Where The Puck Is Going:
Peak Oil and the Next Energy Crisis

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June 8, 2009

EXECUTIVE SUMMARY
Where The Puck Is Going: Peak Oil and the Next Energy Crisis

The world is approaching, or has already reached, Peak Oil. The term Peak Oil refers to the point at which global conventional oil production can no longer increase to meet the demands of a growing world economy. The stagnation and subsequent decline of oil production would drive rising prices, scarcity and growing hardship for an economy built around cheap and abundant energy.

The exact date of the global Peak will not be known until after the fact. The balance of informed opinion suggests a Peak no later than 2020. Production data since 2005 is consistent with a peak/plateau beginning in late 2005.

Since mitigation must begin decades before Peak, essentially all likely Peak dates call for immediate and concerted action to adapt. Action will be required at all levels of government and of the economy. While cities cannot carry out all the required actions, there is a great deal of preparation that can and should be undertaken at the municipal level.

While alternative energy sources will play a role in our future economy, it is highly unlikely that they will able to replace declining petroleum supplies. Successful adaptation will largely depend on reducing our energy dependency. Dramatically increased efficiency at all levels (transportation, housing, food production etc.) is essential.

Being fundamentally an issue of reducing fossil fuel consumption, Peak Oil calls for many of the same measures as climate change. Transportation is particularly vulnerable to Peak Oil and presents the most immediate challenge.

Compared to other Canadian cities, the Greater Moncton area enjoys a number of advantages in adapting to reduced fossil fuel supplies. In particular the likely resurgence of the railroad industry, the availability of good wind power resources, and the potential for tidal power from the Bay of Fundy all present enormous opportunities. We must act quickly to seize these opportunities while shoring up our weaknesses.

The recent collapse in oil prices is due to temporary economic factors. The recession obscures but does not change the underlying resource reality, nor does it in any way reduce the urgent need for adaptation.

A growing number of cities has recognized the problem of Peak Oil and established task forces to develop strategies to adapt. It is recommended that Moncton establish a Peak Oil Task Force immediately.

"Skate to where the puck is going, not to where it is."

-Wayne Gretzky

Introduction

Impending "Hubbert Peak" of global oil production; serious consequences for urban development.

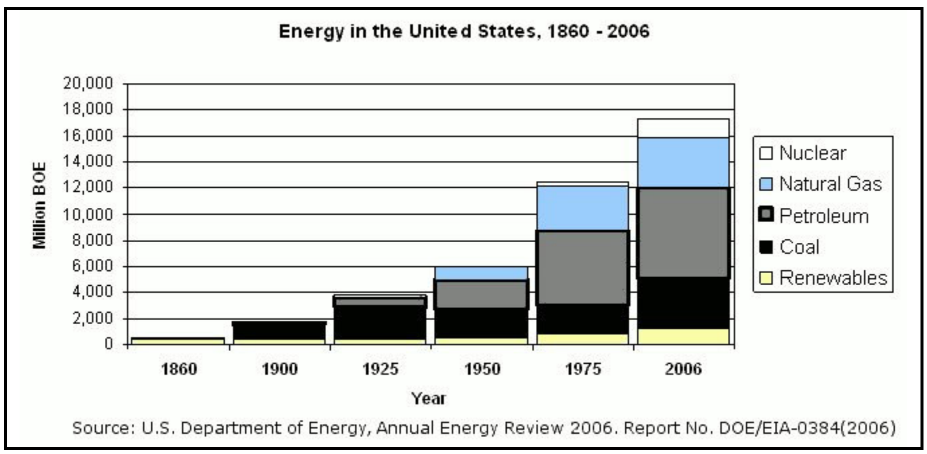
The functioning of any modern city is directly tied to the availability of energy. Within a short- to medium-term planning horizon, the world faces permanent and growing energy shortages and/or price increases. These effects will be the result of the global phenomenon known as "Peak Oil."[1] The purpose of this paper is to lay out the issue of Peak Oil and the implications for the City of Moncton, and to propose the beginnings of an adaptation strategy.

Oil dependency

Modern life dependent on cheap, stable petroleum supplies.

For the past century, we have been able to rely on a stable and steadily-increasing supply of energy to feed our needs. This energy supply has come overwhelmingly from non-renewable fossil fuels, of which the most important has been petroleum.

Figure 1: Contribution of different sources to energy in the United States, 1860-2006.



Petroleum's advantages over other fuels.

There are practical reasons for this dependency. Leaving aside the environmental consequences such as global warming, conventional oil has been the cheapest, most versatile, most powerful and safest energy source around. All other known energy sources—solar, wind, coal, tar sands, nuclear, biomass etc.—involve serious compromises on one or more of these fronts.

Modern transportation, housing, food production and economic development are all directly tied to the reliable supply of cheap oil and natural gas. North American cities, in particular, have adapted to

[1] Peak Oil theory was first proposed by petroleum geologist M. King Hubbert, who in the 1950's used the observed behaviour of oil fields over their life cycles to correctly predict the year (1970) in which oil production in the United States would reach its highest rate and begin to decline. The generalized Hubbert Curve has since been observed in essentially all oil-producing regions, and is accepted as a basic axiom of the petroleum industry.

take advantage of this cheap and abundant energy source. However, in doing so, they have evolved into a form that cannot easily function without these non-renewable resources.

A growing body of theory and evidence now suggests that oil depletion will become a problem sooner rather than later.

