What is a "break-even" price for shale oil?

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There has been much speculation in the media about the "…break-even price for shale oil to be profitable…". Seemingly an interesting question, but there is no specific answer to it, and a simple response would be misleading. However, the subject is worth discussing in a Canadian context.

First, we must not confuse shale gas with shale oil! Though oil and gas markets and businesses seem very similar (drilling, fracturing, pipelines, energy…), in the North American marketplace, the price of gas and oil have been disconnected for five or six years. This has occurred for at least three good reasons: first, these products serve different needs (oil is transportation, gas is heat and power); second, because of the shale gas revolution[1] there has been a long-term gas glut but not an oil glut; and third, gas is invariably a by-product of shale oil production, but the reverse is not true (much shale gas is dry gas – only CH_4).

The glut of CH_4 is generated in large part by the desire of operators to find and produce more profitable shale oil and "wet gas", and these targets invariably contain a lot of associated CH_4. (wet gas may be over 90% CH_4). The gas glut is likely to continue for 10 years or a generation because so much of it can now be produced cheaply, so supply constraints are unlikely. For example, in the Montney Formation in BC/AB alone, there is enough gas – proven reserves – to meet current Canadian production levels for 150 years, likely much longer as technology continues to improve and costs are forced down. Gas producers in the Montney Formation in Canada could make money at $2.50/MMBTU, if only there was a pipeline allowing LNG exports from the west coast of BC.

And, the break-even price for shale oil? As for any mineral or commodity, from gravel to gold, from trees to titanium, from soya beans to pork bellies, there is a range of producers with different quality assets, different costs, and different capabilities to reduce cost when under pressure. The "quality of the asset" is a critical aspect: every geological shale oil asset is different, even in the same formation 5 km apart, some are great, some are marginal. At $100/b, it was easy to make money even with an asset of modest quality. Today, if you are stuck with a poor quality shale oil asset you are in trouble.

Not all companies are the same in terms of their approach to business. In Canada, for example, CNR (Canadian Natural Resources) has done remarkably well over the last 20 years simply by focusing on being the lowest-cost, most efficient producer. The same goes for shale oil: some corporations are remarkably lean and efficient, others less so. Some of the less efficient shale oil companies with a lot of overhead are in trouble. Companies like Statoil have enough in their bank accounts to stay in the game, but not for a long time if they are bleeding money and cannot reduce costs. But, the shale oil business is different than the conventional oil business: the production profiles of wells is totally different, and this has resulted in a different economic structure for the shale oil business. This structure is short-term driven, hedge fund financed, and highly reactive to costs and prices. In general, places like Saudi Arabia have failed to understand these differences because they are in the conventional oil business: long well lives, fewer wells, shorter-term drilling campaigns, etc. Many critics of the oil industry (persons against fossil fuels and anti-big business in general) have failed to understand this critical difference. Big oil companies like Shell and Saudi ARAMCO fund projects internally from cash flow. Small shale oil companies have hedge funds and other private financial backers providing the $$ for drilling (often

[1] E.g http://www.eia.gov/pressroom/presentations/sieminski_10172014.pdf

under contractual obligations to drill a certain number of wells per month), and the returns are calculated over several years (2-4), not over decades, as is the case for large conventional oil and gas projects such as an oil sands project. The business paradigm for shale oil is different!

Many people become confused by simplistic media articles that discuss a "cost of shale oil". Sometimes these article are pure nonsense or are ideologically driven. Some producers need $75/b today to make a profit, some have already driven down their full costs to less than $35/b. The high-priced producers are shutting down, and trying to salvage something by selling their assets to other companies, but they may have to settle for a low price if the asset is of poor quality. (Exxon is aggressively purchasing acreage in the Permian Basin for example, as the prices have dropped a lot.) This happens in every commodity turn-down, even for platinum and potatoes: high cost producers are winnowed out by the challenges, and the low-cost producers become more efficient. Unless, of course, governments step in to protect high cost producers, as for our dairy industry in Canada, rice growing in Japan, and just about every local agricultural commodity in Europe.

Winnowing poor performers is perfectly normal, but what has surprised many is just how rapidly the efficient producers have driven their costs down by reducing personnel, drilling smarter and quicker, and so on. Some of us were not surprised. When prices dropped to $50-55/b and some silly commentators were predicting the end of the shale oil industry, I said publicly in an interview that these small companies could likely cut their costs by at least 30% and perhaps more, staying profitable in the face of low prices. This is what has happened. It is a remarkable strength of the USA that so many critics fail to remember: adaptation to different and difficult economic situations in the USA is actually easier than in any other large country in the world. In the case of shale oil in the USA, no government is stepping in to support prices, give subsidies, or otherwise keep the market from eliminating the high-cost producers.

Another factor of great importance is the remarkably rapid advances in better technology, better drilling rigs, shorter well completion methods, and so on. Even before the downturn in prices last year, the cost of a 2.5 km deep well with a hydraulically fractured 1.5 to 2 km long horizontal section had dropped by 15-25% in different plays. Costs continue to drop; drilling and service companies want to keep active and retain skilled employees if they can, but many rigs have been shut down as well. The rig statistics are remarkable, showing how quickly small companies adapt to a softening price. Many rigs that have been shut down will never drill again because they are "old fashioned", and the rate of development and adoption of new technologies is tremendous.

