An examination of the impact of the federal carbon pricing system on Nova Scotian households

Larry Hughes, PhD

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17 October 2022

Abstract

In 2023, Nova Scotians will begin paying the federal benchmark carbon price of $65 per tonne of CO_2e emitted. The Nova Scotia government's arguments that the benchmark cost will be too expensive for Nova Scotians were rejected by the federal government.

In this report, we use data from Efficiency Nova Scotia and Natural Resources Canada to estimate the carbon costs for a variety of Nova Scotian households if the province is subject to the 2022-23 price of $50/tonne of CO_2e. We then apply the 2022-23 federal carbon rebate (the Climate Action Incentive payment or CAIP) for households in two provinces paying the federal benchmark price (Ontario and Saskatchewan) to the carbon costs for similar sized Nova Scotian households. The report shows that Nova Scotia's energy mix will require the federal CAIP to be higher in Nova Scotia than in any of the other provinces currently subject to the federal carbon price.

CAIPs are based on household income, the number of people in a household, and the assumed energy consumption (and hence emissions). CAIP is intended to protect low- and middle-income households from financial hardship caused by the household's carbon costs. The report shows that in some cases the CAIP might not cover these costs. The report recommends that Nova Scotia develop a system using the CAIP funds to ensure that Nova Scotians are not unfairly impacted by the federal price on carbon.

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Introduction

On 1 April 2023, the federal price on carbon will increase from $50/tonne of CO_2e to $65/tonne.[1] All provinces, including Nova Scotia, will be expected to price their emissions accordingly.

There has been a Canada-wide benchmark price on carbon since 2019, when it was $20/tonne. To most Canadians, the price and associated cost were listed on purchases of any carbon-intensive energy source, such as gasoline. One notable exception was Nova Scotia's carbon pricing system which not only hid the price from consumers but ensured that Nova Scotians paid the least per tonne of carbon emitted.

All provinces were expected to submit their new carbon pricing systems proposals (for 2023 onwards) to the federal government in August 2022. Nova Scotia's plan, which was to be a continuation of the province's original program, was rejected by the federal government, despite a last-minute plea from Timothy Halman, Nova Scotia's Minister of Environment and Climate Change.

Consequently, Nova Scotia will join four other provinces that do not have their own benchmark, Ontario, Manitoba, Saskatchewan, and Alberta, and are subject to the federal stringency requirements (or carbon pricing system). In the federal system, consumers pay the carbon price on any emissions-intensive fuel they purchase. About 90% of the monies collected are returned by the federal government as a quarterly Climate Action Incentive Payments (or CAIP) to low-and middle-income individuals and households considered least able afford their carbon price. High-income individuals and households do not receive the CAIP and are expected to change their behaviour rather than continuing to pay the carbon price.

This report examines the potential impact of the federal carbon price on 36 different combinations of household size, household heating requirements, household electricity use, and vehicular use in Nova Scotia. To estimate the value of the CAIP required for Nova Scotians, the federal price on carbon for 2022-23 ($50/tonne of CO_2e) is determined for the emissions associated with the 36 household combinations. Then, the CAIP made to the same size of household in Ontario (the province with the lowest CAIP) and Saskatchewan (the province with the highest CAIP) is compared with the Nova Scotia carbon costs. The results show that if Ontario's CAIP was used in Nova Scotia, all the households examined would suffer a loss; however, if Nova Scotian households received Saskatchewan's CAIP, small, low-energy consumption households would receive a rebate exceeding what they had paid. The CAIP for high-energy consumption households would not cover the household's carbon cost.

The report also identified several shortcomings with the federal system that will need to be addressed, preferably in the near-term. The report argues that rather than fighting the federal government, the

[1] CO_2e or carbon dioxide equivalent is a method of expressing the global warming potential of any gas in terms of carbon dioxide. An energy source's CO_2e is the sum of the CO_2e's of the gases it emits during combustion.

Nova Scotia government should take the recommendations made in this report and develop a better, more equitable carbon pricing system.

Emissions sources

Nova Scotians will be subject to carbon pricing for their residential emissions in three energy services (space heating, domestic hot water heating, and lighting and appliances) and the transportation sector.

Carbon prices vary by energy source. The more CO_2e produced per unit of energy consumed, the higher the carbon price for the energy source. The carbon prices for the energy sources used in this report are listed in Table 1.

Table 1: Carbon content and carbon-price for 2022-2023 at $50 per tonne

Energy source	CO_2e content	Volume per tonne	Carbon price at $50/tonne
Light fuel oil	2.755 kg/L	362.9 L/t	13.78 ¢/L
Electricity	0.598 kg/kWh	1,675.0 kWh/t	2.99 ¢/kWh
Gasoline	2.307 kg/L	433.5 L/t	11.54 ¢/L
Natural gas	51.5 kg/GJ	19.4 GJ/t	257.50 ¢/GJ

We examine a range of possible emissions and carbon prices for these energy sources assuming that Nova Scotia had been subject to the 2022-2023 federal price on carbon.

Space heating

Most Nova Scotian homes are heated by a combination of one or more energy sources: heating oil, electricity, and wood. Figure 1 shows the number and types of heating systems used in the province in 2019, when slightly over half of the homes used heating oil for heating, about 22 percent used electricity (excluding heat pumps), and almost 14 percent used wood in combination with another fuel source, such as fuel oil or electricity. A small but growing number of households use heat pumps (4.9 percent) and wood (3.7 percent), with limited numbers heating with natural gas, propane, and coal.

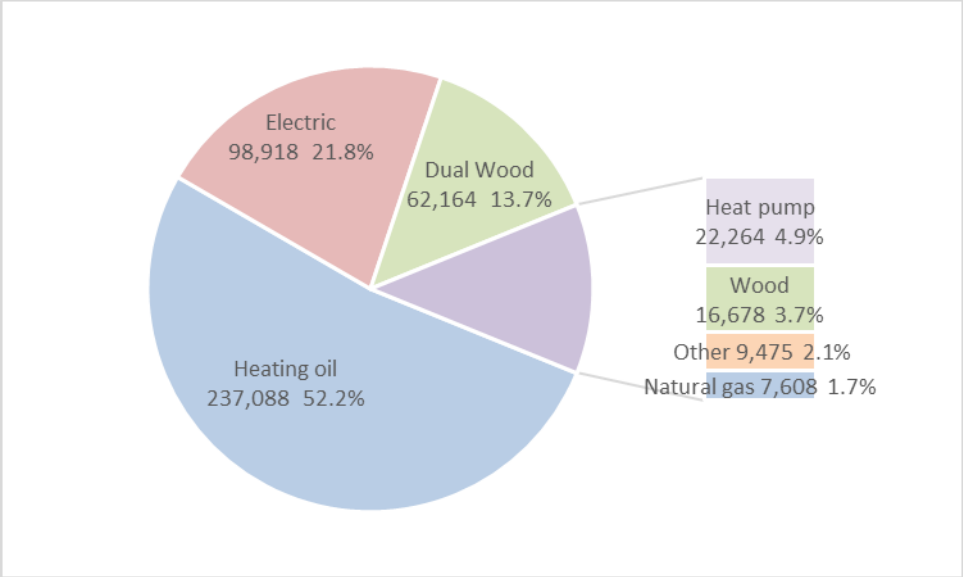


Figure 1: Total residential heating system stock by fuel source in Nova Scotia in 2019

