Help Cities Lead: Impact Modelling of Five Initiatives to Reduce Building Sector Greenhouse Gas Emissions

December 2020

Prepared for the
BC Hydro Community Energy Manager Network

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ACKNOWLEDGEMENTS

We would like to acknowledge the local government project team for their guidance and collaboration in not only developing the study scope but also for providing valuable ongoing feedback throughout the entire study. This committee included:

- Maya Chorobik, Community Energy Association
- Nikki Elliot, Capital Regional District
- Matt Horne, City of Vancouver
- Anastasia Lukyanova, City of Powell River
- Laura Sampliner, City of Port Moody
- Robyn Webb, City of Victoria

We would also like to acknowledge the contribution of the BC Hydro Community Energy Managers Ideation initiative and others who provided valuable feedback and context to support this work.

AUTHORSHIP

This report was prepared by Integral Group.

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INTRODUCTION

The Government of British Columbia has set legislated targets to reduce province-wide greenhouse gas (GHG) emissions by 40% from 2007 levels by 2030 and 80% by 2050. Building-sector emissions account for about 11 per cent of British Columbia's total GHG inventory. The sector is the third-highest contributor following road transportation (27.1%) and the oil and gas sector (17.6%). At the local government level, emissions from existing buildings contribute between 40 and 60% of community emissions.[i] [ii]

A number of BC local governments have established ambitious targets of their own to significantly reduce GHG emissions from buildings. However, while the Provincial Government's success in achieving deep building-sector emissions reductions hinges on the success of local governments to achieve their targets, local governments are significantly constrained in doing so. With the exception of the City of Vancouver, which is regulated under Vancouver Charter, the Local Government Act prohibits local governments from enacting their own building regulation, limiting them to the use of informational campaigns, incentives, and other voluntary measures to encourage emissions reductions from the building sector.

Given the constraints on local government action and the current inability of existing provincial policies to achieve the province's emissions targets, local governments are asking for additional provincial action. A new suite of policy actions is being promoted by BC's *Help Cities Lead* initiative[iii], a coalition of local government representatives and non-governmental organizations who have come together to encourage the Provincial Government to expand the authority of local governments to achieve GHG reductions in their building sector.

Purpose of the Report

This report demonstrates the greenhouse gas savings potential of the suite of five policy actions advanced by *Help Cities Lead* if adopted province wide. The five key measures encompass:

1. Mandatory home energy labelling;
2. Mandatory building benchmarking and reporting;
3. Property Assessed Clean Energy (PACE) financing;
4. GHG requirements for new construction; and
5. GHG requirements for existing buildings.

If enabled, these measures would directly support the goals and actions reduce GHG emissions from buildings of all levels of government as well as utilities. They would also demonstrate the BC Government's continued leadership and commitment to work with local governments to reduce GHG emissions in the building sector in a meaningful way.

Additional information on each of the five measures can be found on the *Help Cities Lead* website (helpcitieslead.ca), including six briefing notes: one for each of the actions described above, as well as a sixth that explores the integrated suite of actions altogether.

MODELLING THE IMPACT OF ACTIONS

Integral Group modelled the GHG impacts of each of the five actions individually and as an integrated package to help understand the impact on provincial GHG emissions. Five scenarios were modelled:

- **Scenario 1:** Mandatory energy benchmarking & labelling
- **Scenario 2**: Scenario 1 + PACE financing
- **Scenario 3**: Scenario 2 + GHG requirements for new construction
- **Scenario 4:** Scenario 3 + GHG requirements for existing buildings
- **Scenario 5:** Scenario 4 + voluntary efforts

The percentage of GHG emissions savings assumed for each scenario over the business-as-usual forecast are shown in **Table 1**. Key modelling inputs used to derive these savings can be found in **APPENDIX A: MODELED SCENARIOS**.

