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ADAPTATION TO
CLIMATE CHANGE TEAM

BACKGROUND REPORT

CLIMATE CHANGE ADAPTATION AND THE LOW CARBON ECONOMY IN BC

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DECEMBER 8, 2010

ACKNOWLEDGEMENTS

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ACT consulted a panoramic range of individuals and sources to achieve this report. In particular, we would like to thank PICS Fellow and UVic Engineering PhD Candidate Mike Fischer for kindly providing a technical review of this document. ACT would also like to thank PICS Director Tom Pedersen, ACT Board member and former BC Deputy Minister of Sustainable Resource Management, Jon O'Riordan, and all session partners for their helpful comments.

ACT:

ACT (the Adaptation to Climate Change Team) is a five-year series of six-month sessions that brings leading experts together with decision-makers and experts from industry, community, academia, and government, to explore the risks posed by climate change and generate policy recommendations for sustainable adaptation.

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The Pacific Institute for Climate Solutions (PICS) pulls together the intellectual capital in BC's large and exceptional community of scientists, engineers, economists, environmental and socio-behavioural impact assessment specialists, policy analysts and governance experts, many of whom are based at BC's four research-intensive universities and are internationally recognized leaders in their fields, into a dynamic knowledge network that integrates multi-disciplinary approaches to climate change.

ISBN: 978-1-77287-034-3

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1.0 INTRODUCTION

Addressing the sustainability challenge makes sense regardless of one's views on climate change.

This report, which forms the background to the accompanying ACT "Climate Change Adaptation and the Low Carbon Economy in BC Summary Recommendations" report, is intended to encourage dialogue amongst citizens and the Government of British Columbia about three major challenges that must be addressed if we are to leave a sustainable world for our children:

- The **ENERGY** challenge – our heavy reliance on oil will present significant challenges now that the era of cheap and easy oil has passed;
- The **CLIMATE CHANGE** challenge – the abundance of heat-trapping greenhouse gas emissions, which we have pumped into the atmosphere, are changing our climate and threatening to destabilize the delicate balance that makes life on Earth possible; and
- The **ECOSYSTEM** challenge – the majority of the ecosystem services that nature provides are not sustainable. We are currently exceeding the carrying capacity of the Earth and degrading the ecosystems we rely upon for life. We are running a substantial ecological deficit.

(NB: For convenience, we routinely refer to these three challenges collectively as *the sustainability challenge* throughout this report, with the acknowledgement that sustainability as a concept can include a far more complex set of issues, including social justice).

The preponderance of scientific data overwhelmingly points to significant human influence on climate change. Despite the evidence, there remain some who do not recognize anthropogenic climate change. Regardless of their beliefs on climate change, they should recognize that there is an urgent need to address the broader sustainability challenge for there can be little debate that oil production outside the Organization of Petroleum Exporting Countries (OPEC) has peaked and has started to decline. Moreover, it is clear that many of the ecosystems that support life on earth are facing significant stress. Therefore, we believe that addressing the sustainability challenge makes sense regardless of one's views on climate change.

The answer to the sustainability challenge is clear: it is imperative that we significantly reduce our ecological footprint and move to a low-carbon economy.

BC is well positioned to meet the sustainability challenge and provide leadership to the rest of Canada and the world.

Reducing our ecological footprint does not automatically require a lower quality of life. Other countries around the world, such as the Netherlands, have managed to maintain a standard of living very similar to our own but with significantly smaller ecological footprints. Fear that our quality of life must be sacrificed in order to protect the environment should not stand in the way of action.

Just as the issues of energy security and supply, climate change and protection of our ecosystems are intricately interwoven, so too are the solutions that we must implement. Reducing our ecological footprint is one important way in which we can help to enhance our resilience to the sustainability challenge. In brief—a low-carbon economy and a more resilient energy system together reduce the effect of the energy challenge and the amount of greenhouse gases (GHGs) being pumped into the atmosphere, thereby helping to address both the climate change and ecosystem challenges. In addition, shifting our economy to react to the sustainability challenge will better position BC to compete in the 21st century economy, since all jurisdictions will be forced to find similar solutions.

BC is well positioned to meet the sustainability challenge and provide leadership to the rest of Canada and the world. We have many advantages to assist us in leading the way to maintain and enhance our economically prosperous, high-quality lifestyle while also addressing the sustainability challenge. Among our advantages are not only our geography and abundance of renewable energy sources, but also the many individuals and organizations which have led the way to date in creating relatively progressive public policy.

We conclude our report by presenting policy opportunities for the Government of British Columbia in the area of governance, energy conservation, adaptation and insurance. We believe these policy opportunities will be helpful in addressing what has already become an urgent situation. We recognize that the sustainability challenge will require global responses that are not necessarily discussed in this report, as our focus is on BC in particular. It should also be noted that the policy opportunities are drawn from our own experience, but they reflect many of the ideas that have been put forth by a wide range of individuals and groups including non-governmental organizations, academics, business and government leaders. There is no lack of ideas and policy prescriptions on this subject; however, we sense a complacency that is particularly concerning given the magnitude of the challenge we face.

It is time to step up our actions to address the sustainability challenge.

THE ENERGY CHALLENGE

Our heavy reliance on oil will present significant challenges now that the era of cheap and easy oil has passed.

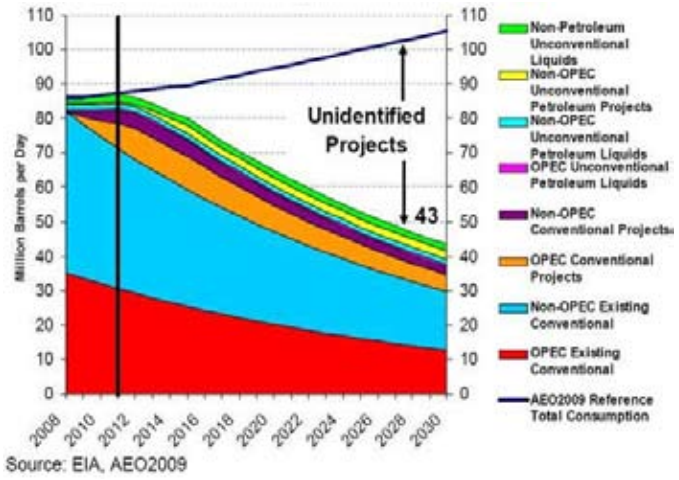
Oil is popular in part because of the high level of concentrated energy that it contains. Three spoonfuls of oil contain the same amount of energy as eight hours of hard human labour[1]; burning one litre of oil provides energy equivalent to 20 days of hard human labour[2]; and a fully-fuelled jumbo jet contains the same amount of energy as 13,000 years of hard human labour.[3] Combine this incredible amount of concentrated energy with the relative ease with which oil can be transported, and it is understandable why oil is the most demanded fossil fuel in the world.

Around the globe, we consume about 1,000 barrels of oil every second. That amounts to about 31 billion barrels of oil consumed every single year.[4] Our incredible dependence on oil is problematic because oil resources are finite: an ever-increasing number of experts are forecasting a near term peak in conventional oil production followed by a terminal decline due to physical depletion of oil resources.[5,6] Assessments of when we reached or when we *will* reach a peak in global oil production vary from 2005 to 2030.[7] Already a total of fifty-six oil-producing countries have experienced a peak in their oil production (see Table 1)

The International Energy Agency estimates an annual decline rate of 6.7 percent in existing oil fields which have passed their production peak.[8,9] The UK Energy Research Centre (UKERC) estimates that, just to offset the decline rate in existing oilfields, we would need to bring the equivalent of another Saudi Arabia into production every three years.[10] The magnitude of this challenge is highlighted by the fact that we are already consuming over three barrels of oil for each barrel of conventional oil we discover.[11]

The Energy Information Administration (EIA), the statistical and analytical agency of the US Department of Energy, predicts that production of all liquid fuels, including oil, will plummet after 2012. According to the EIA, "unidentified projects" will be needed to maintain our current trajectory of oil production.[12]

FIGURE 1 - GLOBAL LIQUID FUEL PRODUCTION



1 Homer-Dixon and Garrison, 2009.
2 Lardelli, 2010.
3 Lardelli, 2010.
4 Lardelli, 2010; Homer-Dixon and Garrison, 2009.
5 Sorrell et al., 2009.
6 Ralston, 2008.
7 Sorrell et al., 2009.
8 International Energy Agency, 2008.
9 The IEA expects the decline rate to rise to 8.6 percent by 2030.
10 Sorrell et al, 2009.
11 Homer-Dixon and Garrison, 2009.
12 Sweetnam, 2009.

TABLE 1. THE EXPANDING GROUP OF POST-PEAK OIL PRODUCERS

COUNTRY	PEAK	COUNTRY	PEAK
Albania	1974	Libya	1970
Argentina	1999	Mexico	2003
Australia	2000	Morocco	1963
Austria	1955	Myanmar	1981
Barbados	1999	Netherlands	1986
Belarus	1974	Norway	2001
Benin	1985	Oman	2001
Brunei	1979	Papua New Guinea	1993
Bulgaria	1969	Peru	1982
Cameroon	1985	Poland	2004
Chad	2005	Romania	1976
Chile	1982	Russia	1987
Colombia	1999	Senegal	1991
Croatia	1977	Slovakia	1995
Cuba	2004	South Africa	2004
Czech Republic	2003	Spain	1983
Denmark	2004	Syria	1996
Egypt	1993	Tajikistan	1979
France	1988	Trinidad and Tobago	1978
Gabon	1997	Tunisia	1980
Georgia	1985	Turkey	1991
Germany	1967	Turkmenistan	1973
Greece	1984	Ukraine	1970
Hungary	1982	United Kingdom	1999
Indonesia	1977	United States	1970
Iran	1974	Uzbekistan	1999
Italy	2005	Venezuela	1970
Kyrgyzstan	1961	Yemen	2001

Source: Sorrell et al., 2009.

The bulk of remaining oil deposits are in tar sands or under ultra-deep water, requiring great expense, technological advancements, and long lead-in times to bring the projects on-stream.

Finding these unidentified projects—equivalent to finding a new Saudi Arabia every three years—presents an enormous challenge. Even oil executives, like former Shell CEO Jeroen van der Veer, are adamant that the era of "easy oil" has passed.[13] The bulk of remaining oil deposits are in tar sands or under ultra-deep water, requiring great expense, technological advancements, and long lead-in times to bring the projects on-stream.[14] As we use up the "cheap, easy oil", the energy return on energy invested (EROEI) goes down—for example, it takes one barrel of oil to extract four barrels of oil from the Alberta tar sands, compared to one barrel of oil to extract 15 to 25 barrels of oil from conventional sources.[15] Additionally, these 'scraping-the-barrel' methods of petroleum extraction and the increasing incursion into ecologically sensitive areas carry a much higher ecological risk than conventional production. This was most recently made evident by the catastrophic oil spill in the Gulf of Mexico.

When we combine the requirement to bring on a massive amount of new production just to offset the decline rate with the fact that we have already exploited the cheap, easy-to-access oil, the nature of the energy challenge we face becomes clearer. But when we also look at our current levels of consumption—again, we are consuming three barrels of oil for each barrel of conventional oil we discover[16]—the true state of the energy challenge we face becomes alarming.

We are heavily reliant on oil. But the era of cheap, easy oil is over. As a result, we are facing a significant energy challenge.

13 Sauven, 2010.
14 Sauven, 2010.
15 Homer-Dixon, 2006.
16 Homer-Dixon and Garrison, 2009.

THE CLIMATE CHANGE CHALLENGE

Recent scientific studies indicate that a global average increase of 2°C is a tipping point, beyond which irreversible damage to the global climate would occur.

The abundance of heat-trapping greenhouse gas emissions, which we have pumped and continue to release into the atmosphere, are changing our climate and threatening to destabilize the delicate balance that makes life on Earth possible.

The preponderance of scientific data overwhelmingly points to significant human influence on climate change. Greenhouse gases (GHGs) are at record levels and, according to the paleo-climatic record, even a slight increase in the level of atmospheric GHG concentrations will prove untenable for human life.[17] This past decade (2000-2009) was the hottest in the temperature record,[18] and many of the predicted effects of climate change are already happening much more quickly than anyone anticipated.[19] Despite the evidence, there remain some who do not recognize anthropogenic climate change. Of course the controversy at the University of East Anglia in 2009 provided material for such sceptics, but it must be noted that three separate investigations were conducted and the conclusion was reached that the scientists "acted honestly and that their research was reliable."[20] There is broad consensus in the scientific community that our climate is changing and that humans bear the bulk of responsibility.

The most recent report by the Intergovernmental Panel on Climate Change (IPCC) concludes that, "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising average sea level".[21] The IPCC report also states that "most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations."[22]

The global average surface air temperature has increased by 0.6°C since 1900 and climate models project an increase between 1.4°C and 5.8°C by 2100, relative to 1990.[23] Recent scientific studies indicate that a global average increase of 2°C is a tipping point, beyond which irreversible damage to the global climate would occur.[24] There is general consensus among scientists that we must stabilize atmospheric GHG concentrations at 450 parts per million (ppm), in order to avoid a global average increase in excess of 2°C. The scenario developed by the International Energy

17 Romm, 2010.
18 World Meteorological Organization, 2009.
19 Climate Change Congress, 2009.
20 Satter, 2010.
21 IPCC, 2007, p. 5.
22 IPCC, 2007, p. 10.
23 IPCC, 2007.
24 WBCSD, 2009.

