Moisture safe cold attics - Assessment based on risk analyses of performance and cost

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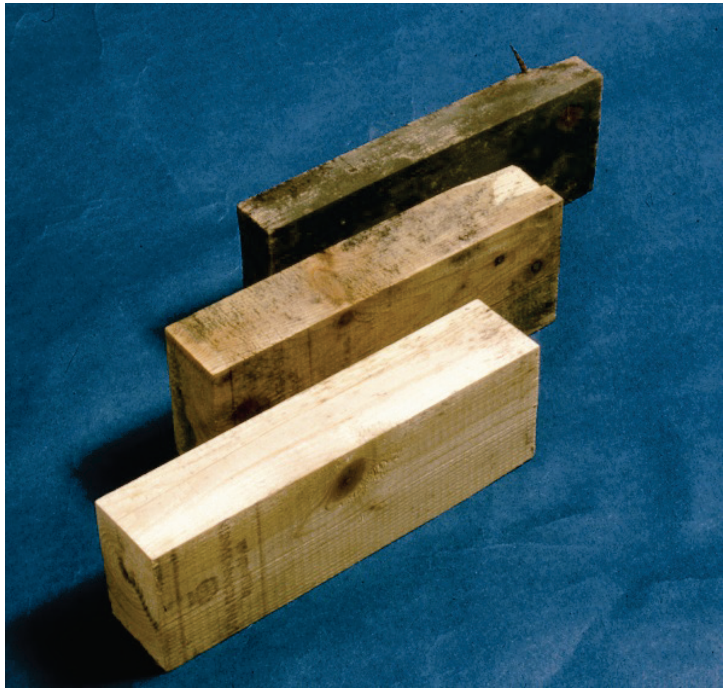
Problems!

At least 60% (mayby up to 84%) of the existing buildings

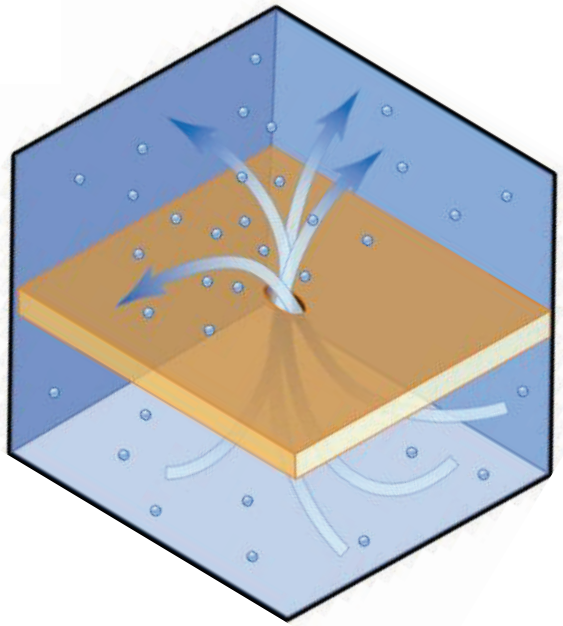
in the area around Gothenburg have mould growth in their attics!