Table 1 GHG savings over 2007 levels for Business-As-Usual Forecast and each of the five modeled scenarios

Year	Business-as-usual	Scenario 1 (S1) Mandatory energy benchmarking & labelling	Scenario 2 (S2) S1 + PACE Financing	Scenario 3 (S3) S2 + GHG requirements for new construction	Scenario 4 (S4) S3 + GHG requirements for existing buildings	Scenario 5 (S5) S4 + additional voluntary efforts
2030	16%	19%	22%	27%	33%	42%
2050	21%	26%	35%	50%	63%	78%

Figure 1 shows the modelled total GHG emissions from 2015 to 2050 for the business-as-usual forecast for buildings in BC, as well as the projected emissions for five different scenarios. Each scenario represents a different combination of initiatives intended to reduce GHG emissions in the building sector. Key modelling inputs used can be found in **APPENDIX B: BUSINESS-AS-USUAL FORECAST.** The assumptions used in both Appendix A and B were taken from several different sources, including published government and non-governmental organization reports and the Provincial Government's Climate Action Secretariat.

Before interpreting the results, it should be noted that the business-as-usual scenario does not include the Province's "aspirational" goal to implement a standard by 2035 for all space and water heating equipment sold in BC to have a minimum energy performance standard with a coefficient of performance (COP) that is greater than one. This standard, if enacted, would significantly limit the use of natural gas space and water heating equipment and indeed have a major impact on reducing GHG emissions after 2035. However, its aspirational in nature and the 15-year timeline for implementation translated into too low of a confidence level to include it into the model's baseline.

