KAIROS Research Paper

A Sustainable Energy Economy is Possible

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In July 2011, federal, provincial and territorial energy ministers called for a public debate on a national energy strategy. This invitation presents KAIROS with an opportunity to elaborate on the vision for a just and sustainable energy policy first articulated in 2007.[1] In *Re-energizing the Future: Faith and Justice in a Post-Petroleum World,* KAIROS presented ethical and theological principles as the basis for policy proposals related to energy and climate change. KAIROS' approach to the policy debate is based on our belief that we "share in God's covenanted relationship with all of Creation," with a responsibility to build life-nurturing, sustainable communities among humans and with the rest of the Earth community.[2]

Re-energizing the Future pays particular attention to the imperative to reduce greenhouse gas emissions in order to prevent disastrous climate change. Our call for a new, more sustainable energy policy addresses the particular responsibility of those who, historically, have been the heaviest users of fossil fuels to reduce their greenhouse gas emissions. This responsibility is especially important for Canadians who are among the largest per capita consumers of fossil fuels, using more than five times as much per person as the world average.

KAIROS envisions a transition away from fossil fuels towards energy efficiency, conservation and a reliance on renewable sources. We see this as vital if we are to have any hope of keeping the increase in global temperatures at less than two degrees Celsius above their pre-industrial levels. Unfortunately, the world is moving in the opposite direction. According to the latest data compiled by the Organization for Economic Cooperation and Development, carbon dioxide emissions from burning fossil fuels are on track to grow by 70% by 2050, driving global temperatures up by as much as 6 degrees Celsius by 2100.[3]

Such a drastic increase in temperature is not compatible with the continuation of life on Earth as we know it. Moreover, it violates our covenant obligation with the Creator to preserve the Earth's ecological integrity, with particular attention to vulnerable populations living in arid regions, small island states and coastal regions who are most impacted by climate change.

This report elaborates on the vision first articulated in *Re-energizing the Future.* We begin by looking at the immense potential for gains in energy efficiency and use of renewable energy at the global level. We then look at the specific challenges we face in Canada with respect to greenhouse gas emissions and the adoption of renewable energy alternatives. Next we consider how Canadians must exercise more responsible stewardship over our remaining fossil fuel reserves even as we explore the significant potential for developing renewal energy. We then examine policy options for achieving greater energy efficiency and reliance on those renewable sources. Finally, we discuss the extraordinary potential for job creation by investing in green alternatives and how Canada can finance the transition to a just and sustainable energy economy.

Part One: A Global Perspective on Energy Alternatives

Potential for efficiency gains
Increasing the efficiency with which we use energy is crucial for both economic and ecological reasons. Burning fossil fuels is a truly inefficient way of providing heat or power. A recent study shows that when gasoline is burned in an internal combustion engine, 80% of its energy content is lost as waste heat. On the other hand, electric vehicles waste only 20% of their energy. The authors of the study conclude that if fossil fuels were eliminated from the energy mix, we would need to produce only two-thirds as much energy as at present.[4]

David Suzuki notes: "Less than 10 per cent of the energy we generate is actually used for its intended purpose. Most of it goes up in smoke. Our economy is fully one-third less energy efficient than the United States and only half as efficient as most European countries."[5] Similarly, over 90% of the raw material extracted for manufacturing is wasted.[6] Recycling and reusing metal products would save substantial amounts of energy. For example, only one-third as much energy is needed to recycle aluminum as would be required to make it from bauxite.

The potential for substantial increases in energy efficiency is considerable. Dutch renewable energy consultants, Ecofys Group, estimate that investments in energy efficiency and recycling could lower global energy demand to 15% below its 2005 level by 2050, allowing for increases in population, travel, transportation and industry outputs.[7]

Greenpeace's *Energy [R]evolution* study states that industrialized countries could decrease their energy consumption by 20% over 10 years through the use of efficiency measures alone, making way for developing countries to increase their consumption by 20%.[8] For example, since 80% of the fossil fuels used in buildings are for space heating, the potential for efficiency gains through better insulation and passive solar or geothermal heating is enormous. Similarly, huge efficiency gains can be achieved by shifting freight and passenger transportation from trucks and cars to railways.

While energy efficiency is a worthwhile goal, its immediate impact is often limited by what is known as the "rebound effect." When efficiency measures translate into savings on hydro bills, people often end up using more electricity. Nevertheless, in the context of a holistic energy plan, efficiency gains remain essential, especially in the light of dwindling supplies of fossil fuels and the likelihood (some, like former bank economist Jeff Rubin, would say the inevitability) of higher energy prices.[9]

The International Energy Agency forecasts that, globally, energy efficiency is set to grow "at a rate twice as high as that seen over the last two-and-a-half decades" under current policy commitments.[10] However, the IEA cautions that this is not good enough if we are to keep global temperatures rising by less than two degrees Celsius over pre-industrial levels. Greater energy efficiency measures will be needed. "The most important contribution to reaching energy security and climate goals comes from the energy we do not consume."[11]

Conservation a must, even with growth in renewable energy

There is tremendous potential for renewable forms of energy. Wind turbines are capable of producing 5 to 15 times more electricity than world power demand. Solar power could produce 30 times more electricity than what is needed. Geothermal systems could produce thousands of times as much energy as all known oil and gas reserves.[12]

Some advocates point with enthusiasm to the rapid growth of renewable energy installations. For example, Greenpeace notes that globally, between 2004 and 2008, wind power grew by 600%, solar photovoltaic by 250% and small-scale hydro by 75%.[13] Similarly, the Intergovernmental Panel on Climate Change (IPCC) noted that 140 gigawatts (GW) of the 300 GW of electrical generation capacity added globally between 2008 and 2009 was from renewable sources.

Nevertheless, the IPCC report says that only 13% of world energy production came from renewable sources in 2008. Most of that (10% of total supply) came from burning biomass which is associated with deforestation and harmful air pollution from indoor cooking fires. The co-chair of an IPCC Working Groups put the challenge succinctly: "It is not the availability of (renewable) resources but the public policies that will either expand or constrain renewable energy development."[14]

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> Intergovernmental Panel on Climate Change 2008

The International Energy Agency reports that if annual subsidies from renewable forms of electricity generation increase five-fold to US$180 billion a year, the share of electrical power generated from renewable sources other than hydro would rise from 3% in 2009 to 15% in 2035. However, this would not be enough to offset a projected 70% increase in nuclear power generation and a 65% rise in world coal use by 2035, under current policies. More vigorous policy measures are needed to achieve a decline in coal use if we are to have any hope of containing climate change.[15]

While global projections of the potential for renewable sources of energy sound promising, they need to be tempered by a realization that their scale is still limited. Geoscientist J. David Hughes asserts that since renewable sources of primary energy, excluding biomass and hydro-electricity, constitute only 2% to 3% of global consumption, they cannot increase fast enough to meet our demand for energy.[16]

Hughes concludes that the solution must emphasize conservation above all else. Per capita energy consumption in European and Southeast Asian countries is less than half that in the United States or Canada. In addition to learning from the initiatives of countries like Germany and Denmark in the application of renewable energy, we need to imitate countries like Japan and South Korea in the development of public transit, efficient railroads and greater urban density.

PART TWO: Canada's Record on Efficiency, GHG Emissions & Renewables

The energy demand and supply projections released by the National Energy Board (NEB) late in 2011 do not bode well for a just and sustainable energy future. Over the next 25 years, they project very small improvements in energy efficiency, a substantial increase in the extraction of bitumen from the tar sands, despite their huge ecological footprint, and very modest increases in the use of renewable substitutes for fossil fuels.[17]

While Canada is making some degree of progress towards greater energy conservation and efficiency, the pace of change is much too slow given the dangers posed by climate change. The National Energy Board projects that demand for all forms of energy will grow by 1.3% every year between 2010 and 2035, only slightly below the 1.4% growth rate between 1990 and 2008.[i] The NEB attributes this declining rate of growth in demand primarily to a slowing of population and economic growth and higher energy prices.[18]

The role of efficiency gains appears to be minor as energy use per unit of Gross Domestic Product is projected to decline by only 1.1% a year between 2010 and 2035, compared to a 1.2% annual drop from 1990 to 2008. While efficiency gains are expected from new automobile and light truck emission regulations, it appears that without other policy initiatives Canadians will continue to waste vast amounts of energy compared to Europeans and Southeast Asians.

In terms of impact on climate change, the most disturbing projection in the NEB's forecast is that tar sands production and exports will triple by 2035. While the NEB consults widely with the oil industry, it is under no obligation to pay attention to Environment Canada's forecast that greenhouse gas (GHG) emissions from the tar sands will grow by 88% between 2010 and 2020.

The NEB projects a five-fold growth in wind power between 2010 and 2035, with its share of total electrical generation capacity rising from less than 2% to 6%. Over the same period it forecasts that the share of Canada's electricity generated by biomass, solar and geothermal sources combined will grow from 2% to 6% of total capacity. Thus by 2035 it forecasts that these "new renewables" will account for only 12% of total electrical generation.

While the NEB expects Canadian hydroelectric capacity to grow by 16% by 2035, its share of total electrical generation is expected to decline to 56% in 2035 (from 59% in 2010) due in part to more reliance on burning natural gas to generate electricity. The NEB predicts no significant movement away from reliance on fossil fuels towards electricity in the industrial, commercial or transportation sectors as would occur, for example, by a switch to electric vehicles.

While the trends to slower growth in demand, lower energy intensity and an increasing share for renewable power are moving in the right direction, they fall far short of the pace of change needed to contain the threat of escalating climate change.

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[i] The NEB report uses 1990 to 2008 as its historical reference period, excluding data from 2009 because the impact of the 2009 global recession on the economy and energy demand is viewed as a deviation from historical trends.