Agency (IEA) for stabilizing GHG concentrations at 450 ppm requires a peak in our fossil fuel use to occur before the year 2020.[25]

But there is increasing concern that even stabilizing GHG concentrations at 450 ppm may not be adequate. Approximately 2,000 scientists attended the Copenhagen Climate Science Congress at the end of 2009 and came to the following conclusion:

> Recent observations confirm that, given high rates of observed emissions, the worst-case IPCC scenario trajectories (or even worse) are being realised. For many key parameters, the climate system is already moving beyond the patterns of natural variability within which our society and economy have developed and thrived. These parameters include global mean surface temperature, sea-level rise, ocean and ice sheet dynamics, ocean acidification, and extreme climatic events. There is a significant risk that many of the trends will accelerate, leading to an increasing risk of abrupt or irreversible climatic shifts.[26]

Because of this, there is a growing call for atmospheric GHG concentrations to be brought below 350 ppm in order to avoid dangerous climate change. James Hansen of the National Aeronautics and Space Administration (NASA) in the US, the first scientist to warn about climate change more than twenty years ago, has expressed his support for a target of at least 350 ppm, saying:

> If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced [from its current 390 ppm] to at most 350 ppm.[27]

Whatever precise reduction in emissions is needed to avoid dangerous climate change, one thing is clear: we are running out of time to reduce our GHG emissions. Bill Gates argues that we must reach zero emissions by the year 2050.[28] Andrew Weaver, Canada Research Chair in Climate Modelling and Analysis and a lead author with the IPCC, spells out the challenge we face if we are to avoid exceeding an increase greater than 2°C:

> So if society accepts that the 2°C threshold is the upper bound of acceptable global warming, we have 484 billion tonnes of allowable carbon emissions to play with starting January 1, 2007, until the day we finally arrive at zero emissions. And for each year we dither about deciding what to do, we lose 10 billion tonnes, at current emission rates, of our future carbon allotment.[29]

That leaves us about 45 years to reach zero emissions, with considerable uncertainty about potential feedback loops and tipping points that we cannot foresee that may shorten this timeframe.

Canada ranked 10th out of 210 countries for high levels of per capita GHG emissions in 2005.[30] Canada's per capita GHG emissions in 2005 were 22.9 tonnes of carbon dioxide equivalent.[31] BC's emissions intensity was about one-third below the national average.[32]

BC's GHG emissions are broken down as follows:

- Transportation: 36%
- Fossil Fuel Production: 19%
- Other Industry: 18%
- Residential/Commercial: 11%
- Waste: 6%
- Net Deforestation: 5%

25 International Energy Agency, 2009.
26 Climate Congress, 2009.
27 McKibben, 2010.
28 Gates, 2010.
29 Weaver, 2008, p. 254.
30 International Energy Agency, 2010.
31 Human Resources and Skills Development Canada, 2010.
32 Government of British Columbia, 2009.

- Agriculture: 3%
- Electricity: 2%

Individual BC residents are responsible for approximately 30% of BC's GHG emissions (~5 tonnes per person per year). A per household breakdown of the sources of GHG emissions in BC is as follows:

- Cars and trucks: 45.3%
- Space heating and cooling: 16.6%
- Wastes: 13.4%
- Air: 12.5%
- Water heating: 8.5%
- Bus and rail: 2.4%
- Appliances and lighting: 1.3%[33]

Notably, our use of energy accounts for more than 80% of our GHG emissions in BC, with the remainder of our emissions coming from agriculture, waste, and deforestation, etc.[34]

Our climate is changing. We are continuing to pump greenhouse gas emissions into the atmosphere. And the clock is ticking. As a result, we are facing a significant climate change challenge.

33 Government of British Columbia, 2009.
34 Government of British Columbia, 2009.

THE ECOSYSTEM CHALLENGE

Whether we live on the edge of a forest or in the heart of a city, our livelihoods, and indeed our lives, depend on the services provided by the Earth's natural systems.

We are currently exceeding the carrying capacity of the Earth and degrading the ecosystems we rely on for life. The evidence from the Millennium Ecosystem Assessment (MEA) suggests we are already exceeding the carrying capacity of the planet.

Whether we live on the edge of a forest or in the heart of a city, our livelihoods, and indeed our lives, depend on the services provided by the Earth's natural systems. The World Wildlife Fund's 2010 Living Planet Report tells us that we are consuming the resources that underpin those services too fast—faster than they can be replenished. The report suggests that our global ecological footprint now exceeds the world's capacity to regenerate by 30 percent. Humankind is currently using the equivalent of 1.3 planets to provide the resources we consume and to absorb the wastes we produce.[35] If our current global population and consumption trends continue, we will need the equivalent of two planet Earths by at least the year 2050.[36]

However, if everyone consumed resources and produced waste at the rate Canadians do, we would need *4.3 planet Earths*.[37] Canada has the fourth highest ecological footprint per person in the world, after the United Arab Emirates, the US, and Finland.[38]

The Millennium Ecosystem Assessment (MA), prepared between 2001 and 2005, was the largest baseline study of the health of the planet ever completed, involving more than 1,300 scientists from over 95 countries. The MEA examined the twenty-four ecosystem services, which are the benefits provided by ecosystems, including (but not limited to):

- *Provisioning services*: including food, water, timber, fibre and genetic resources;
- *Regulating services*: including the regulation of climate, floods, disease, water quality and waste treatment;
- *Cultural services*: including resources available for recreation, aesthetic enjoyment and spiritual fulfillment; and
- *Supporting services*: including soil formation, pollination, and nutrient cycling.[39]

35 Mitchell, 2007.
36 Mitchell, 2007.
37 Mitchell, 2007.
38 Mitchell, 2007.
39 Millennium Ecosystem Assessment, 2005a, p. 39.

There is a noted correlation between the levels of species loss and energy consumption.

The MA found that over half of the ecosystem services which nature provides (15 out of 24 services) are being used in a manner which is entirely unsustainable.[40]

ACT's Biodiversity report identified that, "over the past century, habitat fragmentation due to human activity on the land and water base in BC has simplified a number of critical ecosystems to the point that they are considered of conservation concern ... In particular, they are losing their natural resiliency to adapt to external pressures, and as a result becoming increasingly vulnerable to climate change."[41] Globally, the MA notes that the current extinction rate is up to one thousand times higher than the fossil record and the projected future extinction rate is more than ten times the current rate. There is a noted correlation between the levels of species loss and energy consumption.[42]

Destruction of ecosystems does not only affect other species, it also affects human well-being. The MA asserts that ecosystem services are

> [A] key instrumental and constitutive factor determining human well-being. The MA findings support, with *high certainty*, that biodiversity loss and deteriorating ecosystem services contribute—directly or indirectly—to worsening health, higher food insecurity, increasing vulnerability, lower material wealth, worsening social relations, and less freedom for choice and action.[43]

In Canada, we are using 4.3 Earths when we only have one.[44] Globally, we are putting at risk over half of the ecosystem services we rely on by using them unsustainably. We are running a substantial ecological deficit, and, as a result, we are facing an unprecedented ecosystems challenge.

40 Millennium Ecosystem Assessment, 2005a.
41 O'Riordan, 2009, p. 5.
42 Millennium Ecosystem Assessment, 2005b, p. 4.
43 Millennium Ecosystem Assessment, 2005b, p. 30.
44 Mitchell, 2007.

THE BRITISH COLUMBIA ADVANTAGE

Initiatives taken by governments at the municipal and provincial levels have proven that BC is prepared to take the lead on climate change mitigation and adaptation.

British Columbia is well positioned to meet the sustainability challenge outlined in the preceding pages. BC's vast expanses of natural resources allow the province to continue to expand and diversify its energy portfolio, particularly with renewable sources. The continued development of these energy supplies will allow BC to transition from its reliance on petroleum, natural gas, and other non-renewable resources. Other advantages that BC enjoys relate to our fortuitous geographic location. The province is large but has a relatively small population. In addition, the province's proximity to major US and Asian markets has permitted the development of important trading partners. The BC population has also shown a strong commitment to environmental preservation. This commitment, combined with our low population density, suggests that the province is willing and able to progressively manage future energy demand. Finally, BC has a long political history of progressive environmental stewardship. Initiatives taken by governments at the municipal and provincial levels have proven that BC is prepared to take the lead on climate change mitigation and adaptation. Taken together, BC is well situated to meet the continuing demands of growth while preserving our abundance of natural resources and unique climate.

SUPPLYING FUTURE ENERGY DEMANDS

Just as BC's history and growth have largely developed around the abundance of natural resources, so too will the province's future energy industry. BC's unique topography contains diverse renewable energy resources. As concerns grow about energy prices, security, and the environmental effects of our dependency on fossil fuels, the demand for renewable energy resources will escalate, and BC is well situated to become energy self-sufficient through the use of clean and renewable energy resources.

Our largest renewable energy source is hydroelectricity, with approximately 90 percent of BC's current electricity production coming from large-scale hydroelectric dams. This percentage could increase as BC Hydro is currently proposing the development of the Site C project, a large-scale hydroelectric dam on the Peace River, which is currently undergoing an environmental and regulatory review, including an independent environmental assessment.[45] Significant environmental concerns have been raised with respect to the Site C hydroelectric development, including concerns that the development plan fails to properly account for the ecosystem services provided by the forests, agricultural fields and other area ecosystems which could be adversely impacted by this development.[46] If Site C is given the go-ahead following the independent environmental assessment, BC's total energy supply from hydroelectric projects could

45 BC Hydro, 2010b.
46 David Suzuki Foundation, 2010c.

BC currently leads Canada in the use of biomass for energy, with the province having 50 percent of Canada's biomass electricity generating capacity.

increase by an additional 25 percent by 2025 due to this development combined with several other smaller projects.[47] However, even without additional developments, it is clear that hydroelectricity will continue to be dominant in meeting BC's future energy demands.

BC currently leads Canada in the use of biomass for energy, with the province having 50 percent of Canada's biomass electricity generating capacity.[48] Bioenergy is derived from organic biomass sources—including trees, crops, food processing and agricultural wastes, and manure. BC's current biomass production breaks down as follows:

- Forestry: 53% (including forest residues from logging practices, road clearing and other forestry activities).
- Mountain Pine Beetle damaged timber: 34%
- Agriculture: 10% (including crop residues that are not utilized, such stalks, husks, straw and other post-harvest fibre. Crops grown specifically for the production of biodiesel and ethanol include grain and canola. Future sources of biomass identified by the BC government are livestock manure and dedicated crop growth).
- Municipal solid waste: 3% (landfills contain biomass that can serve as a source of fuel through the collection of gasses or through combustion).

The BC government's Energy Plan aims for provincial bioenergy production to meet 50 percent or more of the province's renewable fuel requirements by 2020, including the development of at least 10 community energy projects by 2010 that will convert local biomass into energy, and the establishment of "one of Canada's most comprehensive provincial biomass inventories that creates waste-to-energy opportunities."[49] One of the biggest advantages of bioenergy over other clean and renewable energy sources, especially wind and solar, is that biomass sources can be easily stored and used only when needed.[50] In spite of its advantages, there are also concerns about the use of biomass as a source of energy, particularly around the life-cycle emissions and potential land-use conflicts around some aspects of biomass production.[51]

Aside from these already well-established energy sources, there are a number of other potential renewable resource industries that can be further developed. Given increasing investments in solar thermal (relating to cost, efficiency, and storage improvements), this energy source has a high potential for further development.[52] Similarly, wind energy

47 BC Hydro, 2010b.
48 Government of British Columbia, 2008a.
49 Government of British Columbia, 2008a.
50 David Suzuki Foundation, 2010a.
51 Paulsen, 2008.
52 Significant work has already begun on ensuring that the component parts of solar panels can be recycled. For more information, see Larsen, 2009.

projects are expected to increase as the technology advances and energy prices rise. A number of potential sites have been identified for wind energy installations and the projected power production potential is about 114 PJ by 2025,[53] a figure that amounts to about half the total amount of energy currently provided by BC hydroelectricity dams.[54] Geothermal energy has also been targeted for development in BC, which has extensive high- and mid-grade geothermal deposits in most regions. These deposits, further developed, could significantly contribute to the renewable resources supply by 2025. Finally, BC's extensive system of coastal waters is expected to provide yet another source of energy, through both wave and tidal systems. These energy sources are comparatively undeveloped, however, and are expected to provide only a modest increase in energy supply by the year 2025.[55]

There is great potential for renewable energy development in British Columbia. Current large energy sources, such as hydroelectricity and biomass energy, are expected to garner an even greater share of future energy supply production. Although smaller in scale, future developments in solar, wind, geothermal, and ocean power will provide additional energy resources, while also diversifying the province's energy supply. Taken together, these sources can help reduce the province's reliance on oil, natural gas, and other non-renewable resources to meet energy demands, and provide a concentration of innovation and demonstration projects that could potentially act as a strong influence on the rest of the continent.

LOCATION, LOCATION, LOCATION

BC's abundance of current and potential natural resources is especially promising when considering the province's relatively small population size and large geographic area. BC's population density is approximately 4.8 persons/km^2, ranking it as one of the most sparsely populated provinces in Canada. To place BC's population in proper context, Ontario has 12 persons/km^2, Washington State has 36 persons/km^2, and California has 80 persons/km^2. BC clearly holds a comparative advantage in our pursuit to become energy self-sufficient. In fact, the province already produces much more energy (2,214 PJ) than it consumes (1,142 PJ); however, BC imports most of our petroleum products due to our high consumption of oil, primarily to meet our transportation requirements.[56] Although the province's population is expected to grow, BC has the capacity to meet the corresponding increase of energy demands while also reducing demand for fossil fuels.

