AIR TIGHTNESS OF HISTORIC HOUSES

HELTH
Healthy and Energy-efficient Living in Traditional Rural Houses
2010-2013

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CENTRAL BALTIC
INTERREG IV A
PROGRAMME
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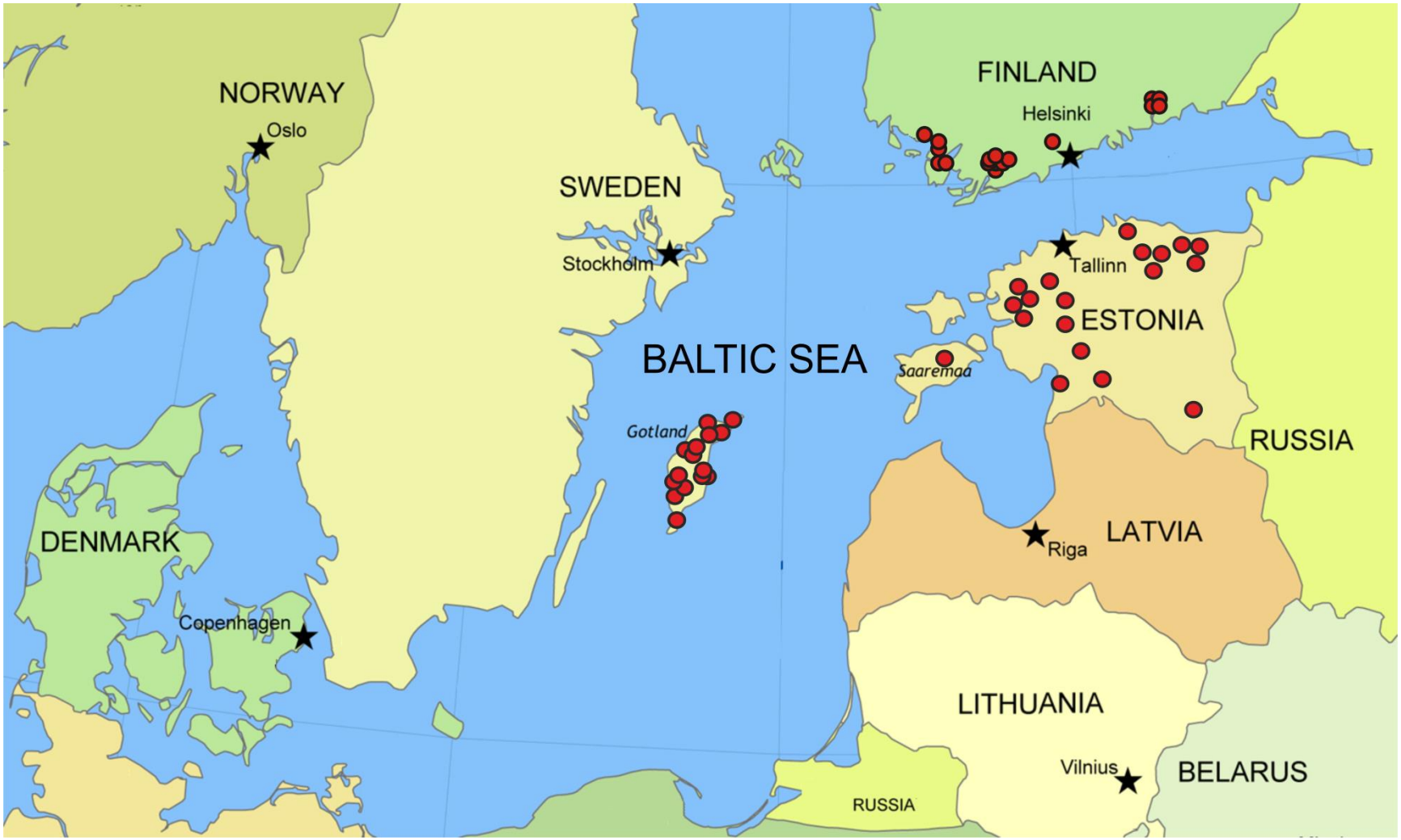
Contents

