Overview

- What is Unconventional Oil?
- The dramatic change in North American Crude Production
  - Shale Oil in the US
  - Oil Sands in Canada
- The Importance of Logistics
  - Why does rail matter?
- Concluding Thoughts
Shale Oil in the United States
Shale oil, also known as tight oil, is light crude oil contained in relatively low porosity and permeability petroleum-bearing formations called shales.

Percentage of pore volume (void space) in tight oil is commonly less than 10%.

Oil contained in these formations will not flow to the wellbore at economic rates without assistance from technologically advanced drilling processes.

Over 20 Shale Oil plays exist.

Bakken & Eagle Ford are most advanced.
Shale Oil & Gas Extraction Technology

- **Horizontal drilling**
  - First drilled vertically to a predetermined depth, typically 3000-10,000 ft
  - Well is then “kicked off” (turned) at an increasing angle until it runs horizontally
  - Then drilled horizontally an additional 10,000-15,000 ft

- **Hydraulic Fracturing (Fracking)**
  - Water and additives are pumped at high pressure into the wellbore creating fractures in the reservoir
  - Sand or proppants (ceramic beads) are pumped into the fissures to hold them open
  - The wellbore can begin pumping oil

Source: Maugeri, Leonardo: "Oil: The Next Revolution"
US Production Renaissance

Source: EIA

US Crude Oil Production

ND Oil Production (b/d)

Sept. 2012 Production = 728,500 b/d

Alaska
California

US crude oil production has increased sharply since 2008

EIA
Canadian Oil Sands
What are oil sands?

- Oil sands are a type of unconventional petroleum deposit
- Loose sand or consolidated sandstone saturated with a dense and extremely viscous form of petroleum known as **bitumen**
- Sands are typically 130-200 feet deep on top of flat limestone

- In Canada, reserves are estimated at 175 billion barrels
- 80% expected to be “in-situ” recovery, 20% mined
Oil Sands Mining

1. **DIG**
   - Oil sand is scooped out of a giant mine and deposited onto massive, 400-ton trucks.

2. **CRUSH & MOVE**
   - Bitumen-rich sand is ground in an ore preparation plant before being sent by pipeline to the primary extraction plant.

3. **EXTRACT**
   - During the primary extraction process, the oil sand is placed in a giant tank where raw bitumen is separated from sand and water.

4. **DILUTE**
   - Bitumen is mixed with naphtha, a chemical solvent, to remove remaining minerals and water.

5. **UPGRADE**
   - To create synthetic crude oil, the bitumen is heated to 900 degrees in giant furnaces, a process that removes excess carbon. Hydrogen is added to prepare it for industrial use.

Source: Suncor
Steam Assisted Gravity Drainage (SAGD)

1. Steam injected and rises, producing heat
2. Hot bitumen drops down
3. Hot bitumen emulsion produced from lower well
4. Bitumen and hot water separated at surface; dilbit sold, water cleaned and recycled

Source: RRResearch
Typical Yields – CN Heavy vs. Bakken

Canadian Heavy Yields

- Vacuum Residue, 32%
- Vacuum Gas Oil, 29%
- Naphtha C5, 14%
- Kerosene, 11%
- Diesel, 12%
- Light Ends C1-C5, 2%

Bakken Blend Yields

- Vacuum Gas Oil, 26%
- Naphtha C5, 36%
- Diesel, 14%
- Kerosene, 15%
- Vacuum Residue, 5%
- Light Ends C1-C5, 4%
Changes in North American Crude Logistics
US Shale & Canadian Growth Forecasts
Largest production growth occurs in the Western Hemisphere

**Figure 2:** Country-by-country evolution of oil production capacity to 2020
(*First 23 countries*)

Resulting in a Fundamental Shift in Global Crude Flows
Crude Pipeline Expansions
Rail infrastructure growth has been explosive

- Rail has filled the gap in pipeline infrastructure
- Rail has lower upfront costs, faster execution
- Comes with higher long-term variable cost
Some Key Thoughts and Questions

Concluding Thoughts:

- North American production is here to stay
- The global balance of crude has changed
- “Energy Self Reliance” – moving from fantasy to reality, but inevitably linked to the global market

Questions for the Future:

- Will the price of crude rise, hold or fall?
- Will logistics keep pace with production?
- What will be the global geopolitical responses?
Questions?