Internationell och nationell FoU-samverkan

Riskbedömningar vid renoveringar för att energieffektivisera bostadshus

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Annex 55 (RAP-RETRO)

International Energy Agency
Energy Conservation in Buildings and Community Systems (ECBCS)

Annex 55:
Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost (RAP-RETRO)

Retrofitting of existing buildings

Potential energy saving (according to the IEA)
of 20-60% in residential space heating and conditioning

In Sweden:
Upgrading to new low energy building performance;
-37 TWh
To today's building standard
-15 TWh

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Background to new annex

Improving the energy efficiency is often the main focus.

Adding insulation and changing the air and vapor tightness results in a different building envelope.

Complex interaction between building envelope, building services, external climate and the users.

As a result retrofitting measures not only often do not meet the energy targets; they also result in performance failures.

Participating countries

1. **Austria** (TU-Wien)
2. **Belgium** (K.U.Leuven, U.Gent)
3. **Brazil** (Pontifical Catholic U. of Paraná)
4. **Canada** (NRC-IRC, Concordia University, BCIT Vancouver)
5. **Czech Republic** (Technical University Prague)
6. **Denmark** (Technical University of Denmark)
7. **Estonia** (Tallinna Tehnikaülikool)
8. **Finland** (VTT, Technical University of Helsinki, Technical U. of Tampere)
9. **France** (Centre de Thermique de Lyon, LAMI, Clermont-Ferrand University, Toulouse U., Nantes University, U. de Savoie)
10. **Germany** (IBP Holzkirchen, Technische Universität Dresden)
11. **Japan** (KINKI U Higashi-Osaka, Kyoto U)
12. **Netherlands** (TU/e)
13. **Norway** (Norwegian University of Science and Technology, SINTEF)
14. **Portugal** (Universidade do Porto)
15. **Slovakia** (Slovak Academy of Sciences)
16. **Spain** (Universidade da Coruña)
17. **Sweden** (Chalmers University of Technology, SP, Lund University, IVL) !!!!!!
18. **Switzerland** (ETH/EMPA)
19. **UK** (Glasgow Caledonian U, U. College London)
20. **USA** (Oak Ridge National Laboratory)

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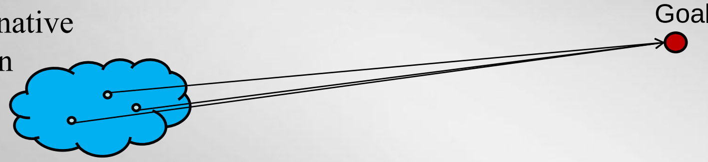
Difficult to design for 100% safety!

We can not double the thickness of the beam
-as in structural engineering!

Deterministic approach

Alternative design

Goal



(Except if we accept poor energy efficiency!)

We must design as safe as possible –
accounting for the all uncertainties and for what might can happen!

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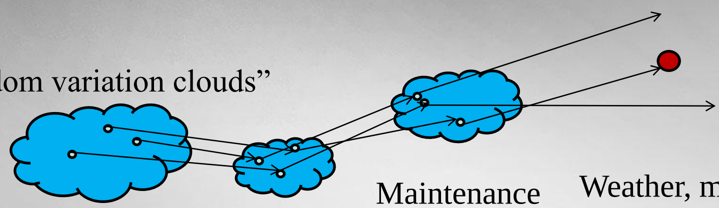
Probabilistic approach

"Random variation clouds"



Production

Maintenance
operation

Weather, material
properties,
exposure to spores,
human behavior,…

Examples of
random variations in:

Workmanship
initial conditions of
material,…

Indoor moisture sources, internal gains
airing, aging of material,
cracks in façades,…

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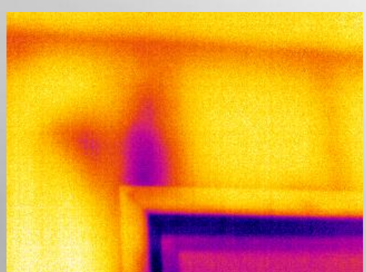
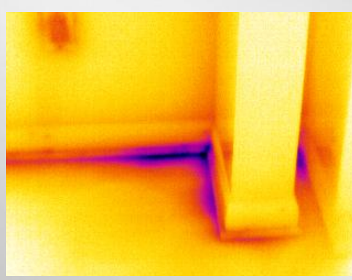
<u>Airtightness:</u>
Design
Workmanship
Durability

A crucial quality!





