Unconventional Oil and Gas: Opportunities for Future Development and Managing Above-Ground Challenges:

February 5th, 2019
Etter-Harbin Alumni Center
University of Texas – Austin
Austin, Texas

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UT ENERGY WEEK 2019
SHOWCASING
THE WORLD'S PREMIER ENERGY UNIVERSITY

The University of Texas at Austin Energy Institute

LONGHORN ENERGY CLUB

Criteria for sustainable energy solutions

ENERGY AND EARTH RESOURCES GRADUATE PROGRAM

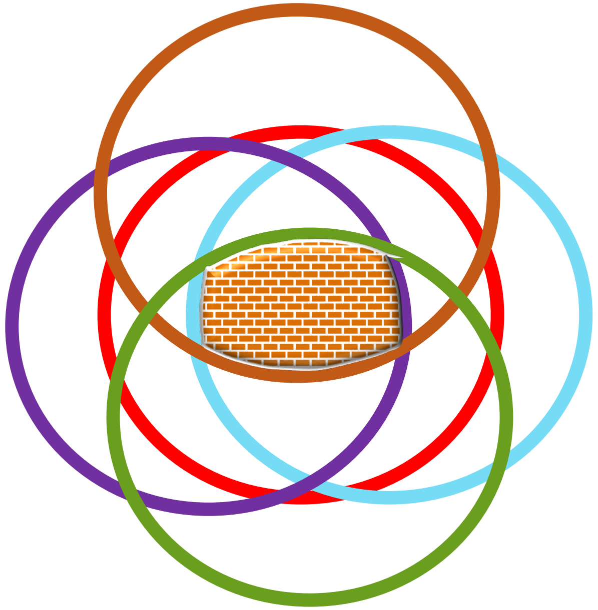
Solving three simultaneous equations:

$f(x_1)$ = **sound science and technology**

$f(x_2)$ = **consistency with policy which adequately addresses the welfare of society**

$f(x_3)$ = **financial viability to attract the interest of investors**

= complexity



Jackson (administrative home) / earth, atmospheric sciences

Cockrell / engineering

McCombs (dual MBA) / economics, finance

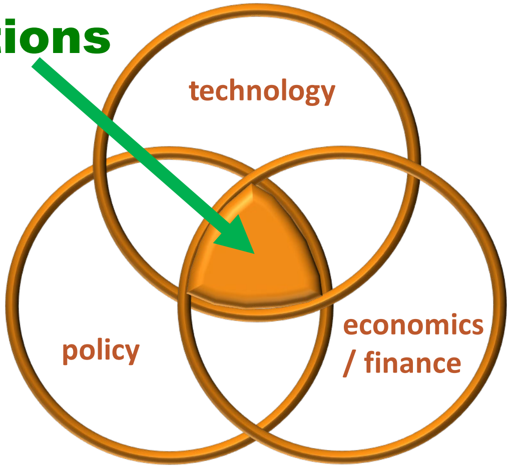
LBJ (dual MPAFF, MGPS) / policy

Law / law, regulation, contracts

+ Energy Institute

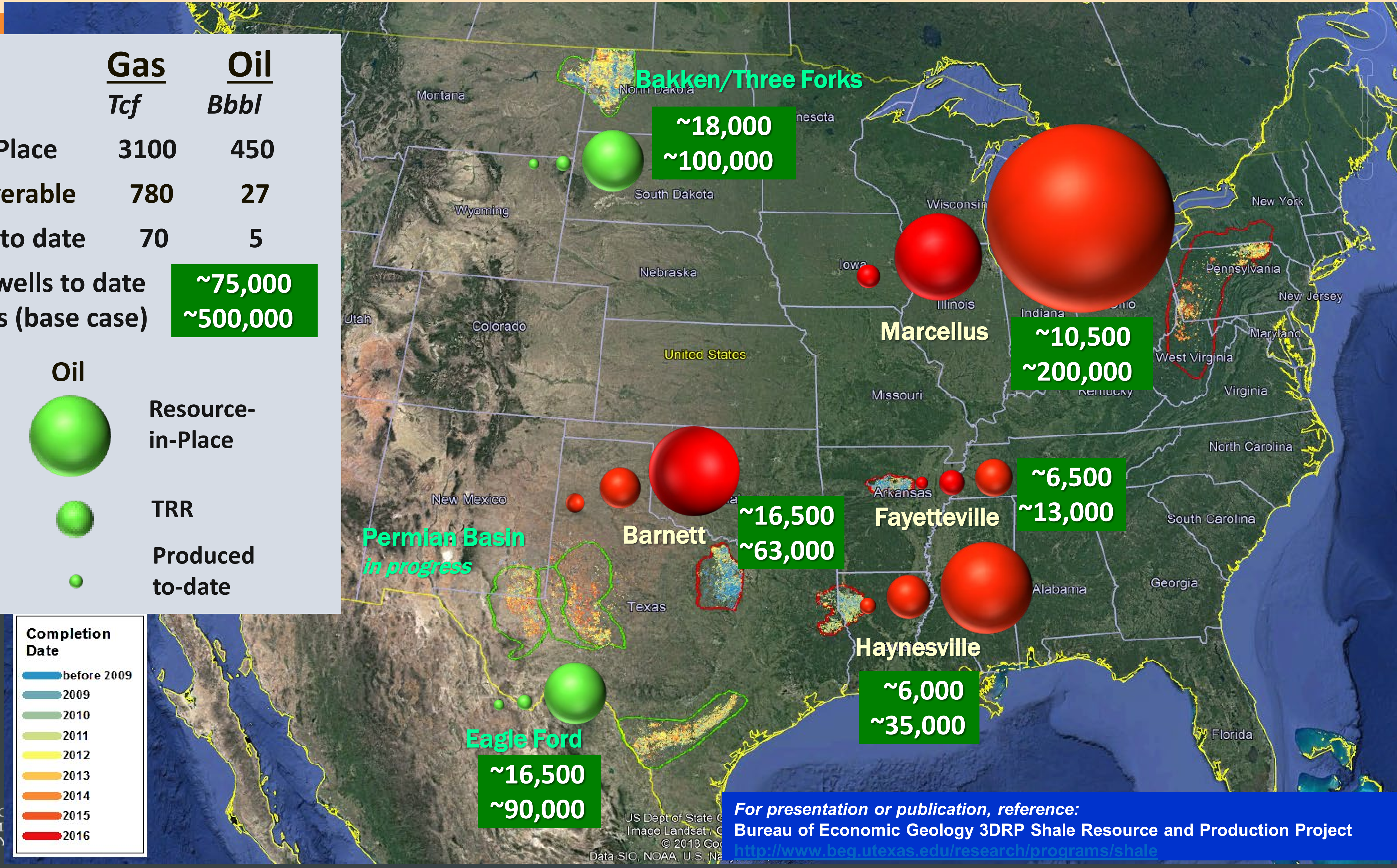
Energy and Earth Resources graduate program

sustainable energy solutions



	Gas	Oil
	Tcf	*Bbbl*
Original In-Place	3100	450
Tech. Recoverable	780	27
Production to date	70	5
Horizontal wells to date	~75,000	
Future wells (base case)	~500,000	

