ACTING ON CLIMATE CHANGE

Solutions from Canadian Scholars

Sustainable Canada Dialogues

United Nations Educational, Scientific and Cultural Organization

UNESCO Chair for Dialogues on Sustainability

McGill

Trottier ISPP

Réseau Environnement

Association francophone pour le savoir

Acfas

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Sustainable Canada Dialogues

ACTING ON CLIMATE CHANGE:
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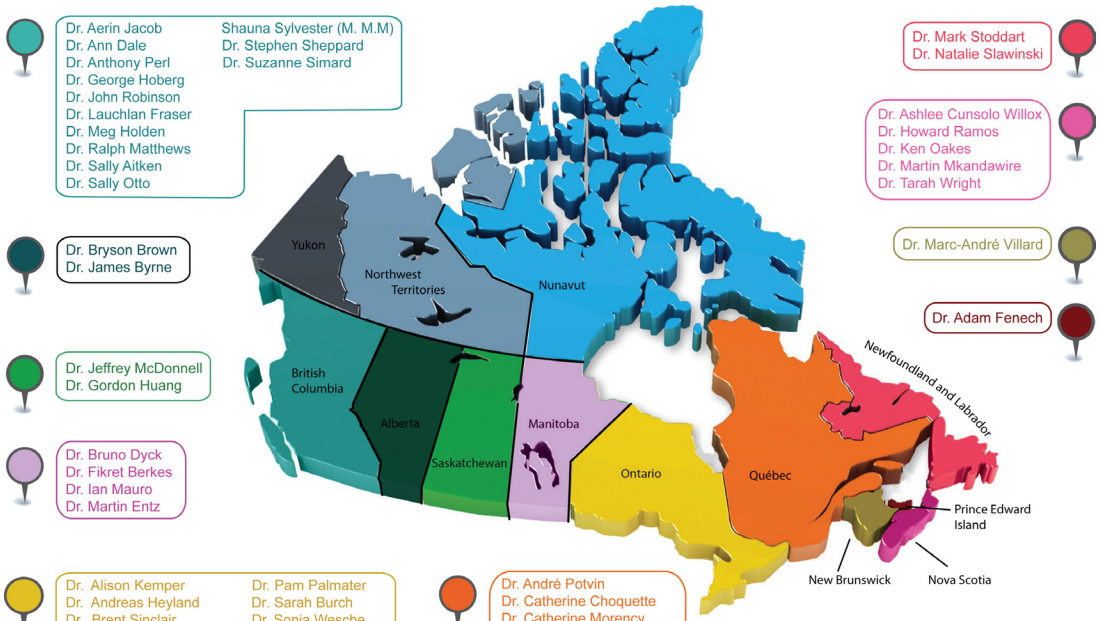
A scholarly consensus on science-based, viable solutions for greenhouse gas reduction. Produced by *Sustainable Canada Dialogues*, an initiative under the *UNESCO–McGill Chair for Dialogues on Sustainability* and the *Trottier Institute for Science and Public Policy*. *Sustainable Canada Dialogues* has mobilized over 60 Canadian scholars from every province, representing climate change expertise in areas from engineering to sociology.

Map of SCD Scholars



EXECUTIVE **SUMMARY**

In fall 2014, United Nations Secretary Ban Ki-moon exhorted all countries in the world to raise the ambitions of their climate change policies to avoid a global temperature increase of more than 2°C during this century. Answering this call, the scholars of *Sustainable Canada Dialogues*[1] (SCD), an initiative that mobilizes over 60 researchers from every province, worked collectively to identify a possible pathway to a low carbon economy in Canada. Our network of scholars represents disciplines across engineering, sciences and social sciences, with sustainability at the heart of our research programs.

Acting on Climate Change: Solutions from Canadian Scholars identifies ten policy orientations illustrated by actions that could be immediately adopted to kick-start Canada's necessary transition toward a low carbon economy and sustainable society. **We unanimously recommend putting a price on carbon.**

The Sustainable Canada Dialogues benefited from collaboration with the Consortium OURANOS[2] that carried out climate simulations for the position paper. The simulations, based on the greenhouse gas mitigation scenarios of the Intergovernmental Panel on Climate Change (IPCC)[3], show that immediate global actions to reduce greenhouse gas emissions would successfully limit temperature increases in Canada. We must act today to ensure tomorrow.

Besides putting a price on carbon *Acting on Climate Change: Solutions from Canadian Scholars* examines how Canada can reduce its greenhouse gas emissions (GHG) by: **1)** producing electricity with low carbon emissions sources; **2)** modifying energy consumption through evolving urban design and a transportation revolution; and **3)** linking transition to a low-carbon economy with a broader sustainability agenda, through creation of participatory and open governance institutions that engage the Canadian public. Our proposals take into account Canada's assets and are based on the well-accepted "polluter pays" principle. They are presented in details in the core document that can be downloaded from the SCD website.

In the short term, policy orientations that could trigger climate action include:

- Implementing either a national carbon tax or a national economy-wide cap and trade program;
- Eliminating subsidies to the fossil fuel industry and fully integrating the oil and gas production sector in climate policies;
- Integrating sustainability and climate change into landscape planning at the regional and city levels to ensure that, amongst other goals, new and maintenance infrastructure investments are consistent with the long-term goal of decarbonizing.

1 http://www.sustainablecanadadialogues.ca/en/scd

2 http://www.ouranos.ca/

3 http://ipcc.ch/home_languages_main_french.shtml

In the short- to middle-terms, the transition could be facilitated by:

- East-West intelligent grid connections that allow provinces producing hydroelectricity to sell electricity to their neighbors while taking full advantage of Canada's low carbon energy potential;
- Well-managed energy efficiency programs that produce significant positive economic returns across the board, through cost savings as well as job creation. Energy efficiency programs could target the building sector as well as businesses and industries.

In the short- to long-terms, the transition could support a transportation "revolution":

- Transportation strategies that move the sector away from its dependence on fossil fuel could rest on the implementation of a basket of options, ranging from electrification of transport to collective and active transportation.

Because renewable energy resources are plentiful, we believe that Canada could reach **100% reliance on low carbon electricity by 2035**. This makes it possible, in turn, to adopt a long-term target of at least **80% reduction in emissions by the middle of the century**, consistent with Canada's international climate mitigation responsibility. In the short-term, we think Canada, in keeping with its historical position of aligning with United States' targets, could adopt a **2025 target of 26-28% GES reductions relative to our 2005 levels**.

We envision climate policy as the ongoing, long-term project of making the *transition* to a low-carbon society and economy. This notion of transition has many advantages: the 80% target establishes the direction of change, allowing Canada to plan for the future while recognizing that goals will take time to accomplish. It permits governments, businesses and citizens to situate their activities within a dynamic context. As with other past and future major transitions, e.g. industrialization or electrification, there will be controversies and setbacks. Some economic sectors will contract as others expand. The most important aspect of Canadian climate policies is to build a sustainable future *starting today*.

Recognition that certain forms of economic development were causing environmental damage led to the notion of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." We have adopted a more recent definition of sustainability that emphasizes the importance of desired futures. We propose that the specific transition pathways to a low carbon economy in Canada could rest on the hopes of Canadians for social and environmental well-being and help articulate a vision for the country.

The transition to a low carbon sustainable society will usher in great opportunities for innovation by developing new technologies, businesses and employment. The international landscape has changed substantively since Canada withdrew from the Kyoto Protocol in December 2011. Canada's major trade partner, the USA, doubled their GHG emissions reduction target in 2014. In 2011, the International Energy Agency (IEA) estimated that investments for energy efficiency were worth USD 310-360 billion[4]. A clear climate policy framework would reduce uncertainty in the business environment, encouraging companies to invest in low-carbon technologies.

We have identified policy orientations designed to deliver viable, large impacts based on our expertise and on dialogue among our members. We do not claim to offer all possible policies or incentives to achieve sustainability, and we understand that further analyses, debate and refinement will be required. However, in virtually all cases, our proposals are in line with a number of international and national analyses of viable policy options to decarbonize.

We believe that putting options on the table is long overdue in Canada and hope that our input will help governments at all levels to make ambitious and thoughtful commitments to emission reductions before December 2015 and the *2015 Paris-Climate Conference*. We wish for an intense period of consultation and policy development to identify the policy instruments, regulations and incentives best suited to Canada. We offer our full cooperation to all levels of government in this challenging, but exciting, period. The time is now ripe to initiate ambitious climate change mitigation efforts.

4 http://www.iea.org/bookshop/463-Energy_Efficiency_Market_Report_2014

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*To **Adèle** (2 months), **Alice** (4 years), **Arthur** (17 months), **Avery** (2 years), **Brookelyn** (7 years), **Camille** (3 years), **Elias** (5 years), **Emma** (1 week), **Evan** (8 years,), **Gabriel** (2 days), **Hanah** (9 years), **Isis** (3 years), **Jai** (10 years), **Josh** (10 years), **Jules** (2 weeks), **Keestin** (5 years), **Louve** (11 years), **Maggie** (13 years), **Megan** (13 years), **Manami** (2 years), **Matthew** (6 years), **Mireille** (13 years), **Naomi** (13 years), **Penelope** (7 years), **Samantha** (18 months), **Tal** (16 months), **Wilson** (12 years), **Wusko** (9 years), and **all other children.***

Your future is our inspiration.

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5 http://normandmousseau.com/-A-common-energy-policy-for-Eastern-.html?lang=en

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FOREWORD

Acting on Climate Change: Solutions by Canadian Scholars presents ten key policy orientations, illustrated by specific actions, that could be adopted to kick-start this country's transition toward a low-carbon society. We offer it as input to Canadian decision-makers, opinion leaders, and elected representatives in preparation for our upcoming federal election followed by the *2015 Paris-Climate Conference*[6].

This position paper received input from 70 Canadian scholars from every province. It was collectively written by 31 *Sustainable Canada Dialogues*[7] (SCD) scholars and reflects expert feedback from 11 SCD reviewers, who were not part of the core writing team, and from 10 external reviewers. The scholars who participated hold a total of 18 research chairs, e.g. Canada Research Chairs, and another 25 are heads of research or academic units. *Sustainable Canada Dialogues* is a voluntary initiative mobilizing scholars working on sustainability and representing expertise in areas from engineering to sociology. We identified policy orientations and actions based on our specialized knowledge and on an initial round of exchange among our members *(Annex 1)*.

Climate change is the most serious "symptom" of non-sustainable development. All sectors of Canadian society must contribute to a transition toward sustainability. We are concerned that if governments in Canada don't steer the course of economic and social development, the next generation of citizens will face dire consequences of extreme warming *(see climate projections in the next section)*.

This position paper focusses on viable, large impact interventions for consideration by Canadian citizens and policy makers. It does not address all possible policies and actions to stimulate reduction of greenhouse gasses. Many of our proposals will require further analyses, debate, and refinement. However, in virtually all cases, our proposals are in line with a number of international and national analyses of viable policy options to decarbonize. We are motivated by a shared view that putting options on the table will stimulate action and is long overdue in Canada.

Federalism makes it challenging to transition to a low-carbon society and economy. Moving away from a piecemeal approach and adopting coordinated climate policy is essential. This position paper identifies policy orientations that could:

- Help cities transition to low-carbon economy;
- Encourage provinces to adopt ambitious greenhouse gas mitigation objectives and cooperate to achieve them;
- Strengthen the environmental platforms of federal political parties;

The *2015 Paris-Climate Conference* will be a "benchmark" in the history of international climate change negotiations. We hope that Canada will be up to the expectations.

6 http://www.cop21.gouv.fr/en

7 http://www.sustainablecanadadialogues.ca/en/scd

Chapter 1
MADE IN CANADA

1.1 A FUTURE WE CAN CHOOSE

As a party to the UN Framework Convention on Climate Change (UNFCCC), Canada has subscribed to the objective of limiting global temperature increase to 2°C over the course of this century. Controlling climate change requires movement toward a society that meets its economic and social needs while reducing, then eliminating, greenhouse gas (GHG) emissions into the atmosphere. Hence the call for "decarbonizing", carbon dioxide (CO_2) being the main GHG produced by humankind.

The Intergovernmental Panel on Climate Change (IPCC) in its most recent report—the Fifth Assessment Report[8]—developed climate scenarios relating future changes in temperature to efforts to reduce global GHG emissions. To visualize Canada's possible future climate, the Consortium Ouranos on Regional Climatology and Adaptation to Climate Change[9] analyzed two scenarios from the IPCC's report (see *Annex 2*).

The first scenario assumed global GHG emissions would stabilize around 2050—an assumption that could be realized if all countries immediately took ambitious mitigation actions. The second scenario assumed global GHG emissions would continue increasing until 2100. Projected changes to Canadian climate were calculated based on the temperature increase between the end of the 20th and 21st centuries.

These scenarios show that immediate global reduction of GHG emissions can help to avoid extreme warming (*Figure 1A*). Conversely, a dearth in ambitious reductions would result in extreme changes. For Canada, the second scenario means that, by the end of this century, coastal British Columbia and Atlantic provinces could warm by about 4°C; northern Saskatchewan, Manitoba, Ontario and Québec could warm more than 6°C; and Canada's Arctic temperature could increase by 14°C (*Figure 1B*).

The real-world consequences of these climate projections can be comprehended by thinking of past climate-related disasters such as the 2013 floods in Toronto and Calgary, the record drought in 2012 that greatly impacted the agricultural sector, Hurricane Juan that ripped up Halifax in 2003, and the 1998 ice storm that left 1.2 million Canadians in Ontario and Québec in the dark for a week in January. The first scenario however suggests that immediate climate mitigation could limit the temperature increase (*Figure 1A*).

8 http://ipcc.ch/

9 http://www.ouranos.ca/

Predicted changes in average annual temperature between over the next 100 years for two scenarios of GHG emissions.