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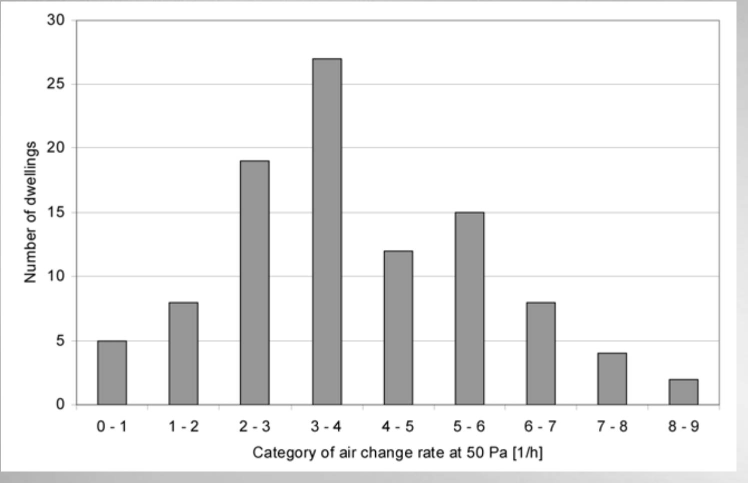
Performance -Air tightness
at 50 Pa of 100 timber-framed Finnish buildings
built after year 2000



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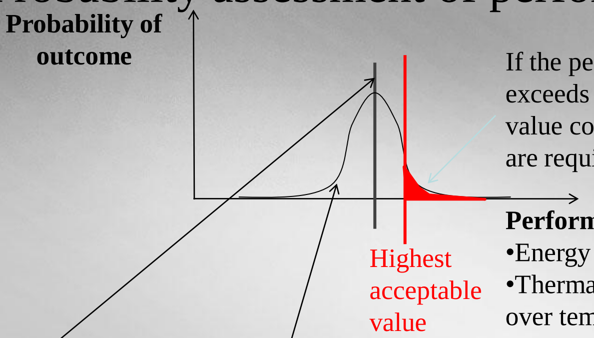
The *scope* of the annex is to:

To develop and provide decision support data and tools for energy retrofitting measures.

The tools will be based on probabilistic methodologies for prediction of energy use, life cycle cost and functional performances.

Probability assessment of performance



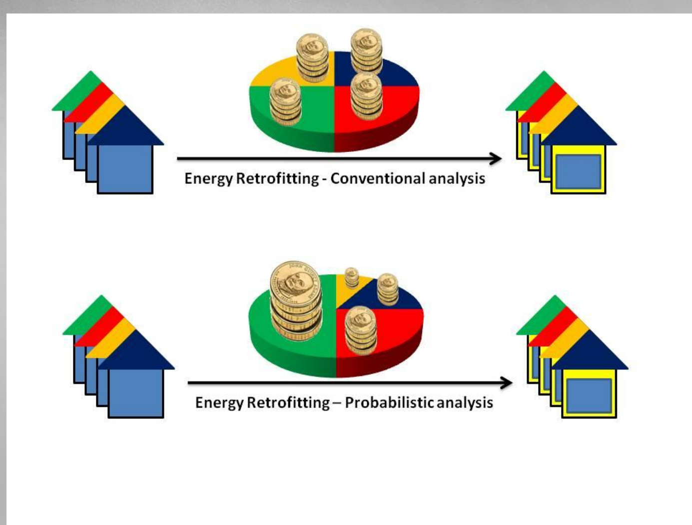
If the performance exceeds the acceptable value costly measures are required.

Performance
- Energy use
- Thermal comfort (draught, over temperatures, cold floors)
- Durability

Conventional analysis gives a single value.

Probabilistic analyses gives a range of values and the probability of exceeding a certain value (critical value or required value) can be assessed.

Spread in LCC due to performance variations
Base-line determined by conventional analysis



Case studies in the annex:

Case Sigtuna, multi-family houses1972-73 Lars-Erik Harderup Johan Stein, Lund U.	**Sweden**
Renovation of multi-family houses Jan Carmeliet ETH/EMPA	**Switzerland**
Social housing in Porto 1970's Vasco P. de Freitas , Nuno Ramos, Porto U.	**Portugal**
Energy Renovation of an Old Single-family House, 1927 Carsten Rode, DTU	**Denmark**
Case Drammen, multi-family house, 1937 A-J Almås, NTNU/SINTEF	**Norway**

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Case Sigtuna, Multi-family houses 1972-73 Sweden

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Renovation of multi-family houses Switzerland

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Social housing in Porto 1970's Portugal

Energy renovation of an old single-family house, 1927 Denmark

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Example:

Mould growth problems in attics

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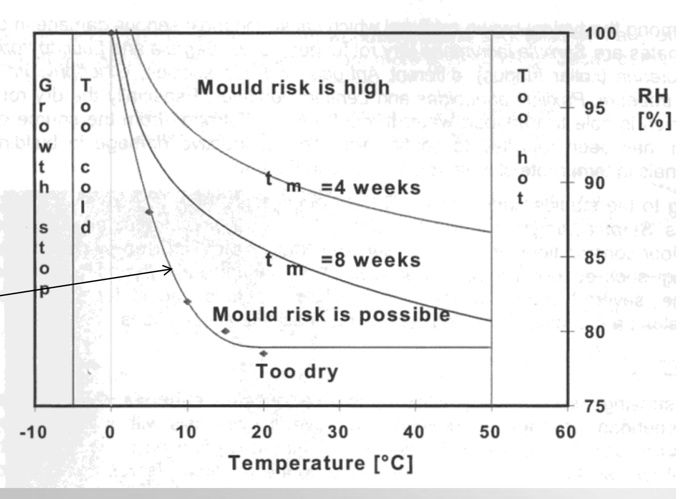
Mould index, (Viitanen)