Climate disaster looms with escalating use of fossil fuels

In its *Statement on the UN Conference on Climate Change* held in Durban, South Africa in 2011, KAIROS called for Canada, along with other industrial countries, to reduce greenhouse gas (GHG) emissions from 40% to 50% below 1990 levels by 2020. This amount of emission reductions is a necessity if we are to have any hope of keeping the rise in global average temperatures under two degrees Celsius above pre-industrial levels.[19]

In the October 2011 Briefing Paper "*Is Durban the world's last, best hope to avoid climate disaster?*" KAIROS cited data from Environment Canada showing that Canada was en route to emitting 785 megatonnes (millions of metric tonnes or Mt) of carbon dioxide equivalent in 2020, twice as large as the level required to meet our 40% to 50% reduction goal.[20] More recent data from Environment Canada indicates that 2020 emissions could be lower than the 785 Mt as the rate of growth in total emissions slowed to 0.25% in 2010 over 2009. Strikingly, the Canadian Association of Petroleum Producers released data showing that emissions from the tar sands had grown by 14% that same year.[21]

Clearly significant emission reductions will have to come mostly from a decrease in the extraction and combustion of fossil fuels since these account for almost three-quarters of total Canadian GHG emissions. The Alberta tar sands are the fastest growing source of Canadian GHG emissions. Since most of the output from the tar sands is exported to the United States, at least a quarter of "Canada's" total GHG emissions have nothing to do with meeting the energy needs of Canadians.

Environment Canada projects that emissions from the extraction and upgrading of bitumen will grow from 49 Mt in 2010 to 92 Mt in 2020. NASA climate scientist James Hansen warns that unless GHG emissions from the tar sands are curtailed, we risk passing a tipping point after which runaway climate change posing a danger to life on Earth would be inevitable.[22]

Curbing exports vital to meeting climate targets

A report from the Canadian Centre for Policy Alternatives, *Peddling GHGs: What is the Carbon Footprint of Canada's Fossil Fuel Exports?,* shows how oil, gas, petroleum products and coal exported from Canada and consumed abroad were responsible for 598 Mt of GHG emissions in 2009.[23] This is equivalent to 115% of all emissions from fossil fuels used in Canada that year.

Moreover, the emissions associated with extracting and processing these fossil fuels prior to their export accounted for just under one-quarter of all emissions within Canada in 2009. Had we kept those exported fossil fuels in the ground and avoided the emissions associated with their extraction, we would have been two-fifths of the way towards meeting our GHG reduction target of keeping emissions 40% to 50% below their 1990 levels.

The CCPA report exposes the incompatibility between the continued exploitation of Canada's remaining hydrocarbon reserves and the goal of containing global climate change. The report compares the carbon content of Canada's remaining fossil fuel reserves with estimates of "the global carbon budget." This "budget" calculates the amount of carbon dioxide equivalent that could be released into the atmosphere worldwide between 2010 and 2050 while still having a 25% chance of keeping the rise in global temperatures below 2^{0} Celsius. It states: “Canada’s confirmed fossil fuel reserves are ... equivalent to one-eighth of the world’s remaining carbon budget [while burning all of Canada’s] probable reserves would take a quarter of the remaining carbon budget. Putting this carbon into the atmosphere would represent a climate catastrophe.”[24]

The CCPA report warns of the dangers of making the tar sands’ already too large carbon footprint even larger by building new export-oriented pipelines. Although President Barack Obama has denied a permit for the Keystone XL pipeline to be built from Alberta to the Cushing, Oklahoma, distribution hub, TransCanada Corporation has submitted a new design purporting to bypass the ecologically sensitive Sand Hills area of Nebraska.

If the revised Keystone XL route is approved, it would increase export capacity by 510,000 barrels a day. Operating at capacity, this would add the equivalent of 80 Mt of carbon dioxide to the atmosphere each year. If the proposed Northern Gateway pipeline from near Edmonton to Kitimat, B.C., were to operate at its capacity of 525,000 barrels a day of diluted bitumen, it would add a comparable amount of GHG emissions to the atmosphere.

Currently, total tar sands production capacity amounts to 1.9 million barrels a day (bbl/d). Approvals have already been granted for projects with an additional capacity of 1.8 million bbl/day, for a total of 3.7 million bbl/d. Current pipeline capacity for transporting bitumen from the tar sands amounts to 3.8 million bbl/d. Thus the construction of any new export pipelines, whether Keystone XL, Northern Gateway or other projects such as expansion of the Trans Mountain line from Edmonton to Burnaby, B.C., would prepare the way for the approval of new tar sands projects and an even larger ecological footprint. KAIROS policy on the tar sands and energy calls for no further approvals of new tar sands projects both for ecological reasons and in support of the rights of the First Nations who would be directly affected.[25]

PART THREE: Managing our Remaining Fossil Fuels Wisely

Energy security for Canadians
Given the slow progress on energy efficiency improvements, the imperative to address GHG emissions from fossil fuels extracted and consumed in Canada, and the time it will take to develop adequate renewable substitutes, it is crucial that we give priority to conservation measures. At the same time we must exercise careful stewardship over our remaining conventional hydrocarbon reserves because, like it or not, we will need them while we make the transition to reliance on low-carbon alternatives.

Canada's reserves of conventional oil have been in decline since 1973 when production peaked at around two million barrels a day.[26] Eighty-six percent of all the conventional oil discovered to date in Canada has already been consumed. The 3.8 billion barrels of remaining reserves of conventional oil would last only eight years if consumed at their 2010 rate of production. When the National Energy Board was formed in 1959 the federal government adopted a "Canada first" policy requiring that there be 25 years worth of proven supply available for domestic use before exports would be allowed. However, the Mulroney government first reduced the 25-year rule to 15 years before effectively eliminating it.

The NEB is not troubled by the decline in conventional reserves as it expects synthetic oil from the tar sands to replace conventional supplies. Moreover it anticipates "an increase in oil-directed drilling and the application of multi-stage hydraulic fracturing in tight oil plays [to result] in growing production in the near term."[27] As described in our Briefing Paper *Coal and Shale Gas Obstacles to Climate Justice*, hydraulic fracturing, or "fracking," involving blasting water, sand and a variety of chemicals underground to break open fissures in rock formations. This process carries grave ecological risks ranging from the pollution of aquifers to earthquakes linked to the injection of wastewater produced during fracking back into the ground in order to dispose of it.

Conservation measures are all the more important given that conventional oil production at its 2010 level of 1.5 million bbl/d is no longer sufficient to cover domestic demand, which reached 1.8 million bbl/d that same year. Even now, Canadians living in Quebec and the Atlantic provinces have to rely on imports for 84% of their oil needs.[28] At the same time, some of the conventional oil produced in western Canada and offshore from Newfoundland is exported. Residents of these Eastern provinces are thus extremely vulnerable in case of an oil supply disruption caused, for example, by a conflict in the Middle East. In fact Eastern Canada is more vulnerable than the United States which relied on imports for 56% of its supplies over the first decade of this century.[29]

In 2010 Canada imported 0.8 million bbl/d, representing almost half of the total Canadian consumption. The share of our imports coming from Norway and the United Kingdom declined from 58% in 2000 to 22% in 2010 as North Sea oil fields are being depleted. Canada has become more dependent on imports from less stable and conflict-prone countries including Algeria, Nigeria, Saudi Arabia, Angola and Iraq.

As Gordon Laxer, political economist at the University of Alberta's Parkland Institute, argues in *Freezing in the Dark*, in the near term Canada should establish a Strategic Petroleum Reserve to store a supply of oil that could be drawn down in the event of an emergency.[30] Moreover, Eastern Canadians' dependency on insecure imports could be cut in half by two measures.

First, the Enbridge pipeline from Sarnia to Montreal, with a capacity of 240,000 bbl/d, could carry Western Canadian conventional oil to refineries in Quebec. In fact, when the pipeline was originally built in the 1970s, that was its function. Later Enbridge reversed its flow to carry imported oil westward from Montreal to Sarnia. As a further irony, Enbridge's Trailbreaker project would reverse the line once again, but not primarily to supply Quebec and enhance Canadian energy security. Rather it would be used to ship tar sands crude through Montreal to Maine for export by ship to refineries in the eastern U.S. or in the Gulf of Mexico.

Secondly, if all the crude oil produced offshore in Newfoundland were consumed in Canada rather than exported, another 150,000 bbl/d could be made available to improve Canadian self-sufficiency. These two measures would cut in half Canadian dependence on offshore supplies.

NAFTA: Major obstacle to a sustainable energy strategy

Provisions of the North American Free Trade Agreement constitute a major barrier to government policy initiatives to conserve dwindling supplies of conventional fuels or reduce petroleum exports. If the Canadian government were to require Enbridge to reverse its Sarnia to Montreal pipeline in order to divert exported conventional crude to serve Quebec markets, the U.S. could invoke NAFTA Article 605. The same is true should the government wish to redirect exports from Newfoundland to domestic rather than U.S. markets. Under Article 605, Canada would be obliged to make available to U.S. importers the same proportion of total oil supply as was exported to the United States over the previous three years.

In our 2008 study *Over a Barrel: Exiting from NAFTA's Proportionality Clause*, co-authored with Gordon Laxer, we explored what invocating the proportional sharing clause might entail.[31] Using the most recent data available at the time (for the years 2004-2006), we calculated that had Article 605 been invoked in 2007, Canada would have been obliged to make 47.5% of its oil supply available to the United States. As new data became available we recalculated the export obligation and found that it rose at a rate of about one percentage point each year. According to the latest data available for 2008-2010, Canada would be obliged to make 52.3% of its oil supply available to the U.S. if Article 605 were invoked.

In our study we examined several scenarios to find out whether invocating proportional sharing might lead to oil shortages in Canada. For example, we studied the consequences of reducing oil production by 10% for conservation purposes as suggested by the David Suzuki Foundation in *Sustainability within a Generation*.[32] Applying this measure in 2007 would have led to a modest domestic shortfall of eight million barrels or one and a half days of domestic demand. However, when we recalculated the consequences for 2010, we found that the domestic shortfall would be much higher at 46 million barrels or 26 days of Canadian needs.

If, as a conservation measure, Canada had decided on a 10% drop in production in natural gas in 2010, the application of the NAFTA proportional sharing clause would have resulted in Canadians facing a shortfall of 289 billion cubic feet of natural gas over a year's time, equivalent to 28 days of domestic consumption.[33]

Another clause in NAFTA that constitutes a barrier to a just and sustainable energy policy in Canada is Article 604 which prohibits export taxes on energy or petrochemical goods. Export taxes on scarce and dwindling supplies of non-renewable resources would serve a dual purpose. On the one hand they would raise revenues for investing in conservation and renewable alternatives. They could also act as an incentive for importing nations to reduce their reliance on fossil fuels.