All these energy systems emit greenhouse gases. The quantity is normally expressed as its emissions intensity, or the greenhouse emissions per unit of energy consumed, such as a litre of fuel or kilowatt-hour of electricity. Table 2 shows the emissions intensities of the energy sources to which the federal carbon-levy is applied. For example, for every litre of fuel oil used, 2.755 kg of CO_2e are emitted. Using about 363 litres of fuel oil produces a tonne of CO_2e.

Table 2: Emissions intensity of household energy sources

Source	Emissions intensity	Volume to produce one tonne of CO_2e	kg CO_2e/GJ
Fuel oil (NIR)	2.755 kg/L	363.0 L	79.5
Natural gas (NIR)	51.5 kg/GJ	19.4 GJ	51.5
Electricity 2020 (NIR)	670 g/kWh	1.49 MWh	186
Electricity 2020 (NSP)	626 g/kWh	1.60 MWh	174
Electricity 2021 (NSP)	598 g/kWh	1.67 MWh	166

The table also compares the emissions for every gigajoule (GJ) of energy consumed. Natural gas produces about 51.5 kg of CO_2e, fuel oil about 79.5 kg, and in 2021, Nova Scotia Power emitted 166 kg per GJ.

Three separate values are shown for electricity: one from the National Inventory Report showing Nova Scotia Power's emissions for 2020, and two from NSP for 2020 and 2021 (their most recent value). The difference between the NIR's value for 2020 (670 g/kWh) and Nova Scotia Power's (626 g/kWh) can be attributed to what is considered "electricity generation". The NIR only considers the volume of electricity generated in Nova Scotia, whereas Nova Scotia Power includes out-of-province purchases thereby increasing the volume of electricity considered.

To get an understanding of the cost of the carbon levy to a typical 1,700 square-foot household, household space-heating consumption data from Efficiency Nova Scotia is used:

- Three space heating requirements are examined: 30 MBTU (a new house meeting the R-2000 standard), 50 MBTU (a new house), and 80 MBTU (an existing, "old" house).[2]
- Three energy sources (Fuel oil, Electricity, and Natural gas) and their typical heating systems and efficiencies. For example, efficiencies range from 70% (for a natural gas fireplace), to 95% for a condensing oil-furnace, to 300% for an electric geothermal heat-pump.

The space-heating energy demand, emissions, and the carbon levy for the various houses and heating systems are shown in Table 3. Each energy source requires a certain volume of energy to meet the space-heating requirements of the different households. The volume of energy varies depending on the conversion efficiency of the heating system and the energy intensity of the energy source; for example, a 30 MBTU using an air-to-air heat pump consumes 4,628 kWh, this increases to 12,340 kWh for a house requiring 80 MBTU.

[2] MBTU – Million BTUs.

Table 3: Space heating energy demand, emissions, and carbon levy
(Assumes 1,700 ft² home) (Volume data from Efficiency Nova Scotia)

Energy source and heating system	Efficiency	Volume (varies by energy source)			CO_2e Emissions (kg)			Carbon-levy ($)		
		New R2000 30 MBTU	New 50 MBTU	Old 80 MBTU	New R2000 30 MBTU	New 50 MBTU	Old 80 MBTU	New R2000 30 MBTU	New 50 MBTU	Old 80 MBTU
Oil		**Litres**			**CO_2e kg**			**Levy**		
Oil - Furnace/Boiler - New	85%	967	1,612	2,579	2,664	4,441	7,105	$133	$222	$355
Oil - Furnace/Boiler - Condensing	95%	863	1,439	2,302	2,379	3,965	6,344	$119	$198	$317
Electricity		**kWh**			**CO_2e kg**			**Levy**		
Baseboard, Furnace/Boiler	100%	8,792	14,654	23,447	5,249	8,749	13,998	$262	$437	$700
Radiant In-floor, Furnace/Boiler	85%	10,344	17,240	27,584	6,175	10,292	16,468	$309	$515	$823
Time-of-Day Rate - Off-peak	100%	8,792	14,654	23,447	5,249	8,749	13,998	$262	$437	$700
Time-of-Day Rate - On-peak	100%	8,792	14,654	23,447	5,249	8,749	13,998	$262	$437	$700
Heat Pumps - Air-to-Air	190%	4,628	7,713	12,340	2,763	4,604	7,367	$138	$230	$368
Heat Pumps - Mini Splits	250%	3,517	5,862	9,379	2,100	3,499	5,599	$105	$175	$280
Heat Pumps - Geothermal	300%	2,931	4,885	7,816	1,750	2,916	4,666	$87	$146	$233
Natural gas		**GJ**			**CO_2e kg**			**Levy**		
Fireplace or Low Efficiency Appliances	70%	40.6	67.7	108.3	2,093	3,488	5,580	$105	$174	$279
Furnace/Boiler - Medium Efficiency	80%	35.5	59.2	94.8	1,831	3,052	4,883	$92	$153	$244
Furnace/Boiler - High Efficiency or Condensing	93%	30.6	51.0	81.5	1,575	2,625	4,200	$79	$131	$210

The emissions associated with each heating system and house depend on the emissions intensity of the energy source (as shown in Table 1). In a new house requiring 50 MBTU, the lowest emissions for each energy source range from 3,965 kg for an oil furnace with a condensing boiler, to 2,916 kg for an electric geothermal heat-pump, and 2,625 kg for a high-efficiency natural gas furnace.

In 2022-2023, the federal levy will be $50 per tonne of CO_2e. Not surprisingly, the lower a household's emissions, the lower the cost of the levy. This is apparent in houses using electricity for heating, the levy on an 80 MBTU can range from $233 for a house with a geothermal heat-pump to $823 for a house with radiant in-floor heating using an electric furnace.

The minimum and maximum carbon levy costs for the three house types are shown in Table 4. The lowest cost is $79 for a new R2000 home heating with a 93% efficient furnace burning natural gas, while the highest possible cost is $823 for a house requiring 80 MBTU using radiant in-floor heating.

