Weatherford

Trends in U.S. Shale Completions

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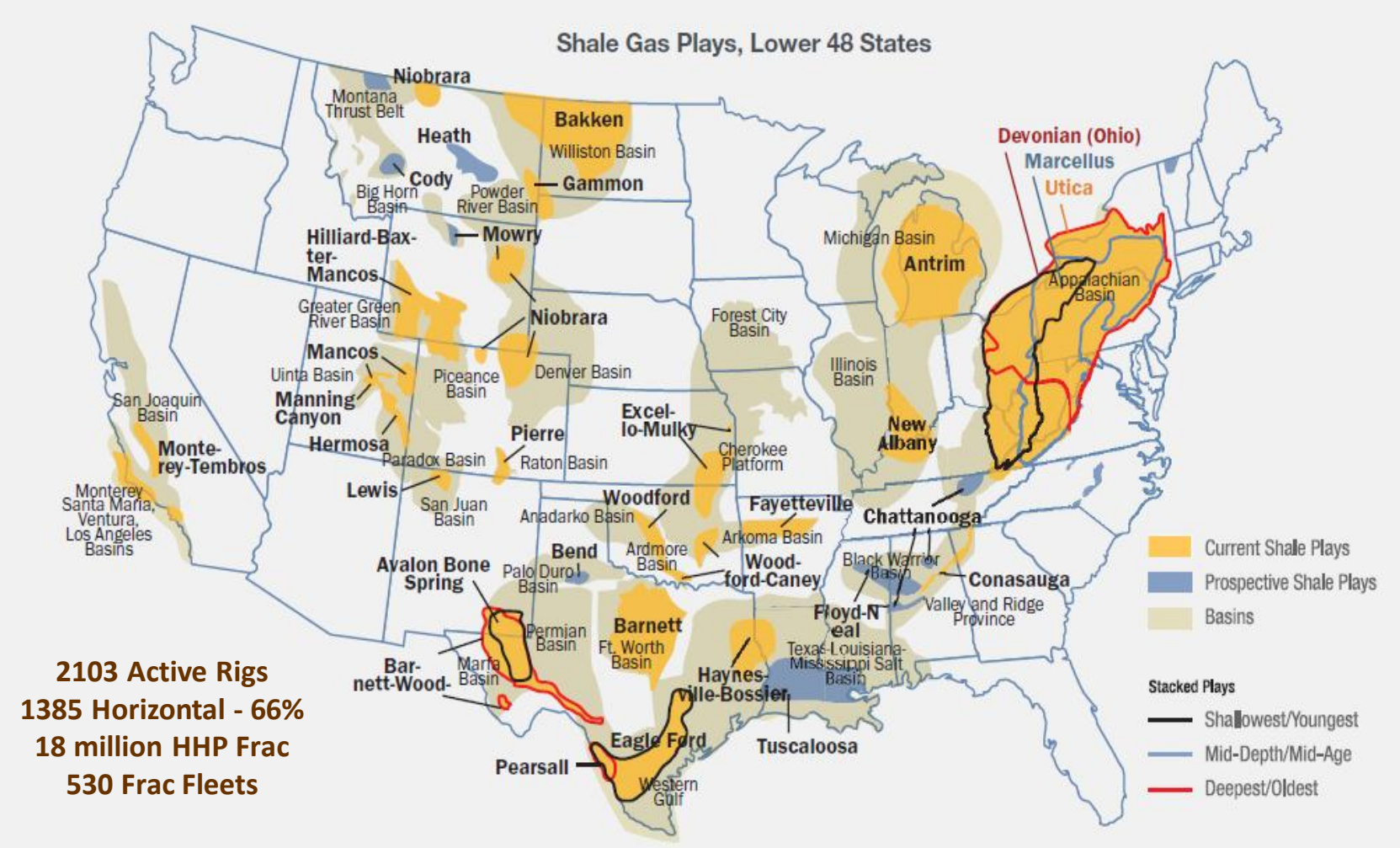
Eagle Ford – Burgos Basin Cross Border Development Conference

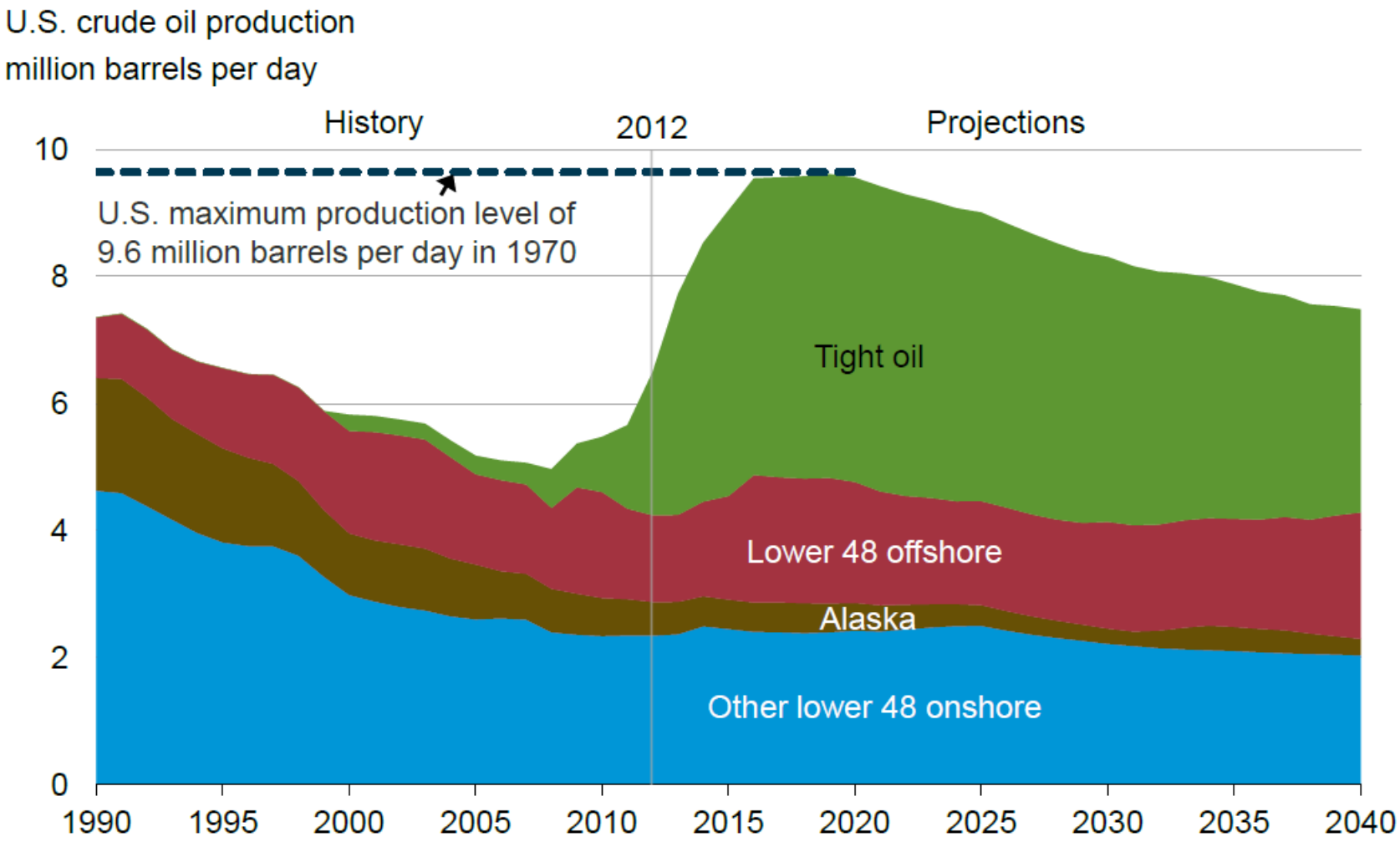
Outline:

