Energy Futures

Cost-Effectiveness Analysis of BC Residential Heat Pump Rebate Programs

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About the Energy Futures Institute

The Energy Futures Institute is a Resource Works-led project that is bringing a fresh perspective to discussions surrounding the future of energy in British Columbia. Having launched in December 2023, Energy Futures is exploring some of the greatest challenges facing British Columbia's energy security, affordability and independence, answering the big questions on how we meet BC's growing energy demand while protecting our environment, not just today but for the coming decades and centuries ahead. Energy Futures is led by former BC cabinet minister Barry Penner. Penner served as BC's Minister of Environment (and introduced BC's first climate plan), Minister of Aboriginal Relations and Attorney General during his four terms as a MLA. Penner represented Chilliwack in the BC Legislature from 1996 to 2012.

About The Author

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Executive Summary

This report assesses the cost-effectiveness of two British Columbia residential heat pump rebate programs in reducing greenhouse gas (GHG) emissions. It calculates the cost per tonne of carbon dioxide equivalent (tCO_2e) abated over a 15-year lifespan for rebates that replace natural gas heating systems with either (a) fully electric heat pumps or (b) dual-fuel heat pump/natural gas systems.

Scenario	GHG Reductions (tCO_2e, 15 yrs)	Full Cost per tCO_2e	Comparison to Social Cost of Carbon ($271)	Comparison to former Carbon Tax ($80)
Dual-Fuel Heat Pump	29.17	$269	Approx. Equal	Above
Electric Heat Pump	41.65	$573	Above	Above

While the electric heat pump scenario results in greater total emissions reductions, the dual-fuel option is significantly more cost-effective relative to both carbon pricing benchmarks. Its cost approaches the Social Cost of Carbon, making it a more viable candidate for cost-effective climate policy. In contrast, the electric heat pump rebate exceeds both benchmarks and is not cost-effective based on this criterion.

1. Introduction

This report evaluates the cost-effectiveness of two heat pump rebate programs in British Columbia in terms of greenhouse gas (GHG) emissions reduction. The analysis examines the following scenarios:

- Natural Gas to Electric Heat Pump
- Natural Gas to Dual-Fuel Heat Pump

For each scenario, we calculate the GHG emissions abated over a 15-year equipment lifetime and determine the cost per tonne of carbon dioxide equivalent (tCO_2e) abated.

2. Analysis of Rebate Programs

2.1 Scenario 1: Natural Gas to Electric Heat Pump

Table 1: Key Variables and Assumptions

Variable	Value	Source
Annual heating demand	52 GJ/year	Natural Resources Canada[1]
Natural gas furnace efficiency	92%	Universal Plumbing and Heating[2]
Natural gas emission factor	0.050 tCO_2e/GJ	Government of BC[3]
Heat pump seasonal COP	2.68	BC Hydro[4]
BC electricity emission factor	0.0099 $kgCO_2e$/kWh	Government of BC[5]
Conversion factor	1 GJ = 277.78 kWh	Fixed
Heat pump lifespan	15 years	BC Hydro[6]
Rebate amount	$16,000	CleanBC[7]
Free-rider rate	33%	BC Hydro[8]

While CleanBC's Energy Savings Program offers up to $24,500 in total rebates, this analysis uses a rebate amount of $16,000 to better reflect overall program costs. Additional amounts are available for specific situations such as northern residents or homes requiring electrical service upgrades, while lower tiers apply to income-tested applicants.

Table 2: GHG Emissions Comparison

System	Annual Energy Input	Annual GHG Emissions	15-Year Cumulative Emissions
Natural Gas Heating	56.52 GJ	2.83 tCO_2e	42.45 tCO_2e
Electric Heat Pump	5,390 kWh	0.053 tCO_2e	0.80 tCO_2e

Results:

- Total emissions saved over 15 years: 42.45 – 0.80 = 41.65 tCO_2e
- Baseline cost per tonne: $16,000 ÷ 41.65 = $384 per tCO_2e
- Free-rider adjusted cost: $384 ÷ (1 – 0.33) = $573 per tCO_2e
  (Note: Adjusted for 33% free-riders. Details in Section 3.2.)

2.2 Scenario 2: Natural Gas to Dual-Fuel Heat Pump

Table 3: Key Variables and Assumptions

Variable	Value	Source
Annual heating demand	52 GJ/year	Natural Resources Canada[1]
Natural gas furnace efficiency	92%	Universal Plumbing and Heating[2]
Natural gas emission factor	0.050 tCO_2e/GJ	BOABC Step Code Handbook[3]
Heat pump seasonal COP	2.68	BC Hydro[4]
BC electricity emission factor	0.0099 $kgCO_2e/kWh$	Government of BC[5]
Dual-fuel split	70% HP, 30% gas	See Section 3.1
Conversion factor	1 GJ = 277.78 kWh	Fixed
Heat pump lifespan	15 years	BC Hydro[6]
Rebate amount	$5,250	See Note on Rebate Amount below
Free-rider rate	33%	BC Hydro[8]

FortisBC offers a base $5,000 rebate for homeowners switching from natural gas heating to a dual-fuel system (heat pump and natural gas). Additional incentives include a $3,000 top-up for northern residents and smaller rebates for related upgrades.[9] An average of $5,250 is used (details in Section 3.2).

