

Title: Canada's Path to a Low-Carbon Economy

Introduction:

In 2015, after the election of the new Liberal government, Canada made a commitment to lower GHG emissions to less than 30% of 2005 levels at the COP 21 meetings in Paris (Trudeau n.d.). Following the Paris meeting, the First Ministers Meeting took place in Vancouver on March 3rd, 2016. The main focus of the conversation was clean growth and climate change (Canadian Intergovernmental Conference Secretariat 2016). These meetings reflected a shift in the Canadian approach to tackling climate change from the previous conservative governments approach. The current political landscape, through the Vancouver Declaration and the Pan Canadian Framework, indicates an alignment between the Provincial, Territorial and Federal Governments showing a willingness to work towards a low carbon vision for the Canadian economy. While there seems to be an emerging consensus on a direction and role for a new low carbon Canadian economy, Canadian provinces have their own unique challenges and contribute to Green House Gas, GHG, reductions through different mechanisms. While provinces like Alberta, Ontario and Quebec have released increasingly progressive legislation to address meet their GHG emissions objectives, Saskatchewan and Manitoba remain resistant to the adoption of policies like carbon taxes or cap and trade measures to limit GHG emissions. Each provincial jurisdiction is uniquely impacted depending on the sectors that most influence their economies.

The goal of a low carbon economy in Canada will require all levels of government to work together in developing policies that can benefit Canada while lowering Canada's overall GHG

emissions. While all provinces and territories are critical in a coordinated effort, over 90% of

Canada's overall GHG emissions come from 5 main provinces: Alberta, British Columbia, Quebec, Ontario, and Saskatchewan (Environment and Climate Change Canada 2016). These provinces will be critical in Canada's plan to meet our COP 21 commitments.

A closer look at the Canadian economy by sector reveals that while over 80% of electricity production is low GHG emitting (Government of Canada 2016), electricity is still a large contributor to Canada's overall carbon emissions. The three largest emitting sectors in Canada are Oil and Gas, Transportation and Electricity. These sectors are followed by buildings, trade exposed industries and agriculture (Environment and Climate Change Canada 2016). A sector specific look at the provinces reveals that Alberta, Ontario, and Saskatchewan have the highest potential for reform in the electricity sector. These provinces will need to have comprehensive policies to address the high emitting energy sources used for electricity production in these provinces. Similar sector specific policies will be critical to address carbon emissions in each province. This paper will examine the key sectors and provinces that are critical to reducing Canada's overall carbon emissions and assess the policies proposed with the potential for GHG savings.

The Canadian Overview: What the numbers say

A provincial breakdown of Canada's emissions profile in Figure 1 reveals the top 5 emitting provinces to be Alberta, Ontario, Quebec, Saskatchewan and British Columbia. The top 5 emitting provinces account for over 90% of the overall emissions in Canada as shown in Figure 2. Alberta

contributes 37% Canadian emissions, and Ontario, at 24% of Canadian GHG emissions, these two provinces will be critical in achieving Canada's plan for a clean energy future and reducing its emissions profile. With approximately 61% of all Canadian emissions coming from Ontario and Alberta alone it is critical to better understand what sectors impact these provinces and which areas can be targeted to effectively reduce overall emissions.

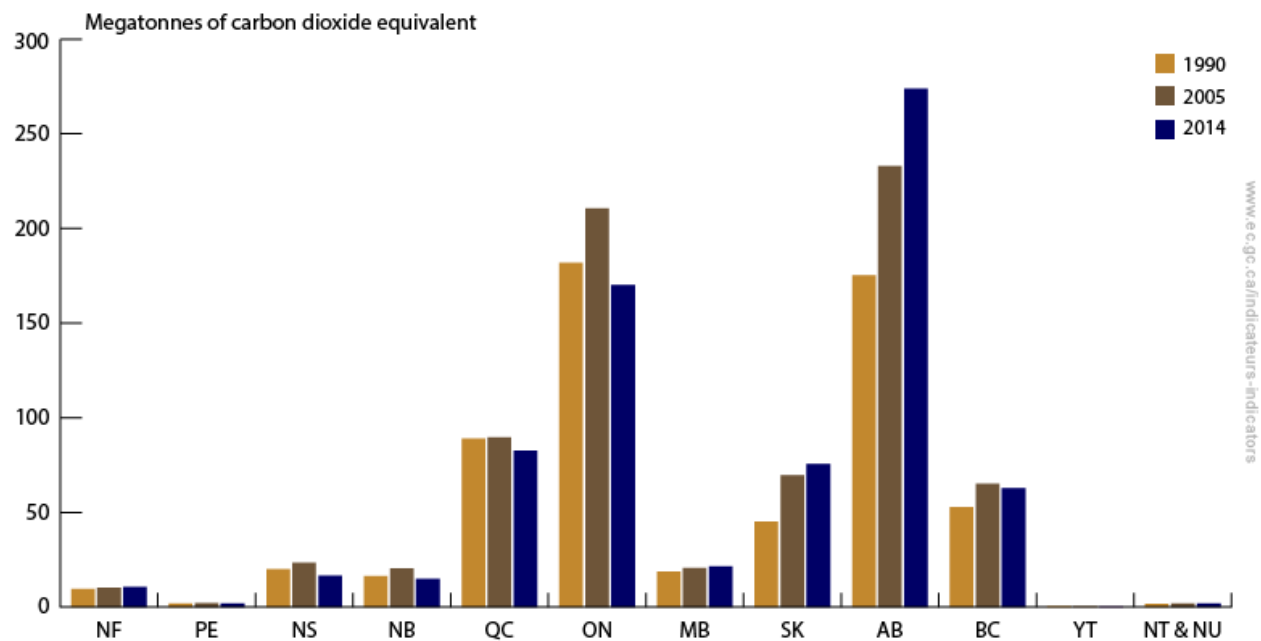


Figure 1: 2013 Canada's emissions profile (Environment and Climate Change Canada 2016)

