Peak Oil

The Future for Fossil Fuels and Impacts for Edmonton

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About M.K Jaccard and Associates

M.K. Jaccard and Associates Ltd. is a Vancouver based energy and climate policy consulting firm that has carried out studies for the BC, Alberta, Saskatchewan, Ontario, Nova Scotia and Newfoundland provincial governments, Environment Canada, Natural Resources Canada, the Canadian National Roundtable of the Environment and the Economy, the Pembina Institute, and the David Suzuki Foundation, as well as several provincial energy utilities and private firms. Its president and owner is Mark Jaccard, professor at Simon Fraser University in the School of Resource and Environmental Management.

Biography

Dr. Chris Bataille has been involved in energy and climate policy analysis for 14 years. He is executive director of M.K. Jaccard and Associates Ltd., an Adjunct Professor at Simon Fraser University, and a board member of Ecotrust Canada. He has managed several large national climate policy studies for TD Bank-Pembina-David Suzuki Foundation, Environment Canada, Natural Resources Canada and the Canadian National Roundtable of the Environment and the Economy, including drafting the most recent instalment of Canada's "National Circumstances" submission to the United Nations Framework Convention on Climate Change. In addition to his contracted work, Chris has published articles in *The Energy Journal* and *Climate Policy,* has edited a special edition of the *Energy Journal* on hybrid modelling, co-wrote a chapter of the most recent *International Handbook of Energy Economics*, and has contributed to a number of peer-reviewed public policy publications, including *Pricing Greenhouse Gas Emissions: The impact on Canada's competitiveness* for the C.D. Howe Institute in January 2009.

Abstract

The argument has been often made that fossil fuels are economically and environmentally unsustainable. Advocates of "peak oil" specifically argue that recent crude oil price increases are proof crude oil is running out, and that we need to replace it with something else soon. In this article I argue that instead of focusing on fossil fuels and crude oil in particular, we as a society, and the City of Edmonton in particular, should be focusing on how to make our energy system as a whole secure and sustainable. There are substantial amounts of crude oil, natural gas and coal left. Long before we can use them all, however, we will forced by security, economic and environmental pressures to switch to using less crude oil and coal and more natural gas and electricity, specifically electricity made with renewable sources. This switch, if carefully done, paced with replacement of energy using machinery as it wears out, will lead to only minor increases in energy prices and a more secure and economically and environmentally sustainable energy system. The article finishes with a list of specific policies for the city of Edmonton.

Discussion Paper

Crude oil is in the news, as usual. As I complete this article the world watches the struggle to stem a huge oil spill in the Gulf of Mexico, before it chokes the rich waters of offshore Louisiana. Less immediately catastrophic, but perhaps more ominous, there has been substantial media coverage of "peak oil" over the last half decade, the idea that we will soon run out of oil, and that the consequences may be drastic. These anxieties have been amplified by the dramatic increase in oil prices from under $20 per barrel in 2003 to $147 at its height in 2008. Prices in the past year have been as low as $44, but have returned to the $75 range, with one year forward contracts at $95 per barrel - the world oil market definitely seems to have changed. Does this mean the world is running out of oil, as "peak oil" advocates argue, and that the price will soon rise astronomically, collapsing our worldwide transportation network? Are the days of using fossil fuels in general, including natural gas and coal, also numbered? Or is this all just overly dramatic theatre, like when crude oil reached over $40 per barrel in the early 1980s, which was about $100 per barrel in today's dollars, and subsequently collapsed to under $20 per barrel? In this article I will explore these possibilities and describe new unfolding dramas that may matter more than our long term resources of crude oil, natural gas and coal, storylines that may probably prevent us from using all fossil fuels in the ground. I will conclude with a summary of potential consequences for the City of Edmonton, and recommend some strategies for the city to deal with these uncertainties.