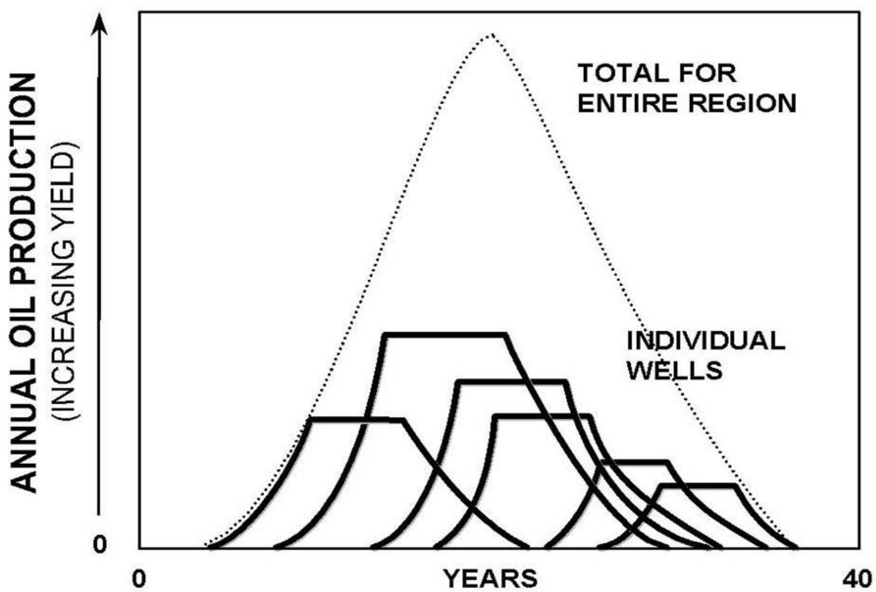
Peak Oil

Peak Oil: The point at which roughly half the total resource has been extracted, after which production cannot be increased and begins to decline.

Data from hundreds of oil fields over the past century have shown a fairly consistent pattern. Over the first half of a field's life, production increases as the resource is mapped and developed. When between 40% and 60% of the recoverable resource has been extracted, however, the remaining oil is increasingly difficult and expensive to extract, and production declines. This rise-peak-decline trend, extrapolated to the global scale, is what is meant by the term "Peak Oil."

Figure 2: Generalized Hubbert Curve showing increase, peak and decline of an oil-producing region.

(Graphic: U.S. Army Logistics Management College. http://www.almc.army.mil/alog/issues/JulAug99/MS406c1.jpg)



What happens when oil production peaks?

To clear up a common misconception: Peak Oil does not mean the world has "run out of oil." Rather, it would signal the end of the *cheap, easy and unconstrained supply of oil* on which we have built our economies. In other words, Peak Oil is primarily about the rate of production, not the amount of the remaining reserve. Whenever it does occur, the peaking and subsequent decline of world production would result in an ongoing and widening gap between supply and demand. This in turn would drive ever-increasing prices for energy and everything that depends on it.[2]

Approximately one-half of the world's endowment of conventional oil has been consumed.

Published estimates vary as to how much recoverable oil existed on Earth in the first place; however, 2500 billion barrels is a relatively optimistic estimate.[3] As of late 2006, the world has consumed 1078 billion barrels. With consumption running at roughly 30 billion barrels a year, then, we are very close to the global halfway point; and by extension, very close to the theoretical global production peak.

Confounding factors.

Oil depletion is complicated by a number of factors beyond pure geology, including:

Much of the remaining oil located in hostile, unstable countries.

- ***Geopolitics.*** Nearly two-thirds of the remaining conventional oil is located in just five Persian Gulf countries. Ten countries have over four-fifths of the remaining oil on Earth. Of these, several are involved in civil wars or insurgencies (Iraq, Nigeria); several others are to a greater or lesser extent at odds with Western interests (Iran, Russia, Venezuela.) The future stability of these supplies is questionable.

Resources in difficult locations.

- ***Geography.*** Having used up the most accessible oil, much of the remaining resource is located in deep water, under polar ice caps, or in otherwise inhospitable, remote or difficult areas. This makes the resource more difficult and expensive to extract and bring to market.

Competition with other countries; speculation and hoarding.

- ***Economics.*** Unlike in decades past, the West now faces competition from large industrializing countries such as China and India. This adds to upward pressure on prices. Another complication is speculation and hoarding; as participants in the market become aware that scarcity is at hand, they attempt to profit by buying low and selling high. This in turn helps to destabilize prices and makes it difficult for market forces to operate efficiently or predictably.

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[2] Not that this increase would necessarily be steady; indeed, the destabilization of oil markets (including ever-larger price swings) has long been expected as a conequence of the global Peak. See Appendix C for a discussion of the recent collapse in the price of oil, and how this relates to the Peak Oil story.

[3] As with many aspects of the Peak Oil story, there is great uncertainty on this point. Estimates of the ultimately recoverable reserve (URR) vary but tend to cluster in the 2000-2500 billion barrel range. Estimates published prior to 1956 ranged from 400 billion to 1500 billion barrels URR; clearly most of these were way off, as oil produced to date has exceeded most of these projections. We have concentrated on the seventy-three estimates of global URR published between 1970 and 2003 which give a range of 1600 to 6000 billion barrels URR. Twenty-nine of the 73 estimates (or just under forty percent) suggest a URR of 2000-2500 billion barrels. Three-quarters of the 73 estimates are under 2500 billion barrels, which forms the basis for our statement that 2500 billion barrels is a fairly optimistic estimate. It is worth noting that there is little correlation between the date of the projection and the estimate; in other words, estimates of global URR have not increased with time. Published estimates from Udall and Andrews 2004.

Confounding factors tend to make things worse; unlikely to make things better.

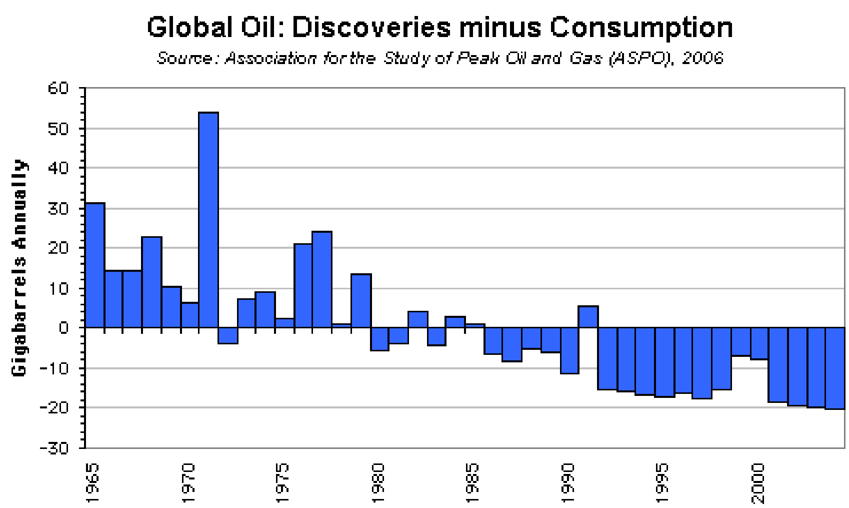
The confounding factors are worth noting because their influence tends to be mostly negative. That is, these factors have great potential to make the situation worse but can do little to make things better. They also make it difficult to ascertain whether observed trends are due primarily to a geological constraint, or are being exacerbated by these other factors.

