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A Capital Mobilization Plan Refresh: Placing Revised Canadian Commitments in Context

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INTRODUCTION

On April 19, 2021, the Canadian federal government announced a desire to reduce GHG emissions by 36% relative to 2005 levels. Three days later, they increased the reduction goal to 40-45% by 2030. Simultaneously the federal government released new historical pre-2020 and projected emissions until 2030. In September 2020, the Institute for Sustainable Finance released a Capital Mobilization Plan (CMP) for a Canadian Low-Carbon Economy. The report was based on 2018 modelling data and used the initial 30% reduction target. We updated our projections using the new data and target of 40-45%.

The original CMP estimated a required capital investment of roughly $128 billion to reduce emissions by 30%. The refreshed estimate increases this estimate to roughly $200 billion. This includes both the increase in the reduction target and the new Government of Canada projected emissions to 2030. Our calculations are based on sector average costs to abate one tonne of CO_2eq. and the cumulative difference between a base case emissions pathway and a linearly declining path that brings us to our target.[1]

In addition, this refresh also puts Canada's commitments, progress and required investment into a global perspective. We show that Canada's projected "With Measures" emissions growth rate for 2020 to 2030 are higher and lag behind the average of developed nations who submit biennial projections to the UNFCCC. We also standardize G7 country's GHG reduction targets to compare levels of ambition. Finally, we apply a similar methodology to calculate the required capital investment for developed and developing economies showing that Canada's required investment as a proportion of GDP is more than double that of developed nations but only a fraction of the required investment for developing economies. In comparison to a set of comparable countries we also find that Canada must allocate more capital as a percentage of GDP to reach a common GHG reduction target.

1 We gather abatement costs estimates from a number of different sources across sectors and average them to find a sector average cost to abate. For a full list of abatement costs used see Appendix A in the Capital Mobilization Plan for a Canadian Low-Carbon Economy. See CMP report.

CMP REFRESH

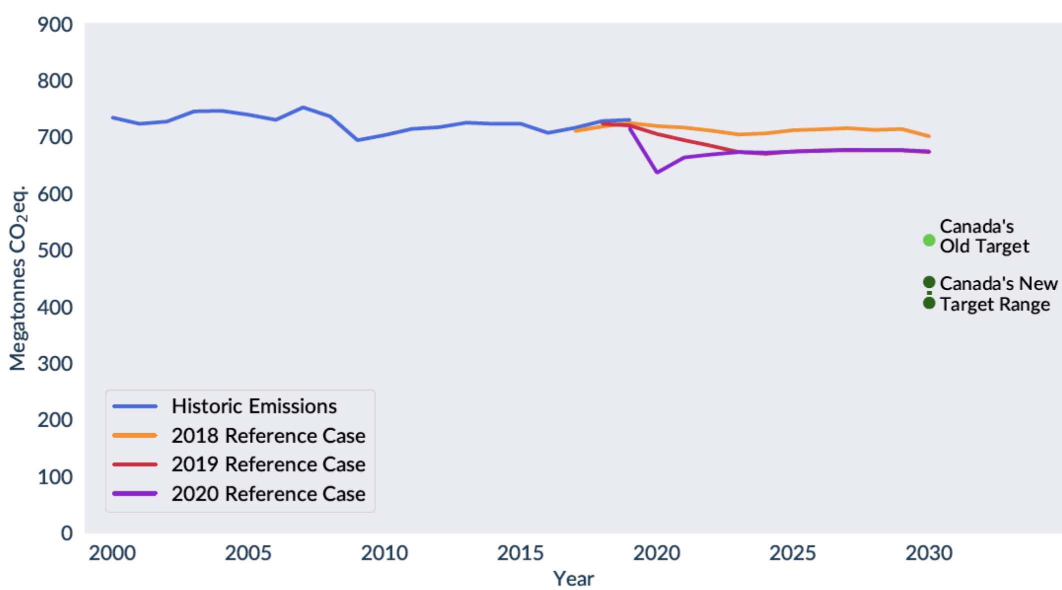
This section updates our estimates from the previous CMP using the new 2020 Government of Canada Reference Case and discusses Canadian developments in sustainable finance since the original CMP release. Little progress has been made towards reducing our emissions and the updated costs reflect this fact. There is no change from 2019 in emissions projections for 2030. While 2020 emissions did dip significantly as a result of lockdown measures, the new projections show emissions rebounding by 2023.

New GHG Emission Data

Environment and Climate Change Canada (ECCC) publishes new GHG projections annually (often called a Reference Case) [1]. This updated Reference Case follows the "with measures" scenario defined by the UNFCCC that incorporates all currently implemented and adopted policies and measures [1, 2]. The new reference case also presents an updated base case that reflects the most recent data on emissions. We plot in Figure 1, projected emissions using the 2018, 2019, and 2020 Reference Cases for comparison. Figure 1 shows that the federal government expects recently implemented emissions reductions policies and programs will have a substantial impact on future emissions. The 2020 Reference Case arrives at identical 2030 emissions compared to the 2019 Reference Case and shows the temporary impact on emissions of the 2020/21 COVID lockdown measures.