BC's west coast location also allows the province to access large western US and Pacific Rim markets. As with all other Canadian provinces, BC's exports predominantly to the US; in 2008, about 54 percent of BC's exports were destined for US markets.[57] BC's location, in combination with massive investments into the Pacific Gateway transportation network, has also allowed the province to make significant expansions into Pacific Rim markets; more than 30 percent of BC exports are now destined for Asian countries.[58] By developing connections to these burgeoning markets, BC has been able to diversify our trade relationships which, in turn, has strengthened BC's economic position to meet the challenges of climate change.

53 The Petajoule (PJ) is used to allow direct comparisons among various types of energy supplied and energy uses (Globe Foundation, 2007).
54 Globe Foundation, 2007.
55 Globe Foundation, 2007.
56 Globe Foundation, 2007.
57 Finlayson and Peacock, 2009.
58 Finlayson and Peacock, 2009.

SUSTAINABILITY IN ACTION – UBC

The University Of British Columbia (UBC) has embarked on one of the most aggressive Sustainability Action Plans of any campus in the world. UBC has already exceeded its Kyoto targets and has set new targets to:

- Reduce GHGs by an additional 33 percent from 2007 levels by 2015
- Reduce GHGs to 67 percent below 2007 levels by 2020
- Eliminate 100 percent of GHGs by 2050

UBC has also partnered with the City of Vancouver and will work together to assist the city to achieve its Greenest City in the World 2020 Action Plan. UBC has provided ten graduate students to support the implementation of the plan. Vancouver has already achieved a 33 percent reduction in municipal operations emissions below 1990 levels. UBC is also in the process of building its Center for Interactive Research on Sustainability (CIRS) which won the Treehugger award for the Best Green Building 2010. The building is the brainchild of Dr John Robinson, UBC professor and Executive Director of Sustainability Initiatives. Architect Peter Busby, of Busby Perkins and Wills, has thrown everything at it – enough photovoltaics to supply 30 percent of the buildings requirements, a wind turbine, ground source heat pumps, solar shading, and high performance glazing. Built with sustainably harvested wood and designed for disassembly, Dr. Robinson believes the project is the highest rated LEEDS building in the world at the moment. It is on budget and ahead of schedule, with an upfront cost premium of only 5 percent.

PUBLIC PERCEPTIONS OF CLIMATE CHANGE

British Columbia's above-average public commitment to the environment, coupled with our low-density population distribution, further contributes to its comparative advantage. Favourable public attitudes lend themselves to public policy support; in BC, the public's general valuation of the environment has fostered progressive environmental policy action. As early as 1995, British Columbians ranked the environment as the second most important problem facing the province, second only to unemployment.[59] Extensive public support of environmental issues and massive investments in climate change research helps establish a political base for which progressive environmental action can be undertaken, and public support for environmental action provides a political base for governments to build upon.

PROGRESSIVE POLICIES

Government policies, at all levels, have reflected British Columbians' commitment to environmentally sustainable living. The first serious commitment to sustainable policy development was seen as early as 1990, culminating in the ambitious BC Carbon Tax scheme launched in 2008 and *The Clean Energy Act* in 2010. A brief review of legislation displays a political willingness on the part of BC governments to meet the sustainability challenge.

1. **Clouds of Change, 1990.** In 1990, the City of Vancouver appointed a Task Force on Atmospheric Change to study the nature of the problem of global environmental change. The task force's final report, entitled Clouds of Change, argued that the city could take the lead and work towards three targets: (1) a complete phase-out of all uses of products containing ozone-depleting chemicals by 1995; (2) a reduction in emissions of sulphur dioxide and methane; and (3) a 20 percent reduction in the 1998 level of carbon dioxide by 2005 through reductions in emissions of local atmospheric pollutants.[60]
2. **Liveable Region Strategic Plan (LRSP), 1996.** In 1996, the City of Vancouver was again at the forefront of sustainable policy development. The LRSP is Greater Vancouver's regional growth strategy. The plan is used by all levels of government in the region as the framework for making regional land use and transportation decisions that are consistent with regional liveability and environmental conservation objectives. Stated generally, the four objec-

59 Blake et al., 1997.
60 Roseland, 1992.

tives of the LRSP are to protect the Green Zone[61]; build complete communities; achieve a compact metropolitan region; and increase transportation choice.[62]

3. **The first BC Energy Plan, 2002.** The BC government's 2002 energy plan, entitled "Energy for Our Future: A Plan for BC," was built on four cornerstones: low electricity rates and public ownership of BC Hydro; secure, reliable supply; more private sector opportunities; and environmental responsibility with no nuclear power sources.[63]
4. **Western Climate Initiative (WCI), 2007.** British Columbia joined the states of Arizona, California, New Mexico, Oregon and Washington in the Western Climate Initiative (WCI). Participation in the WCI is intended to reflect the commitment of governments to take cooperative action to address climate change and implement a joint strategy to reduce GHG emissions.[64]
5. **The second BC Energy Plan, 2007.** In 2007, the BC government unveiled a new energy plan to address the challenges of growing energy demand, higher prices, climate change and the need for environmental sustainability. Key policy actions included promoting conservation, energy efficiency and clean energy while setting out a strategy to reduce GHG emissions and invest in alternative technology.
6. **LiveSmart BC, 2008.** Hoping to build upon the above-mentioned commitment by BC residents to sustainable living, the provincial government launched the LiveSmart campaign to provide further incentives to reward smart choices that save energy, water, fuel, time, and money. This program allows BC residents the advantage of choosing their own ways to reduce their GHG emissions, increase efficiency, and save money related to transportation, home energy use, and other aspects of daily life. The program guides citizen behaviour by subsidizing efficient energy use through rebates and tax deductions.[65]
7. **Climate Action Plan, 2008.** Released in June 2008, BC's Climate Action Plan is an all-encompassing approach to reducing GHG emissions and preparing for the low-carbon realities of the future.[66] The plan incorporates a number of legislative measures that target reductions in GHGs, perhaps most significant of which are the Greenhouse Gas Reduction (Cap-and-Trade) and Carbon Tax Acts. The former involves the implementation of a cap-and-trade system in conjunction with regional partners through the WCI. The cap-and-trade system sets overall emissions levels, while establishing a market-based framework that will allow emitters to trade emissions allowances and offset credits. The Carbon Tax Act creates a powerful economic tool that will help the province reach the targeted 33 percent reduction (of 2007 levels) in GHG emissions by 2020. The Carbon Tax received about 55 percent approval amongst the public in a poll taken shortly after its introduction in 2008.[67] Given that the introduction of new taxes is very rarely welcomed in Canada or elsewhere, this support provides further evidence of the BC public's commitment to the environment.
8. **Pacific Institute for Climate Solutions (PICS), 2008.** The BC government set aside $94.5 million to create the Pacific Institute for Climate Solutions (PICS), hosted and led by the University of Victoria in collaboration with the University of British Columbia, Simon Fraser University, and the University of Northern British Columbia. PICS seeks to "partner with governments, the private sector, other researchers and civil society, in order to undertake research on, monitor, and assess the potential impacts of climate change and to assess, develop and promote viable mitigation and adaptation options to better inform climate change policies and actions."[68]
9. ***The Clean Energy Act,* 2010.** Building on the work of the Green Energy Advisory Task Force, appointed in November 2009, the BC government introduced a new Clean Energy Act in April 2010. The Act seeks to expedite clean energy investments, encourage energy conservation, strengthen environmental protection and promote First

61 The Green Zone protects Greater Vancouver's natural assets, including parks, watersheds, and farmlands.
62 Metro Vancouver, 2010.
63 Government of British Columbia, 2007.
64 Western Climate Initiative, 2010.
65 Government of British Columbia, 2008b.
66 Government of British Columbia, 2008b.
67 Environics, 2008.
68 Pacific Institute for Climate Solutions, 2010.

Nations' involvement in clean electricity development opportunities. Targets contained within the Act include a commitment to meet 66 percent of BC Hydro's future incremental power demand from conservation and efficiency improvements by 2020 and mandates that 93 percent of total electricity generation come from clean or renewable electricity generation. The Act also calls for an integrated resource plan which allows for public input.[69]

With geography *and* relatively progressive policy on our side, BC is in an advantageous position to meet the challenges outlined earlier. Large and diverse clean energy capabilities are abundant in the province, while both the political and the public spheres have expressed their willingness to protect its vast natural resources. We are well positioned to continue to be a leader in North America, and indeed the world, in addressing the sustainability challenge.

So how do we ensure that we continue as a leader and move forward to embrace a low-carbon economy while enhancing the resilience of our energy system? We seek to answer this question in the pages that follow.

69 *The Clean Energy Act,* 2010.

MOVING FORWARD

Thinking through the implications of one's actions is absolutely critical. Here's a brief story from the 1950s that illustrates this imperative:

Borneo is the third largest island in the world, located north of Australia and divided between the countries of Brunei, Indonesia and Malaysia. In the 1950s, malaria was prevalent among the Dayak indigenous people in the interior of Borneo. The World Health Organization (WHO) decided the best solution to address the malaria outbreak was to spray the pesticide dichlorodiphenyltrichloroethane (DDT). At first glance, the program was a success: the number of mosquitoes dropped and the prevalence of malaria declined. But soon, house roofs began falling in, because the DDT killed microscopic parasitic wasps that had kept native thatch-eating caterpillars under control. The government provided the Dayak people with sheet-metal roofs, which proved extremely problematic because the sound of rain pelting the roofs prevented residents from sleeping properly. The DDT-poisoned wasps were eaten by geckoes, which were eaten by cats, which died. Without the cat population to control them, rats multiplied unhindered, substantially increasing the risk of typhus and plague outbreaks. As a result, the air force was commissioned to conduct "Operation Cat Drop" – which parachuted cats into Borneo.[70]

The moral of the story is simple yet challenging: **We need to move to systems thinking. Just like Borneo, our globe is a closed-loop system, and we need to treat it like one.**

It is imperative to understand how things are interconnected in order to find truly adequate solutions to problems. Otherwise, attempted solutions may end up creating a whole host of other complex problems.[71]

The three challenges we currently face—energy, climate change and ecosystem—are all deeply interconnected. So too are the solutions.

In brief—a low-carbon economy and a more resilient energy system together reduce the effect of the energy challenge and the amount of GHGs being pumped into the atmosphere, thereby helping to address both the climate change and ecosystem challenges. In addition, shifting our economy to react to the sustainability challenge will better position BC to compete in the 21st century economy, since all jurisdictions will need to find similar solutions.

But to get there, people must understand the connections between the three challenges and the urgency of addressing them. To ensure that people do not simply throw their hands up in despair, it is also important to reinforce the point that we are already well positioned in BC to address the challenges we face.

The main problem underlying the sustainability challenge is this: humans have an almost unquenchable desire for better lives and improved circumstances, but natural resources are finite. As a result, we must grapple with how the quality of life of people around the world can be improved without continuing to exceed the carrying capacity of our planet.[72]

The answer to all three interrelated challenges is clear: in order to address the energy challenge, the climate change challenge and the ecosystem challenge, we must significantly reduce our ecological footprint and move to a low-carbon economy.

Contrary to what most people assume, reducing our ecological footprint may not necessarily require a lower quality of life. Other countries around the world have managed to maintain a standard of living very similar to our own but with significantly smaller ecological footprints. The Netherlands, for example, has a per capita ecological footprint that is almost half the size of Canada's footprint, but the Netherlands maintains a high standard of living.[73] A high quality of life clearly does not require a massive ecological footprint.

70 Lovins, 2007.
71 Lovins, 2007.
72 Global Footprint Network, 2009.
73 Global Footprint Network, 2009

Reducing our ecological footprint is one important way in which we can help to enhance our resilience to the three interrelated challenges that we face:

- If we reduce our demand for oil, we reduce the effect of the energy challenge and we reduce the amount of GHG emissions we are pumping into the atmosphere.
- If we reduce the amount of our GHG emissions, we reduce the rate of climate change and its consequent effects, a response that will help reduce the extent of environmental degradation.
- If we reduce the extent of environmental degradation and refrain from using ecosystem services unsustainably, we reduce the effect of the ecosystem challenge and move toward the elimination of our ecological deficit, while giving ecosystems the best chance to adapt to any climate shifts that occur.

Through all of this, we enhance our resilience. The energy, climate change and ecosystem challenges present significant threats to the well-being of all species. In order to survive, and in order to thrive, enhancing our resilience is key.

Given the immense importance of the energy sector, it is critical to move beyond ad hoc and reactive approaches to address the sustainability challenge, as it will have significant effects on how and when we use energy. Therefore, ensuring a more resilient, sustainable energy system will require strategic and decisive action.

While the sustainability challenge we face is immense and requires urgent action, humanity has risen to great challenges before and we are certainly able to do so again to address this particular challenge.

BC is well positioned to lead the country, and indeed the world, on sustainable development and cutting-edge energy policy. With pro-active solutions to the sustainability challenge, BC can ensure its position as an environmental leader and capitalize on the advantages this will bring as we shift our approach to how we produce, distribute and consume energy.

Going forward we will need a range of tools to address the sustainability challenge, including **governance, energy conservation, adaptation and insurance.** Each of these is outlined in the pages that follow.

GOVERNANCE

In BC, we have seen significant leadership from the provincial government through initiatives like the carbon tax and climate change strategies, and precedent-setting leadership by municipalities is also notable in areas across the province.

In our context, all orders of government—municipal, provincial and federal—have important roles to play in providing leadership to ensure we adequately address the sustainability challenge. Such leadership will undoubtedly look different from different orders of government and even in different regions. In Sweden, the government enabled sixty communities to make radical commitments to sustainable change throughout the 1980s and 1990s.[74] In BC, we have seen significant leadership from the provincial government through initiatives like the carbon tax and climate change strategies, and precedent-setting leadership by municipalities is also notable in areas across the province.