The first thing we should consider, just to set some context, is that even if the worst fears of the "peak oil" were true, not all usable energy comes from crude oil, not even the majority. In Alberta we heat our homes and buildings and run most of our industry on natural gas. We use electricity for lighting and to run devices throughout our homes, businesses and industry. Our electricity is made from coal, natural gas, hydropower and to an increasing extent from wind, solar and other renewables. Oil is only really used to power cars, buses, trucks, ships, trains and aviation. Technology is not fixed, either. Cars, buses, trucks, ships and trains can all be powered using natural gas, bio fuels (liquid fuels made from agricultural and wood waste), and electricity, either directly or using batteries and hybridization, where braking energy is recaptured in the batteries. Hydrogen may also someday be used to power our vehicles, but the technology to make it economically and store it on vehicles is not yet advanced enough for widespread use.

Crude oil is also used for as a feedstock to make pharmaceuticals, plastics, fertilizers, etc., but most of these can also be made from natural gas, other hydrocarbons and potentially biological sources, e.g. corn derived plastics. The only part of the economy fundamentally

technologically dependent on oil is aviation, and progress is being made even there to use biofuels. We could "get by" without oil at all, and "get by" quite nicely using a lot less oil, conserving what we have for aviation and other priority uses.

The next thing we should take a few moments to think about is what exactly is "peak oil"? The term was coined by a US government geologist in the 1970's by the name of Hubbard when referring to the US supply of conventional crude oil in the continental US. Exploration for new supplies continued to increase US reserves of crude oil well into the 1970s, at which point the rate of discovery started falling rapidly, thus the "peak" in "peak oil". Consumption continued to increase, however, prompting the conclusion that if resources are finite and consumption continues, eventually the resource will run out, and the price will gradually increase to infinity. US consumption did eventually come to exceed production and after the 1970s, replacements for US supplied oil came mainly in the form of increased energy efficiency, switching to natural gas in industry and to heat buildings, expanded oil production in the Gulf of Mexico (with current consequences in Louisiana), and imports of oil from the Middle East.

Advocates of peak oil extrapolate Hubbard's model to the entire world. They argue that eventually we will discover all the oil that can be extracted at a reasonable cost, and at some point, when the resource is running out, the price of crude oil will spike up sharply. At this point, they argue, we will have to find some replacement for crude oil. It's an elegant and compelling argument, but the "difficulty" is we keep finding new replacements for what is considered "economic usable crude oil". The first spike in oil prices helped create the global offshore oil and oil sands industries. These new sources, and others, add a whole new dimension to the global "Hubbard curve". For example, they added the equivalent of a whole new Saudi Arabia in northern Alberta, and Petrobras, the Brazilian state oil company, is now finding and economically extracting oil in the deep waters of the Atlantic Ocean.

Extracting and processing oil, especially from unconventional sources, is not a "mom and pop" operation, however. It requires hundreds of millions to billions of dollars and up to decade of effort to get a new supply project underway. Companies only carry out this kind of effort if they are sure the investment will be economic. The price of oil, however, fluctuates by the day, at the whim of day to day changes in demand and supply disruptions. Temporary spikes in price only lead to new supply if producers are sure the price increases are permanent. This dynamic tension between volatile demand and inflexible supply means that oil prices are guaranteed to be highly unstable through the coming decades. However, if prices stabilize around $75 per barrel, perhaps falling to $50 and rising to $100, many new supply investments on the continental shelves, in deep water and in unconventional sources like oil sands will be economic.

Energy economists, and the energy industry in general, think of the supply of fossil fuels in terms of "reserves" and "resources". "Reserves" applies to the crude oil, natural gas and coal that has been found and explored to the extent that it is known fairly well how much is available in a given deposit and what it is will cost to extract under existing economic and operating conditions. "Resources" refers to geologists' qualified estimates of how much crude oil, natural gas and coal may be in the ground, and will eventually become economic given reasonable predictions of prices and technology. It is for this reason that the reserves associated with Alberta's oil sands are generally measured in decades, and the resource in hundreds of years. British Petroleum (BP) publishes an annual estimate of global oil, gas and coal reserves. If these are divided by current consumption, current oil reserves will last just over 42 years.[1] This, however, is by a strict accounting of the narrowest definition of economic reserves, proved and economically extractable deposits of crude oil with active leases, and only projects "under active development" in the case of oil sands. If global oil consumption continues at its current rate and we include a broader range of economic sources (i.e. economic oil sands not yet under active development), currently estimated economic reserves will last about 70 years or more, and potentially economic resources at least 200 years or more.[2]

