Post Carbon Cities: North American cities respond to peak oil

Uno de los efectos del techo del petróleo —el inminente máximo histórico en la producción de petróleo mundial— es un incremento de la incertidumbre que rodea a los futuros precios del petróleo y a su disponibilidad. Ello plantea enormes desafíos a las ciudades de todo el mundo industrializado, ya que dependen completamente de la casi inmediata disponibilidad de productos petrolíferos relativamente asequibles, especialmente en forma de combustible líquido para el transporte. Algunas comunidades de Estados Unidos y Canadá han comenzado a responder a esta amenaza a nivel de sus gobiernos locales, intentando dar una respuesta social y económica adelantándose a las medidas nacionales.

Munduko petrolio-ekoizpenak laster lortuko duen gehienezko muga historikoaren ondorioz, gero eta zalantza handiagoak daude petrolioaren etorkizuneko prezioei eta haren erabilgarritasunari buruz. Mundu industrializatuko hiriek, bada, erronka handiei egin behar diete aurre. Izan ere, petroliotik eratorritako produktuak eskura izateak erabat baldintzatzen ditu. Batez ere, garraioan erabiltzeko erregai likidoak sorrarazten die mendekotasuna. Ameriketako Estatu Batuetako eta Kanadako komunitate batzuetan, mehatxu horri erantzuten hasi dira. Tokiko gobernuek nazio-mailako neurriei aurrea hartu diete, eta arazoari erantzun soziala eta ekonomikoa ematen saiatzen ari dira.

One of the effects of peak oil — the imminent historic maximum of global oil production — is an increase in uncertainty surrounding future petroleum prices and availability. This poses enormous challenges to cities throughout the industrialized world, as they are utterly dependent on the relative mass affordability near-immediate availability of petroleum products, especially as liquid fuel for transportation. Some communities in the United States and Canada have begun responding to this threat at the local government level, seeking to build local economic and social resilience ahead of national action.

Daniel Lerch
*Post Carbon Institute**

INDEX

Keywords: oil, local government, peak oil.

JEL Classification: Q48, Q41.

1. INTRODUCTION

More than sixty years of aggressively developing petroleum-dependent infrastructure has given us a world of plastics, personal automobiles, and trans-oceanic flights that would have seemed magical to our ancestors. And yet, this same world of technological wonder is acutely at risk. More and more analysts agree that we will pass the maximum point of global oil production — or "peak oil" — within the next five years, with no viable substitute resource in place. At the same time, climate change wrought by an overload of greenhouse gas emissions threatens global ecological catastrophe. Together, the threats of peak oil and climate change pose unprecedented challenges at all levels, particularly to key systems like food, transportation, energy and water.

As awareness about climate change and peak oil has grown throughout the industrialized world, leaders have started to recognize the enormity, severity, and urgency of the challenges that these threats pose particularly at the local level[1] — i.e., to cities, towns, and villages. Short-term climate and energy emergencies, such as fuel shortages and severe weather events, can be quickly damaging to local economies and social well-being; they create immediate burdens that local governments must bear while national agencies mobilize. Moreover, the long-term effects of climate change and fossil fuel depletion can have unique

* Daniel Lerch is author of "Post Carbon Cities: Planning for Energy and Climate Uncertainty" (Post Carbon Press, 2007), the first major guidebook on peak oil for local government officials and staff in the U.S. and Canada. Lerch is the Program Director of Post Carbon Institute (daniel@postcarbon.org, www.postcarboncities.net).

[1] The top resource for such considerations internationally is ICLEI—Local Governments for Sustainability; see www.iclei.org.

consequences for individual communities, depending on local economic structure (e.g., resident industries, skilled labor base), ecological resources (e.g., fresh water, topsoil), and energy and transportation infrastructure. Local leaders — familiar with their own communities' resources, history, and political culture — are often better-equipped than national decision-makers to identify these local strengths and weakness and to plan accordingly.