Taken together, NAFTA Articles 604 and 605 constitute significant obstacles to policy measures aimed at energy conservation or redirecting exported crude to serve import-dependent Eastern provinces. In 2006, in response to these and other challenges to social justice and ecological sustainability, KAIROS called for the removal of Articles 604 and 605 from NAFTA in order to "allow Canada to put taxes and quotas on exports of non-renewable natural resources and free Canada from the obligation to continue exporting petroleum and natural gas to the U.S. even if such exports cause domestic shortages."[34]

The provisions of the investor-state mechanism in NAFTA's Chapter 11 on investment constitute an additional obstacle. These provisions allow U.S. (or Mexican) corporations investing in Canada to launch suits in the event they deem government policies violate their rights under the Agreement. Petroleum companies have already taken advantage of these provisions to interfere in Canadian energy policy. For example, Exxon Mobil and Murphy Oil launched identical suits seeking millions of dollars in damages after Newfoundland required them to invest a small portion of their revenues from offshore petroleum extraction on research and development.

An energy superpower?

Prime Minister Stephen Harper insists that Canada is "an energy superpower" with "an ocean of oil-soaked sand" under the boreal forest of Northern Alberta.[35] His claim that Canadian oil reserves are the second largest in the world (after Saudi Arabia) is based on the assumption that another 169 billion barrels of oil can be extracted from the tar sands as easily and efficiently as the 7.5 billion barrels already extracted. There are reasons, however, to doubt this assumption.

Most of the 26 billion barrels of tar sands reserves under active development are being extracted through surface mining. The minable areas under active development contain 22.9 billion barrels of reserves while another 3.1 billion barrels are located deeper underground where bitumen is extracted through *in situ* operations, mostly through Steam Assisted Gravity Drainage. SAGD involves the injection of steam deep underground to melt the bitumen allowing it to flow. Since remaining minable areas contain only 11 billion barrels, the vast majority of the 143 billion barrels of tar sands reserves that are not yet licensed for development can only be extracted by *in situ* methods.

Geoscientist J. David Hughes points to a crucial difference between mining operations and the extraction of bitumen through SAGD. The latter technique is much less efficient than mining in terms of its EROEI (Energy Return on Energy Invested). EROEI measures the amount of energy that must be expended in order to obtain another unit of useful energy. As Hughes puts it, “It costs energy to get energy, and the whole point is to get back more than you put in.”[36] For example, for conventional oil, the average EROEI is 20 to 1, meaning that 20 units of useful energy are extracted for every unit expended in the process. The giant Gahawar oil field in Saudi Arabia has an exceptional EROEI said to be greater than 100 to one.

Table 1: Energy Return on Energy Invested and Costs for Electricity Generation

	EROEI	**Cents/kWh**
Hydro	11:1 to 267:1	1
Coal	50:1	2 to 4
Natural Gas	10:1	4 to 7
Wind	18:1	4.5 to 10
Wave	15:1	12
Solar Photovoltaic	3.75:1 to 10:1	21 to 83
Geothermal	2:1 to 13:1	10
Tidal	6:1	10
Conventional Oil	19:1	
Tar Sands mining	5.7:1	
Tar Sands in situ	3.8:1	
Oil Shale	1.5:1 to 4:1	
Biodiesel	1.9:1 to 9:1	
Ethanol	0.5:1 to 8:1	

Source: Heinberg, Richard. *Searching for a Miracle*. Post Carbon Institute. 2009. Tables 1A, 2 and 3. And Hughes, J. David. *The Northern Gateway Pipeline*. Global Sustainability Research Inc. 2011. p.14.

At the other end of the scale, as shown in Table 1, the EROEI on ethanol produced from corn in North America is, by some estimates, actually negative. As explained in our briefing paper *Are Agrofuels Alternatives to Oil*?, more energy is expended in farming corn, transporting it and distilling it than is contained in each litre of ethanol produced. On the other hand ethanol produced from sugarcane in Brazil still has a positive ratio of around eight to one.

For tar sands mines, Hughes estimates the EROEI at 5.7 to 1. For current *in situ* operations, the ratio falls to 3.8 to 1. The ratio for *in situ* extraction is lower because steam-assisted gravity drainage (SAGD) requires burning about one thousand cubic feet of natural gas to produce enough steam to extract each barrel of bitumen from underground. Mining operations use only about half as much natural gas to separate the bitumen from sand and clay. Both kinds of operations require another 0.5 thousand cubic feet of gas to upgrade each barrel of bitumen into synthetic crude by injecting hydrogen derived from natural gas.

What makes the future of tar sands operations problematic is that the EROEI for *in situ* extraction is falling. Since the shallower reserves were developed first, SAGD probes must go deeper and deeper underground to reach bitumen deposits.[37] Alberta author Andrew Nikiforuk has uncovered evidence that SAGD may be reaching its limits of viability: "A detailed energy balance analysis sponsored by the Alberta government for SAGD suggests that its [EROEI] is close to 1:1. That makes bitumen as a source of energy as pathetic and tragic as corn ethanol. A few SAGD projects have even recorded [EROEI] in negative numbers."[38]

Nikiforuk then adds "[M]any energy experts regard the use of natural gas for bitumen production as folly."[39] Yet this wasteful use of natural gas is actually subsidized by the Alberta government. Tar sands operators can deduct part of the cost of the natural gas they use to extract and upgrade bitumen from the royalties they owe to the province as well as from their provincial and federal corporate taxes. In 2010, these deductions cut their costs for natural gas in half.[40]

Shale gas boom shaking up markets (as well as the ground)

The boom in the extraction of shale gas through hydraulic fracturing or "fracking" in the United States is having repercussions in Canada. Exports of natural gas from Canada to the U.S. fell by 16% between 2007 and 2010, while imports from the U.S. rose by 67%. While Canada is still a net exporter, this may soon change.

The U.S. Energy Information Administration (EIA) has doubled its 2010 estimate of how much natural gas could be extracted from its shale formations to 862 trillion cubic feet (Tcf) as of 2011.[41] The EIA expects that shale gas will account for 46% of U.S. supply by 2035, while its dependence on imports will fall from 11% in 2009 to just 1% in 2035. The price of natural gas in the U.S. fell from about US$15 per million BTUs in 2005 to below US$2 million in 2012. The chief economist for the International Energy Agency, Dr. Fatih Birol, estimates that the shale gas boom in the U.S. has caused a 50% decline in investment in renewable energy.[42]

In his January 24, 2012, State of the Union Address, President Obama pledged his support for the "safe and responsible development of the near 100-year supply of natural gas."[43] Anxious to counter attacks from Republicans over his denial of a permit for the Keystone XL pipeline, the president said shale gas development would support over 600,000 jobs by the end of the decade. He also pledged to subsidize the conversion of truck engines to run on natural gas.

Although Democratic members of Congress had uncovered information that 29 substances used in fracking operations are known carcinogens or other toxic chemicals, President Obama promised only "common sense new rules to require the disclosure of the chemicals used in fracking operations on public lands."

Nearly 1,000 cases of water contamination have been reported near fracking sites in the U.S.[44] The U.S. Environmental Protection Agency has found evidence of toxic and cancer-causing chemicals in both shallow wells and deep groundwater near fracking sites in Wyoming.[45] Fracking is also known to release naturally occurring, but highly carcinogenic, radon gas from shale rock.[46]

Fracking uses an enormous amount of water. Each well in various U.S. shale gas plays uses from 8.7 million to 14.3 million litres.[47] In addition, some 200,000 litres of chemicals are injected into each well. Despite this, President Obama has not promised to seek amendments to provisions of President George W. Bush's 2005 Energy Policy Act exempting fracking operations from the U.S. Clean Water Act.

Neither did the president support the Fracturing Responsibility and Awareness of Chemicals Act (FRAC Act) introduced into the House of Representatives by Democratic members of Congress. The FRAC Act would amend the Safe Drinking Water Act to repeal an exemption allowing the underground injection of fluids by hydraulic fracturing operations.

James Northrup, a retired manager for Atlantic Richfield, the seventh largest oil company in the U.S., addressing a 2011 public hearing in New York, cited an industry study showing that 25% of fracked wells leak after five years and 40% after eight years. "Everybody in the industry knows that gas drilling pollutes ground water," he said. "It's not ... whether they leak. It's how much."[48]

Earthquakes associated with the reinjection of fracturing fluids underground have been reported in Ohio, Arkansas, Oklahoma and Texas as well as in Britain.[49] According to the *New York Times*, in 2006 at a fracking site in Indonesia, "The eruption of a mud volcano … killed at least 13 people, and displaced more than 30,000 residents."[50]

One of the most contentious issues is evidence of large methane releases into the atmosphere from shale gas wells. Studies by Professor Robert Howarth of Cornell University have found that methane emissions from shale gas fracking are 1.3 to 2.1 times larger than methane emissions from conventional gas wells. He has found that as much as 8% of the methane, a greenhouse gas 25 times more potent than carbon dioxide, contained in shale gas wells is escaping into the atmosphere. Howarth calculates that the greenhouse gas emissions from shale gas are 1.2 to 2.1 times greater than emissions from conventional gas wells over a 20-year time frame and comparable to coal over 100 years.[51]

