The Potential of Unconventional Oil Resources: Between Expediency & Reality

By Mamdouh G. Salameh*

Introduction

A large share of the world's remaining oil resources is classified as unconventional. These resources such as Canada's tar sands oil, Venezuela's extra-heavy oil and shale oil, known collectively as synfuels, have been promoted as a major source of energy that could offset the decline in conventional oil production and reduce dependence on Middle East oil. Others by contrast see unconventional oil as an expensive and extremely pollutant oil resource whose production consumes voracious amounts of energy.

The inclusion of unconventional oil resources in Venezuela's and Canada's proven oil reserves has raised the proven oil reserves of Venezuela to 296.6 billion barrels (bb) and Canada's to 175.2 bb and vaulted these two countries to first and third places respectively in the world's reserves rankings.[1]

Unconventional oil resources have only recently been considered to be part of the world's oil reserves as higher oil prices and new technology enable them to be profitably extracted and upgraded to usable products.

Previously the term 'crude' has been restricted to conventional oil resources which are capable of flowing up a well-pipe, either under pressure existing in the reservoir, or with the mechanical assistance of bottom-hole pumps or gas lift. Excluded from this definition is oil extracted from shale or from the highly-viscous, semi-solid deposits found in Canada's bituminous tar sands and Venezuela's extra-heavy oil.

Even OPEC has been persistently adamant in rejecting Venezuela's demand to have its unconventional extra-heavy oil reserves added to its conventional heavy and medium reserves and reflected in its OPEC production quota.

Unconventional oil resources are generally costly to produce, though considerable progress has been made in addressing technical challenges and lowering costs.

In the medium- to long-term, almost all of the world's unconventional oil supply will come in the form of tar sands oil, extra-heavy oil and shale oil. Unconventional oil production (excluding biofuels) is projected to rise from 1.55 million barrels a day (mbd) in 2011 to 3.05 mbd by 2020.[2]

The only significant unconventional oil production today comes from the Canadian tar sands oil and so far most of the bitumen has been extracted from huge mines. But mining is expensive, and new projects need an oil price of $80/barrel to make a 10% return on investment.[3] The process also requires huge volumes of water. Worse, mining is only possible for deposits less than 75 meters deep – and that is just 20% of the total resources.

The rest has to be produced using in-situ techniques like steam-assisted gravity drainage (SAGD), where steam is injected into a horizontal well to melt the bitumen which then flows down into a lower well to be pumped out. This is cheaper and uses much less water than mining, but far more energy – usually in the form of natural gas – because of the need to raise steam. An industry-sponsored report in 2005 found that if tar sands oil production rose to 5 mbd by 2030, it would devour 60% of western Canada's entire gas supply, which it said would be 'unthinkable'.

So with huge reserves and new technologies, can unconventional oil offset the decline in conventional oil production and the depletion of its reserves? Surprisingly, promoters of the newest technologies are sceptical. They stress the massive investments that will be required to reach the industry estimates of 3.75 mbd by 2030 and doubt production can be raised significantly further. They reckon that unconventional oil resources are not going to solve the world's oil supply problems.

Conventional and Unconventional Oil Resources are not the Same

There are major differences between conventional and unconventional oil resources in terms of API, recovery rate, environmental and productivity factors as well as the energy input needed to produce them (see Table 1).

Unconventional oil has an API ranging from 7%-8%. This compares with 22% or less for conventional heavy oil, 22%-31% for medium oil and 31%-45% for light or sweet oil. This means that on the basis of API, 3 barrels of unconventional oil equate with one barrel of conventional heavy oil, or 4 barrels with

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See footnotes at end of text.

