



**CEE**

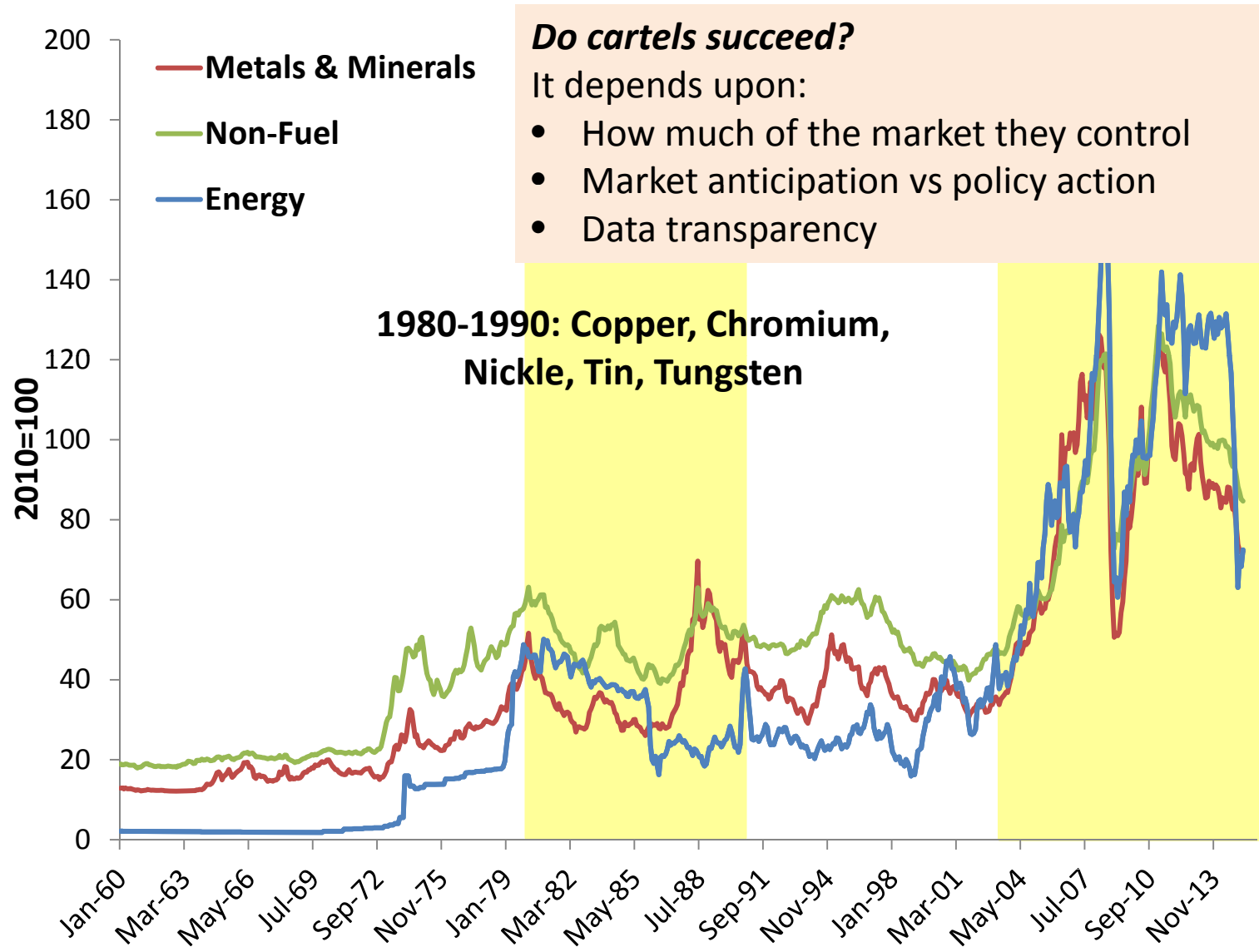
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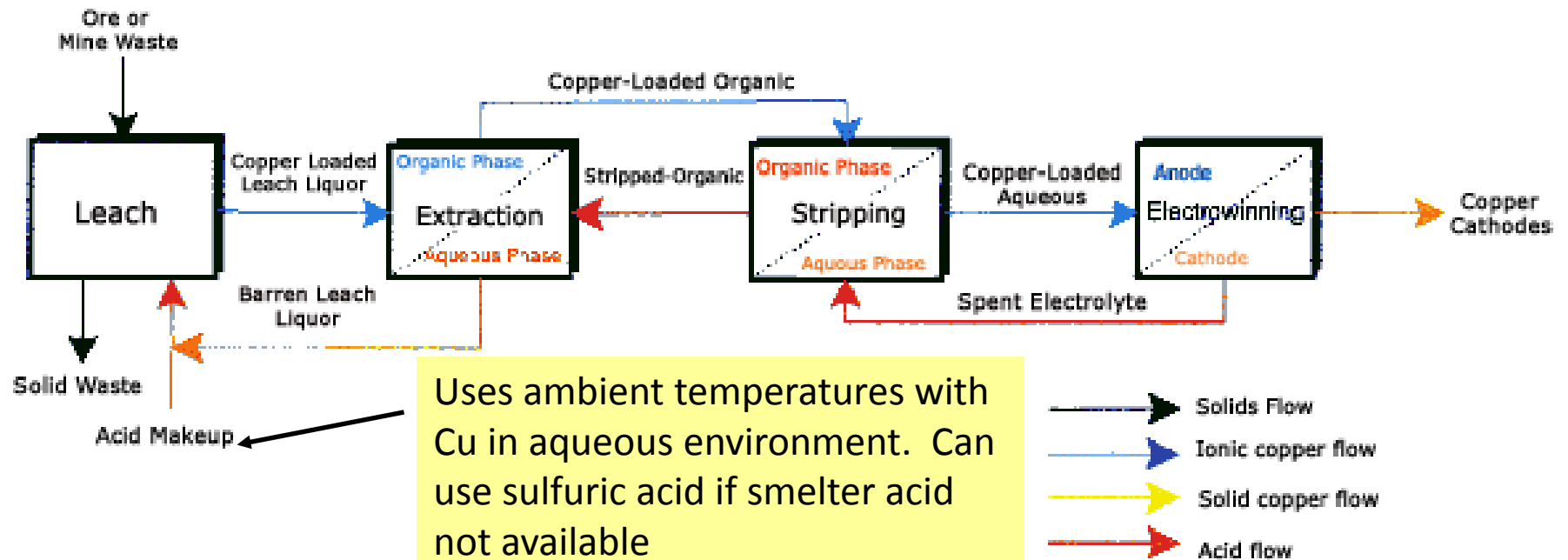
# Paradoxically Abundant?

*Mayer Brown, Houston, April 1, 2014*

# Simon-Erlich Wager



## Simplified Flow Chart Leach - Solvent Extraction - Electrowinning Process



- "Beginning in the mid 1980s a new technology...SX/EW Process, was widely adopted. This new copper technology utilizes smelter acid to produce copper from oxidized ores and mine wastes. Today, worldwide, approximately 20% of all copper...is produced by this is process. In Latin America, the total is closer to 40% whereas in the United States the total is approaching 30%."
- "A second technology that has aided in the production of environmentally clean copper is that of bacterial leaching or bioleaching."

<http://www.copper.org/publications/newsletters/innovations/2001/08/hydrometallurgy.html>

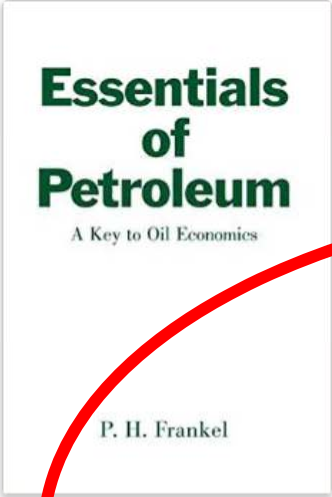
# Channeling Paul Frankel

From his earliest work, *Essentials of Petroleum*, first published in 1946, he underlined the fact that the **industry was not self-adjusting**. To observe that oil is a liquid - as he did - might appear a truism. To spell out the economic implications of this fact - **the relationship of fixed and variable costs, the price inelasticity of both supply and demand, the menace of the marginal barrel combined with the aleatory nature of exploration**, all leading to the inherent instability of the industry - was to illuminate for oil men and women the framework in which they lived their working lives.