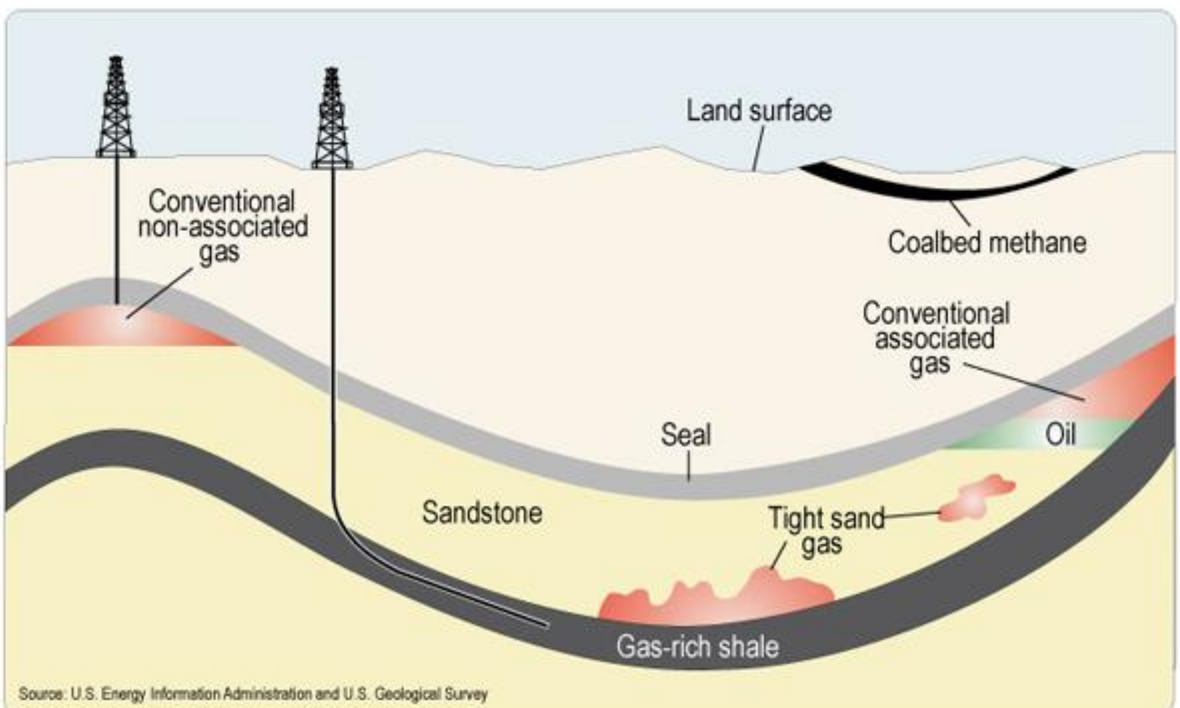
Some critics have attempted to discredit Howarth's work on the grounds that he emphasizes short-term time frames. One of those critics, Dr. Michael Levi, from the U.S. Council on Foreign Relations Program on Energy Security and Climate Change, concedes that there are grounds for looking particularly at short-term impacts given the urgency of avoiding near-term tipping points where GHG emission could make climate change irreversible.[52]

Unconventional fuels

What is popularly referred to as "**shale oil**" might be better termed "**tight oil**" as it refers to oil trapped in tiny cracks in various kinds of rock including limestone shale in Colorado estimated to contain 1.5 billion barrels of oil.

Oil shale refers to a fine-grained sedimentary rock containing kerogen, a type of insoluble organic matter that can yield oil when heated in the absence of oxygen. Kerogen is found in marlstone rock and known as an "undercooked" precursor to bitumen and crude oil. It is estimated that there are 2.8 to 3.3 trillion barrels of kerogen worldwide of which 62% are located in the United States.

Shell Oil corporation is testing the feasibility of extracting crude from kerogen though an *in situ* process where the rock is heated causing underground water to turn into steam that 'micro-fractures' the formation.[53] The National Petroleum Council, an industry advisory group reporting to the U.S. Energy Secretary, does not expect substantial supplies from oil shale to become available in the near future. It says that production might amount to 250,000 barrels a day by 2035 although its ultimate potential is more than twice as large as that of the Alberta tar sands.[54]



Bitumen is a heavy, viscous hydrocarbon found mixed in with sand and clay that must be upgraded through infusions of hydrogen before it can be refined into products like gasoline.

There are an estimated 1.8 trillion barrels of bitumen underground in Northern Alberta, of which 7.5 billion barrels have already been extracted. Another 169 billion barrels could be produced using current technologies. With technological breakthroughs, it is estimated that a further 145 billion barrels might be added to reserves.

Shale gas is found in fine-grained, sedimentary rocks such as shale or mudstone. The Energy Information Administration (EIA) estimates U.S. reserves at 862 trillion cubic feet (Tcf). The Canadian Society for Unconventional Resources (CSUR) estimates Canadian reserves at 128 to 343 Tcf.

Tight gas is extracted from sandstone or limestone rocks with very low permeability. The CSUR says Canadian reserves may be between 215 and 476 Tcf.

Coalbed methane is, as the name suggests, found in coal seams. The CSUR estimates reserves at 34 to 129 Tcf.

Natural gas in Canada

At the end of 2009, the NEB estimates total remaining, marketable conventional natural gas reserves at 346 trillion cubic feet (Tcf). The NEB says that exploiting tight gas, shale gas and coalbed methane might raise total reserves to 664 Tcf but cautions that this number is tentative given a lack of publicly available assessments.

An industry-sponsored group, the Canadian Society for Unconventional Resources (formerly called the Canadian Society for Unconventional Gas) is more bullish in its estimates saying that total marketable gas resources are between 733 and 1,304 Tcf.[55] While their estimate of remaining conventional gas (357 Tcf) is only slightly higher than that of the NEB, their estimates of the potential for tight gas (215 to 476 Tcf) and shale gas (128 to 343 Tcf) are much more ambitious than those of the NEB.

Citizen groups in Quebec, New Brunswick and British Columbia continue to call either for moratoria or banning of shale gas exploration. Calls for a moratorium in Quebec increased after the provincial Ministry of Natural Resources found gas leaks at 19 out of 31 shale gas wells it inspected. When the *Réseau oecuménique Justice et Paix* (ROJeP) called for a complete halt to fracking in Quebec, it pointed not only to the hazards posed by toxic chemical leaks but also to the disruption of agriculture and delays in the development of renewable energy.[56]

Similarly, independent members of the B.C. legislature and citizens in the Peace River region have demanded a public enquiry before shale gas fracking is allowed to proceed. A national poll conducted by Environics Research for the Council of Canadians early in 2012 found that 62% of

Canadians support a moratorium on fracking for natural gas until all environmental reviews are complete.[57]

Companies engaged in shale gas extraction in Canada want to avoid more stringent government regulations by adopting a set of voluntary guidelines concerning issues of water contamination. The Canadian Association of Petroleum Producers is calling for its members to adhere to a code of voluntary disclosure of the chemicals they use, water well testing, handling of fracking fluids, water recycling and risk management plans.[58]

Coal in Canada

The NEB projects that Canada has sufficient coal reserves to last for 100 years at current rates of extraction. Some 88% of the coal produced in Canada is used to generate electricity, while the remainder is metallurgical coal used by the steel industry. The NEB projects that overall Canadian demand for coal will decrease from 58.4 megatonnes (Mt) in 2008 to 37.2 Mt in 2035. This decline is largely due to the retirement of thermal power plants. Ontario plans to phase out its coal-fired plants by 2014 and Nova Scotia intends to decrease its reliance on coal from 75% currently to 40% by 2020.

While this decrease in coal use in these two provinces is good news, it is not being matched by Alberta and Saskatchewan, two provinces that rely heavily on coal for power generation. When federal Environment Minister Peter Kent introduced draft GHG emission reduction regulations in August 2011, they were widely criticized as too weak. An analysis by the David Suzuki Foundation concluded that the regulations would reduce GHG emission by only 10 Mt between 2015 and 2025 rather than the 15 Mt reduction claimed by Environment Canada. Even if the larger reduction target were achieved, it would amount to only 2% of total Canadian emissions.

In January 2012, Ottawa offered the provinces an opportunity to implement their own regulations if they are deemed to be “equivalent” to the federal standards. Ontario’s Environment Minister and analysts from civil society have raised concerns that other provinces will implement less stringent measures than would be the case under the federal requirements.[59]

While the NEB’s projection of weakening demand for thermal coal use across Canada reflects a movement in the right direction, it is counterbalanced by a forecast that total Canadian coal production is expected to increase from 67.8 Mt to 94.7 Mt over the years 2008 to 2035. This increase would result from expanded exports of metallurgical coal, largely to Asian markets. The NEB projects coal exports will grow from 26.5 Mt in 2008 to 40.3 Mt in 2016. It also acknowledges that overseas markets for metallurgical coal may contract if Asian countries switch to other sources of energy.

The prospect of expanded coal production is disconcerting in light of James Hansen’s assertion that “coal emissions must be phased out as rapidly as possible or global climate disasters will be a dead certainty.”[60]

North American projections ignore Canadian sovereignty

As discussed above, the U.S. market for natural gas from Canada is already contracting. The application of fracking technology to conventional oil fields may also soon affect markets for synthetic fuels from the tar sands. In a typical oil field, 50-70% of the petroleum in place remains underground after initial primary extraction. As fracking technologies are used to extract more of this oil, conventional oil producers will benefit to the detriment of tar sands operators.

According to the U.S. Geological Survey (USGS), fracking technologies applied to the tight oil play in the Bakken Oil Formation in North Dakota, South Dakota and Montana have resulted in a 25-fold increase in the amount of technically recoverable oil from that field.[61] The USGS estimates the recoverable oil from the Bakken field at 3 to 4.3 billion barrels. Other accounts place the potential much higher.[62] Similarly, if a commercially viable process were to be developed to extract petroleum from oil shale, more oil might eventually be recoverable from deposits in Colorado, Utah and Wyoming than are recoverable from the tar sands.

A report prepared for the U.S. Energy Secretary by the National Petroleum Council, representing the most powerful oil and gas companies in the United States and Canada, outlines a variety of scenarios for North American production up to the year 2035. What is striking about the report is its near total disregard for the Canada-U.S. border as it frequently melds together production estimates from the two countries (while excluding Mexico) without distinguishing sovereign jurisdictions. The range of estimates the report gives for future production of gas and oil are very wide, as they depend on multiple regulatory decisions such as the approval of pipeline projects and permits for the use of hydraulic fracturing.

The National Petroleum Council says that onshore natural gas production in Canada and the U.S. could either grow from 24 trillion cubic feet (Tcf) in 2010 to 36 Tcf in 2035 or decline to around 18 Tcf "depending on regulatory, access or technology restrictions."[63] What this means in practice is that if fracking technologies are allowed to be widely employed, the industry expects to increase gas production by 50% over 25 years. But if fracking is restricted, production could fall by 25%.