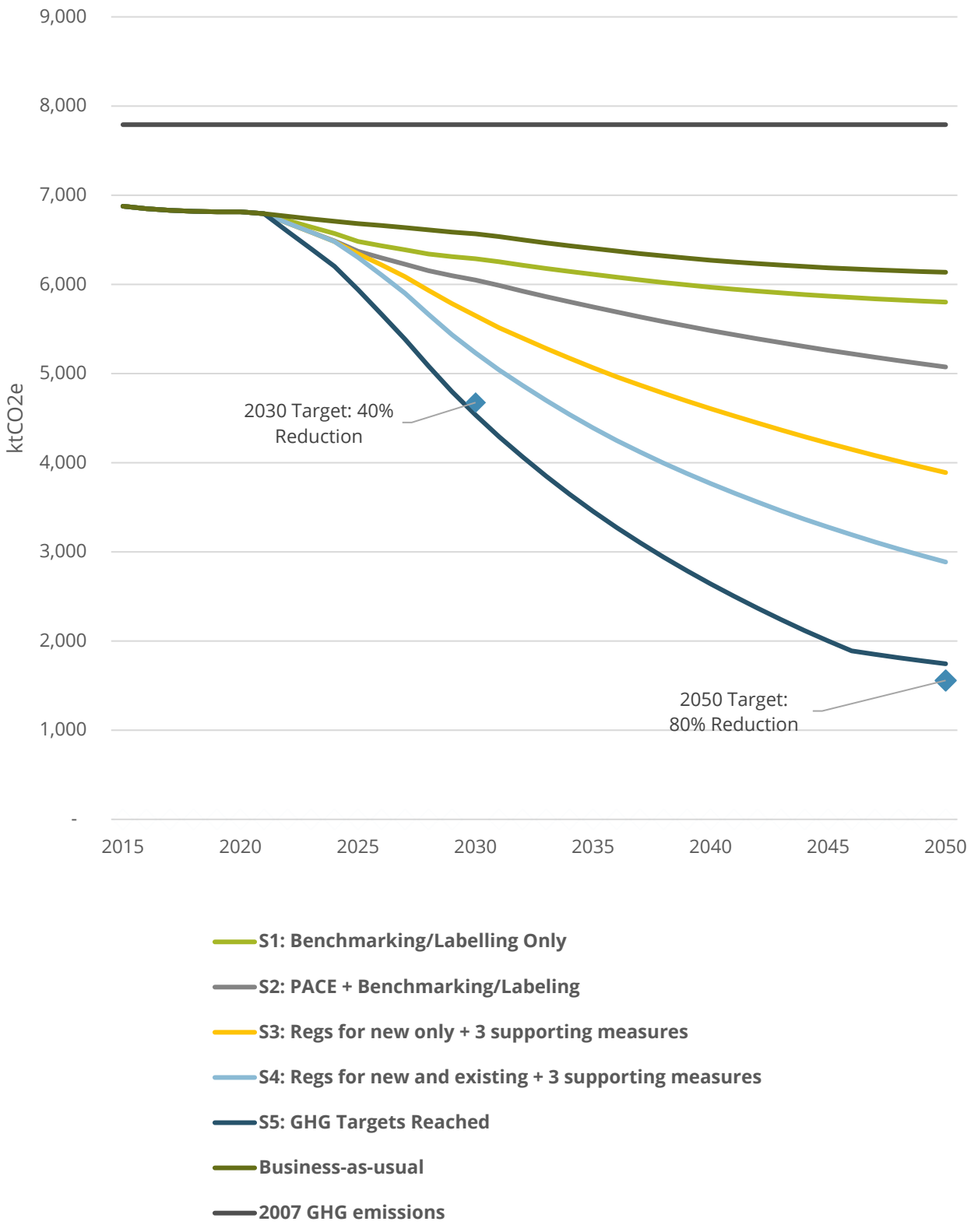

Figure 1 - Comparison of GHG emissions for the Business-As-Usual Forecast and each of the six scenarios (2015-2050)

Results

The modelled results clearly demonstrate that existing provincial measures to reduce GHG emissions will not achieve the Province's GHG reduction targets for 2030 and 2050.

Of the five scenarios modelled, Scenario 5 comes the closest to achieving the Provincial Government's GHG emissions reduction targets.

Like Scenario 4, Scenario 5 uses a combination GHG performance requirements for new and existing buildings, mandatory benchmarking and home energy labelling, and PACE financing. The key difference between these two scenarios is that in Scenario 5, voluntary upgrades that result from benchmarking, labeling and PACE financing are assumed to lead to a 4% annual voluntary uptake of retrofits instead of the 2% uptake that is assumed for Scenarios 2-4. This increase was made to demonstrate the level of additional voluntary effort needed to fully achieve the province's targets.

Key lessons from these modelling results include the following:

1. Mandatory benchmarking and labelling on their own are insufficient to achieve deep GHG savings from the building sector.
2. The simultaneous use of PACE financing and mandatory benchmarking and labelling are likely to lead to more significant GHG savings but will still be inadequate to achieve GHG savings at a level needed to achieve provincial government long-term targets (and likely local government targets as well).
3. All things being equal, GHG performance requirements for new and existing buildings are needed to motivate the building sector to take the steps needed to reduce GHG emissions in a timeline that is consistent with long-term climate change targets.
4. The five policies should be considered as an integrated suite of actions to drive deep GHG emissions reductions from the building sector, rather than standalone measures.
5. Even with the full suite of initiatives adopted, it is likely that additional measures (such as incentives, increases in the carbon tax and other steps to raise the price of fossil fuel, the introduction of a heat pump minimum performance standard, and reductions in the cost of low-carbon fuels such as electricity and RNG) will be needed to achieve the 4% annual uptake of voluntary retrofits that was used in Scenario 5 and bend the emissions curve low enough to achieve the Province's 2030 and 2050 GHG reduction targets for the building sector.

Conclusion

The modelling results above demonstrate how the five policy measures advanced by *Help Cities Lead* would significantly increase the province's ability to achieve deep GHG savings from the building sector. Without these kinds of measures, it is very unlikely that the province's GHG targets for 2030 and 2050 will be met for this sector. However, it is important to recognize that BC is a large, varied province covering six major climate zones with considerable market differences between the heavily populated southwestern and south-central regions and its rural communities. Implementation of

province-wide initiatives to decarbonize buildings therefore can take some time to develop and implement.