While this report is aimed at the Government of British Columbia, we must note that there is a leadership vacuum at the federal level. The Institute of Public Administration of Canada has concluded that: "Leadership at the national level is especially needed to meet this large national and international challenge."[75] The Pew Center for Global Climate Change highlighted the need for federal leadership in the US—its conclusions also apply in the Canadian context:

> "The federal government is the most important player for four primary reasons: it owns and manages a significant number of holdings and natural resources; its programs, regulations, and guidelines affect the ability of others to adapt; it is an important provider of technical, fiscal, and other support; and it plays a crucial role in dealing with impacts that cross geographic or jurisdictional boundaries."[76]

Despite the leadership demonstrated by many BC municipalities, there are concerns that provincial government decisions may serve to hamper municipalities by taking away their ability to make necessary decisions to address the sustainability challenge. Concerns have been raised about the disempowerment of BC municipalities through, for example, the Trade, Investment and Labour Mobility Agreement (TILMA), which the BC government signed with the Alberta government in 2007.[77] The provisions contained within TILMA limit municipal councils' ability to ensure the most responsive actions are taken locally regarding climate change mitigation and adaptation, food security, local land and resource use and local economic stimulus. The University of Victoria Environmental Law Centre concludes that, "TILMA has the potential to endanger local initiatives to protect the environment."[78] Similar concerns have been raised about the expanded TILMA, the New West Partnership which now includes BC, Alberta and Saskatchewan.[79]

74 James and Lahti, 2004.
75 Institute of Public Administration of Canada, 2009.
76 Smith et al., 2010.
77 UBCM, 2007.
78 Skeels and Zaltz, 2007.
79 Clark, 2010.

All orders of government must provide increased leadership on addressing the sustainability challenge.

These concerns highlight the need to ensure that municipalities are empowered to implement local solutions to the sustainability challenge.

All orders of government must provide increased leadership on addressing the sustainability challenge. This will require substantial horizontal and inter-governmental cooperation and bold leadership. As the Institute for Public Administration of Canada concluded with regard to energy and environmental issues: "Canadians are ready for action from their governments."[80]

Strong leadership from BC can blaze the trail for the rest of Canada.

SETTING STANDARDS AND PROVIDING LEADERSHIP

Governments have a critical role to play in providing leadership and encouraging citizens and business to make necessary changes. The role of governments in this regard includes engaging in stakeholder consultations, selecting priorities, framing the issues, raising public awareness, setting standards, developing legislation and regulations, providing incentives, enforcing sanctions and demonstrating leadership through Crown corporations, public utilities, and other agencies of government.[81] Governments also have an important coordination role to play, ensuring that decisions about adaptation to climate change or moving to a low-carbon economy are not made in isolation but are rather coordinated across orders of government and relevant agencies.[82]

COMMUNITY ENGAGEMENT

The importance of community engagement as a policy tool to achieve change should not be underestimated. One need only look at the Danish island of Samsø for proof of this. Samsø became the first island in the world to be powered entirely by renewable energy through some innovative but simple community engagement: free beer and a competition. The free beer attracted residents to attend community meetings, and the renewable energy competition created excitement among residents and tapped into the innate human desire to trounce our competitors. The lesson

80 Institute of Public Administration of Canada, 2009.
81 Institute of Public Administration of Canada, 2009.
82 Smith et al., 2010.

from Samsø is that large-scale change is simply a collection of small-scale changes, and it is easy to get change at the local level when residents become excited about a particular course of action.[83]

James and Lahti (2004) studied 60 communities in Sweden which made radical commitments to sustainable change throughout the 1980s and 1990s. Each of the communities made a commitment to the following:

- To eliminate their community's fossil fuel dependence and wasteful use of scarce metals and minerals;
- To eliminate their community's dependence upon persistent chemicals and wasteful use of synthetic substances;
- To eliminate their community's encroachment upon nature; and
- To meet human needs fairly and efficiently.

James and Lahti identify seven specific stages used by these Swedish communities to bring about change:

1. Finding the "fire souls": engaging those community residents who are passionate about bringing about change.
2. Raising awareness: fostering a common understanding of the challenge facing humanity and pointing out that local actions connect to global movements.
3. Endorsing common principles: getting municipal leaders to endorse common principles for sustainable operating and development – this represents the beginning of the institutionalization of change.
4. Involving the implementers: moving beyond the municipal leaders to ensure that those on the ground who will carry out the change are involved in the creation of an action plan – this includes reaching out to community leaders, representatives of interest groups, and residents.
5. Applying the action plan: laying out the steps to achieve the desired change.
6. Endorsing the whole plan: getting official endorsement from the community leadership in order to fully institutionalize the action plan.
7. Keeping it going: continuing to move in the direction of the goal, monitoring success along the way and correcting for failures.[84]

James Meadowcroft, Canada Research Chair in Governance for Sustainable Development, concludes that community engagement is absolutely essential to adequately address major challenges, such as the energy challenge, climate change challenge, and ecosystems challenge:

> [T]hese are issues that cannot be successfully 'sorted out' behind closed doors by scientists, industry leaders, and top state officials. Their reach is too profound; their impact on diverse social strata and practices is too great. And the innovation-potential required to address them is widely distributed.[85]

A critical element to successfully addressing the challenges we face will be a **long-term, extensive public dialogue** about both the extent of these challenges and how to address them. A meaningful dialogue with key stakeholders and citizens about the possibilities for a low-carbon economy and a more resilient energy system will enable a more positive vision of our communities in the future.

If free beer and a competition can transform a Danish island into the first island in the world to be powered entirely by renewable energy, then innovative community engagement can definitely help BC to address the sustainability challenge.

83 Turner, 2007.
84 James and Lahti, 2004.
85 Meadowcroft, 2008.

PRICING

Based on fundamental microeconomic principles, pricing tools can be effective in guiding human behaviour towards environmental objectives without reliance on stringent regulations and continuous oversight. Through the incorporation of negative externalities, the pricing of negative environmental commodities, the valuation of ecological services, and the elimination of misguided subsidies (all of which are explained further below), pricing tools can lead to more sustainable behaviour. Contrary to the assumptions of many, free market principles and environmental sustainability do not have to oppose one another. Properly used, environmental pricing tools employ market principles to attain environmental ends.

Environmental pricing can control externalities and incorporate the full financial costs of environmentally damaging behaviour and development. An externality is something that does not monetarily affect the producer of the good or service, but does influence the standard of living of society as a whole. Negative externalities, such as pollution, are regularly not accurately accounted for in the measure of the total economic costs of a producer's actions. The environmental costs are not subtracted from the producer's revenues and the environmental costs get borne by society as a whole. When market prices fail to include environmental costs or benefits, they mislead firms and consumers about real values and costs and encourage decisions that result in environmental damage.[86] Pricing tools can serve to internalize the externality by transferring the costs onto the producers; which in turns results in greater efficiency in resource management. Despite being a market-based tool, governments, at any level, will ultimately have to lead the way in the application of these pricing tools.

An example of the internalization of negative environmental costs is the reformation of electricity energy pricing. In the case of BC, the development of new, large-scale electricity generation projects to meet the expected demand increases has significant financial and environment expenses. Large hydro projects, for example, require significant environmental investments in the form of altered river flow systems and land losses to reservoirs. If these environmental costs are not incorporated into the per-unit price of electricity consumption, the market will fail to find efficiencies. The market is flawed by the underestimation of costs and overstatement of electricity demand.

For environmental pricing to succeed, it is assumed that society places a value on environmental quality and would be willing to pay something to have pollution reduced. Establishing a price on a negative environmental commodity, such as carbon, creates a market where firms compete to reduce their environmentally harmful behaviour. Given that it is unlikely that all pollution will be eliminated, policy-makers must decide upon standards for an acceptable environment. Thus, the policy-makers' role is to establish 'tolerable' limits of pollution; the subjective evaluation of the minimum standards that must be met in order to achieve what may be described as a 'reasonable quality of life'.[87] By placing a price on pollution that equals the value people assign to the quality of the environment, and letting firms respond to that price in a free market, pricing tools can efficiently reach the desired levels of pollution established by policy-makers.

The creation of carbon credits, or 'cap-and-trade', demonstrates an example of this theory in practice. By pricing carbon emissions and establishing acceptable amounts of carbon pollution, governments create a market for the negative environmental good. Through the manipulation of the tax or price, the government can achieve whatever standards of environmental quality are desired. Firms that have the lowest marginal abatement costs, reduce more pollution than other firms and benefit through the sale of carbon credits. In other words, production will be undertaken by those in the best position to produce environmental quality in the least costly manner. Moreover, attaching a price to pollution will also foster technological innovation as firms become more willing to invest into finding ways to seek greater efficiencies. While there is a long history and exhaustive list of papers and books on this subject, the point in this report is that we no longer have the time to delay taking concrete measures—we must act now.

86 Thompson and Bevan, 2010.
87 Thompson and Bevan, 2010.

Pricing tools are effective in reaching desired environmental outcomes only if they are properly aligned to meet these objectives. Often market interference in the form of subsidies can lead to negative environmental outcomes. Through the misguided use of inefficient regulations, subsidies, and tax exemptions, government policies can upset the market's ability to efficiently manage resources. Government interventions distort the price system and result in environmental degradation, or worsen situations when such degradation already exists.[88] Policy-makers must clearly understand the objectives and possible environmental effects of government-provided subsidies.

Although crucial to the functioning of the Earth's life-support system, ecosystem services tend not to be appropriately valued. Air and water purification, decomposition of waste, soil and vegetation generation and renewal, and greenhouse gas mitigation are examples of the types of services the planet's ecosystem provide. Yet because natural capital is not fully captured in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, it is often given too little weight in policy decisions.[89] Although there exist palpable difficulties in determining exact monetary values for these services, policy-makers must consider these current and future values. The valuation of ecological services will help avoid the so-called 'tragedy of the commons'[90] by creating a more precise measure of the impact of each incremental change to the Earth's ecosystem. The benefits arising from changing our ecosystem must be compared to the costs incurred by society in the long-term. Through the pricing of ecological services, policy-makers are better positioned to undertake cost-benefit analyses that more accurately assess the true benefits and costs of environment-modifying activities.

Despite the stated merits to environmental pricing tools, there are some equity concerns regarding their application. Environmental pricing tools are often accused of unfairly burdening low income people. Consumption taxes based on environmental objectives inflect a greater burden on the poor than on the rich. For example, a carbon tax added to the per-unit price of gasoline will have a higher tax burden on lower income consumers because the tax represents a higher percentage of their income. As a result, critics of pricing tools suggest that conservation and environmental protection through pricing instruments occurs on the backs of the poor. However, consumption taxes do not necessarily need to be entirely regressive. Policy-makers can build into the system a mechanism that redistributes collected tax revenues back to lower income people through tax reductions or benefit payments. This, in fact, is how the BC government has decided to address the equity distribution issue with its provincial carbon tax program. Lower-income British Columbians receive 'Climate Action Credits' in the form of payments added on to the existing federal Goods and Services Tax (GST) Credit.[91] These payments are meant to reduce the financial impact of the regressive carbon-tax on those with lower-incomes.

As it becomes more apparent that human activities are impacting the quality of the environment, new approaches are needed to meet the challenge of changing the way society functions. Although regulations and government oversight have a role in environmental protection, and while community engagement can have a powerful role to play in affecting change, pricing tools take advantage of market powers to reach efficient outcomes. The methods of valuing negative externalities, negative environmental commodities (e.g. carbon), and ecological services are not perfect. Yet, the social and monetary costs of environmental degradation are becoming increasingly clear. Environmental pricing tools hold great promise for affecting change.

88 Barde and Honkatukia, 2003.
89 Costanza et al., 1997
90 The 'Tragedy of the Commons' refers to the challenge of multiple individuals acting independently and rationally (in their own self interest) depleting a shared limited resource.
91 Government of British Columbia, 2008b.

ENERGY CONSERVATION AND A SHIFT TO RENEWABLE ENERGY

As we outlined earlier in this report, moving to a low-carbon economy is an important element of addressing all three aspects of the sustainability challenge: reducing our demand for fossil fuels, reduces the effect of the of the energy challenge and the amount of GHG emissions we are pumping into the atmosphere; reducing our GHG emissions reduces the rate of climate change and its effects, a response that will help reduce the extent of environmental degradation; and, finally, reducing environmental degradation and refraining from using ecosystem services unsustainably reduces the ecosystem challenge and allows us to move toward the elimination of our ecological deficit while also giving ecosystems the best chance to adapt to climate shifts that occur. Therefore, we are convinced that moving to a low-carbon economy is an important and effective way of meeting the sustainability challenge and adapting to its effects.

Increasing energy conservation and energy efficiency is a critical component of moving to a low-carbon economy and meeting the sustainability challenge:

- Energy Conservation: Conserving energy—reducing the amount of energy we use—is a valuable approach to enhancing the resilience of energy systems. If less energy is demanded, less energy needs to be produced and transmitted, saving resources for the future and reducing the strain on current infrastructure and transmission grids.[92] This also buys time for advances in research and development.[93] Demand-side solutions which result in increased energy conservation are critical to enhancing the resilience of the energy system and improving environmental sustainability.[94] Reducing our use of energy not only reduces our GHG emissions, but it also makes good sense in light of the other two challenges we face—as cheap, easy oil becomes more scarce and as our current ecological deficit must be reduced, decreasing our energy use will help us address both of those challenges.
- Energy Efficiency: Energy efficiency refers to how completely energy is used and how much of it is wasted. Increasing the end-use efficiency of energy raises our overall supply of energy and the duration of buffer stocks.[95] Typically, efficiencies are sought in the extraction and conversion aspects of the energy system, as well as occasionally, the distribution aspects. End-use efficiency is often the least exploited area of efficiency, but energy savings that occur nearest to the consumer are the most important savings: due to successive energy conversions, ten units of fuel need to be fed into a conventional thermal power station in order to deliver one unit of energy through a pipe. Conversely, one unit of energy saved in the transmission process saves ten units of energy on the production end.[96] Improving end-use efficiency is thus the quickest and most effective way to save energy, and is therefore an effective approach to enhancing the resilience of the energy sector.[97]

Increasing our reliance on renewable energy sources is another critical way of moving to a low-carbon economy, addressing the sustainability challenge, and adapting to its effects.[98] Reducing our dependence on fossil fuels for energy by increasing our use of cleaner and greener alternatives will mean that we will be less affected by the end of cheap easy oil, we will reduce our GHG emissions, and we will address our massive ecological deficit.

