Attic Ventilation in Northern Canadian Climates

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Paper #90

Overview

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2. Key Findings
3. Methodology
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5. Conclusion

Background

- Sustainable lifestyle destroyed by colonization.
- Dependence on foreign resources for housing.
- Poorly designed houses leads to overcrowding.

Background

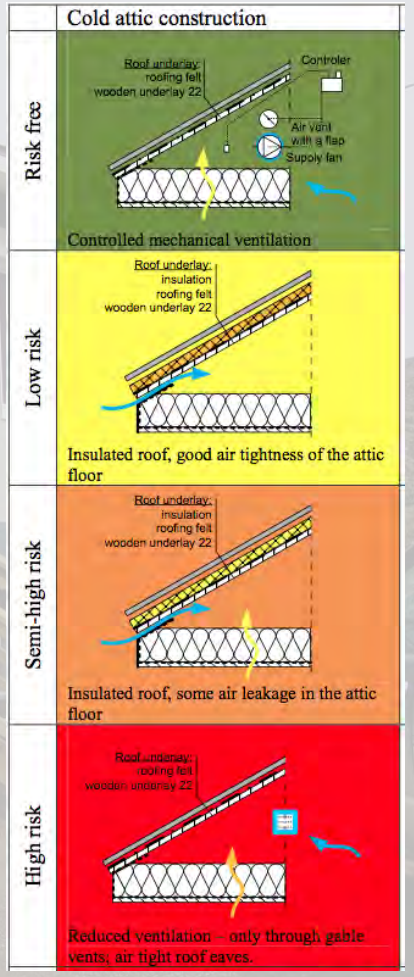
- Houses for Inuit communities must be:
  - Durable
  - Easy to construct
  - Energy efficient
  - Simple
  - Inexpensive

Background

- 142 SIP houses constructed since 2009.
- Construction was quick and easy.
- New SIP houses incorporate an unvented attic.
- Building designs lack testing and evaluation.

Attics in Cold Climate

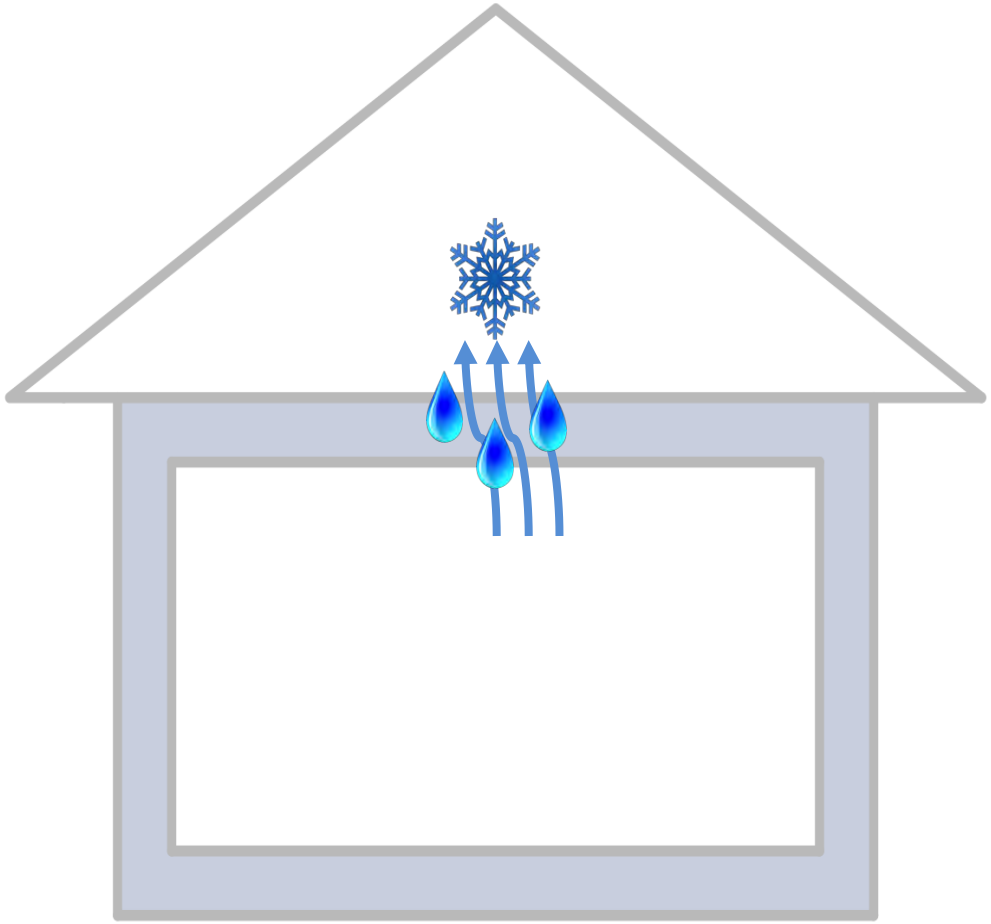
- Attic ventilation can alleviate moisture problems.
- Unvented, airtight attics can perform very well.
- Hygrothermal simulations can evaluate attics performance.
- Best attic designs for Swedish climate evaluated.
- 1:300 rule for attic ventilation is still enforced by code.