Figure 1 also highlights the large gap between projected emissions and committed emissions. This is discussed in greater detail in the next section.

Figure 1: Canada's Historic and Projected Emissions



Source: Author. Data used to generate the graphic is from Environment and Climate Change Canada (ECCC).
Notes: Canada's old target refers to the previous goal of 30% below 2005 levels. Canada's new target range refers to the government's more recently announced 40-45% reduction below 2005 levels. For both targets the most recent reporting for 2005 emissions levels was used. The 2020 Reference Case are emissions projections that are defined by ECCC and include "all policies and measures funded, legislated and implemented by federal, provincial and territorial governments as of September 2020" [13]. 2018 and 2019 Reference Cases follow similar definitions.

The 2019 Reference Case projected growth rate for emissions between 2018 and 2019 was -0.42%. The most recent 2020 Reference Case projected -2.0%. The actual growth rate was positive and not negative and saw an increase of 0.28%. This may seem trivial but this highlights the difficulty in projecting GHG growth rates and how hard actually reducing emissions is, in Canada. We hope that the future brings large and lasting decreases in emissions to bring us in line with our commitments.

UPDATED TOTAL REQUIRED INVESTMENT ESTIMATES

To estimate the total required investment, we use a similar methodology found in the original CMP. This method begins with looking at the difference between where emissions are headed and where they need to be.[2] In this step we assume that emissions follow Reference Case 2020 until the end of 2021 and then decrease linearly between 2022 and 2030.[3] In this scenario we calculate a cumulative Mt. CO_2eq. difference between the required path to achieve the target and the 2020 Reference Case to be 1,233 Mt. CO_2eq. We then calculate an abatement required for each sector by multiplying the sector's proportional emissions (Proportion (%) column in Table 1) by the 1,233 Mt. CO_2eq. total. We also model so that the land use, land-use change and forestry (LULUCF) is responsible for 5% of the total abatement required.

Sector specific GHG abatement costs are then calculated by averaging across abatement costs found in publicly available academic papers, industry reports and estimates.[4] Each sector's GHG abatement cost is then multiplied by its corresponding abatement required value to find the sector's total required investment. Summing across all sectors amounts to a total required investment estimate of $201 billion.

Table 1 summarizes by reporting the proportion of total abatement required for each sector, average abatement costs, abatement required and total required investment. The $201 billion is higher than the original estimate of $128 billion. Canada has made little progress in reducing emissions since the original CMP and the new reduction target is larger by almost half than the original target. Assuming that these investments will be evenly distributed across the years that remain until 2030, this total required investment represents 0.97% of 2019 GDP.[5] Table 1 below is consistent with Table 2 of the original CMP report.

Table 1: Total Weighted Average Abatement Cost Breakdown

Sector	Proportion (%)	Average Cost ($/t CO_2eq)	Abatement Required (Mt. CO_2eq)	Required Investment ($ millions)	Proportion of Required Investment (%)
Oil & Gas	25.5	126	314	39,493	19.7
Transportation	24.8	283	305	86,415	43
Buildings	11.8	123	145	17,857	8.9
Heavy industry	9.8	126	121	15,224	7.6
Agriculture	9.3	88	115	10,030	5
Electricity	7.6	214	94	20,178	10
Waste & others	6.3	139	77	10,751	5.4
LULUCF	5	14	62	852	0.4
Total	**100**	**N/A**	**1,233**	**200,801**	**100**

Source: Authors' calculations, ECCC (2021), and CMP (2020).
Notes: Numbers may not sum up exactly due to rounding. Proportion (%) column is percent of total emissions for all sectors except LULUCF minus 5% distributed evenly across to model for LULUCF abating 5% of the total. This column is then multiplied by total abatement required to get a sector specific abatement required value. Average cost is the sector's average abatement cost for one tonne of CO_2eq., for a full list of abatement costs see Appendix A in the Capital Mobilization Plan for a Canadian Low Carbon Economy (2020).

2 Where emissions need to be is a 42.5% reduction in GHG emission levels compared to 2005, which is the mid point of the 40 to 45% reduction commitment range. The path that we model to get there is emissions that are 20 Mt. CO_2eq. lower in 2022 compared to 2021 and then drop by 25 Mt. CO_2eq. annually. All calculations to follow also use these assumptions.

3 The beginning of 2022 was chosen as we assume that the effects of the COVID-19 lockdown will be less pronounced.

4 See Capital Mobilization Plan for a Canadian Low Carbon Economy (2020) Appendix A for a full list of abatement costs used.