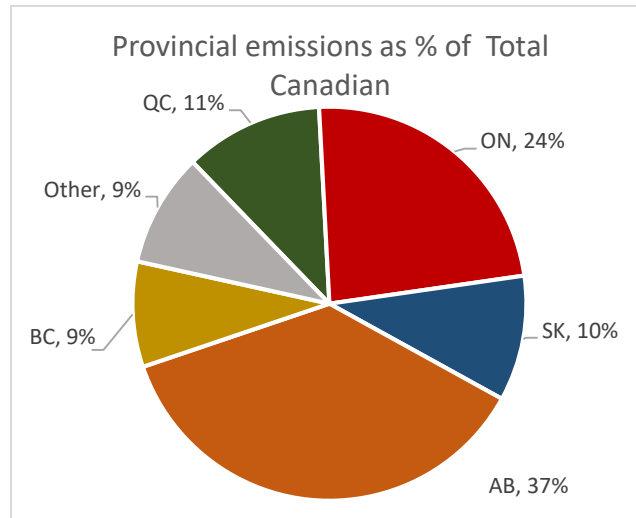


Figure 2: Provincial emissions by % of total. Calculated from results in (Environment Canada 2015)

A view of Canada's emission profile by sector as shown in Figure 3 shows that stationary combustion sources and transportation account for 45% and 25% of all Canadian emissions respectively. Stationary combustion sources include emissions from Electricity production, Industry sector (including mining and refining oil as well as manufacturing), construction, residential, commercial and Agriculture and forestry (Environment Canada 2015). Key policies to address emissions in these sectors will be needed to reduce emissions.

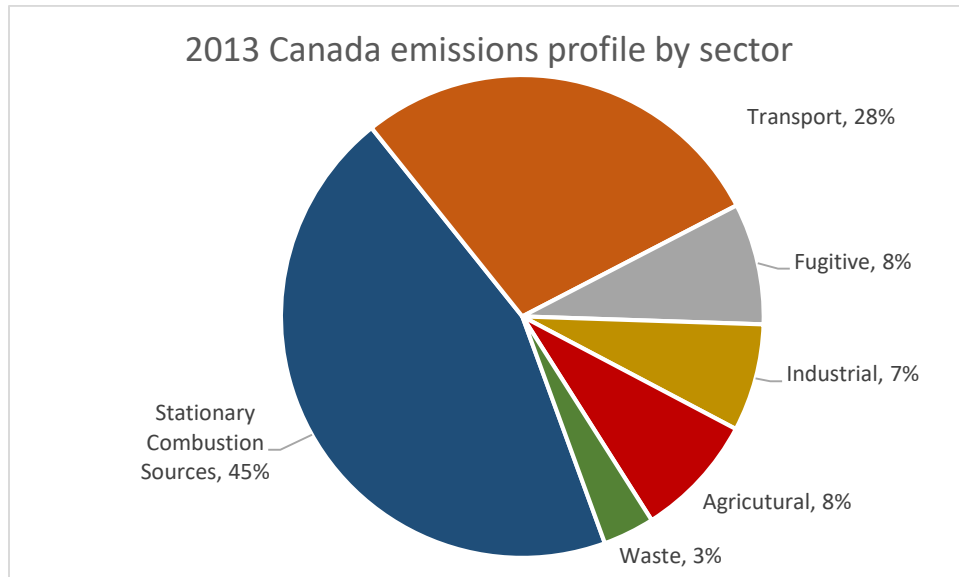


Figure 3: Canada's emission profile by sector graphed using data from (Environment Canada 2015)

An overview of Canadian provinces by their emissions profile reveals key differences in the policies that will be needed in these jurisdictions. Figure 4 illustrates that stationary combustion sources make up a large proportion of emissions from Alberta and Ontario. 21% of all Canadian emission from stationary sources come from Alberta. These include emissions from electricity production as well as from the oil and gas industry. Across Canada transportation is another key sector that accounts for 28% of overall emissions. Ontario, Alberta, and Quebec have the highest emissions contribution from the transportation sector with 8% of total Canadian emissions coming from Ontario's transportation sector alone. Alberta and Quebec contribute 6% and 5% of total Canadian emissions through their transportation sectors. Fugitive emissions, which result largely from coal mining and oil and gas related activities (Environment and Climate Change Canada 2016), account for 8% of Canada's total emissions and the bulk of these emissions are contributed from Alberta at 5% as shown in Figure 4. Saskatchewan and British Columbia also contribute towards fugitive emissions at 2% and 1% respectively. Agricultural emissions result in 8% of Canada's total emissions with Alberta contributing 3% of total emissions and Saskatchewan at 2%. Ontario,

Quebec and Other provinces contributing the remaining 3%. Industrial activities result in 7% of Canada's total emissions with Ontario contributing 3% and Alberta at 2%, Quebec at 1% and the remaining provinces contributing another 1%.

