Active Investing in the Energy Sector

What is the 'right' oil price?
Sometimes the answer takes a long time to emerge…

Brent Oil Prices, 1980s-2017

The 2014/5 Commodity Correction – 1980s vs 2017

SIMILARITIES

• High oil prices result in an increase in production from non-OPEC producers
• OPEC defends market share, increases production.
• Following OPEC’s decision, prices decline 67% in 1986 vs. 60% in seven months in 2014/2015.

DIFFERENCES

• Current OPEC spare capacity is 4% vs. 16% in 1985.
• New supply is largely comprised of unconventional, longer duration projects.
• After increasing elasticity to lower prices in 1986, oil demand grew in excess of 2% for next 4 years. Today, demand growth is not so certain.
Shale: a technological and economic revolution in energy

Alongside subsalt deepwater drilling and liquefied natural gas transportation, production of gas and oil from shale is one of the most revolutionary energy developments in our lifetime.

REVOLUTION TIMELINE

- '80s: Concept
- '02-'04: Practical reality
- '09-'15+: Major equity market phenomenon
- '07-'08: Commercial viability

THE ALLIANCE OF FRACKING AND HORIZONTAL DRILLING

THE RESULTS

US Crude Production: 1900-2014

US LNG Imports (mmcf)

Source: The Bloomberg Investment Professional, as of 31-Dec-14

Shale market response to lower oil prices

US Onshore Rig Count

North American Liquid Fuel Production Slows

- In response to the commodity environment, E&Ps laid down rigs at record pace and then added them back
- Although timing is uncertain, decline rates will inevitably impact production growth, as fewer wells are drilled.
- The Energy Information Administration (EIA) currently forecasts that the market should be in balance for the first half of 2018

Source: Baker Hughes

Source: Energy Information Agency (EIA)
What (and when?) will the ultimate oil market outcome be?

Cost cutting and efficiency gains already appearing

- Will the oil market mean revert once excess supply has been absorbed
- Or will the equilibrium price settle lower as the cost curve moves down?
- How strong will demand be? Are developed markets structurally at a peak? Can EM growth continue to be as strong as it has been in the last decade?

FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY

Is a new longer term energy equation emerging?

Growth in Alternative Energy Supply

- Overall primary energy consumption growth rates are slowing
- …and at the margin, new demand is being met by an unconventional hydrocarbon barrel, or by alternative energy.
- …and a huge opportunity lies in the energy efficiency sphere

FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY
Taking a broader view of Energy

The Energy Value Chain: Where are the Price Points?

MFS analysts provide in-depth research of every stage of the Energy value chain, and look to invest in segments where pricing power and returns are improving sustainably.

Understanding all parts of the capital structure

Case study: Petrobras

The world’s best offshore oil assets

...but rising capex and falling profitability kills equity value before they come onstream

Source: Petrobras 2007 Annual Report
'The last barrel of oil will have no value'

...but what will be the reason for this?

"The Stone Age came to an end, not because we ran out of stones, and the Oil Age will come to an end, not because we have a lack of oil."  Sheikh Yamani, 2000

A simple challenge:

...find 13mtoe of energy supply next year

<table>
<thead>
<tr>
<th>World Primary Energy Supply (TPES), 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit</strong></td>
</tr>
<tr>
<td>#13000        Million tonnes of oil eq. (MTOE)</td>
</tr>
<tr>
<td>#15590        Terawatt hours (TWh)</td>
</tr>
<tr>
<td>#52080        Trillion Btu</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>x 11.6</td>
</tr>
<tr>
<td>x 11.6</td>
</tr>
<tr>
<td>x 40.0</td>
</tr>
</tbody>
</table>

Growth Rates in TPES

<table>
<thead>
<tr>
<th></th>
<th>1 yr</th>
<th>5 yr</th>
<th>10 yr</th>
<th>20 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>0.9%</td>
<td>0.9%</td>
<td>0.6%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Europe</td>
<td>-2.0%</td>
<td>-0.1%</td>
<td>-0.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>China</td>
<td>2.6%</td>
<td>5.1%</td>
<td>6.6%</td>
<td>6.5%</td>
</tr>
<tr>
<td>ROW</td>
<td>2.4%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>3.2%</td>
</tr>
<tr>
<td>GLOBAL</td>
<td>0.5%</td>
<td>2.3%</td>
<td>2.0%</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

Hard to grow GDP without fuelling energy demand growth

Source: Energy Information Agency (EIA)
...Made harder by this trend:

'Conventional' Oil Production Peaked in 2005

- Conventional oil is: 22-40 deg API, extracted from a sandstone or carbonate reservoir.
- 10 years of evidence would suggest that world production of conventional oil peaked-out at 4mtoe (82m bpd)
- That's ~30% of Total Primary Energy Supply...
- If production has barely held flat at $85 average oil prices (2005-2014), we should fear the impact of $50 oil prices for an extended period

Source: Energy Information Agency (EIA)

FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY

Shale and alternatives to the rescue...so far...

'Unconventional' hydrocarbon supply

- A combined 900MTOE of incremental energy supply since conventional oil peaked in 2005

Source: Energy Information Agency (EIA)

FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY
How much bigger can shale get?

