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INTO THE "RED ZONE" WE GO

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Introduction

"The decision to cut production, in hindsight, was a mistake. But it is clear that the IEA and other reporting agencies did not do the Saudis any favors with their inaccurate forecasts at the time....Fast forward to today and we see many of those same seeds having been planted over the past couple of years." Energy Aspects on the OPEC 2006 Production Cuts, September 28, 2018

"In an ironic twist, we believe that the events that took place at the end of 2006 have now been repeated....In retrospect, it is painfully obvious these OPEC cuts were unnecessary. Back in 2006, we wrote extensively about the flaws in the IEA data. The IEA was significantly overestimating 2007 non-OPEC oil supply and underestimating 2007 global demand. Also, if you carefully analyzed 2006 oil market data, it was clear the IEA was seriously misestimating 2006 oil balances as well." Goehring & Rozencwajg Associates, Natural Resource Market Commentary, 4th Quarter 2016

"The oil markets are entering the red zone." Fatih Birol, IEA Executive Director October 9, 2018

Back in January 2017, we started our fourth quarter letter with the title: "Oil Prices are Heading Much, Much Higher." At the time, oil prices stood a little over $50 per barrel, US shale production had begun to rebound strongly, and huge amounts of bearish sentiment weighed on global oil markets.

We explained what happened a decade earlier when OPEC, relying on flawed IEA oil market data, cut 1.2 mm barrels per day of production in October 2006.

Soon after OPEC enacted its production cuts, non-OPEC oil supply unexpectedly faltered and global demand began to significantly exceed expectations. As a result, inventories drew relentlessly throughout 2007.

Once OPEC realized their production cuts were a mistake, it was already too late. OPEC aggressively boosted production in the fourth quarter of 2007, but as 2008 dawned, inventories continued to draw while prices continued their advance. By the summer of 2008, as the global financial crisis intensified, oil prices spiked to $145 per barrel. The price spike to $145 per barrel was proof enough that our analysis, as outlined at the end of 2006 and the beginning of 2007 in our quarterly letters, had been correct.

In our January 2017 essay, we put forward our belief that OPEC, again influenced by flawed IEA data, had cut production into a market that had already quietly swung into deficit. We made the prediction that oil prices could exceed $100 sometime in 2018.

When we wrote that piece, no one agreed with our analysis. Since then, global inventories have plunged, prices have advanced by almost 50%, and the talk of oil breaking $100 per barrel has become more and more frequent.

As many of you know, we pride ourselves on the original research we do here at Goehring & Rozencwajg. When Adam Rozencwajg (now the other half of the eponymous Goehring & Rozencwajg) first came to work for me in 2007, I told him that our goal is to recognize, understand, and quantify important trend changes taking place in various commodity markets long before they became widely recognized by the general investment community.

I also told him that we wanted to make our investment decisions and have our research in print long before such trend changes became front page headlines in the financial press. When we wrote "Oil Prices Are Heading Much, Much Higher," consensus opinion believed global oil markets to be in massive structural surplus—a surplus so substantial that even material cuts to OPEC production could do little to reduce record-high inventories. As noted above, we strongly disagreed with this analysis.

To understand why the 2016 OPEC cuts caused a repeat of the 2006 experience, one must appreciate the IEA portrayal of global oil markets in 2016 (which we now know were wildly off the mark), and how OPEC in turn responded to those projections. As late as November 2016, the IEA estimated that total global oil supply had exceeded demand by almost 750,000 b/d.

Furthermore, in their projection of 2017 balances, they estimated the "call on OPEC" (that is the difference between global demand and non-OPEC supply) would be 33.3 mm b/d. With OPEC producing at 33.5 mm b/d, this meant that, unless OPEC cut production, inventories would grow by an additional 200,000 b/d in 2017.

Given the near-universal bearishness in global oil markets at the time, few analysts noticed that significant errors had crept into the IEA data during the summer of 2016. First, although the IEA supply and demand figures implied a massive 2016 surplus, global inventories actually begun to decline starting in June. In order to account for this lack of predicted inventory build , a huge number of "missing barrels" had crept into the IEA balances.

By November 2016, over 1 mm b/d of "miscellaneous to balance" oil had appeared in the IEA report. (For those unfamiliar with the IEA term "miscellaneous to balance," it refers to the difference in oil barrels produced less barrels consumed which can't be found in inventory — we call them "missing barrels." As readers of these letters know, the IEA has consistently and chronically underestimated global oil demand primarily from the non-OECD world over the last 10 years. We have great confidence these "missing barrels" are not unaccounted for, but have actually been consumed.)

As we wrote in 2016, we believed that surging non-OECD oil demand had already overtaken the surge in OPEC supply following the failed OPEC meeting in November 2014. Instead of building throughout 2016 (as the IEA predicted), inventories had actually started quietly receding by July. Furthermore, based upon our modelling, we believed that 2017 would see significant inventories draw -- even without any OPEC production cuts. Heavily influenced by the IEA's bearish 2016 and 2017 oil market data, OPEC cut production by 1.2 mm b/d in November 2016. In an unprecedented move, these cuts were joined by 300,000 b/d of non-OPEC production cuts – mainly from Russia.

Consensus opinion following the October 2016 OPEC meeting concluded the production cuts would do little to normalize inventory levels. Nothing could have been further from the truth!

Global inventories peaked at a record 4.7 bn barrels in July of 2016 (420 mm barrels above 10-year averages) and have fallen steadily since. Today they stand at 4.4 bn barrels, only 30 mm barrels above the 10-year average. Never have inventories fallen this far in such a short period of time.

"AS FATIH BIROL, EXECUTIVE DIRECTOR OF THE INTERNATIONAL ENERGY AGENCY, SAID ON OCTOBER 9TH: "THE OIL MARKETS ARE ENTERING THE "RED ZONE.""

Looking into 2019, our models suggest global inventories will continue to experience unanticipated drawdowns throughout the year. Although it has received little comment from oil analysts, 400,000 b/d of "missing barrels" have already crept back into the IEA's oil balance over the first seven months of 2018. Once again, these "missing barrels" signal to us that the IEA's demand figures will be raised significantly from here. Please read the oil section of this letter, where we will go over all of the supply and demand issues and related problems facing global oil markets as we enter 2019.

As Fatih Birol, Executive Director of the International Energy Agency, said on October 9th: "the oil markets are entering the "red zone."

But there is something else we want discuss here. Back in January 2017, our bullish outlook was focused on the IEA's chronic underestimation of global demand. Indeed, looking back over the last two years, the IEA has been forced to raise their 2016 oil demand estimation by 1.2 mm b/d (and given the lingering 2016 "missing barrels," we think more revisions are forthcoming). Furthermore, the IEA's original 2017 demand estimate has been raised by 400,000 b/d thus far.

While the IEA clearly had developed a problem estimating demand, we largely agreed with their assessment of non-OPEC oil supply. If anything, the IEA has actually underestimated non-OPEC oil supply growth. For example, during the three-year period spanning 2016 to 2018, the IEA has underestimated non-OPEC oil supply by 200,000 b/d per year (2016 was overestimated by 1 m b/d, 2017 was underestimated by 900 k b/d and 2018 to date has been underestimated by 700 k b/d).

However, we believe big problems are now developing that will lead to massive disappointments in the IEA's estimate for non-OPEC oil supply over the next several years. While chronic demand underestimation will continue to be a problem (merely the continuation of a decade-long trend), it will be joined by a period of chronic overestimation of non-OPEC oil supply (a mistake the IEA has largely avoided over the last five years).

The coming problems in conventional non-OPEC oil supply is a subject that few investors have noted. For example, the IEA is still looking for 550,000 b/d of non-OPEC oil production growth outside of the US in 2019 – something our models tell us will be impossible to achieve.

"CONTINUED UNDERESTIMATION OF DEMAND, COMBINED WITH UNANTICIPATED DISAPPOINTMENTS IN NON-OPEC OIL SUPPLY WILL PUT TREMENDOUS PRESSURE ON OPEC TO INCREASE OIL PRODUCTION IN THE COMING YEARS."

Last quarter, we explained why investors should expect large unanticipated drops in non-OPEC production outside of the US beginning in 2019 and persisting into the middle part of next decade. Continued underestimation of demand, combined with unanticipated disappointments in non-OPEC oil supply will put tremendous pressure on OPEC to increase oil production in the coming years. In today's letter, we will discuss some of the issues facing Saudi Arabia, the largest OPEC producer and only member country with any excess pumping capacity. While both President Trump and the IEA have implored Saudi Arabia to produce more oil, it remains unclear whether they can in fact bring online their two mm b/d of alleged spare capacity.

Read on for our take on this critical debate, including why we believe the Saudi Aramco IPO was pulled. The material we put forward is extremely controversial, but we believe our research is pointing us in the right direction regarding the present condition of the Saudi oil industry. It represents another extremely bullish data point that absolutely no one has factored into their global oil estimate for the next decade.

Q3 2018 Natural Resource Market Commentary

Natural Resources were notably weak in Q3. Escalation of the Trump-inspired trade war with China, combined with continued talk of additional US interest rate hikes and further strengthening in the US dollar caused most commodity markets to drift lower.

Precious metals led the commodity markets lower. Continued talk of further interest rate increases by the US Federal Reserve, combined with strength in the US dollar, put severe selling pressure on the precious- metal complex. Gold fell over 5% during the quarter, silver fell almost 9%, and platinum fell 4%. The only exception was palladium which rose over 12% during the quarter. Momentum continues to build in Europe to ban diesel-powered automobiles which would result in more gasoline-powered cars on the road. Palladium is the preferred metal used in catalytic converters for gasoline engines.

Gold-related equities were also extremely week. For example, the NYSE "Gold Bug Index" fell almost 20% during the quarter. As most of our readers know, we believe a huge gold bull market lies in the not-too-distant future, and the pieces for that keep falling into place. We believe the sideways correction in the gold price, which has been ongoing for over two years, has not yet run its course. As of today, we remain on the sidelines. Please read the "Precious Metals" section of this letter, where we discuss the data points we are watching and how we are timing our entry point into the upcoming

gold bull market.

Energy prices were mixed in Q3. WTI fell 1%, but Brent oil prices advanced a strong 4%. The initial impacts of Iranian sanctions have tightened both Asian and Atlantic basins and put significant upward pressure on the Brent market. Energy-related equities were mixed: the S&P E&P index rose a little less than 1%, but oil service stocks were weak. The Philadelphia Stock Exchange Oil Service Index (OSX) fell 3.5%. As Fatih Birol, executive director of the International Energy Agency (IEA) stated in his October 9th Bloomberg interview: "Global oil market are now entering the 'Red Zone'".