Governments have several levers at their disposal to encourage increased use of renewable energy sources: for example, through regulation and legislation, governments can mandate that renewable energy sources form a certain percentage of the energy portfolios of utilities, or governments can provide incentives to increase our use of renewable energy sources.

92 Kraemer, 2008.
93 Lovins, 2005.
94 Tertzakian, 2009.
95 Lovins, 2005.
96 Lovins, 2005.
97 Lovins, 2005.
98 Tertzakian, 2009.

To encourage increased use of renewable energy sources, the BC government included a provision within *The Clean Energy Act, 2010* that establishes a feed-in tariff program which allows BC Hydro to enter into energy supply contracts with those who generate electricity from clean or renewable resources, specifically biomass, biogas, geothermal heat, hydro, solar, ocean, wind or any other prescribed resource.[99] The intention of such a feed-in tariff program is:

> To create a market to foster the development of emerging technologies that can supply electricity from British Columbia's renewable resources. It would provide an opportunity for electricity generation projects using emerging technologies to prove their performance while earning revenue from their power production.[100]

While moving to a low-carbon economy is critically important, we must also ensure that we enhance our resilience by strengthening infrastructure and improving operations. For example, the inherent intermittent nature of renewable energy sources introduces considerable operational complexity to the energy system. The storage capacity in BC's large reservoirs helps to flatten out this intermittency, but Smart Grid technologies will also play a key role.[101] This would allow demand-side efficiency gains to be coupled with responsive demand that can fluctuate with the availability of renewable energy on the electricity grid at any given time. The section that follows outlines several other key ways in which BC can increase our resilience by strengthening infrastructure and improving operations.

99 *The Clean Energy Act, 2010*.
100 Government of British Columbia, 2010.
101 BC Hydro, 2010c.

ADAPTATION

When facing challenges as great as those outlined in this report, some argue that the focus ought to solely be on preventing the issues in the first place. It is undoubtedly ideal to avoid challenges by foreseeing the consequences of our actions well in advance and adjusting our behaviour accordingly. However, in the case of climate change, current concentrations of GHGs in our atmosphere are already substantial enough to mean that changes in our climate will inevitably occur, regardless of our success at curtailing further GHG emissions.[102,103] Therefore, we must couple our efforts to mitigate the cause of the problem—in the case of climate change: GHG emissions—with efforts to adapt to the effects that are already happening and those that are projected for the future.

TABLE 3 - MITIGATION AND ADAPTATION

MITIGATION	ADAPTATION
Mitigation is defined as follows: "An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases."[1] In other words, mitigation is the elimination or reduction of long-term risk and hazards associated with climate change through the reduction of greenhouse gas emissions.	Adaptation is defined as follows: "[A]djusting decisions, activities, and thinking because of observed or expected changes in climate in order to moderate harm or take advantage of new opportunities."[2] A more technical definition from the IPCC is as follows: "[A]djustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation."[3] Adaptation is intended to reduce vulnerability and enhance resilience. Resilience is defined as follows by the IPCC: "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change."[4]

1. IPCC, 2007.
2. Policy Research Initiative, 2009.
3. IPCC, 2007.
4. Parry et al., 2007, p. 37.

This report is based on the premise that our efforts to mitigate climate change (as well as the energy and ecosystem challenges) must strategically align with our efforts to adapt to the adverse effects that will result from it. Whenever possible, our adaptation efforts should complement our mitigation efforts, and vice versa.

There is no doubt that the three interrelated challenges outlined in this report will have profound effects on all aspects of human society. Oil prices will increase substantially because more and more of the oil we consume will be obtained from oil deposits that are more difficult and costly to access, including tar sands and under ultra-deep water.[104] We will experience the effects of climate change, including increasing climate chaos, flooding, drought, intense heat,

102 Field et al., 2007
103 Meehl et al., 2007
104 Sauven, 2010.

and water scarcity.[105] Because of overconsumption and the subsequent degradation of ecosystems, we will experience declines in the services provided to us by ecosystems, including provisioning services (food, water, timber, fibre and genetic resources), regulating services (regulation of climate, floods, disease, water quality and waste treatment), cultural services (resources available for recreation, aesthetic enjoyment, and spiritual fulfilment), and supporting services (soil formation, pollination, and nutrient cycling). The effects of the energy, climate change and ecosystem challenges are far-reaching.

Table 4 outlines some of the key ways in which each of the challenges will affect our energy system.

TABLE 4 - EFFECTS ON THE ENERGY SYSTEM

CHALLENGE	EFFECTS ON THE ENERGY SYSTEM
Energy	• Our energy system – and indeed our economic system – may be thrown into upheaval because our energy system is based on access to cheap, easy oil, which may no longer be available.[5] • We will need to implement alternative energy solutions.[6] • We will need to dramatically increase end-use energy efficiency.[7] • We will require unprecedented demand-side measures, specifically energy conservation, as well as regulatory provisions, such as building codes.[8]
Climate Change	• We will need to transition to a virtually zero-carbon economy, requiring wholesale changes to how we power our world.[9] • Climate change will lead to reduced heating needs and increased cooling needs for buildings.[10] • Climate change will also affect energy production and supply (a) through interruptions due to extreme weather, (b) in regions dependent on water or thermal power plant cooling that face reductions in water supply, (c) where temperature increases reduce overall efficiencies, and (d) where changed conditions affect decisions about location of facilities.[11] • Energy systems will need to be "climate-proofed"—they must be adapted to withstand the effects of climate change by diversifying energy sources, reinforcing technical equipment and locating it more appropriately, expanding regional linkages, updating disaster preparedness planning, managing demand, and investing in technological change.[12]
Ecosystems	• We will need to increase the efficiency of our resource use and reduce the negative effects on our ecosystems. This will require levels of energy conservation and increases in energy efficiency on a sustained basis that has never before been achieved.[13]

5. Homer-Dixon and Garrison, 2009.
6. Williamson et al., 2009.
7. Lovins, 2005.
8. Tertzakian, 2009.
9. Homer-Dixon and Garrison, 2009.
10. Wilbanks et al, 2008.
11. Wilbanks et al, 2008.
12. Williamson et al, 2009.
13. Millennium Ecosystem Assessment, 2005.

105 David Suzuki Foundation, 2010.

A FOCUS ON THE EFFECTS OF CLIMATE CHANGE

While the end of cheap, easy oil and our ecological deficit will undoubtedly affect our energy system, climate change may prove to have the most profound effect. Changes in temperature and climatic conditions will affect how much energy we use and when we use it. Temperature and climatic changes will also have effects on energy production and transmission. In particular:

- **Climate change will affect the *demand* for energy:** Studies indicate that it is 'virtually certain' that climate change will lead to increased demand for cooling and reduced demand for heating[106] and 'very likely' that temperature increases will lead to higher peak demand for energy.[107] Demand for energy could also be affected by increased energy use resulting from the effects of climate change (e.g. increased water pumping and desalination in areas adversely affected by water shortages).[108]
- **Climate change will also affect the *supply* of energy:** All existing sources of energy are vulnerable to climatic variability. Climate change will affect water and air temperature, the frequency and speed of the wind, humidity levels, precipitation amounts, and the frequency and severity of extreme weather events. All of these mechanisms could profoundly affect the production and supply of both renewable and traditional sources of energy. Table 5 outlines how the specific climate change impacts will affect key energy sources in British Columbia.

TABLE 5 - EFFECTS OF CLIMATE CHANGE ON ENERGY SUPPLY IN BRITISH COLUMBIA

(T = water and air temperature; W = wind; H = humidity; P = precipitation; and E = extreme weather events).

ENERGY SOURCE	BC %[14]	CLIMATE IMPACT MECHANISM[15,16]
Hydropower	92.8%	• Water availability and quality (T, E). • Temperature-related stresses (T, E). • Operational modification due to extreme weather such as floods and droughts (T, E).
Natural Gas	6.0%	• Cooling water quantity and quality (T). • Cooling efficiency (T, W, H). • Disruptions of off-shore extraction and transport (E).
Waste & Biomass	1.0%	• Potential short-term impacts from timber kills (W, E). • Potential long-term impacts from timber kills and changes in tree growth rates (T, P, H, E, and CO_2 levels). • Changes in food crop residue and dedicated energy crop growth rates (T, P, H, E, and CO_2 levels).
Diesel Oil	0.2%	• Cooling water quantity and quality (T). • Cooling efficiency (T, W, H). • Disruptions of off-shore extraction and transport (E).

14. Percentage of total energy mix in 2004. Source: BC Energy Plan (2007).
15. Wilbanks et al, 2008.
16. Tierney, 2007.

106 Wilbanks et al, 2008.
107 Wilbanks et al, 2008.
108 Tierney (2007).

ADAPTING OUR ENERGY SYSTEM TO CLIMATE CHANGE

As discussed earlier, this report is based on the premise that some amount of climate change is unavoidable. Because a certain amount of damage has already been done,[109,110] it is critically important to focus on adaptation in addition to mitigation. Energy is not only a driver of climate change; it will also be affected by climate change. Therefore, adaptation will be required.

The Government of Canada's Policy Research Initiative (PRI) held a workshop on climate change adaptation in the Canadian energy sector in January 2009, which concluded:

> There is some adaptation occurring in Canada, particularly within industry, but it is still ad hoc and reactive. Integrating climate change impacts into existing planning processes such as risk management is a constructive approach. Barriers to overcome to make adaptation more strategic include limitations in awareness, availability of information, and decision-making support tools.[111]

Common, broad approaches to advancing adaptation in the energy sector identified by the PRI include:

1. **Thinking and planning for the long-term** – long-term approaches are needed in planning of policies, regulations, codes, standards, business strategies and infrastructure design;
2. **Sharing and disseminating knowledge, research and best practices** – education is key to advancing adaptation within the energy sector;
3. **Resolving funding mechanisms and market signals** – incentives may be necessary, including providing funding in order to advance adaptation work within the industry, until we find an adequate way of pricing the externality;
4. **Integrating climate change adaptation** into existing planning and decision-making processes;
5. **Harmonization of policies, regulations and standards** – industry considers the provision of clear signals and the harmonization of policies, regulations and standards between the various orders of government as an important element of advancing adaptation and linking it with mitigation;
6. **Improved incorporation of science**; and
7. **Linking mitigation and adaptation approaches.**

ENHANCING RESILIENCE THROUGH STRENGTHENED INFRASTRUCTURE AND IMPROVED OPERATIONS

Changes in our climate could affect the supply of energy through impacts on infrastructure that may challenge our operations.

The vast majority of BC's energy is derived from hydro production. Table 6 contains specific examples of hydro production adaptation instruments identified at the Policy Research Initiative energy adaptation workshop: operational, non-structural adaptations are applicable with regard to existing infrastructure, whereas structural adaptations can be integrated into the design of new infrastructure.

109 Field et al., 2007.
110 Meehl et al., 2007.
111 Policy Research Initiative, 2009.

TABLE 6 - ADAPTATION INSTRUMENTS FOR HYDRO INFRASTRUCTURE PLANNING AND OPERATIONS[112]

NON-STRUCTURAL	STRUCTURAL
• Bring changes to operating rules. • Develop or improve hydrological forecasting tools. • Better coordination of the operation of the project with other water-use projects in the watershed. • Develop improved technologies to evaluate the performance of projects and to identify ways of operating them under modified climatic conditions. • Modification of engineering design practices.	• Divert water course of upstream tributaries. • Create new upstream storage reservoirs. • Increase the capacity of spillway. • Design dams in such a way that, if needed, additional spillways or other physical components could be considered in the project. • Modify the dimensions of canals in order to reduce head loss or increase their discharge capacities. • Modification to the characteristics of electrical components (generators, transformers, transmission line, etc). • Add controllable gates to free spillways.

Climate change could also affect the transmission and distribution components of our energy system. BC's extensive transmission and distribution system includes over 18,000 kilometres of transmission lines, 56,000 kilometres of distribution lines, 888,399 utility poles and 323,238 transformers.[113] Transmission infrastructure will obviously be affected by high winds, extreme weather events and increased wildfires. Transmission and distribution infrastructure will also affected by temperature: hotter temperatures cause transmission lines to sag which diminishes their ability to carry electricity[114] and leads to increased losses of energy during transmission and distribution.[115] Currently, there is a dearth of research on how climate change will affect transmission and distribution technology. Governments and power companies would be well advised to fund additional research and development to ensure our infrastructure is capable of withstanding the effects of climate change and transmitting energy in the most efficient manner possible.

Of course, we must note that the risk-reward calculus tends to keep investors from putting their money into developing new energy technologies because of the risk of the failure of that new technology as well as the need for regulatory changes. While governments cannot protect against technology failures during research and development, they can ensure a policy environment that encourages innovation rather than allowing regulations to act as a barrier to innovation. Governments can also increase their own spending on energy innovation, including stable funding for research and development.[116]

112 Policy Research Initiative, 2008.
113 BC Hydro, 2010.
114 Tierney, 2007.
115 Reiter, 2009.
116 American Energy Innovation Council, 2009.

