Oil and Natural Gas Demand: Will we see them peak?

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Company Profile As of June 30, 2017

- Explore for, produce, transport and market hydrocarbons, including crude oil, natural gas, natural gas liquids (NGL), liquefied natural gas (LNG) and bitumen

- Operations and activities in 17 countries
  - Exploration in 12 countries
  - Production in 11 countries

- 12,200 employees worldwide

- Six operating segments
  - Alaska
  - Lower 48
  - Canada
  - Europe and North Africa
  - Asia Pacific and Middle East
  - Other International
Highly Differentiated, Diverse Portfolio  As of Q2-2017

1. Largest independent E&P by production and proved reserves. Full year 2017 estimated production is on a pro-forma basis as if announced transactions were completed on Jan. 1, 2017 and excludes Libya.

2. Cost of Supply (CoS) is the Brent equivalent price that generates a 10 percent return on a point forward and fully-burdened basis. Resources are post announced transactions.


4. Burden = capital infrastructure + foreign exchange + price-related inflation + G&A.
Unless on a 2 degree carbon trajectory, most forecasts peak beyond 2030 or don’t peak at all during their forecast period.
What Determines Oil Demand?

Determinants

- Energy demand
- Income
- Price of oil, refined products
- Prices of complements
- Prices of substitutes
- Tastes/Preferences

Source: Demand data from U.S. EIA
World Need for Affordable, Efficient Energy May Extend Oil’s Life Longer

Next 25 years: +2.3 Bln people

2016:
3 Bln people cook or heat home with biomass
1.2 Bln (16%) have no access to electricity

Source: U.N. population estimates; IHS-Markit GDP forecast; Energy Demand from IEA WEO 2016
GDP in trillion real 2010 $, PPP

GDP per Capita, real 2010 $, PPP

Source: Oxford Economics
Low Oil Prices Incentivize Oil Demand As Observed in the U.S.

- Transportation oil use increases during periods of low oil prices
  - Shift to larger vehicles offsets fuel efficiency improvements
  - Stronger growth in vehicle miles traveled

**Graphs:**
- **Continued Shift in U.S. to SUVs/Light Trucks**
  - % SUV/Light Trucks vs. % Cars

- **VMT Increases in a Lower Price Environment**
  - Billion Miles/Day vs. $/Gallon (Inverse Scale)
  - Source: EIA, STEO

- **Weighted Fuel Economy of New U.S. Passenger Vehicle Sales**
  - Flat efficiency
  - Source: University of Michigan Transportation Research Institute
Substitutes Not Obvious in Some Oil Demand Sectors

**World Oil Demand by Sector (MMBD)**

- **2015**
  - Power: 94 MMBD (28%)
  - Freight: 108 MMBD (18%)
  - Maritime: 24 MMBD (7%)
  - Aviation: 23 MMBD (7%)
  - Petchem: 23 MMBD (7%)
  - Feedstock: 21 MMBD (7%)
  - Process Heat: 21 MMBD (7%)
  - Buildings: 21 MMBD (7%)
  - Other: 23 MMBD (7%)

- **New Policies 2040**
  - Power: 121 MMBD (23%)
  - Freight: 108 MMBD (21%)
  - Maritime: 24 MMBD (4%)
  - Aviation: 23 MMBD (4%)
  - Petchem: 23 MMBD (4%)
  - Feedstock: 21 MMBD (4%)
  - Process Heat: 21 MMBD (4%)
  - Buildings: 21 MMBD (4%)
  - Other: 21 MMBD (4%)

- **Current Policies 2040**
  - Power: 106 MMBD (54%)
  - Freight: 56 MMBD (21%)
  - Maritime: 18 MMBD (7%)
  - Aviation: 18 MMBD (7%)
  - Petchem: 18 MMBD (7%)
  - Feedstock: 18 MMBD (7%)
  - Process Heat: 18 MMBD (7%)
  - Buildings: 18 MMBD (7%)
  - Other: 18 MMBD (7%)

**Demand Growth by Sector (2015-2040, MMBD)**

- **New Policies**
  - Net growth of 14 MMBD or 14%

- **Current Policies**
  - Net growth of 27 MMBD or 28%

Petroleum Fuels Offer Efficient Energy Delivery

Energy Density per Unit Weight vs Volume
(Data scaled relative to gasoline)

Source: Energy density values from EIA, U. of Calgary, Wikipedia
Electric Vehicles will Increase but May Remain Small Part of Fleet

Morgan Stanley Estimates EV’s Could Reach 50% of New Sales by 2040

Global Annual Sales of EV (PHEV/BEV) By Region

- ROW
- Europe
- China
- US
- % of Global Sales (right axis)

China is largest single market. Gov’t policies incentivize this.