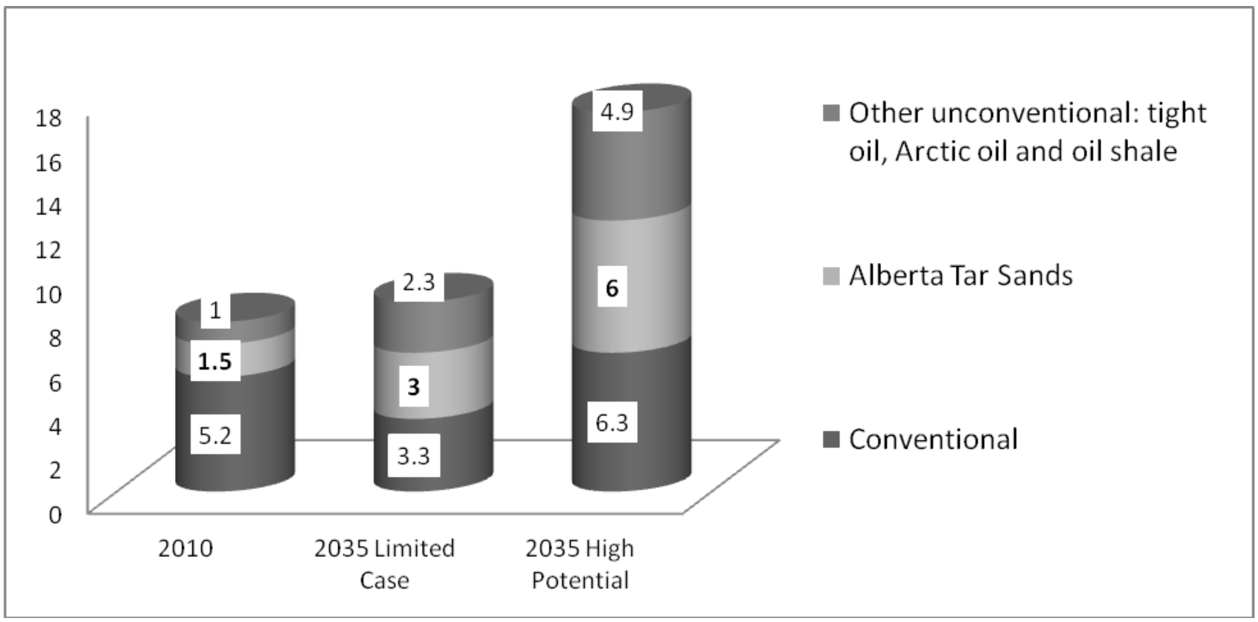
The National Petroleum Council's estimates for oil are equally wide ranging. It says that conventional oil production in Canada and the U.S., which was 5.2 million barrels a day (mb/d) in 2010, could either fall to 3.3 mb/d or increase to 6.3 mb/d in 2035. It would depend on whether offshore drilling is allowed and on the availability of carbon dioxide for injection into wells for enhanced oil recovery. The latter contingency appears to depend on whether carbon capture and storage is adopted as a measure to contain CO_2 emissions.[64]

The Council's projections for non-conventional oil are also wide-ranging, i.e., 2010 production of 2.5 mb/d could grow to between 5.3 mb/d and 10.9 mb/d by 2035. Most of the anticipated growth would come from increasing extraction of bitumen from the Alberta tar sands from 1.5

mb/d in 2010 to between 3 and 6 mb/d in 2035. Tripling of production to 4.5 mb/d is thought to be the most likely scenario.

In an uncharacteristic recognition of national sovereignty, the Council says that output growth to 4.5 mb/d assumes that the "Canada/U.S. free-trade relationship remains." It also acknowledges that oil prices have to remain high enough to justify new investments in the tar sands, that "sufficient pipeline capacity in built" and that "public acceptance of oil sands development is maintained by continual environmental performance improvements."[65] The report goes on to say that if "governments implement stronger clean energy policies" tar sands production in 2035 is likely to be just 3 mb/d.

Scenarios for North American Oil Production
Millions of Barrels a Day



Source: National Petroleum Council. *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources.* 2011.

These scenarios from the National Petroleum Council show how the oil and gas industry in North America anticipates both a possible revival of conventional oil and expanded production from unconventional sources. While the Council's aggregate data treats North America as a seamless whole, downplaying national jurisdictions, our call for a just and sustainable energy future requires that Canadian federal, provincial, local and First Nation governments assert jurisdiction over resource development within their territories. In the case of unconventional natural gas, some jurisdictions, including Quebec and Nova Scotia, have placed moratoria on hydraulic fracturing pending reviews of its safety.

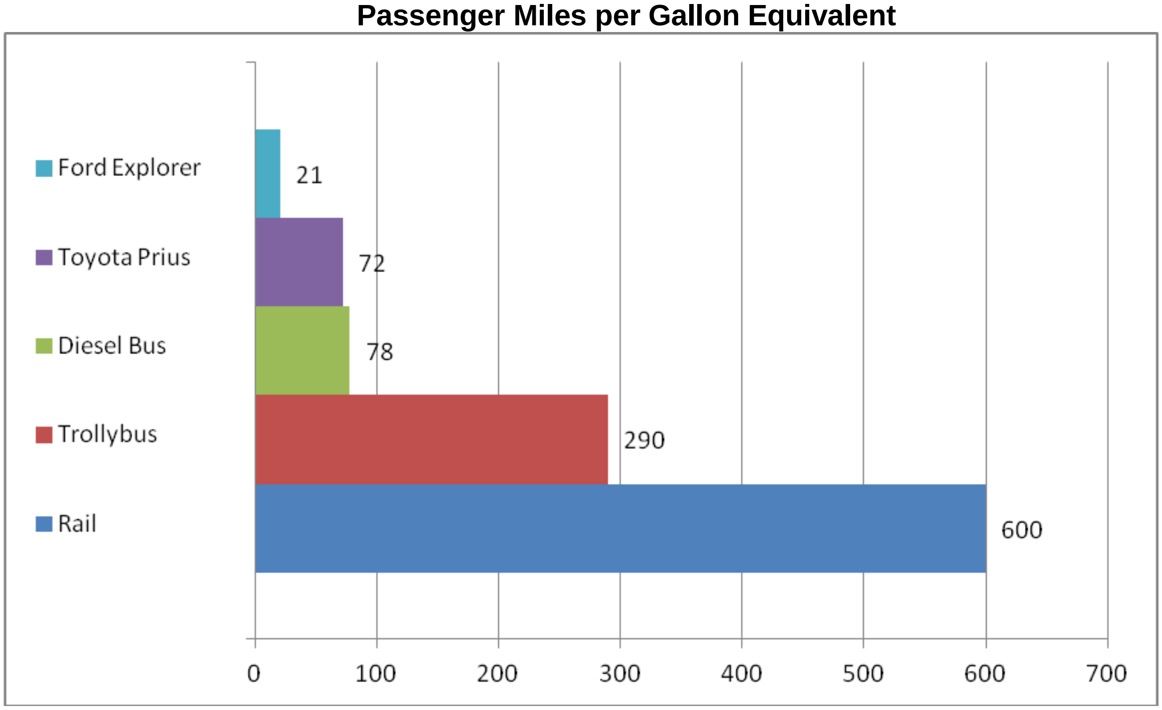
Part Four: Policy Options for Advancing Conservation & Renewable Energy

KAIROS is a member of the Green Economy Network (GEN) along with 23 labour, environmental and community organizations. This network of civil society organizations has issued a three-part platform for putting Canada on the road to a just and sustainable energy policy. Two of the three policy areas advocated by the GEN emphasize conservation measures.

Transportation systems
The transportation sector is responsible for almost one-quarter of Canadian GHG emissions. Fossil fuels used for transportation can be saved through improvements to public transit and city planning to reduce urban sprawl, installing walkways and delineating bicycle paths. Cities with high densities favourable to public transit use four to seven times less energy for transportation than cities with low densities.[66] One of the best measures would involve moving more merchandise and passengers by rail instead of roads.

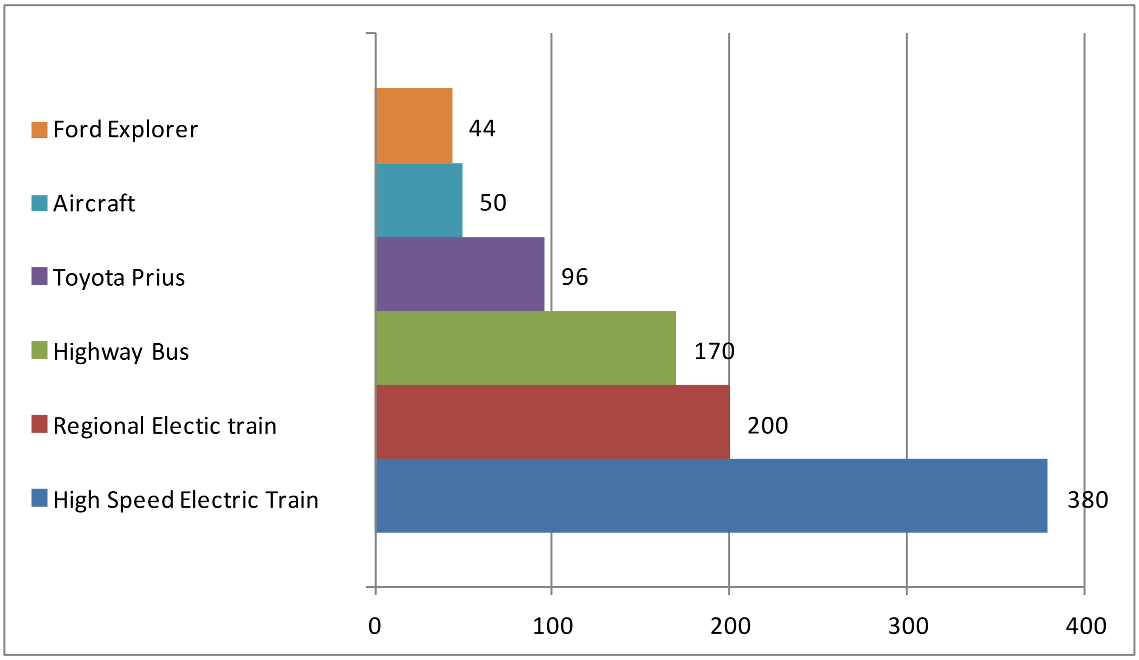
The Green Energy Network's plan calls for improving public transit within urban centres and introducing high-speed rail service between cities. GEN is calling for federal, provincial and municipal co-operation to invest $55 billion in public transit over five years, generating 211,599 jobs annually. Investing an additional $25.7 billion in inter-city high speed rail would create 101,647 jobs a year over five years.[67] The following graphs illustrate the relative efficiency of various transportation modes for urban and long distance travel.

Typical Efficiency in Urban Transportation
Passenger Miles per Gallon Equivalent



Typical efficiency assumes 1.5 persons per automobile; 25 passengers per diesel bus and 30 passengers per New Flyer Trollybus operating in Vancouver; and average passenger load for subways.

Typical Efficiency in Long-Distance Transportation
Passenger Miles per Gallon Equivalent



Source: www.strickland.ca/efficiency.html Estimates assume 1.5 passengers per vehicle in case of autos.