*The Independent, 29 October 1992*

# A Market at Work

Look inside ↓




**Essentials of Petroleum**  
A Key to Oil Economics  
P. H. Frankel





**Essentials of Petroleum: A Key to Oil Economics** Hardcover – 1969  
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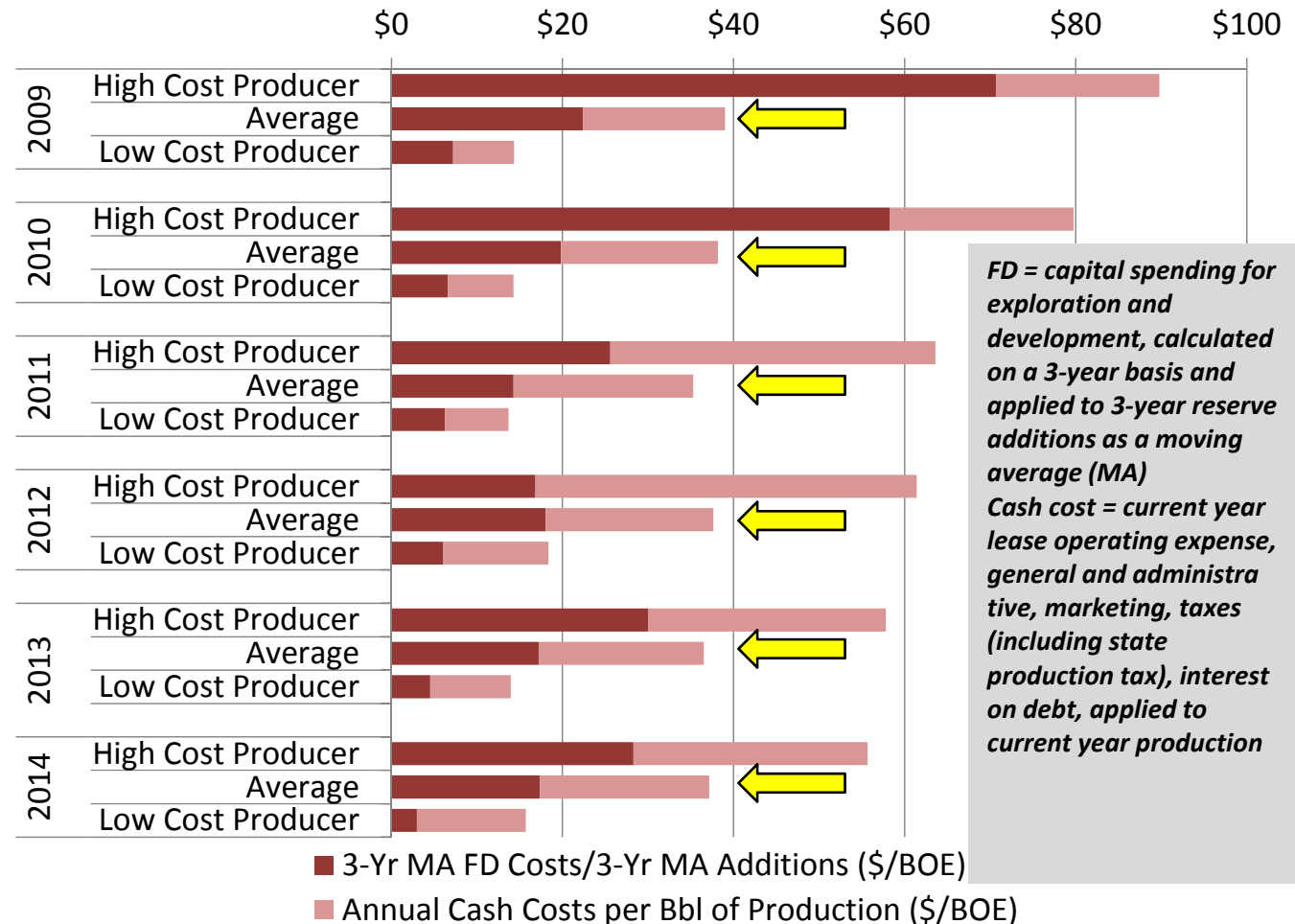
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# Upstream Matters! Part Deux

*We add 2014 reporting data and affirm key considerations going forward*

***Our sample represents the top tier of U.S. producers including leading shale players.***

- We have **\*restated work** from earlier research for changes to our sample and methodology
- The 15 publicly traded companies we use comprise **68% of Top 40** gas producers (NGSA.org) and **33% of U.S.** marketed natural gas production
- In this snapshot including **2014** reporting we state results mainly in barrel of oil equivalent terms
- Overall, while FD capex has dropped, largely a result of increased volumes, **cash costs remain substantial and stubborn.**

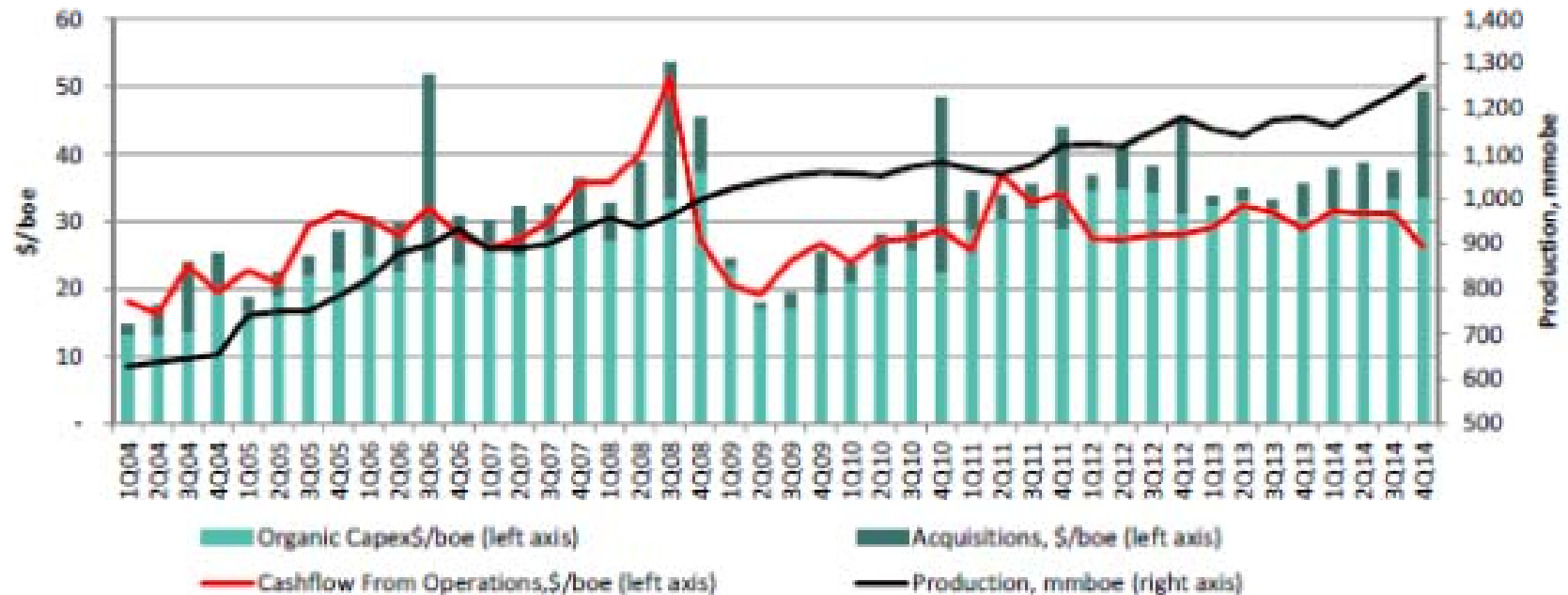


***The cheapest producers are also the “gassiest” – smaller companies that, for the most part, did not move out of gas and into liquids because of cost and capital constraints.***