As we wrote in this letter's introduction, the 2016 OPEC production cuts have significantly tightened global oil markets. With the world now set to lose potentially 2 mm b/d of Iranian exports as we progress into 2019, oil markets could reach record levels of tightness in the coming quarters. But there is another very bullish data point emerging in global oil markets that no one has commented on. In last quarter's letter's we outlined our research on the developing supply problems in the non-OPEC world outside of the US. We believe large errors have crept into the IEA's 2019 market balance on both the demand and now increasingly the supply side.

Over a year ago, we put forward a $100 price target for oil, and few market commentators agreed with us. However, more and more headlines now bring up the $100 crude subject. We remain extremely bullish towards global oil markets, and we believe investors should continue holding significant weighting in oil-related investments. The oil bull market has far to run.

For a complete discussion on 2019 oil market fundamentals, please be sure to read the "Oil Section" of this letter. We will discuss demand, the impact of the Iranian sanctions, and coming huge disappointments in non-OPEC oil supply. Our research tells us 2019 is shaping up to be another bullish year for oil-related investments.

US natural gas prices firmed in the third quarter and finished a touch over $3.00 /mcf. It was an extremely cold spring during which we actually withdrew gas from storage all the way through the 3rd week of April—something we have never observed in the 25 years of data that we keep. Combined with the fourth hottest summer ever here in the US this caused inventories to fall about 16% (or 600 bcf) below 5 year averages as the 2018 injection season comes to a close. Given the relative low storage level and the strength of demand, we do run the risk of a natural gas price spike if this 2018-2019 winter turns out to be colder than normal. However, supply continues to grow relentlessly. The latest Energy Information Agency data indicates natural gas supply is growing 8.7 bcf / day--an incredible 12% year-over-year rate. At some point, North American natural gas markets will enter a bull market, but because of surging gas supply (which is now occurring with a rig-count that is down almost 90% from a decade ago) we remain neutral towards North American natural gas markets, even with inventories at below normal levels. Please read the "Natural Gas" section of this letter, where we discuss the incredibly strength of global LNG markets, and its potential long-term impact on US natural gas markets.

Base metals were weak in the third quarter. Trump-inspired trade wars and their potential impacts on global growth weighed heavily on all base metals. Copper fell 5%, aluminum fell 3%, zinc fell 8%, and nickel (which has been an EV-related "darling" over the last six months) fell 15%. Metal-related

equities were also weak. For example, copper stocks (as measured by the Global X Copper Miners ETF) fell over 8% during the quarter.

Copper remains our favorite metal. Although we cannot gauge the ultimate impacts from a full-blown trade war, thus far they have been minimal. Chinese copper demand, after a year of lack-luster growth in 2017, has firmed considerably. According to the World Bureau of Metal Statistics (WBMS), Chinese copper consumption for the first seven months of 2018 showed year-on-year growth of over 5%. Also, China has tightened thresholds on impurities in scrap metal imports and anecdotal reports indicate copper cathode and concentrate imports into China have surged in September to make up the difference. On the supply side, WBMS monthly data clearly indicates we have now reached an almost two-year stretch of absolutely zero growth in copper mine supply.

The latest data point demonstrating the difficulty in growing mine supply comes from Rio Tinto Zinc (RTZ), the majority owner of the large Oyu Tolgoi copper project in Mongolia. RTZ announced that first production from its underground expansion at Oyu Tolgoi (first scheduled to come online in 2020), has been delayed nine months due to technical issues.

Reflecting growing demand and zero supply growth, exchange traded inventories in the third quarter declined to their lowest level in three years and now stand at 450,000 tonnes (down from almost 800,000 tonnes at the end of the second quarter).

Copper has now rebounded 10% off its $2.60 per pound low reached at the beginning of September. Although investors remain focused on Trump's trade wars and their related impact on Chinese copper consumption, the analytic community continues to completely ignore the potential for massive increases in Indian copper demand.

We believe definitive evidence has emerged that India is now following the same commodity consumption trajectory as China did back in the early 2000s. China today has an installed base of approximately 200 pounds of copper per person. According to our models, this level of copper is exactly what is needed to support a real per capita GDP of $10,000. By comparison, India today has less than 15 pounds of copper invested per person -- a level similar to what China had back in 1995-2000.

As India continues along its economic progression, it will steadily move from the 15 pounds installed per person today to eventually reach levels seen in China and elsewhere. The implications are tremendous. Please read the "Copper" section, where we talk about the current electrification of India and its huge impacts on future copper demand.

Uranium was one of the few metals to show a positive return for the quarter. Uranium prices advanced a strong 20% and now stand a little over $27 per pound. One of the more intriguing elements to the upcoming uranium bull market has been the emergence of intense interest in the physical metal from both retail and institutional investors.

We remain bullish on uranium prices and continue to add to our positions. We didn't write about the uranium markets last quarter, but for those who are interested, please read the "Uranium" section of this letter where we outline all the positive events that have occurred in global uranium markets

over the last six months. It's an extremely bullish story and we continue to recommend investments in the uranium industry.

After pulling back significantly in the second quarter on trade-war fears, grain prices were mixed during Q3. Corn rose almost 2% while soybeans fell almost 2% and wheat rose almost 3%. Fertilizer prices, on the other hand, showed marked strength. Potash prices for Brazil delivery rose almost 10%, phosphate prices increased 6%, and global urea prices rose a strong 20%. The underlying fundamentals in global agricultural markets have not changed significantly since our last letter. Global grain demand remains extremely strong while the 2018 US harvest, according to the latest World Agricultural Supply and Demand (WASD) report, will be a record again for soybeans and a near-record for corn. For the fourth year in a row, US weather conditions in 2018, have again been near perfect.

According to the latest WASD, the 2019 corn carryout will rise to 1.8 billion bushels, still far below the 2.3 billion bushel carryout experienced back in 2017. However, given strong global demand, corn's "stocks-to-usage" ratio keeps dropping and is now hitting all-time lows levels.

Global grain markets remain on a knife's edge. Extremely strong demand has been met over the last four years with near-perfect growing conditions and record crop yields. However, solar cycles suggest that the unprecedented run of record growing conditions may be coming to an end. Although the US experienced a near perfect growing season, Europe, Australia, and areas surrounding the Black Sea all experienced severe drought conditions.

The soybean-growing areas of Brazil were exceptional dry in July and August, but recent rains have now returned, resulting in good spring planting conditions. Nevertheless, we have to closely watch the conditions in Brazil as the season progresses. Given extremely strong global grain demand, any adverse weather patterns could wind up having outsized impacts on global grain inventories. It would not take much for global grain inventories to swing from above-normal levels to record lows in a very short period of time.

Now that the 2018 Northern Hemisphere harvest season is coming to a close, we believe grain markets will be quiet for the next several months. We believe a large bull market in the global grain complex may very well take place in 2019. It is something we are carefully monitoring and we recommend investors keep their positions in all fertilizer equities (our preferred agricultural investment vehicle). We will write extensively on conditions in global grain markets in our upcoming Q4 2018 letter.

The Saudi Oil Dilemma and the Saudi Aramco IPO

(This speech was delivered by Leigh Goehring at the first Goehring & Rozencwajg Natural Resource Investor Day held on September 27, 2018)

For those who closely follow global oil markets, one of the more intriguing front page stories has been whether Saudi Aramco will go public.

Its IPO could wind up solving one of the great mysteries of the last 30 years: the ultimate size of Saudi Arabia's oil reserves. Saudi Aramco has released no reserve data in 40 years, and a huge debate

has emerged regarding their ultimate size.

We have our own opinions on the size of these reserves. We strongly believe Saudi Aramco's reserves as reported today are overstated. The Saudis, for a variety of reasons, do not wish this to be exposed.

The size of Saudi Arabia's remaining recoverable reserves is of critical importance to global oil markets as we progress into the next decade. If the Saudi reserves are overstated, this calls into question two important things. First, do the Saudis actually have the excess pumping capacity they claim to and second, do they have the reserves available to keep pumping at 10.5 mm b/d before depletion issues permanently impair their current production capacity? The global oil industry has never questioned the Saudis ability to pump at least 10 mm b/d indefinitely. The question is whether this assumption is valid.

For those not familiar with Saudi Aramco, it's the national oil company of Saudi Arabia that owns all the oil and natural gas fields in the country.

They also own all of the country's oil and gas processing, transportation infrastructure, and refining capacity. They are the world's largest producer of crude oil and a large producer of both natural gas and natural gas liquids. The Saudi government finally gained 100% control of Aramco in 1979. Prior to that, it was a consortium made up of Exxon, Mobil, Chevron, and Texaco that had discovered, developed, produced, and marketed the country's oil starting just before World War II. Since 1980, Saudi Aramco has operated as a 100% privately-owned government oil company.

In early 2016, in a move that took the oil world by surprise, Crown Prince Mohammed bin Salmon announced that a piece of Saudi Aramco would be sold to the public in an IPO scheduled for 2018. Since then, the financial press repeatedly indicated the Saudi Aramco IPO would be pushed out into the future. Then rumors emerged that the deal might ultimately be pulled entirely. This summer, insiders related to the deal strongly suggested the IPO had been permanently shelved and that the army of investment bankers, lawyers, and accountants had been told to stand down. As of today, it looks like the Saudi Aramco IPO has been placed on hold permanently.

Most press reports about the underlying causes for the delay quote government officials and related financial experts who blame the complexities involving various underlying subsidiaries, including very funny stories about Saudi Aramco's camel-beauty-pageant business. It turns out that besides the camel beauty pageants, Saudi Aramco owns schools, hospitals, airline fleets, and soccer stadiums, all unrelated to the oil and gas industry.

But we believe there is a much more important reason for the Saudi Aramco IPO delay, an incredibly important story that has received zero coverage in the press.

Thirteen years ago, a book was published that ignited a huge debate among global oil analysts. The book, Twilight in the Desert, was an attempt by Matt Simmons to research, investigate and quantify the true size of the Saudis' oil reserves. There has always been a high level of controversy surrounding the Saudis' oil reserves. The last published reserve figure complying with US reserve reporting standards was published in 1976, over 40 years ago. Reports of proven reserves

on a field-by-field basis regularly published throughout the 1970s by the 'Oil and Gas Journal" (a respected trade publication), stopped in 1977.

In his book, Mr. Simmons questions the validity of Saudi Aramco's reported reserve figures and makes the case that the reported figure had to be seriously questioned.

In 1977, the four US oil companies that then controlled Aramco published what would be the final reserve report complying with SEC standards. In that report, they listed 100 bn barrels of proved reserves and another 50 bn barrels of probable reserves.

