

OIL SUPPLY AND TECHNOLOGY

2016 EIA/DOE ENERGY CONFERENCE

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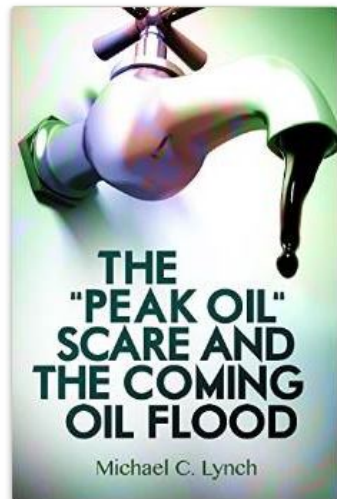
THE BOOK IS FINALLY HERE! (WELL, END JULY)

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The "Peak Oil" Scare and the Coming Oil Flood

Hardcover – July 31, 2015

by Michael C. Lynch (Author)

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In the last decade, oil experts, geologists, and policy makers alike have warned that a peak in oil production around the world was about to be reached and that global economic distress would result when this occurred. But it didn't happen. *The "Peak Oil" Scare and the Coming Oil Flood* refutes the recent claims that world oil production is nearing a peak and threatening economic disaster by analyzing the methods used

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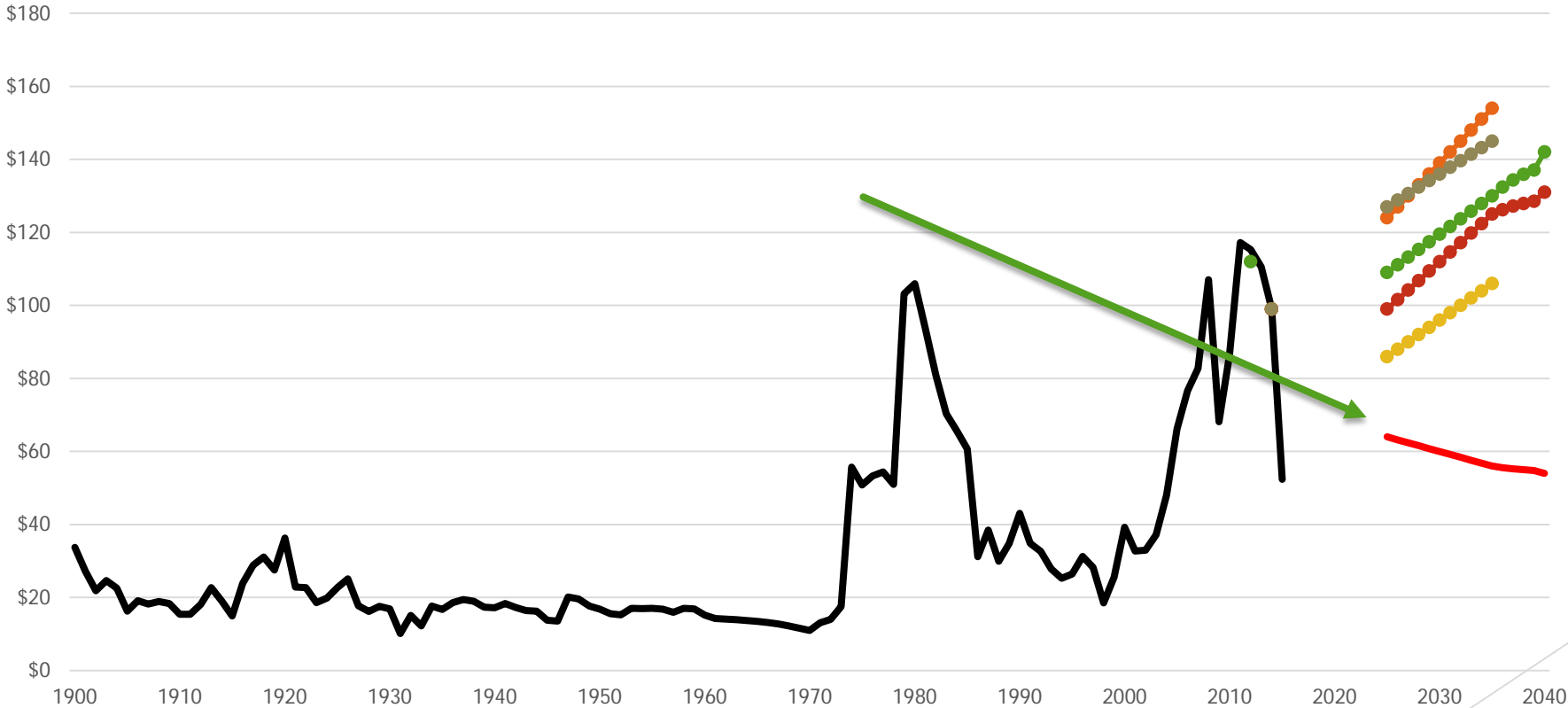


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2014 DOE PRICE FORECAST SURVEY



...IN HISTORICAL CONTEXT



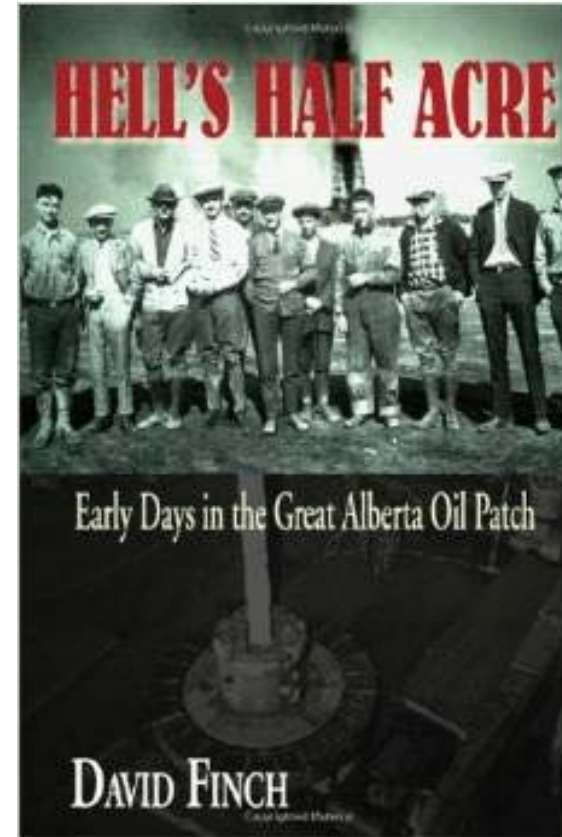
PRICE FORECASTING

- ▶ SHORT-TERM ALL BUT IMPOSSIBLE
 - ▶ WEATHER, GDP, SUPPLY DISRUPTIONS, HURRICANS, PLAGUES, TERRORISM,...
- ▶ LONG-TERM MORE AMENABLE
 - ▶ DEMAND: GDP, PRICES, TAXES
 - ▶ SUPPLY: ACCESS, COST
- ▶ MOST IMPORTANT FACTORS IN 50 YEARS, SHORT-TERM SUPPLY DISRUPTIONS, CHANGES IN ACCESS TO SUPPLY

