CODES CANADA

Impact Analysis for PCF 2061: Overheating in New Dwelling Units

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Canada

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Executive Summary

The proposed change described in PCF 2061 is recommending that the National Building Code of Canada mandate the addition of an acceptable upper indoor temperature that must be maintained in a single living space within each dwelling unit by the addition of mechanical cooling and/or by passive design measures. This report summarizes the impact analysis for implementing a maximum indoor air temperature for a single living space in a dwelling unit by the addition of mechanical cooling.

The benefits of reducing indoor air temperatures by installing single room ductless mini-split air conditioning (DMSAC) units in Part 9 dwelling units, and apartment type dwelling units, followed a pattern typical of preventive interventions, with the direct costs incurred up front and a delay before the full benefits are experienced. The direct benefits included the number of overheating related deaths prevented and any treatment costs avoided following the reduction in indoor air temperatures. The results of the analysis were presented in two parts:

I. Example case: single room DMSAC units in dwelling units, including apartment type dwelling units, built in 1 year
II. Full analysis: single room DMSAC units in dwelling units, including apartment type dwelling units, built over a 20-year period, the lifespan of the DMSAC units.

The methodology used to estimate the benefits provided by installing a DMSAC unit in a single living space in each dwelling unit, including apartment type dwelling units, was defined as follows:

- Two estimates (lower and upper) of current overheating related deaths associated with extreme heat events (estimated using a cutoff of 2.5th temperature percentile)
- Expected 100% effectiveness of the DMSAC in new dwelling units, assuming use by the occupants, in reducing illness and death associated with extreme heat events only.
- 20-year service life of the DMSAC

The annual cost for the 12 months period between July 1, 2021 and June 30, 2022 for installing a 9000 BTU/hr single room DMSAC units in 221,492 dwellings of all types, including apartment type dwellings, is estimated to be $475,398,711. The estimated operational costs over the 1-year period is estimated to be $43,123,518. It is estimated that the lifespan of a DMSAC will be 20 years with minimal maintenance. The total cost of both the initial installation and operation costs at the end of the 20-year time period is estimated to be $1,337,869,100. The total treatment costs for illnesses related to overheating during extreme heat events over the 20-year time period is estimated to range between $2,430,920 and $14,853,880 for the lower and upper estimates, respectively. The cumulative number of overheating related deaths prevented over 20-year period during extreme heat events was estimated to be 2,520 and 17,290 for the lower and upper estimates, respectively, in the residents of all dwellings completed over 20 years following the installation of the DMSAC.

The impact analysis on installing a DMSAC unit in a single living space in each dwelling unit, including apartment type dwellings, demonstrates that the main benefit would be preventing 2,520 to 17,290 overheating associated deaths during extreme heat events in Canada over 20 years should the proposed change be adopted. Although the costs incurred for installing DMSAC units in all dwelling types, including apartment type dwellings, always exceeded the savings from preventing cases requiring overheating related illness treatment during extreme heat events, the cumulative cost per overheating death prevented decreased steeply after implementation and was lower than the Treasury Board of Canada Secretariat VSL after 1 year to 9 years for direct cost comparisons, and after 1 year to 19 years for direct and indirect cost comparisons.

Scope

This report summarizes the impact analysis for PCF 2061 on maximum indoor air temperature for dwelling units. The staff led proposed change is recommending that the National Building Code mandate the addition of an acceptable upper indoor temperature that must be maintained in a single living space within each dwelling unit by the addition of mechanical cooling.

Method

The Standing Committee on Housing and Small Buildings (SC-HSB) agreed to limit the requirements for mechanical cooling to a single room in a dwelling unit. The analysis is based on the evaluation of the costs and benefits of installing single room ductless mini-split air conditioning (DMSAC) units in Part 9 and apartment type dwelling units built in a single year. The single year cost demonstrates the benefits from reducing overheating over time and are experienced over the lifespan of the air conditioning unit. The method is depicted in Figure 1.

The benefits of reducing indoor temperatures from installing a DMSAC for a single living space per dwelling unit follows a pattern typical of preventive interventions, where the costs are incurred up front while there is a delay before the full benefits are experienced. The direct benefits include the number of deaths related to overheating prevented and the associated medical treatment costs avoided by the reduction of exposure to high indoor temperatures with the installation of mechanical cooling in dwelling units.

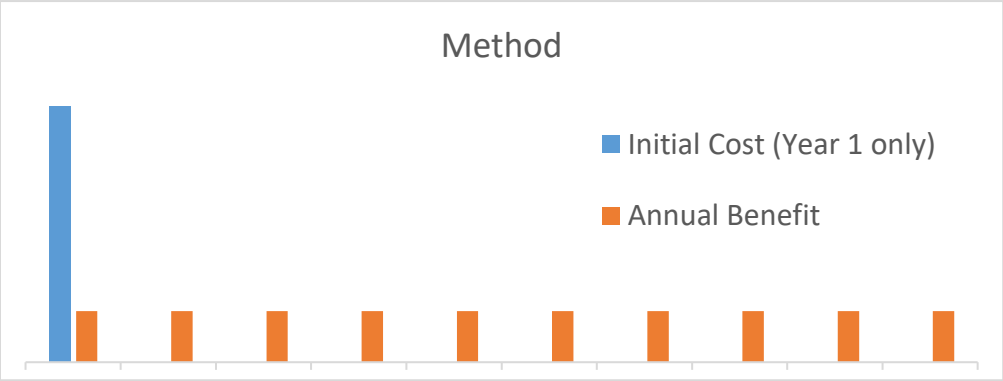

Figure 1: Method for direct cost/benefit analysis for ductless min-split air conditioning

Service Life of DMSAC

The service life of a DMSAC is estimated to be 20 years. For this analysis, the service life represents the expected lifespan of the unit with minimal maintenance. (1)

Quantitative Initial Direct Costs

The most recent data available was used to determine the quantitative direct costs for this analysis: based on the 2022 cost estimates for the installation of a 9,000 BTU/hr (3/4 ton) ductless mini split air conditioning system (2)and the third and fourth quarter 2021/ first and second quarter 2022 CMHC data on new housing completions (3).