Immediately after the takeover of Aramco by the Saudi government was completed in 1979, the new entity reported an updated reserve report showing 150 bn bbl of proved reserves. In retrospect, we can assume the Saudis simply took the 50 billion barrels of probable reserves and moved them into the proved category.

Saudi Aramco did not issue an updated report until 1982, when they announced their "proved" reserves had increased to 160 billion barrels. And in a move that is still shrouded in mystery, in 1988 they boosted their proved reserve figure by 150% or more than 100 mm barrels to reach 260 billion barrels.

To this day, the difference between the 150-billion-barrel figure released by the "old Aramco" in 1977 and the 260-billion-barrel figure released in 1988 has never been substantiated by any supporting data.

Also adding significantly to the mystery is what has happened to this reserve figure since the 1988 report. Even though the Saudis have pumped almost 100 billion barrels since 1988, the 260-billion-barrel figure has never been adjusted for production.

Although there has never been any supporting reservoir data, this 260-billion-barrel reserve figure is still assumed by most reporting services to be correct. For example, the 2018 BP Statistical Review lists Saudi Arabia's reserves at 266 billion barrels, the same reserve figure they used over 20 years ago in 1997.

After he published his book in 2005, a lively debate broke out between Matt Simmons and the Saudi Arabian government in which (as you might have predicted) the Saudis tried to discredit Mr. Simmons' conclusions. Claiming he had no access to accurate data (which of course no one outside of Saudi Aramco does), the Saudis said that not only was Mr. Simmons incorrect, but that their reported 260-billion-barrel figure might actually be too low!

Several Saudi officials at the time went public stating that their true recoverable reserves were much closer to 400 billion barrels and, if they were being optimistic, this figure could actually approach 800 billion barrels.

So the question remains to this day: what are Saudi Arabia's true reserves figures? Are they some level significantly less than 260 billion barrels (that is -- do you believe Matt Simmons), or do you

believe the Saudis' stated 260-billion-barrel figure is actually overly conservative?

No one outside of the highest levels of Aramco has access to the necessary data to make an accurate assessment of Saudi's reserves, so any attempt to estimate the size of these reserves must use some indirect method. For example, Mr. Simmons (who was denied any access to Saudi Aramco data) agonizingly read more 200 papers related to the Saudi oil industry published by the Society of Petroleum Engineers (SPE) over a 40-year period going back to 1961. Gleaning as much information as he could from these papers, he concluded that the size of the Saudis' reserves had to be seriously questioned.

I have to admit that after spending the last 30 years studying the global oil industry, I too have become fascinated with the whole Saudi Arabia oil-reserve controversy. It's an incredibly complicated and fascinating subject.

I was lucky enough to visit Saudi Arabia's most famous oil reservoir, the Ghawar field, back at the beginning of 2004. Although I was given little in the way of new information on what was happening at the field, it was revealed by Halliburton that they were drilling an extensive number of horizontal wells at the top of the Ghawar anticline -- in itself an admission that the field was entering a sort of severe mid-life crisis. Since then I have made several attempts to re-enter the country, but each time either my visa was issued and then revoked or my potential sponsor told me it wasn't worth going through the visa application process at all.

Annoyed by Mr. Simmons' book, the Saudis to this day are intent on keeping people out who might be interested in learning more about the size of their reserves.

To estimate the true size of the Saudi reserves, I am going to present results from methods that have proved very useful in the past to accurately estimate ultimate recoverable reserves of a field or hydrocarbon producing region, as well as predicting when a field or region's production will peak.

We use a simple mathematical technique called Hubbert Linearization. King Hubbert was a famous and extremely controversial geologist who worked for Shell Oil from the early 1940s all the way to the 1960s.

While I never met Mr. Hubbert, I have met a number of people who knew him well and as many of you know, he was quite a formidable character. Hubbert's theories centered on the belief that the future production profile of a hydrocarbon basin could be fairly accurately predicted, given several assumptions. Hubbert believed that following the discovery of a new oil or gas field, its production would follow the shape of a bell curve.

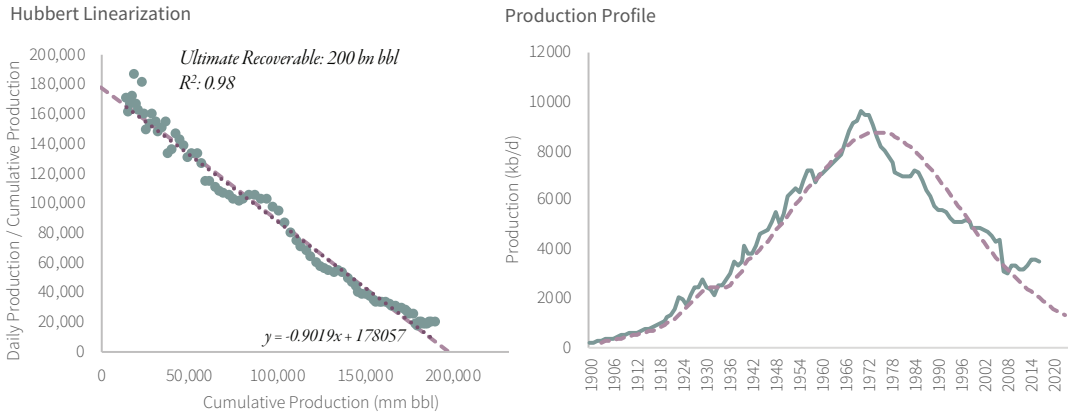
Hydrocarbon production from a new field would ramp up before reaching a "peak" which would occur when one half of the field's recoverable reserves had been produced. Following this peak, production from the field would decline in a manner that mirrored the ramp-up phase. According to Hubbert's theories, the most important factor in determining a field's peak level of production is to accurately estimate the field's total recoverable reserves.

Hubbert Linearization often provides a good estimation of total recoverable reserves. Once half

of the recoverable reserves were produced, Hubbert believed the field's production would decline. Hubbert's analysis gained a huge amount of prominence after he used it to predict that US oil production would peak in 1970 at 9.5 mm b/d and ultimately recover 200 billion barrels of oil.

While Hubbert failed to predict the rise of shale production some 50 years later, if you look only at conventional oil production in the US, his prediction was amazingly accurate.

CHART 1 US Conventional Production

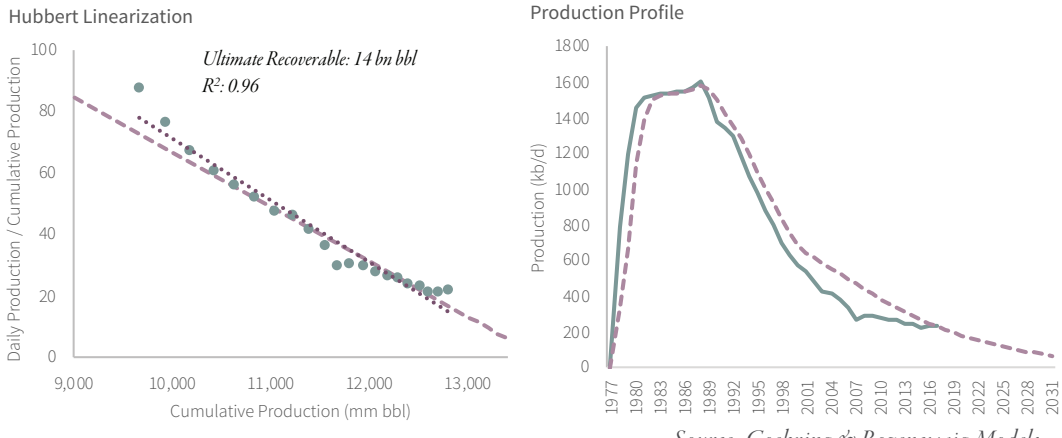


Source: Goehring & Rozencwajg Models

Despite the accuracy of Hubbert's many predictions, his methodology has remained controversial. Nevertheless, oilfield production trends first identified by Hubbert in the late 1950s have expressed themselves repeatedly around the world and include such high profile fields as Prudhoe Bay and the North Sea.

For example, the Hubbert Linearization of the Prudhoe Bay field implies recoverable reserves of 13 billion barrels, very much in line with the original 15 billion barrel recoverable reserve estimate put forward when the field was first discovered back in 1968.

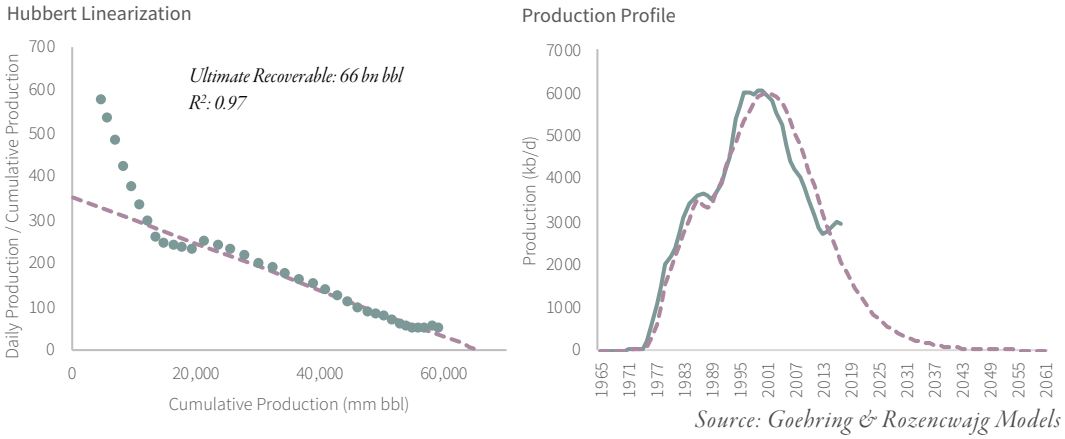
CHART 2 Prudhoe Bay



Source: Goehring & Rozencwajg Models

Regarding the North Sea, Hubbert Linearization tells us that approximately 65 billion barrels of oil will be recovered, very much in line with consensus estimates.