- Air tightness
- Leakage routs
- Air change rate

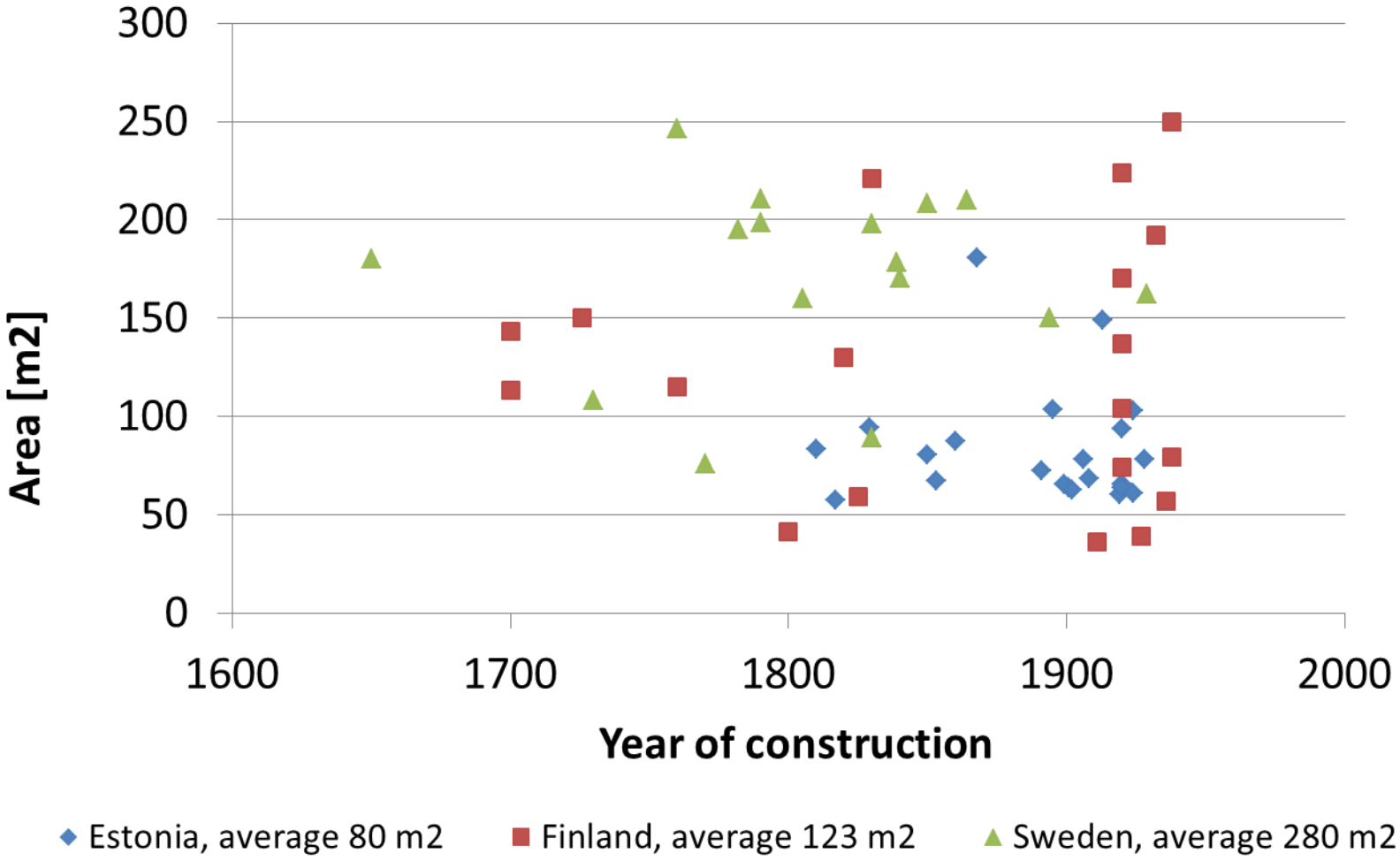
Studied houses

The project concerns traditional and historical rural houses which are built before 1940.