# Comparative View

## Capex Exceeds Cash Flow

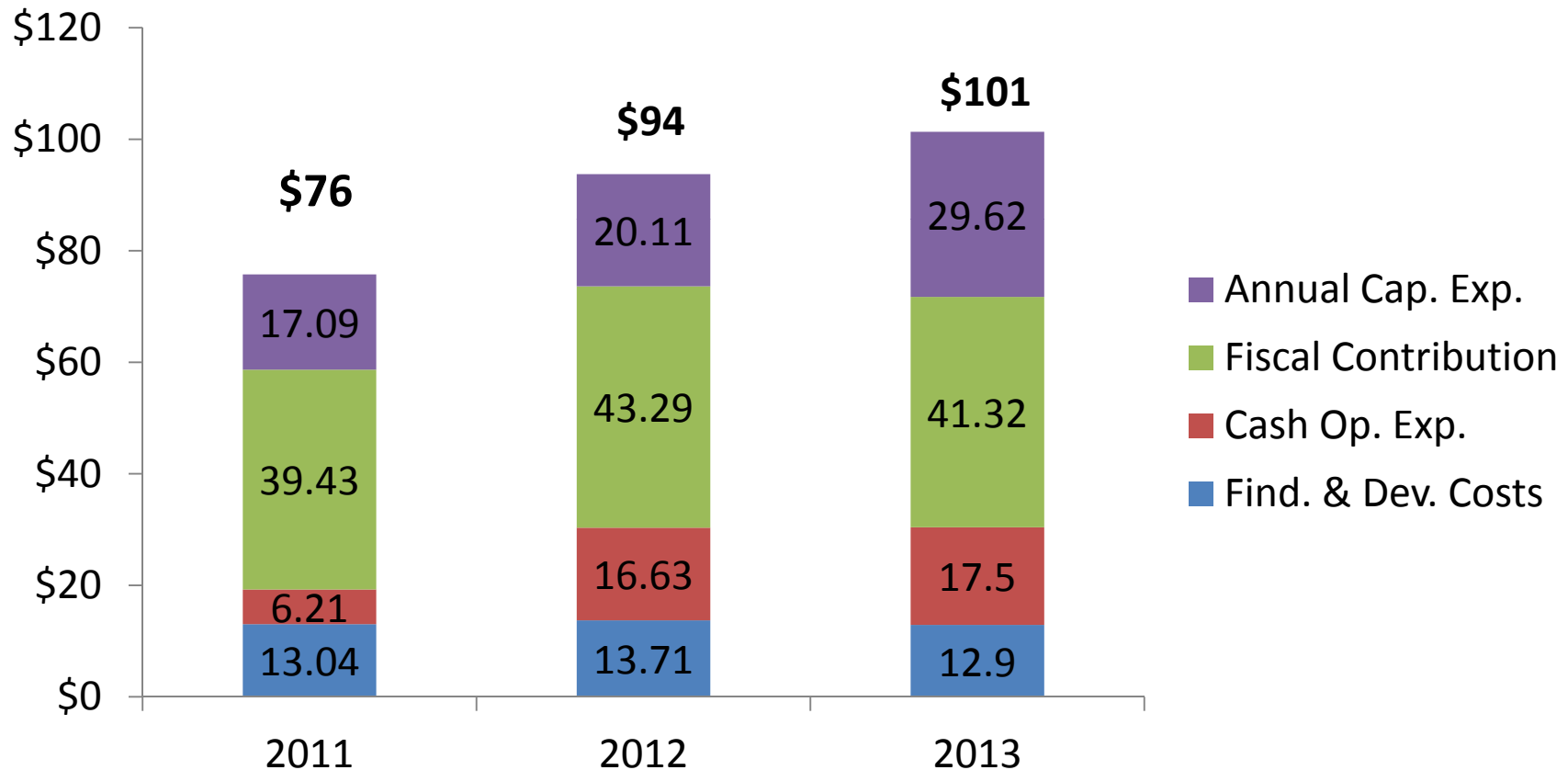
Cash flows from Operations and Capex



Source: Company reports, Bernstein analysis, Bloomberg

**Challenge: how much in cost, and with what return to hit the type curve?**

# Weighted Average NOC Breakeven Costs (\$/BOE)

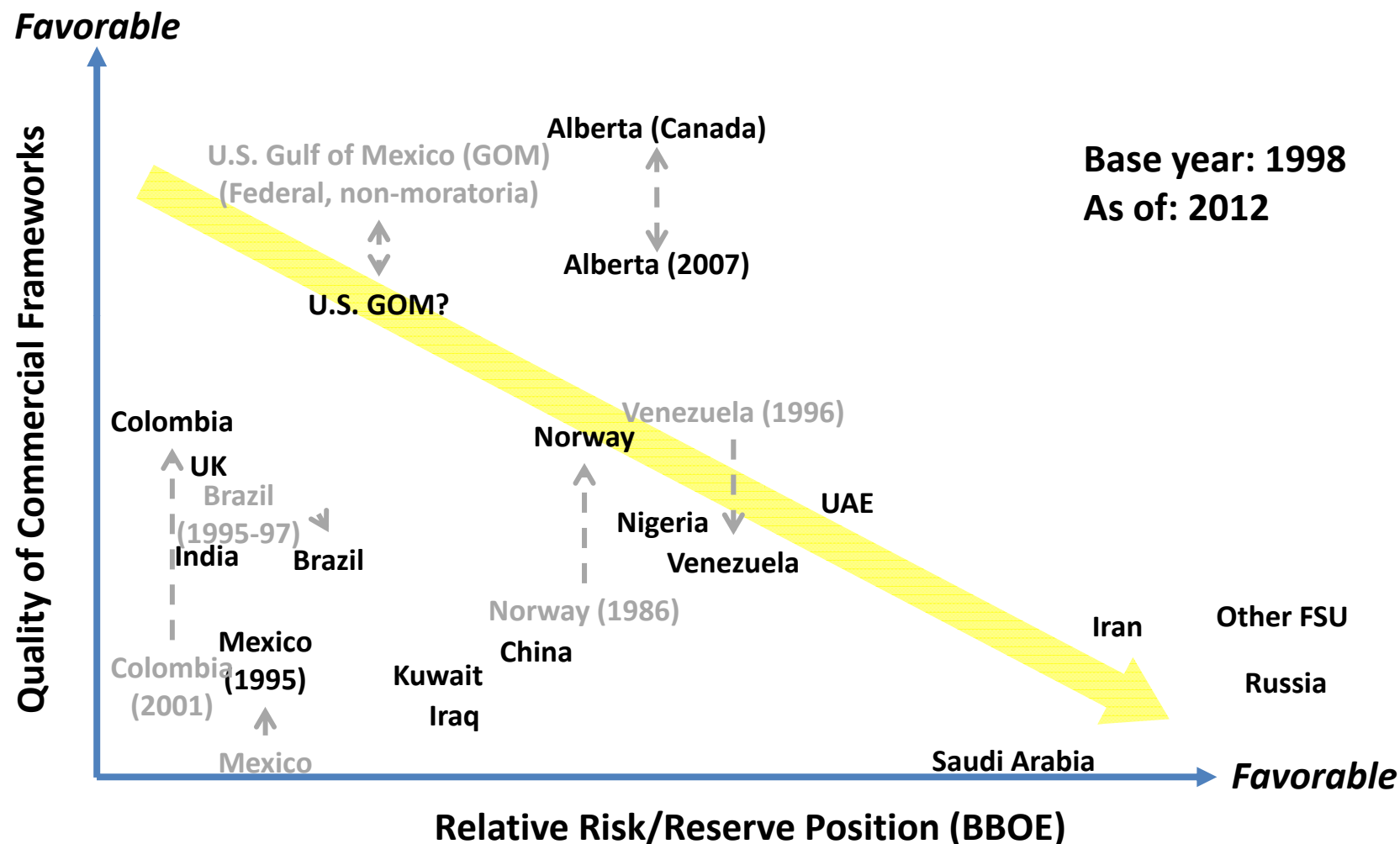




# Problem

- We believe that costs for the commodity could be getting cheaper.
- Costs for companies are stubborn.
- What is the best way to view extractive industries?
- *Are cost components increasingly non-technical and, if so, inadequately managed?*

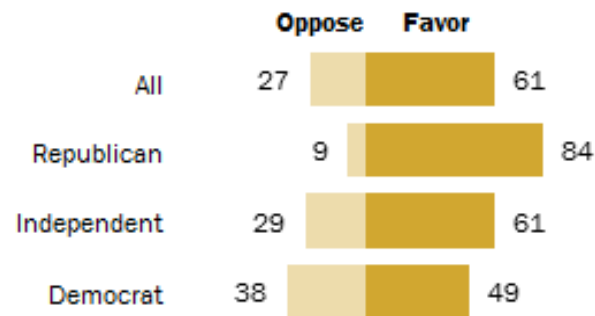
# Upstream Regimes: Inverse Relationship



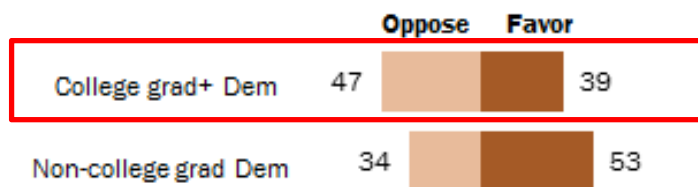
# KXL Barometer

## Across Parties, Support for Keystone

*Favor/oppose building Keystone XL pipeline ...*



## But Democrats Are Divided



Survey conducted Feb. 27-Mar. 16, 2014.

PEW RESEARCH CENTER

## Moderate, Lower-Income Democrats Favor Keystone; Women Split

<i>Building the Keystone XL pipeline ...</i>	<b>Favor %</b>	<b>Oppose %</b>	<b>DK %</b>
<b>All Democrats</b>	49	38	13=100
Men	58	37	6=100
Women	43	38	19=100
Conservative/Moderate	56	32	12=100
Liberal	40	46	14=100
White	48	38	14=100
Black	48	39	14=100
18-29	55	37	8=100
30-49	45	41	15=100
50-64	50	38	12=100
65+	50	32	19=100
Post-graduate	35	51	14=100
College grad	41	44	14=100
Some college	52	35	13=100
HS or less	54	33	13=100
<i>Family income</i>			
\$100,000 or more	36	51	14=100
\$50,000-100,000	48	42	11=100
Less than \$50,000	54	34	13=100

Survey conducted Feb. 27-Mar. 16, 2014. Democrat N=1,036. Whites and blacks include only those who are not Hispanic. Figures may not add to 100% because of rounding.

