1 Building envelope component incremental costing by climate zone

All costing data, except for windows and skylights, were collected from RSMeans (2023). The incremental material and labour costs were accounted for in the analysis. Costing was converted from USD to CAD using the Bank of Canada's exchange rate from August 2023 (i.e., 1.34).

Costing data for windows were obtained from the Local Energy Efficiency Partnerships (LEEP) database (NRCan, 2018). The unit costs of the fenestration systems were adjusted for inflation from 2019 to 2023 using the Bank of Canada's inflation calculator, which increased costs by 15%.

Costing data for skylights (where an incremental cost of 35% applies to a standard size of 2 ft. × 4 ft. only; other sizes would have a significantly higher incremental cost of 70%) were obtained from Columbia Skylights and apply to all regions in Canada.

Table 1. Incremental Cost of Components in Buildings > 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 4

Buildings > 300 m^3	**Climate Zone 4**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	6.91	10.43	14.69
Cathedral ceilings and flat roofs	4.67	4.67	0.00
Floors over unheated spaces	4.67	4.67	0.00
Walls above grade	2.78	5.69	37.60
Foundation walls	1.99	3.46	28.13
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	N/A	N/A	N/A
Heated floors	2.32	2.32	0.00
Slabs-on-grade with an integral footing	1.96	1.96	0.00
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.84	1.05	105.32
Skylights	2.92	2.02	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 2. Incremental Cost of Components in Buildings ≤ 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 4

Buildings ≤ 300 m^3	**Climate Zone 4**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**

Ceiling below attic	6.91	8.67	6.61
Cathedral ceilings and flat roofs	4.67	5.02	2.16
Floors over unheated spaces	4.67	5.02	–3.48
Walls above grade	2.78	3.23	–3.03
Foundation walls	1.99	3.46	28.13
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	N/A	N/A	N/A
Heated floors	2.32	2.84	3.25
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/m^2**
Slabs-on-grade with an integral footing	1.96	2.84	17.74
Windows and sliding glass doors	1.84	1.05	105.32
Skylights	2.92	2.02	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 3. Incremental Cost of Components in Buildings > 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 5

Buildings > 300 m^3	**Climate Zone 5**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/m^2**
Ceiling below attic	8.67	12.19	15.42
Cathedral ceilings and flat roofs	4.67	5.02	2.16
Floors over unheated spaces	4.67	5.02	–3.48
Walls above grade	3.08	5.69	42.12
Foundation walls	2.98	3.46	4.33
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	N/A	N/A	N/A
Heated floors	2.32	3.72	19.99
Slabs-on-grade with an integral footing	1.96	3.72	34.48
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/m^2**
Windows and sliding glass doors	1.84	1.05	105.32
Skylights	2.92	2.02	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 4. Incremental Cost of Components in Buildings ≤ 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 5

Buildings ≤ 300 m^3	**Climate Zone 5**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	8.67	8.67	0.00
Cathedral ceilings and flat roofs	4.67	5.02	2.16
Floors over unheated spaces	4.67	5.02	–3.48
Walls above grade	3.08	3.85	9.58
Foundation walls	2.98	3.46	4.33
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	N/A	N/A	N/A
Heated floors	2.32	2.84	3.25
Slabs-on-grade with an integral footing	1.96	2.84	17.74
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.84	1.05	105.32
Skylights	2.92	2.02	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 5. Incremental Cost of Components in Buildings > 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 6

Buildings > 300 m^3	**Climate Zone 6**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	8.67	12.19	15.42
Cathedral ceilings and flat roofs	4.67	5.02	2.16
Floors over unheated spaces	4.67	5.02	–3.48
Walls above grade	3.08	5.69	42.12
Foundation walls	2.98	3.97	26.68
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	N/A	N/A	N/A
Heated floors	2.32	3.72	19.99
Slabs-on-grade with an integral footing	1.96	3.72	34.48
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.61	0.94	80.84
Skylights	2.75	1.84	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 6. Incremental Cost of Components in Buildings ≤ 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 6

Buildings ≤ 300 m^3	**Climate Zone 6**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	8.67	8.67	0.00
Cathedral ceilings and flat roofs	4.67	5.02	2.16
Floors over unheated spaces	4.67	5.02	–3.48
Walls above grade	3.08	3.85	9.58
Foundation walls	2.98	3.97	26.68
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	N/A	N/A	N/A
Heated floors	2.32	2.84	3.25
Slabs-on-grade with an integral footing	1.96	2.84	17.74
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.61	0.94	80.84
Skylights	2.75	1.84	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 7. Incremental Cost of Components in Buildings > 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 7A