BAD SUPPLY FORECASTING

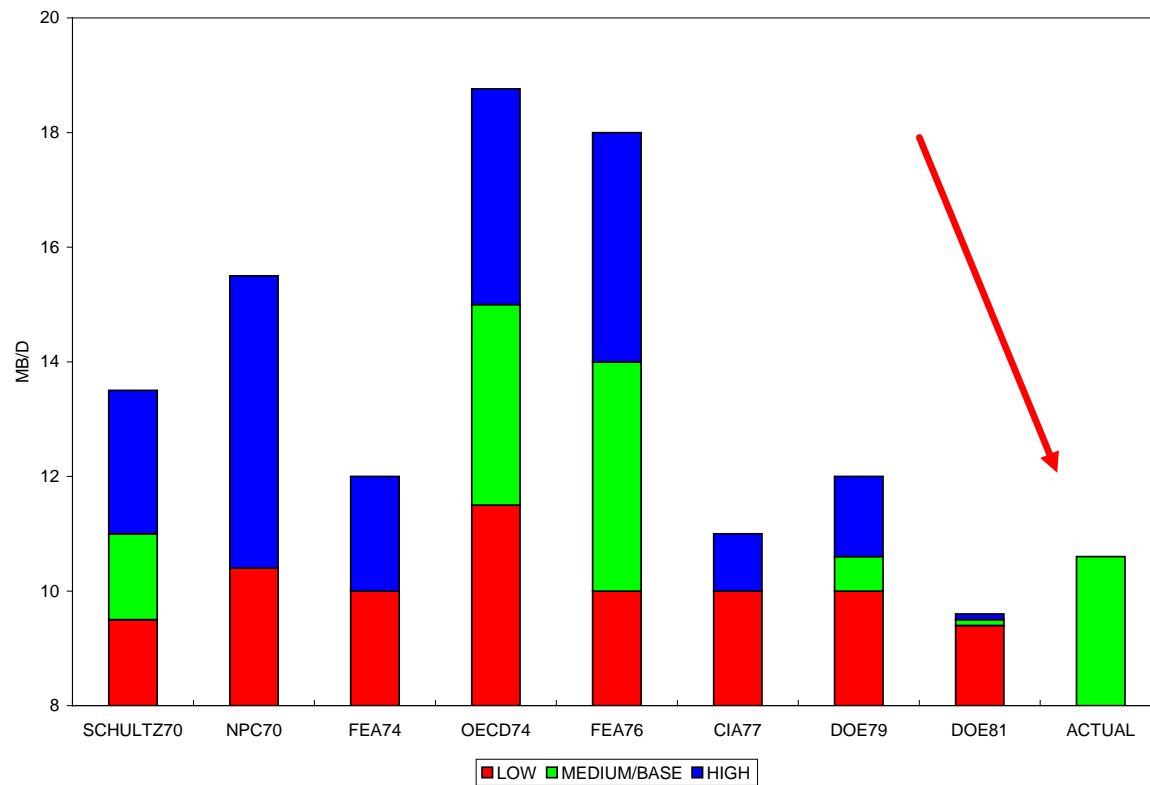
- ▶ “EASY OIL IS GONE”
- ▶ COSTS ARE HIGH (\$100) AND RISING
- ▶ NOWHERE TO DRILL
- ▶ NO MORE GIANT FIELDS
- ▶ EVERY PLACE HAS BEEN STUDIED/DRILLED
- ▶ DISCOVERIES ARE NOT KEEPING UP WITH PRODUCTION

THE EASY OIL IS GONE



EARLY SUPPLY FORECASTING (US Q in 1985)

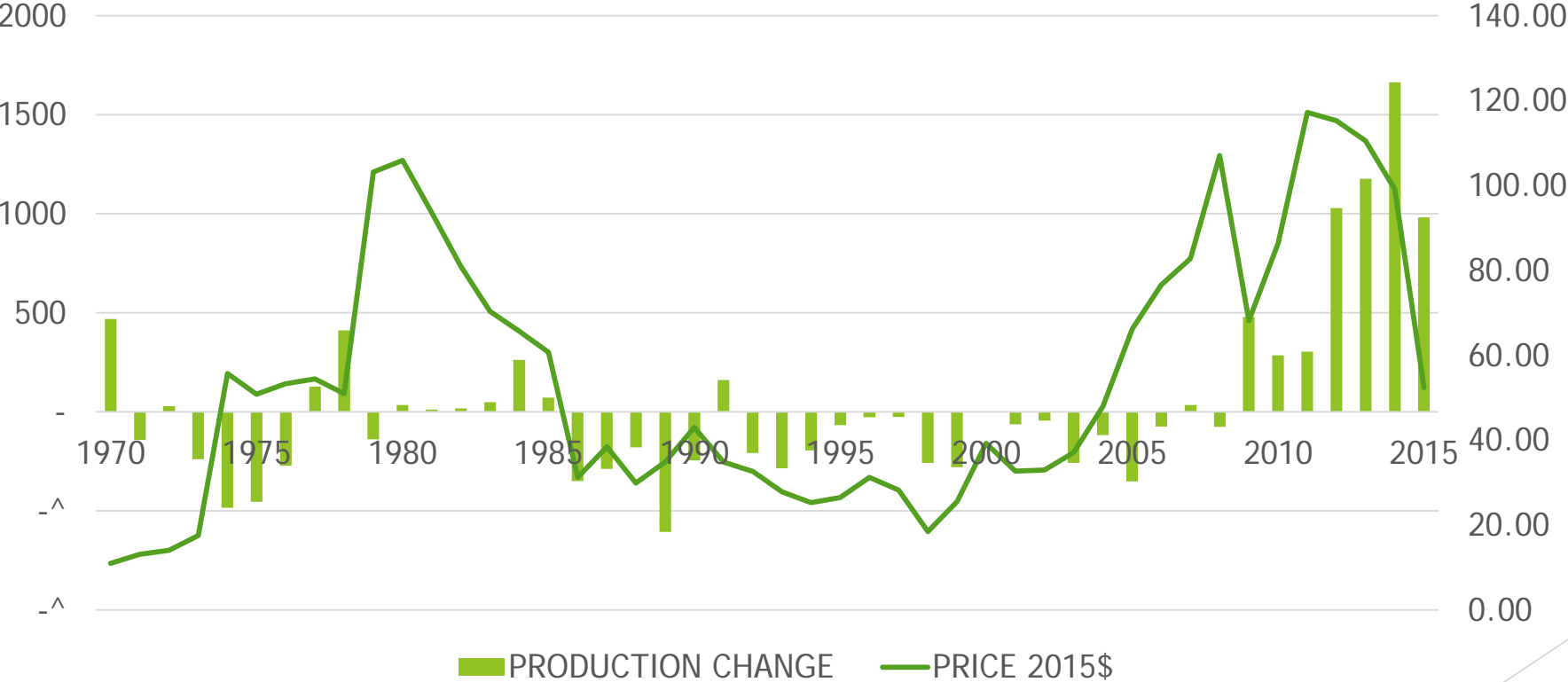
$$e_s = .03$$



OMITTED VARIABLES

- ▶ PRICE ELASTICITY CONFUSED BY:
 - ▶ ROYALTIES, TAXES
 - ▶ COSTS
 - ▶ CYCLICAL
- ▶ PRICE MATTERS
 - ▶ PEAK OIL IS NONSENSE
- ▶ POLITICS MATTERS
 - ▶ RESOURCE NATIONALISM IS CYCLICAL