FIGURE 1A **2071-2100 : RCP 4.5**

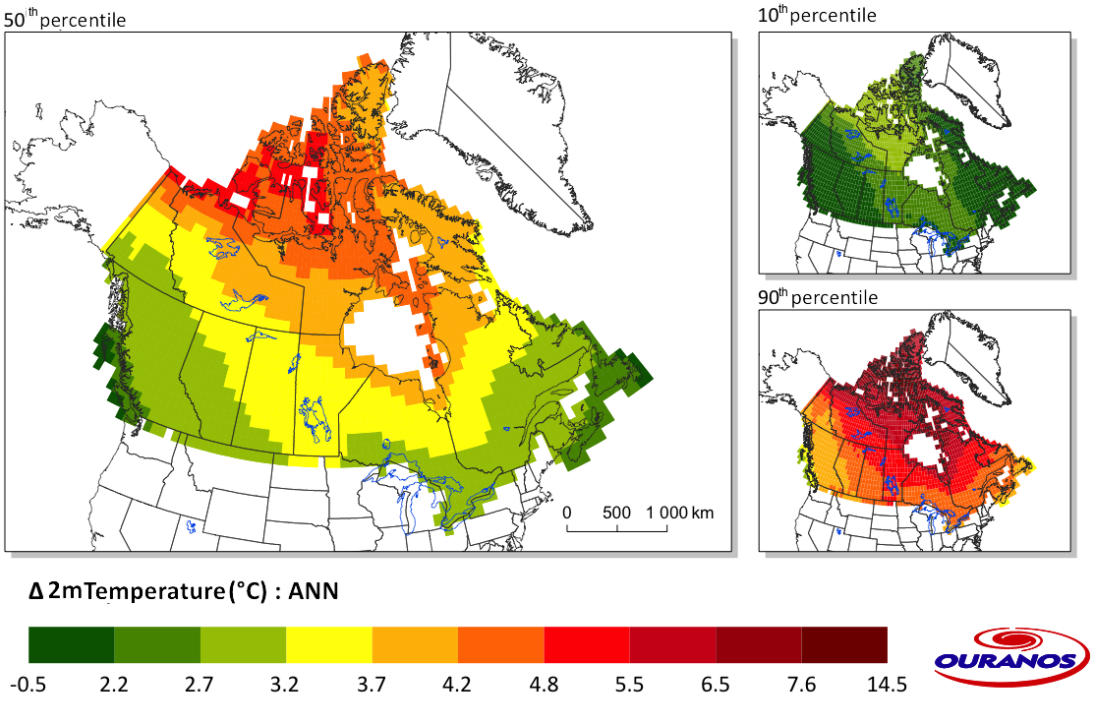

FIGURE 1B **2071-2100 : RCP 8.5**

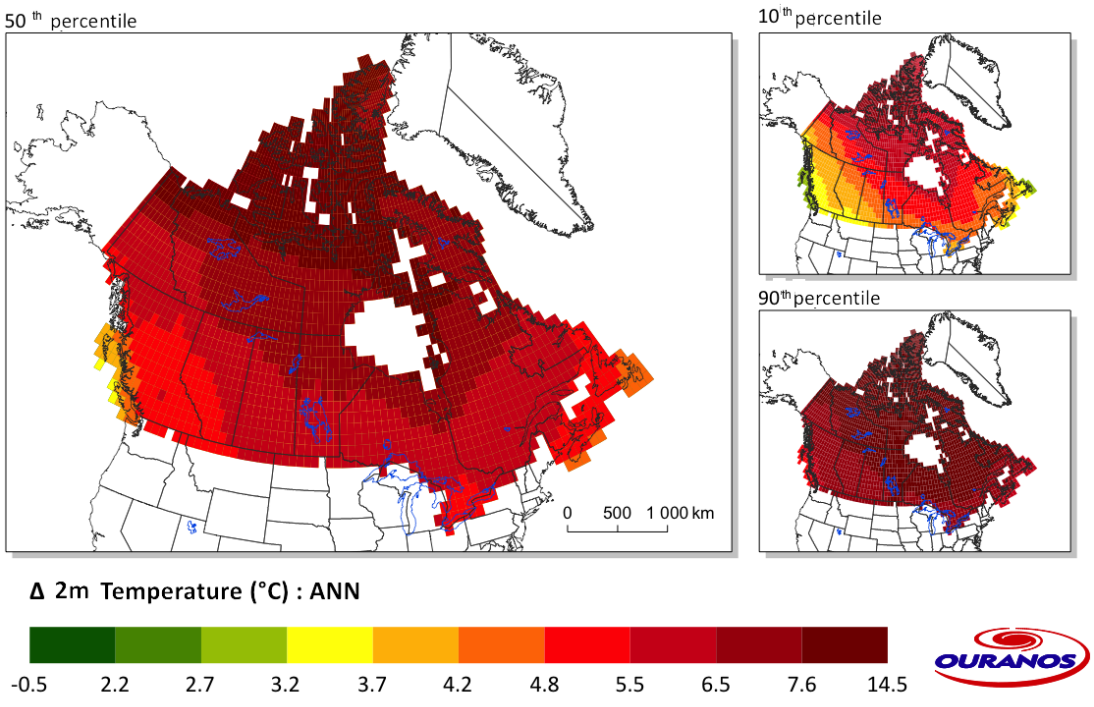

FIGURE 1

Change in annual mean 2 meters surface temperature between the two periods: 1971-2000 and 2071-2100 for two Representative Concentration Pathways (RCP) scenarios used in IPCC global climate scenarios (http://ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf). The first scenario (named RCP4.5 by the IPCC) assumes that GHG emissions will stabilize by 2050 while the second (RCP8.5) assumes strong and continuous emissions for the entire century. The maps on the left show the median (50th percentile) of the 77 simulations that were run (See Annex 2 for methodological details), while the 10th and 90th percentile of the distribution are presented on the right panels.

Canada's current emissions reduction target is to reduce emissions 17 percent relative to 2005; a goal set in 2009, as part of the Copenhagen Accord to align our targets with those of the United States *(Figure 2)*. It is now widely acknowledged that Canada will not achieve this target[10]. Still, targets are an essential starting point for developing policies and the international landscape has changed in important ways since Copenhagen 2009. The 2014 China-United States Agreement[11] saw the US adopt an emissions reduction target of 26-28 percent relative to 2005, and China accepted that its peak in emissions will occur in 2030 or sooner.

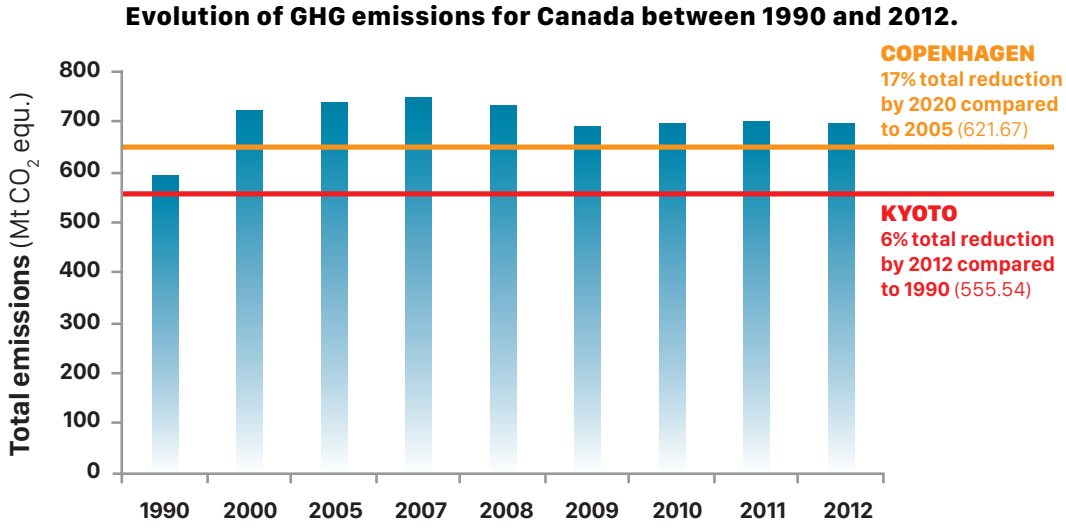

FIGURE 2

Changes in emissions between 1990 and 2012 for Canada using data from the Canadian inventory of GHG 1990-2012. The red line represents Canada Kyoto's target (-6 % of 1990) and the orange one the current target (-17 % of 2005).
(**Source:** Table S3 and S2.1b http://www.ec.gc.ca/ges-ghg/default.asp ?lang=En&n=83A34A7A-1)

A major societal challenge for the 21st century, transitioning to a low-carbon society and economy will create opportunities to enhance prosperity and well-being by modernizing infrastructure, developing regional renewable energy sources, improving the liveability of cities and creating new businesses and employment. The transition will require new technologies and new ways of doing things.

We feel that failure to move with the rest of the world toward lowering GHG emissions could jeopardize Canada's competitiveness and capacity for innovation. The current decline in oil prices demonstrates the fragility of the fossil fuel industry in a world looking to decarbonize itself. Diversifying Canada's energy portfolio could improve both energy and economic security[12].

The *2015 Paris-Climate Conference* provides an opportunity to revisit Canada's target. To limit the consequences of climate change, United Nations (UN) Secretary Ban Ki-moon has indeed exhorted all countries in the world to increase their GHG mitigation targets.

1.2 ROLES OF JURISDICTIONS

Canadian climate actions must take into account this country's regional diversity. The book *Hot Air*[13] creates a fascinating depiction of historical decision-making in Canada, tracing Canada's inability to meet targets in part due to absence of a concerted vision between federal government and provincial.

10 http://www.oag-bvg.gc.ca/internet/English/att__e_39876.html

11 http://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change

12 Bridge, G. and Le Billon, P. (2013). Oil. Cambridge, UK : Polity

13 Simpson, J., et al. (2008). Hot Air : Meeting Canada's climate change challenge : Emblem Editions, pp 288. ISBN 978-0771080975

1.2.1 Federal Government

The scope of government action is delimited by the 1867 Canadian Constitution Act at the federal and provincial levels. A key role of federal government is to negotiate international treaties, but the Constitution Act also endows the federal government with important and exclusive legislative powers to reduce GHG emissions in areas such as : international and interprovincial trade and commerce, direct and indirect taxation, navigation and shipping, interprovincial works and undertakings and federal properties. The federal government also has residual power over any matter not accorded to the provinces.

1.2.2 Provincial Governments

Provinces have exclusive legislative powers over natural resources, provincial property, civil rights, local works and undertakings, municipal institutions, electricity and energy, direct taxation and delegation of powers to municipalities

1.2.3 Municipal Governments

Municipal governments (i.e. cities, towns) are created under provincial or territorial laws and must act within the powers conferred by legislature. Municipalities can regulate matters such as zoning, parks, construction permits, water and waste disposal services, general welfare and environment issues. Municipal governments are responsible for drinking water, local roads and transportation systems, storm and wastewater systems and sewer infrastructure[14].

1.3 TODAY'S CLIMATE POLICY

Absence of federal leadership on climate policy has led to a patchwork of different provincial policies, each addressing climate change in its own way. The current climate action plans of all 10 provinces can be downloaded from the SCD website[15]. Policies of the federal government and the four largest provinces (Alberta, British Columbia, Ontario and Québec) are as follows :

- **Federal** government has promised a sector-by-sector regulatory approach. It has followed the American lead in adopting new GHG rules for the automobile sector. It has enacted a regulation that essentially bans new coal-fired power plants without sequestration, and phases out existing plants over a long time period. Canada's federal government has yet to enact long-promised regulations for the country's fastest-growing source of emissions : the oil and gas sectors.
- **Alberta**'s climate plan adopted in 2007 includes an objective of peaking GHG emissions in 2020. Its policy combines regulatory and fiscal measures. It establishes an intensity target for large emitters requiring major industrial facilities to reduce their " emissions intensity " by *up* to 12 %, relative to their typical performance or " baseline " level. If emitters cannot meet targets, they must purchase carbon offsets for emissions above target, or pay $15 per tonne CO_2 equivalent (CO_2 eq.) into a technology fund. This tax has had very little noticeable impact on Alberta's emissions to date. Only 4 % of Alberta's total emissions are covered under the provinces specified emitters system[16].
- **British Columbia** has legislated a target of 33 percent below 2007 levels by 2020. Among its most important measures, the province has introduced a revenue-neutral carbon tax, currently set at $30 per tonne CO_2 eq. and emissions have declined in British Columbia since 2007[17].
- **Ontario**'s climate target is to reduce emissions 15 percent below 1990 levels by 2020. Ontario has pursued a regulatory approach, banning the use of coal in electricity production and leading to the largest GHG emission in the country. It has supplemented the coal phase-out with incentives (feed-in tariffs) to increase renewable electricity production.

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14 Bernstein, S. (2002). International institutions and the framing of domestic policies : the Kyoto Protocol and Canada's response to climate change. Policy Sciences, 35(2), 203-236.

15 http://www.sustainablecanadadialogues.ca/en/scd/communicating-sustainability-solutions

16 http://www.pembina.org/docs/oil-sands/sger-climate-policy-backgrounder.pdf

17 https ://www.ec.gc.ca/indicateurs-indicators/default.asp ?lang=en&n=18F3BB9C-1

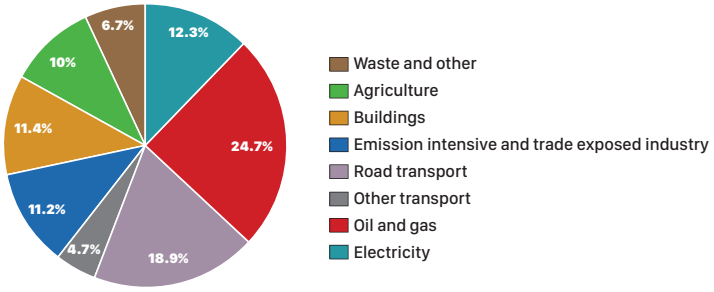
- **Québec** pledges to reduce emissions 20 percent below 1990 levels by 2020. To achieve this target, Québec has adopted a common cap and trade system along with California, the Western Climate Initiative[18] (WCI). In Québec, the WCI regulation first came into effect on January 1st 2014 and was extended to energy distributors on January 1st 2015. The price floor of carbon is currently $12.08 per tonne CO_2 eq.[19].

1.4 CANADA'S ENERGY PORTFOLIO

Canada is endowed with a vast array of energy resources. Oil, gas and renewable energies all support our economy and way of life. Outside of electricity, Canada's energy consumption is dominated by fossil fuels, responsible for 24.7 percent of total GHG emissions (*Figure 3A*)[20]. In 2012, Canadians consumed an average of 7.2 tonnes of oil equivalent per person, translating to 23 liters of fuel per person per day[21]. Renewable energy (the potential of which has been known since the 1980s[22]) is one of Canada's largest resources. Existing hydroelectric plants and wind power facilities are cost-effective sources of electricity. It has been shown that wind alone could provide several times existing fossil and nuclear electricity supply up to a cost (including transmission) of about 8 cents/kWh[23].

GHG emissions by sector in 2012 as a percent of total Canadian emissions.

FIGURE 3A



Total energy consumed in Canada in 2012.

FIGURE 3B

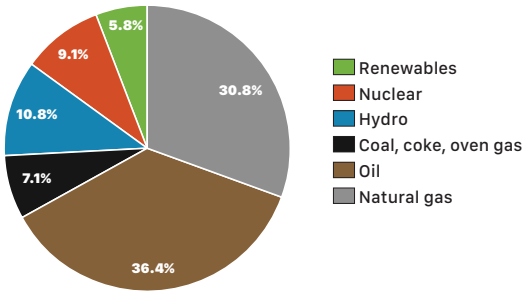


FIGURE 3

a. GHG emissions by sector in 2012 as a percent of total Canadian emissions. (**Source:** Table S-2 http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1). For "Fossil fuel" the values for production, exploitation as well as fugitive sources were combined while "Other energy" combines energy used in manufacturing industries, construction, commercial, residential, agriculture and forestry. **b.** Energy usage by Canadians in 2012 broken down by sources (in %). (**Source:** Canada's Energy Future 2013 - Energy Supply and Demand Projections to 2035 - An Energy Market Assessment, National Energy Board, 2013. https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2013/index-eng.html)

18 http://www.wci-inc.org/

19 http://www.mddelcc.gouv.qc.ca/changements/carbone/ventes-encheres/2015-02-18/Avis_encheres_fev2015.pdf

20 http://www.ec.gc.ca/ges-ghg/default.asp ?lang=En&n=83A34A7A-1

21 Report on Energy Supply and Demand in Canada, Statistics Canada (2012).

22 Robinson, J.B., et al. (1985). Determining the long-term potential for energy conservation and renewable energy in Canada. Energy, 10(6), 689-705.

23 The potential of wind energy to largely displace existing Canadian fossil fuel and nuclear electricity generation", Energy, 50, 93-102, 2013.