Buildings > 300 m^3	**Climate Zone 7A**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	10.43	12.19	7.34
Cathedral ceilings and flat roofs	5.02	5.02	0.00
Floors over unheated spaces	5.02	5.02	0.00
Walls above grade	3.08	5.77	44.85
Foundation walls	3.46	4.78	31.88
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	N/A	N/A	N/A
Heated floors	2.84	3.72	16.74
Slabs-on-grade with an integral footing	3.72	3.72	0.00
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.61	0.94	80.84
Skylights	2.75	1.84	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 8. Incremental Cost of Components in Buildings ≤ 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 7A

Buildings ≤ 300 m^3	**Climate Zone 7A**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	10.43	10.43	0.00
Cathedral ceilings and flat roofs	5.02	5.02	0.00
Floors over unheated spaces	5.02	5.02	0.00
Walls above grade	3.08	3.85	9.58
Foundation walls	3.46	4.78	31.88
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	N/A	N/A	N/A
Heated floors	2.84	3.72	16.74
Slabs-on-grade with an integral footing	3.72	3.72	0.00
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.61	0.94	80.84
Skylights	2.75	1.84	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 9. Incremental Cost of Components in Buildings > 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 7B

Buildings > 300 m^3	**Climate Zone 7B**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	10.43	12.19	7.34
Cathedral ceilings and flat roofs	5.02	5.80	22.22
Floors over unheated spaces	5.02	5.42	49.10
Walls above grade	3.85	6.65	51.71
Foundation walls	3.46	5.22	36.78
Unheated floors above frost line	1.96	2.84	17.74
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	4.44	4.62	2.00
Heated floors	2.84	4.62	33.46
Slabs-on-grade with an integral footing	3.72	4.62	16.72
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.44	0.82	70.59
Skylights	2.41	1.61	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 10. Incremental Cost of Components in Buildings ≤ 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 7B

Buildings ≤ 300 m^3	**Climate Zone 7B**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	10.43	10.43	0.00
Cathedral ceilings and flat roofs	5.02	5.02	0.00
Floors over unheated spaces	5.02	5.02	0.00
Walls above grade	3.85	4.80	18.83
Foundation walls	3.46	5.22	36.78
Unheated floors above frost line	1.96	1.96	0.00
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	4.44	4.44	0.00
Heated floors	2.84	3.72	16.74
Slabs-on-grade with an integral footing	3.72	3.72	0.00
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.44	0.82	70.59
Skylights	2.41	1.61	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 11. Incremental Cost of Components in Buildings > 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 8

Buildings > 300 m^3	**Climate Zone 8**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	10.43	12.19	7.34
Cathedral ceilings and flat roofs	5.02	5.80	22.22
Floors over unheated spaces	5.02	5.42	49.10
Walls above grade	3.85	6.65	51.71
Foundation walls	3.97	5.22	14.43
Unheated floors above frost line	1.96	2.84	17.74
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	4.44	4.62	2.00
Heated floors	2.84	4.62	33.46
Slabs-on-grade with an integral footing	4.59	4.62	2.00
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.44	0.82	70.59
Skylights	2.41	1.61	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 12. Incremental Cost of Components in Buildings ≤ 300 m^3 to Achieve Tier 5 Compared to Base Code in Climate Zone 8

Buildings ≤ 300 m^3	**Climate Zone 8**		
Component	**Base Code RSI Value**	**Tier 5 RSI Value**	**Incremental Cost, $/$m^2$**
Ceiling below attic	10.43	10.43	0.00
Cathedral ceilings and flat roofs	5.02	5.02	0.00
Floors over unheated spaces	5.02	5.02	0.00
Walls above grade	3.85	4.80	16.09
Foundation walls	3.97	5.22	14.43
Unheated floors above frost line	1.96	2.84	17.74
Unheated floors below frost line	0	1.96	14.49
Heated and unheated floors on permafrost	4.44	4.44	0.00
Heated floors	2.84	4.62	33.46
Slabs-on-grade with an integral footing	4.59	4.62	2.00
Component	**Base Code Max. U-Value**	**Tier 5 Max. U-Value**	**Incremental Cost, $/$m^2$**
Windows and sliding glass doors	1.44	0.82	70.59
Skylights	2.41	1.61	35%*

Note to Table:

* The incremental cost is shown as a percentage.