5 GDP is in current market prices.

Scenario Analysis

The investment required to abate a tonne of carbon is an important input into any estimate on the amount of capital required to meet any emissions target. We rely on an estimate calculated as the average publicly reported cost for a specific type of emission. In the original CMP and the baseline estimate used here, we assume that abatement costs remain constant until 2030. This assumption is conservative, but may not reflect the hope that new lower cost abatement technologies are introduced, or that existing technologies will become less expensive as they are scaled up. To include the potential for declining amounts of required capital we model a situation in which abatement costs decline by 5% annually for the Oil & Gas, Transportation, Buildings, Electricity and Heavy Industry sectors.[6] Another assumption from the original CMP and in our baseline estimate, is that abatement costs re-occur each year. This means we assume that the emissions must be abated in perpetuity and that policy and behavioural changes never lead to non-emissions. This is clearly an unlikely scenario as people, firms and governments re-evaluate their decisions and make investments in technologies that are low or zero emissions from the outset. To model this, we introduce two scenarios: the first scenario assumes that 50% of costs do not re-occur once abated, the second scenario assumes that 25% of costs do not re-occur.

The baseline scenario estimates the total required investment assuming all costs re-occur. We believe most costs are recurring—either through gradually writing off a productive asset of the useful life or because a project has high operating costs like CCS technology. There is however, significant uncertainty in the technology costs and effectiveness, behavioural changes and policy instruments that lead to permanent shifts in emissions. Some examples of permanent changes are; the electrification of public transit, a shift to work-from-home arrangements that reduce travel or changes in building codes.

Table 2 summarizes our estimates and shows how non-recurring and declining costs affect sector specific and total investment estimates. The baseline estimate of recurring emissions and constant technology costs leads to a new estimate of roughly $200 billion Canadian dollars to reduce 2030 emissions by 42.5% over 2005 emissions. This is roughly 56% higher than the estimate from the original CMP mostly due to the increase in committed emissions from 30% to between 40% and 45%. Assuming that technology costs fall by roughly 5% per year reduces the required investment to roughly $152 billion. The two scenarios that estimate the investment required under the assumption that 50% or 25% of emissions are non-recurring generates estimates between $91 and $155 billion. The lowest estimate of $91 billion assumes that technology costs decline by 5% annually and that only 50% of emissions re-occur. The highest scenario estimate of $155 billion assumes that prices do not decline and that only 25% of emissions do not re-occur. Declining technology costs and permanent shifts in emissions behaviours can reduce the total investment required by roughly 54%. This suggests that efforts to invest in new abatement technologies, alongside systemic changes in behaviour, can dramatically reduce the amount of capital required to reduce our emissions. An important note is that a decrease in the capital required does not decrease the benefits associated with the technologies, policies and systems developed. Having shown the possible cost declines resulting from these various assumptions (that were designed to lower our cost estimate) we still choose to keep our top line result of $201B as it is our most conservative estimate.

6 Cost declines are far from certain and not evenly distributed across technologies. 5% was chosen as a simplifying assumption and because it is inline with some cost decline predictions for renewables. For example, in one scenario The National Renewable Energy Laboratory projects a LCOE price decline in residential PV from 15.1 U.S. Cents/kWh to 5.0 in 2030 which implies a -4.7% CAGR [3]. This set of sectors were chosen as we believe they will be most affected by technological advancements.

Table 2: Scenario Analysis Table

Sector	Percentage of costs that are non-recurring					
	50%		25%		0%	
	P.D.	No P.D.	P.D.	No P.D.	P.D.	No P.D.
Oil & Gas	17,323	22,696	22,956	30,572	28,752	39,493
Transportation	37,905	49,660	50,231	66,896	62,912	86,415
Buildings	7,833	10,262	10,380	13,824	13,001	17,857
Electricity	8,851	11,596	11,729	15,620	14,690	20,178
Heavy industry	6,678	8,749	8,849	11,785	11,084	15,224
Agriculture	5,764	5,764	7,764	7,764	10,030	10,030
Waste & others	6,179	6,179	8,323	8,323	10,752	10,752
LULUCF	489	489	659	659	852	852
Total	**91,022**	**115,394**	**120,893**	**155,444**	**152,072**	**200,801**

Source: Authors' calculations.
Notes: P.D. stands for price decline which is a scenario where we assume abatement costs in all sectors except for Agriculture, Waste & Others, and LULUCF experience an annual price decline of 5%.

Provincial Analysis

We also report these required investments by province. Similar to the sector analysis, we calculate a weighted average abatement cost for each province. This cost is a product of sector average abatement costs and the proportion of emissions that come from each sector, in each province or territory. We also include the 5% contribution from the LULUCF in the provincial analysis. We then use this cost and multiply it by the "Abatement Required" column to find the total cost or required investment for each province. The set of "Abatement Required" values for each province is calculated by finding how much each province emits relative to the country as a whole and multiplying this percent value by the total abatement required (1233 Mt. CO_2).