In Sweden: Approx 2 miljon buildings, 73 +/-7 % have cold attics

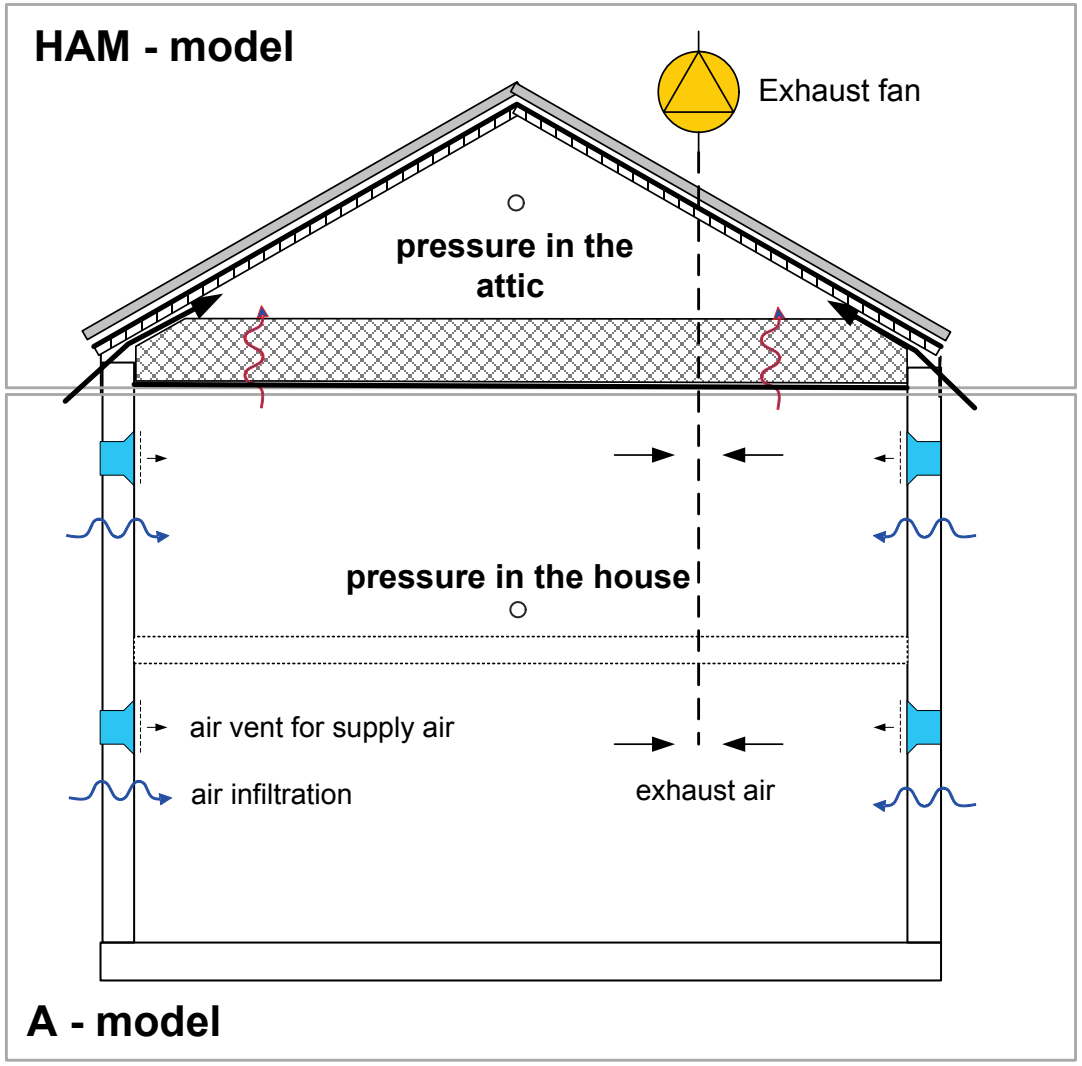


Difficult to design!

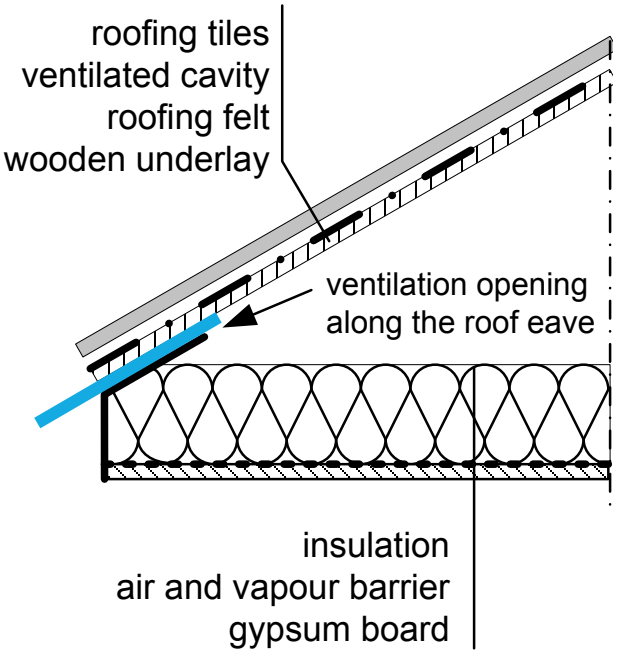
- An air tight attic floor should be achieved – but is difficult to guarantee
- Ventilation system, heating system, moisture production and external climate influences the performance.