Hagentoft & Sasic Kalagasidis (2014)

Vented Attics

Unvented Attics

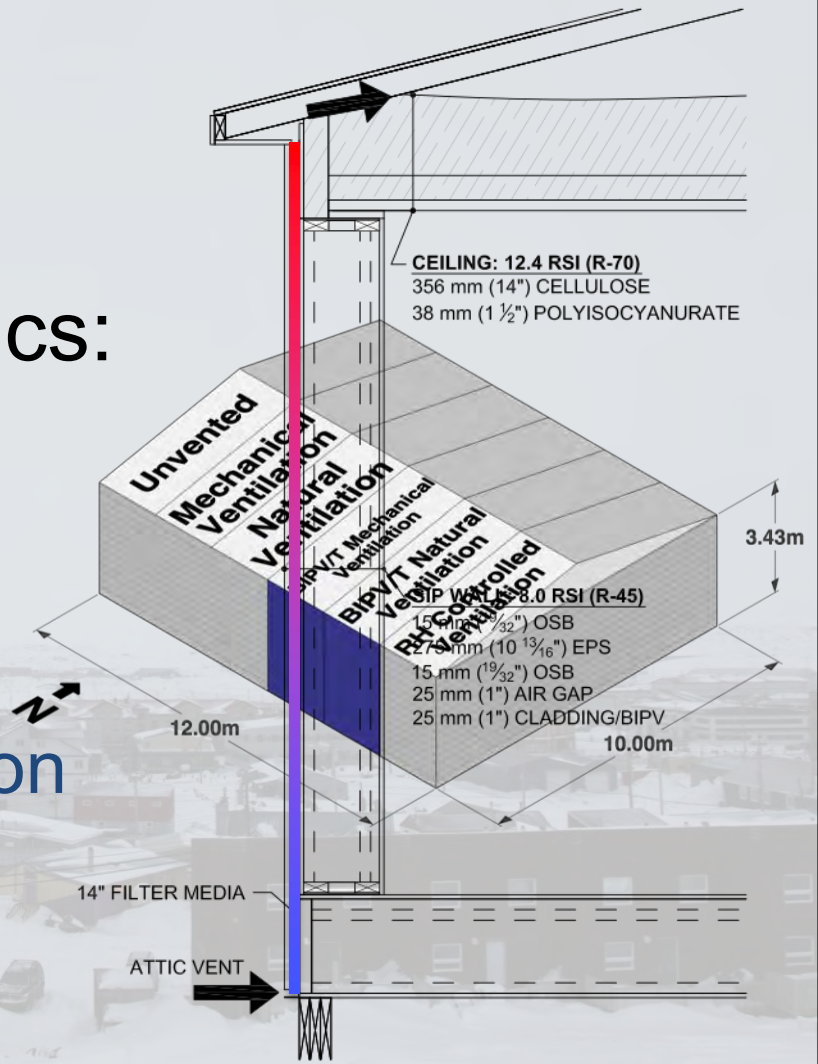


Objective

- To investigate using hygrothermal simulations the comparative hygrothermal performance of attics of various ventilation strategies, including novel BIPV/T attic ventilation, subjected to extreme cold climates.

Simulation Setup

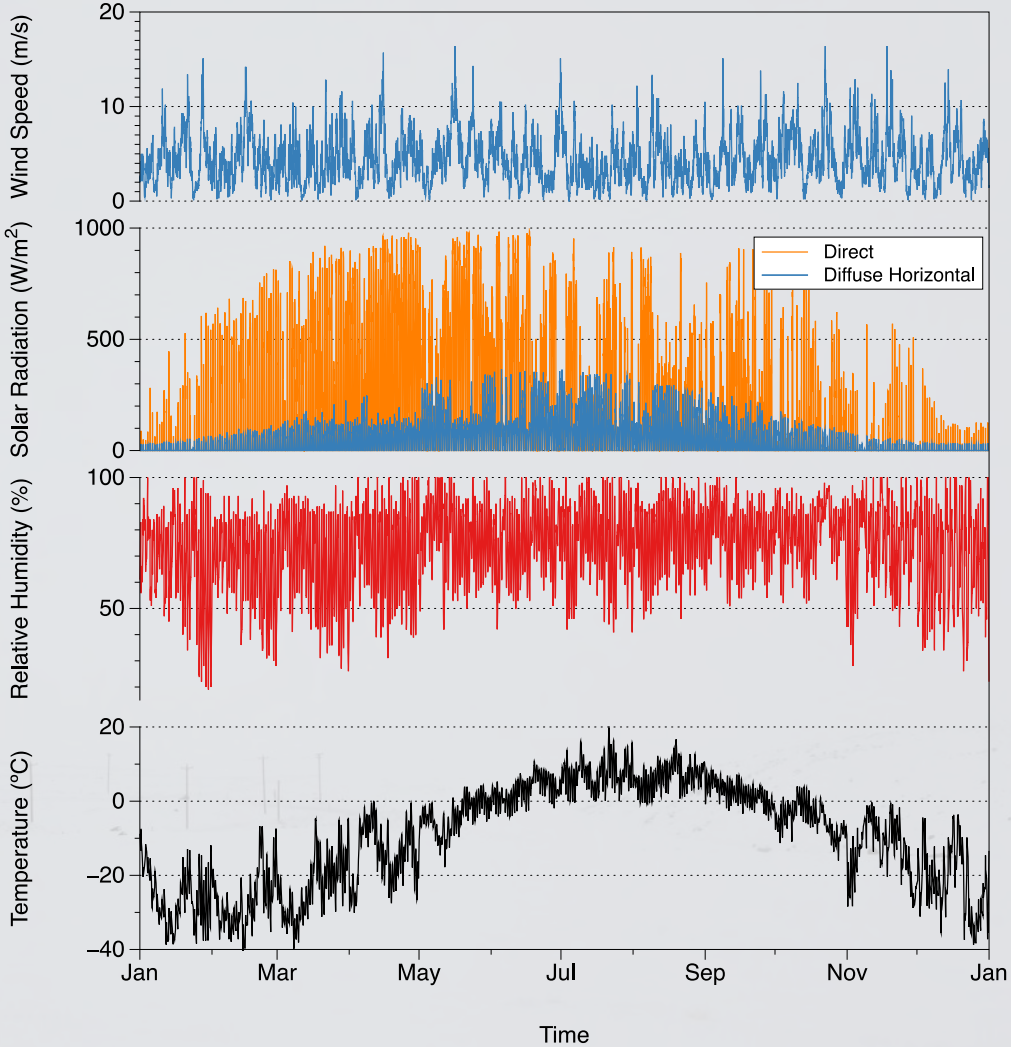
- Hygrothermal model developed in WUFI Plus.
- 12 x 10 m house with 6 attics:
  - No ventilation
  - Mechanical ventilation
  - Natural ventilation
  - BIPV/T mechanical ventilation
  - BIPV/T natural ventilation
  - RH controlled ventilation



Background | Key Findings | Methodology | Results | Conclusion

Iqaluit Weather

- TMY weather file provides hourly data on temperature, relative humidity, solar radiation, and wind conditions.