The $200 billion in capital required to meet our commitments will not be evenly distributed across provinces. Table 3 reports the proportion of total emissions, average cost, required abatement, required investment and investment in terms of GDP, per province. Required capital estimates per province range from $67 billion for Alberta and $241 million for Nunavut. Saskatchewan has the highest amount of required capital in terms of GDP with 2.55% and Ontario, Quebec and British Columbia have the lowest with 0.59, 0.61, and 0.7 respectively. Yukon and Nunavut have the highest average cost to abate as the Transportation sector, a costly sector to reduce emissions in, makes up a very large portion of their total emissions at 75% and 87% respectively. Table 3 below is consistent with Table 4 of the original CMP report.

As in the original CMP, the amount of required investment and the ease with which that capital can be mobilized varies dramatically across jurisdictions. Coordination across multiple levels of government will be important to ensure that emissions are reduced as efficiently as possible. The role of the private sector is equally important.

Table 3: Provincial Required Investment Breakdown

Region	**Proportion of Total Emissions** (%)	**Average Cost** ($/t CO_2eq)	**Abatement Required** (Mt. CO_2eq)	**Required Investment** ($ millions)	**Investment Proportional to GDP** (%)
Alberta	37.8	146	466	67,819	2.14
Ontario	22.4	173	276	47,661	0.59
Quebec	11.5	179	141	25,287	0.61
Saskatchewan	10.3	151	126	19,027	2.55
British Columbia	9	176	111	19,554	0.7
Manitoba	3.1	160	38	6,135	0.92
Nova Scotia	2.2	204	27	5,592	1.33
New Brunswick	1.7	182	21	3,811	1.11
Newfoundland and Labrador	1.5	187	19	3,500	1.1
Prince Edward Island	0.2	178	3	527	0.78
Northwest Territories	0.2	213	2	466	1.14
Yukon	0.1	238	1	278	0.98
Nunavut	0.1	251	1	241	0.73

Source: Authors' calculations, Statistics Canada Table: 36-10-0222-01.
Notes: Proportion of GDP column uses total annual required investment and 2019 GDP at current market prices.

Canada's 2021 Budget — New GHG Targets and Green Investments

In addition to a new GHG reduction target, Canada has updated historically reported GHG emissions. This is important because GHG reductions are measured relative to 2005 emissions. These have been revised upwards by 9 Mt. CO_2eq., meaning that we have come closer to our target without actually abating emissions.

The newly revised 2005 emissions level means that the 36% reduction target outlined in the federal budget translates to a decrease from 517 to 473 Mt. CO_2eq. Canada's more recent target is a 40-45% reduction relative to 2005 levels implying a 2030 emissions level range of 407 to 443. In annual terms, this means Canada must reduce emissions by 4.8% annually to reach our 2030 target.[7] Reducing emissions by close to 5% annually is ambitious. Since 1990, Canada's annual average GHG emissions growth rate was +0.69%. It should be noted that beside the 5.7% decrease in 2009 as a result of the financial crisis, Canada has never reduced emissions by more than 2.24% (2016) since 1990.

The latest federal budget included many policy items that do not directly specify the particular method for GHG reduction. Some pundits would applaud this approach as it is not picking "winners and losers". For example, such policies include the issuance of a green sovereign bond and reductions in income tax rates for businesses that manufacture zero emission technologies [4]. Specific GHG reduction methods include electric vehicles, building retrofits, and carbon capture, utilization and storage (CCUS). Building retrofits, through interest-free loans, have attracted the most government financial support. This is likely to be an effective use of capital as the original CMP identified building retrofits as the only area that was likely to have the highest return on invested capital. It is likely that $1 invested in a building retrofit generates greater than $1 in direct financial benefits.

Outside of the recent budget announcement that included a $4.4 billion investment in building retrofits, the Government of Canada has announced $2.75 billion in funding to enhance public transit systems by financing a switch to clean electrical power, including the purchase of zero-emission public transit and school buses [5]. The Canada Infrastructure Bank—a federal Crown corporation of Canada—also announced in October 2020 a $10 billion Growth Plan which includes $1.5B for zero-emission buses, $2.5B for clean power and $2B for energy efficient building retrofits [6]. The common investment across these three announcements are electric transport, clean electricity and green buildings, highlighting the government's priorities and areas that they presumably believe have the lowest costs for GHG abatement and/or are the best ways to catalyze further private sector investment. These investments are also in line with the findings of the original CMP where we identify transportation as a key sector with hard to abate emissions and high abatement costs. Tackling these sectors lays the groundwork to meet our reduction commitments.

Advocates of government intervention will also applaud this push for electric transport as electric vehicles (EV) are becoming increasingly likely to be the most prominent passenger vehicle of the future. Further, EV take up is largely dependent on a) price and b) charging station availability, both of which will be improved through direct government stimulus and private sector investment. The parallel announcement of smart and clean power grids is critical to handle the increased electricity demand that is required to power electric transportation.

