

Harvard Energy Journal Club

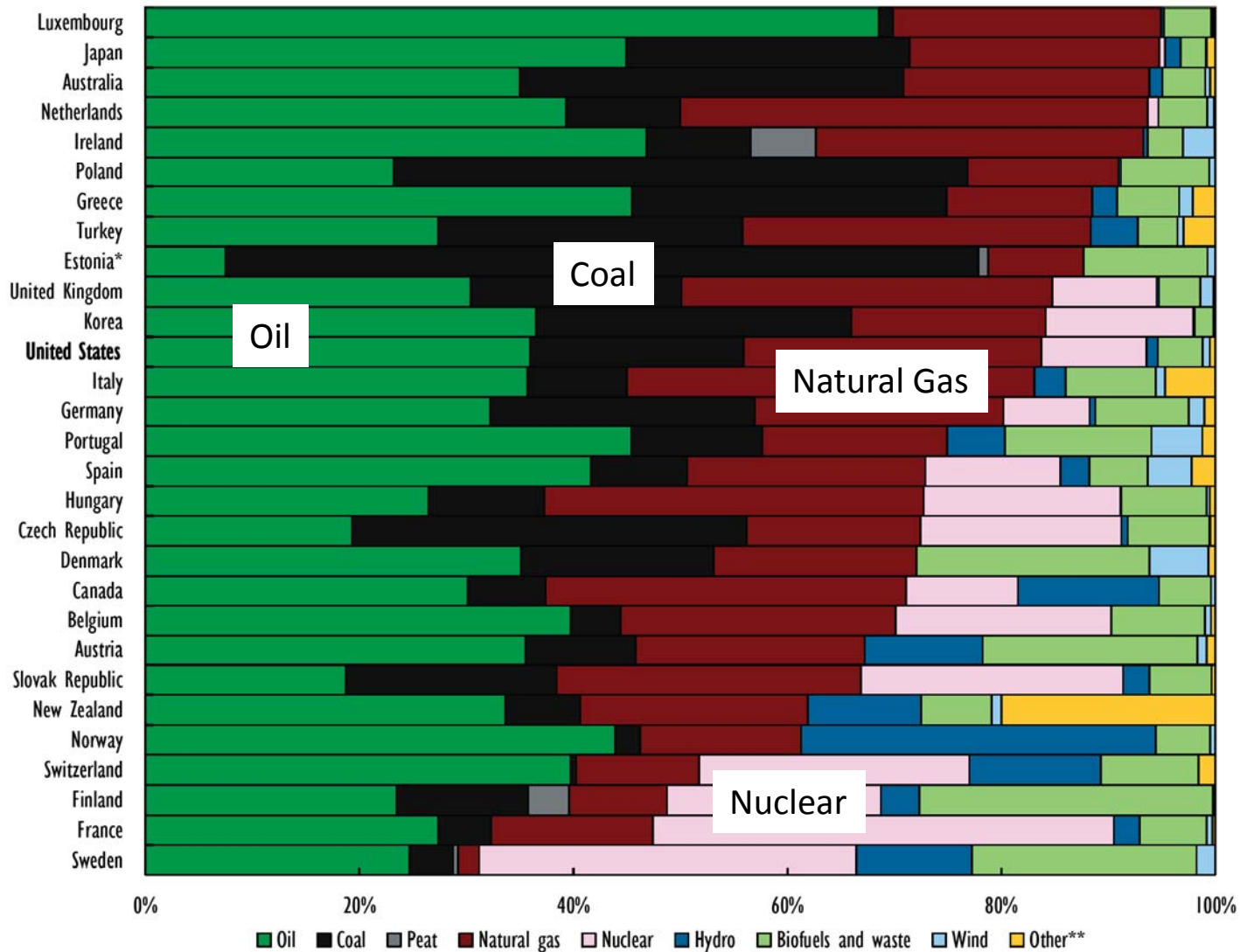
## Economics of Oil Production

Robert Kleinberg  
Schlumberger  
Cambridge Massachusetts

3 March 2016

Why Are We Still Taking About Fossil Fuels?

**Figure 2.3** Total Primary Energy Supply, 2013



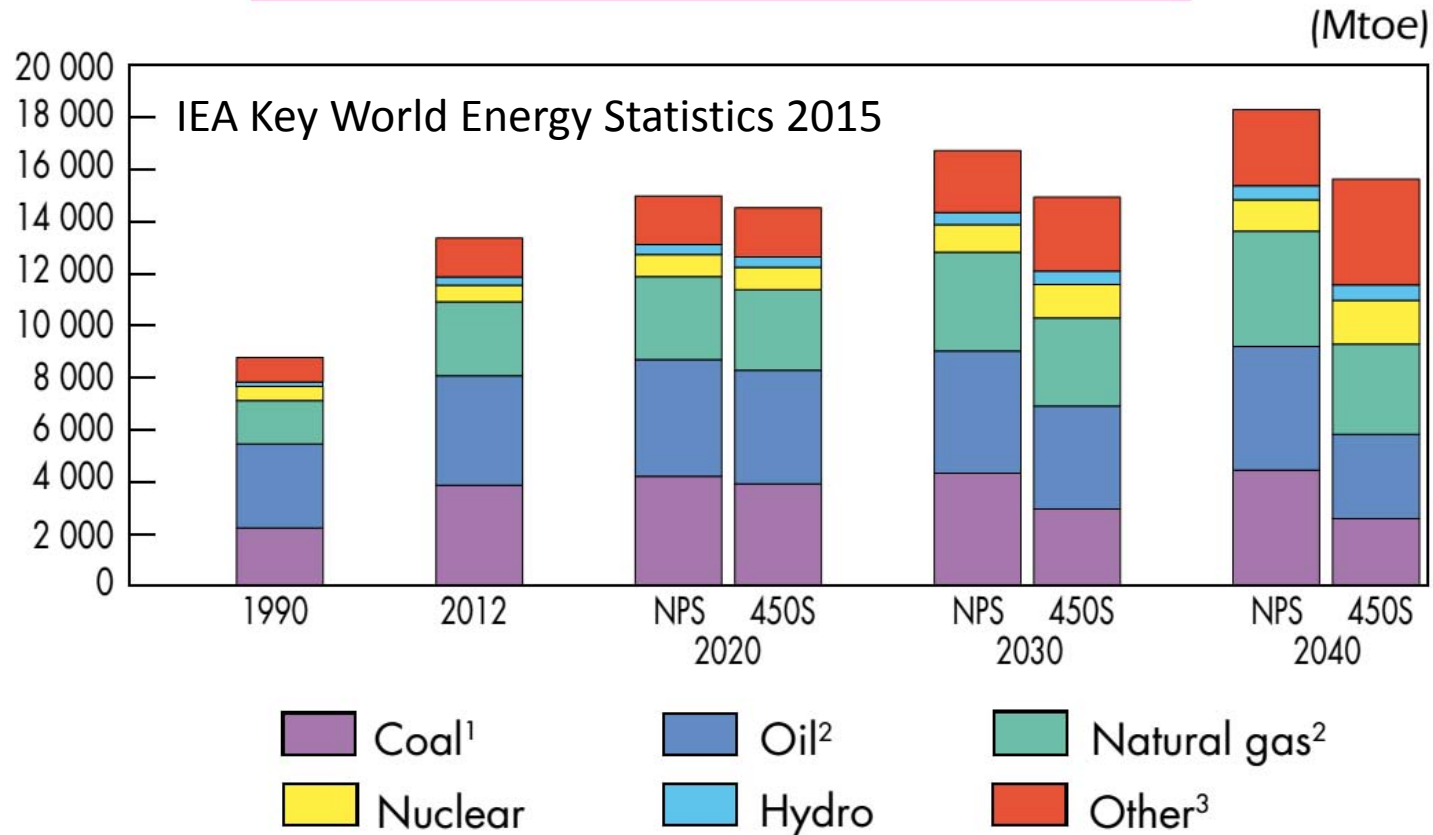
Note: data are estimated.