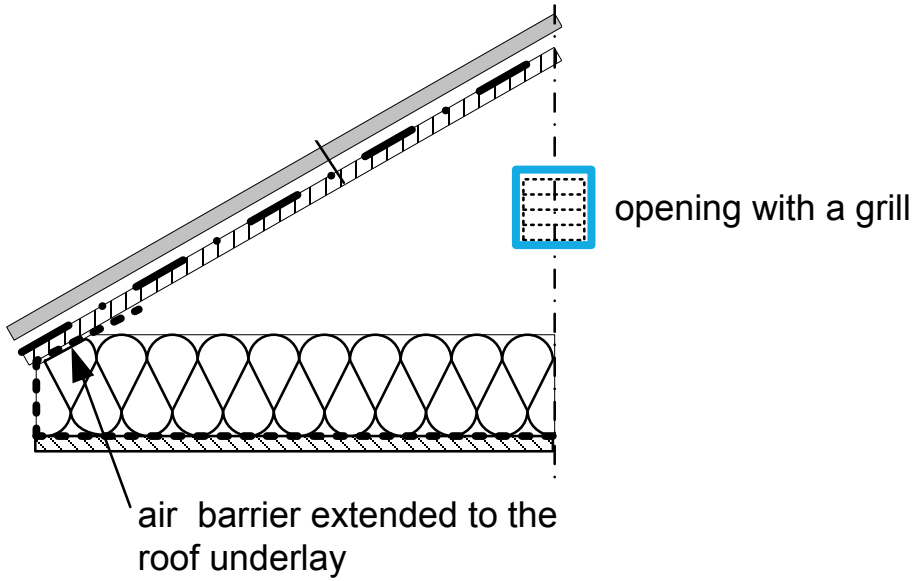


Studied Attic

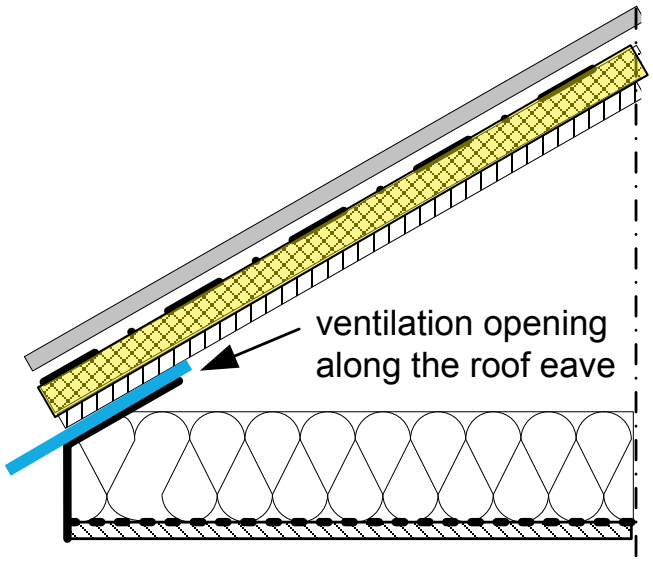


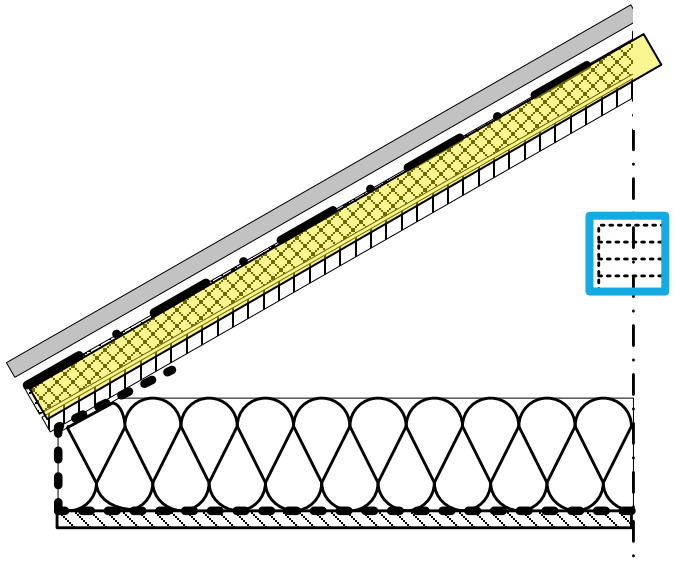
1 - Conventionally naturally ventilated attics
Varying vent opening areas