1. U.S. Oil & Gas Production – Economic Impact of Shale
2. Enabling Technologies: Fracturing, Directional Drilling
3. Shale Completion Trends
4. Water Use in Completions
5. Water Treatment
6. Waterless Alternatives

U.S. Shale Oil & Gas Activity Map



U.S. Oil & Gas Shale Production



Source: EIA

Global Potential for Shale Oil & Gas

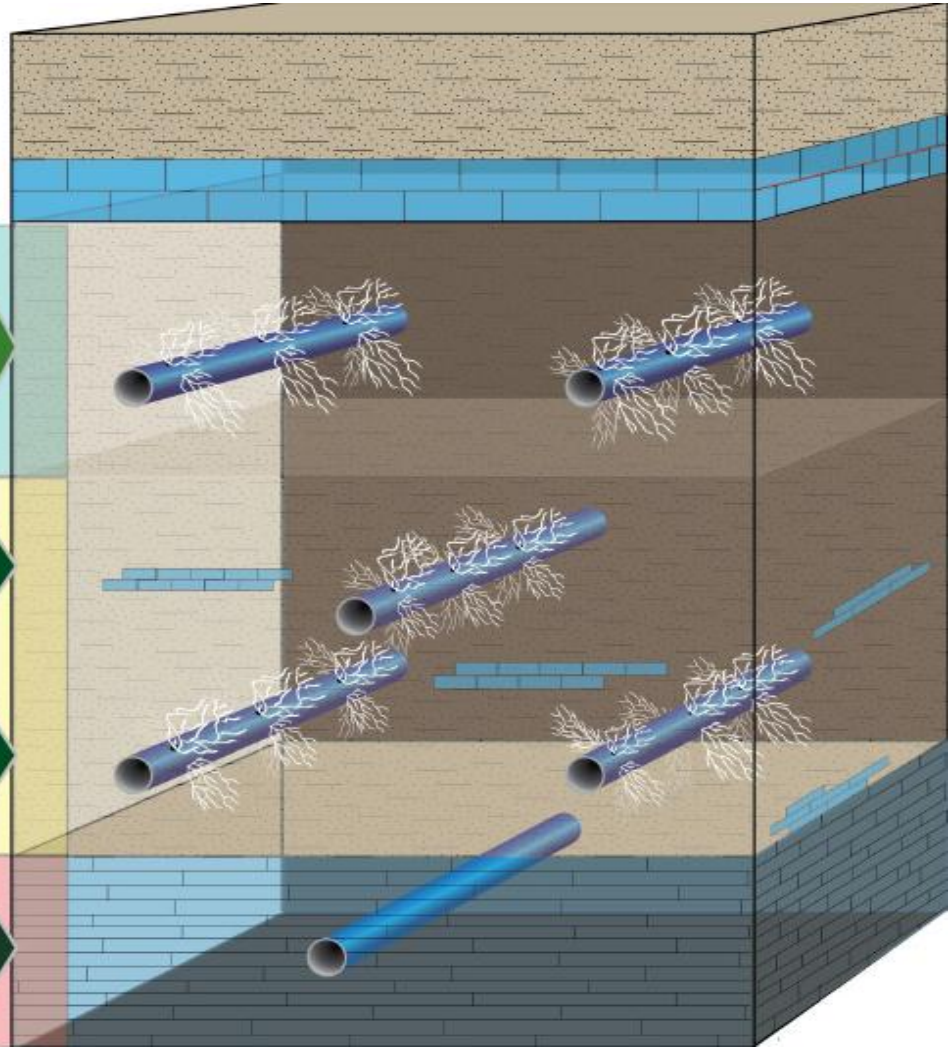
Shale oil		
rank	country	billion barrels
1	Russia	75
2	United States	58
3	China	32
4	Argentina	27
5	Libya	26
6	Venezuela	13
7	Mexico	13
8	Pakistan	9
9	Canada	9
10	Indonesia	8
	World total	**345**

Shale gas		
rank	country	trillion cubic feet
1	China	1,115
2	Argentina	802
3	Algeria	707
4	United States	665
5	Canada	573
6	Mexico	545
7	Australia	437
8	South Africa	390
9	Russia	285
10	Brazil	245
	World total	**7,299**