Table 4: Minimum and Maximum carbon levy cost (from Table 3)

Carbon levy cost	New R2000 30 MBTUs	NEW - 50 MBTUs	OLD - 80 MBTUs
Minimum	$79	$131	$210
Maximum	$309	$515	$823

Domestic hot water

Figure 2 shows Nova Scotia's domestic hot water (DHW) heating stock in 2019, when over 97 percent of Nova Scotian households used either electricity (224,741 households or 49.5%) or heating oil (217,129 households or 47.8%). Both have been increasing steadily since 2000, although the number of households heating with oil increased by 36% compared to those using electricity, which increased by only 10.4%.

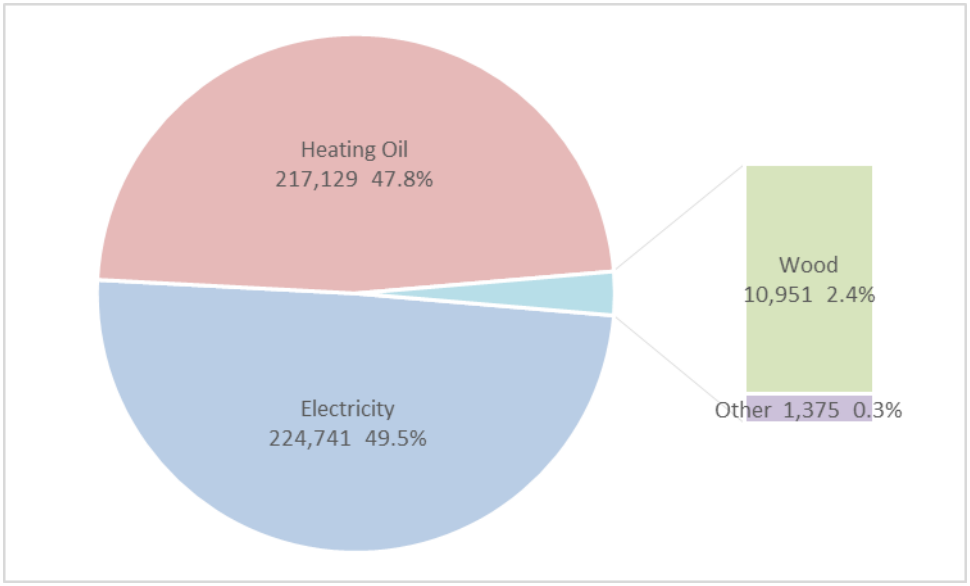


Figure 2: Domestic Hot Water stock for Nova Scotia in 2019
(Other includes coal, propane, and natural gas)

Despite the roughly even split between the number of households using electricity and heating oil, about 55.4% of the energy used for producing domestic hot water (DHW) came from heating oil and 37.7% from electricity, with the remainder produced by wood (6.8%) and less than one percent from other sources including natural gas. This gives an indication of the efficiency of the water heating systems.

As with space heating, a variety of factors affect the carbon cost of supplying a household with DHW: the number of people in the household, the water heating system used, and the efficiency of the system, as shown in Table 5. For example, in a two-person household, carbon costs range from $43 for a high-efficiency oil boiler to $80 for an old electric water heater, while in the six-person household, the costs range from $129 (high-efficiency oil boiler) to $240 (old electric water heater).

Natural gas was not included in the DHW analysis because of its limited penetration.

Table 5: DHW Carbon-levy costs
Seasonal (winter/summer) efficiencies assumes seven months for winter [Oct-Apr] and five months for summer [May-Sep] (System types and efficiency data from Efficiency Nova Scotia)

System type	Efficiency	Energy			Emissions			Levy		
		Two person	Four person	Six person	Two person	Four person	Six person	Two person	Four person	Six person
Electricity		kWh/year			t CO_2e/year			Levy		
Electric water heater - old	85%	2,675	5,350	8,026	1.60	3.19	4.79	$80	$160	$240
Electric water heater - new	90%	2,527	5,053	7,580	1.51	3.02	4.53	$75	$151	$226
Instantaneous heater	95%	2,394	4,787	7,181	1.43	2.86	4.29	$71	$143	$214
Oil		Litres/year			t CO_2e/year			Levy		
Stand alone water heater	55%	385	770	1,154	1.06	2.12	3.18	$53	$106	$159
Tankless coil - Winter	75%	282	564	847	0.78	1.56	2.33	$71	$143	$214
Tankless coil - Summer	25%	847	1,693	2,540	2.33	4.67	7.00			
High efficiency boiler - Winter	75%	282	564	847	0.78	1.56	2.33	$43	$86	$129
High efficiency boiler - Summer	60%	353	705	1,058	0.97	1.94	2.92			
Natural gas		GJ/year			t CO_2e/year			Levy		
Stand alone heater - conventional	55%	15	30	45	0.77	1.53	2.30	$38	$77	$115
Instantaneous heater	93%	9	18	26	0.45	0.91	1.36	$23	$45	$68
High efficiency boiler - Winter	90%	9	18	27	0.47	0.94	1.41	$24	$48	$72
High efficiency boiler - Summer	85%	10	19	29	0.50	0.99	1.49			

Lighting and Appliances

The third source of residential emissions is from lighting and appliances. These are indirect emissions in that most lighting sources and appliances used in Nova Scotia rely on electricity from Nova Scotia Power.

The average electricity consumption for lighting and appliances per person per household is estimated to be 2.3 MWh. The electricity consumption and carbon costs for a two-, four-, or six-person household are listed in Table 6. The costs range from $138 to $277, to $415, for the two-, four-, and six-person households, respectively.

Table 6: Lighting and appliances electricity consumption in Nova Scotia for 2019

	Two person	Four person	Six person
Consumption (MWh/yr)	4.64	9.28	13.91
Emissions (tonnes)	2.77	5.54	8.31
Levy	$138	$277	$415

Transport

In 2019, there was a total of 326,530 cars and 258,891 light trucks on Nova Scotia's roads. Between 2000 and 2019, the total number of cars and light trucks increased by 34.6%. Most of the growth occurred in light trucks, which increased by 89.2%, while cars rose by only 9.6%. As Figure 3 shows, the number of cars has been decreasing since the peak in 2011; all the growth has been due to light vehicles.