Deployment Scenarios for the Stock of Electric Cars to 2040

Million EV in Vehicle Stock

Source: Morgan Stanley

Source: IEA, OPEC, BNEF, Goldman Sachs, Morgan Stanley, PIRA and Various Oil Companies
Views of EV Sales by Industry

Comparison of Electric Vehicles Adoption Forecasts
Automakers vs. Oil Companies

Auto and Oil Industry Views

- The auto industry sees greater EV sales growth sooner than the oil industry
- Global auto industry investing in new EV models
  - Ford plans 13 hybrids and BEVs by 2022
  - Daimler targets EVs of 15-20% of sales by 2025
  - VW plans electrics for all models by 2030

Source: Bloomberg New Energy Finance
Are EV Projections Out of Sync With Reality?

Electric and Plug-in Hybrid Vehicle Sales as a % of Total Car Sales

- Deutsche Bank
- PwC
- Frost & Sullivan
- BNEF
- IEA
- Roland Berger
- BCG
- Deloitte


- Forecastsers historically overstated the rate of EV penetration
- Technology change and consumer preferences are extremely difficult to forecast
- Several factors make EV penetration more plausible today
  - Gov’t bans on fossil fuel cars
  - Automakers plans
  - Lower battery cost

Previous forecasts for EV sales have been overstated

U.S. Global

Thomas Edison, 1913

Government Drivers of EV Penetration

Key Drivers
- Challenge of meeting more stringent fuel efficiency and air emissions regulations, although currently uncertain in the U.S.
- Meeting CO₂ targets in Europe, particularly in light of “diesel gate”
- For China:
  - Reduction of local air emissions
  - Enhancing domestic energy security
  - Industrial policy to develop domestic battery and EV industries
Battery Costs Have Dropped Sharply But Are Not Yet Competitive

Battery Pack Cost Projections

- **Historical***: Goldman Sachs, Tesla, GM, Nissan, BYD, BNEF
- $/kWh
- $100/kWh threshold where competitive with ICE

Rising Demand for Metals in Lithium-ion Batteries

- Manganese, Nickel, Cobalt, Lithium
- L-I Battery Demand (right axis)

Cobalt price increases have pushed up battery costs by ~7%

Source: IEA Global EV Outlook BNEF, EIA, Car Manufacturers, Goldman Sachs and Wood Mackenzie

Battery costs have declined significantly but are not expected to be competitive with the internal combustion engine (ICE) before 2020

Source: Bloomberg
Vehicle Miles Traveled Moderates EV Impact on Oil Demand

**Global Fleet Growth Increases VMT**

- BNEF
- BP
- ExxonMobil
- OPEC
- Morgan Stanley

Differences in views on fleet growth result in different views on VMT

**VMT Growth Offsets Decline in Global Gasoline Demand by 2040 Due to Efficiency Increase and EVs**

- Bull Case, 37
- Bear Case, 12

- 2015 Demand: 24
- Change in VMT: 49
- MPG of ICE: -21
- Owned EV: -8
- Shared EV: -21
- 2040 Demand: 23


Source: Morgan Stanley “Electric Cars and Oil: Shared/Autonomous EVs Not Too Bad For Gasoline Demand?”, May 29, 2017
Autonomous Driving: Could Self-Driving Cars Could **Increase** Energy Use?