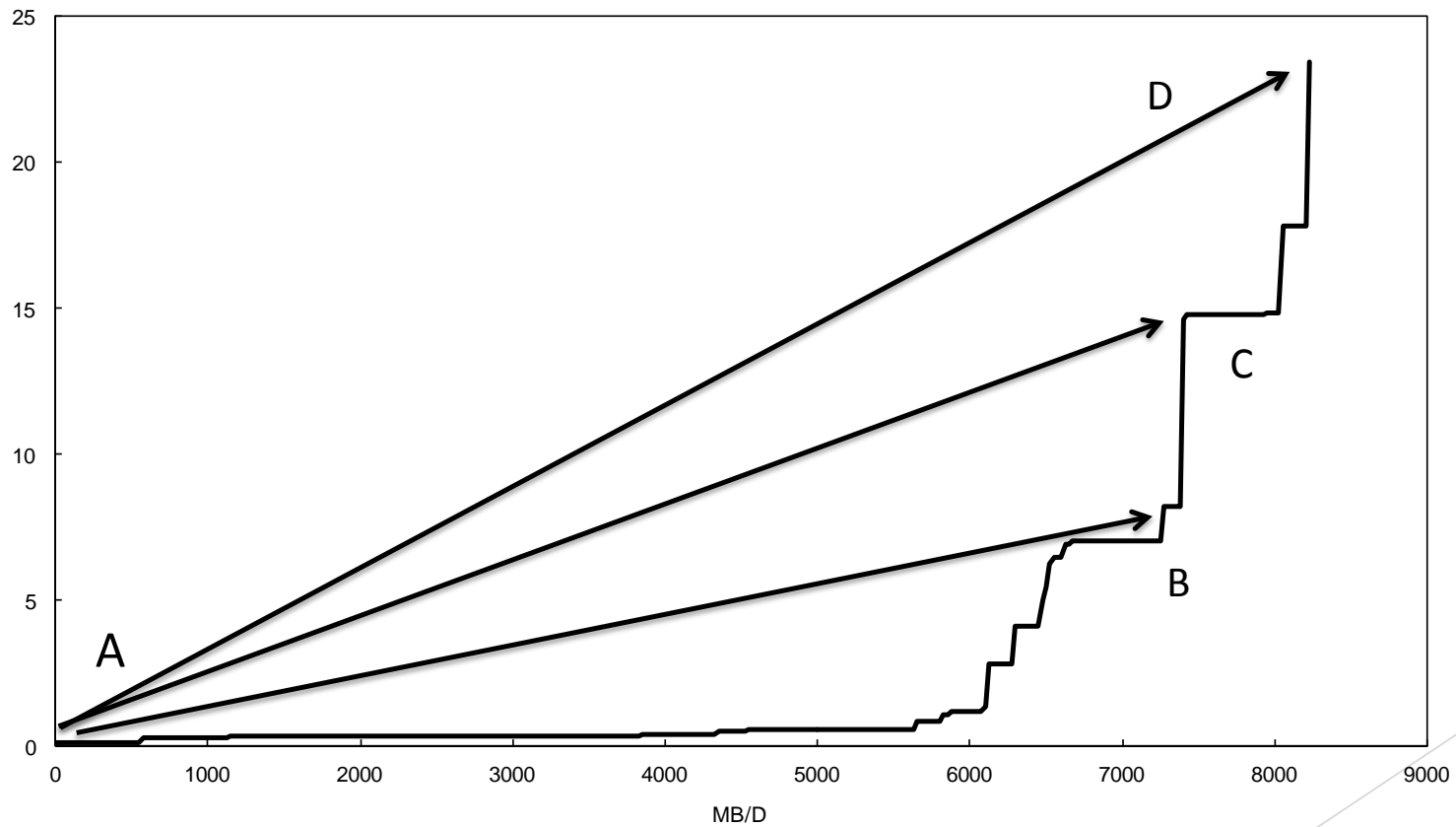
US OIL SUPPLY AND PRICE



READING SUPPLY CURVES

(RIGHT TO LEFT IS NOT TIME)

NON-OPEC THIRD WORLD SUPPLY CURVES

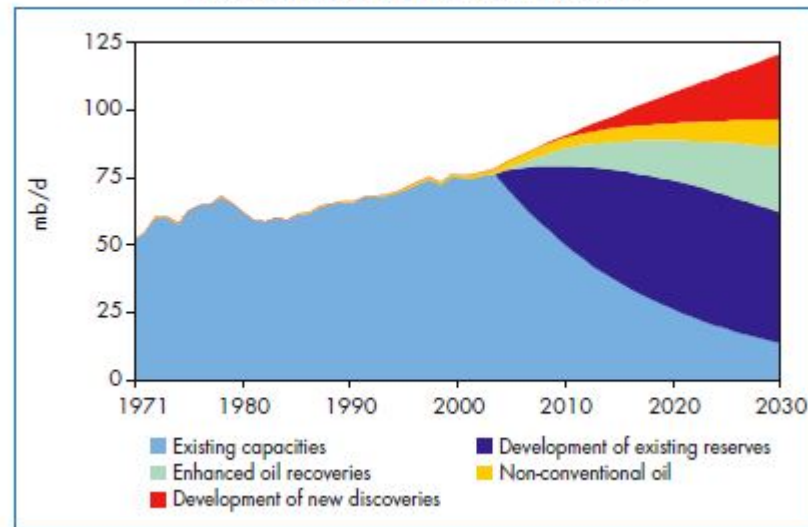


SUPPLY CURVE MOVED BY:

