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Impact of US Shale Oil Revolution on the Global Oil Market, the Price of Oil & Peak Oil

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Abstract

Reports about the US shale oil boom being a game changer have proliferated after the November 2012's prediction by the Paris-based International Energy Agency (IEA) that the United States will overtake Saudi Arabia and Russia to become the world's biggest oil producer by 2020 and energy self-sufficient by 2030. While such rosy predictions play well to the IEA's audience, which is largely American, they don't stand up to scrutiny. Still, it is clear that US shale resources might at some point play some role in non-OPEC supply prospects. The paper will argue that US shale oil production would hardly make a dent in the global oil supplies as it would largely offset the decline in US conventional oil production. It will also argue that the US would never be able to overtake Saudi Arabia or Russia in oil production and would continue to be dependent on oil imports for the foreseeable future. The paper will conclude that the shale oil boom in the United States would not be easy to replicate in the rest of the world nor would it invalidate the peak oil concept.

Key Words: shale oil, OPEC, game changer, resources, peak oil

Introduction

Much has been written about the United States shale oil revolution. Some sources like the IEA went as far as to predict that the United States will overtake Saudi Arabia and Russia to become the world's biggest oil producer by 2020 and energy self-sufficient by 2030. **1** Others called it a game changer with a new emerging balance of power in the global oil market. Yet others were in such a state of euphoria about the success of American shale oil production to say that it may deny OPEC the power to set global oil prices and that the world oil industry won't be the same in the wake of shale. Some also jumped the gun and claimed that the idea of peak oil had gone in flames. The above claims aside, given recent increases in US shale oil and gas production, it is now clear that these resources might at some point play some role in non-OPEC supply prospects.

However, it begs the questions: what is the potential contribution of shale oil to the future global oil supply? Will the high development costs, and environmental impacts and challenges affect this potential? And will it be possible to replicate the US success story globally?

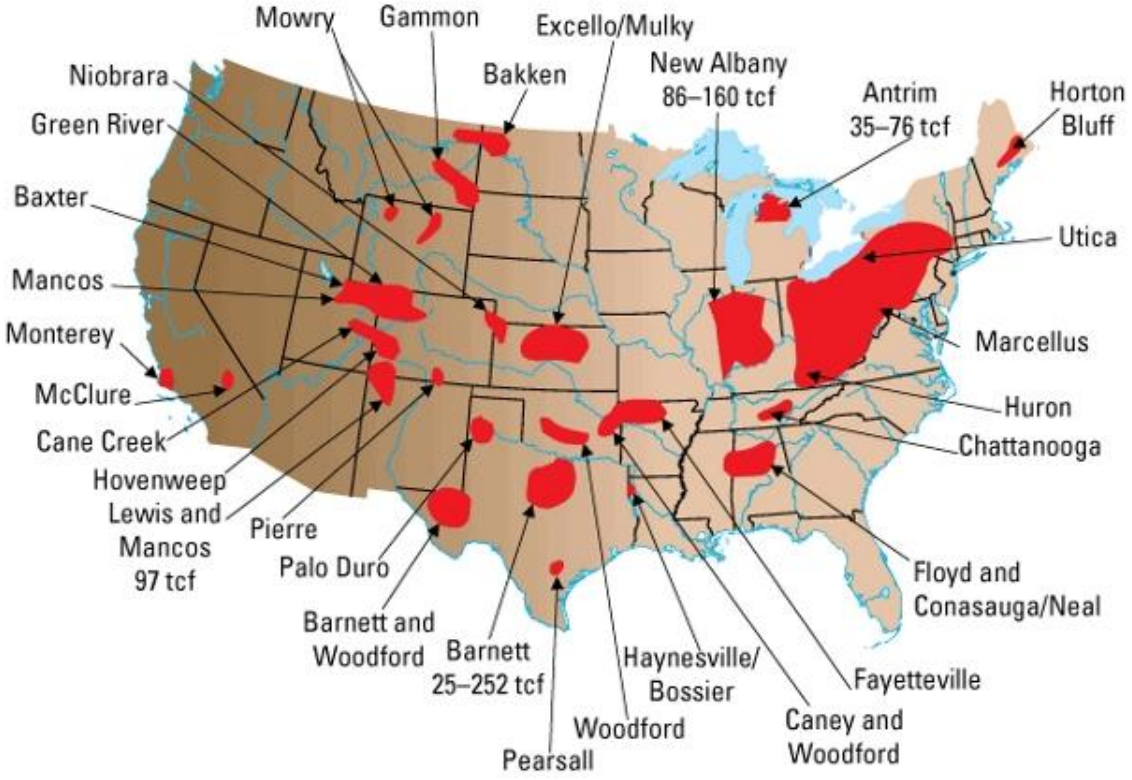
US shale oil production is projected to increase from about 1 million barrels a day (mbd) in 2012 to 2 mbd in 2020 possibly reaching 3 mbd by 2025. **2** However, this increase would hardly offset the normal annual depletion rate of 3%-5% in US conventional oil production, estimated at 1.2 mbd–2.0 mbd during the same period. **3** So the global oil market would hardly benefit from the US shale oil production.