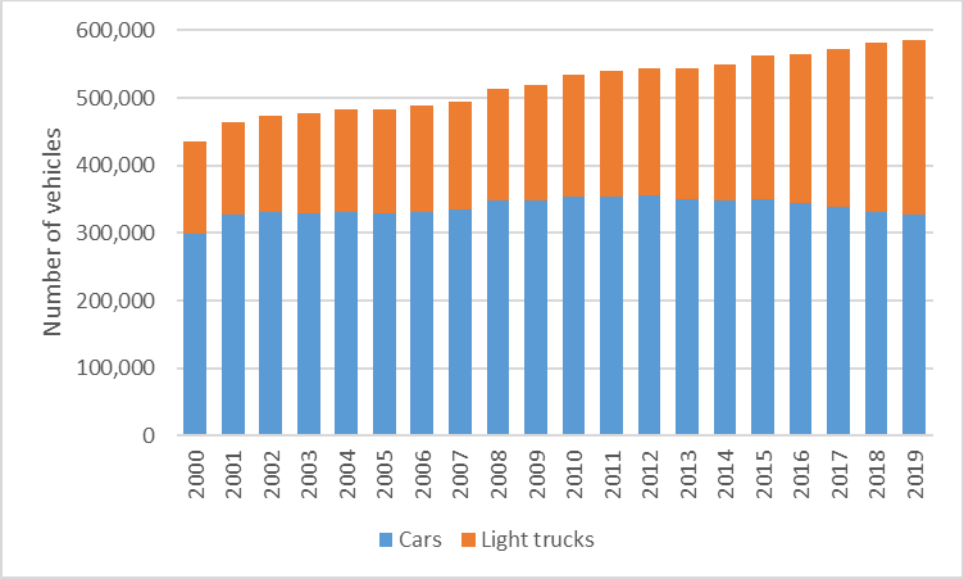


Figure 3: Nova Scotia volumes of cars and light trucks between 2000 and 2019

In Table 7, the average distance driven, fuel consumption, and estimated carbon cost are listed for cars and light trucks. Based on the average values, the expected carbon emissions for cars and light trucks will be 3.1 tonnes and 5.2 tonnes in 2023. The carbon costs will be $200 and $339 for a car and light truck, respectively.

Table 7: Vehicle data for 2019 and carbon prices

	Cars	Light trucks	Total	Weighted average
Stock	326,530	258,891	585,421	
Average annual distance (km)	21,068	22,205		21,571
Fuel consumption (L/100km)	6.3	10.1		8.0
Estimated annual consumption (L)	1,327	2,248		1,724
Fuel emissions (kg/L)	2.32	2.32		2.32
Total emissions (t)	3.1	5.2		4.0
2023 Cost per vehicle ($65/tonne)	$153	$259		$199

Since the type of vehicle driven by a household is not known, the vehicle used in the carbon cost estimates is based on a weighted average of the distance driven and fuel consumption of the cars and light trucks there are in the province. The hypothetical vehicle would emit 4 tonnes and have a carbon cost of $200 in 2022-2023.

There were 0.60 vehicles per person in Nova Scotia in 2019. The number of vehicles per household is assumed to be 1.2, 2.4, and 3.6, for the two-, four-, and six-person households, respectively.

Application of 2022-2023 carbon price

The cost of a household's carbon emissions is the sum of the carbon costs for the household's space heating emissions, domestic hot water emissions, lighting and appliance emissions, and transport emissions.

Using the data described in the previous sections, carbon costs are estimated for 36 different household combinations where:

- A household consists of two, four, or six people.
- Heating demand is either 30, 50, or 80 MBTU, and is met by one of fuel oil, electricity, or natural gas.
- Domestic hot water demand is met by oil or electricity and determined by the number of people in the household.
- Electricity demand for lighting and appliances is based on the number of people in the household.
- Private transportation for households assumes one vehicle for every two people.

The carbon price is applied to the minimum and maximum emissions from space heating and domestic water heating, lighting and appliances, and transportation for three different household sizes (two, four, and six people). The combinations are summarized in Table 8, where:

- Minimum space heating carbon costs refer to the high-efficiency natural gas boilers.
- Maximum space heating carbon costs refer to radiant in-floor heating.
- Minimum water heating carbon costs refer to the high-efficiency oil boilers.
- Maximum water heating carbon costs refer to old electric water heaters.

Table 8: Interpretation of carbon cost combinations

Combination	Space Heating for 30, 50, 80 MBTU Systems	Domestic Hot Water for 2, 4, or 6 people	Lighting and Appliances for 2, 4, or 6 people	Transportation for 2, 4, or 6 people
Min-Min	Minimum space heating cost for each system type.	Minimum DHW heating cost for number of people	Number of people in household	Number of people in household
Min-Max	Minimum space heating cost for each system type	Maximum DHW heating cost for number of people		
Max-Min	Maximum space heating cost for each system type	Minimum DHW heating cost for number of people		
Max-Max	Maximum space heating cost for each system type	Maximum DHW heating cost for number of people		

The ranges of carbon costs for different family sizes and heating systems are now examined. The results are an estimate, intended to show the range of possible carbon costs for different sized households based on their energy requirements.

Two-person family household

The emissions for a two-person household assume the use of one vehicle and the lighting and appliance energy requirements for two people. The DHW emissions for two people depend on the type of water heating system used, while the space heating emissions depend on the heating system and assume one of the three household heating demands.

As shown in Figure 4, the carbon costs to the household in 2022-2023 range from $499 (minimum space and water heating emissions) in the 30 MBTU house to $1,126 (maximum space and water heating emissions) in the 80 MBTU house.

In the lowest carbon cost household (Min-Min), the dominant cost is transportation ($238), whereas in the highest carbon-cost household (Max-Max), the dominant cost is space heating ($669). In all cases, transportation is the principal cost when the space heating costs are at a minimum.

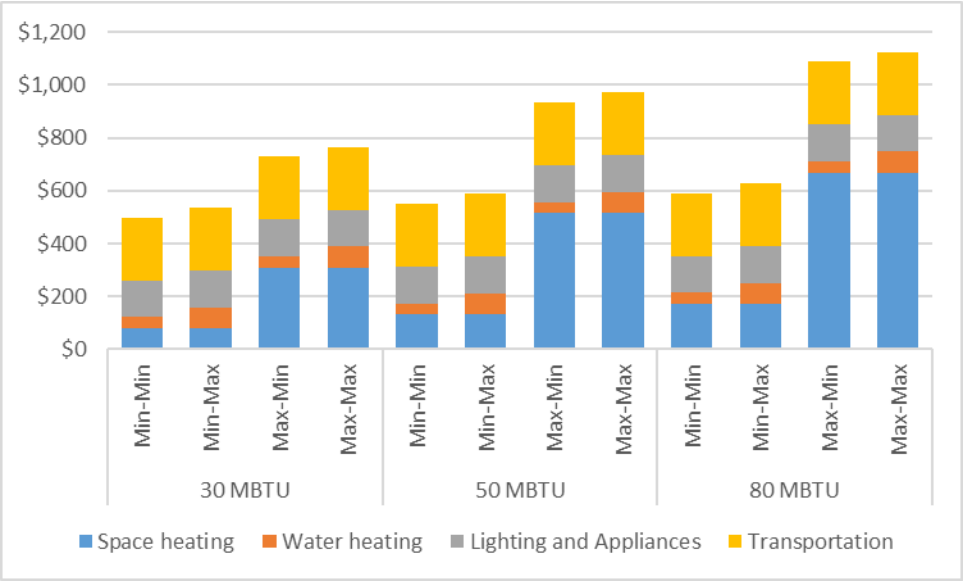


Figure 4: Carbon costs for a two-person family household

Four-person family household

Increasing the size of the household increases the emissions from water heating, lighting and appliances, and transportation. Space heating emissions remain unchanged because the building's energy demand, and hence emissions, remain constant, regardless of the number of people in the household.