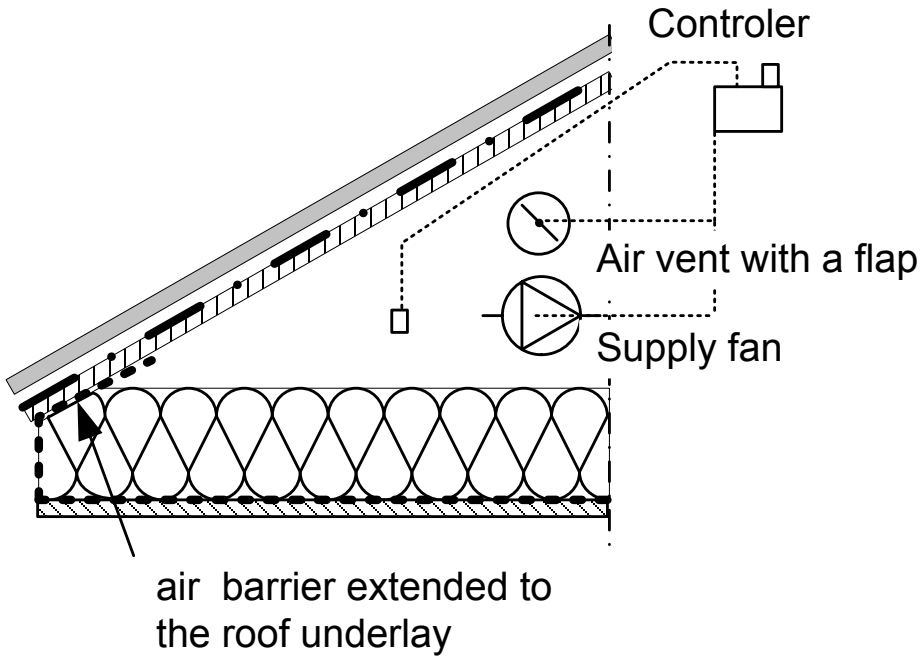


2 - Natural ventilation – Insulated roof

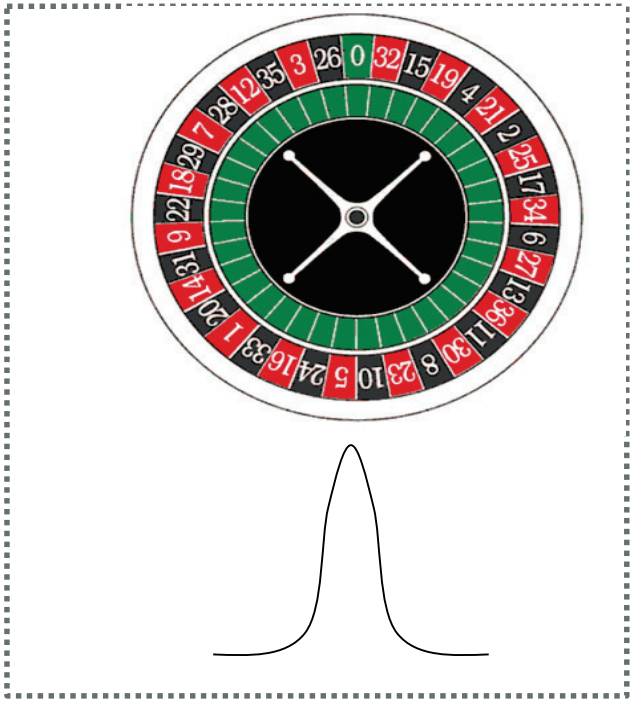




3 - Controlled mechanical ventilation



