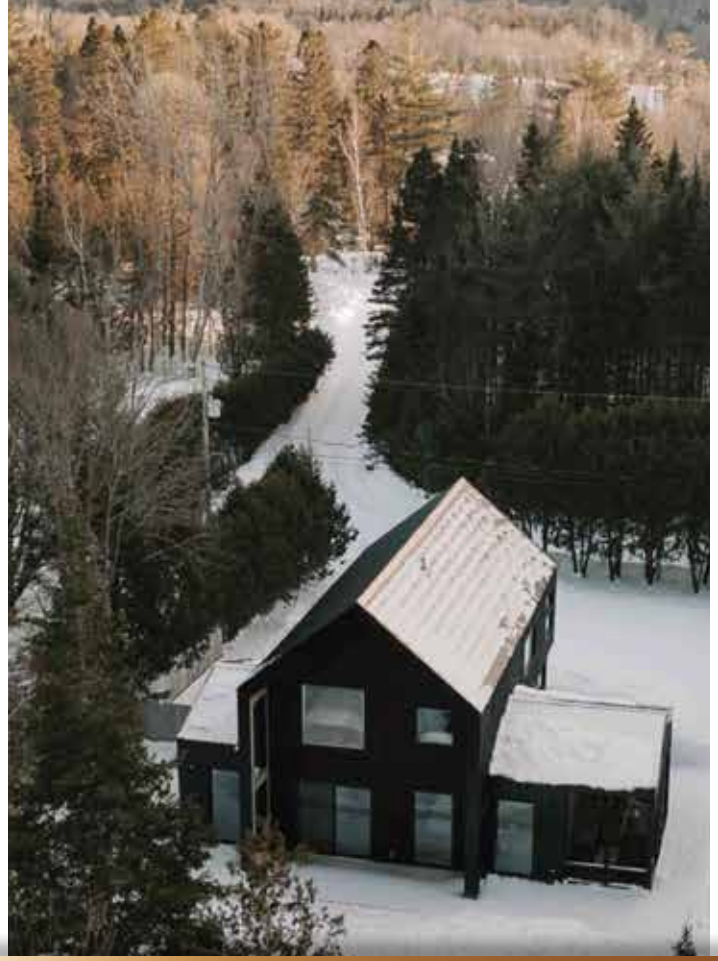
COLD CLIMATE

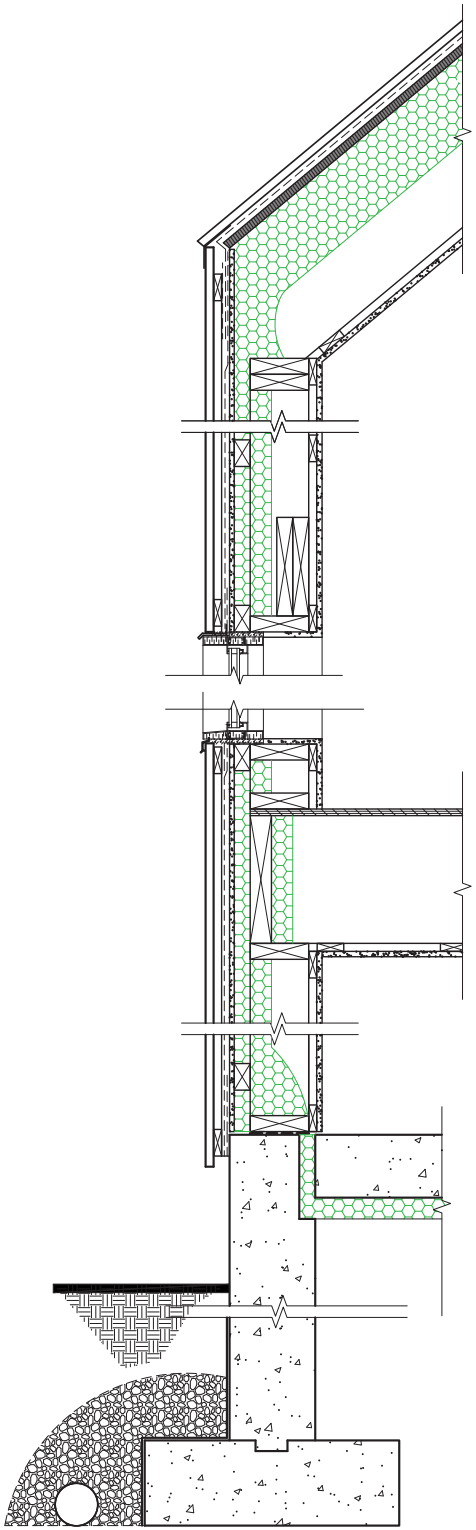
CASE STUDY

HUNTSMAN
BUILDING SOLUTIONS



THE PROJECT

The house is located in Sainte-Adèle Québec, Canada. This is a nice little town in the Laurentians, around ski mountains, rivers and lakes. The house construction began in 2019 and completed in July 2020, when the owners moved in. It sits on a small lot by a river, facing south. After looking at many options for the insulation of their project, the owners decided to go with Heatlok Soya closed cell spray foam for the whole house (roof, walls and under slab). Having seen the D-Max wall assembly for commercial construction, the owner, whom also has a background in architecture, decided to apply this concept for his residential property. This concept provides time and cost savings during construction, and over the lifetime of the building by reducing energy consumption while reducing carbon operational emissions. Closed cell spray foam usually represents a larger investment up front, but the payback is provided by energy savings and durability. The fact that the Heatlok product has an Environmental Product Declaration (EPD), confirming its lower carbon footprint compared to any other types of insulation, also had an impact on the insulation choice.



THE BUILDING ENVELOPE

The priority in this project was of course, the quality of finishes, but most importantly, the quality and durability of the building envelope. This is the foundation of building performance.

The roof assembly consisted of:

- Exterior Steel Roof
- Full Surface Peel and Stick Membrane
- OSB Sheathing
- 2x12 Rafters
- 7” Heatlok Soya Closed Cell Spray Foam
- Interior Furring
- Gypsum Sheathing

With the Scandinavian design of the house, the unvented roof assembly allowed for a very straight line at the intersection of the roof and wall. No overhangs or soffits. With a vented roof, there would have been a need for a ventilation grid, compromising the design and increasing the risk of water infiltration, wind uplift or even burning ember penetration in the case of a forest fire.

The wall assembly consisted of:

- Exterior Wood Cladding
- Double Exterior Furring (vertical and horizontal)