Investments in building retrofits are an important way to catalyze local job creation. Further—as highlighted in the Capital Mobilization Plan (2020)—there are instances of negative abatement costs within the buildings sector as GHG abatement opportunities can save money and reduce GHG emissions simultaneously. However, these negative abatement cost opportunities are not easily accessible; they require home and business owners to invest large sums of capital now, for small uncertain payoffs in the future. Providing easily accessible information that highlights the cost savings, thereby reducing the uncertainty from these retrofits, is one potential step towards realizing negative abatement cost opportunities.

7 This calculation assumes the projected 2021 emissions are correct and that we reach the middle of our target range.

Private Sector Commitments

The private sector has also made a number of GHG reduction commitments. A study from April of 2021 by the Institute for Sustainable Finance surveying GHG commitments of companies in the TSX Index found that a substantial portion of emissions associated with the Index would be eliminated if the companies met their stated reduction targets. In particular, the study found that the “2030 estimate of emissions reductions for the 60 companies with targets would total 72.8m, representing a 34.2% reduction from the 2019 emissions total of 213.0m for these 60 firms” [7].

Commitments have also come from the Oil and Gas sector, Canada’s largest emitting sector. As of June 2021 Canadian Natural Resources Ltd., Cenovus Energy Inc., Imperial Oil Ltd., MEG Energy Corp., and Suncor Energy have formed an alliance to improve technology such as carbon capture and reach net-zero GHG emissions from operations by 2050 [8]. Such commitments are essential for Canada to succeed in long term GHG reduction goals.

PUTTING THIS IN A GLOBAL CONTEXT

Canada is a small individual actor in the global context. The provincial analysis highlights the heterogeneity across jurisdictions in a relatively homogeneous country like Canada. A global analysis provides some context about the capital required for the planet to transition and a comparison to Canada. In this section we analyze Canada’s commitments, total abatement and required investment compared globally.

To compare required investment globally we first require data on historical emissions to build a projection for future emissions. We build a model that projects emissions for every country with enough historical data.[8] Unlike Canada, most countries do not provide annual emissions projections, making our projections an important contribution. To project emissions we use an autoregressive distributed lag regression model that uses three years of historical data and makes use of several country and economic variables such as population, GDP, total GHG emissions and emissions from fossil fuels. Forecasts of fossil fuel emissions from the International Energy Agency (IEA), population from the World Bank and GDP forecasts from the International Monetary Fund (IMF) to 2025 were also used to improve our projections. The main data source is the World Resources Institute CAIT dataset on GHG emissions [9]. This data is the most comprehensive data on Climate Watch—a leading climate data platform—as it emphasizes completeness allowing for a meaningful analysis across countries and time.

Required capital is categorized using the WRI CAIT emissions groupings; energy, waste, agriculture, and industrial processes.[9] We separate transportation and fugitive emissions, two subgroups of the energy category, because of their inherent differences in abatement opportunities and costs. Using the proportion of each emissions group and the corresponding average abatement cost, we calculate a weighted average cost to abate for developed, developing and in transition economies. These country groupings follow the United Nations and are based on World Economic Situation and Prospects (WESP).

After average abatement costs are found and projections are made, the methodology largely follows the methodology used in the CMP; a linearly declining path is constructed so that a 42.5% GHG emissions reduction compared to 2005 levels is reached by 2030, and then the cumulative difference between this path and the projected is multiplied by the corresponding average weighted abatement cost.[10]

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8 Not every country was included due to data limitations, however, we project emissions for 133 countries representing 96% of total global emissions.

9 To the extent possible, data in CAIT, WRI followed the IPCC Common Reporting Framework used by the UNFCCC (IPCC, 1996b) [9].

10 Although not all countries have targets nor are they the same as Canada’s, a common 42.5% abatement target was used for illustrative purposes.

Table 4 summarizes both historical GHG emission growth rates and the projected results, using our projection methodology, for the next decade for each WESP group and compared to Canada. We do this to provide some historical context and to highlight where each group's emissions are projected to be. This is important because if a region's emissions have been and are expected to continue trending downwards, then a given GHG reduction target will be easier to achieve. Over the past 25 years, developing countries have had the highest GHG emissions growth rate and are also projected to reduce (growth rates) by the most. Developed economies are projected to have the lowest average emissions growth rate of which Canada lags behind. Despite the large drop in emissions growth, developing countries are still projected to increase annual emissions by 0.91% per year between 2019 and 2030. Both in transition and developed economies are projected to reduce emissions by 0.07% and 1.11% annually between 2019 and 2030. In contrast to developed countries, Canada increased emissions from 1995 to 2019. Our projections do show a slight decrease in annual emissions between 2019 and 2030 but at a rate far below our developed economy peers. Clearly Canada has some work to do by 2030.