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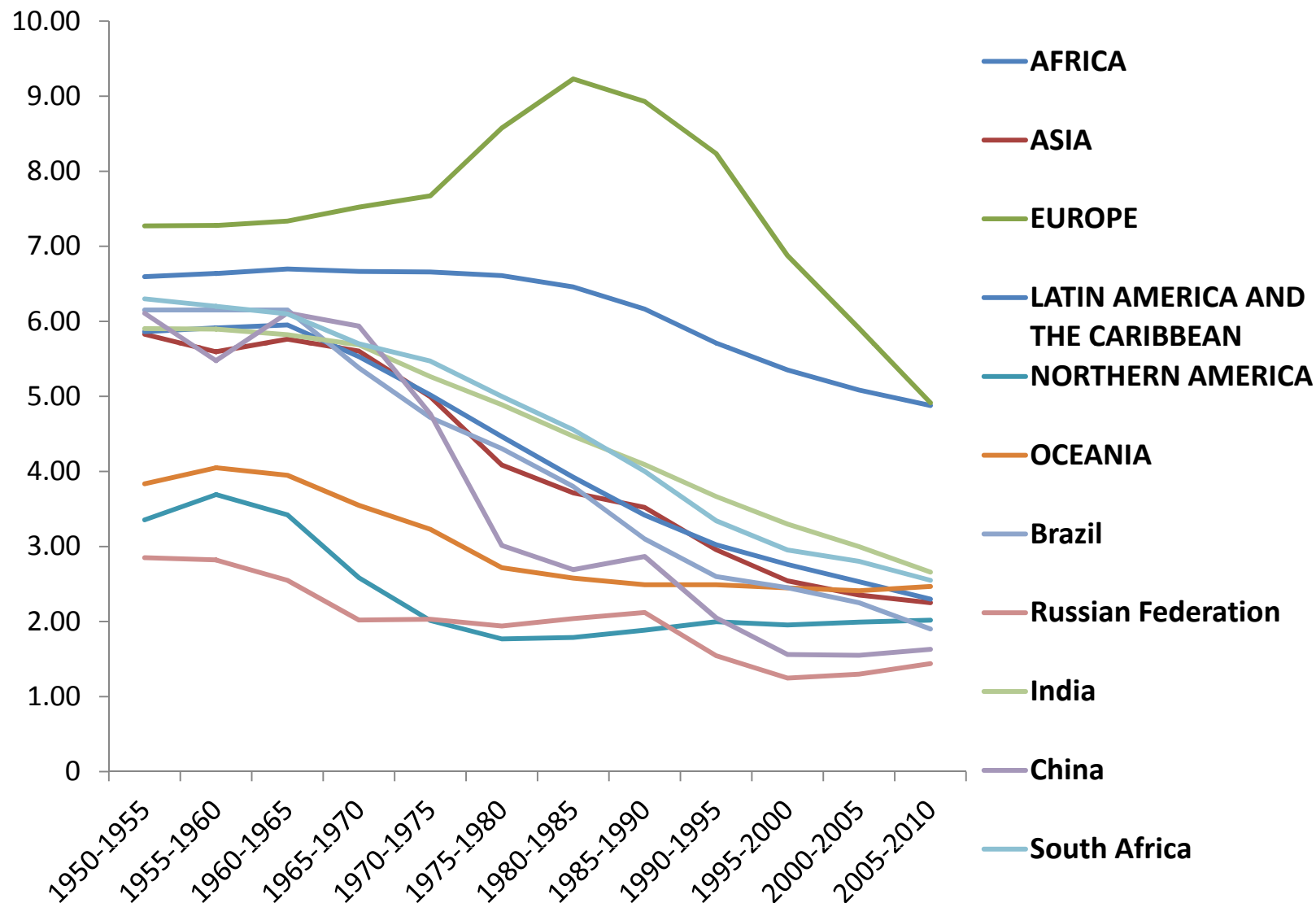
# Exports: The Crude Oil Debate

*“In a situation where we still import 7 million barrels of crude oil per day, I don’t think an overly compelling argument has been made on the basis of pragmatic economics,” Moniz said [at CERAWeek]. Fuel Fix, 4/23/5*

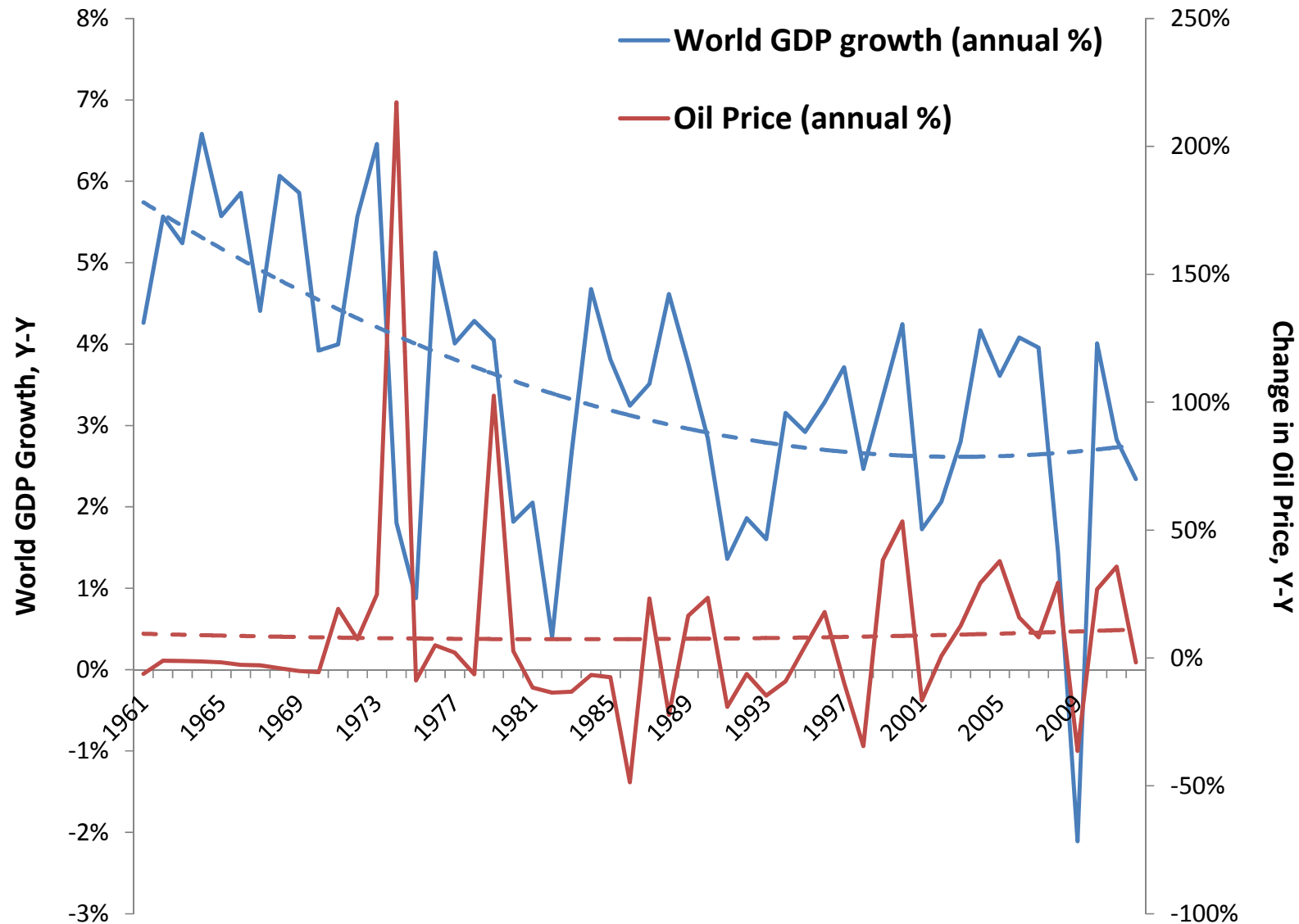
What are the economic, environmental benefits of petroleum system optimization?