With regard to the economics of US shale oil development, the drilling and completion costs for a horizontal shale oil well currently range from $4 to $6 million. This relatively high cost arises from the steep first year decline rate of 70% - 90% for the wells. Nevertheless, a break-even oil price of $72-$80/barrel suggests that most shale oil plays are profitable at current oil price levels. **4**

Shale Oil Reserves

There are large uncertainties about the size of US shale oil resources with estimates ranging between 800 billion barrels (bn) to 1.5 trillion barrels (tr) and spread all over the United States (see Map 1).

Map 1
Shale Formations in the United States



Source: Energy Information Administration (EIA).

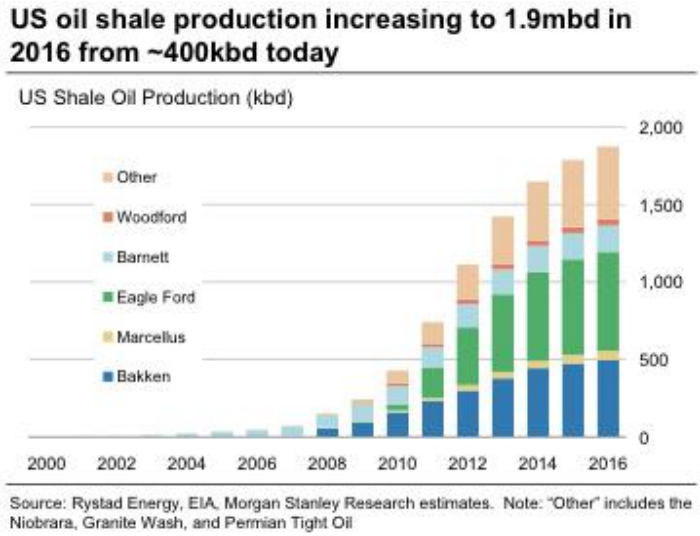
Although no serious attempts have been made yet to analyze its size, it seems that even if the in-place volumes are large, reserves will not be as high due to very low recovery factors, presently in the range of 1% to 10% with few exceptions. It is one thing having huge resources of shale oil in-place and quite another turning them into a sizeable production capacity. **5**

According to EIA's 2012 Energy Outlook, the unproved technically recoverable shale and tight oil resources in the US were estimated in 2010 at 33 billion barrels (bb), with recoverable shale gas resources about 480 trillion cubic feet (tcf). For the latter, it is worth mentioning that this level is almost half that reported (827 tcf) a year earlier. It is a further indication of the large uncertainties still associated with recoverable resource estimates. **6**

US Shale Oil Potential

Total US shale oil production from known "main" plays is projected to increase from about 1 mbd in 2012 to 2 mbd in 2020 before it plateaus at 3 mbd by 2025 and then starts its downward trend (see Figure 1).

Figure 1



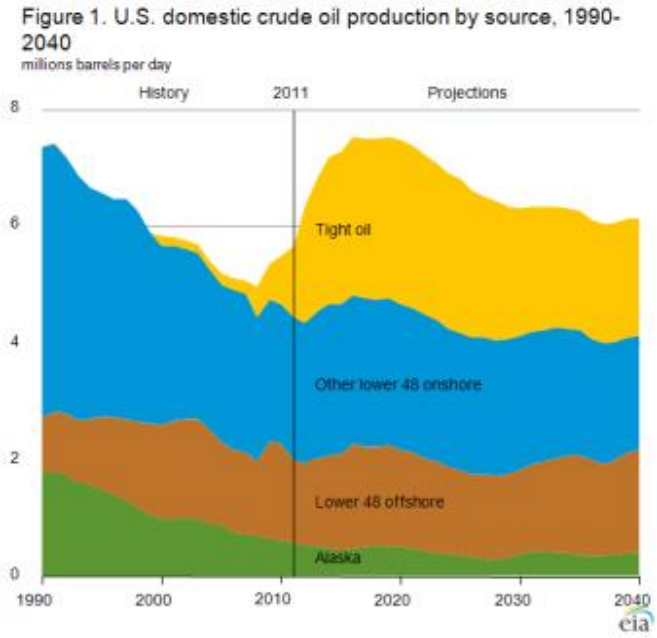
Total US oil production is projected to increase from 6.41 mbd in 2012 to a projected 7.50 mbd in 2019 (see Table 1 & Figure 2). The growth results largely from a significant increase in onshore crude oil production, particularly from shale and other tight formations. After about 2020, production begins declining gradually to 6.1 mbd by 2035 through to 2040 as producers develop sweet spots first and then move to less productive or less profitable drilling areas. **7**

Table 1
US Current & Projected Crude Oil Production,
Consumption & Imports, 2012-2035
(mbd)

	2012	2013	2014	2015	2016	2019	2020	2025	2030	2035
Production	**6.41**	**6.64**	**6.88**	**7.04**	**7.21**	**7.50**	**7.40**	**6.93**	**6.49**	**6.10**
Consumption	**18.46**	**18.48**	**18.50**	**18.52**	**18.54**	**18.60**	**18.62**	**19.50**	**19.11**	**18.86**
Net Imports	**12.05**	**11.84**	**11.62**	**11.48**	**11.33**	**11.10**	**11.22**	**12.57**	**12.62**	**12.76**
As a % of Consumption	**65%**	**64%**	**63%**	**62%**	**61%**	**60%**	**60%**	**64%**	**66%**	**68%**

Sources: OPEC World Oil Outlook 2112 / BP Statistical Review of World Energy, June 2012 / EIA Early Overview of Annual Energy Outlook 2013 (AEO2013) / Author's Estimates.