Given this context, a first important step to implementing these measures would be for the province to enable and then support local governments to opt-in to using them for their own communities when they are ready to do so. Local governments that choose to adopt them would be able to more effectively derive deep GHG savings from across the entire spectrum of the building sector: new and old; large Part 3 buildings and smaller Part 9 buildings; residential, commercial, and institutional. This will ultimately go a long way to helping these local governments achieve their own long-term GHG reduction targets.

The voluntary adoption of these measures by local governments will also provide the Provincial Government and all local governments in BC with important insights into how to design and implement these kinds of initiatives effectively.

In November 2020, the Mandate Letters issued to five different BC provincial ministers included direction to start to implement some aspect of three of the five measures requested by *Help Cities Lead*: home energy labeling, PACE financing, and a GHG requirement for new construction. This is a very promising start. The province should be encouraged to develop and implement these measures within the next two years.

As demonstrated by the modelling completed for this report, the remaining two measures requested by *Help Cities Lead* – benchmarking and GHG requirements for existing buildings - will also need to be established as quickly as possible to put the province and its communities on a path to achieve their long-term GHG reduction targets for the building sector. Nearly two thirds of buildings standing in 2050 will be ones that are already built today and opportunities for deep building retrofits are notoriously rare (about once every 15 to 20 years for most buildings), so adopting these two additional measures aimed at accelerating emissions reductions from the existing building sector is critical.

Time is of the essence for implementing all five of the measures included in this report. The sooner they can be adopted by BC municipalities and eventually province-wide, the sooner the Province will be on a realistic path to achieve its GHG reductions targets in the building sector.

APPENDIX A: MODELED SCENARIOS

Below are the assumed action impacts for each of the five initiatives (see **Table 2**). Impacts are based on average annual savings per building and annual uptake. Figures were gathered from case studies.

Table 2 Assumed impact for each of the five Help Cities Lead initiatives

Action Name	Applicable Building Archetypes	Annual Energy Savings	Annual Uptake	Notes	Source for Impact Assumptions
Benchmarking (BM)	SFD	0.0%	0%	Benchmarking not applicable for Part 9	Not applicable for Part 9
Benchmarking (BM)	Commercial	2.4%	85%	Savings are additive up to a set cap of 10% energy savings per building 85% is compliance with reg of eligible buildings Assumes 61% buildings are eligible for Stage 1, 85% with Stage 2 (from case studies).	EnergyStar Average Savings[iv]
Benchmarking (BM)	Apartment	2.4%	85%	Savings are additive up to a set cap of 10% energy savings per building 85% is compliance with reg of eligible buildings Assumes 58% buildings are eligible for Stage 1, 88% with Stage 2 (from case studies).	EnergyStar Average Savings[v]
Home Energy Labelling (HEL)	SFD	15.0%	1%	Uptake is for % buildings renovated, total labelled will be higher	Pembina Energy Labelling Paper[vi]
Home Energy Labelling (HEL)	Apartment	0.0%	0%	Energy labelling not applied to Part 3	Not applicable for Part 3
Home Energy Labelling (HEL)	Commercial	0.0%	0%	Energy labelling not applied to Part 3	Not applicable for Part 3
PACE - alone	SFD	18.7%	0.02%	PACE without labelling will see uptake similar to Toronto (0.02%).	Existing City of Toronto[vii] PACE program. Increased by 2.5x for BC GHG impact modelling purposes.