This article will focus on the challenges that peak oil poses at the local level, and review some of the actions that early-adopter cities in the United States and Canada have undertaken in response. Although the context within which North American local governments operate is often quite different compared to that of their counterparts in Europe — particularly as regards land ownership, land use planning, transportation planning and funding, and national economic planning — it is nevertheless instructive for cities in all industrialized countries to consider the experiences of cities in those economies which have pursued oil-dependent infrastructure development longer and more intensely than most others.

First, however, an introduction to the basic challenges of peak oil is necessary.

2. **PEAK OIL**

The term peak oil refers to the point at which total global oil production cannot grow any further and begins to decline. Peak oil is often misunderstood as an issue of the global oil supply decreasing. Strictly speaking, the global oil supply has been decreasing since commercial oil drilling started drilling in the mid-1800s. It is rather the decline of the historically-increasing flow of oil from underground reservoirs to markets that matters, because it is this flow that has been fueling the ever-growing global economy for over half a century.

This flow is made up of two kinds of oil, which analysts generally refer to as "conventional" and "unconventional". Conventional oil is the oil that has been produced from regions like central-southern United States (Texas, Oklahoma) and the Arabian Peninsula for decades; it made up about 86% of total global oil production in 2007. Unconventional oil is usually considered to include low-grade and logistically-difficult resources like tar sands, oil shale, heavy oil, deepwater oil, and polar oil. Some analysts talk about unconventional "sources" and use this broader umbrella to include natural gas liquids and biofuels.

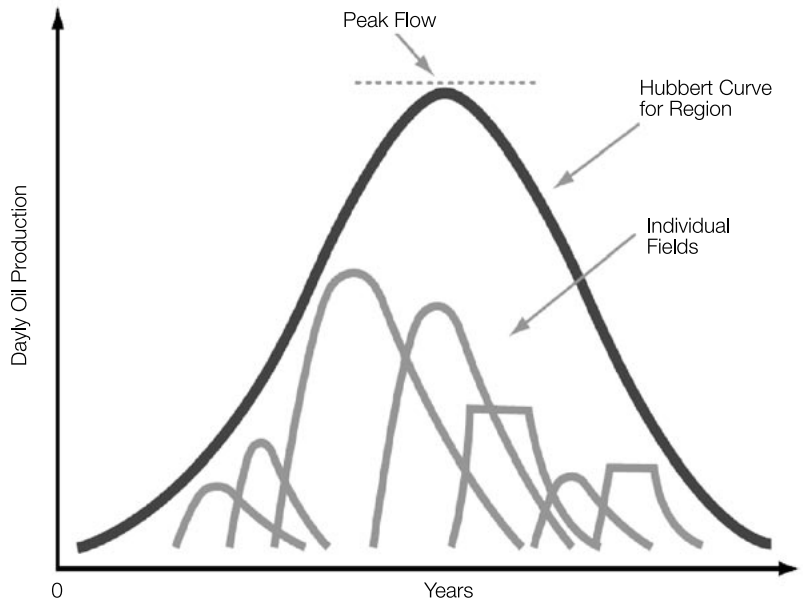
The peak oil concept originated in the work of the late geophysicist M. King Hubbert. Hubbert described how the cumulative oil production of a region roughly follows a bell curve; this is due in part to the fact that larger deposits tend to be discovered and produced first, producing a peak in regional production followed by decline as smaller wells are unable to maintain production growth (Hubbert, 1956).

The peak oil concept is useful because it helps us see past short-term supply and demand variables to the underlying physical and economic realities that determine the flow of oil over the long term. From such a perspective, oil production in a region (or the world) can be seen to proceed through three phases:

1. Money is spent to find and extract oil. The easiest-to-find oil is produced

Graphic 1

The Hubbert Curve of Oil Production[2]



Source: Hubbert (1956).

first, and the flow of oil to the market increases steadily.[2]

2. The growth of the flow of oil starts to slacken. Money is spent to find and extract oil that is less accessible and/or more difficult to produce, so as to maintain a steadily increasing flow of oil to the market to meet steadily rising demand.

