Simulating Canada's 2030 Emissions Reduction Plan

Scenario Overview and Policy Assumptions

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AUTHORS

Franziska Förg, Massimiliano Munn, Brianne Riehl, and Sam Harrison
Navius Research Inc.
Franziska@NaviusResearch.com

Dave Sawyer and Anna Kanduth
Canadian Climate Institute
dsawyer@climatechoices.ca

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Introduction

In this document, we present the assumptions used to characterize federal policies for an updated analysis of the 2030 Emissions Reduction Plan (ERP) using Navius' integrated gTech-IESD model. For this analysis, the model is run in 5-year increments out to 2035.

We simulate three policy packages with varying levels of policy design certainty:

1) Legislated policies. This includes currently legislated provincial and federal policies, detailed spending allocated in a federal budget, or projects that are in the planning phase. Note that, for brevity, this document highlights recently legislated federal policies and does not present an extensive list of legislated policies included in this analysis.

2) Developing policies. This includes legislated and developing policies. Developing policies include new policies for which details have been published about coverage, stringency and timelines, but have not yet been legislated. For these policies, some uncertainty remains regarding final policy design.

3) Announced policies. This includes legislated, developing and announced policies. Announced policies are those for which the intent of implementation has been officially announced, but little detail is available about policy design. Our characterization of these policies is illustrative and shows the level of greenhouse gas reductions that could be achieved if these policies were implemented with the policy design described in this document.

To demonstrate the impact of policy overlap, we simulate two versions of the developing and announced policy packages. In one scenario we assume the industrial carbon price remains binding at $170/t by adjusting benchmarks to account for overlap with other policies, including the Clean Electricity Regulations and the oil and gas sector emissions cap. In the other scenario, we allow these policies to interact with the industrial carbon price, which can lead to the carbon price dropping to zero.

We also simulate a counterfactual "no carbon policy" scenario that shows what might have happened if we hadn't introduced any emission reduction policies over the past ten years.

In addition to considering policy uncertainty through the above-described scenario approach, we also address uncertainty in factors that are outside the control of Canadian governments via a sensitivity analysis. The sensitivity analysis varies assumptions about global oil prices and low-carbon technology costs to present a range in potential impacts of the above-described policy packages.

1. Policy Packages

1.1. Announced Policies

1.1.1. GHG emissions cap on the oil and gas sector

Policy	GHG emissions cap on the oil and gas sector
Stringency and timeline	The federal government has announced its intention to cap greenhouse gas (GHG) emissions from the oil and gas sector. On December 6th, 2023, Environment and Climate Change Canada published a regulatory framework to cap oil and gas sector GHG emissions. The framework proposes a national emissions cap-and-trade system with an upper bound on GHGs from the oil and gas sector which will be phased in between 2026 and 2030. The framework distinguishes between the "emissions cap level" and the "legal upper bound". The emissions cap level is proposed to be set between 106 and 112 Mt CO_2e. The legal upper limit is proposed to be set between 131 and 137 Mt CO_2e. The oil and gas sector will be issued emissions allowances at the emissions cap level. However, the oil and gas sector is allowed to emit more than the cap, up to the upper bound, through the use of other eligible "flexible" compliance units. Flexible compliance units can be either 1) purchased by paying into a decarbonization fund (the unit price is to be set at the estimated price necessary to achieve the upper bound) or 2) offset credits under Canada's GHG Offset Credit System or a recognized provincial offset credit system. Emission allowances would be tradeable between covered facilities and bankable for up to six years (two three-year compliance periods). Emission allowances are proposed to be allocated as free allowances (free of charge) to the covered facilities in the first compliance period.
Sectors/ Emissions covered	Direct and indirect GHGs from upstream oil and gas and Liquid Natural Gas facilities, including methane emissions. The framework proposes coverage of indirect emissions from transfers of thermal energy, hydrogen, CO_2, and electricity. The intent is to avoid carbon leakage, for example by switching from cogeneration (covered) to using electricity from the grid (not covered), and to avoid competitiveness impacts between facilities with own use of products versus those with imports.
Policy Category	Announced
Assumptions	The announced oil and gas cap is simulated as a tradable performance standard which requires the oil and gas sector to reduce its emissions intensity and allows for compliance credit trading between oil and gas sectors. Carbon intensity benchmarks are calculated to be consistent with the emissions cap. The emissions cap covers emissions from upstream oil and gas activities and LNG

	production and is set at 128 Mt CO_2e, starting in 2030. The cap is set at 128 Mt rather than the upper bound of ~135 Mt, as we estimate indirect emissions from grid electricity consumption to be around 7 Mt in 2030. Our analysis does not implicitly include these indirect emissions and therefore assumes a lower emissions cap to reflect the narrower emissions coverage. Methane emissions are "covered" by the cap, meaning that these emissions count towards the 128 Mt cap, but methane reductions cannot generate compliance credits under the cap. We simulate two versions of this policy, one that allows for overlap between the federal and provincial output-based pricing systems (OBPS) and the oil and gas emissions cap and one that seeks to minimize policy overlap. For the latter, oil and gas emissions are excluded under the OBPS once the cap comes into effect in 2030. This avoids an influx of non-incremental OBPS credits as a result of the oil and gas emissions cap, which could lead to the carbon price under the OBPS being non-binding.
References	https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/oil-gas-emissions-cap/Regulatory%20Framework_OG%20Emissions%20Cap_Dec%206_full.pdf En4-460-2022-eng.pdf (publications.gc.ca) https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/oil-gas-emissions-cap.html https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/oil-gas-emissions-cap/options-discussion-paper.html https://www.ctvnews.ca/politics/canada-plans-to-finalize-emissions-cap-by-mid-2024-minister-says-1.6496245

