Unconventional Crude Oil: New Sources of Supply

ASPO USA 2012 Conference November 30 – December 1, 2012 Austin, Texas

Laura K. Atkins Director of Petroleum Research Hart Energy Research

"Crude" Outline

- Heavy Crude Oil

 Conventional
 Unconventional

 Shale/Tight Oil
- Costs/economics
- Conclusions

Heavy Oil and Bitumen Resources



Heavy Crude Outlook by Region



New Heavy Oil Developments

Project	Incremental Capacity 2011 - 2020	Incremental Capacity 2020 to 2030
Canadian Oil Sands	1,695	1,316
US tar Sands	29	
Venezuelan Orinoco Belt	1,569	1,199
Colombia HO Development	126	
Ecuador Pungarayacu	30	30
Ecuador ITT		80
China New Disc.&Tar Sands		400
Angola Offshore HCO	258	
Madagascar Tsimiroro & Bemolanga	153	177
Congo Tchikatanga-Makola Bitumen		30
UK North Sea Undeveloped HO Fields	135	
Russia Tatarstan Bitumen	30	20
Kuwait Northern Heavy Oil Fields	200	
Iran Azadegan and Ferdows Fields	324	
Iraq Heavy Oil	740	
Total	5,289	3,251

North American Shale/Tight Oil & Condensate Forecast by Play



Source: Rystad Energy

28 billion barrels produced by 2030

Bakken Power Law Decline Example

Well API Number 3310501643 Williams County North Dakota



qi = 2,303 boe/day EUR = 164,000 BOE Di = -0.85 N = .23 D₀₀ = -.00002

Barnett Shale History and Forecast using Power Law Decline Curves





Some Bakken Wells Exhibit a Harmonic Decline Curve



Well: API No. 3310501607 Williams County North Dakota

qi = 93 b/d Di = .00224 b/d/d b = 1.0

Typical Bakken Hyperbolic Decline Curve (Continental Resources)



Source: Rystad Energy

Bakken Well Economics

		Average 1st Year				
Well	Well Cost \$mm	Oil Rate b/d	Average GOR	EUR (mbbl)	IRR	NPV _{7.5} \$mm
1	7.0	110	379	127	4%	(\$0.87)
2	8.7	226	421	168	7%	(\$0.09)
3	6.9	66	2,331	122	3%	(\$1.32)
4	7.0	311	1,170	216	31%	\$2.80
5	6.5	1563	215	215	18%	\$1.93
6	8.7	626	1,058	419	66%	\$7.00
7	7.0	203	1,859	526	29%	\$4.91
8	6.0	441	729	601	87%	\$10.91

Oil Price: \$90.00 per Barrel Natural gas Price: \$3:00 per MCF

Bakken Breakeven Oil Prices



Well Capex \$5 to \$10.3 million 1st Month Rate 400 to 1000 BOE/D Red well: 600 BOE/D, \$10.3 million Capex

Development Costs of New Sources of Crude Oil

Country	Project	Initial Investment (US\$ Million)	Initial Reserves (Million Barrels)	\$ per Barrel
Canada	Oil Sands Athabasca In-Situ	\$1,773	190	9.33
Canada	Mining Projects	\$9,250	722	12.81
Canada	Mine + Upgrader	\$11,900	671	17.74
Venezuela	Orinoco Belt Average	\$23,557	1,767	14.00
Congo	Tchikatanga-Makolas	\$4,290	150	28.60
United States	Nikaitchuq Offshore Alaska	\$2,000	220	9.09
U.K. North Sea	Mariner and Bressay	\$10,700	600	17.83
Iran	South Azadegan	\$2,000	1,640	1.22
Saudi Arabia	Manifa	\$11,000	10,000	1.10
Brazil	Papa Terra	\$5,200	380	13.68
Brazil	Pre-Salt	\$250,000	14,300	17.48
United States	Bakken Ave. Shale Oil Well	\$8.24	470	17.54
United States	Permian Ave. Shale Oil Well	\$4.56	318	14.34

"Cheap" oil still available in the Middle East

Sources: Company annual reports, press releases, Hart/Rystad North American Shale Quarterly

What About the Rest of the World? Technology Transfer from North America

- There are 136 E&P companies with lease positions in non-North American plays, according to our July 15th count.
- 26 non-North American E&P companies have bought into NA plays to acquire technological knowledge/expertise/ hydrocarbon supply.
- 28 North American E&Ps and global majors have acquired shale leases outside of the region.

HARTENERGYARTENERGY



Technology Transfer -- \$\$\$ (Tremendous influx of funds even during the great recession)



Source: KPMG & Hart Energy A&D Center

HARTENERGYARTENERGY

Global Oil Supply by Type



Major new sources of crude oil: Iraq, Brazil pre-salt, Unconventional heavy oil, Shale/tight oil, Condensate & NGL from LNG developments and shale gas

Forecast has no shale or tight oil outside North America.

The Future ain't what it used to be

- Yogi Berra

- Canadian oil sands and other unconventional heavy oil production will contribute an incremental 6 million b/d by 2030
- Shale and tight oil in North America will add nearly 4 million b/d incremental production between 2011 and 2030
- Global development of shale resources could contribute even more production
- Light and medium crude oil from Brazil and Iraq will help mitigate decline in this category
- Most of these sources of crude oil are economic at today's crude price
- Demand growth has slowed and may slow further as energy efficiency improves and price increases
- But, supply interruptions are always possible
 - Political instability in oil producing countries
 - Wars, etc.

Hart Energy Research

THANK YOU

Laura Atkins Director of Petroleum Research Hart Energy +1 713.260.6476 latkins@hartenergy.com

Crude Oil Infrastructure Bottlenecks in N. America Caused by Huge Increase in Shale Oil Production

Canadian Oilsands Production being shipped to the US by rail.







Differentials with a Distinction ...

Distinctly new crude pricing regime emerges due to misalignment of new oil supply seeking access to legacy refiners



Shale & Tight Resource Advantages

Shale Gas – Lower Fuel Costs for Energy-Intensive Refining



U.S. average refiner consumes 0.43 mmBTU Natural Gas per crude barrel
 U.S. Refiners currently have ~\$6.45/bbl advantage over like Asian competitors

Condensate and NGL Barrels to the US Gulf Coast



Sources: Hart Energy HCO, Hart Energy/Rystad Energy NASQ

Major Sources of NGL



Sources: Hart Energy/Rystad Energy NASQ, Rystad Ucube

Major Sources of Condensate: (It's not just from shale plays)



Sources: Hart Energy HCO, Hart Energy/Rystad Energy NASQ, Rystad Ucube

HARTENERGY

Shale Liquids Production in the US and Canada will Displace Most Light Crude Imports to North America



Source: Hart Energy/Rystad Energy North American Shale Quarterly



Shale Wells Can Produce for a Long Time

Upper Bakken Shale Well Morgan Draw 21-19H



Hart Energy Global Heavy Crude Oil Forecast

- Field-level forecast of production to 2035 for most regions
- Updated annually
- "Conventional" heavy oil with API gravities 10° to 22°
- "Unconventional" Heavy Oil below 10° API gravity
 - Mostly Canadian Oil Sands and Venezuelan Orinoco Crude
 - Also found in Africa, China, Russia, Colombia, Ecuador