Figure 2



Source: EIA, Annual Energy Outlook 2013 Early Overview

Oil imports are projected to decline from 65% of consumption in 2012 to 60% by 2019 before they resume their rise reaching 68% by 2035. This means that there is neither a chance for the United States ever to become self-sufficient in oil nor to overtake either Saudi Arabia or Russia in oil production. The fall of imports since 2009 reflected two things: a decline in domestic demand in the wake of the 2008-09 global financial crisis and increasing shale oil production.

Assessing the producible reserves of a shale / tight oil formation is much more

complicated than evaluating conventional oil resources. Each shale formation is different and the properties within an individual field (porosity, permeability, etc.) can sometimes vary from well to well. Consequently the assessment of both recoverable resources in a single field as well as its productivity over time requires a highly customized analysis. Furthermore, the rapid output increase and decline of shale/tight oil-producing wells further complicates matters and makes shale/tight oil operations a "drilling-intensive" activity. In other words, it requires continuous drilling of new wells for maintaining and increasing production. For these reasons, it is impossible to make any reasonable evaluation of the future production from a shale/tight oil formation based on the analysis of a few wells data and such limited activity. **8**

Can the US Overtake Saudi Arabia & Russia as Top Oil Producer?

Reports about the US shale oil boom being a game changer have proliferated after the November 2012's prediction by the IEA that the United States will overtake Saudi Arabia and Russia to become the world's biggest oil producer by 2020 and energy self-sufficient by 2030. While such rosy forecasts play well to the IEA's audience, which is largely American, they are not borne out by the realities of the global oil market.

The IEA said it saw U.S. oil production rising to 10 mbd by 2015 and 11.1 mbd in 2020 before slipping to 9.2 mbd by 2035. Saudi Arabian oil output would be 10.9 mbd by 2015, the IEA said, 10.6 mbd in 2020 but would rise to 12.3 mbd by 2035. Russian oil output, which over the past decade has been steadily above Saudi Arabia, is projected to stay flat at over 10 mbd until 2020, when it will start to decline to reach just above 9 mbd by 2035 (see Table 2 & Figure 3).

Table 2
IEA Projections of US, Saudi Arabia & Russia's Oil Production
2015-2035
(mbd)

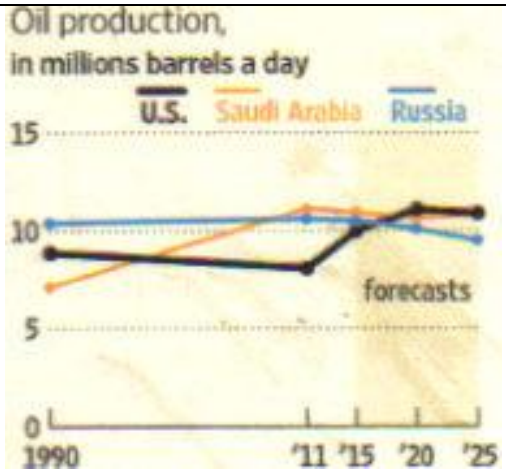
	2015	2020	2035
United States	10.00	11.10	9.20
Saudi Arabia	10.90	10.60	12.30
Russia	10.00	10.00	9.00

Source: IEA's Annual Energy Outlook 2012.

Allowing for the slow shale oil production and the steep depletion in US conventional oil production ranging from 3%-5% per annum, the projected US oil production by 2020 would amount to no more than 7.40 mbd, far less than the IEA projection of 11.10 mbd and far below the projected production of Saudi

Arabia and Russia at 10.60 mbd and 10 mbd respectively. Moreover, that level of shale oil production is probably sustainable for a couple of years because of the early peak and steep first year decline in shale production rates from new wells estimated between 70% and 90%.

Figure 3



Source: IEA, Annual Energy Outlook 2012

Another claim that does not stand up to scrutiny is that the success of American shale oil production has the potential to deny OPEC the power to set global oil prices and could also shift the balance of power in global energy markets. As the US adds supply, OPEC's influence over prices would wane. **9** That is not going to happen since the world will become increasingly dependent on OPEC after 2020. In addition to increases from Saudi Arabia, Iraq will account for 45% of the growth in global oil production to 2035 and would become the second-largest exporter, overtaking Russia. OPEC's share of world oil production will rise to 48% from 42% now.

US Shale Oil Contribution to Global Oil Supplies

The outlook for long-term global oil demand increases by almost 19 mbd over the period 2012-2035, reaching 107.3 mbd by 2035 (see Table 3).

Total non-OPEC supply increases by 1.3 mbd over the 2012-2016 period. The key sources of supply driving this growth are rising levels of shale oil production from the US, Canadian oil sands and crude oil from the Caspian and Brazil.

In 2012 US shale oil production amounted to less than 1% of global oil supplies and this is projected to rise to 2% by 2019 possibly reaching 3% by 2025. Such a level of production will hardly make a dent in global oil supplies and would hardly deny OPEC the power to set global oil prices.