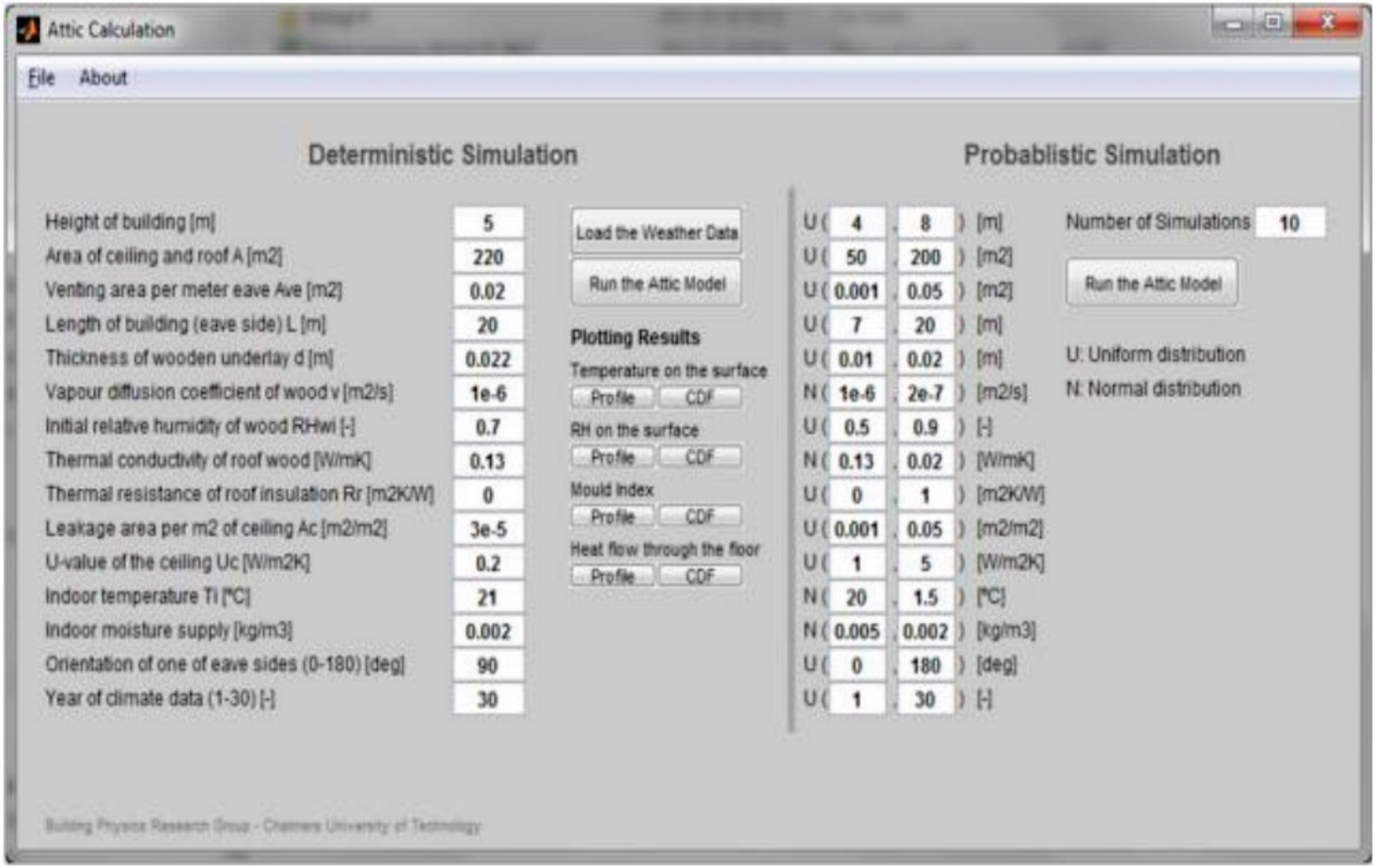
Probabilistic analysis
Monte Carlo simulations
Mould growth risk



Simulation Tools: HAM-Tools (Sasic),
SimpleColdAttic (Hagentoft,Nik)