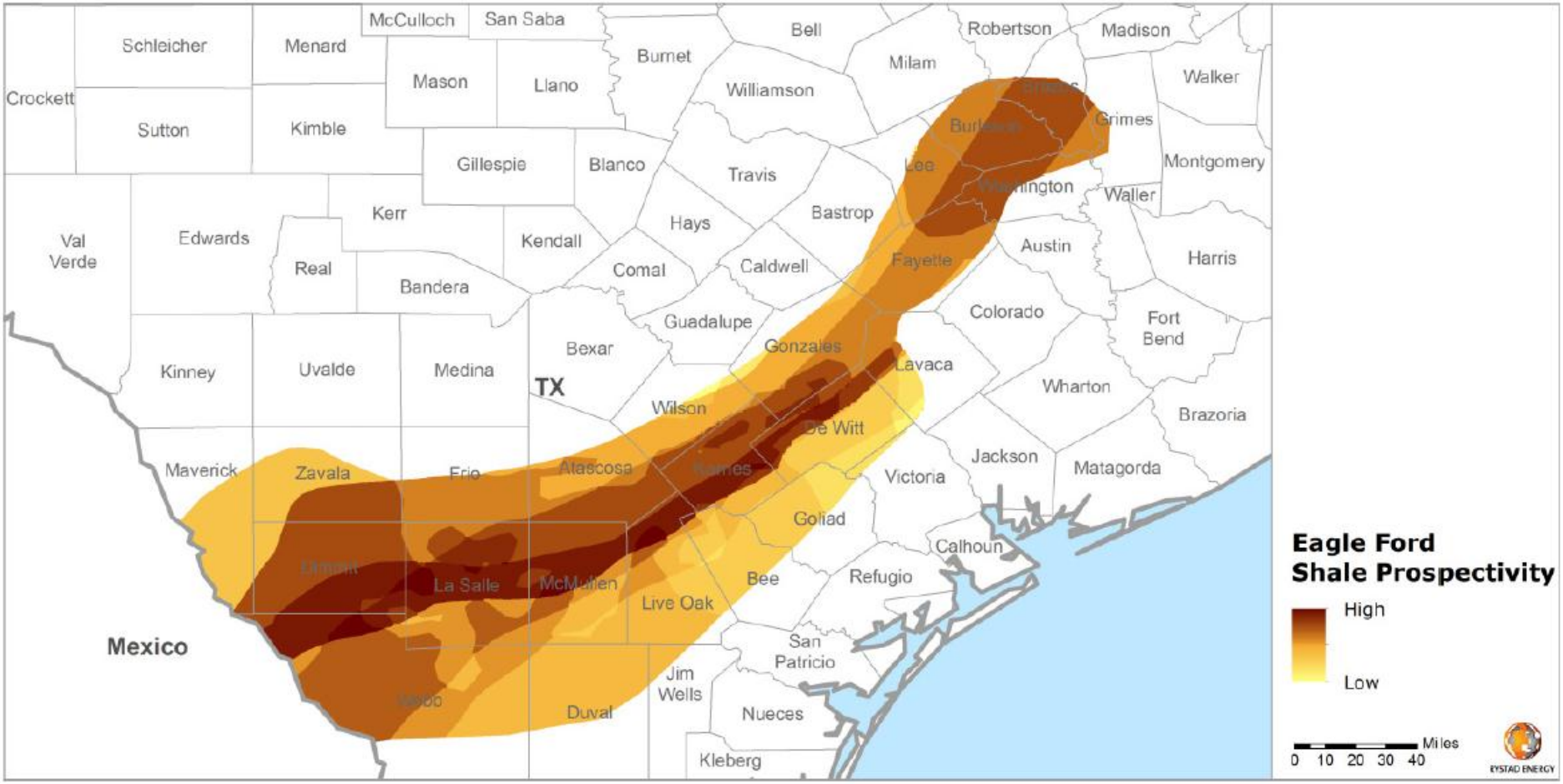
Source: EIA

The Eagle Ford Formation

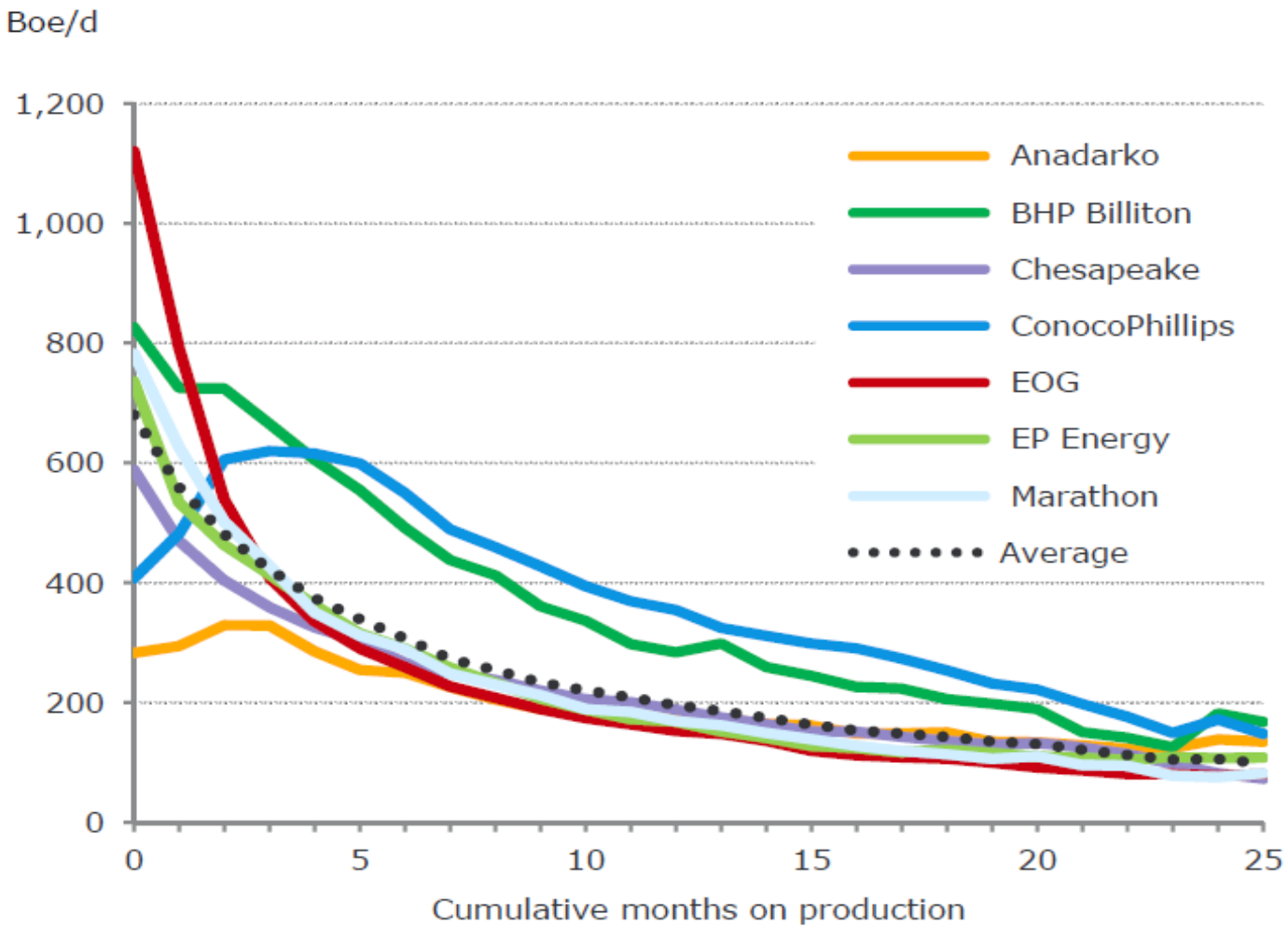
Marquis	Palmetto	Cotulla-Wycross	Cotulla-La Salle/Frio	Catarina	
✓	✓		✓	✓	Upper Eagle Ford
	✓	✓		✓	Lower Eagle Ford Target 1
✓	✓	✓	✓	✓	Lower Eagle Ford Target 2
✓	✓		✓	✓	Buda



