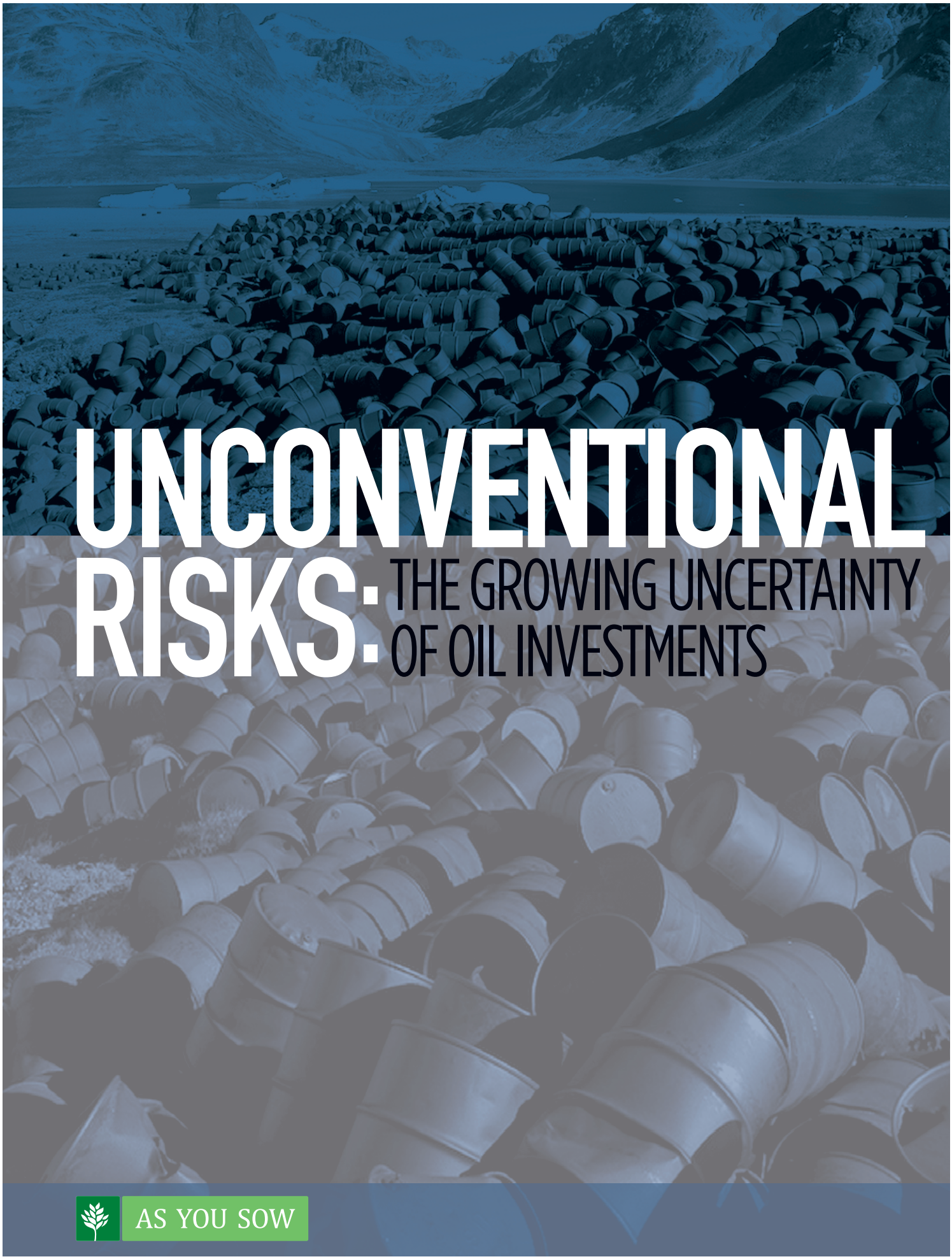

UNCONVENTIONAL RISKS: THE GROWING UNCERTAINTY OF OIL INVESTMENTS

AS YOU SOW

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Please note that any errors or omissions are solely the responsibility of the authors.

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GLOSSARY

- **2-Degree Scenario:** The phrase "2-degree scenario" refers to a scenario in which global warming is maintained below 2 degrees Celsius. The International Energy Agency has adopted a "450" scenario which estimates the parameters and conditions necessary to maintain global warming below 2 degrees.[I]
- **Break-even cost:** The oil price at which an oil company's returns equal or exceed its full cycle cost of production.
- **Cash cost:** The oil price a company must receive to meet or exceed costs of production operations.
- **Conventional oil:** Crude oil produced by a well drilled into a geologic formation in which the reservoir and fluid characteristics permit the oil to readily flow to the wellbore. (From U.S. Energy Information glossary).[II]
- **Debt:** Total company debt reported on U.S. financial statements. Total debt includes both the short-term and long-term debt, and may be in the form of bonds, loans, and other financial instruments.
- **End cash:** The remaining value of a company's assets that are cash or can be converted into cash immediately at the end of the fiscal year.
- **Independent oil companies:** Small- to medium-cap oil exploration and production companies. These firms are often investor-owned, and are not typically vertically integrated.
- **Mb/d:** "Million barrels per day" is a common measure for oil production. For an example of scale, global consumption of oil and other liquids was 90.7Mb/d in 2013.[III]
- **National Oil Companies (NOCs):** Oil and gas companies controlled by governments. NOCs include, among others, Gazprom (Russia), Statoil (Norway), Saudi Aramco (Saudi Arabia), Petrobas (Brazil), Iraq National Oil Company (Iraq), Pemex (Mexico), PDVSA (Venezuela), National Iranian Oil Company (Iran), Sinopec (China), etc. NOCs may be partially owned by private investors.
- **Oil majors:** Large-cap investor-owned oil companies. In this report, "oil majors" collectively refers to ExxonMobil, BP, Chevron, Shell, Total, and ConocoPhillips. Analysts may differ in which companies are considered majors; some consider Eni to be a major, others may no longer consider ConocoPhillips a major because it divested its downstream business. The oil majors are also known as "supermajors," or simply "majors," terms that will be used interchangeably hereafter.
- **Organization for Economic Cooperation & Development (OECD):** The organization, whose mission is to promote policies to improve the economic and social well-being of people around the world, includes 34 countries, including most European nations, Mexico, Japan, Korea, New Zealand, Australia, U.S., and Canada.[IV]
- **Organization of the Petroleum Exporting Countries (OPEC):** An intergovernmental organization of 13 oil exporting developing nations that coordinates and unifies the petroleum policies of its member countries. Members include Algeria, Angola, Ecuador, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, UAE, and Venezuela.
- **Scenarios:** A group of parameters energy agencies and oil companies use to create projections of various market conditions that typically address demand, supply, market changes, etc. International Energy Agency (IEA) and Energy Information Agency (EIA) scenarios are sometimes referred to by their scenario title only, for example, the "IEA 450 Scenario."
- **Unconventional oil:** This phrase typically refers to oil that: (a) requires more complex and, in some cases, more costly technology to extract; (b) requires additional processing and refinement; and/or (c) is located in remote or extreme locations. Unconventional oil extraction is generally, though not always, characterized by higher costs than conventional oil. Examples of unconventional resources include:
  - oil resources that occur at great oceanic depths, requiring "deepwater" drilling;
  - oil resources located at remote locations such as the Arctic, i.e., "Arctic" drilling; and
  - oil resources in difficult-to-access geological formations. This includes tight oil in shale deposits that require hydraulic fracturing, acidizing, and other extraction methods, as well as tar sands located in bitumen deposits.

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FOREWORD

July 13, 2016

With each passing quarterly report from the coal, oil and gas industries, the news gets worse, strengthening the call for a reconsideration of the vast role fossil fuel investment plays in the global economy.

Low prices, technological change, political instability, regulatory action and public sentiment are combining to create ever more fragile conditions, opening markets up to new opportunities for competitors.

The rapid decline of the coal industry is a good example, propelled by competition from technology-driven alternatives that include wind, solar, energy efficiency and innovations in the production of natural gas. The coal industry is a good instance, too, of deep-seated resistance to change. Coal producers continue to mine too much coal for a shrinking consumer base, creating needless and massive value destruction for investors. Meantime in the U.S., where the coal industry has declined especially far and fast, a fundamental decoupling is under way as the overall economy gains jobs and the stock market rises.

The recent persistence of low oil prices is eroding the oil and gas industry's market power as well. Over the past 30 years or so, the oil industry has gone from dominating global capital markets with strong returns to becoming a significantly diminished—though still profitable—player. Ten years ago, the industry, bolstered by dramatic spikes in prices, planned a future based on developing high-cost oil sands and hydraulic fracking of natural gas and conventional oil reserves. When prices collapsed, the inherent risks in these initiatives were exposed. The prolonged outlook now for low oil prices throws into question the ability of oil companies to achieve return targets, replenish reserves, pay down debt, build cash reserves and maintain dividend commitments.

This year, global markets saw oil prices drop to $28 per barrel and today we look at $50 per barrel oil as a sign of "recovering" oil prices—down from what used to be seen as a norm of $85 per barrel. However, $50 per barrel oil will not return the industry to profitability. It will simply add to greater short-term stock speculation and volatility. Fundamentally, the capital-expenditure budgets of oil producers are also now being reduced to reflect a reconsideration of oil's long-term investment prospects. The dynamics of the oil industry have changed. Even if prices do rise due to renewed cooperation among producers, oil price spikes—which normally provide the industry with capital for new investment—are likely to be ever smaller going forward than in the past, and the up cycles will be of shorter duration.

Competitors, in the meantime, have a greater capacity to mobilize than ever, and will benefit from experience and a stronger institutional footing. Low-carbon technological alternatives in the transportation and electric power sector are moving from new-stage development into a period of greater efficiency that allows for expanded market share. Even with this progress, however, financial, technological and political impediments continue to create barriers to greater market penetration of alternatives to fossil fuels. The need for greater investment and political mobilization to combat these risks is urgent.

Turbulence in global and national political institutions today is challenging many of the fossil fuel industry's claims to legitimacy. The geopolitics of oil production is no longer based on a consensus of its leaders but by fragmented competition between producer nations. Greater levels of state-owned reserves are competing with private-oil muscle. State-owned actors are using revenue strategies, market position and political spheres of power and influence to create new rules. Political volatility contributes to oversupply, keeping world oil prices low.

Organized public opposition to coal, oil and gas stems in large measure from the impact of fossil fuels on climate and pollution across the globe. But opposition stems as well from those whose concerns are also tied to currency, fiscal and economic risks. Both forms of opposition create material risks of a political and regulatory nature.

Opposition to fossil fuels based on environmental impacts is growing dramatically and is now a global, permanent and skilled presence. Such opposition inspires action that can incur costly delays, and requires legal and political accountability on the basis of public health and welfare standards. Financial objections to fossil fuel projects are generally also based on rising consumer prices or taxation schemes to pay for fossil fuel subsidies.

The fossil fuel industry has also lost face on the innovation front, where the renewable-energy and clean-transportation sectors are beginning to carry the day. This loss erodes public confidence in fossil fuel industries, and tugs at the legitimacy of national governments that support the status quo. How governments respond sets the tone and tenor of global and local political discourse, and provides the backdrop for global investors. China's unacceptable levels of air pollution from coal-fired power plants, for example, has forced a realignment of priorities at the highest of levels of its governing party.

Perhaps the single greatest area of realignment is in the field of science. Science increasingly shows how fossil fuels are a risk to the environment and to public health, and advancements in climate science have documented the gradual warming of the earth and have led to calls for curtailing carbon-dioxide emissions. Fossil fuel companies have responded largely by promoting confusion about the science and have provided highly questionable, conflicting information to investors, regulators and business partners (suppliers, labor, insurance, transport and consumers).

Short-term revenue erosion for oil companies is becoming a long-term weakness as these financial, political, and environmental risks converge. This paper details how that weakness moves onto oil-company balance sheets as tighter margins, weakened dividends, capital-expenditure cutbacks, project cancellations and delays, distressed sales and increased scrutiny of liquidity assertions.

Fiduciaries for institutional funds have a choice to make. They can ignore the downside and weak outlook of fossil fuels and thwart the world-wide search for alternatives (which is what happened when coal markets began to turn five years ago). Or they can act responsibly, directing their money managers and professional staff to construct investment plans that are increasingly fossil free.

Such plans are the blueprints that fiduciaries need if they are to act prudently and meet the challenges of the energy transition. And when money managers and investment banks resist making these changes, fiduciaries must provide firm and constant direction. Retirees, taxpayers, non-profit grantees, faith and university communities all depend on sound investment policies.

Implicit in a new fossil free portfolio is the need for fund managers to construct an asset allocation strategy that meets financial targets. Asset allocation studies are consistent with the specific philosophy and history of a fund, and take into account its appetite for change and risk. A solid plan presents options, benchmarks and opportunities along the way to adjust investment strategy as conditions change.

Some institutional investors have shrugged off the financial impact of billions of dollars in coal industry losses over the past several years because coal has never been a sizable contributor to investment portfolios and the stock market grew as coal collapsed. Oil and gas investments, however, like oil and gas use, are different. Their size and historic contribution to investment funds is material. Red flags missed here are far more perilous than those missed for coal.

As You Sow released a report in 2011, which I co-authored, cataloguing the risks to investors in the coal sector. The cumulative risks we presented then have now materialized into a perfect storm of financial distress and structural decline in the coal sector. The portrait of the oil industry in this study is appropriately more complex, but similar alarms are nevertheless clear. A storm is threatening.

Tom Sanzillo

EXECUTIVE SUMMARY

In 2011, near the height of U.S. coal consumption, As You Sow published a report highlighting the growing financial risks to the U.S. coal industry, the ***Financial Risks of Investments in Coal***, which predicted the structural basis for what has become a permanent decline of the industry. The paper argued, correctly, that some of the most profitable companies in the U.S. at the time would soon be weakened by changing market fundamentals.

This paper considers current structural changes in the oil market that have the potential to contribute to a weakening of the oil industry. While the coal and oil markets differ in certain aspects, similarities include higher capital costs (in the case of oil, higher costs associated with finding and producing new reserves); increased competition; global demand constraints due to climate and other air pollution-related regulations; alternative and substitute technologies; and increased social activism focused on industry.

Higher Cost Reserves & Supply Competition — One of the most significant challenges for oil in a carbon constrained economy — in which demand for oil is slowing or falling — is competition for remaining market share. Today, the majority of low cost reserves are owned by nationally controlled oil companies (NOCs). As oil majors' current supplies of conventional reserves are depleted, they must find new reserves, generally at greater cost. *Independent oil companies, including the majors, are thus becoming the world's high cost producers*, making them less competitive. This trend has been broadly masked by the past decade's record high oil prices.

This trend has recently had major repercussions for the profitability of the majors, which are competitive with lower-cost NOCs only to the extent they have similarly low cost oil, or to the degree oil prices are high enough to cover their costs of reserve exploration and development. At prices of $30 and even $40-plus dollars per barrel, most oil majors are not competitive. Yet, so long as oil price is high enough to ensure the profitability of the majors over the long term, for example $80 per barrel or more, high oil prices simultaneously create market conditions that accelerate long-term demand destruction, ironically reducing the frequency and extent of oil price rebounds in the future.

Financial Indicators of Structural Risk — As a result of these trends, the financial fundamentals of oil majors have been declining over the past decade with balance sheets marked by falling cash positions, rising debt levels, declining profits, and flat or marginally increasing production, all of which began before, and was exacerbated by, the 2014 oil price drop.

- **Increasing Capital Expenditure:** Between 2000 and 2014, total capital expenditures of the oil majors grew 308%, from $41 billion to $166 billion.[1] Despite these increases in capital investment, the total oil equivalent production from the oil majors decreased 1.7% in the same period,[2] reflecting in part, the rising costs of replacing reserves. Reduced access to conventional supplies of crude has required most independent oil companies, including the oil majors, to develop unconventional, higher cost resources (e.g., deep water, Arctic, and tar sands), which are often in extreme and remote locations and require complicated extraction processes, increasing costs of production. As a result, the cost of producing the marginal barrel of oil is increasing.[3]
- **Declining Profit Margins:** From 2011-2013, oil prices were at the highest levels in history. Yet, due to spiraling costs of finding and developing new resources, among others, oil majors' profit margins have declined. The majors' average return on equity has been declining since it peaked in 2005, reflecting decreasing profitability over the last decade.[4]
- **Mounting Debt:** From mid-2000 to 2014, debt among oil majors has more than tripled as the oil majors took on debt at unprecedented rates.[5] Debt appears to have supported capex, operations, share buybacks, and/or

1 As You Sow Analysis, using financial data sourced from 10k and/or 20F statements, for years 2000-2015, for the following companies: BP (ticker: BP); ExxonMobil (ticker: XOM); Chevron (ticker: CVX); ConocoPhilips (ticker: COP); Royal Dutch Shell (ticker: RDS); Total (ticker: TOT). Subsequent analysis using this dataset is hereinafter cited as "As You Sow Analysis." Note: some statistics cited in subsequent analysis address and/or compare only some years of this data as set forth in associated text.