Construction Cost per Dwelling Unit

The average costs per dwelling unit were calculated using RSMeans Online with data for 2022 (2). A 9,000 BTU/hr (3/4 ton) DMSAC was used for costing as they are much more common on the market with costing of a 6,000 BTU/hr (1/2 ton) unit not available through RSMeans. An additional unit cost was provided for the upgrade form a 100 amp electrical panel to a 200 amp panel.

This system will be used for the cost/benefit analysis as it meets the requirements of cooling a single room at a lower cost to that of a central air conditioning system. Furthermore, a DMSAC can be installed where a ducted HVAC system has not been installed.

Table 1 contains national unit costs per dwelling unit for the DMSAC. Appendix 1 contains the individual items included in the US national average costing estimates, which were adjusted to provide the slightly lower Canadian national average estimate (see Appendix A).

	Ductless Mini Split A/C for one room
RSMeans (CDN National Average)	$2,107

Table 1: National costs for installation of a single 9000 BTU/hr DMSAC

National and Regional Annual Construction Costs

National and regional new housing construction completions for all Part 9 and apartment type dwellings are summarized in Table 2. These were obtained from the CMHC quarterly data reports for the third and fourth quarters of 2021 and the first and second quarters of 2022 (3). Housing completions for the North are not supplied as there is no data available.

Regional	**Total**
CANADA	**221,492**
British Columbia (BC)	43157
Alberta (AB)	27,804
Saskatchewan and Manitoba	11240
Ontario (ON)	75101
Quebec (QC)	54407
Atlantic (NB, NS, PEI, NFLD)	9,783

Table 2: National and regional building construction completions for 2021/2022

The annual national and regional costs for the installation DMSAC units for Part 9 and apartment type dwelling units, in Canada between July 1, 2021 and June 30, 2022. Table 3 was derived by combining the values from Table 1 with those from Table 2.

National/Region	Regional Cost
CANADA	**$475,398,740**
BC	$ 93,207,711
Alberta	$ 60,163,009
Saskatchewan/ Manitoba	$ 22,405,443
Ontario	$ 164,943,443
Quebec	$ 114,992,778
Atlantic (NS.NB, PEI, NFLD)	$ 19,686,357

Table 3: Annual national and regional costs for installation of a 9000 BTU/hr DMSAC for 2021/2022

Quantitative Indirect Costs

Operating Costs

The use of air conditioning to cool a room will use electricity to do so. An annual cost has been determined to do so using the following assumptions:

- The DMSAC unit operates 24 hours/day during the summer.
- The air conditioner will operate throughout the summer months (summer is on average 93.6 days in the northern hemisphere).
- The seasonal energy efficiency rating (SEER) will be 14.3 which is common for a basic ductless mini split air conditioning unit.
- An average daily unit energy cost is collected from Electricity Prices in Canada 2023 (4). 2023 values were used as 2022 values were not readily available for all provinces.

The following formula was used to calculate the annual energy costs for operating a 9000 BTU/hr ductless mini split unit (5):

(**Cost**, $/year) = (**unit size**, BTU/h) × (**hours per year**, h) × (**energy cost**, $/kW·h) ÷ (**SEER**, BTU/W·h) ÷ (1000, W/kW)

Table 4 shows the national and regional annual costs to operate the air conditioning unit in question with average unit costs for electricity.

Region	Annual cost for mini split ($)
CANADA	**$ 43,123,518**
BC	$ 7,059,882
Alberta	$ 10,293,624
Saskatchewan/ Manitoba	$ 2,182,021
Ontario	$ 15,195,191
Quebec	$ 6,089,627
Atlantic (NS.NB, PEI, NFLD)	$ 2,303,173

Table 4: Annual national and regional 2023 operating costs of a 9000 BTU/hr DMSAC for 2021/2022 housing completions

Greenhouse Gas Emissions (GHGe)

The electricity used to operate a DMSAC is created in different ways across Canada. These methods can be coal, gas, nuclear, and renewable sources with wind and solar being examples. Certain methods of electricity generation will produce more GHGe than others. Table 5 shows the national and regional annual GHGe required to power the air conditioning unit in question.

National/Region	Regional Annual GHGe of 9000 BTU/hr mini-split (tonnes CO2/year)
CANADA	**13.17**
BC	0.05
Alberta	3.55
Saskatchewan/ Manitoba	3.49
Ontario	0.15
Quebec	0.01
Atlantic (NS.NB, PEI, NFLD)	5.92

Table 5: Annual national and regional 2023 GHGe from 9000 BTU/hr DMSAC for 2021/2022 housing completions

Qualitative Indirect Costs

An increased load on the electrical grid would be expected from operating the DMSAC during a high heat event. There could be the potential for grid failure during a high heat event depending on the current infrastructure and the number of dwelling units on the grid. This could also potentially lead to a need to increase the capacity of an electrical grid over its current state to address the increased load.

An example at the dwelling unit level of a grid increase may be the need to increase the transformers and electrical cabling that service individual dwelling units. However, there could potentially be the need for an increase to the electrical grid at a much larger scale.