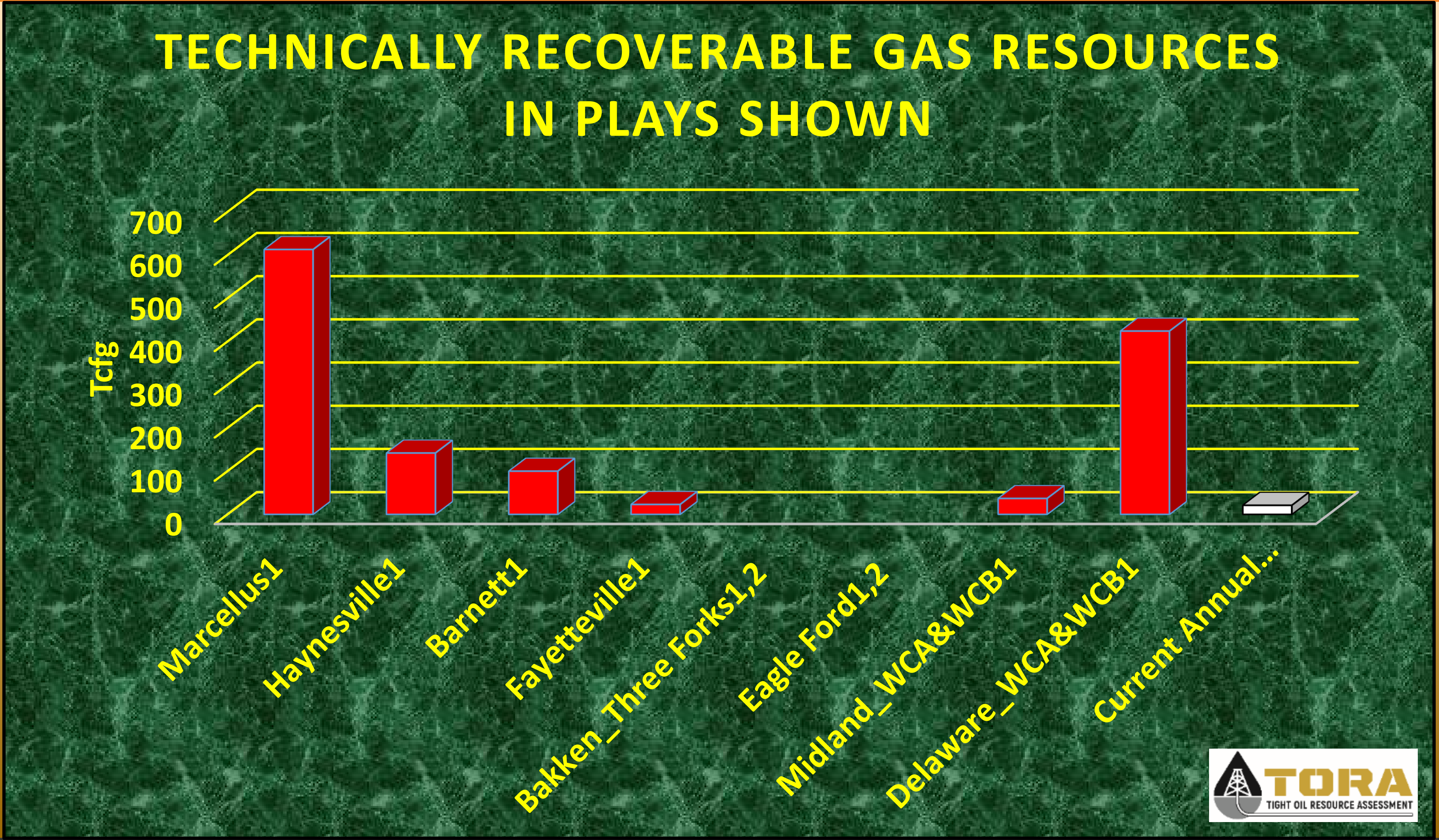
Gas	Oil	
		Resource-in-Place
		TRR
		Produced to-date



Bureau of Economic Geology

For presentation or publication, reference:
Bureau of Economic Geology 3DRP Shale Resource and Production Project
http://www.beg.utexas.edu/research/programs/shale

3,553 TCFG Total Technically Recoverable Reserves are over 50 years current annual Consumption.



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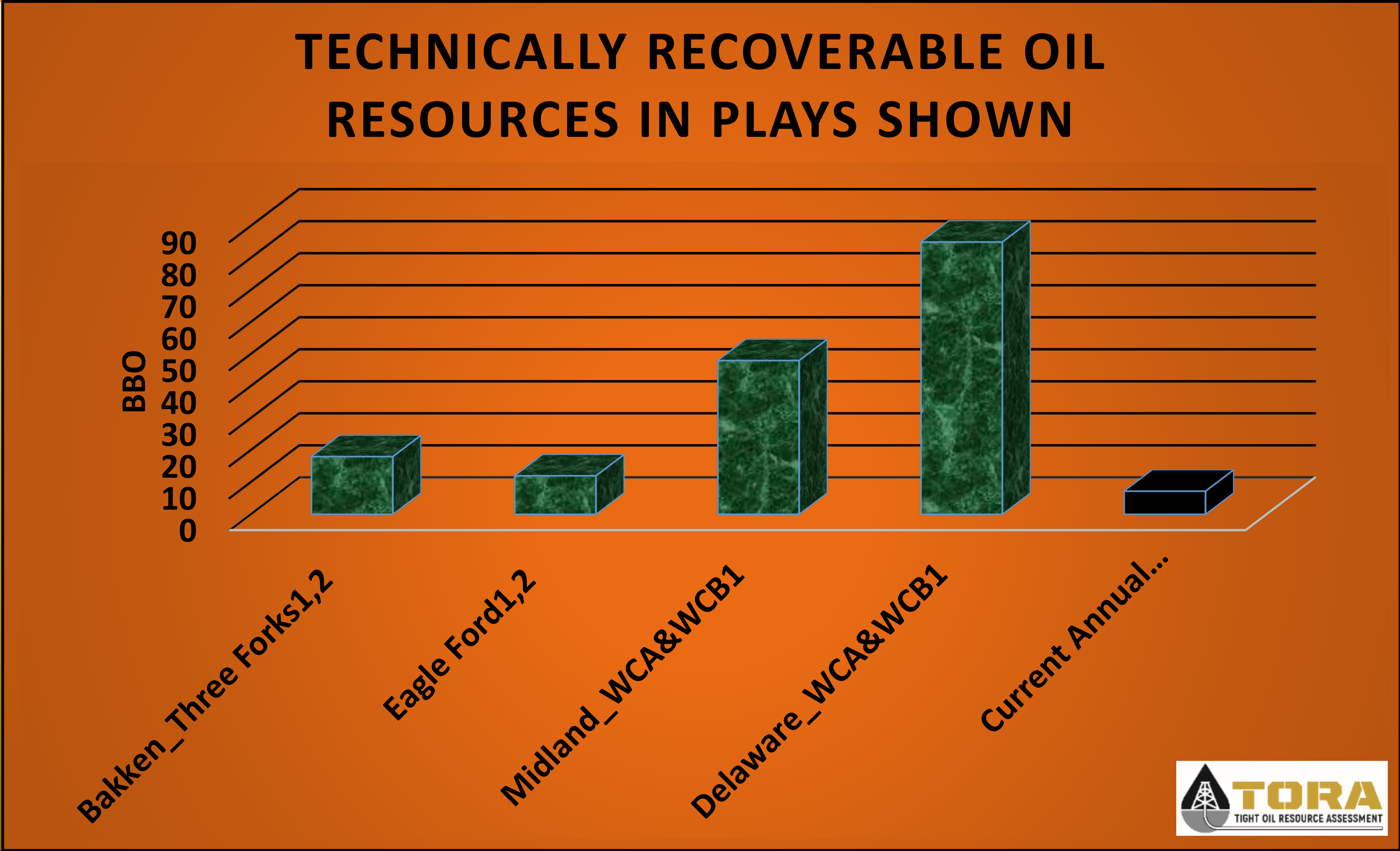
170 BBO Total Technically Recoverable Reserves are over 23 years current annual Consumption.



TORA TIGHT OIL RESOURCE ASSESSMENT

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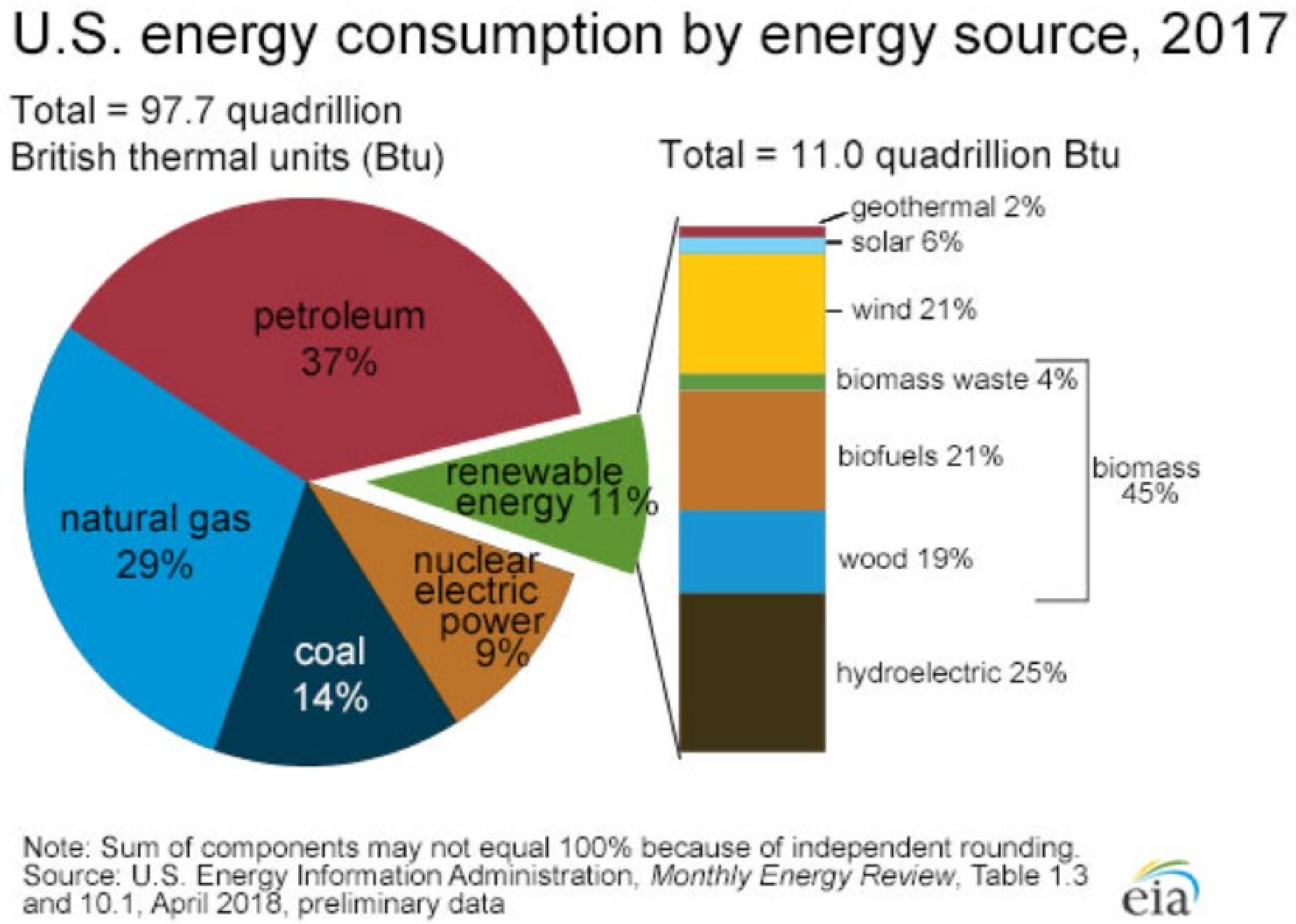