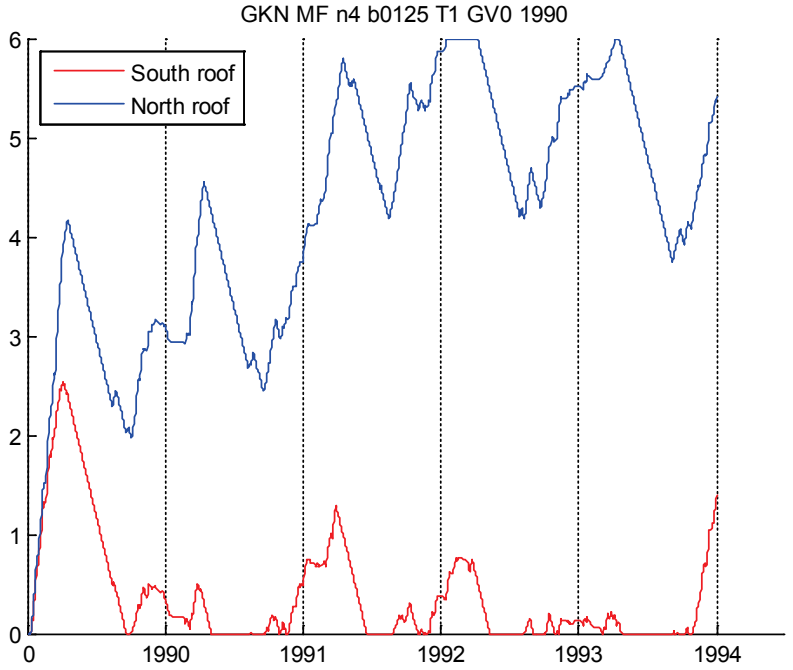
SimpleColdAttic (Hagentoft,Nik)

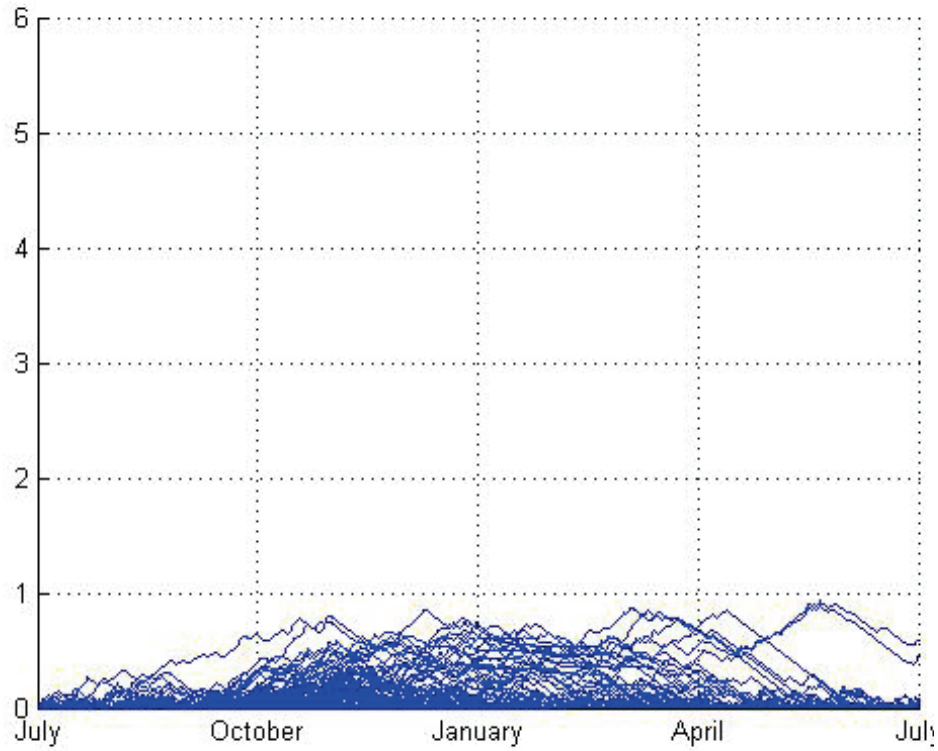
Free sofware: www.byggnadsteknologi.se/downloads.html