Quantitative Monetary Annual Benefits

Method

Table 6 shows two estimates for the percentage of deaths attributed to extreme heat based on Canadian data that have been reported during the last decade. The lower estimate of 0.27% of total annual mortality (6) was based on an analysis of temperature and death data from 1986-2009 in 21 cities in Canada, which showed that about half the 0.54% of total deaths reported were due to extreme heat and half to moderate heat. The upper estimate of 1.66% was derived from the 740 excess deaths due to extreme heat reported from June 25 – July 2, 2021 in BC in the recently publication 'The case for adapting to extreme heat: Costs of the 2021 B.C. heat wave' (7). Statistics Canada reported that the annual number of deaths in B.C. in 2021 was 44,587 (8). The percentage of decedents aged over 70 years was similar for the deaths attributed to the B.C. heat wave and for the total annual deaths in B.C. in 2021. The upper estimate of the number of excess deaths, excess hospitalizations, excess emergency department (ED) visits and excess ambulance trips attributable to extreme heat among residents living in new housing completions between July 1, 2021 and June 30, 2022 are presented in Table 7 below (see details in the following paragraph). The lower estimate for these quantities were determined using the ratio of the lower to upper estimates of the percentage of deaths attributable to extreme heat. The associated healthcare system costs were calculated using the average per person costs, at $11,845 per hospitalization, $323 per ED visit and $461 per ambulance trip (see Appendix B).

Healthcare system use and costs	Upper estimate	Lower estimate
% deaths attributable to extreme heat	1.66%	0.27%
# excess deaths attributable to extreme heat	76	12
# excess hospitalizations	55	9
Cost of excess hospitalization	$651,477	$106,605
# excess emergency department (ED) visits	134	22
Cost of excess ED visits	$43,242	$7,099
# excess ambulance trips	104	17
Cost of excess ambulance trips	$47,975	$7,842
Total cost of healthcare	$742,694	$121,546

Table 6: Deaths and healthcare system use and costs attributed to extreme heat for residents of new housing completions between July 1, 2021 and June 30, 2022

Upper estimate derived from 2021 BC heat dome	Total BC 2021	Total Canada[1] Q3_2021 - Q2_2022	New housing completions Canada[2] Q3_2021 - Q2_2022
# excess deaths	740	5,354	76
# excess hospitalizations	530	3,835	55
# excess ED visits[3]	1,300	9,406	134
# excess ambulance trips	1,009	7,301	104

Table 7: Upper estimate of deaths and excess healthcare system uses due to extreme heat

The total number of excess deaths, excess hospitalizations, excess emergency department (ED) visits and excess ambulance trips attributable to extreme heat were conservatively estimated to be the values reported for the 2021 B.C. heat wave (7). The total number of deaths and healthcare system uses due to extreme heat in Canada between July 1, 2021 and June 30, 2022 were estimated using the ratio of deaths reported in Canada during that period to deaths in BC in 2021 (322,615 /44,587). The number of healthcare system uses for residents of the new housing completions in Canada was estimated using the average number of residents per dwelling from the number of private dwellings occupied by usual residents and the population for the 10 provinces in the 2021 Census (9) and the percentage of Canadian population residing in the new housing completions (1.426%).

Quantitative Direct Cost/Benefits Comparison

Table 8 and Figure 2 depict the initial costs for the installation of DMSAC units for Part 9 and apartment type dwelling units in Canada, completed between July 1, 2021 and June 30, 2022, as well as the annual upper and lower estimated healthcare costs prevented over the expected 20-year lifespan of the DMSAC.

Year	**Annual construction costs ($)**	**Annual excess healthcare costs prevented ($)**	
		upper estimate	lower estimate
1	475,398,740	742,694	121,546
2		742,694	121,546
3		742,694	121,546
4		742,694	121,546
5		742,694	121,546
6		742,694	121,546
7		742,694	121,546
8		742,694	121,546
9		742,694	121,546
10		742,694	121,546
11		742,694	121,546
12		742,694	121,546
13		742,694	121,546
14		742,694	121,546
15		742,694	121,546
16		742,694	121,546
17		742,694	121,546
18		742,694	121,546
19		742,694	121,546
20		742,694	121,546

Table 8: Direct annual costs and excess healthcare costs prevented for new housing completions built between July 1, 2021 and June 30, 2022.

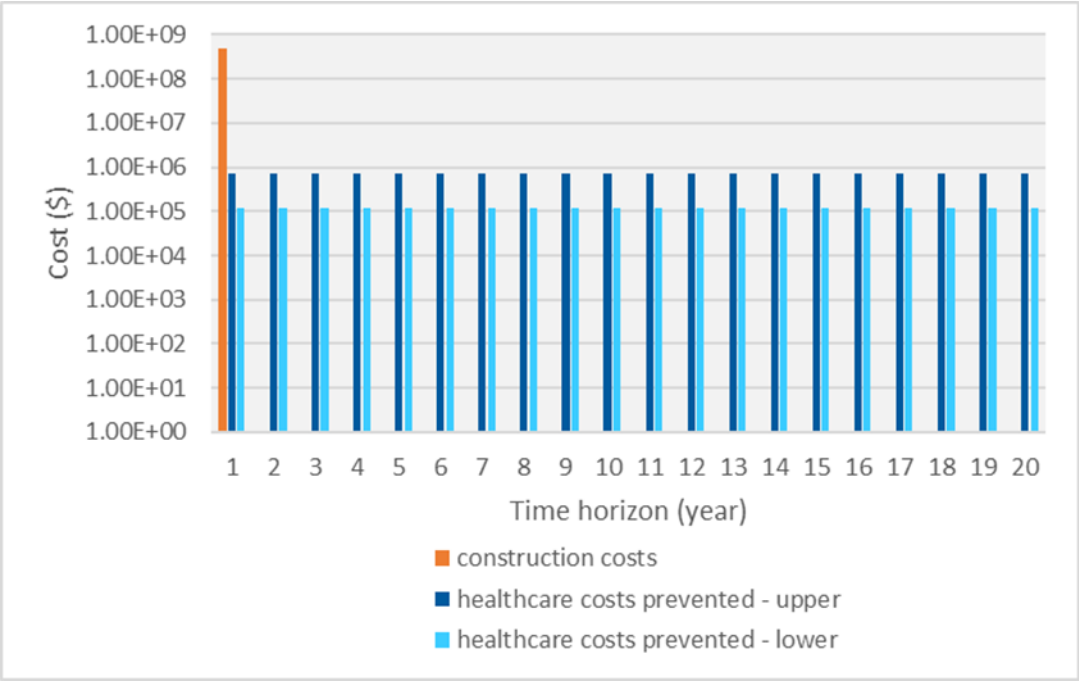

Figure 2: Direct annual costs and excess healthcare costs prevented for new housing completions built between July 1, 2021 and June 30, 2022.