2 Building envelope component incremental costing by region

Table 13. Climate Zones by Region

Degree-Days Below 18°C	BC	Alberta	Saskatchewan and Manitoba	Ontario	Quebec	Atlantic Canada	Northern Canada
Zone 4: HDD < 3000	Yes	No	No	No	No	No	No
Zone 5: HDD 3000 to 3999	Yes	No	No	Yes	No	Yes	No
Zone 6: HDD 4000 to 4999	Yes	Yes	Yes	Yes	Yes	Yes	No
Zone 7A: HDD 5000 to 5999	Yes	Yes	Yes	Yes	Yes	Yes	No
Zone 7B: HDD 6000 to 6999	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zone 8: HDD ≥ 7000	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 14. Incremental Cost of Components in Buildings > 300 m^3 by Region

Buildings > 300 m^3	Incremental Cost, $/$m^2$						
Component	**BC**	**Alberta**	**Saskatchewan and Manitoba**	**Ontario**	**Quebec**	**Atlantic Canada**	**Northern Canada**
Ceiling below attic	7.34–15.42	7.34–15.42	7.34–15.42	7.34–15.42	7.34–15.42	7.34–15.42	7.34
Cathedral ceilings and flat roofs	2.16–22.22	2.16–22.22	2.16–22.22	2.16–22.22	2.16–22.22	2.16–22.22	22.22
Floors over unheated spaces	–3.48–49.10	–3.48–49.10	–3.48–49.10	–3.48–49.10	–3.48–49.10	–3.48–49.10	49.10
Walls above grade	37.60–51.71	42.12–51.71	42.12–51.71	42.12–51.71	42.12–51.71	42.12–51.71	51.71
Foundation walls	4.33–36.78	14.43–36.78	14.43–36.78	4.33–36.78	14.43–36.78	4.33–36.78	14.43–36.78

Unheated floors above frost line	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	17.74
Unheated floors below frost line	14.49	14.49	14.49	14.49	14.49	14.49	14.49
Heated and unheated floors on permafrost	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Heated floors	0.00–33.46	0.00–33.46	0.00–33.46	0.00–33.46	0.00–33.46	0.00–33.46	33.46
Slabs-on-grade with an integral footing	0.00–34.48	0.00–34.48	0.00–34.48	0.00–34.48	0.00–34.48	0.00–34.48	2.00–16.72
Windows and sliding glass doors	70.59–105.32	70.59–80.84	70.59–80.84	70.59–105.32	70.59–80.84	70.59–105.32	70.59
Skylights	35%*	35%*	35%*	35%*	35%*	35%*	35%*

Note to Table:

* The incremental cost is shown as a percentage.

Table 15. Incremental Cost of Components in Buildings ≤ 300 m^3 by Region

Buildings ≤ 300 m^3	**Incremental Cost, $/$m^2$**						
Component	**BC**	**Alberta**	**Saskatchewan and Manitoba**	**Ontario**	**Quebec**	**Atlantic Canada**	**Northern Canada**
Ceiling below attic	0.00–6.61	0.00	0.00	0.00	0.00	0.00	0.00
Cathedral ceilings and flat roofs	0.00–2.16	0.00–2.16	0.00–2.16	0.00–2.16	0.00–2.16	0.00–2.16	0.00
Floors over unheated spaces	–3.48–0.00	–3.48–0.00	–3.48–0.00	–3.48–0.00	–3.48–0.00	–3.48–0.00	0.00
Walls above grade	–3.03–18.83	9.58–18.83	9.58–18.83	9.58–18.83	9.58–18.83	9.58–18.83	16.09–18.83

Foundation walls	4.33–36.78	14.43–36.78	14.43–36.78	4.33–36.78	14.43–36.78	4.33–36.78	14.43–36.78
Unheated floors above frost line	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74
Unheated floors below frost line	14.49	14.49	14.49	14.49	14.49	14.49	14.49
Heated and unheated floors on permafrost	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heated floors	3.25–33.46	3.25–33.46	3.25–33.46	3.25–33.46	3.25–33.46	3.25–33.46	16.74–33.46
Slabs-on-grade with an integral footing	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	0.00–17.74	0.00–2.00
Windows and sliding glass doors	70.59–105.32	70.59–80.84	70.59–80.84	70.59–105.32	70.59–80.84	70.59–105.32	70.59
Skylights	35%*	35%*	35%*	35%*	35%*	35%*	35%*

Note to Table:

* The incremental cost is shown as a percentage.

3 Building envelope components

3.1 Ceilings below attics

Typical trusses were assumed to have a spacing of 610 mm on centre (o.c.) and RSI 2.11 (R12) insulation in the cavity between the bottom chords (38 mm × 89 mm). Additional insulation is then layered above to achieve higher thermal insulation performance. Interior finish was assumed to be 12.7 mm gypsum board. Insulation was assumed to be blown fibreglass.

Table 16. Incremental Cost of Ceilings Below Attic Assemblies by Thermal Insulation Performance Level

Nominal Insulation RSI, $(m^2 \cdot K)/W$	Assembly Effective RSI, $(m^2 \cdot K)/W$	Incremental Cost, $/m^2
7.04 (R40)	6.91	0.00
8.81 (R50)	8.67	6.61
10.57 (R60)	10.43	14.69
12.33 (R70)	12.19	22.03
14.09 (R80)	13.96	29.37

3.2 Cathedral ceilings and flat roofs

Roof joists were assumed to be 38 mm × 235 mm at 610 mm o.c. It was also assumed that 19 mm strapping was installed between the joists and the 12.7 mm gypsum board interior finish. For flat roofs, both the joists and cavity insulation were assumed to vary with varying effective thermal resistance; as more insulation is added to the cavity, the joist depth may need to increase to maintain a vented air space. Therefore, incremental costing of cathedral and flat roofs considered both nominal cavity insulation and joist framing. All joists were assumed to be spaced at 610 mm o.c., and all assemblies were assumed to have the addition of 19 mm strapping. Cavity insulation was assumed to be batt insulation.