2 *Id.*

3 *See* "Carbon Supply Cost Curves: Evaluating Financial Risk to Oil Capital Expenditures," *Carbon Tracker Initiative*, May 2014, p. 11, **http://www.carbontracker.org/wp-content/uploads/2014/09/CTI-Oil-Report-Oil-May-2014-13-05.pdf**.

4 As You Sow Analysis; *see also* "Declining Profit Margins" section below for additional detail on this analysis.

5 As You Sow Analysis; *see also* "Mounting Debt and Credit Downgrades" section below for detail on this analysis.

dividends, as profit margins declined. Whether this increasing indebtedness is reflective of historically low interest rates, or was necessary to fund the increasing costs of reserve replacement and dividends, the oil majors' debt positions are structurally distinct from what they were 15 years ago. Recent credit rating downgrades show that rating agencies are starting to take notice.

- **Decreasing Cash:** Also from 2000-2014, several of the oil majors had significant decreases in cash reserves, resulting from increased spending, lower profit margins, maintenance of dividends and/or share repurchases, and debt servicing. In particular, Exxon's cash reserves have plummeted since 2008, ConocoPhilips' cash peaked in 2010, and Chevron's cash peaked in 2012.[6] An eroding end cash position and a weak revenue outlook heightens the potential for credit access and repayment problems.
- **Oil Price Collapse Exacerbates Financial Situation:** The oil majors' decade-long trend of financial stress has been exacerbated by oil prices collapsing in mid-2014. It is unclear how long the oil majors can weather the low price market, even with 2015 reductions in capital expenditures and a focus on low cost projects. The majors' balance sheets also face increased pressure as the companies continue to support high dividends to assure investors of the companies' financial strength, even when doing so requires companies to cannibalize earnings and potentially take on more debt.

Demand Constraints & Mounting Social Pressures — Compounding changing market and financial conditions, an array of technological, environmental, political, and social factors currently render the scale of future oil demand growth uncertain. The potential for peaking or even declining demand should raise significant concern for oil majors and investors.

- **2015 Paris Accord & other regulations.** The 2015 COP21 Paris Accord solidified global policy and resulted in a multilateral commitment to maintain global warming below 2-degrees Celsius — a goal requiring dramatic greenhouse gas emission reductions. At the same time, an array of laws across the world are being enacted to respond to climate change. Critically, the majors' oil demand projections do not comport with a 2-degree scenario.
- **Energy emissions decoupling from economic growth.** In 2014, the world saw the first modern example of economic growth decoupling from energy emissions on a global scale, undermining the long held assumption that fossil fuels are required for economic growth.
- **Competitive technologies.** The majors' own reporting recognizes the significant power that fuel efficiency and other technologies, including electric vehicles, have to markedly reduce oil consumption. These technologies are rapidly penetrating the regions from which the majors expect most future oil demand increases to emerge.

As the world moves to address climate change,[7] and as new regulations and technology slow or reduce demand for oil and other fossil fuels, risk to oil and gas companies escalates. Already, demand for oil has stabilized and even fallen in OECD countries, despite rising gross domestic product, due primarily to the success of fuel efficiency standards and technology innovations. In an increasingly low carbon economy marked by declining oil demand, marginal oversupply can sufficiently decrease price so that higher cost producers become unprofitable. This market positioning has created permanent vulnerability for oil majors.

This paper does not argue that any future is foretold for oil majors or the larger community of independent oil producers — only that acknowledging signs of change and planning appropriate action is imperative. While each company must forge its own path, shareholders must be confident that oil majors are sufficiently proactive in remaining competitive; there is tremendous opportunity cost in delaying responsive action.

New policies, such as carbon pricing, could help send the market signals necessary to help ease this transition. Similarly, dramatic cost reductions, including substantial technology innovations, would help reduce some aspects of investor concern. Other potential strategies include:

6 As You Sow Analysis; *see also* "Decreasing Cash" section below for detail on this analysis.

7 For an example of global regulatory action on climate change, see "Historic Paris Agreement on Climate Change: 195 Nations Set Path to Keep Temperature Rise Well Below 2-Degrees Celsius," *UN Climate Change Newsroom*, December 12, 2015, **http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/**.

1. Shrink to grow. Majors have the option of divesting areas of their business that are not profitable at low oil prices, and operating as leaner, stronger companies. This is the strategy recently adopted by ConocoPhilips and discussed in depth by a recent Carbon Tracker analysis.[8]

2. Yield companies, Master Limited Partnerships, Royalty Trusts. Yield companies, Master Limited Partnerships (MLPs), and Royalty Trusts offer tools for oil companies to create stand-alone business units out of their riskiest divisions or assets, protecting the stable and value generating elements of their companies, reducing capital costs for their primary company, and helping to resolve mounting threats to liquidity.

3. Legacy production. Rather than pursuing unconventional resources, the majors could continue to produce their remaining conventional reserves, which are substantial. This strategy is likely be more successful in combination with diversification, including diversification into renewable energy resources.

4. Diversify into growing areas of the energy sector. It is becoming evident that investment in sustainable technology is now more likely than oil to have a place in the emerging low carbon economy. Total provides an example of an oil and gas company successfully diversifying into low carbon technology.

> "[T]o continue to attract investors and capital, the oil and gas industry as a whole must develop a value proposition that is consistent with its core production not growing as overall production growth may not be possible for all players."
>
> – World Economic Forum, Davos 2016

5. Consulting. Like Xerox and IBM, which successfully shifted from hardware into services in the face of market and technology changes, the majors have specialized expertise they can offer oil markets. Indeed, the majors already do provide significant consulting services to NOCs, an area which could feasibly grow.

History is replete with companies that failed to recognize the inevitability of change in their markets. This paper examines the claim, which is echoed to some degree by all oil majors, that there is little risk to the companies' ability to conduct business as usual. While acknowledging the importance oil has played in the successful economic development we have experienced over the past century, it is incumbent on investors, markets, and the oil companies themselves, to recognize the growing markers of change that will affect their future. Once dominant players in world markets, oil majors now share problems found at many risky companies, including increasing cost structures, deteriorating financial fundamentals, changing demand for their product, and management that has failed to address key areas of risk. This report considers oil majors' present and future prospects, and the market forces that, over the next three decades, will reshape them.[9]

8 McNulty, Sheila, "Shrink-to-Grow Strategy at Heart of Conoco Break Up," *Financial Times*, July 14, 2011, **http://www.ft.com/cms/s/0/cae109f4-ae33-11e0-8752-00144feabdc0.html#axzz49v1dQSR7**; see "Sense and Sensitivity: Maximising Value with a 2D Portfolio," *Carbon Tracker Initiative*, May 2016, p. 7, **http://www.carbontracker.org/wp-content/uploads/2016/05/Sense-Sensitivity_Full-report2_28042016.pdf**; *see also* "Future of Oil & Gas," Global Agenda Council on the Future of Oil & Gas, World Economic Forum, p.4, April 2016, ("Companies will also have to consider when it no longer makes sense to continue exploration for new resources in high cost, long lead time environments."). **http://www3.weforum.org/docs/GACFutureofOilandGas_Executive_Summary.pdf**.

9 Even though smaller, investor-owned exploration and production companies, or "E&P" companies, are likely more acutely vulnerable to changing market fundamentals than oil majors — because they are generally smaller, not integrated, and do not have equivalent capital resources — we do not specifically address them in this paper. This report focuses on oil majors because these large cap companies are often perceived by both analysts and investors as strong and relatively invulnerable investments. Because oil majors represent billions of dollars of value, their growing risk is significant to investors and to the economy and therefore worth specific analysis. According to *Chatham House*'s recent report, *International Oil Companies: The Death of the Old Business Model*: "Together [the majors, excluding ConocoPhilips, which had a market capitalization of approximately $55 billion in June 2016 (Yahoo Finance)] have a market value of $994.5 billion, which is larger than the 2012 GDP of the Netherlands and New Zealand combined. The [majors] are also a core concern for pension funds . . . pension funds and individual retirement accounts make up 47 per cent of the share ownership of U.S. oil companies in the S&P 500 index." *See* Stevens, Paul, "International Oil Companies: The Death of the Old Business Model," *Chatham House*, May 2016, p.30, **https://www.chathamhouse.org/sites/files/chathamhouse/publications/research/2016-05-05-international-oil-companies-stevens.pdf**. For more information on E&P risk, see "Oil and Gas Exploration and Production," Markets, *The New York Times*, **http://markets.on.nytimes.com/research/markets/usmarkets/industry.asp?industryStartRow=1**.

I. FINANCIAL INDICATORS OF STRUCTURAL RISKS

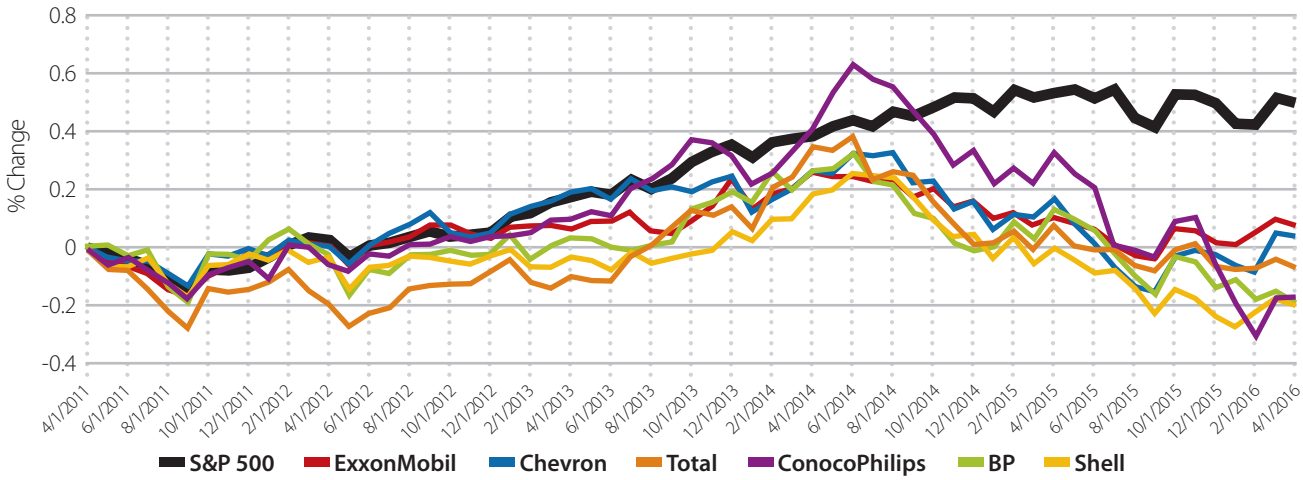
Financial indicators of structural risk in the oil industry have become more pronounced over the last decade. As outlined below, 2000-2015 was characterized by key trends which, when considered in combination, culminate in growing risk for oil majors, which neither the market nor the oil majors appear to have internalized. [See Appendix for company specific graphs on these key trends.] Indeed, with some exceptions the majors have generally trailed the S&P since 2012. Only in the face of the 2014 price drop, however, have global energy and financial markets begun recognizing fundamental weaknesses in oil company investment profiles. For the most part, oil majors have not yet faced significant liquidity hurdles, nor have markets penalized them proportionately for long term declining performance and disadvantageous forward looking prospects. These outcomes are likely unless oil majors' business plans begin to reflect changing markets.

Oil Majors' Financial Stress Pre-dates the 2014 Oil Price Downturn

Oil majors' balance sheets shared red flags prior to the current low-price environment. Growing financial distress was evident before 2014, as the majors undertook investments assuming a long-term, high-price environment, and continued domination of financial and energy markets. The current low price environment has exposed many of those risks, and companies are now scrambling to manage declining revenues, record levels of debt, and a weak long-term demand outlook.

Many analysts believe that the 2014 downturn in oil prices is cyclical, representative of volatility typical of the oil industry, geopolitics, and temporary adverse market conditions. While oil prices can and likely will rebound to some degree, the 2014 downturn lays bare the majors' vulnerability to competition from low-cost producers seeking to increase market share, downward demand pressure from regulatory curbs on carbon, and competition from new technologies. Supermajor financial distress is not only a consequence of these changes, but may not be recoverable without strategic and responsive action that adapts company business models to evolving energy markets. By delaying adaptation to changing market circumstances, the majors run the risk that assets still on balance sheets, including certain reserves and downstream refining facilities, will lose their value over time.

Figure 1: Stock Performance (Adjusted Closing Price) of Oil Majors vs. S&P 500: April 2011 to April 2016



Declining Market Dominance

The erosion of oil majors' dominance of the S&P 500, as shown in the Figure 2, reflects the majors' declining importance to financial markets generally.[1] From the 1970s through the mid-1980s, oil was a primary driver of returns in the United States and global financial markets, but in the mid-1980s, tech companies like Apple and Microsoft began to eclipse oil companies. Now, the majors are significantly underperforming the S&P. [See Figure 1 above.]

Figure 2: Top Ten Companies of S&P 500 1980-2016

1980	1985	1990	2000	2005	2010	2016
IBM	IBM	IBM	General Electric	General Electric	ExxonMobil	Apple
AT&T	Exxon	Exxon	ExxonMobil	ExxonMobil	Apple	Microsoft
Exxon	General Electric	General Electric	Pfizer	Microsoft	Microsoft	ExxonMobil
Standard Indiana	AT&T	Phillip Morris	Citigroup	Citigroup	Berkshire Hathaway	Johnson & Johnson
Schlumberger	General Motors	Royal Dutch Petroleum	Cisco Systems	Proctor and Gamble	General Electric	General Electric
Shell Oil	Royal Dutch Petroleum	Bristol Myers Squibb	Walmart	Walmart	Walmart	Berkshire Hathaway
Mobile	duPont	Merck	Microsoft	Bank of America	Google	Facebook
Standard California	Amoco	Walmart	AIG	Johnson & Johnson	Chevron	Amazon
Atlantic Richfield	Bell South	AT&T	Merck	AIG	IBM	AT&T
General Electric	Sears and Roebuck	Coca-Cola	Intel	Pfizer	Proctor and Gamble	JPMorgan

Increasing Capital Expenditures

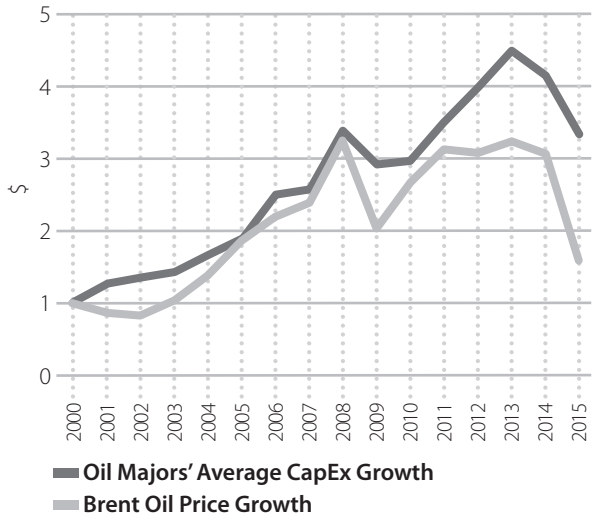
In the past decade, oil majors' total capital expenditures rose substantially, even while production and reserves remained stable or declined. Capital expenditures have increased in large part due to the substantial escalation in exploration and production costs associated with finding and developing new sources of crude oil, a problem that was masked by high oil prices until 2014.[2]

As analysts have noted, conventional oil discoveries peaked in the 1960s and new oil resources are harder to find and access.[3] PricewaterhouseCoopers notes that "[a]s exploration becomes more difficult and competitive, larger companies are relying more heavily on acquisitions and unconventional sources such as oil sands and shale formations to bolster reserves."[4] Developing unconventional reserves can be significantly more costly than developing conventional reserves due to a variety of factors; they tend to require unconventional extraction methods (shale and oil sands); are found in remote locations (Arctic); are located in countries that are politically volatile; and/or are often of lower quality, requiring more processing.[5]

Between 2000 and 2014, the oil majors' total capital expenditures grew by 308% to $166 billion in 2014.[6] [See Figure 1.] To give a sense of the outsized spending, from 2010 to 2014 the supermajors spent a total of $766 billion on capital expenditures, which exceeded their collective net income by $195 billion.[7] In comparison, from 2000 to 2009, the oil majors' collective net income was $109 billion larger than their capital expenditures.