- Weather Barrier
- OSB Sheathing
- Horizontal 2x3 Wood Furring
- Vertical 2x6 Wood Studs
- 4” Heatlok Soya Closed Cell Spray Foam (installed in the cavity of 2x6 and 2x3 assembly)
- Interior Furring
- Gypsum Sheathing

The fact that there’s 1.5” of spray foam on the exterior of the entire structure (including LVL’s and rim boards) ensures that the airtightness is perfect, but also acts as a secondary barrier against water infiltration. Spray foam acts as the insultation, air barrier and vapor barrier, all in one product. It therefore removes the need to install an additional vapor barrier product (like polyethylene sheeting) on the interior, simplifying the work. It is also very quick to install, as only 1 and a half days were needed to complete the installation. This is very quick for a 2,000 square foot project.

The slab and foundation consisted of 2” of Heatlok Soya below the concrete slab with 1” between the slab and the foundation walls. The radon protection was important for the owners and the fact that this spray foam product acts as a radon barrier was an added benefit to the other properties highlighted previously.

HEATING AND MECHANICAL SYSTEMS

As this project is a slab on grade, with an additional story on top, it allowed for a polished and electric heated concrete slab for the ground level, while the upper level has engineered wood floors with baseboards heating.

Again, the goal was to increase the building performance through the building envelope rather than with mechanical systems. Therefore, the mechanical systems were kept very simple. Only a Heat Recovery Ventillation (HRV) air exchanger was installed. The model was Lifebreath RNC6-ES, with extraction grids in both bathrooms and grids in all bedrooms and main living area. The windows and doors were also typical and not considered high-performance windows or doors.

AIR LEAKAGE

Air barriers are one of the most important parts of the building envelope. Not only can reducing air leakage reduce the risk of condensation, but it also greatly decreases energy consumption and improves comfort. Heatlok Soya does not only have a high thermal resistance, it is one of the best and durable air barrier product in the industry.