Hydrocarbons account for two-thirds of the United States Energy Sources.

The United States Economy and Economic Standing in the World has historically, continues to develop, and operates on clean, inexpensive energy.

Developing Countries and those in Poverty need inexpensive energy sources to develop and compete.

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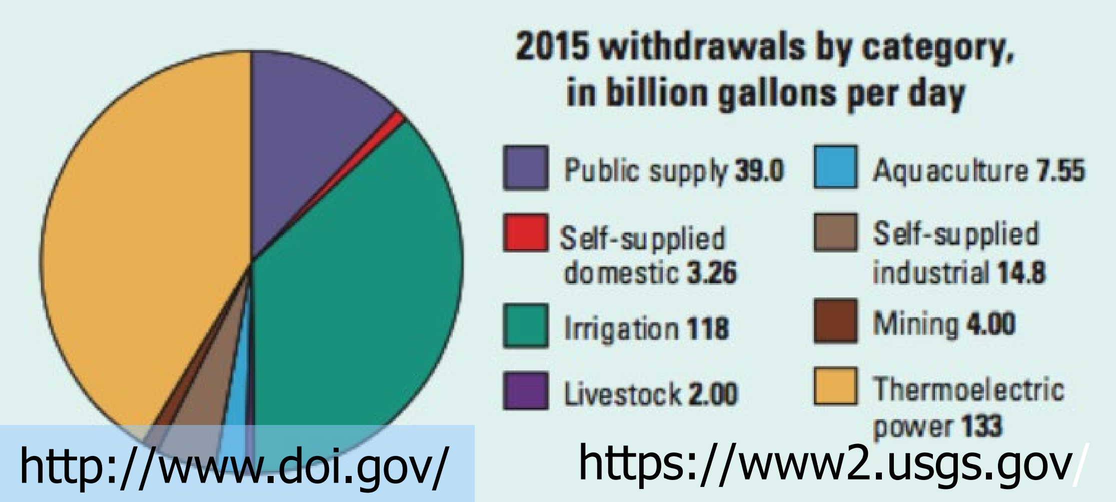
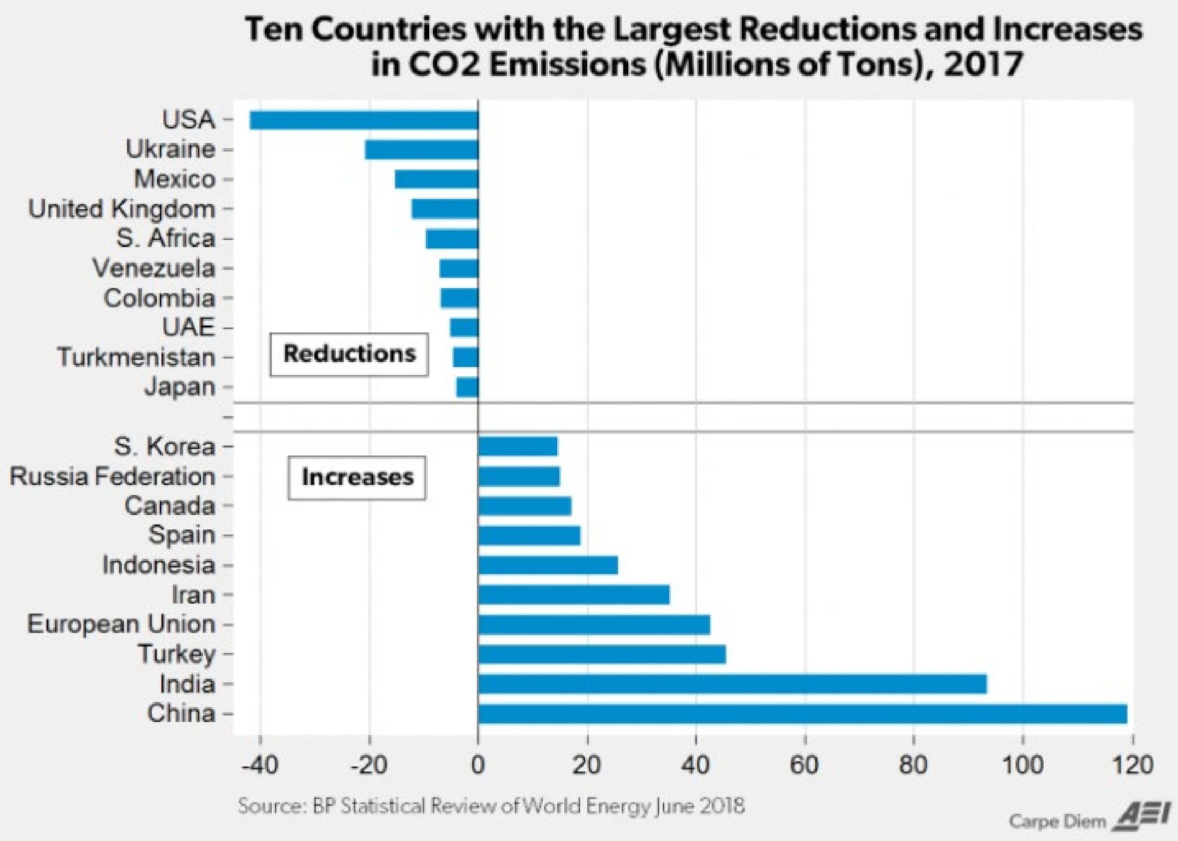
Externalities of Oil & Gas Extraction:



http://www.doi.gov/ https://www2.usgs.gov/

U.S. Oil & Gas Industry accounts for 8% of national GDP and uses approximately 2% of U.S. water supply.



U.S. Oil & Gas Industry has reduced emissions 26% in the last several years while doubling production. A greater than 50% decrease per energy unit.

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Why Unconventional, Resource Plays Developed first in the United States:

1. Innovators are Small Independents, individuals or small companies.
2. Fee (Private) Mineral Ownership.
3. Infrastructure.
    a. Fields, pipelines,
    b. Service Companies,
    c. Information,
    d. Technology
        (i). Drilling,
        (ii). Completions.
4. Marginal Economics per well and total CapEx.