Table 4: Emissions Growth Rates by WESP Group

Group	1995-2019	2019-2030	Difference
Developing	3.48	0.91	2.57
In Transition	0.21	-0.07	0.28
Developed	-0.53	-1.11	0.58
Canada	**0.49**	**-0.08**	**0.57**

Source: Authors' calculations and World Resources Institute CAIT dataset.
Notes: Growth rates are expressed as CAGR (%), rounded to two decimal points. Groupings are done by WESP which is short for World Economic Situation and Prospects and is defined by the United Nations.

Global GHG Targets

To give Canada's new GHG reduction target some context, we compare it to targets from other G7 countries. We collect the most recently announced GHG target for each G7 country and then calculate the compound annual growth rate (CAGR) that would be necessary for the country to reach their stated target. This standardization is done so that we can compare and highlight how ambitious a country's target is relative to other advanced economies. For further context, we include the amount of electricity that is currently generated from renewables and total natural resource rents as a percentage of GDP. A high proportion of GDP that comes from natural resource rents can indicate how dependent an economy is on extractive often high emitting industries, meaning a higher target for an extractive dependent economy, all else equal, could mean greater obstacles during the pursuit of this target such as higher transition and political risk. The share of electricity that is generated from coal can also indicate how easy it is to reach a given GHG reduction target because swapping coal for a lower emitting or renewable energy source is generally viewed as an easy GHG abatement opportunity—the more of it that remains the more opportunities for affordable and relatively easy GHG reducing projects.

Table 5 shows that Canada is in the middle of the G7 in terms of the annual GHG emissions reduction required to meet our reduction target. Electricity from renewables are by far the highest for Canada, while electricity from coal is amongst the lowest. This is important because it means that two main methods of finite and sensible GHG reduction—increasing the share of renewables in the electricity grid and lowering the production of electricity from coal—have been used up more relative to other G7 countries. This means that Canada is likely to face greater difficulties in reducing annual GHG emissions relative to our G7 peers. Canada also has, by far, the largest natural resource rents proportional to GDP, which is relevant because it can lead to higher levels of transition and political risk. Conversely, if decarbonization is done effectively it could be a source of large GHG reductions. A list of each country's GHG reduction targets are available in Table 9 of the Appendix.

Table 5: CAGR required for G7 GHG Reduction Targets Compared to Other Relevant Metrics

Country	CAGR needed for target	Electricity from renewables (%)	Electricity from Coal (%)	Natural resource rents (%)
Italy	-5.89	39.81	9.91	0.10
United Kingdom	-5.58	32.94	5.13	0.66
United States	-4.97	17.38	27.26	0.71
Canada	**-4.50**	**67.42**	**7.49**	**2.47**
Japan	-3.98	21.90	28.48	0.03
Germany	-3.46	35.28	35.80	0.08
France	-2.57	19.69	1.46	0.04

Source: Author's calculations, Our World in Data, United Nation Climate Change.
Notes: CAGR stands for compound annual growth rate. The "CAGR needed for target" uses the most recently announced country specific GHG reduction goal that is not net-zero and the latest year (2018) for GHG emissions data offered on the UNFCC website. Country targets use either 1990 or 2005 as the base year and the year 2030 or 2035 for which the target should be met by. Natural resource rents are proportional to GDP.

Another way to compare Canada's climate action relative to other countries, is to examine GHG projections found in the biennial reports (BR) submitted to the UNFCCC. In these reports Annex 1 parties have to submit GHG projections under a with measures (WM) scenario which incorporates currently implemented and adopted policies and measures.[11] Additionally, there is an optional scenario submission labeled with additional measures (WAM) which adds in planned, but not yet implemented, policies and measures [2]. There are roughly 30 countries that submit these BRs and we calculate the reported growth rate of emissions from 2020 to 2030 for all countries under both scenarios and compare Canada's growth rate to the average.[12] The first BR was due to the UNFCCC by January 2014 and submissions have been ongoing since. There have been a total of four BR submissions to date. We provide this analysis because it shows how Canada's projected emissions (that reflect policies and measures) have evolved over time, along with how they compare to our peers. In other words, projections contained in these reports provide a convenient way to track government action on reducing future GHG emissions as they turn policies into raw data that can be compared across countries and over time.

Table 6 clearly shows that Canada's policies and measures that manage and minimize GHG emissions have been lagging behind the average. For example, in 2015 BR submissions reflect that the average country that submitted a BR report believed that their emissions between 2020 and 2030 would decrease by 1.07%, whereas Canada's modeled emissions showed an anticipated increase of 6.05%. As reflected by their first BR submission, Canada began with much higher anticipated emissions growth rate for the 2020 to 2030 time period but has worked to decrease it and has almost closed the gap between it and the average. Canada still needs to translate their UNFCCC reported and expected emissions into actual emissions reductions.