Conservation in residential and commercial buildings

There is an enormous scope for improving the energy efficiency of Canadian homes and buildings by improving insulation, sealing leaks, installing energy efficient windows and per-room temperature controls. Deciduous trees can provide summer shade to reduce the demand for air conditioning while allowing the winter sun to shine on buildings. Passive solar systems can capture sunlight to heat or cool buildings.

GEN's Green Homes platform has three components. First, the retrofitting of two-fifths of Canadian homes by 2020 to achieve an average 30% energy saving per home. Second, the upgrading of 150,000 low-income homes by 2015 to reduce their energy bills by 30% on average. Third, increase the energy efficiency of new homes by 2% per year until 2020. After that year, all new homes would be built to net zero energy standards, meaning that they would produce more energy than they would consume.

Similarly, GEN's Green Building platform calls for improving the energy efficiency of industrial, commercial, business and public buildings by 50% over 10 years and requiring all new buildings to be net zero after 2020. Investing $50 billion over 10 years in retrofitting Canadian homes and buildings would generate 988,800 jobs over a decade and reduce Canada's greenhouse gas emissions by 10 million tonnes a year by 2020. If all the green buildings targets were met, the GHG reductions would amount to 33 million tonnes a year by 2030.[68]

Co-operation among federal, provincial, municipal and First Nation governments would be needed to implement innovative financing arrangements and inclusion of energy efficiency measures in building codes. Unfortunately, the federal government took a step backward in January 2012 when it announced that it would stop accepting applications for funding under the popular eco-ENERGY home retrofit program two months before the program was due to end. Workers in the home retrofit sector estimate that, at the time of this announcement, the government had paid out less than half of the $400 million promised in the 2011 federal budget.[69]

Investing in renewable energy

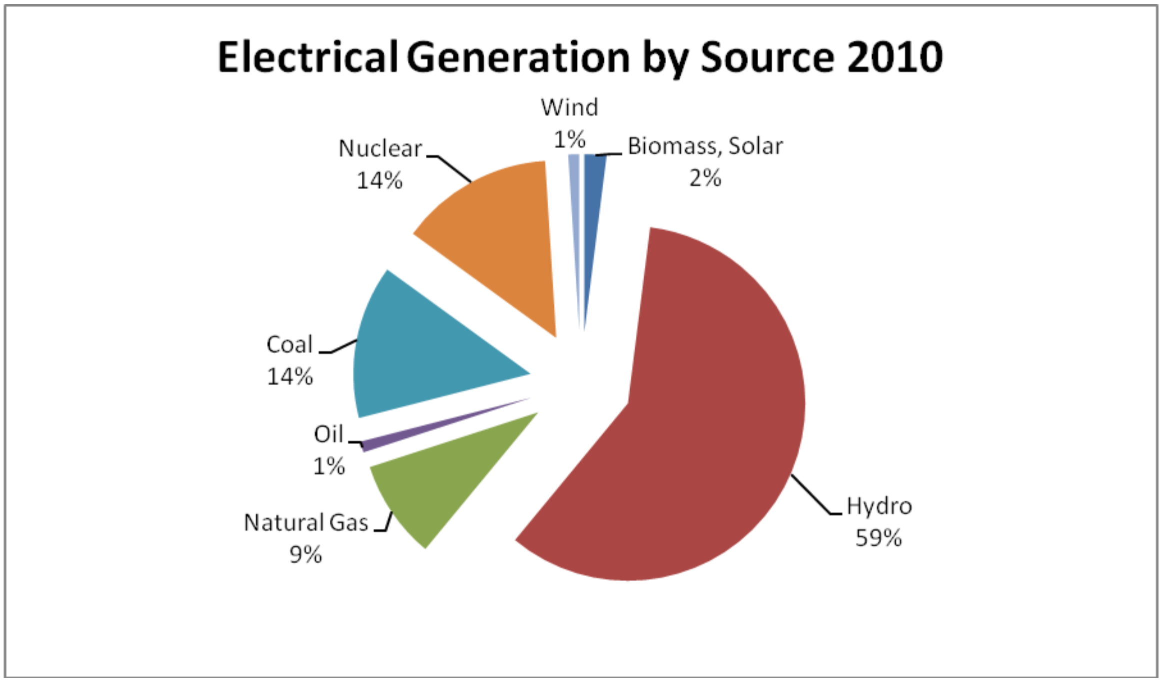
The third element in the GEN platform is a call for annual federal investments of $4.65 billion in wind, solar and geothermal renewable energy projects. GEN estimates this amount of investment would create 92,000 full-time jobs each year. Moreover, these jobs would be spread across the country and could involve preferential hiring for people from marginalized communities.

Table 2 summarizes the scope for expanding renewable electrical generation capacity according to the industry associations representing Canadian wind, hydro, solar, geothermal and wave and tidal power producers.

Table 2: Scope for Additional Power Generation Capacity
Gigawatts (billions of watts)

	Potential additional capacity	Job creation	Greenhouse gas reduction estimates (Megatonnes CO_2)
Canadian Wind Energy Association[70]	55 GW by 2025	52,000 full-time jobs	17 Mt
Canadian Hydro Power Association[71]	29 GW by 2030	51,828 direct, indirect and induced full-time jobs	
Canadian Solar Industries Association[72]	9 to 15 GW by 2025	41,000 jobs	15 to 31 Mt
Canadian Geothermal Energy Association[73]	5 GW with current technology; 10 GWplus from Enhanced Geothermal Systems		
Ocean Renewable Energy Group[74]	25 GW by 2025 as target		

These industry projections indicate that Canada has sufficient renewable power generation capacity to replace the power supplied by coal-fired and nuclear plants as they are retired from service. In 2010, coal-fired and nuclear power plants each supplied 14% of Canadian electricity demand, about 19 GW of generating capacity for each mode. While the NEB projects that overall demand for electricity will increase by 37 GW by 2035, efficiency and conservation measures could reduce or even reverse this projection. On the other hand, a switch to electric vehicles or use of more electricity in industry would add to power demand.



Source: National Energy Board. *Canada's Energy Future: Energy Supply and Demand Projections to 2035.*

While the industry projections described in Table 2 indicate that there is ample scope for new renewable power generation, not every potential project should be built. Communities and local planning authorities must be consulted and empowered to decide what options work best for them.

Twenty percent of the hydroelectric potential cited by the Canadian Hydropower Association would involve building large dams. In British Columbia, First Nations in the Peace River region and environmental groups are resisting the Site C dam project that would destroy forests and flood farmland. At first glance, run-of-river hydro projects, which divert water through turbines before returning it downstream, seem like a better alternative. Indeed small-scale, run-of-river hydro has been successful in parts of Asia. Many of the proposed projects in B.C. are meeting resistance because they are industrial scale ventures intended to serve export markets.

Similarly, careful consideration must be given to the location of wind turbines for their impact on human and non-human life, including migratory birds. Renewable power installations also have a carbon footprint. As J. David Hughes points out, a two-megawatt wind turbine can require "260 tonnes of steel requiring 170 tonnes of coking coal and 300 tonnes of iron ore, all mined, transported and produced by hydrocarbons."[75] Hughes suggests that at a good site such a turbine would produce more energy than was used to build it within three years, but “at a poor location, [the] energy payback may be never.”

The most commonly cited reservation concerning wind and solar projects is that wind and sunshine are not constantly available. While advances are being made in large-scale battery storage, and designs exist for combination wind-hydro developments, intermittency remains a concern. It is frequently argued that natural gas-fired power plants, with boilers that can be quickly fired up, should be kept ready to augment wind or solar power in case of need.

However a Pembina Institute briefing note *“Is Natural Gas a climate change solution for Canada?”* argues: “There are several reasons why increased consumption of natural gas-fired electricity is not required to support a major expansion of intermittent wind or solar power. These include: the capacity of existing electricity systems to integrate new variable-output sources; the fact that backup natural gas-fired generating capacity may only need to be used sparingly; the use of ‘smart’ grids to integrate a higher proportion of intermittent sources; the possibility of expanding interconnections to regions with hydropower; and emerging energy storage technologies that smooth the output of energy from the wind and the sun.”[76]

The other major objection to the rapid development of renewable power installations is their cost. Table 1 gives one set of estimates for the cost per kilowatt hour of various power generation from a 2009 U.S. study. More recent information indicates that renewable energy costs are falling due to technological developments and economies of scale. According to the U.S. Energy Information Administration the cost of building a new wind turbine is already competitive with that of a new coal-fired plant.[77]

Wind may even have a competitive advantage if coal-fired utilities are required to incorporate carbon capture and storage ability into their design. While the EIA maintains that solar photovoltaic projects are currently more than twice as costly as wind or coal generation, the Canadian Solar Industries Association expects their costs to drop by more than 50% by 2025.

A recent study by Queen’s University professors asserts that solar photovoltaic electricity “has already obtained grid parity in specific locations and as installed costs continue to decline, grid electricity prices continue to escalate, and industry experience increases, PV will become an increasingly economically advantageous source of electricity over expanding geographical regions.”[78]

Both the Canadian Wind Energy Association and the Canadian Solar Industries Association maintain that they currently need government policy support in order to become competitive. A prime example of the kind of support they seek is the feed-in-tariff program in Ontario that pays producers premium prices. As of the middle of 2012, onshore wind projects in Ontario earned 11.5 cents per kilowatt hour (kWh) while residential consumers paid a peak rate of 10.8 cents per kWh. Small scale, commercial solar rooftop PV projects qualified for higher FITs of 54.8 cents/kWh. Feed-in tariffs were reduced by about 15% for wind and 20% for solar installations from their 2011 levels after a review of the program determined that costs had fallen since the program was initiated in 2009. The wind association also calls for guaranteed access to distribution grids, tax credits and incentives to stimulate turbine manufacturing.

In addition to renewable power generation, we need to develop further solar and geothermal heating systems for buildings and hot water. According to the Canadian Solar Industries Association, solar thermal technologies are approaching market competiveness with natural gas systems in Western provinces and Ontario and with electric heating in Quebec. They state that solar hot water systems in new buildings are only marginally more expensive than natural gas installations.

Geothermal potential merits more attention

While wind, solar and hydro technologies receive a lot of attention, the potential of geothermal energy has not received as much consideration. In June 2011 the Geological Survey of Canada released an extensive report confirming that Canada has huge potential to tap into geothermal energy both as a source of heat and for electrical power.