Crude oil is not the only fossil fuel, nor is it necessarily the most important for running our economy. Natural gas and coal both have very important roles to play. Natural gas, substantial amounts of which come up with crude oil out of the ground, was originally considered a dangerously flammable waste byproduct of oil production. To reduce these hazards it was flared or vented. Eventually methods were found to capture the gas and sell it for its heating value, which lead to the development of today's purpose built natural gas extraction, processing and transportation industry, which provides the primary method of heating buildings and a major component of industrial heat.

Natural gas was originally confined to continental pipeline transport, and as a result prices were set by demand and supply connected by the pipeline system. The advent of ocean shipping of liquefied natural gas means the natural gas industry is rapidly acquiring the characteristics of a global market, with prices set by a balance of global demand and supply. LNG tankers from the Middle East and Russia will now change course mid-ocean depending on landed natural gas prices in the US, Asia and Europe.

North American continental natural gas resources were also thought to have peaked up until a few years ago. A fundamental change has occurred in drilling and extraction technology,

[1] BP Statistical Review, 2009.
[2] Mark Jaccard. Sustainable Fossil Fuels: The Unusual Suspect in the Quest for Clean and Enduring Energy. Cambridge University Press, 2005.pp.147-153

however, which now allows producers to go directly into the source rock and "mine" the natural gas (i.e. "shale gas"). While expensive, requiring wholesale natural gas prices of $4-5 or more per gigajoule to be economic (they are currently $2-3 per GJ, a ten year low), this new technology has expanded the province of gas exploration across North America. The impact of this new source of supply is still being sorted out, but observers agree that the natural gas industry has fundamentally changed, and that regions that have in the past been gas importers, (e.g. eastern Canada) could in the future provide much of their own gas and even become net exporters.

BP's current estimate of the global natural gas reserve to consumption ratio is currently 63 years. If we include a broader definition of rapidly developing unconventional sources from Jaccard (2005), currently economic reserves would last more than 150 years at current consumption levels, and the overall potentially economic resource over 500. However, there are several technologies similar to shale gas (e.g. deep geo-pressurized gas) that could expand the economic resource base out to several thousand of years worth of current consumption. And if we can find a way to mine the natural gas hydrates that litter the ocean floor, we will have enough gas for tens of thousands of years (Jaccard 2005, p.152).

As with oil prices, natural gas production and transportation is a highly capital intensive business, with long lead times for new projects. Demand fluctuates daily, driven by warmer and cooler winters, fluctuating demand for electricity made with natural gas, and general economic turbulence. Volatile demand and inflexible supply means that natural gas prices are guaranteed to be highly unstable through the coming decades.

Fossil fuels are not only used directly, we also use them to make electricity. Most of Alberta's electricity, and almost half of that for North America, is made by burning coal. Coal is also used directly to make steel and provide process heat for many energy intensive industries (e.g. cement). World coal reserves are substantial compared to our current use rate, and located worldwide. For some countries, such as China, coal is the only fossil fuel they have in abundance. BP's current worldwide reserve to production ratio for coal is 122 years, under existing operating conditions and costs. Again, under a broader estimate of reserves if world coal consumption continued at its current rate, reserves will last just over 200 years and the estimated economic resource well over 2000 years (Jaccard 2005, p.148).

Coal prices are less volatile than oil and natural gas, but because all three commodities are somewhat substitutable for one another, as the prices for each rise and fall, the prices of the others will do the same. Coal and natural gas are especially substitutable for each other, even on a daily and monthly basis, as both can be used for industrial heat and especially to make electricity.