CHART 3 North Sea

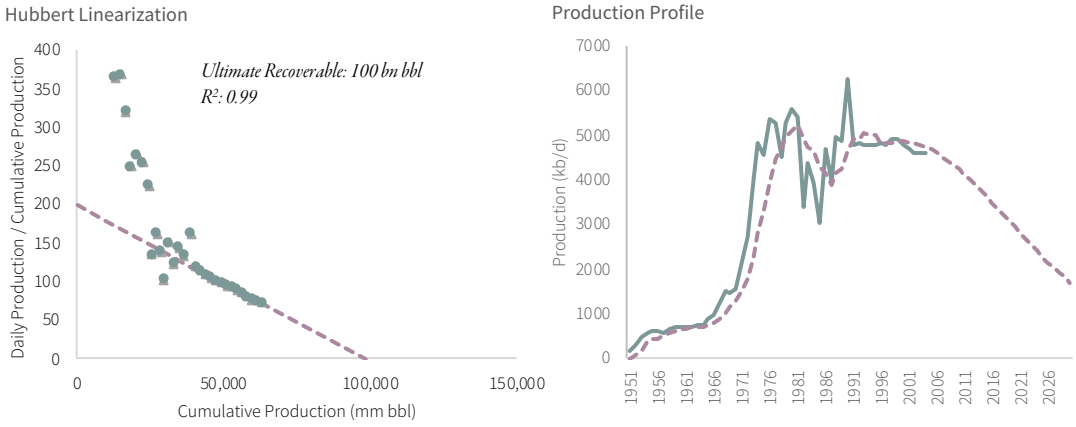


Source: Goehring & Rozencwajg Models

And I should point out that Hubbert Linearization works for all the shale plays. The Barnett natural gas field should recover 19 tcf of gas according to a Hubbert Linearization. I should point out that is significantly less than the 30 tcf recoverable estimate made by the US Department of Energy's Energy Information Agency.

Although controversial, (we admit that one of Hubbert's biggest drawbacks is that it fails to capture ever-increasing field recovery assumptions), we decided to apply Hubbert Linearization to the largest of the Saudi oil fields, the Ghawar field, which at its peak represented over 50% of total Saudi production.

CHART 4 Ghawar Field



Source: Goehring & Rozencwajg Models

Ghawar is by far the world largest oil field. Discovered in the late 1940s, the field formed the foundation of the Saudi oil industry for decades, and it has been a massive contributor to the growth in global oil production since the end of World War II period. On the right, you see the production history of the field . We have good data going up to 2008, however after that point data becomes difficult to find. On the left is the Hubbert Linearization of Ghawar's production history, a plot of cumulative production versus the ratio of current production to cumulative production.

In a field where production grows at an exponential rate, plateaus, and then begins to decline, this logistic growth function will exhibit an initial "noisy" period before settling into a very predictable straight line that can then be extrapolated to estimate a field's ultimate recoverable reserves.

As you might expect, there are additional problems associated with using this technique with the Ghawar field. For example, Hubbert Linearizations works best when a field is produced in an unconstrained manner. However, in the case of Ghawar, the field was "choked back" and did not produce at full capacity during the oil-glut years between 1981 and 1991.

Despite these problems, starting approximately 20 years ago, Ghawar's Hubbert Linearization still managed to turn into a straight line. In the case of Ghawar, its Hubbert Linearization crosses the X-axis at 100 billion barrels - a figure I should point out is very close to the CIA's estimate of Ghawar's recoverable reserves (if you are curious about this, I once sat next to a CIA Saudi analyst at a dinner many years ago and we extensively discussed the whole controversy surrounding Saudi reserves).

Furthermore, structural mapping and analysis of the Ghawar field indicates that the structure (basically an underground dome) originally contained 200 bn barrels of oil. If our Hubbert Linearization is anywhere near accurate, it would suggest that approximately 50% of the original oil-in-place will be recovered -- an incredibly high figure.

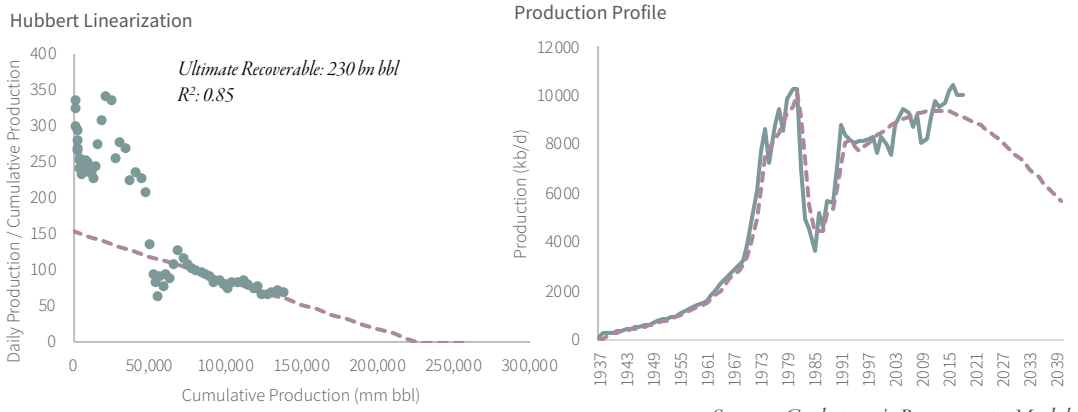
Out of the 100 billion barrels of recoverable reserves, we believe Ghawar has produced approximately 75-80 billion barrels to date, meaning that at most only 25 billion barrels remain. If our analysis is remotely accurate, two important conclusions can be drawn.

"OUR MODELLING TELLS US THAT GHAWAR'S OIL PRODUCTION IS DEFINITELY IN DECLINE."

First, although Ghawar's remaining 25 billion barrels of proved reserves are among the world's largest, our modelling tells us that Ghawar's oil production is definitely in decline. Although we have no official data, we believe Ghawar's production peaked out a 5.5 mm b/d and has been in decline for a decade. Second, it has always been believed that Ghawar represents over 50% of the Saudi total reserves. If Ghawar stands at just 25 billion barrels of remaining reserves, and no significant oil field discoveries have been made since the 14-billion-barrel Shaybah discovery all the way back in 1968, one must seriously question the Saudi's claim that they still have 260 billion barrel of remaining reserves.

The statement I just made, really only a hunch, gains further validity when we use Hubbert Linearization to calculate the total recoverable reserves for Saudi Arabia as a whole. Using historical Saudi production data (in this case, we have extremely good data since they must accurately report their production to OPEC), we can see that a Hubbert Linearization again produces an extrapolatable straight line.

CHART 5 Total Saudi Production (to 2010)



Source: Goehring & Rozencwajg Models

As you can see from the chart, the Hubbert Linearization of total Saudi production (with data up until 2010) became a straight line back around 1995. Extrapolating this straight line until it crosses the x-axis suggests that total Saudi recoverable reserves will be 230 billion barrels.

But here's an interesting twist.

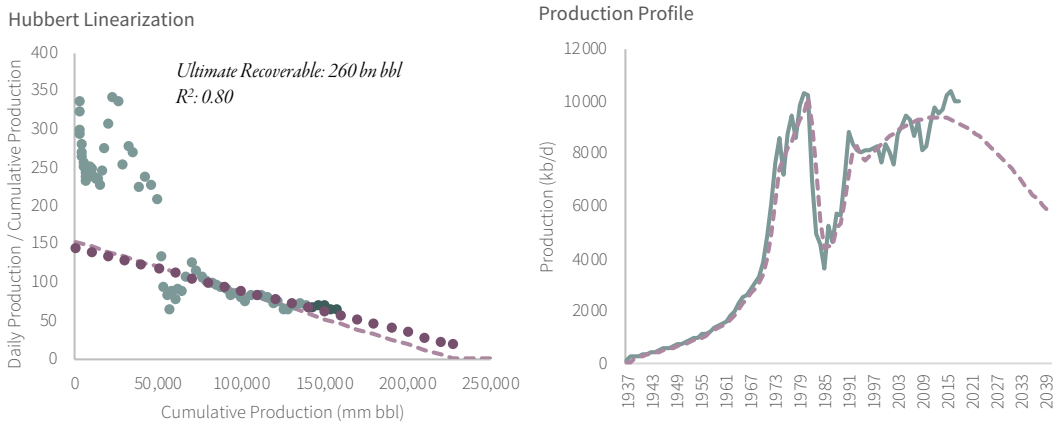
Back in the late 1950s, Aramco discovered two huge fields: Khurais and Manifa with 20 and 15 billion barrels of recoverable oil, respectively. Both fields were briefly put into production in the early 1960s, however both had problems that precluded full field development. Khurais lacked a water drive and had to immediately rely on secondary recovery (i.e., waterflood) to make the field productive. This was a serious problem for a field located over 150 miles from a water source! Manifa, meanwhile, produced an extremely low-quality crude that few buyers wanted. Although the two fields contained 35 billion barrels of recoverable oil combined, neither field ever produced significant quantities of oil and many analysts (including Matt Simmons) believed neither field would ever be put into full development.

The Hubbert Linearization goes up to 2010. Neither field was producing then, and the Hubbert Linearization produced a straight line that didn't include them.

However, the Saudis fooled everyone (including Matt Simmons) and by 2007 they had undertaken massive developments of both projects, including the building of two new refineries to process Manifa's low-quality oil. Both fields commenced production in 2010 and have undergone expansion projects, doubling their production. Today the fields are producing two million barrels per day combined.

What is so interesting is the impact this additional production has had on our Hubbert Linearization since 2010. As you can see from the chart below, the straight line has now pivoted. Instead of crossing the x-axis at 230 billion barrels of recoverable reserves, the linearization now indicates 260 billion barrels of recoverable reserves. In other words, our Hubbert Linearization has correctly "picked up" the incremental 30-35 billion barrels of reserves that are expected from both Khurais and Manifa.

CHART 6 Total Saudi Production (to 2017)



Source: BP Statistical Review, Goehring & Rozencwajg Models

But the bears will argue that this is proof that Hubbert Linearization doesn't work. For example, they ask: "Won't a large number of new discoveries in Saudi Arabia shift the curve again, just like what happened after the addition of production from both Khurais and Manifa?"

The answer is that it could happen, but it is highly unlikely. Remember, both Khurais and Manifa were discovered in 1957. The last giant-field discovery, the Shaybah field in the extreme eastern province of Saudi Arabia, occurred back in 1968. The country has been exhaustively explored since then and no large fields (greater than a billion barrels) have been found. Although you should "never say never," the probability of future large-scale conventional oil fields discoveries in Saudi Arabia is slim. (The only possible new discoveries could be in their shales - which I will touch on in minute.)

If our Hubbert Linearization is even remotely accurate, you can now see the dilemma facing Saudi Aramco. While the Saudis are adamant their remaining total recoverable reserves are 260 billion barrels, our Hubbert Linearization leads us to believe that total recoverable reserves are only 260 billion barrels.

Saudi oil production started back in 1937 and we calculate that over 150 billion barrels of these recoverable reserves have already been produced. If our Hubbert Linearization is accurate, total remaining recoverable reserves are not anywhere near the 260 billion barrels claimed by Aramco, but rather are much closer to 100 billion barrels.