\* Estonia's coal represents mostly oil shale.

\*\* Other includes geothermal, solar, wind, and ambient heat production.

Source: IEA (2014), *Energy Balances of OECD Countries 2014*, OECD/IEA, Paris.

# Total Primary Energy Supply Projection to 2040



*NPS: New Policies Scenario  
(based on policies under consideration)*

*450S: 450 Scenario<sup>4</sup>  
(based on policies needed to limit global  
average temperature increase to 2 °C)*

1. In these graphs, peat and oil shale are aggregated with coal.
2. Includes international aviation and international marine bunkers.
3. Includes biofuels and waste, geothermal, solar, wind, tide, etc.
4. Based on a plausible post-2014 climate-policy framework to stabilise the long-term concentration of global greenhouse gases at 450 ppm CO<sub>2</sub>-equivalent.

# Outline

## 1. Breakeven Costs

- Full Cycle
- Half Cycle
- Lifting Cost

## 2. Well Costs: USA vs Europe

## 3. Leases, Royalties, Taxes

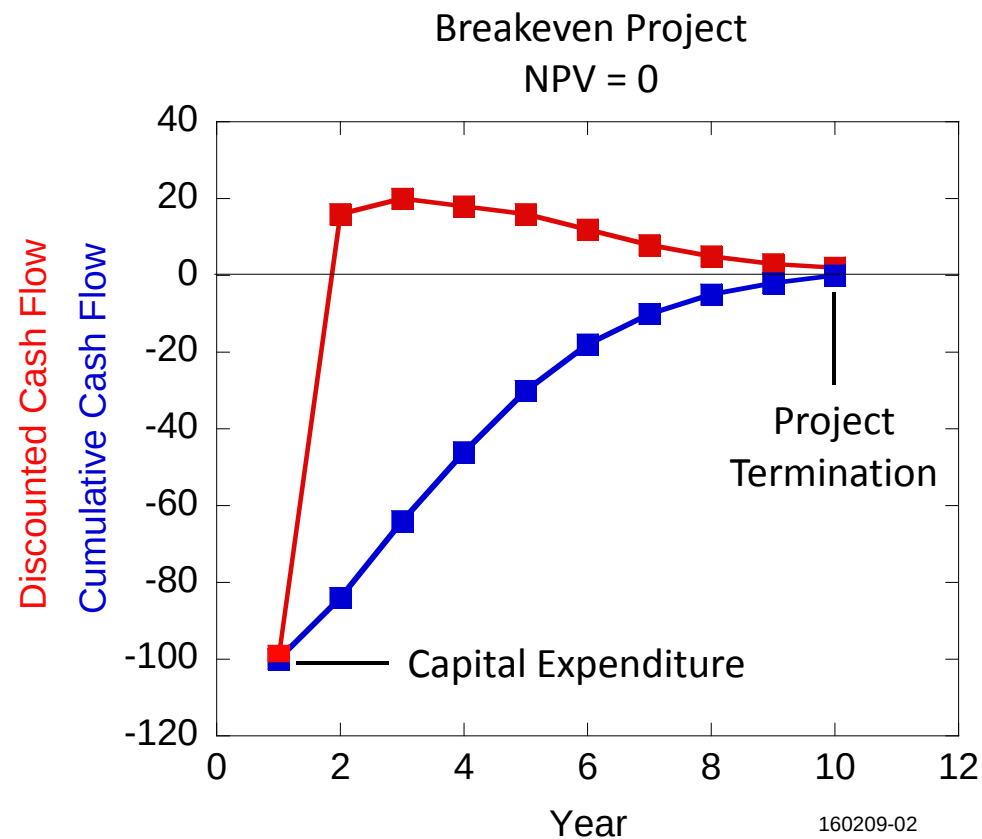
## 4. Risk Discounts

## 5. Transportation Costs

## 6. How Breakeven Costs Change

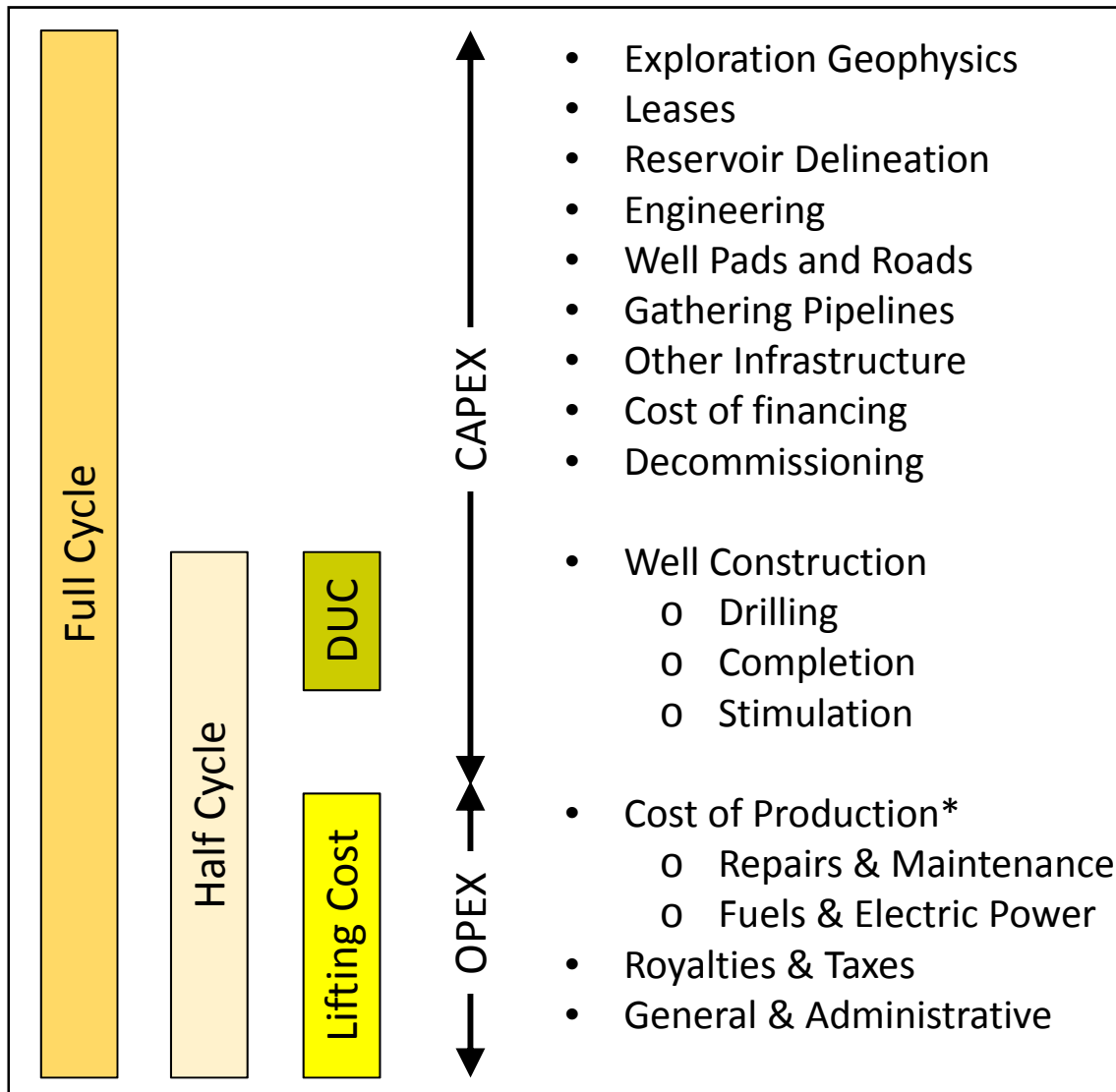
## What is the Breakeven Cost? (also called Breakeven Price, Levelized Cost of Energy)

The Breakeven Cost is the cost of producing a commodity, for which the net present value (NPV) is zero. The NPV is the sum of a project's discounted cash flows (positive and negative).



# Elements of Breakeven Costs

Various operators break down these categories in various ways



## When These Breakevens Are Used

Full Cycle – Project Planning  
\$60-\$80/bbl (mid-2015)

Half Cycle – Maintain Level Production  
\$45-\$65/bbl (mid-2015)

Lifting Cost – Continue Production from  
Existing (Declining ) Wells  
\$10-\$15/bbl (mid-2015)

\* Also called  
Lease Operating Expense (LOE)