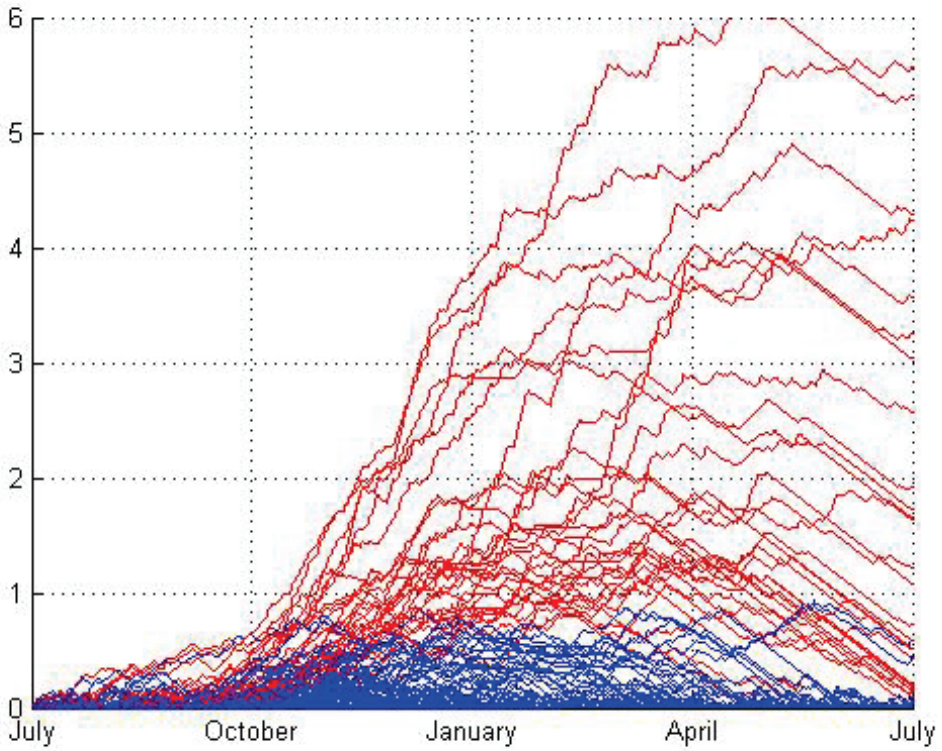


Index	Growth rate	
0	No growth	Spores not activated
1	Some growth detected only with microscopy	Initial stages of hyphae growth
2	Moderate growth detected with microscopy	Coverage more than 10 %
3	Some growth detected visually	New spores produced
4	Clear visually detected growth	Coverage more than 10 %
5	Plenty of visually detected growth	Coverage more than 50 %
6	Very heavy and tight growth	Coverage around 100 %

Mould index, (Viitanen)





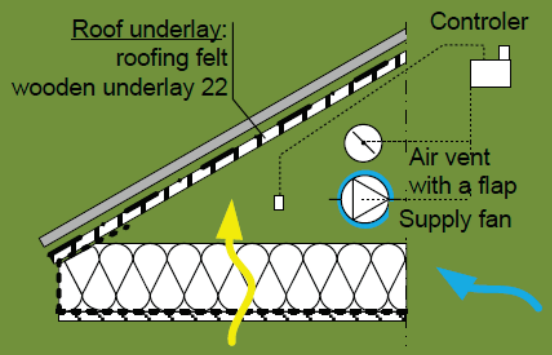
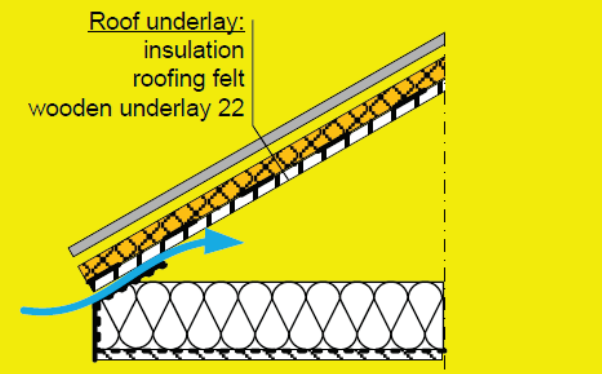