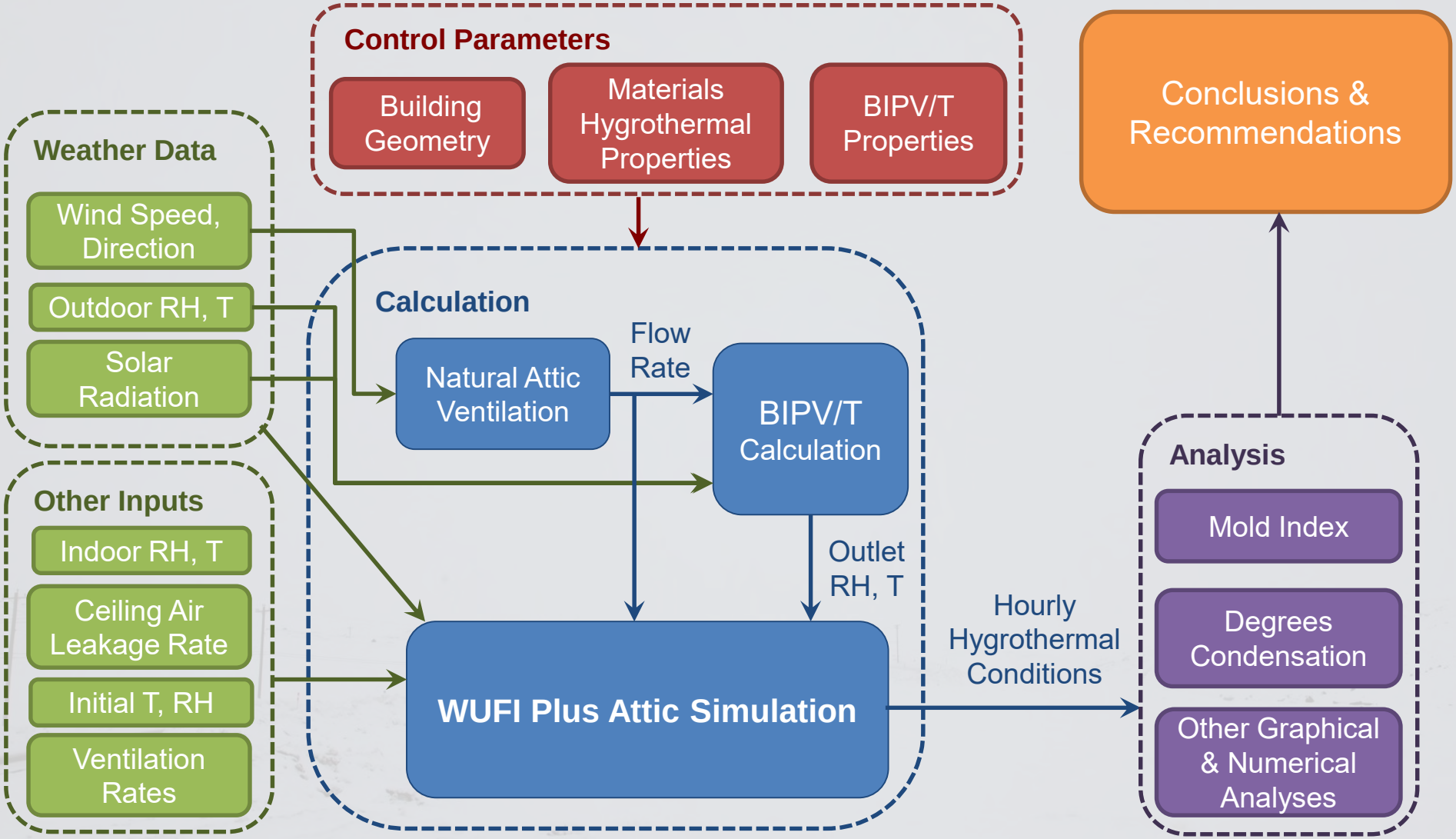


Simulation Methodology

- Various levels of air leakage
- CFD simulations used to determine ventilation rate by Kayello et al. (2016)
- Simplified BIPV/T heat transfer model developed by Athienitis et al. (2004)
- Mold Growth Index by Hukka & Viitanen (1999) to evaluate attics

