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INTELLECTUAL AMMUNITION

## Just-In-Time Energy

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As crude hits the top of our predicted 2015 trading range, we look ahead to \$15-\$40 oil.

Energy industry colleagues that have been reading our reports have gravitated to one in particular: ["Grant Me \\$20 Oil, But Not Yet"](#) (February 17, 2015). Obviously production engineers and petroleum geologists cringe at the thought of \$20 oil. Their first response is, "you can only get so much oil out of those rocks." The problem with this conventional oil production view is that the industry has now phase-shifted into an entirely new generation of technology.

- It's not just that new technology means that petroleum isn't scarce anymore. It's also that the new technology enables entirely new business models for the industry.
- Mega-projects that require billions in upfront capital are unnecessarily risky when oil is no longer scarce. Light tight oil formations available in the United States (and globally) can be drilled and completed for millions -- that's millions, with an "m", not billions -- of dollars that will produce the majority of a well's estimated ultimate recovery within a year or two of bringing it on line.
- This is "just-in-time production" analogous to the methods pioneered by Japanese manufacturers in the 1970s and 1980s, which led directly to hyper-efficient global supply-chain management first implemented by Walmart in the 1990s. For the energy industry, this nimbleness and freedom from capital intensity is more suited for today's rapidly evolving global economy than the three- to five-year lead times and punishing capital requirements associated with mega offshore projects.

We don't envision oil prices falling to \$20 for several years at the soonest. For now, we stand by our call for a range from \$50-\$65 for 2015 (see ["Oilageddon: The Sequel"](#) January 15, 2015). But over the 156-year history of crude oil as a global commodity, in today's dollars it has generally held to a range between \$15 and \$40. That's because innovation and technology and entrepreneurship always came to the rescue, even when everyone was certain we'd hit "peak oil." What's new now is that global light tight oil resource availability is understood to be effectively limitless, with cost-control -- not physical scarcity -- the only challenge. At the same time, oil faces new competition as a transportation fuel. And while it's only a hangover from a time of scarcity when conservation had to

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### Update to strategic view

**OIL, US RESOURCE STOCKS:** Oil is now subject to "just-in-time production" and kaizen, a productivity revolution reminiscent of the Japanese manufacturing productivity surge of the 1970s and 1980s. This productivity, coupled with competition from alternative fuels for transportation borne by ever more efficient batteries, onboard lighter all-electric vehicles, means oil prices will eventually revert to their historical norm of \$15-\$40 in today's dollars. This doesn't mean that less oil will be consumed in the future, nor that oil producers can't grow and prosper. But the old model of mega-projects has passed, and the future belongs to the nimble.

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be seen as a virtue, there is a global political push toward a lower-carbon world. It all points to lower oil prices in the future.

**THE SUPPLY SIDE** The new generation of oil and gas production technologies are ripe with new opportunities to reduce costs.

- To be sure, today's ascendent new technologies stand on the shoulders of giants.
- Horizontal drilling and hydraulically fracturing wells have been around on a smaller scale from Prudhoe Bay to tight gas formations in the Lower 48 since the 1980s. But today they represent the overwhelming majority of wells drilled in North America.
- Long laterals -- up to 15,000 feet -- have needed to be drilled for years. These run within oscillating formations that can sprawl over hundreds of square miles. The ability to keep the drill bit in the middle of the formation drives production efficiency, which requires ever-increasing advances in telemetry and remote guidance. 3D and 4D seismic research, requiring massive amounts of computing power, help locate and drain a productive area. Thus information technology becomes central to exploration and production -- so the relentless efficiency gains from Moore's Law are directly relevant to the oil and gas industry.
- Pad drilling originated with offshore projects, all the way from the original shallow waters to the ultra-deep wells being drilled today, but the concept transitioned to on-shore after 2010.

Today's surge in production is coming predominantly from wells that are horizontally drilled and hydraulically fractured from pads. Because such wells exhaust quickly, exponentially more of them must be drilled. On the face of it, that is an inefficiency. But the exponential increase in the number of wells means a similar increase in learning -- about the multitude of processes that can be tweaked, combined and recombined to increase production and reduce well costs. Some of these are still quite new, so there's still a long way left to travel down lots of learning curves where cost savings wait to be captured.

- For example, the great diversity of geologies and formations faced by hydraulic fracturing have driven a constant improvisation of new completion slurries, designer cocktails of various types of sand, chemicals and water.

The new technology generation allows operators to model production as a manufacturing operation -- and when conceived this way, new efficiencies can be wrung out of old tools. While a human, a wrench, and a conveyor belt had existed for centuries, Henry Ford put them together to revolutionize the production process -- not only in his industry, but others as well -- except energy, until now.