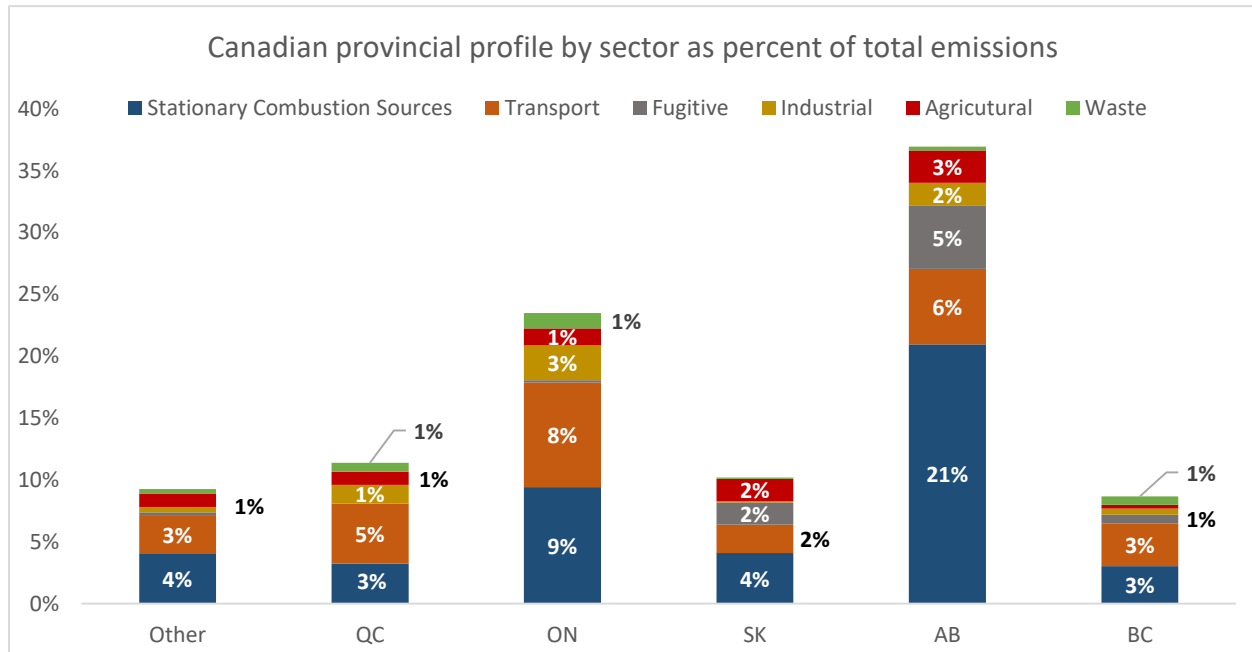


Figure 4: Canadian provinces emissions profile by sector, graphed using data from (Environment and Climate Change Canada 2016)

In addition to the emissions profile of each province, it is important to note how large the economies of each province are. Ontario has the largest economy at 37% of the overall Canadian GDP with Quebec at 19% and Alberta at 18% followed by British Columbia at 13% as reflected in Figure 5. While Ontario's economy is larger than Alberta at 37% Canadian GDP, it contributes only 34% of Canadian GHG emissions. In contrast, Alberta is 18% of Canadian GHG emissions but contributes 37% of total Canadian GHG emissions.

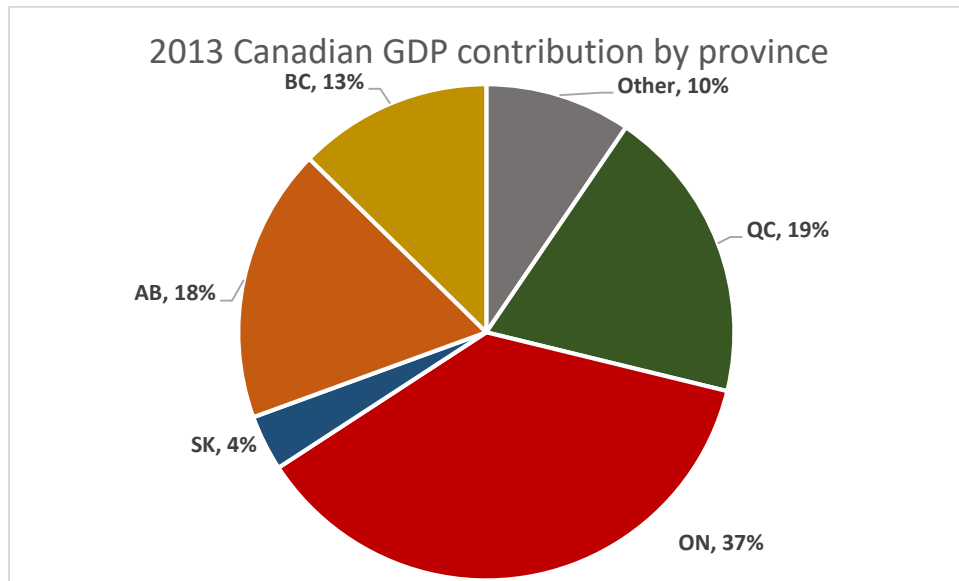


Figure 5: Canadian GDP percentage contribution by province, (Statistics Canada 2016)

A look at the amount of emissions released by each province for each unit of GDP illustrates differences in the provinces as shown in Figure 6. While Saskatchewan accounts for only 4% of overall Canadian GDP it releases the most emissions to produce each unit of that GDP at 1208 tCO₂eq/Million CAD. Alberta has the second highest emissions released at 874 tCO₂eq/Million CAD while Ontario, British Columbia and Quebec are well below the national average of 426 tCO₂eq/Million CAD. While the total contribution of emissions may be small, the information in Figure 6 that emissions in Saskatchewan's economy has a higher energy intensity than even Alberta.