3. It becomes too expensive (it is no longer cost-effective) to keep finding and adding enough of the "difficult oil" to make up for the declining "easy" oil. The total flow of oil goes into permanent decline.

Globally, we are well within the second phase described above. The consternation which peak oil seems to engender in the public sphere has to do with how soon we'll enter the third phase — that is, how soon we will pass global peak oil.

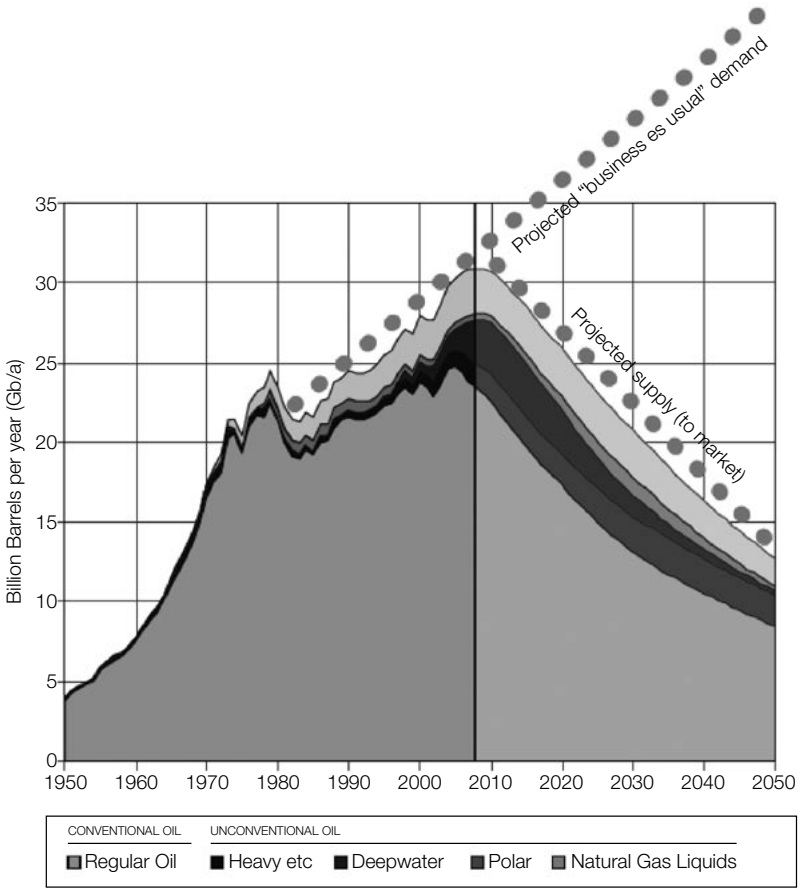
Worldwide discoveries of conventional oil peaked in the 1960s, and production of this oil is universally acknowledged to be at or near permanent decline. The global economy

[2] While the peak of oil production does not necessarily occur at the halfway point of total production, as suggested by this graphic, it generally does.

is relying on unconventional oil production to fuel future growth. However, the complexities involved in producing this "difficult" oil are such that there simply will not be enough available to replace declining conventional oil supplies while also meeting regularly-increasing global demand as quickly and as cheaply as the global economy has been accustomed to. Although estimates vary widely of the amount of unconventional oil that will eventually reach the global market, few observers now feel that total world oil

Graphic 2

History and Projection of World Conventional and Unconventional Oil Production



Source: Made by the author.

production can keep up with the rate of demand growth experienced since the 1980s.

Early this decade a small but quickly growing group of petroleum geologists, economists and other students of the peak oil concept began warning that the global peak of oil production was not decades away, as was generally assumed, but rather was looming within the next fifteen years (Hirsch, 2005). As recently as 2007, however, peak oil was still not widely discussed; mainstream observers[3] tended to regard then-historically high oil prices as an anomaly to what was otherwise expected to be a long-term trend of sub-$60 oil prices, coupled with steadily rising global economic output and global oil production.