1.1.2. Medium- and Heavy-duty Vehicle Emissions Standard

Policy	Medium- and Heavy-duty Emissions Standard
Stringency and timeline	The ERP announced plans to develop a medium- and heavy-duty ZEV sales mandate with the goal of achieving 35% ZEV sales by 2030 and 100% by 2040 in selected medium- and heavy-duty categories, based on feasibility. Furthermore, interim targets for pre-2030 years are being explored. The Government has stated that it is examining proposed rules from the U.S. Environmental Protection Agency on emissions from heavy-duty vehicles. The US EPA is planning to announce their heavy-duty vehicle emissions standard in July 2024.
Sectors/ Emissions covered	There are currently no details on policy design available but the federal government previously expressed interest in developing a policy like California's Advanced Clean Trucks Regulation. California's regulation applies to manufacturers of on-road medium- and heavy-duty vehicles, excluding transit buses.
Policy Category	Announced
Assumptions	The announced medium- and heavy-duty vehicle emissions standard is based on California's Advanced Clean Trucks Regulation. California's medium- and heavy-duty emissions standards require that 30% of heavy- and 50% of medium-duty new vehicle sales be ZEVs in 2030, and 40% and 75% in 2035, respectively. Each year, vehicle manufacturers need to retire a certain number of credits in compliance with these targets. Credits are generated through the sale of low-carbon emission vehicles and can be traded. For full battery electric and fuel cell electric vehicles, the number of credits generated depends on the vehicles' weight class. For plug-in electric vehicles, credit generation also depends on electric range.
References	En4-460-2022-eng.pdf (publications.gc.ca) https://www.canada.ca/content/dam/eccc/documents/pdf/cepa/21199_HDV%20Discussion%20Document_Dec%2016_MinO%20Approved_Final_EN.pdf https://www.canada.ca/en/environment-climate-change/news/2021/12/government-launches-consultations-on-commitment-to-require-all-new-cars-sold-in-canada-be-zero-emission-by-2035.html https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/heavy-duty-vehicle-engines-zero-emission-future-discussion-paper.html

1.1.3. National Net-zero Emissions Building Strategy

Policy	National Net-zero Emissions Building Strategy
Stringency and timeline	The ERP mentions that $150 million will be invested to develop the Canada Green Buildings Strategy, a national net zero by 2050 buildings strategy. As part of the strategy, regulatory standards to phase out fossil-fuel heating in buildings will be developed. The Green Buildings Strategy aims to reduce building emissions by 37% from 2005 levels by 2030 and to achieve net-zero by 2050.
Sectors/ Emissions covered	To our knowledge, there is currently no information available regarding policy design.
Policy Category	Announced
Assumptions	The announced national net-zero emissions building strategy is a federal regulation which bans the installation of new and replacement[1] oil and gas heating systems in residential and commercial buildings by 2026.
References	En4-460-2022-eng.pdf (publications.gc.ca) https://natural-resources.canada.ca/public-consultations-and-engagements/the-canada-green-buildings-strategy/25009

[1] This analysis does not account for the cost of electric panel upgrades which may be necessary when replacing a furnace with an electric heating system in an existing building. This does not impact findings on GHG policy impacts but may underestimate the cost of switching to an electric heating system in existing buildings.

1.1.4. Waste methane capture

Policy	**Waste methane capture**
Stringency and timeline	The ERP states the federal government's intention to create landfill methane regulations with the goal of reducing waste emissions through waste methane capture and treatment. Canada's 2022 Methane Strategy mentions that the government intends to "[develop] new regulations to increase recovery and destruction of methane from large municipal solid waste landfills by about 50% by 2030 from 2019 levels". It also mentions that the regulation will aim for "[reduction] of about 50% per year by 2030, from the 2019 level". The government plans to have draft regulations by 2024 and final regulations coming in force in 2025.
Sectors/ Emissions covered	Landfill methane emissions.
Policy Category	Announced
Assumptions	The announced waste methane capture regulation requires that in each province a minimum of 50% of total landfill methane emissions be destructed through either flaring or methane capture and utilization by 2030.
References	En4-460-2022-eng.pdf (publications.gc.ca) En4-491-2022-eng.pdf (publications.gc.ca) Reducing methane emissions from Canada's municipal solid waste landfills: discussion paper – Canada.ca https://open.canada.ca/data/en/dataset/8e05f27c-8172-458b-8884-b8fe38b48217/resource/68250f9c-4980-49e9-92a7-e4050072f4de

1.2. Developing Policies

1.2.1. Clean Electricity Regulations

Policy	**Clean Electricity Regulation**
	The Clean Electricity Regulations (CER), as proposed in Gazette Part I, are a prescriptive regulation limiting the emissions intensity of fossil fuel electricity generators to an annual average of 30 tCO2e/GWh. CCS projects can emit at 40 tCO2e/GWh under certain circumstances. This will apply to generators with a capacity factor of more than 5%. It is not a tradeable performance standard; all regulated units must meet the standard.
Stringency and timeline	The emissions standard would apply to most units starting on January 1st, 2035. The following cases would have more time to comply: ■ Units commissioned prior to 2025, except for coal-fired units, would have until 20 years after their commissioning (compliance starting in 2044 for a unit commissioned in 2024), or ■ Between 2035 and 2040 for units that were coal-to-gas conversions, based on the emissions intensity of these units.
Sectors/ Emissions covered	The proposed regulations would apply to an electricity generation unit that meets all three of the following criteria: ■ uses any amount of fossil fuels to generate electricity, ■ has a capacity of 25 MW or greater, ■ operates more than 450 hours per year (otherwise a 150kt CO2e/year emission ceiling applies instead), and ■ is connected to the NERC-regulated electricity system (i.e., the main North American grid, which doesn't include the territories, remote communities, or off-grid industry). In practice, this will effectively cover all emissions from utility electricity generation in Canada. The regulations also apply to all cogeneration emissions at facilities which are net exporters of electricity.
Policy Category	Developing
Assumptions	The 40 tonne CO2e/GWh CCS emission standard is right on the cusp between allowing CCS to comply with the CER or not. This could mean that a lot of CCS facilities might just barely not be in compliance with the CER. In our simulation, a 90% CCS capture is just not in