INSURANCE

Successful adaptation measures are fundamentally important to both maintaining and extending insurability.

Climate change presents a significant challenge for the insurance industry. The challenge arises because standard underwriting practices have been grounded in historical experience and will now require risk quantification approaches that are anticipatory.[117] This challenge is demonstrated by the effect of Hurricane Andrew in south-eastern Florida in 1992: $22.3 billion of insured damage was caused and nine insurers were made insolvent because their underwriting practices were based on historical occurrences over the preceding 30 years, during which time there had not been a hurricane of such a magnitude.[118] It was not only the nine insurers that were caught off guard by Hurricane Andrew: a hurricane of such a magnitude, along with the increasing frequency of hurricanes after 1995, was largely unanticipated by property developers and policy makers as well.[119] This underscores the need for all sectors to work together collaboratively to ensure adequate adaptation occurs. A study in the UK demonstrated that, in spite of increased incidence of storm surge as a result of climate change, insurable losses resulting from storm surge in 2030 would actually be lower than they are today if appropriate adaptation occurs in high-risk coastal communities.[120] Another study on the tropical Atlantic coastline showed that simply building a home on an elevated platform (between 0.5 and 1.5 metres high) would reduce insurable losses to between 10 and 80 percent below their present day levels, in spite of sea level rise causing 1-in-200 year losses to increase by 20 percent. It is clear that successful adaptation measures are fundamentally important to both maintaining and extending insurability.[121]

But climate change also presents an opportunity for the insurance industry because the insurance tool can be used to promote adaptation.[122,123] Despite the predictions of major changes to global climate patterns, policy action in many respects has been slow. Inaction can largely be attributed to three factors: First, many people doubted the reality of climate change for quite some time, despite considerable agreement between scientists. Second, because both the causes and impacts of climate change are of a global nature, policy solutions frequently require pan-jurisdictional coordination and synchronized responses. The conversion to a low-carbon economy is expensive and requires an internationally coordinated and synchronized response in order to avoid undue costs accruing to early adopters,[124] and policy-makers are wary of policy innovations that involve an assumption of an inequitable amount of risk. Third, because of the global

117 Herweijer, Ranger and Ward, 2009.
118 Swiss Re, 2006.
119 Herweijer, Ranger and Ward, 2009.
120 Lloyd's of London, 2008.
121 Herweijer, Ranger and Ward, 2009.
122 Herweijer, Ranger and Ward, 2009.
123 Mills, 2007.
124 Zurich, 2009.

Insurance premiums can induce relocation away from higher risk areas and encourage more robust building codes.

ambivalence towards climate change predictions, measuring the potential risks posed by the threats to human health, economic activity, and ecosystem damage is complex. For that reason, it is difficult to attach a monetary value to the risks, which in turn makes it hard to validate expensive, long-term solutions to the climate change problem while balancing economic growth and competition.

The abovementioned impediments to policy action are centred on the uncertainties surrounding climate change. Ultimately, climate change is about risk, and insurance providers excel at risk management. In exchange for the payment of premiums, insurance providers are willing to take on the risk of future losses to a second party. Inherent to this process is the capacity of insurers to recognize and price risk. Insurance is also instrumental in ensuring the deployment of technology that is sustainable and economically efficient. Insurers' efforts to protect assets and avoid risk foster an environment of innovative behaviours and technology development. Taken together, these capabilities lend themselves naturally to developing products and mechanisms that reduce the risks presented by climate change.

There are a number of methods that insurers can use to assist public and private sector policy makers reach their adaptation and mitigation objectives[125]:

- *Awareness and risk education*: Insurers can provide extensive knowledge on the loss causes associated with many of the risks anticipated from climate change.[126] For example, insurance premiums can induce relocation away from higher risk areas and encourage more robust building codes.[127]
- *Risk pricing*: By accurately pricing risk, insurers can incentivize risk-reducing decision-making. As a result, reliable and consistent price signals are established for policy makers.
- *Enabling conditions and regulation of insurance programs*: Through legislations, financial oversight and monitoring, public and private policymakers can provide incentives for insurance to promote risk-reducing activities.
- *Direct financing of risk and reduction measures*: Insurers can invest directly in risk reduction measures to avoid large compensation claims.
- *Risk reduction as a prerequisite for insurance*: As a prerequisite for coverage, insurers can require that policyholders undertake specific risk reduction measures. This instrument has parallels to the way insurance companies have used building code inspection and enforcement to make housing more protected from the threat of fire. [128]

125 Warner et al., 2009.
126 Warner et al., 2009.
127 Cook and Dowlatabadi, 2010.
128 Warner et al., 2009.

As market-based instruments, these tools of insurance can only be effective if government actions do not distort or undermine the private incentives.[129] Insurers must be left to accurately price risk and attach these costs to liabilities of risky behaviour. In other words, risk-reducing behaviour will only occur if actors are held fully responsible for their risky behaviour. An example in the context of climate change is the United States National Flood Insurance Program. By providing broad financial aid packages to flooded homes and businesses, this program undermines the feasibility of a private insurance market.[130] For insurance to be most effective, government must let the knowledge and experience of the industry work.

This does not mean that government should step out of the way entirely. Governments have a critically important role to play in supporting good risk management in society and partnering with the insurance industry through the development of appropriate and stringent building code requirements and other standards, based on an understanding of the way that climate change will radically alter historical expectations in terms of weather patterns, sea-level rise, even new health risks.

Currently, the insurance industry uses its own insurance codes to achieve improvement in existing infrastructure. However, according to a report prepared by major international insurer Zurich, "if policy makers were to simply change building code standards to make this resilience mandatory, the speed of adaptation would increase."[131] Similar calls for more stringent building codes have come from a number of insurers[132] and insurance economists.[133] The insurance industry itself must also ensure that it is not only basing its risk assessments on 'experienced risks', because climate change demands that 'anticipatory risks' also be considered in order to promote proactive adaptation to climate change.[134]

Climate change presents enormous challenges to public policy makers. The timelines for climate change vary, the magnitude of impacts is uncertain, and best practices in terms of responses to these threats are in the process of being developed. Insurance as a tool for adaptation and mitigation can effectively and efficiently manage these uncertainties. As a market-based instrument, it is responsive to the evolving pressures of severe weather events. It not only encourages risk-averse behaviour on the part of public and private actors, it can also foster the innovation of new ideas and technologies that rise to the challenges of climate change. The risks inherent in climate change dictate a role for insurance to balance risk exposure and financial sustainability. Cooperation and collaboration with public policy makers can help to achieve full utilization of the insurance tool in the face of climate change, as well as the energy and ecosystem challenges.

129 Zurich, 2009.
130 Zurich, 2009.
131 Zurich, 2009. p. 5.
132 Mills, 2007.
133 Herweijer, Ranger and Ward, 2009.
134 Cook and Dowlatabadi, 2010.

POLICY OPPORTUNITIES

The following list of policy opportunities is by no means fully comprehensive or necessarily original. BC is blessed with a wide range of competent NGOs, academics and policy makers that are constantly evaluating our situation and providing policy recommendations, some of which have been included here. The goal of this report is to emphasize the urgent need to **act now** and to lay out some of the key policy opportunities that exist.

Acting now makes good economic sense. In 2005, the United Kingdom government commissioned Sir Nicolas Stern to conduct a review of the economics of climate change. Stern concluded that the costs of urgent and decisive action to reduce GHG emissions, in order to avoid the serious consequences of climate change, are significantly less than the costs associated with the consequences that will be avoided.[135] If we act now, it will cost us less than if we fail to act.

BC is well positioned to lead Canada and the rest of the world on sustainable development and cutting-edge energy policy. With pro-active solutions to the sustainability challenge, BC can maintain its position as an environmental leader and capitalize on the advantages this will bring as we shift our approach to how we produce, distribute and consume energy. It must be noted that all economies are going to have to adjust and, by building on the reputation we have developed, we will be able to position ourselves well to compete in the economy of the 21st century.

Of course, actions in BC cannot solve the global sustainability challenge, but we have to be part of a global movement to take action. We are well positioned to continue to be a global leader.

In order to address the sustainability challenge, we have to adjust our risk profile and start to adopt policies more quickly at every level of government. While action needs to take place at many levels, we have concentrated our recommendations on the four policy areas emphasized in this report: **governance, energy conservation, adaptation and insurance.**

We have identified policy opportunities in each of these categories based on thorough research on current provincial policy, the goals of the Climate Action Secretariat, approaches being considered around the world, and practical measures that are open to BC in the coming months:

GOVERNANCE

1. **Establish a National Centre for Sustainable Energy Solutions** to lead the nation in the transition to clean energy. In addition to making connections and building key relationships, the Centre could fund research and pilot projects and aggressively promote the transition to clean energy and a low-carbon economy. The Centre should build on environmental leadership already underway in Canada, marshalling the venture capital industry, utilities, all orders of government, business and post-secondary resources to fund and promote resilient, sustainable, clean energy technology development and commercialization.
2. **Raise the price of carbon.** The BC government should raise the price of carbon by at least $5 per tonne per year after 2012, while evaluating our progress on our emission reduction targets by 2015. The carbon tax should continue to be revenue-neutral in the sense that it should not be used to fill the province's General Revenue Fund and it should continue to ensure that low-income individuals and households are protected. Surplus funds from the carbon tax – those funds remaining after low-income rebates are paid – should be devoted to ease and quicken BC's transition to a low-carbon economy, including to assist with energy retrofits and promote innovation. The BC government should also provide leadership through the Council of the Federation in order to establish a national framework for the effective pricing of not only carbon but also water and ecosystem services.
3. **Establish a timeframe in which to move electricity prices to more accurately reflect the market price or cost of new supply.** The timeframe should be sufficient to allow for the economy and individual British Columbians to adjust. The additional revenue should be used to offset the effect on low-income individuals and

135 Stern, 2006.

households, with additional surplus funds used to support the transition to a low carbon economy. In the interim, the BC government should direct BC Hydro to expand their two-tier pricing strategy to all classes of customers and ensure that the top-tier reflects market prices for at least 30% of BC Hydro's customer load. (This would be coupled with a an increase focus on energy conservation, including retrofit programs).

4. **Establish a system of ecosystem-specific carbon offsets,** in order to restore or at least conserve those ecosystems that sequester carbon.
5. **Establish a Natural Capital Index,** similar to the Nature Index of Norway, which would supplement our current reliance on GDP as a measure of progress to ensure that ecosystem services are taken into account.
6. **Tighten the building code and increase the requirements for zero emission buildings throughout the province.** The BC government should also require new public buildings to be evaluated using a lifecycle-cost methodology that incorporates consideration of climate change projections.
7. **Provide leadership through the Council of the Federation to implement a national mandatory energy-emissions labelling requirement.** This could be similar to Germany's Blue Angel program, implemented over thirty years ago. Such a program works as an innovative force as well as a reliable aid to consumers by providing them with important information on the life-cycle emissions of products.[136]
8. **Establish a world-class biennial competition for the best sustainable development plan created by Regional Districts which focuses on transitioning to a low carbon economy.** Funding to assist in the implementation of this program should be derived from surplus funds resulting from the carbon tax and electricity prices that more accurately reflect the market price. This program should encourage building upgrades, district energy systems, and zero carbon transportation alternatives.
9. **Facilitate an ongoing, extensive, province-wide public dialogue and the development of a sustainable development action strategy.** This could be based on models already developed in BC, such as QUEST, Sustainable Cities, and MetroQuest.
10. **Provide leadership through the Council of the Federation to establish a national adaptation framework.** The national adaptation framework should encourage increased coordination of adaptation efforts in all sectors, including energy.

ENERGY CONSERVATION AND A SHIFT TO RENEWABLE ENERGY

1. **Encourage energy conservation and efficiency.** This is undoubtedly the most important component of any energy strategy. BC Hydro is already a world leader in encouraging conservation and efficiency but they should enhance those efforts by implementing a demand-side call for energy reduction of 5,000 GWH/year of energy savings.
2. **Encourage increased energy retrofits by promoting the already-proven business case for energy retrofits and making it worth it for homeowners to undertake them.** Strategic retrofits can increase building resilience to extreme weather as well as reduce emissions. Unfortunately, upfront costs often act as a barrier to undertaking energy retrofits. The BC government should provide increased education about the business case for retrofits, and put in place appropriate incentives to undertake them.
3. **Develop the full suite of clean, renewable energy sources available in British Columbia.** This is in keeping with *The Clean Energy Act (2010)* and is essential as we move towards a zero carbon world. In order to accomplish this, the provincial government needs to establish a framework to guide this development. We urge the provincial government to adopt the recommendations for clean energy development produced by a consortium of non-governmental organizations including the David Suzuki Foundation, Pembina Institute and Watershed Watch Salmon (see Appendix B). It is also important to establish a hierarchy for fossil fuels based on fit with purpose. For

136 For more information, see: http://www.blauer-engel.de/en/blauer_engel/balance/success_stories.php

example, aviation, ships, plastics and fertilizers will require fossil fuels for the foreseeable future; cars, homes and public transportation can more easily convert to renewable energy. Because we cannot wean ourselves off fossil fuels immediately, we need a game plan to get us there.