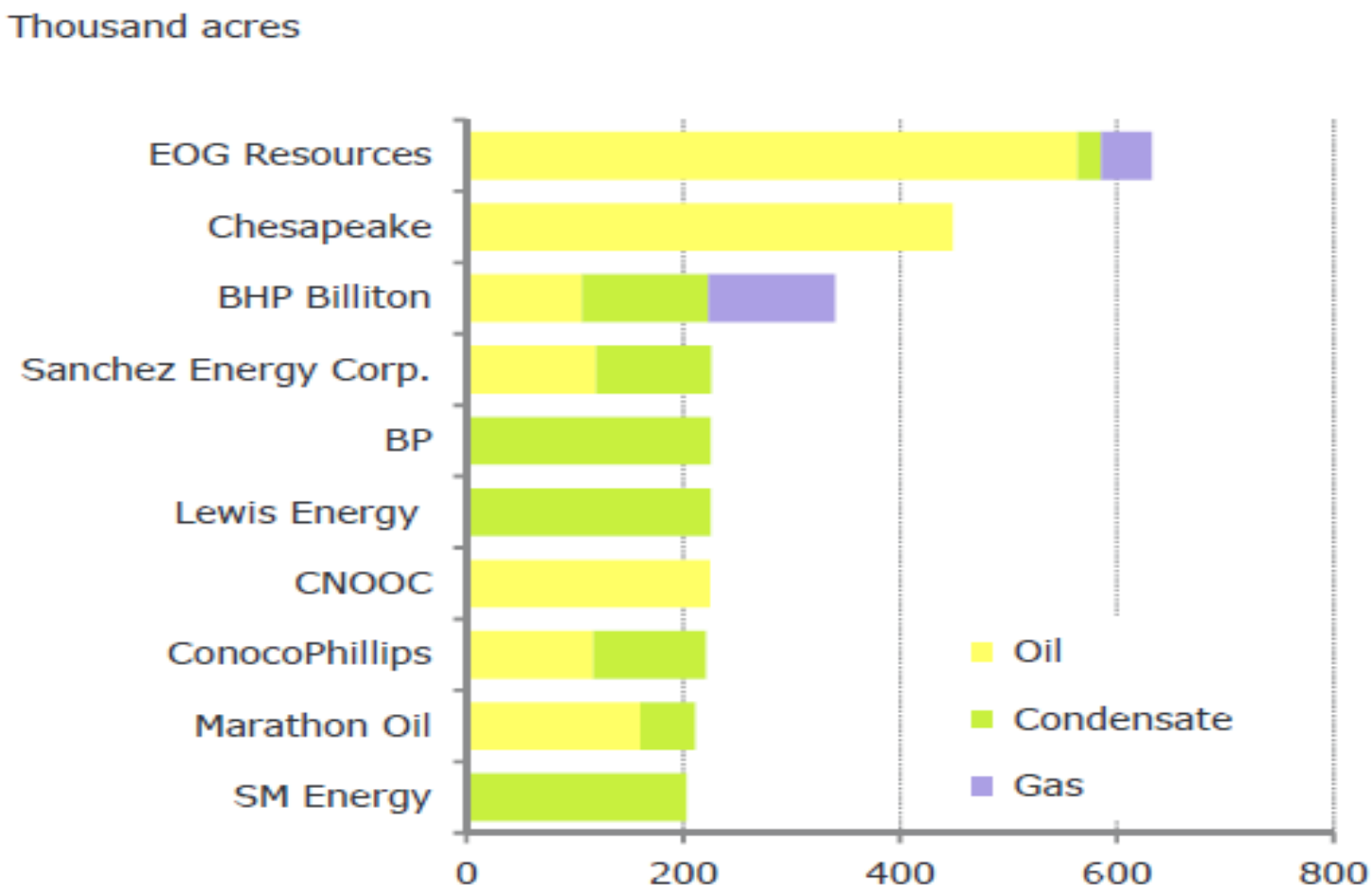
The Eagle Ford Formation in Texas



Eagle Ford Average Decline Rates



Oil & Gas Companies in the Eagle Ford



Typical Eagle Ford Hydraulic Fracturing Site

Trends in U.S. Completions; and Eagle Ford

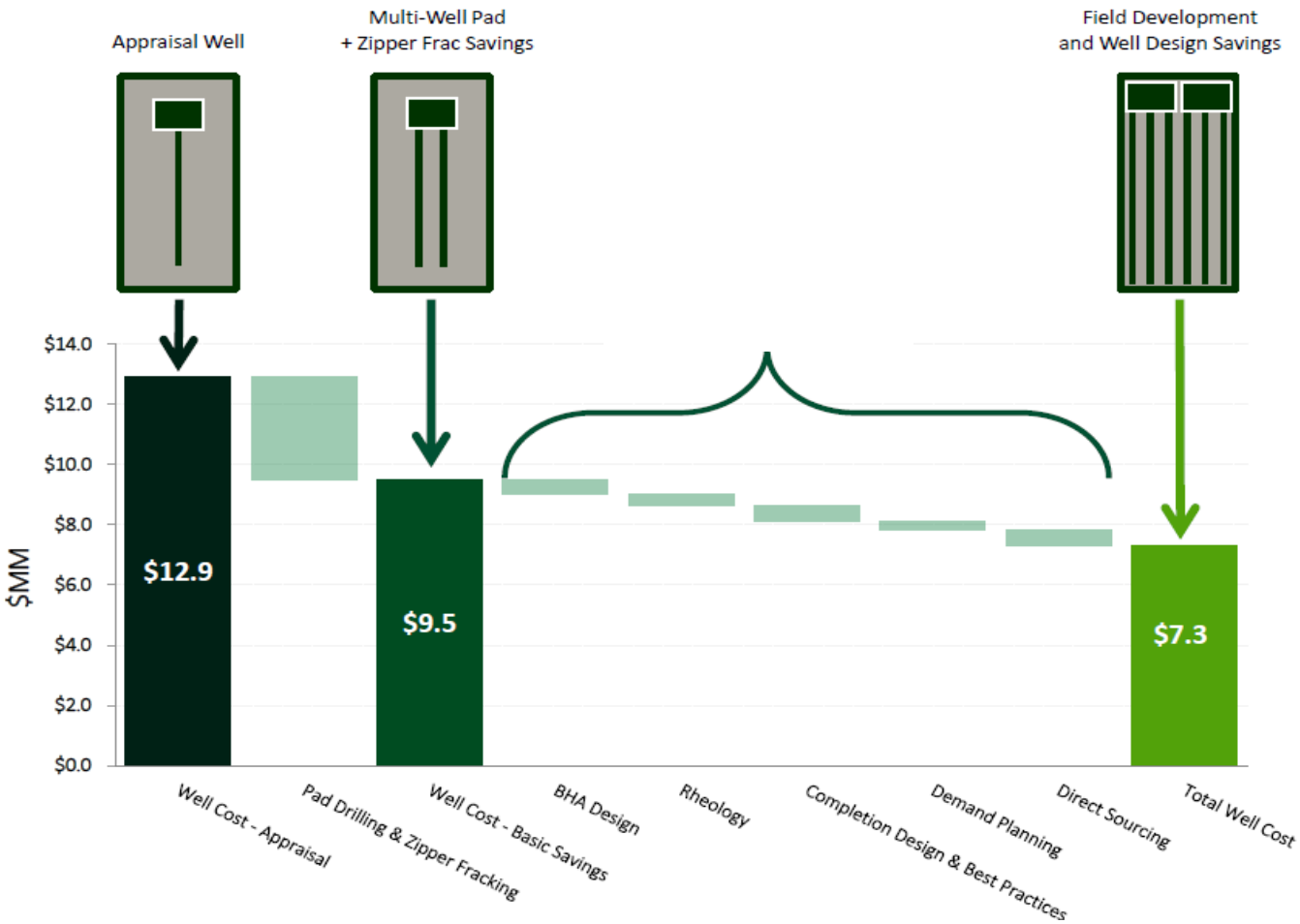
- **Lowering Costs by:**
  - ✓ **Zipper Fracturing on pad locations**
  - ✓ **Optimizing proppant logistics (rail, trans-loading, trucking)**
  - ✓ **Fuel substitution (CNG, LPG, line gas for diesel)**
  - ✓ **"Increased use of slickwater fluids**

- **Improving well production by:**
  - ✓ **"Engineered" completions using LWD to adjust plug/packer positions**
  - ✓ **Stacking lateral wellbores to reduce spacing in multi-pay basins**
  - ✓ **"Super-fracs" using significantly higher proppant (sand) amounts**
  - ✓ **Re-fracturing horizontal wells to offset decline**

- **Decreasing Environmental footprint:**
  - ✓ **Limiting freshwater use in fracturing**
  - ✓ **Recycle and use of produced/flowback waters for fracturing**
  - ✓ **Reducing gas in air, sound emissions while fracturing**