	compliance with the CER. In this analysis, we assume a 95% CCS capture rate to enable CCS as a compliance option under the CER. In our simulation, the CER applies to utility generation and the net export portion of electricity generated through cogeneration. Under the regulation, any cogeneration facility that exports electricity to the grid must comply with the regulations. As the model does not simulate cogeneration at the facility level, only the portion of electricity exported to the grid falls under CER compliance in our simulation. (This may underestimate the stringency of the policy, as in reality, all electricity generated by a cogeneration facility must comply with the CER if any is exported to the grid, not just the exported portion.) The CER coming into force date for coal-to-gas conversion units falls between 2035 and 2040, depending on the emissions intensity of these units. In our simulation, the CER compliance requirement for coal-to-gas conversion units is assumed to start in the 2036 to 2040 5-year simulation period (this may underestimate the stringency of the policy for coal-to-gas conversion units in 2035, as some units may be covered in that year).
References	https://www.gazette.gc.ca/rp-pr/p1/2023/2023-08-19/html/reg1-eng.html

1.2.2. Light-duty Vehicle Emissions Standard

Policy	Light-duty Emissions Standard
Stringency and timeline	The amendment to the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations, as proposed in Gazette Part I, establishes a zero-emission vehicle (ZEV) sales mandate, requiring manufacturers and importers to meet an annual percent target of new light-duty ZEVs offered for sale in Canada. The ZEV mandate will require at least 20% of all new light-duty vehicle sales to be ZEVs by 2026, 60% by 2030, and 100% by 2035. This sales target does not include exported vehicles. At the end of each compliance period, regulated suppliers must present sufficient credits to comply with the reduction requirement. Credits are produced through the sale of ZEVs whereby the number of credits per vehicle depend on the all-electric range: ■ A battery electric vehicle, fuel cell vehicle, or plug-in hybrid electric vehicle (PHEV) with an all-electric range of 80 kms or more receives one credit. ■ In 2026, PHEVs with an all-electric range of 16-49km receive 0.15 credits and none thereafter. ■ Until 2028, PHEVs with an all-electric range of 50-79km receive 0.75 credits and none thereafter. The contribution of PHEV credits towards the sales target is limited to 45% for model year 2026, 30% for model year 2027 and 20% for model years 2028 and beyond. Compliance deficits can also be satisfied by purchasing credits from other companies, using banked credits, or until 2034 to a capped extent (6%-10%) by creating credits through investments in ZEV activities such as charging infrastructure. For each investment of $20,000 indexed to inflation, one compliance credit is created. A company can bank excess credits in any given model year to use towards compliance for up to five model years. Companies are not permitted to use banked credits to meet their sales targets starting in model year 2035 and beyond.
Sectors/ Emissions covered	Light-duty vehicle manufacturers and importers.
Policy Category	Developing
Assumptions	ZEV sales are endogenously simulated based on the credits received per vehicle sale, compliance cost, and consumer behavior (such as heterogeneity of preferences). Credit banking is not explicitly simulated as the model runs in 5-year time increments and balances supply and demand of credits for each 5-year time period (no surplus credits). We assume that the $20,000 per credit investment option will not be used by suppliers as credit prices are expected to be lower than this price. We will double check that this assumption holds true after a first set of runs

	by checking the marginal credit price. This expectation is in line with ECCC's assessment in the Regulatory Impact Analysis.
References	gazette.gc.ca/rp-pr/p1/2022/2022-10-29/pdf/g1-15644.pdf Canada Gazette, Part 1, Volume 156, Number 53:

1.2.3. 75% reduction in oil and gas methane emissions

Policy	75% reduction in oil and gas methane emissions
Stringency and timeline	The federal government recently published proposed regulations that seek to reduce methane emissions from the oil and gas sector by at least 75% below 2012 levels by 2030. This builds on the federal government's current methane regulations, which seek to achieve a 40% to 45% reduction in methane emissions in the upstream oil and gas sector below 2012 levels by 2025.
Sectors/ Emissions covered	The methane regulations cover upstream oil and gas emissions.
Policy Category	Developing
Assumptions	We simulate the 75% methane reduction requirement as a regulatory requirement requiring increased uptake of abatement actions and technologies for surface casing vent flows, leaking, and venting, such as increased monitoring, flaring, and well reworking, in the upstream oil and gas sector.
References	https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/81000-2-5163-CGI-Unoffical%20Version%20Non%20Officielle.pdf https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/consultation-reducing-methane-emissions-oil-gas-sector.html En4-460-2022-eng.pdf (publications.gc.ca)

1.3. Legislated Policies

1.3.1. Federal Fuel Charge

Policy	**Federal Fuel Charge**
Stringency and timeline	The federal fuel charge is a backstop policy that applies a tax on fossil fuels in provinces that don't have an equally stringent carbon pricing system. The federal government announced that the federal fuel charge will be increased annually by $15/tCO2e after 2022 until the tax reaches $170/tCO2e in 2030 and stays constant at that level thereafter.
Sectors/ Emissions covered	All sectors except emissions-intensive trade- exposed industries. Fuel charge proceeds are returned to the province in which they were collected and provided as a fixed transfer to households.
Policy Category	Legislated
Assumptions	We assume that the tax rate of the federal fuel charge applies in all provinces and territories, except for Québec, which is covered by a cap-and-trade system. Costs are assumed to be passed through to fuel prices. Businesses and households are assumed to make decisions based on short-term (5-year) foresight as to what the carbon price will be at the end of each 5-year simulation period (e.g., in 2026 the $170 carbon price will be used for decision-making).
References	https://laws-lois.justice.gc.ca/eng/acts/G-11.55/FullText.html https://laws-lois.justice.gc.ca/eng/regulations/SOR-2018-12187/