Cost savings in energy production are occurring up and down the supply chain -- in transport, materials, economies of scale, and 24-by-7 operations. As in industry, there are companies that stand out at the wave-

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front of progress. We have written about one of them -- EOG Resources (see ["I Have Seen the Future, and It Fracks"](#) February 24, 2015). While EOG might be considered the industry's technology leader, its success depends on other companies in oil-field services that combined and improved various aspects of drilling for oil and gas, onshore and offshore, which has brought a revival in US production that was unthinkable less than a decade ago.

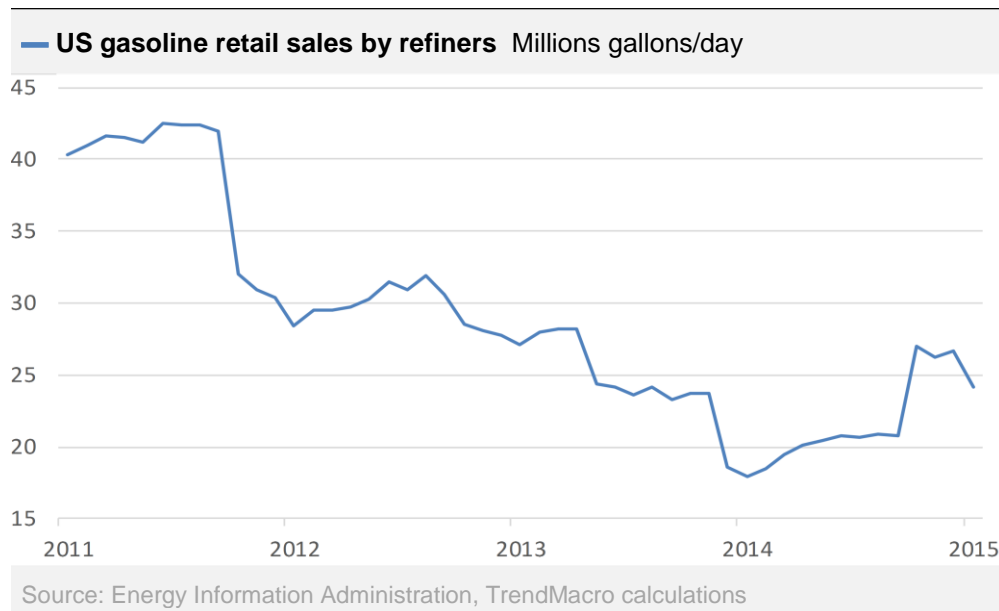
- Especially now, under the lash of lower global prices, the entire ecosystem of energy is engaged in *kaizen* -- the commitment to "continuous improvement" -- pioneered by the Japanese alongside the "just-in-time production" model.

Meanwhile, Saudi Arabia (and a few other OPEC members) have excess capacity at a cost of less than \$10 in their best fields. While Saudi has not cut production, it is producing below full potential as it usually has.

- Its monopolistic game, over many decades, has been to keep oil scarce -- to extract the highest dollar amount for a barrel, hopefully without ever tipping the global economy into recession. Inadvertently, this opened up a price umbrella under which initially expensive new technologies were economically feasible to develop in North America.
- Now, thanks to the new just-in-time model developed during an era of high prices, North America has an energy supply at a cost of production that will decrease with each passing quarter and will, itself, drag prices secularly lower.
- Sheik Ahmed Zaki Yamani, Saudi Minister of Oil and Mineral Resources from 1962 to 1986, [said it best](#) when he lamented that "technology is the real enemy."
- Now, stuck with technology-driven competition it inadvertently made possible, our thesis is that the Saudi decision *not* to try to support prices means they *aren't* attempting a rear-guard action to crush North American, Russian, or Iranian competitors (see ["Saudisfaction Guaranteed"](#) March 13, 2015). The Saudis are looking for market share, and [they have duly taken it](#) as prices fell from above \$100, and then stabilized in the \$50-\$65 range. OPEC members want prices to remain elevated to fund continued generous social spending, which is required for monarchies to survive.
- So the Saudis are [reasonably happy](#) to let oil prices drop, rebalance market-shares in their favor, and bet that reduced prices will reaccelerate demand in the future.
- And the Saudis know better than most that many regimes in the Middle East and North Africa are unstable. Yemen is the current hotspot and getting hotter (see ["Oil and the Obama Doctrine"](#) April 10, 2015) ~. Iran has [reportedly](#) sent vessels to the Yemeni coast as the ongoing Sunni-Shia regional conflict intensifies, which has pushed the global Brent crude benchmark to the top of our expected 2015 price range.

- Besides, the Saudis probably welcome having a source of just-in-time supply in North America, taking some pressure off their high-stakes role as the keeper of the "OPEC call," to ramp up volumes quickly if aboveground obstacles threaten to reduce OPEC exports.