Table 3
World Oil Demand & Supply, 2012-2035
(bb)

	2012	2014	2015	2016	2020	2025	2030	2035
World Oil Demand	88.70	90.70	91.80	92.90	96.90	100.90	104.20	107.39
World Oil Supply	84.40	84.63	85.37	85.17	87.91	89.62	90.05	90.06
Non-OPEC	46.60	47.70	47.90	47.90	48.68	48.92	49.16	49.31
OPEC	36.80	35.80	36.20	36.00	37.23	37.70	37.89	38.00
US Shale oil	1.00	1.13	1.27	1.27	2.00	3.00	3.00	2.75
Demand / Supply Deficit *	- 4.30	- 6.07	- 6.43	- 7.73	- 8.99	- 11.28	-14.15	-17.33
Shale oil as % of Global Supply	1%	1%	1%	1%	2%	3%	3%	3%

Source: OPEC: World Oil Outlook 2012 / IEA, World Energy Outlook 2012 / BP Statistical Review of World Energy, June 2012 / EIA, Energy Outlook 2012 / Author's projections.

* The demand/supply deficit is accounted for by stock changes, consumption of non-petroleum additives and substitute fuels. Otherwise it will be reflected in higher oil prices.

A major factor driving the global oil demand would be a huge expansion in the Chinese economy which is projected to overtake the US economy in purchasing power parity (ppp) soon after 2015 and by 2020 using market exchange rates. Chinese real gross domestic product is expected to increase by 5.7% annually between 2011 and 2035.

Another factor would be a rise of 1.8 billion in the world's population to 8.6 billion which would lead to a spike in global oil demand by more than a fifth by 2035, keeping pressure on oil prices.

Under an IEA's "New Policies" scenario, which assumes a range of measures are taken to curb oil consumption in Europe, the United States, China and elsewhere, the oil price could rise to just over $215/barrel by 2035 in nominal terms, or $125 in 2011 terms. **10**

If fewer steps are taken to promote renewable energy and curb carbon dioxide emissions, oil would likely exceed $250/barrel in nominal terms by 2035 and reach $145 in real terms.

Russia, which remains the largest individual energy exporter throughout the period, sees its revenues from oil, natural gas and coal exports rise from $380 billion in 2011 to $410 billion in 2035," the IEA said.

Fossil fuels in general will remain dominant in the global energy mix, supported by subsidies that, in 2011, jumped by almost 30 percent to $523 billion, due mainly to increases in the Middle East and North Africa. **11**

Impact on the US Economy

So far the only estimate of the broader impacts of the combined shale oil and gas production on the US economy has been made by Citigroup, according to which "the cumulative impact of new production and reduced consumption could increase real US gross domestic product (GDP) by 2% to 3.3%, or by $370 bn to $624 bn, by 2020". **12**

As to the labour market, Citigroup estimated "that as many as 3.6 million new jobs may be created by 2020. Some 600,000 jobs would be in the oil and gas sector, another 1.1 million jobs in related industrial and manufacturing activity, and the remainder in ancillary sectors". **13**

Finally, the shale oil & gas revolution may substantially help reduce the US current account deficit which, "currently is running a negative 3% of GDP, by anywhere from 1.2% of GDP to 2.4% of GDP". **14**

US industrial production is projected to grow more rapidly due to the benefit of strong growth in shale oil and gas production and an extended period of relatively low natural gas prices, which lower the costs of both raw materials and energy. Specific industries such as the bulk chemicals and primary metals industries benefit from the greater availability of natural gas at relatively low prices. **15**

Bank of America Merril Lynch calculates that there is already a combined value shift, or "energy carry", of more than $300 bn/year in America's favour as the US oil import bill falls and as gas reserves that have expanded to 100 years at current demand, underpin cheap power generation and an international cost advantage for US heavy industry. Heavy industry can buy US gas currently at a price of $3.60 per thousand cubic feet (between a third and a half of the price being paid in the rest of the developed world). **16**

The United States will rely more on natural gas than either oil or coal by 2035 as cheap domestic supply boosts demand among industry and power generators. Moreover, opening US gas up to global prices by allowing it to be exported as liquefied gas would turn the US into a major gas exporter.

A surprise bonus of shale gas boom in the US is a coal boom overseas according to IEA sources. Coal, displaced at home by shale gas, is finding its place overseas particularly in the European Union, India and China, now the world's largest coal importer.

Meanwhile, manufacturers in the US have announced more than $90 bn worth of investments to take advantage of cheap natural gas according to new calculations underlying how the shale revolution appears to be driving the country's industrial renaissance. The US investment boom has caused concern among manufacturers in Europe, who fear they will find it difficult to compete in energy-intensive sectors. **17**

Can OPEC Disrupt US Shale Oil Production Surge?

OPEC does not see increased U.S. oil output as a threat to its interests but is skeptical about current forecasts on the boom of American shale oil production.

Analysts have suggested a looming dent in OPEC's influence as a result but OPEC Secretary General Abdullah Al-Badry told reporters his organization "is not really concerned" about any increase in world supply due to U.S. shale oil production. He, however, questioned industry estimates that U.S. shale extraction could amount to an extra 3 mbd within 20 years as well as forecasts of U.S. energy independence. **18**

Fears that OPEC will boost output to push down oil prices are misplaced. OPEC's ability to push prices lower to disrupt new emerging sources of supply is constrained by members' higher fiscal break-evens, a result of the social turmoil unleashed by the Arab Spring. **19**

OPEC members need prices at least as high if not even higher to the ones that shale drillers need to sustain their businesses. Saudi Arabia needs oil prices on average at $95/barrel to sustain the extra spending. UAE is in a similar situation. On the other hand, US shale developments need prices of $72-$80/barrel to break even, according to industry estimates. The shale boom, thus, is not in danger. At least, not in danger of an OPEC attack.