By the end of 2008 the public discourse on global oil supplies had shifted markedly, most notably by the unprecedented dismal tenor of the International Energy Agency's annual "World Energy Outlook" report that year (IEA, 2008). The report's Executive Summary points out that nearly all future world oil production growth depends on supplies from OPEC, and ends with the unequivocal judgment that "the era of cheap oil is over," warning member nations that, "the time to act is now." Furthermore, the report noted, "Current global trends in energy supply and consumption are patently unsustainable,...the sources of oil to meet rising demand, the cost of producing it and the prices that consumers will need to pay for it…[are all now] extremely uncertain."

The massive and largely unexpected oil price swing of 2008 obviously played a role in this shift; after ranging between $50 and $75 for nearly two years, the price of oil suddenly surged past $100 in January 2008, climbed past $147 in July, and fell below $50 by the end of the year. From a more long-term perspective, this extreme price behaviour heralded a new phase for global oil flow for two main reasons: the world's increasing reliance on unconventional oil resources, and the context of a severe global economic downturn. As the price of oil falls, more of the potentially-producible unconventional oil becomes unprofitable: in late 2008 as the price of oil fell below $100, many unconventional and even refinery projects were delayed or cancelled around the world for this very reason (Reuters, 2008). This presents a problem when the economy recovers and oil demand begins to rise. Such unconventional oil projects, because they are logistically more difficult to pursue than conventional projects[4], will not immediately begin producing more oil just because prices have risen.

Meanwhile, the world continues to draw on its supply of conventional oil, discoveries of which have been in decline since the 1960s. Thus when demand for oil does returns to its historic trend and prices go up, the world will have less conventional oil available than today, and unconventional oil

[3] Before late 2007, neither the OECD's International Energy Agency nor the United States' Energy Information Administration warned of a serious run-up in prices in the foreseeable future. As late as August 2007, CNN reported it was the "consensus of analysts" that oil barrel would not exceed $100 (Hargreaves, 2007).

[4] Unconventional oil projects are incredible feats of engineering. State-of-the-art deepwater projects extract oil from below many thousands of feet of ocean and seabed, and require a small army of highly-trained engineers and geologists to operate. Some of the big deep-sea projects can take from six to nine years from discovery to regular production. The logistical (and financial) considerations of such projects are obviously magnitudes greater than what was required for mid-20th century conventional production from on-land sites in regions like Texas and Saudi Arabia.

sources won't necessarily be ready to meet the new demand. Prices will be forced upward until sufficient demand is destroyed to achieve equilibrium. Indeed, some commentators have said that global peak oil will turn out to have occurred in July 2008 at ~87 million barrels per day (mbpd) (Heinberg, 2008), for the simple reason that by the time the global economy demands more than 87 mbpd it will be prohibitively expensive to deliver that much to the market, and both demand and supply (flow) will be forced back down.

3. THE CHALLENGES CREATED BY PEAK OIL

Peak oil is an issue of concern because of the global economy's sheer dependence on oil. Its most mundane economic functions are so dependent on an uninterrupted global flow of cheap oil that merely a few weeks' disruption of that flow would cause unimaginable economic chaos. This dependence is most acutely felt in transportation. With oil accounting for over 95% of our energy use in both agriculture and transportation in the United States, for example, there are no substitute resources ready to replace oil in the quantities and in the varied functions currently required:

— Cars can be powered by electricity, but millions of petrol-powered cars cannot be replaced with electric vehicles — nor can a vast international fueling and maintenance infrastructure be completely retrofitted to serve such vehicles — in less than ten years[5].

— Trucks can be powered by biofuels, but the world cannot produce nearly enough biodiesel, ethanol and other fuels for the global truck fleet without sacrificing vast quantities of essential agricultural land.

— The world's fleet of jet engine airplanes, essential to the globalized economy, cannot as yet be flown on anything except petroleum fuel, recent experiments with biofuels notwithstanding.