1.3.2. Output-Based Pricing Systems

Policy	Output-Based Pricing System
Stringency and timeline	The Output-Based Pricing System (OBPS) is a tradable emissions performance standard that puts a price on industrial emissions if a facility's emissions intensity exceeds the sectoral benchmark. The federal government announced that the OBPS carbon price will be increased annually by $15/tCO2e until it reaches $170/tCO2e in 2030. Furthermore, sectoral OBPS benchmark stringency is proposed to be increased annually by 2 percentage points starting in 2023. Electricity benchmark stringency will not be increased as the federal government intends to address this sector's emission intensity through the Clean Electricity Regulations. The federal OBPS applies currently in Manitoba, Prince Edward Island, the Yukon, and Nunavut. Provincial/territorial governments in BC, Alberta, Saskatchewan, Ontario, New Brunswick, Nova Scotia, Newfoundland and Labrador, and the Northwest Territories have implemented provincial/territorial carbon pricing systems for large final emitters that apply instead of the federal OBPS. For all provincial systems, the backstop fund price is the same as the federal OBPS, though model results for tradeable credit prices will differ by province as benchmarks and tightening rates vary by province and sector.
Sectors/ Emissions covered	The OBPS or equivalent provincial/territorial systems are assumed to apply to industrial facilities emitting more than 10 kilotonnes of CO2e annually, and in any other sectors that are eligible to opt-in
Policy Category	Legislated
Assumptions	We assume that the legislated provincial/territorial and federal systems will apply in their currently legislated form until 2035 (i.e., we do not assume benchmarks will tighten to maintain a $170/t credit price). OBPS proceeds are used to fund low-carbon technologies for industrial sectors. For electricity, hydrogen, and heat from cogeneration, benchmarks as specified in physical units in the regulation are simulated directly in the model. Other sectors for which provincial benchmarks are specified in physical units (e.g., tCO2e/t of mined ore) are assumed to be equivalent to the generic benchmark for other sectors as defined in the regulation (e.g., 20% below the historic baseline). Eligible opt-in facilities are assumed to opt-in. Implicitly, new facilities are assumed to have commodity-based benchmarks (rather than facility-specific benchmarks as they would in reality, which creates no marginal incentive to reduce emissions). Banking and borrowing of credits is not included.

	Firms are assumed to make decisions based on foresight as to what the carbon price will be at the end of each 5-year simulation period (e.g., in 2026 the $170 carbon price will be used for decision-making). We simulate two versions of this policy. In one version we assume the industrial carbon price remains binding at $170/t by adjusting benchmarks to account for overlap with other policies, including the Clean Electricity Regulations. In addition, the oil and gas sector is excluded under the industrial carbon pricing system to avoid overlap with the oil and gas cap. In the other scenario, we allow these policies to interact with the industrial carbon price without changing policy coverage or the stringency of the industrial benchmarks. This can lead to the carbon price under the OBPS dropping to zero.
Key references	Federal OBPS: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-266/index.html BC: https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/carbon-tax/obps-technical-backgrounder.pdf Alberta: https://www.alberta.ca/technology-innovation-and-emissions-reduction-regulation Saskatchewan: https://publications.saskatchewan.ca/#/products/120897 Ontario: https://www.ontario.ca/page/emissions-performance-standards-program New Brunswick: https://www.canlii.org/en/nb/laws/regu/nb-reg-2021-43/latest/nb-reg-2021-43.html Nova Scotia: "Tightening Rate Comparison" word document provided by ECCC. Newfoundland and Labrador: https://www.assembly.nl.ca/Legislation/sr/regulations/rc180116.htm Northwest Territories: https://www.justice.gov.nt.ca/en/files/legislation/petroleum-products-carbon-tax/petroleum-products-carbon-tax.r1.pdf

1.3.3. Tax credit for CCUS and DAC Investment

Policy	**Investment tax credit for CCUS**
Stringency and timeline	Budgets 2022 and 2023 provide details on the investment tax credit (ITC) for carbon capture and direct air capture and utilization and storage. The ITC is available at 60% for investment in direct air capture (DAC) equipment, 50% for investment in carbon capture, utilization and storage projects (CCUS), and 37.5% for investment in related transportation equipment. The tax credit rates will be reduced by 50% starting in 2031 and phased out after 2040.
Sectors/ Emissions covered	Investments by taxable entities in CCUS and DAC, excluding CO_2 use for enhanced oil recovery and CCUS with coal-fired electricity generation units.
Policy Category	Legislated
Assumptions	The CCUS ITC applies to all CCUS applications except for CO_2 used for enhanced oil recovery and CCUS used with coal-fired electricity generation units. The ITC is assumed to become available in 2023 at 50% for CCUS and 60% for direct air capture units, declining to 25% and 30%, respectively, for the 2031 to 2040 period. The tax credit available for CCS and natural gas-fired electricity generation is pro-rated by the current share of taxable and non-taxable entities and combined with the Clean Electricity Investment Tax credit. We assume that the CCUS tax credit will be made available in all provinces with suitable geological storage or access to storage (e.g., through pipelines).
References	https://www.budget.canada.ca/2022/home-accueil-en.html https://www.budget.canada.ca/2023/pdf/budget-2023-en.pdf https://www.budget.canada.ca/2022/report-rapport/tm-mf-en.html