Whether crude costs $60/barrel or twice that amount, the US is going ahead with shale oil production. Even if US benchmark West Texas Intermediate (WTI) oil drops 30% from the current price of $86/barrel, oil companies will boost production as new technology allows them to extract crude from shale. Saudi Arabia can't afford a decline of that magnitude after the government pledged an unprecedented $630 bn on social welfare and building projects. The Kingdom couldn't meet these commitments if prices fell 25% from the current $110/barrel.

As demand falls, OPEC's key producers will come under growing pressure to curb output. But the problem is when prices are above $100/barrel, Saudi Arabia and other OPEC producers will be very reluctant to do this. **20** Thus, US shale producers can't lose. For them, that is more than ample. However, the real threat to shale oil production will come from rising costs of production and environmental opposition.

Yet there are risks to supply, too, which might push prices up. Oil markets continue to be spooked by fears that the violence in the Middle East could spread to oil-producing countries.

In addition, supply from non-OPEC countries such as the North Sea, Canada and Brazil was disappointing in 2012, and there are concerns it could continue to underperform in 2013.

The Problems looming over US Shale Oil

Among the major obstacles to unlocking the huge potential of the shale/tight plays in the US is the lack of an adequate infrastructure to transport and refine oil and the sclerotic rules governing the overall US oil domestic movements. The United States champions free trade and free access to global oil for any country, but oil can't move freely throughout the United States or be exported from the country. **21**

Another serious problem overshadows US shale oil production. Regardless of the source of supply, most future shale oil production will consist of light sweet oil, the benchmark for which is the WTI. This phenomenon presents a considerable challenge for US refineries along the central corridor to the Gulf Coast.

Many of these refineries have reached a high level of complexity over the years through massive investments to increase their ability to process heavy-sour crudes, the majority of US oil imports. For those refineries, switching to light oil will involve a decrease in economic margins and technical problems, unless the price of US light oil falls until it competes with heavy oil. Insufficient pipeline capacity, coupled with refining issue, explains why from 2011 on US light oil traded at a strong discount compared to Brent oil, a similar crude (in terms of density and sulphur content) that is the most important international oil benchmark.

Theoretically, the possibility of exporting US crude oil could address these questions, but US laws ban oil exports for the sake of national security except for modest volumes which must be authorized by federal authorities. In addition to the problem of shale oil transportation and refining, there is the difficulty of what to do in the future with the trillion cubic feet of natural gas associated with shale/tight oil production. The natural gas collapse of early 2012 led many companies to stop their intensive drilling activities in the shale gas arena, but they did not stop producing wells supplying methane to an already oversupplied market. The natural gas production associated with shale/tight oil plays, thus, could prolong the market apathy, complicating the overall economics of shale/tight oil production and even the feasibility of fully deploying its potential. There is no single best solution for this problem. **22**

To be sure, a prolonged bearish gas market could limit the development of shale/tight oil. There are now supporters of gas exports through gas liquefaction, gas-to-liquid (GTL) projects, the development of compressed natural gas (CNG) industry, and coal displacement through natural gas in power generation – each striving to demonstrate the appeal of its own solution.

Over the decade, another problem affecting the production of all shale/tight oil plays in the US will be the inevitable rising costs of services, rigs, labour and pipelines, caused by inflationary pressure from the frenetic activity throughout the shale/tight oil and gas sector. **23**

The Environmental Impact of Shale Oil Production

Shale oil and gas are extracted by pumping water, sand and chemicals into the ground at high pressure to crack rocks open, a process known as hydraulic fracturing, or "fracking."

However, hydraulic fracturing is increasingly perceived as contributing to water and land contamination, causing natural gas infiltration into fresh water aquifers, and even triggering earthquakes. Moreover, the intensive use of water will increasingly impose additional costs and could threaten the viability of projects for shale oil and gas.

The consumption of water required by fracking is certainly a problem. A shale well requires between 4 and 5 million gallons of water (15-19 million litres). **24** This may exacerbate water shortage in states where water availability is already a problem.

In any case, the solution to this problem is to minimize the use of water. The industry is already searching for technological solutions that range from the recycling of wastewater from fracking opertations to the use of high-pressure propane in place of water to fracture wells. These solutions are in the experimental stages and are still quite expensive, but they are necessary to cope with another problem concerning fracking and water: what to do of contaminated water coming up from drilling operations.

The chemicals used in hydraulic fracturing process also threaten the potential of shale oil and gas. Therefore, the full disclosure of chemicals used in fracking should be mandatory. Moreover, the possibility that fracking operations may produce earthquakes should be thoroughly investigated.

Therefore, the oil industry needs to develop technological solutions to minimize water use, minimize and report chemical use, and carefully monitor production sites. However, if such a collective effort by industry does not materialize, the government may respond with more onerous regulation in the near future that could impact U.S. shale oil production.