The scientists who conducted the study found that geothermal energy potential is broadly distributed across the country. They state that Canada's "in-place geothermal power exceeds one million times Canada's current electrical consumption, although only a fraction of this can likely be produced."[79] They do not specify exactly what fraction might be produced since data exists on the potential for only 40% of Canada's landmass. Hence they call for more geoscience research and mapping.

A new report on the *Equinox Summit: Energy 2030*, convened by the Waterloo Global Science Initiative, describes how Enhanced Geothermal Systems have the potential to use the earth's heat to generate electricity in a wide variety of locations. Geothermal power production to date has mostly occurred in places like Iceland where "naturally occurring heat, water, and rock permeability allow easy energy extraction.

"Enhanced geothermal is a new approach ... [that] create[s] geothermal power from hot, dry rock sites through 'hydraulic stimulation,' pumping high-pressure cold water down an injection well into the rock. This increases fluid pressure in the naturally fractured rock, mobilizing shear events that enhance permeability, a process known as hydro-shearing, which is very different from hydraulic ... fracturing used in the oil and gas industry."[80]

The Geological Survey of Canada study states that remote Northern communities could be among the first to use geothermal power. While Canada does not yet have any geothermal electrical power production, decreasing costs are making use of low-temperature geothermal heating more feasible. Moreover, the study finds that the environmental impacts of geothermal development, while not negligible, are relatively minor compared with other energy sources. They leave a land footprint through support roads, pumping stations and surface pipes that is less than half as large as that of fossil fuels.

Geothermal electricity is projected to be cost competitive with coal within the next 15 years.[81] In Canada a variety of public initiatives could accelerate the development of geothermal power. Public funding for exploration could complete the geological mapping needed to identify locations suitable for geothermal power. In addition, tax credits, rebates, subsidies and power purchase agreements could promote private investments. The U.S. has a production tax credit for geothermal that Canada could imitate. A tax credit of 1.8 cents/kWh would reduce the cost by as much as 30%.

Wave and tidal power

As with geothermal power, the potential for generating electricity from wave and tidal power is substantial with its full potential yet to be explored. A study by the Canadian Hydraulics Centre, a division of the National Research Council, estimates that wave power off Canada's Pacific coast totals about 37 GW, while its potential off the Atlantic coast amounts to 146.5 GW, more than twice as much as current electricity demand.[82]

Wave energy in winter is four to seven times larger than in summer. Due to environmental considerations, only a fraction of this potential can be converted into useful power. Nevertheless, the potential is sufficient to justify further research and development. According to the Ocean Renewable Energy Group, UK government studies estimate that ocean power generation saves 0.44 tonnes of CO_2 per megawatt hour when compared with combined cycle natural gas turbines.[83]

The same study identified 190 sites where reliable and predictable tides could generate 42 GW of electricity, equivalent to 63% of current demand. Since 1984, the Annapolis Royal Generating Station in the Bay of Fundy with a capacity of 20 MW has been producing enough power to run 6,000 homes. Total capacity for tidal power from the Bay of Fundy is estimated at 2.5 GW.[84] The Canadian Hydraulics Centre found that Nunavut has the largest potential for tidal power of any province or territory.

This brief summary of the potential for renewable energy has not attempted to determine whether one type is more suitable than another. In fact no one mode of renewable power generation, whether hydro, wind, solar, geothermal, wave or tidal, will be suitable in every part of Canada. A variety of options need to be explored.

PART FIVE: Making the Transition to a Just & Sustainable Energy System

The energy sector represents around seven percent of the Canadian economy. Decisions about future investments will have a profound effect on where jobs are created, the distribution of economic costs and benefits and the consequences for both local and global ecological systems. According to the Canadian Energy Research Institute, oil corporations intend to commit $252 billion in capital spending for new tar sands projects between 2010 and 2035. In addition, they will spend another $1,824 billion on tar sands operations, maintenance and other capital expenditures required to maintain production.[85] The CERI forecasts that this investment will increase the number of direct, indirect and induced jobs generated by the tar sands from 75,000 in 2010 to 905,000 in 2035.

While this job creation projection sounds impressive, experience shows that investments in energy conservation and renewable energy production create, on average, about three times as many jobs per dollar as investments in oil production.[86]

A Just Transition

Recognizing that some jobs will be lost as fossil fuels are phased out, KAIROS policy on the tar sands and energy calls for "a funded transition plan for sustainable jobs in a renewable energy sector."[87] We are working with trade unions and other social and ecological advocates in the Green Economy Network to elaborate what such a transition plan could entail.

The Communications, Energy and Paperworkers union represents 35,000 workers in the oil and gas extraction, refining and petrochemicals sectors. At its convention in 2000, recognizing the necessity for a transition to a low-carbon economy, the CEP passed the policy document *Just Transition to a Sustainable Economy in Energy*. It states: "The cost of change should be fairly distributed throughout society. ... Sustainable employment must be part of the solution along with a sustainable economy and healthy ecosystems. Just transition is about planning for these changes in a fair and equitable way."

It then outlines some principles for how a just transition can be achieved:
i)Provide appropriate training and relocation funds.
ii)Involve workers and their unions in decision-making.
iii)Implement preferential hiring for displaced workers when green industries receive public funding.
iv)Share costs through a Just Transition Fund managed by unions, governments, and employers using funds from Employment Insurance, Human Resources and Skills Development Canada and a portion of taxes and royalties collected on fossil fuels.

Financing the transition
Financing for the transition to a just and sustainable energy system will have to come from a variety of sources including redirecting subsidies away from fossil fuels, collecting adequate royalties on natural resource extraction and taxes, particularly a carbon tax on activities that generate greenhouse gas emissions.

In our 2008 study *Pumped Up: How Canada subsidizes fossil fuels at the expense of green alternatives*, we called for redirecting the subsidies that the federal and provincial governments give to fossil fuels to efficiency, conservation and renewable energy projects.[88] About $1.4 billion in annual subsidies from the federal government are available to the petroleum sector.[89] One of them, the Accelerated Capital Cost Allowance for tar sands projects, amounts to an incentive for rapid development of new extraction projects. Worth around $300 million a year, this subsidy should be eliminated immediately.

In our Briefing Paper *Can Quantitative Easing Fund Green Jobs?*, we explain how a monetary policy tool used by central banks to stimulate economic activity could be used to fund investments in clean energy.[90] Quantitative easing whereby central banks create money through loans to governments could be used to restore funding to the ecoEnergy home retrofit fund discussed above and the ecoEnergy for Renewable Power program which the federal government launched in 2007 only to discontinue new allocations as of March 31, 2011. The Green Economy Network also calls for allocating a portion of revenues from a carbon tax and a 5% surtax on gasoline which could generate $2 to $2.5 billion a year.

Other options for funding the transition to a just and sustainable energy system include reinstating the federal corporate income tax rate at 28% for the oil and gas and financial industries. Restoring federal corporate income tax rates to their 2007 levels would return $2 billion to the federal treasury in 2012-13; $3 billion in 2013-14 and 2014-15.[91]

The Alternative Federal Budget (AFB)[92] shows that a carbon tax set at an initial rate of $30 per tonne of carbon dioxide would raise around $10 billion a year if levied on non-industrial fuel users and another $7.5 billion if levied on the approximately 500 large industrial carbon emitters who are responsible for about one-third of Canadian emissions.

The AFB proposes that half of the carbon tax revenues be refunded at an annual rate of $300 per adult and $150 per child so that low-income earners would not be unduly penalized. The rest of the money raised by the carbon tax would fund energy efficiency, renewable energy and climate change adaptation measures.

Alberta subsidies – 'misplaced generosity'

Provincial governments should also redirect subsidies away from fossil fuels. For example, tar sands companies deduct the costs of natural gas used to extract bitumen from royalty payments owed to Alberta as well as from their provincial and federal corporate taxes. This subsidy may cost Albertans as much as $31 billion between 2010 and 2019 if government projections for natural gas prices prove accurate.[93]

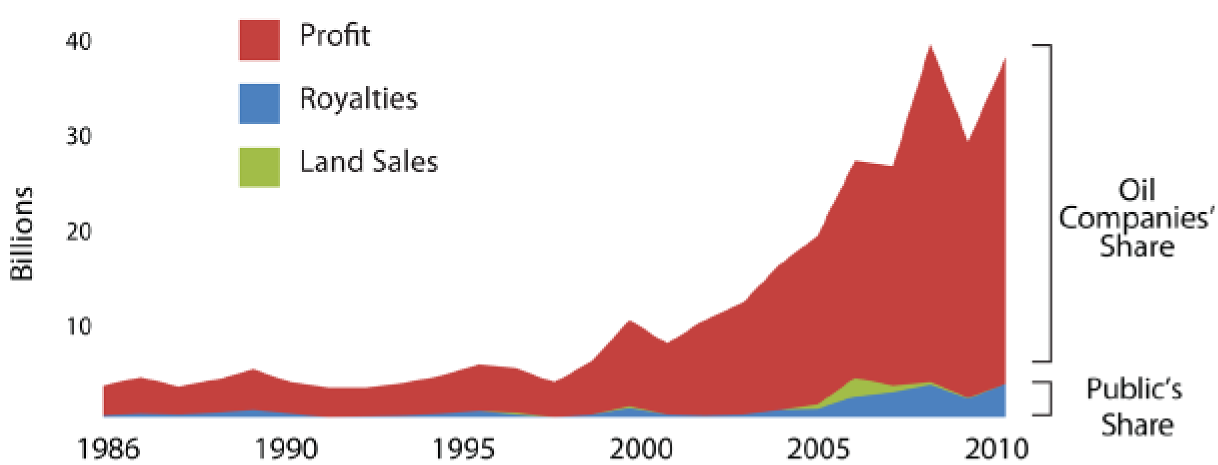
The Parkland Institute's landmark study, *Misplaced Generosity: Extraordinary profits in Alberta's oil and gas industry*, examined the role of low provincial royalty rates and land acquisition charges. The authors explore how companies in the oil and gas industry capture most of the "economic rent" that is the economic surplus accruing after allowing for production costs and a normal rate of profit.

The Parkland study defines "excess profits" as those that exceed a normal 10% rate of return on investments. The study found that between 1999 and 2008 the provincial government allowed conventional oil and gas corporations to collect $121 billion worth of excess profits because royalty rates were so low. Similarly, between 1997 and 2008, tar sands companies earned between $97 billion and $127 billion in pre-tax profits, of which 80% to 90% were in excess of a normal rate of return.