1.3.4. Tax Credit for Clean Hydrogen Investment

Policy	**Clean Hydrogen ITC**
Stringency and timeline	Budget 2023 introduces details on the Clean Hydrogen Investment Tax Credit (ITC), which subsidizes eligible project costs by between 15% and 40%, depending on the life cycle carbon intensity (CI) of the hydrogen produced. The ITC will cover between 15% and 40% of eligible project costs, with the projects that produce the cleanest hydrogen receiving the highest levels of support (assuming labor requirements are met): ■ 40% for hydrogen with a CI smaller 0.75 kg/kg H2 ■ 25% for hydrogen with a CI between 2kg and 0.75kg ■ 15% for hydrogen with a CI between 4kg and 2kg ■ 0% for hydrogen with a CI greater 4kg The tax credit is phased out starting in 2034, whereby property that becomes available for use in 2034 can receive half the credit rate and property that becomes available after 2034 can no longer receive the tax credit.
Sectors/ Emissions covered	Hydrogen production with a life cycle carbon intensity equal to or lower than 4kg per kg of hydrogen produced.
Policy Category	Legislated
Assumptions	The ITC is assumed to be available to all energy-carrier hydrogen facilities (not for hydrogen used as a feedstock). Hydrogen produced through steam methane reformation with carbon capture and storage and hydrogen produced from electrolysis are assumed to be eligible for the 15% ITC, assuming a carbon intensity between 2 and 4kg/kg H2. Wages and apprenticeship conditions are assumed to be met.
References	https://www.budget.canada.ca/2023/pdf/budget-2023-en.pdf https://www.budget.canada.ca/fes-eea/2022/report-rapport/FES-EEA-2022-en.pdf https://www.budget.canada.ca/2022/home-accueil-en.html https://www.budget.canada.ca/2023/pdf/tm-mf-2023-en.pdf

1.3.5. Tax Credit for Clean Technology Investment

Policy	**Clean Technologies ITC**
Stringency and timeline	The 2022 Fall Economic Statement and Budget 2023 provide details on the Clean Technology Investment Tax Credit. The Tax Credit refunds 30% of capital investments by taxable entities (e.g., excluding Crown Corporations) in low-carbon electricity (including nuclear), electricity storage systems, low-carbon heat and electricity equipment, and industrial off-road zero emission vehicles. It is available for technologies purchased between 2023 and 2034.
Sectors/Emissions covered	Investments by taxable entities in renewable and nuclear electricity generation, storage, commercial and industrial heat pumps, non-road heavy-duty zero emission vehicles.
Policy Category	Legislated
Assumptions	We assume that the tax credit is available for: ■ Investment in solar, wind, hydro, tidal, geothermal, biomass, nuclear and small nuclear reactor electricity generation; ■ Investment in short-term and seasonal long-term storage (lithium-batteries and hydrogen storage) ■ Commercial and industrial heat pumps ■ Non-road heavy-duty zero-emission vehicles Wages and apprenticeship conditions are assumed to be met. The available credit amount for electricity generation and storage investments is pro-rated by the current electric capacity share of taxable vs. non-taxable entities and combined with the Clean Electricity Investment Tax Credit where the targeted investments by technology type overlap.
References	https://www.budget.canada.ca/2023/pdf/budget-2023-en.pdf https://www.budget.canada.ca/fes-eea/2022/report-rapport/FES-EEA-2022-en.pdf iveyenergycentre_electrification_and_investment_final.pdf (diigo.com)

1.3.6. Tax Credit for Clean Electricity Investment

Policy	**Clean Electricity ITC**
Stringency and timeline	In addition to the 30% investment tax credit (ITC) for taxable entities, Budget 2023 introduces a 15% ITC for eligible investments made by non-taxable entities (e.g., Crown Corporations). The ITC is available for investments in non-emitting electricity systems, including nuclear and abated natural gas, storage, and interprovincial transmission equipment. The tax credit is available for projects constructed between 2023 and 2034.
Sectors/Emissions covered	Investments by non-taxable entities in renewable, nuclear and abated natural gas electricity generation, storage and transmission equipment.
Policy Category	Legislated
Assumptions	We assume that the tax credit is available for: ■ Investment in solar, wind, hydro, tidal, geothermal, biomass, nuclear and small nuclear reactor electricity generation; ■ Investment in short-term and seasonal long-term storage (lithium-batteries and hydrogen storage) ■ Abated natural gas-fired electricity generation Wages and apprenticeship conditions are assumed to be met. The available credit amount is pro-rated by the current electric capacity share of taxable vs. non-taxable entities and combined with the Clean Technology Investment Tax Credit where the targeted investments by technology type overlap.
References	https://www.budget.canada.ca/2023/pdf/budget-2023-en.pdf iveyenergycentre_electrification_and_investment_final.pdf (diigo.com)

1.3.7. Clean Fuel Regulations

Policy	Clean Fuel Regulations
Stringency and timeline	The Clean Fuel Regulations are a performance-based fuel supply standard requiring fossil fuel suppliers that produce 400 m^3 or more of gasoline or diesel to reduce the lifecycle GHG intensity of their fuels by 14 g CO2e/MJ in 2030, relative to a 2016 baseline carbon intensity. The CFR creates a credit-based compliance market which allows regulated fuel suppliers and voluntary credit generators to trade compliance credits. At the end of each compliance period, regulated suppliers must present sufficient credits to comply with the reduction requirement. Credits can be produced by reducing upstream emissions associated with liquid fossil fuel production, blending low carbon fuels such as ethanol into the liquid stream, or end-use fuel switching in transport. Supply of low-carbon gaseous fuels can generate gaseous credits which can be used by regulated suppliers to meet up to 10% of compliance through instream credit trading.
Sectors/ Emissions covered	Gasoline and diesel used in transportation, except for aviation gasoline or gasoline and diesel that is exported, used for research purposes and vehicles only used for competition.
Policy Category	Legislated
Assumptions	Credit generation through increased low-carbon fuel blending, transportation electrification and carbon capture and storage used in upstream oil and gas extraction is endogenously simulated as a function of compliance costs, resource availability and provincial and federal policies. All CCS projects linked to liquid fossil fuel production are assumed to be considered "additional" and qualify for CFR credit generation. CCS credit generation is pro-rated by the ratio of domestic use versus exports. For crude oil production, we assume that 20% of CCS qualifies for credit generation, as about 80% of extracted crude oil is exported. For refineries, we assume that 80% of CCS can generate CFR credits, as a large share of refined petroleum products is used domestically. We also assume that generic quantification method credits for actions such as methane conservation and refinery process improvements are created up to the 10% limit by 2030 (about 2.9 Mt CO2e worth in credits in 2030).
References	https://laws-lois.justice.gc.ca/eng/regulations/SOR-2022-140/FullText.html https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2021/market-snapshot-canadas-crude-oil-exports-kept-pace-with-production-over-the-last-decade.html. https://open.canada.ca/data/en/dataset/792aad48-1745-41dd-8424-55e49d98fa0c.