Current climate policy debate will certainly be influenced by the unexpected surge in oil production capacity. Policymakers will have to address the potential environmental and climate impacts of a substantial increase in oil supply.

Industry should also be prepared to make appropriately large investments in developing technologies that will reduce the environmental footprint of oil production and use.

US Oil Independence

The US shale oil revolution might represent a “game-changer” for the United States in a relatively short period of time but not because it might enable it to become oil independent.

Since the first oil crisis in 1973, the notion of oil self-sufficiency has been of great importance in US political debate. Yet oil self-sufficiency may be important only in cases of major wars, when the disruption of sizeable foreign oil supplies could endanger the military effort or the country’s self-defence.

In all other cases, one must never forget that the oil market is global and fungible, and a country can’t be insulated from what is happening in the rest of the world even if it is self-sufficient in terms of oil consumption. For example, a fall in oil prices because of overproduction in the Middle East can influence the market for higher-cost US or Western hemisphere oil, just as an oil price spike during a major crisis in the Middle East can affect oil prices in the US.

At the same time, the Western Hemisphere could return to a pre-World War II status of theoretical oil self-sufficiency, and the United States could dramatically reduce its oil import needs. However, countries like Canada, Venezuela and Brazil may decide to export their oil and gas production to markets other than the US for purely commercial reasons, making the notion of Western Hemisphere self-sufficiency irrelevant.

US Shale Oil Production Versus the Oil Price

With US shale oil production surging and with profitability for US domestic oil producers very high and with no change in sight to US rules preventing crude oil exports, it is projected that WTI prices would continue to lag behind international prices with the risk of WTI temporarily falling to $50/barrel over the next 24 months to force a slowdown in supply growth or a change in crude oil export rules.

The US crude oil market could come to resemble the natural gas market. In the natural gas market the US has produced more gas than it could use or export. So

while prices remain relatively high throughout much of the world, natural gas prices in the US have collapsed.

The basic story is that shale oil production is growing faster than anyone has expected and the infrastructure can barely keep up. Meanwhile the shale oil producers have no reason to stop pumping. Their borrowing costs are at record lows, their breakeven profitability levels are well below current oil prices and refining capacity is also very tight right now. So the bottom line is: large production, low breakeven costs, low financing costs, and tight capacity across the entire petroleum infrastructure. The ingredients are there for a price collapse.

Oil independence is not really the issue confronting the US economy. The real issue is the cost of oil – not its country of origin. The problem isn't the availability of the fuel but the price needed to get it out of the ground. **25**

Unfortunately, that is already more than we can afford. That Brent oil, the de facto world oil price setter, is hovering near $110 /barrel is a clear signal of US growing dependence on the very unconventional sources of supply being championed in the IEA report.

American oil independence is not going to change the reality of triple-digit oil prices. On the contrary, oil prices will have to climb much higher for the IEA's forecast to come true.

The IEA pretends that its prediction for a huge increase in unconventional oil supply can occur with only a modest increase in oil prices from current levels. Such unbridled optimism is belied by what is going on in the industry. Getting oil out of the ground has never been more expensive. Just look at the pullback in capital spending among oil sands operators in Canada. And costs are only going up from here. Forecasts of exponential growth in US shale oil ignore some very real challenges with it – such as wells that deplete at a rate of more than 40%, even in rich fields like Eagle Ford in Texas, and a lack of pipeline infrastructure in the Bakken in North Dakota. **26**

Just like the forecasts the IEA made a decade ago about the much anticipated increase in deep-water production from the Gulf of Mexico, the agency's hopes for another game changer are unlikely to pan out.

Horizontal drilling, fracking or steam-assisted gravity drainage (SAGD) is not why we are now tapping supply from problematic sources like the oil sands or shale oil. Neither of these are new discoveries. The real reason that once-marginal sources of supply have been catapulted to prominence, is soaring global oil prices. Without higher prices, no one would be chasing shale oil or trying to pull tar-like bitumen out of the oil sands.

It is no mystery how rising prices work. The higher the price of oil, the more will be produced. This is a fundamental economic tenet that rings true except where the oil resources such as conventional oil have peaked and are in steep decline. In a world of $200-a-barrel oil, the IEA is probably right in believing that US production might reach 11 mbd.

The problem with such a bullish outlook for supply is explained by another economic axiom – the dampening effect of a slump in demand. The higher the price of oil, the less of it our economies can afford to burn. If global economic growth is already grinding to a halt when oil prices are around $111/barrel, what do you think would happen to economic growth – and hence global oil demand – if prices reached the even higher levels needed to make the IEA's supply dreams come true.

Has US Shale Oil Production Made Peak Oil Redundant?

Claims that the idea of peak oil had gone in flames as a result of surging US shale oil production, are not borne out by the realities in the global oil market. In fact, the concept of peak oil and the peak oil theory are a reality impacting on the global economy, the world global market and the price of oil.