According to the Renoclimat report, this house achieved an ACH 50 of 0.5. This means that there are 0.5 air changes per hour at a pressure differential of 50 pascals. This is very low, which means excellent performance of the air barrier. It is also estimated to have a leakage area of 118.3 cm^2 (18 in^2). The same house, built to code, would be at an ACH 50 of 2.17 with a leakage area of 485.8 cm^2 (75 in^2). The leakage area is more than 4 times smaller in this case study house than in a house built to code.

The inspector that performed the blower test was very impressed by this house and said it was the most airtight house she ever tested.

D-MAX WALL ASSEMBLY

This concept started on the commercial side of construction and has gained a lot of traction, very quickly, since its launch. The first project was completed in 2018 and in 2025, there are now more than 150 completed projects. Although, built with steel and concrete structures on the commercial side, it can easily be adapted to wood frame construction on the residential side. The goal of this assembly is to increase performance while reducing costs, materials, and time spent on projects. Continuous insulation, or thermal bridge covering is now mandatory. We therefore need more than just cavity insulation, we need to cover the entire structure. The D-Max concept allows for this but also allows for the thermal bridges to be covered at the same time the cavity insulation is installed. The horizontal 2x3's, that are installed on the outside of the 2x6's, create an additional cavity outside of the structure, allowing spray foam to seal and insulate this gap. Since the spray foam can be applied in only one application, and completely from the interior, this reduces the number of interventions and materials required to complete the building envelope. On the residential side, this concept might not provide the same initial savings as on the commercial side, but does provide a quick payback with high energy savings, as demonstrated above, while increasing the quality, durability, and comfort of the house.

ENERGY EFFICIENCY AND CONSUMPTION DATA

Quebecers used an average of 191 gigajoules of energy in 2021, more than triple the global average of 54 gigajoules, according to the 2024 edition of L'État de l'énergie au Québec, an annual report prepared by HEC Montréal's energy management chair.

According to the evaluation from the energy efficiency program Renoclimat, this house is expected to use 75 gigajoules while an identical, typical new house (by code), would be at 101 gigajoules. An external company was mandated by the provincial energy efficiency program to come on site for an evaluation and a blower door test. This evaluation and testing was conducted 4 years after the house construction. This demonstrates the durability of the building envelope and its performance.

Many houses are tested right after they are built which doesn't demonstrate the long-term performance of the building envelope. A typical product's performance can degrade over time, products can sag, lose their adhesion, and even mold can sometimes quickly appear because of air and vapor barriers products that often leave room for error when they are being installed. That's not the case with closed cell spray foam as it's mold resistant, does not move or settle over time, and its durability has been demonstrated through many studies and testing.

Energy Data Summary Table

Years	Dates		Days	kW/h Total	Average kW/h per day	Average Exterior Temperature (Celsius)	Amount including taxes ($)
Year 1	6/30/2020	8/27/2020	59	617	10.5	20	70.69
	8/28/2020	10/28/2020	62	2245	36.2	9	185.92
	10/29/2020	12/29/2020	62	6191	99.9	-1	602.55
Year 2	12/30/2020	2/25/2021	58	6673	115.1	-9	658.74
	2/26/2021	4/29/2021	63	4424	70.2	2	412.8
	4/30/2021	6/29/2021	61	1880	30.8	14	162
	6/30/2021	8/30/2021	62	1238	20	19	117.01
	8/31/2021	10/28/2021	59	1902	32.2	12	162.61
	10/29/2021	12/29/2021	62	5682	91.6	-3	554.77
	Total or total average		**365**	**21799**	**59.98**	**5.83**	**2067.93**
Year 3	12/30/2021	2/25/2022	58	6851	118.1	-13	686.76
	2/26/2022	4/28/2022	62	4485	72.3	0	427.97
	4/29/2022	6/29/2022	62	1535	24.8	15	141.64
	6/30/2022	8/29/2022	61	1151	18.9	18	113.26
	8/30/2022	10/28/2022	60	2329	38.8	11	198.35
	10/29/2022	12/29/2022	62	5449	87.9	0	543.09
	Total or total average		**365**	**21800**	**60.13**	**5.17**	**2111.07**
Year 4	12/20/2022	2/27/2023	60	6025	100.4	-7	609.83
	2/28/2023	4/28/2023	60	3947	65.8	3	381.89
	4/29/2023	6/29/2023	62	2242	36.2	14	198.8
	6/30/2023	8/30/2023	62	1007	16.2	18	106.38
	8/31/2023	10/30/2023	61	2306	37.8	12	203.09
	10/31/2023	12/28/2023	59	6020	102	-2	628.66
	Total or total average		**364**	**21547**	**59.73**	**6.33**	**2128.65**
Year 5	12/29/2023	2/28/2024	62	6809	109.8	-7	716.36
	2/29/2024	4/29/2024	61	4332	71	2	436.59
	4/30/2024	6/27/2024	59	1639	27.8	15	156.74
	6/28/2024	7/18/2024	21	374	17.8	20	39.64