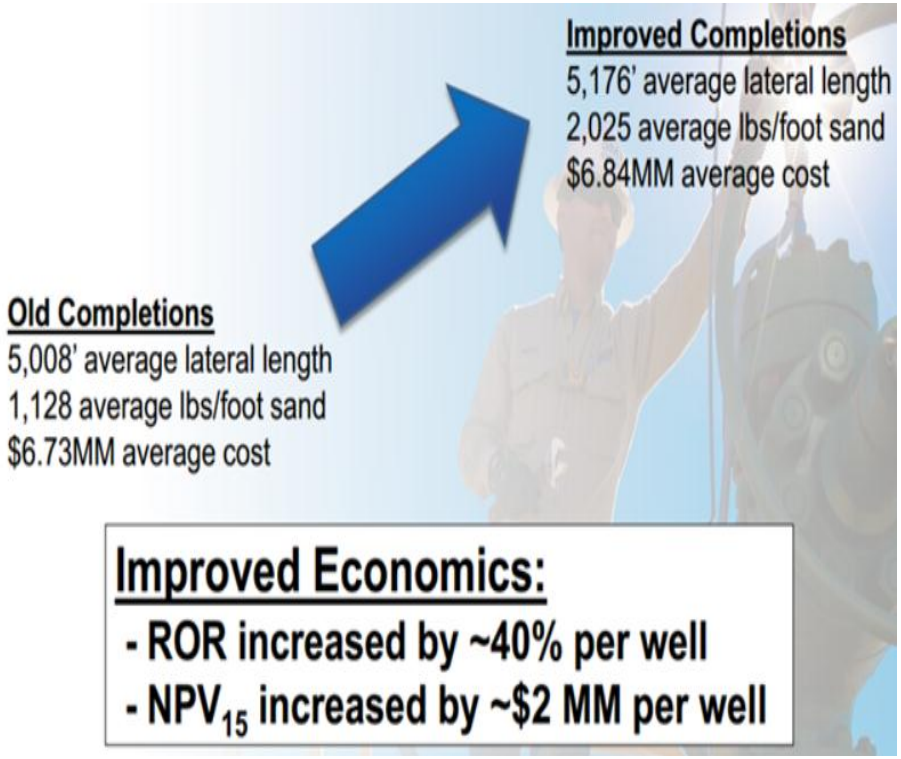
Lowering Completion Cost

Pads drilling lowers drilling and completion costs



Lowering Completion Cost

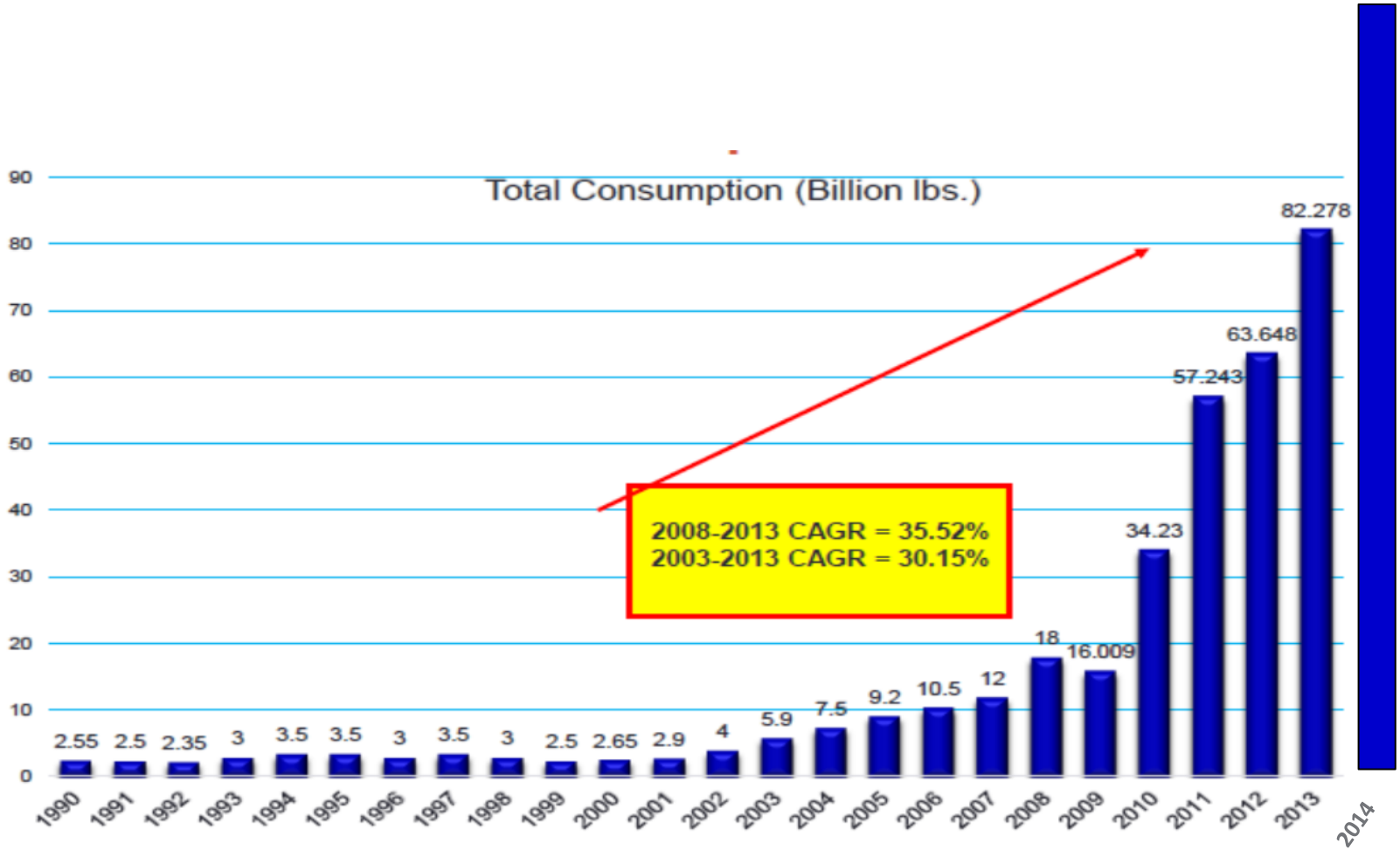