In a four-person household, carbon costs range from $918 in the 30 MBTU Min-Min household to $971 in the 50 MBTU Min-Min household and $1,010 in the 80 MBTU Min-Min household (see Figure 5). The highest overall carbon cost of $1,582 is in the Max-Max 80 MBTU case.

In the household with a 30 MBTU space heating demand, transportation costs of $477 for two vehicles exceeds the maximum space heating emissions cost of $309. In the 50 MBTU household with the maximum heating system, the heating system carbon cost of $515 exceeds the two-vehicle transportation cost.

Transportation carbon costs also exceed the minimum space heating carbon costs in an 80 MBTU household of $171. Transportation carbon costs are exceeded in the maximum carbon cost case where the space heating cost is $669.

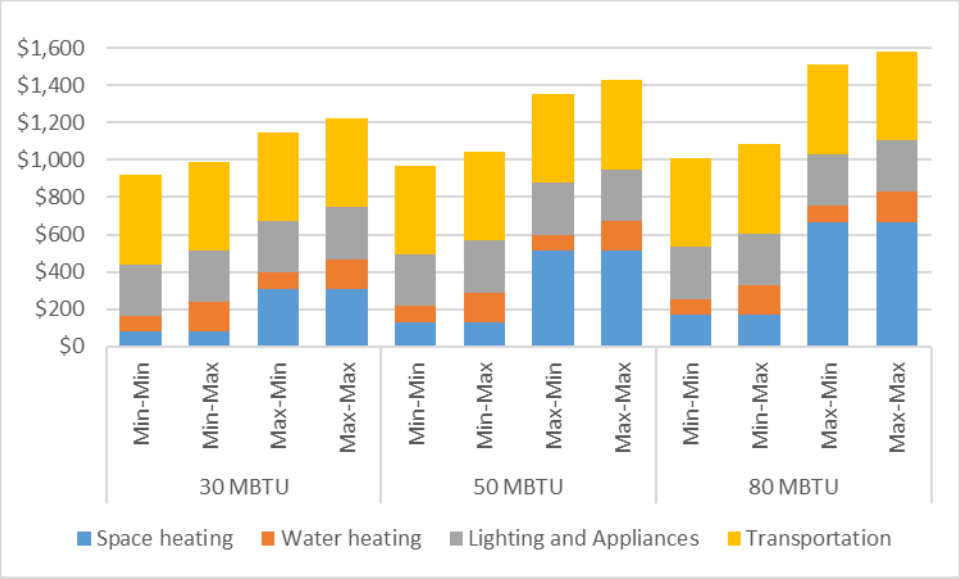


Figure 5: Carbon costs for a four-person family household

Six-person family household

In Figure 6, household carbon costs for the six-person household are shown; they range from $1,338 (Min-Min household) to $2,039 (Max-Max household).

The principal cause of the increasing carbon cost in the six-person household is the result of an increase in the consumption of electricity for lighting and appliances and gasoline for transportation for the increase in the number of vehicles.

In the 30 MBTU household, the carbon costs for lighting and appliances ($415) and transportation ($715), exceeds the minimum and maximum carbon costs for both space heating ($79 to $309) and DHW ($129 to $240). In fact, the carbon cost of transportation in the six-person household exceeds the carbon cost of space heating in all cases, including when the house is subject to the maximum carbon cost for 80 MBTU of heat ($669).

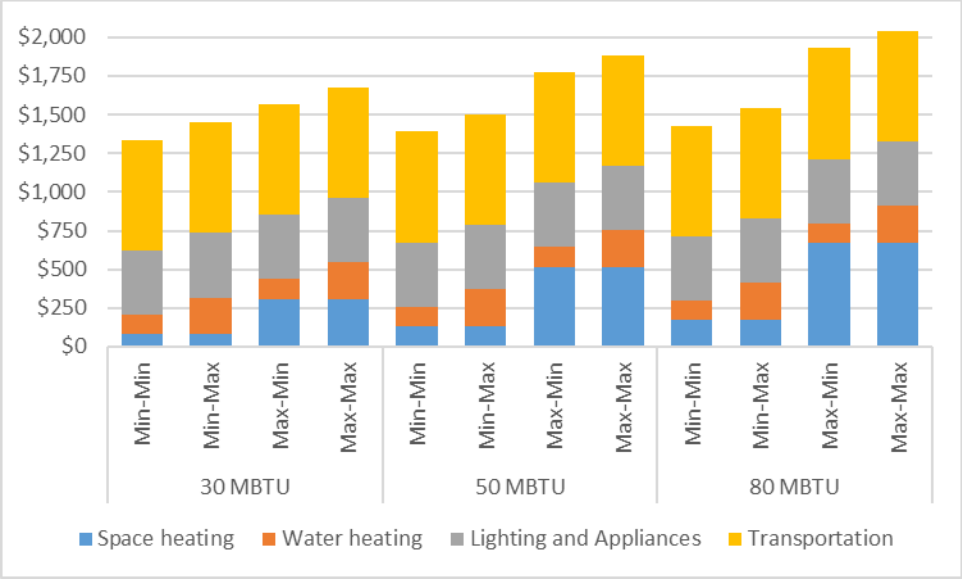


Figure 6: Carbon costs for a six-person family household

Application of the Climate Action Incentive in Nova Scotia

Presently, four provinces are subject to the federal carbon pricing program: Ontario, Manitoba, Saskatchewan, and Alberta. Qualifying residents in these provinces receive a Climate Action Incentive (CAI) payment which offsets part of, or exceeds, their carbon costs.

For 2022-23, the carbon price is $50 per tonne of emissions. The federal government is to issue Climate Action Incentive payments (CAIP) quarterly, as is done with the HST rebate. This redresses a shortcoming in the original CAIP which was paid annually between 2018 and 2022.

The CAIPs vary by province, the composition of the household, the size of the household, and the expected annual energy use and emissions of the household. The payments are issued quarterly.

The size of payments vary by the number of people living in the household: payments for a single adult (Table 9), exceeds that of the second person (adult or first child of a single parent) in the household (Table 10), and the amounts paid for each child (Table 11).