Table 17. Incremental Cost of Cathedral Ceiling and Flat Roof Assemblies by Thermal Insulation Performance Level

Nominal Cavity RSI, $(m^2 \cdot K)/W$	Joist Lumber Dimensions	Assembly Effective RSI, $(m^2 \cdot K)/W$	Incremental Cost, $/m^2
4.93 (R28)	38 mm × 235 mm	4.67	0.00
5.46 (R31)	38 mm × 235 mm	5.02	2.16
6.16 (R35)	38 mm × 286 mm	5.80	24.37
7.04 (R40)	38 mm × 286 mm	6.49	26.83

3.3 Floors over unheated spaces

The interior finish was assumed to be linoleum flooring for all exposed floor assemblies, and all assemblies are assumed to have a joist spacing of 610 mm o.c. Sheathing, wood joist depth and cavity were costed for all assemblies. Cavity insulation was assumed to be fibreglass batt.

Table 18. Incremental Cost of Floors Over Unheated Spaces by Thermal Insulation Performance Level

Nominal Cavity RSI, (m²·K)/W	Joist Lumber Dimensions	Sheathing	Assembly Effective RSI, (m²·K)/W	Incremental Cost, $/m²
3.52 (R20)	38 mm × 124 mm	0.88 RSI	4.71	0.00
4.93 (R28)	38 mm × 124 mm	None	5.02	–3.48
5.46 (R31)	38 mm × 235 mm	None	5.42	45.61
7.04 (R40)	38 mm × 286 mm	None	6.77	70.18

3.4 Wall assemblies

Reference and higher performance wall assemblies were selected from the Canadian Wood Council's (CWC, 2023) Effective R Calculator. Since material and labour costs for double stud systems were not readily available, only single stud systems were considered. Assemblies were also filtered for those with interior ½ in. gypsum board, exterior vinyl siding, no exterior air space, house wrap sheathing membrane and polyethylene vapour barriers (the latter two wall assembly components do not impact thermal performance).

Table 19. Incremental Cost of Wall Assemblies by Thermal Insulation Performance Level

Assembly Effective RSI, (m²·K)/W	Description	Incremental Cost, $/m²	CWC Wall ID #
2.79	2 × 6 at 16 in. o.c. framing, R19 cavity insulation, 3/8 in. OSB sheathing, vinyl siding	0.00	9733
3.10	2 × 6 at 24 in. o.c. framing, R22 cavity insulation, 3/8 in. OSB sheathing, vinyl siding	–4.52	9740
3.23	2 × 6 at 24 in. o.c. framing, R24 cavity insulation, 3/8 in. OSB sheathing, vinyl siding	–3.03	9745
3.46	2 × 4 at 24 in. o.c. framing, R14 cavity insulation, 3/8 in. OSB sheathing, 1.5 in. XPS, vinyl siding	0.07	10045
3.85	2 × 6 at 24 in. o.c. framing, R19 cavity insulation, 3/8 in. OSB sheathing, 1 in. foil faced polyiso, vinyl siding	5.07	10155
4.07	2 × 6 at 24 in. o.c. framing, R22 cavity insulation, 3/8 in. OSB sheathing, 1 in. foil faced polyiso, vinyl siding	8.24	10160
4.20	2 × 6 at 24 in. o.c. framing, R24 cavity insulation, 3/8 in. OSB sheathing, 1 in. foil faced polyiso, vinyl siding	9.74	10165
4.35	2 × 4 at 24 in. o.c. framing, R14 cavity insulation, 3/8 in. OSB sheathing, 2.5 in. XPS, vinyl siding	12.93	12272

4.80	2 × 4 at 24 in. o.c. framing, R14 cavity insulation, 3/8 in. OSB sheathing, 3 in. XPS, vinyl siding	21.16	12352
4.88	2 × 6 at 24 in. o.c. framing, R22 cavity insulation, 3/8 in. OSB sheathing, 2 in. XPS, vinyl siding	23.89	10005
5.01	2 × 6 at 24 in. o.c. framing, R24 cavity insulation, 3/8 in. OSB sheathing, 2 in. XPS, vinyl siding	25.38	10010
5.32	2 × 6 at 24 in. o.c. framing, R22 cavity insulation, 3/8 in. OSB sheathing, 2.5 in. XPS, vinyl siding	32.11	12512
5.69	2 × 4 at 24 in. o.c. framing, R14 cavity insulation, 3/8 in. OSB sheathing, 4 in. XPS, vinyl siding	37.60	12432
5.77	2 × 6 at 24 in. o.c. framing, R22 cavity insulation, 3/8 in. OSB sheathing, 3 in. XPS, vinyl siding	40.33	12592
6.66	2 × 6 at 24 in. o.c. framing, R22 cavity insulation, 3/8 in. OSB sheathing, 4 in. XPS, vinyl siding	56.78	12672