# We the People Are Changing



# Oil and Growth Politics



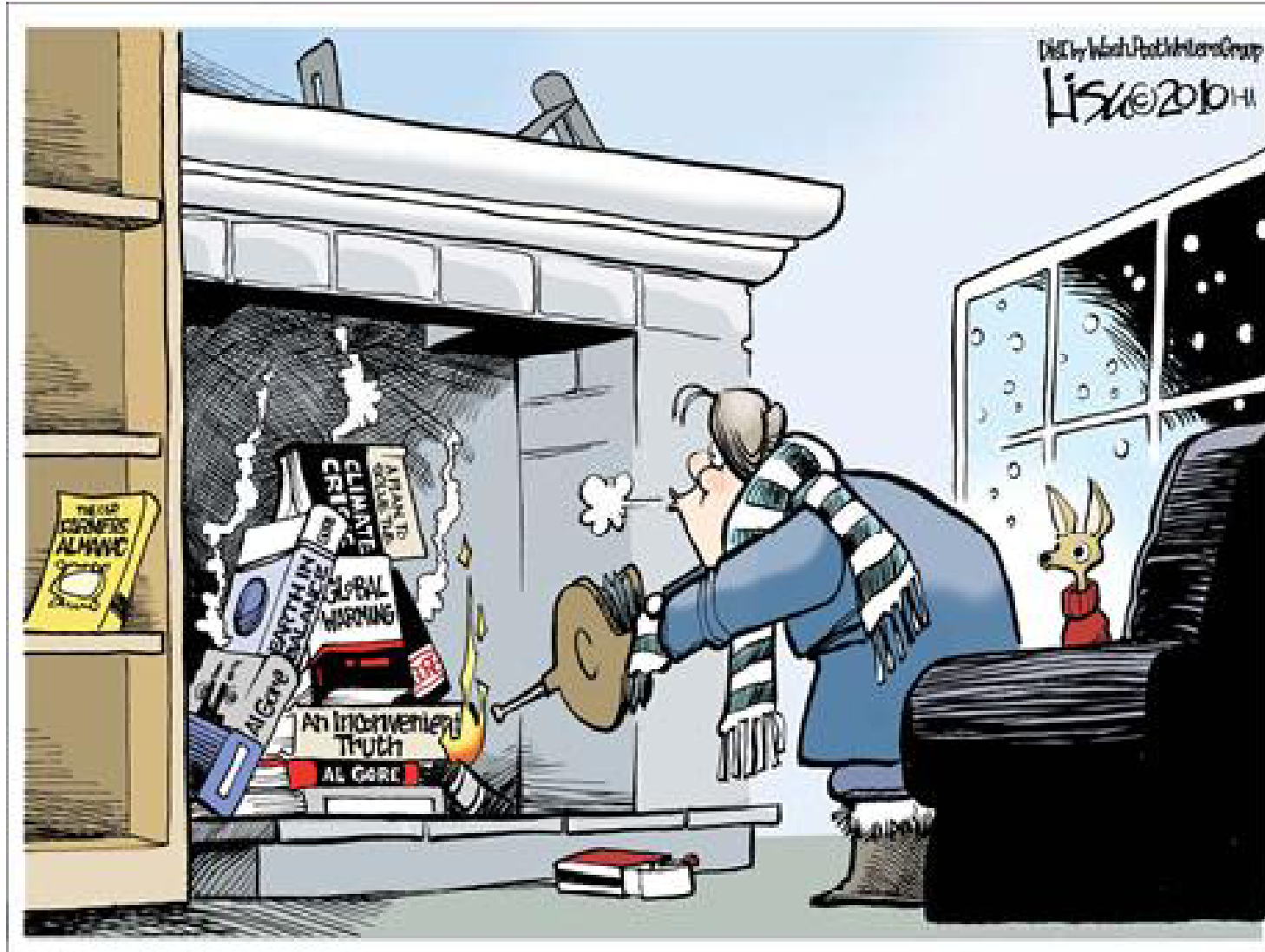
# What About Oil and Freedoms?

*Is there an inverse relationship?*

193 Countries		PARTLY	NOT
	FREE	FREE	FREE
Oil Production	23 mmb/d	20 mmb/d	30 mmb/d
Avg. GDP per Capita	\$12,292	\$2,677	\$2,283

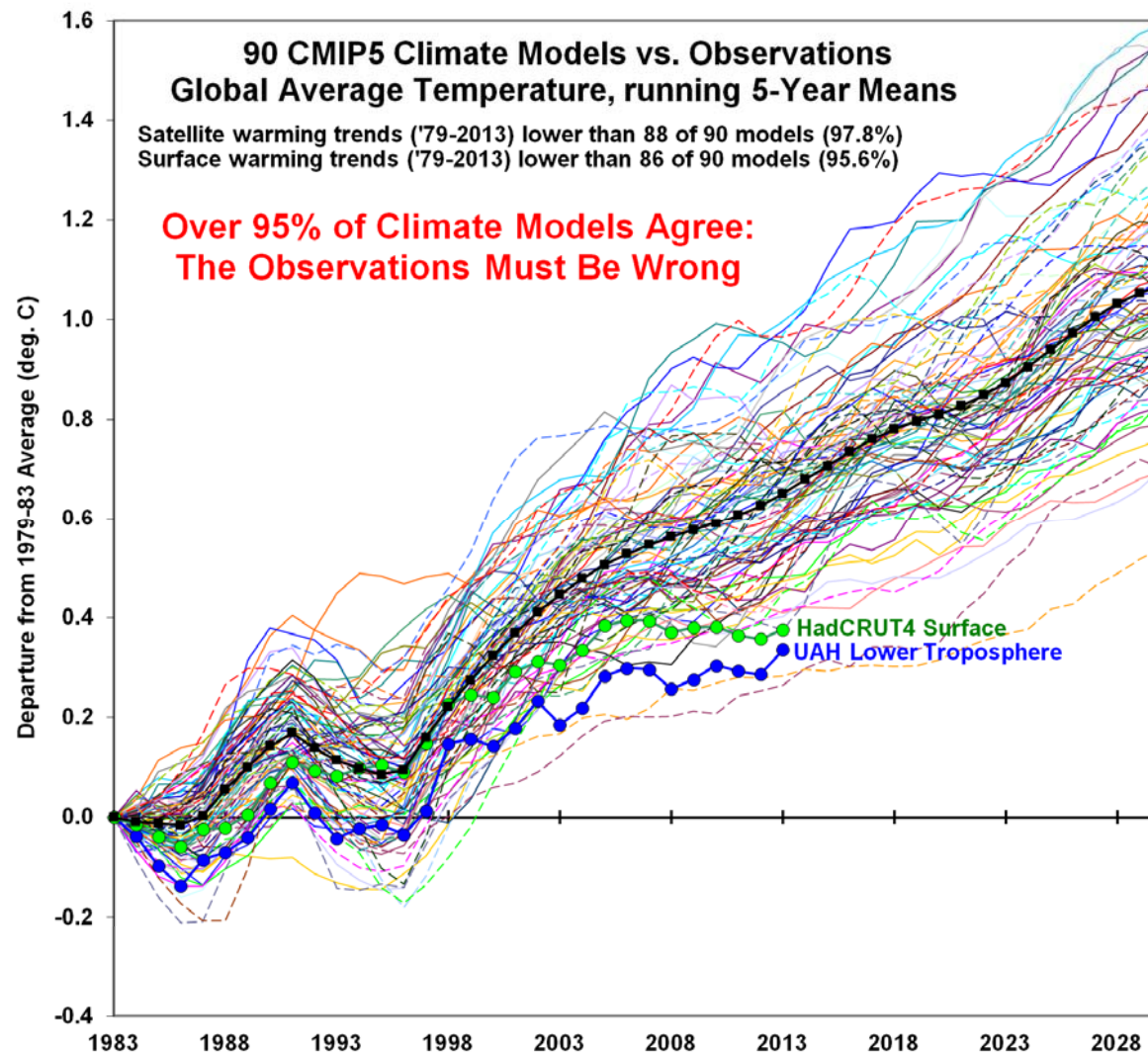
Freedom House Survey, 2001, [www.freedomhouse.org](http://www.freedomhouse.org)

# Politically Convenient





# Have Model, Will Publish



# Dynamic Earth

“Although warming of the northeastern Antarctic Peninsula began around 600 years ago, the high rate of warming over the past century is **unusual (but not unprecedented)** in the context of natural climate variability over the past two millennia.”