Factors	Conventional Oil	Unconventional Oil
API	22%-45%	7%-8%
Recovery Factor (RF)	34%	5%-10%
Productivity rate	100 barrels	5-10 barrels
GHG emissions	64 kg / barrel	75 kg / barrel
Reservoir pressure	existent	non-existent
Diluents	not needed	essential
Flow rate	free flowing	viscous / semi-solid
Production costs	$1-$10/barrel	$40-$60/barrel
Classification	Crude	Non-crude

Table 1
Major Differences between Conventional & Unconventional Oil Resources
Sources: IHS Energy Database / Alberta Government Data / IEA, World Energy Outlook 2011.

a barrel of conventional medium oil or 5 barrels with a barrel of conventional sweet or light oil (see Table 2).

So when Canada, for instance, says it has proven reserves of 175 bb of crude bitumen, this should not be taken to mean the same as 175 bb of Iraqi or Saudi reserves but should only equate to 58 bb of conventional heavy oil or 43 of medium oil or 35 bb of light oil.

There is another major difference. The recovery factor (RF) for unconventional oil ranges from 5%-10% whilst conventional oil reserves have a global average RF of 34%. Therefore, it is ludicrous and illogical to treat unconventional oil reserves equally as conventional oil reserves. Not all reserves are equal.[4]

And when it comes to productivity, unconventional oil lags hugely behind conventional oil. The real problem is the slow extraction rate. The productivity rate of conventional oil is estimated at 10-20 times more than that of unconventional oil. It is estimated that only 5-10 b/d of unconventional oil can be extracted from a mine compared to 50-100 b/d from a conventional oil well of similar reserve size.

Unconventional oil		Conventional oil
3 barrel	=	1 barrel of heavy oil
4 barrel	=	1 barrel of medium oil
5 barrel	=	1 barrel of light oil

Table 2
API Equivalence
Source: Author's calculations.

Anywhere in the world, of course, it takes energy to produce energy. But tar sands oil and extra-heavy oil are especially voracious consumers of energy, consuming about 1000 cubic feet of natural gas to convert a barrel of bitumen into light crude oil that refiners want. In 2011 Canada produced 1.3 mbd of tar sands oil consuming in the process an estimated 1.3 billion cubic feet (bcf) of natural gas a day, equivalent to 8% of Canada's entire daily production.[5]

And to add to their woes, the extraction and upgrading of one barrel of unconventional oil releases 75 kg (165 lb) of GHG emissions.[6] This is 15% higher, on average, than emissions from conventional oil production.

In conventional oil production, reservoir pressure from gas and water associated with the oil is generally sufficient to cause the oil to flow to a production well. If natural reservoir pressure becomes depleted, then oil flow may be enhanced by injecting gas or water into the reservoir to push the residual oil to the production well. Tar sands oil and extra-heavy oil commonly require the addition of diluents (gas condensate, natural gas liquids, or light crude) to enable the oil to be transported by pipeline. In recent projects in the Venezuelan Orinoco heavy oil belt, 1 barrel of diluents was required for every 3 or 4 barrels of extra-heavy oil produced while tar sand oil needs a one-third blend of condensates or a half blend of synthetic light oil to move it through a pipeline. The cost of producing a barrel of tar sands oil is currently estimated at $50-$60 compared to that of conventional oil which can range from $1 per barrel in Iraq to $3/barrel in Saudi Arabia and over $10 in the United States and Canada.

So in summary, critical issues for the development of tar sands oil and extra-heavy oil include large and growing capital costs, lengthy time to produce, constraints on natural gas and water supplies, the need for large volumes of diluents and environmental degradation.

Unconventional Oil Reserves

Recoverable unconventional oil resources are estimated at 603 bb: 173 bb of tar sands oil reserves in Canada, an estimated 270 bb of extra-heavy oil and bitumen reserves in Venezuela and 160 bb of oil shale worldwide (see Table 3).

Production

As a result of the development of tar sands reserves, tar sands oil is now the source of almost half of Canada's oil production (see Table 4).