DUC = Drilled Uncompleted

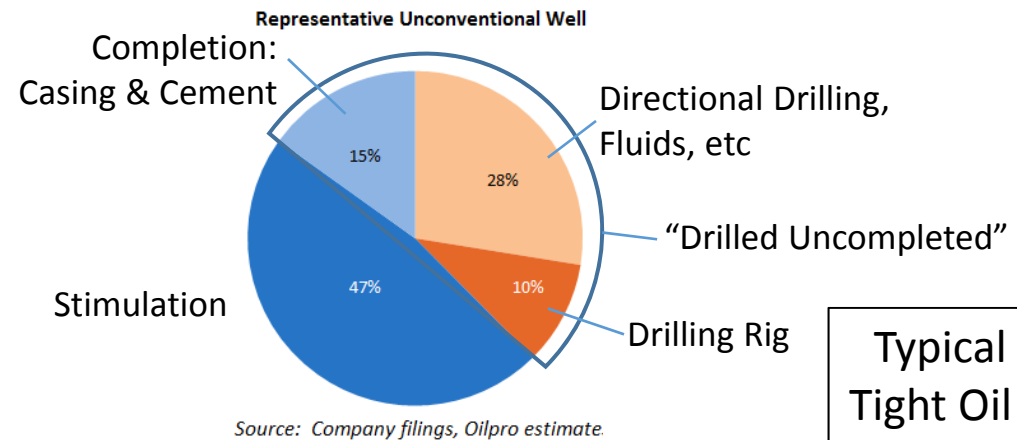


# Well Cost – Usually the Largest Component of Breakeven Cost



Drilling & Completion  
Dimmit County, Texas

Stimulation  
Washington County, Pennsylvania



Typical USA  
Tight Oil Well:  
\$5-8 million





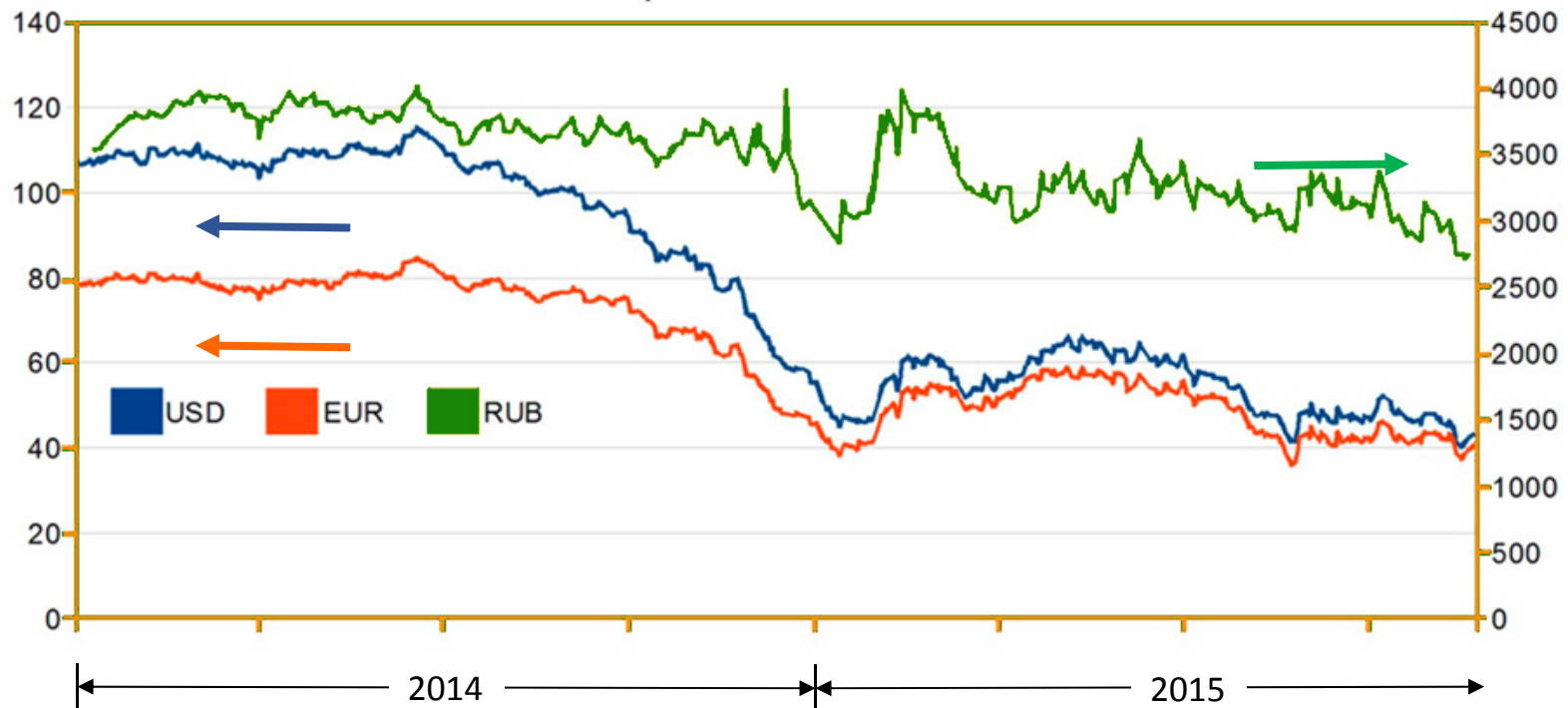
## Drilling/Completion/Stimulation Costs Depend on Economies of Scale

|                                                                                                                                                                                 |                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Drilling Rigs - Land (mid-2014)<br>United States:                   1850<br>Europe:                           100<br><span style="float: right;">www.energyeconomist.com</span> |                                                                                                                                              |