Studied houses
Location



Studied houses
Construction year and area[m²]

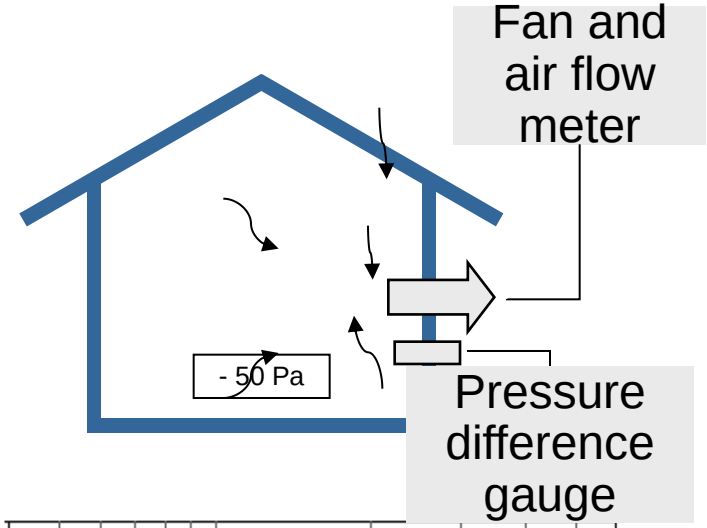


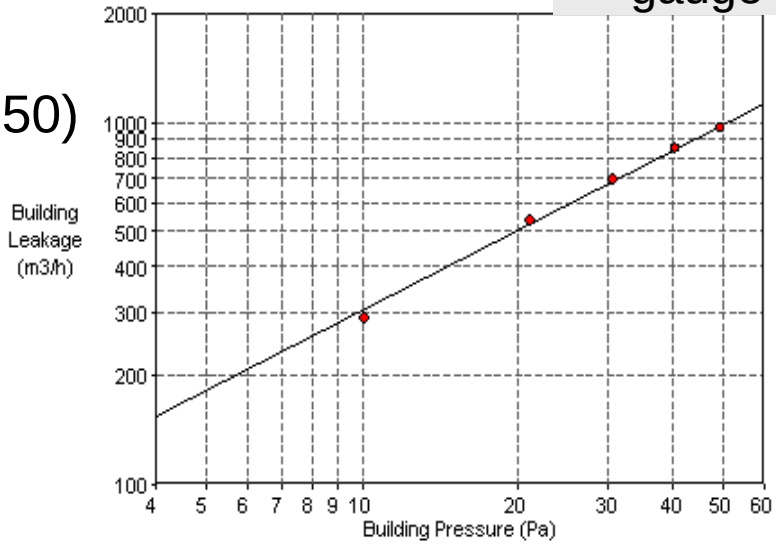
Air tightness

Air tightness measurement

Principle

- Close all, vents and holes (stoves, dumpers, ventilation unit)
- Use the fan to create pressure difference (under / overpressure)
- Measure
  - Amount of air
  - Pressure difference over envelope (10, 20, 30, 40, 50)





