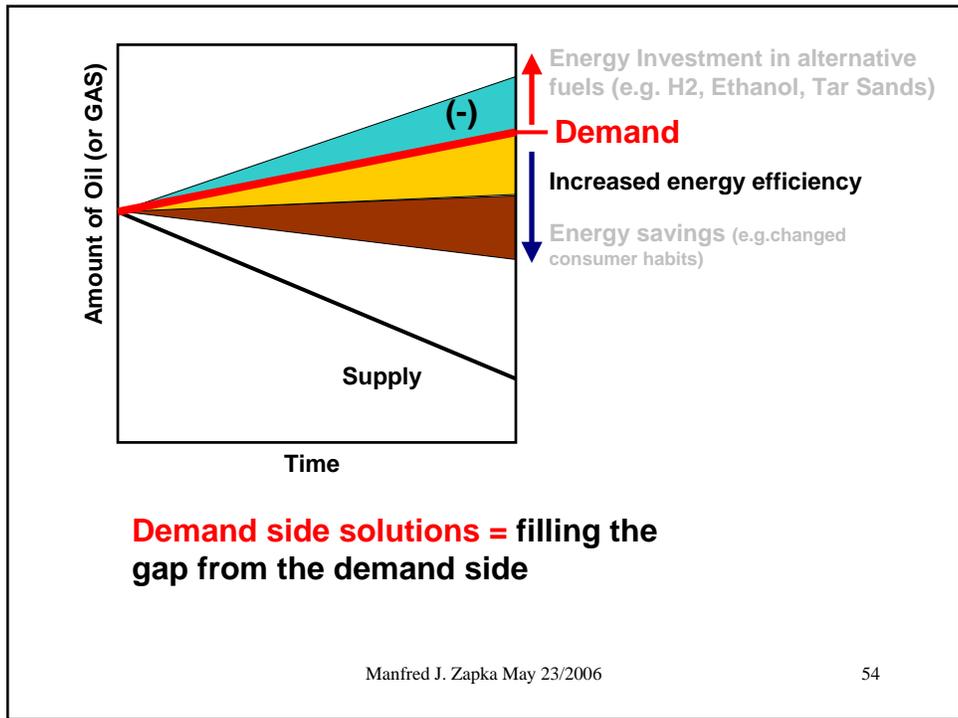
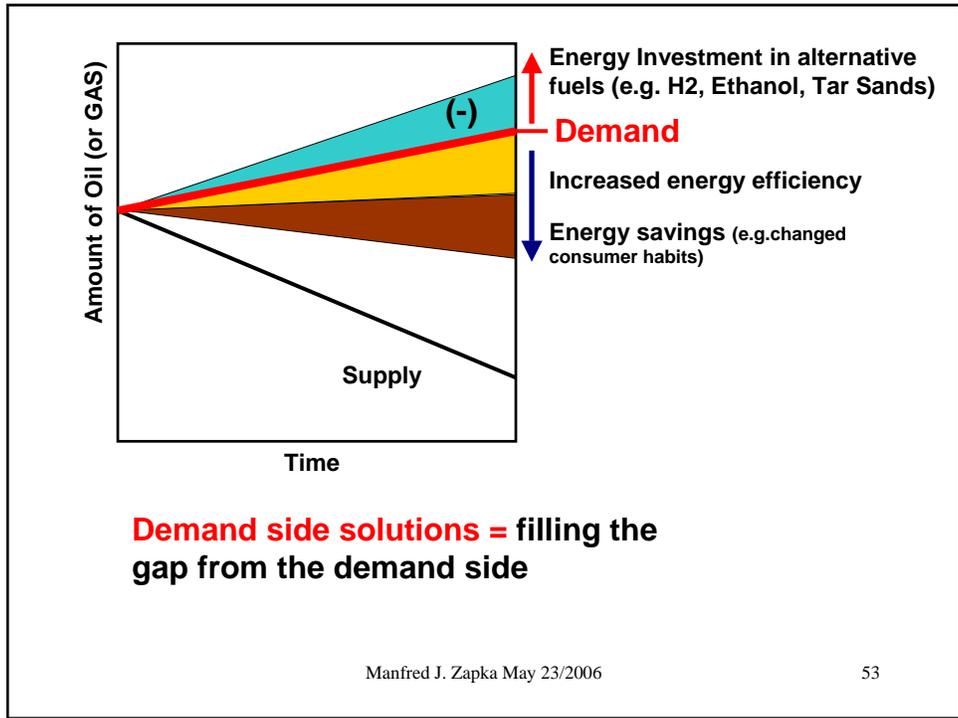
Examples:	EIOER
• Conventional Oil production from Giant Fields	~ 40 – 60
• Conventional Oil production average today	~ 20
• Tar sands	~ 1.3
• Oil Shale	???