Increased sand use improves (EUR/NPV)



Maximizing sand rail transfer lowers cost

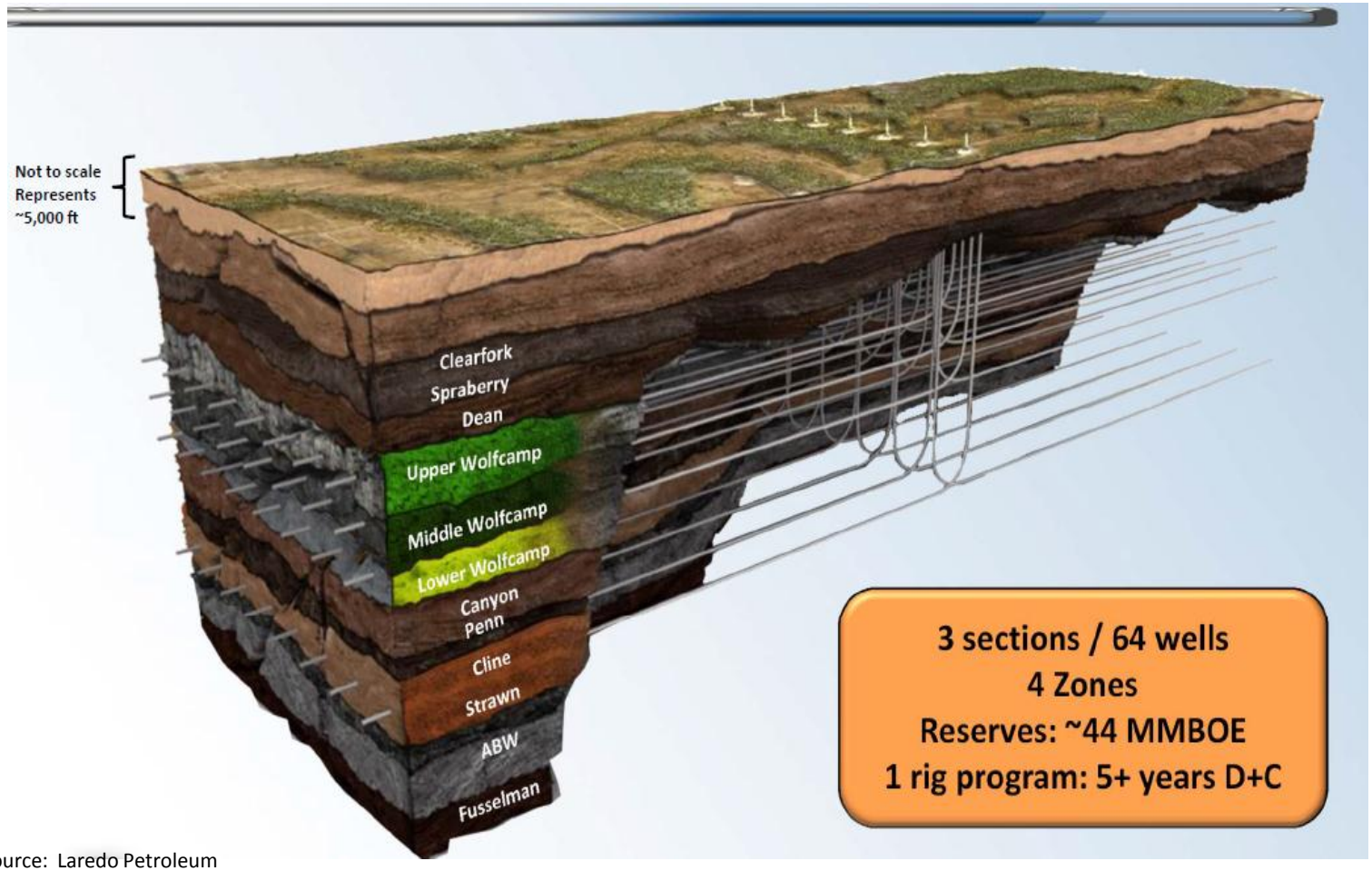
Minimizing sand truck transfer lowers cost