Table 9: CAIP for a single adult (or first adult in a couple) for 2022-23

Payment date	ON	MB	SK	AB
July 2022 (Double-Up)	$186.50	$208.00	$275.00	$269.50
Oct-22	$93.25	$104.00	$137.50	$134.75
Jan-23	$93.25	$104.00	$137.50	$134.75
Total	$373	$416	$550	$539

Table 10: CAIP for a second adult in a couple (or first child of a single parent) for 2022-23

Payment date	ON	MB	SK	AB
July 2022 (Double-Up)	$93.00	$104.00	$137.50	$135.00
Oct-22	$46.50	$52.00	$68.75	$67.50
Jan-23	$46.50	$52.00	$68.75	$67.50
Total for 2022-23	$186	$208	$275	$270

Table 11: CAIP for each child under 18 (starting with the second child for single parents) for 2022-23

Payment date	ON	MB	SK	AB
July 2022 (Double-Up)	$46.50	$52.00	$69.00	$67.50
Oct-22	$23.25	$26.00	$34.50	$33.75
Jan-23	$23.25	$26.00	$34.50	$33.75
Total	$93	$104	$138	$135

The energy sources used by a household and availability of different energy sources are not considered when determining the CAIP.

The differences in CAIP are significant, with households in Ontario receiving the lowest payment and those in Saskatchewan, the highest (Table 12). For example, the difference in payments between the two provinces for a two-person household is $177 and a six-person household, $446.

Table 12: CAIP by household size for 2022-23

Household composition	Size	ON	MB	SK	AB
One adult	1	$373	$416	$550	$539
Two adults or one adult plus child	2	$559	$624	$825	$809
Two adults plus two children	4	$745	$832	$1,101	$1,079
Two adults plus four children	6	$931	$1,040	$1,377	$1,349

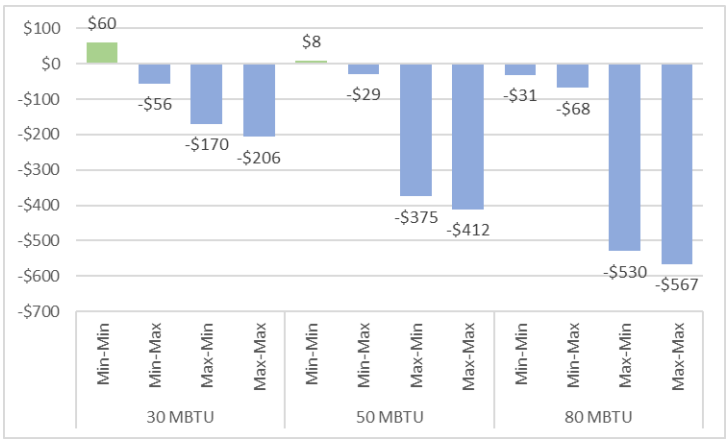
As an example, if the carbon-costs of a two-person household in Ontario were $259, the CAIP would be $559, and the household would have a gain of $300. However, if a different two-person household in Ontario had carbon costs of $859, the household would experience a loss of $300.

We now compare the 2022-23 CAIPs for Ontario and Saskatchewan with Nova Scotia's sample residential carbon costs for 2022-23.

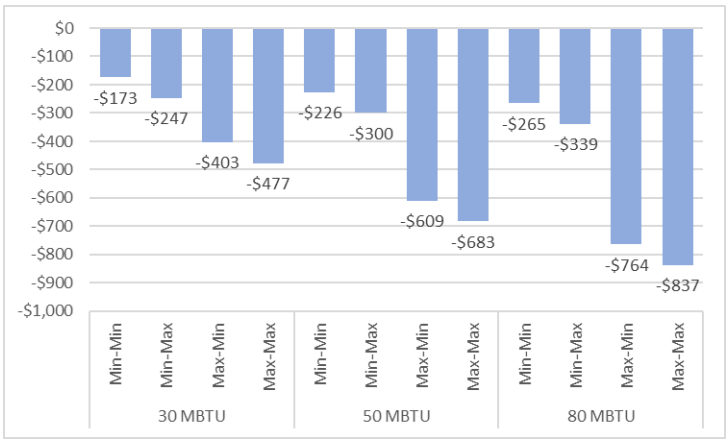
Ontario

If Nova Scotians paid the federal carbon price on their residential energy use and the 2022-23 Ontario-level CAIP was in effect, most of the household combinations examined in this report would be out-of-pocket.

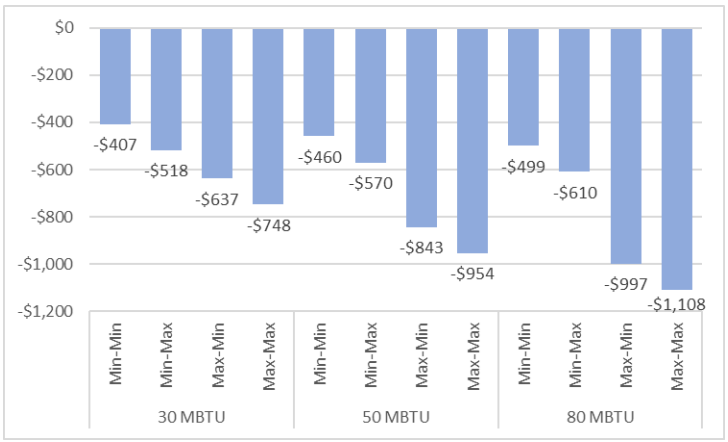
The range of impacts is shown in Figure 7. In the two-person household, a 30 MBTU house using the most efficient heating system and DHW system would range from a $60 gain to a loss of $567 in an 80 MBTU house using the least efficient heating and DHW systems. The greatest losses would be in the six-person households, with losses ranging from $407 for a 30 MBTU house with the most efficient heating and DHW systems, to $1,108 for an 80 MBTU house with the least efficient systems.



Two-person household



Four-person household



Six-person household

Figure 7: Impact on Nova Scotian households after application of Ontario-level CAIP

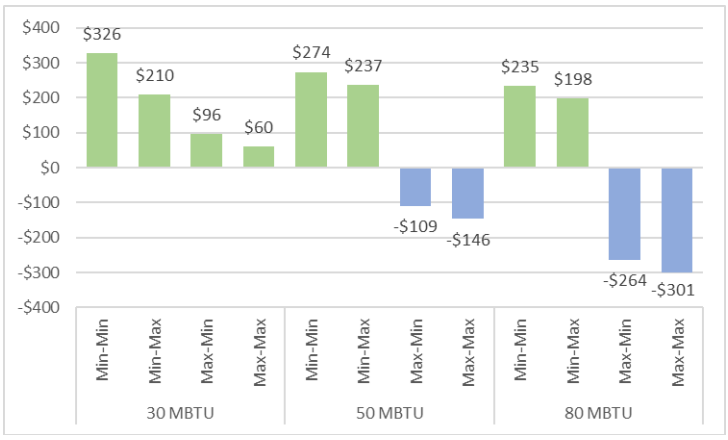
Saskatchewan

The Saskatchewan CAIP is considerably greater than Ontario's, so the impact on Nova Scotian households would be less with the application of Saskatchewan's CAIP.