The RSI 3.10 assembly costs $4.52/m^2 less than the reference RSI 2.79 assembly. This is due to the RSI 2.79 assembly having 16 in. o.c. studs, whereas the RSI 3.10 assembly has 24 in. o.c. studs. There are fewer studs per m^2 and, as reported by RSMeans, the material and labour costs are therefore reduced.

3.5 Foundation walls

All foundation wall assemblies were assumed to have 200 mm concrete walls and interior 12.7 mm gypsum board finishes. The interior framing and cavity insulation and the exterior insulation (assumed to be extruded polystyrene, XPS) were the only elements assumed to vary between the different foundation wall assemblies considered. All interior framing was assumed to be spaced at 610 mm o.c.

Table 20. Incremental Cost of Foundation Walls by Thermal Insulation Performance Level

Framing Studs Lumber Dimensions	Nominal Cavity RSI, (m^2·K)/W	XPS RSI, (m^2·K)/W	Assembly Effective RSI, (m^2·K)/W	Incremental Cost, $/m^2
38 × 89 mm	2.11 (R12)	None	1.98	0.00
38 × 140 mm	3.52 (R20)	None	2.98	23.80
38 × 140 mm	4.23 (R24)	None	3.46	28.13
38 × 140 mm	3.52 (R20)	0.88 (R5)	3.97	50.48
38 × 140 mm	4.23 (R24)	0.88 (R5)	4.34	54.81
38 × 140 mm	4.23 (R24)	1.32 (R7.5)	4.78	60.01
38 × 140 mm	4.23 (R24)	1.76 (R10)	5.22	64.91

3.6 Slabs-on-grade and below grade

Only under-slab rigid insulation was assumed to vary between the different effective thermal resistance performance levels.

Table 21. Incremental Cost of Slabs-on-Grade and Below Grade Assemblies by Thermal Insulation Performance Level

XPS RSI, $(m^2 \cdot K)/W$	Assembly Effective RSI, $(m^2 \cdot K)/W$	Incremental Cost, $/m^2
1.76 (R10)	1.96	0.00
2.64 (R15)	2.84	17.74
3.52 (R20)	3.72	34.38
4.42 (R25)	4.62	51.20

3.7 Windows

Table 22. Incremental Cost of Windows by Thermal Transmittance Value

U-Value, $W/(m^2 \cdot K)$	Solar Heat Gain Coefficient	Incremental Cost, $/m^2	LEEP Database Reference
1.84	0.40	0.00	LEEP-MB-Winnipeg - window:double_glaze:vinyl:glass:double_lof_lowe: insulating_spacers:air_fill:shgc_0.5:u-value_1.82
1.61		37.00	LEEP-MB-Winnipeg - window:shgc_0.51:u-value_1.65
1.44		60.92	Interpolated
1.22		85.96	Interpolated
1.05		105.32	LEEP-MB-Winnipeg - window:shgc_0.44:u-value_1.08
0.94		117.84	Extrapolated
0.82		131.51	Extrapolated

3.8 Skylights

Self Flashing Fixed – Model VSF (U-value decrease from 2.75 to 1.84)

- 2 × 4 double glazed loE^3 to 2 × 4 triple glazed loE^3: 35% premium
- Standard sizes other than 2 × 4: 70% premium

Curb Mounted Fixed – Model VCM – OF (U-value decrease from 2.41 to 1.61)

- 2 × 4 double glazed loE^3 to 2 × 4 triple glazed loE^3: 35% premium
- Standard sizes other than 2 × 4: 70% premium

4 Airtightness

Mandatory airtightness testing is required by Tier 5 of the prescriptive path to validate compliance with Airtightness Level (AL) 4, considering that:

1. Increasing the airtightness level of the house is essential for achieving Tier 5 energy performance, as the energy loss due to air leakage/infiltration accounts for a significant portion of the overall building energy loss. Figure 1 shows the percent energy loss due to air leakage/infiltration with different levels of airtightness for different climate zones.