| Pressure Pumping Horsepower (mid-2014)<br>United States:                           19 million hhp<br>Rest of World (ex-Russia/China):   2 million hhp                           |                                                                                                                                              |
| Human Capital<br>Geologists<br>Geophysicists<br>Drillers<br>Petroleum Engineers                                                                                                 | Service Company Infrastructure<br>Seismic Surveys<br>Directional Drilling<br>Drilling Fluids<br>Formation Evaluation<br>Hydraulic Fracturing |

**Frontier Area Expense ~ 3x US Land**  
(Schlumberger Estimate)

# Oil Price in Local Currencies

**Europe Brent Spot Price FOB: Dollars per Barrel, Euros per Barrel and Rubles per Barrel 2014-2015**



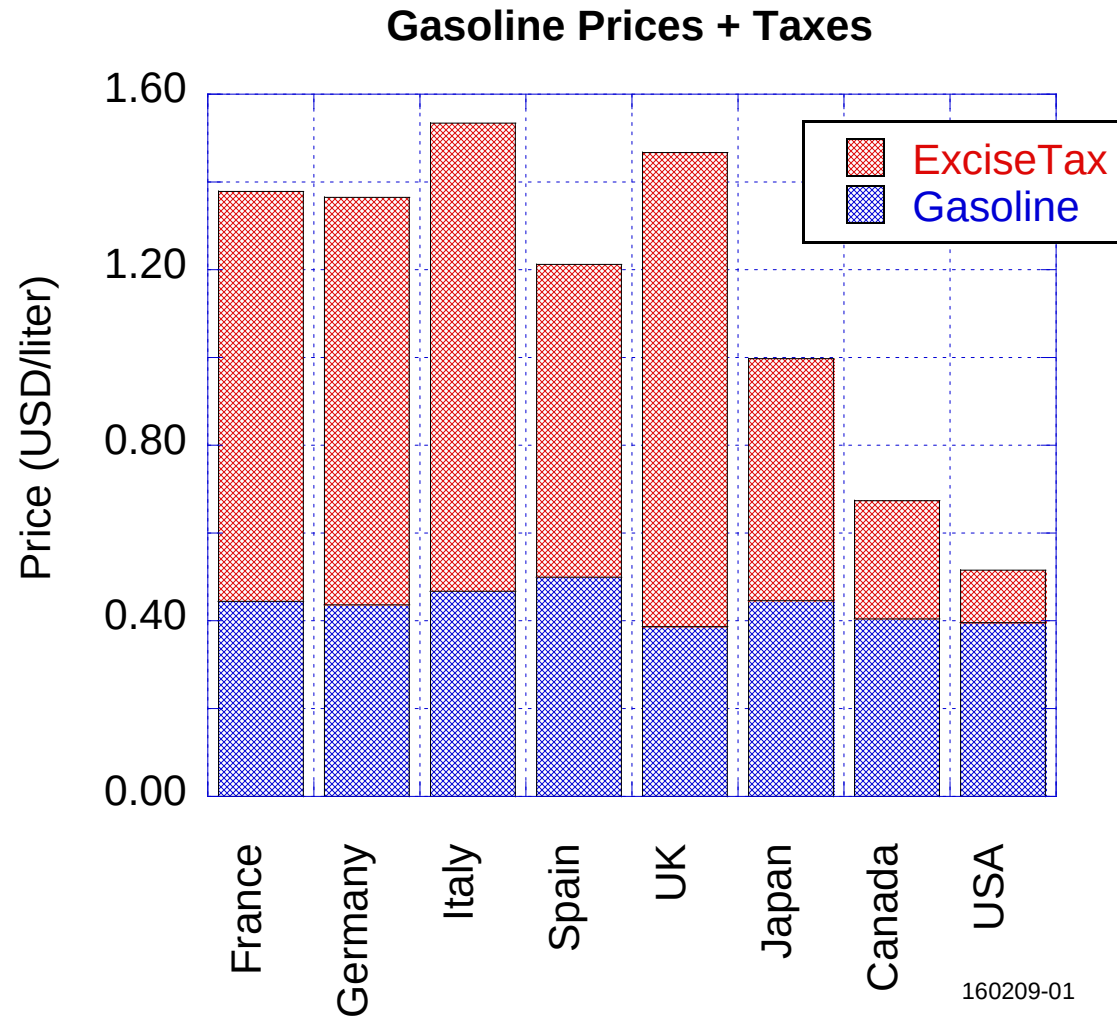
Source: Based on EIA, ECB, and CBR

Gefira 2 December 2015

USA: Net present value (in dollars) collapsed  
Russia: Net present value (in rubles) declined modestly