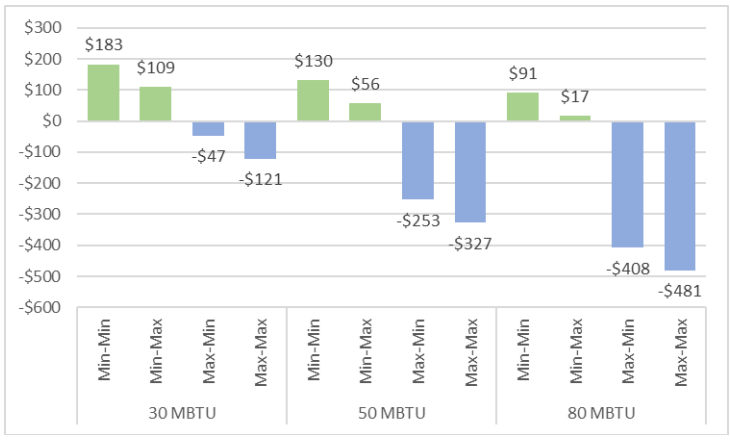
Figure 8 shows the impact of the Saskatchewan CAIP on Nova Scotian households. Most two-person households would experience a gain of between $60 and $326, with some households experiencing a loss ranging from $109 to $301.

As the number of people in the household increases, the impacts of the carbon cost become more apparent, despite the CAIP. In the four-person household scenarios, households using the most efficient heating systems (Min-Min and Min-Max), receive a gain of between $17 and $183. However, households with inefficient heating systems suffer losses of between $47 and $481.

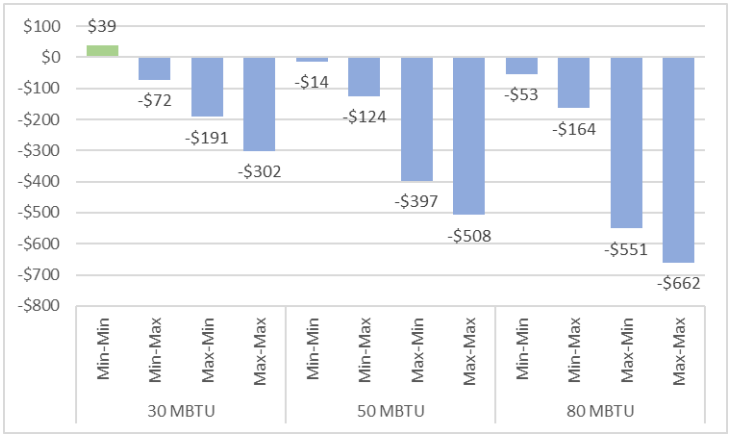
In the six-person households, except for the 30 MBTU house using the most efficient heating and DHW systems which experience a gain of $39, all others face a loss because of their carbon cost. The losses range from $72 to $662.



Two-person household



Four-person household



Six-person household

Figure 8: Impact on Nova Scotian households after application of Saskatchewan-level CAIP

Discussion

The report has shown the impact of the carbon price on different combinations of household energy systems, family sizes, and vehicle usage. The numbers are meant to be representative. They would change in different situations, such as the size of the house, a colder or warmer winter, a change in the number of vehicles used by a household, driving habits, differences in water usage, and the number and type of appliances.

The differences in provincial Climate Action Incentive payments can be attributed to the emissions intensity of the energy systems available in each province (see Table 13):

- 52% of Nova Scotian households use heating oil for heating, which has a higher emissions intensity than natural gas, which is used in 67.5% of Ontario homes and 92.5% of Saskatchewan homes.
- Households in all three provinces use electricity for space heating. In Ontario, 12.6% use electricity, whereas in Nova Scotia it is 21.8%. Since Ontario relies heavily on nuclear and hydroelectricity for its power, its emissions intensity is 28 kg/MWh, while in Nova Scotia, which is still heavily reliant on coal for its power, has an emissions intensity of 670 kg/MWh.
- As with space heating, Nova Scotians rely on emissions-intensive energy sources such as electricity (49.5%) and heating oil (47.8%) for their DHW, whereas three-quarters of Ontario households use

natural gas and 20% use low-emissions electricity, while in Saskatchewan, DHW is almost exclusively natural gas.

- In transportation, Nova Scotian vehicles (both cars and light trucks) are driven greater distances than in either Saskatchewan or Ontario. This results in more emissions per vehicle.

Table 13: Comparison of residential energy systems
(Data sources: NRCan Office of Energy Efficiency and National Inventory Report - Electricity)

Service	System	ON	SK	NS
Space heating systems	Heating oil	6.2%	3.3%	52.2%
	Natural gas	67.5%	92.5%	1.7%
	Electric	12.6%	5.0%	21.8%
	Heat Pump	6.7%	2.8%	4.9%
	Other (Propane and Coal)	1.1%	1.5%	1.7%
	Wood	1.0%	1.8%	3.7%
	Dual wood	4.9%	2.1%	14.1%
DHW heating systems	Electricity	20.4%	13.3%	49.5%
	Natural Gas	75.1%	85.8%	0.0%
	Heating Oil	2.8%	0.5%	47.8%
	Coal and propane	0.7%	0.2%	0.3%
	Wood	1.0%	0.2%	2.4%
Lighting and Appliances	Lighting (GJ/HH)	3.1	4.3	3.7
	Appliances (GJ/HH)	11.9	16.1	15.9
Emissions intensity for electricity (kg/MWh)		28	620	670
Transportation	Cars (km)	16,704	16,724	21,068
	Light trucks (km)	17,540	17,475	22,205

A provincial or territorial CAIP is determined from the carbon costs paid by those living in the region and collected by the federal government. The energy sources available in Nova Scotia and used by Nova Scotians should result in the federal government collecting more per household in Nova Scotia than in other provinces. This should mean a higher CAIP for Nova Scotian households, more in line with Saskatchewan's than Ontario's.

If this occurs, some Nova Scotians will benefit because the CAIP exceeds their carbon costs. However, Nova Scotians whose CAIP does not cover their carbon costs will experience a loss.

The purpose of the CAIP is to encourage individuals and households to "take action" to either:

- *Reduce* their energy consumption.

  Reducing energy consumption will, depending on the energy source, reduce emissions, and reduce the household's carbon costs.