11 "Annex I Parties include the industrialized countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States." [10]

12 Some countries, notably the U.S., have not submitted a report in recent years.

Table 6: GHG Projections Reported to the UNFCCC

BR#	Year	WM Growth Rate (%)		WAM Growth Rate (%)	
		mean	Canada	mean	Canada
1	2013	0.09	**10.76**	-3.65	**n/a**
2	2015	-1.07	**6.05**	-7.05	**n/a**
3	2017	-2.62	**-0.96**	-8.95	**-15.50**
4	2019	-5.85	**-4.62**	-16.53	**-12.94**

Source: Author's calculations, UNFCCC.
Notes: BR stands for biennial report and the year is the average initial submission year. WM is short for "with measures" and WAM is short for "with additional measures". WM is mandatory for submissions to the UNFCCC whereas WAM is optional. WM incorporates all currently implemented and adopted policies and measures, whereas WAM also adds in planned yet-to-be implemented policies and measures. Canada only started to submit the WAM scenario in 2017. Growth rates are total CO_2eq. excluding LULUCF growth rates from 2020 to 2030.

Required Investment

This section compares Canada's estimated required investment to developed, developing and in transition economies. We also compare Canada to a number of comparable countries. We take the estimated total required capital divided by nine (the number of years) to arrive at an annual figure. To better understand how large the required capital is relative to a country's GDP we divide by the group's total GDP in USD. We also divide the annual investment by Gross Capital Formation (GCF) to relate this to the average amount of annual investment in a specific country grouping.[13] GCF is an important metric to include because it reflects the amount of annual spending on fixed assets. GHG investment opportunities are often investments in fixed assets so comparing average annual investments to required abatement investments is important to understand. Countries with a high GCF will have a relatively easier time diverting capital to abatement opportunities. These results are summarized in Table 7 below.

Table 7: Required Investment Relative to GDP and GCF by WESP Group

Group	Average Cost ($/t CO_2eq)	Abatement Required (Mt. CO_2eq)	Annual Required Investment ($B)	Required Investment Proportion to	
				GDP (%)	GCF (%)
Developed	142	13,998	221	0.447	2.23
Developing	123	108,596	1,484	4.234	14.66
In Transition	106	8,257	97	4.367	19.25
Canada	**139**	**1,457**	**23**	**1.296**	**5.76**

Source: Author's calculations, World Bank.
Notes: GCF is short for Gross Capital Formation (formerly gross domestic investment) and is defined by the World Bank as outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. GDP values are from 2019 and GCF is a trailing 5 year average as the timeliness of this metric varies country to country. Costs and investment values are in USD. WESP is short for World Economic Situation and Prospects and is defined by the United Nations. Calculations use a common 42.5% GHG reduction relative to 2005 levels.

13 Some developing countries that we forecast emissions for do not have GCF data so we subtract their required investment from the total prior to calculations.

The slightly different procedure for our global analysis estimates a higher annual investment of 1.3% of 2019 GDP for Canada. The estimates differ as a result of using our own GHG projections that are based purely on an econometric model and are more pessimistic than government projections. Additionally, we use a GHG emissions database that includes all countries, including Canada, making the results comparable across countries. This 1.3% of GDP for Canada is much higher than the average 0.45% of GDP for developed countries. Canada's required investment is higher because our estimates project Canada's emissions to remain relatively flat over the next decade. In contrast, our projections suggest that developed countries' emissions will trend downward. In general, Canada's economy is dependent on resource extraction—a high carbon emitting activity—meaning that a higher level of investment will be required compared to the average developed economy.

Table 7 also shows that in comparison to developing and in transition economies Canada has to allocate relatively less of its GDP towards emissions abatement. It should be noted that the anticipated GDP growth for these developing economies will bring some convergence to these metrics but overall the difference is expected to largely remain. These differences in amount of GDP required should also signal the need for global coordination of efforts and financial resources. The average abatement cost is lowest for in transition economies and highest for developed economies. One reason in transition economies have a low average cost is because a large percentage of their emissions are classified as fugitive emissions, such as methane leaks in the natural gas drilling, extraction, and transportation process, which has an associated low abatement cost. Developed economies have a higher weighted average abatement cost because a relatively large portion of their emissions come from the transportation sector which, as previously mentioned, is a costly and hard to abate sector.

When comparing the total required investment to the group's GCF value we see that the required investment is relatively low for developed economies, with only 2.23% of GCF diversion to carbon abatement required to meet the reduction goal. Developing and in transition economies will be required to mobilize 14.66% and 19.25% of their GCF respectively. While the amount of capital to be mobilized is large, it does not exceed even 1/4 of average annual GCF. Importantly, the low amount of capital relative to GDP and GCF for developed economies leaves a large amount of slack for investments in other economies. Consistent with our overall comparisons for Canada, the required capital for Canada is above the average for developed economies with 5.76%, but below the average for developing and in transition economies.