4. **Develop a feed-in tariff program.** This is also in keeping with *The Clean Energy Act (2010)* and would target community renewable energy close to markets. This could include bio-energy from municipal sewage and organic solid waste, agricultural waste and forest waste.
5. **Support increased electrification of the transportation sector.** The BC government should develop a program to provide infrastructure and other support to electric vehicles (both individual and commercial vehicles; both battery and hybrid vehicles). This should include the subsidization of metered recharging equipment for public areas (throughout BC) and assistance for industry and households with on-site installation of recharging equipment. This would require the BC government to direct BC Hydro to establish the necessary infrastructure and to direct the British Columbia Utilities Commission (BCUC) to allow such expenditures. The BC government should also create a revenue neutral fee-bate system for zero emission vehicles, using the initial licensing fee or the annual licensing fee.

ADAPTATION

1. **Increase funding for research and development to ensure technology and infrastructure—including reservoirs and transmission lines—is capable of handling increased strain resulting from the effects of climate change.** This would require provincial government direction to BC Hydro, and would build on investments already made by the former British Columbia Transmission Corporation (BCTC).
2. **Commission a study to examine the value of assets at-risk and the economic costs of coping with and adapting to climate change by 2100, if the world continues on its business-as-usual path.** This study should include a sea-level rise assessment report, which should consider a range of scenarios for 2050 and 2100 and advise on the cost of planning for future sea-level rise, as California is doing. The results of this study should be publicized widely in order to increase awareness of the urgent need to act.[137]
3. **Require and support each of BC's municipal governments to prepare a regional version of the same report with a financial update every five years.** The BC government should support municipal governments in this regard by providing a common planning framework, online access to current downscaled climate data, and provincial grants.
4. **Mainstream adaptation and climate data/impact projections into all decision making and planning.** The BC government should ensure that mitigation efforts and adaptation efforts are complementary whenever possible and support research into ways to combine these two inter-related paradigm shifts.

INSURANCE

1. **Collaborate with the insurance industry to ensure full utilization of the insurance tool in both adaptation and mitigation of climate change. Resist, as much as possible, any government interference that undermines or distorts the incentives within the insurance market that are designed to mitigate and manage risk.** Insurance can be an effective tool to encourage risk-averting behaviour and foster the innovation of new ideas and technologies that rise to the challenges of climate change. However, these mechanisms can only be effective if public policy decisions do not undermine their efficacy.
2. **Develop a distance-based vehicle insurance program.** This would require provincial government direction to the Insurance Corporation of British Columbia (via a special direction to the British Columbia Utilities Commission).

137 BCSEA recommendation #58.

CONCLUSION

We face some of the most challenging and yet innovative times in the history of humanity.

Addressing the three interrelated challenges we face and achieving a sustainable future will mean not only substantial reductions in GHG emissions from today's levels, but also other significant environmental, social, and economic benefits, including;

- More cost-competitive BC businesses through improved resource and energy efficiency and the easier movement of goods
- Major improvements in local air quality from the reduction of smog precursors and particulates
- Healthier and more liveable communities for existing citizens and skilled workers from outside the province seeking a place to live
- Greater preservation of BC's unique wilderness and natural areas as a result of more sustainable resource extraction and land use practices
- Increased tourism and business location successes due to a high quality of life
- Enhanced attractiveness for international investment

As we delve deeper into the nature of effective adaptation to the sustainability challenge, it becomes increasingly apparent that we must address adaptation and mitigation approaches together, in order to save time and money, and ensure that we do not develop approaches for one that undermine the other. This report represents ACT's first attempt to draw these strands together, as well as those presented by other sustainability issues.

We are fortunate to live in BC, a province that has already taken a leadership role on innovation in both clean technology and policy relating to mitigation, with enormous potential to do the same for a coordinated mitigation-adaptation approach, especially through the actions of provincially supported initiatives such as PICS.

Due to climate change, which acts as a driver for other serious issues that already exist such as peak oil and ecosystem stress, we face some of the most challenging and yet innovative times in the history of humanity, and BC has the resources and leadership to show the way to many other jurisdictions that will follow.

We hope that the thoughts and policy opportunities presented in this report will prove useful as BC moves forward as a leader in the era of the low-carbon, resilient economy.

REFERENCES

American Energy Innovation Council (2009). *A Business Plan for America's Energy Future.* Washington, DC: AEIC. Available at: http://www.americanenergyinnovation.org/full-report

Averyt, M.T. and H.L. Miller (Eds.) (2008). *Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* (pp. 748-845). Cambridge, UK: Cambridge University Press.

Barde, J-P. and O. Honkatukia (2003). "Environmentally Harmful Subsidies." *Institut du développement durable et des relations internationals (IDDRI).* http://www.iddri.org/Activites/Seminaires-reguliers/barde.pdf

BC Hydro (2010a). *Organizational Overview.* Vancouver: BC Hydro. Available at: http://www.bchydro.com/annual_report_2010/organization_overview.html.

BC Hydro (2010b). *Site C Clean Energy Project.* Vancouver: BC Hydro. Available at: http://www.bchydro.com/planning_regulatory/site_c.html

BC Hydro (2010c). *Smart Technology.* Vancouver: BC Hydro. Available at: http://www.bchydro.com/planning_regulatory/projects/smart_metering_infrastructure_program/smart_meter_and_grid_technology.html

Blake, D., N. Guppy, and P. Urmetzer (1997). "Canadian Public Opinion and Environmental Action: Evidence from British Columbia." *Canadian Journal of Politiqua Science / Revue canadienne de science politique.* 30.3 (1997): 451-72. http://www.jstor.org/stable/3232087.

Clark, C. (2010). *The New West Partnership, TILMA, cities, and you … why this all matters.* Saskatoon: Charlie Clark. Available at: http://charlieclark.ca/the-new-west-partnership-tilma-cities-and-you-why-this-matters

Climate Change Congress (2009). *Key Messages from the Congress.* Copenhagen: University of Copenhagen. Available at: http://climatecongress.ku.dk/newsroom/congress_key_messages/.

Cook, C. and H. Dowlatabadi (2010). *Learning Adaptation: Climate-Related Risk Management in the Insurance Industry.* Unpublished manuscript.

Costanza, R. (1997). "The value of the world's ecosystem services and natural capital." Nature 387, (1997): 253-260.

David Suzuki Foundation (2010a). *Biomass.* Available at: http://www.davidsuzuki.org/issues/climate-change/science/energy/biomass/

David Suzuki Foundation (2010b). *Climate Change.* Available at: http://www.davidsuzuki.org/issues/climate-change/

David Suzuki Foundation (2010c). Protecting the Peace: DSF's statement on BC's Site C project. Available at: http://www.davidsuzuki.org/media/news/2010/04/bcs-site-c-project-statement/

Environics (2008). *British Columbians Give Nod of Approval to their New Provincial Carbon Tax.* Available at: http://erg.environics.net/media_room/default.asp?aID=668.

Field, C.B., L.D. Mortsch,, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W. Running and M.J. Scott. (2007). North America; in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds, Cambridge: Cambridge UP, 617-652.

Finlayson, J. and K. Peacock (2009). *British Columbia's Global Linkages: A Snapshot*. Vancouver, BC: Business Council of British Columbia.

Flannigan M., K. Logan, B. Amiro et al. (2005). "Future area burned in Canada." *Climatic Change*, 72,1-16.

Gates, B. (2010). "Innovating to Zero." *Ted Talks*. New York: Ted Conference LLC. Available at: http://blog.ted.com/2010/02/innovating_to_z.php

Global Footprint Network (2009). *World Footprint: Do We Fit on the Planet?* Oakland, CA: Global Footprint Network.

Globe Foundation (2007). *The Endless Energy Project: A Blueprint for Complete Energy Self-Sufficiency in British Columbia*. Vancouver, BC: Globe Foundation.

Government of British Columbia (2007). *The BC Energy Plan*. Victoria, BC: Government of British Columbia. Available at: http://www.energyplan.gov.bc.ca/default.htm

Government of British Columbia (2008a). *BC Bioenergy Strategy*. Victoria, BC: Government of British Columbia. Available at: http://www.energyplan.gov.bc.ca/bioenergy/

Government of British Columbia (2008b). *Climate Action Plan*. (2008): Apr. 7, 2010. http://www.metrovancouver.org/planning/development/strategy/Pages/LivableRegionStrategicPlan.aspx.

Government of British Columbia (2009). *B.C.'s Greenhouse Gas Emissions*. Victoria: Government of BC. Available at: http://www.livesmartbc.ca/learn/emissions.html.

Government of British Columbia (2010). *Feed In Tariff Regulation Consultation Paper*. Victoria, BC: Government of British Columbia. Available at: http://www.empr.gov.bc.ca/RET/RenewableEnergyTechnologies/Documents/Feed%20In%20Tariff%20Consultation%20Paper.pdf

Heinberg, R. (2008). "Nine Percent". *Energy Bulletin*. Sebastapol, CA: Post Carbon Institute. Available at: http://www.energybulletin.net/note/47041.

Herweijer, C., N. Ranger, and R. Ward (2009). "Adaptation to Climate Change: Threats and Opportunities for the Insurance Industry." *The Geneva Papers*, 34, (360-80). The International Association for the Study of Insurance Economics.

Homer-Dixon, T. (2006). "The End of Ingenuity". *The New York Times*. New York: The New York Times.

Human Resources and Skills Development Canada (2010). *Environment – Greenhouse Gases*. Ottawa: Government of Canada. Available at: http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=64.

Homer-Dixon, T. and N. Garrison (Eds) (2009). *Carbon Shift: How the Twin Challenges of Oil Depletion and Climate Change Will Define the Future*. Toronto: Random House.

International Energy Agency (2008). *World Energy Outlook 2008 Fact Sheet: Global Energy Trends*. Paris: International Energy Agency.

International Energy Agency (2009). *From Financial Challenge to 450 ppm: the IEA Maps Out the Energy Sector Transformation and its Financial Consequences Under a Global Climate Agreement*. Paris: International Energy Agency. Available at: http://www.iea.org/press/pressdetail.asp?PRESS_REL_ID=290.

International Energy Agency (2010). *CO2 Emissions From Fuel Combustion*. Paris: International Energy Agency. Available at: http://www.iea.org/co2highlights/

Intergovernmental Panel on Climate Change (2007). "Summary of Policy Makers." *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor. And H.L. Miller (Eds). Cambridge, UK: Cambridge University Press.

Institute of Public Administration of Canada (2008). *Climate Change and Canadian Public Policy: Adaptation and Action*. Toronto: IPAC. Available at: http://www.ipac.ca/documents/AdvicetoGovernment.pdf.

James, S. and T. Lahti (2004). *The Natural Step for Communities: How Cities and Towns Can Change to Sustainable Practices*. Gabriola, BC: New Society Publishers.

Kraemer, R.A. (2008). "What Price Energy Transformation?" *Survival*, 50:3, 11-18.

Lardelli, M. (2010). "The Peak of Oil Production is Passed". *Energy Bulletin*. Sebastapol, CA: Post Carbon Institute. Available at: http://www.energybulletin.net/52667.

Larsen, K. (2009). *End-of-life PV: then what? – Recycling solar PV panels*. Available at: http://www.renewableenergyfocus.com/view/3005/endoflife-pv-then-what-recycling-solar-pv-panels/

Lloyds of London (2008). "Coastal Communities and Climate Change: Maintaining Future Insurability", part of the 360 Risk Project. www.lloyds.com

Lovins, A.B. (2005). *Energy End-Use Efficiency*. Snowmass: Rocky Mountain Institute. Available at: http://www.udel.edu/igert/JournalClub/JC5.pdf

Lovins, A.B. (2007). *Imagine a World*. Snowmass: Rocky Mountain Institute. Available at: http://www.rmi.org/cms/Download.aspx?id=1390&file=ImagineAWorldOCR.pdf&title=Imagine+a+World.

McKibben, B. (2010). *350 Science*. Washington: 350.org. Available at: http://www.350.org/about/science.

Meadowcroft, J. (2008). *Governing the Transition to a New Energy Economy*. Ottawa: Carleton University.

Meehl, G., T. Stocker, W. Collins, P. Friedlingstein, A. Gaye, and J. Gregory. (2007). Global climate projections. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B.

Mills, E. (2007). "From Risk to Opportunity: 2007", *Insurer Responses to Climate Change*. A CERES-Report. Boston.

Metro Vancouver. (2010). "Livable Region Strategic Plan." Apr. 6, 2010. http://www.metrovancouver.org/planning/development/strategy/Pages/LivableRegionStrategicPlan.aspx.

Millennium Ecosystem Assessment (2005a). *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press.

Millennium Ecosystem Assessment (2005b). Ecosystems and Human Well-being: Biodiversity Synthesis. Washington, DC: World Resources Institute.

Mitchell, S. (2008). *Canadian Living Planet Report 2007*. Toronto: WWF-Canada.

O'Riordan, J. (2009). ACT Summary Report: Climate Change Adaptation and Biodiversity. Vancouver, BC: Simon Fraser University's Adaptation to Climate Change Team.

Pachauri, R.K and A. Reisinger (2008). *Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva: Intergovernmental Panel on Climate Change, 2007.

Paulsen, M. (2008). *Groups say BC's bioenergy plan will worsen global warming.* Available at: http://thetyee.ca/Blogs/TheHook/Environment/2008/09/25/UBCMBioenergy/print.html

Parry, M., O. Canziani and J. Palutikof (2007). Technical summary. In M. Parry, O. Canziani, J. Palutikof, P.J. van der Linden, and C. Hanson (Eds.), *Climate change 2007: Impacts, aAdaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. (pp. 23-78). Cambridge: Cambridge University Press.

Policy Research Initiative (2009). *Climate Change Adaptation in the Canadian Energy Sector*. Ottawa: Government of Canada.