2014 Frac Sand Usage - 50% growth



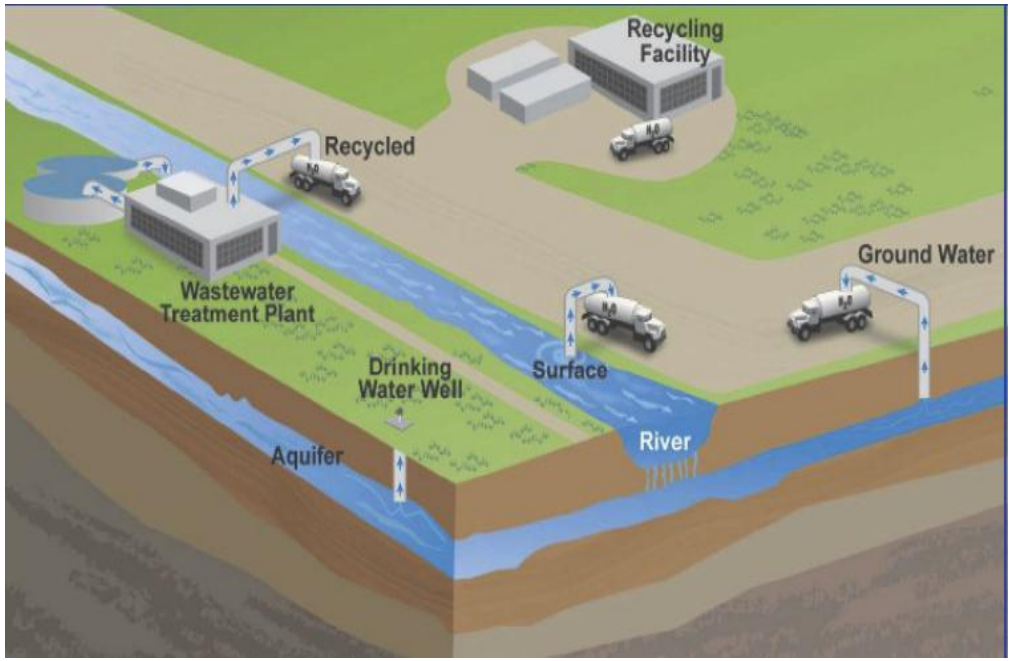
Lowering Completion Cost

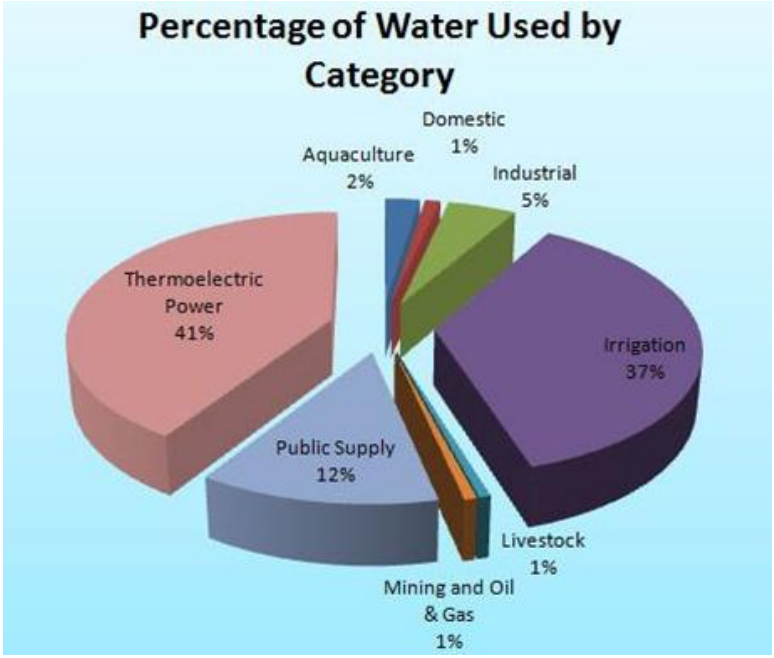
Stacking and staggering horizontal wells lowers cost



Source: Laredo Petroleum

Lowering Environmental Footprint





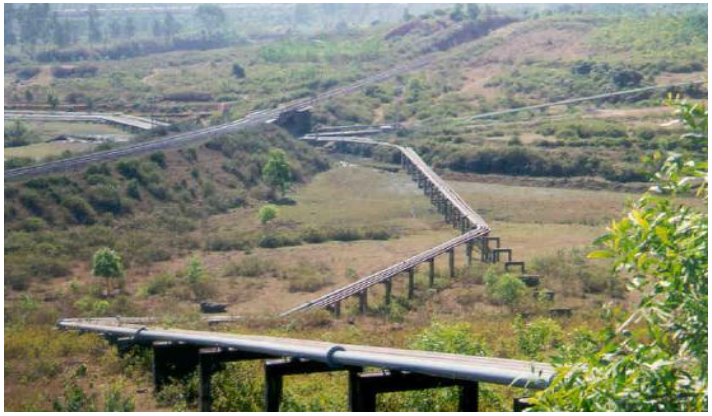
Small in comparison to other water users the oil & gas industry struggles to secure a "social license" to use water on a large scale

Lowering Environmental Footprint

Source: Ceres – Hydraulic Fracturing & Water Stress

Industry's Approach to Produced Water

- Increase use of produced water in fracturing
- Develop fluids that use high salinity water with minimal treatment OR without any treatment
- Develop chemistries to mitigate the effect of interfering ions
- Lower amount of water disposal
- Reduce trucking cost and number of trucks on roads
- Explore novel approaches to moving sand and water – possibly as slurry