Table 9 and Figure 3 depict the cumulative costs for the installation of DMSAC units for Part 9 and apartment type dwelling units completed in Canada over a 20-year time horizon, as well as the cumulative upper and lower estimated healthcare costs prevented over the same timeframe. A 1% increase in both the population growth and housing completions have been assumed in Table 9, following the average population increase between the 2001-2021.

Year	Cumulative construction costs ($)	Cumulative healthcare costs prevented ($)	
		upper estimate	lower estimate
1	475,398,740	742,694	121,546
2	955,551,467	2,235,509	365,853
3	1,440,505,721	4,485,946	734,149
4	1,930,309,518	7,501,581	1,227,674
5	2,425,011,353	11,290,066	1,847,680
6	2,924,660,206	15,859,130	2,595,432
7	3,429,305,548	21,216,579	3,472,207
8	3,938,997,343	27,370,297	4,479,295
9	4,453,786,056	34,328,247	5,617,999
10	4,973,722,656	42,098,471	6,889,635
11	5,498,858,622	50,689,092	8,295,532
12	6,029,245,948	60,108,314	9,837,033
13	6,564,937,147	70,364,423	11,515,494
14	7,105,985,258	81,465,788	13,332,285
15	7,652,443,850	93,420,862	15,288,789
16	8,204,367,028	106,238,182	17,386,403
17	8,761,809,438	119,926,370	19,626,538
18	9,324,826,272	134,494,135	22,010,619
19	9,893,473,274	149,950,273	24,540,085
20	10,467,806,746	166,303,668	27,216,390

Table 9: Cumulative direct costs and excess healthcare costs prevented for new housing completions built over 20 years

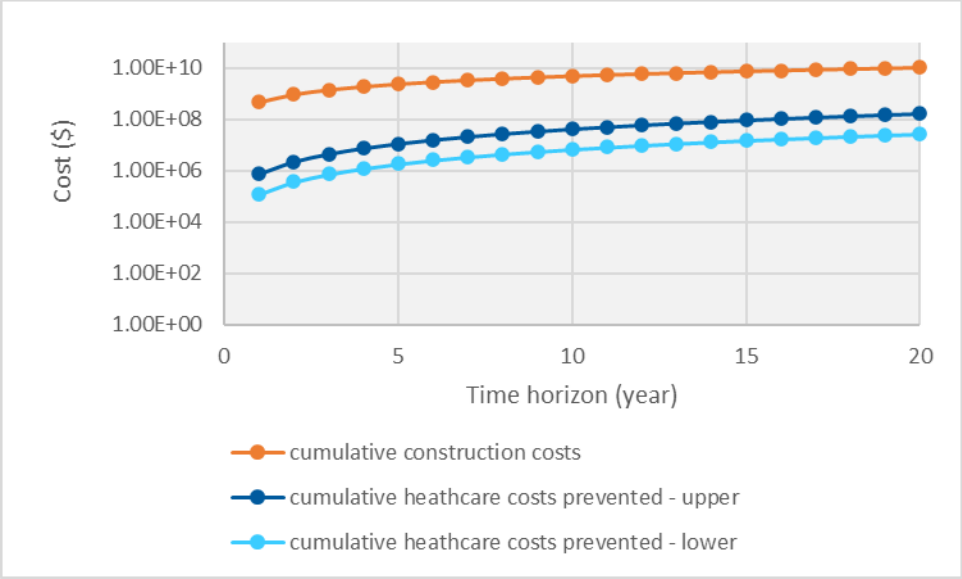

Figure 3: Cumulative direct costs and excess healthcare costs prevented for new housing completions built over 20 years

Quantitative Direct and Indirect Cost/Benefit Comparison

Table 10 and Figure 4 depict the initial costs for the installation of DMSAC units in a single year for Part 9 and apartment type dwelling units completed in Canada between July 1, 2021, and June 30, 2022, as well as the yearly operational costs over the expected 20-year lifespan of the DMSAC. These estimated numbers are compared with the annual upper and lower estimated healthcare costs prevented over the same timeframe. A 1% increase in both the population growth and housing completions have been assumed in Table 10, following the average population increase between the 2001-2021.

Year	**Annual construction costs ($)**	**Annual operational costs ($)**	**Annual healthcare costs prevented ($)**	
			upper estimate	lower estimate
1	475,398,740	43,123,518	742,694	121,546
2		43,123,518	742,694	121,546
3		43,123,518	742,694	121,546
4		43,123,518	742,694	121,546
5		43,123,518	742,694	121,546
6		43,123,518	742,694	121,546
7		43,123,518	742,694	121,546
8		43,123,518	742,694	121,546
9		43,123,518	742,694	121,546
10		43,123,518	742,694	121,546
11		43,123,518	742,694	121,546
12		43,123,518	742,694	121,546
13		43,123,518	742,694	121,546
14		43,123,518	742,694	121,546
15		43,123,518	742,694	121,546
16		43,123,518	742,694	121,546
17		43,123,518	742,694	121,546
18		43,123,518	742,694	121,546
19		43,123,518	742,694	121,546
20		43,123,518	742,694	121,546

Table 10: Direct and indirect annual costs and excess healthcare costs prevented for new housing completions built between July 1, 2021 and June 30, 2022.