A key advantage held by Alberta electricity producers, however, is that Alberta is essentially one very large coal bed. Its current coal fired electricity plants are sitting right on top of coal deposits; energy analysts joke that you can shovel coal straight from the ground into the boilers, allowing for the country's lowest thermal coal prices. Another interesting wrinkle in Alberta's electricity supply situation is the oil sands. They require huge amounts of process heat and steam. This heat and steam can be made with boilers, or it can be made using what are called "cogeneration" units, that produce electricity and steam at the same time. While more expensive than boilers for making steam, they are much more energy efficient as an electricity and steam production system, and the value of the electricity, which can be used on site or sold, can often tilt the balance towards cogeneration. Analysts estimate that all of Alberta's new electricity supply could be supplied by the oil sands in the near future. In fact, the limiting factor for cogeneration installation in the oil sands is not capacity, but a market for the electricity – some cogeneration projects have been scaled back or cancelled because they would provide too much electricity for Alberta's electricity pool to absorb, and there is a lack of transmission to other regions, e.g. BC and the US markets.[3]

In summary, there are decades to centuries of oil left, and centuries to millennia of natural gas and coal left. Medium to long run supply is not going to be a problem. Because of the capital intensive and risky nature of energy projects, however, short run supply, which determines price volatility, will be an issue.

What does this mean for fossil fuel consumers? Gasoline and diesel prices are likely to be volatile and steadily increase as oil companies are pushed to produce more and more unconventional oil. Natural gas prices will also be volatile, but will find an upward ceiling that will reflect the as yet unknown overall average cost of production from shale gas[4]. This may change if a substantial amount of the transport fleet is converted to natural gas, which may increase its price and reduce the upward pressure on oil prices. Alberta electricity prices may also be somewhat volatile, depending on the mix of coal, natural gas, oil sands cogeneration and renewables that provide the power, but not as volatile as gasoline, diesel and natural gas prices.

Beyond simple supply and demand, fuels sourced within North America are likely to be more reliable than those that have to travel across the seas from potentially unreliable suppliers. Energy sourced from multiple suppliers is also more secure. Each of the energy policy bills currently before the US congress contains an "energy security" component, whereby energy that comes from North America is to be preferred to that which is sourced internationally,

[3] National Energy Board. June 2006. "Canada's Oil Sands. Opportunities and Challenges to 2015: An Update." pp.45-48.

[4] In conversation with industry insiders, a typical guess of the wholesale gas price from shale gas is about $5-6/GJ, i.e. the typical cost of producing the last GJ of gas in a competitive market.

especially from the Middle East and other politically unstable areas. This would indicate a long term preference for oil, coal, natural gas and electricity made from North American fossil fuels and renewables.

One cannot forget either that much of Edmonton's prosperity rests on the western Canadian oil and gas industry. All current operating oil sands projects will remain economic, but future developments will be uncertain, depending on what the long run fuel for the transport sector will be. New oil sands projects have lots of competition, be it energy efficiency, alternative fuels, or other suppliers of oil. Shale gas projects will have competitors across North America. The biggest advantage of the current industry is that the pipeline system is currently set up to extract, process and move natural gas from the Western Canadian sedimentary basin to eastern Canada and the US. Alberta, BC and Saskatchewan's energy policy makers cannot rest on their laurels, however. They will need to consider new markets, including Asia, and to make sure new developments are made at the highest standard of environmental protection.

Finally, there is one last uncertainty that any decision maker needs to consider in regards to energy: climate change policy. Several climate change and energy security bills are before the US Congress, and Canada's federal government had committed to equaling US policy when it occurs. BC already has a significant carbon tax and has committed to joining the Western Climate Initiative cap and trade system, while Alberta already applies effectively a $15/tonne CO_2e charge on large industrial plants over a given level of emissions intensity. Given these developments, it is likely that within five to ten years all of North America is likely to live under significant carbon dioxide emissions restrictions, probably reductions on the order of 10-15% from today's levels, including purchases of international emissions reductions. Coal, when burned, has the highest emissions of carbon dioxide per unit of useful energy. Gasoline and diesel emit about 70% of the carbon emissions of coal, while natural gas emits about 50% of the carbon emissions of coal. Old electricity making equipment tends to be about 25-30% efficient in making electricity from coal and natural gas, while modern equipment is 50-60% efficient. Put all this together, and coal will soon become relatively more expensive than natural gas than currently, and coal and natural gas are going to become more expensive to use than electricity made from hydroelectric power, wind and solar energy. As energy supply and demand investments tend to be long lived, wise policy would argue, all other things being equal, coal use be avoided in favour of natural gas, and natural gas use be avoided in favour of electricity made with renewables. In terms of volatility and long term carbon costs, electricity is to be favoured over directly using any of the fossil fuels.