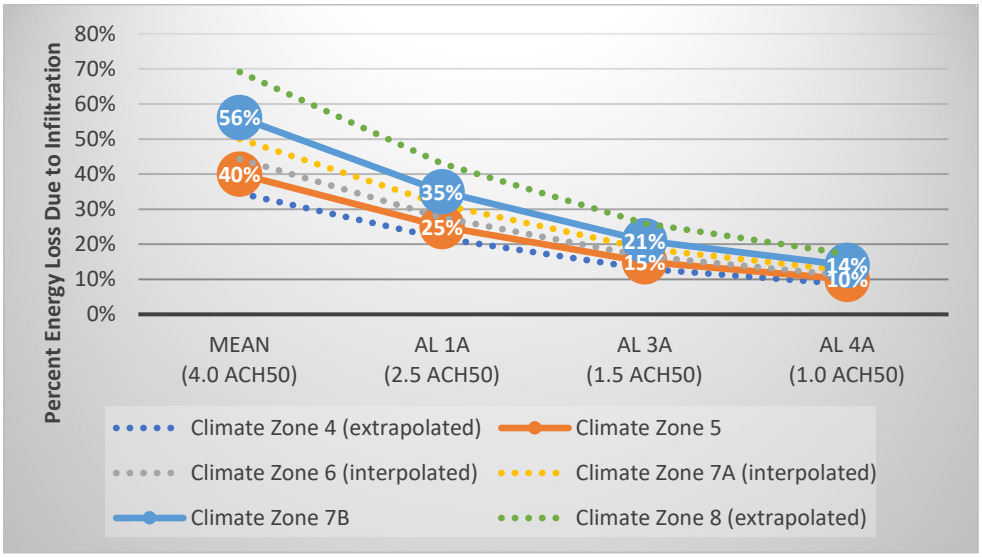

Figure 1. Percent energy loss due to air leakage/infiltration for houses

Notes to Figure:

- 240 new construction housing archetypes from NRCan CanmetENERGY were used in this preliminary analysis
- MEAN (4.0 ACH_{50}): mean plus one standard deviation of 19,333 detached home blower door tests, vintages 2015–2019, from EnerGuide Housing Database
- AL 1A (2.5 ACH_{50}): Airtightness Level (AL)-1A according to Table 9.36.6.4.-A in the NBC 2020, which is the value used in the energy model calculations for the reference house
- AL 3A (1.5 ACH_{50}): recommended airtightness level for Energy Performance Tier 4 in the NBC
- AL 4A (1.0 ACH_{50}): recommended airtightness level for Energy Performance Tier 5 in the NBC

2. It is difficult to verify whether the current prescriptive measures to minimize the air leakage of building components and assemblies have been properly constructed based on a visual inspection alone without conducting a whole building airtightness test, especially for houses built to meet high energy performance tiers.
3. Conducting an airtightness test would be the most economical way to achieve the energy savings goal for Tier 5, as the cost of an airtightness test would be offset by decreasing the construction costs for a Tier 5 design at increasing levels of airtightness (i.e., a savings of $4,000 to $50,000). Table 23 shows examples of wall assemblies to achieve Tier 5 performance under different airtightness levels, and Table 24 shows the estimated associated costs by geographic region.

Table 23. Typical Wall Assemblies to Achieve Tier 5 Performance with Different Airtightness Levels

Wall Construction					
Zone 4	**Zone 5**	**Zone 6**	**Zone 7A**	**Zone 7B**	**Zone 8**
½ in. gypsum board					
Smart vapour retarder					
2 × 4 framing at 16 in. o.c.		2 × 6 framing at 16 in. o.c.			
Batt insulation (R12)		Batt insulation (R19)			
½ in. plywood sheathing					
Spun bonded polyolefin					
3.2 ACH 5 in. XPS (R25) **2.5 ACH** 4.5 in. XPS (R22.5) **1.0 ACH** 4 in. XPS (R20)	**3.2 ACH** 5 in. XPS (R25) **2.5 ACH** 4.5 in. XPS (R22.5) **1.0 ACH** 4 in. XPS (R20)	**3.2 ACH** 7.5 in. XPS (R37.5) **2.5 ACH** 6.5 in. XPS (R32.5) **1.0 ACH** 4 in. XPS (R20)	**3.2 ACH** 8.5 in. XPS (R42.5) **2.5 ACH** 7 in. XPS (R35) **1.0 ACH** 4 in. XPS (R20)	**3.2 ACH** 12 in. XPS (R60) **2.5 ACH** 10 in. XPS (R50) **1.0 ACH** 5.5 in. XPS (R27.5)	**3.2 ACH** 12 in. XPS (R60) **2.5 ACH** 10 in. XPS (R50) **1.0 ACH** 5.5 in. XPS (R27.5)
Strapping					
Vinyl siding					

Table 24. Estimated Cost of Typical Wall Assemblies in Climate Zones 4 and 5 for a Small, 2-Storey, 261 m^2 (2,809 $ft.^2$) House to Achieve Tier 5 Performance with Different Airtightness Levels by Region

Zones 4 and 5	ON	BC	AB	Prairies	QC	Maritimes	Northern
3.2 ACH RSI 6.53 (R37)	$70,219	$70,494	$70,013	N/A	N/A	$71,730	N/A
2.5 ACH RSI 5.99 (R34)	$65,927	$66,202	$65,721	N/A	N/A	$67,421	N/A
1.0 ACH RSI 4.81 (R27)	$61,635	$61,909	$61,429	N/A	N/A	$63,111	N/A

Note to Table:

Costing data were collected from RSMeans. Costing includes bare materials and labour.