Ralston, J. (2008). "Peak Oil: The Eventual End of the Oil Age". *Energy Bulletin*. Sebastapol, CA: Post Carbon Institute. Available at: http://www.energybulletin.net/50840.

Reiter, U. (2009). "Climate Change Adaptation Scenario for the European Electricity Sector". *Earth and Environmental Science* 6 (2009).

Romm, J. (2010). "The Year Climate Science Caught Up With What Top Scientists have Been Saying Privately for Years". *Climate Progress*. Available at: http://climateprogress.org/2010/01/04/the-year-in-climate-science-scientists/.

Roseland, M. (1992). "The Greening of North American Local Government: Local Responses to Global Environmental Change." *Planning Practice and Research*. 7.1 (1992): 13.

Satter, R. (2010). "'Climategate' Investigation Vindicates Scientists, Finds Research Reliable." Associated Press.

Sauven, J. (2010). "Peak Oil Predictions". *The Guardian*. London: The Guardian.

Skeels, M. and F. Zaltz (2007). *TILMA and Local Government Environmental Initiatives*. Victoria: University of Victoria Environmental Law Centre

Smith, J.B., T. Cruce, S. Seidel, and H. Holsinger (2010). *Adapting to Climate Change: A Call for Federal Leadership*. Arlington, VA: Pew Center on Global Climate Change.

Sorrell, S., J. Spiers, R. Bentley, A. Brandt and R. Miller (2009). *An Assessment of the Evidence for a Near-Term Peak in Global Oil Production*. London: UK Energy Research Centre.

Stern, N. (2006). *The Economics of Climate Change*. Cambridge: Cambridge UP.

Swiss Re (2006). "Natural catastrophes and man-made disasters 2005: high earthquake casualties, new dimension in windstorm losses", *Swiss Re Sigma Series*, 2/2006, www.swissre.com/resources/e109a780455c56b897efbf80a45d76a0-Sigma2_2006_e.pdf.

Tertzakian, P. (2009). *The End of Energy Obesity: Breaking Today's Energy Addiction for a Prosperous and Secure Tomorrow*. Hoboken, N.J.: John Wiley and Sons.

The Clean Energy Act (2010). Statutes of British Columbia. Part 1, section 1, subsection 1, cited to the official printed version.

Thompson, D. and A. Bevan (2010). "Sustainable Prosperity: Making markets work *for* the environment." Ottawa: University of Ottawa. http://www.sustainableprosperity.ca/files/Smart_Budget.pdf

Tierney, S. (2008). *Energy Systems and Adaptation to Climate Change*. AMS Annual Meeting – January 21, 2008 – Panel on Adaptation to Climate Change Energy Systems and Adaptation.

Turner, C. (2007). *The Geography of Hope: A Tour of the World We Need*. Toronto: Random House Canada.

Union of British Columbia Municipalities (2007). *Local Governments and the Trade, Investment and Labour Mobility Agreement (TILMA)*. Policy Paper #4 – 2007 Convention. Richmond, BC: UBCM.

Warner, K. (2009). *Adaptation to Climate Change: Linking Disaster Risk Reduction and Insurance*. Geneva: United Nations International Strategy for Disaster Reduction Secretariat, 2009.

Weaver, A. (2008). *Keeping our Cool: Canada in a Warming World*. Toronto: Penguin Group.

Western Climate Initiative (2010). *Western Climate Initiative*. http://www.westernclimateinitiative.org/about-the-wci.

Wilbanks, T., V. Bhatt, D. Bilello, S. Bull, J. Ekmann, W. Horak, Y.J. Huang, M. Levine, M. Sale, D. Schmalzer, and M. Scott (2008). *Effects of Climate Change on Energy Production and Use in the United States*. Washington, DC: US Climate Change Science Program.

Williamson, L., H. Connor and M. Moezzi (2009). *Climate-Proofing Energy Systems*. Paris: HELIO International.

Wotton B. and M. Flannigan (1993). "Length of the fire season in a changing climate." *Forestry Chronicle*, 69,187-192.

World Business Council on Sustainable Development (2009). *The Power to Change: A Business Contribution to a Low-Carbon Economy*. Geneva: WBCSD.

World Meteorological Organization (2009). *2000-2009, The Warmest Decade*. Geneva: World Meteorological Organization. Available at: http://www.wmo.int/pages/mediacentre/press_releases/pr_869_en.html

Zurich Financial Services Group (2009). *The Climate Risk Challenge: The Role of Insurance in Pricing Climate-Related Risks*. Zurich: 2009.

APPENDIX A – CLIMATE CHANGE PROJECTIONS FOR BC

Unless noted, all information from:
Pacific Climate Impacts Consortium's "Climate Overview: Hydro-climatology and Future Climate Impacts in BC" (2009) (Available at http://pacificclimate.org/docs/publications/PCIC.ClimateOverview.Revised.March2009.pdf)

TEMPERATURE

GCM [138] PREDICTIONS: Based on A2 and B1 scenarios[139].

GCM predictions: an ensemble (i.e. 15 GCMs, plus two different emission scenarios= 30 projections total) of projections provides a range of plausible future climate conditions. [A]

By middle of the 21st century (2050s) annual temperature for BC are estimated to be +1.7 C warmer than the 1961-1990 baseline.

Projected winter season temps in 2050s: +1.9 C

Projected summer season temps in 2050s: + 1.8 C

RCM[140] PREDICTION: RCM introduces a more realistic representation of elevation and land surface characteristics to GCM projections. Based on A2 scenarios only. [A]

Single projection of annual temperature in the 2050s is +2.6 C warmer than baseline for BC.

Projected winter temps in 2050s: +3.3 C

Projected summer season temps in 2050s: +2.3 C

PRECIPITATION

GCM PREDICTIONS: Based on A2 and B1 scenarios [A]

Trends in annual precipitation during the century were primarily positive (+22% per century), but vary spatially across BC. Larger in interior (up to 50% per century).

By middle of the 21st century (2050s) BC is expected to be +6% wetter than the 1961-1990 baseline.

Projected precipitation in winter 2050s: +7% wetter

Projected precipitation in summer 2050s: - 3% drier

138 Global Climate Model
139 A2 emission scenario: most closely describes an extension of current emissions in an uncoordinated (heterogeneous) world economy. B1 refers to a more adaptive global society
140 Regional Climate Model

RCM PREDICTION: RCM introduces a more realistic representation of elevation and land surface characteristics to GCM projections. Based on A2 scenarios only. [A]
Projected precipitation in winter 2050s: 13% wetter

Projected precipitation in winter 2050s: 14% wetter

TEMPERATURE AND PRECIPITATION:REGIONAL 2050S AVERAGE ANOMLIES FROM THE 1961-1990 BASELINE.

BASED ON GCM PREDICTIONS

REGION	TEMPERATURE ANOMALY (CELSIUS)			PRECIPITATION ANOMALY (%)		
	WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
Columbia Basin	1.8	2.4	1.9	7	-8	4
Peace Basin	1.9	2.0	1.8	8	-4	7
North Coast	1.5	1.4	1.4	6	-8	6
North East Interior	2.4	1.8	1.9	9	3	7
Northwest	2.0	1.8	1.8	10	4	8
Okanagan	2.0	2.6	2.1	5	-8	5
South Coast	1.5	1.7	1.5	6	-13	6
BC	**1.9**	**1.8**	**1.7**	**7**	**-3**	**6**

SNOWPACK

Canadian Regional Climate Model (CRCM4i) projections: [A]

Relative changes in spring snow water equivalent are shown as a percentage difference between the CRCM4 1961-1990 baseline and the 2050s (2041-2070) projection.

Decline of spring snowpack by the 2050s (-200kg/m^2). Effect is pronounced in the Coastal Mountain ranges (-500 kg/m^2)

Relative changes of spring snowpack show declines (-18%) across most regions of BC, most notably along the North and South Coast (-56% and -54%).

Most of the largest decreases in snowpack occur in the mountainous regions of BC, but declines tend to be greater in the Coastal Mountains versus the Rocky Mountains.

UNCERTAINTIES

Despite recent improvements in RCM predictive capability, there is still uncertainty associated with these estimates.

Snowpack is a difficult variable to measure for other reasons than those detailed above. As the projected changes to snowpack rely both on temperature and precipitation, a great deal of uncertainty is associated with estimates.

In areas where it snows, a warmer climate means major changes in the timing of the runoff: stream flow increases in winter and early spring, and then decreases in late spring, summer, and fall.

Runoff shifting 20 to 40 days earlier within this century. This reduces summer water availability.

In relatively warm areas on the western slopes of the Cascade Mountains, for example, runoff will reduce about 30% by mid-century, whereas in colder areas in the Rocky Mountains reductions would be about 10%. Areas dominated by rain rather than snow are not expected to see major shifts in the timing of runoff.

GLACIERS

Modelling efforts in BC are spatially limited and different regions in BC have not been adequately represented.

Due to the presence of more than 10,000 glaciers in Western Canada, projected changes cannot be made with fully dynamic glaciological models for all glaciers, although these models may serve well for projecting changes for modelling changes in glacier cover at a regional scale.

BC Glacier loss will continue throughout the 21st century because increased melt rates will exceed supplements from increased snowfall.

Glacial retreat in southern BC and the Rocky Mountains may be catastrophic given the projected increases in air temperature and prevalence of precipitation falling as rain rather than snow.

Bridge Glacier, covers the largest fraction of watershed area in BC and has been quantitatively modeled. Projections for the 2050s show substantial reductions of the area of the Bridge glacier by up to 20%, even without further warming of the current climate.

The projected decline of glaciers in southern BC is corroborated by studies of other glaciers to the southeast (outside of BC) in the Blackfoot-Jackson Glacier Basin in Glacier National Park, Montana where glacier area is protected contracted to be entirely zero by 2030.

SEA LEVEL[141]

The expected changes in sea level for the BC coast will differ from the global projections; they will not be uniform.

Because of the many uncertainties in measuring past sea level changes and predicting future sea levels, the possible range could be much greater.

141 Sea Level information from: Government of Canada. "Projected Sea Level Changes for British Columbia in the 21st Century" December 2008. http://www.env.gov.bc.ca/epd/climate/pdfs/sea-level-changes-08.pdf

LOCATION	SEA LEVEL RISE BASED ON EXTREME LOW ESTIMATE OF GLOBAL SEA LEVEL RISE (METRES)	SEA LEVEL RISE ON MEAN ESTIMATE OF GLOBAL SEA LEVEL RISE (METRES)	SEA LEVEL RISE BASED ON EXTREME HIGH ESTIMATE OF GLOBAL SEA LEVEL RISE (METRES)
Prince Rupert	0.10-0.31	0.25-0.46	0.98-1.16
Nanaimo	-0.04	0.11	0.80
Victoria	0.02-0.04	0.17-0.19	0.89-0.94
Vancouver	0.04-0.18	0.20-0.33	0.89-1.03
Fraser River Delta	0.35	0.50	1.20

FOREST FIRES

Drought and high temperatures will decrease tree growth in most areas. They will also increase the frequency and intensity of mountain pine beetle and other insect attacks, further increasing fire risk and reducing timber production, an important part of the regional economy.[142]

The mountain pine beetle outbreak in BC has destroyed 33 million acres of trees so far; by 2018, it is projected that the infestation will have run its course and over 78% of the mature pines will have been killed.

Flannigan et al. used historical relationships between weather/fire danger and area burned in tandem with two GCMs to estimate future area burned **in Canada**.[143]

The results suggest an increase of 74-118% increase in area burned by the end of the 21st century.

Climate warming is expected to make fire seasons longer. It is estimated that the fire season length in Canada, on average, will increase by 22%.[144]

142 Forest Fire Information from: US Global Change Research Program http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/download-the-report;

143 Flannigan MD, Logan, KA, Amiro BD et al. 2005.

144 Wotton BM and MD Flannigan, 1993.

APPENDIX B – RECOMMENDATIONS FOR RESPONSIBLE CLEAN ELECTRICITY DEVELOPMENT IN BRITISH COLUMBIA[145]

British Columbia's progress on clean electricity policy and development can be dramatically improved by making BC's electricity supply as clean, renewable and low-impact as possible.

British Columbia's progress on clean electricity policy and development can be dramatically improved by:

1. Ensuring that energy conservation and efficiency is the highest priority.
2. Making BC's electricity supply as clean, renewable and low-impact as possible.
3. Adopting a renewable electricity planning framework that limits environmental, social, and economic impacts and maximizes public benefit.
4. Reforming water licensing, land leasing decisions and governance.
5. Strengthening the environmental assessment process, addressing and managing cumulative effects, and improving monitoring and compliance performance.
6. Developing an informed consensus about the conditions whereby renewable electricity could be exported from BC, if at all.

145 For further details on these recommendations, visit: http://wcel.org/sites/default/files/publications/Clean%20Electricity%20Recommendations.pdf. Prepared by David Suzuki Foundation, Pembina Institute, Watershed Watch Salmon Society and West Coast Environmental Law. Endorsed by BC Spaces for Nature, BC Sustainable Energy Association, Cassiar Watch, David Suzuki Watch, Forest Ethics, Friends of Clayoquot Sound, Friends of Wild Salmon, Georgia Straight Alliance, Living Oceans Society, Northwest Watch, Outdoor Recreation Council, Pacific Wild, Pembina Institute, Raincoast Conservation Foundation, Sierra Club of Canada (BC Chapter), Skeena Watershed Conservation Coalition, SkeenaWIld Conservation Trust, Steelhead Society of British Columbia, Sunshine Coast Conservation Association, T. Buck Suzuki Environmental Foundation, Watershed Watch Salmon Society, West Coast Environmental Law, West Kootenay EcoSociety, Wilderness Tourism Association, and Wildsight.

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