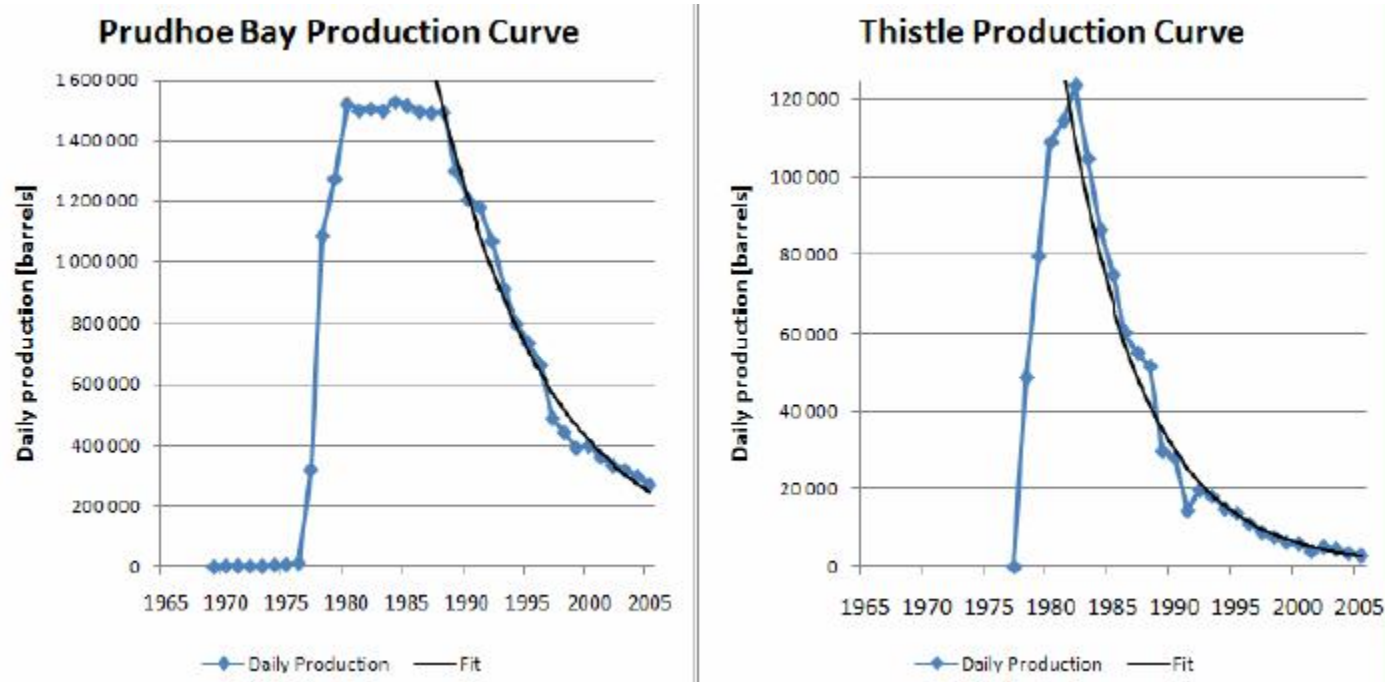
- ▶ DEPLETION
- ▶ TECHNOLOGY
- ▶ INFRASTRUCTURE
- ▶ CYCLICAL COSTS
- ▶ ACCESS

DEPLETION AND THE RED QUEEN

Figure 3.20: World Oil Production by Source



IMPACT OF DECLINE AT FIELD LEVEL

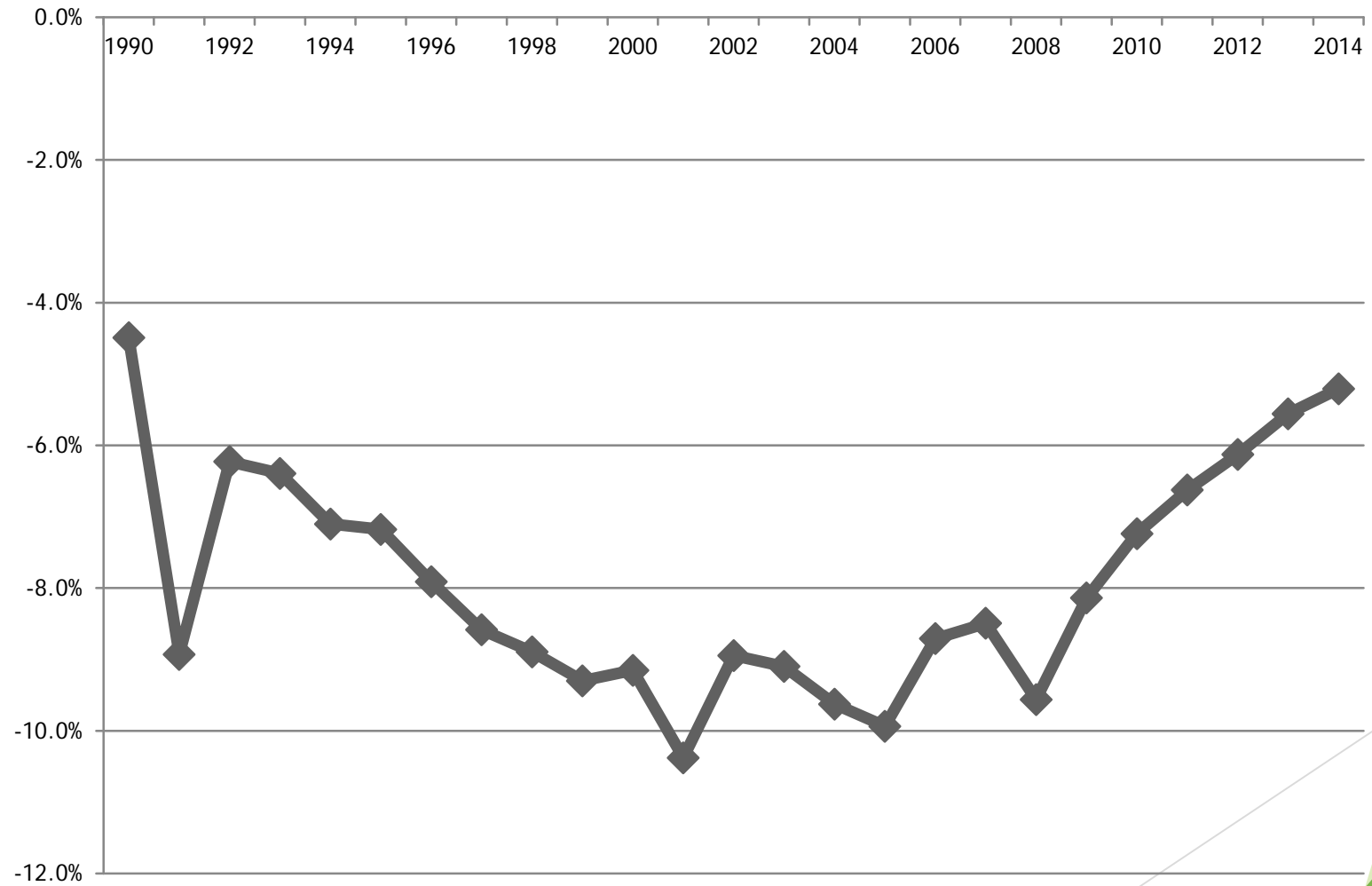


SOURCE: HOOK, HIRSCH AND ALEKLETT (2009)