Table 8 is consistent with Table 7 but groups of countries such as developed and developing have been replaced with several countries of interest. What is immediately clear is the very low annual investment required by the United Kingdom (and other EU countries). This is mainly a result of projected emissions being very close to the path that would get the U.K. to the common GHG target that we model. Our projected emissions, to the extent possible, incorporate policies and measures that reduce GHG emissions.[14] The projections also incorporate historical trends of GHG emissions of which the U.K. has experienced large relative reductions. Lastly, it is important to remember that these cost estimates all use the same GHG reduction target (42.5% below 2005 levels) and helps to explain why the U.K. has set a relatively more ambitious target that reflects their unique situation.[15] Other core variables like GDP and population growth work their way into our GHG projections and also help to explain the differences in total abatement required. For example, the U.K. and Canada have roughly similar levels of expected GDP growth for the future yet Canada's population growth is expected to be roughly double that of the U.K.[16]

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14 This makes our projected emissions for most EU countries to be on a downward trend as many implemented policies are anticipated to bring further emission reductions. These results are also consistent with findings of the Climate Action Tracker as they find that the U.K.'s current policies leave them on track to meet their old 57% reduction target relative to 1990 levels, a target that is slightly more ambitious than the one we model [11].

15 Using the most recent data released from the WRI we can see that for the U.K. a 42.5% reduction relative to 2005 levels would mean annual GHG emissions of 382 Mt. CO_2eq. by 2030 while their new country specific target implies a much lower 164 Mt. CO_2eq. by 2035.

16 Obviously projecting GDP is not an exact science but the point here is that it looks very likely that the difference in variables between Canada and the U.K. will be higher for population compared to GDP growth.

Apart from China and Australia, Canada must invest the most as a proportion of their GDP amongst countries listed in Table 8 to meet this common 42.5% reduction that we model. Again, this is due to a number of reasons previously listed, but also because since 2005 these countries with lower required investment have experienced declining levels of annual GHG emissions or progress towards this target. This contrasts Canada's annual emissions that have remained essentially flat since 2005 (719 Mt CO_2eq. were emitted in 2019 and 2005). This means Canada must work to make up for lost time as we pursue our 2030 target.

Table 8: Required Investment Relative to GDP and GCF by Country

Country	Average Cost ($/t CO_2eq)	Abatement Required (Mt. CO_2eq)	Annual Required Investment ($M)	Required Investment Proportion to	
				GDP (%)	**GCF** (%)
China	125	43,834	608,814	4.227	11.43
Australia	125	1,403	19,499	1.406	5.71
United States	145	6,888	110,978	0.518	2.75
Japan	145	1,348	21,720	0.428	1.89
Germany	143	343	5,454	0.141	0.71
France	141	205	3,212	0.118	0.52
United Kingdom	142	12	200	0.007	0.04
Canada	**139**	**1,457**	**22,504**	**1.296**	**5.76**

Source: Author's calculations, World Bank.
Notes: GCF is short for Gross Capital Formation (formerly gross domestic investment) and is defined by the World Bank as outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. GDP values are from 2019 and GCF is a trailing 5 year average as the timeliness of this metric varies country to country. Costs and investment values are in USD. Calculations use a common 42.5% GHG reduction relative to 2005 levels for all countries listed. Table is sorted (excluding Canada) by the proportion to GDP column.

SUMMARY

Canada is at an important crossroad. We have an ambitious commitment to reduce emissions by 2030 now enshrined in federal law [12]. The first report highlighted that the amount of capital required to reduce emissions is not insurmountable.

This refresh highlights that while the emissions target is now even more ambitious and that we have essentially "lost" two years of abatement potential, the required capital is still not insurmountable. We modify the methodology of the original CMP and document the impact of non-recurring costs and declining technology costs. Both assumptions by definition reduce the total expected costs of reducing emissions – highlighting the importance of new lower cost technologies for emissions abatement. In a global context, Canada is not leading the pack on reduction commitments or actual emissions reductions.

The projected relative investment required for Canada is higher than the average for developed economies but below those of developing and in transition economies. The investment for Canada is also much higher than most other comparable countries when applying a common GHG reduction target. In sum, this refresh re-iterates the points made in the original CMP. Reducing emissions is doable, not onerously expensive, and should not be viewed through purely cost lens. The investments made today into infrastructure, new business models, and natural assets will pay dividends for this and future generations.

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APPENDIX

Table 9: Detailed GHG reduction target for G7 countries

Country	Percent Reduction	Base Year	Target Year
Canada	42.5%	2005	2030
France	40%	1990	2030
Germany	55%	1990	2030
Italy	60%	1990	2030
Japan	46%	2013	2030
United Kingdom	78%	1990	2035
United States	51%	2005	2030

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