1.3.8. Canada Infrastructure Bank Spending

Policy	Canada Infrastructure Bank Spending
Stringency and timeline	The Healthy Environment and Healthy Economy federal climate plan states that the Canada Infrastructure Bank (CIB) has a long-term investment target of $5 billion for clean power projects. It further outlines that the CIB has committed $1.5 billion for zero emission buses, $2.5 billion for low-carbon power projects, including storage, transmission, and renewables, over 3 years, and $2 billion for commercial building retrofit upfront costs. The ERP mentions that CIB will receive a total of $35 billion with priorities to invest in green infrastructure ($5 billion), public transit ($5 billion) and clean power ($5 billion). Budget 2023 announced that the CIB will invest at least $10 billion through its Clean Power priority area, and at least $10 billion through its Green Infrastructure priority area.
Sectors/Emissions covered	Buildings and other infrastructure, transit, electricity generation.
Policy Category	Legislated
Assumptions	CIB spending is simulated as a $1.5 billion subsidy for zero-emission buses, $500 million for electric charging and hydrogen refueling infrastructure (included in the "1.3.12. Funding for charging stations" policy), and $2 billion for commercial high efficiency building shells and heating technologies over three years. The $10 billion subsidy for renewable electricity generation and storage over eleven years can't be simulated in the integrated model. A linear model like IESD can't solve for two variables at the same time, in this case 1) how much of the lump sum amount is used by a particular technology and 2) how much generation is added by that technology.
References	https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf https://www.budget.canada.ca/2023/pdf/budget-2023-en.pdf En4-460-2022-eng.pdf (publications.gc.ca) https://cib-bic.ca/en/sectors/priority-sectors/

1.3.9. Net Zero Accelerator

Policy	**Net Zero Accelerator**
Stringency and timeline	A Healthy Environment and a Healthy Economy announced an investment of $3 billion over 5 years for the Net Zero Accelerator, which provides funding for development and adoption of low-carbon technologies in all industrial sectors. Budget 2021 provided an additional $5 billion over seven years for the Net Zero Accelerator.
Sectors/Emissions covered	Funding is available to low-carbon industrial technologies.
Policy Category	Legislated
Assumptions	The Net Zero Accelerator is simulated as an $8 billion subsidy over seven years for industrial low-carbon technologies and sectors, including carbon capture and storage technologies, biofuel and low-carbon hydrogen production, electrification of industrial heat production and compression, fuel switching to wood waste and hydrogen for industrial heat production, efficient electric motors, and direct air capture.
References	https://www.budget.canada.ca/2021/pdf/budget-2021-en.pdf https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf

1.3.10. Low Carbon Fuel Fund

Policy	**Low carbon fuel fund**
Stringency and timeline	The Healthy Environment and Healthy Economy Plan and Budget 2021 announced that $1.5 billion will be provided over five years to support the production and use of low carbon fuels.
Sectors/Emissions covered	Funding is available for low carbon fuels.
Policy Category	Legislated
Assumptions	This is simulated as a subsidy for liquid biofuel, renewable natural gas and low-carbon energy carrier hydrogen production over five years. Subsidy values are assumed to be nominal.
References	https://www.budget.canada.ca/2021/pdf/budget-2021-en.pdf https://www.canada.ca/en/department-finance/news/2021/04/budget-2021-a-healthy-environment-for-a-healthy-economy.html

1.3.11. Incentives for Zero-Emission Vehicles Program

Policy	**Incentives for Zero-Emission Vehicles Program**
Stringency and timeline	The ERP announced an additional $1.7 billion to extend the iZEV program for another three years. The iZEV program provides rebates of up to $5,000 for light-duty zero emission vehicles. In addition, $547.5M of funding over four years are made available for the new iMHZEV program which provides rebates of up to $200,000 for medium- and heavy-duty zero emission vehicles.
Sectors/Emissions covered	The rebate program provides subsidies to plug-in hybrids, battery electric vehicles, and fuel cell electric on-road vehicles.
Policy Category	Legislated
Assumptions	We simulate the iZEV funding as a 1.7 billion subsidy, additional to historic and remaining iZEV funds for zero emission light-duty vehicles, including battery electric vehicles, plug-in hybrids, and fuel cell electric vehicles, over three years. iMHZEV funding is simulated as a $547.5 million subsidy for battery electric vehicles, plug-in hybrids and fuel cell electric vehicles over four years. Subsidy values are assumed to be nominal.
References	En4-460-2022-eng.pdf (publications.gc.ca) https://www.budget.gc.ca/efu-meb/2021/report-rapport/EFU-MEB-2021-EN.pdf https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/medium-heavy-duty-zero-emission-vehicles https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/program-statistics