The principal author, Regan Boychuk, sums up his findings: "Put simply, tar sands operations are given virtually royalty-free oil to cover all of the costs of constructing and operating these enormous projects. In effect, these projects are built and run through a transfer of public wealth."[94]

In 2012 the Parkland Institute updated its original study. The *Misplaced Generosity Update* found that, "Since 1986, more than $285 billion worth of bitumen and synthetic crude oil have been produced from the tar sands. From these resources the oil companies have netted approximately $260 billion in pre-tax profits, while the public has received less than $25 billion in return." The following figure taken from that update shows how public revenues amount to only 6% of the total value extracted from the tar sands over 24 years.

FIGURE 1 | Distribution of Tar Sands Revenue ($2010)



Source: Calculations based on data retrieved from CAPP, Statistical Handbook,November 2011.

Source: *Misplaced Generosity: Extraordinary profits in Alberta's oil and gas industry. Update 2012*. Edmonton: Parkland Institute. Used with permission.

Raising royalties to collect more of the excess profits that are captured by the oil and gas industries is clearly one way of securing resource rents for reinvesting in a sustainable energy future. Since underground fossil fuels belong to the provinces under Canada's constitution, it is up to provincial governments to decide how much they will charge companies for drilling rights through land sales and what royalties they will collect on their production. It is also up to the provinces to determine whether income from land sales and royalty payments will be saved, spent or invested. In 1976, under Premier Peter Lougheed, Alberta started to put a portion of its petroleum revenues into the Alberta Heritage Savings Trust Fund. But after 1987 the province stopped setting aside oil and gas revenues for investing in other industries to create a more diversified economy less dependent on fossil fuels.

Whereas Lougheed had expected the Heritage Fund to have grown to around $100 billion by 2012, it is now estimated to be worth only about $15.4 billion. Political economist James Laxer notes, "With roughly the same population as Alberta, Norway has accumulated more than US$500 billion from the sale of its North Sea oil production."[95] In her February 2012 budget, Premier Alison Redford chose not to raise royalties or put revenues from natural resources into the Heritage Fund but instead to continue spending them on public programs.

The Parkland Institute has recommended that non-renewable resource rents be placed in the Heritage Fund with a portion of those funds made available to arms-length foundations to invest in diversifying the provincial economy.[96] One of these foundations would be mandated to promote the renewable energy sector in Alberta and across Canada through procurement, price subsidies and grants for Research and Development.[97] Similarly, the Premier's Council for Economic Strategy, appointed by former Premier Ed Stelmach, insisted that, "It is critical to realign the province's fiscal regime such that capital derived from sale of [non-renewable energy] assets is invested in shaping the future."[98]

Over dependence on fossil fuel exports

The 2011 Report of the Premier's Council's, *Shaping Alberta's Future*, warned that the province is too dependent on fossil fuel extraction and exports, particularly of tar sands oil to the United States. The panel, chaired by former federal cabinet minister David Emerson, warned: "Markets for Alberta's high-carbon energy will decline or disappear due to unacceptable environmental impact or unprofitable economics."[99] In particular, the report says, "We must plan for the eventuality that oil sands production will almost certainly be displaced at some point in the future by lower-cost and/or lower emission alternatives."[100]

The panel's warnings must be taken seriously as there are already signs of vulnerability for Alberta's export markets. The concerns of U.S. citizens, including farmers, Indigenous peoples and environmentalists, influenced President Barak Obama in his decision to withhold the permit for the Keystone XL pipeline. While the focus was primarily on Nebraska's environmentally sensitive Sandhills area which overlies the Ogallala aquifer, awareness of the ecological impact of tar sands oil was also a factor.

The European Union's draft Fuel Quality Directive may identify tar sands oil as having a higher carbon footprint than other types of petroleum, making it more expensive for European purchasers. Although Canada does not yet export tar sands oil to Europe, such a designation would set a precedent. Hence the federal government has lobbied furiously to persuade European environment ministers to exclude tar sands crude from the directive.

While the Premier's Council report clearly calls for investments to diversify Alberta's economy away from over dependence on fossil fuels into areas such as medical technology and biotechnology, it does not recommend abandoning high-carbon resources such as bitumen and coal. Instead it calls for two strategies. One is to build pipelines to the Pacific for exports to Asia. At the same time, the report notes: "China is investing heavily in electric vehicles with a view to cutting energy consumption in half and replacing 20% of the gasoline and diesel fleet with new-energy cars by 2020. Mass production of inexpensive, reliable electric car [sic] with competitive performance characteristics could change the world's driving habits and reduce oil demand."[101] The second strategy is to transform the environmental and operational performance of coal and tar sands operations by investing in such measures as coal gasification or carbon capture and storage.[102]

Summary and Conclusion

Not long ago a plausible scenario held that as production of conventional oil and natural gas peaked and prices rose, investments would shift seamlessly from depleting hydrocarbons to renewable forms of energy.

With the advent of deep sea drilling in areas such as the Gulf of Mexico and offshore from Brazil and hydraulic fracturing of tight oil and shale gas formations, analysts like Daniel Yergin are questioning the peak oil thesis. Yergin now asserts: “The world is clearly not running out of oil. Far from it. The estimates for the world’s total stock of oil keep growing.”[103] But this growth very much depends, Yergin admits, on policy decisions to sanction more development of unconventional oil resources despite the ecological risks.

Other analysts contest Yergin’s assertion that the world has many years of oil production growth before supplies plateau. Thomas Homer-Dixon points out: “Each year the world’s mature conventional oil fields produce about four million barrels a day less oil than the previous year, a gap that has to be filled just to keep global output constant.”[104]

Moreover, each of the unconventional sources of fossil fuels has a lower energy return on energy invested than conventional oil (see Table 1). In the end, the contrasting views put forward by Yergin and Homer-Dixon will be resolved not by intellectual debate but by political decisions to encourage or discourage the exploitation of a variety of unconventional resources including the tar sands, tight oil and shale gas.

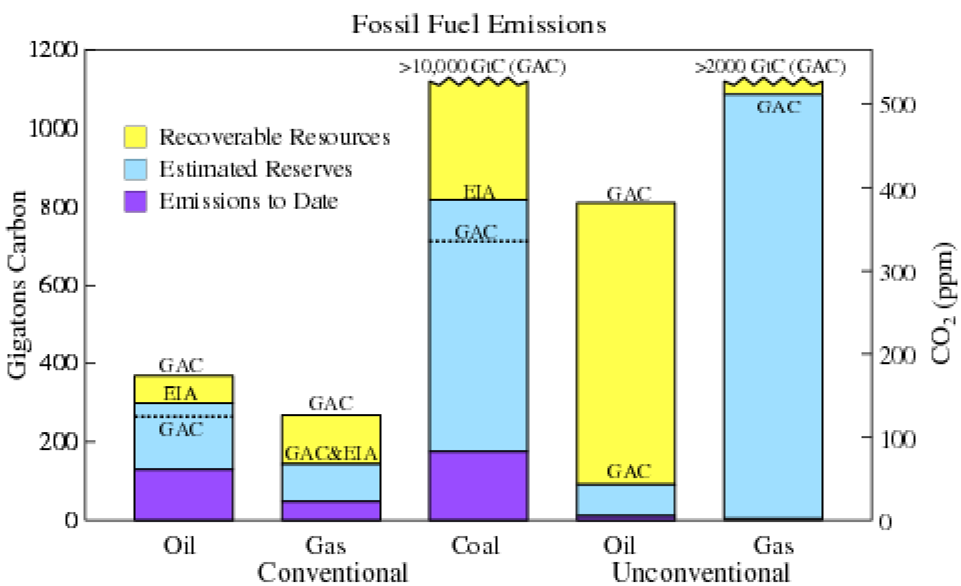
In this report we have described industry plans for substantial new investments in the tar sands and hydraulic fracturing technologies that are changing the outlook for oil and gas markets throughout North America. One consequence is a decline in investment in renewable alternatives. We cited an estimate by Fatih Birol, chief economist at the International Energy Agency, that the shale gas boom in the U.S. has cut investments in renewable energy in half.

This report has drawn attention to the large ecological footprint of bitumen from the tar sands which emits 3.2 to 4.5 times more greenhouse gases than conventional oil at the point of extraction. We have also described concerns about the dangers that hydraulic fracturing to extract shale gas poses for water contamination, earthquakes and greenhouse gas emissions. We believe that the most persuasive case against the extension of the era of dependence on fossil fuels is neither technological nor economic but ecological.

A new study by University of Victoria climate scientist Andrew J. Weaver and graduate student Neil C. Swart examined the global warming potential of various types of conventional and unconventional fossil fuels. Their data shows that the carbon content of world coal reserves is 41 times as large as that of the Alberta tar sands and that unconventional natural gas reserves contain eight times as much carbon as the tar sands.

Contrary to media spin that portrays the study as indicating that we therefore do not need to worry about emissions from the tar sands,[105] Weaver and Swart argue eloquently for ensuring "a rapid transition of energy systems to non-greenhouse-gas-emitting sources, while avoiding commitments to new infrastructure supporting dependence on fossil fuels," including expansion of tar sands operations or export pipelines.[106]

A similar investigation by NASA climatologist James Hansen, summarized in the following chart, reinforces the message that the largest stores of remaining carbon reserves (shown in blue) and potentially recoverable resources (shown in yellow) are found in coal, unconventional gas and unconventional oil which includes tar sands, tight oil and oil shale as described in this report.



Source: James Hansen web page http://www.columbia.edu/~mhs119/YoungPeople/

If we are to have any hope of avoiding disastrous climate change, climate scientists agree that we cannot afford to burn all the remaining conventional oil and gas let alone release the carbon trapped in coal seams and every type of unconventional oil or gas.

In this report we have reiterated KAIROS' call for a sustainable energy strategy based on conservation and the development of renewable energy. We have also restated the goal to reduce greenhouse gas emissions to 40% or 50% below 1990 levels. This is an enormous challenge as Canadians are some of the largest per capita consumers of fossil fuels on earth, using more than five times as much per person as the world average.

The consequences of failure to change course are grave given the threat that climate change poses to life on earth.[107] Yet the possibilities for success are also within reach, given the potential for conservation measures and the development of renewable energy sources chronicled in this study.

End Notes

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