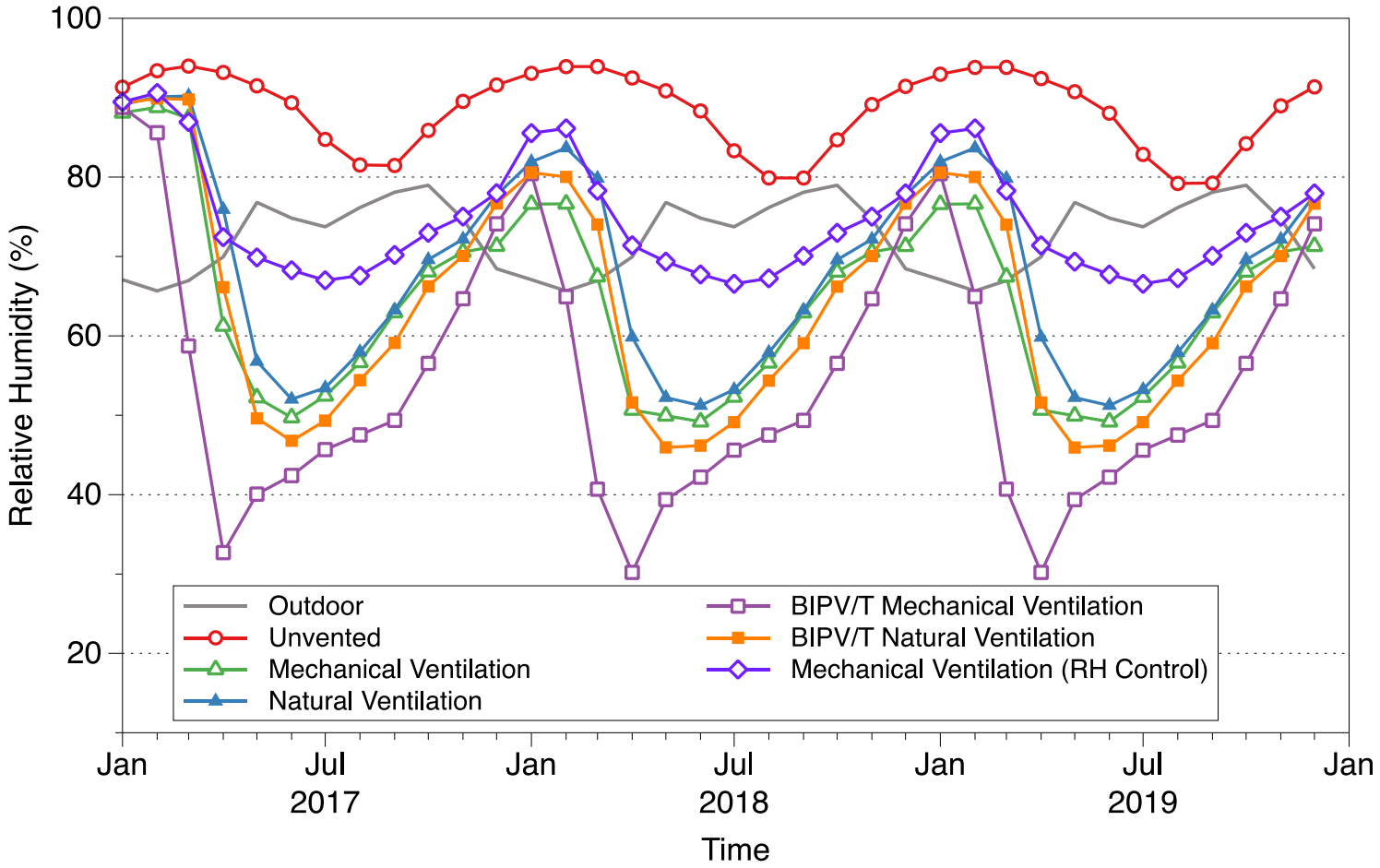
	Attic Ventilation Strategy					
Parameter	**Unvented**	**Mechanical Ventilation**	**Natural Ventilation**	**BIPV/T Mechanical Ventilation**	**BIPV/T Natural Ventilation**	**RH Controlled Ventilation**
Attic Volume	10 m^3					
Ventilation	0.05 ACH (0.5 m^3/h)	3 ACH (30 m^3/h)	Wind Dependent	9 ACH (90 m^3/h) Active only in the day	Wind Dependent	3 ACH Active when humidity difference > 0.5 g/m^3
Air Leakage Rates	None: 0 $m^3/h/m^2$, Low: 0.036 $m^3/h/m^2$, Medium: 0.09 $m^3/h/m^2$, High: 0.18 $m^3/h/m^2$					
Ceiling Assembly	203 mm of cellulose insulation and 38 mm PIR (equivalent to 7 RSI)					
Roof Assembly	Plywood, Spun-bonded Polyolefin, Air Space, Metal Roofing					
Indoor Environment	22 ºC, 40% RH					
Outdoor Environment	Iqaluit, Nunavut Typical Meteorological Year (TMY2) weather file					
Initial Attic Conditions	-20 ºC, 80% RH					
Simulation Duration	3 years starting January 1st					