Action Name	Applicable Building Archetypes	Annual Energy Savings	Annual Uptake	Notes	Source for Impact Assumptions
PACE - alone	Apartment	12.7%	0.12%	PACE without benchmarking will see uptake similar to Toronto (uptake data is before benchmarking in Ontario)	City of Toronto PACE[viii] before provincial benchmarking program. Increased by 2x for BC GHG Impact Model purposes.
PACE - alone	Commercial	12.7%	0.12%	Assumes similar to Apartment	City of Toronto for apartments used as a proxy
PACE - with BM/HEL	SFD	Scenarios 2-4: 30% Scenario 5: 55.0%	Scenario 2-4: 2% Scenario 5: 4%	PACE with labelling will see jump in projects undertaken. Uptake and retrofit savings adjusted to meet 2030/2050 targets.	Scenario 2-4: Average results from City of Toronto HELP program. Uptake assumed to be double of labelling alone – implied in report that improved financing increases uptake, but no concrete figure provided. Scenario 5: increased to demonstrate additional effort needed to achieve GHG targets
PACE - with BM/HEL	Apartment	Scenario 2-4: 19% Scenario 5: 40%	Scenario 2-4: 2% Scenario 5: 4%	PACE with benchmarking will see increase in uptake.	Scenario 2-4: Average results from City of Toronto Hi-Rise program[ix]. Uptake assumed to be double of labelling alone – implied in report that improved financing increases uptake, but no concrete figure provided. Scenario 5: increased to demonstrate additional effort needed to achieve GHG targets

Table 3 Error! Reference source not found. shows the year that each of the impacts listed in Table 5 come into effect for business-as-usual forecast and each of the five scenarios.

Table 3 - Schedule that each initiative was applied in order to achieve 40% GHG reduction by 2030 and 80% by 2050

Action	Archetype	BAU	S1: Benchmark/ Labelling Only	S2: PACE + Benchmark/ Labelling	S3: GHG Regs for New + 3 supporting measures	S4: GHG regs for New & Existing + 3 supporting measures	S5: GHG Targets Reached[x]
Benchmarking - % Applicable 1st Stage	SFD	N/A	N/A	N/A	N/A	N/A	N/A
Benchmarking - % Applicable 2nd Stage	SFD	N/A	N/A	N/A	N/A	N/A	N/A
Benchmarking - % Applicable 1st Stage	Apartment	OFF	2022	2022	2022	2022	2022
Benchmarking - % Applicable 2nd Stage	Apartment	OFF	2025	2025	2025	2025	2025
Benchmarking - % Applicable 1st Stage	Commercial	OFF	2022	2022	2022	2022	2022
Benchmarking - % Applicable 2nd Stage	Commercial	OFF	2025	2025	2025	2025	2025
Home Energy Labelling	SFD	OFF	2022	2022	2022	2022	2022
Home Energy Labelling	Apartment	N/A	N/A	N/A	N/A	N/A	N/A
Home Energy Labelling	Commercial	N/A	N/A	N/A	N/A	N/A	N/A
PACE	SFD	OFF	OFF	2022	2022	2022	2022

Action	Archetype	BAU	S1: Benchmark/ Labelling Only	S2: PACE + Benchmark/ Labelling	S3: GHG Regs for New + 3 supporting measures	S4: GHG regs for New & Existing + 3 supporting measures	S5: GHG Targets Reached[x]
PACE	Apartment	OFF	OFF	2022	2022	2022	2022
PACE	Commercial	OFF	OFF	2022	2022	2022	2022
NC GHGI - Level 1 (2-year savings lag)	SFD	OFF	OFF	OFF	2022	2022	2022
NC GHGI - Level 1 (3-year savings lag)	Apartment	OFF	OFF	OFF	2022	2022	2022
NC GHGI - Level 1 (3-year savings lag)	Commercial	OFF	OFF	OFF	2022	2022	2022
NC GHGI - Level 2 (2-year savings lag)	SFD	OFF	OFF	OFF	2025	2025	2025
NC GHGI - Level 2 (3-year savings lag)	Apartment	OFF	OFF	OFF	2025	2025	2025
NC GHGI - Level 2 (3-year savings lag)	Commercial	OFF	OFF	OFF	2025	2025	2025
ExB GHGI - Level 1	SFD	OFF	OFF	OFF	OFF	2025	2025
ExB GHGI - Level 1	Apartment	OFF	OFF	OFF	OFF	2025	2025
ExB GHGI - Level 1	Commercial	OFF	OFF	OFF	OFF	2025	2025
ExB GHGI - Level 2	SFD	OFF	OFF	OFF	OFF	2028	2028
ExB GHGI - Level 2	Apartment	OFF	OFF	OFF	OFF	2028	2028
ExB GHGI - Level 2	Commercial	OFF	OFF	OFF	OFF	2028	2028
ExB GHGI - Level 3	SFD	OFF	OFF	OFF	OFF	2031	2031