Evidence of depletion

Growing evidence of depletion.

Regardless of when the world reaches (or reached) Peak Oil, it is clear that the resource is being depleted. Since the 1980's, global oil consumption has outstripped new discoveries, to the point that we now consume between two and four barrels of oil for every new barrel we discover.

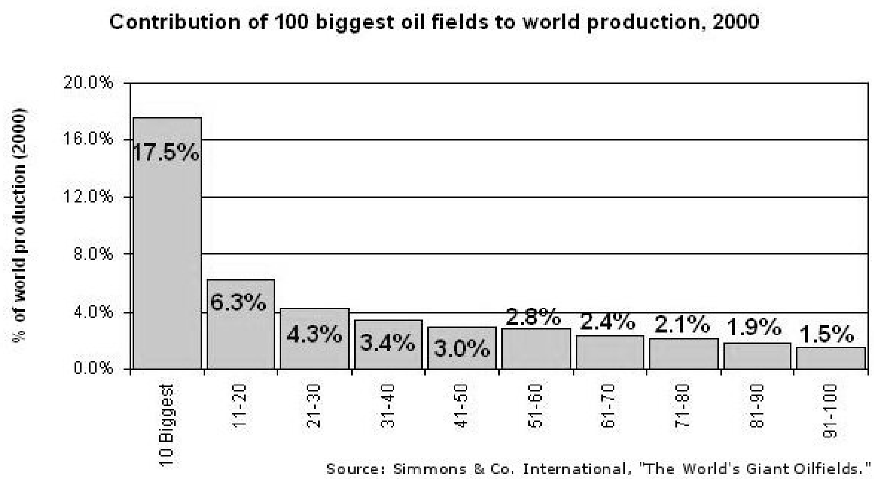
Figure 3: Growing gap between consumption and new discoveries, 1980-present.



70% of the oil produced today comes from fields discovered prior to 1970.[4] The world's oil comes disproportionately from a small number of supergiant fields. The ten highest-producing fields account for over one-sixth of all global production.

[4] Matthew Simmons, "The World's Giant Oilfields." Hubbert Center Newsletter #2002/1. M.King Hubbert Center for Petroleum Supply Studies, Colorado School of Mines. January 2002.

Figure 4: Ten fields account for 17.5% of all global production.



Confirmed decline at Burgan, Cantarell and Daquing fields.

As of 2007, production is declining from three of the world's five largest oil fields. In the case of Mexico's Cantarell complex--the last supergiant field to be discovered, in 1976--production is falling by 16% a year.[5]

Timing of the global Peak

Projections of a global Peak; widely varying dates; clustered around 2010-2020.

Until recently, a great deal of discussion centred on the question of when world oil production would reach a global peak and begin to decline. Aside from a handful of extreme outliers, projections on the optimistic end suggested a Peak as late as 2037.[6] Most projections, however, clustered around earlier dates. In 2004, a simple majority of published predictions suggested a Peak between 2010 and 2020.[7] Historic data from the 24 post-peak oil-producing nations suggested a global Peak between 2003 and 2016[8]. In 2004, the Association for the Study of Peak Oil and Gas (ASPO) revised its global Peak projection from 2010 to 2008.[9] The differences in projected Peak dates stem from differing assumptions about variables such as future discoveries and improvements in technology, as well as from a lack of transparency in the oil industry and the inherent difficulty of estimating reserves which are hidden underground.

[5] Observed decline at Cantarell from December 2006 to December 2007; projected decline to December 2008. ASPO USA. Peak Oil Review, Volume 3, number 5. February 4, 2008

[6] 2037 was the U.S. Energy Information Agency's "mean case" scenario and was generally presented as that agency's "best guess."
http://www.eia.doe.gov/pub/oil_gas/petroleum/feature_articles/2004/worldoilsupply/oilsupply04.html

[7] Steve Andrews and Randy Udall, "Oil Prophets: Looking at world oil studies over time." May 26-27, 2004. http:// www.peakoil.net/iwood2003/paper/AndrewsPaper.doc

[8] Richard C. Duncan, "Three world oil forecasts predict peak oil production," *Oil and Gas Journal,* May 26, 2003.

[9] Uppsala Hydrocarbon Depletion Study Group, Oil and Gas Liquids 2004 Scenario (updated May 15, 2004 by Colin J. Campbell.) [online] http://www.peakoil.net/uhdsg/Default.htm.

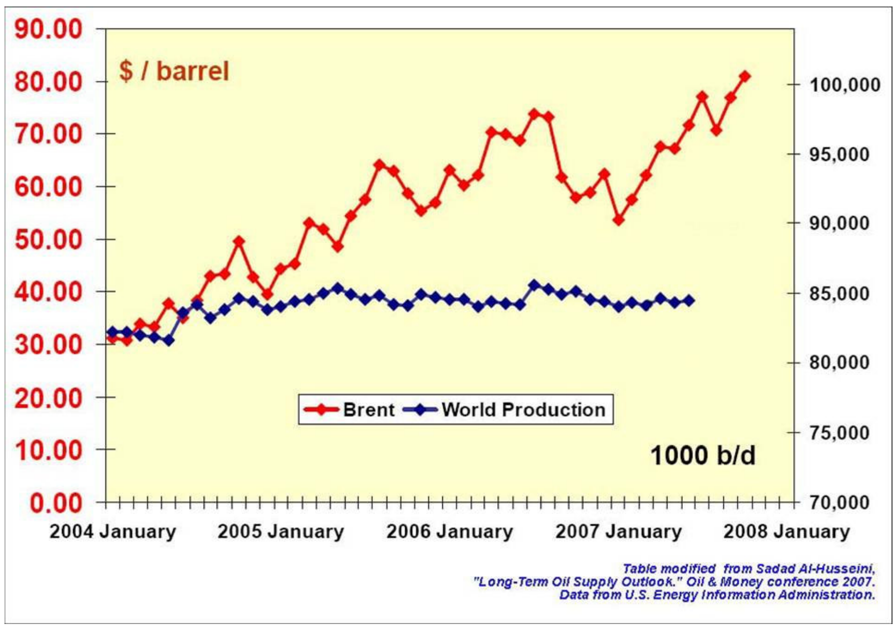
Peak Oil can be conclusively identified after the fact.