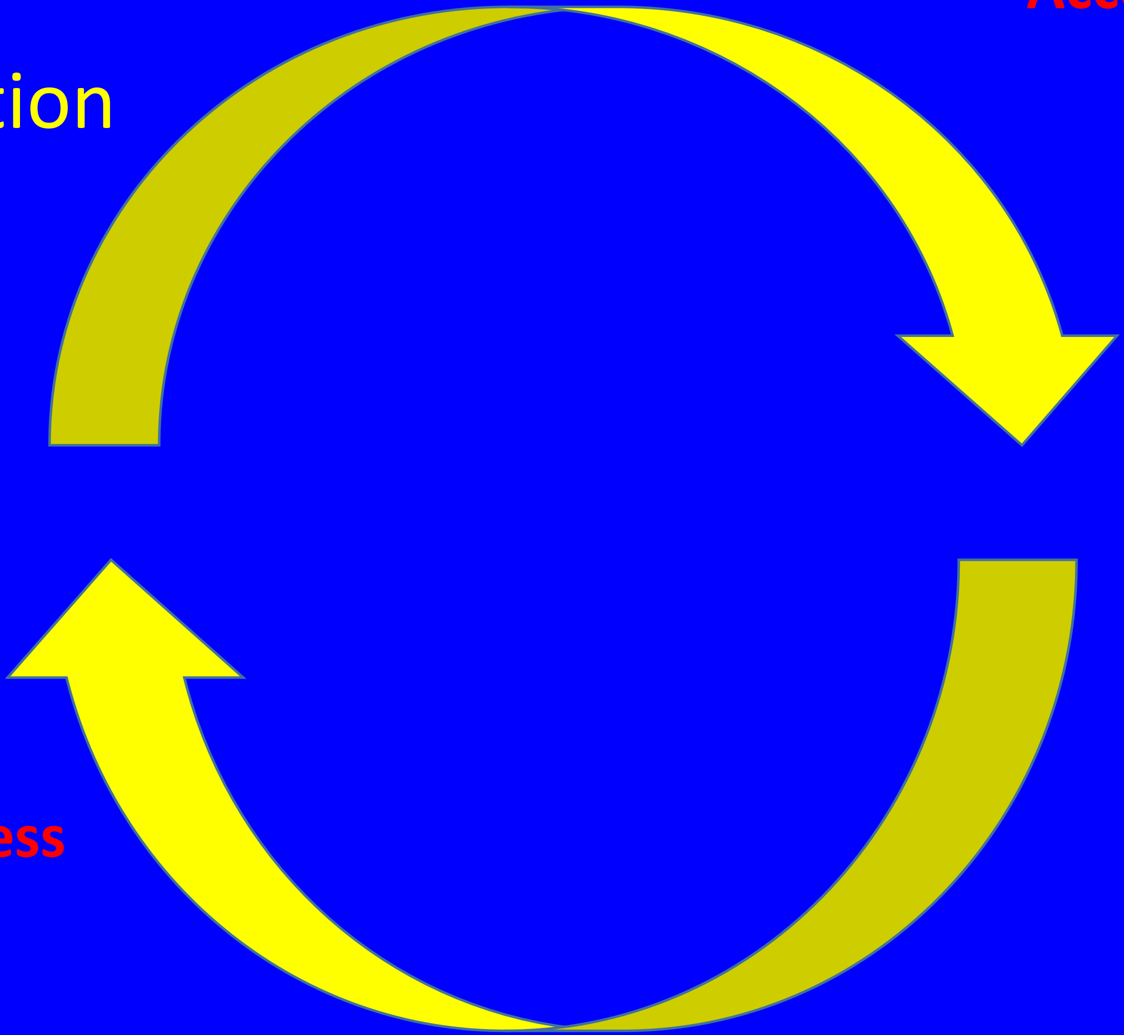
Organizational / Trend-Play Life Cycle

Accounting

3. Maturation

4. Decline

Finance



2. Process

Lawyers

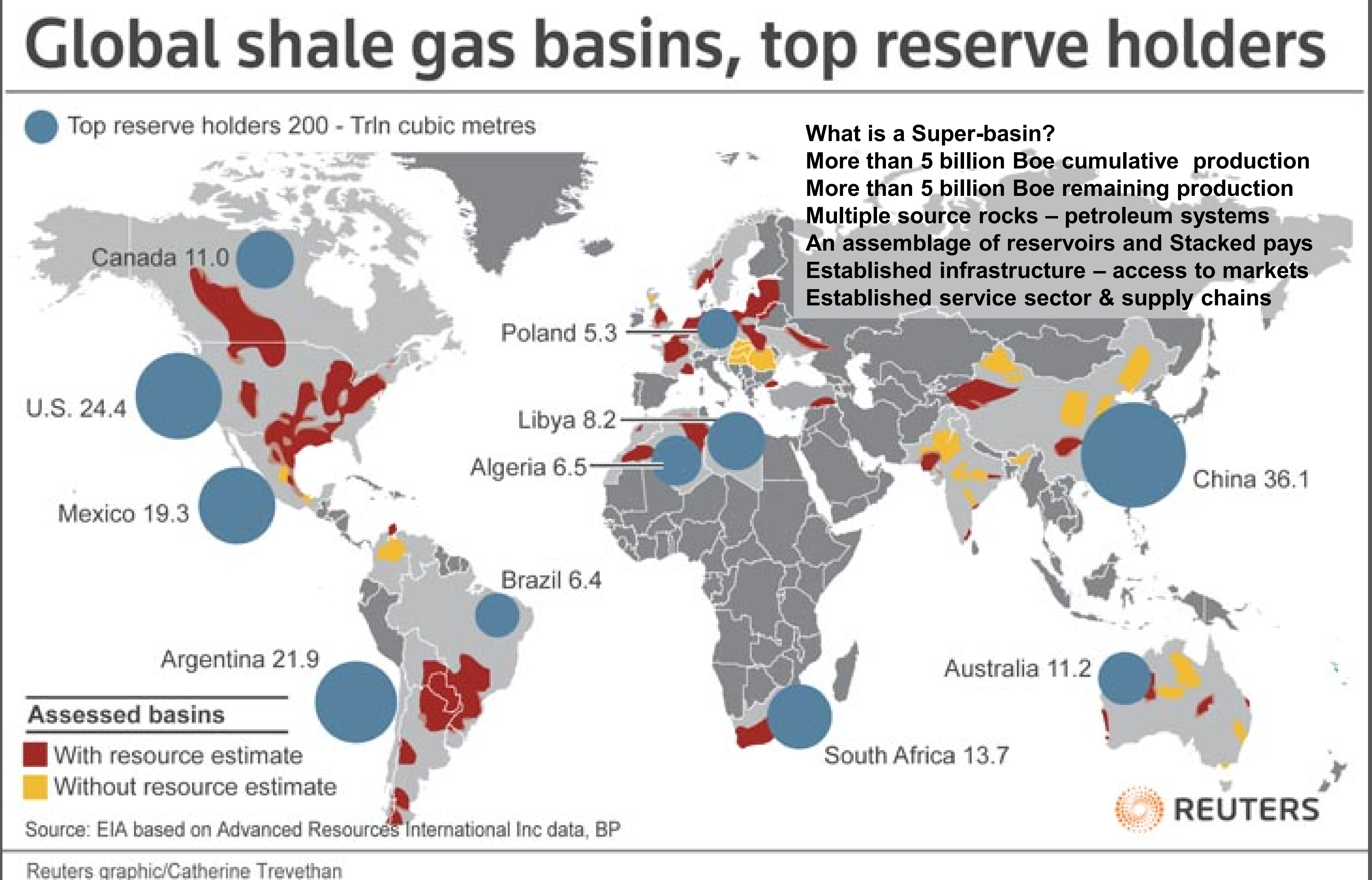
Engineers

Landman – Business Development

5. Destruction

Geosciences

1. Innovation, Re-Invention, Re-Building



What is a Super-basin?

More than 5 billion Boe cumulative production

More than 5 billion Boe remaining production

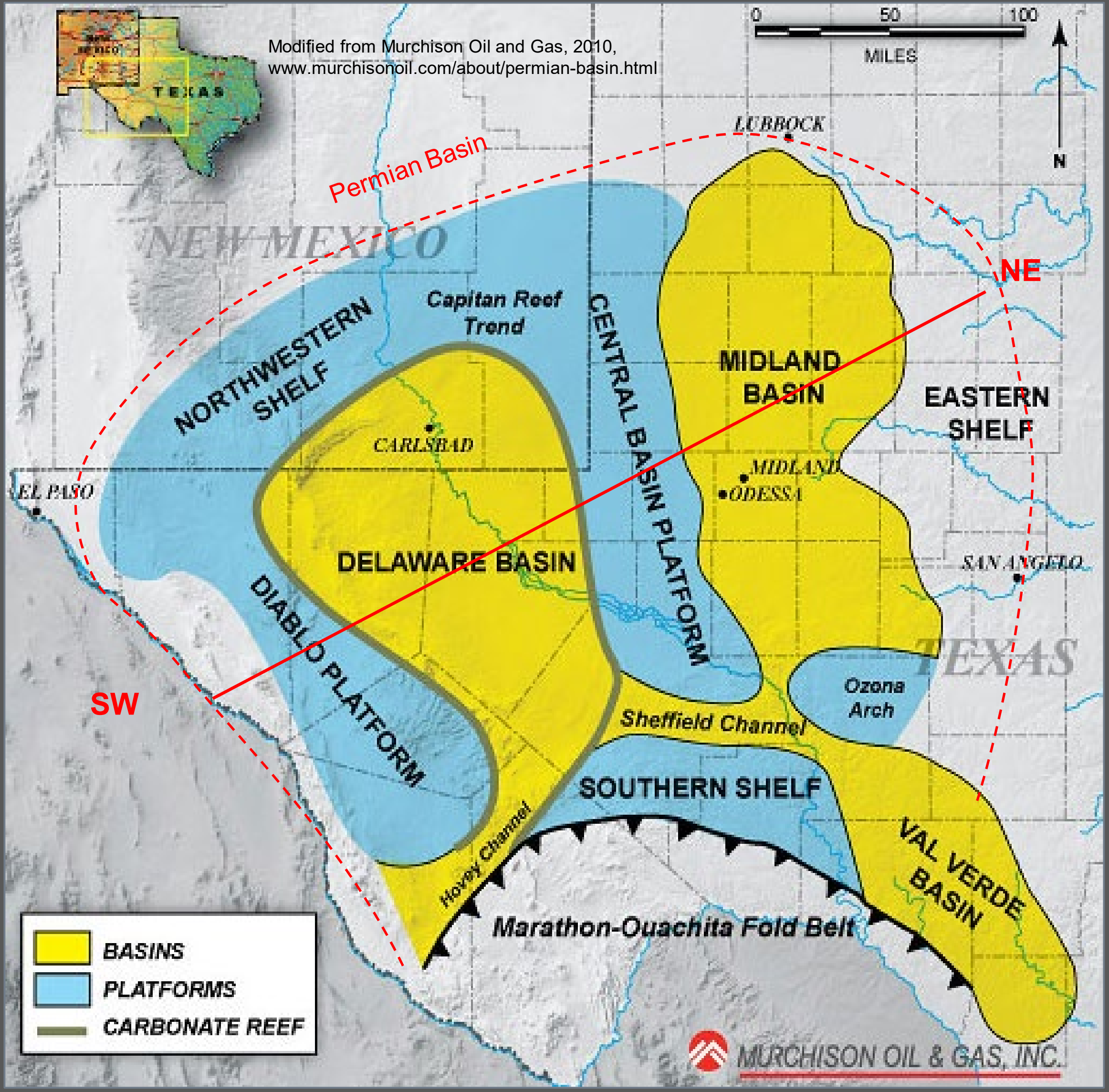
Multiple source rocks – petroleum systems