  Nova Scotia's main sources of emissions are space heating and transportation. Energy demand for space heating and transportation can be reduced through conservation measures such as using less energy for space heating and driving less, respectively. Conservation measures are typically short-term and do not address the system's underlying structural problems. A household reducing its energy consumption might reduce energy costs or emissions, or both, but could have health (lack of warmth during the winter) or economic (if they are unable to get to their place of employment) consequences.

Energy demand for space heating can also be reduced through home retrofits; for example, adding insulation and upgrading windows. There are programs in place to help Nova Scotians financially to reduce their energy consumption. Households that do not meet the eligibility requirements would be at a disadvantage.

Reducing energy demand for transportation can be achieved by altering driving habits and following suggestions for making the vehicle more fuel efficient. Using an alternate form of transportation is only possible if it exists. Many Nova Scotians who live in rural areas would be at a disadvantage; however, the CAIP recognizes this and increases the payment by 10% in certain areas of a province.

- *Replace* either:

  a) The energy sources an energy system currently use to one that is less carbon intensive, or

  b) The system that converts the energy presently used to one that is less carbon intensive.

  Solar photovoltaic panels (PVs) are an example of a replacement action which replaces an energy source (electricity from Nova Scotia Power) but uses the energy in the same way. Households that have taken advantage of the province's net metering program benefit from this.

  Replacing incandescent bulbs with LEDs is an example of using a new energy system (LEDs) using the same energy source (electricity). Similarly, replacing a gasoline vehicle with a hybrid electric vehicle still uses gasoline, but the conversion process is different.

- *Restructure* their energy use by changing both:

  a) The energy sources they use to ones that are less carbon intensive, and

  b) The system that converts the energy to use the new energy sources.

  Nova Scotia Power is restructuring its energy system, from coal and oil to an increasing reliance on renewables and natural gas. Ideally, the financial impact of Nova Scotia Power's restructuring will be less than the carbon price, reducing the carbon cost associated with electricity for all Nova Scotians.

  As the emissions intensity of electricity declines and the carbon price increases, it is highly likely that Nova Scotians will restructure their heating and DHW systems to electric, away from oil.

  Some households are restructuring their transportation system by replacing their gasoline-powered vehicle for one that is fully electric.

Apart from energy demand reduction caused by non-monetary conservation measures, all these actions require a household to make an expenditure which could be beyond their means. This could lead to a positive feedback loop, with the household unable to pay for an emissions reduction action because the cost of the federal carbon price is increasing. Ideally, households falling into this category would qualify for programs to offset the cost of home energy retrofits.

However, transportation is a different matter. Provincial governments have programs to offset part of the cost of an electric vehicle for those who can afford an electric vehicle. However, the present lack of both public charging infrastructure and a supply of affordable electric vehicles will mean that Nova Scotians will continue paying the carbon costs for their use of gasoline and other transportation fuels through no fault of their own. Moreover, the lack of vehicle sales information from the province makes sales and ownership difficult to determine.

There is another less discussed problem with the CAIP. As more households reduce their emissions by reduction, replacement, or restructuring actions, the available funds to pay the province's CAIP will

decrease. If the CAIP is not targeted at the households most affected by the price on carbon, those less affected by it will still receive a portion of an ever-shrinking fund.

The CAIP program attempts to address these problems by determining the level of payments based on income: high-income households receive less than low-income ones. This assumes that high-income households will respond to carbon price signals by restructuring their energy use. It also assumes that a household receiving a CAIP which exceeds its carbon costs will put the payment into low-carbon alternatives. However, this only works if low-carbon alternatives are both available and affordable to all households, and households do not use the CAIP on activities other than low-carbon alternatives.

At present, the CAIP is based on an estimate of Nova Scotia's carbon emissions for the upcoming year. If the estimate is low (for example, because of an unexpectedly cold winter), the carbon price could be an unjustifiable burden on low-income households with high energy demands.

In the event a low-income household's CAIP is unable to cover its carbon costs, a mechanism should be available to cover the losses.[3,4] Ideally, any such funds would come from the monies collected for the CAIP. However, it would mean estimating an individual household's emissions:

- Any emissions from a household using electricity to meet some combination of space heating, DHW, and lighting and appliance needs can be determined with a fair degree of accuracy using Nova Scotia Power's emissions intensity, since the company knows both its energy mix and each household's electricity consumption.
- If a record of a household's consumption of fuel oil or natural gas for space heating or DHW is available, it can be used to estimate the household's emissions. If, in the case of fuel oil, records are not available, an approximation could be determined from, for example, neighbouring households, past records, or fuel consumption data for households with similar heating systems.
- Vehicle emissions can be estimated from annual distance driven using past odometer readings, and the age and type of vehicle.

The CAIP is paid in advance, based on an assumed level of emissions for all households, regardless of the types of energy used. If household emissions could be estimated beforehand, CAIP could be tailored to individual households. A more difficult, but fairer and more equitable approach.

Summary

The Nova Scotia government's protests notwithstanding, Nova Scotians will be subject to the federal carbon pricing system starting in 2023. Based on what has happened in other provinces, a properly priced CAIP should mean that most Nova Scotian households will not be subject to losses because of their carbon costs. Higher-income households should not benefit from CAIP.

Nova Scotia's high residential carbon emissions are due to the carbon-intensive energy sources used for space heating and transportation. As Nova Scotia Power decarbonizes, electricity will become less emissions-intensive, making it a more attractive fuel for space heating, DHW, and for those who can afford an electric vehicle, transportation.

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[3] Households that face hardships because of carbon pricing should be referred to organizations that can take action to reduce their energy consumption and consequently, their energy and carbon costs.

[4] This is similar to Nova Scotia Power's Fuel Adjustment Mechanism (FAM), which adjusts power rates to reflect the actual costs of the fuel used rather than a forecast.

Although natural gas results in the lowest emissions for space heating and DHW, the lack of access to natural gas in most of the province means it is unlikely it will reduce the carbon costs for many more households than it already does.

Increasing the number of occupants in a household increases the CAIP, but it also increases the consumption of energy. If the energy is emissions intensive, the carbon cost of this energy could offset any potential gains from the larger CAIP.

The report has shown that because of the high-emissions energy sources used by Nova Scotians, the province's CAIP will need to exceed that of Saskatchewan. It will also be necessary to ensure that large energy-intensive households, regardless of their size, are not unduly penalized, especially if they are low- or middle-income.

While it is understandable that the provincial government objects to Nova Scotian households being required to pay the federal backstop carbon price, we will be subject to it, so the province should make it a priority to modify the CAIP so that the impact of the carbon cost does not unduly burden low-income Nova Scotians, especially if low-emissions households continue to benefit from it.

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