Air tightness measurement with blower door

Measurement equipment

- Fan + frame
- Measuring unit
- Computer

Air tightness

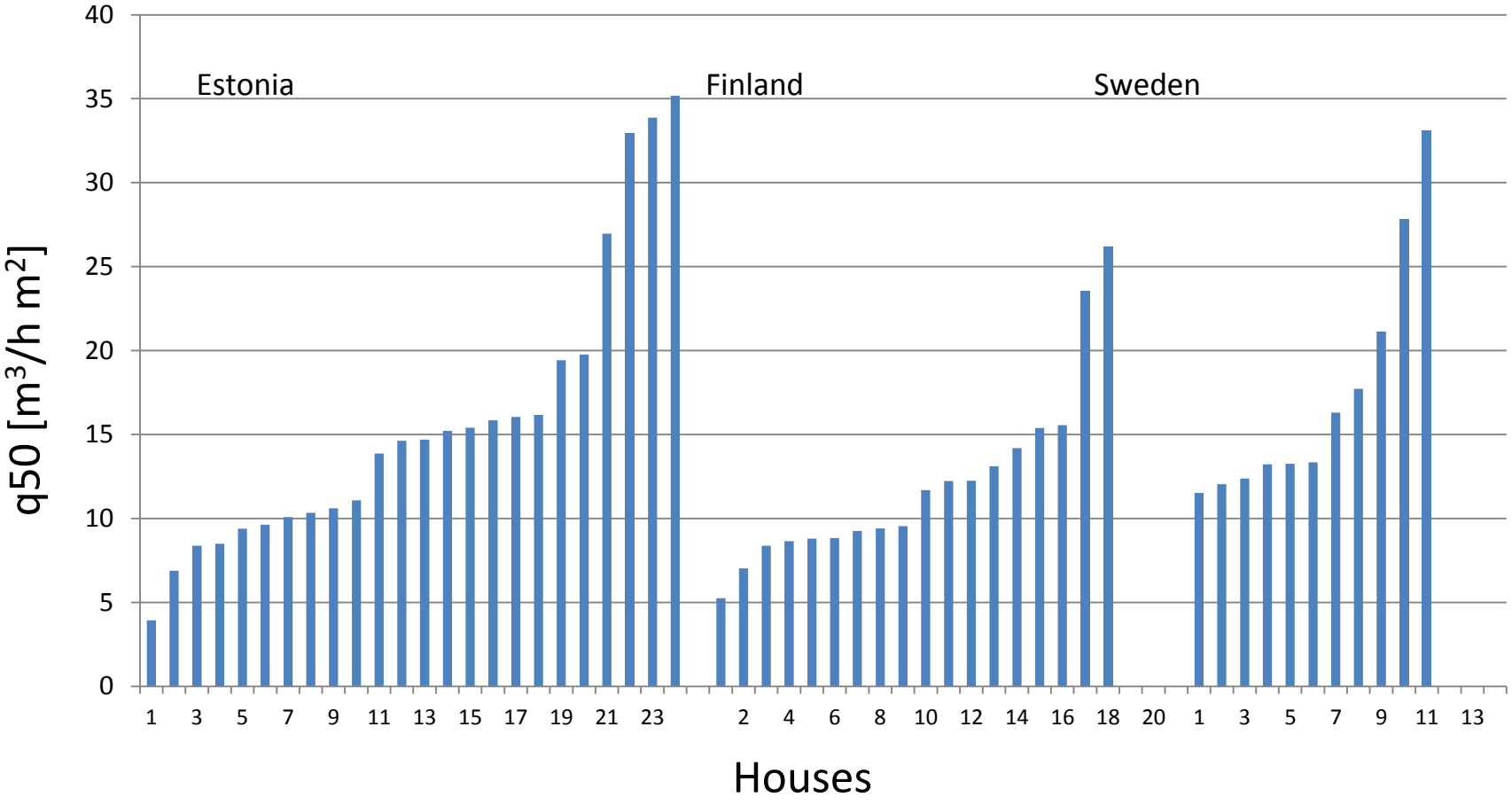
- n_{50} [1 / h]

$$n_{50} = \frac{\text{Air leakage through envelope in 50 Pa } [m^3/h]}{\text{Volume } [m^3]}$$

