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Building Envelope News

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How can you believe energy-savings forecasts?

More confidently than ever before... especially when your project includes an upgrade to the building envelope.

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The relationship between high performance building envelopes and improved energy efficiency, especially lower energy operating costs per square foot, has been accepted for some time by most engineers in the building envelope fraternity. But building owners and non-envelope engineering disciplines have taken longer to believe and apply this thinking to their projects.

However, the step-by-step assessment and calculation procedures used to predict savings match the proven savings from a growing inventory of documented projects.

Assessment and calculation

Calculating potential energy savings is a 3-stage process: a field survey, estimating air-leakage flow rate and appropriate corrective measures, then calculating potential savings and cost/benefit analysis. Let's look at a real-life example of a condominium building in Mississauga, Ontario.

Field survey

Major air leakage paths were discovered at exterior doors, window joints, duct penetrations, interior doors, roof/wall intersections, conduits passing through floors and elevator shafts and vents on the roof. Air sealing measures that would reduce the heating load and improve occupant comfort included weather-stripping common area doors (especially smoke shaft, stairwell, exterior and underground doors and those to roof/elevator, garbage and mechanical room), weather-stripping windows, sealing and caulking soffit/wall joints, fire cabinets and around windows.

Air leakage flow rates

In Fig. 1, we can see this Mississauga condo has an air leakage area of about 5.4185 m² (58.3 ft²) or about 2.9 cm²/m² of envelope area. Classification is as follows:

- Tight building – less than 0.7 cm²/m² of building envelope area
- Average – 0.7 to 1.6 cm²/m² of building envelope area
- Loose – 1.7 to 3.6 cm²/m² of building envelope area

Fig 1.

Air-sealing measures		Number	W/S, m	Caulk, m	W/S, m2/m	Seal, m2/m	W/S, m2	Seal, m2	Total, m2
Doors	Exterior Doors	43	262.13	301.45	0.00045	0.00012	0.1180	0.0362	0.1541
	Interior Doors	63	384.05	441.66	0.0003	0.00005	0.1152	0.0221	0.1373
Conduits		11				0.0006	-	0.0007	0.0007
Windows – awning	W/S		11,333.68	10,003.54	0.0003	0.00009	3.4001	0.9003	4.3004
Walls				10.67	0.00045	0.0003	-	0.0032	0.0032
Elect recep	Sealing	68				0.0001	-	0.0068	0.0068
Shafts Mechanicals	Pipes	21				0.0008		0.0168	0.0168
	Elect service shaf	100				0.00799166		0.7992	0.7992
							3.6333	1.7852	**5.4185**

The air leakage area (5.418 m²) was distributed as per the field observations. The appropriate airflow calculation parameters are shown in ***Fig. 2.***

The estimated monthly average air leakage rate is shown in ***Fig. 3.*** The heating season is assumed from mid September to end of May. Higher indoor/outdoor temperature differences during the winter months of December to February lead to higher air leakage rates.

Estimates of Energy and Cost Savings
Estimated total cost of air leakage control measures to upgrade this condo was $99,846. Assumptions used to estimate energy and cost savings included:

- Air sealing measures would be about 60 per cent effective based on previous field experience
- Weather data based on 30-year climate normals and monthly average weather data for Mississauga
- Fuel prices and calculated cost savings using utility data provided for the building
- Building operating data and schedules as provided by property management
- Overall building interactive effects (solar and internal gains and other loads) and purchased space heating consumption estimated at about 67% of total heat losses
- Retrofit measures assumed to reduce overall air leakage by 40%

Fig. 4 shows month-by-month energy savings associated with air-sealing measures.

Fig. 5 shows the summary of potential energy cost savings associated with air sealing measures. In this building, air-sealing upgrades would reduce the utility bills (mainly natural gas) by $20,580 every year, resulting in a simple payback period of about 4.9 years. The annual space heating cost savings would be about 14% of the total natural gas bill.

This example shows energy cost reduction potential with a generally acceptable return on investment. These cost-effective retrofits can result in other significant benefits, such as improved building durability, increased comfort and satisfaction of tenants, elimination of interior condensation, improved quality of the indoor environment and enhanced fire and smoke safety and security.

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Fig 2.

		Terrain	**Cpw**	0.18	
Wind shielding	2	1. Open	**Cd**	0.85	
		2.Suburban	**Wind velocity**	7	m/s
Ao	0.6	3.Urban	**ALC equivalence**	60	%
a	0.28		**Outdoor temp.**	-16	C
			TDS	0.85	

Fig 3.

Month	Airleakage Rate, m3/s
Jan	14.58
Feb	13.85
Mar	10.20
Apr	7.29
May	4.37
Sep	5.83
Oct	8.75
Nov	10.20
Dec	14.14

Fig. 4

Month	Degree Days	Energy Savings	
		Nat Gas, m3	$
January	791	18,619	$ 4,841
February	709	16,689	$ 4,339
March	578	9,522	$ 2,476
April	406	4,775	$ 1,242
May	82	579	$ 150
June	-	-	-
July	-	-	-
August	-	-	-
September	103	965	$ 251
October	267	3,762	$ 978
November	447	7,361	$ 1,914
December	718	16,882	$ 4,389
Total for the year	4100	79,153	$ 20,580

Fig. 5

		Heating Cost Savings ($)	Installation Cost ($)	Payback Period (Years)
1	Peel Condominium #xxx	$20,580	$99,846	4.9