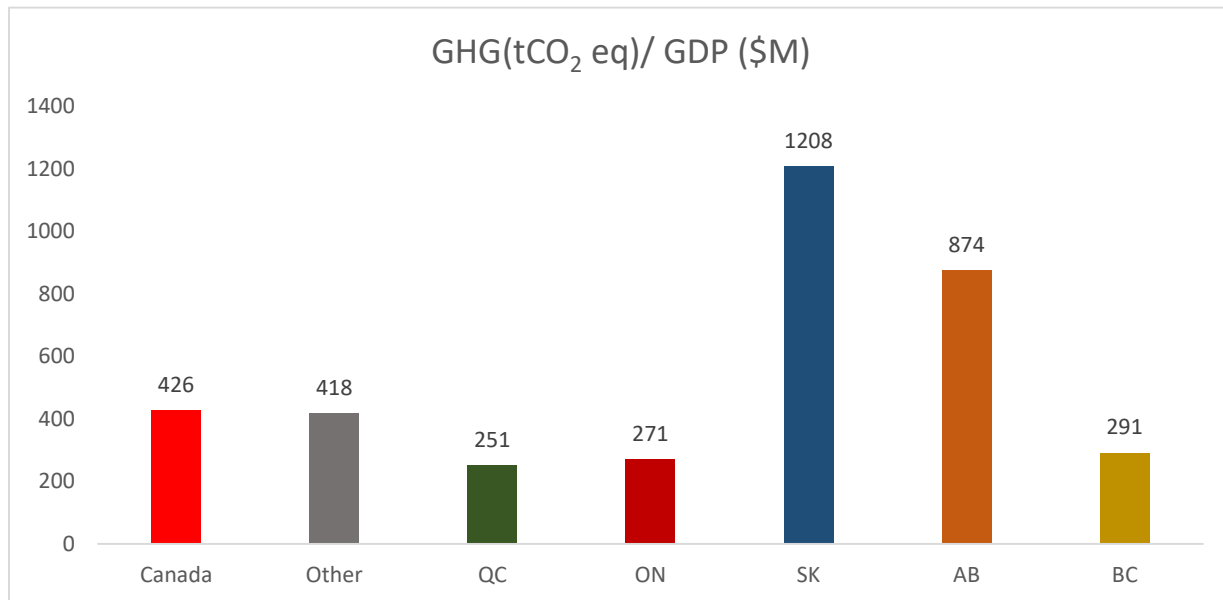


Figure 6: GHG(tCO₂ eq)/ GDP (\$M) Calculated from (Environment Canada 2015)and (Statistics Canada 2016)

Note that the emissions from the stationary combustion sources in Figure 7 reveals key areas where GHG emissions can be reduced. Mining and oil and gas production lead to 13% of all emissions in Canada. These emissions are largely contributed from Alberta with British Columbia, and Saskatchewan contributing approximately 16% of the overall emissions.

Mining and oil and gas emissions are closely followed by electricity and heat production at 12%, Manufacturing industries and residential emissions cause 6% of total emissions each. Note these emissions by province sheds light on which provinces can have the most influence in each area.

From Figure 8 it can be seen that Alberta and Saskatchewan contribute the most to GHG emissions from their electricity sector. Given that 51% of Alberta's current electricity supply comes from coal and 39 from natural gas, electricity is one area where Alberta can make significant GHG reductions (Government of Alberta 2015). Similarly, Saskatchewan's electricity comes largely from coal at 42%

and gas at 34% (SaskPower 2015). While a 72% of Ontario's installed generation capacity is near non-emitting, 28% comes from gas (IESO 2015) resulting in 7% of total emissions in Canada coming from Ontario's electricity sector. British Columbia and Quebec have a largely hydro-based electricity generation system and thus add less than 3% of total emissions from their electricity generation as illustrated in Figure 7.

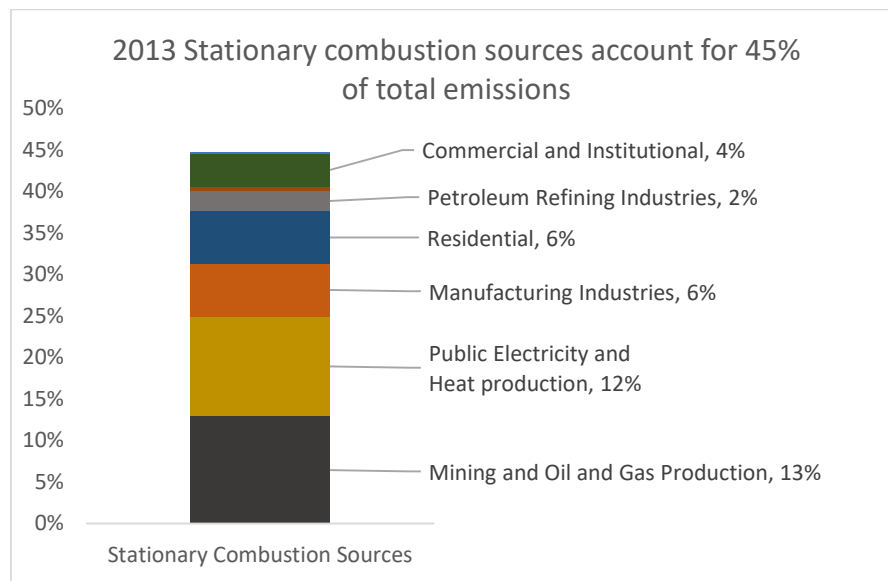


Figure 7: 2013 Stationary combustion sources account for 45% of total emissions, calculated from (Environment Canada 2015)