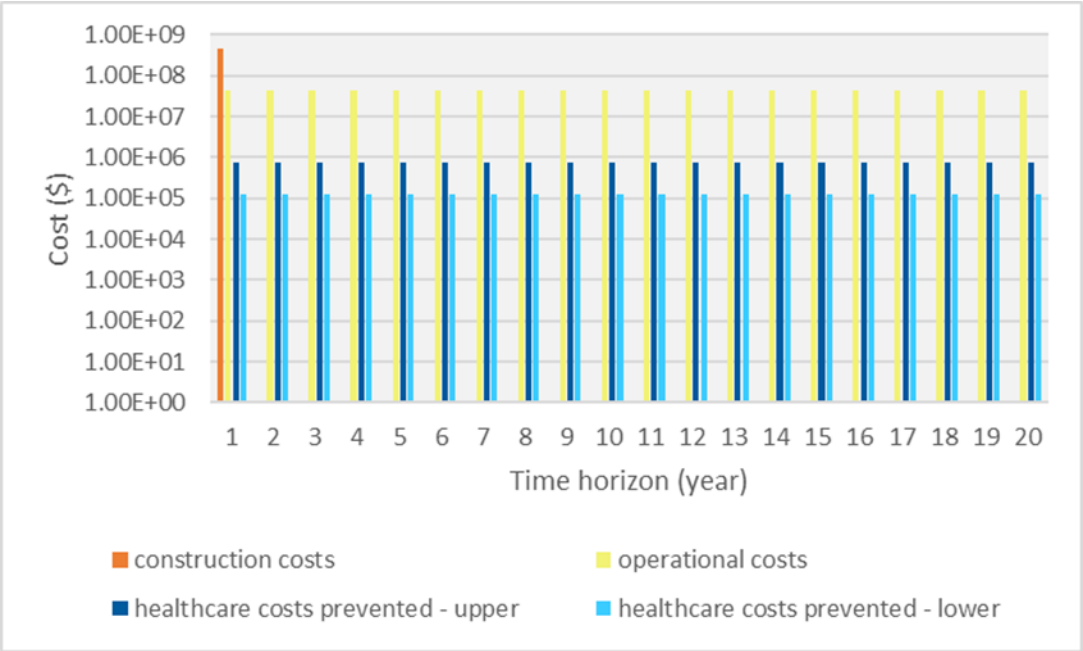

Figure 4: Direct and indirect annual costs and excess healthcare costs prevented for new housing completions built between July 1, 2021 and June 30, 2022

Table 11 and Figure 5 depict the cumulative costs for the installation of DMSAC units for Part 9 and apartment type dwelling units completed in Canada from for a 20-year time horizon, as well as the cumulative upper and lower potential healthcare costs prevented over the same time period. A 1% increase in both the population growth and housing completions have been assumed in Table 11, following the average population increase between the 2001-2021.

Year	Cumulative construction costs ($)	Cumulative operational costs ($)	Cumulative healthcare costs prevented ($)	
			upper estimate	lower estimate
1	475,398,740	43,123,518	742,694	121,546
2	955,551,467	129,801,789	2,235,509	365,853
3	1,440,505,721	260,470,361	4,485,946	734,149
4	1,930,309,518	435,569,137	7,501,581	1,227,674
5	2,425,011,353	655,542,419	11,290,066	1,847,680
6	2,924,660,206	920,838,952	15,859,130	2,595,432
7	3,429,305,548	1,231,911,969	21,216,579	3,472,207
8	3,938,997,343	1,589,219,235	27,370,297	4,479,295
9	4,453,786,056	1,993,223,092	34,328,247	5,617,999
10	4,973,722,656	2,444,390,506	42,098,471	6,889,635
11	5,498,858,622	2,943,193,113	50,689,092	8,295,532
12	6,029,245,948	3,490,107,265	60,108,314	9,837,033
13	6,564,937,147	4,085,614,077	70,364,423	11,515,494
14	7,105,985,258	4,730,199,476	81,465,788	13,332,285
15	7,652,443,850	5,424,354,248	93,420,862	15,288,789
16	8,204,367,028	6,168,574,087	106,238,182	17,386,403
17	8,761,809,438	6,963,359,644	119,926,370	19,626,538
18	9,324,826,272	7,809,216,576	134,494,135	22,010,619
19	9,893,473,274	8,706,655,597	149,950,273	24,540,085
20	10,467,806,746	9,656,192,528	166,303,668	27,216,390

Table 11: Cumulative direct and indirect costs and excess healthcare costs prevented for new housing completions built over 20 years