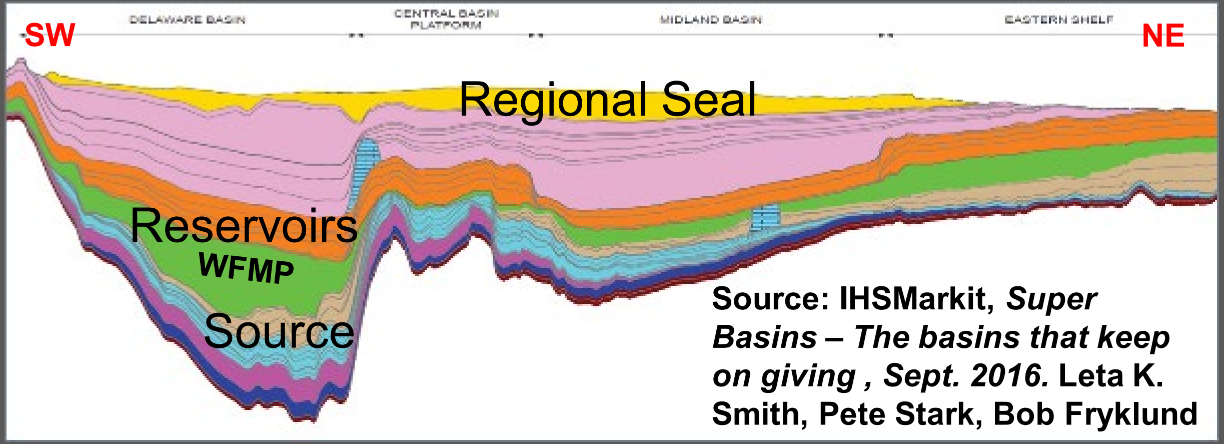
An assemblage of reservoirs and Stacked pays

Established infrastructure – access to markets

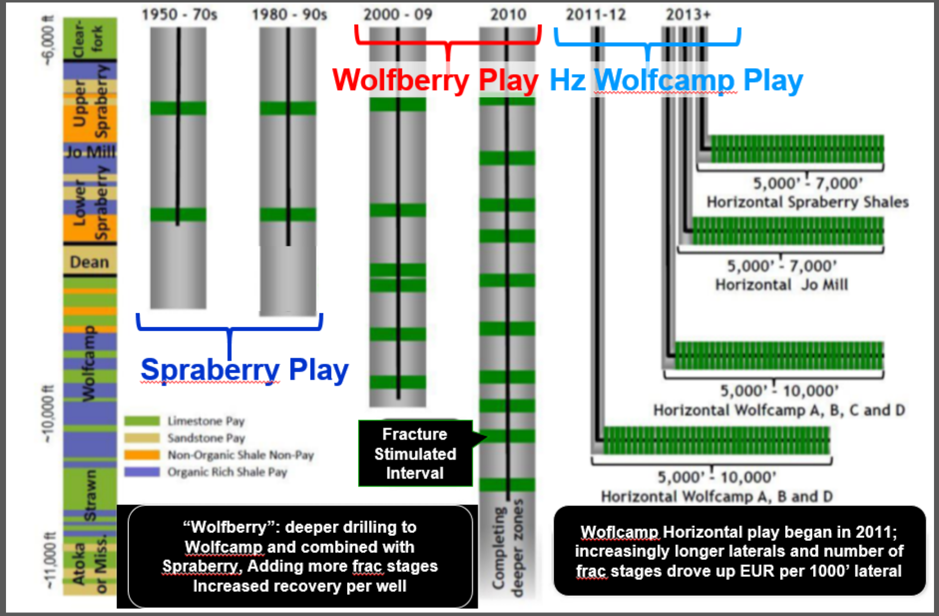
Established service sector & supply chains

Permian Basin –"super basin" prototype architecture onshore, unconventional, geology and engineering



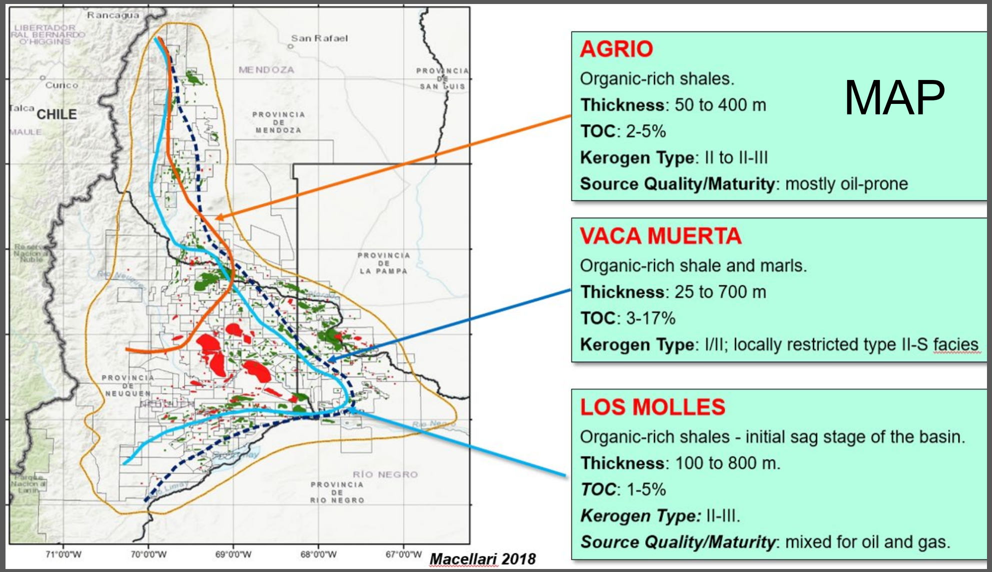


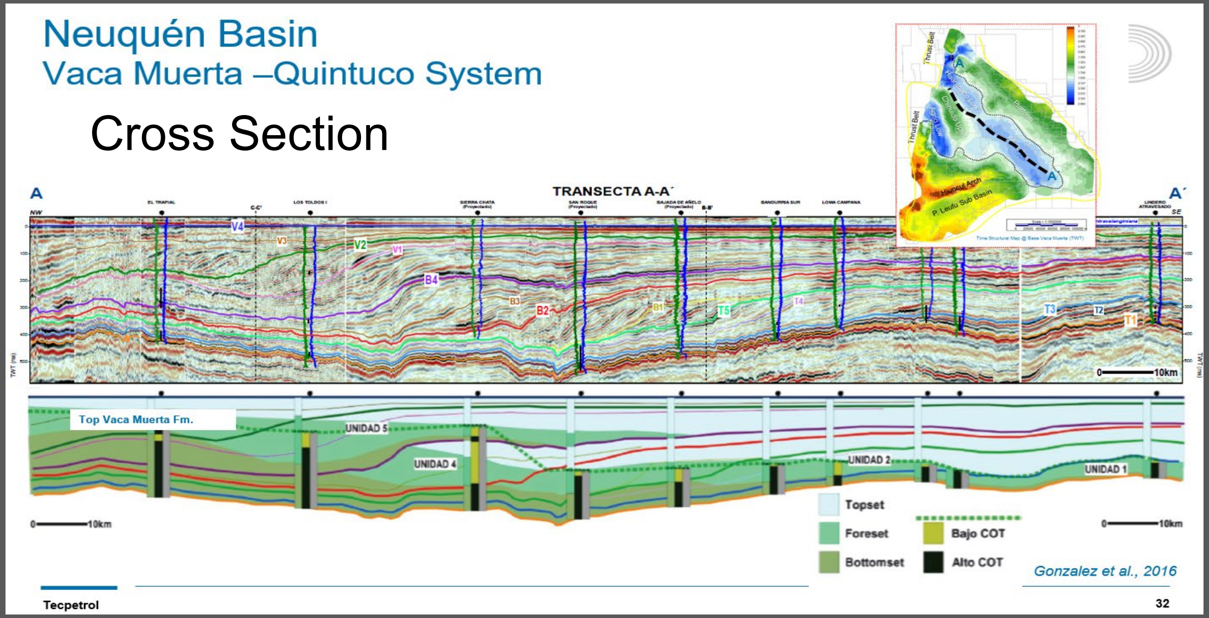
1) Four source zones; three low in pile; 2) Maturation due to Permian subsidence for most of basin; 3) Late salt seal reduces leakage;