It has in any case long been understood that the global Peak would only be identified for sure after the fact, once several years' worth of production became available showing stagnation or decline. As a historical example, while production in the continental United States peaked in 1970, this fact was only confirmed several years later in 1973. A similar delay would be expected at the global level.

Peak possibly already past; now on "bumpy plateau" that precedes global decline.

Recently, oil production data has suggested that the world reached a plateau in late 2005, with daily production hovering around 84 - 85 million barrels per day despite dramatic price increases. If the world did indeed reach peak output in 2005 or 2006, it makes the situation much more urgent: the question is no longer "When will production no longer be able to increase to meet world demand?" Rather, it is "When will it now begin to decline?" and "what must we do to adapt?"

Figure 5: Oil production since 2005 has not increased in response to higher prices.



Anticipating and adapting to Peak Oil

Hirsch Report

In 2005, a report was commissioned by the U.S. Department of Energy on the subject of Peak Oil. The Hirsch Report (named for its principal author, Dr. Robert L. Hirsch) drew the following conclusions:

- The timing of the global Peak is unknown but likely within 20 years (as of 2005);
- The transition from fossil fuels will be "abrupt and revolutionary," as opposed to the "gradual and evolutionary" historic transitions away from wood and coal;

- Oil peaking is primarily a liquid fuels problem for the transportation sector, not an "energy crisis" in the usual sense;[10]
- Adaptation will require not only conservation, but major efforts to produce alternative liquid fuels;
- Mitigation will require a minimum of ten years' concerted, expensive action to avoid major hardship. The challenge of oil peaking deserves immediate, serious attention, if risks are to be fully understood and mitigation begun on a timely basis.

Anticipating the consequences in order to prepare.

In preparing for Peak Oil, it is useful to consider some specific consequences that a decline in oil supplies would entail. Broadly speaking the consequences may be broken into short-term and long-term effects on transportation, the economy, housing, and food production and distribution.[11]

Transportation

Transportation, short-term.

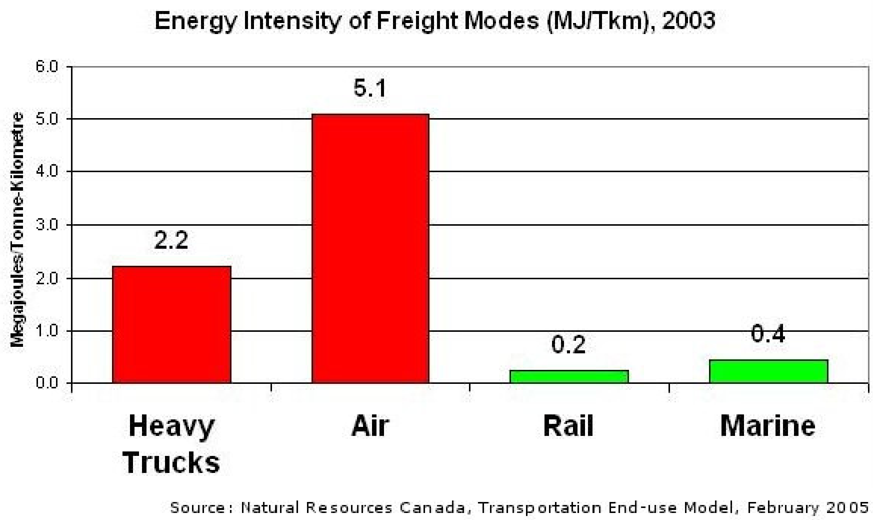
Short-term

- since 90% of our transportation fuels come from petroleum, and since the overwhelming majority of our existing infrastructure and equipment is built to run on gasoline or diesel, Peak Oil's most immediate effect will be on transportation. Many effects in other realms will be indirectly related to transport.
- increase in gasoline prices prompts shift away from SUV's towards compact cars and hybrids;
- increased demand for public transit and active-transportation facilities, as well as carpooling, especially at the economic margins (i.e. lower-income people);
- decline in air travel and failure of some commercial airlines.

[10] We understand and to some extent respect the distinction being made. However, since so many of our systems are now inextricably linked to transportation (car dependency, long-distance transport of food, globalized manufacturing, etc.) we feel that this distinction begs the question. If almost everything we do is dependent on cheap and reliable transportation, and if transportation fuels become scarce, then this is for all practical purposes a system-wide energy crisis.

[11] The body of this report was written in 2005, with periodic updates since then. It is worth noting that these predicted effects were postulated in 2005, and that many of the short term effects cited here are now being seen in 2008.

Figure 6: Transport by air or road is far more energy-intensive than trains and shipping.



Long-term

Transportation, long-term.

- eventually, fuel prices go high enough that even high-efficiency cars are uneconomical to use;[12]
- more people, driven by economic pressures, make locational and lifestyle choices to minimize or eliminate driving (e.g. moving downtown or closer to workplaces and transit)[13]
- highly energy-intensive transport industries cease to be viable;
- resurgence of more efficient travel modes (especially rail, shipping);
- for highways, rising cost of maintenance plus decreased utility may lead to disinvestment and decay;
- waterfronts may return to being transportation terminals as river and ocean transport become more cost-effective than roads.

The Economy

Short-term effects

Economy, short-term

- oil crises of 1973-74 and 1980-81 were accompanied by

[12] Data on vehicle fuel efficiency suggest that an immediate fleet-wide shift to the most efficient vehicles available (i.e. hybrids and subcompacts) could, in principle, triple per-kilometre efficiency. This would in turn compensate for up to a 200% increase in fuel prices. Unfortunately, it is highly unlikely that fuel prices will only triple; scenarios in which gasoline costs $5 or even $10 a litre are now considered fairly optimistic.