These could be supplemented by solar photovoltaic, geothermal, ground-based heat recovery, biomass and biogas to supply a large portion of our energy needs across the country[24].

1.4.1 Electricity

Electricity production in Canada is already a relatively low-carbon enterprise: 62 percent of our electricity needs are produced from renewable energy sources (mostly hydroelectricity) and 15 percent from nuclear[25]. Fossil fuels produce only 23 percent of our electricity. In 2012, direct clean-energy sector jobs totalled 23,700; just above direct oil sands jobs which employed 22,340[26].

1.4.2 Extractive Sector

Canada is a major producer and refiner of natural resources including oil, gas, iron ore and aluminum. These resources are often exported and used outside Canada. Rapid technological advances in the 20th century drove international demand for raw materials to maintain an ever-growing population with an increasing standard of living.

The sector of energy intensive industries (e.g. mining, paper, cement, but excluding oil and gas) accounts for 6-8 percent of national GHG emissions or 45-55 Mt CO_2 eq. per year. In 2012, Canada's mining sector accounted for 3.9 percent of our national gross domestic product (GDP) contributing $52.6 billion in mineral exports (about 20 percent of total exports)[27].

Public scrutiny over mining activities has greatly increased. This, more than any other factor, has resulted in a shift toward sustainability in the Canadian mining sector. After all relevant government permits have been issued; the informal "social license" (i.e. the permission granted to an operation by the local community through conditional acceptance, or revoked by public protest) must continually be earned rather than assumed. Contemporary mining operations are now cognizant that environmental and social disruption must be minimized. The Mining Association of Canada now has a set of independently-evaluated tools and indicators to drive performance while ensuring key risks are responsibly managed[28]. These are positive first steps toward the goal of fully including the extractive sector in a national climate action plan.

1.4.3 Per Capita Consumption

On one hand, Canada's proportion of *low-carbon* energy sources, at 25.7 percent, is higher than the world average of 18.3 percent, and higher or similar to countries with ambitious climate policies such as Germany (20 percent) or Denmark (26.8 percent)[29] but it is lower than world leaders, for example Sweden (68 percent).

On the other hand, Canadians' average energy consumption (*Figure 3B*) is higher than that of other people in developed countries. This directly affects carbon dioxide emissions: Canadians produce 20.1 tonnes of CO_2 eq. per person: *twice* the average emissions of Europeans. Per capita, Canadians contribute disproportionally to GHG levels compared with the rest of the developed world.

1.5 CANADA'S TRANSPORTATION CHALLENGE

Transportation is Canada's second largest sector of GHG emissions — after energy — accounting for 23.6 percent or 165 Mt CO_2 eq.[30] *(Figure 3A)*. With the exception of subways and a few suburban trains, freight and passenger transportation relies heavily upon a fossil-fuelled truck and automobile sector.

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24 Recent estimates suggest that biomass, wind, hydro, solar thermal and solar photovoltaic alone would be sufficient to provide 1.5 times the total energy used in Canada in 2010. See C. Barrington-Leigh and M. Ouliaris, The renewable energy landscape in Canada : a spatial analysis (March 2014) http://wellbeing.research.mcgill.ca/publications/Barrington-Leigh-Ouliaris-DRAFT2014.pdf

25 Throughout out this position paper we used the 2012 Canadian GHG inventory : http://www.ec.gc.ca/ges-ghg/default.asp ?lang=En&n=83A34A7A-1

26 This comparison is for direct employment jobs only in 2012, including the following sectors : biorefinery products, power generation (excluding crown corporations), grid and infrastructure, energy efficiency and clean transportation. http://cleanenergycanada.org/2014/12/03/comparing-oil-sands-employment-clean-energy-jobs/

27 http://mining.ca/resources/mining-facts

28 Throughout this position paper we used the 2012 Canadian GHG inventory : http://www.ec.gc.ca/ges-ghg/default.asp ?lang=En&n=83A34A7A-1

29 See statistics on various countries on http://www.iea.org/statistics/

30 http://www.ec.gc.ca/ges-ghg/default.asp ?lang=En&n=83A34A7A-1

Road transport is the largest sub-sector of transport emissions; in Canada it represents 18.9 percent of total emissions.

The majority of large Canadian cities were developed to meet the needs of car or truck travel. Growth around the metropolitan areas of Calgary, Edmonton, Montréal, Ottawa/Gatineau, Toronto and Vancouver, for example, is all concentrated in suburban areas[31]. The resulting increased share of cars and trucks in daily transportation largely defines the challenges of low-carbon transportation. Combustion of oil by vehicles generates air pollution. High-volume vehicular traffic makes the practice of active modes (such as walking and cycling) riskier and less attractive. In the Montréal area, the share of trips made by foot among 5-9 year-old children decreased almost 20 percent between 1987 and 2008[32], and the number of road casualties increased with traffic volume[33].

Important investments are continually made to maintain and develop the road network. The New Climate Economy Report[34] suggests funding for existing infrastructure should be redirected toward more compact, connected and coordinated urban infrastructure development. Such redirection can build on two realizations:

1. Current road infrastructures have residual capacity and could be used by more people (for example, there may not be residual capacity for cars during peak periods, but there *is* residual capacity for people that could be reached by increasing car occupancy).
2. Both transit systems and infrastructures supporting sustainable transportation are essential collective services that assure every individual has access to transportation at a reasonable cost.

Improving transportation sustainability will require a shift in public attitudes and behaviors, supported by forward thinking decision-making to provide access to alternatives. Research on factors affecting travel behaviors can help us create strategies that drive change. Many factors combine to affect choice of transportation modes. These include: household structure, age, gender, time and cost of trips on various networks, availability and cost of parking at destination, presence of children in the household and the necessity to fulfill their travel needs, level of car ownership and weather conditions.

When rethinking Canada's transportation system, it is essential to distinguish mature, proven technology ready to deploy from prototypes that require more time to establish. Development of new transportation technology represents an important goal for innovation and could be a magnet for research and development, while proven technology can immediately help deliver low-carbon transportation.

1.6 TRANSFORMATIONS WHERE PEOPLE LIVE

Besides transportation, housing is the key determinant of a Canadian household's GHG emissions according to a lifecycle analysis[35]. The Canadian building sector, responsible for more than 12 percent of GDP, is a major consumer of both energy and materials, contributing 11.4 percent of Canadian GHG emissions in 2012[36] *(Figure 3A)*.

At the residential scale, energy-efficient technologies and green building construction standards have offset the GHG emissions associated with the ever-increasing size of single-family homes[37]. At the scale of cities, the solution to sprawl and dependency on private automobiles is to increase density through strategic design of smart-growth, mixed-use and walkable cities[38]. These transformations will bring to urban centers visible changes and opportunities for improved quality of life. Green infrastructure can

31 http://canadiansuburbs.ca/canadiancitygrowthchart.html

32 http://publications.polymtl.ca/994/1/2012_FelixPepin.pdf

33 Morency, P. and Drouin, L. (2008). Apaisement de la circulation : des données probantes pour l'action, Journées annuelles de santé publique, http://jasp.inspq.qc.ca/Data/Sites/1/SharedFiles/presentations/2008/15_30_PMorency_LDrouin.pdf

34 http://newclimateeconomy.report/

35 Ferguson, T. M. and MacLean, H. L. (2011). Trade-linked Canada–United States household environmental impact analysis of energy use and greenhouse gas emissions. Energy Policy, 39(12), 8011-8021.

36 Figure S-8; http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1

37 http://www.cesarnet.ca/blog/secret-life-canada-s-energy-systems and Hyde, R.et al. (2007). The Environmental Brief: Pathways for Green Design. Taylor & Francis, 166-176.

38 Norman, J., et al. (2006). Comparing high and low residential density: life-cycle analysis of energy use and greenhouse gas emissions. Journal of urban planning and development, 132(1), 10-21. and Chance, T. (2009). Towards sustainable residential communities; the Beddington Zero Energy Development (BedZED) and beyond. Environment and Urbanization, 21(2), 527-544.

provide environmental benefits such as: reduced urban heat, reduced energy for heating and cooling, carbon storage, storm water retention, flood prevention, reduction of combined sewer overflows in older cities and more[39].

While Canada needs a new agenda for cities to maintain and improve livability, it will, however, also be essential to develop transition pathways for low population densities and large distances to ensure that they fully benefit from the transition to a low-carbon economy and society. Because proximity to a variety of amenities plays a key role in sustainable living, landscape planning becomes a key component of both urban and rural design strategies[40].

1.7 THE BUSINESS CASE FOR SUSTAINABILITY

A clear climate policy would increase certainty in Canada's business environment, encouraging companies to invest in low-carbon technologies[41]. A variety of organizations such as companies, governments, universities, hospitals and NGOs, already benefit from having lowered their GHG emissions and thereby reduced costs, better managed risks and improved reputations and social license to operate. In a carbon-constrained world, pro-active organizations may develop capabilities that not only increase their ability to compete and survive but also attract the best employees to their organizations[42].

Opportunities exist for all types of organizations for innovation[43] arising from, and activities associated with, the transition to a low-carbon society. Opportunities to innovate include:

- Green product development
- Clean technology adoption
- Development of sustainable production processes
- Business/organizational models that embrace sustainable footprints.

Citizens might also be able to seize new opportunities. According to Bloomberg New Energy Finance clean energy investments increased, in the USA alone, from USD 10 to USD 50 billion between 2004 and 2014[44] with homes becoming a " competitive battleground, with utilities, device vendors, third-party solar providers, and even telecom companies indicating that they may have a role to play in intelligent residential energy systems ". Rooftop solar is the fastest growing form of distributed energy. Furthermore, in 2011, the International Energy Agency (IEA) estimated that investments for energy efficiency were worth USD 310-360 billion. The investments in energy efficiency are apparently producing results since energy use is 60% less today than it would be if energy was used in the way it was forty years ago.[45].

39 Hough, M. (2004). Cities and natural process : a basis for sustainability. Routledge.

40 Formann, R.T.T. (2008). Urban regions : ecology and planning beyond the city. Cambridge University Press.Development-Asce 132(1) : 10-21.

41 Hoffman, A. J. (2005). Climate change strategy : The business logic behind voluntary greenhouse gas reductions. California Management Review, 47(3), 21-46. and Wiegand, M. (2005). Regulatory uncertainty slows utility investment. Business and the Environment, June, 9.

42 Jackson S. E. and Seo, J. (2010). The greening of strategic HRM scholarship. Organization Management Journal, 7(4), 278-290. and Pinkse, J. and Kolk, A. (2009). International Business and Global Climate Change :Taylor & Francis Group.

43 Lash, J. and Wellington, F. (2007). Competitive advantage on a warming planet. Harvard Business Review, March : 94-102.

44 http://www.bcse.org/images/2015%20Sustainable%20Energy%20in%20America%20Factbook.pdf

45 http://www.iea.org/bookshop/463-Energy_Efficiency_Market_Report_2014

Chapter 2

CANADA'S TRANSITION TO A LOW-CARBON SOCIETY

Canada needs an integrated climate action plan. The most important aspect of the plan is to get going today.

This Chapter identifies policy orientations *(in blue)*, illustrated by a number of actions *(in green)* that could allow Canada to adopt new emissions reduction targets before the *2015 Paris-Climate Conference*. Transitioning to a low-carbon society could be facilitated by climate policies designed with the following characteristics :

Environmentally effective
Policies meeting GHG reduction targets without causing other excessive environmental impacts ;

Cost-effective
Policies achieving the necessary GHG reductions at the least possible cost ;

Administratively feasible
Complexity of policies being within the governance capacity of the implementing jurisdictions ;

Equitable
Policies that are not placing unjustified burdens on any region, sector, or income group ;

Politically feasible
Policies acceptable to Canadian publics and their elected representatives[46].

Climate policies could rest on the "polluter pays" principle. Canadians are accustomed to this notion : for instance, taxes on cigarettes are justified in part by generating the income necessary to cover the health-related costs of smoking.

In addition, meaningful climate policies require three elements :

1. An objective (clear target and timeline) ;
2. A choice of policy instruments (subsidies or tax incentives, regulation, carbon tax or cap and trade, research and development) ; and
3. The design of policy instruments to achieve the stated objective.

46 Adapted from Jaccard, M., and Rivers, N. (2008). Canadian Policies for Deep Greenhouse Reduction. A Canadian Priorities Agenda : Policy Choices to Improve Economic and Social Well-Being. Jeremy Leonard, Christopher Ragan and France St-Hilaire, eds. Ottawa : IRPP. http://irpp.org/research-studies/jaccard-rivers-2007-10-29/

Because energy, transport, and building infrastructure last several decades, and they lock in development along specific pathways[47], we believe that a **long-term target of 80% emissions reduction**, aligned with IPCC's recommendation for developed countries[48], should be adopted immediately to inform current decision making. Failure to do so would imprison Canada in a high-carbon development pathway.

A medium-term target is needed for 2025 that will raise the ambition of Canada's emissions reduction effort beginning now. To maintain past consistency with US objectives, Canada could adopt the recently announced US target of **26-28% below 2005 levels by 2025**.

2.1 KEY ENABLING POLICY

KEY POLICY ORIENTATION # 1 : Put a price on carbon

Challenging trade-offs among different policy options means there is no mechanism for reducing GHG emissions that fully meets all desired characteristics of climate policies. For example, a basket of regulations can be effective, and more politically palatable to some, but could be less cost-effective than a carbon tax or cap and trade[49]. It could however be a tremendous administrative challenge to regulate non-industrial sources of GHG emissions that collectively account for a significant share of Canada's emissions.

Widespread agreement nevertheless exists among climate policy analysts that carbon pricing should be a key component of any comprehensive climate change policy. There is less agreement on which carbon pricing mechanism (a carbon tax, or cap and trade) provides the best balance.

2.1.1 Carbon Tax or Cap and trade ?

Carbon taxes have been the preferred instrument of economists for decades because of their cost-effectiveness and administrative simplicity. British Columbia implemented an effective model of a revenue-neutral carbon tax in 2008 that is receiving increasing recognition around the world[50]. In the contemporary political climate, however, carbon taxes come with special political baggage.

Cap and trade, when designed effectively, can be virtually as cost-effective as a carbon tax, although its administrative complexity likely makes it more costly than a tax. The basic feature of a cap and trade system is that the government establishes an absolute cap on emissions designed to decline over time, allowing it to meet a GHG reduction target. The government issues allowances or permits to emitters, and emitters can trade their allowances in a regulated market. This approach has the advantage of directly controlling the quantity of emissions, as well as providing greater certainty and accountability that targets will be met. However, cap and trade poses special administrative challenges because the market in permits must be regulated to avoid manipulation. A cap and trade system has been in place in the European Union for eight years, and is also operating in California and Québec[51]. However, overall, we find more advantages to a national approach.

The choice between carbon tax or cap and trade depends on the weight placed upon different criteria and consequences. If price certainty and administrative simplicity are valued most, then carbon tax is the better instrument. If avoiding new types of taxes and greater certainty over emission control are most important, then cap and trade is the better instrument. Either a carbon tax or a cap and trade system could work effectively, efficiently, and fairly to enable Canada to meet a ambitious GHG reduction targets.

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47 Lecocq, F. and Shalizi, Z. (2014). The economics of targeted mitigation in infrastructure. Climate Policy, 14(2), 187–208.

48 http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_SPMcorr1.pdf

49 Nordhaus, W. (2013). The Climate Casino : Risk, Uncertainty, and Economics for a Warming World. New Haven : Yale University Press. Part IV.