THISTLE FIELD UPDATED

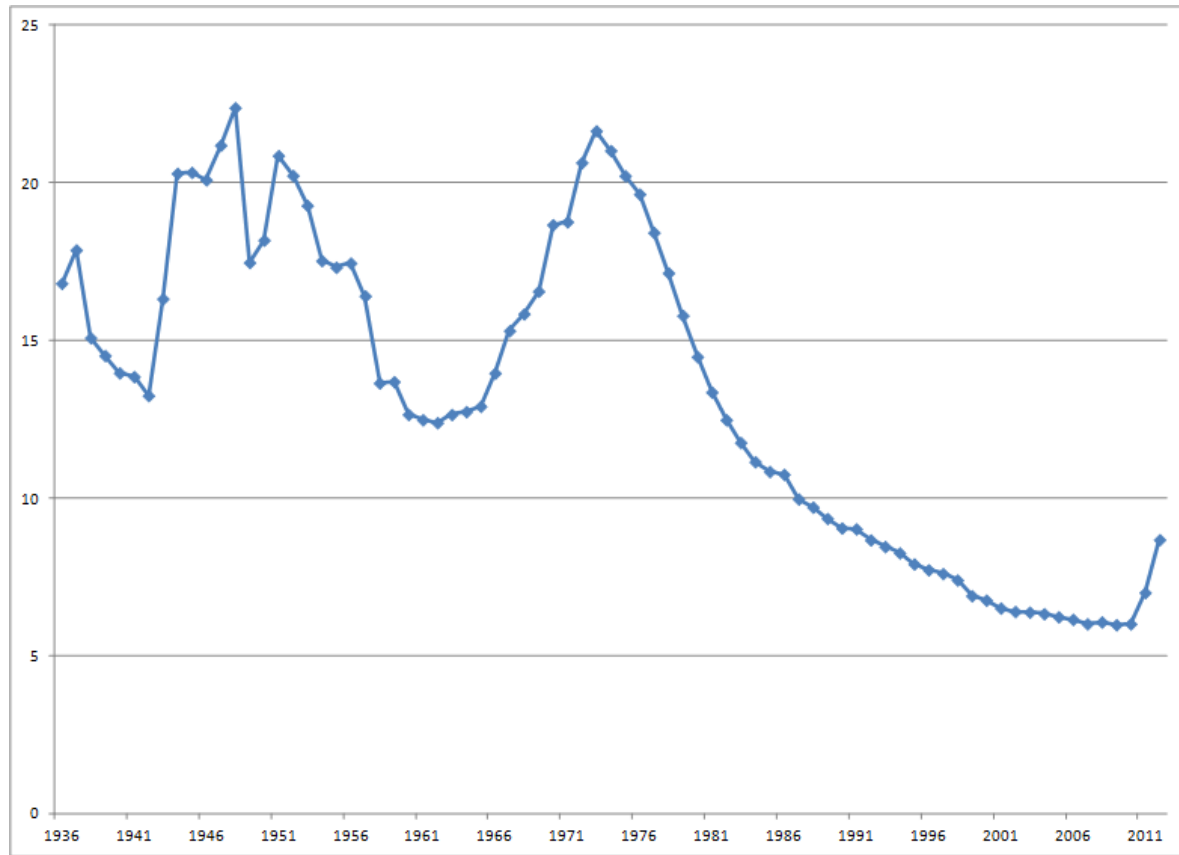


THISTLE DECLINE FROM 1978



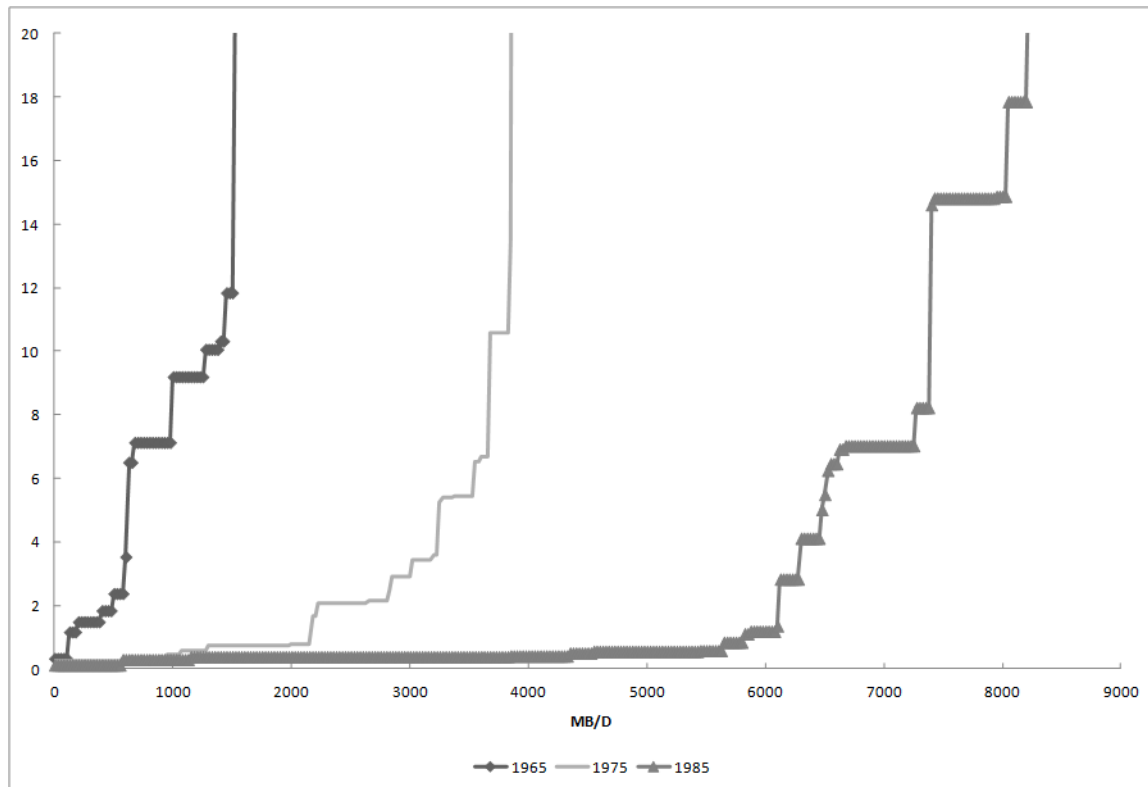
DEPLETION AND COSTS

PRODUCTION PER WELL, TEXAS, B/D/WELL



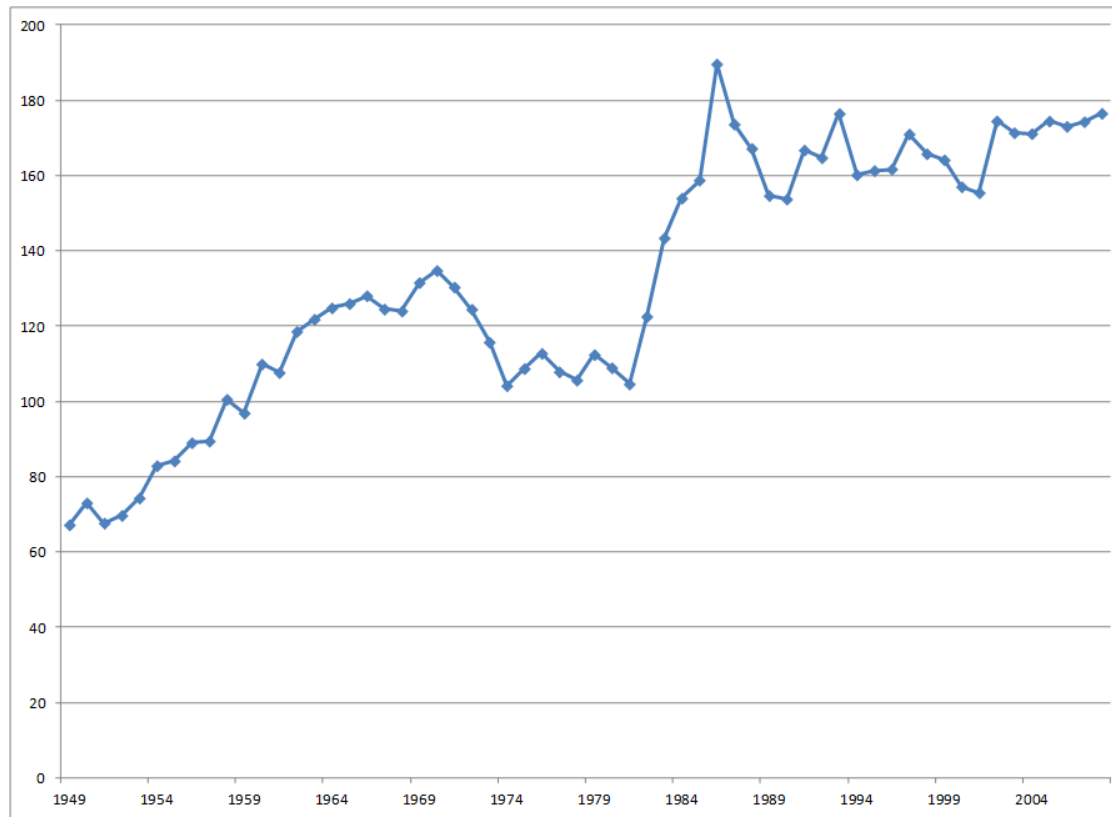
INFRASTRUCTURE IMPACT

LDC SUPPLY CURVES



TECHNOLOGY IMPACT