[13] *" By 2012, there should be some 10 million fewer vehicles on American roadways than there are today—a decline that dwarfs all previous adjustments including those during the two OPEC oil shocks."* Rubin, Jeffrey. "Heading for the exit lane." CIBC World Markets, June 26, 2008.

economic recession and inflation/"stagflation" as energy costs were passed on throughout the economy;
- oil-rich countries (including to some extent Canada) may be cushioned for a while by their oil wealth, however, in the long term even these will be depleted;
- large-scale business models, especially those highly dependent on long supply lines, overseas manufacturing, and regionalized customer bases (e.g. big-box stores) suffer from increasing costs;
- industries such as home renovation (for increased efficiency), solar and wind generators, bicycle manufacture and sales, etc. may benefit.

Long-term effects

Economy, long-term.

- eventually, globalized manufacturing stops being practical; the energy savings and short supply lines of domestic manufacturing outweigh the labour-cost savings of outsourcing overseas;[14]
- some industries (e.g. big-box retail, auto sales and services, mass tourism) will likely vanish;
- recycling/rehabilitation/repair/resale of existing manufactured goods becomes proportionately more important than making and selling new goods
- economic relations become much more localized and small-scale.

Housing

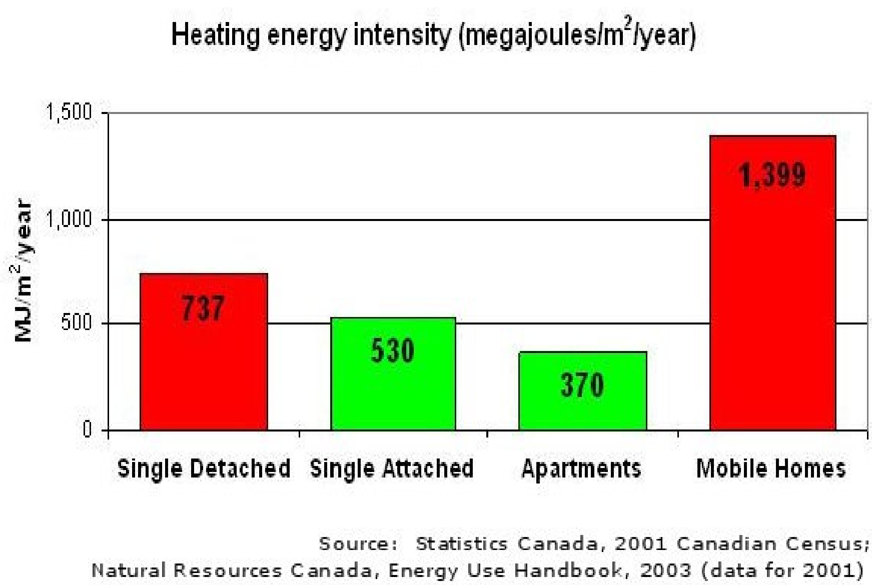
Housing, short-term.

Short-term

- large suburban houses (energy-intensive to heat/cool, as well as for transportation to and from work, shopping etc.) become less attractive to homebuyers;
- suburban living generally (i.e.living far from major destinations or transit routes) becomes less affordable.

[14] Rubin, Jeffrey. "Soaring oil prices will make the world rounder." CIBC World Markets, Occasional Report #55. October 19, 2005.

Figure 7: Single-detached houses are twice as hard to heat as apartments.



Long-term

Housing, long-term.

- suburban living as a whole becomes unaffordable to all but the wealthy;
- energy efficiency and convenience of location takes precedence over dwelling size, lot size and building typology in leading the market; people who once preferred single-detached homes on large lots will compromise and live in duplexes, rowhouses or apartments for the sake of easier heating and better locations downtown or near transit.

Agriculture and food distribution

Short-term

Agriculture, short-term.

- rise in food prices as cost of energy is passed on through the cost of energy-intensive farm "inputs" (fertilizers, pesticides, tractor fuel etc.) and processing/distribution (freezing, drying, shipping etc.);
- meat and dairy products are several times more energy-intensive than vegetable products; these would become proportionately more expensive.

Agriculture, long-term.

Long-term

- at a certain point, urban/rural economics returns to the historical model of towns relying much more on farms in the immediate hinterland, rather than on food imported over great distances;
- as with manufacturing, the industrial model of farming (highly mechanized and energy-intensive large farms located far from the end user) eventually becomes uncompetitive;

- local, smaller-scale, labour-intensive (human- and animal-powered) farming becomes more economically competitive;
- large cities that have paved over their immediate hinterlands may have difficulty sustaining large populations, and there may be migrations from larger centres to smaller-scaled communities;

How vulnerable is Moncton?

Moncton ranks 11th out of 45 CMA's on the Energy Crisis Resiliency Index.

In some respects, the Greater Moncton area is *relatively* less vulnerable to the impending energy crisis than other Canadian cities. In a study conducted in 2007, we found that Moncton ranked eleventh out of 45 Census Metropolitan Areas in terms of resiliency given a prolonged energy and liquid fuels shortage.[15] The study was based on climate data, as well as Census data on housing stock and transportation mode shares.

More broadly, we have tentatively identified a set of strengths and weaknesses for the Greater Moncton area, not all of which are necessarily reflected in the 2007 study.

Strengths/Opportunities

Moncton's strengths.