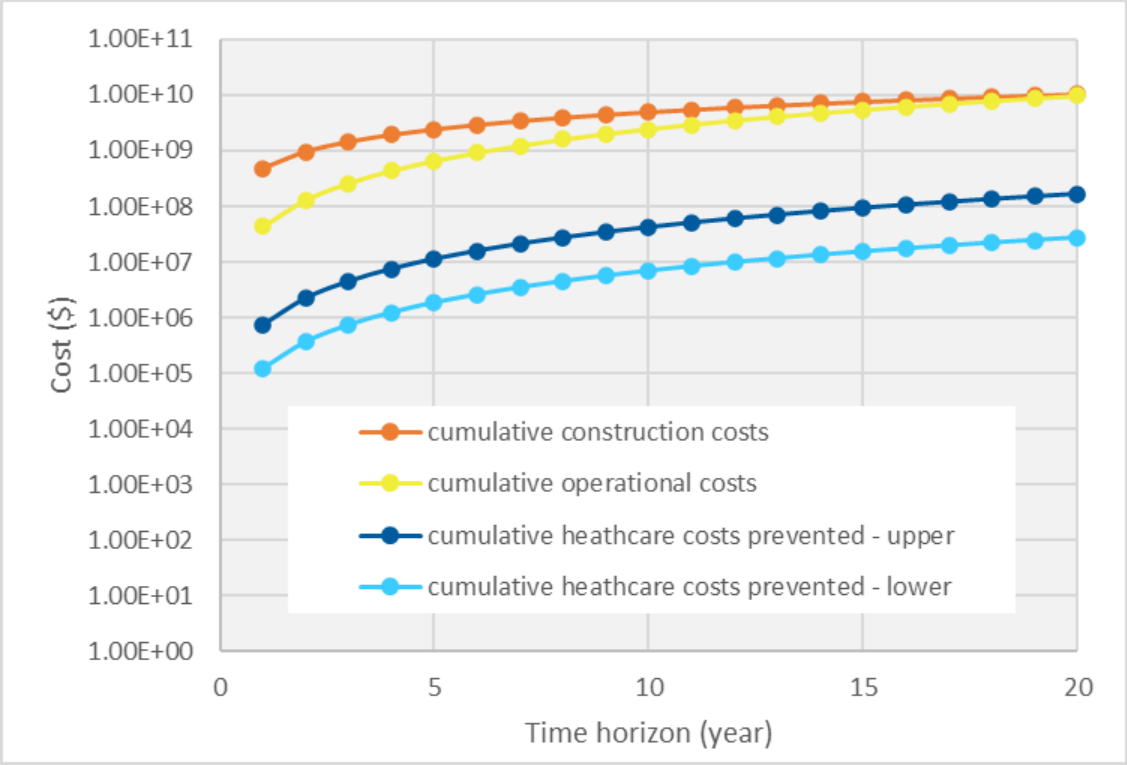

Figure 5: Cumulative direct and indirect costs and excess healthcare costs prevented for new housing completions built over 20 years

Quantitative Number of Overheating Deaths Prevented

Deaths Prevented

The proposed change of installing a DMSAC unit in a single living space within each Part 9 and apartment type dwelling units will have the benefit of reducing the number of deaths related to overheating. Table 12 and Figure 6 depicts the comparison of the upper and lower estimates of the cumulative number of deaths during extreme heat events that would be prevented by the proposed change. Cumulative values are determined by assuming the proposed change implemented in 1 year will continue to prevent deaths during extreme heat events annually for 20 years, while in year 2 will continue to reduce deaths annually for the next 19 years, and so on. A 1% increase in both the population growth and housing completions have been assumed in Table 11, following the average population increase between the 2001-2021.

Year	Number of preventable deaths	
	Upper estimate	Lower estimate
1	76	12
2	229	36
3	460	72
4	770	120
5	1,160	180
6	1,631	252
7	2,184	336
8	2,820	432
9	3,540	540
10	4,345	660
11	5,236	792
12	6,214	936
13	7,280	1,092
14	8,435	1,260
15	9,680	1,440
16	11,016	1,632
17	12,444	1,836
18	13,965	2,052
19	15,580	2,280
20	17,290	2,520

Table 12: Upper and lower estimates of the cumulative number of preventable deaths

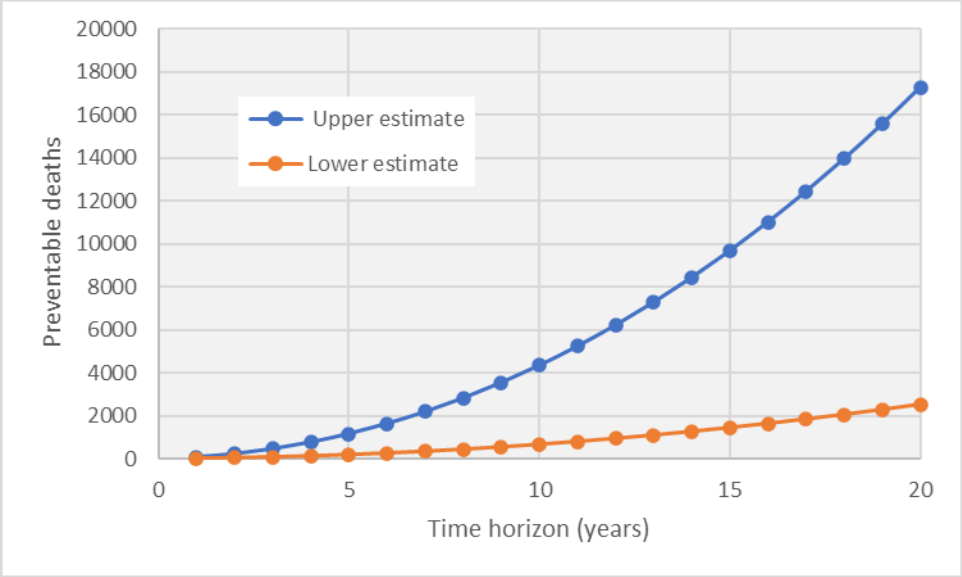

Figure 6: Upper and lower estimates of the cumulative number of preventable deaths

Cost Comparison

The cumulative cost per overheating death prevented provides a useful comparison of the costs and the benefits of installing DMSAC units for Part 9 and apartment type dwelling units. The cumulative cost per overheating death prevented decrease rapidly and then stabilize.

The TBS' cost-benefit analysis guide describes the Value of Statistical Life (VSL) as the aggregation of the estimated willingness to pay for a small reduction in mortality risk across many individuals in an exposed population (10). The VSL does not represent the value of an individual human life, but the marginal value of mortality risk reductions in a population. A value of 8.3 million in 2021 Canadian dollars was obtained for the VSL by indexing the 2007 value of $6.5 million (10) using the Statistics Canada Consumer price index (11).

Direct Cost Comparison

Table 13 and Figure 7 present the estimates for the example case of direct costs per death prevented for 1 year of installation of DMSAC units for Part 9 and apartment type dwelling units, for both the lower and upper estimates of overheating deaths prevented. The cumulative values are calculated for each year over the expect 20-year lifespan of the DMSAC.

The cost per death prevented was lower than the VSL for the first year for the upper estimate of deaths prevented, and dropped below the VSL after the 9th year for the lower estimate of deaths prevented.