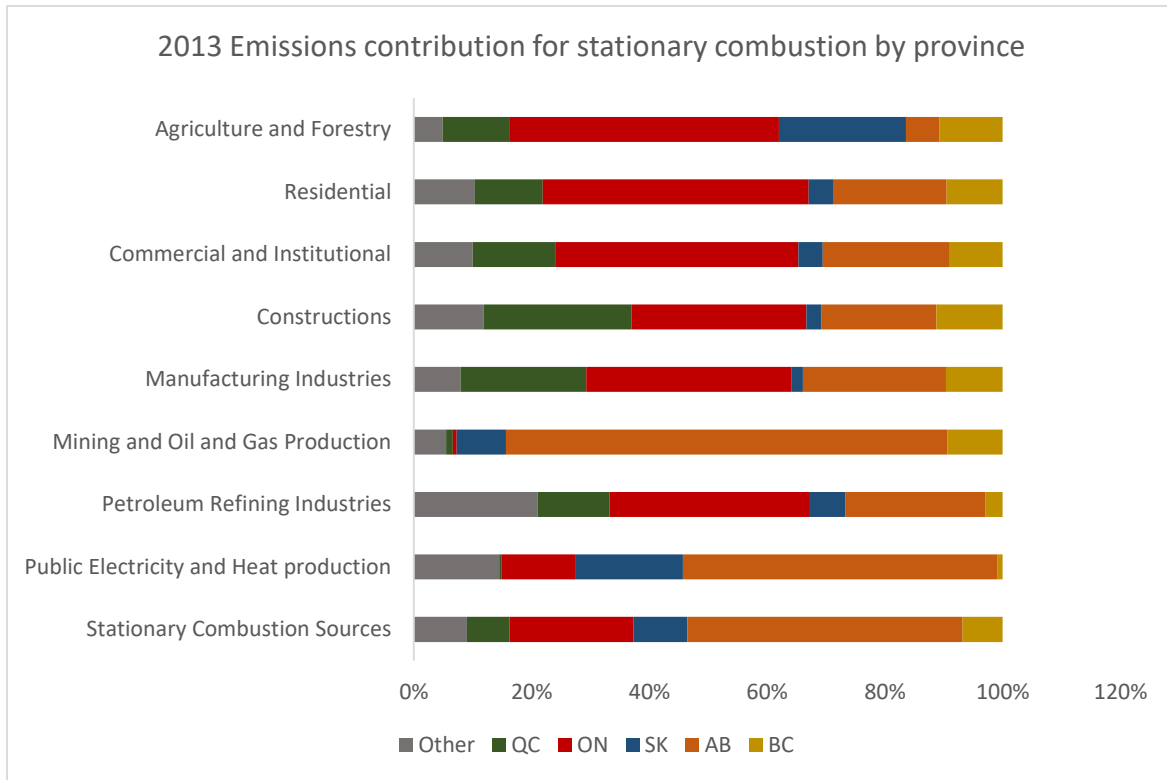


Figure 8: 2013 Stationary combustion source GHG contribution by province, calculated from (Environment Canada 2015)

Through the information presented in this section, it is noted that provincial and federal policies will need to address GHG emissions in key sectors. Provincially it is critical that Alberta, Ontario, British Columbia, Quebec, and Saskatchewan show climate leadership to ensure that Canada meet its GHG targets. Additionally, the key sectors that require strong policy measures will be transportation which accounts for 28% of overall emissions in Canada as well as stationary combustion sources at 45% Figure 3. Policies will also be needed to address overall emissions from residential emissions, manufacturing sectors and specifically from public electricity and heat production as well as Mining and oil and gas production. The following section considers the policies outlined by federal and provincial governments to help mitigate the impacts of climate change and reduce Canada's overall GHG emissions.

Time for action: the policy context:

Transportation:

Transportation accounted for 28% of Canada's total GHG emissions in 2013, Figure 3. These emissions are contributed from all provinces and a comprehensive policy is needed to mitigate their impact. Figure 9 illustrates the emissions contribution made by mode of transportation. Two main categories of vehicles contribute the most to GHGs from transportation: on-road passenger vehicles at 81% and on-road freight at 28% (Specific Mitigation Opportunities Working Group 2016). A large portion of these emissions come near urban centers. The federal government has committed to reducing these emissions by establishing stricter GHG emissions standards for passenger vehicles for 2014-2018 models with even more strict standards being enforced for post-2018 models. The federal government is also working together with the provinces, territories and the private sector to help increase the integration of infrastructure that can support electrical vehicles, EVs, (Government of Canada 2016). The federal government has announced \$62.5 million CAD for the deployment of electric vehicle charging stations and alternative fueling stations (Specific Mitigation Opportunities Working Group 2016). The government has also committed to using cleaner fuels and the development of a clean fuel standard as well as investing in infrastructure that will create transportation hubs and ports that can support better public transportation (Government of Canada 2016).