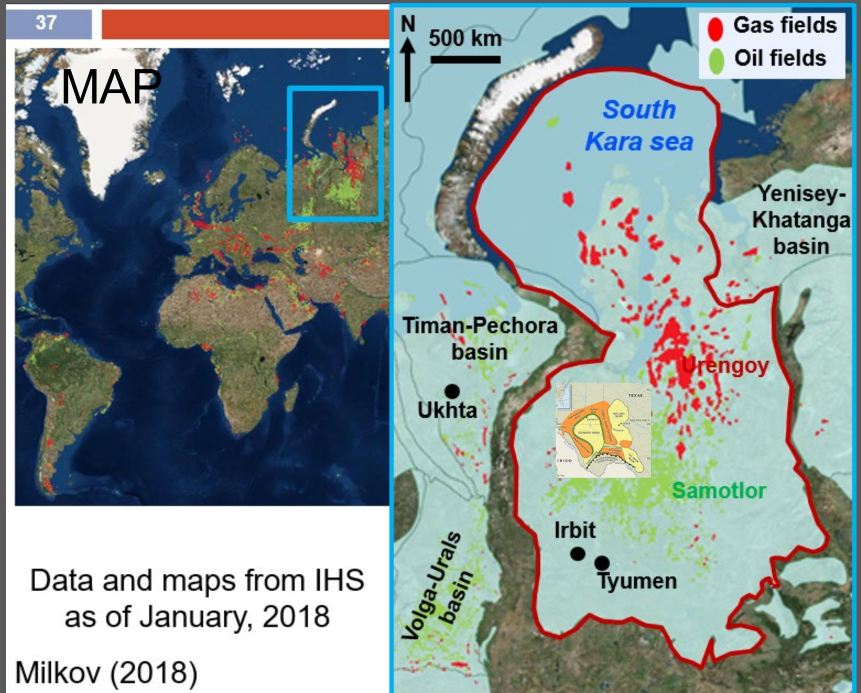
Modified from Pioneer Natural Resources (2013) and Blomquist, 2016

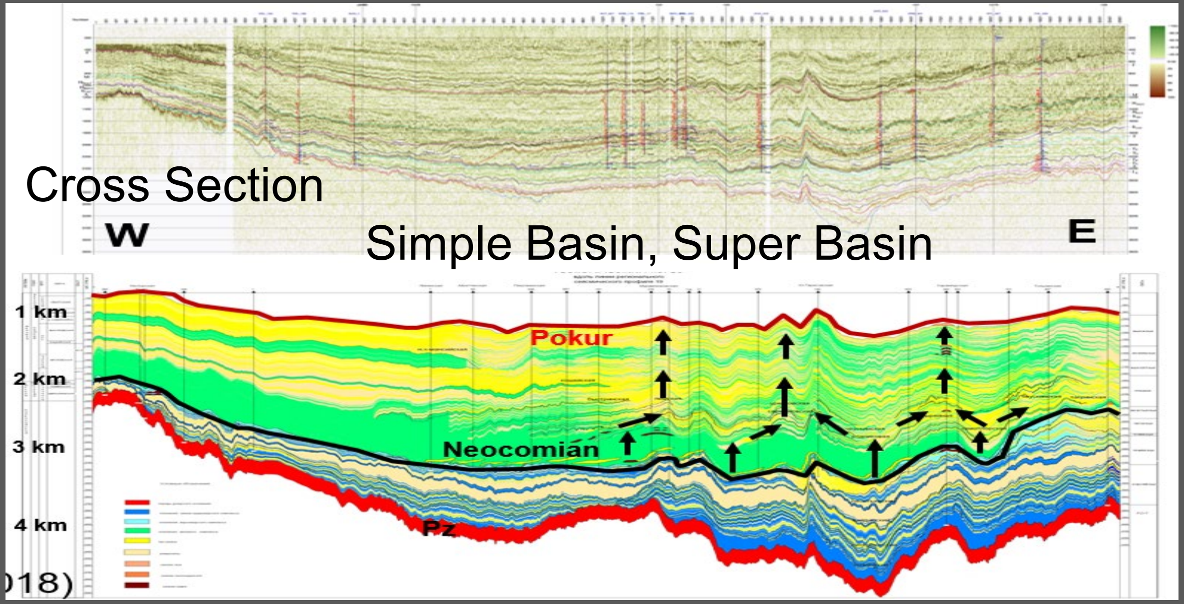
Argentina Neuquen Bains, Vaca Muerta



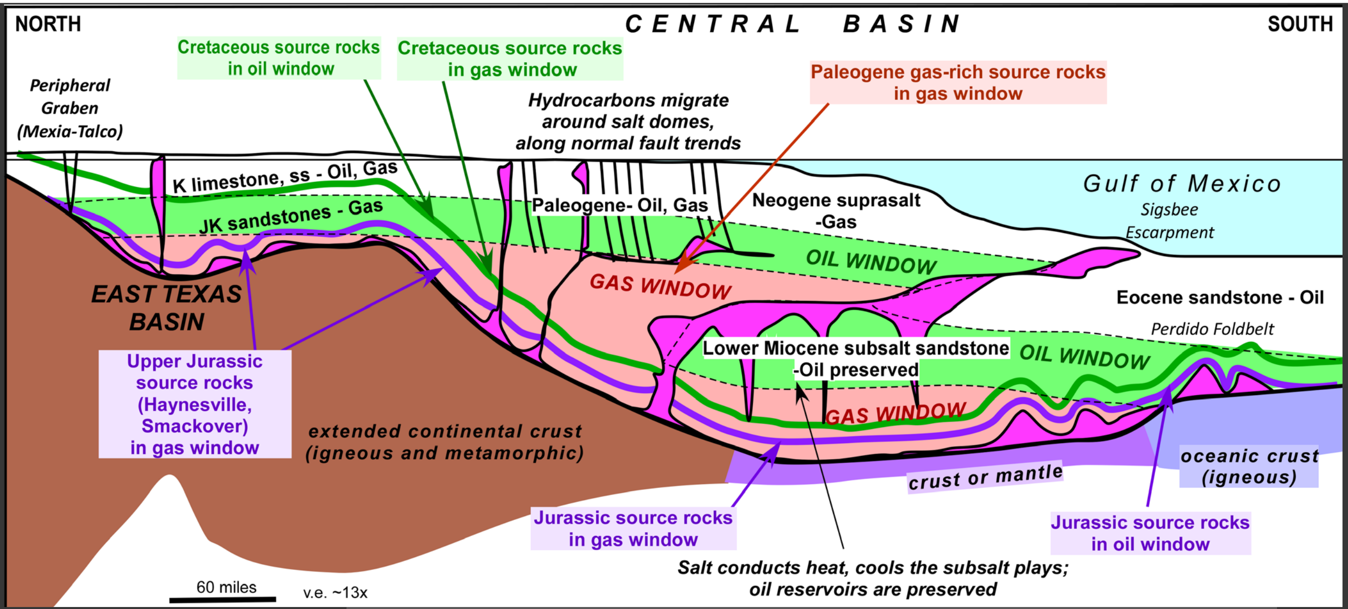


Russia, W. Siberian Basin

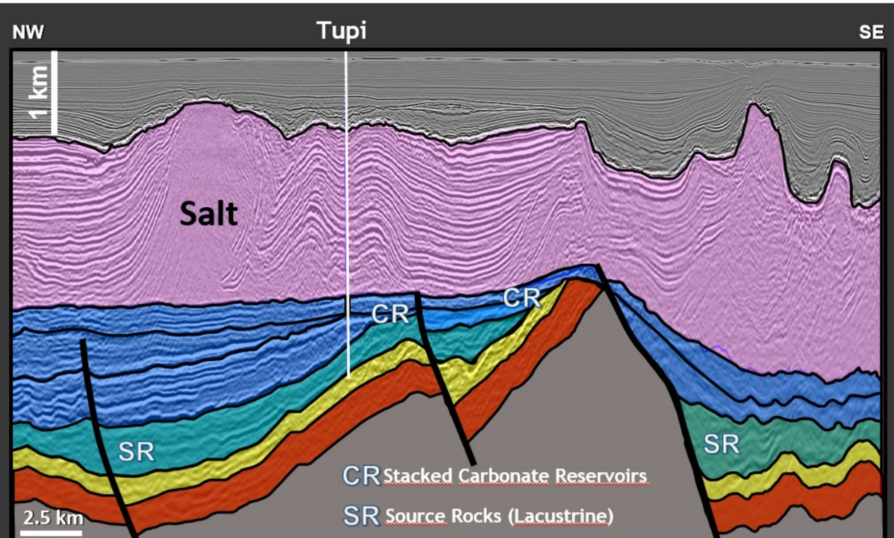




Gulf of Mexico–"super basin" prototype architecture, onshore, unconventional, and offshore conventional geology and geophysics