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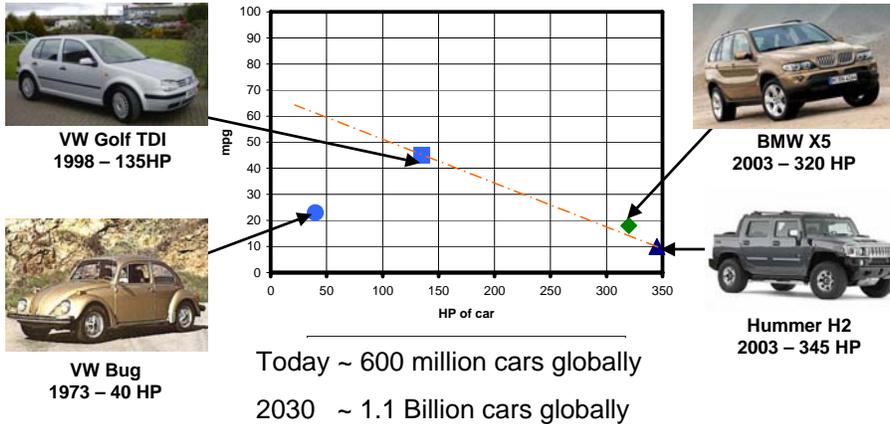
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- Many technologies are available to make alternative fuel:
- Central challenge
- Low (or even <1) EIOER ratio
 - Substantial production hardware and high energy input
 - Not easily scalable; biofuel needs huge agricultural areas
 - Environmental degradation
 - Generally lower energy content
 - Typically needs different transport, storage and power conversion technology
 - Cannot substitute for all properties of crude oil
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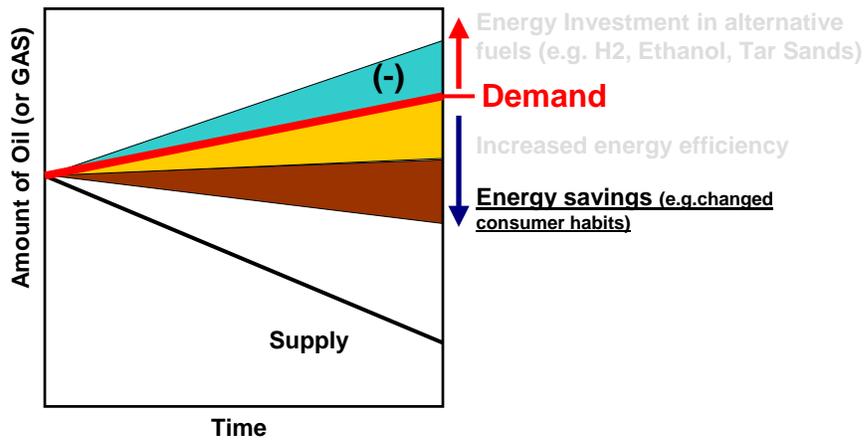


Increased energy efficiency does not necessarily result in fuel savings



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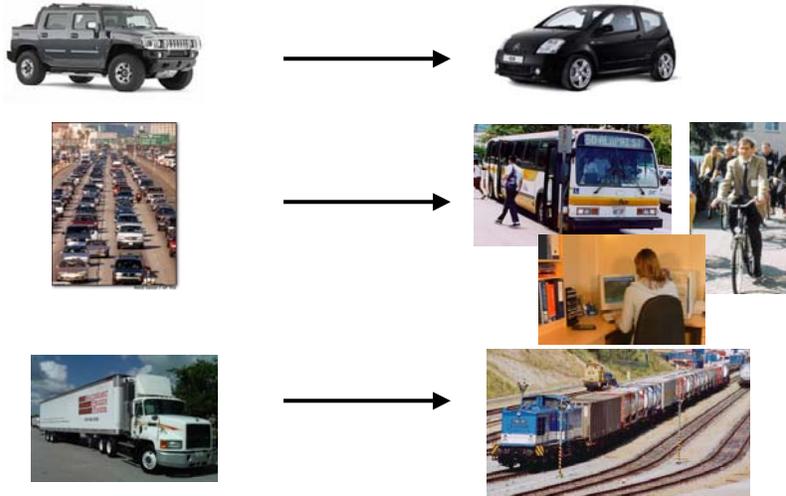


Demand side solutions = filling the gap from the demand side

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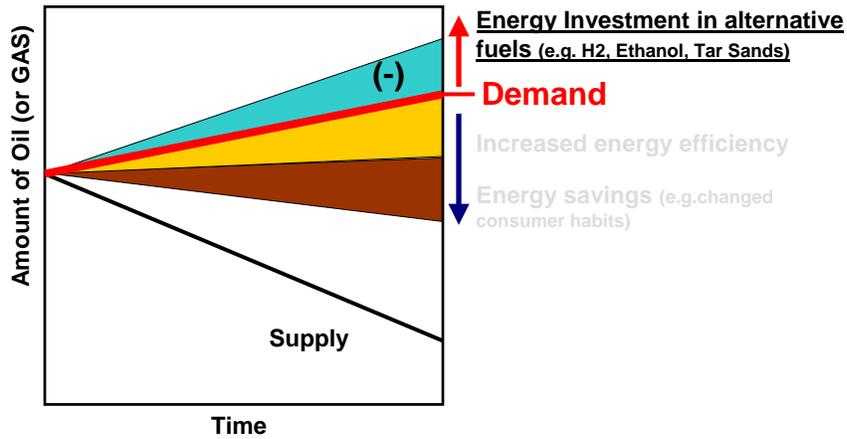
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Changed consumer habits that result in actual fuel savings



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Demand side solutions = filling the gap from the demand side

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Need fuel (and energy) to create alternative fuel infrastructure
and for production of fuels

- ❑ H₂ (from fossil fuel) has EIOER ratio ~ 0.2 (energy sink)
- ❑ Ethanol has EIOER ratio ~ 1.0 (we do not really gain energy)
- ❑ Etc.

Implementing alternative fuels will require lots of fuel and energy
just at a time when we need every "ounce" to satisfy increasing
demand

Biggest Problem we face ...

Insufficient data to make 100% accurate
prediction ..

Our current energy outlook .. foggy



What should you as a prudent “energy driver” do in such a situation?



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Our current energy driving habit ... speeding up



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Energy driving habit should be ... **Slowing down**



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Thank You

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