Leading up to and after the peak of global oil production, oil prices will generally rise and supplies and prices are be expected to become more volatile — which of course has been the experience of the last few years. This volatility is, in many ways, a bigger problem than higher prices alone. If the world merely faced steadily rising prices, businesses and nations could make reasonable economic projections and adjust policy, budgets and plans accordingly. Instead, this energy price volatility means it is no longer possible to project with any certainty whether oil will be at $60, $125 or $200 in six months, and certainly not in six years. Herein lies a key problem: decisions about city planning and infrastructure can no longer honestly assume a steady supply of affordable fuel to power the vehicles that national and local economies depend on.

This highlights two key assumptions about oil found in most planning and policy decisions: it is assumed that oil (and the energy and products that come from it) is going be both available in the foreseeable future and affordable in the foreseeable

[5] In their report to the U.S. government on the impacts and mitigation of peak oil, Hirsch et al. noted, "Mitigation will require a minimum of a decade of intense, expensive effort, because the scale of liquid fuels is inherently extremely large."

future. Just about every building, neighborhood and highway in the industrialized world that has been planned and built in the last 60 years has been based on these two assumptions — indeed, without them it becomes nearly impossible to make any kind of meaningful plan or infrastructure investment. How might a ten-year, multi-billion dollar highway project proceed without a basis for projecting increased vehicle trips? How a ten-year, multi-billion dollar public transit project might proceed with no basis for projecting future ridership and induced economic activity?

And yet, some expectation of future energy costs is required in order to make defensible planning and policy decisions. The world after peak oil is a world of "energy uncertainty" in which neither future energy price trends nor the effects of these trends on the global economy are known. This uncertainty creates a wide variety of risks and vulnerabilities for cities. Decision-makers at all levels need to make their own determinations about the future, starting with a realistic assessment of possible local economic and social trends in an energy-scarcer world. Local decision-makers in particular should take a four-part approach to addressing energy uncertainty:

1. Identify local changes and local vulnerabilities that have been brought about by energy uncertainty, or that may arise in the future.
2. Mitigate local vulnerabilities while contributing to broader efforts that are mitigating peak oil at a global level.
3. Prepare for potential problems in the short term, such as sudden fuel shortages and price spikes.
4. Plan for long-term changes that cannot be avoided, minimizing the disruption they will cause and taking advantage of the opportunities they will offer.

Table 1

Local Impacts and Vulnerabilities, Portland (Oregon) Peak Oil Task Force

Impacts on Transportation and Land Use (T)

T1. Automobile use will decline and people will seek alternative transportation for their needs.

T2. People and businesses will relocate to be closer to each other and to transportation options; population will likely shift to city centers, and density and mixed-use development will increase.

T3. Transportation of freight will become more costly, likely leading to mode shifts from air and truck to rail and boat.

T4. Air travel may decline significantly.

T5. Maintenance of road infrastructure will be increasingly difficult because of loss of revenue and reliance on asphalt.

.../...

Table 1 (continious)

Local Impacts and Vulnerabilities, Portland (Oregon) Peak Oil Task Force

Impacts on Food and Agriculture (F)

F1. The amount and variety of food produced will decrease.
F2. Food will cost more.
F3. Low-income households are most vulnerable to higher prices and could see a decline in diet and nutrition.
F4. The kinds of foods produced and processed will shift, introducing business pressures and opportunities for food producers and processors.
F5. Households will experience increased pressure to grow process and handle their own food.
F6. Food retailing options will shift.
F7. There will be less food waste and changes in packaging.

Impacts on Business, Economy and Jobs (E)

E1. Prices will rise, and the number of business start-ups and failures will increase.
E2. Some businesses will experience significantly higher production and distribution costs; others may be more impacted by changes in demand for their products and services.
E3. Unemployment will likely increase in the short term.
E4. Impacts will vary in intensity by industry and business division.
E5. Portland's population may grow faster than forecast as a result of in-migration.

