Tight Oil and The Willing Suspension of Disbelief

College of the Coast & Environment
Louisiana State University    November 22, 2019
Any movement, activity or event in nature requires energy.

Human society runs on energy:
- Work requires energy—joules/calories.
- Subsistence: energy intake = energy expenditure.
- Surplus: energy intake > energy expenditure.
- If I accumulate excess energy such as grain, I may choose to have you do some of my work in exchange for some of that energy.

Money is a call on work:
- Today, most work is done by oil, natural gas and coal.
- 1 barrel of oil contains about 4.5 years of human manual labor.

“Energy is and always will be the currency of life”
-Nate Hagens
Energy is the Economy

For now, that means oil, natural gas and coal

- Petroleum: 36.5%
- Natural Gas: 30.6%
- Coal: 13.1%
- Nuclear: 8.3%
- Wind: 2.5%
- Solar: 0.9%
- Biomass: 5.1%
- Hydro: 2.7%
- CO2: 2.8%
- Solar: 0.9%
- Wind: 2.5%
- Biomass: 5.1%
- Hydro: 2.7%
- Energy is the Economy

Source: EIA & Labyrinth Consulting Services, Inc. Table_1.3_Primary_Energy_Consumption_by_Source
The End of Cheap Oil
Low, stable oil prices ended in 1973
Higher oil prices have been a key factor in the global economy ever since
*All values in October 2019 dollars*

- Iran Revolution & War with Iraq 1980
- OPEC Oil Embargo, Oct 1973
- 1st Gulf War 1990
- End Bretton Woods Aug 71
- Financial Collapse 2007-2009
- Arab Spring 2011-12
- Asian Financial Crisis 1998

Source: EIA, Federal Reserve Bank & Labyrinth Consulting Services, Inc.

Oil & Gas General/CPI-Adj WTI Oil Price GT $90
World liquids production growth stopped in the early 2000s
Oil price increased from $35 in 2003 to $155/barrel in 2008
Massive global investment in exploration & production until 2014

Source: EIA STEO & Labyrinth Consulting Services, Inc.
2014-16 oil price collapse caused by over-supply of tight oil, deep water oil and oil sands

Unconventional oil development possible because of $101 average oil price 2005-2014

Incremental World Production

Brent Price (RHS)

$101 Avg

Deep Water & Oil Sands

Tight Oil

Source: EIA, Cansim, Drilling Info & Labyrinth Consulting Services, Inc

EIA/EIA International/International_data MASTER.xlsx
U.S. Tight Oil & Shale Gas Plays
Conventional oil plays involve drilling reservoir rocks with vertical wells.

After all the commercially attractive conventional fields in the U.S. were discovered and were in depletion, unconventional plays were the only option.

Tight oil plays (fracking) involve drilling the source rock with horizontal wells.

Tight oil horizontal wells cost 2-3 times more to drill and complete than conventional vertical wells.

There is considerable fanfare about the new volumes of oil but little discussion about the cost of the technology and its effect on the price of oil.
Up to 600 Olympic-sized swimming pools of freshwater are trucked in from lakes, rivers and streams to the fracking well.

NATURAL GAS is then piped, liquefied and exported to consumers.

PRESSURE forces cracks in rock, sand holds the cracks open and natural gas flows back up.
All increase in U.S. production since 2011 has been tight oil
55% of U.S. crude + condensate production is from tight oil plays
14% is from deep water and 31% is from conventional plays

2000-2011 average 5,440 b/d
2019 average 12,131 b/d
+6,700 bopd

Source: EIA DPR, Drilling Info & Labyrinth Consulting Services, Inc.
Oil & gas drilling costs increased 3x (200%) from 2002-2014 because of cost of unconventional oil & gas technology. Costs of drilling fell -42% after 2014 as oil price & services were devalued.

U.S. and the world have been borrowing forward on their surplus energy.

It feels like good times but it's not.