Year	**Direct cost per death prevented ($)**	
	For upper estimate of deaths prevented	For lower estimate of deaths prevented
1	6,245,474	39,606,433
2	4,162,952	26,532,934
3	3,121,782	19,996,827
4	2,497,153	16,075,682
5	2,080,794	13,462,020
6	1,783,446	11,595,495
7	1,560,480	10,195,933
8	1,387,102	9,107,681
9	1,248,434	8,237,348
10	1,135,011	7,525,505
11	1,040,521	6,932,529
12	960,595	6,430,992
13	892,112	6,001,302
14	832,782	5,629,090
15	780,891	5,303,580
16	735,124	5,016,532
17	694,462	4,761,538
18	658,098	4,533,536
19	625,387	4,328,479
20	595,807	4,143,091

Table 13: Direct costs per death prevented for new housing completions built between July 1, 2021 and June 30, 2022 over a 20-year time period.

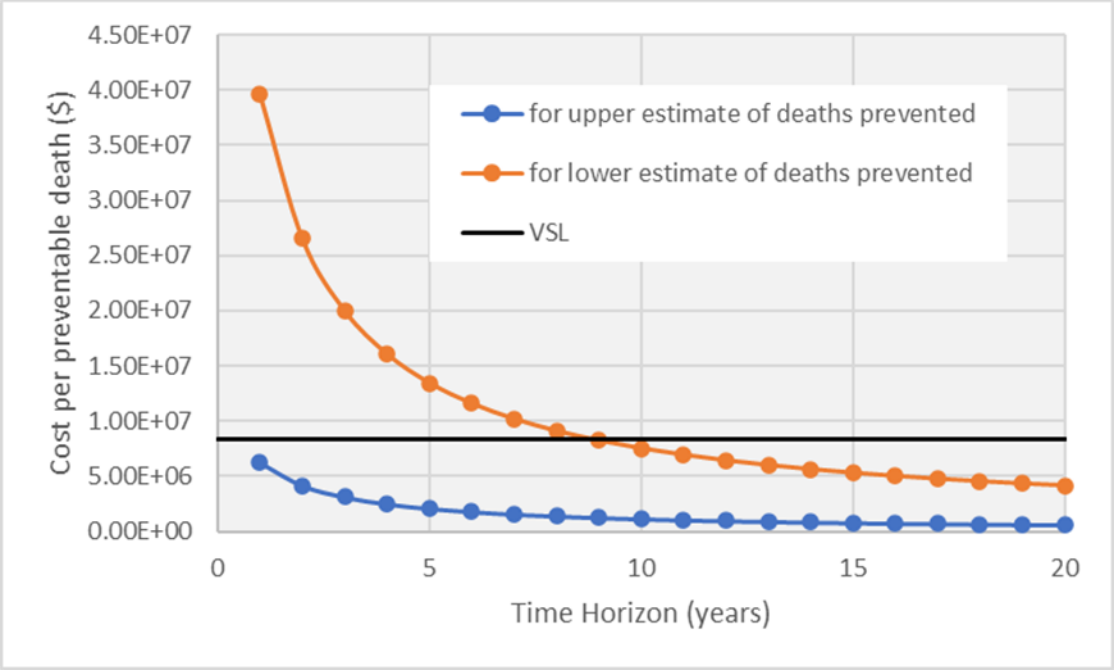

Figure 7: Direct costs per death prevented for new housing completions built between July 1, 2021 and June 30, 2022 over a 20-year time period.

Direct and Indirect Cost Comparison

Table 14 and Figure 8 present the estimates for the example case of the combination of direct and indirect costs per death prevented for 1 year of installation of DMSAC units for Part 9 and apartment type dwelling units, for both the lower and upper estimates of overheating deaths prevented. The cumulative values are calculated for each year over the expect 20-year lifespan of the DMSAC.

The cost per death prevented was lower than the VSL for the first year for the upper estimate of deaths prevented, and dropped below the VSL after the 19th year for the lower estimate of deaths prevented.

Year	Cost per death prevented ($)		Number of preventable deaths	
	lower estimate	upper estimate	Upper estimate	Lower estimate
1	6,812,889	43,200,059	76	12
2	4,729,772	30,138,539	229	36
3	3,688,022	23,614,471	460	72
4	3,062,827	19,705,425	770	120
5	2,645,917	17,103,923	1,160	180
6	2,348,032	15,249,618	1,631	252
7	2,124,543	13,862,337	2,184	336
8	1,950,655	12,786,429	2,820	432
9	1,811,492	11,928,502	3,540	540
10	1,697,587	11,229,127	4,345	660
11	1,602,628	10,648,682	5,236	792
12	1,522,247	10,159,740	6,214	936
13	1,453,322	9,742,707	7,280	1,092
14	1,393,565	9,383,216	8,435	1,260
15	1,341,258	9,070,493	9,680	1,440
16	1,295,089	8,796,296	11,016	1,632
17	1,254,038	8,554,217	12,444	1,836
18	1,217,297	8,339,197	13,965	2,052
19	1,184,222	8,147,188	15,580	2,280
20	1,154,291	7,974,914	17,290	2,520

Table 14: Direct and indirect costs per death prevented for new housing completions built between July 1, 2021 and June 30, 2022 over a 20-year time period.