"SAUDI OIL PRODUCTION STARTED BACK IN 1937 AND WE CALCULATE THAT OVER 150 BILLION BARRELS OF THESE RECOVERABLE RESERVES HAVE ALREADY BEEN PRODUCED... IF OUR HUBBERT LINEARIZATION IS ACCURATE, THE TOTAL REMAINING RECOVERABLE RESERVES ARE NOT ANYWHERE NEAR THE 260 BILLION BARRELS CLAIMED BY ARAMCO, BUT RATHER ARE MUCH CLOSER TO 100 BILLION BARRELS."

So there you have it: the Saudis claim to have 260 billion barrels of reserves and we believe the true figure is much closer to 100 billion. Although recoverable reserves could improve over time as technology improves field recoveries, I should point out that Saudi Aramco has always used "best-in-class" reservoir management techniques. Ghawar's 50% recovery factor is proof of their proficiency. We can assume advancements in field recovery assumptions would be incremental from here.

Although there has been chatter on the internet claiming that the independent reserve engineers are "satisfied" that Aramco's reserve statements are "realistic," we stand by our contention that the Saudi Aramco IPO was pulled because it would be extremely problematic for the Saudis to admit their reserve figures have been vastly overstated for years. It would also call into question whether Saudi Arabia really has the large volumes of "excess" pumping capability they have always claimed.

What does this mean for future oil balances and prices? First, we believe the reserve issues are already showing up in the Saudis production figures. Remember, the Saudis have always claimed they have 12-12.5 million barrels per day of pumping capability and this claim was made long before the extra 2 mm barrels of production from Khurais and Manifa came on-line. The Saudis have again grown production above 10 mm b/d, and we will have to see if they can exceed this figure -- especially now that Trump is exhorting them to do so.

Going back to the Ghawar field, our modelling tells us that the field is now almost 75% depleted. Given its remaining reserves, we believe the field is now in steep decline. Although no data has been released, we believe the extra production brought on by Khurais and Manifa has now been offset by production declines in Ghawar and other older Saudi giant fields such as Safaniya. Can the Saudis produce at 12 to 12.5 mm b/d if they had to? Our analysis leads us to believe they cannot. In fact,

if our reserve estimation is correct, we believe today's 10.5 mm b/d rate will become increasingly difficult to maintain as we progress into the next decade.

Problems with Aramco's production will add yet another very bullish story to global oil markets as we progress into the next decade, a subject few oil analysts even consider.

Where could we be wrong on all this? The massive conventional oil reservoirs in Saudi Arabia were all sourced from a very rich shale. It is not inconceivable that the Saudis, using US shale production technology, could at some point produce large quantities of oil from their shales. But we believe Aramco is many years away from being able to do it. Also, we don't even know the geological and geochemical properties of the Saudi shales. For example, the US Geological Service, which has geologically mapped and geochemically analyzed most of the world's shale basins, has never been given access to the shale basins in the Middle East.

Could the Saudis (and the other Middle Eastern oil producers) become big shale producers some day? My gut feel strongly suggests "yes," but at this point we just don't have enough data to make any sort of prediction. I guarantee that it will be something that we will follow very closely in the years ahead.

OIL MARKETS

In the middle of 2017, the battle cry of nearly every oil analyst was "lower for longer." Oil prices at the time were threatening to break $40 per barrel while concerns over rapid shale development and plummeting demand had convinced analysts we were entering a post-oil world. We vehemently disagreed with this view and now, less than eighteen-months later, oil has reached a cycle-high of $86.47 per barrel, global inventories are nearing dangerously low levels, and traders' fears have focused on how the market can find enough barrels to replace production disappointments from Venezuela and sanction-related shortfalls from Iran.

In the introduction to this letter, we explained what our models told us that led us to take such a contrarian bullish stance. In this essay, we will explore what those same models are telling us today and what implications they hold for the future.

While the headlines today are decidedly more bullish, most of them remain focused on Venezuelan production disruptions and Iranian crude embargos. While these two factors are certainly quite bullish in the near-term, we think that many analysts continue to miss the bigger picture. Almost by definition, every time a commodity market gets extremely tight, some exogenous event will come to the fore as a catalyst sending prices higher. While many analysts will describe this event as the cause of the rally, it is instead a symptom of a tight underlying commodity market. This is a particularly important distinction today because the actual drivers of the oil-market tightness over the last 18 months are rapidly getting more severe.

As we have written time and again, the most important driver of global oil balances over the last two years has been demand which continues to be much more robust than analysts predicted. Instead of reaching "peak demand" as many market-watchers called for, global oil demand growth today remains at historically high levels. The most recent IEA report suggests 2018 demand grew by 1.4

mm b/d compared with 2017, marking another year of strong growth. However, our models tell us that this demand is again being dramatically underestimated.

"INSTEAD OF 1.4 MM B/D OF GLOBAL DEMAND GROWTH, WE BELIEVE 2018 GROWTH WILL ACTUALLY COME IN CLOSER TO 1.9 MM B/D, MARKING THE THIRD HIGHEST READING IN 20 YEARS AND CAPPING THE STRONGEST FOUR-YEAR CUMULATIVE PERIOD OF GROWTH SINCE 1979."

As long-time readers of our letters know, we believe the IEA's models suffer from a chronic underestimation of global oil demand. In nine of the last 10 years, the IEA has underestimated demand by 1 mm b/d on average (and as much as 3.3 m b/d in certain years). Even though they have only been publishing a 2019 demand projection for the last four months, the IEA has already revised it higher by over 200,000 b/d. In particular, we believe the IEA is underestimating the impact on non-OECD demand growth that occurs when a country goes through its "S-Curve" tipping point of economic development. The key to watch for is the IEA's "miscellaneous to balance" line item, which is nearly always accounted for through upward revisions to demand. So far in 2018, the IEA's balancing item has averaged over 400,000 b/d. We believe once again this balancing item is a sign that demand will be revised higher by a comparable amount.

Instead of 1.4 mm b/d of global demand growth, we believe 2018 growth will actually come in closer to 1.9 mm b/d, marking the third highest reading in 20 years and capping the strongest four-year cumulative period of growth since 1979.

We have long discussed the extremely positive demand trends taking place globally. The number of people around the world that are currently going through their period of accelerated oil demand growth (their "S-Curve" tipping point) has gone from a relatively stable 700 mm since 1960 to over 2.5 billion as India now enters its tipping point alongside China. We have never had so many people going through their period of intensive commodity demand growth at the same time and the impact cannot be overstated.

We first wrote about the rise of Indian commodity demand back in 2016 and we followed this up last year with a more in-depth analysis (please see our 4Q2017 letter). In February 2018, we traveled to India (our fifth trip in 10 years) and our visit confirmed our bullish outlook. After having long been dismissed as an immaterial source of resource demand, analysts are now finally coming around to the fact that Indian demand will accelerate materially from here. OPEC now predicts Indian oil demand will grow by 6 mm b/d over the next 22 years and our models suggest this could actually be too conservative. In August, oil consultants Wood Mackenzie predicted that India will overtake China as the world's largest oil demand growth center by 2024. In order to meet future gasoline and diesel demand, Saudi Aramco has announced its decision to invest $44 bn in the Ratnagiri refining complex in India. When commissioned in 2022, it is expected to process 1.2 million barrels per day, making it as large as Reliance's Jamnagar refinery (currently the world's largest).

While global oil demand growth will continue to be very robust for much longer than most analysts think, a new dynamic has taken hold in global oil markets with very bullish ramifications.

We first discussed the upcoming disappointments in non-OPEC oil production in our 2Q2018 letter. As you will recall, over the last several years there has been a dramatic collapse in conventional oil discoveries in the non-OPEC world. Anemic upstream capital spending over the last five years nearly guarantees that the dearth of conventional discoveries will persist for some time to come. Moreover, a huge number of major development projects have been delayed or cancelled outright and, as a result,

we expect that non-OPEC production will significantly disappoint over the medium-term.

There are signs these disappointments are happening already, much sooner than we had projected. Only a few months ago, analysts were optimistic that Brazil would be a significant source of non-OPEC growth in 2018 with the IEA originally calling for 260,000 b/d of year-on-year growth. That figure has now been revised down by an incredible 90% as disappointments in deep-water development continue to challenge operators. These difficulties are spreading to other regions as well. At the beginning of the year, the North Sea was expected to buck its trend of declining production and grow by 100,000 b/d in 2018. Instead, persistent maintenance (a sign of field exhaustion) has resulted in production declining by 100,000 b/d instead of growing by a comparable amount, making 2018 the second consecutive year of North Sea declines.

Luckily, Canada was able to grow production in 2018 to help meet global demand and prevent inventories from drawing even faster. However, this was the result of several decades-long lead-time projects finally coming online after substantial delays. In total, Canadian production is expected to have grown by 270,000 b/d this year as Suncor's world-class Fort Hills project finally came online in January, with total capacity of 200,000 b/d. Furthermore, Mackay River Phase 1, Horizon Phase 3, and the offshore Hebron platform all commenced operations at the end of 2017 and helped drive year-on-year production growth. While this growth helped inventories from drawing further, our models suggest it cannot be repeated. Looking forward, the only Canadian projects expected to come online in 2019 are the Jackfish Expansion and the Christina Lake Phase G with a combined total of only 70,000 b/d or less than 25% of the new capacity that contributed to Canada's 2018 production growth.

Once again, all eyes are turned to the US shales as the only material source of non-OPEC production growth in 2019. While we continue to expect another year of strong growth from the US, our models tell us it will not be enough to balance global oil markets. In our Q1 2018 letter, we explained why we believed two out of the three major US shales were now suffering the first signs of field exhaustion. In particular, the improvement in drilling productivity in the Eagle Ford and Bakken was only a fraction of what we would have expected given the much longer lateral lengths and greater well completion intensities being used. We concluded that these factors were masking the underlying deterioration in well quality as producers exhausted their tier-one inventory and were forced to drill their tier-two locations.

Since then, we have been watching for indications that our analysis is leading us in the right direction. While production from these fields continues to grow, we are now seeing signs that our models are indeed correct. For example, during the third quarter, 517 wells were completed in the Eagle Ford. Despite the fact that this was 15% greater than the 450 wells completed during Q4 of 2017, net production growth in the play slowed by 50% (68,000 b/d during 3Q2018 versus 129,000 b/d during Q4 of 2017). Similarly, during Q3, 392 wells were completed in the Bakken – 54% more than during Q4 of 2017. Despite this sharp increase in completion activity, net production only grew by half that rate. For example, production grew by 70,000 b/d during Q4 of 2017 and 85,000 b/d during Q3 of 2018.

These trends are exactly what you would expect to see in plays exhibiting the first signs of exhaustion. While it is still possible to grow production, it is requiring more and more effort to do so. Eventually, the deterioration of well quality overtakes the ability to increase development and the field enters into decline.