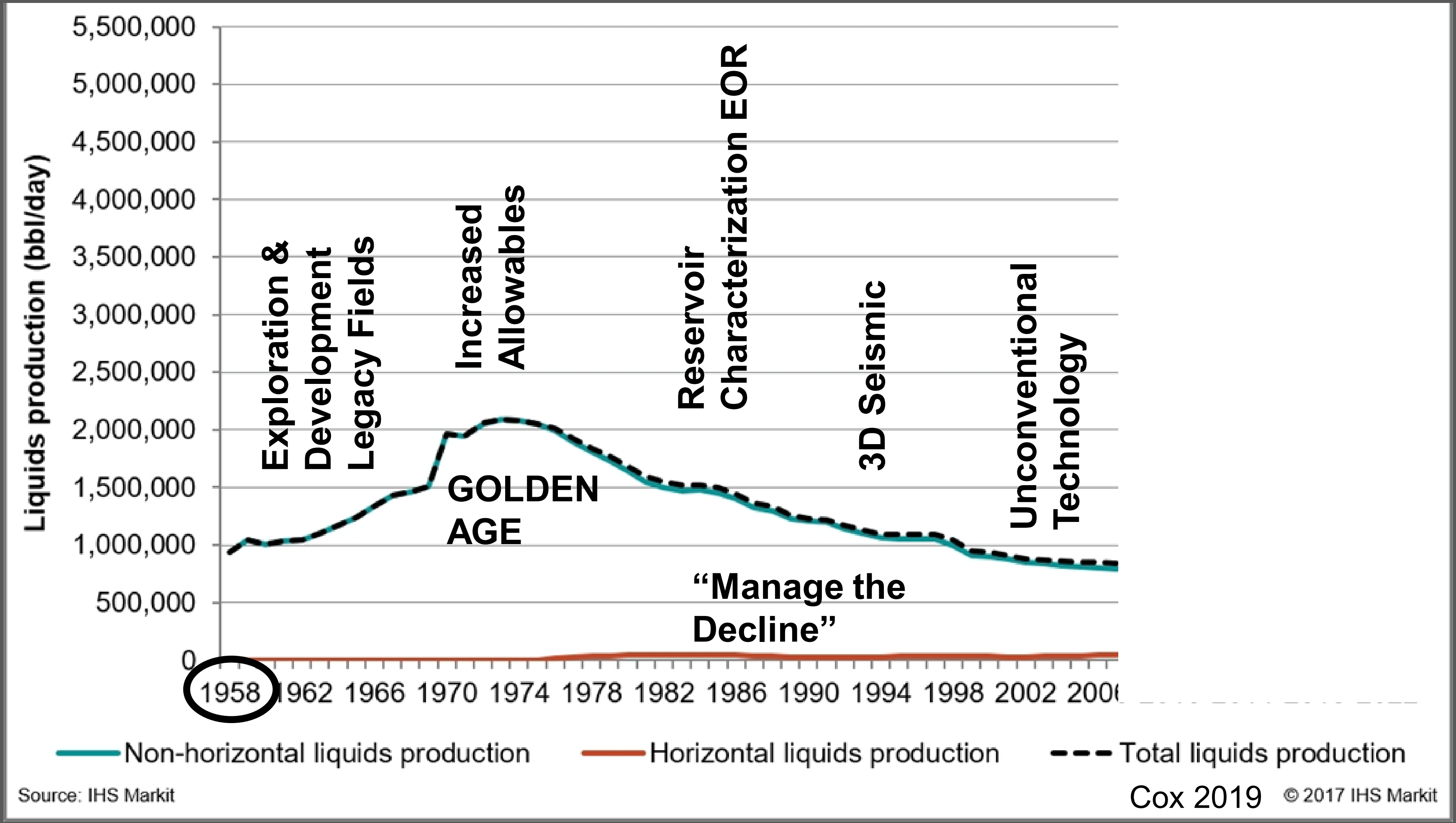
Brazil, Santos and Campos Basins Pre-Salt



1) Three main sources, two low in section (Jurassic, mid-Cretaceous)
2) Generation continuing at present
3) Repetition of oil window by salt nappe(s)
4) Strong vertical migration, no superseal; leaky basin

Courtesy Tom Ewing, 2018; Cindy Yielding 2018; Otaviano Pessoa 2018

Production Rejuvenation of “mature basin” Permian 1958 to 2019+



Back to the Future!

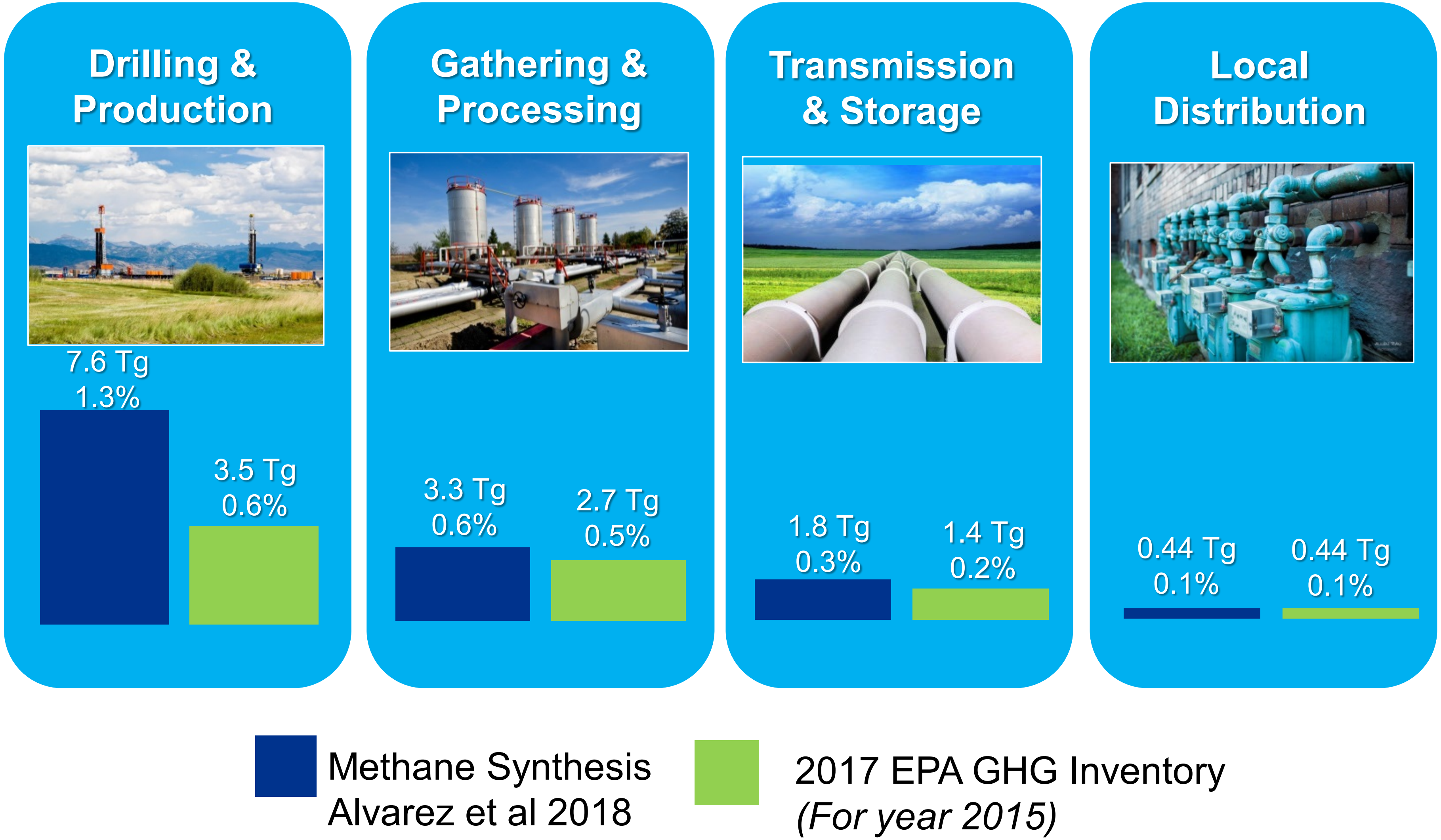
1) Be a part of the Energy Solution
2) Be a lifelong learner
3) Be proactive in professional organizations, say yes!