- Unlike many cities, the City of Moncton proper has a large and functional Downtown, established before the automobile era, which should be relatively better able to function when driving becomes unaffordable to most people. Ample vacant land in the Downtown area can accommodate more development;
- Having been economically disadvantaged for much of the past few decades, Moncton has not seen the same degree of auto-dependent suburbanization as larger and more prosperous cities, and proportionately less of the region's viable farmland has been given over to suburban development;
- Moncton's location on a river, with significant vacant land on the riverfront, will make river transport and docking facilities feasible;
- Tidal power is not cost-effective under today's conditions. However, the Bay of Fundy, with the highest tides in the world, may be among the first sites in North America to become viable as tidal power resources. Moncton's position as the largest urban center near the Bay means it may benefit

[15] Moerman, Tim. "Canada After The Peak: Evaluating Canadian cities' readiness for the new energy crisis." Plan Canada, Spring 2007.

from industrial development, much as Buffalo, New York grew into an industrial center to take advantage of the hydroelectric potential of Niagara Falls;

- Similarly, the Moncton area enjoys comparatively high wind speeds and proximity to many excellent wind power sites, many of which are already being exploited;
- Moncton's historical role as a railway town makes it likely to benefit from a resurgence of freight and passenger rail services in Atlantic Canada;
- Although limited to one VIA train per day, Moncton does enjoy passenger rail service and a passenger station Downtown. This puts Moncton in an enviable position compared to Saint John or Fredericton, which have been cut off from passenger service for years;
- Although winters are cold, Moncton's climate is otherwise hospitable, with ample water supplies within reach. This is a clear advantage when we consider that many post-WWII cities grew up in deserts and semi-arid areas where water must be moved long distances.

Weaknesses/Threats

Moncton's weaknesses.

- The transportation sector still accounts for a large proportion of Greater Moncton's employment base. The trucking and aviation subsectors are highly vulnerable to rising liquid fuel prices and supply disruptions;
- Moncton's evolution into a regional retail ("Big Box" or "Power Center") destination, and the related emphasis of retail jobs in the employment base, is problematic. This retail model depends on large catchment areas and therefore long driving distances. This sector may suffer from increasing fuel prices;

Figure 8: Top ten industries by percentage of workforce employed, 2001

Moncton CMA				Canada			
	Industry	**#**	**%**		**Industry**	**#**	**%**
1	Retail trade	7,865	12.0%	1	Manufacturing	2,174,285	13.7%
2	Health care and social assistance	7,015	10.7%	2	Retail trade	1,754,885	11.1%
3	Manufacturing	5,565	8.5%	3	Health care and social assistance	1,511,360	9.5%
4	Transportation and warehousing	5,200	8.0%	4	Accommodation and food services	1,046,045	6.6%
5	Accommodation and food services	4,805	7.4%	5	Educational services	1,021,025	6.4%
6	Administrative and support, waste management and remediation services	4,325	6.6%	6	Professional, scientific and technical services	982,300	6.2%
7	Public administration	3,990	6.1%	7	Public administration	904,480	5.7%
8	Wholesale trade	3,970	6.1%	8	Construction	879,245	5.5%
9	Educational services	3,945	6.0%	9	Transportation and warehousing	774,220	4.9%
10	Construction	3,470	5.3%	10	Other services (except public administration)	748,400	4.7%
	Top ten total:	**50,150**	**76.8%**		**Top ten total:**	**11,796,245**	**74.3%**

Source: Statistics Canada, 2001 Census

Moncton's weaknesses (cont'd.)

- Much of Moncton's growth over the past decade has been in less-sustainable, more automobile-dependent patterns, including the spreading out of retail services and the concurrent loss of such services in central locations;
- Although Moncton enjoys a high rate of walking and cycling to work, and ever-improving public transit service, the local culture is still highly automobile-oriented to an extent not seen in some other cities;
- A significant amount of Moncton's housing stock is in the form of single-detached houses and mini-homes. Although the preferred housing choice when heating costs are low, these energy-intensive forms will prove less viable as fuel prices increase.

Peak Oil presents opportunities for Moncton.

Overall, the balance of strengths and weaknesses is encouraging. A basic principle of any adaptation strategy must be to further develop our strengths and to shore up our weaknesses. Indeed, there are a number of unique opportunities from which, if we act quickly and decisively, Moncton could benefit enormously.

The case for immediate and decisive action.

Uncertainty has complicated policy development.

The uncertainty regarding the timing of Peak Oil has made it difficult to develop a policy response. As was the case until recently with global warming, uncertainty meant that decision-makers (at both the staff and political level) were reluctant to "go out on a limb" and risk being wrong.

In Staff's opinion, immediate and decisive action is now necessary and justified.

Based on the information available to us, however, **we must now recommend that Peak Oil be treated as a serious problem demanding an immediate and decisive response.** The basis for this recommendation is as follows:

The precautionary principle: Better to adapt too soon than to wait until it is too late.

1. The exact date of the global Peak and decline will be known only after it has already passed—which is to say, once it is too late to prepare for it. Given the consequences of failing to act in time, versus the consequences of acting prematurely, waiting until we are absolutely sure is not a responsible option.

New data point suggest a more immediate Peak.

2. To the extent that new facts and data have become available in recent years, they have tended to point towards a much earlier peak date than previously. To cite an extreme case, the U.S. Energy Information Agency long supplied the most optimistic projections, suggesting a peak between 2037 and 2112. However, the EIA's data now show a net decline in world oil production starting in 2005. In other words, the optimists' projections are now contradicted by their own empirical data.

Most published estimates see a global Peak within 2-12 years.

3. A simple majority of projections have suggested a global Peak date sometime between 2010 and 2020—that is, within two to twelve years.

Mitigation must begin 20 years in advance of Peak to avoid major hardships.

4. A major U.S. Department of Energy report on Peak Oil mitigation (the Hirsch Report) states that, to avoid major hardships and liquid fuels shortages, mitigation measures must be begun at least twenty years ahead of the global Peak. Measures begun ten years in advance will still result in major disruptions and hardship.[16]
5. Following points #3 and #4, we are now well within the twenty-year horizon for most projected peak dates and therefore well into the period in which mitigation starts to be appropriate.

[16] Hirsch, Robert. "Peaking Of World Oil Production: Impacts, Mitigation, & Risk Management." February 2005.

Production and price data suggest a global Peak in 2005.

6. World production and price data since 2005 are generally consistent with a Peak in late 2005 or 2006. If this is the case, we are quickly approaching a worst-case scenario—that is, whereby mitigation is left until after the Peak—and the situation may fairly be characterized as an impending emergency.
7. In general, data that on the surface appear to suggest a more distant or less severe crisis—including last year's collapse in oil prices from $147 to $50 a barrel or less—are readily accommodated within a model that nonetheless indicates constrained energy availability in the near term.

Optimism re: economics, technology has yet to be justified.