Mould growth potential

Definitely OK if M<1

$$M = \frac{RH}{RH_{crit}(T)}$$



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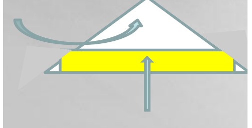
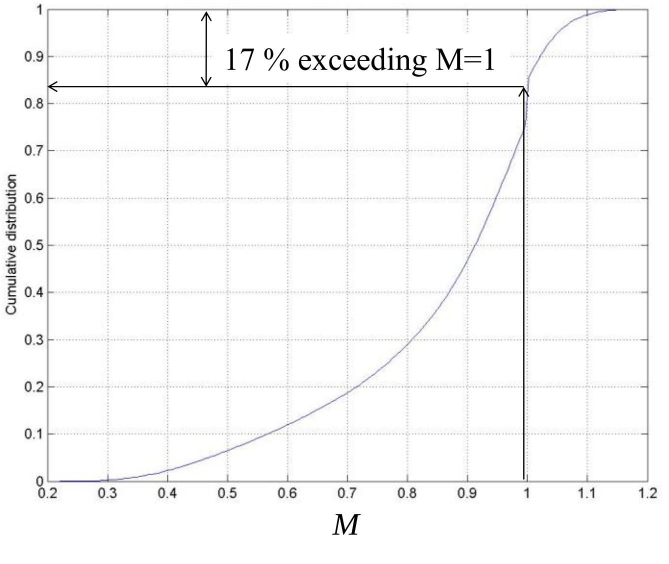
Monte Carlo simulations

<u>Less ventilated attic</u>

d_i=0,5 m

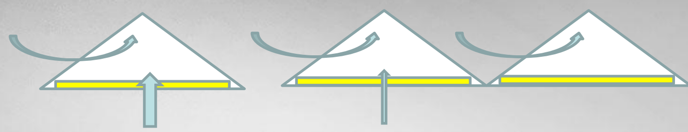
Less tight



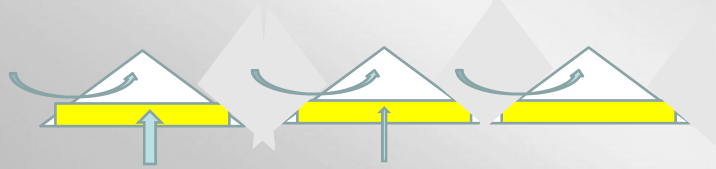


Less ventilated attic

Probability of hourly values of the year to exceed M=1



Insulation thickness	Leaky attic floor	Less tight attic floor	Tight attic floor
d_i=0,05 m	14 %	11 %	2%
d_i=0,5 m	18 %	17 %	9%



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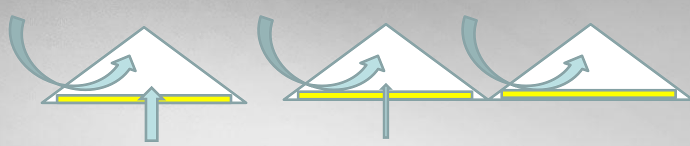
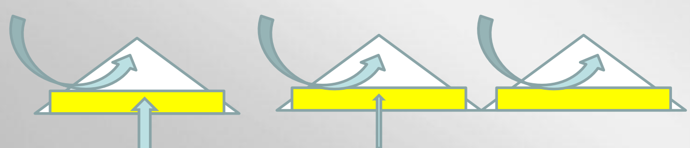
Well ventilated attic

Probability of hourly values of the year to exceed M=1



	Leaky attic floor	Less tight attic floor	Tight attic floor
d_i=0,05 m	23 %	12 %	6%
d_i=0,5 m	27 %	20 %	13%



Svenskt "Spegel-projekt"

Finanseras av Formas (J Arfvidsson projektledare)

Medverkande från:
•Chalmers
•LTH
•IVL
•SP

Minst 5 doktorandprojekt knyts till projektet

och

Minst 9 disputerade forskare

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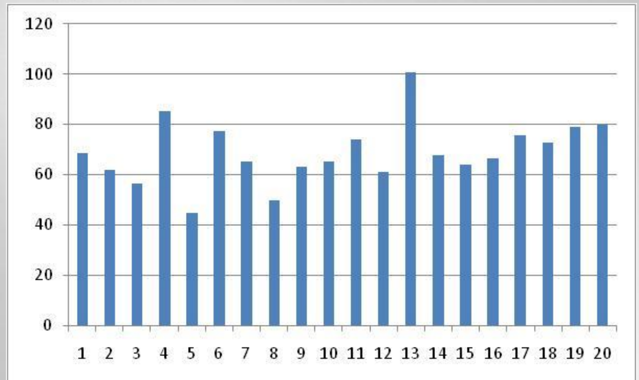
Lindås – South of Göteborg

From 2001

kWh/m^2



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Distribution of annual energy demand per square meter in 87 similar Swedish dwellings from the 80's