Table 25. Estimated Cost of Typical Wall Assemblies in Climate Zone 6 for a Small, 2-Storey, 261 m^2 (2,809 $ft.^2$) House to Achieve Tier 5 Performance with Different Airtightness Levels by Region

Zone 6	ON	BC	AB	Prairies	QC	Maritimes	Northern
3.2 ACH RSI 9.33 (R53)	$93,019	$93,019	$92,572	$92,178	$92,229	$93,448	N/A
2.5 ACH RSI 8.28 (R47)	$84,435	$84,435	$83,988	$83,628	$83,645	$84,829	N/A
1.0 ACH RSI 5.69 (R32)	$62,974	$62,974	$62,527	$62,253	$62,184	$63,283	N/A

Note to Table:

Costing data were collected from RSMeans. Costing includes bare materials and labour.

Table 26. Estimated Cost of Typical Wall Assemblies in Climate Zone 7A for a Small, 2-Storey, 261 m^2 (2,809 $ft.^2$) House to Achieve Tier 5 Performance with Different Airtightness Levels by Region

Zone 7A	ON	BC	AB	Prairies	QC	Maritimes	Northern
3.2 ACH RSI 10.04 (R57)	$101,603	$101,603	$101,157	$100,728	$100,813	$102,067	N/A
2.5 ACH RSI 8.80 (R50)	$88,727	$88,727	$88,280	$87,903	$87,937	$89,139	N/A
1.0 ACH RSI 5.78 (R33)	$62,974	$62,974	$62,527	$62,253	$62,184	$63,283	N/A

Note to Table:
Costing data were collected from RSMeans. Costing includes bare materials and labour.

Table 27. Estimated Cost of Typical Wall Assemblies in Climate Zones 7B and 8 for a Small, 2-Storey, 261 m^2 (2,809 $ft.^2$) House to Achieve Tier 5 Performance with Different Airtightness Levels by Region

Zones 7B and 8	ON	BC	AB	Prairies	QC	Maritimes	Northern
3.2 ACH RSI 12.33 (R70)	$131,648	$131,648	$131,202	$130,652	$130,858	$132,232	$134,807
2.5 ACH RSI 10.57 (R60)	$114,480	$114,480	$114,033	$113,552	$113,690	$114,995	$117,433
1.0 ACH RSI 6.69 (R38)	$75,850	$75,850	$75,404	$75,078	$75,061	$76,211	$78,340

Note to Table:
Costing data were collected from RSMeans. Costing includes bare materials and labour.

Codes Canada conducted a survey in spring 2023 on the availability and cost of airtightness testing in Canada, which supports the rationale that airtightness testing is available at fairly low prices (i.e., $150 to $3,250, see Table 28), and shows that the price increase to account for travel costs covering long distances is reasonable.

Table 28. Cost of Airtightness Test by Geographic Region

Type of Test	ON	BC	AB	Prairies	QC	Maritimes	Northern
Blower door	$200–$3,000 ($575 median)	$150–$2,000 ($475 median)	$150–$2,000 ($425 median)	$250–$2,000 ($500 median)	$250–$1,200 ($500 median)	$250–$1,250 ($750 median)	$3,250*

Note to Table:
Costing data were collected from a survey on airtightness testing by Codes Canada.*Costing includes estimated travel costs.

5 HVAC and service water heating system

5.1 Heat-recovery ventilator/energy-recovery ventilator

A heat-recovery ventilator (HRV) or an energy-recovery ventilator (ERV) with a minimum 75% sensible recovery efficiency (SRE) is required by the Tier 5 Prescriptive Path. See Table 29 for the incremental costs and percent energy savings of HRVs/ERVs with different efficiencies.