Simulation Methodology



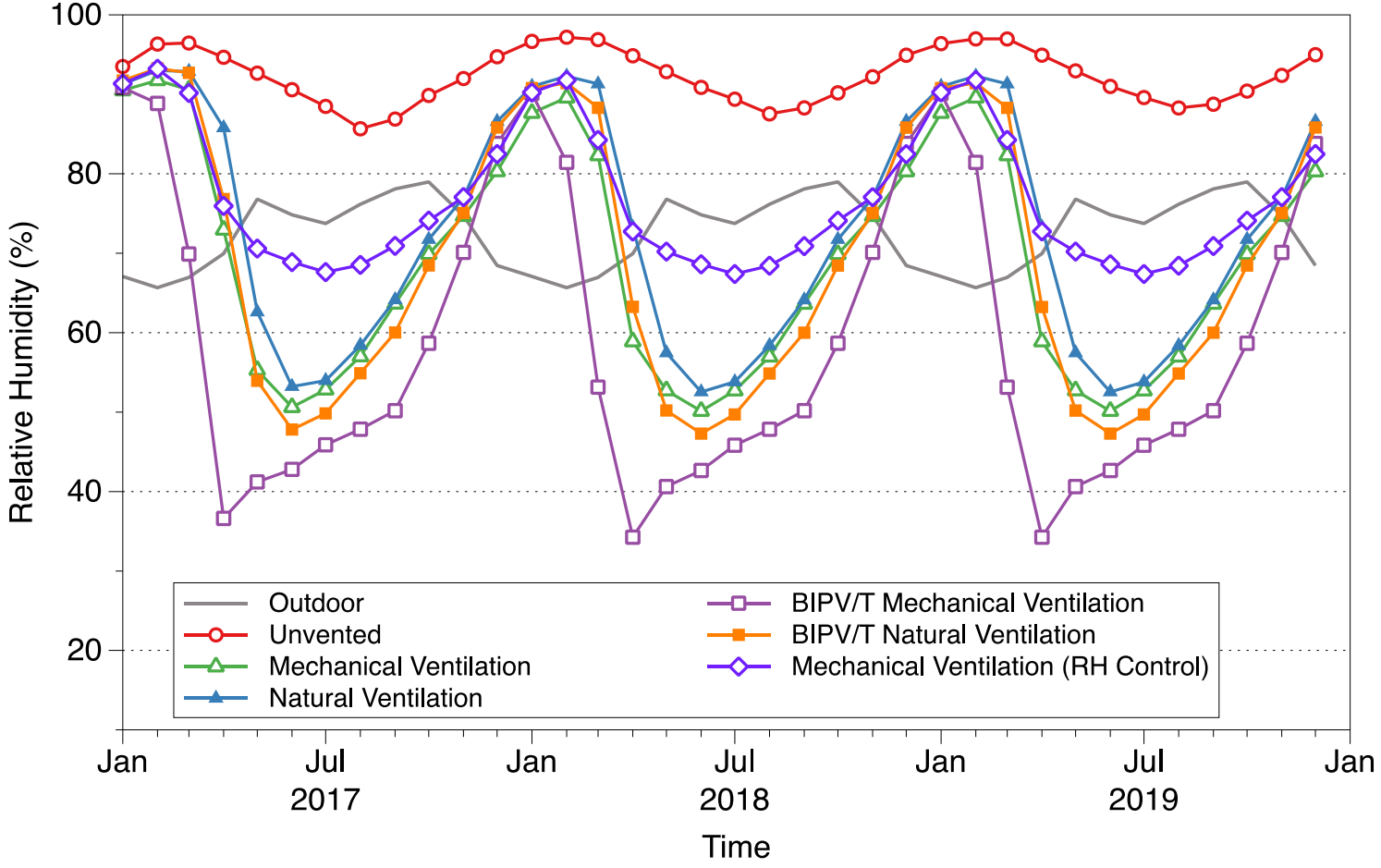
Results

- No air leakage



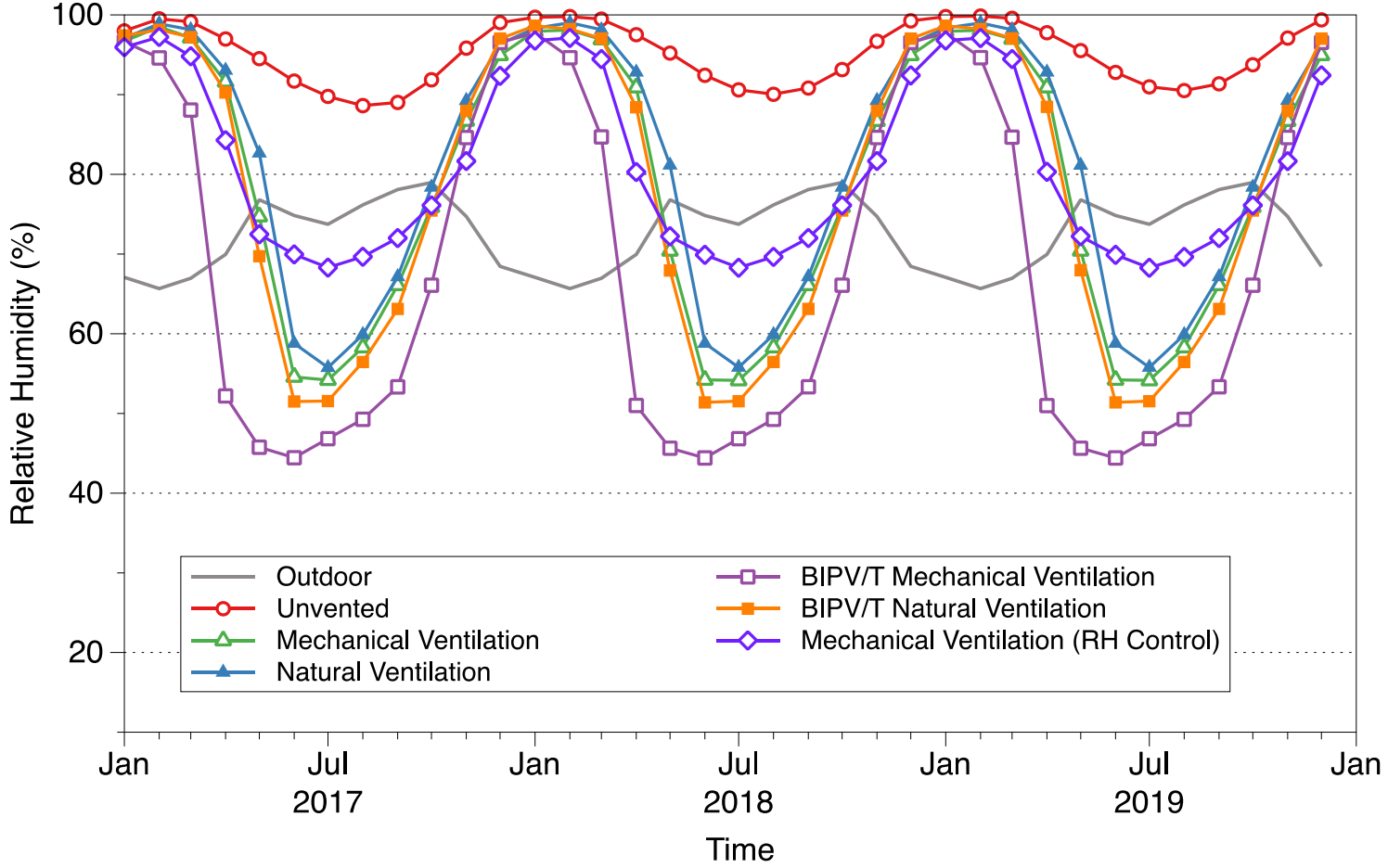
Results

- Low air leakage



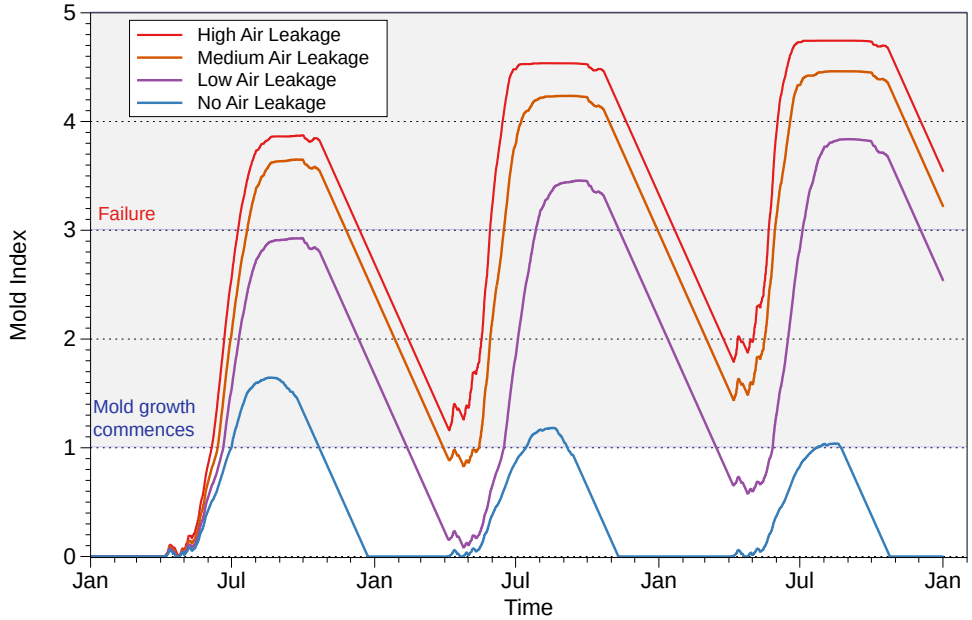
Results

- High air leakage



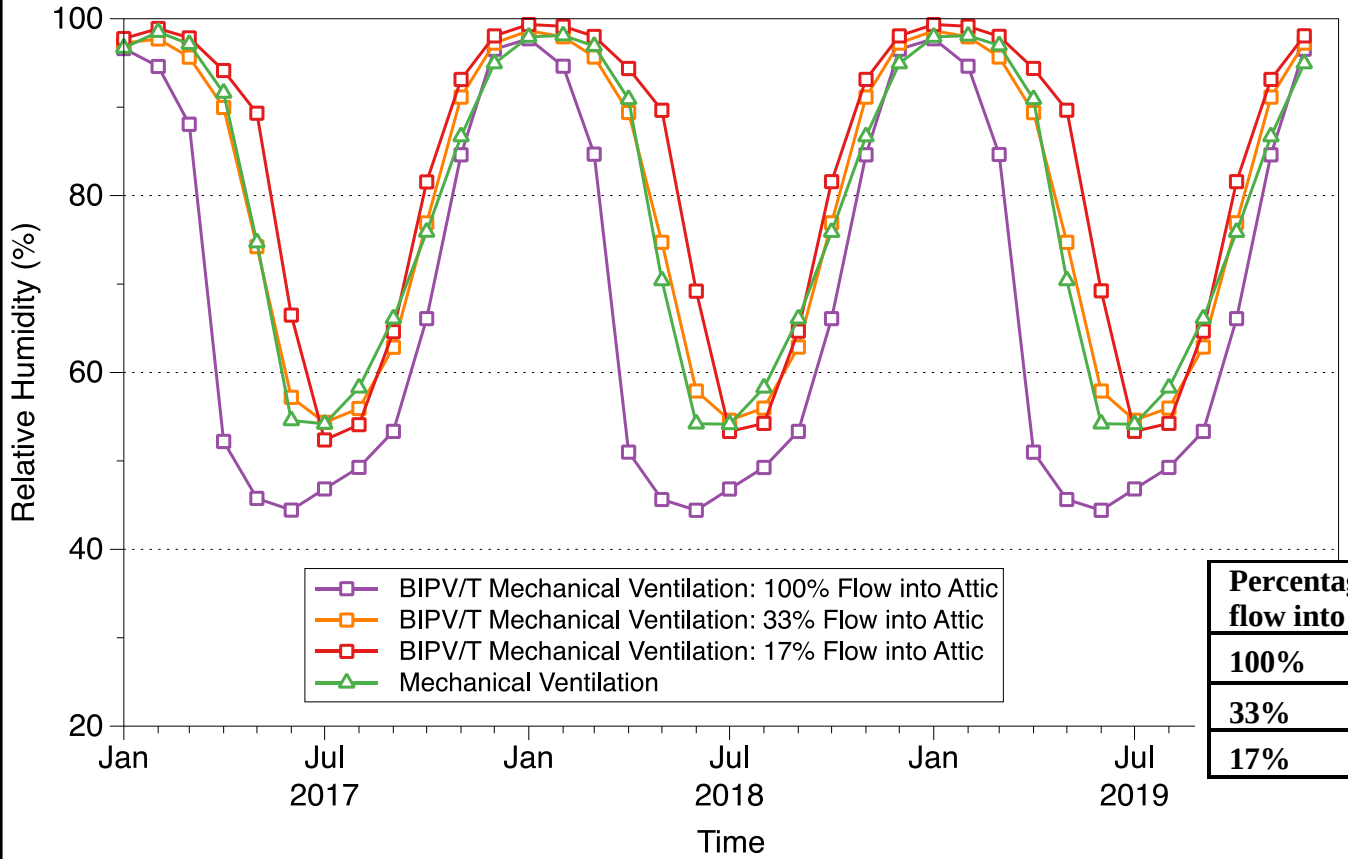
Results