In addition to the federal government's plans, provinces are also creating policies to reduce the pollution from transportation. Ontario is promoting the use of EVs by providing incentives of up to \$14,000 per vehicle and \$1,000 per charging station (Government of Ontario 2016). The Ministry

of energy in Ontario is also working towards creating a charging station network that will connect highways workplaces and public places in Ontario.

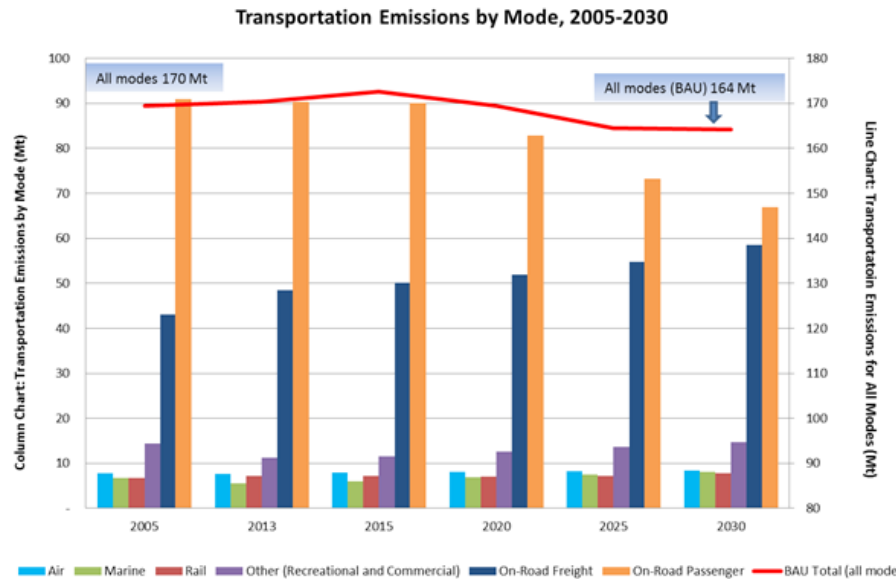


Figure 9 Transportation Emissions by Mode, 2005-2030 (Specific Mitigation Opportunities Working Group 2016)

Quebec has also worked towards encouraging more EVs on the road with incentives of up to \$8,000 for each vehicle and \$600 for charging stations (Government of Quebec 2012). The province of Quebec has committed to having 25% of its light passenger fleet to be electric by the year 2020. This commitment is accompanied by investments in charging infrastructure and technologies by the government. British Columbia is offering rebates of up to \$8,250 off the price of a new EV (BC Hydro 2016). There is also a wide network of charging stations across the province that include 1,000 Level 2 chargers that can charge a car most EVs in 5 hours and 30 DC fast chargers that can fully charge the car in 30 minutes (BC Hydro Power Smart 2016). Alberta and Saskatchewan do not currently offer incentives for EV ownership. However, Alberta and Saskatchewan have a high share of fossil fuels in their primary energy supply and therefore these

provinces should first work towards reform in their electricity supply mix to ensure that the energy that would fuel any EVs would itself have reduced emissions.

Electricity

Alberta, Ontario, and Saskatchewan contribute the most emissions through their electricity sector. With Alberta contributing 53% of all GHG generated in the sector, Saskatchewan at 18% and Ontario at 12%, Figure 8. The policies to address the electricity sector emissions in these provinces will have a significant impact on Canada's overall emissions profile.

The Alberta government has recently released its Climate Leadership Plan (Government of Alberta 2016). The plan addresses key components of the electricity sector with the planned phase-out of coal by 2030. The Alberta government has committed to ensuring that 30% of Alberta's electricity come from renewable sources by 2030 and the remaining coming from natural gas. While natural gas is comparatively a much cleaner source of energy than coal, it is not a non-emitting source of energy. Therefore, electrifying transportation in Alberta may not result in similar emissions reductions as Ontario, British Columbia, and Quebec where the underlying electricity supply is largely non-emitting in the form of nuclear and hydro.

Saskatchewan's roadmap for electricity commits to having 50% of all generation by 2030 from renewable sources (Sask Power 2016). The province has committed to adding 30% generation from wind by 2030 and 60 MW of utility scale storage by 2021. Saskatchewan is also looking to add more hydro capacity. As almost 76% of Saskatchewan's current electricity comes from coal and

natural gas, the remainder comes from a mix of hydro (14%), wind (3%) and imports and other sources (7%) (SaskPower 2015). However, the commitment to 30% renewable may only result in the change of 7% of the existing electricity capacity. Saskatchewan's plan also does not address the emissions from its coal supply. While the federal government has announced a plan to accelerate the phase-out of coal nationally, Brad Wall, the current Premier of Saskatchewan, has expressed concerns about the government's plan. While adding some renewable generation to the province's current supply would have some impact on the provinces overall emissions profile, without phasing out coal the effect will not be significant.