8. Arguments that previously suggested that Peak Oil would trigger responses that would solve it from a supply side, or would be readily compensated for by technology and economics, have tended not to be justified by the evidence. These include the economic argument that higher prices would stimulate more discoveries and production (they have not) and that alternative fuels and technology would come on line fast enough to offset stagnating or declining crude production (ditto.)

Confounding factors are likely to produce the same effects in advance of geological Peak.

9. The most likely scenarios that would delay a global Peak would nonetheless cause similar problems and point to the same policy response. For example, the OPEC countries could deliberately reduce production to conserve their resource; this would delay the global Peak but would do so by constraining energy supplies. A recession would reduce demand and prices, but would be accompanied by a reduced ability to pay for fuel and a reduced standard of living.

Peak Oil reinforces the same policy imperatives indicated by climate change.

10. The policy responses implied by an imminent Peak are broadly similar to those called for by climate change, i.e. concerted action to reduce dependency on fossil fuels. The difference is that while it is possible (though inadvisable!) to delay action on climate change, Peak Oil leaves us much less flexibility as it will force reduced consumption through scarcity.

What are other cities doing?

Adapting to Peak Oil will require concerted action at all levels of government. Many of the required measures are beyond a city's ability to initiate. However, there are a great many steps that can and should be undertaken at the municipal level, especially with regards to reducing energy demand.

Municipalities are taking action on Peak Oil.

Over the past several years, several municipalities have begun to take action on Peak Oil. In January 2006, the City Council of Burnaby, BC received a detailed staff report on the issue; Hamilton, Ontario also commissioned a report. In the United States, the councils of cities including San Francisco; Oakland, California; Portland, Oregon; Franklin, New York; and Bloomington, Indiana have passed Peak Oil resolutions and/or established task forces to address the issue. Citizens' groups in cities including Dallas, Austin and Seattle are developing resolutions to be presented to their respective councils. The Town Council of Kinsale, Ireland has gone so far as to adopt an "Energy Descent Plan" intended to cope with a permanent decline in fossil fuels.

Recommendations

Recommendations

These measures taken by other cities represent a good first step towards dealing with the issue. We recommend that Moncton City Council take the following steps:

Adopt Peak Oil resolution.

1. **Adopt the attached Peak Oil Resolution.** This resolution is based on the one adopted in 2007 by the City of San Francisco, modified as appropriate to Moncton's context. Adopting this resolution will signal to the public that Council has recognized this issue, and will give City and Planning Commission staff a clear mandate to explicitly take energy issues into consideration when carrying out their duties.

Establish Peak Oil Task Force.

2. **Establish a Peak Oil Task Force.** This task force should be small—around eight to ten people. It should include at least one Councillor, several City staff members, a town planner, and representatives of the business, academic, development and environmental communities. The purpose of the task force is to work through the implications of Peak Oil for Moncton, and to develop an appropriate community strategy and policies for adaptation and mitigation.

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Websites:

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The Association for the Study of Peak Oil and Gas (ASPO) also tracks the issue at http://www.peakoil.net and publishes the "Peak Oil Review," a free weekly e-digest of news and developments on the issue.

APPENDIX A: Proposed Peak Oil Resolution

Peak Oil Plan of Response and Preparation

Resolution acknowledging the challenge of Peak Oil and the need for Moncton to prepare a plan of response and preparation

WHEREAS, World oil production is nearing or has passed its point of maximum production (known as "Peak Oil") and will enter a prolonged period of irreversible decline leading to ever-increasing prices; and

WHEREAS, The availability of affordable petroleum is critical to the functioning of our transportation system, the production of our food and of petrochemical-based consumer goods, the paving of roads, the lubrication of machinery, and myriad other parts of the economy; and,

WHEREAS, Moncton has already demonstrated leadership in confronting challenges of global climate change, including participating in the Cities for Climate Protection program and establishing an Active Transportation and other policy initiatives, and has a rich diversity of citizens committed to maintaining Moncton's long-term viability; be it

RESOLVED, That Moncton City Council acknowledges the unprecedented challenges of Peak Oil; and, be it

FURTHER RESOLVED, That Council supports the undertaking of a city-wide assessment study in order to inventory city activities and their corollary resource requirements, evaluating the impact in each area of a decline in petroleum availability and of higher prices, with the aim of developing a comprehensive plan of action and response to Peak Oil; and, be it

FURTHER RESOLVED, That Council hereby requests that the City Manager's office take steps to establish a Peak Oil Task Force, comprising members of Council, the Planning Commission, City and Commission Staff, and the public, to examine the issue of Peak Oil and to develop a framework for adapting to fossil fuel depletion.

APPENDIX B: Alternative Energy

Alternative energy sources.

Alternative energy sources such as wind, solar, biomass etc. bear some discussion here. Certainly, these will have to be part of our future energy mix; and as the price of oil rises, these will become, *in relative terms,* economically viable. Indeed, Moncton is particularly well-placed to benefit from wind and tidal power resources.

Alternatives cannot deliver the same level of service (cost, versatility, rate of delivery) as petroleum.

However, we must be careful to understand the limits of alternatives. The popular press has demonstrated a certain irrational exuberance about the potential for alternative energy, especially with regards to alternative-fuel cars, and has contributed to a mistaken sense that Peak Oil can be substantially offset by alternative energy sources. **A couple of quantitative examples should help correct this impression:**

- A barrel of oil contains 6100 megajoules' gross heat energy. This is the equivalent to about 23,000 hours' worth of human labour (75 J/s). Assuming a wage of $8 an hour, a barrel of oil is therefore worth about $180,000 worth of work. Viewed that way, what we have come to regard as “normal” (i.e. energy that costs less than $100 per barrel-equivalent) is in fact quite exceptional and unlikely to be replicated by any natural system.
- In 2006 the world used 28.6 billion barrels of oil and natural gas liquids. This amounts to 175 trillion megajoules per year, equal to the round-the-clock output of 8,600 CANDU-6 nuclear reactors like the one at Point Lepreau. In other words, we would have to build one new Point Lepreau every day for the next 23 years to reach this capacity.
- At a gross yield of between 57,000 and 108,000 MJ/hectare,[17] it would take between 30% and 100% of all the farmland on Earth to produce enough biofuels to replace the oil currently used for transportation purposes.[18]

Alternative fuels don't scale.