Although prices were rising, since 2008 the rate of the majors' capital expenditures growth exceeded the rate of oil price increase, demonstrating a widening gulf between oil price and capital expenditure growth. [See Figure 3.] In 2015, capital expenditures were aggressively cut to respond to the 2014 drop in oil price; however, capital reduction opportunities are limited to the extent oil majors attempt to consistently replace their reserves and maintain steady production levels.[8]

Figure 3: Avg. Capital Expenditure Growth vs. Oil Price Growth: April 2011 to April 2016



Declining Production Levels

Despite escalating capital expenditures, the total oil equivalent production of the oil majors has declined 11.6% between 2005 and 2014.[9] [See Figure 4 below.] Similarly, high capital expenditures have not substantially benefited oil majors' production, which decreased 1.5% annually on average from 2009 to 2014 while capital expenditures rose 41%.[10]

Figure 4: Capital Expenditures

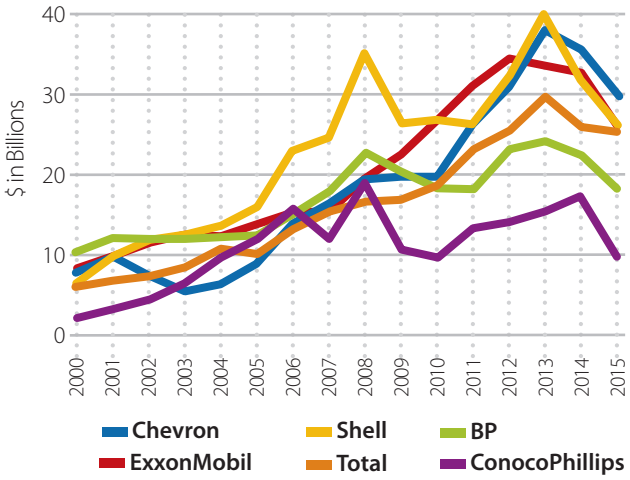
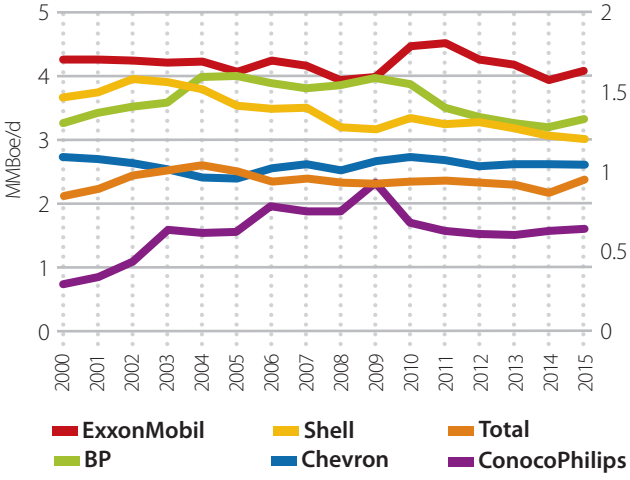


Figure 5: Oil and Gas Production



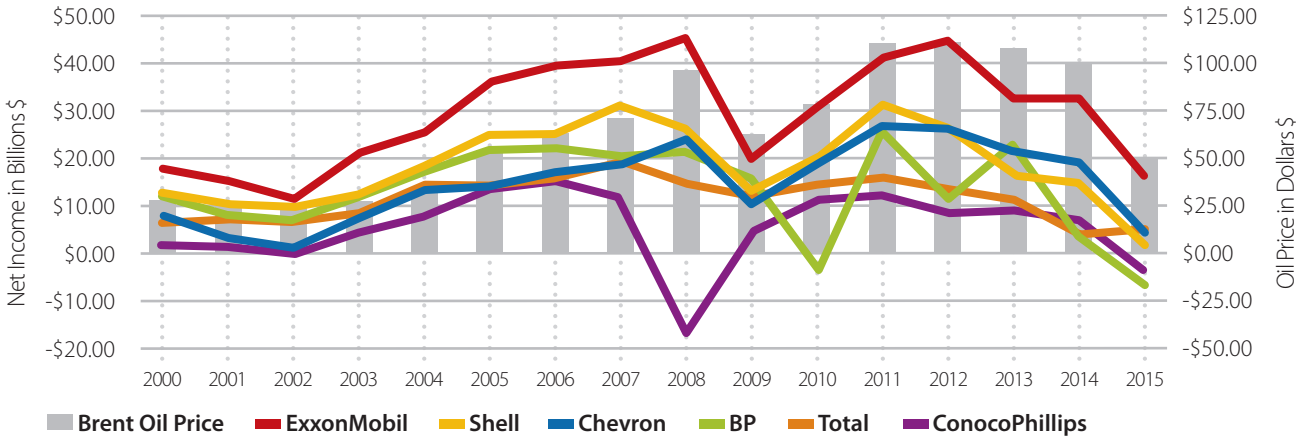
Oil majors' increased capital expenditures, in the face of marginally declining production, highlights a quandary: diminishing return on investment over the last decade. From 2011 to 2013, Goldman Sachs estimates that, on average, no major new oil project came online with production costs below $70 per barrel, with most projects requiring $80-100 oil costs to break even.[11] Expensive projects require high oil prices for profitability, raising the majors' risk of stranded, unprofitable assets if prices do not rise substantially and stay high into the future. The high oil price required for majors to break-even makes them especially vulnerable to the production choices of NOCs (which, as discussed below, control the vast majority of the world's remaining low-cost conventional crude reserves) and to declining demand, which will increasingly be a factor as the world moves to decarbonize energy systems. Oil majors have responded to the post-2014 oil price drop by reducing capital expenditures by an average of 18% by Q2 2015.[12] While capital expenditures on new oil reserves remain substantial, the declining expenditures will likely decrease future production while creating opportunities to ramp up investment in new business models, including renewable energy projects.

Declining Profit Margins

Oil prices annually averaging over $100 per barrel until early 2014, should have boosted oil major profit margins. In fact, oil prices reached highs above $120 per barrel between 2011 and 2013. Yet, instead of increased profit margins, the total net incomes of the oil majors' declined 47% from 2011 to 2014 due to increased spending; as oil prices collapsed into 2015, the oil majors' total net income fell another 79% through Q2 2015.[13]

Similarly, the majors' average return on equity (ROE) peaked in 2005. In 2014, the majors' average ROE was approximately 33% of what it was in 2005, suggesting a 10-year trend of decreasing profitability. In 2015, the average ROE was practically zero, at 0.2%. Consequently it is no surprise that the majors have been missing earnings targets since 2013.[14]

Figure 6: Net Income and Oil Price



Mounting Debt and Credit Downgrades

Oil majors' current level of debt, which has notably escalated over the last decade, presents additional concerns.[15] Between the years of 2000 and 2015, Exxon's debt increased 179%; Chevron's 147%; BP's 148%; ConocoPhillips' 261%; Total's 289%; and Shell's a noteworthy 686%. While various reasons exist as to why oil majors may raise debt capital — such as a favorable lending environment, low-cost money, promising investment opportunities, or financing balance sheet growth through merger and acquisition activities — the increasing debt taken on by the oil majors can also be a sign of structural stress. Starting in mid-2011, the oil industry's cash spending (including dividends, capital expenditures, and stock repurchases) began to outpace cash from operations, and the companies appear to have increased debt to compensate.[16]

Oil majors' debt increase has grown disproportionately to total assets. From 2005 to 2014, oil majors' average debt to assets ratio grew 9.5% to 15.7%, a 65% increase. In the same period, Exxon, Shell, ConocoPhillips, and BP's debt ratios all more than doubled. Significantly, unless oil prices rebound, the oil majors' debt situation appears increasingly problematic. Further, several majors have recently issued debt. For example, in 2015, Chevron issued $6 billion in bonds, 2016 brought a €2 billion issuance from BP, as well as Exxon's second largest debt issuance ever, at $12 billion.[17]

Figure 7: Total Debt

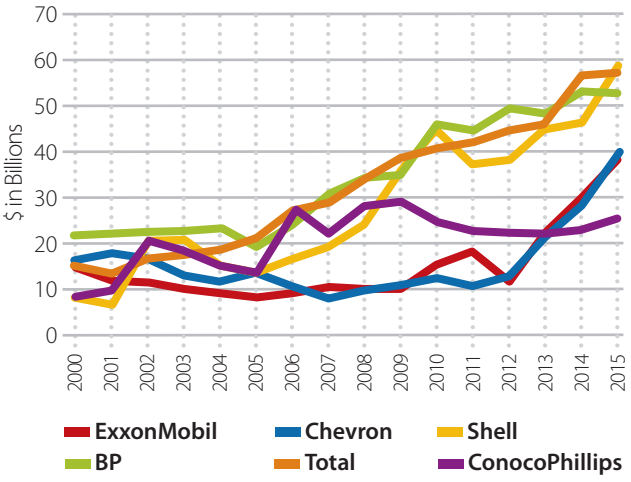
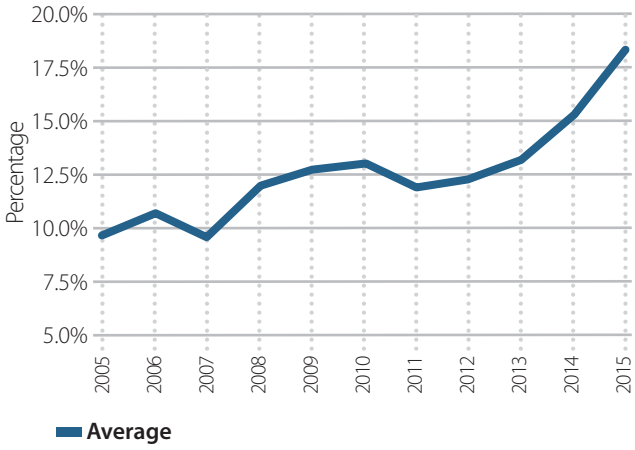


Figure 8: Oil Majors' Average Total Debt to Total Assets Ratio



Liquidity may become a problem for the majors with Q1 2016's landmark credit downgrades. In February 2016, S&P cut Chevron's credit rating for the first time in 30 years and, a day later, cut Shell's rating to its lowest since 1990. At the same time, S&P noted expectations that Total and Exxon could be next.[18] ConocoPhillips is also under review for downgrading, along with most of the shale gas industry. In cutting or threatening to downgrade credit ratings, S&P noted that slashing drilling budgets and other cost-cutting "are insufficient to stem the meaningful deterioration expected in credit measures over the next few years."[19] Indeed in April 2016, following Exxon's failure to replace its reserves, S&P downgraded Exxon's credit for the first time in 86 years, noting, amongst other issues, its concern that "[i]n our view, the company's greatest business challenge is replacing its ongoing production."[20] Moody's credit agency also advised investors it is reviewing oil majors' credit ratings for potential downgrades.[21] Not long after Moody's cut Exxon's credit rating, it lent a powerful endorsement to the Paris Accord by stating that, in assessing the credit implications of carbon transition risk for its baseline credit rating analysis, it would use a central scenario based on the national commitments put forward as part of the Paris Accord.[22]

Credit downgrades can result in higher capital costs, which can have serious implications for capital-driven industries like oil; downgrades also damage market confidence, which is currently one of the majors' most important assets. Generally weak price outlooks, and the increasing amount of capital expenditures necessary to replace reserves, suggest that existing debt levels may become unsustainable.

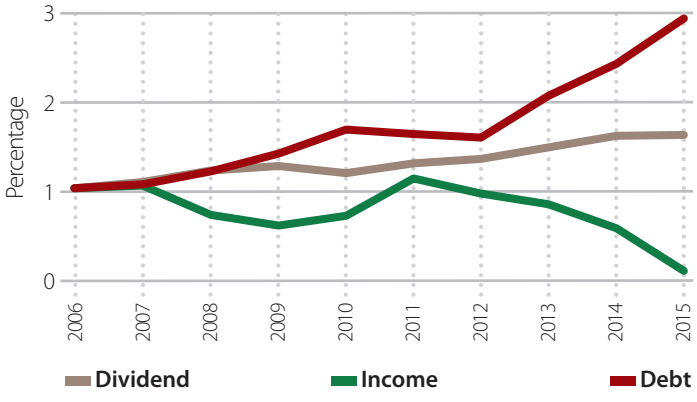
Decreasing Cash

Oil majors' increasing costs, reduced income, and mounting debt is escalated by their weakening cash positions. ExxonMobil's cash peaked in 2007 at $34 billion, and its net income through Q2 2015 is just a tenth of what it was in 2007, at $3.7 billion.[23] ConocoPhillips' cash peaked at $9.5 billion in 2010, but fell to $2.4 billion by 2015.[24] Chevron's cash peaked in 2012, falling from $21 billion to $11 billion in 2015.[25] The European oil majors have managed their cash more effectively, though their debt is proportionally higher than the U.S. majors', potentially masking a cash shortfall. Further, both BP's and Total's cash has declined.[26] With less cash available than in prior years, oil majors are financing dividends from debt, despite increasing credit risk.[27]

Risky Dividend Policies

Under typical business conditions, a company will issue dividends when its operations have generated excess net income or when profitable investments have been exhausted. Dividends, being an optional expense, are usually one of the first cuts made in response to falling net income. Yet, despite depressed net incomes, the majors are continuing to pay and even increase dividends, raising the possibility dividends are being financed by debt.

Figure 9: Dividend per Share vs. Income per Share vs. Debt per Share



Oil majors maintain investor loyalty by delivering value in the form of regular, substantial dividend payments.[28] Because consistent dividend payments are crucial in maintaining investor confidence, some companies have "declared their dividends untouchable."[29] As recently as November 2015, Total's CEO, Patrick Pouyanné, "stated that it would be a 'terrible mistake' to remove dividends and signal that 'we aren't good at our business.'"[30] Shell's CEO, Ben van Beurden, stated that he was "pulling out all the stops" to protect the dividend.[31] A former White House economist, Philip Verleger, told press that "[i]f [oil majors] cut the dividend, their share prices would plummet," noting that these companies are no longer viewed as growth

companies, but as sources of income to pension funds and retirees.[32] As a result of these pressures, between 2006 and 2014, oil majors' annual dividend payment per share increased approximately 65% on average, even while net income dropped 40% and total debt more than doubled.[33]

The 2014 oil price collapse further strained oil majors' ability to issue dividends, at a time investors were anxious to see dividends maintained. During the first nine months of 2015, Shell, ExxonMobil, Chevron, and BP's earnings fell by more than 70%, yet these companies endorsed dividend increases collectively averaging 10% above the previous years.[34] In 2016, ExxonMobil and Chevron announced their 33rd and 28th straight year of dividend growth, respectively.[35] As of Q1 2016, the only oil majors to decrease their dividends have been Total and ConocoPhillips.

Oil majors' focus on dividend payments placates shareholders in the short-term but ultimately increases enterprise risk in the long-term, raising the question of whether investments in these companies are sustainable.

Stock Repurchasing

Stock repurchasing is another area that raises questions about oil majors' financial management. Some oil majors have substantially increased stock buybacks in the last two decades. Company repurchasing of its own stock on the open market, known as stock buybacks, removes stock from circulation and reduces the total number of shares. This process can decrease volume to inflate stock prices and key financial ratios that are measured per share, such as earning per share, price to earnings ratio, price to book value, cash flow per share, and dividend growth. While buybacks can help management achieve earnings per share compensation targets and may boost short-term shareholder value, this value creation should not be confused with value created by improved operational performance.[36]

Over the last decade, oil majors have prioritized stock buybacks, repurchasing $364 billion of stock between 2005 and 2014.[37] Before the 2008 recession, oil majors were on a repurchasing spree, buying back $223 billion of their own shares, while issuing just $156 billion in dividends.[38] As the recession moved into full effect, and much of the gain from recent share buybacks vanished due to declining oil majors stock prices, buybacks were reduced at BP, Total, and Chevron, while modestly cut back at ExxonMobil, ConocoPhillips, and Shell.