The total cost for electricity is very low for a house of 2,000 sq ft; around 175$/month. The owners also maintained a warm interior temperature, usually between 22ºC and 23ºC (71°F and 74°F). For the purpose of this case study, we've only looked and the data of the complete years which were year 2,3 and 4.

This table confirms the estimation from Renoclimat. They estimated the house at 75 gigajoules, with 68 gigajoules for electricity alone, which represents around 18,980 kw/h for a yearly total cost of 1,800$. Still in accordance with their evaluation, the same house, if built to code, would be between 101 and 112 gigajoules, with 94 gigajoules to 106 for electricity, representing 26,150 to 29,450 kw/h for 2,660$ to 2,800$ yearly.

Therefore, a well-sealed and insulated house like this one can save up to 1,000$ per year on electricity costs. These cost savings can be attributed to the building envelope as everything else is in line with a typical house (windows, mechanical systems, heating systems…).

Over a period of three years, the house had an average consumption of 21,715 kw/h per year. This represents 2,060$ yearly. This is slightly higher than estimated in the Renoclimat report, as occupant behavior impacts the performance. We can estimate that with the same occupant behavior, a house built to code would use around 29 905 kw/h, which would represent 2,835$.

These are the numbers with the current energy costs. If energy costs increase, then the owner are protected as the impact will be much less for this house than a traditionally insulated house.

**Note: For clarity, these numbers have been rounded to the closest 5$.*
***Note: Energy cost data is represented in CAD.*

RADON PROTECTION AND DATA

Although the Laurentians does not typically have high levels of radon, radon can be present anywhere in high concentration. Radon testing was conducted 4 years after the house construction, using an alpha track detector from AccuStar. The device was installed in the office, since this is where the owners spent most of their time. and was left for 4 months, between March and July. For accuracy of the testing, windows were never opened in that room during that time. Once testing was completed, the device was sent back to the lab for analysis. The results came back with a radon level of <15 Bq/m^3 which is considered very low. The Canadian action level is at 200 Bq/m^3. According to evictradon.org, the average level of radon per home in Canada is 85.3 Bq/m^3.

Heatlok Soya as not only been tested as an air barrier, which is one of the main ways radon travels, but also for radon diffusion through the material. At only 1", Heatlok Soya greatly outperforms traditional measures for soil gas protection, recommended in the Canadian Building Code.

"Newer properties in Canada have higher average radon levels than older ones. The reasons for this are still emerging, but are thought to be due to the fact that, overall, they tend to be larger in square footage, can be better insulated, and often have higher ceilings.", mentions the website. With newer homes that are better sealed than older homes, there is definitely less natural ventilation. This is one of the reasons why mechanical ventilation is important. Mechanical ventilation is important in this case study house, but not to extract radon as it is blocked before it can ever enter the building envelope.