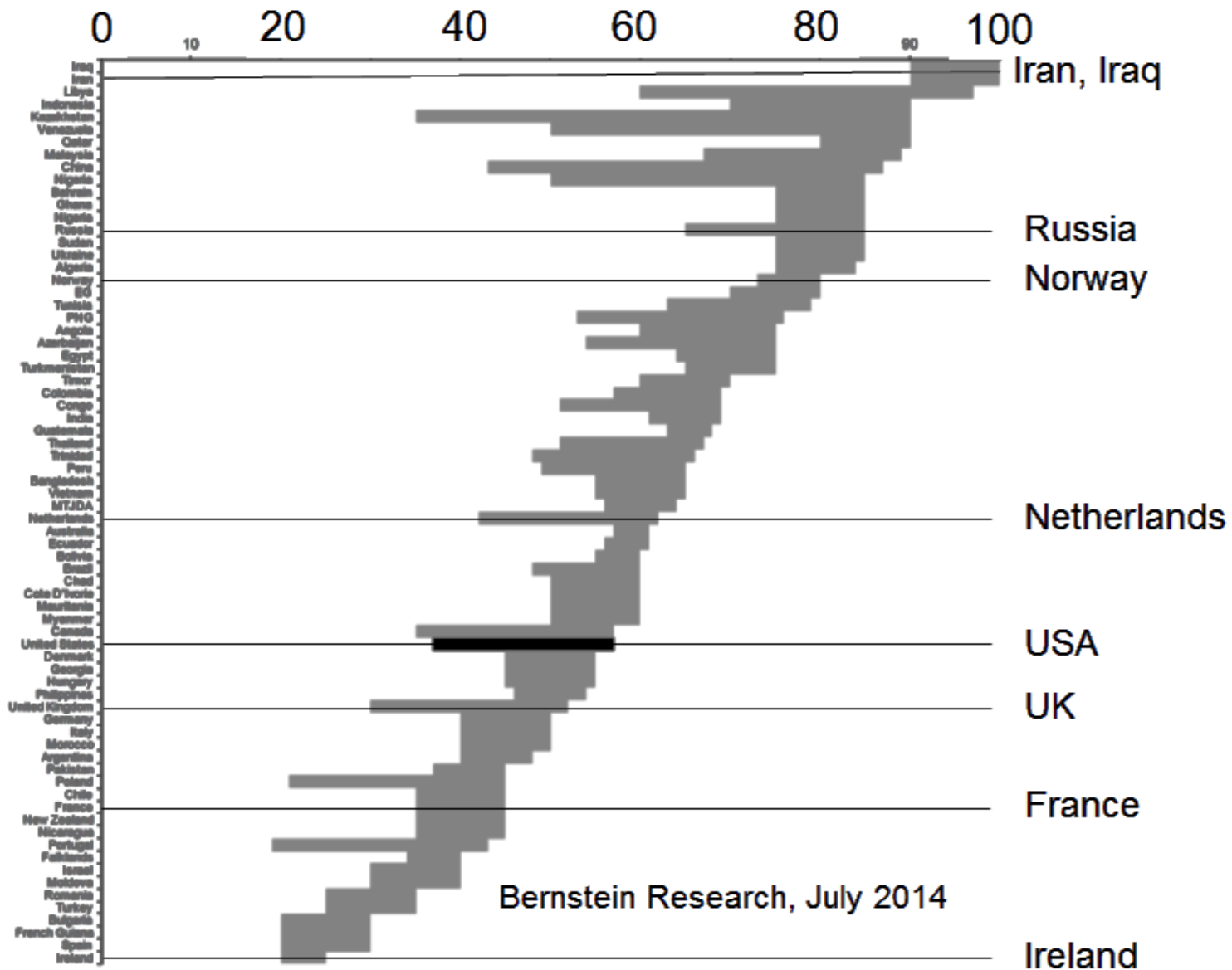
## Leases, Royalties, Taxes: “Government Take”

| Source        | Explanation                | Recipient             |                     |
|---------------|----------------------------|-----------------------|---------------------|
|               |                            | USA                   | ROW                 |
| Lease         | Right to drill in an area  | Resource holder       | National government |
| Royalty       | Fraction of gross proceeds | Resource holder       | National government |
| Severance Tax | Tax on value or volume     | States                |                     |
| Income Tax    | Tax on profits             | Federal, States       | National government |
| Property Tax  | Tax on reserves            | States, Localities    |                     |
| Equity Stake  | Corporate dividend         |                       | National government |
| Excise Tax    | Tax on volume (retail)     | Federal, State, Local | National government |