Aggressive share repurchasing can mask balance sheet weakness, and can make a company's dividend payment appear larger than the total money spent on dividends by decreasing the number of outstanding shares [as seen in Figures 10, 11 below].[39] For instance, between 2005 and 2014, ExxonMobil's dividend grew 142%, but the total capital spent for dividends grew only 58%.[40] Further, 51% of ExxonMobil's earnings per share from 2003 to 2013 resulted from stock buybacks, not organic earnings growth.[41]

Figure 10: ExxonMobil's Dividends vs. Repurchases

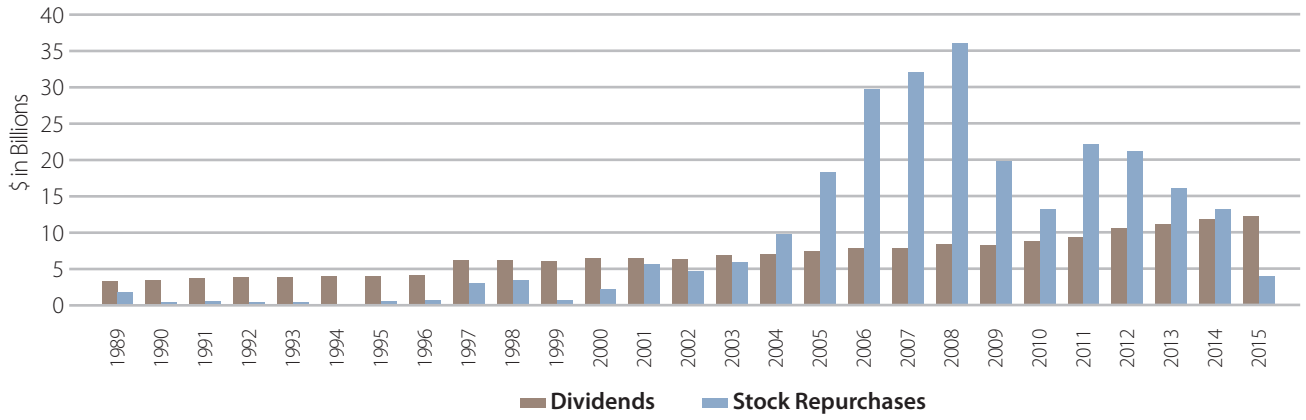
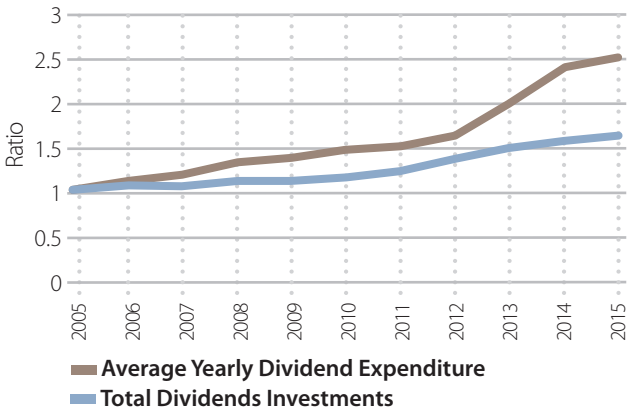


Figure 11: ExxonMobil's Dividend Inflation



Stock repurchasing also provides benefit to executives whose pay hinges in large part on stock price and stock options. "By artificially increasing the value of shares, stock buybacks inflate the equity-based pay that goes to top fossil fuel executives, further insulating these business leaders from pressure they might otherwise feel to shift to more sustainable . . . business models."[42]

Oil major executives that use large scale stock repurchasing programs prevent capital from being invested in the productive and competitive capabilities of the company, including investments in technology that can help the company diversify in response to decarbonizing energy markets.

Oil Price Collapse Exacerbates Financial Situation

Collapsing oil prices beginning in 2014 only exacerbated oil majors' long-term financial performance problems. While oil majors have cut as many costs as currently feasible and reduced capital expenditures, it appears questionable whether, as higher cost producers, they have sufficient financial strength to weather long-term commodity price challenges from NOCs.

Driven by periods of growth and recent price spikes in excess of $100 per barrel, the oil majors were planning to commit billions of dollars to higher-cost, higher-carbon unconventional projects. The Carbon Tracker Initiative estimated in May 2014 that oil majors had a total of $321 billion of capital expenditure planned through 2025 for projects that require over $80 per barrel crude oil price to break even.[43] This included $22.3 billion in Arctic drilling, $76 billion in oil sands projects, $102 billion in ultra-deepwater, and a variety of other high-cost project types.[44] During this time, supermajor investing strategy and decision-making appear to have been based primarily on optimistic oil price and demand forecasts, with little consideration for the potential that new market realities could dampen demand and oil prices in the near to midterm.

Such optimism is not supported by underlying market conditions. Weak and worsening financials; higher costs of exploration and production; increasing competition from renewables and disruptive technologies; impending climate change regulatory risk; productivity gains in fuel efficiency technologies; and competition from NOCs that can produce at significantly lower cost than oil majors, comprise a set of structural changes that do not yet appear to be fully incorporated into the majors' decision making. Further, oil prices are a "double-edged sword" for the oil industry. Low oil prices make it impossible to recover costs; high oil prices allow competitive technologies to gain a foothold, leading to irrevocably depressed long term demand, oversupply, and lower price.

Inadequate Risk Assessment from Wall Street

Though supermajors are facing noteworthy balance sheet distress, and have been for years, many investors remain bullish on oil majors, as evidenced by recently oversubscribed debt offerings from the majors.[45] Investor faith in the majors, despite contradictory balance sheet red flags, exists partly because sell-side analysis frequently fails to sufficiently account for unmanageable downside risks that could impact oil majors' future profitability. For example, most analysts seem to believe that while the downturn in the oil sector is serious, it is attributable to normal commodity market imbalances, rather than more fundamental structural changes to the oil market.[46]

In particular, the financial sector often fails to account for the growing likelihood that, even as price volatility smooths in the near term, climate change regulation creates serious long-term, and potentially near-term, challenges for the majors. This report reviewed several equity analyses by major financial institutions which, together, advise thousands of clients. None of these analyses discussed the implications of climate change.[47] Indeed, none of the reports reviewed use the words "climate change." While regulatory news is covered sporadically in sell side equity analysis, the accelerating global shift away from carbon-intense resources, and its potential for demand destruction, has yet to be meaningfully acknowledged across a significant portion of analysts and investors.[48] While some analysts have priced in these risks, much of the current oil sector analysis is focused on the projected outcomes of the next quarter; near-term price estimates; oil majors' investments in infrastructure; and near-term risk factors. Even where central banks, especially European banks, have done important research on the financial implications of climate change and carbon asset risk, these reports appear to be siloed. Aggravating factors, such as falling demand in OECD countries and growing global energy efficiency, are also generally not recognized.

Overinvesting is a foreseeable consequence of ignoring risk, as is the correction that follows when markets eventually recognize risk. Indeed, this has been played out before, as recently as the 2008 recession, when banks, investors, and consumers largely failed to recognize the toxicity of the assets in which they were investing.

II. ESCALATING SUPPLY COMPETITION

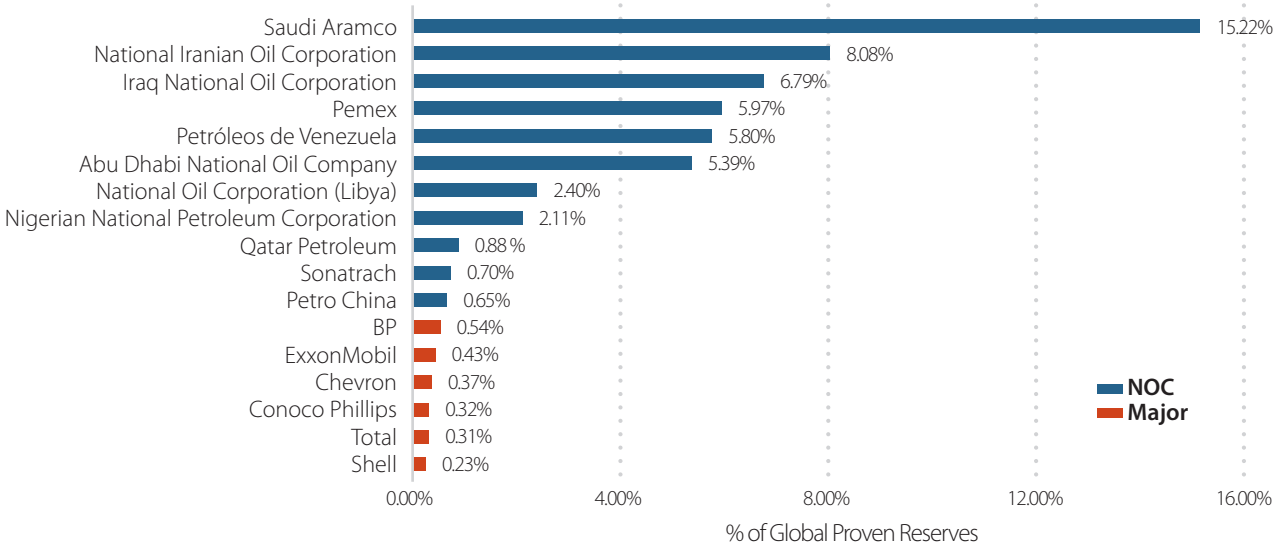
The size, scale, and role of oil majors in global oil markets is widely misunderstood. Even the words "supermajor" or "oil major" may lead investors to believe that oil majors have a much larger role in global oil markets than they currently do. In fact, oil majors represent a small slice of global oil production, and an even smaller proportion of global conventional (i.e., lower cost) oil reserves.

Supply Transition from Oil Majors to National Oil Companies

Fundamental changes in the control of global conventional oil supply has radically altered the market in which oil majors operate. In the 1950s, companies referred to as the Seven Sisters (Esso, Mobil, BP, Royal Dutch Shell, Gulf Oil, Chevron, and Texaco) owned or controlled 85% of global oil reserves.[49] In the 1970s, oil producing countries began asserting greater dominance over their national oil reserves, evicting private oil companies or pushing them into contractor or minor partnership roles. That transition is complete, and today, 90% of proved reserves are controlled by NOCs, while the oil majors now control just 2.2% of global proved reserves.[50] Other integrated international oil companies and wholly upstream companies account for the rest.[51]

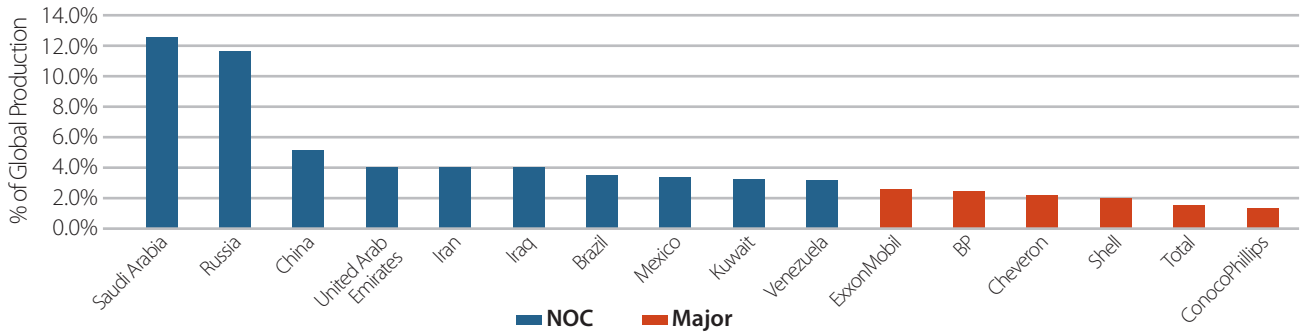
As a result of these changes, and contrary to popular perception, the largest energy companies by reserves are now controlled by governments.[52] Saudi Aramco, Gazprom (Russia), China National Petroleum Corp., National Iranian Oil Co., Petróleos de Venezuela, Petrobras (Brazil), and Petronas (Malaysia) are all larger than ExxonMobil, the largest of the oil majors by reserves.[53] The figure below compares oil majors' proved reserves to the proved reserves of large NOCs.

Figure 12: Percent of Global Oil Reserves: National Oil Companies vs. Oil Majors



The supermajors' declining role and market power in global oil markets is also reflected in production.[54] In 2010, state-controlled oil companies collectively controlled 75% of production.[55] From 2005 to 2014, oil majors' market share of global oil production dropped from 13.4% to 9.7%.[56] As shown below in Figure 13, each of the majors have lower production than Saudi Arabia, Russia, China, UAE, and Iran, respectively.[57] However, in terms of potential production through 2035, the private sector is as significant as the NOCs, depending on oil price.[58]

Figure 13: Percent of Global Production (2014): Majors vs. Oil Producing Countries



Oil Majors Are Becoming Higher Cost Producers

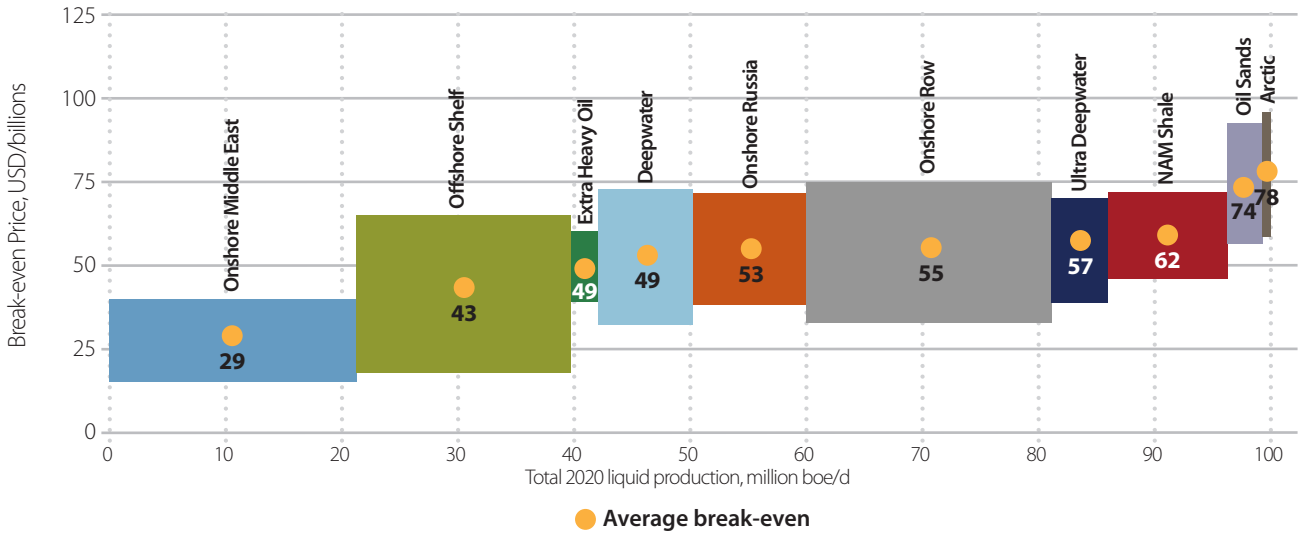
As a result of this transition, a majority of low cost oil reserves are now controlled by countries and associated NOCs.[59] The countries that can produce oil at an average cost of $25 per barrel or less, namely Saudi Arabia, Russia, Iran, Iraq, UAE, Algeria, Kuwait, Venezuela, and Libya, have national oil companies that dominate production in those regions.[60] Indeed, these nine countries alone, which are only a subset of the NOCs and can produce for only $25 per barrel, could meet 112% of oil demand through 2050 in a 2-degree emissions scenario, leaving little room for global competition.[61]

In contrast, oil majors' exploration and production costs have risen as their access to conventional crude has declined. Bain & Company notes that "new conventional finds — oil that is relatively easy to access on land or in shallow water — are fewer and smaller."[62] Although majors currently have low cost reserves in their portfolios (below $60 per barrel), they are estimated at approximately a quarter of the low-cost reserves possessed by NOCs.[63] As these

conventional reserves decline, they must be replaced with higher cost sources. Since 2008, oil majors' conventional proven reserves dropped by almost five billion barrels.[64] As an example, in 2014, ExxonMobil's resource base, which includes proved reserves and other reserves likely to be developed, is reported at approximately 20% for conventional oil and gas.[65] The rest of its oil resources are unconventional, including shale, oil sands, Arctic projects, etc.[66]

The average break-even point for unconventional oil methods, as estimated by Rystad Energy, are $53 per barrel for deepwater, $62 per barrel for North American shale, $74 per barrel for oil sands, and $78 per barrel for Arctic, while onshore Middle East break-even costs average $29 per barrel or lower.[67] [See Figure 14 below.]

Figure 14: Break-even Prices for Non-producing Assets

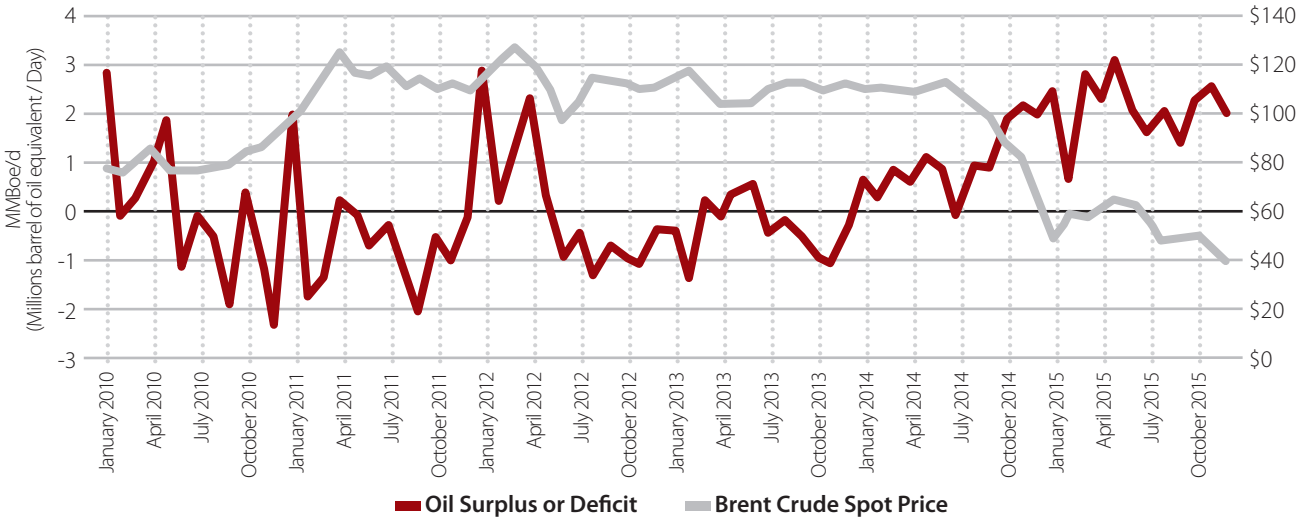


In some of the least expensive countries to produce oil, including Saudi Arabia, Iran, and Kuwait, foreign companies are not allowed to develop or explore for oil other than through a production-sharing contract or as a subcontractor or vendor of technical services.[68] Majors have contracts (joint ventures, production sharing agreements, etc.) with oil producing countries for various services, but among the 20 countries with the largest oil reserves, foreign companies only have unfettered access to four—Canada, United States, Brazil, and Norway.[69] An understanding of oil majors' limited access to oil producing countries' reserves helps explain the majors' pursuit of high-cost and high-carbon reserves.