A 10% reduction in carbon emissions will not be enough in the long run, either. The respected climate change science community is arguing we need to reduce emissions by up to 80% by later in this century to prevent catastrophic climate change, especially as the economies of

China, Brazil, India reach their full potential. This will require an almost complete conversion away from fossil fuels by the end of the century, or at least to a system where we bury or otherwise trap the carbon dioxide away from the atmosphere, perhaps using carbon capture and storage. This could begin with projects to use the captured carbon dioxide to renew old crude oil wells (i.e. "enhanced oil recovery").

So what possible adaptation strategies does Edmonton have for the changing energy landscape? What policies can it implement to make its citizens' lives easier, cheaper and better in the coming decades? The options below focus on reducing energy use through energy efficiency and conservation, fuel switching to more reliable and locally sourced energy, and motivating good policy to deal with changing demands on the energy system. As a beginning, I suggest the following strategies for the city. 1) Convert municipal fleets to high efficiency vehicles (e.g. cold adapted hybrids) and alternative fuels (natural gas in the short run, electricity and biofuels in the long run). Once the concept is proven, encourage commercial and taxi fleets to follow. 2) Adopt advanced energy efficiency standards (or better yet, low and eventually zero carbon emission standards) for all municipal buildings, and eventually for all new buildings. Encourage retrofits of older buildings. 3) Work with transit planning and land use authorities to make the city more transit friendly. 4) Work with utilities to gradually replace the existing coal driven electricity plants with sources that have lower carbon emissions (e.g. oil sands cogeneration, coal with carbon capture and storage, natural gas driven combined cycle turbines, wind, biomass, solar etc.) with the goal of eventually replacing all electricity sources with renewables. Nuclear power may also need to be considered, but only if the full cost and implications of waste disposal and decommissioning are included. 5) Adopt polices to encourage electrification, and the capacity to eventually switch to electricity for all energy end-uses in the city. 6) Purchase necessary municipal natural gas supply requirements forward on the futures market. 7) If feasible, consider implementation of a city carbon charge, one that includes the full cycle carbon content of gasoline, diesel, fuel oil, natural gas and electricity, and use the revenue to reduce property and city taxes and pay for new transit. 8) Push for good, reasonable provincial and federal policy for dealing with the changing energy landscape (i.e. carbon pricing, low and eventually zero emission building and vehicle standards, and financial support for technology and infrastructure to help municipalities, households, and firms transition to a low oil, low carbon future).

These policies are all feasible using today's technology, and are generally sensitive to the constraints on our politicians, who generally desire to continue getting elected. They will mean only very gradual rises in energy prices as a share of the typical family's budget, but they will eventually get us to near-zero-emission energy supply and demand system, which

helps solve the global climate change problem and avoids the so-called peak oil threat, all while providing domestic security of supply.

Edmonton, like all North American municipalities, is facing a changing energy landscape. Oil is going to get continually more expensive, with probably wild swings in price, but it isn't going to run out for the foreseeable future. Natural gas will get more expensive and the price will be volatile, but its cost is unlikely rise as much as oil due to increased supply possibilities at a reasonable cost. We will continue the process of electrifying our economies, making more and more of our electricity using natural gas and renewables. Finally, we will have to either wean ourselves off fossil fuels long before they run out, or learn how to dispose of the carbon dioxide waste somewhere other than the atmosphere. None of this means that oil and gas cannot continue to be a mainstay of Edmonton's economy. But – and this is a big but – we need good, effective and reasonable policy that helps us to carefully consider our energy supply and consumption decisions moving forward.