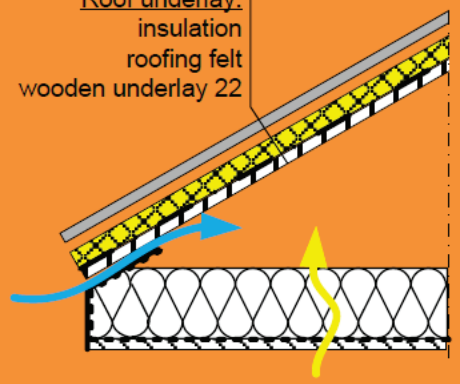
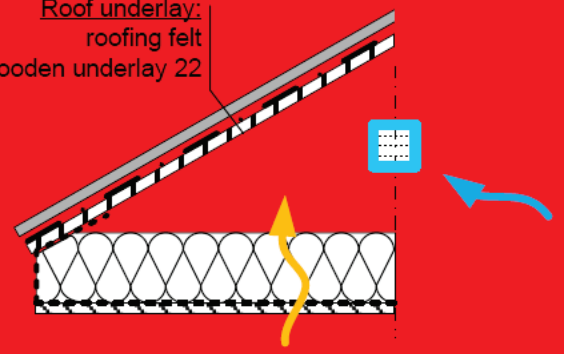
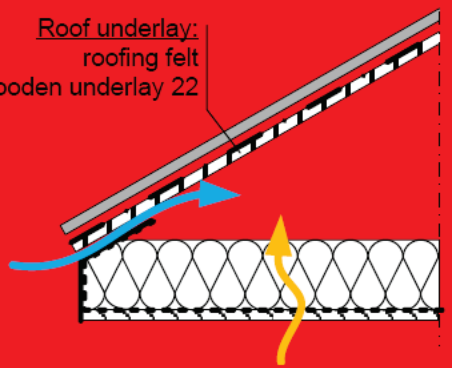
MGI during a year – Above 1 (once) – The attic is considered damaged!

Only one year is studied

Risk free (green)
Low risk (yellow)
Semi high risk (orange)
High risk (red)

Conclusions in a nutshell Swedish conditions

	Cold attic construction	Requirements and sensitivity
Risk free	 Controlled mechanical ventilation	• The airtightness of the attic should be at least 10 1/h@50Pa • Ventilation should start directly after completeness of attic construction • Requires alarm function for failure of mechanical devices • Lowest total life cycle cost
Low risk	 Insulated roof, good air tightness of the attic floor	• Requires durable solution for the airtightness of the attic floor. • Works better at low moisture excess in the building (well ventilated housing - preferably exhaust only mechanical ventilation system). • Sensitive to the building orientation. • Some sensitivity to the local and future climate. • Should be supplemented with dehumidifiers in the construction phase to eliminate built-in moisture.

Semi-high risk	 Insulated roof, some air leakage in the attic floor	• Works better at low moisture excess in the building (well ventilated housing - preferably exhaust only mechanical ventilation system). • Sensitive to the local and future climate. • Should be supplemented with dehumidifiers in the construction phase to eliminate built-in moisture.
High risk	 Reduced ventilation – only through gable vents; air tight roof eaves.	• Extra sensitive to the lack of air-tightness in the attic floor and high moisture excess in the home. • Should be supplemented with dehumidifiers in the construction phase to eliminate built-in moisture. • Sensitive to future climate.
High risk		• Extra sensitive to the lack of air-tightness in the attic floor and high moisture excess in the home. • Sensitive to future climate. • The most expensive technical solution when lifecycle cost is assessed. • Should be supplemented with dehumidifiers in the construction phase to eliminate built-in moisture.

Economical Analysis – Total cost (SEK) per year

Alternative	Base investment	Operation. Cost (SEK)	City	Airtightn. Moisture Supply	Risk MGI>1	Damage investment Cost	Reduction in energy demand (kWh)	Yearly cost (SEK)
1. Convent.	76380	0	GBG	-	100	38400	0	5 739
2 Insulated roof	94135	0	GBG	Good low	10	3840	10 (1%)	4 889
2 Insulated roof	94135	0	GBG	Not good high	50	19200	10	5 657
2 Insulated roof	94135	0	STO	Good low	0	0	10	4 697
2 Insulated roof	94135	0	STO	Not good high	20	7680	10	5 081
3 Controlled ventilation	88427 (80927)	600	-	-	0	0	7 (1%)	4 639

Interest rate is 5% - on initial investment cost
Controlled ventilation: Fan is exchanged every 15 year – Cost: 500 SEK/year,
Plus 100 SEK for electricity bill
Renovation costs is included/correspond to a an extra initial investment
– when damaged – clean and install controlled ventilation
No ill-will (bad-will) is included
Initial cost for drying of building damp is included with 5000SEK (for the two first cases)
Real value – no inflation
GBG: Gothenburg STO: Stockholm

Thanks!

Correct ventilation?

- Construction damp → Requires ventilation
- Moisture entering from occupied space → Requires ventilation
- Vapor in outdoor air → Minimize the ventilation