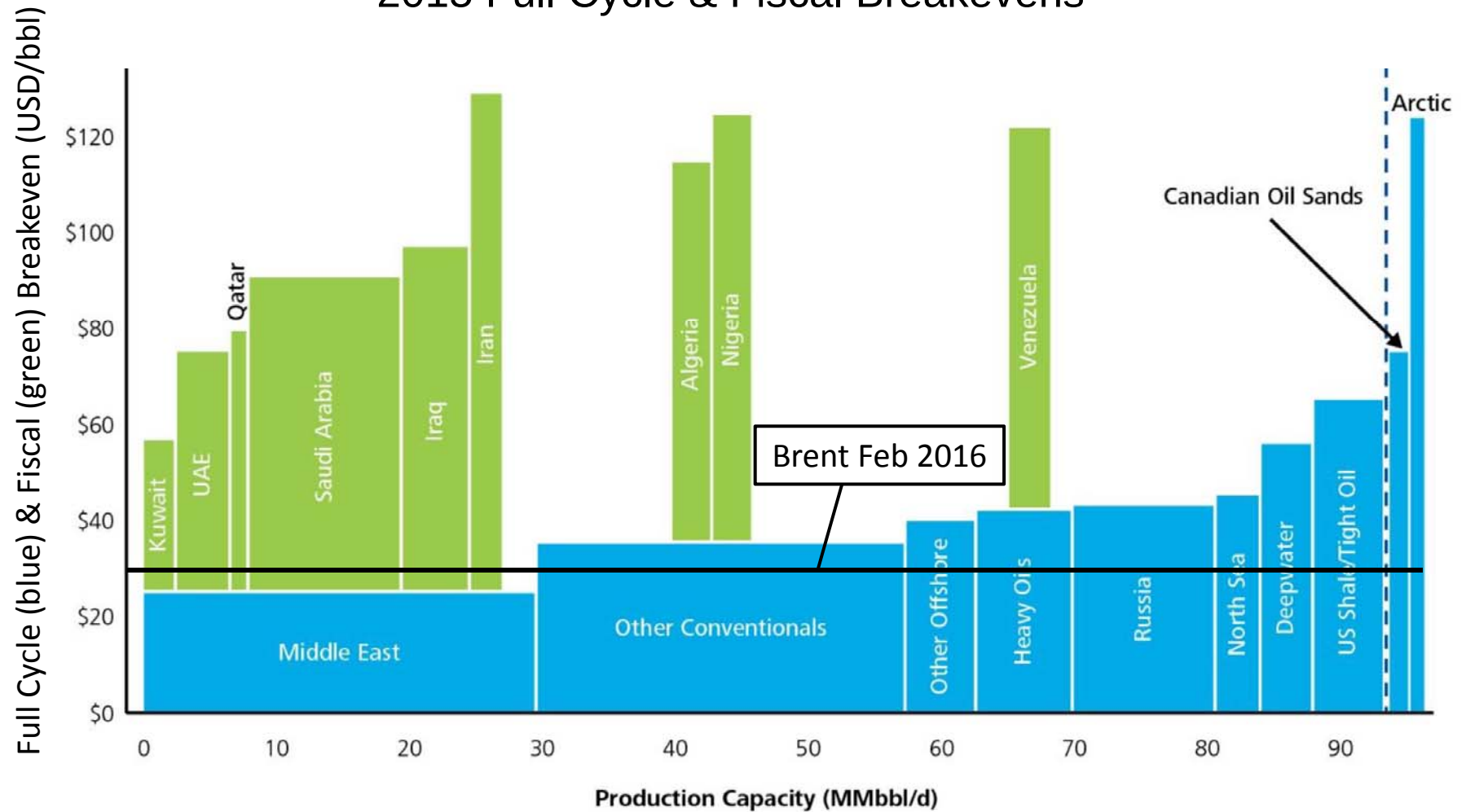


IEA Monthly Oil Price Statistics  
January 2016

# Fiscal Terms (% Government Take)

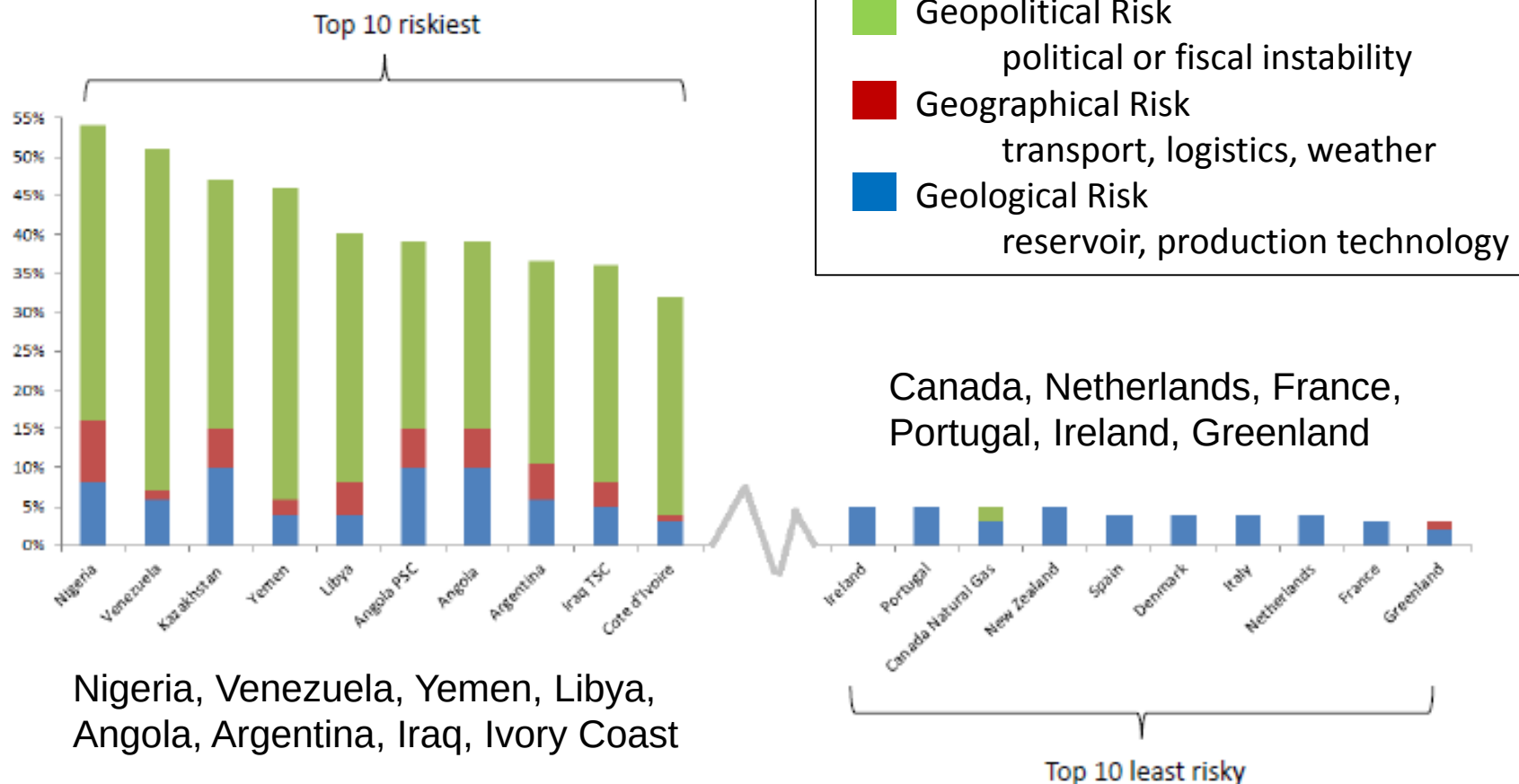


## The Resource Curse: 2015 Full Cycle & Fiscal Breakevens



Deloitte, Oil Prices in Crisis, 4 February 2015

## Sampling of risk discount by country



Source: Wolfe Research estimates

Sankey, Global Oil & Gas  
Wolfe Research, July 2014



## Country Risk Specific to “Fracking”

### Unconventional project status

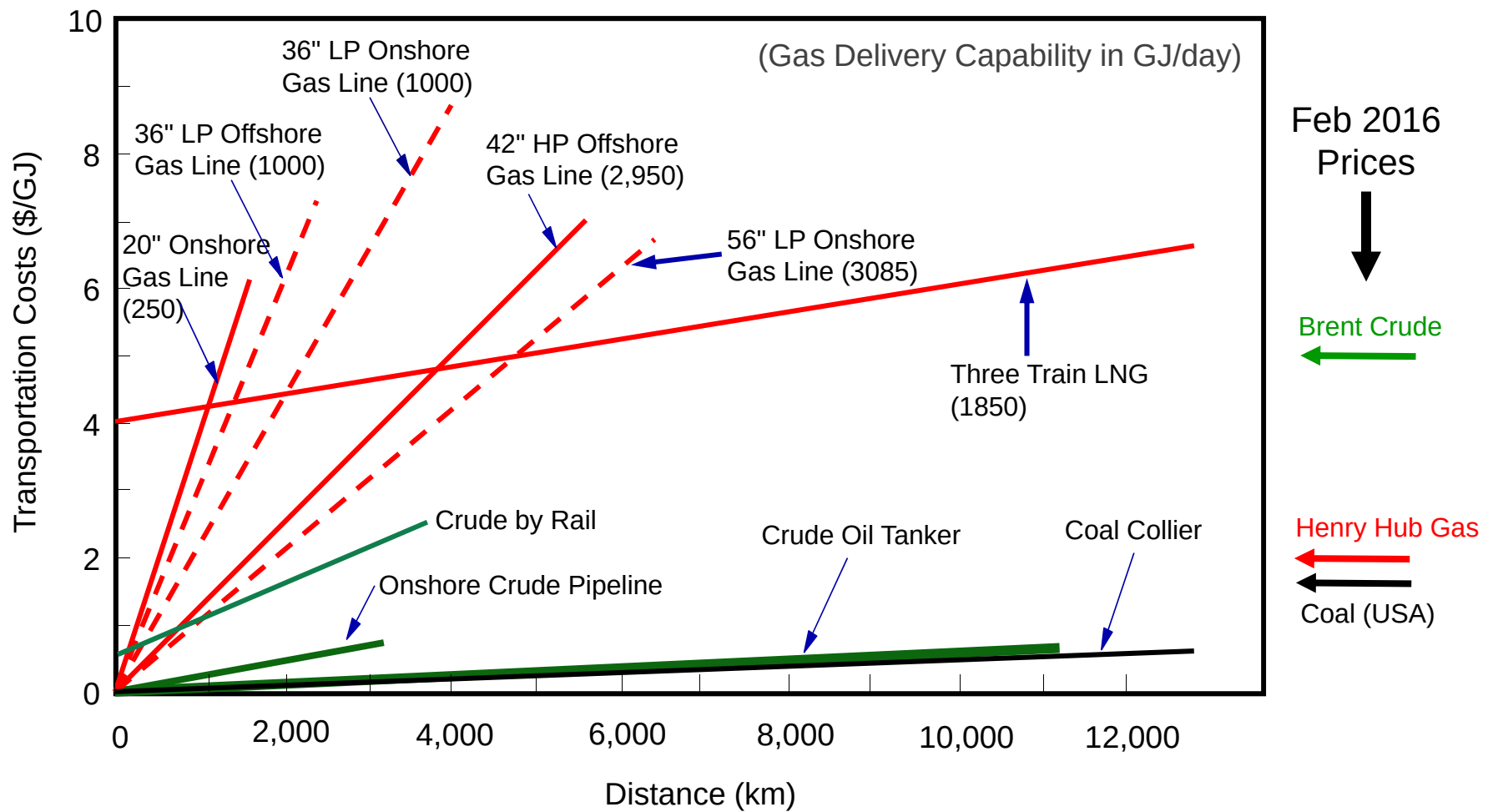
- Strong opposition or moratorium
- Mixed support
- Activity is allowed/operational activity



Source: Wood Mackenzie

Wood Mackenzie, July 2014

## Coal, Oil & Gas Transportation Costs



## Keystone XL Pipeline

. . . this pipeline would neither be a silver bullet for the economy, as was promised by some, nor the express lane to climate disaster proclaimed by others.