Supply Transitions and Factors Leading to the Mid-2014 Oil Price Collapse

While not widely understood, relatively small changes in oil supply or demand can create dramatic effects on the price of oil. In the past 10 years, oil surplus or deficits have occurred due to imbalances within the range of 2-4 mb/d, or only 3-4% of global supply.[70] These relatively small surpluses and deficits have considerable oil price impact. For example, during the 2014 oil price collapse, a 2 mb/d surplus existed — about 2% of global supply — inciting an average price collapse of $60 per barrel between June 2014 and December 2015. [See Figure 15.][71] The fact that relatively small deficits or surpluses in oil supply can significantly shift global prices suggests the power large oil producers potentially wield over global oil markets. For instance, the U.S., Saudi Arabia, and Russia all produce over 10 mb/d, and the 2015 supply surplus represents only 15-20% of these countries' respective production levels.[72]

Figure 15: Global Oil Surplus and Deficit vs. Oil Price



The dramatic growth of U.S. tight oil production from shale deposits was one of the primary factors leading to the 2014 oversupply of oil and subsequent price collapse. Between 2009 and 2013, this supply increased 2 mb/d.[73] This new resource provided U.S. oil production with its first major upturn since oil production in the lower 48 states peaked in the 1970s,[74] making the U.S. the largest oil producing nation in the world in 2014, overtaking both Saudi Arabia and Russia.[75]

The "shale revolution" relied on unconventional oil production methods, such as hydraulic fracturing.[76] The break-even price of shale oil differs by play, by producer, and even by well, with the lowest 2014 average breakeven cost at $42 per barrel in the Eagle Ford and the highest at $80 per barrel in the Wolfbone play.[77] From 2011 to 2015, the breakeven costs of producing shale oil dropped by approximately 50%, depending on play, for a variety of reasons, including improved drilling techniques.[78] Yet, in 2015, cost ranges for shale oil production were still projected to be near $50 per barrel in four out of five major plays, remaining vulnerable to underpricing by NOCs with lower production costs.[79] This higher cost is due, in part, to the fact that continued investment and drilling is necessary to maintain output of shale wells due to their rapid decline rates.[80]

In 2014, the U.S.' cost vulnerability was exposed as Saudi Arabia and other producers within the OPEC not only failed to constrain production to maintain high oil prices, but increased production levels.[81] Historically, Saudi Arabia has exerted a stabilizing force in world oil markets, constraining production where necessary to maintain high oil prices; but in late 2014, Saudi Arabia declined to continue playing this role. With approximately 34.2% of global market production and 73% of the world's proven reserves represented in OPEC's membership, OPEC countries currently have the ability to determine global oil market price dynamics.[82]

As described in greater detail below, in addition to excessive oil production from the U.S. and OPEC members, oil prices were also affected by weaker than expected demand from China and OECD countries, increased efficiency, and growing fuel substitution.

Increased National Oil Company Production Post-2014 Oil Price Collapse

Since the 2014 oil price collapse, some of the largest NOCs have added production, compounding the oversupply and low oil price situation. From 2014 to 2015, several oil exporting countries have sustained or increased production levels, including Iraq, which increased its oil production 16%, adding slightly over 1 mb/d of oil to the global market.[83] In 2015, Iran stated an intent to raise oil production "at any cost" to defend the country's market share, which it has

since executed, facilitated by the recent end of United Nations' economic sanctions against it.[84] In total, OPEC crude oil production has grown over 1 mb/d from May 2014 to December 2015.[85] Due to this continuing oversupply, prices have remained relatively low, despite U.S. oil production's slow decline since March 2015.[86]

Saudi Arabia's Role in Global Oil Markets

As one of the largest oil producing countries, Saudi Arabia plays a crucial role in the global oil market. In December 2015, it is estimated that Saudi Arabia produced 10.1 mb/d, which accounts for approximately 10.6% of global supply, and 31% of OPEC's production.[87]

Many traditional motives have been assigned to Saudi Arabia's failure to cut production in the face of oversupply caused by the U.S. shale boom. One popular theory is that Saudi Arabia has geopolitical objectives, including undermining Russia and Iran, which derive much of their profits from oil revenue and build federal budgets around high cost oil.[88] Another theory is that Saudi Arabia is seeking to retain market share by producing below the cost of North American shale oil producers.[89] If either or both are motives, the desired goal is being achieved. Russia and Iran's economies are being negatively impacted by low-priced oil.[90] Similarly, many U.S. producers have, temporarily at least, shut down wells and cut back oil production and capital expenditures.[91]

Yet, despite these changes, Saudi Arabia has yet to cut production.[92] This maintenance comes at a high price. Saudi Arabia and other nations with government budgets built on expectations of high oil prices are experiencing severe impacts by continuing to produce at levels that reduce oil prices.[93] For example, Saudi Arabia issued a substantial amount of its first-ever sovereign debt, and made first-ever cuts to its famous subsidies and welfare benefits system, which includes free healthcare and education for residents.[94]

> "Thirty years from now there will be a huge amount of oil — and no buyers. Oil will be left in the ground. The Stone Age came to an end, not because we had a lack of stones, and the oil age will come to an end not because we have a lack of oil."
>
> — Sheikh Ahmed Zaki Yamani, former Oil Minister

What, then, is the motivation for continuing production at levels that cause such hardship? There may be an additional goal served either directly or indirectly by Saudi Arabia maintaining production during a period of low prices. Given the increasing impacts of climate change, and the recognized need to decarbonize energy systems, Saudi Arabia's leadership may be seeking to monetize the country's oil assets to the greatest extent possible before they become stranded.[95] As the former oil minister, Sheikh Ahmed Zaki Yamani, said, "Thirty years from now there will be a huge amount of oil — and no buyers. Oil will be left in the ground. The Stone Age came to an end, not because we had a lack of stones, and the oil age will come to an end not because we have a lack of oil.[96]"

Recently, Saudi Arabia announced its intention to transition to a post-oil economy, and released Vision 2030, an extensive roadmap for this transition, including a suite of policy changes to diversify the nation's economy away from oil.[97] For example, Deputy Crown Prince Mohammed bin Salman has recently laid out plans to sell stock of Saudi Aramco to start a $2 trillion Public Investment Fund, with the purpose of diversifying the kingdom's income sources beyond oil.[98]

For perspective, at Saudi Arabia's 2015 production levels, its proved reserves, if accurate, could last up to 70 years, or until approximately 2085.[99] In a 2-degree scenario, at its 2015 market share level, Saudi Arabia would only be able to monetize 39% of its reserves.[100] Maintaining high production levels even in a low-price environment not only allows Saudi Arabia to gain market share, but also reduces the long-term risk of stranded assets by selling more of its oil, more quickly.

Regardless of why Saudi Arabia has not curbed its production, oil majors face systemic long-term risk from NOCs.[101] OPEC's refusal to reduce production despite the resulting low oil price may suggest a pivotal shift in oil markets. Where supply is no longer managed for high prices, but to gain market share or liquidate reserves, low-cost producers have the least amount of risk, while high-cost producers are more heavily exposed to commodity price risk.

Oil majors today face a historically unique set of market challenges in which they hold diminishing influence over market share, must seek increasingly high cost reserves, face a global move away from fossil-fuel based energy, and, at least for now, must compete in a world without OPEC price controls. The Saudi Arabia oil minister recently noted that,

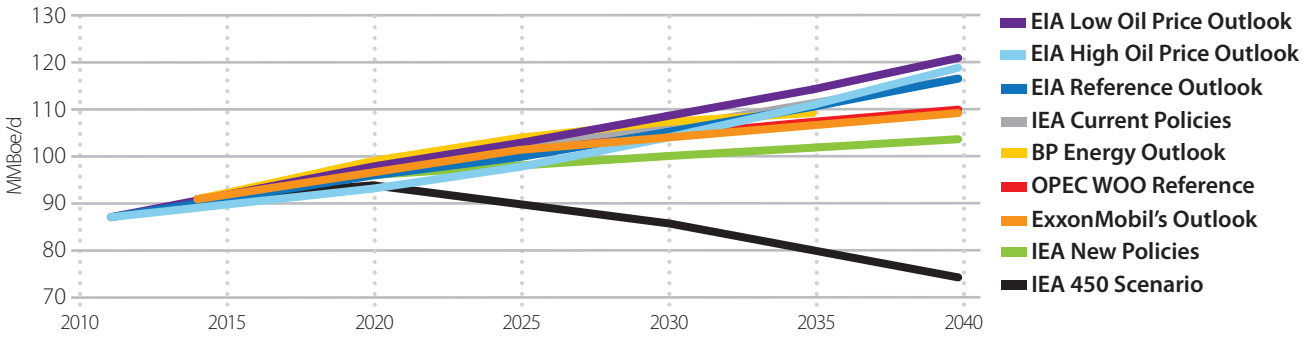
> Efficient markets will determine where on the cost curve the marginal barrel resides. The producers of those high-cost barrels must find a way to lower their costs, borrow cash or liquidate. It sounds harsh, and unfortunately it is, but it is the most efficient way to rebalance markets. Cutting low-cost production to subsidize higher cost supplies only delays an inevitable reckoning.[102]

This sentiment underscores the need for oil majors and investors alike to recognize and respond to changing market realities. Responsive steps may include stress testing, a 2-degree business plan, curbing development of high-cost, high-carbon projects, and diversifying their energy portfolios.[103]

III. ENERGY TRANSITIONS AND OIL DEMAND DESTRUCTION

Moving into the future, oil demand remains uncertain. Currently, energy agencies and oil industry outlooks, outside of the IEA's 450 ppm case (which corresponds to a 2-degree Celsius scenario), predict that global oil demand will continue to rise until 2040, growing between 10-30% [See Figure 16 below.][104] These outlooks and the oil majors' demand expectations rely significantly on increasing liquid fuel demand in developing countries, with relatively modest decreases or slight increases in OECD oil demand. While demand for liquid fuels is likely to increase in developing countries as industrialization occurs, the amount of demand remains in substantial question. A range of factors suggest that oil and gas may not play as large a role in those markets as it has historically in developed nations. Already, regulations and technology disruptions are in play, which could reduce demand more than expected in these outlooks.

Figure 16: Demand Outlooks



Bullish demand projections are often used to justify oil exploration and production investment but, as described below, long-term historical outlooks have not accurately forecast energy demand and changing energy markets, missing important trends. The oil industry is currently vulnerable to multiple factors that can corrode long-term global oil demand — leaving the future uncertain for oil majors and their shareholders. As the recent extreme changes in the U.S. coal market demonstrate, a combination of competition, technology disruption, increasing energy efficiency, and air quality protections can lead to decreased demand.

Energy Transitions

The lessons of history are clear: no energy product is safe forever. Oil has not always been the primary energy resource. Big Oil had predecessors in the form of Big Timber, Big Whale Oil, and Big Coal, and dramatic energy transitions occurred in each of these areas. According to research from Boston University, "Energy consumption in the U.S. shifted from 70% wood in 1870, to 70% coal in 1900, to 70% oil and gas in 1960."[105] These shifts occurred within a space of 50 to 100 years or less, or occurred simultaneously, underscoring how quickly economies can adapt to a new, more convenient, affordable, or otherwise advantageous energy source or technology.

Energy transitions are often incited by disruptive technology. From the 1700s through the mid-1800s, wood was the controlling fuel source in the U.S.[106] Wood was eventually wholly replaced by the burning of coal for power.[107] A few decades later, whale-based energy began and then it too was rendered obsolete. Disruptive technologies emerged in new refining techniques to extract kerosene from crude oil, as well as by less expensive, less risky, and more convenient alternatives, such as coal.[108] These transitions share important market conditions with those occurring in current oil markets, including cost increases, energy options with improved functionality (low carbon), and competition from new market entrants.

Consumers worldwide have demonstrated extreme aptitude for adopting and accelerating rapid technology shifts. The most relevant example is the "digital revolution" in which consumers globally transitioned from analog, to digital, to mobile technology. Both phones and cameras were established technologies for over 100 years when the digital revolution caused these products to rapidly shift to digital formats. This process took down some of the U.S.' most established brands and companies that either decided not to make a shift in the face of changing circumstances or took action too late.[109]

One of the most iconic examples of the failure to adapt to quickly shifting consumer preferences and changes in technology is Polaroid.[110] With $3 billion in revenue in the early 1990s, Polaroid was a leading Fortune 100 company and famous U.S. technology brand.[111] Fifteen years later, a company that had ruled photography in the U.S. and, much of the world, for 70 years was bankrupt and its primary product became a cultural symbol of nostalgia. Polaroid failed to adapt to digital technology and its demise took just five years.[112] Just prior to the company's fall to digital cameras, Polaroid's CEO told the press, "[a]nyone who says instant photography is dying has his head in the sand."[113]

Another form of technology transition is "leapfrogging," in which developing countries readily adopt cost-effective, advanced technologies, a process facilitated by the fact that these countries are less encumbered by entrenched prior technologies, infrastructure, and sunk costs. The most iconic and relevant example of leapfrogging is found in the telecom industry, where developing nations effectively leapfrogged cost-prohibitive, fiber-optic-line infrastructure by adopting wireless communication technologies.[114] Mobile phones had an astounding annual growth rate of 60% in Africa.[115] As of "2005, the fastest growing mobile phone markets, China and India, added 1.3 million mobile phone subscribers every week and 1.77 million subscribers every month respectively."[116]

As was the case with mobile phones, the costs of building centralized energy transmission systems can now, in large part, be avoided by instead adopting increasingly cheap and effective low-carbon alternatives already being deployed in OECD countries, including distributed renewable electric power. Renewable energy is particularly well-suited to lower income countries where, once installed, the energy resource itself is not only free, but pollution free. This cheaper energy source threatens to also destroy demand for more costly liquid fuels and liquid fuel infrastructure. Electric vehicles can be charged from solar infrastructure, especially as battery technology matures and becomes

significantly cheaper. In turn battery technologies are likely to reach economies of scale more quickly due to widespread adoption of renewables used in conjunction with storage.[117] Significantly, then, developing nations do not need to leapfrog cars, transportation, or electricity to develop successfully; they only need centralized power plants and internal combustion.

There are several lessons one should take away from such energy and technology transitions. Consumers and societies are happy to rapidly substitute products that help consumers meet their needs faster, more cheaply, or more conveniently. Changing market fundamentals can eliminate once-leading companies unpredictably; maladaptive firms may not be able to withstand even the first five years of what is ultimately a decade's long transition to new energy technology norms. Time and again, companies in the crosshairs of history fail to recognize the precariousness of their situation and the need to appropriately, and often times, quickly adapt and diversify their product or business model.