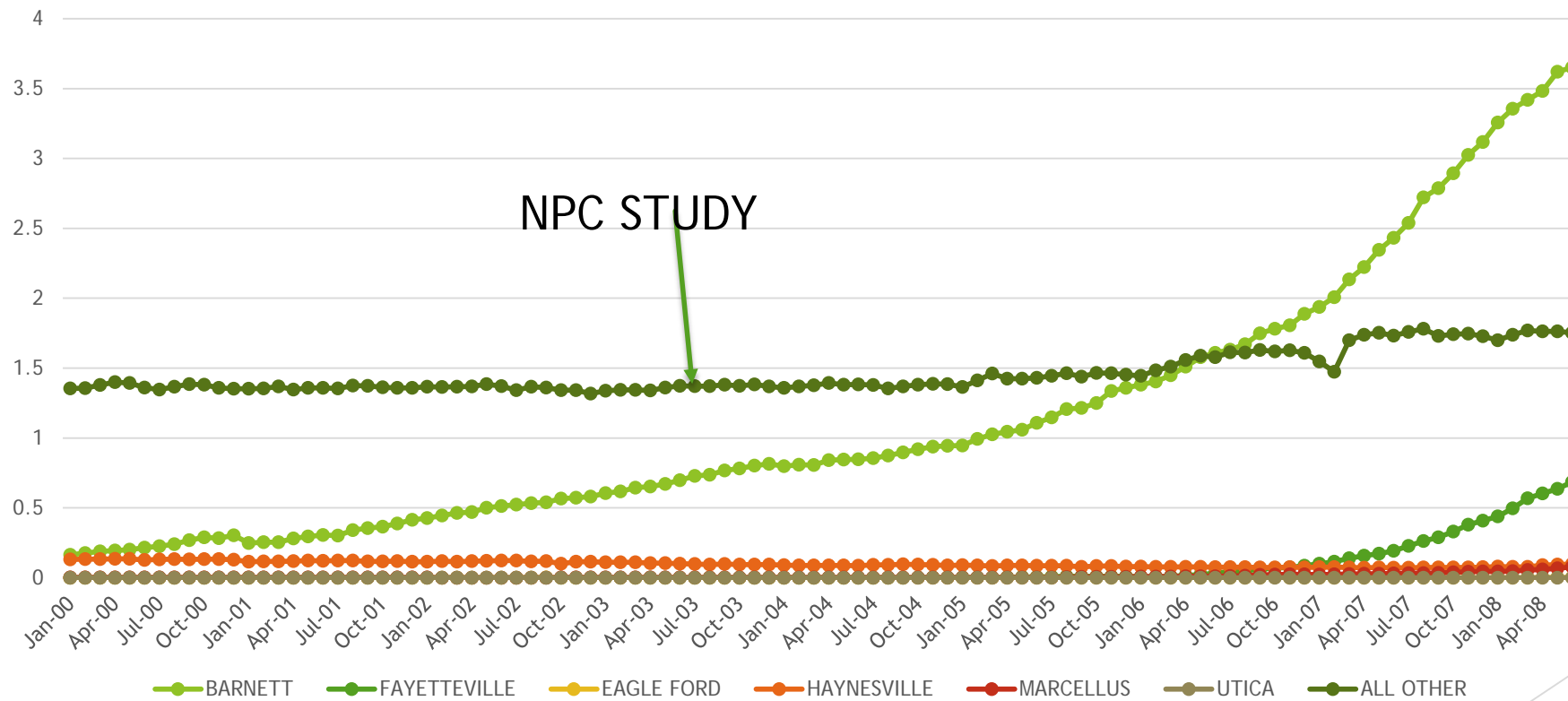
(000 FT/RIG YEAR)



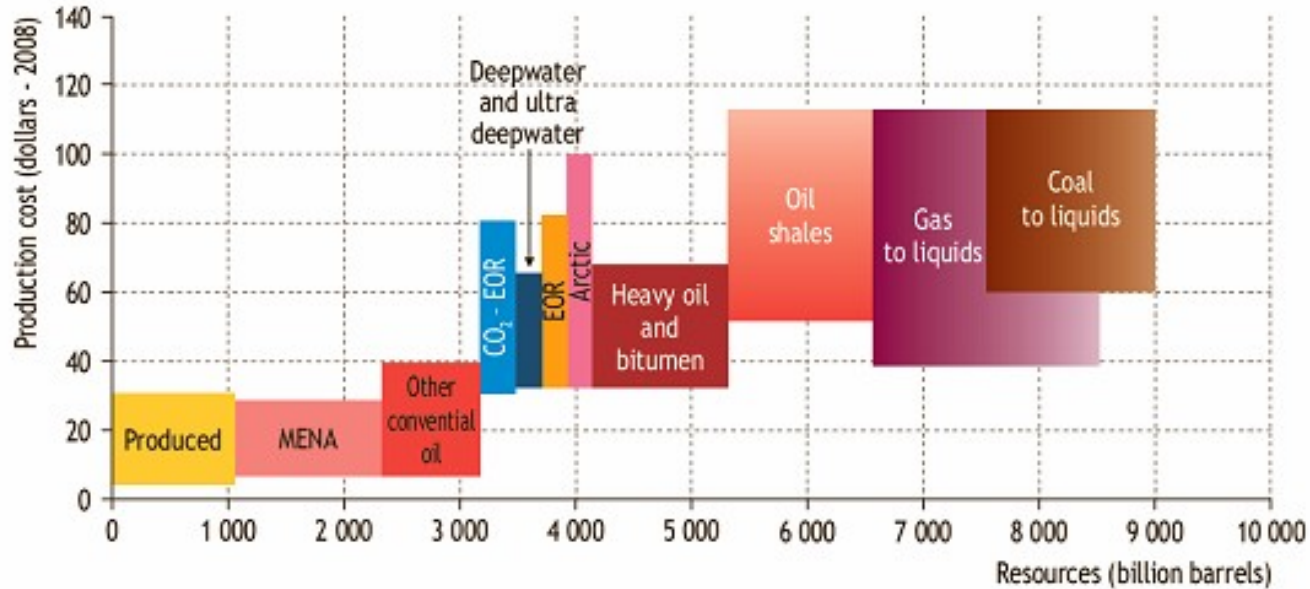
THREE APPROACHES TO PREDICTING TECHNOLOGICAL PROGRESS

- ▶ TOP-DOWN
 - ▶ SOLOW, TILTON
- ▶ BOTTOM-UP
 - ▶ TRADE PRESS, NOT SO MUCH ACADEMIC
- ▶ ANECDOTAL
 - ▶ NPC, MANY ACADEMICS