Canada	Venezuela	Worldwide	Total
Tar sand oil	Extra-heavy oil	Shale oil	
173	270	160	603

Table 3
Unconventional Oil Reserves (bb)
Sources: BP Statistical Review of World Energy, June 2012 / U.S. Department of Energy.

Because growth of tar sand oil production has exceeded declines in conventional crude oil production, Canada has become the largest supplier of oil and refined products to the United States ahead of Saudi Arabia, Mexico and Venezuela.7 Venezuela's extra-heavy oil production capacity is estimated currently at 310,000 b/d (see Table 5).

Can Unconventional Oil Resources Bridge the Energy Gap?

Production of unconventional oil currently amounts to 1.55 mbd and is projected to rise to 3.05 mbd by 2020 and 3.75 mbd by 2030. In 2011, unconventional oil contributed 2% to global oil demand and this is projected to rise to only 3% by 2030 (see Table 6). This level of production will not even offset the depletion of conventional oil production estimated at 3.5 to 3.9 mbd.

	2007	2008	2009	2010	2011	2015	2020	2025	2030
Tar Sands oil	1.20	1.17	1.20	1.40	1.30	1.43	1.72	2.00	2.15
Conventional	2.11	2.05	2.02	1.97	1.85	1.64	1.28	0.90	0.69
Total	3.31	3.22	3.22	3.37	3.15	3.07	3.00	2.90	2.84

Table 4
Canada's Tar Sands Oil Production (mbd)

Sources: BP Statistical Review of World Energy, June 2012 / IEA, World Energy Outlook 2011 / Alberta Government Data.

	2007	2008	2009	2010	2011	2015	2020	2025	2030
Oil production	2.61	2.56	2.50	2.36	2.10	2.64	3.14	3.24	3.50
Of which:									
Extra-heavy oil	0.41	0.40	0.35	0.31	0.32	0.50	0.55	0.60	0.75

Table 5
Venezuela's Current & Projected Crude Oil Production (mbd)

Sources: BP Statistical Review of World Energy, June 2012 / US Energy Information Administration (EIA): Country Analysis Brief/Platts, www.platts.com.

Environmental Issues

Tar sands development is the single largest contributor to the increase in climate change in Canada. In 2011 tar sands oil production emitted an estimated 80 million tones of CO_2.[8]

Like all mining, tar sands operations have an effect on the environment. Tar sands projects affect the land: when the bitumen is initially mined and with large deposits of toxic chemicals; the water is polluted during the separation process and through the drainage of rivers; and the air is also polluted due to the release of carbon dioxide and other emissions, causing deforestation. Current tar sands oil production techniques require 2-5 barrels of "makeup" water per barrel of product.[9] Immense amounts of water are currently being discarded into settlement ponds in which it may take 200 years for the smallest particles to settle down to the bottom. Some of these impoundment ponds are many miles in area and will pose an environmental problem or hazard for many centuries. Approximately two tons of oil sands are needed to produce a barrel of oil (roughly 1/8 of a ton).[10]

	2009	2010	2011	2015	2020	2025	2030
Demand	84.10	86.40	88.03	90.40	107.00	112.35	117.40
Supply	79.95	81.32	83.58	81.20	81.10	80.50	80.00
Of which							
Unconventional	1.55	1.55	1.55	1.93	3.05	3.40	3.75
As a % of global demand	2	2	2	2	3	3	3

Table 6
Current & Projected Contribution of Unconventional Oil to Global Oil Demand, 2009-2030 (mbd)

Sources: U.S. Department of Energy's International Energy Outlook, 2011 / IEA, World Energy Outlook 2011 / BP Statistical Review of World Energy, June 2012 / OPEC World Oil Outlook 2011 / Author's projections / U.S. Joint Operating Environment - 2010.

Still, there are some major benefits to be derived from unconventional energy resources.

Lessons from the United States

While shale gas has revolutionized gas production and reserves in the United States, it is the development of shale oil which will have the greatest impact on U.S. oil production and oil imports in coming years.