50 Harrison, K. (2013). The Political Economy of British Columbia's Carbon Tax. OECD Environmental Working Paper 63. http://www.oecd-ilibrary.org/docserver/download/5k3z04gkkhkg.pdf ?expires=1394731610&id=id&accname=guest&checksum=D7C2C9BF73AFC-88901C793F4A343698D

51 Newell, R., et al. (2013). Carbon markets 15 years after Kyoto : Lessons learned, new challenges. The Journal of Economic Perspectives, 123-146.

2.1.2 National or Provincial ?

Persistent concerns about regional equity suggest that to be politically feasible, climate policies should not result in significant regional redistribution. The relatively decentralized nature of Canada's federation raises questions about which is more desirable : a national plan or a differentiated province-led approach like the one Canada has today.

From a cost-effectiveness standpoint, a national GHG reduction plan has advantages. There would be concerns about fairness and competitiveness if emitters in one province paid a significantly different carbon price than emitters elsewhere in Canada. A cap and trade system would realize economic benefits from being applied to a larger and more diverse area. Moreover, a national approach would avoid the challenging question about how to allocate emission reduction targets to provinces, because in either the carbon tax approach or a cap and trade system, provincial emission levels would be responses to market signals, not established in advance. But a national approach would be politically challenging, especially given the diverse policy instruments currently in use by different provinces and various political sensitivities within the country.

In the short term, adopt either a national carbon tax or a national cap and trade program.

National Carbon Tax
A national revenue-neutral carbon tax could be built on the British Columbia model and apply to all fuel use. The tax would need to increase over time for Canada to meets its emission reduction targets.

National Cap and Trade
A national cap and trade could be modeled on the basic design of the Québec system. Since it is linked to the much larger California system, some of the risks of administrative complexity are reduced.

2.1.3 National Carbon Tax

With a national carbon tax, one approach to adjusting the price over time would be to link the tax to the social cost of carbon (currently $40/tonne CO_2 or higher[52] and estimated to increase annually by $1/tonne CO_2). To improve equity, carbon tax revenues could be distributed back to the provinces of origin. Adjustments to the tax system could be made (as is the case in British Columbia) to ensure the carbon tax does not disadvantage low-income groups. Any national system would require provinces with different policy instruments already in place to adapt. If Québec wanted to keep its cap and trade system, for example, it could either negotiate an equivalency agreement that ensures its carbon price levels are similar to the rest of the country, or comply with a province-specific emission cap.

2.1.4 National Cap and Trade

A national cap and trade program would benefit from building on an existing system. Careful design, guided by the following questions, could help smooth the transition :

- What sources are covered ? Our proposal would cover industrial and utility emissions and fuel distributors.
- Are allowances auctioned or issued for free (" grandparenting ") ? Québec-California's Cap and Trade system provides free allowances to certain industries. Our proposal would begin by providing free allowances but then increase the fraction of allowances auctioned over time. While this approach would slow the flow of new revenues to governments, it would ease the transition to the new climate policy and allow emitters time to adjust.
- Are prices regulated with price floors, caps, or both ? Our proposal would establish a price floor that would increase over time, and a mechanism to minimize permit price volatility.

52 Hope C, Hope M. (2013) The social cost of CO_2 in a low-growth world. Nature Climate Change 3, 722-724. and Howarth RB, Gerst MD, Borsuk ME. (2013) Risk mitigation and the social cost of carbon. Global Environmental Change 24,123-131.

- How are actions linked with other jurisdictions ? There are some important tensions between different policy instruments, so introducing a national cap and trade program will pose some challenges for provinces, like British Columbia and Alberta, that have pursued alternative instruments. There would be considerable benefits in cost-effectiveness for having a national system. But provisions could be made for equivalency agreements, if provinces wanted an option to continue relying on their existing policy instruments. However, it would be important to develop a legally-binding, province-specific reduction target in that case.
- How should revenues be allocated from auctions ? To address regional equity concerns, as auction revenues increase, they could be returned to the province of origin, and that province of origin could decide how to use those revenues. To address the differential impact of implementing the system on different income groups, income taxes could be adjusted accordingly.
- Should offsets be allowed from non-regulated emitters ? Offsets can increase flexibility and reduce compliance costs, but need to be carefully regulated to ensure their legitimacy. We recommend following the practice of California, Québec, and the EU, and allow well-regulated offsets but limit them to a maximum of 8 % of emitters' compliance obligations.

A carbon pricing mechanism is an essential first step, but more will be required from governments at all levels over coming decades to accelerate the transition to a low-carbon society. Increased funding for research, development and deployment of low-carbon technologies, stronger regulatory standards, measures to encourage citizen initiatives and public education are all important. By strengthening green and low-carbon innovations we can address the challenge of climate change and increase opportunities for prosperity and sustainable development.

2.2 FURTHER ELEMENTS OF THE TRANSITION TO A LOW-CARBON ECONOMY AND SOCIETY

Energy is the main source of GHG emissions and thus at the heart of climate change mitigation. According to Canada's latest GHG inventory (1990-2012)[53], energy accounts for 81 percent of all human-related GHG emissions. Canada's economy relies heavily upon natural resource extraction, including oil and gas, which is highly energy intensive and is largely targeted for export[54]. Over the last decade, the Canadian government has resisted efforts to reduce GHG emissions largely due to concerns over the international competitiveness of emission-intensive commodities[55]. Yet in Canada, emission-intensive industries and extraction sectors, including oil, gas, potash and mining, represent about 35 percent of all GHG emissions. Above and beyond industrial usage, which includes natural resource extraction and transformation, the average Canadian still produces 30 percent more emissions than the total per person in Europe, leaving plenty of space to undertake positive actions on energy-related GHG emissions.

2.2.1 Energy Production : Electricity

With vast, already installed hydropower capacity and rich potential in undeveloped renewable energy sources that could be harnessed to produce electricity (*Figure 4*), Canada could rapidly move away from fossil fuels in the electricity sector[56]. This transformation, which would put Canada at the forefront of green electricity internationally, could also provide significant cost-savings and give leverage to a number of Canadian industrial sectors.

KEY POLICY ORIENTATION # 2 :
Include aggressive goals for low-carbon electricity production in federal and provincial climate action plans.

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53 http://www.ec.gc.ca/ges-ghg/default.asp ?lang=En&n=83A34A7A-1

54 In 2012, for example, 74 % of crude oil, 57 % of marketable natural gas and 23 % of refined petroleum products produced in Canada were exported. See Report on Energy Supply and Demand in Canada 2012 preliminary, Statistics Canada, 2014. (57-003-X).

55 Rivers N. (2010) Impacts of climate policy on the competitiveness of Canadian industry : How big and how to mitigate ? Energy Economics, 32(5), 1092-1104.

56 Barrington-Leigh, C. and Ouliaris, M. (2014) The renewable energy landscape in Canada : a spatial analysis (March 2014) http://wellbeing.research.mcgill.ca/publications/Barrington-Leigh-Ouliaris-DRAFT2014.pdf

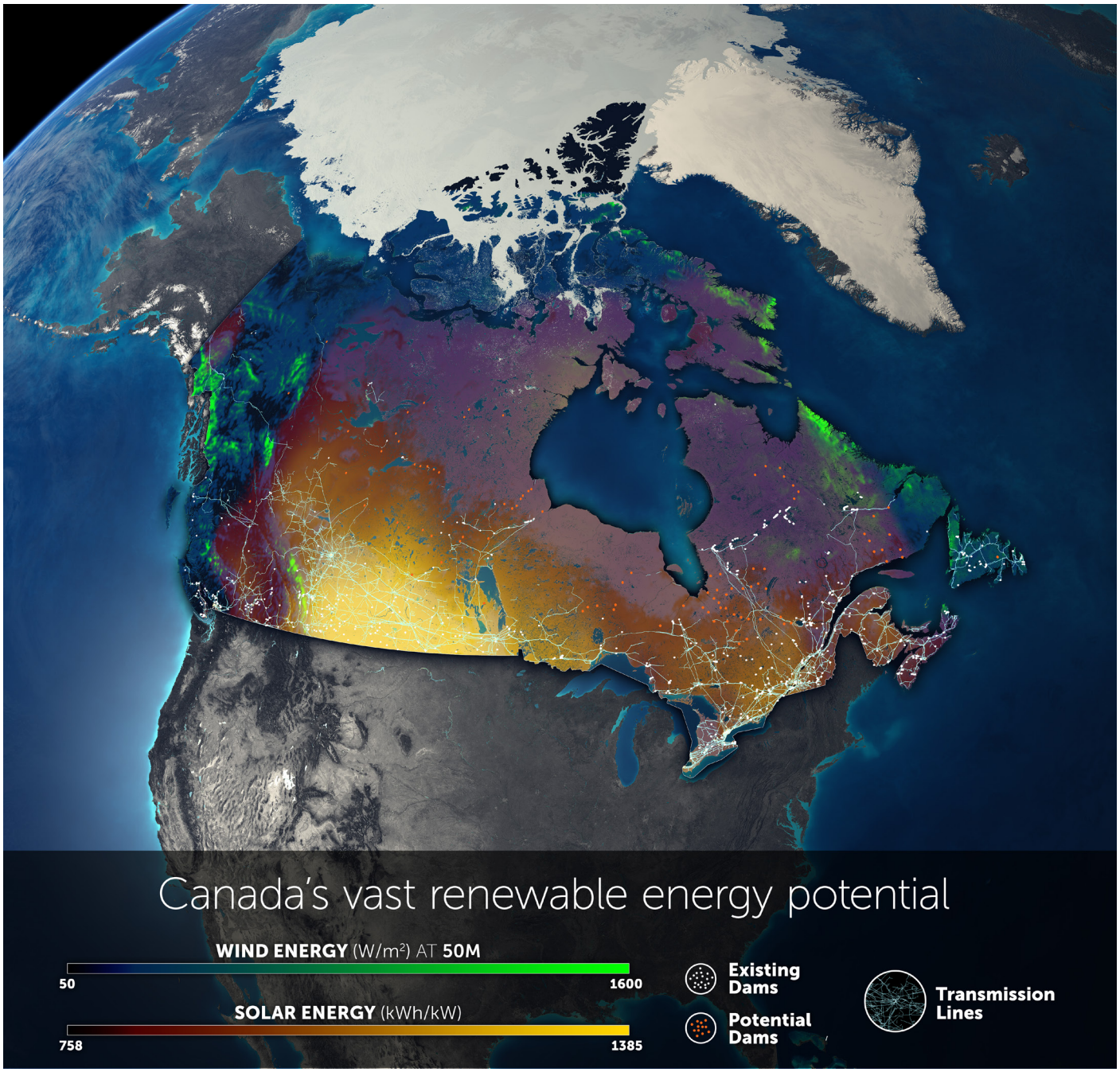

FIGURE 4: MAP OF NATIONAL RENEWABLE ENERGY

East-west interconnections of the electrical grid between provinces could rely on the large-scale hydroelectric infrastructures developed over the past half-century across Canada, dominated by British Columbia, Manitoba, Québec and Newfoundland-and-Labrador. Hydroelectricity could then be combined with intermittent renewables such as wind and solar energy across the country.

Wind energy resources are abundant in the southern prairies, near the Great Lakes, across much of northern British Columbia, Yukon, Nunavut, Quebec and Newfoundland. West and east coast offshore wind development also have substantial potential. Solar energy resources are viable across much of southern Canada, most notably on the southern prairies.

DATA: **Solar Energy:** Published by Natural Resources Canada and Environment Canada. Reproduced with the permission of Natural Resources Canada © Her Majesty the Queen in Right of Canada, 2007. **Wind Energy:** Images downloaded from http://pv.nrcan.gc.ca/ on February 1 2015. **Tranmission Lines:** Government of Canada; Natural Resources Canada; Earth Sciences Sector; Canada Centre for Mapping and Earth Observation. **Existing Dams:** Natural Resources Canada, Atlas of Canada 1,000,000 National Frameworks Data, Hydrology – Dams (V6.0), 2010. **Potential Dams:** Global Forest Watch Canada, Hydropower Developments in Canada: Number, Size and Jurisdictional and Ecological Distribution, 2012. **Earth:** NASA, Globaïa.
DESIGN: Félix Pharand-Deschênes, Globaïa.

Among the number of possible actions to support this first step toward a low-carbon Canada, two appear especially promising:

In the short-term, adopt ambitious sectorial targets for low-carbon electricity production.

Seventy-seven percent of Canada's electricity is already produced from low-carbon emission sources. Combining current hydroelectric production capacity with plentiful untapped renewable energy resources and east-west intelligent grid connections[57] between provinces (see next action bullet), could allow Canada to adopt a target of 100 percent low-carbon electricity production by 2035. While this might seem very ambitious, it is in fact coherent with lowering prices for renewable technologies[58] and the current international context. Norway, for example, already generates 100 percent of its electricity using renewable energy while a number of European countries and regions[59 60 61 62] have adopted, above and beyond low-carbon electricity, a 100 percent renewable energy target. A number of studies and reports[63] propose pathways to achieve such ambitious targets.

Fully developing Canada's low-carbon energy potential however would have to be done taking into account broader sustainability issues, since energy infrastructure can have important environmental and social costs[64]. In addition, the potential of new technologies (such as carbon capture and storage) for reaching 100 percent low-carbon electricity needs to be evaluated[65]. Finally there are technical, political, social and economic barriers to adoption of low-carbon energy solutions that need to be identified and eliminated in a systematic manner to reach the 100 percent low-carbon energy target and meet the multiple needs of local communities while protecting ecosystems. Many of the technical barriers appear in fact to be barriers of information[66] and seem easier to surpass at the municipal level than at higher level of governments[67].

In the short to mid-term, support interprovincial electricity transportation infrastructure.

High-voltage east-west electricity transportation infrastructure between adjacent provinces would allow provinces that produce hydroelectricity (British Columbia, Manitoba, Newfoundland-Labrador and Québec) to sell it to their neighbors. This infrastructure development could be in part supported by the Federal government. Simulations by CESAR., at University of Calgary, show that importing hydro power from BC could lower Alberta's electricity emissions (although this would require development of untapped hydro reserve and a framework for interprovincial cooperation[68]). Similarly, modelling[69 70], done at the University of Regina indicates that importing hydroelectricity from Manitoba would allow Saskatchewan to lower emissions from electricity production, pointing out that once hydro and wind capacities have reached maximum available levels, the least-cost option would then be electricity import. It is noteworthy that Québec and Ontario have recently signed an agreement to expand electricity trading

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57 The Deep Decarbonization Canada chapter emphasizes the importance of an "enhanced transmission grid flexibility and energy storage technologies to allow more electricity generation from intermittent renewables" (p. 14).

58 Prices for wind energy, for example, are quickly falling. On December 16, 2014, Hydro-Québec announced that it has accepted three submissions for 450 MW at an average price of 7.6 ¢/kWh including 1.3 ¢/kWh for transport. http://nouvelles.hydroquebec.com/fr/communiques-de-presse/697/appel-doffres-visant-lachat-de-450-mw-denergie-eolienne-hydro-quebec-distribution-retient-3-soumissions-totalisant-4464-mw/

59 http://www.umweltbundesamt.de/en/publikationen/germany-2050-a-greenhouse-gas-neutral-country

60 http://www.nytimes.com/2014/11/11/science/earth/denmark-aims-for-100-percent-renewable-energy.html ?_r=0

61 http://www.scotland.gov.uk/Topics/archive/National-Planning-Policy/themes/renewables

62 http://www.esv.or.at/english/energy-in-upper-austria/

63 http://go100re.net/e-library/studies-and-reports/ and The New Climate Economy Report to "raise ambition for zero-carbon electricity (NCE -Energy, p 27-28)". and https ://web.stanford.edu/group/efmh/jacobson/Articles/I/susenergy2030.html

64 Shaw, K. (2011). Climate deadlocks : the environmental politics of energy systems. Environmental Politics, 20(5), 743-763.