In analyzing the latest data, we noticed something that we had not expected. Based on this analysis, the Permian is also starting to experience its first signs of field-level exhaustion. During Q3, completions totaled 1,263 wells in the Permian or 8% greater than during Q4 of 2017. Despite this slight acceleration in development, production growth actually slowed from 270,000 b/d during Q4 of 2017 to 156,000 b/d during Q3 of 2018. While some of this data may have been distorted by infrastructure bottlenecks, it nevertheless suggests the Permian may be maturing more quickly than we had originally anticipated. In our past letters we have said that never before has so much depended on seven counties in West Texas. If these counties are showing signs of fatigue, it would have an enormous impact on global oil balances. It is simply too early to tell if these data points from the Permian are material or just noise. We will continue to monitor them very closely and will report our findings in our next letter.

Given near-record demand growth and disappointments throughout non-OPEC, we expect the tightness in the global oil markets to continue, even aside from recent problems in OPEC. In its latest report, the IEA predicts global demand will grow by 1.5 mm b/d in 2019 to reach 100.8 mm b/d. As we explained, we believe this figure will actually come in approximately 400,000 b/d higher (in line with the average balancing item over the last several months) to reach 101.2 mm b/d. US production is expected to grow by 1.2 mm b/d to reach 16.2 mm b/d. While we have reservations about this figure, to be conservative, we are comfortable using the IEA's higher estimate. The IEA is projecting non-OPEC supply outside the US to grow by 500,000 b/d but, given our discussion above, we find this figure to be impossible. In particular, we do not believe Canada can grow production at nearly 80% of this year's figure when only 20% of the new capacity is expected to start up. Instead, we project non-OPEC supply outside the US will grow by only 1-200,000 b/d to reach 40.2 mm b/d. Given processing gains, biofuels and OPEC NGLs, that would leave total non-OPEC crude oil supply at 56.4 mm b/d, implying a so-called Call-on-OPEC of 32.7 mm b/d.

Will OPEC be able to produce at these levels? We remain highly doubtful.

The most immediate issue remains the impact of Iranian sanctions scheduled to commence next month. While some analysts are calling for 2 mm b/d of lost production, we feel that a more reasonable estimate is 1 mm b/d on a year-on-year basis. While Iraq has some spare capacity, continued unrest in that country makes it unlikely to expect material growth in the foreseeable future.

The next most pressing issue is the collapse of Venezuelan production. Production has already fallen by 1.1 mm b/d since 2016 and tragically this figure is expected to fall by another 3-400,000 b/d in 2019, with continued unfortunate humanitarian repercussions.

The only remaining OPEC country with any spare capacity is therefore Saudi Arabia. In September, Saudi Arabia produced 10.5 m b/d and, although they continue to claim they have nearly two million barrels per day of spare capacity, they have only ever reached 10.6 mm b/d for a one-month period in the summer of 2016 before needing to rest their fields. Will Saudi Arabia be able to summon ~1.5 mm b/d of its spare capacity to meet both the inherent deficit in the global market plus the reduction in both Iranian and Venezuelan crude? We do not believe so and invite you to read the previous essay: "The Saudi Oil Dilemma" for an in-depth study of the Saudi oil industry.

As we mentioned in our introduction, even the IEA has suggested the oil markets are "entering the red zone." Our models have been warning about severe tightness in the oil markets for two years

now and we are seeing the impacts on inventories and price.

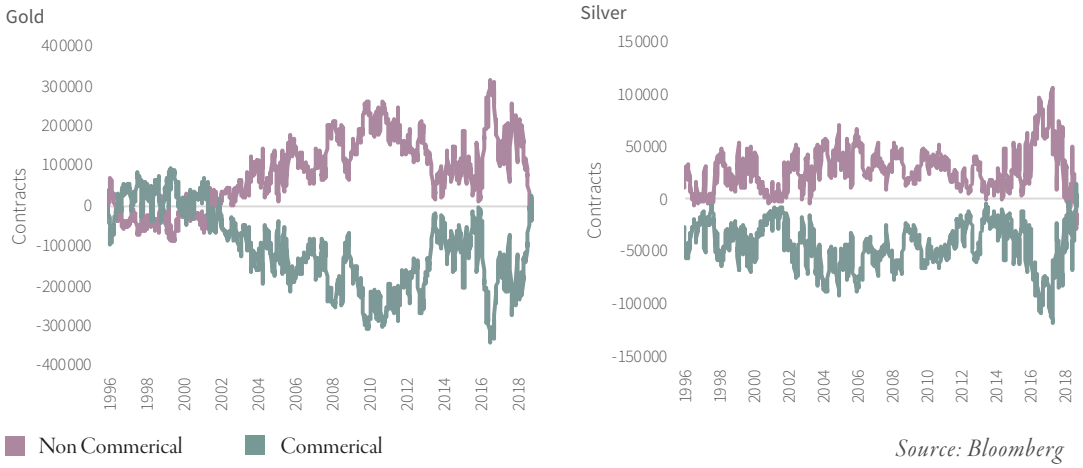
P.S. We would like to address an observation in recent weeks regarding inventories. We have seen an uptick in US inventories relative to seasonal levels over the last two months. Our models suggest to us that this is the result of increased OPEC exports in advance of the US-led embargoes which go into effect next month. We experienced a similar phenomenon in January 2017 ahead of the OPEC production-cuts taking hold. If inventories continue to grow, we will be forced to revisit certain of our assumptions, but as of now we believe it will be temporary and not reason for concern.

PRECIOUS METALS

Precious Metals were the weakest performing metal group in Q3. Lackluster physical demand from Indian, Chinese, and Western Investors combined with a strengthening US dollar created a powerful sell-off across the entire precious metal complex. Gold was down 5%, silver down 9%, and platinum was down 4%. Precious metals equities were also poor performers during the quarter. For example, the NYSE Gold Bug Stock fell almost 20%. The only precious metal that bucked the downward trend was palladium. News flow out of Europe continues to suggest more and more regulations (and possibly an outright ban) on diesel engines for passenger car use are forthcoming. Palladium is the catalytic metal of choice in gasoline powered vehicles and would stand to benefit.

As we suggested in the "Natural Resource Market Commentary" section of this letter, the upcoming bull market in precious metals is getting closer. More pieces of the "gold bull-market puzzle" are falling into place. The latest bullish data point to emerge is the positioning of the so-called "commercial" versus "speculator" traders on the COMEX metals exchange for both gold and silver. For those unfamiliar with futures trading, most bear market bottoms are made when the commercials (i.e., commercial users of gold or "the smart money") are net long in their trading positions and the speculators (i.e., the traders or "trend followers") are correspondingly net short. Since the beginning of the precious metals bull market, which really took off at the end of 2001, we have never experienced a period on either the Comex silver and gold exchange where commercials were net long and speculators were net short. However, back in August, for the first time in 16 years commercial traders actually went net long and speculators went net short in both gold and silver futures markets.

CHART 7 COMEX Trader Net Positions



Source: Bloomberg

The large pullback in gold and silver prices that started in March has finally created enough value to induce the commercial traders to take a net long position and enough bearish sentiment to induce speculators to go net short. As you will see, it's yet another bullish data point confirming the end of the bear market that started in 2011. The next leg of the gold bull market is getting closer.

Before we conclude that this "sideways" correction in precious metals (now in place since the end of 2015) is ending and our long-discussed bull market has begun, let us look at a very interesting story: the history of commercial and speculator trading behavior on the Comex futures markets over the last 20 years. . We will start by discussing the history of the gold market, which has some interesting differences compared to the silver market.

The final leg of the great 20-year bear market in gold began in the beginning of 1996 when gold rallied back to nearly $420 per ounce. As European Central Banks intensified their selling, gold producers rushed to sell forward their future production, causing the gold price to fall relentlessly. By the first quarter of 1997, the gold price had fallen to $340 per ounce and at that point, commercial traders had established net long positions while speculators had swung net short on the Comex exchange.

"BY THE SUMMER OF 2001, COMMERCIAL TRADERS HAD SWUNG FROM NET LONG TO NET SHORT AND SPECULATORS FROM NET SHORT TO NET LONG -- A POSITIONING THEY HAVE MAINTAINED CONTINUOUSLY FOR THE LAST SEVENTEEN YEARS. UNTIL AUGUST."

But did this seemingly bullish development signal the end of the bear market? In retrospect, we know it did not. From Q1 of 1997 (when commercials were net long approximately 40,000 contacts and speculators were net short 40,000 contracts), the gold price continued to fall. Except for some brief exceptions, commercial traders continued to increase their net long positions while speculators continued to increase their net short positions for the next two years.

By the very bottom of the gold market (reached in August of 1999 when gold reached $253 per ounce), commercials had increased their net long positions to almost 100,000 contracts while speculators had gone net short the same amount. Even with the announcement of the "Washington Agreement" (in which European Central Banks agreed to limit their annual gold sales causing a massive gold price rally from the low $250s to $325 in just two short weeks), the commercials did not unwind their net long positions nor did the speculators unwind their shorts. After peaking at $325 per ounce in October 1999, gold rolled over and made a secondary low of $257 per ounce in March 2001. This marked the final low in the 20-year gold bear market. By the summer of 2001, commercial traders had swung from net long to net short and speculators from net short to net long -- a positioning they have maintained continuously for the last seventeen years. Until August.

Turning to silver, the historical positioning between commercials and speculators is even more interesting. Except for the most recent episode, the last time commercials were net long and speculators net short was back in July of 1997 when silver bottomed at $4.15 per ounce. In the next eight months, silver experienced an explosive rally following the announcement that Warren Buffet had accumulated 130 mm ounces of silver (or about 30% of annual mine supply). Silver peaked at $7.30 per ounce seven months later in February 1998 and then proceed to give back nearly all of its gains over the next four years.

Silver finally bottomed at $4.10 by the end of 2001. While speculators went net short at that

point, commercials never quite went net long. Nevertheless, we know it was a great time to be a silver buyer: silver proceeded to surge over ten-fold in price in the next 10 years.

The fact that gold and silver commercials and speculators have both now reached net long and net short positions in their respective future trading accounts is highly unusual -- the last time we experienced such an episode was all the way back in 1997, over 21 years ago. So what can we learn from the occurrence of such an unusual event?

In retrospect, we now know the 1997 event signaled that the bear markets in both gold and silver were nearing an end; however, we also know that it did not mark the exact end of the bear market in gold and silver.

In other words, we believe having COMEX commercials net long and speculators net short is a necessary but not sufficient condition for a major market bottom. It is another important indicator informing us that the precious metal correct phase is nearing an end. However, if recent history is any guide, we could potentially experience a significantly long period of corrective price action before a new bull market starts in earnest. Remember, commercials were net long gold and speculators net short gold on the COMEX for over three years before the gold bull market started at the end of 2001.