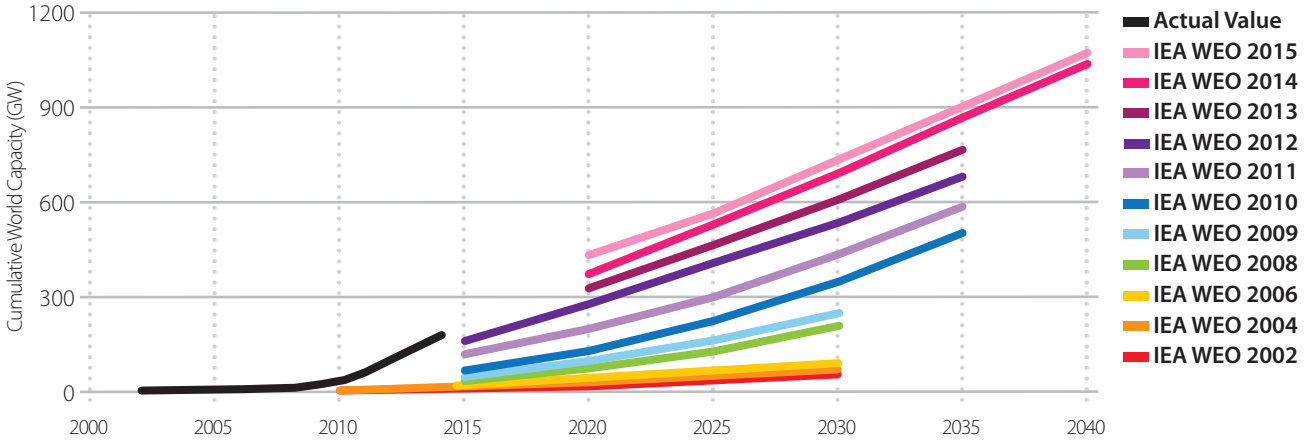
Inaccuracy in Predicting Energy Transitions

Like other industries that failed to adapt in a timely way, part of the reason may have been a "demand misread."[118] Research and projections from the EIA and the IEA are often used by the financial sector to justify significant investment in particular energy sources. Oil companies also use selected agency scenarios in their analysis of demand. These agencies have been bullish on oil demand, bearish on disruptive technology and, significantly, have not adequately addressed climate change in their reference scenarios. While these agencies' short-term forecasts are generally fairly reliable on the scale of months, they often make significant errors in projections of multi-year trends.[119]

Renewables

The IEA's reference case scenario significantly underestimated the actual, exponential increase in deployment of wind and solar. For example, in 2006, the IEA predicted that it would take 24 years to reach 87 gigawatts (GW) of global solar capacity, but this capacity was surpassed by 2012, four times faster than the IEA predicted.[120] From 2004 to 2015, the IEA's reference case projection of 2030 global solar deployment increased 857% from its original forecast of only 76 GW.[121] Wind projections followed a similar trend, with the IEA's projections for 2030 global wind capacity increasing more than three-fold (328 GW to 1,046 GW) from 2004 to 2015.[122] In contrast, the entity that most accurately predicted the actual growth of solar markets was the nongovernmental organization Greenpeace. Greenpeace's 2004 solar deployment projections, while bold at the time, matched historical outcomes more accurately than the IEA's.[123]

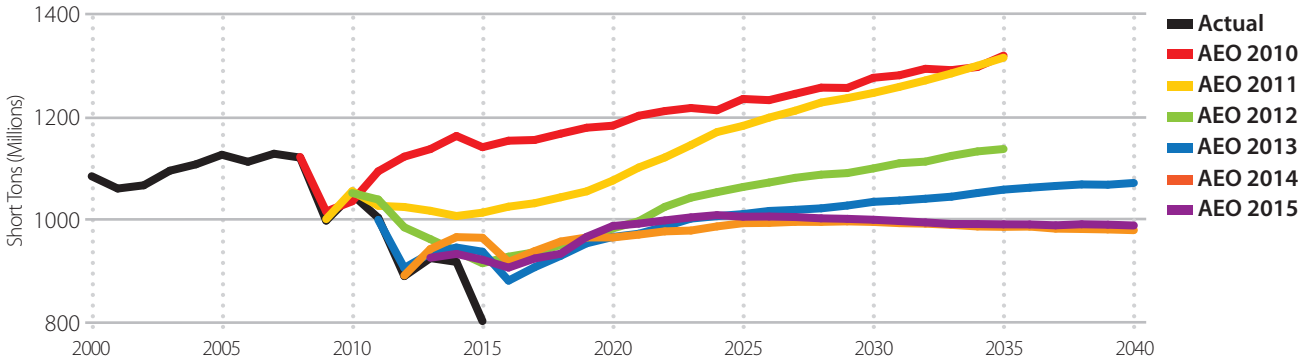
Figure 17: IEA Global Solar Capacity Projections Over Time



Coal

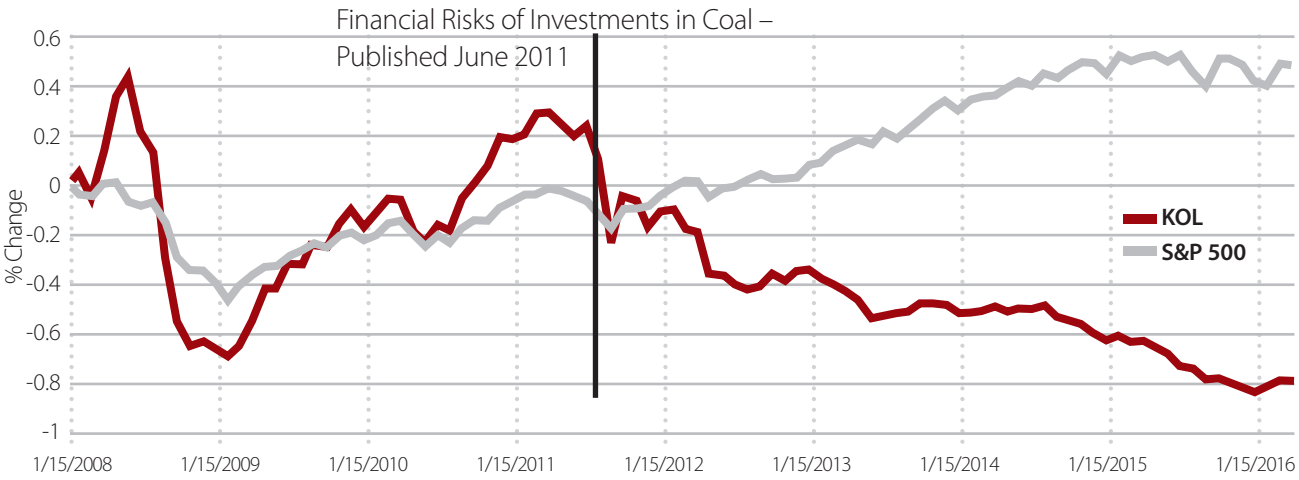
Another significant energy transition not recognized in a timely manner was the rapid decline of U.S. coal-fired electricity generation. In 2007, the peak of U.S. coal use, the EIA's Annual Energy Outlook reference case projected that U.S. coal consumption would *increase* 50% by 2030.[124] In reality, coal consumption significantly declined in most states between 2007 and 2015, marking the beginning of a permanent electric power transition away from coal.[125]

Figure 18: U.S. Total Coal Consumption vs. EIA Projections in Coal



In contrast, in 2010, As You Sow foretold, in its ***Financial Risk of Investing in Coal*** report, the near-term decline of the U.S. coal industry based on clear and publicly available indicators, including the falling price of substitute resources, growing public concern over coal's negative environmental impacts, and increasing regulatory risk, among others.[126] As show in Figure 19, the value of the coal industry fell precipitously following the report's publication suggesting such an outcome was possible.

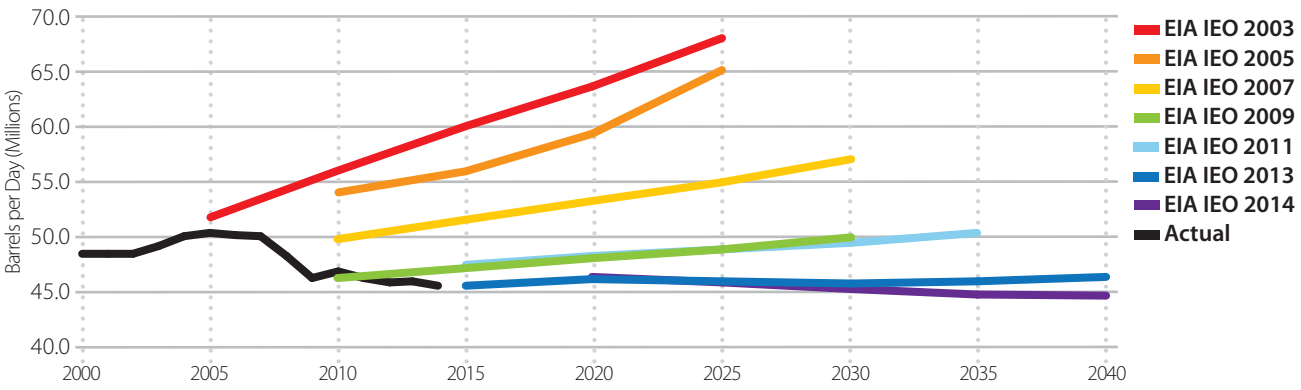
Figure 19: U.S. KOL Market Vector vs. S&P 500



OECD Oil Demand Decline

The EIA and IEA also inaccurately projected oil demand. For example, as shown in Figure 20, oil demand in OECD nations peaked in 2000, but the EIA's IEO reference case continued to project a rise in demand until its 2011 International Energy Outlook release, thereby not recognizing OECD's declining demand for *11 years*. Similarly, the IEA generally overestimated oil consumption over the last 15 years, including missing predictions of peaking OECD oil demand.[127]

Figure 20: EIA Forecast of OECD Oil Demand (Mb/d)



Projections must be recognized for what they are, forecasts of possible future outcomes based on current information. Investors should note the uncertainty and difficulty of accurate projections of energy market performance, even at the most sophisticated energy agencies in the world. The retrospective record of inaccuracy in some of the EIA and IEA's projections underscore the complexity involved in forecasting the scale of disruptive energy sector trends, the growth and uptake of new technologies, or even to forecast energy demand in the mid- to long-term. This is a cautionary tale that investors should take into account when assessing oil majors' bullish predictions about oil demand, the likelihood of success of potential substitutes, and the majors' risk analysis going forward.

GDP Decoupling from Energy Emissions

For decades, fossil fuel consumption and GDP growth had an established relationship of correlated growth.[128] The financial sector has historically relied on GDP growth estimates to inform estimates of fossil fuel use, including oil. GDP projections also form the basis for equity analysis. Given the historical relationship between growth in GDP and energy demand, it is unsurprising that supermajors and financial analysts would trust that historical trends would continue into the future. Yet, in 2014, global GDP grew, but carbon emissions from energy remained stable.[129] This was the first modern example of economic growth decoupling from energy emissions on a global scale, undermining the automatic assumption of a fossil fuels-GDP relationship. This trend held true in 2015, when data confirmed that 2015's energy-related emissions again stalled while global GDP increased.[130]

There is no dispute that energy demand is rising in some regions, but whether this new energy demand will be met by fossil fuels, including oil, is no longer a foregone assumption. An array of factors, including increasing energy efficiency and substitute technology developments, have come together to contribute to a decoupling that, after two years of this pattern, appears likely to be the "new normal."

This trend is also being seen in large regional markets. As an example, China's National Bureau of Statistics reported that "industrial production from January [2016] through May [2016] was up 5.9%, while electricity demand rose only 0.9% — suggesting that the decoupling of electricity demand from economic activity that began in 2014 is continuing."[131]

This decoupling is significant. Oil majors often base their demand projections on assumptions that growth in oil use is *required* for economic growth, especially in developing countries. The decoupling of energy emissions from economic growth, however, demonstrates that economic growth *in conjunction with* declining or stable fossil fuel use is now not only a goal, but a trend that is likely to continue into the foreseeable future.

Increased Fuel Efficiency Could Peak Demand

Another key factor to be considered in demand projections is that fuel efficiency improvements in vehicles could significantly reduce global oil demand. Since 2005, OECD oil demand has peaked, largely due to efficiency gains.[132] In the IEA, EIA, and oil majors' reference scenarios, OECD oil demand will decline modestly moving forward, driven primarily by government policies on fuel efficiency.[133] The prospects for global oil demand growth, therefore, rely primarily on increased oil demand from developing countries.

Fuel efficiency, however, can play a crucial role in mitigating and potentially peaking oil growth not only in developed countries, but also in developing nations. Assuming a scenario of continued economic growth, fuel efficiency provides a means by which countries can increase mobility, while reducing environmental impacts, including air pollution and global warming—stated goals of many developing nations. Even some of the majors recognize that fuel efficiency is expected to peak global light-duty vehicle oil demand. For example, ExxonMobil's 2015 Outlook recognizes that the global fleet of personal vehicles will nearly double by 2040 due to a growing middle class in developing countries.[134] However, increases in fuel efficiency will result in little change to total fuel demand, causing a peak of light-duty vehicle oil demand by 2020.[135] In fact, fuel efficiency could outpace oil industry projections as new technologies are developed.

Light-Duty Vehicles

Ultra-strong, light-weight materials can decrease car weight by 10-60%, resulting in significantly increased fuel efficiency.[136] Other technologies, such as turbocharged engines, can increase fuel efficiency 20-40%.[137] Further, increasing hybrid and electric vehicle penetration can significantly increase the average fuel economy of the global vehicle fleet without requiring replacement of existing vehicles. China and India have enacted other significant fuel efficiency policies to combat air pollution, including limiting car owners to driving only every other day in parts of China.[138]

Heavy-Duty Transport

Oil majors predict that heavy-duty transport will be the largest growth area driving global oil demand. The potential for high demand growth in the sector, however, may be overestimated. Heavy-duty transport demand *peaked in OECD nations prior to 2010*.[139] The U.S. is moving forward with its first heavy-duty fuel efficiency standards.[140] Multiple efficiency options, such as light weighting, improved aerodynamics, and gains in engine thermal efficiency, are predicted to create significant efficiencies in U.S. heavy-duty vehicle fuel consumption.[141] These technology developments can be applied to heavy-duty vehicle fleets across the world and in developing countries. In fact, companies are incentivized to adopt such technologies to reduce fuel costs. The growth in heavy-duty vehicle use that the majors predict in developing countries is also subject to increasing regulation for air quality improvements, which has become a major social issue in China and India, among others.[142]

Other Modalities

There are numerous other fuel efficiency technologies that have the potential to increase fuel efficiencies across all transportation sub-sectors, including airplanes and marine freights.[143] New information technologies can save fuel across all sectors through advances, such as satellite connected trip planners to minimize traffic; other cloud-based optimization technologies have already resulted in savings of 10-20% of aviation fuel use.[144] Increased urbanization and smarter public transportation systems can also reduce oil consumption in cities.[145]

The potential for peaking of global oil demand through fuel efficiency is realistic and underscored in the IEA's report, *Policy Pathways: Improving the Fuel Economy of Road Vehicles—A Policy package*, which outlines policy recommendations that could peak global transportation energy use by 2020.[146] The U.N. Environmental Program, and other key international organizations, have established the Global Fuel Economy Initiative (GFEI) to enact efficiency goals to double vehicle efficiency by 2050 and reach goals associated with keeping global temperature rise under 2-degree Celsius, a scenario in which oil demand peaks in 2020.[147] Additionally, a Stanford study found that in a high fuel efficiency technology scenario, oil demand peaks by 2025.[148] In comparison, the majors do not forecast an oil peak before 2040.

Fuel Substitution by Electric Vehicles

Electric vehicles (EVs) can also significantly and permanently reduce oil demand. Currently, hybrid and electric vehicle deployment exceeds oil industry outlooks and, assuming current growth rates continue, is on track to meet the IEA's 2-degree scenario forecast of 80 million electric vehicles on the road by 2025.[149] From 2011 to 2014, global EV stock has more than tripled, and annual sales increased over 600%.[150] Bloomberg New Energy Finance predicts that EVs can displace enough oil demand by 2023 to cause similar oil oversupply conditions as triggered by the 2014 price collapse; it also projects that electric vehicles will cost less than $22,000 by 2040.[151] Hybrids and plug-in hybrids have even greater potential to disrupt oil demand quickly as they do not require new infrastructure.

Automobile industry leaders are beginning to seriously commit to electric vehicle production. In recent years, major car brands including Ford, General Motors, Nissan, BMW, KIA, and Toyota have increased hybrids and electric vehicle offerings.[152]

Oil majors expect a significant amount of oil demand growth to stem from China and India. However, both countries have instituted electrified vehicle programs, which will have the effect of deflating oil growth projections. China has instituted a variety of policies, and has a rigorous fuel efficiency standard, which promotes electric vehicles with the stretch goal of having five million electric vehicles on the road by 2020.[153] EV sales have increased since the inception of the program, with the first nine months of 2015 seeing double the amount of electric vehicle sales compared to the previous year.[154] China is also home to the world's largest electric vehicle manufacturer, BYD.[155] BYD has had strong EV sales despite low oil prices, and EVs now account for half of BYD's profits.[156] BYD is also electrifying public transportation, taxis, and trucking, producing electric buses and light trucks in China and abroad.[157] Though new, initial indicators are good. Orders have included delivery company DHL, Transport for London, and U.S. transportation organizations.[158] As a result of these changes, Deutsche Bank suggests China's oil demand could be halved by 2024.[159]

India has also instituted programs to begin electrifying transportation, and adopted a goal of deploying five to seven million electric and hybrid vehicles by 2020.[160] The government has deployed a program called Faster Adoption and Manufacturing of Electric Vehicles (FAME). This plan incentivizes EV deployment across vehicle segments in metropolitan regions of India by financing technology development, demand creation, charging infrastructure, pilot programs, and research and development.[161] India also waives taxes and fees for electric vehicles.[162] Though still very modest, in 2015 Indian electric vehicle sales rose 25%.[163] Similar to China, India houses another of the world's largest car companies, Tata Motors. Tata Motors is moving toward EV and hybrid production.[164] Like BYD, Tata recently won an important contract to produce electric buses.[165] Though the Indian EV market is nascent, it is stirring and compounds the uncertainty of the majors' demand projections.