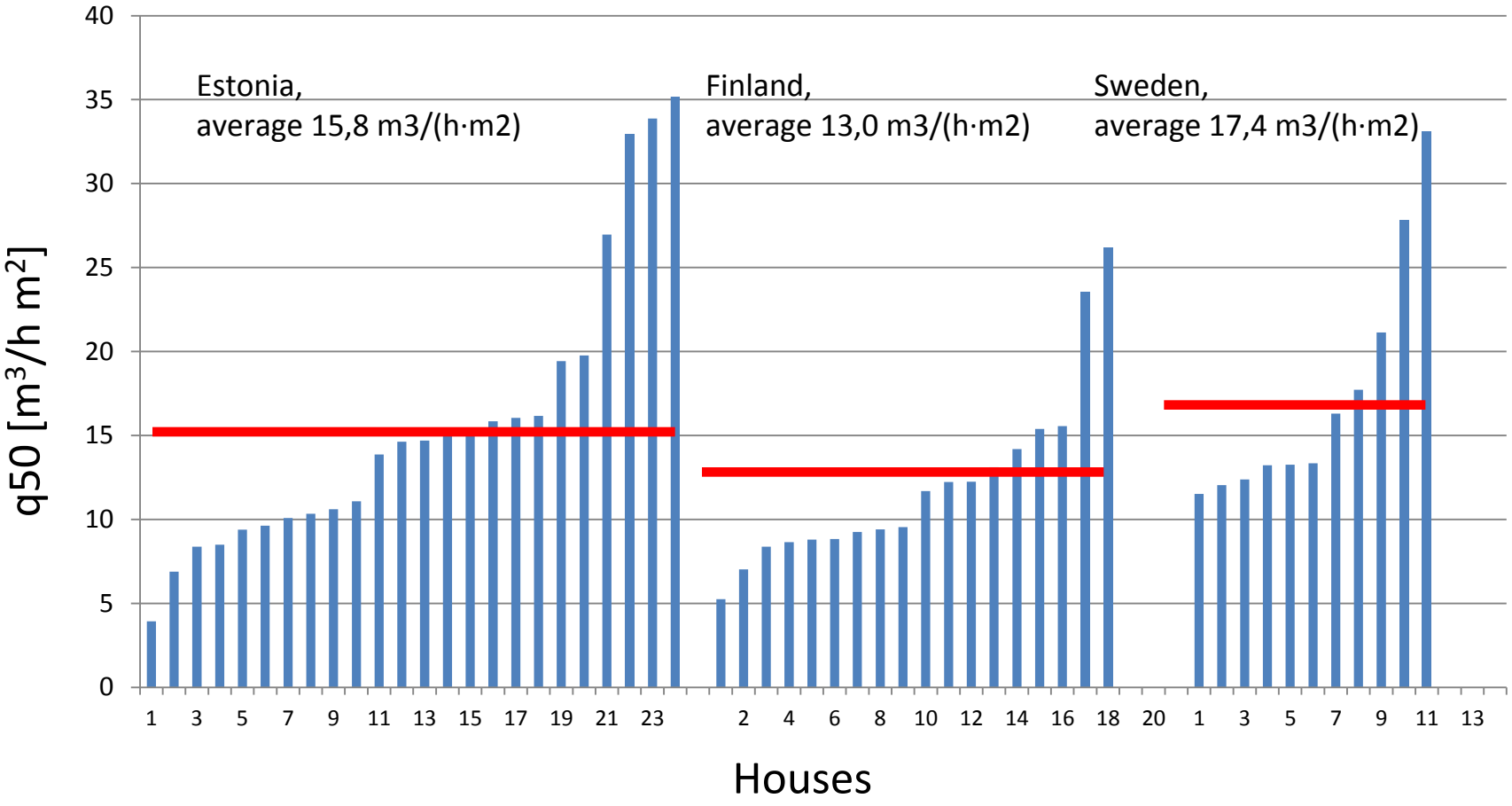
- q_{50} [$m^3/h\ m^2$]

$$q_{50} = \frac{\text{Air leakage through envelope in 50 Pa } [m^3/h]}{\text{Envelope area } [m^2]}$$