Concern about the depletion of conventional global oil reserves seems to have intensified for several reasons, including technological improvements in geological data gathering and analysis, the increasingly sparse reserves discovered by new drilling, question marks over the real size of global proven reserves and concerns that much of the world's conventional oil especially in the Middle East, is coming from old and over-exploited mega-fields that are becoming less productive. There is no risk that we are running out of oil but chances of being able to match the projected growth in demand over the medium term with a rise in production is being seriously questioned. **27**

The peak oil theory concerns the long-term rate of extraction and depletion in conventional oil and other fossil fuels. It states that any finite resource such as crude oil will have a beginning, middle and an end of production, and at some point it will peak. Oil production typically follows a bell-shaped curve when charted on a graph with the peak of production occurring when approximately half of the oil has been extracted. With some exceptions, this holds true for a single well, a whole field, an entire region, and presumably the world (see Figure 4). Peak Oil does not mean 'running out of oil', but 'running out of cheap oil'.

Conventional oil production peaked in 2006. My own research, however, indicates that the peak may have already been reached in 2004 if we factor in what I describe as "OPEC's inflated proven oil reserves". My research indicates that OPEC's proven oil reserves are overstated by some 300 bb. **28**

Figure 4

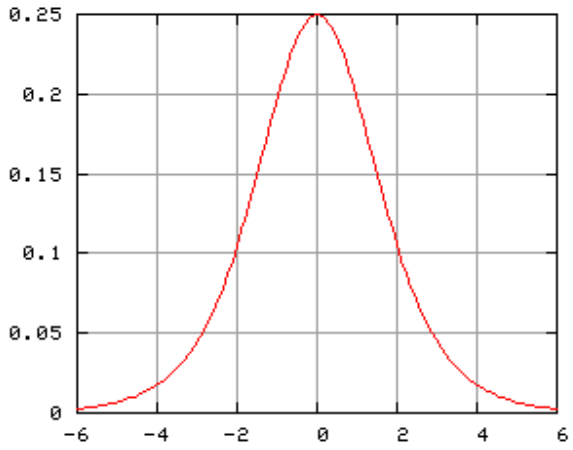


Figure 1: Hubbert Curve.

Nine of the top oil producers in the world have already peaked: USA peaked in 1971, Canada 1973, Iran 1974, Indonesia 1977, Russia in 1987, UK 1999, Norway 2001, Mexico 2002 and Saudi Arabia 2005 (see Table 4).The only one among the top producers that has clear capability to increase production is Iraq once stability is restored to the country.

Table 4
The Peak & Depletion of Conventional Crude Oil

Country	Date of Peak Discovery	Date of Peak Production	% Discovered	% Depleted	Ultimate Production (bb)
Canada	1950s	1973	95	76	25
Iran	1960s	1974	94	76	130
Indonesia	1950s	1977	93	65	31
Mexico	1950s	2002	94	55	55
Norway	1970s	2001	93	48	33
Russia	1940s	1987	94	61	200
Saudi Arabia	1950s	2005	96	60	210
UK	1970s	1999	94	63	32
USA	1930s	1971	98	88	195
The World	1962	2006	94	56	2100

Sources: Association for the Study of Peak Oil's (ASPO) website www.peakoil.net / IEA / Petroleum Review / OPEC.

Moreover, three of the world's largest oilfields have already peaked. Kuwait's Burgan, the world's second largest accounting for 60 percent of Kuwait's reserves, peaked in November 2005. Also Mexico's giant Cantarell peaked in March 2006. And Saudi Arabia's Ghawar, the world's largest oilfield accounting for 60 percent of Saudi oil production, or 5 mbd, peaked in April 2006 and is now declining at a rate of 8 percent per year. **29**

The world is currently consuming just over 32 bb a year, yet on average finding just over 6.80 bb a year. Over the period 1992-2011, only 23 percent of the global oil production has been replaced by new discoveries or by enhanced oil recovery (EOR) (see Table 5).

Table 5
Global Crude Oil Reserve Additions, 1992-2011
(bb)

Year	Added Reserves	Annual Production	As % of Annual Production
1992-2011	129.19	553.51	23
Average	6.80	29.12	23

Sources: IHS Energy Group's Data / BP Statistical Review of World Energy, 1993-2012.

Estimates at the beginning of 2012 indicate that there are just 893 bb of conventional oil yet-to-produce. This is defined as the sum total of global remaining reserves and any reserve additions from new discoveries (see Table 6).

Table 6
Ultimate Global Conventional Oil Reserves
& Depletion Rate (end of 2011)

Volume		**Description**
Ultimate Reserves (bb)	2,100	Amount of production when production ceases
Produced so far (bb)	1,207	Until the end of 2011
Yet-to-produce (bb)	893	Ultimate reserves less produced
Discovered so far (bb)	2,015	Produced plus remaining reserves
Yet-to-find (bb)	85	Ultimate reserves less discovered
Discovery rate (bb/y)	7	Annual additions from new fields
Depletion rate (%)	3	Annual production as % of the yet-to-produce

Sources: USGS / BP Statistical Review of World Energy, June 2012 / IHS Energy Group, World Petroleum Trends (WPT).

Should we worry about peak oil? Our world is completely dependent on oil. The most critical factor determining the performance of the world economy is access to inexpensive oil.

With more than fifty oil-producing countries now in decline, focus on the oil-rich Middle East has sharpened dramatically. Countries of the Middle East have traditionally been able to relieve tight oil markets by increasing production, but, as the this region nears its own oil peak, any relief it can provide is limited and temporary.

The public, business leaders and politicians are all under the illusion that oil depletion is a straightforward engineering problem of exactly the kind that technology and human ingenuity have so successfully solved before.