**Increased Consumption**
- More miles traveled (VMT) due to lower cost and greater convenience
- New user groups (e.g., young, old, infirm, etc.)
- Increased features and higher highway speeds
- Switch away from mass transit to robo-taxis

**Reduced Consumption**
- Greater likelihood of electrifying robo-taxi fleets
- Efficiency improvement (eco-driving, platooning, right-sizing vehicle for purpose)
- Car sharing / carpooling reduces VMT
- Supports mass transit by fixing the “last mile” problem

Range in possible impact on energy use:\(^1\)

<table>
<thead>
<tr>
<th>Down 45%</th>
<th>Up 100%</th>
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<tbody>
<tr>
<td>Only moderate automation</td>
<td>High automation</td>
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<tr>
<td>Efficiency gains captured and high gov’t intervention limiting driving</td>
<td>Increased travel and low gov’t intervention limiting driving</td>
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\(^1\) Source: “Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles” Z. Wadud, D. Mackenzie, P. Leiby ; Car and Driver
Impacts on Oil Demand

World Oil Demand Growth (YoY, MMBD)

Range of Forecasts

Oil Displaced by Electric Vehicles (MMBD)

IEA New Policies

BP

IEA 2 Degrees

PIRA

BP

GS

IEA New Policies

BNEF

BP

IEA 2 Degrees

PIRA

Carbon Tracker
Long Term Market Growth of Global Natural Gas

Global Natural Gas Demand Growth:
Average Growth of 1.6% per year to 2025 and 1.2% from 2025 to 2040

- All available forecasts have global gas demand growth through 2025, and most have growth through 2040.

- Weak or no growth by 2040 is associated with following the 2 degree GHG trajectory.
  - Governments may not choose natural gas as a vehicle for decarbonization.

- The scenario with the highest demand growth (Shell Mountains) is driven by the sharp rise in affordable supplies of shale and tight gas.

Costs declines for renewables are slowing down

**Wind ($/MWh)**

- 2009: $169
- 2010: $148
- 2011: $92
- 2012: $95
- 2013: $95
- 2014: $81
- 2015: $77
- 2016: $62

Decelerating improvement

66% Decrease in 7 Yrs.

**Utility-Scale Solar PV ($/MWh)**

- 2009: $394
- 2010: $270
- 2011: $166
- 2012: $149
- 2013: $104
- 2014: $86
- 2015: $70
- 2016: $61

Leveling off

85% Decrease in 7 Yrs.

Source: Lazard’s Levelized Cost of Energy Analysis – V. 10.0., December 2016; Does not include Transmission, Subsidies, or Intermittence.
Gas combined cycle has the lowest unsubsidized cost of energy unless CO\textsubscript{2} prices are very high.

Many levelized cost assessments exclude system integration costs for renewables:
- Back-up conventional power & storage costs to manage intermittency
- Additional transmission and grid costs
- Shut-in of publicly supported surplus renewable capacity
- “Stranded costs” for non-renewable generation capacity made surplus by subsidized renewables

Levelized cost assessments also exclude environmental externalities.
- At $3.50 gas with system integration costs at 30% renewables penetration:
  - ~$77/ton CO\textsubscript{2} price needed for unsubsidized wind to compete with gas
  - ~$107/ton CO\textsubscript{2} price needed for unsubsidized PV to compete with gas

*System integration cost include costs of managing intermittency and transmission costs. These costs and Air Quality/GHG from UT’s Center for Energy Economics Competitiveness of U.S. Renewable-Generation Resources
Every time the Production Tax Credit (PTC) was allowed by Congress to expire at the end of the year, and not renewed quickly, wind-capacity additions fell significantly the next year:

Wind Capacity Additions

Liabilities in Bankruptcy since 2014
Market Capitalization (US companies)

Source: Bloomberg, UT’s Center for Energy Economics
Competitiveness of U.S. Renewable-Generation Resources
Summary

- The risk of global oil demand peaking before the 2040’s is lessened by (1) the lengthy time it takes to turn over the vehicle fleet, (2) rising incomes and mobility in developing countries and (3) growth in freight transport, air travel and petrochemicals.
  - A peak by the 2040’s probably requires a combination of high EV penetration, weak economic growth, and substantial fuel efficiency improvement across the transportation and other sectors.

- Global natural gas demand is likely to be more robust than oil demand
  - The 2 degree Carbon Scenario or strong renewables penetration in power generation could reduce the rate of growth in gas demand.