65 Van Alphen, K., et al. (2010). Accelerating the deployment of carbon capture and storage technologies by strengthening the innovation system. International Journal of Greenhouse Gas Control, 4(2), 396-409.

66 Richards, G., et al. (2012). Barriers to renewable energy development : A case study of large-scale wind energy in Saskatchewan, Canada. Energy Policy, 42, 691-698.

67 St-Denis, G. and Parker, P. (2009). Community energy planning in Canada : The role of renewable energy. Renewable and Sustainable Energy Reviews, 13(8), 2088-2095.

68 Transforming Alberta's power sector to address barriers to oil sands production and export, David B. Layzell, CESAR Initiative, University of Alberta, Presentation at the Conoco Phillips IRIS Seminar Series (June 4th, 2014). http://www.cesarnet.ca/research/exploring-strategies-transforming-alberta-s-electrical-systems

69 Lin, Q. G., et al. (2005). An energy systems modelling approach for the planning of power generation : a North American case study. International journal of computer applications in technology (International Network of Centres for Computer Applications), 22(2), 151-159.

70 Lin, Q. G., et al. (2010) The Optimization of Energy Systems under Changing Policies of Greenhouse-gas Emission Control—A Study for the Province of Saskatchewan, Canada. Energy Sources, Part A : Recovery, Utilization, and Environmental Effects, 32(17), 1587-1602.

and cooperate on climate change[71].

2.2.2 Energy Production : Oil and Gas

In 2012, according to Environment Canada[72], oil and gas production was responsible for about 160 Mt CO_2 eq. ; more than three times the GHG emissions associated with energy consumed by the rest of Canada's industry (Figure 3). As such, the oil and gas extraction and transformation sector comes just after transportation for national GHG emissions and could surpass it, if growth continues.

KEY POLICY ORIENTATION # 3 :
Integrate the oil and gas production sector in climate policies

In a continental energy market, Canadian energy producers and exporters in energy intensive industries will face pressure to harmonize with the US. A strong regulatory framework incorporating carbon pricing could favor the development and deployment of innovations[73].

In the short-term, eliminate all direct and indirect subsidies to the fossil fuel industry[74].

In addition, federal and provincial governments could orient the industry.

In the short- to mid- terms, develop a clear regulatory framework coherent with the transition to a low-carbon society and economy.

2.3 ENERGY CONSUMPTION

It is important to understand that reducing GHG emissions demands limiting negative environmental impacts of energy use through energy switching, energy efficiency and some form of energy conservation[75]. Energy efficiency, in particular, is crucial to avoiding unnecessary expansion of energy infrastructure[76], and serves as a focus for innovation and increased competitiveness. It was shown almost twenty years ago that the earlier energy efficiency measures would be adopted in Canada, the lower the cost of GHG emission reduction[77].

KEY POLICY ORIENTATION # 4 :
Adopt a multi-level energy policy with energy efficiency and cooperation in electrification at its core.

Following the lead of the USA, Canada has positioned itself as a leader in efficiency standards in a few sectors, such as industrial electric motors. However, Canada's Energy Efficiency Act[78] lags behind current best practices. The following considerations could be addressed by a national energy efficiency policy elaborated jointly by the federal and provincial governments.

In the short-term, develop a national energy policy with long-term plans for transitioning to low-carbon energy.

Currently decision-making is made in a fragmented way disconnecting energy production, transport and consumption, as well as jurisdiction. A multi-level energy policy could incorporate the following elements :

1. Update norms and standards of energy efficiency across the economic sectors to the highest possible levels, with automatic increments planned ahead ;

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71 http://www.cbc.ca/news/business/ontario-quebec-sign-deals-on-electricity-climate-change-1.2844837

72 http://www.ec.gc.ca/ges-ghg/default.asp ?lang=En&n=83A34A7A-1

73 Van Alphen, K., et al. (2010). Accelerating the deployment of carbon capture and storage technologies by strengthening the innovation system. International Journal of Greenhouse Gas Control, 4(2), 396-409.

74 According to the New Climate Economy Report : "With oil-producing country governments facing the greatest asset stranding risk, there will be a need to address and manage the budgetary consequences of reduced demand and the falling oil prices that would result. This should include more rapid phasing out of current fossil fuel subsidies" (NCE - Finance Chapter p. 35-37 http://newclimateeconomy.report/).

75 See for recent overview : Richards, G., et al. (2012). Barriers to renewable energy development : A case study of large-scale wind energy in Saskatchewan, Canada. Energy Policy, 42, 691-698.

76 Shaw, K. (2011). Climate deadlocks : the environmental politics of energy systems. Environmental Politics, 20(5), 743-763.

77 Harvey, L.D.D., et al. (1997). Achieving ecologically-motivated reductions of Canadian CO_2 emissions. Energy, 22(7), 705-724.

78 http://www.nrcan.gc.ca/energy/regulations-codes-standards/6861

2. Favour low- or zero-carbon energy sources whenever possible ;
3. Adopt a lifecycle integrated approach to energy projects ;
4. Limit energy losses by favouring energy reuse.

In the short-term, ensure government efficiency standards and procurement.

Government leadership for climate action could be shown by ensuring that government purchases at federal, provincial and municipal levels should be "smart" (i.e. secure, sustainable). Governments are big purchasers, and their practices can influence private industry to follow, especially since private industry supplies government entities[79].

In the mid- to long-term, implement efficiency targets for energy use in the extractive industry.

An energy framework could be designed to improve energy efficiency in all natural resource extraction. Extractive industries, which are generally energy intensive, are often located far away from connected electricity grids. It is important to encourage these industries toward maximizing low-carbon energy and moving to low-carbon electricity production, even for the most remote sites. The mining industry is directly affected by climate change and already identifying mitigation options[80 81].

2.4 ENERGY CONSUMPTION : TRANSPORTATION

Canada's transportation system will need to undergo a major revision in the context of the transformation of the energy sector proposed above. Realistic visions for a sustainable Canada mean advancing sustainable ways to transport people and goods over long and short distances[82]. Given the long turnaround time associated with transportation because of vehicle and infrastructure lifespans, it is essential that industry, public sector and consumer investments start to be guided by the need to achieve a reduction of 80 percent in emissions within 35 years.

Governments' investment orientations need to consider that infrastructures built today must foster and sustain a transition to a low-carbon society[83]. This is essential to ensure Canadians have the most cost-effective transportation alternatives in the future. Federal money could support the transformation of transport through development of necessary infrastructure.

KEY POLICY ORIENTATION # 5 :
Throughout Canada, rapidly adopt low-carbon transportation strategies.

Given the complexity of the transportation sector[84], a range of actions might be needed and remain to be fully evaluated in terms of cost/benefit returns :

In the short term, update emissions standards for vehicles and support fuel diversification.

National emission standards could match regions with "best practices" (European or Californian standards within North America), not only for cars, but also for sport utility vehicles and trucks. In addition, the use of natural gas hybrids, biodiesel and the development of electric alternatives for the cars and the heavy trucking industry can contribute to the transition. The production of biodiesel fuel should be strictly controlled to avoid creating adverse effects on biodiversity or water quality.

In the mid- to long-terms, electrify road transport.

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79 Brammer, S. and Walker, H. (2011). Sustainable procurement in the public sector : an international comparative study. International Journal of Operations & Production Management, 31(4), 452-476.

80 Ford, J. D., et al. (2010). Perceptions of climate change risks in primary resource use industries : a survey of the Canadian mining sector. Regional Environmental Change, 10(1), 65-81.

81 Ford, J. D., et al. (2011). Canary in a coal mine : perceptions of climate change risks and response options among Canadian mine operations. Climatic change, 109(3-4), 399-415.

82 Richard, G. and Perl, A. (2010). Transport Revolutions : Moving People and Freight Without Oil. Gabriola Island, BC : New Society Publishers, 433 pp.

83 Lecocq, F. and Shalizi, Z. (2014). The economics of targeted mitigation in infrastructure. Climate Policy, 14(2), 187-208. and Nilsson, M. and Eckerberg, K. (2007). Environmental Policy Integration in Practice : Shaping Institutions for Learning, London : Earthscan.

84 Kennedy, C., et al. (2005). The four pillars of sustainable urban transportation. Transport Reviews, 25(4), 393-414.

The IPCC Fifth Assessment Report (Working Group III[85]) stresses the importance of electrification in the historical evolution of energy production and consumption, emphasising substituting fossil fuel with electricity in transportation, as much as possible.

Urban transport offers a good place to start, for example by electrifying all public (taxi, municipal cars, etc.) and freight fleets[86]. Car-sharing fleets (e.g. Communauto[87] in Montréal) could help showcase electric cars and facilitate their adoption[88]. Electrification of vehicles may be the key element of the transition to low-carbon pathways in jurisdictions like Québec[89], where transport represents 78.4 percent of GHG emissions and electricity is already low in carbon.

In the short- to mid-terms, support new models of transportation.

An array of alternatives to privately owned cars could be made available and plans of access for public transportation could be developed in all Canadian cities. These could include buses, car sharing, taxi-buses[90] and electric trolley-buses[91]. Federal or provincial funding could be made available to establish electric trolley-buses or rapid transit networks conditional upon municipalities removing all on-street parking along these corridors or other disincentives to driving. A range of policies, from tolls to parking fees, have been proposed to stimulate such changes. Across 36 metropolitan areas in Canada, on average only 8 percent of workers commuted to work by public transit in 2011[92]. Setting ambitious targets could help orient investments.

In the short-term, favor active transportation.

The environmental and health benefits of active transportation, such as bicycling and walking, could be taken into account in infrastructure planning. Bicycle paths and streets, wide sidewalks and bicycle parking spaces are needed, while bike-sharing systems (for example, Toronto's Bike Share[93]) could expand the range of bicycle users. Given the length of the winter season, efforts can also be deployed to promote four-season bicycling[94]. Regulations need to be modified to reflect the needs of active transportation (for example vis-à-vis stop signs), and to ensure the safety of cyclists.

In the mid-term, improve and increase intercity rail and intermodal transportation.

Improve rail infrastructure to increase the proportion of freight transport by train, and to provide high-speed passenger train alternative(s) to personal vehicle use. Three times more fuel efficient than trucks, intermodal shipping reduces energy consumption, contributing to improved air quality and environmental conditions. In the USA, shifting 10 % of long-haul freight from truck to rail would save nearly one billion gallons of fuel annually, according to a study by the Federal Railroad Administration. And replacing over the road shipping with intermodal transportation for shipments of more than 1,000 miles would reduce GHG by 65 %, according to the Environmental Protection Agency (EPA)[95].

In addition, high-speed electric train projects (e.g. Vancouver-Seattle-Portland, Calgary-Edmonton, Montréal-Ottawa-Toronto) could be completed in the middle term, provided there are shifts in priority from government spending on road and airport infrastructure expansion to electric train deployment projects. High-speed train networks could then expand in other areas, including suburban and rural zones, along with measures to handle the last-kilometer hurdle. The impact of such projects on emissions reductions, and their economic viability, depends upon their success in decreasing air and car travel between target destinations.

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85 http://mitigation2014.org/report/publication

86 http://www.aqtr.qc.ca/images/stories/Activites/2013/mobilite/castonguay.pdf

87 http://communauto.com/index_eng.html

88 Struben, J. and Sterman, J. D. (2008). Transition challenges for alternative fuel vehicle and transportation systems. Environment and Planning B : Planning and Design, 35(6), 1070-1097.

89 http://www.mddelcc.gouv.qc.ca/changements/ges/2010/inventaire1990-2010.pdf

90 http://www.ville.victoriaville.qc.ca/content/fr-CA/s2f_taxibus.aspx

91 Unruh, G. C. (2002). Escaping carbon lock-in. Energy policy, 30(4), 317-325.

92 http://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-012-x/2011003/tbl/tbl1a-eng.cfm

93 http://www.bikesharetoronto.com/

94 http://www.ledevoir.com/documents/pdf/rapportveloquebec16nov.pdf

95 http://www.fhwa.dot.gov/environment/air_quality/cmaq/reference/intermodal_freight_transportation/

2.5 ENERGY CONSUMPTION : CITIES AND BUILDINGS

Cities are home to 81 percent of Canadians[96]. They concentrate wealth, innovation, education, consumption, and GHG emissions, as well as poverty and vulnerability. SCD's vision of cities is articulated at three interconnected levels : landscape, city and building.

KEY POLICY ORIENTATION # 6 :
Integrate landscape, land use, transportation and energy infrastructure planning policies at multiple scales to ensure climate change mitigation.

In 2011, 52 percent of Canada's metropolitan population lived in medium- and high-density neighbourhoods, and 48 percent lived within 9 km of a city centre[97]. However, throughout Canada, cities are increasing urban density, mixed land uses and non-automobile transportation options, while encouraging climate-friendly buildings and reduction of energy consumption. Strategic landscape planning can provide environmental, economic and social benefits to both rural and urban areas, including resilience to the effects of climate extremes and protection of agriculture, as well as improving cultural, recreational, public health, social equity and education benefits.

In the short-term, integrate climate change into the heart of territorial and urban planning and identify new avenues for financing.

New "smart" urban development projects such as providing incentives to build-in ecological resilience and reduce reliance on cars will require considerable investment. Land value tax financing is probably neither sufficient nor adequate since it incentivizes developer-led. New financing approaches, such as divesting from currently planned road and highway expenses, could be considered. Valuation of natural and constructed landscapes for their ecosystem functioning and environmental management benefits, for example climate change mitigation via thermal cooling[98], represents a critical paradigm shift in municipal and provincial planning.

In the short-term, acknowledge the importance of, and support, green infrastructure and " smart growth[99]" city planning.

Landscape and open-space planning is tied to mobility because "smart" city planning reduces the need to travel and creates space for active mobility, such as walking and bicycling. " Smart growth[100] " cities are designed for high amenity, mixed land use and medium to high dwelling density, with all systems (water, waste, energy, transportation, buildings, etc.) made sustainable, clean, accessible, integrated and connected using advanced technologies. In this context, the " green infrastructure " of urban regions becomes an important component of public infrastructure irrespective of the size of the urban area[101].

Canada has a harsh climate and heating is a considerable energy expense. In total, building heating is responsible for about 80 Mt CO_2 eq[102]. Heating across the country is mostly done by natural gas and oil, except in Québec and Manitoba where renewable electricity provides a considerable proportion of heat for residential, commercial and institutional buildings. Urban densities and designs that allow access to sunshine are critical for implementation of passive and active solar heating strategies. The building sector should be a leader in reducing energy use and GHG emissions.

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96 Statistics Canada, 2011. "Population, urban and rural, by province and territory." http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo62a-eng.htm

97 Statistics Canada, 2011. "Population, urban and rural, by province and territory." http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo62a-eng.htm

98 Hough, M. (2004). Cities and natural process : a basis for sustainability. Routledge.

99 "Smart growth" cities are designed for high amenity, mixed land use and medium to high dwelling density, with all systems (water, waste, energy, transportation, buildings, etc.) made sustainable, clean, accessible, integrated, and connected using advanced technologies.