- President Obama, 6 November 2015

|                  |                                                                                     |
|------------------|-------------------------------------------------------------------------------------|
| Route:           | Hardisty, AB to Steele City, NB: 1900 km                                            |
| Capacity:        | 830,000 bbl/day in 36 inch diameter pipeline<br>36% of Alberta Heavy Oil Production |
| Rail Equivalent: | 10 x 100-car trains/day @ 821 bbl/car                                               |
| Cost Difference: | Rail – Pipe = \$7.65/bbl                                                            |

Crude Oil Benchmark Prices (IHS, 18 January 2016)

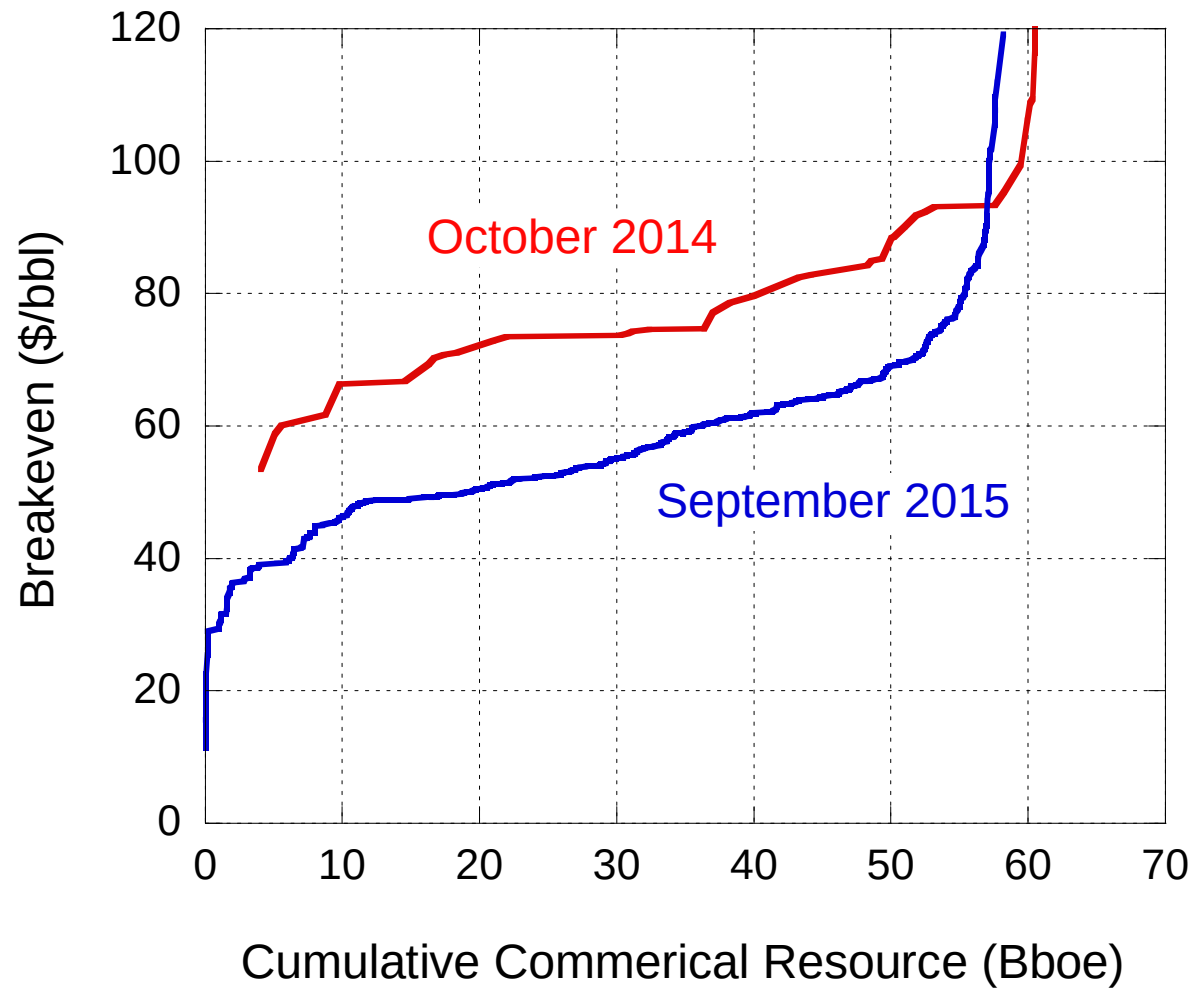
West Texas Intermediate @ Cushing: \$29.42/bbl