The pressure on the oil price will continue unabated in coming years because of the growing global demand for oil and the dwindling global proven oil reserves. The peak oil theory explains how the rising oil prices will continue to impact on the global economy all through the 21st century.

However, the fact that the oil price has been hovering near $110-$111/barrel for the last three years despite the worst global recession the world has ever witnessed, and the rush for the development of expensive unconventional oil resources such as shale oil and tar sands oil are a repudiation of the claim that the idea of peak oil had gone in flames and a proof that the peak oil theory is valid and alive.

Can the US Shale Success be Replicated Elsewhere?

The US shale success can't be easily replicated in other areas of the world – at least in a short period of time – due not only to the huge resource base of shale / tight oil plays existing in the US, but also to some unique features of the US oil industry and market. **30**

First of all, in the US individuals and companies may own property rights on mineral resources, while in most parts of the world these rights belong to states only. This fact gives a huge incentive to land owners to lease their property rights and to the oil industry to lease or buy them.

Another major feature of the uniqueness of the US and Canada is the presence of thousands of independent oil companies ranging from very small to multibillion companies, that historically played the role of pioneering new high-risk and high-reward frontiers.

Yet another feature is the presence of several financial institutions, funds, capital ventures, equity firms that are eager to fund independent companies, oftentimes by becoming their equity partners.

A final unique feature of the US and Canadian hydrocarbon arena is the broad availability and flexible market of drilling rigs and other essential tools of exploration and production. For instance, the US and Canada have about 65% of all drilling rigs existing in the world. **31**

All these features are foreign to other parts of the world, and they make the US and Canada a sort of unique play for experimentation and innovation, such as the case of US shale oil and gas or Canadian tar sands.

Conclusions

There is a huge amount of hype surrounding the US shale oil revolution. While the US shale oil production will probably have a positive impact on domestic oil production and the level of oil imports, it will not be a game changer for the global oil market.

US shale oil production will hardly make a dent in the global oil supply and its contribution to global supply would only rise from 1% in 2012 to 2% by 2020 possibly reaching 3% by 2035.

The US oil production including shale oil will peak at 7.50 mbd in 2019 before it starts to decline reaching 6.10 mbd by 2035. This means that there is neither a chance for the United States ever to become self-sufficient in oil nor to overtake either Saudi Arabia or Russia in oil production.

Moreover, The US will never be in a position to deny OPEC the power to set global oil prices as OPEC would be contributing 48% to global supplies by 2035 compared to 3% for US shale oil production.

However, the biggest obstacles to an expansion of US shale oil production would be a backlash against its adverse impact on the environment and rising costs of production resulting from the steep first year decline rate of 70%-90% for new wells. Without higher prices exceeding $90/barrel, no one would be chasing shale oil. Moreover, rising US shale oil production does not in any way invalidate the concept of peak oil.

The shale oil boom in the United States would not be easy to replicate in the rest of the world. This situation is not much different from Brazil's success story with ethanol.

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Footnotes

1 The International Energy Agency's (IEA's) Annual Energy Outlook 2012.
2 OPEC's World Oil Outlook 2012, pp.121-122.
3 This is calculated on the basis of 3%-5% annual depletion rate of US conventional oil production between 2012 & 2020 and estimated at 1.2 mbd-2.0 mbd. A1 mbd increase in shale oil production during the same period will partially offset the decline in conventional oil but leave a deficit of 200,000 b/d -1 mbd.
4 OPEC's World Oil Outlook 2012, p.122.
5 Ibid., p. 121.
6 Ibid., pp. 121-122.
7 EIA's Annual Energy Outlook 2013 Early Overview (AEO2013), released on 5 December, 2012, p.8.
8 Leonardo Maugeri, Oil: The Next Revolution (a paper published by Belfer Centre for Science & International Affairs at Harvard Kennedy School, June 2012), p. 45.
9 Bloomberg report accessed through http://www.crainscleveland.com/article/20121211/BLOGS03/121219978
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19 Javier Blas, OPEC Unlikely to Disrupt US Shale Boom, Financial Times, December 12, 2012.
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26 James Hamilton, How Shale and Tight Oil Have Changed the Look of US Oil Production, accessed on 17 December, 2012 at: http://oilprice.com/Market-Intelligence-Report.php.

27 Mamdouh G Salameh, Peak Oil & the Impending Oil Crunch (A lecture given at the invitation of Masdar Institute for Science & Technology, 15 February, 2011, Abu Dhabi, UAE).
28 I was the first among oil experts to calculate and prove that OPEC's proven oil reserves are inflated by at least 300 bb. This figure has become a world reference quoted by energy experts, energy Institutes and organizations worldwide. I presented my findings in a paper entitled: "OPEC Proven Reserves: How Realistic?" at the 24th USAEE/IAEE North American Conference, July 8-10, 2004, Washington DC, pp.3-4.
29 Mamdouh G Salameh, The Changing Oil Fundamentals: Impact on the Global Oil Market & Energy Security (A paper given at the ECSSR 17th Annual Conference, November 1-2, 2011, Abu Dhabi, UAE), p.7.
30 Leonardo Maugeri, Oil: The Next Revolution, p. 45.
31 Ibid., p. 46.

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