100 http://www.epa.gov/smartgrowth/tisg.htm

101 Green infrastructure is defined as spatially and functionally integrated networks of natural and constructed vegetative systems and green technologies that leverage the functions of natural ecosystems to provide environmental, social and economic benefits http://www.asla.org/greeninfrastructure.aspx

102 http://www.ec.gc.ca/ges-ghg/default.asp ?lang=En&n=83A34A7A-1

KEY POLICY ORIENTATION # 7 :
Support evolution of the building sector toward a carbon neutral or carbon-positive sector[103].

While energy efficiency in the residential sector improved 29 percent from 1990-2007, overall energy use in this sector increased 7 percent[104]. Between 1990 and 2007, the number of households increased 31 percent while the average Canadian home became 10 percent larger leading to an increase in the number of dwellings and more energy consumed.

In the short-term, adopt ambitious targets for energy demand and efficiency of buildings and include climate change mitigation in national building codes.

By 2035, nearly three- quarters of Canada's buildings will be new or renovated. A new building code, improving energy efficiency of the housing sector to support Architecture 2030[105] targets, could be developed. Such a code could incorporate stringent performance standards such as PassivHaus[106] and consider post-occupancy evaluation in green building projects[107].

A range of actions could help the building sector become carbon neutral or net-positive[108] : energy demand could be cut significantly through proper siting, building and urban density, and by incorporating daylighting, solar heating and natural ventilation. The energy efficiency of environmental control systems could increase and the remaining energy demand could be met by active low-carbon energy.

However tighter building regulations represent additional costs to the developers, and extra labor and work hours for the workers. Changing industry practices could be supported through improved training in the workforce, financing by governments, financial incentives to build better, more sustainable and efficient buildings and disincentives to developers that don't follow best practice guidelines.

In the short- to mid-term, invest in renewable and ambient energy for new and existing buildings.

Design and technology are available to create more climate-friendly buildings at little or no additional cost through cutting demand, increasing efficiency, and shifting to low-carbon energy sources[109]. Options for 100 percent heating transfer to renewable energy include hydroelectricity, solar, biomass and geothermal heat. As with the transportation sector, evolution of the building sector is slow and requires considerable investments. Including requirements for natural lighting, passive heating and cooling and use of active renewable energy in new urban developments is one of the possible ways forward.

Existing buildings could be renovated to the highest possible technical standards for energy efficiency[110]. This could be facilitated by funding from the federal and/or provincial governments. The " pay as you save " policy developed in the UK for building energy efficiency[111] is an interesting model that could be considered for buildings already in place. Electric heat pumps and new insulation can reduce the GHG emissions of old buildings.

2.6 TRANSITIONING TO A LOW-CARBON SOCIETY

Understanding GHG reduction as part of a medium- to long-term transition to a low-carbon society has many advantages.

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103 Kolokotsa, D., et al. (2011). A roadmap towards intelligent net zero-and positive-energy buildings. Solar Energy, 85(12), 3067-3084. and Reed, W. (2007). Shifting from 'sustainability'to regeneration. Building Research & Information, 35(6), 674-680.

104 http://oee.nrcan.gc.ca/publications/statistics/trends09/chapter3.cfm ?attr=0

105 http://architecture2030.org/

106 http://www.passivhaus.org.uk/

107 e.g. UK's CarbonBuzz initiative http://www.carbonbuzz.org/

108 See section 3.5 for definition and example.

109 Cole, R. (2013). Shifting Performance Expectations : Net Positive Buildings. Retrieved from http://www.cesb.cz/cesb13/proceedings/0_keynote/CESB13-Key_Cole.pdf ; Building Performance Institute Europe : http://bpie.eu/eusew_2014.html#.VMpn1ryON8U ; Dekay, M. and Brown, G. Z. (2014). Sun, wind, and light : Architectural design strategies. John Wiley & Sons. : New-York, 413 p.

110 Harvey LDD. (2014) Global climate-oriented building energy use scenarios, Energy Policy, 67, 473-487

111 http://www.ukgbc.org/content/pay-you-save-task-group

- It establishes the direction of change, allowing Canada to plan for the future while recognizing goals take time to accomplish (Figure 5);
- It permits governments, businesses and citizens to situate their activities within the context of expected changes;
- It provides historical references allowing Canadians to understand the transition to a low-carbon economy and society in the light of past social and technical changes, such as industrialization, electrification, the rise of information and communications technologies or democratization.

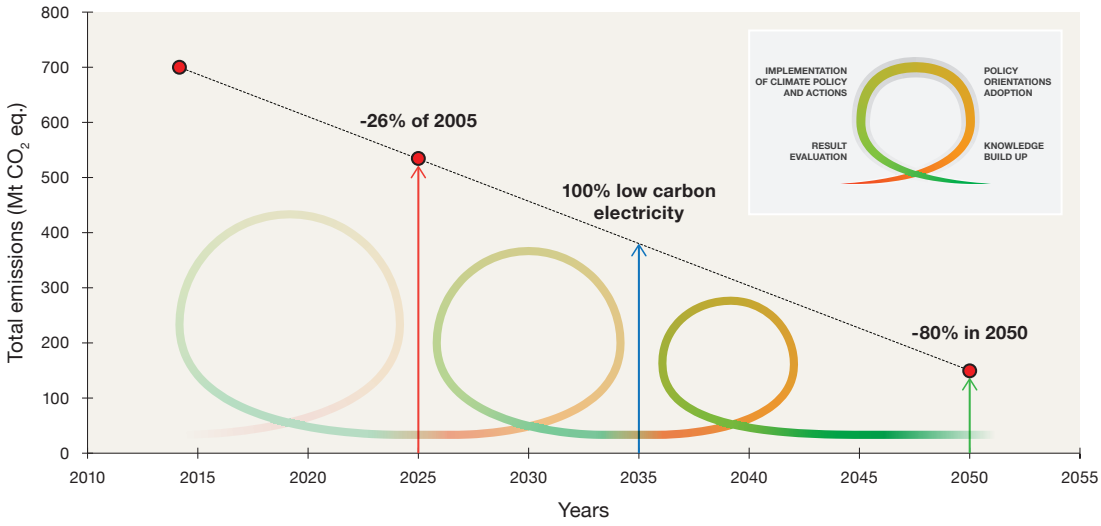

FIGURE 5: TRANSITION TOWARDS A LOW CARBON ECONOMY
Emissions reduction targets as well as target for the production of electricity from renewable sources will flag the road for the transition to a low carbon economy. Progress should be monitored periodically and, at each time, the most appropriate policies and actions, according to the current state of knowledge, should be implemented.

As with other past and future major transitions, there will be controversies and setbacks. Some economic sectors will contract as others expand and adjustment policies may be required. But it will also usher in great opportunities for developing new technologies, businesses and employment.

There are many different routes and pathways consistent with a low-carbon future in Canada. Carbon emissions from transport can be cut by encouraging people to walk, ride a bike, take public transit or drive a low-emission vehicle. Probably we will do more of all of these—but how they will be combined into the future we choose to build remains to be seen. Similarly, we can generate low-carbon electricity with hydro, wind, solar and other renewable energies, but also with nuclear power or fossil sources equipped with carbon capture and storage.

Different regions will opt for different combinations of these and other technologies depending on their vision, energy mixes[112] and emissions sectors[113]. Decarbonisation priorities in Québec, with its hydro-based electricity system, will look different from those in Alberta, which relies substantially on coal and has a developed a hydrocarbon extraction sector. Different realities exist in the other provinces as well. Determining decarbonisation pathways necessarily involves choices about what is acceptable and desirable in the low-carbon world we want to build.

Viewed from the standpoint of the country as a whole, this diversity is complicated. However, it can also be seen as an advantage because different regions can explore different routes, drawing on different technologies, industries and practices. There is room for creativity and cooperation as different provincial and city governments develop transition pathways suitable to their particular circumstances, mobilizing local resources, business interests, technological prowess and cultural norms to encourage movement toward low-carbon emission solutions.

112 http://www.cesarnet.ca/background-energy-systems
113 http://www.cesarnet.ca/blog/dividing-big-picture-visualizing-provincial-diversity

Above all, it should be recognized that no one knows in advance which technologies or institutional solutions will ultimately prove most effective, cost-efficient and socially acceptable. We do not know exactly what the world will look like in thirty or fifty years' time. However, Canada will not be travelling solo on this road to transformation. Nations around the globe engage with the challenge of defining low-carbon development trajectories. Indeed, almost every carbon reduction method advanced in this position paper has already been taken up by decision-makers in one or another developed States. And many countries—including Germany, Sweden, Denmark and the United Kingdom—have already begun to set their policies within the framework of a deliberate transition to a low-carbon emission society. Advancing this transition means getting going now, applying policies that are most appropriate according to the current state of knowledge, then systematically monitoring progress and adjusting our efforts over time on the basis of lessons learned (Figure 6).

[1] *"Smart growth" cities are designed for high amenity, mixed land use and medium to high dwelling density, with all systems (water, waste, energy, transportation, buildings, etc.) made sustainable, clean, accessible, integrated, and connected using advanced technologies.*

FIGURE 6: TRANSITIONAL PATHWAYS

A possible road map for Canada`s transition to a low carbon economy highlighting ten proposed policy orientations that would allow to reduce greenhouse gas emissions by 80% by 2050. A number of possible actions illustrate each policy orientations.

Chapter 3

LINKING CLIMATE CHANGE TO THE BROADER SUSTAINABILITY AGENDA

Sustainability has become an increasingly popular concept since the middle of the past century. This stemmed from the realization that certain forms of economic development were depleting natural resources or causing environmental damage, leading to the notion of sustainable development as articulated by the World Commission on Environment and Development (1987)[114]: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

More recently, discussions around sustainability began to view sustainability as a property of desired futures that takes into account the ecological, social and economic consequences of different courses of action[115]. This novel vision recognizes both environmental and human well-being as ends in themselves. It does not look at social or human issues only as means to achieve environmental sustainability, making it a more positive, actionable definition.

Transition to a low-carbon society is a matter of urgency. As pathways to reduce Canada's GHG emissions are identified, it is important to take into account the broader sustainability agenda. The first section of this chapter focuses on natural resource extraction (other than mineral resources) in view of the importance of livelihoods. The second section addresses elements of governance.

3.1 CANADA'S NATURAL ASSETS

3.1.1 Sustaining Biodiversity

Canada is home to 70,000 known species of plants, animals and fungi[116]. These species make up Canadian ecosystems - they feed, clothe, and house us; filter our water; process pollutants; pollinate our plants; and produce the air we breathe. Biodiversity provides jobs to millions of Canadians, contributing $24.8 billion to the GDP in 2012 in agriculture, forestry, fishing and hunting[117], and can sustain innovation. For example, a recently discovered fungus in Nova Scotia holds promise in the war against multiple-resistant strains of bacteria. In another recent example, a University of British Columbia team has discovered genes within the microbial world that may help the biofuel industry process plant lignin. Biodiversity represents billions of generations of evolution, providing a diversity of solutions to a wide

114 Bruntland, G. (1987). Our Common Future. Oxford University Press, pp383

115 Robinson J. and Cole R. J. (2014). Theoretical underpinnings of regenerative sustainability. Building Research & Information, 1-11.

116 Mosquin, T., et al. (1995). Canada's Biodiversity : The variety of life, its status, economic benefits, conservation costs and unmet needs (p. 293). Ottawa, ON : Canadian Museum of Nature.

117 https ://www.ic.gc.ca/app/scr/sbms/sbb/cis/gdp.html ?code=11

variety of environmental problems, a bank of solutions into which we can tap.

Unfortunately, Canadian biodiversity is in decline. Nearly 700 species have been found to be at risk Canada[118], and many of these species are worse off now than when they were first found to be at risk[119]. Declines in fishing catch have impoverished many east-coast communities. On the west coast, trawling and dredging have severely damaged the breeding grounds of several populations of eulachon ("candlefish"), a once abundant fish of great cultural importance to many west coast First Nations.

Canada could lead the world in developing technology and policies that are biodiversity-neutral or even positive. For example, one such policy might require that, for every road built, corridor access and causeways are improved to facilitate migration and connectivity among habitats. The discussion on green infrastructure in Section 2.5 of this document, proposes actions with biodiversity-neutral or even positive consequences. As biodiversity is lost globally, countries will increasingly demand such solutions. The leaders in a sustainable, biodiversity-neutral or positive future will therefore gain business opportunities by providing the know-how and technology to ensure human livelihoods and species coexistence are compatible, not in conflict.

3.1.2 Water Resources

Water resources around the world are under increasing stress and Canada is no exception despite its above-average availability per capita[120]. Human population growth is the most prevalent water resource stressor. Canadians benefit from water for our own consumption, and rely upon it for about all aspects of life: energy, food, health and more.

Canadians also dedicate huge volumes of water to energy production[121]. Those volumes are controlled by engineers to guarantee a continuous, timely flow of energy, modifying the natural hydrology of rivers. Canadians also irrigate much of the agricultural land in the Prairies[122], and it is highly plausible this practice could expand throughout Canada under a changing climate that brings warmer, longer growing seasons.

When asked their main concerns about water, Canadians typically note the desire to protect their own health while drinking potable water[123]. Vast volumes of bottled water are purchased by Canadians every day, despite living in a country that imposes some of the strictest norms on municipal potable water distribution. Many Canadians mistrust the initial quality of municipal intake waters and believe non-traceable amounts of pollutants remain in the water and threaten long-term well-being.

The occurrence of severe flood events (e.g. Saguenay in 1996, Red in 1997, and Bow and Elbow in 2013) is another reality Canadians now face. In Canada, floods are recognized as the most common, largely distributed, natural hazard to life, property, the economy, community/industry water systems and the environment. Evidence exists that flood-prone weather conditions associated with increased risk of flooding are becoming more prevalent. Climate models predict this intensification will continue.

Driven by an increasing preoccupation of Canadians with the safety of drinking water, a multi-layer barrier approach has been proposed for managing drinking water systems from source to tap in order to reduce risks to public health[124]. Its concept is straightforward: if individual barriers may be inadequate in removing or preventing all contamination risks, together they increase assurance that water will be fit to drink.

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118 http://www.sararegistry.gc.ca/search/SpeciesSearch_e.cfm

119 Favaro, B., et al. (2014). Trends in Extinction Risk for Imperiled Species in Canada. PloS one, 9(11), e113118.

120 World Water Assessment Programme. (2009). The United Nations World Water Development Report 3 : Water in a Changing World. Paris : UNESCO, and London : Earthscan.

121 Statistic Canada's water surveys reveal that the thermal power generation sector (nuclear and fossil fuel) is by far the largest gross water user in Canada, accounting for approximately 64 % of all water withdrawn in 2005. This excludes water use by the hydroelectric power generation sector which is not captured by Statistic Canada's industrial water survey. See : National Round Table on the Environment and the Economy. (2010). Changing Currents : Water Sustainability and the Future of Canada's Natural Resource Sectors. Ottawa : NRTEE.