However, for those long-term investors with no performance constraints, we believe the present weakness in both gold and silver presents a buying opportunity. For example, looking back at the last bear market, if you had bought gold at $350 per ounce back in Q1 of 1997, by the beginning of 2001, you were sitting with nearly a 30% loss. Yet, by 2011, gold was approaching $1,900, and your $350 per ounce entry point looked like a great buying opportunity returning 13% per year compounded despite the fact that the bear market was not quite finished.

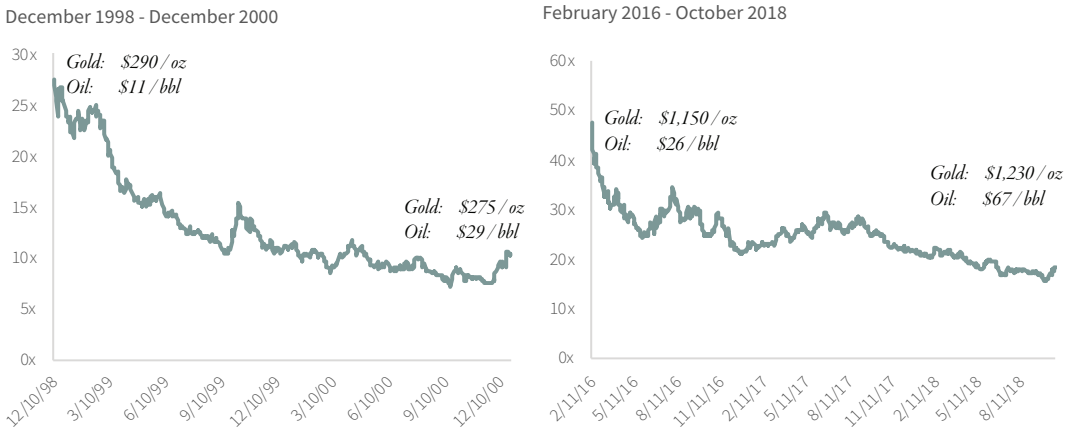
The same investment opportunity presented itself with silver. If you bought silver in 1997 when commercials were net long and speculators net short, you would have paid $4.15 per ounce. If you didn't sell during the "Buffet" rally in silver, four years later you were sitting with a slight loss. However, by the spring of 2011 your silver investment would have delivered you a 19% compounded rate of return.

We believe the same situation is being offered to long-term investors once again. The fact that both gold and silver speculators have gone net long and net short respectively tells you that huge imbedded investment value exists in both gold and silver and that an approaching bull market gets closer.

For those operating under performance constraints looking for the optimal time to enter precious metal markets, we would still counsel a "sit-on-the-sidelines" strategy. Gold is down 6% as we write while silver is down almost 15%, and related precious metal equities are down nearly 25%. "Sitting-on-the-sidelines" this year has been the correct strategy so far.

For those wanting to time the optimal entry point for the upcoming precious metals bull market, we believe one more piece to the gold bull market puzzle needs to fall into place before the bull market can begin in earnest -- the "gold-oil" ratio.

CHART 8 Gold/Oil Ratio



Source: Bloomberg

In previous letters, we wrote how the gold-oil relationship today is repeating what happened between 1999 and 2001. Back in 1999, when oil hit $11 per barrel, gold became very expensive relative to oil. Historically, such extreme readings often take years to work off and what happened back in 1999 to 2000 was no exception. After peaking at nearly 30:1 (one ounce of gold bought 30 barrels of oil), oil proceeded to appreciate 230% in the next 18 months. During that time, gold prices declined by almost 10%. By the end of 2000, gold had become radically undervalued. In fact, gold had become about as cheap as it ever gets relative to oil: one ounce of gold bought only 7 barrels of oil. At that point, gold (and particularly gold stocks) began to radically outperform both oil-related investments and the stock market in general. For example, over the next six years gold prices tripled and gold stocks surged more than eight-fold.

In the current cycle, the gold-oil ratio hit an all-time high of 44:1 (the highest level in the over 160 years of data that we keep). As in the 1999-2000 experience, oil has radically outperformed gold ever since. Since the February 2016 low, oil prices have advanced over 180% compared to a gold price that has only advanced a little less than 20%.

The gold-oil ratio has steadily contracted and today stands at slightly over 17 (it actually broke 16 at the beginning of October - a new cycle low). Although open to a wide variety of interpretations, we believe that we are still on track to have the gold-oil ratio trade back into the low teens this cycle.

For example, if oil were to reach $100 per barrel in this cycle (which we think is getting closer) while gold continued to drift slightly lower from here, the gold-oil ratio could easily approach 10:1. At that point gold would become a tremendous buy, just like it was in Q4 of 2000.

As we stated in our previous letter, we continue to prefer oil-related investments over precious metal investments, although we believe yet another piece in the precious metal bull market investment puzzle has now fallen into place: the positioning of precious metal futures traders on the Comex exchange.

COPPER

Copper prices were weak during the quarter as Trump-related trade war rhetoric weighed on all base metals. As we mentioned in the introduction, while we cannot gauge the ultimate impacts from

a trade war, as of today they seem minimal. A dearth of new copper projects continues to impact global supply and we proceed now through a second year of no growth in copper mine production. At the same time, demand has firmed considerably with Chinese copper consumption up over 5% for the first seven months of the year. Strong demand and anemic supply growth has caused exchange-traded inventories to plummet by nearly 50%, reaching their lowest levels in three years.

Based on extremely favorable supply and demand trends, copper continues to be our favorite metal. In past letters, we explained how copper demand growth in the coming decade would be impacted by two major trends: the development of emerging market economies and the push toward renewable power. Today we would like to focus on the former of these two, focusing in particular on a potential near-term catalyst that we believe could propel copper demand over the next several years. For those interested in how investments in renewable power will impact copper demand, we invite you to read our 2Q2016 letter where we go into great detail on this subject.

An economy that wants to develop and grow requires increasing levels of copper investment. The relationship between real per capita GDP and installed copper is very different than those commodities that are "consumed" (i.e., crude oil). Since copper is used in long-lived capital goods, we believe it's more appropriate to look at the cumulative installed copper base in an economy and not annual consumption in any given year. Graphing the installed copper base versus real GDP on a per capita basis shows a trend that is repeated across all countries over many decades. Simply put, you cannot run an economy of a given size without having installed a certain amount of copper stock.

CHART 9 Per Capita Installed Copper Base vs. Per Capita Real GDP

Source: World Bank, International Monetary Fund, International Copper Study Group, Goehring & Rozencwajg Models

In our 4Q2017 we wrote an in-depth essay on how, after many years of disappointments, India had finally reached an important inflection point in its commodity consumption. Regarding copper, the most important driver we mentioned was the need to build out the Indian electrical grid. Connecting homes and businesses to the power grid is an incredibly copper-intensive task and we argued this would be a huge driver of incremental global copper demand going forward. India has one of the lowest levels of copper installed per capita in the world. With a real per capita GDP of $4,500 (in real 2005 US dollars), we calculate India has less than 14 pounds of copper installed in its economy per person. China, on the other hand, has nearly 170 pounds of copper installed per person today and when China's real GDP per capita was comparable to India's (in 2004), we estimate

it still had 45 pounds per person. In other words, at comparable levels of real GDP, China had three times the installed copper base per capita than India.

We traveled to India in February and spoke to several executives about our research. We were told repeatedly that rural electrification was a top priority of the current government and that it was, in fact, approaching 100%. Soon after we returned, on April 28th 2018, PM Modi tweeted that every Indian village was now electrified, fulfilling one of his key campaign promises of connecting 18,000 villages to the power grid within his first 1,000 days.

Despite PM Modi's tweet, we were very skeptical of this claim, given that Indian copper demand growth has remained lackluster over the last several years. In fact, Indian copper demand in 2017 still remained 12% below its 2009 peak. How could India possibly have connected all 18,000 of its unelectrified villages with only 14 pounds of copper installed per person?

"HOW COULD INDIA POSSIBLY HAVE CONNECTED ALL 18,000 OF ITS UNELECTRIFIED VILLAGES WITH ONLY 14 POUNDS OF COPPER INSTALLED PER PERSON?"

To understand why this is such a mystery, consider how electricity is generated and distributed. Power is generated at a power plant, fueled by either coal, natural gas, uranium, or renewable sources. The electricity is then transmitted in bulk along high-voltage power lines to various substations. At this point, the electricity is "stepped down" using transformers and distributed to various end users in a suitable voltage. These transformers contain hundreds of kilograms of copper wire each, forming the primary and secondary "coils" of the transformers. Copper's high conductivity makes it uniquely capable of servicing these transformer coils. Based on our models, it would have been impossible to connect such a large number of customers to the power grid, without a noticeable uptick in installed copper (and by extension copper demand).

As we tried to get to the bottom of this mystery, several articles appeared in the press that helped shed light on the situation. A careful reading of PM Modi's definition of "connection" showed that an entire village was deemed to be electrified if a high voltage power line reached at least one transformer in the village and public places (such as schools) were connected. In fact, far from being 100% electrified, it now looks as if only 7% of the 18,000 villages now have 100% household connectivity.

While this revelation is certainly an embarrassment for the government's initiative, it is incredibly bullish for copper demand over the near-term. High voltage power lines now pass within a short distance of every Indian village (a huge accomplishment in and of itself). While these high voltage lines are very steel- and aluminum-intensive, they use little to no copper at all. The copper intensive part of the process is next, as additional transformers are added to the village substations allowing additional households to connect.

Increased scrutiny and negative press accounts surrounding Modi's electrification claims have now created the political incentives to push for greater household adoption. Looking at recent reports, the Indian government has introduced initiatives aimed at recapitalizing the local power distribution companies in hopes they will be freed to increase household hookups. After two years of slow growth, Indian power transformer manufacturers are now seeing 30% increases in sales driven entirely by unit volumes.

Certainly, nothing is straightforward in India and the power industry is no exception. Indeed, there

"IF INDIA WERE TO REACH EVEN HALF OF THE INSTALLED COPPER BASE THAT CHINA HAD AT THE SAME LEVEL OF GDP OVER THE NEXT FIVE YEARS, WE ESTIMATE THAT WOULD REQUIRE NEARLY 5 MILLION TONNES OF INCREMENTAL COPPER OR AN INCREDIBLE 900,000 TONNES PER YEAR."

has been persistent inadequate capital spending at the Indian power distribution level for several years. As a result, India is in the strange situation of having surplus electricity generation but frequent power outages.