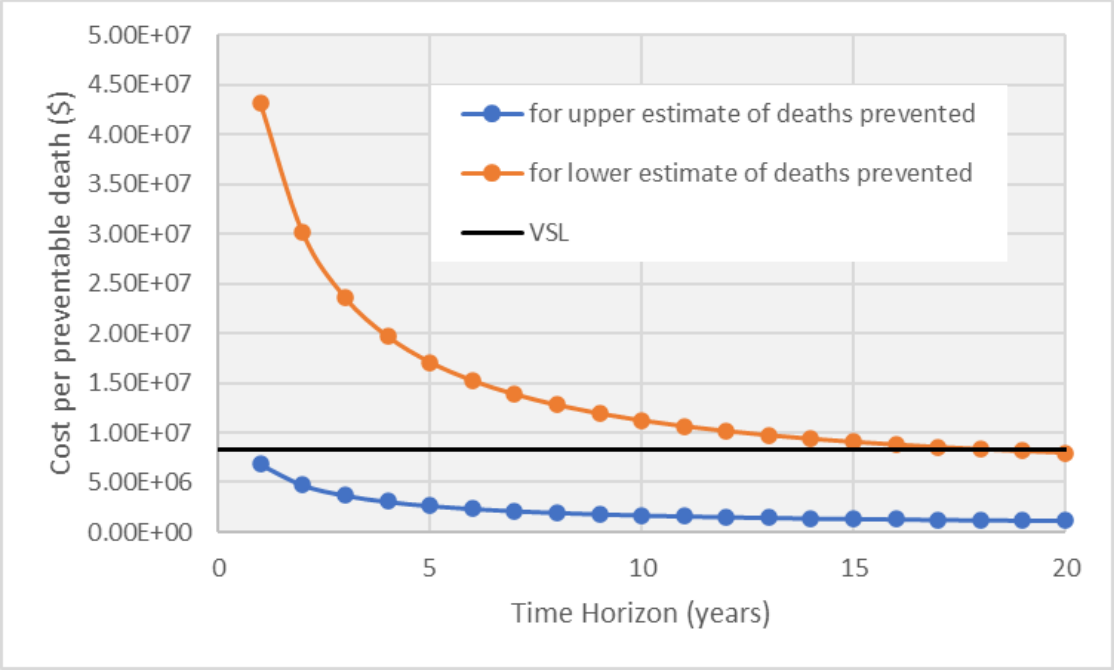

Figure 8: Direct and indirect costs per death prevented for new housing completions built between July 1, 2021 and June 30, 2022 over a 20-year time period.

Limitations

During the development of the impact analysis, assumptions were made regarding data and calculation methods used.

Deaths in Canada Related to Overheating

Deaths related to overheating in Canada have been reported from both a complex epidemiological analysis and from a study based on identification of individual deaths due to heat related illness by the BC Coroners Service for the 2021 BC heat event. However, these values result from both the time period evaluated and the population exposed. Provinces do not usually identify overheating as a cause of death. The range shown for deaths prevented in this analysis are based on published data for overheating deaths during extreme heat events, including the 2021 BC heat dome. US data is more plentiful, but their climate is quite different and cannot be used as a direct comparison for Canada.

Analysis of Northern Regions

The analysis supplied does not include values for the Yukon, Northwest Territories, or Nunavut. CMHC does not track housing completions as used in the analysis, and the housing starts are only tracked for Yellowknife and Whitehorse, which does not give a clear picture of construction in the North. In addition, the death data available for the North from Statistics Canada is incomplete.

Indirect Costs

Operational costs for the DMSAC units, and the assumptions for the calculations, have been supplied in the analysis. The assumptions used to determine the monetary values are based on conservative values of the unit running 24 hours per day for the entire summer. It is expected that the units may not be required to operate continuously, and the value may be lower, but the actual values for the conditions being addressed by PCF 2061 were not available while creating the impact analysis.

The load on the electrical grid has been identified as a qualitative indirect cost. However, this is very difficult to quantify as the effect related to PCF 2061 will vary greatly across Canada depending on the age and robustness of an area's electrical grid, as well as current municipal requirements. For this reason, it is identified as a qualitative indirect cost.

Points for Consideration That Do Not Affect the Analysis

Current Installation Rate for Air Conditioners in New Construction

Not all new construction would be void of a permanent air conditioner at the time of occupancy. Some new home buyers are having permanent air conditioning units installed during construction. Statistics Canada shows that 61% of home shad air conditioners in 2019 and 64% in 2021 (12). However, a couple considerations related to this data include the following:

- The data was for all air conditioners, which could also have included window mounted, non-permanent, air conditioners. Central air conditioners were present in 42% of homes in 2019, and 38% of homes in 2021, showing a slight drop in installations.
- There was no data available to determine whether any of the percentage of air conditioning units above the value reported as central air conditioning units were DMSAC units, so we conservatively assumed that data did not include any DMSAC units.

A builder from Alberta was asked for information on their company's rate of installation of air conditioning units related to the approximately 130 m^2 to 160 m^2 housing stock that the CBHCC would be considering for their affordable home archetypes. The current installation rate for new construction in these home sizes was only 13.75%, with an additional 2% installing air conditioning rough ins for future completion.

This information is useful to determine how many new home owners may not be directly affected by the proposed change. However, this data was not used in the analysis as the installation of a permanently affixed air conditioner is still voluntary, and the recent trend of fewer new home owners opting to do so.

Conclusion

The annual cost for the 12 months period between July 1, 2021 and June 30, 2022 for installing a 9000 BTU/hr single room DMSAC unit in 221,492 Part 9 and apartment type dwelling units is estimated to be $475,398,711. The estimated operational costs over the 1-year period are estimated to be $43,123,518. It is estimated that the lifespan of a DMSAC will be 20 years with minimal maintenance. The total cost of both the initial installation and operation costs at the end of the 20-year time period is estimated to be $1,337,869,100. The total treatment cost for illnesses related to overheating during extreme heat events over the 20-year time period is estimated to range between $2,430,920 and $14,853,880 for the lower and upper estimates, respectively. The cumulative number of overheating related deaths prevented during extreme heat events was estimated to be 2,520 and 17,290 for the lower and upper estimates, respectively, in the residents of all dwellings completed over 20 years following the installation of the DMSAC.

The impact analysis for PCF 2061 on installing a DMSAC unit in a single living space within each dwelling unit, including apartment type dwellings, demonstrates that the main benefit would be preventing 2,520 to 17,290 overheating associated deaths during extreme heat events in Canada over 20 years should the proposed change be adopted. Although the costs incurred for installing DMSAC units in all dwelling types, including apartment type dwellings, always exceeded the savings from preventing cases requiring overheating related illness treatment during extreme heat events, the cumulative cost per overheating death prevented decreased steeply after implementation and was lower than the Treasury Board of Canada Secretariat VSL after 1 year to 9 years for direct cost comparisons and after 1 year to 19 years for direct and indirect cost comparisons.

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