Tata has cited battery cost as a barrier to cost effective production.[166] Battery cost, which is a large factor in total EV cost, is also falling rapidly. From 2007 to 2014, battery costs fell by 14% annually, and are expected to fall another 60% by 2020.[167] New advances in manufacturing can reduce battery costs. For example, material-science professor from MIT, Yet-Ming Chaing, has recently gone public with a new technology that is expected to cut the cost of an entry-level battery plant by 90%, leading to 30% reductions in total battery cost.[168] Similarly, Tesla Motors, one of the market leaders in cost effective batteries and electric vehicles, is building a battery factory, "the Gigafactory," to achieve economies of scale in battery production that have the potential of lowering battery cost by 70%. This significant price reduction could lead to much higher mass market electric vehicle penetration given the potential for affordable 200-300 mile range vehicles in coming years.[169]

Advances in electric vehicles are occurring synergistically with advances in renewable energy. Tremendous research and investment is going into batteries and other energy storage methods, which will enable widespread renewable energy generation and reduce the carbon intensity of the power sector. Residential renewable energy systems can be used to charge electric vehicles, and also act as energy storage, which mitigates power demand peaks that otherwise strain utility grids. This renewable energy/EV synergy, is enabled through inexpensive, more efficient batteries, and can provide developing countries opportunities to offset costs of an electric grid and avoid the need for gasoline infrastructure; leapfrogging directly to new technologies.

China and India Moving Toward Low Carbon Development

One of the oil majors' key investment theses is that developing nations, particularly China and India, will grow and be a source of significant oil demand into the future. India and China will certainly grow, but how much oil is required for that growth is unclear. China appears to be reducing coal and increasing renewables at scale, suggesting the beginning of a societal shift toward sustainability. India also has multiple programs in place to reduce use of coal and increase renewables. If these countries follow trends similar to OECD nations, they are likely to also target transportation for decarbonization and efficiency.

China's intended nationally determined contribution (INDC)[170] includes agreements to reduce its carbon intensity by 60% from 2005 levels and peak its emissions by 2030.[171] China, in an effort to deflate its credit bubble, is enacting economic policies to shift towards services while also reducing coal use.[172] As part of these reforms, China announced cuts in national coal and steel production, resulting in millions of layoffs in China's coal industry.[173] China's coal industry correction suggests a structural move away from coal, with the country's coal use peaking in 2013, and coal imports down 30% in 2015.[174] At the same time, China is building its renewable portfolio. In the release of its most recent five year plan, China announced a goal of 20% renewable energy generation by 2030, additions of 58 gigawatts of solar by 2020, and a swath of policies to accelerate distributed solar deployment.[175] Currently, China is the world's largest wind producer and accounted for 40% of new global solar energy capacity in 2015.[176] By the end of 2014, China had 114 gigawatts of installed wind and added another 32 gigawatts in 2015.[177] Further, China has put in place rigorous carbon intensity targets, with the goal of cutting energy-related carbon intensity by 40-45% by 2020 from 2005 levels.[178] China's coal reduction and renewable energy adoption has resulted, in part, from social unrest related to its extreme urban air pollution.

India's pollution problems dwarf China's.[179] Though India has made significant commitments to coal, doubts are being raised as to whether these coal projects will be built due to solar's increasing cost competitiveness.[180] Branded the "next solar superpower," India is planning to add 175 gigawatts of renewables by 2022.[181] This solar growth could make the forecasted coal expansion redundant given that unsubsidized solar is already at or near grid parity with coal power in India.[182] By 2020, Indian solar power prices could be 10% lower than coal prices.[183] Where efforts to bring private capital into India's coal market have been thwarted by India's Supreme Court, India raised $100 billion for renewables projects in 2015 alone.[184] The same bidders on India's coal projects are now also bidding on India's solar projects, signaling an interest in India's energy market generally, rather than coal specifically.[185] In an instance that may be representative of wider trends, land earmarked for a coal plant will now be developed into utility solar.[186]

Thus, while renewable energy does not yet compete directly with oil, investors should note that India and China are beginning a path toward decarbonization. The majors' projections for oil demand in these nations may not account for demand destruction being put in motion by national decarbonization actions and commitments, or for the potential that these investments may facilitate the development of competitive technologies, such as solar facilitating greater electric vehicle use.

IV. SOCIAL MOVEMENTS AND REGULATORY RISK

Increasing Carbon Regulation Emerging in Response to Climate Change

Oil majors — and the financial community — commonly downplay or disregard regulatory risk and its potential consequences to oil majors. For example, in 2014, ExxonMobil told investors that it does "…not believe a scenario consistent with reducing GHG emissions by 80 percent by 2050 [the level required to keep warming below 2-degrees and avoid the worst effects of climate change], lies within the 'reasonably likely to occur' range of planning assumptions, since we consider the scenario highly unlikely."[187] ExxonMobil further opined that "an artificial capping of carbon-based fuels to levels in the 'low carbon scenario' [such as IEA 450ppm] is highly unlikely…."[188]

And yet, at COP21 in Paris in December 2015, international negotiations resulted in a historic agreement by 195 nations to address climate change and to keep global warming below 2-degrees Celsius. The Paris Accord is underpinned by action plans called Intended Nationally Determined Contributions (INDCs), which are documents that outline how nations plan to implement the carbon reduction targets they committed to delivering.[189] In most countries, INDCs have political momentum and will form the basis for future actions on climate change.[190] When implemented, current INDCs will limit global warming from climate change to 2.7 degrees Celsius.[191] Further, parties also agreed to transparency on their implementation of INDCs, with a five-year ratcheting mechanism to move countries toward the 2-degree goal. More significantly, world leaders agreed to work to limit warming to 1.5 degrees Celsius in the future.[192] With INDCs in place, uncertainty regarding whether a 2-degree target will be reached is reduced.

> "COP21 was definitely a watershed. There will be a 'before' and 'after' COP21."
>
> –Patrick Pouyanne, Total Chairman and CEO

Even the growth of existing laws to address climate change have generally not been fully accounted for by industry or analysts. A study reviewing legislation from the 99 countries responsible for 93% of global emissions found that climate change legislation has doubled every five years since 1997.[193] At the end of 2014, there were 804 climate change laws in effect globally.[194] In the countries studied, 80% have renewable energy targets and 90% have low-carbon energy targets.[195] Climate legislation can regulate carbon dioxide directly, such as a carbon tax, or the commodities that produce greenhouse gases, such as a gas tax.

Climate change legislation is growing globally and in many cases faster in non-OECD nations, which are often more vulnerable to negative impacts from climate change.[196] For instance, China is on the cusp of deploying a carbon market, which appears likely to be one of the world's largest and most sophisticated.[197] Meanwhile, India plans to double its coal tax.[198] Increasing regulation of carbon-intense commodities in the countries oil majors are relying on for demand growth should give investors pause.

Environmental laws that have indirect climate benefits can also powerfully affect oil and gas demand prospects. Indirect climate laws such as those to protect public health can have the effect of reducing carbon emissions and fossil fuel use. An example of indirect climate legislation is the increasing restrictions and bans on gasoline powered car sales. Norway, for instance, seems likely to ban the sale of gasoline cars after 2025, and a similar bill has been proposed in Denmark.[199] Additionally, cities including Paris, Madrid, Dublin, Copenhagen, Milan, Chengdu, Helsinki, Hamburg, and Oslo are significantly expanding "car free" zones, which, while not a total ban, could have serious effects on the use of light-duty vehicles in these cities.[200] Other megacities such as Sao Paolo and Mexico City have permanent restrictions on car use based on congestion.[201] In this way, indirect environmental regulation can have noteworthy effects on fossil fuel demand and can set precedent for, and help create the infrastructure that supports, further fossil fuel demand reductions going forward.

Carbon asset risk is increased by regulatory risk. Carbon asset risk refers to the risk that fossil fuel reserves may become stranded and unsaleable in the future. Stranding can occur due to market forces, as we are seeing with the oil price drop, but can also occur due to government prohibitions limiting use of a carbon-based commodity. The amount of fossil fuels that can be burned before runaway climate change occurs is limited; nearly two-thirds of known reserves cannot be burned without severe climate repercussions.[202] Barclays predicts that in a 2-degree world, the oil industry is posed to lose $22 trillion of potential revenue, which gives a sense of the enormous magnitude of regulatory risk facing the oil industry.[203] Additionally, the projected lost revenue from oil is the most exposed of all fossil fuels and is much larger than the expected revenue losses from coal (which has already lost significant value) at $5.8 trillion, and natural gas, at $5.5 trillion.[204]

Social Movements Driving Regulatory Changes

Perhaps more important than the laws currently on the books is the growing, sustained, global social movement to address climate change. This global movement, made up of a broad and diverse array of civil society groups across the world, was formed in response to the longstanding failure of government to act in the face of devastating and escalating climate risk. The coming together of millions of people to demand climate action at December 2015's COP21 meeting was an undeniable force in world governments' decision to act to curb greenhouse gas emissions.[205] These groups continue to demand immediate action to address climate change by governments, corporations, and even the markets that finance them.

In the U.S. alone, a wide range of movements are occurring simultaneously and converging. This includes work by sophisticated NGOs, such as the Sierra Club's *"Beyond Coal"* Campaign, which is often credited with successfully helping to stop the licensing of 170 U.S. coal projects.[206] The *Beyond Coal* campaign helped to phase out nearly 40% of U.S. coal fired power plants which, together with low gas prices and increasingly competitive renewables, undermined the U.S. coal industry, and stranded billions of dollars of coal assets.[207] Peabody (the largest coal company in the U.S.) noted that fossil fuel divestment advocacy might adversely affect demand for, and the price of, its stock, and limit its access to capital and financial markets, disclosing this as a material risk in its annual report.[208] Peabody, Arch Coal, and Alpha Natural Resources — some of the largest coal companies in the world — filed for bankruptcy in 2015 and 2016.[209] It is worth nothing that the bankruptcies of Peabody, Arch Coal, and Alpha Natural Resources were preceded by the bankruptcy of dozens of smaller coal companies; a trend of bankruptcies of smaller companies has recently occurred in the oil industry.[210]

In many ways, the social opposition faced by coal is a litmus test for the oil industry. Anti-Keystone XL pipeline activism helped prevent Keystone XL, once a $2.9 billion project, from being built, which led to other pipeline cancellations.[211] Similarly, social activism targeting hydraulic fracturing (fracking) projects presents risks to oil majors' extraction of tight oil. Fracking has faced serious opposition over water contamination, environmental damage, and negative community impacts. In the U.S., there have been dozens of local resolutions against fracking, with a number of categorical fracking bans, including the state of New York.[212] Internationally, France has banned fracking and Germany's moratorium has hindered tight oil production in the region.[213] Fracking bans have the potential to affect future oil supply, as tight oil is the primary growth area in U.S. oil production and many new international fields are tight oil shale deposits.

A broad range of indigenous peoples worldwide have established a strong "Keep it in the Ground" campaign to prevent fossil fuels from being extracted. At the same time, movements have developed to oppose U.S. federal oil leasing, privatization of federal real estate for oil and gas development, and to oppose local and regional oil and gas infrastructure, including actions against expansion of existing pipelines, new compression stations, and oil and coal trains based on the grounds of climate, health, safety, and property rights.[214]

Also of potential relevance is the fossil fuel divestment movement, which asks individuals and groups to divest fossil fuel holdings in their investment portfolios. A growing group of foundations, cities, university endowments, faith-based groups, health-based organizations, individuals, and pension funds with a combined $3.4 trillion of assets under management, have agreed to undertake a spectrum of fossil fuel divestment commitments; with many groups excluding from their portfolio the top 200 companies with the largest fossil fuel reserves.[215] This movement, once

dismissed by the oil industry, has attracted the attention and participation of major institutional investors.[216] The movement has been effective in focusing worldwide attention on the link between climate change and fossil fuels, has gained tremendous media attention, and continues to grow affiliates across the world. Even the former Chairman of Shell, Sir Mark Moody-Stuart, noted that fossil fuel divestment is a 'rational' response to the oil industry's lack of action on climate change.[217]

Conflicts between civil society and the fossil fuel industry can often introduce unforeseen costs, such as increased staff time, fines, litigation, opportunity costs, design modification costs, discontinued operations, and others.[218] It is estimated that public campaigns against tar sands cost the oil industry $17.1 billion.[219] Activism and litigation against Shell's Arctic drilling led to both restricted permits and a narrow drilling window, which was then narrowed further when activists physically blocked the transportation of drilling rigs.[220] This, combined with falling oil prices, led to Shell's ending the Arctic drilling effort — a decision which cost the company's shareholders $7 billion.[221]

Other social action includes focused media stories. ExxonMobil is being called to account for the fact that, beginning in the 1970s, its scientist and engineers had made early accurate forecasts about the potential harm of climate change, yet the company was alleged to have spent millions in corporate funds to obfuscate the existence of climate change.[222] What was initially a media-story has now expanded to allegations of fraud to shareholders by various attorneys general.

Social risk is not generally priced into or accounted for by the majors or the financial community.

Oil Majors' Demand Forecasts on a "Collision Course" with Climate Change

The most obvious problem with oil majors' demand projections is what happens to the climate if they are accurate. If oil majors' demand projections are actualized, without immediate, equivalent, cost effective, and successful long term carbon capture and storage, the result will be a rise in global temperature somewhere between 3.6 to 5.5 degrees Celsius.[223] Such temperature rise ensures cataclysmic climate change and global impacts across all nations and societies, making it difficult to maintain a functioning economy.

Every degree of warming brings about damage at a massive scale, which can escalate unpredictably and exponentially. At 2-degrees, intense weather events, including wildfires, heat waves, and storms — which have already begun devastating people and the economy worldwide — would be more intense, with hurricanes exceeding category five, weather patterns dominated by Super El-Nino's, and unprecedented heat.[224] At 3-degrees, global economies would see "massive disruptions," including unstable food supply, resource wars, and large movements of climate refugees due to rising sea levels inundating many of the world's coastal megacities.[225] At 3-degrees, substantial global glacial loss will likely have occurred, and the Amazon may have desiccated into grasslands.[226] Anders Levermann, professor at the Potsdam Institute, told press that "[i]n short, beyond 2-degrees of warming we are leaving the world as we know it."[227]

The world in a 4-degree scenario has been described as "a different planet."[228] Humans and animal life may not be capable of surviving four degrees. At 4-degrees, the loss of forests, topsoil, and ocean life (such as corals, plankton, and algae) further compounds global warming, by both releasing otherwise stored carbon dioxide, and by failing to produce oxygen.[229] Atmospheric oxygen levels could drop inverse to rising carbon levels, leading to "mass mortality" in humans and animals.[230] Feedback loops, such as methane releases from defrosted permafrost that intensify global warming, may be irrevocable.[231] These devastating impacts only get worse at 5 to 6 degrees Celsius, which would likely lead to large scale extinction of plants and animals and overwhelm society.

The majors' failure to recognize the globally catastrophic results of achieving their demand projections should alarm investors. If global governments fall short of maintaining global warming at or below 2-degrees Celsius, it is unclear whether societies will exist as they do today, and whether markets will exist in which to sell oil.

V. CONCLUSION

Transitions occur with regularity across the economic landscape. While change can be perceived as catastrophic, or as progress, the inevitability of change is clear. Already this decade we have seen energy segments transformed. Coal is foundering — not just in the U.S, but in what were recently seen as sure footholds across the globe — and new energy sources and technologies are beginning to thrive.

While still not widely recognized, the oil industry is also within the crosshairs of change. Many of the companies that brought this transformative energy to the world are coming under increasing pressure across a range of issues, from competitive economics, to the fast approaching impact of climate change and the global strategic response to it. Investors may be incredulous that the financial stability of oil majors, which have been anchors in the worldwide economy for nearly a century, is in question. However, even large, important companies can eventually become unprofitable.

Oil majors' financial performance is already declining, a slide which began in a period experiencing some of the highest oil prices in history. While the market remains bullish on oil, expecting a price rebound, it is becoming increasingly clear that the past is not an indicator of the future for this market, and that no rebound can fully protect oil against the economic realities of an increasingly costly product, growing competition from new technologies, and a need to quickly reduce use of fossil fuels. In fact, the high oil prices that would sustain oil companies will, at the same time, ensure that substitutes and alternatives become increasingly cost-effective, accelerating the replacement of oil.[232]

The sheer size of the oil majors is no guarantee against decline. At the time of its collapse, Lehman Brothers was an 150 year old company with $600 billion in assets, nearly twice BP's current asset base.[233] Lehman Brothers had never posted a loss until June 2008, yet the Company declared Chapter 11 Bankruptcy by September.[234] As recently as weeks before its bankruptcy, Lehman Brothers was still raising capital and "investors renewed hopes that the troubled investment bank was moving closer to raising capital to buffer it against a deteriorating economic environment."[235]

This paper does not argue that any future is foretold for oil majors or the larger community of independent oil producers — only that acknowledging signs of change and planning appropriate action is imperative. Oil majors have options to respond to coming changes if they begin to act now; however there is tremendous opportunity cost in delaying responsive action. New policies, such as carbon pricing, which Exxon has recently begun vocally supporting, could help send the market signals necessary to help the majors transition. Similarly, dramatic cost reductions, including substantial technology innovations, would help reduce some aspects of investor concern. Other potential options include:

1. Shrink to grow. Majors have the option of divesting areas of their business that are not profitable at low oil prices, and operating as leaner, stronger companies. This is the strategy recently adopted by Conoco Philips.[236]

Carbon Tracker argues that the majors can maintain profitable business operations through an aggressive adoption of "shrink to grow" policy exercising the capital discipline to decline projects that require a high oil price. To accomplish this successfully, the majors would need to accept a demand forecast which comports with a 2-degree limit on global warming.[237] If the majors do not rapidly unwind high-oil cost projects and plan for a 2-degree compliant demand scenario, if they carry on with business as usual, investors remain at risk.