Oil & Gas General/U.S. Public Debt

Debt Inflection Point 1982

Average price since 2014 is 44% higher than 1986-2004 avg.
High oil prices & inflation caused negative demand growth during oil shocks of 1970s.

2011-14 high oil prices not accompanied by negative demand growth possibly because of long-term decline in interest rates & inflation.
42 Billion 2017 Reserves Highest in U.S. History from +4.4 Billion Tight Oil Increase

Reserve forecast based on production forecast implies step-change in U.S. reserve levels
2018-2030 annual reserve additions based on 2009-2017 historical average

Source: EIA, EIA Annual Energy Outlook 2019 & Labyrinth Consulting Services, Inc.
EIA 2019/AEO 2019/Table 14. Oil and Gas Supply.xlsx

Not realistic
IEA tight oil forecast for 11 mmb/d in 2030 exceeds EIA AEO 2019 forecast by 7%
2019 EIA estimate already +0.7 mmb/d (+10%) too high
Adjusted forecast suggests peak tight oil production of 8.5 vs 10.3 mmb/d in 2031

Source: EIA Annual Energy Outlook 2019 & Labyrinth Consulting Services, Inc.
Willing Suspension of Disbelief: EIA tight oil reference case peaks at 10.28 mmb/d in 2031 & declines to 8.38 mmb/d by 2050
Berman case peaks at 9.45 mmb/d in 2025 and declines to 1.5 mmb/d by 2050

Source: EIA & Labyrinth Consulting Services, Inc.
95% of sampled tight oil companies had negative cash flow in Q1 2019

Capital expenditures/cash from operating activities

Capex/Cash Flow > 1

Capex/Cash Flow < 1

Source: Yahoo Finance & Labyrinth Consulting Services, Inc

Oil & Gas General/Sampled E&Ps/Sampled E&Ps MASTER
61% of tight oil-weighted U.S. companies had positive cash flow in Q3 2019 compared to only 50% in Q2.

Good correlation between cash flow & net income-to-enterprise value ratio.

Capital expenditures/cash from operating activities

Normalized Net Income-Enterprise Value Ratio (RHS)

Capex/Cash Flow > 1

Capex/Cash Flow < 1

Source: Yahoo Finance, SEC 10-Q filings & Labyrinth Consulting Services, Inc

Labyrinth Consulting Services, Inc.
Oil prices have been substantially lower since 2014
And investment has fallen correspondingly

Two Charts We Can’t Ignore

**OIL PRICE ($/BBL WTI)**

**Then**

**Now**

**What Wins?**

- Consistent performance across cycles
- Resilience to downside
- Full exposure to upside

**What Matters?**

- Disciplined capital allocation
- Returns on and of capital
- Responsible execution
BUY LOW, SELL HIGH!

Tight oil rig count tripled (2.9x) May 2016 to Mar 2018 as WTI went from $30 to $60

It has decreased -94 since December 2018: SELL!!!

3x Rigs < $60 WTI
193 - 558 rigs

WTI Price
2-month lagged (LHS)

Rig Count
(RHS)

Source: Baker Hughes, EIA & Labyrinth Consulting Services, Inc.

Rig Count 2019/Monthly Shale Gas-Tight Oil Rig Count Data
U.S. tight oil production increased from 7.05 to 7.11 mmb/d in October.
Production growth is fairly flat at about 18% annualized.
Most 2019 growth is in Permian (+16%) & in the Bakken (+6%).

Source: EIA DPR, Drilling Info & Labyrinth Consulting Services, Inc.
EIA 2019/DUC-DPR/dpr-data_MASTER
Markets never valued WTI at more than $65/barrel
Share prices failed to out-perform WTI after prices reached $70 in May 2018

Source: Yahoo Finance, EIA & Labyrinth Consulting Services, Inc.