US Shale Basins

Example: Bakken 2005...

...and 2013

Source: Energy Information Agency (EIA)

FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY

How far can the shale story go?

Intensity of drilling has risen:

Future regulatory issues?

Source: ITG (www.itg.com)

Source: USGS (www.usgs.gov)

FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY
Built on cheap equity…and cheap debt

<table>
<thead>
<tr>
<th>Market</th>
<th>Issues</th>
<th>Outstandings</th>
<th>Interest Yield</th>
<th>Burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>US High Grade</td>
<td>573</td>
<td>$435Bn</td>
<td>3.27%</td>
<td>$14.22Bn</td>
</tr>
<tr>
<td>US High Yield</td>
<td>336</td>
<td>$35Bn</td>
<td>5.80%</td>
<td>$2.03Bn</td>
</tr>
<tr>
<td>EM Corporate</td>
<td>44</td>
<td>$205Bn</td>
<td>5.20%</td>
<td>$10.66Bn</td>
</tr>
<tr>
<td>European High Grade</td>
<td>56</td>
<td>$57Bn</td>
<td>1.30%</td>
<td>$0.74Bn</td>
</tr>
<tr>
<td>European High Yield</td>
<td>4</td>
<td>$1.5Bn</td>
<td>5.25%</td>
<td>$0.08Bn</td>
</tr>
<tr>
<td>Asian Corporates</td>
<td>53</td>
<td>$76.5Bn</td>
<td>1.38%</td>
<td>$0.99Bn</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,013</td>
<td><strong>$810Bn</strong></td>
<td></td>
<td><strong>$28.73Bn</strong></td>
</tr>
</tbody>
</table>

A 2% increase in rates increases Global Debt burden to $44.93Bn

Total US 909 $470Bn 3.46% $16.26Bn

A 2% increase in US rates increases Debt Burden to $25.65Bn

Source: Barclays Capital as of 12/31/16

FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY

No turning back the alternative energy tide

Governments will pursue CO2 mandates

Investments in renewables will rise

- Government CO2 reduction targets will force continued uptake of renewable energy

Source: Energy Information Agency (EIA)

FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY
A warning from Physics!

Lower energy returned on investment => more GDP consumed in energy production

• EROI: Energy out / Energy in
  • Unimportant if you can manage the cost of capital / allocate incremental capital without constraint. VERY important if you can’t...
  • Increasing evidence to suggest that shales, solar etc currently have an inferior EROI than conventional supplies that they are replacing
  • (lower volume output, lower thermal energy value, higher relative energy input cost)
  • ...IMPLYING lower energy surpluses, and the increasing risk of an energy 'cliff' impacting global growth potential at current levels of energy intensity

---

Energy efficiency gains may prove vital

...1/3 of total energy production is lost

• We are quite wasteful: 1/3 of the energy we produce is lost through electricity production, hydrocarbon extraction, refining/ transformation, and distribution
• Final consumption, by industry, transport, households (heating, lighting) is also inefficient, with a further ~30% lost, despite improving energy intensity
By 2020, battery cost reduction makes mass market adoption a very viable situation.

- Car battery math:
  - Mileage currently is 4-5 miles / KWh
  - For a 200 mile range, therefore, we are looking at storage of ~45KWh capacity
  - @$400/kWh, battery cost per car is about $18,000.
  - In seven years this drops to $9000 as a base case, could surprise by dropping to even $4500, which will be a game changer

- Panacea for mileage anxiety:
  - Porsche Mission E introduced a few weeks ago.
  - 310 miles driving range on full charge.
  - 80% of which can be recharged in 15 minutes.
  - 582Bhp of power in it too.

- Grid/home storage considerations:
  - Size/weight/mobility limitations less significant
  - Time to charge not as fast, time to discharge not as fast.
  - @ 30 KWh/day, an average home needs $15,000 worth of battery capacity to last through a day.
  - Again, this will halve over a 5-7 year period.

- The more one looks at these numbers, the more it seems like the battery revolution is very possible.
- … and with it, a longer term reduction in demand for fossil fuels.

A huge prize in demand efficiency in the auto sector

- OECD CO2 spec changes are forcing efficiency improvements on automotive OEMs
- Drivetrain and chassis improvements to double average auto efficiency by 2025 – transportation is ¼ of global primary energy consumption, and almost all of it is currently hydrocarbon based (~40mmboed).
Conclusions: Energy is a durable theme … (not just a cyclical play)

- Energy is the engine of global GDP
- ...and >80% of today's energy demand is satisfied by hydrocarbons
- Not all hydrocarbons are the same:
  - ...we have witnessed the limits of the conventional hydrocarbon age, and have entered the unconventional era
- The declining energy surplus caused by this transition will make for a more complex cycle in the future
- Equity markets will continue to allocate capital to advantaged plays in the battle to navigate the declining energy surplus
- MFS will seek to identify those plays in this evolving long term theme


FOR INSTITUTIONAL AND INVESTMENT PROFESSIONAL USE ONLY