Action	Archetype	BAU	S1: Benchmark/ Labelling Only	S2: PACE + Benchmark/ Labelling	S3: GHG Regs for New + 3 supporting measures	S4: GHG regs for New & Existing + 3 supporting measures	S5: GHG Targets Reached[x]
ExB GHGI - Level 3	Apartment	OFF	OFF	OFF	OFF	2031	2031
ExB GHGI - Level 3	Commercial	OFF	OFF	OFF	OFF	2031	2031

APPENDIX B: BUSINESS-AS-USUAL FORECAST

2015 Baseline

Using 2015 as a Baseline year, a baseline energy use breakdown was developed for buildings in British Columbia. Total building area for both residential and commercial buildings was taken from the building area provided by the Climate Action Secretariat for the Clean BC baseline modelling. The residential building area was further split into Small Residential and Apartment based on the 2015 Residential Breakdown for British Columbia given in Table 18 of NRCan's Comprehensive Energy Use Database (CEUD)[xi].

NRCan's CEUD was also used to define the energy profile for British Columbia's residential and commercial building area. This was based on the following inputs:

- Split of energy use between Space Heating, Water Heating and Other Electricity (Table 2 Residential, Table 39 Residential, Table 2 Commercial);
- Space Heating Breakdown, count by system and total energy by system (Table 5 Residential, Table 21 Residential, Table 24 Commercial);
- Split of energy use Apartment versus Small Residential (Table 6 Residential); and
- Water Heating System Split (Table 10 Residential, Table 28 Residential, Table 26 Commercial).

BC Energy Step Code

Table 4 shows the model's assumptions with regards to the province-wide adoption of the BC Energy Step Code.

Table 4 - BC Energy Step Code province-wide adoption

Archetype	Step	Year Implemented - Start
SFD	1	2015
SFD	2	2022
SFD	3	2025
SFD	4	2028
SFD	5	2032
Apartment	1	2015
Apartment	2	2022
Apartment	3	2027
Apartment	4	2032
Commercial	1	2015
Commercial	2	2022
Commercial	3	2027

Equipment Replacement

Each year, a percentage of existing buildings and mechanical equipment is modified for the following reasons:

- Existing buildings are demolished and replaced with new buildings with applicable Energy Step Code energy performance levels.
- Existing space heating and water heating equipment at end of life is upgraded and replaced with more efficient equipment.

Table 5 shows the assumptions used for the rate of modification at different points in time. 2015-2030 rates were provided from the BC Climate Action Secretariat. 2030-2050 rates were calculated to achieve a 100% replacement by 2050. Of the modified area, it was assumed that 20% of this area would be classified as demo and be replaced with new, and 80% would be assigned as equipment modification.

Table 5: Annual Building Area Modified (% of 2015 Baseline Area)

Year	Residential	Commercial
2015-2020	8.0%	0.7%
2020-2025	2.6%	1.3%
2025-2030	2.9%	2.0%
2030-2050	1.6%	4.0%
TOTAL 2015 Building Area Modified by 2050	100%	100%

The annual modified building area was divided between the floor area for different space heating types according to the baseline projections provided by the Climate Action Secretariat for the CleanBC baseline modelling. This provided the split for space heating systems up to 2030. The percent split provided for 2030 is applied to subsequent years up to 2050. The percentage split between space heating systems for residential and commercial buildings from 2015-2015 are shown in **Table 6** and

Table 7, respectively.