Payback Calculation Table

	Canada (CAD) (rate 11 cents CAD per Kw/h)	US (USD) Average rate (16,54 cents USD per Kw/h)
If house is kept for 75 years	**Net Present Value**	**Net Present Value**
Inital upfront investement	13,000.00 $	$9,100.00
Cost savings on energy consumption over 1 year	775.00 $	$1,354.63
Present value of Cost savings on energy concumption over 75 years	22,765.63 $	$39,792.14
Present value of net benefit over 75 years	9,765.63 $	$30,692.14
(approximate) Years for present value of energy savings to equal the initial investment	24	8
If house is sold after 10 years		
Inital upfront investement	13,000.00 $	$9,100.00
Present value of cost savings on energy consumption over 10 years	6,595.56 $	$11,528.41
Present value of premium when selling for the high efficiency building enveloppe	7,408.00 $	$5,185.60
Present value of net benefit after 10 years	1,003.56 $	$7,614.01
New owner for 65 years		
Inital upfront investement for new owners	10,000.00 $	$7,000.00
Savings left for new buyers over 65 years	21,827.18 $	$38,151.82
Present value of net benefit for second owner over 65 years	11,827.18 $	$31,151.82

COST ANALYSIS

For this case study, the incremental cost for using a high-performance building envelope from Huntsman Building Solutions (HBS) over a more traditional fiber insulation building envelope is approximately 13,000$. Is it worth it? Let's see …

The high-performance building envelope is very durable, and the performance is very dependable over a long period of time. The Environmental Product Declaration (EPD) for the product is based on a timeframe of 75 years. Let's use that figure to determine what the current value of all the energy savings is over that time. Using the energy costs for this house you save about 775$/year. If you discount future years by 3% a year, to account for inflation, you end up with a current value of 22,765$.

If you were sitting at a table with your builder and someone from your utility company, would you write your builder a check for 13,000$ if you knew that would cause the representative from the utility company to write you a check for 22,765$ on the spot?

What if you don't stay in the house for 75 years? Almost nobody does that. You should be able to get a premium when you sell the house over what a house with a traditional building envelope would get (which was the case with this house). If you stayed in the house for 10 years, the current value of the energy savings is 6,595$. That leaves 21,830$ future energy savings to be earned by subsequent owners over 65 years. If you get a premium of 10,000$ when you sell after 10 years, the present value of that is 7,410$ and you still come out 1,005$ ahead. The new owner only pays that 10,000$ premium (not the whole 13,000$) and has a current value of future energy savings of 21,120$. That is a much better deal than buying a house with a traditional building envelope.

The energy costs for this area are some of the lowest in North America. If you take the same energy savings, but use an average cost of US energy. The advantages grow significantly for both the full 75-year scenario and the first and second homeowner if sold after ten years. In the average US energy cost scenario, a 9,100$ USD initial investment yields a present value of energy savings of 30,700$ – more than triple the initial investment.

If you use a simple payback calculation, you do not get an accurate assessment of the financial picture. It would take almost 24 years for the present value of the energy cost savings in Quebec to be equal to the initial investment. If you conclude you are unlikely to stay in the house that long, and therefore it is not worth it for you to choose the better building envelope, you are ignoring the future energy savings. This means the premium you can get when you sell, which still offers the next homeowner a comparably attractive deal to the one the original owner had, is being improperly ignored.

When you step back and look at this story, it shows what a compelling value a high-performance building envelope from HBS really is. Think about it this way. If you want to buy a Lincoln instead of a Ford, you have to pay more in order to get it. The Lincoln is some combination of higher quality and performance at a higher price. The ground chuck at the grocery store costs less than the filet mignon at the nice restaurant by the lake. Almost everything works that way. You pay more for higher quality and performance. However, that is not the way it works with a high-performance building envelope from HBS. Not only are you getting the better building envelope, you are also getting paid for choosing it compared to common alternatives. You don't have to think about that too long!

CONCLUSION

This case study demonstrates many things. Focusing on only increasing the building envelope performance can provide considerable savings per year on electricity costs. This house is estimated to consume 43% less energy than a typical new house. By reducing energy consumption, we can also reduce carbon emissions from operational emissions, while using a product that has less embodied carbon than most insulating products. In addition, the owners of this home will be better insulated from future energy cost increases, bringing peace of mind if energy price spikes occur.

The upfront investment is a bit higher than using traditional construction methods, but in addition to the payback of close to a 1000$ per year, the comfort is increased, the interior temperature is steady, there aren't any drafts or cold spots, as the air sealing is close to perfection. The resale value has also increased as many home buyers are now looking much more for energy efficient, durable and resilient homes. The initial investment was definitely worth it and the owners were quite impressed by this hidden added value.

RESOURCES

Radon Test Results

Renoclimat House Energuide Results

REFERENCES

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