Air Leakage Rate	Highest Mold Growth Index Attained					
	Unvented	Mechanical Ventilation	Natural Ventilation	Mechanical BIPV/T Ventilation	Natural BIPV/T Ventilation	RH control
None	1.65	0.00	0.00	0.00	0.00	0.00
Low	3.84	0.00	0.01	0.00	0.00	0.00
Medium	4.46	0.01	0.03	0.00	0.01	0.00
High	4.74	0.02	0.04	0.00	0.02	0.00



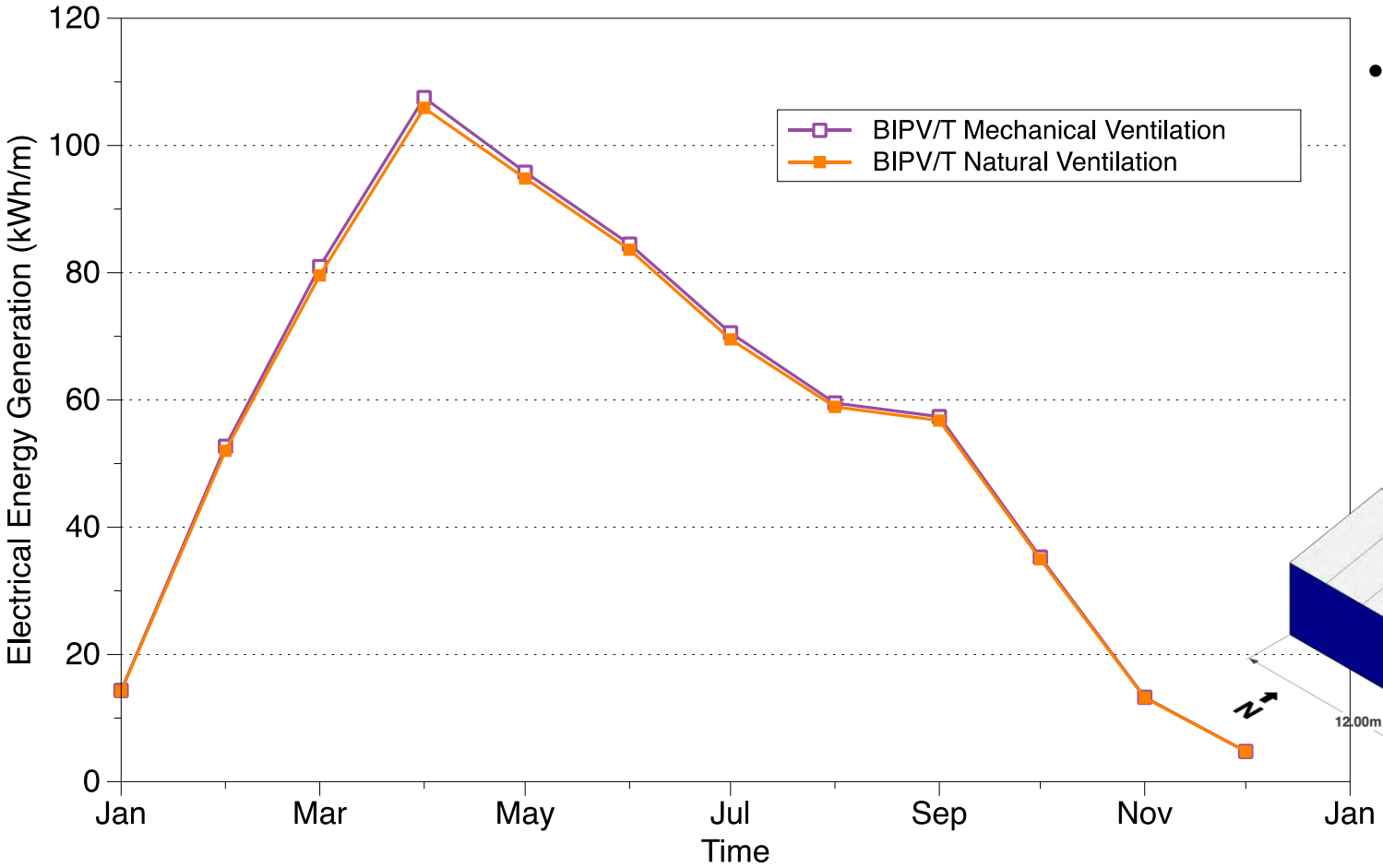
Results

- High air leakage, partial BIPV/T flow to attic

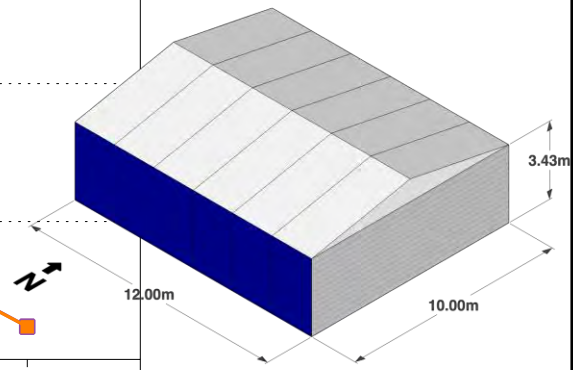


Percentage flow into attic	Attic Air Changes	Highest Mold Growth Index
100%	9	0.00
33%	3	0.08
17%	1.5	0.32