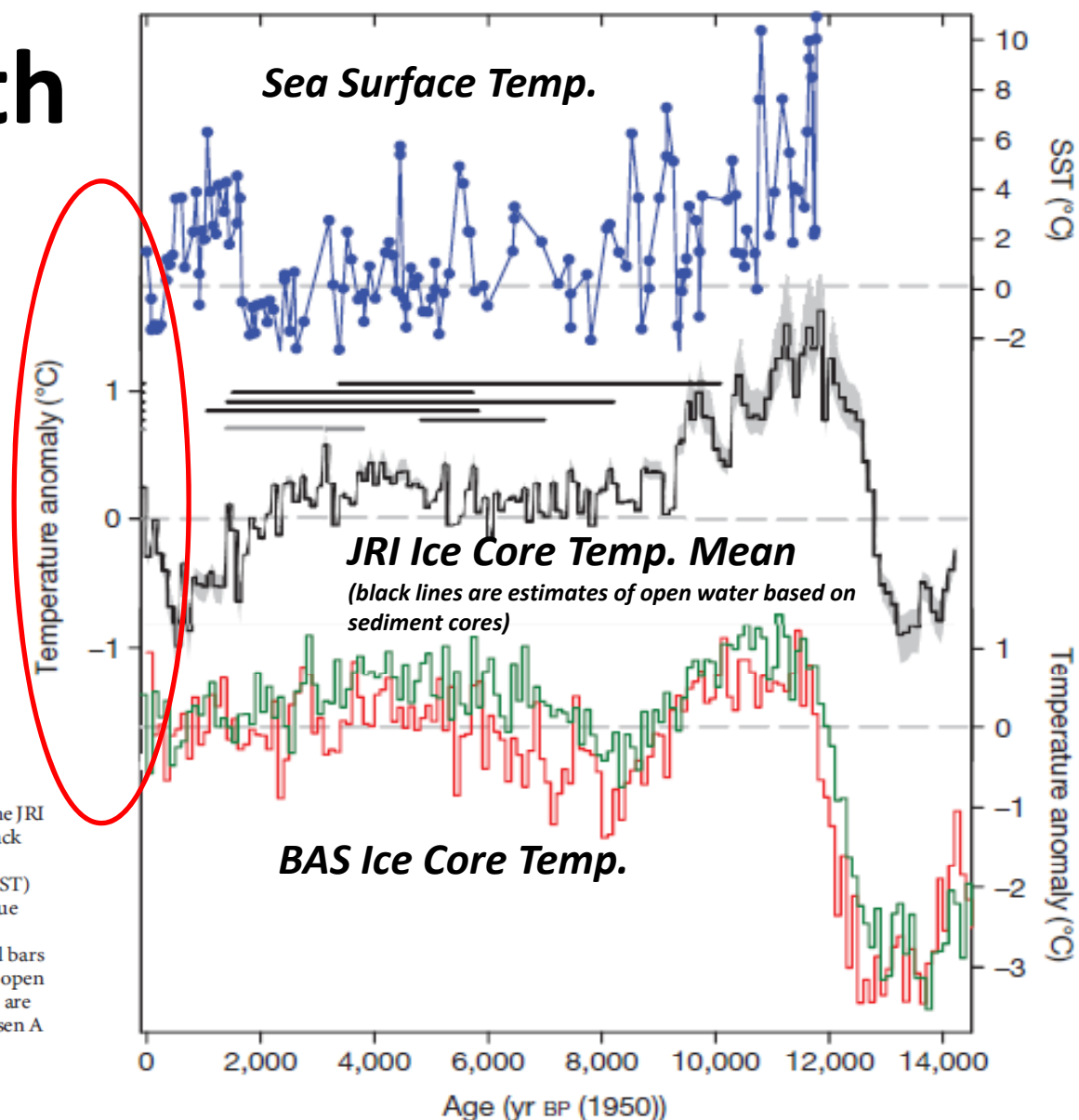


Figure 3 | Holocene temperature history of the Antarctic Peninsula. The JRI ice-core temperature reconstruction relative to the 1961–1990 mean (black trace, 100-yr average; the grey band indicates the standard error of the calibration dependence) is shown alongside a sea surface temperature (SST) reconstruction from off the shore of the western Antarctic Peninsula (blue curve)<sup>17</sup>, and temperature reconstructions from the Dome C (red)<sup>29</sup> and Dronning Maud Land (green)<sup>30</sup> ice cores from East Antarctica. Horizontal bars show intervals in the Holocene when marine sediment cores indicate that open water was present in the area of the Prince Gustav (black; top to bottom are north to south core sites; original <sup>14</sup>C ages have been calibrated)<sup>3</sup> and Larsen A (grey)<sup>5</sup> ice shelves, which collapsed in AD 1995.

# The Role of Science

Browser window showing the University of Texas at Austin news article: "Researchers Find Major West Antarctic Glacier Melting from Geothermal Sources".

URL: <http://www.utexas.edu/news/2014/06/10/antarctic-ç>

Page Title: Researchers Find Major West Antarctic Glacier Melting from Geothermal Sources

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UT Home > News > Researchers Find Major West Antarctic...

## Researchers Find Major West Antarctic Glacier Melting from Geothermal Sources

June 10, 2014

AUSTIN, Texas — Thwaites Glacier, the large, rapidly changing outlet of the West Antarctic Ice Sheet, is not only being eroded by the ocean, it's being melted from below by geothermal heat, researchers at the [Institute for Geophysics](#) at The University of Texas at Austin (UTIG) report in the current edition of the *Proceedings of the National Academy of Sciences*.

The findings significantly change the understanding of conditions beneath the West Antarctic Ice Sheet where accurate information has previously been unobtainable.

The Thwaites Glacier has been the focus of considerable attention in recent weeks as other groups of researchers found the glacier is on the way to collapse, but more data and computer modeling are needed to determine when the collapse will begin in earnest and at what rate the sea level will increase as it proceeds. The new observations by UTIG will greatly inform these ice sheet modeling efforts.

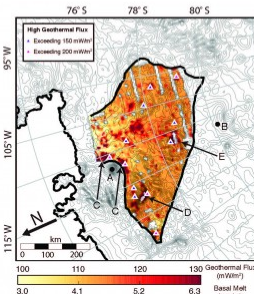
Using radar techniques to map how water flows under ice sheets, UTIG researchers were able to estimate ice melting rates and thus identify significant sources of geothermal heat under Thwaites Glacier. They found these sources are distributed over a wider area and are much hotter than previously assumed.

The geothermal heat contributed significantly to melting of the underside of the glacier, and it might be a key factor in allowing the ice sheet to slide, affecting the ice sheet's stability and its contribution to future sea level rise.

The cause of the variable distribution of heat beneath the glacier is thought to be the movement of magma and associated volcanic activity arising from the rifting of the Earth's crust beneath the West Antarctic Ice Sheet.

Knowledge of the heat distribution beneath Thwaites Glacier is crucial information that enables ice sheet modelers to more accurately predict the response of the glacier to the presence of a warming ocean.

Until now, scientists had been unable to measure the strength or location of heat flow under the glacier. Current ice sheet models have assumed that heat flow under the glacier is uniform like a pancake griddle with even heat distribution across the bottom of the ice.



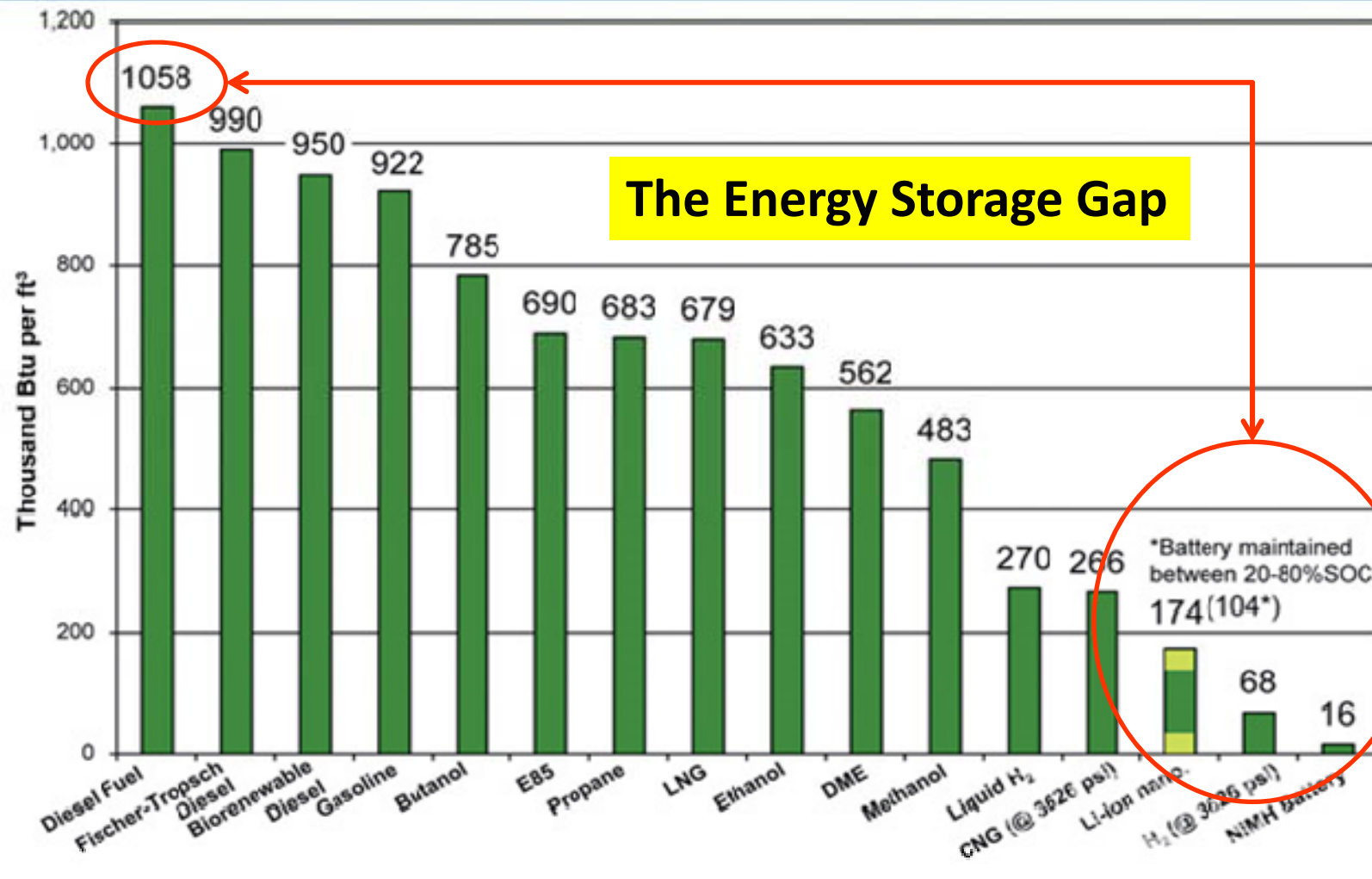
This map shows the locations of geothermal flow underneath Thwaites Glacier in West Antarctica that were identified with airborne ice-penetrating radar. The dark magenta triangles show where geothermal