The U.S. accounted for the entire net increase in oil output over the past three years – excluding OPEC and the Former Soviet states – as its large shale reserves begin to reshape the global energy market.

The U.S. increased daily production of crude oil and other liquid hydrocarbons by 1.1 mbd during 2008-2011, while other non-OPEC countries lost a net 200,000 barrels a day (b/d) during the same period.[11]

While the U.S. remains the world's largest oil importer, the surge in its oil production means that the proportion of its oil demand met by imports is projected to start a downward trend from 58% in 2011 to much lower proportions in coming years (see Table 7).

Advances in the techniques of horizontal drilling and hydraulic fracturing, first applied to shale gas reserves, are now making it possible to produce oil from the huge U.S. shale reserves that were not previously commercially viable. Thanks to U.S. shale and Canadian tar sands, North America may become self-sufficient in oil by 2025.[12]

	2008	2009	2010	2011	2015	2020	2025	% change 2008-2025
Crude oil production	6.73	7.27	7.56	7.84	8.00	8.60	8.82	+ 31%
Consumption	19.50	18.77	19.18	18.84	18.65	19.58	20.56	+ 6%
Net imports	12.77	11.45	11.62	11.00	10.65	10.98	11.74	- 8%
As a % of Consumption	65	61	61	58	57	56	57	

Table 7
2008-2025 U.S. Current & Projected Crude Oil Production, Consumption & Imports

Sources: BP Statistical Review of World Energy, June 2012 / Financial Times, June 14, 2012, p. 8 / Author's projections.

Conclusions

The potential of unconventional oil resources is highly overrated. Apart from the limited size of production, unconventional oil is costlier to produce, more pollutant, a more voracious user of energy and is of poorer quality than conventional oil. It is one thing having huge reserves of unconventional oil resources and quite another turning them into a sizeable production capacity.

Still, there are some major benefits to be derived from unconventional energy resources. Tar sand production is already helping to partially offset the decline in Canada's conventional oil production while shale oil production in the U.S. could, eventually, help it reduce its dependence on oil imports.

In spite of this, the contribution of unconventional oil production to global oil supplies in the next 25 years will only make a dent in the future demand for energy despite the multi-billion dollar investment in unconventional oil resources.

Any benefits that are derived from the production of unconventional oil must be balanced against the adverse impact on the environment in terms of deforestation, degradation of land and water resources and the vociferous consumption of natural gas.

Footnotes

[1] BP Statistical Review of World Energy, June 2012, p. 6.

[2] Mamdouh G Salameh, **The Changing Oil Fundamentals: Impact on Energy Security & the Global Oil Market** (a paper given at the 17th ECSSR Annual Energy Conference, 1-2 November, 2011, Abu Dhabi, UAE), p. 10.

[3] David Strahan, **Non-conventional oil: Can it Fill the Gap?** Petroleum Review, February 2010, p16.

[4] Mamdouh G Salameh, **Saudi Proven Crude Oil Reserves: The Myth & the Reality Revisited** (a paper given at the 10th IAEE European Energy Conference, Vienna, 7-10, September 2009),p. 8.

[5] BP Statistical Review of World Energy, June 2012, p. 22.

[6] **Canada's Oil Sands – Opportunities & Challenges to 2015: an Update**, National Energy Board, June 2006, p. 38.

[7] **Canadian Energy Review 2007**, National Energy Board of Canada, May 2007.

[8] **Climate Change**, Greenpeace Canada.

[9] **FAQ – Oil Sands**, Government of Alberta Environment Ministry. http//:environment.gov.ab.ca/inf/fags/fag5-oil sands. asp.

[10] **The Facts about Alberta Tar Sands**, Climateandcapitalism.com.

[11] Financial Times, June 14, 2012, p. 8.

[12] According to Mr Ryan Lance, Chief executive of ConocoPhillips, the third largest US oil company by production as reported by the Financial Times on June 14, 2012, p. 8