1.3.12. Funding for charging stations

Policy	**Funding for charging stations**
Stringency and timeline	The ERP states that an additional $400 million will be allocated to ZEV charging stations. In addition, $500 million in Canada Infrastructure Bank funds will be invested into improving the electric charging and hydrogen refueling infrastructure.
Sectors/Emissions covered	Funding is available for electric charging and hydrogen fuel cell refueling network improvements.
Policy Category	Legislated
Assumptions	This is simulated as a $900 million subsidy for light-, medium-, and heavy-duty zero emission vehicles, including plug-in hybrids, battery electric and fuel cell electric vehicles, over five years. Subsidy values are assumed to be nominal.
References	En4-460-2022-eng.pdf (publications.gc.ca) https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf https://www.budget.canada.ca/2021/pdf/budget-2021-en.pdf

1.3.13. Large Truck Retrofits

Policy	**Large Truck Retrofits**
Stringency and timeline	The ERP includes a $199.6 million subsidy for retrofitting large trucks currently on the road.
Sectors/Emissions covered	Medium- and heavy-duty transportation
Policy Category	Legislated
Assumptions	This is simulated as a $199.6 million subsidy for efficient heavy-duty vehicles over five years, excluding zero emission vehicles as those are subsidized under the iMHZEV program. Subsidy values are assumed to be nominal.
References	En4-460-2022-eng.pdf (publications.gc.ca) https://www.budget.canada.ca/2022/home-accueil-en.html

1.3.14. Heat pump subsidies

Policy	**Heat pump subsidy**
Stringency and timeline	Budget 2023 provides $500 million in funding through the Oil to Heat Pump Affordability (OHPA) Grant for low- and median-income households that switch from oil heating to a heat pump. In addition, the Low Carbon Economy Fund provides $250 million in home heating oil transition funding for low-income households that switch from heating oil to low-carbon heating systems.
Sectors/Emissions covered	Funding is available to low-income households for switching away from oil heating to heat pumps or other low-carbon systems.
Policy Category	Legislated
Assumptions	The OHPA grant and home heating oil transition funding are simulated as $750 million in subsidies for heat pumps in the territories and provinces with high heating oil use.
References	https://www.budget.canada.ca/fes-eea/2023/report-rapport/FES-EEA-2023-en.pdf

1.3.15. Greener Home Loans

Policy	**Interest-free home retrofit loan**
Stringency and timeline	Budget 2021 allocated $4.4 billion on a cash basis ($778.7 million on an accrual basis over five years, starting in 2021-22, with $414.1 million in future years), to the Canada Mortgage and Housing Corporation to provide interest-free loans up to $40,000 to low-income homeowners for home retrofits. The ERP announced an additional investment of $458.5 million into the low-income loan program.
Sectors/Emissions covered	Funding is available to low-income households for efficiency upgrades of residential building shells and heating technologies.
Policy Category	Legislated
Assumptions	This is simulated as a $1.2 billion subsidy ($778.7 million + $458.5 million) over seven years for efficient residential building shells and heating technologies. Subsidy values are assumed to be nominal.
References	En4-460-2022-eng.pdf (publications.gc.ca) https://www.canada.ca/en/department-finance/news/2021/04/budget-2021-a-healthy-environment-for-a-healthy-economy.html

1.3.16. Greener Homes Grant

Policy	**Residential efficiency retrofits**
Stringency and timeline	Budget 2021 included $2.6 billion for residential energy efficiency improvements over seven years.
Sectors/Emissions covered	Funding is available to households for efficiency upgrades of residential building shells and heating technologies.
Policy Category	Legislated
Assumptions	This is simulated as a $2.6 billion subsidy for efficient residential building shells and heating technologies over seven years. Subsidy values are assumed to be nominal.
References	https://www.budget.canada.ca/2021/pdf/budget-2021-en.pdf

1.3.17. Green and Inclusive Community Buildings program

Policy	**Community buildings upgrade**
Stringency and timeline	Budget 2021 proposed to invest $1.5 billion over three years for repairs and efficiency upgrades in community buildings and for building new energy efficient community buildings.
Sectors/Emissions covered	Funding is available for efficiency upgrades of building shells and heating technologies in community buildings.
Policy Category	Legislated
Assumptions	This is simulated as a $1.5 billion subsidy over three years for community and commercial efficient building shell and heating technologies. Subsidy values are assumed to be nominal.
References	https://www.budget.canada.ca/2021/pdf/budget-2021-en.pdf

1.3.18. Deep Retrofit Acceleration Incentive

Policy	
Stringency and timeline	Budget 2022 announced the Deep Retrofit Acceleration Incentive, which provides $200 million in funding for retrofitting commercial and institutional and multi-unit residential buildings.
Sectors/Emissions covered	Funding is available for deep retrofits for commercial and institutional buildings and multi-unit residential buildings.
Policy Category	Legislated
Assumptions	This is simulated as $200 million in funding over 5-years, starting in 2023, for near zero building envelopes for commercial and institutional and multi-unit residential buildings.
References	https://www.budget.canada.ca/2022/home-accueil-en.html The Government of Canada Announces Calls for Applications for Green Building Retrofits to Enable Climate Action in Industries and Communities - Canada.ca

1.3.19. Ontario steel plant upgrades

Policy	**Ontario steel plant upgrades**
Stringency and timeline	Two major steel companies in Ontario, ArcelorMittal and Algoma, announced that they will upgrade their steel plants, which will result in greenhouse gas reductions of about 3 Megatonnes in each plant.
Sectors/Emissions covered	Steel production
Policy Category	Legislated
Assumptions	This is simulated as a switch to less carbon intensive forms of steel production, such as direct reduced iron steel production, and achieves about a 6 Megatonnes reduction in GHG emissions in 2030 relative to 2020.
References	https://www.globenewswire.com/news-release/2021/11/11/2332532/0/en/Algoma-Steel-Announces-Final-Investment-Decision-for-Electric-Arc-Steelmaking.html https://corporate.arcelormittal.com/media/press-releases/arcelormittal-and-the-government-of-canada-announce-investment-of-cad-1-765-billion-in-decarbonization-technologies-in-canada

1.4. No Carbon Policy Scenario

This is a counterfactual scenario that aims to demonstrate what emissions might be in the absence of carbon policy implementation. The underlying assumption in this scenario is that, without policy implementation, there would be no incentive to adopt low-carbon technologies and processes unless for cost benefits (e.g., more efficient technologies can save money) or behavioural preferences. This scenario is purely illustrative and serves as a counterfactual to demonstrate how many emissions reductions have been achieved as a result of carbon policy and investments in low-carbon technologies to date.