122 If agriculture is responsible for only 10 % of all Canadian water withdrawn in 2005, the fact that much of this water is not returned to the watershed after usage makes agriculture accounting for approximately 66 % of all consumptive water use by major Canadian sectors. See : National Round Table on the Environment and the Economy. (2010). Changing Currents : Water Sustainability and the Future of Canada's Natural Resource Sectors. Ottawa : NRTEE.

123 2014 Canadian Water Attitudes Study, commissioned by RBC. http://www.rbc.com/community-sustainability/environment/rbc-blue-water/water-attitude-study.html

124 Canadian Council of Ministers of the Environment. (2004). From Source to Tap : Guidance on the Multi-Barrier Approach to Safe Drinking Water. Federal-Provincial-Territorial Committee on Drinking Water and the CCME Water Quality Task Group, Winnipeg.

From source to tap, numerous stakeholders use water along rivers. Water management is thus a multi-layer endeavour and invites revisiting of legislative and policy frameworks to favor public involvement, source protection and management. Many Canadian authorities are now elaborating novel management systems, which could serve as an inspiration to solve other issues such as promoting optimal water use, preventing river and aquifer pollution or reducing the impact of floods on people and society.

KEY POLICY ORIENTATION # 8 :
Safeguard biodiversity and water quality during Canada's transition to a low-carbon society, while aiming for net positive approaches when possible.

3.2 NATURAL RESOURCE EXTRACTION

Canada's wealth of natural resources seemed nearly limitless early in our colonial history, and natural resources remain cornerstones of the Canadian economy. However, climate change is imposing substantial impacts on forests, agriculture and biodiversity. New approaches are needed to increase their resilience. The limits of our activities based on natural resource extraction have become apparent through the large costs of production and extraction in terms of GHG emissions, deforestation, loss of biodiversity and pollution of waterways. The strong impact of fishing on biological diversity with its dire consequences for human livelihoods is a lesson to be constantly remembered.

3.2.1 Sustainable Fisheries and Marine Ecosystems

Fisheries were important in Canada's economic history but have left a legacy of boom-and-bust cycles. Perhaps the most famous example of such a cycle is the collapse of the Newfoundland cod (Gadus morhua), following Canada's declaration of a 200-mile exclusive economic zone ahead of the provisions of the 1982 Law of the Sea, the rapid expansion of offshore fleets, booming harvests, and finally the (1992) collapse of the cod stocks.

Fisheries have become less important in the overall economy, but remain important as ever as integral parts of ecosystems and biodiversity, and as ecosystem services for human well-being. Despite enabling legislation, sustainability planning does not exist in practical terms for Canada's three oceans. The Royal Society of Canada's report, Sustaining Canadian Marine Biodiversity (2012)[125], concluded that little substantive progress has been made in fulfilling international commitments for marine biodiversity. Furthermore, the health of ocean ecosystems continues to be of concern. Key biophysical uncertainties driving changes in Canada's fisheries and marine ecosystems include the effects of climate change, biodiversity loss and ocean acidification. Hence, there is a need to understand the challenges facing Canada's fisheries and oceans, to identify future policy options and to develop a shared vision for sustainability.

In some cases, communities themselves are addressing the governance gap between intended management and actual outcomes. Responding to cutbacks in federal government science and monitoring programs, the Nova Scotia fishing community of Port Mouton Bay has taken matters into its own hands. Working with its own science partners, the community carried out the necessary research to show that salmon aquaculture operations in the area have been damaging the local ecosystem and livelihoods[126].

3.2.2 Sustainable Forest Management

Canada's forests account for 9 percent of all forests and 24 percent of boreal forests worldwide. They remove carbon dioxide from the atmosphere and moderate local climate, water flow and air quality. Forests are home to two-thirds of all species in Canada and are the source of more than 65 percent of Canada's fresh water. Except for the past two decades, forests have been the primary sinks for our GHGs. Over 70 percent of aboriginal communities live in forests. In 2013, forest harvesting contributed $19.8 billion to the nation's GDP and directly employed 216,500 people[127].

125 http://www.ianas.org/books/Sustaining%20Canada%27s.pdf

126 Berkes, F. (2015). Coasts for People. Interdisciplinary Approaches to Coastal and Marine Resource Management. New York : Routledge. p. 166.

127 Natural Resources Canada. (2014). The State of Canada's Forests 2014.

Canada's forests are being negatively impacted by increased natural disturbances due to climate change, and also by resource extraction. Lengthened summers and increased drought have created the fuel and weather conditions for earlier, more frequent and more severe forest fires. Warming temperatures led to massive insect and disease outbreaks such as the mountain pine beetle in western Canada. Canada's "State of the Forest" statistics indicated 3.9 percent of our forests were disturbed in 2013 by insects, fire, logging, and for economic development—roughly four times the rate of disturbance expected for sustainable forest production. The World Resources Institute reported in 2014 that Canada accounted for 21.4 percent of forest degradation worldwide in the past 13 years, the highest rate globally[128]. Oil and gas development and increased forest fires were highlighted as major drivers of this degradation.

The majority of forests in Canada are on public land and regulated under provincial forest management policies. Federal policies also affect climate change mitigation and adaptation, carbon sequestration, monitoring of forest pests and diseases, and control of imported materials that may transport pests or pathogens. We can help forests and their resident species adapt to new climates by adopting more rigorous forest management policies that reduce deforestation from all activities, accelerate reforestation, increase forest diversity and resilience, promote local and adaptive management of forests and conserve large areas of continuous forests,. The resulting forests will sequester carbon and continue to provide the wide range of ecosystem services on which humans and biodiversity rely.

3.2.3 Opportunities in Agriculture

According to the 2014 census, Canada's agriculture and food sector is responsible for 8 percent of national GDP and employs about 12 percent of Canadians[129]. Exports are responsible for over half our agricultural economy. Farming in Canada is predominantly a family business, although farm sizes have increased dramatically due to declining returns per unit of production. Threats to Canadian agriculture include overspecialization (which makes production systems ecologically and economically fragile), water pollution, declining effectiveness of agrochemical biocides, high reliance on fossil fuel energy for fertilizer manufacturing and increases in crop and animal diseases owing mostly to overspecialized monocultures.

The Canadian agriculture sector is embarking on a number of "sustainability initiatives" such as including full lifecycle considerations (e.g., canola, beef, pulse production), developing organic production and paying farmers for ecosystem services (e.g., water filtration, biodiversity enhancement). These initiatives are led by different organizations including commodity groups, farm groups and corporations; they will help Canada's future competitiveness in international markets by maintaining our production capacity and offering the world clean, healthy food. Improvements in sustainability will also improve the quality of Canada's food supply (e.g., improved nutrient density and overall healthfulness of foods), leading to improved human health outcomes. Finally, a diverse, ecologically-integrated agriculture can buffer against variable weather and other environment stresses, allowing Canada to adapt to changing economic, social and environmental circumstances.

KEY POLICY ORIENTATION # 9 :
Support sustainable fisheries, forestry and agriculture practices, offering opportunities not only to limit GHG emissions but also, where possible, to enhance carbon sequestration, protect biological diversity and water quality.

3.4 BUILDING RESILIENT GOVERNANCE FOR SUSTAINABILITY

To begin the examination of sustainability governance in Canada, it is important to consider four key pillars:

- Building strategic capacity
- Integrating climate change and sustainability into development decision-making,

128 Hansen, M. C., et al. (2013). High-resolution global maps of 21st-century forest cover change. Science, 342(6160), 850-853.

129 http://www.agr.gc.ca/eng/about-us/publications/economic-publications/alphabetical-listing/an-overview-of-the-canadian-agriculture-and-agri-food-system-2013/?id=1331319696826

- Mobilizing society
- " Learning by doing "[130]

Leadership, an element of strategic capacity, has been shown to be the most important factor influencing the success of climate change governance since it is needed to stimulate an organizational culture of innovation and collaboration[131]. Canada needs a climate change champion !

3.4.1 Towards Effective Climate Change Governance in Canada

Knowledge acquisition and the provision of expert knowledge are key elements needed to build strategic capacity for climate change since they allow for increased understanding. Scientific knowledge provides the basis for evidence-based decision-making and clarifies the context in which the interests of stakeholders are to be considered. Furthermore scientific and technological advances will sustain sustainability and climate change mitigation innovation. Free access to scientific information can help citizens and policy makers to better understand and predict the nature and impacts of climate change ; better evaluate the effectiveness, impacts, and risks of climate change mitigation strategies ; and identify new approaches and technologies that will improve the political, economic, and social acceptability of sustainability and climate change mitigation.

Canada's numerous research networks provide a wealth of scientific expertise on climate change and sustainability, ranging from energy (e.g. CESAR[132]) to the impact of climate change (e.g. ArticNet[133]). Applied research organizations such as the Consortium Ouranos[134] in Québec and the Pacific Institute for Climate Solutions[135] in British Colombia provide valuable models for connecting scientific knowledge with a variety of public and private stakeholders, as well as the general public.

However, information alone is not enough to trigger leadership on climate change and more effective climate change governance[136 137]. It is clear that decisions are made more on the basis of intuition and values than on rational, careful consideration of costs and benefits of action[138]. This highlights the importance of triggering a values shift in response to climate change – a task that requires action on the part of governments, private sector leaders, and civil society – and creating a vision of the future that is both desirable and feasible[139]. This shift in values could help Canada to redefine national interests in light of climate change risks and elaborate a strategic policy framework.

After elaborating a strategic policy framework, there is a need to establish organizations focused on the transition to low-carbon pathways, and also embed climate action in existing organizations and policies. Canada has past experience in governance innovation that can be drawn upon to facilitate such a transition : for example, the Canadian Council of Environment Ministers and the national, provincial and municipal round tables on the environment and the economy and their structural arrangements. Effective climate change governance favors policy coherence within government, supports policy congruence between levels of government ; and enhances participatory policy-making to close implementation gaps, transitioning de facto to multi-level governance[140]. Multi-level governance allows for decisions that engage a multiplicity of politically independent but otherwise interdependent actors - private and public - at different levels of territorial aggregation in more-or-less continuous negotiation/deliberation/

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130 Meadowcroft, J. (2010). Climate change governance. World Bank Policy Research Working Paper Series, 4941.

131 Burch, S. (2010). Transforming barriers into enablers of action on climate change : insights from three municipal case studies in British Columbia, Canada. Global Environmental Change-Human and Policy Dimensions, 20(2), 287-297.

132 http://www.cesarnet.ca/

133 http://www.arcticnet.ulaval.ca/

134 http://www.ouranos.ca/en/default.php

135 http://pics.uvic.ca/

136 Tribbia, J. and Moster, S. C. (2008). More than information : what coastal managers need to plan for climate change. Environmental Science & Policy, 11(4), 315-328.

137 Kollmuss, A. and Agyeman, M. (2002). Mind the gap : why do people act environmentally and what are the barriers to pro-environmental behavior ?. Environmental education research, 8(3), 239-260.

138 Slovic, P., et al. (2007). The affect heuristic. European journal of operational research, 177(3), 1333-1352.

139 Burch, S., et al. (2014). Triggering transformative change : a development path approach to climate change response in communities. Climate Policy, 14(4), 467-487.

140 Urwin, K. and Jordan, A. (2008). Does public policy support or undermine climate change adaptation ? Exploring policy interplay across different scales of governance. Global environmental change, 18(1), 180-191.

implementation[141] [142].

Another essential element of the building of strategic capacity is social mobilisation. Moving toward sustainability requires behavioral changes, promoted by adequate policies, by all relevant populations and sectors of society[143]. It has been shown that individuals are more likely to restrain their behavior voluntarily if they recognized the legitimacy and fairness of the process establishing limits[144]. Information about interconnected environmental and societal risks and how to manage them[145] is therefore an important aspect of the transition to a low-carbon society.

In a country as geographically dispersed, diverse, and pluralistic as Canada, the pursuit of climate change mitigation and sustainability requires a governance system that can integrate the knowledge and practices of multiple stakeholders[146]. Canada has historically benefited from its strong democratic institutions, efficient structures of federal governance, and a professional civil service, since the end of the Second World War. In the face of climate change, however, there is a need for policy approaches that use longer time horizons, systems thinking, adaptive management and integrated decision-making in community planning[147].

The new hyper-connected and collaborative world moves away from traditional, siloed government structures, which are mismatched when it comes to addressing broad, horizontal cross-cutting issues[148]. The governance system could take advantage of the push/pull from web technologies and emerging digital innovations crucial to civil society as a neutral convenor of multiple actors, including the business sector[149]. For example, web channels for key public policy issues and ideas can be tested, developed, and evolve using informed deliberative dialogues from Canadians who choose to be involved.

Governments at all levels should participate regularly in a multi-direction exchange of information of climate change impacts and response options. Part of this involves communicating how climate change is already affecting Canadian communities, particularly northern communities, and starting a conversation around visions of a sustainable future. Informing the public about climate change ensures that individuals can understand the key issues[150]. It also facilitates dialogues among key stakeholders and the general public regarding possible measures of mitigation. Doing this means finding ways to make large-scale environmental problems relatable by translating climate change from an abstract concern to an everyday experience[151], thus generating informed personal responses from the general public.

Several jurisdictions within Canada are already adopting innovative measures for engaging the general public on climate change. For example, the province of British Columbia has created the LiveSmart BC Energy Efficiency program, which serves as a hub for information on services and community programs related to energy efficiency, and promoting the use of smart meters to enable the public to better understand and change their energy consumption patterns. Ontario developed a climate change mapping browser[152], an online tool the public can use to view projections of the impacts of a changing climate. Prince Edward Island has created a wind energy interpretive centre[153] to help educate the public about

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141 Hooghe, L.& Marks, G. (2001) Types of multi-level governance. European Integration online Paper 5, http://eiop.or.at/eiop/texte/2001-2011a.htm.

142 Rabe, B. G. (2007). Beyond Kyoto : Climate change policy in multilevel governance systems. Governance : An International Journal of Policy, Administration, and Institutions, 20(3), 423-444.

143 Levin, K., et al. (2012). Overcoming the tragedy of super wicked problems : constraining our future selves to ameliorate global climate change. Policy Sciences, 45(2), 123-152.

144 Tyler, T. R., and Degoey, P. (1995). Collective Restraint in Social Dilemmas - Procedural Justice and Social Identification Effects on Support for Authorities. Journal of Personality and Social Psychology 69(3) : 482-497.

145 Carpenter, S. R., et al. (2009). Science for managing ecosystem services : Beyond the Millennium Ecosystem Assessment. Proceedings of the National Academy of Sciences, 106(5), 1305-1312.

146 Castells, M. (2009). Communication Power. Oxford, UK : Oxford University Press.

147 Burch, S. et al. (2014). Triggering transformative change : a development path approach to climate change response in communities. Climate Policy, 14(4), 467-487.

148 Biermann, F., et al. (2012). Navigating the Anthropocene : improving earth system governance. Science, 335(6074), 1306-1307.

149 Newell, R. and Dale, A. (2015) Meeting the Climate Change Challenge (MC3) : The Role of the Internet in Climate Change Research Dissemination and Knowledge Mobilization. Environmental Communication, 1-20.

150 Brulle, R. J., et al. (2012). Shifting public opinion on climate change : an empirical assessment of factors influencing concern over climate change in the US, 2002–2010. Climatic change, 114(2), 169-188.

151 Shaw, A., et al. (2009). Making local futures tangible—synthesizing, downscaling, and visualizing climate change scenarios for participatory capacity building. Global Environmental Change, 19(4), 447-463.