These calculations and others illustrate the principle of scaling. It is one thing to develop a car that can run on ethanol or electricity or hydrogen. It is quite another to replace our current system with such

[17] Farrell, Alex et. al. “Energy Balance Analysis Meta Model (EBAMM) Release 1.0.” December 26, 2005.
[18] Calculations by Moerman 2006, based on data from: Farrell 2005; Nonhebel, Sanderine. “Renewable Energy and Food Supply: Will There Be Enough Land?” Renewable and Sustainable Energy Reviews 9, pp.191-201. 2004; Wolf, J. et. al. “Exploratory study on the land area required for global food supply and the potential global production of bioenergy.” Agricultural Systems 76, pp. 841-861. 2003.

a technology--that is, to produce enough ethanol or electricity so that hundreds of millions of people can drive those cars for a total of billions of kilometers each year.

Urban planning critic James Howard Kunstler sums up the issue thusly:

J.H. Kunstler on alternative energy sources.

> "A commonly-held view is that 'new technology' supplied by human ingenuity will eventually solve North America's problem with oil. This reveals a common misunderstanding, namely, that technology and energy are essentially the same thing, and that the one can always be substituted for the other."
>
> "The fact that energy and technology are **not** the same thing is crucial to understanding our predicament. There are really only five energy sources available to us: non-renewable oil, natural gas, coal, and uranium; and renewable solar (which includes wind, hydro, photovoltaic, and bio-mass, all dependent on sunlight acting on the earth.) The hope is that technology will somehow allow us to capture an equivalent amount of energy from renewables that we now get from non-renewables. This is the central fallacy of techno-hubris."
>
> "No combination of alternative fuels will allow us to run (North) American life the way we have been used to running it, or even a substantial fraction of it."

Conservation will be forced by scarcity.

Having "done the math," we concur with this point of view. Concentrated, high-quality energy is an inherently scarce commodity. We have used petroleum for a century precisely because it is (environmental effects aside) the easiest, most versatile, cheapest energy source around. There is no other source that can deliver the amount of energy we are used to, at the rate we are used to, for the applications and at the prices to which we have become accustomed.

Fundamental changes are coming whether we like it or not.

It follows that the peak and decline of conventional oil will force fundamental changes in the way we use energy, including dramatically reducing our consumption. It is important to note that this reduction **will happen whether we want it to or not**--that is, our consumption will be constrained by the availability of energy and by our inability to acquire the desired quantities, and not necessarily as a result of government policies or personal initiative.

The focus, then, should not be on encouraging people to use less energy--this is inevitable regardless of what we do. Rather, efforts (at least at the municipal level) should be directed at creating an environment where, as energy and liquid fuels become less available and more expensive, people can adapt as easily and painlessly to less energy-intensive lifestyles. For example, it's not about encouraging people to take public transit; it's about making sure the transit service is in place so that when someone can no longer afford to drive, she can continue her daily activities with a minimum of hardship.

APPENDIX C: Why have oil prices collapsed?

During the second half of 2008, the price of oil fell to below $40 a barrel, down over two-thirds from record highs earlier in the year. This is no cause for complacency. **The fall in oil prices is primarily the result of temporary economic factors that do not change the permanent geological and resource reality.**

Economic crisis has reduced demand temporarily.

Firstly, the world economy is undergoing a crisis severe enough to merit comparisons the Great Depression. Until last fall, the world economy was chugging along and attempting to grow, and for the past several years, demand for oil has strained against an apparent production ceiling of around 84-86 million barrels a day. This ceiling persisted for several years, despite sharply rising prices that provided every incentive to increase production. The resulting tightness in oil markets helped to drive a bidding war for available supply. (It is worth noting that the price spikes of the 1973-74 oil crisis were triggered by a 5% drop in crude supply, further supporting the idea that a relatively small gap between supply and demand can drive a very large price increase.) The recent reduction in economic activity and therefore in demand for energy has temporarily reduced demand to substantially below the available supply, resulting in a price collapse.

Deleveraging.

Secondly, the souring of debts and tightening of credit worldwide has driven a process of deleveraging. Investors who have borrowed (leveraged) large amounts of money to buy stocks, bonds and other instruments, are now under pressure to pay off worried creditors. This has driven a mass selloff of real assets (including oil) to raise money to pay these debts—even if the mass sellof itself has the effect of depressing prices.

Destabilization of oil markets.

Thirdly, the peaking of world oil production itself contributes indirectly to the instability. For instance, oil can be bought up and hoarded by speculators. In previous years there was little incentive for speculators to hoard oil against future price increases, because it was generally known that someone (primarily an obliging regime in Saudi Arabia) could and would increase production to modulate prices. Now, however, the evidence is growing that even Saudi oil production has peaked, and that supply cannot be readily increased. This has encouraged a great deal of speculative buying since 2005, contributing to price increases.

In any case, Peak Oil theory has long expected a destabilization of oil prices along with an ongoing price increase. In other words, it was foreseen that prices would swing through a wider and wider range, but "ratcheting up" over the long term. What we have seen recently is entirely consistent with that model.

Current low prices discourage investment in new production.

Indeed, this instability in oil prices may make things worse in the long term. It takes years for a new drilling project to reach the production stage. The business decision to start a project, and whether it is cost-effective to pursue, depends on the price of oil—if a given deposit costs $60 a barrel to extract and the expected market price of the resource is only $50, it's a net money loser. Unfortunately, the current price collapse has the effect of discouraging investments that would otherwise sustain production three or four years from now. Temporarily low prices also discourage the development of alternative energy resources for the same reason.

Recovering economy will strike the same production ceiling.

It is likely that once the economy recovers and demand for energy increases again, it will strike the same ceiling as before (84-86 million barrels per day) resulting in the same price increases as we saw from 2005 to 2008. Worse, as supplies begin to decline, that ceiling will begin to descend.

Economic crisis has eclipsed Peak Oil but the problem is still there.

In short, dramatic though the recent price collapse may be, it is no cause for complacency. Oil is still a finite resource, we are still approaching (or have already reached) a natural limit in the ability to produce it, and adaptations still need to be made.