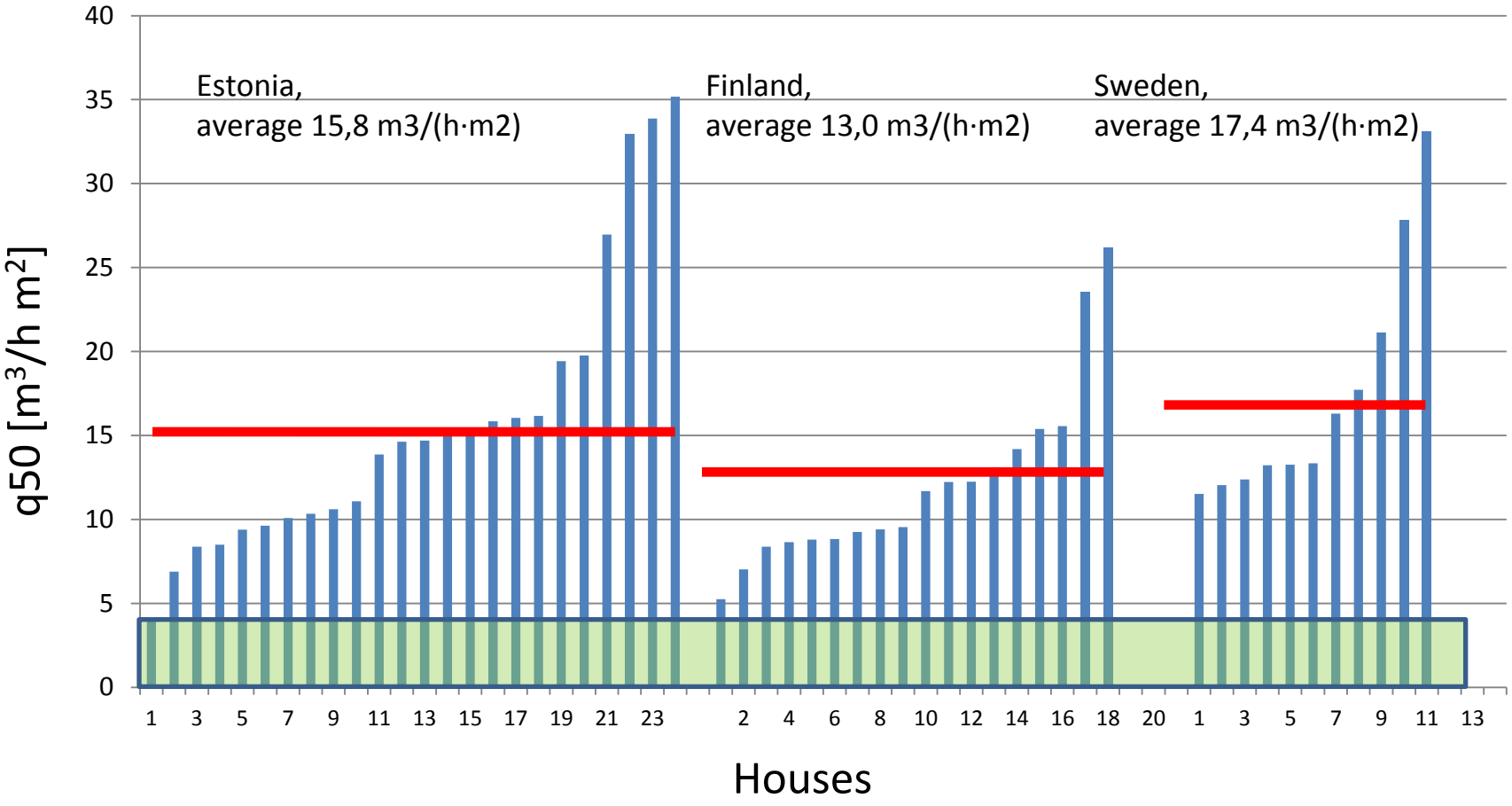
Air tightness: q50 [m³/h m²]