152 http://www.ontario.ca/government/search-results ?external_tag=Natural+resources+maps

153 http://welcomepei.com/listing/wind-energy-interpretive-centre-gift-shop/

the transition toward this low-carbon energy technology.

Ultimately, effective climate change governance is not simply a matter of information provision : ambitious targets and actions[154], developed through a participatory process that engages a wide swathe of actors, integration with other policy domains[155], and frequent opportunities for course-correction are all required.

3.4.2 Indigenous Governance for Sustainability

As Canada moves forward to meet the challenges posed by renewable energies, future resource extraction, and industrial development, Indigenous sovereignty and Indigenous governance are defining issues. Despite a 40,000 year history of cultural continuity, land usage, and prosperous living with and on the land, Indigenous peoples in Canada have been consistently marginalized, discriminated against and politically disempowered through the enduring legacies of colonialism[156]. Current governance structures in Canada do not always support or recognize the inherent rights and sovereignty of Indigenous peoples for self-governance. For example, many land claims remain unsettled and many historic Treaties are not honoured.

The push to low-carbon energy could well involve new land negotiation. Many Aboriginal People value Mother Earth, view themselves as stewards/caretakers and have taken on the role of aboriginal social entrepreneurs to safeguard their values. For example, energy projects that threaten to violate First Nations lands have met strong opposition[157]. Other First Nations have responded by proposing renewable energy projects that protect the land, air and water while creating much-needed employment[158].

Recognizing Indigenous sovereignty and governance institutions are therefore core ingredients, not only of good governance in general, but more specifically of good governance for sustainability[159]. These can only be recognized through meaningfully working with Aboriginal People, communities and governments across Canada, and through commitment from the Canadian government to conclude the outstanding land claims and unresolved sovereignty issues across the country.

3.4.3 Regaining leadership in global sustainable development and climate governance

Since our resignation from the Kyoto Protocol in 2011, Canada is no longer seen as a world leader in its contribution to some of the multilateral global initiatives that we helped develop in the 1990s, most notably the UNFCCC. To regain our international leadership role, Canada could rejoin the new global consensus of like-minded countries by ratifying the UN Convention to Combat Desertification (from which we pulled out in 2013), the Nagoya Protocol on Access and Benefit-Sharing of the Convention on Biological Diversity and the 2015 UN Framework on Climate Change as well as the new post-2015 Sustainable Development Goals. Canada could also take advantage of the opportunities for dialogue and learning provided by the recently created High-level Political Forum on Sustainable Development.

In addition, Canada's current international presence largely centers on our mining industries. Canadian corporations with overseas operations must comply with the laws of the host countries. However, many developing countries have laws that are weak, non-existent or inadequately enforced, a private Bill, Bill C-300, was deposited at the Federal level asking the regulation of Canadian mining abroad but was defeated[160]. Collaborating with local communities in the opening, operations and closing of mines using the highest international standards could restore Canada's international reputation in this area. The federal government could implement the recommendations formulated by National Roundtables

154 Eom, J., et al. (2015). The impact of near-term climate policy choices on technology and emission transition pathways. Technological Forecasting and Social Change, 90, 73-88.

155 Brouwer, S., et al. (2013). Mainstreaming climate policy. The case of climate adaptation and the implementation of EU water policy. Environment and Planning C, 31(1), 134-153.

156 Coulthard, G. S. (2007). Subjects of empire : Indigenous peoples and the 'politics of recognition' in Canada. Contemporary Political Theory, 6(4), 437-460.

157 Globe and Mail. (2012b). The age of extreme oil : 'This used to be a forest ?'. May 19 2012 ; Globe and Mail (2012c). B.C. Natives willing to 'go to the wall' against Enbridge pipeline. July 30 2012.

158 Henderson, C. (2013). Aboriginal Power : Clean Energy & the Future of Canada's First Peoples. Ontario, Canada : Rainforest Editions.

159 Alfred, T. (2001). From sovereignty to freedom : Towards an Indigenous political discourse. Indigenous affairs, (3), 22-34.

160 Fitzpatrick, P. et al. 2011. « From the Whitehorse Mining Initiative Towards Sustainable Mining: lessons learned». Journal of Cleaner Production 19: 376-384.

on Corporate Social Responsibility and the Canadian Extractive Industry in Developing Countries[161], a multi-stakeholder process that was carried out in 2006 and 2007.

In the context of climate change, by emulating the approach taken by the Norwegian International Climate and Forest Initiative[162], Canada could consider leveraging Canadian resources, technologies and expertise to accelerate the development and diffusion of low-carbon energy solutions in developing countries. In the context of restoring its international leadership, Canada would need to come to the *2015 Paris Climate Conference* with a clear and concerted vision of how it will address climate change and with an ambitious goal to reduce its GHG emissions. Canada has much to gain by doing so. Nobel Laureate in Economic Sciences (2009) Elinor Ostrom demonstrated that communication, trust and reciprocity are essential for the sound management of resources held in common such as the ocean and the atmosphere[163]. In the context of international climate negotiations, where mistrust prevails, Canada's change of attitude would help build momentum for an agreement as developing countries expect developed nations to act on climate change first[164]. If Canada ever wants to ensure that international policies on climate change do not unduly undermine the competitiveness of its high emission industry[165], this trust-building will be paramount.

KEY POLICY ORIENTATION # 10 :
Facilitate the transition to a low-carbon sustainable society through the implementation of more participatory and open governance institutions.

3.5 THE NEED FOR VISIONS

The early notion of sustainability emerged from concerns around the health of the biosphere; consequently the objective was to limit environmental damage. Hence discourses were cast in terms of reducing harm or damage, and as such, have been criticized for being uninspiring[166]. This novel vision of sustainability breaks away from the negative paradigm by favoring " net-positive " approaches[167]. " Net positive " buildings, such as the Centre for Interactive Research on Sustainability[168], that are designed to be net positive in terms of energy, carbon, water quality, health, productivity and subjective wellbeing exemplify this approach. The local organic food movement can be also seen as a positive sustainability action that not only reduces the impact of agriculture and transportation but also brings important local livelihood and economic benefits.

Given that sustainability can improve environmental, social and economic well-being, the transition to a low-carbon and sustainable society represents a positive opportunity for change. It provides the possibility for all Canadians to act on the future at hand. Rather than positioning climate change in the context of depressing futures, we hope that our collective work to identify policy orientations and possible actions with positive overall consequences will open new doors. The transition to a low-carbon economy and sustainable society can mobilize society around technical and social innovations and become the basis for a new vision for Canada.

161 http://www.pdac.ca/policy/corporate-social-responsibility/policy/2012/01/04/national-roundtables-on-csr

162 https ://www.regjeringen.no/en/historical-archive/Stoltenbergs-2nd-Government/Ministry-of-the-Environment/Ryddemappe/2008/why-a-climate-and-forest-initiative/id526489/

163 Ostrom, E. (1990). Governing the Commons. Cambridge University Press, pp 280.

164 Simpson, J., et al. (2008). Hot air : Meeting Canada's climate change challenge. Emblem Editions, pp 288.

165 Rivers, N. (2010). Impacts of climate policy on the competitiveness of Canadian industry : How big and how to mitigate ?. Energy Economics, 32(5), 1092-1104.

166 Robinson, J. and Cole, R. J. (2014). Robinson J. and Cole R. J. (2014). Theoretical underpinnings of regenerative sustainability. Building Research & Information, 1-11.

167 Svec, P., et al. (2012). REGEN : toward a tool for regenerative thinking. Building Research & Information, 40(1), 81-94. See the special issue of Building Research and Information on "Net-zero and net-positive design", 43(1) 2015.

168 www.cirs.ubc.ca

Chapter 4
CONCLUSION

Canada's transition to low-carbon society can take many pathways, and each will be determined by its jurisdiction's resources and vision. The transition pathway that we propose is conditioned by knowledge of its authors and rests on our collective desired future. SCD hopes that this position paper will serve to develop a broader vision of possible futures in Canada and stimulate the identification of measures that can ensure, and favor, a positive transition for the industry sector and for employment.

The Canadian labour movement has actively examined the impact of green growth on employment and noted the importance of addressing displacement of workers and stability of labour conditions in a new green economy[169]. The Green Economy Network[170] developed a common platform to build a green economy in Canada identifying employment options. Currently the Green Economy Network's working groups focus on three priorities including transportation, renewable energy and building energy conservation, all highly compatible with the key actions discussed herein. It is noteworthy that the Green Economy Network has its roots in a dialogue initiated in 2008 by the Canadian Labour Congress and environmental organizations. The consultations leading to the common platform mentioned above included consultations with 10 unions across the country, demonstrating that key actors in the labour sector are already thinking about and ready to embark on the transition to sustainability.

It is also essential to acknowledge that the transition to a low-carbon economy require strong investment. Already in 2007, the UNFCCC published a report[171] examining the needed investment and financial flows. A key conclusion was that investments made at the time of renewing infrastructure were amongst the most efficient, since "investment decisions… taken today will affect the world's emission profile in the future". The report also concluded that in the absence of investment in climate change mitigation, the cost of adaptation would soar, suggesting that effective mitigation is actually cost-reducing over the long run. More recently in 2014, the New Climate Economy Report (NCE)[172] dedicated a chapter to finance, concluding the transition will demand significant investments by all sectors of society, from industry to households, and emphasizing the essential role governments need to play through direct investment in infrastructure and putting in place policies and regulations that will orient private investment toward the low-carbon economy. Groups of researchers in Canada, complementary to SCD, are addressing economic and financial aspects of climate change mitigation, in particular Sustainable Prosperity[173] and Canada's Ecofiscal Commission[174].

Several of the policy orientations and actions SCD proposes for Canada's transition to a low carbon sustainable society could be fully implemented in the next 15 years, given political will and efforts to engage stakeholders across all sectors of society. Other more complex actions might take up to 35 years. It is thus essential to begin immediately. As such, the Climate Change Summit of the Premiers planned for April 2015 is an important milestone.

We envision the next two years as an intense period of consultation and policy development to identify the policy instruments, regulations and incentives best suited for Canada. We offer our full cooperation to all levels of government in these challenging but exciting times. We hope that the initiatives mentioned above as well the present position paper will stimulate all levels of governments, from cities to federal, to adopt policies allowing Canada to make an ambitious and thoughtful commitment of emissions reduction in December at the *2015 Paris-Climate Conference*.

169 https ://www.policyalternatives.ca/publications/commentary/work-life-role-labour-green-industrial-revolution

170 http://www.greeneconomynet.ca/

171 http://unfccc.int/resource/docs/publications/financial_flows.pdf

172 http://newclimateeconomy.report/

173 http://www.sustainableprosperity.ca/Home+EN

174 http://ecofiscal.ca/

Annex 1
PROCESS

PHASE 1

To build our collective vision of a pathway to sustainability for Canada, a Delphi survey was launched in June 2014. It proceeded in three rounds, each circulated to all Sustainable Canada Dialogues scholars.

Round 1 asked: "Bearing in mind the upcoming federal elections and the United Nations Climate Change Conference, Paris 2015, what key recommendations/solutions do you think Sustainable Canada Dialogues could propose to Canadian policy makers to foster sustainable development in Canada?" A total of 268 recommendations were received.

In Round 2, statements provided in Round 1 were rated according to their perceived importance. The 51 recommendations receiving a high median score and low interquartile range served as input for Round 3, in which actions were ranked for achievability and potential impact.

The number of scholars answering the Delphi survey is 36, 22, 27 respectively for Delphi rounds 1, 2 and 3. A total of 43 scholars have answered at least one of the three rounds.

PHASE 2

The Delphi survey identified six main areas for action:

1. Transition to a low-carbon economy;
2. Transforming the energy system;
3. Urban planning and transportation;
4. Governance and institutions;
5. Land use;
6. Education, information and research.

Six drafting groups were formed, each with 3 to 6 scholars by thematic area. Their expert knowledge and the recommendations retained in the third round of the Delphi survey served as the basis for Acting on Climate Change. The proposals put forth by the drafting groups were compared with the climate mitigation plans of EU, France, Germany, Japan, Norway, UK and USA, and also compared with the reports of the IPCC AR5-Working group III, the New Climate Economy and Deep De-carbonization's Canadian chapter. The energy section benefitted greatly from a workshop[175] held in November 2014 to discuss meeting energy needs for eastern Canada.

Following the academic tradition, the first version of our position paper was send for evaluation to the members of the SCD that did not participate in the drafting groups as well as to external reviewers. Reviews were received from 11 scholars from teh SCD and from 10 external reviewers. Responses to the comments received were incorporated to the final version of the position paper by a small comity of 4 person (CP, GH, JM, NM). The report was then re-send for a final review to two members of the SCD that acted as editors (SB, MH) who confirmed that the comments had been addressed successfully. The position paper was circulated one last time to all members of the SCD for final approval.

PHASE 3 - NEXT STEPS

Acting on Climate Change identifies 10 key policy orientations to guide the transition to a low carbon sustainable Canada. The position paper will be circulated to green business associations, environmental NGOs, trade unions, municipalities, organizations and private citizens to stimulate discussions. It is complemented by a dedicated issue of Alternatives Journal, March 2015, where SCD scholars further developed and illustrated some of the issues addressed here[176]. We hope that it will inspire Canadians and opinion leaders, politicians and civil servants to take action. Canada needs a collective vision of desired pathways to our futures.

175 http://normandmousseau.com/-A-common-energy-policy-for-Eastern-.html ?lang=en

176 http://www.alternativesjournal.ca/

Annex 2
CLIMATE SIMULATION METHODOLOGY

The maps (Map 1) were produced by Ouranos[177] using data of the multi-model CMIP5[178]. Two of the four representative concentration pathway scenarios used by IPCC for the Fifth Assessment Report[179] are shown. The RCP 4.5 climate scenario was obtained by 77 simulations and the RCP 8.5 by 60. We acknowledge the World Climate Research Programme's Working Group on Coupled Modelling, which is responsible for CMIP, and we thank the climate modeling groups (Table 1) for producing and making available their model output.

177 www.ouranos.ca

178 http://cmip-pcmdi.llnl.gov/cmip5/index.html ?submenuheader=0

179 http://ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf

Table 1

MODELLING GROUP

Beijing Climate Center, China Meteorological Administration (BCC)College of Global Change and Earth System Science, Beijing Normal University (GCESS)
Canadian Centre for Climate Modelling and Analysis (CCCMA)
Centro Euro-Mediterraneo per I Cambiamenti Climatici (CMCC)
Centre National de Recherches Meteorologiques / Centre Europeen de Recherche et Formation Avancees en Calcul Scientifique (CNRM-CERFACS)
CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia), and BOM (Bureau of Meteorology, Australia) (CSIRO-BOM)
Commonwealth Scientific and Industrial Research Organisation in collaboration with the Queensland Climate Change Centre of Excellence (CSIRO-QCCCE)
The First Institute of Oceanography, SOA, China (FIO)
EC-EARTH consortium
Institute for Numerical Mathematics (INM)
Institut Pierre-Simon Laplace (IPSL)
LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences; and CESS, Tsinghua University (LASG-CESS)
LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences (LASG-IAP)
Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies (MIROC)
Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais) (MOHC)
Max Planck Institute for Meteorology (MPI-M)
Meteorological Research Institute
NASA Goddard Institute for Space Studies (NASA-GISS)
Norwegian Climate Centre (NCC)
National Institute of Meteorological Research/Korea Meteorological Administration (NIMR/KMA)