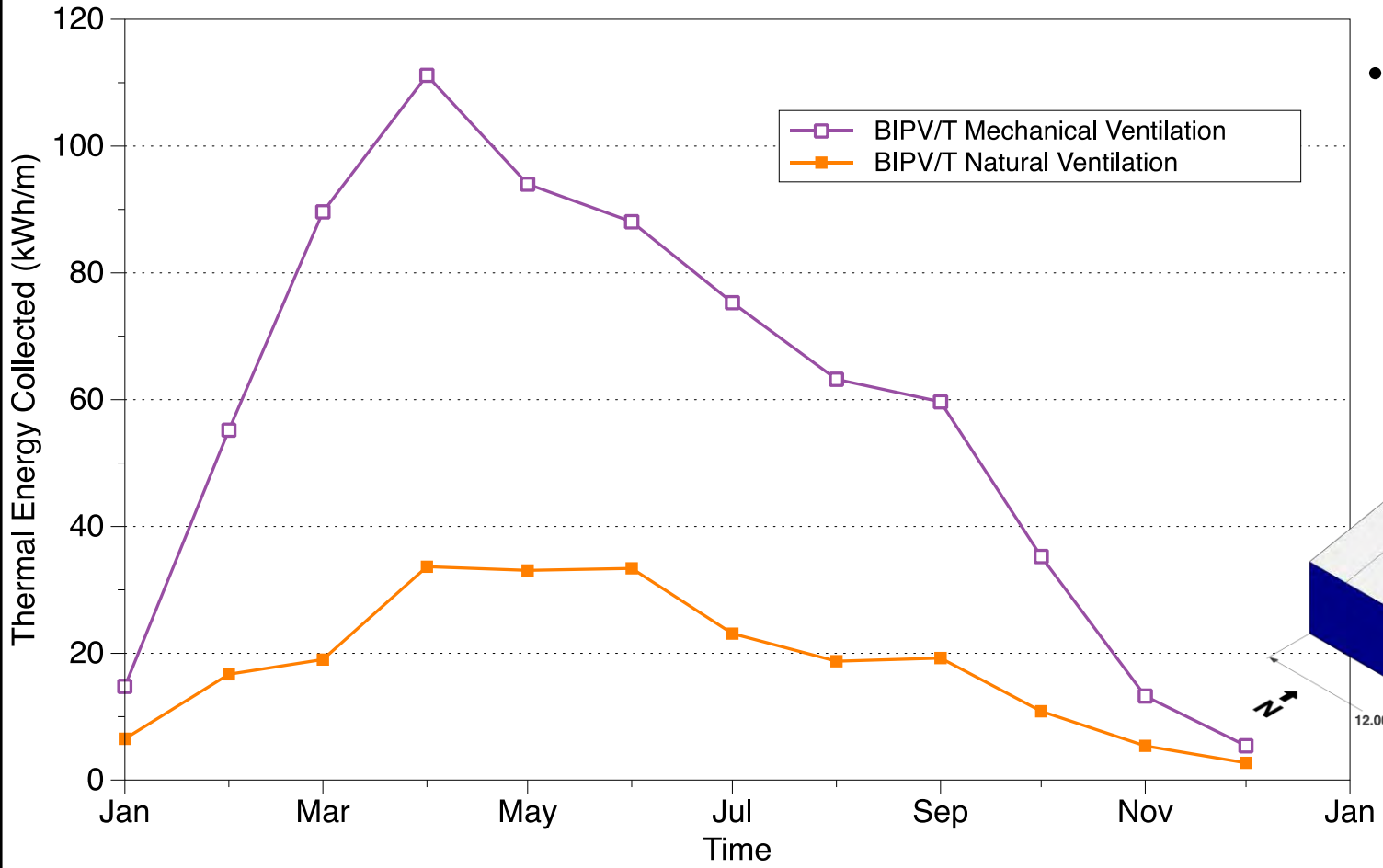
Results



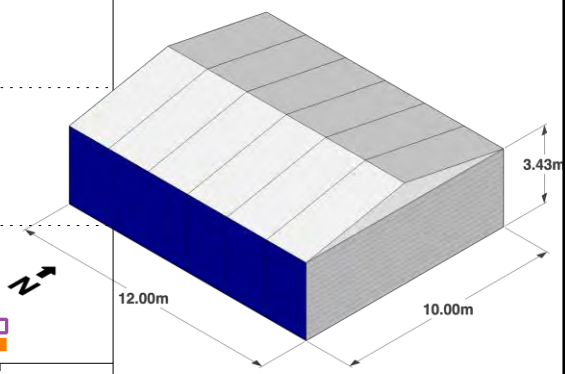
- 150% of annual electricity consumption of energy efficient house



Results



- 50% of annual space heating of energy efficient house



Conclusion

- Attic ventilation in arctic climates is a unique issue.
- Unvented attics are found to be a high-risk design.
- Ventilating attics either mechanically or passively shown to be effective.
- The springtime is the most crucial and effective time to ventilate.
- Allowing the attic ventilation air to pass through a BIPV/T is shown to improve the performance of the attic further.
- Only a fraction of the BIPV/T air would need to be used for attic ventilation.
- 50% of annual heating needs and 150% of annual electrical needs can be produced.

Thank you!

Questions?

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