Among the many technology-based reasons for reduced well costs are:

- Automated rigs employing fewer persons
- Pad development techniques that reduce time to drill each well (the rig can be moved in hours to the next hole on the pad, not days)
- Better drilling bits and measurements while drilling that reduce drilling time
- Better hydraulic fracturing methods so that each well is fractured in 3-4 days rather than 5-6 days
- Better seismic and exploration methods that improve the chances of identifying "sweet spots" (more highly naturally fractured regions, or regions with more liquid)
- Improved monitoring and optimization approaches allowing companies to improve their efficiency "on the fly"

- An emphasis now on re-fracturing wells rather than drilling new ones, thereby getting additional oil out of the asset, rather than simply drilling at a mad pace to "skim the cream"
- Looking at enhanced recovery ideas. For example, CO_2 injection for shale oil, something that I think is going to work to help oil recovery, is being tried in the field. Also, remember that when a carbon tax is instituted, CO_2 injection will be even cheaper (carbon tax credits)

So, here is what will happen, I think:

- Oil prices may stay low, even drop lower, but there is little prospect for a sharp price recovery.
    - There is a glut of high-quality low-sulphur oil, courtesy in no small part to the increase of oil production by 4 million b/d over the period 2011-2014.
    - Studying the futures markets for oil may help one appreciate uncertainty but no futures market can predict a sudden drop or sudden rise in price because futures prices are predicated on stability (black swans remain black swans[2], and market people remain market people).
- Futures markets do not factor in the impact of technological advances. This is a flaw of many commentators as well, and particularly economists it seems:
    - Jeff Rubin failed to see the impact of technology (http://www.bnn.ca/News/2014/12/2/Rubins-200-oil-was-a-little-off-the-mark-quits-calling-prices.aspx)
    - Leonardo Maugeri deeply understood the impact of technology, but was largely ignored at the time (http://belfercenter.ksg.harvard.edu/files/Oil-%20The%20Next%20Revolution.pdf)
- USA (and Canada) are making technological advances in the oil and gas industry more rapidly than anywhere else in the world:
    - This means that sophisticated smaller companies (and the big companies in North America that buy them out) will be remarkably well-positioned to stay in business by reducing production costs
    - This means that the technical gap between the NA O&G industry and much of the rest of the world (e.g. Iran, China) is not narrowing, it seems to be widening at present.
    - Seeking efficiencies and constructive technologies are "investments in the future" from the point of view of oil production, and will help these companies maintain future dominance in the industry (Halliburton, Schlumberger, for example)
- A large number of small producing companies will disappear, and maybe one or two intermediate size ones.
    - There is now a "consolidation" going on, and this is normal.
    - Consolidation takes place in several ways: selling of assets at bargain prices to stay alive; or, companies merging or simply being bought out at low prices.
    - The financing underpinning company activity is a critical aspect and is different between big and small companies.
- Gas is a "no profit by-product" of the pursuit of liquids production.
    - This means gas will stay at a low price far longer than oil, especially in North America, because it is "co-produced" along with the oil
    - Cheap natural gas in North America and the beginnings of a world LNG industry is forcing Russia and Iran to reduce prices in an effort to retain market share (Russia also funds anti-fracking groups in western Europe)

[2] https://en.wikipedia.org/wiki/Black_swan_theory

- Oil sands investments have dropped sharply, quick recovery is unlikely, long-term recovery is uncertain because of technology advances.
    - This will continue to be the case, giving a long-lasting impact to the heavy oil business in Alberta.
    - If costs of renewables and energy storage continue to drop, oil sands (as a high cost and higher carbon producer) may have a less stellar life than was thought some years ago.
    - Investments in AB are shifting to shale oil (Duvernay, Cardium…) and shale gas
    - If other means of replacing oil needs with gas are developed (more efficient CNG vehicles for cities, for example), oil demand may decline slowly, and high cost producers will suffer
- Natural gas will continue to displace coal relatively rapidly in USA and Canada, less rapidly elsewhere because there is not yet a fully fungible world-trade in LNG (but it is coming soon!).
- General carbon taxes are just around the corner, historically speaking.

Canada has moved very quickly in terms of creating and adopting the technological advances on the drilling and production side of the shale oil and shale gas sectors, but in terms of advancing exports of natural gas by creating LNG facilities and pipelines, Canada has lost 5-6 years of competitive edge. This is unfortunate because the easiest and quickest way to reduce CO_2 emissions and pollution in the world at this time is to switch as rapidly as feasible to natural gas turbines, instead of coal-fired power. The population health benefits are well documented, and the only issues of genuine substance are the need for more reliable detection and reduction of methane emissions, the elimination of wasteful flaring, and the improvement of the natural gas transmission systems to reduce fugitive methane to values below 1%. Technologies currently exist to do all of these, at reasonable cost.

It is well to remember that the Obama government last week took a huge step in reducing coal burning, and China and India want very much to do the same because of the huge environmental impacts of coal on their population and landscapes. Canada would do well to try and recover some of that lost time for gas exports, not only to profit and charge royalties which sustains our own quality of life, but also to help others have a better life quality and fewer health problems, and also make a profit on our resources. We are blessed with a light population, large amounts of hydro power, and abundant resources of almost everything. What are our responsibilities to the rest of the world?

August 10 2015

Research interests

Maurice carries out research in coupled problems in geomechanics including thermal and non-thermal oil production, wellbore integrity, deep disposal technologies for solid and liquid wastes, hydraulic fracture mechanics, CO_2 sequestration in saline aquifers, shale gas and shale oil mechanics, and compressed air energy storage in salt caverns. He holds 10 patents and has co-authored two textbooks and 550 full text conference and journal articles. Maurice works as an advisor to the following governments: Alberta, Quebec, New Brunswick and Newfoundland, and counsels clients requiring geomechanics advice on energy and oil and gas issues.

Current research projects are focused on:

- Hydraulic fracturing in naturally fractured rock masses
- Energy wellbore integrity and gas seepage
- Compressed air energy storage in salt caverns
- Enhanced geothermal energy systems for intermediate grade energy
- Deep waste disposal and induced seismicity