SHALE GAS PRODUCTION



RESOURCE-BASED SUPPLY CURVE



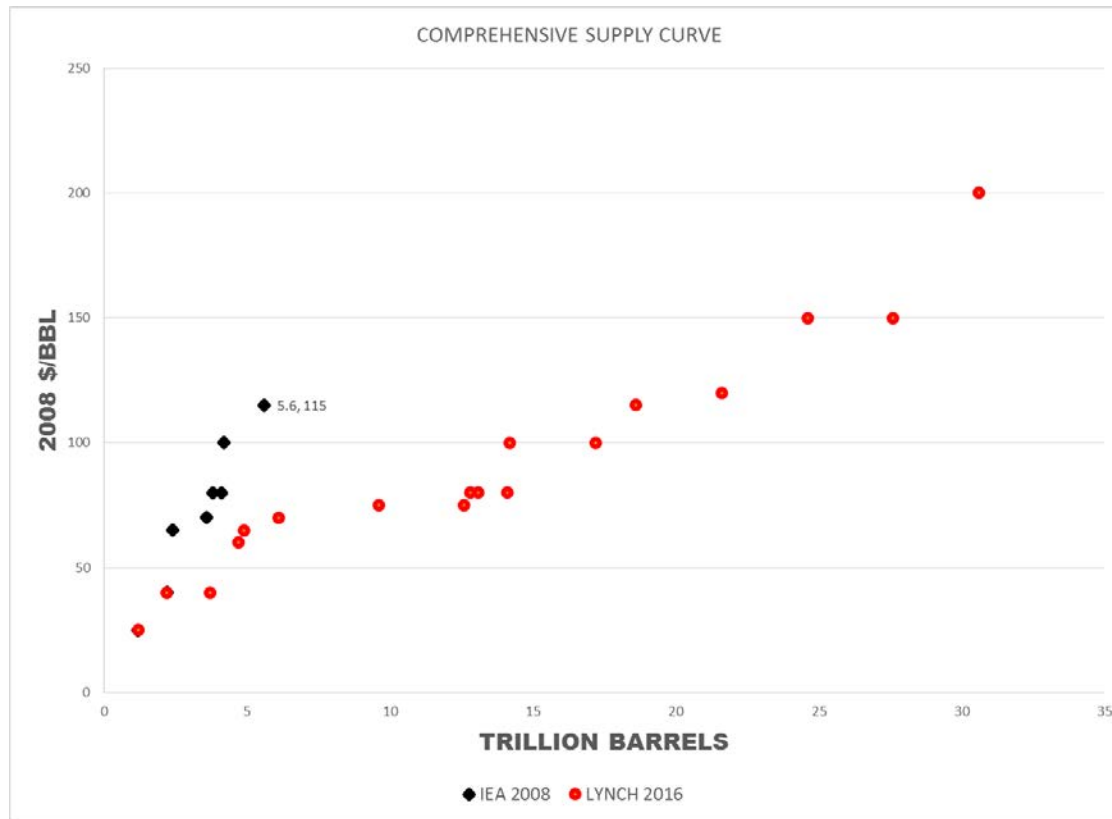
Source: IEA (2008)

Note: The curve shows the availability of oil resources as a function of the estimated production cost. Cost associated with CO₂ emissions is not included. There is also a significant uncertainty on oil shales production cost as the technology is not yet commercial. MENA is the Middle East and North Africa. The shading and overlapping of the gas-to-liquids and coal-to-liquids segments indicates the range of uncertainty surrounding the size of these resources, with 2.4 trillion shown as a best estimate of the likely total potential for the two combined.

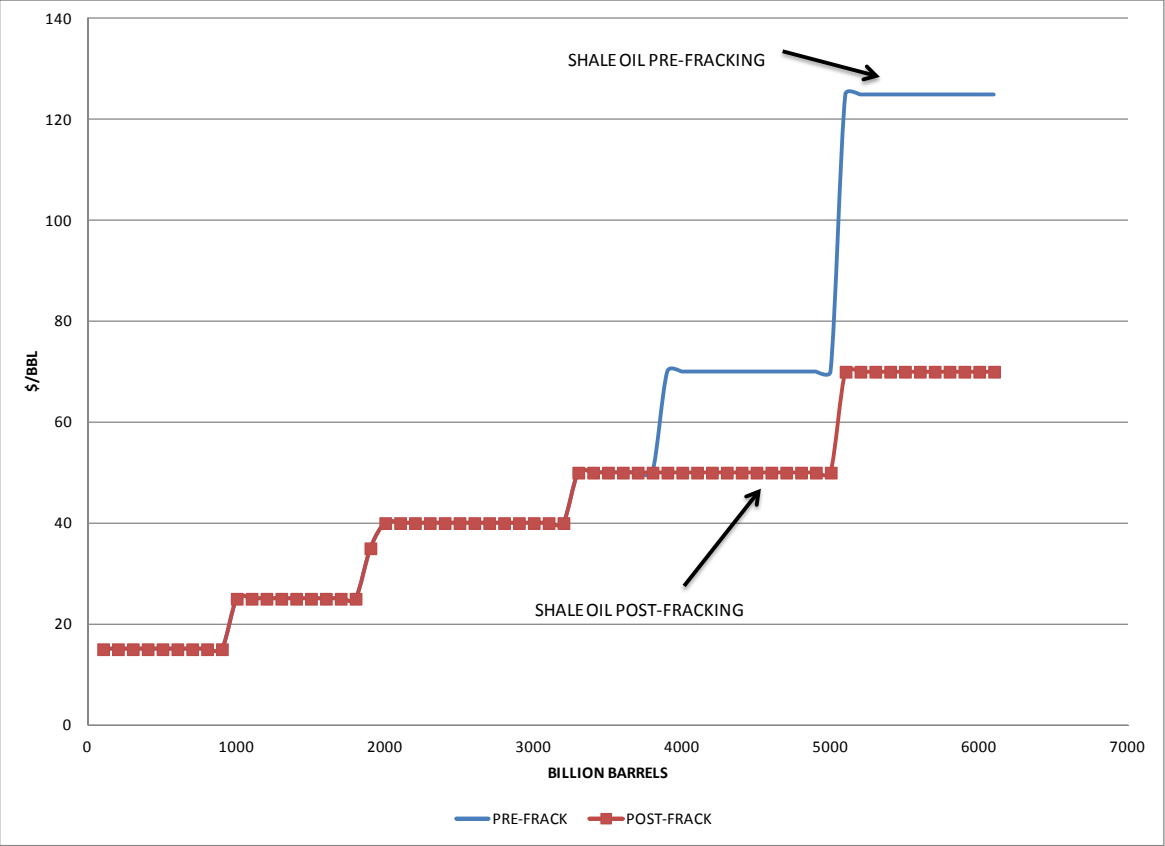
RESOURCES, INCLUSIVE

- ▶ CONVENTIONAL: 4000
- ▶ UNCONVENTIONAL: 2500 (EXCL GTL, CTL)
- ▶ UNECONOMIC, UNRECOVERABLE CONVENTIONAL: 7000
- ▶ SAME UNCONVENTIONAL: 15000?
- ▶ SHALE OIL (NOT OIL SHALE): TRR: 3400
 - ▶ UN, UN: 7600
- ▶ RESOURCE CURVE GOES FROM 6.5 TRLN TO 40 TRLN
 - ▶ MOST VERY HIGH COST

RESOURCE BASED SUPPLY CURVE (TOTAL, NOT RECOVERABLE)