While Ontario's energy supply is approximately 71% non-emitting, it has 28% of installed natural gas (IESO 2015). Ontario's electricity sector contributes to 12% of total emissions from the electricity sector in Canada, Figure 4. The Ontario government has had a long-standing commitment to reducing GHG emissions in the electricity sector. With several nuclear power plants nearing their end of life, Ontario's commitment to low GHG supply mix will need to be assessed. According to the Ontario government, key policies will be implemented to ensure that Ontario can meet its commitment to creating a low carbon future (Ministry of Energy 2016). The province has committed to expanding its natural gas facilities with a commitment of over \$230 Million CAD to go towards natural gas projects. Two nuclear power plants; Darlington and Bruce- are also expected to undergo refurbishing starting in 2016 and 2020 respectively. To maintain a low GHG baseload supply of energy, the Pickering facility will be operated until 2024. The Darlington plant has a capacity of 3500 MW and Pickering station has a capacity of 3100MW (Ontario Power Generation 2016). The Bruce station has a capacity of 6300MW (IESO 2016). There

is increasing resistance to the continued support of nuclear power facilities for both environmental and economic reasons (Perkel 2016) with concerns that refurbishment of the Darlington plant may not be a sound long-term strategy for Ontario's electricity future. However, without the use of nuclear power in Ontario, there is a valid concern for how renewables could replace the baseload energy supplied by these sources. The province is making continued investment in renewable generation as well as upgrades to the utility grid to help integrate these sources. The capacity of energy supplied by the nuclear plants, along with issues of the intermittent nature of renewables and the price of energy storage raises key questions about how Ontario could replace its nuclear base power with renewables.

The federal government is supporting the initiatives of the provincial governments through actions outlined in the Pan-Canadian Framework (Government of Canada 2016). In collaboration with the provinces and territories, the Government will be accelerating the phase out of coal and setting new national standards for natural gas plants. The government will also support the integration of renewables through investment in the transmission grid. This includes working with the provinces to build more interconnection through transmission lines and modernizing the electricity system through the use of smart-grid technologies. The federal government has also supported the development of new hybrid and renewable energy systems that will help reduce the dependence that remote communities have on diesel for electricity supply.

A collaborative effort between the provinces to increase connectivity with the electric grid indicates that first step in ensuring that Canada can reduce its GHG emissions in this sector. While

not all provinces have indicated full support for all the elements presented in the framework, this begins a concerted discussion from which Canada can move forward.

Industry Sector

Approximately 40% of Canadian GHG emission come from Canada's industrial sector. This includes oil and gas production and refining, manufacturing industries as well as low carbon industrial sector, Figure 7 and Figure 3. Alberta contributes a significant amount of GHGs to Canada's industrial sector through oil and gas production activities, manufacturing and low carbon industrial sector. 75% of all emissions from oil and gas production and 24% of all manufacturing emission come from Alberta, Figure 8. Ontario also contributes a significant amount of emissions through its industrial sector with 34% of all petroleum refining emissions and 34% of all GHG from manufacturing coming from the province, see Figure 8. Policies in Alberta and Ontario will have a considerable impact on the overall GHG reduction targets for Canada.

Alberta has taken steps to reduce emissions from its oil and gas sector by implementing a cap and trade mechanism that will implement a \$30/tonne carbon price to oil sands facilities based on the results achieved by high-performing facilities. Additionally, Alberta has legislated limits on the oil sands emission to a maximum of 100 Mt in any given year (Government of Alberta 2016). A 45% reduction in methane emissions by 2025 has been set as the Alberta target. Federal support to reduce methane emissions has also been echoed in the Pan-Canadian Framework (Government of Canada 2016). The Alberta government is making investments in clean technologies that can further help increase efficiencies and help reduce the province's footprint.

Quebec generates most of its industrial emissions from petroleum refining, manufacturing, and low carbon industrial sectors. Within Quebec, the industrial sector accounts for 28% of overall emissions (Government of Quebec 2012). Quebec has committed financial support to its industrial sector where businesses have chosen to convert from high-emitting energy sources to low-emitting energy sources. The Quebec program allows for the industrial sector to innovate new technologies and methods for reduction of GHG emissions while providing incentives to them. The government of Ontario is helping the industrial sector access programs and services through the development of a green bank (Government of Ontario 2016). The province will also be providing support through the development of new approval systems that would also reduce the time taken to implementing low-carbon technologies.

British Columbia's climate leadership plan indicates their commitment to increasing gas-fired boiler emissions and incentivizing businesses to use efficient gas equipment (Government of British Columbia 2016). In addition to this, British Columbia indicates its carbon tax at \$30/ tonne and increased efficient electrification to help its industrial sector. The carbon tax mentioned is effectively frozen and indicates a failing commitment from the government of British Columbia to take any concrete action towards mitigating the effects of GHG emissions. The province's commitment to the liquefied natural gas industry may have impacted its' climate leadership position (Keller, B.C.'s climate plan: What you need to know 2016).

The federal government is working with the provinces to help build on several initiatives such as reducing methane and HFC emissions, improving industrial energy efficiency and investing in technology (Government of Canada 2016). A collaborative plan to reduce emissions in the industrial sector across Canada will ensure that industrial players face consistent regulations across provincial jurisdictions and have access to similar incentives to build towards reducing their GHG emissions profile.