Table 4: GHG Emissions Comparison

System	Annual Energy Input	Annual GHG Emissions	15-Year Cumulative Emissions
Natural Gas Furnace	56.52 GJ	2.83 tCO_2e	42.45 tCO_2e
Dual-Fuel System	16.96 GJ (gas), 3,773 kWh (electric)	0.885 tCO_2e	13.28 tCO_2e

Results:

- Total emissions saved over 15 years: 42.45 – 13.28 = 29.17 tCO_2e
- Baseline cost per tonne: $5,250 ÷ 29.17 = $180 per tCO_2e
- Free-rider adjusted cost: $180 ÷ (1 – 0.33) = $269 per tCO_2e

3. Comparative Analysis

Table 5: Comparison to the Former BC Carbon Tax and Federal Social Cost of Carbon

Rebate Program	Cost per tCO_2e Abated	Former BC Carbon Tax ($80)	Federal SSC ($271)[10]
Natural Gas to Electric Heat Pump	$573	Above	Above
Natural Gas to Dual-Fuel Heat Pump	$269	Above	Approx. equal

The former BC carbon tax, set at $80 per tonne of CO_2e (eliminated on April 1, 2025), reflected what the province was willing to pay to avoid an additional tonne of CO_2e, serving as a practical policy-based price signal. The federal Social Cost of Carbon (SCC), estimated at $271 per tonne of CO_2e for 2025, attempts to capture the broader, long-term economic and non-market damages from one additional tonne of emissions. However, its value is controversial because the assumptions used to calculate it, like the discount rate and damage functions, are highly sensitive.[11]

A simple rule-of-thumb for interpreting rebate costs:

Against the Carbon Tax: If the cost per tCO_2e > $80, the program is less cost-effective than the tax. This means it costs more than what BC previously accepted as a fair price for abatement, making it harder to justify the cost on economic efficiency grounds.

Against the SCC: If the cost per tCO_2e < $271, it suggests the program may generate net societal benefits by avoiding greater economic damages than its cost. However, given the uncertainties in how the SCC is calculated, this should be considered a possible, but not definitive, justification.

- Natural Gas to Dual-Fuel Heat Pump: At $269/$tCO_2e$, this cost is approximately equivalent to the SCC but well above the carbon tax. It suggests the costs equal the benefits from avoided damage, though it is more expensive than what BC previously accepted.
- Natural Gas to Heat Pump: At $573/$tCO_2e$, this cost exceeds both benchmarks, indicating it is costly both relative to past carbon pricing and estimated climate damages, and is difficult to justify based on cost-effectiveness alone.

3.1 Assumptions for Dual-Fuel System

The analysis assumes a 70%/30% operational split between heat pump and natural gas usage. This reflects typical system performance in BC's climate, where heat pumps can meet heating needs down to 2–5 °C.[9] The natural gas furnace supplements during colder periods when heat pump efficiency declines. While performance will vary by home, the 70/30 ratio represents a reasonable average for modeling purposes.

3.2 Limitations and Uncertainties

Behavioural Rebound Effects. This analysis assumes constant heating demand post-retrofit (52 GJ annually). In reality, lower heating costs may lead to increased energy use, for instance, heating more rooms or raising indoor temperatures. Studies estimate that direct rebound effects reduce net savings by 10%.[12] Additionally, new air conditioning use may arise in homes without prior cooling. While the GHG impact of such changes is likely small due to BC's electricity having a relatively low GHG profile, these effects are excluded, and the results should be seen as best-case estimates.

Further, some portion of the energy cost savings may be spent on other goods or services that indirectly result in emissions (indirect rebound). While difficult to quantify precisely, total rebound (direct and indirect) may reduce GHG savings by up to 20% in some contexts.[12]

Free-Rider Adjustment. A 33% free-rider rate is applied, meaning one-third of rebate recipients are assumed to have adopted the upgrade without incentives. This adjustment is based on BC Hydro Demand-Side Management (DSM) program evaluations. While necessary for accurate attribution, free-rider rates may differ by income, region, or market dynamics.

Rebate Amount Variability. The rebate values used ($16,000 for electric, $5,250 for dual fuel) represent the best estimate of typical program costs but may vary by region, income level, and upgrade needs. These values are simplified averages and do not reflect all cases.

Dual-Fuel System Usage Split. The 70/30 operational split used for modeling is an informed estimate. Real-world use may vary depending on thermostat settings, user preferences, and regional climate. If heat pump utilization is lower than assumed, emissions reductions and cost-effectiveness would both be negatively affected.

4. Conclusion

This analysis finds that both heat pump rebate programs reduce emissions from natural gas heating but differ substantially in cost-effectiveness. The dual-fuel program reduces emissions at a cost of approximately $269 per tonne of CO_2e, just below the federal SCC benchmark of $271, suggesting it may be possibly justified as a climate mitigation measure.

In contrast, the fully electric heat pump rebate program delivers greater absolute emissions reductions per household but at a significantly higher cost, $573 per tonne, exceeding both the SCC and BC’s former carbon tax benchmark of $80 per tonne.

Given limited program budgets, the dual-fuel rebate appears to offer a more cost-effective use of public funds. Policymakers could consider continuing this program while exploring alternative approaches to residential electrification that achieve similar emission reductions at a lower cost per tonne.

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