**THE DEMAND SIDE** As we have argued, lower oil prices resulting from a permanent new abundance are a huge stimulus to growth, coming as they do after five years of the highest inflation-adjusted prices in history (see, among many, ["2015: Oil Change for the Global Economy, US Edition"](#) December 31, 2014). Today's lower prices are not a reflection of lower demand, and they will lead to higher demand. Indeed, US gasoline sales are already climbing as prices have fallen (please see the chart below), and [sales of light trucks](#) have held up well despite a harsh winter.



Yet the same price umbrella that nurtured the technology revolution in horizontal drilling and hydraulically fracturing of unconventional resources also subsidized other energy technologies -- such as cane and corn ethanol, and palm biodiesel. While all of these loosely-termed "renewables" are in direct competition with refined petroleum products (gasoline and diesel) to fuel global mobility of the future, the one we think that needs to be watched most closely is not, strictly speaking, an energy source at all, but rather a way to store and transport energy -- the battery. It is the battery, not the energy that charges the battery, that will open up the age of the all-electric automobile, and thus poses the greatest competition to oil.

- Moore's Law definitely applies to battery technology. Costs expressed as dollars/kilowatt-hour are rapidly declining in lithium-ion (li-ion) batteries -- they've [reportedly](#) dropped 43% since 2010, and will make electric drive-trains cost-competitive with the internal combustion engine in the 2020s.
- General Motors has [announced](#) it will try to bring the all-electric Chevy Volt, with a 200-mile cruising range, mainstream in 2016.

- From 2011 to 2013, global electric vehicle sales have increased by a factor of four from a small base of 52,000, while hybrid vehicle sales have more than doubled from 715,000 to 1.65 million. While still small in comparison to global sales of 85 million vehicles overall, battery power is making serious inroads.
- The electric car company Tesla [announced](#) future construction of a “gigafactory” that will produce battery packs for 500,000 electric vehicles per annum by 2020. It probably wasn’t a coincidence that founder Elon Musk would name his company "Tesla." At the end of the 19th century, it was the alternating current, developed by Nikola Tesla -- generated by Niagara Falls hydropower -- that started to take market share from oil as the fuel for lighting America's homes and cities. We forget now that kerosene -- used as an illuminant for lamps -- was initially almost the entire end-market for crude oil when it was first discovered in Pennsylvania in 1859. Great technology transitions take time, and move in unexpected ways -- gasoline for transportation didn't overcome kerosene for lighting as the number one refined petroleum product until 1919.
- Gasoline will be difficult to displace as a transportation fuel. After all, the energy-density of gasoline -- that is, the amount of power it can unleash for a given unit of weight -- makes it extraordinarily compelling as a "self-charging battery," that is, a portable reservoir of energy to power transportation.
- When Tesla and other competitors have had the time to perfect the electric car, we will discover energy efficiencies that have little to do with the source of power that charges the batteries. An all-electric drive train can be both lighter and have greater torque than the current internal combustion model -- so even if the onboard battery is charged by a gasoline-powered generator, fuel efficiencies will nevertheless be achieved.
- But gasoline isn't the only competitor for charging batteries, nor even the most obvious one. Right now the electricity that charges Tesla batteries likely comes from hydro, nuclear, natural gas, coal, or -- to a tiny degree -- some renewable like solar or wind. It is too early to tell which fuel -- if left to the merits of the various competitors, free of government subsidies -- will eventually power global vehicle fleets. At the moment, the global governmental jihad against "climate change" tips the scales to favor fuel sources that reduce carbon emissions.

**SUPPLY AND DEMAND** The burgeoning supply side -- paired with a demand side with an ever-wider menu of alternatives to oil -- argues for a return to the historical price range for crude between \$15 and \$40.

- The imponderable in this is the demand response to the collision of abundant oil and greater efficiency in its use. Both abundance and efficiency, separately, tend to lead to greater demand. In other words, oil efficiency does not imply less oil utilization. Indeed, if history is any guide, it implies the exact opposite.
- So a world in which oil trades between \$15 and \$40 can also be a world in which the quantities of oil produced and consumed are greater than ever. That's bad news only for oil producers who were

counting on scarcity to earn monopoly rents. For producers willing to compete, and to relentlessly reduce their costs as the semiconductor industry has had to do over a half century of Moore's Law, there is ample opportunity to "make it up in volume."

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### Bottom line

Oil is now subject to "just-in-time production" and *kaizen*, a productivity revolution reminiscent of the Japanese manufacturing productivity surge of the 1970s and 1980s. This productivity, coupled with competition from alternative fuels for transportation borne by ever more efficient batteries, onboard lighter all-electric vehicles, means oil prices will eventually revert to their historical norm of \$15-\$40 in today's dollars. This doesn't mean that less oil will be consumed in the future, nor that oil producers can't grow and prosper. But the old model of mega-projects has passed, and the future belongs to the nimble. ▶