# Climate Math Whiz

- Total annual CO<sub>2</sub> emitted is 188 bn ton
- 8bn is derived from human activity
  - US produces 2 bn
- Net generation from US coal plants is ~170mm MWh
  - CO<sub>2</sub> production is ~2,250 lbs/MWh, or 191mm tons
- **The total atmosphere is 5 quadrillion tons**
  - We would be removing 0.00000382% if all CO<sub>2</sub> from U.S. coal-fired power gen was captured or eliminated
  - We would be removing 0.00016% if all CO<sub>2</sub> attributed with human activity were captured or eliminated
  - Current atmospheric CO<sub>2</sub> concentration is about 386ppm or 0.039% [400ppm 04 0.040%]



## Energy Density of Fuels

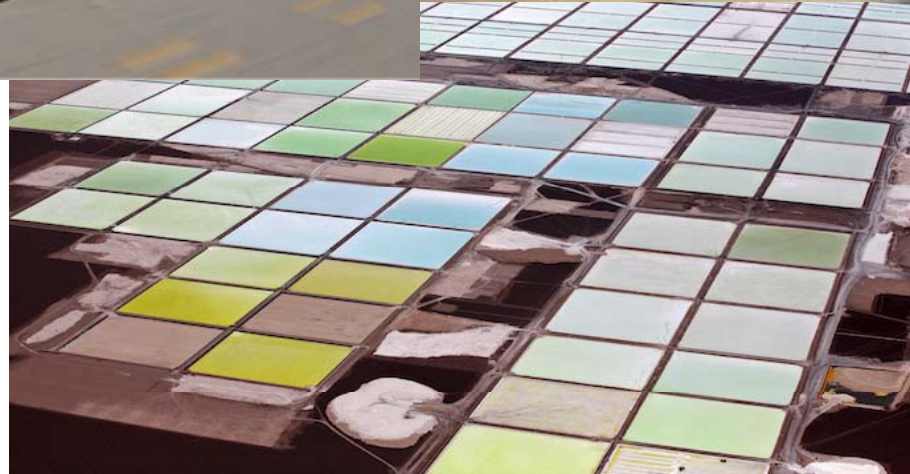




# Zoom Zoom

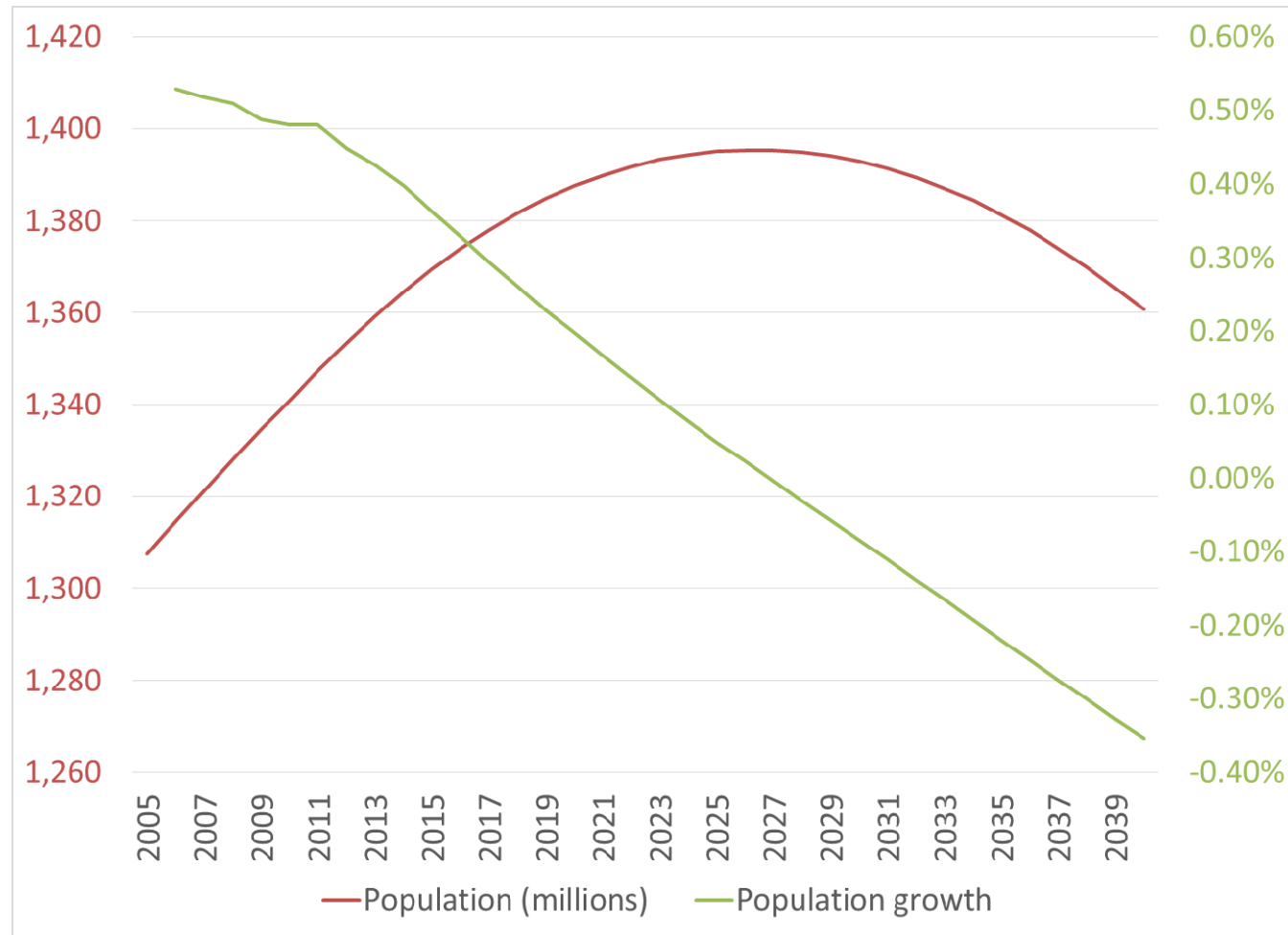


*Treehugger.com*



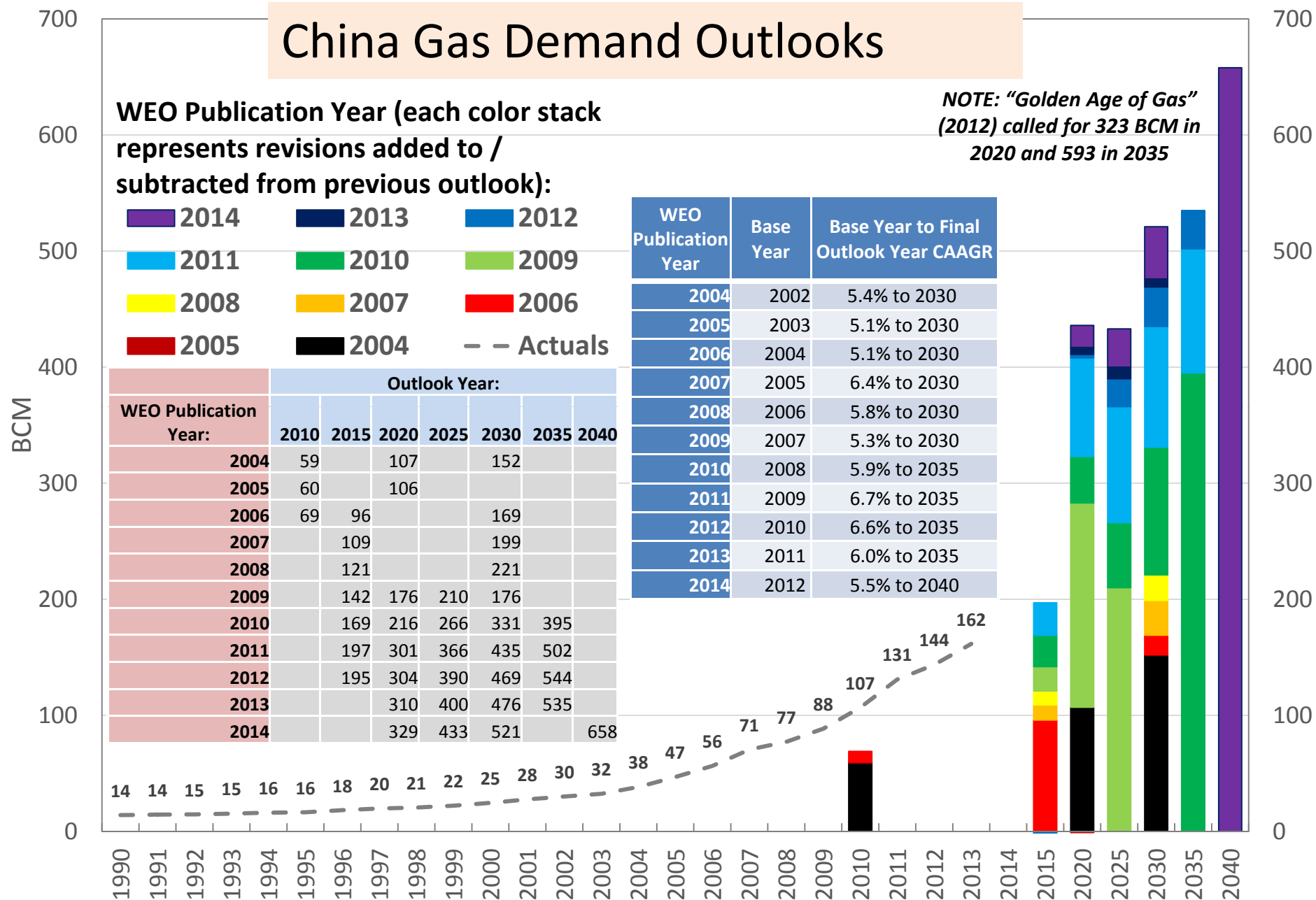


# Population Growth Slowing Fast, Expected to Plateau by 2025

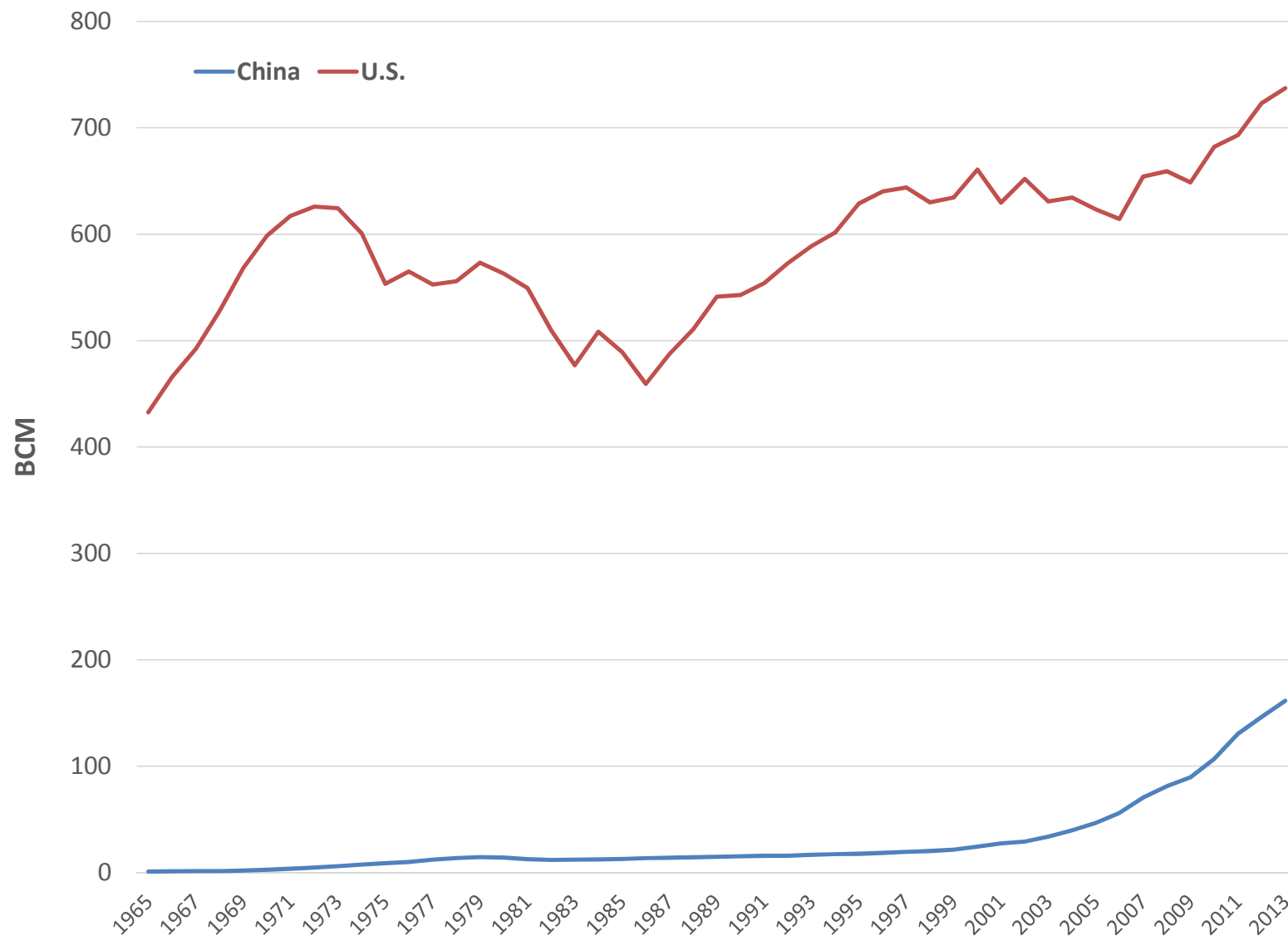




# China Gas Demand Outlooks

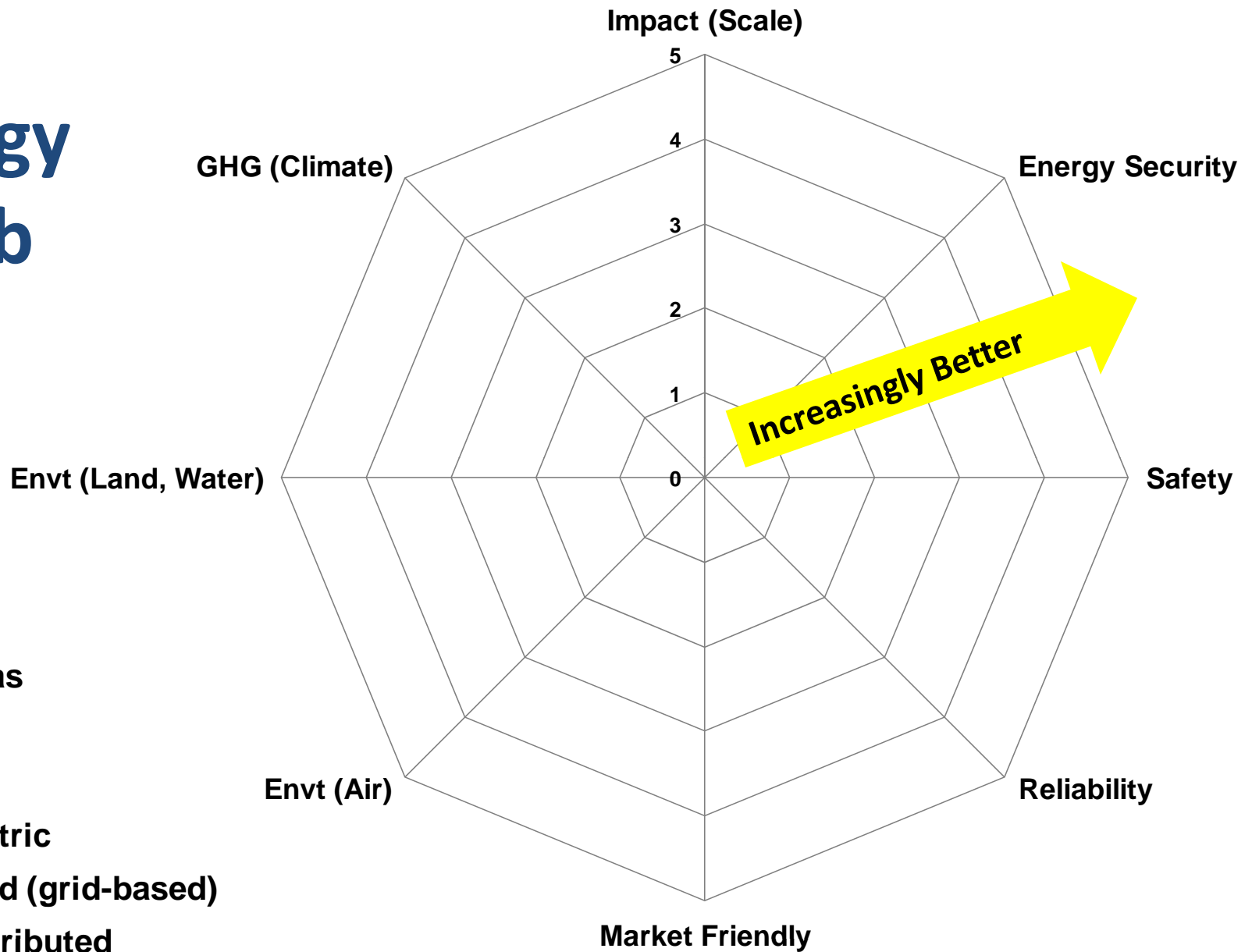


# Natural Gas Trajectories



# An Energy Web

- Coal
- Natural Gas
- LNG
- Nuclear
- Hydroelectric
- Solar, Wind (grid-based)
- Solar, Distributed



# An Energy Web

- Coal
- Natural Gas
- LNG
- Nuclear
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- Solar, Distributed