Table 29. Estimated Percent Energy Savings and Incremental Cost of HRVs/ERVs with Different Sensible Heat-Recovery Efficiencies

SRE	Energy Savings (%)	Incremental Costs for HRV/ERVs in Various Regions, $						
		ON	BC	QC	SK and MB	Atlantic Canada	AB	Northern Canada
70%	3.9–4.4	200	200	200	200	200	200	200
80%	4.4–5.0	395	395	395	395	395	395	395
85%	4.7–5.3	855	1,305	1,305	1,305	1,305	1,305	1,305

Source: buildwithrise.ca, includes profit and Canada-wide free shipping
Notes to Table:
Products:

- Honeywell Home VNT5070H1000/U (SRE ~60%)
- Greentek PH 7.15 ES (SRE ~65%)
- Greentek PH 10.22 ES (SRE ~70%)
- Greentek Solace 2.0H (SRE ~80%)
- Greentek Solace 1.5H-EC (SRE ~85%)

5.2 Space heating

Heat pumps were recommended to use as the space heating equipment for the electric and dual-energy packages. To ensure the performance of the heat pump in colder Climate Zones, the heat capacity and the coefficient of performance in heating mode (COP_h) at certain testing temperatures were specified. Specifications of the cold climate heat pumps reduce the options for heat pump equipment available to achieve compliance with Tier 5.

The criteria of the cold climate heat pump efficiency align with the EnergySTAR program (https://www.energystar.gov/products/heating_cooling/heat_pumps_air_source/key_product_criteria).

Compared to the heat pump systems that currently meet Base code prescriptive compliance criteria (i.e., Article 9.36.3.10 of the NBC), the cold climate heat pump equipment proposed for Tier 5 prescriptive compliance were estimated to cost 30%–70% more, depending on the equipment size.

Table 30. Estimated Cost of Ductless Mini-Split Heat Pump

HP Size (Btu)	Recommended Room Size ($ft.^2$)	Basic		Tier 5		Incremental Cost	
		HSPF5	Cost, $	HSPF5 (≥ 8.7)	Cost, $	Efficiency	Size Difference
9000	100–450	7.8	900	11	1,200	33%	–
12000	450–750	8.4	1,100	10.5	1,500	36%	24%
18000	700–1000	8.3	1,200	11	2,000	67%	23%
24000	1,000–1,250	8.0	1,400	10	2,200	57%	13%

Source: Information obtained from https://senville.ca/ on August 9, 2023, includes Canada-wide free shipping
Note to Table:
Product: Ductless Mini-Split Heat Pump with AC

Table 31. Estimated Cost of Ducted Heat Pump

HP Size (Btu)	Recommended for Room Size ($ft.^2$)	Basic		Tier 5		Incremental Cost
		HSPF5	Cost, $	HSPF5 (≥ 8.7)	Cost, $	
24000	1,000–1,250	8.3	10,268	9.6	24,008	134%

5.3 Service water heating

Heat pump water heaters are required as the service water heating equipment for the electric and dual-energy packages in the Tier 5 prescriptive path.

Heat pump water heaters cost between $2,950 and $3,899, depending on the size, which is 69%–84% more expensive than basic electric water heaters. (NOTE: cost information obtained from https://www.homedepot.ca/en/home.html on July 17, 2023.)

5.4 Drain-water heat-recovery

Drain-water heat-recovery (DWHR) units with minimum 42% heat-recovery efficiency were also required in the Tier 5 prescriptive path.

DWHR units with 42% heat recovery efficiency are sold through larger plumbing contractors for less than $500. Table 32 shows the cost and energy savings of DWHR units with different heat-recovery efficiencies.

Table 32. Estimated Fraction of Energy Savings and Cost of DWHR Units with Different Heat-Recovery Efficiencies

Heat Recovery Efficiency	Energy Savings, %	Cost of DWHR Unit, $						
		BC	AB	SK and MB	ON	QC	Atlantic Canada	Northern Canada
30%*	1.5–2.4	402	402	402	402	402	402	402
40%**	2.0–3.1	499	499	499	499	499	499	499
50%**	2.4–3.7	539	539	539	539	539	539	539
60%**	2.8–4.4	699	699	699	699	699	699	699
70%***	3.2–5.0	1,410	1,410	1,410	1,410	1,410	1,410	1,410
75%***	3.4–5.4	1,674	1,674	1,674	1,674	1,674	1,674	1,674

Source: homedepot.ca and renewability.com, includes profit and Canada-wide free shipping. Costs are effective as of May 11, 2023.

Notes to Table:

Products:

* Powerpipe DWHR unit, 3 in. drain (for 30% efficiency units)

** ThermoDrain DWHR unit, 3 in. drain with PEX (for 40%–60% efficiency units)

*** Powerpipe DWHR unit, 4 in. drain (for 70% and 75% efficiency units). The costs for 70% and 75% efficiency DWHR units are for 4 in. drains compared to 3 in. drains for other efficiencies, resulting in higher costs.

The 42% efficiency DWHR units could also be purchased and installed by house builders for between $500 and $700 (e.g., ~$540 in the Greater Toronto Area, ~$650 in the Ottawa area, or ~$520 in the Edmonton area). (NOTE: information on installation costs was provided by a manufacturer's representative at the Task Group meeting in April 2023.)