Impacts on Public and Social Services (S)

S1. Vulnerable and marginalized populations will grow and will be the first and hardest hit by peak oil.
S2. Increasing costs and decreasing incomes will reduce health coverage and further stress the health care system, a system already in crisis.
S3. Protection of public health will be at increased risk.
S4. Demand for social services will increase, but the ability to provide service will decline.
S5. Heating, maintenance and monthly housing costs will consume a larger share of household budgets and push people toward lower-quality housing choices.
S6. Demand for public school services may increase at the same time that costs of maintaining public school facilities increase.
S7. It is unclear whether demand for electricity will increase or decrease; electric loads served by natural gas-fired generation will have to be reduced or replaced by renewable energy.
S8. First responders, especially police, may become primary service providers as social services struggle to meet demand.
S9. Water, sewer and solid waste services are not expected to be affected significantly.
S10. Competitive, individualistic responses could erode community spirit and cohesion.

Source: Made by the author.

In the city of Portland, Oregon (U.S.) a government-appointed task force studied the potential impacts of peak oil and recommended strategies the city could

implement in response. The task force spent over six months researching their community's provisioning and support systems, consulting with over 80 stakeholders in the process. In its March 2007 final report, the most comprehensive assessment of its kind at the time, the task force identified 26 specific impacts and vulnerabilities. Although this list was developed specifically for the context of Portland, it gives an indication of the kinds of vulnerabilities any locality can expect to find.

4. **LOCAL RESPONSES**

Local governments have been responding to climate change — especially in Europe, but more recently throughout the United States as well — since at least the 1992 Earth Summit in Rio de Janeiro, which launched the Local Agenda 21 efforts to promote local action on sustainability. Local actions on the peak oil crisis, in contrast, have only begun fairly recently, some of the earliest in the United States and Canada.

By early 2009 more than 20 communities in North America had taken some kind of official action on peak oil (and many more have seen action among citizen grassroots groups), recognizing it as a legitimate and urgent economic problem that deserves serious attention at the local level. This is a diverse group, including communities large and small, urban and rural, conservative and liberal. Many of these communities have passed resolutions acknowledging the local challenges of peak oil. The two most substantive types of action, however, have been reports and task forces:

4.1. **Reports**

Burnaby, British Columbia (a suburb of Vancouver) was one of the first local governments to consider the local effects of peak oil. A January 2006 internal report by a transportation planner working for the city focused on the enormous challenges Burnaby faces in making its automobile-centric economy work without cheap oil. The report raised awareness about energy issues internally and has been used to provide background on certain City Council decisions, such as the promotion of cycling infrastructure and opposition to freeway widening (Ramsey, 2006). Another Canadian city, Hamilton, Ontario, solicited a report received April 2006 on the case for moving to electric transport in a post-peak oil world. The report, authored by a former Toronto City Councilor, argued that peak oil and future energy constraints were essential considerations for the city's long-term strategy, and suggested that Hamilton could return to its early-20th century streetcar roots by re-investing in electrified transportation (Gilbert, 2006).

Metro, the regional planning body of the Portland, Oregon area in the United States, also received an internal report[6] on peak oil in April 2006. This white paper identified future oil supply uncertainty as a serious risk management issue for Metro, particularly with regard to the agency's regional transportation and land use planning responsibilities. The problem was summarized in this way:

> "We increasingly face the potential for economic crisis brought about by uncertainty in our supply of oil, but we are unable to

[6] The report was prepared by the author of this article while a policy analyst at Metro.

> accurately predict in what way that supply may be threatened, and how severe that threat may be. Although the resilience of the world economic system in general — and the oil production system in particular — may sufficiently mitigate a crisis with ample time, these systems may not be able to respond in desirable ways to sudden and severe periods of instability."

Not all peak oil reports have been government initiatives. A citizen group in Willits, California (population 5,000) authored one of the first community energy vulnerability assessments in January 2005, spurring their City Council to establish an ad hoc energy committee to further consider municipal options for using alternative energy sources.

4.2. **Task forces**

Portland, Oregon was the first U.S. city to launch a task force to investigate the local ramifications of global oil decline. In May 2006, a citizen group convinced the Portland City Council to establish a peak oil task force with the following goals:

- study "current and credible" information on oil and natural gas production, as well as possible economic and social consequences of decline;
- seek community input on impacts and possible solutions;
- recommend strategies the City and its bureaus can take to mitigate the impacts of declining energy supplies;
- propose methods of educating the public so as to create behavior change and reduce fossil fuel dependence.