Oil & Gas Supply/Sampled E&Ps/Sampled E&Ps MASTER.xlsx
• Inventory is part of supply. Demand is consumption, net imports & movements into & out of inventory.
• A cross-plot of C.I. vs price results in a yield curve.
• The comparative inventory yield curve uses C.I. instead of maturity & oil price instead of yield.
• The concept is identical.
• The yield curve crosses the y-axis at the 5-year average.
• That is the “mid-cycle” price, the market-clearing price of the marginal barrel needed to maintain supply.
• The market is short on oil price when C.I. is positive, or more than the 5-year average, & long when C.I. is negative or less than the 5-year average.
• The slope of the yield curve reflects the market’s sense of urgency about supply.
Comparative inventory accurately reflects market price response to supply & demand fundamentals

Source: EIA & Labyrinth Consulting Services, Inc.
WTI comparative inventory continues to indicate $60 mid-cycle price on blue yield curve but October C.I. is at the 5-year average suggesting that price may have been devalued to the green yield curve.
• Bone Spring evaluation indicates commercial area is 1.2 mm acres with 3,807 wells = ~300 acre/well spacing—lots of room for “Tier 1” infill.
• Average break-even price is $60/barrel based on company-stated future cash flows from proved reserves.
Here's the Problem

Here's Another Problem

Keeping Them Honest

Fundamental Premise – Low Cost of Supply Wins

COST OF SUPPLY = $/BBL WTI OIL PRICE REQUIRED TO ACHIEVE A POINT-FORWARD 10% RETURN

- All components rigorously calculated for each entity
- All barrels of resource discounted at 10%

<table>
<thead>
<tr>
<th>CAPITAL</th>
<th>OPEX</th>
<th>ROYALTY</th>
<th>TAXES</th>
<th>PRODUCT MIX</th>
<th>DIFF TC WTI</th>
<th>WT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACILITIES</td>
<td>LIFTING</td>
<td>TRANSPORTATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10</td>
<td>$12.50</td>
<td>$4.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COST OF SUPPLY CALCULATED ACROSS >100 ENTITIES IN THE PORTFOLIO

<$40/BBL

<table>
<thead>
<tr>
<th>2018 10-K</th>
<th>Future Cash Flow</th>
<th>Proved Reserves</th>
<th>CF/boe</th>
<th>SEC Price</th>
<th>Breakeven</th>
<th>Variable OPEX</th>
<th>Break Even Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>COP</td>
<td>$43,363.00</td>
<td>4,383</td>
<td>$9.89</td>
<td>$65.56</td>
<td>$55.67</td>
<td>$4.01</td>
<td>$59.68</td>
</tr>
</tbody>
</table>
Oil Quality Matters: U.S. tight oil is ultra-light

- Doesn't contain heavier molecules needed for diesel & many refined products
- 30-35° API gravity is average world refinery input quality
- 99% of Permian basin oil is lighter than 35° API gravity

Source: Drilling Info & Labyrinth Consulting Services, Inc.
End of the Age of Oil?

- Consumption of all world energy sources expected to increase by 2050.
- Renewables and natural gas increase the most.
- Coal and liquids increase the least.
- Renewables to increase from 15% to 28% of world energy consumption by 2050.
- Coal decreases from 26% to 20% and liquids decrease from 32% to 27%.
- Natural gas will remain at 22% & nuclear will decrease from 5% to 4%.
World demand growth has been remarkably consistent at an average of 1.25 mmb/d annually since 1970. Only 7 out of 49 years of negative demand growth (1980-83, 1985, 2008-09).

Concluding Thoughts

- Energy is the economy and oil is the master energy resource.
- Oil will continue to dominate the world energy landscape for decades because no other energy source can meet global needs.
- Unconventional oil has bought the world a few decades of high density energy but does not offer a meaningful long-range alternative.
- Humans have never gone from higher- to a lower-density energy source.
- While increased use of renewable energy is inevitable and desirable, it is not a satisfactory substitute for oil.
- A transition away from an oil-weighted energy supply will be complex, costly and lengthy despite supporting arguments or preferences.
- There is no clear way forward that includes sustaining current levels of energy use.
- The best path forward is to stop looking for improbable solutions that allow us to live like energy is still cheap, and find ways to live better with less.