Table 6: Building Modification Split by Space Heating System - Residential

Year	Oil	Natural Gas	Wood	Electric Resistance	Electric Heat Pump
2015-2020	0.3%	17.7%	0.8%	78.6%	2.6%
2020-2025	0.7%	56.4%	3.0%	30.9%	8.9%
2025-2030	0.8%	56.0%	3.4%	30.8%	8.9%

Table 7: Building Modification Split by Space Heating System - Commercial

Year	Oil	Natural Gas	Electric Resistance	Electric Heat Pump
2015-2020	2.2%	78.2%	19.6%	0.0%
2020-2025	0.0%	80.0%	20.0%	0.0%
2025-2030	0.6%	80.7%	0.1%	18.6%

The same approach and ratios were used to define new building area, both from net new floor area and demolished and replaced area. However, for new construction oil and wood space heating systems are not included.

Space and Water Heating Equipment Upgrades

Table 8 shows the space heating EUI improvements applied to existing buildings modified. Baseline performance was assumed to be equivalent to the 2015 EUI developed using NRCan's CEUD[xii]. Improvements then are based on the difference between this baseline and the space heating EUI for BC Energy Step Code Step 1 from the supporting dataset established for the BC Energy Step Code Metrics Report[xiii].

Table 8 Assumed Improvement to Space Heating Energy Use Intensity after Upgrade

Archetype	Space Heating System	Improved Percentage of Space Heating EUI at time of replacement
SFD	Natural Gas	55%
SFD	Elec Res	48%
SFD	Elec HP	49%
SFD	Wood	55%
SFD	Oil	55%
Apartment	Natural Gas	90%
Apartment	Elec Res	90%
Apartment	Elec HP	69%
Apartment	Wood	90%
Apartment	Oil	90%
Commercial	Natural Gas	31%
Commercial	Elec Res	35%
Commercial	Elec HP	90%
Commercial	Oil	31%

Table 9 shows the forecasted floorspace for each major building types at three points in time 2015, 2030, and 2050. 2015 and projections for 2030 were provided by the BC Climate Action Secretariat. Projections for 2050 are based primarily on projected population growth from BCStats[xiv]. The split between single family dwelling and apartment was based on NRCan's CEUD[xv].

Table 9 Forecasted total building area (m^2) by archetype

Year	SFD	Apartment	Commercial	TOTAL
2015	219,873,345	60,577,350	102,178,742	382,629,437
2030	260,642,715	72,995,281	141,420,482	475,058,478
2050	306,624,307	90,581,077	167,636,145	564,841,529

Table 10 shows the baseline distribution of space heating equipment for each of the three major building types at five-year intervals, starting in 2015. Forecasted business-as-usual heating equipment inputs are based on the assumptions applied to new construction and modified buildings as discussed above.

Table 10 Baseline Area split by space heating system

Year	Archetype	Elec HP	Elec Res	Natural Gas	Oil	Wood
2015	SFD	3.6%	35.4%	55.8%	0.25%	5.0%
2030	SFD	4.0%	38.8%	52.8%	0.21%	4.2%
2050	SFD	4.8%	37.8%	53.7%	0.18%	3.5%
2015	Apartment	3.6%	35.4%	55.8%	0.25%	5.0%
2030	Apartment	4.0%	38.9%	52.8%	0.21%	4.1%
2050	Apartment	5.1%	37.6%	53.9%	0.17%	3.3%
2015	Commercial	0.0%	16.4%	79.4%	4.2%	
2030	Commercial	4.3%	15.2%	77.5%	3.0%	
2050	Commercial	6.6%	12.8%	78.1%	2.5%	

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