Oil and gas advocacy

Colin Leyden

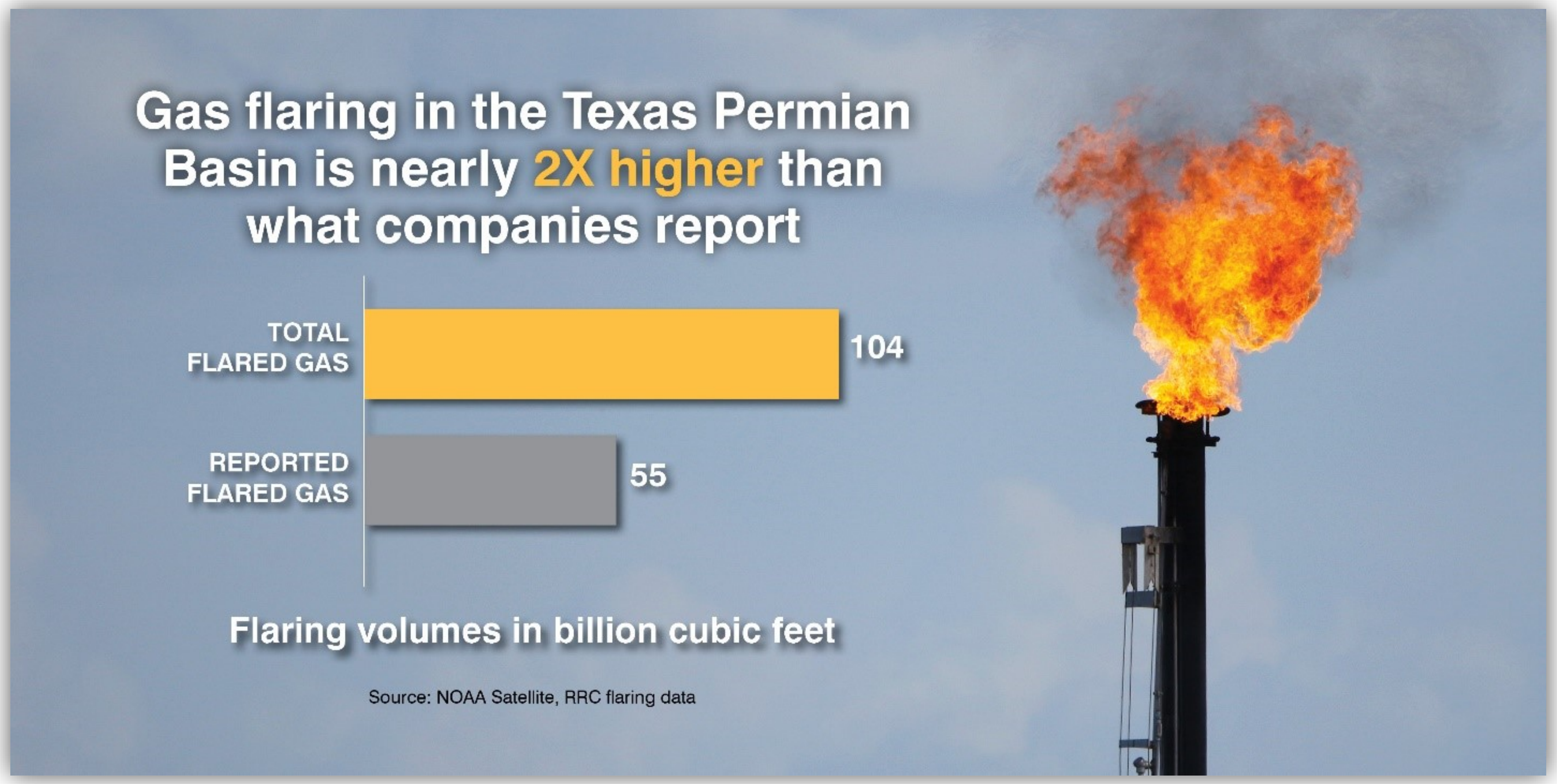
EDF ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

U.S. O&G Supply Chain
2015 Methane Emissions

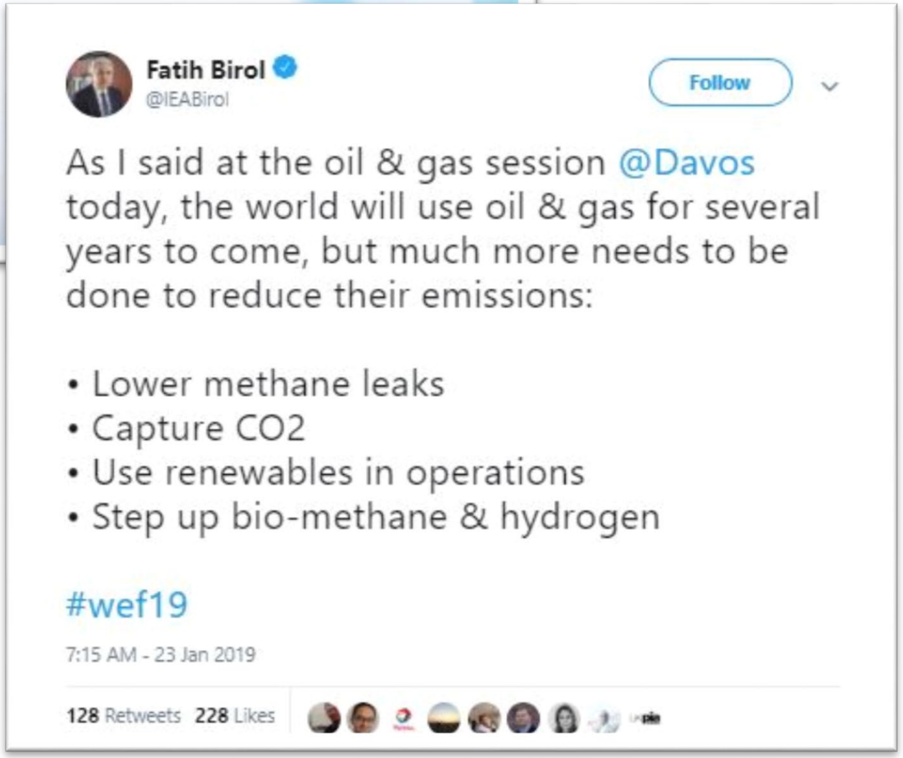


Flaring In Texas

- 4.4% of all Permian gas in 2017
- 1 Trillion cubic feet 2012-2017 statewide




iea
International
Energy Agency


Fatih Birol
@IEABirol
Follow
As I said at the oil & gas session @Davos today, the world will use oil & gas for several years to come, but much more needs to be done to reduce their emissions:
• Lower methane leaks
• Capture CO2
• Use renewables in operations
• Step up bio-methane & hydrogen
#wef19
7:15 AM - 23 Jan 2019
128 Retweets 228 Likes

Unconventional oil & gas development: environmental impacts

Sheila Olmstead
The University of Texas at Austin & Resources for the Future

Energy Week
February 5, 2019

U.S. unconventional production has generated significant benefits.

- Selected economic benefits of the boom in U.S. unconventional oil and gas production:
  - U.S. natural gas price dropped 47% compared to a counterfactual without new U.S. production, 2007-2013, generating $74 billion/year in benefits to U.S. consumers (Hausman and Kellogg 2015).
  - New oil and gas extraction increased aggregate US employment by up to 640,000, and decreased the unemployment rate by 0.43 during the Great Recession (Feyrer et al. 2017).
  - U.S. personal income increased *in 2014 alone* by $67 billion (0.5%) due to oil and gas royalty income (Brown et al. 2019).
  - Coal-to-gas switching in electricity generation (due to cheap gas) has reduced local air pollution concentrations, with associated health benefits of ~$17 billion/year (Johnsen et al. 2019).

What about environmental costs?

- Research has established links between fracking and local/regional air pollution, surface water pollution (Olmstead et al. 2012), groundwater contamination, greenhouse gas emissions , seismicity from waste disposal, increased accidents (Muehlenbachs et al. 2017), etc.

- Markets capitalize some risks:
  - In PA, groundwater-dependent homes within 1.5 km of a shale gas well lose 10-17% of their market value, relative to homes at the same distance that use municipal piped water (Muehlenbachs et al. 2015).
  - OK homes in seismically-active regions lose 3-5% of their market value at the onset of the earthquake boom from produced water injection (Metz et al. 2017).

- Which potential environmental costs from unconventional production are likely to be most significant, and what can communities, firms, and regulators do?