Twelve task force members were selected from the business, government, education and non-profit sectors (and notably including the former chief of staff to the mayor during the 1970s energy crises). The task force split into four sub-groups: Land Use and Transportation; Food and Agriculture; Public Services; and Economic Change. These sub-groups reviewed existing reports and data, and interviewed over 80 different stakeholders and issue experts. The task force's final report, released in March 2007 (Portland Peak Oil Task Force, 2007), reviewed potential impacts and vulnerabilities both for in general and for each of the four sub-group areas. It also made eleven specific recommendations to the City Council, resting on the two goals of (a) reducing Portland's exposure and (b) strengthening community cohesion:

The Portland Peak Oil Task Force has served as a model for other communities, although each effort has been organized and has functioned in ways unique to local economic, political and cultural contexts. To date, the following U.S. communities (ordered by population) have also initiated task forces or commissions:

- San Francisco (Calif.)
- Austin (Tex.)
- Oakland (Calif.)
- Alachua County (Fla.)
- Spokane (Wash.)
- Bellingham City / Whatcom County (Wash.)
- Berkeley (Calif.)
- Bloomington (Ind.)
- Westerly (R.I.)
- Brattleboro (Vt.)
- Sebastopol (Calif.)
- Franklin Town (N.Y.)
- Haines Borough (Alaska)

Table 2

Portland Peak Oil Task Force Recommendations Summary (March 2007)

1. **Reduce total oil and natural gas consumption** by 50 percent over the next 25 years.
2. **Inform citizens** about peak oil and foster community and community-based solutions.
3. **Engage business, government and community leaders** to initiate planning and policy change.
4. **Support land use patterns that reduce transportation needs**, promote walkability and provide easy access to services and transportation options.
5. **Design infrastructure to promote transportation options** and facilitate efficient movement of freight, and prevent infrastructure investments that would not be prudent given fuel shortages and higher prices.
6. **Encourage energy-efficient and renewable transportation choices**.
7. **Expand energy-efficiency programs and incentives** for all new and existing structures.
8. **Preserve farmland** and expand local food production and processing.
9. **Identify and promote sustainable business opportunities.**
10. **Redesign the [social] safety net** and protect vulnerable and marginalized populations.
11. **Prepare emergency plans** for sudden and severe shortages.

Source: Made by the author.

In early 2008, Spokane, Washington launched the first joint peak oil - climate change task force in the U.S. as part of a sustainability strategic planning effort. Also in Washington that year, the City of Bellingham and Whatcom County launched the first city-county joint peak oil task force.

Local governments in Australia and the U.K. have also initiated reports and task forces:

– The Environmental Protection Agency of the Australian state of Queensland is developing an Oil Vulnerability Mitigation Strategy and Action Plan.

– Brisbane, Australia convened what was likely the world's first joint peak oil - climate change task force in 2006. The task force's March 2007 report included 31 recommendations across eight strategy areas.

– The City of Bristol in the U.K. convened a Peak Oil Task Force in September 2008. Its final report is expected to review peak oil and its general impacts, discuss risks and opportunities, and make recommendations for action.

– In early 2009, Somerset County (in which Bristol lies) passed a resolution committing to providing support and assistance to all county towns that wish to join the Transition Towns movement, a growing international network of citizen groups preparing their communities for peak oil and climate change.

Resolutions, reports and other materials from these and other local governments around the world are available online at http://www.postcarboncities.net/peakoilactions.

5. RECOMMENDATIONS

Local responses to peak oil should work in tandem with local responses to global warming. Both challenges have the same root cause — the unbridled consumption of fossil fuels — and can largely be addressed with similar strategies. A joint approach also reinforces the urgency to act quickly: at current rates of fossil fuel consumption we will most likely pass peak oil by 2010, and according to NASA's James Hansen we seriously risk catastrophic climate change if we do not have carbon emissions well in decline by 2016.