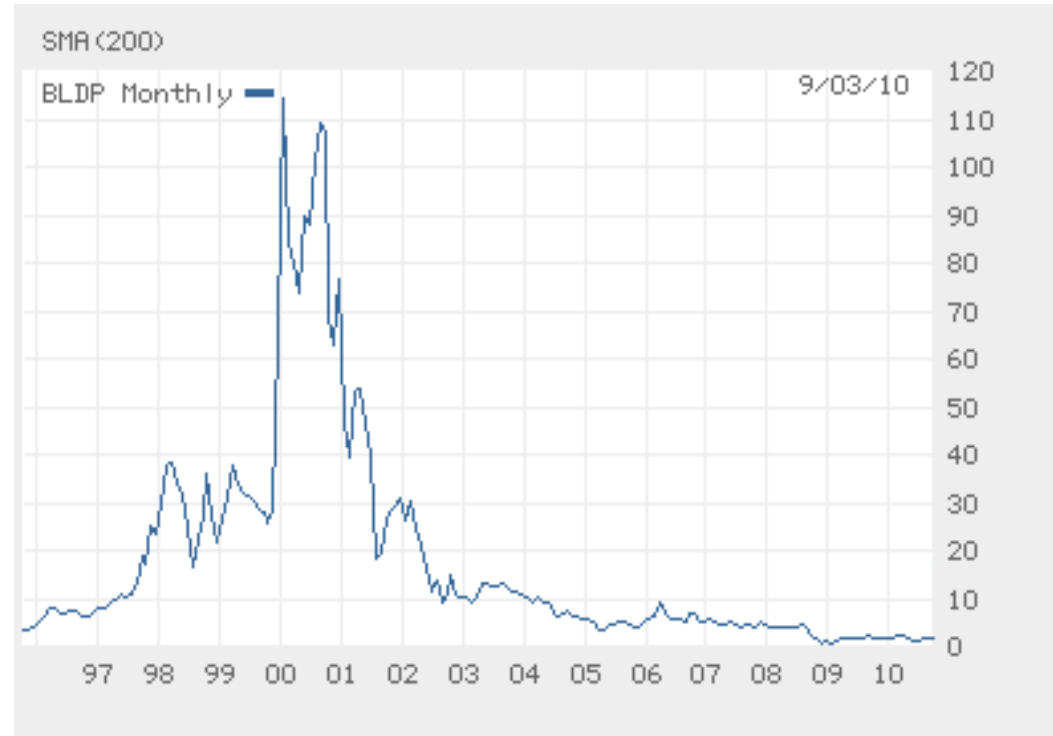
FRACKING MOVES THE CURVE



BASIC GUIDELINES

- ▶ IRRATIONAL EXUBERANCE
 - ▶ BROAD SUPPORT FOR SECTOR
 - ▶ SYNFUELS IN 1980S, CLEANTECH NOW
- ▶ BAD SCIENCE
 - ▶ PHYSICS IS NOT CHEMISTRY
 - ▶ WHERE'S MY FLYING CAR
- ▶ CHANGE GRADUAL
 - ▶ BREAKTHROUGHS USUALLY LOOK LIKE CURVES, NOT STEPS
 - ▶ SHALE MOST PROMINENT EXCEPTION

IRRATIONAL EXUBERANCE: INDUSTRY HFCV



BALLARD POWER ANNOUNCED A HYDROGEN FUEL CELL ADVANCE IN THE MID-1990S. CAR COMPANIES PREDICTED MASS PRODUCTION VEHICLES BY 2005. STOCK PRICE REFLECTS THE CHANGING FORTUNES.

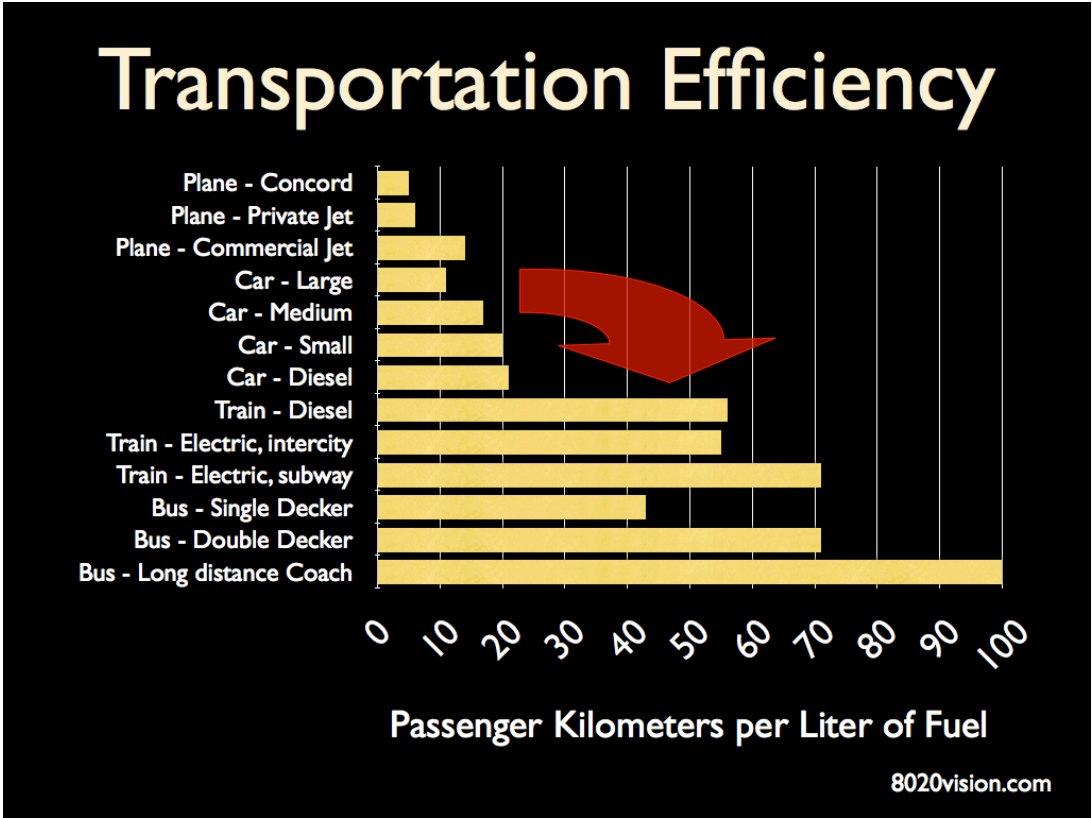
IRRATIONAL EXUBERANCE: THE PRESS

“Putting the zoom into electric cars” (CNN 2007)

The Next Little Thing

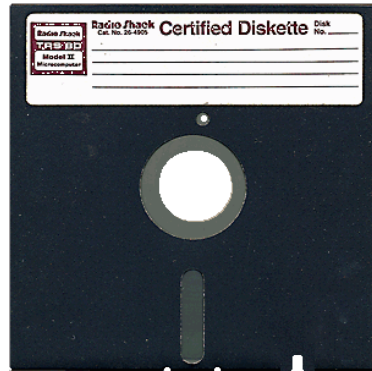
- ▶ Aptera Motors, Carlsbad, Calif.
- ▶ Think Global, Palo Alto*
- ▶ Zenn, Toronto
- ▶ Zap, Santa Rosa, Calif.
- ▶ Commuter Cars, Spokane
- ▶ A.C. Propulsion, San Dimas, Calif.

PHYSICS CAN'T BE BEAT: FUEL-EFFICIENCY BY MODE



ELECTRONICS IS EASY, CHEMISTRY IS HARD

1981: Memory=128K



▶ CAR BATTERY

▶ Same size, power in 3 decades



2011: Memory = 4GB



TECHNOLOGY MARCHES ON, FORECASTING DOESN'T

- ▶ EVOLUTIONARY PROGRESS EVERYWHERE
 - ▶ NOT JUST SOLAR, BATTERIES
- ▶ NEW TECH MOVES FAST AT FIRST
 - ▶ LITHIUM-ION BATTERIES, FRACKING
- ▶ MATURE AREAS RARELY SURPRISE
 - ▶ SOLAR, BATTERY GETTING LONG IN THE TOOTH
- ▶ MOST SURPRISES DON'T PAN OUT
 - ▶ CELLULOSIC ETHANOL, SEGWAY, HGCV, FBR, ETC.
- ▶ STILL ROOM FOR PROGRESS
 - ▶ FUSION, BATTERY, BIOMASS, METHANE HYDRATES