Western Canadian Select @ Hardisty: \$15.12/bbl

Heavy Oil Lifting Cost: ~ \$20/bbl

At today's oil prices, the extra transportation cost is the difference between economic and uneconomic heavy oil production.

## US Tight Oil Breakevens



WoodMac 1410 North American Breakeven  
WoodMac 1509 Lower 48 Breakeven

151125-01

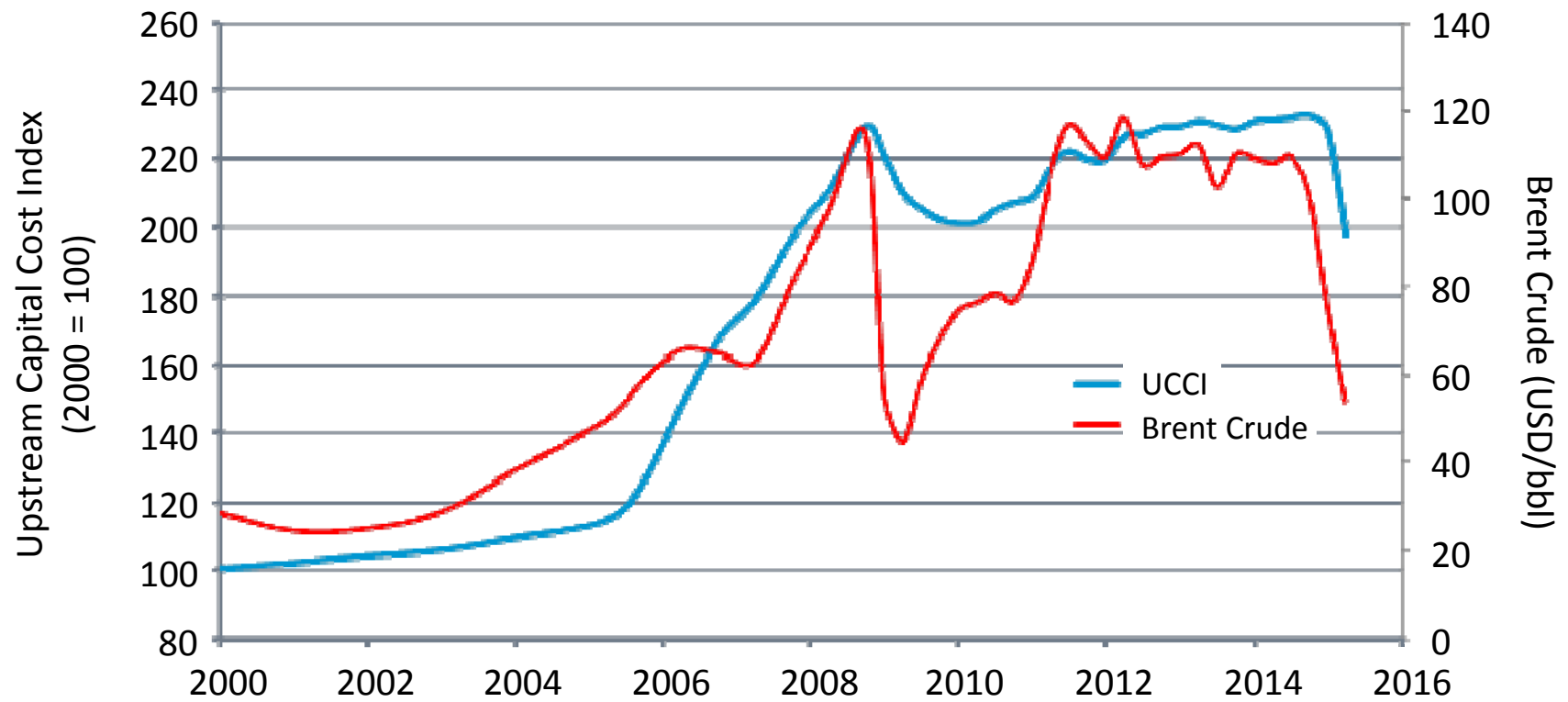
## Why Breakeven Points Change

| Increase                                                                 | Decrease                                                                                               |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
|                                                                          | Geological derisking                                                                                   |
|                                                                          | More efficient drilling/<br>completion/stimulation                                                     |
|                                                                          | Supply chain optimization                                                                              |
| Competition for leases                                                   | Consolidation of leases                                                                                |
| Infrastructure shortages                                                 | Infrastructure buildout                                                                                |
| Service cost increases<br>o Equipment shortages<br>o Personnel shortages | Service cost discounts<br>o Amortization of CAPEX<br>o Service efficiencies<br>o Increased competition |
| Tax rate increases                                                       | Tax rate decreases                                                                                     |

Early in development cycle

Late in development cycle

## Oilfield Services Costs Follow Price



IHS Upstream Capital Cost Index, November 2015

151117-01

Robert L. Kleinberg, Ph.D.  
Unconventional Resources  
Schlumberger-Doll Research  
One Hampshire Street  
Cambridge, MA 02139

617-768-2277

[kleinberg@slb.com](mailto:kleinberg@slb.com)

<http://www.linkedin.com/pub/robert-kleinberg/19/177/131>

Member of the National Academy of Engineering



Dimmit County, Texas