In the "no policy" scenario, we remove low-carbon policies on all jurisdictional levels, starting in 2015. This includes but is not limited to:

- All policies listed in Sections 1 through 3 above
- Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations
- Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations
- Regulations Amending the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations
- Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity
- Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds
- Hydrofluorocarbon (HFC) policies
- Provincial renewable portfolio standards
- Provincial biofuel blending mandates
- Provincial low-carbon technology subsidies and funding
- Nova Scotia's GHG cap on electricity generation
- Québec's renewable natural gas mandate
- British Columbia's low-carbon fuel requirements

- Québec's and British Columbia's light-duty zero emission vehicle mandates
- Québec's ban on new oil heating in buildings

We did not remove the following policies and investment decisions as they are either decisions that we expect would have also been made in the absence of carbon policy or would require reparameterization of baseline technologies in the model:

- Muskrat falls in Newfoundland and Labrador
- Nuclear power plant refurbishment in New Brunswick and Ontario
- Minimum efficiency requirements for buildings

1.5. Other Policy Assumptions

This section describes the key reasons for differing results between our current 2023 analysis of the federal Emissions Reduction Plan (ERP) and our previous 2022 ERP analysis[2]. Three key differences explain the change in the emissions impacts of policy in the 2023 analysis relative to 2022.

1. **Calibration Updates.** Our current analysis has been calibrated to the 2023 National Inventory Report (NIR) and Canada Energy Regulator's Canada's Energy Future 2023 "Current Measures" global oil price forecast. Historic NIR emissions can vary between reporting years due to methodology improvements. These NIR reporting changes lead to variations in calibration values between last year's and this year's analysis, such as higher fugitive emissions in the oil and gas sector and lower emissions in the heavy-duty transport sector.
2. **Model Updates.** Many changes have been made to the model since last year's analysis. The largest of these changes is the integration of Navius' macro-economic model gTech and electricity model IESD and, as a result, improved representation of the electricity sector. As a result of the model integration with IESD, representation of electricity technology availability and cost has been improved. A key difference is the cost of renewable generation, which is lower in IESD due to the hourly resolution of this model and representation of declining capital costs of renewables through economics of scale and learning. IESD also includes technologies that were not accounted for in last year's ERP analysis, such as battery storage and better representation of cogeneration. This leads to differences in emissions in the electricity sector and all sectors that consume electricity in this analysis relative to last year's analysis.
3. **Scenario Design Differences.** Policy scenarios have been changed to reflect recent policy updates and announcements. Scenario assumptions used in the 2022 analysis are described in the 2022 technical report[3]. Policy scenarios simulated in this year's analysis are described in Sections 2 through 5 in this document.

[2] https://climateinstitute.ca/reports/assessment-2030-emissions-reduction-plan/

[3] https://climateinstitute.ca/wp-content/uploads/2022/04/SimulatingCanadas2030ERP_March2022.pdf

2. Sensitivity Analysis

For each of the policy packages described above, we use a set of baseline technology cost assumptions[4] and a global oil price based on the "Current Measures" forecast from the Canada Energy Regulator's (CER) Canada's Energy Future 2023[5]. To account for uncertainty, we also simulate alternative oil price and technology cost assumption packages, as outlined in the matrix below:

	Global Oil Price		
Low-carbon technology costs	High	Canada Net Zero	Global Net Zero
Low	X	X	X
High	X	X	X

Low-carbon technology costs are bundled into a 'techno-optimistic' (low) and 'techno-pessimistic' (high) sensitivity. Under the techno-optimistic sensitivity, the lower range of cost assumptions found in literature are used for wind and solar, battery electric vehicles, hydrogen fuel cells, hydrogen production, heat pumps, carbon capture and storage, and second-generation biofuel production. Under the techno-pessimistic sensitivity, the higher cost range found in literature is used. Bundling these higher and lower cost assumptions allows us to represent an upper and lower range in low-carbon technology cost uncertainty.

The Canada and Global Net Zero oil price assumptions are based on the Canada Energy Regulator's "Canada Net Zero" and "Global Net Zero" oil price forecasts[6]. The high oil price is based on the US Energy Information Administration's (EIA) Annual Energy Outlook 2023 reference case oil price forecast[7].

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[4] See gTech-IESD model documentation here: https://canadaenergydashboard.com/data/navius_research_gtech_iesd_model_documentation.pdf

[5] https://apps.rec-cer.gc.ca/ftrppndc/dflt.aspx?GoCTemplateCulture=en-CA

[6] https://apps.rec-cer.gc.ca/ftrppndc/dflt.aspx?GoCTemplateCulture=en-CA

[7] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=12-AEO2023&cases=ref2023~highmacro~lowmacro~highprice~lowprice~highogs~lowogs~highZTC~lowZTC~aeo2022ref&sourcekey=0

Table 1: Brent oil price assumptions in $2022 USD/barrel

	2025	2030
CER Current Measures (reference)	79	75
EIA Reference Case (high)	87	90
CER Canada Net Zero (low)	77	64
CER Global Net Zero (lowest)	73	35