Built Environment

Built environment accounts for approximately 10% of all Canadian emission as seen in Figure 7. These emissions account for energy used in heating and cooling buildings. Ontario, Alberta, and British Columbia account for the majority of the emissions in this sector. Ontario alone contributes approximately 45% of emission from this sector with Alberta contributing close to 20% of emissions as reflected in Figure 8. Therefore, the policies laid out in Ontario and Alberta will be critical in the reduction of emissions from these sectors. Significant improvements can be made in this area by improving the efficiency of the buildings. In addition to improving efficiency standards for gas fireplaces and heating equipment, British Columbia is improving the BC building code to be net zero ready by 2032 and developing new energy efficiency requirements for new buildings (Government of British Columbia 2016).

Quebec has an ambitious plan to help reduce GHG emissions from its built environment which includes developing green provisions that will be adopted in the construction code to ensure that minimum standards are maintained. They will also be developing energy efficiency requirements for all types of buildings and reducing the barriers to integrating renewable energies in new

developments. In the residential sector, the government will be supporting residents who want to transition from fossil fuel heating to renewable energy heating sources by providing financial incentives. The government will also be subsidizing the cost of equipment to supply renewable energy to buildings that are not currently connected to the grid (Government of Quebec 2012). For the commercial and institutional sectors, the government will be increasing energy efficiency subsidies and support integration of renewable heating systems. The government of Quebec has also committed to reducing the use of heavy oil in heating commercial and institutional buildings. Ontario's plan to reduce emission from built environment is comprehensive and provides several incentives to lower GHGs in this sector. Ontario has targeted 8 main areas which include multi-residential buildings, schools and hospitals, heritage buildings, home owners, new buildings, individuals and businesses, low carbon energy supply and work force training and technical capacity (Government of Ontario 2016). Ontario's plan balances the need to keep energy prices affordable for residents, increases adoption of new technologies that reduce the over emissions profile of the buildings, updates the codes to ensure building efficiencies are maintained and develops tools and training mechanisms to support a shift to a low carbon building sector. The government of Alberta will be implementing programs and products that can help increase energy efficiency in Alberta homes. This will include installations of efficiency products, rebates for efficient appliances and incentives for high-efficiency retrofits.

The federal government's policies to support initiatives from provinces in this sector are aligned with existing efforts. These will include increasing the efficiency of new buildings, retrofiting

existing buildings, improving energy efficiency for appliances and equipment and supporting the development of new building codes and energy efficient housing in Indigenous communities.

Agriculture:

Agriculture accounts for 8% of Canada's overall GHG emissions with 7% coming from Alberta, Ontario, Saskatchewan and Quebec. Alberta and Saskatchewan have not outlined a detailed policy to address GHG emissions from the agricultural sector while Quebec and Ontario both address the sector in their climate leadership plans. Quebec's government will focus on promoting technologies that can capture biogas from decomposing manure as well as managing crop, livestock and soil management to help reduce GHG emissions (Government of Quebec 2012). Ontario has outlined a commitment to help reduce agricultural GHG emissions by providing incentives to help retrofit indoor agricultural facilities.

The federal government will be supporting the provincial initiatives by increasing carbon sinks through forests, wetlands, and agricultural lands, generating bioenergy and bioproducts (eg biogas from manure) and supporting additional innovation in new technologies.

Discussion and Conclusion:

The adoption of the Pan-Canadian Framework by most provinces signals that Canada is working towards a collaborative approach to meeting its COP 21 GHG reduction targets. Without the support of Saskatchewan and Manitoba (Cheadle 2016), it is important to assess how successful the framework can be. While Saskatchewan contributes a significant amount of emissions through its electricity sector and its industrial sector, the province cumulatively contributes 10% towards

Canada's overall GHG targets. In contrast, Manitoba contributes less than 3% (Figure 1). While the political resistance of Manitoba and Saskatchewan raises larger issues towards the success of the Pan-Canadian Framework, their overall Canadian footprint is not significant enough to endanger Canada's objectives. Additionally, federal regulations that will develop cleaner fuel standards and higher fuel efficiency regulations can still result in GHG savings from key sectors in these provinces. Saskatchewan's resistance towards a coal phase-out raises questions about the future of coal in the province and the success of the federal plan to phase out coal by 2030. Of the provinces that have a significant GHG footprint in Canada, Saskatchewan remains the strongest resistor.

In addition to Saskatchewan, British Columbia's climate leadership plan and policies leave much to be desired. British Columbia's policies are largely targeted towards promoting LNG in the province and effectively stalling on progress made from previous climate leadership initiatives like their carbon tax. While some policies in its built spaces and transportation sector remain promising, effectively British Columbia is standing still after making some progress.

The three most effective policy proposals come from Alberta, Ontario, and Quebec. Combined, these provinces account for 72% of Canada's overall emissions and 74% of its GDP. With developments to cap emissions in Alberta's industrial sector and the planned phase out of coal in the province the potential for GHG reductions is promising. Quebec and Ontario both have detailed plans to address industrial emitters and Ontario has also laid out key policies to help with emissions from its electricity sector. With the cancellation of planned renewable feed-in tariff contracts in Ontario (Corcoran 2016), the planned refurbishment of two nuclear generators and

the expected expansion of natural gas generation, questions are raised about whether or not the province's GHG emissions will rise in the future. Federal government support for upgrading the transmission grid and creating more cross provincial connections has the potential to help trade electricity from non-emitting provinces and reduce overall GHG emissions from the electricity sector.

The Pan-Canadian Framework and the provincial climate leadership plans do not align on all sectors of the economy and do not have support from all provinces. However, they offer the first step for Canada to build towards a low carbon economy.

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