Joint energy-climate community strategies should focus on two main goals: reducing overall consumption, and meeting basic needs more locally. In this way communities can reduce their reliance on trans-oceanic supply lines, reduce their vulnerability to rising and volatile energy prices, and reduce their contributions to global warming.

In *Post Carbon Cities: Planning for Energy and Climate Uncertainty* (Lerch, 2007) the author reviewed the experiences of North American cities that, up to that point, had taken official action on peak oil, with a focus on Portland and its groundbreaking task force. Drawing from the work of these cities, five key principles were outlined that local governments should integrate into ongoing decision-making and long-range planning for addressing both peak oil and global warming:

1. Prioritize addressing transportation and land use issues

Over the last sixty years, a significant portion of urban and suburban growth in the Western world has assumed widespread ownership of private automobiles fueled by petroleum. This has slowly created communities that have little resilience against disruptions to the global flow of oil. Peak oil must be incorporated into long-range land use and transportation planning assumptions by considering a broad range of oil price and availability scenarios.

2. Tackle private energy consumption

The vast majority of urban energy use comes from private consumption, a large part of this from heating, cooling, and lighting buildings, as well as heating water. Government agencies must use a variety of policy and investment tools to encourage serious energy conservation and efficiency by both businesses and households. In particular, local political leaders should engage the business community aggressively, challenging local business leaders to reinvent the local economy a world of petroleum prices.

3. Attack the problems piece-by-piece and from many angles

With peak oil likely occurring within the next few years (if it hasn't happened already, per the discussion above), there is no time to wait for development of new energy solutions. Timely reduction of oil consumption and carbon emissions requires multiple solutions using existing technologies and practices, because no single

solutions can alone achieve the vast reductions needed in the time available.

4. Plan for fundamental changes... and make fundamental changes happen

Elected officials, government staff, and business and community stakeholders need to be educated about the challenges of peak oil. They must also be challenged to develop and implement their own solutions. Officials and staff alike should be encouraged to show leadership by integrating peak oil and climate change considerations into their own decisions.

5. Build a sense of community

The social resilience that comes from a strong sense of community is essential for meeting the complex and unknown local challenges that will result from of peak oil and global warming. The knowledge, skills, experiences, and social capital of a strong community contribute more to a community's resilience over time than specialized infrastructure projects or government programs. Governments and other stakeholders should foster a sense of community as a way of building social and economic resilience to peak oil.

REFERENCES

GILBERT, R. (2006): "Hamilton: The Electric City". City of Hamilton, Ontario. Online at http://postcarboncities.net/node/267.

HARGREAVES, S. (2007): "Why oil won't hit $100." Cable News Network. Online at http://money.cnn.com/2007/08/07/news/economy/cheap_oil/index.htm.

HEINBERG, R. (2008): "Say Goodbye to Peak Oil." Post Carbon Institute. Online at http://postcarbon.org/say_goodbye_peak_oil.

HIRSCH, R. (2005): "Peaking of World Oil Production: Impacts, Mitigation, and Risk Management". Report for the United States Department of Energy.

HUBBERT, M.K. (1956): "Nuclear Energy and the Fossil Fuels". Drilling and Production Practice, American Petroleum Institute & Shell Development Co. Publication No. 95.

INTERNATIONAL ENERGY AGENCY (2008): World Energy Outlook 2008. Paris.

Lerch, D. (2007): Post Carbon Cities: Planning for Energy and Climate Uncertainty. Post Carbon Press. Sebastopol, California.

PORTLAND PEAK OIL TASK FORCE (2007): "Descending the Peak: Navigating the Transition from Oil and Natural Gas". City of Portland, Oregon. Online at http://postcarboncities.net/portland-potf-report.

RAMSEY (2006): "Global Peak in Oil Production: The Municipal Context". City of Burnaby, British Columbia. Online at http://postcarboncities.net/node/164.

REUTERS (2008): "FACTBOX-Financial crisis hits global oil investment". Online at http://www.reuters.com/article/marketsNews/idUSN1337075920081113.