Lowering Environmental Footprint

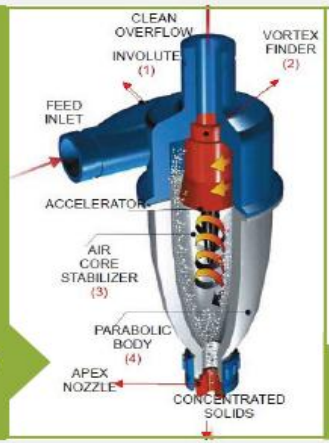
1.Chemicals

2.Ozone Oxidation

5. Deionization

3. Nano-filtration

4. Hydrocyclones



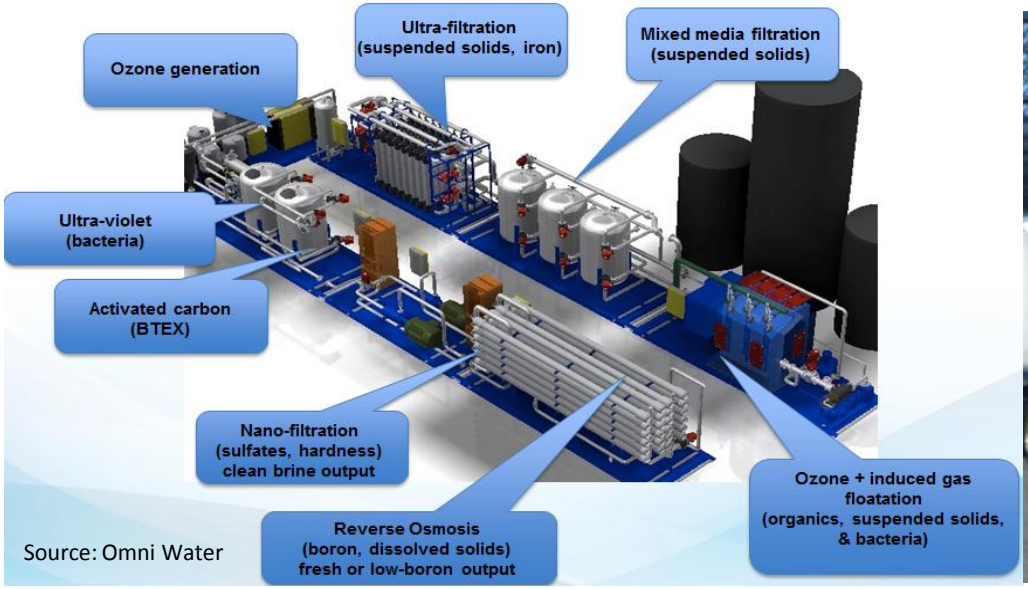
6. UV

MVR Evaporator, RO, EC…and many more

Source: Apache Corporation

Treatment of Produced/Flowback Water

10,000 barrels/day modular unit



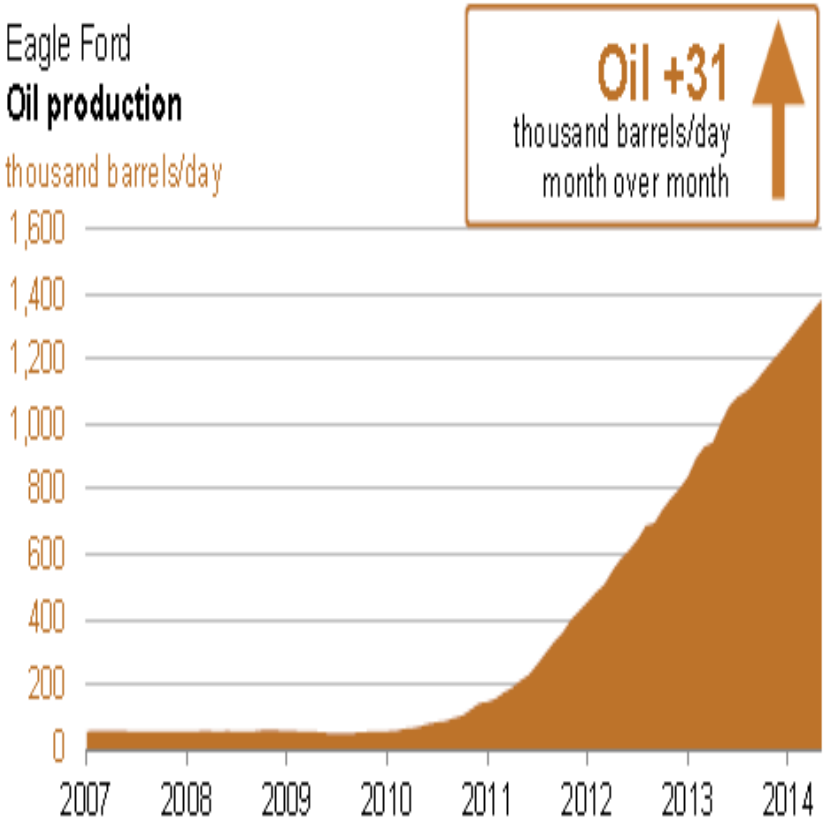
Source: Omni Water

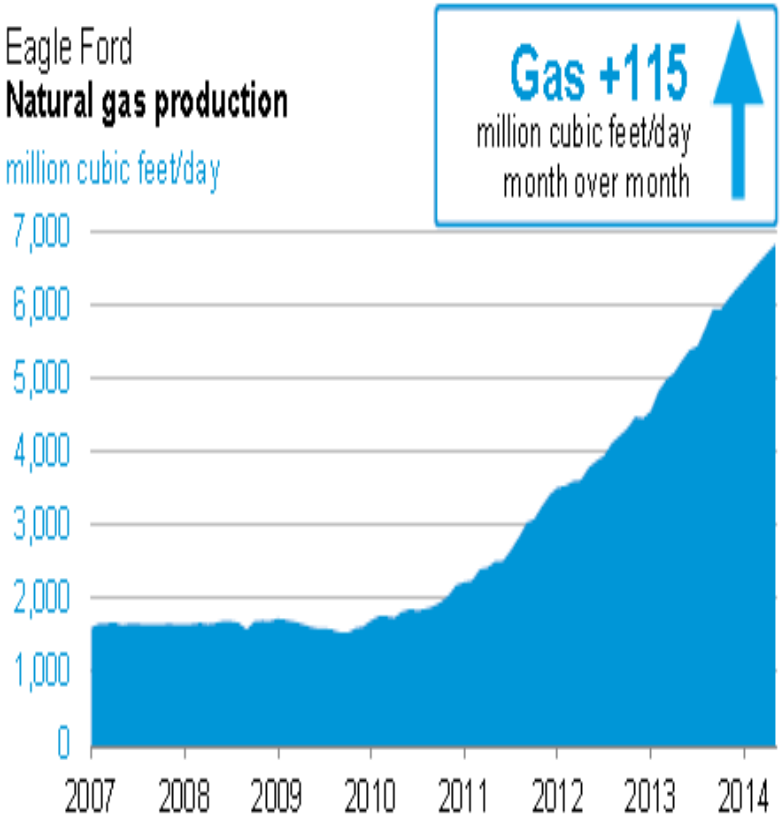
2500 barrels/day truck mounted unit

Source: Omni Water

Modular Unit	Function
DAF Module	Clarifies water to 15 micron range
Ozone Module	Oxidizes polymers, kills bacteria
Mixed Media Module	Clarifies water to 5 micron range
Ultra Filtration Module	Clarifies water to sub-micron range
Nano Module	Reduces hardness, sulfates
RO Module	Reduces boron, TDS

Success Can Happen Quickly





Thank You, Gracias