Nevertheless, given the increased scrutiny regarding village electrification issues in the press, and the need for the Prime Minister to make good on his campaign promises, we think we could be approaching a period of intensive copper demand growth from the Indian power sector in the next several years.

We believe that the power sector will serve as a catalyst to help close the gap between India's per capita installed copper base and China's from 2004 (at a comparable level of real per capita GDP). If India were to reach even half of the installed copper base that China had at the same level of GDP (i.e., 20 pounds per person) over the next five years, we estimate that would require nearly 5 million tonnes of incremental copper or an incredible 900,000 tonnes per year. Given global refined copper demand has averaged 600,000 tonnes per year over the last five years, even if we are off in our estimates the impact will be huge.

Given the demand and supply outlook, we remain bullish on copper-related investments and believe any continued weakness there is a buying opportunity.

URANIUM

Uranium spot prices were strong during the quarter, rising over 20% to nearly $30 per pound. From their lows made at the end of 2016 at $17.75 per pound, spot uranium prices have now advanced by nearly 60%. While this move has been impressive, spot prices still remain some 80% below their peak of a decade ago.

In our Q12018 letter, we laid out our investment odyssey with uranium over the last two decades. First, we had great success as we properly identified the changing trends surrounding the "mega tonnes to mega watts" program at the end of the 1990s. Next, we re-entered the market following the Fukushima incident, after all the related uranium securities fell sharply. In retrospect, this was a mistake as new production from Canada and Kazakhstan came online at the same time as Japan was slow in restarting its nuclear power sector and Germany decommissioned the majority of its reactors.

For the last several years, we have remained on the sidelines although we continued to monitor uranium markets closely. Ultimately, we argued, uranium would re-enter a bull market as the next generation of nuclear power facilities (mostly in China, India, and the Middle East) started up. Given our models, we expected the global uranium markets to slip into deficit sometime early next decade. However, at the end of 2017, both Cameco and Kazataprom announced production curtailments at their uranium mines. Because of these closings, our models suggested uranium markets could slip into deficit as early as this year.

In our last letter, we only touched on the uranium markets briefly in the introduction. We explained how Cameco, on their Q2 conference call, had announced they would be forced to purchase

volumes in the spot market during the second half to meet their long-term obligations after having curtailed production at McArthur River. We explained how this would serve as a test of the often-opaque spot market: if excess inventories were easily available, Cameco would be able to procure its volumes without impacting price. If, on the other hand, the market was tight, the arrival of Cameco in the spot market would cause prices to rise. Given the price action since we last wrote, we are more confident that the global uranium markets are indeed much tighter than people realize.

"PLEASE NOTE THAT THESE VEHICLES ARE NOT OPEN-ENDED. THE URANIUM THEY PURCHASE IS, FOR THE MOST PART, REMOVED FROM THE MARKET ENTIRELY."

Since we last wrote, another source of unexpected physical demand has entered the market--one that we believe could become substantial as this bull market unfolds. We are referring to the emergence of investor demand for physical uranium. The Uranium Participation Corp is a well-known closed-end investment vehicle in Canada that purchases and holds physical uranium. This summer, it was joined by Yellow Cake PLC in an IPO listed in London. Over the last 12 months, the Uranium Participation Corp in Canada has issued 17 million shares and we estimate the proceeds were used to purchase 2.1 mm lbs of U3O8. Meanwhile, the Yellow Cake IPO raised approximately US $170 mm that we estimate was used to purchase ~8 mm lbs. Furthermore, Tribeca Investment Partners, an Australian investment firm, is looking at a similar vehicle. Please note that these vehicles are not open-ended. The uranium they purchase is, for the most part, removed from the market entirely.

The rise of investment demand on top of very bullish mine supply and reactor demand dynamics should help push prices higher. Since we last wrote, two very positive demand announcements were made. First, the Japanese courts have paved the way for the restart of their ninth closed reactor which will greatly help Prime Minister Abe in his quest to bring back nuclear as a material source of power generation. Second, after a 168-hour test run, the Sanmen power plant commenced commercial operation of its AP1000 reactor in China. This is so important because it is the first of the so-called "third-generation" reactors to operate on a commercial basis. Nuclear industry officials are calling the commissioning a landmark event in the industry. (On an historical note, this is the same reactor design that was plagued by delays and cost overruns in both Georgia and South Carolina and ultimately caused Westinghouse to declare bankruptcy.) China has five other AP1000 reactors in various stages of construction, testing, and commissioning. This initial successful startup is a huge step in China realizing its nuclear ambitions.

"CHINA HAS FIVE OTHER AP1000 REACTORS IN VARIOUS STAGES OF CONSTRUCTION, TESTING, AND COMMISSIONING. THIS INITIAL SUCCESSFUL STARTUP IS A HUGE STEP IN CHINA REALIZING ITS NUCLEAR AMBITIONS."

Turning to supply, Kazakhstan revised down their estimates for 2018 uranium production by 20% to 21,600 tonnes (equivalent to ~56 mm lbs of U3O8). This figure is largely in line with the model we laid out for you in our Q1 letter and forms the basis for our bullish outlook going forward. Moreover, the Kazakhstan energy minster confirmed these cuts would persist until at least 2020. While we had expected this, it marked the first time the government confirmed it explicitly. Meanwhile, Kazataprom announced they would move ahead with their IPO of 25% of the uranium producer on the London exchange sometime in early 2019. They have released their offering documents and are now starting to meet with investors. In our next letter, we will go through what we were able to learn from these documents.

We remain very bullish on the global uranium industry. After a brutal ten-year bear market that saw prices decline by 90%, our models now tell us the fundamentals have become decidedly bullish. The deficit between demand and supply will approach 45,000 tonnes by 2030—representing over 50% of today's world mine supply. We originally modelled this deficit to emerge in the next 5 years, however, the supply cuts announced by both Cameco and Kazataprom, combined with the strong

emergence of investor demand in the physical metal, have now pushed forward the emergence of this deficit to as early as 2019. This is exactly the type of market we love to be involved with: prices are still 80% off their highs, investor interest among generalist investors is extremely low, and the fundamentals have turned strongly positive. We recommend investors continue to purchase uranium-related investments.

NATURAL GAS MARKET

Henry Hub gas prices rallied during the quarter, ultimately reaching $3.37 per thousand cubic feet – their highest level since January. Hotter-than-average temperatures across the US resulted in additional natural gas demand which more than offset surging production. For the quarter as a whole, inventories built by 700 billion cubic feet (bcf) compared with 10-year average seasonal builds of 830 bcf, implying a market that was undersupplied by 1.3 billion cubic feet per day (bcf/d). According to our models, weather made up for more than 100% of this shortfall as production continues to surge. Inventories in the US currently stand some 600 bcf below their long-term averages – the largest deficit since 2014.

As we have long argued, even in the face of an inventory deficit, we simply cannot get constructive on US natural gas with production growing as quickly as it has been. For example, in July (the last month with available data), US dry gas production grew by 8.7 bcf/d on a year-on-year basis, another all-time growth record (the third such record set in the last 12 months). Furthermore, these records were achieved with a rig count that is 50% below where it was five years ago and 90% below its peak in 2008. The hot summer certainly bailed out inventories, and if we have a very cold winter, Henry Hub natural gas prices could certainly see a weather-related spike.

While we remain neutral on US natural gas, we are increasingly bullish on global liquified natural gas (LNG). We have followed this market for many years, though we have not written about it since the summer of 2014. At that time, we explained how global demand projections from most analysts and large consultants were dramatically understated.

Most analysts take a so-called "bottoms up" approach in which they model each regasification import terminal in order to determine a country's future LNG demand. Using such an approach, planned liquification capacity was expected to overwhelm new regasification terminals and the market was expected to be in perpetual surplus as the decade progressed.

Our models used a wildly different approach and came to a completely different answer. We studied the relationship between real GDP per capita and a country's energy mix. We noticed that countries with lower per capita GDP burned more coal, while richer countries burned more natural gas. While coal is a very dirty fuel, it is nevertheless very cheap. Natural gas is incredibly clean burning compared with coal. However, due to its low energy-to-volume ratio (i.e., because it is a gas), it requires a huge amount of infrastructure investment. As a result, a developing country cannot afford to burn natural gas, but as it gets richer its population becomes increasingly concerned about air quality and natural gas gains share.

The difference between these two methodologies led to wildly different views, particular as it related to China. For example, using a "bottoms up" approach, most analysts at the time expected

Chinese LNG demand to reach 6-7 bcf/d by 2020. Our models told us that demand would reach nearly twice this level. Based upon the relationship between GDP and natural energy penetration and announcements of long-term guidelines made at the time by various government officials, we assumed Chinese gas would go from 5% of total energy in 2013 to 10% by 2020. This equates to 50 bcf/d of total gas demand by the end of the decade. If domestic gas production were able to double from 10 bcf/ to 20 bcf/d, and pipeline imports went from 2 bcf/d to 13 bcf/d, then total supply would equal 33 bcf/d, implying a deficit of 18 bcf/d. While 8 bcf/d would be met from planned regasification facilities, that would leave another 11 bcf/d of latent demand. If even 25% of this were met by incremental LNG imports, then total imports would reach 12 bcf/d – twice the level put forward by most analysts.

After some initial delays, we think we are finally starting to see these extremely strong trends taking hold today. The delays were caused by Japan's decision to leave its nuclear reactors offline longer than anyone expected, following the Fukushima incident. Japan turned to natural gas power plants to make up for this. With Japan as an aggressive buyer, we believe the LNG supply simply was not available for Chinese imports until Australian and US cargos came to market over the last year.

At present, Chinese LNG demand is surging. **For the first nine months of the year, Chinese imports are up an incredible 50% year-on-year. We think this will continue.** We estimate that total 2018 LNG imports could approach 8 bcf/d – far above analysts' expectations.

However, its not just China that will drive LNG demand going forward. Using our same methodology, we expect India, Turkey, Pakistan, and Thailand will all see sharply higher demand for LNG volumes between now and 2025. Furthermore, as domestic demand comes in stronger than expected, several LNG exporting countries are facing feed gas shortages. Indonesia, Egypt, and Brazil have all run into problems and limited exports since we first identified this potential bottleneck several years ago. Indonesia's new large-scale export terminal on Papua is now expected to entirely serve domestic gas demand and as a result no volumes are expected to reach the export market.

We don't have space in this letter, but in our next edition we will outline our full outlook for LNG supply and demand between now and 2025. As a preview, we are extremely bullish on the outlook for global natural gas. Ultimately, this will help tighten the US market as well, as additional LNG export terminals (both here in the US and in Canada) come online in 2019 and into the coming decade. Whether or not it is enough to absorb the seemingly endless growth in domestic production is up for discussion. In the interim, we remain neutral towards North American natural gas markets.