2. Diversify into growing areas of the energy sector. Exxon, Chevron, and BP, each invested and then divested renewable energy divisions between 2000 and 2008. Since then, the majors' have not made significant new investments in sustainable technology, which is more likely than oil to have a place in the low carbon economy. While at that time, the market may not have been sufficiently responsive to such innovative investments, it is becoming evident that significant new investment in sustainable technology is now more likely than oil to have a place in the emerging low carbon economy. Total provides an example of an oil and gas company successfully diversifying into low carbon technology, with a majority stake in Sunpower, the world's largest solar panel producer, and a planned purchase of French battery maker Saft Groups SA. While each company must forge its own path, shareholders must be confident oil majors are sufficiently responsive to changing energy markets, including intensifying climate imperatives, and are proactive in remaining competitive.

3. Yield companies, Master Limited Partnerships, Royalty Trusts. Yield companies, Master Limited Partnerships (MLPs), and Royalty Trusts offer tools for oil companies to create stand-alone business units out of their riskiest divisions or assets, protecting the stable and value generating elements of their companies, reducing capital costs for their primary company, and helping to resolve mounting threats to liquidity. These vehicles are being used more widely across the energy sector and are available as three of the many options the majors can take advantage of if they decide to minimize their — and their investors' — exposure to unprofitable, high risk portions of their business.

4. Legacy production. Rather than pursuing unconventional resources, the majors could continue to produce their remaining conventional reserves, which are substantial. However, given the market penalty Exxon suffered for not maintaining market expectations on reserves, it is unclear how successful this strategy will be without changes to reserve reporting requirements and broad market re-education. This strategy is likely be more successful in combination with diversification, including diversification into renewable energy resources.

5. Consulting. Like Xerox and IBM, which successfully shifted from hardware into services in the face of market and technology changes, the majors have specialized expertise they can offer oil markets. Indeed, the majors already do provide significant consulting services to NOCs, an area which could feasibly grow.

6. Disclosures. Transparency and disclosure to shareholders about risks associated with changing energy markets, and the company's plans for addressing those risks — including risks associated with the Paris Agreement to maintain global warming below 2-degrees Celsius — are critically important to shareholders in assessing the company's competitiveness and value. As demonstrated over the past three years by shareholder engagements and resolutions asking energy companies to address carbon asset risk and the 2-degree scenario, among other similar issues, shareholders are actively seeking such disclosure.

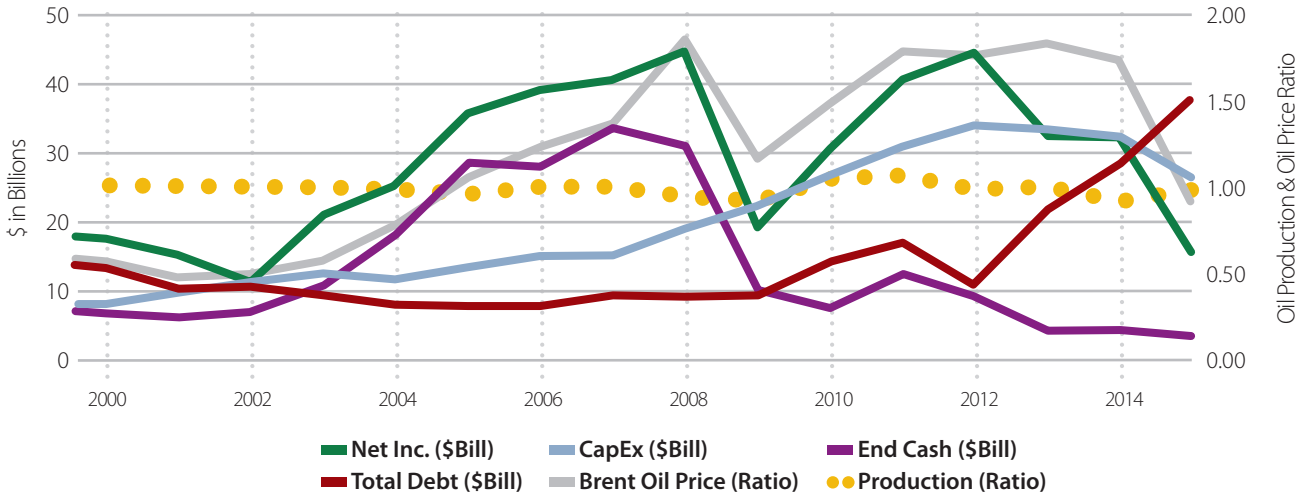
As outlined in this paper, it is becoming increasingly clear that the oil industry is faced with an array of forces that are acting simultaneously to bring about permanent oil demand destruction and unrelenting competition to market share. Whether demand destruction occurs in the short or mid-term, future demand is unlikely to match the current optimistic projections of oil majors. As demand declines, oil majors will have to compete with lower cost NOCs for the remaining market share.

Most oil majors do not yet appear to be sufficiently responsive to these shifts. Oil majors are operating within a closing window in which they still have the financial strength and investor confidence to act responsively to ensure their businesses thrive into the future. Those steps could mean assuming a 2-degree scenario and modifying their businesses accordingly; rapidly diversifying into generalized energy companies; growing their consulting businesses; and more. However, until the majors take forward steps, investors are increasingly at risk.

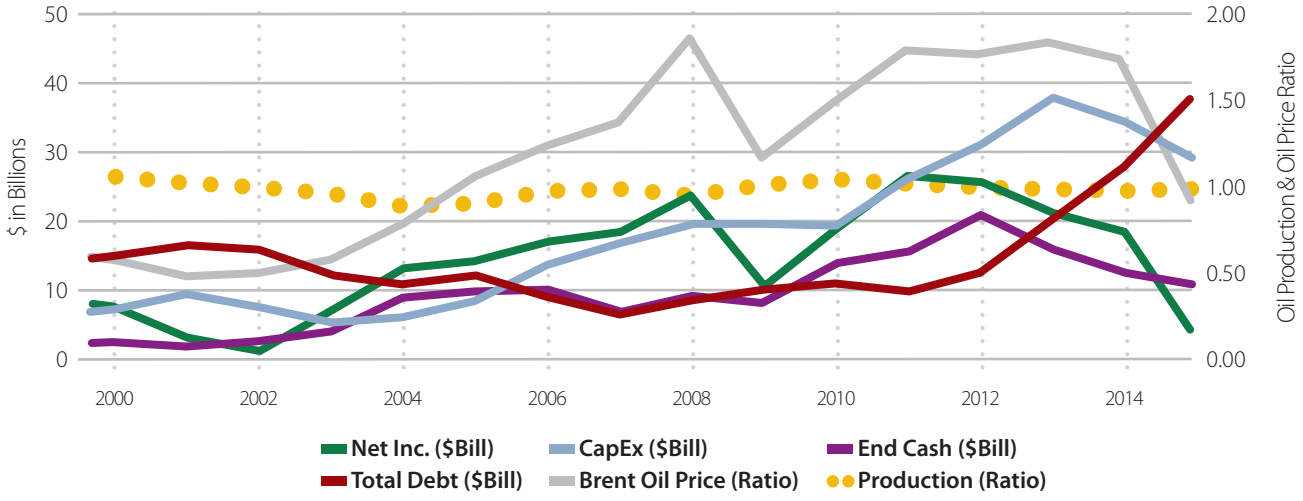
Successful investors will be those who recognize this transitional moment in energy markets, and unflinchingly assess the financial condition and future potential of oil companies, including the majors. This assessment must be based on the market's trajectory, rather than on the company's history, which is likely to differ substantially from its future. As is so commonly stated — but often little heeded — past performance does not predict future results.

APPENDIX: FINANCIAL CHARTS OF OIL MAJORS

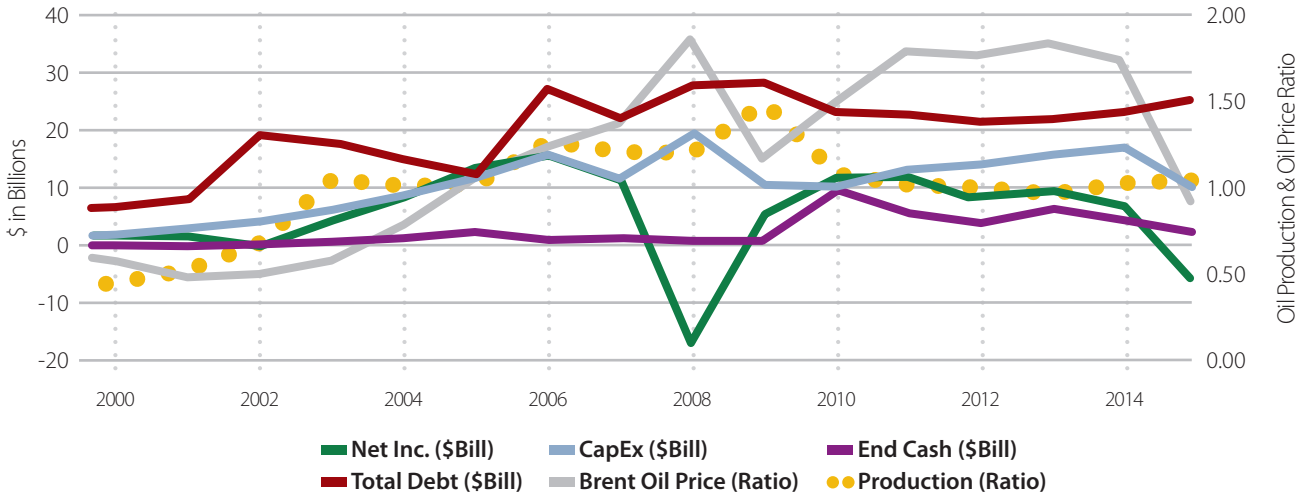
ExxonMobil: Key Financials 2000-2015



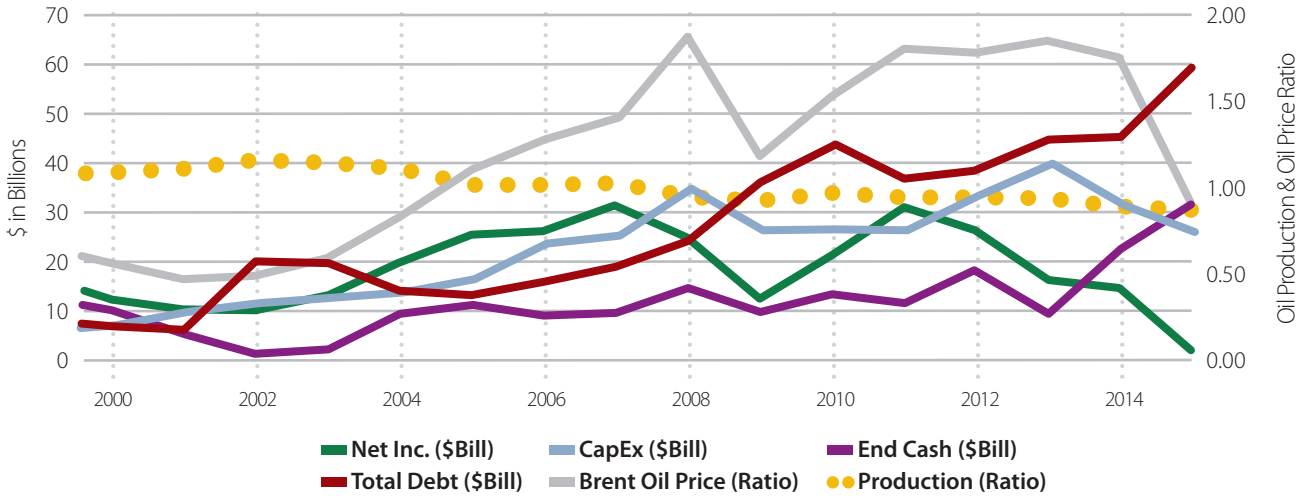
Chevron: Key Financials 2000-2015



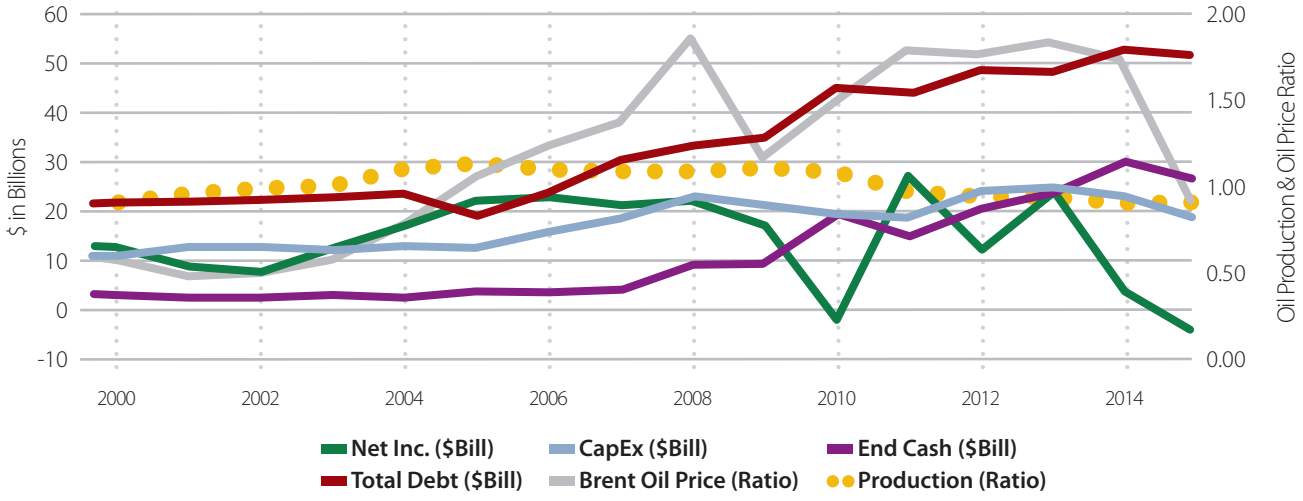
ConocoPhillips: Key Financials 2000-2015



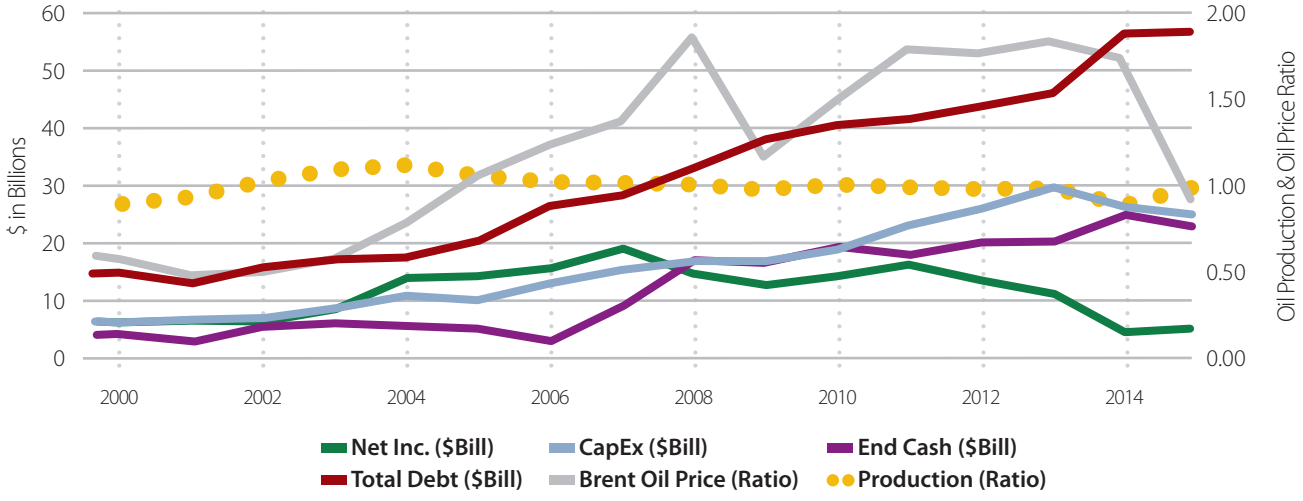
Shell: Key Financials 2000-2015



BP: Key Financials 2000-2015



Total: Key Financials 2000-2015



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