Air tightness: q50 [m³/h m²]



Air tightness: q50 [m³/h m²]

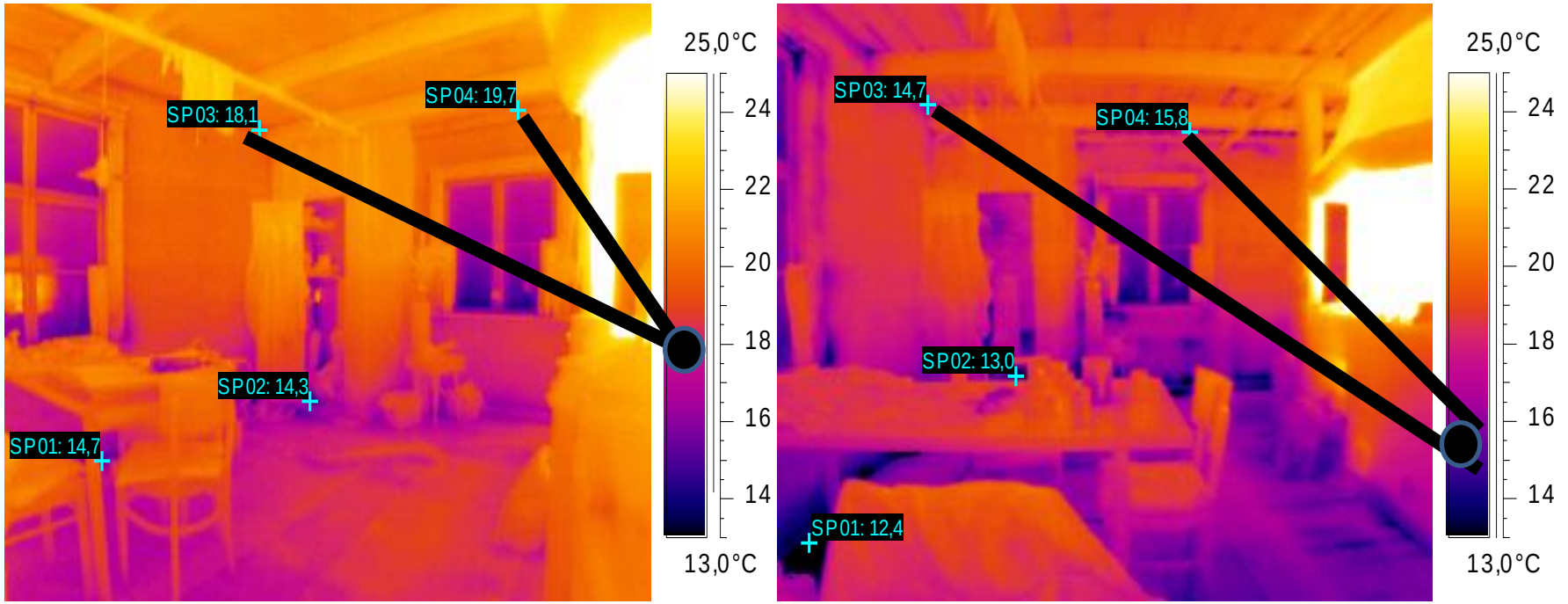


Leakage routs and structures

Average structures

- Wall:
  - Log
  - Stone
  - Timber frame
- Floor and ceiling:
  - Wooden boards and insulation
- Foundation:
  - Ventilated crawlspace
  - Closed crawlspace
  - Slab on ground

Leakage places and thermal bridges: Thermal camera imaging



-1 Pa

-50 Pa

Leakage distribution

- The common air leakage places were located in the junctions of
  - walls: external and internal
  - floor and wall
  - wall and ceiling.

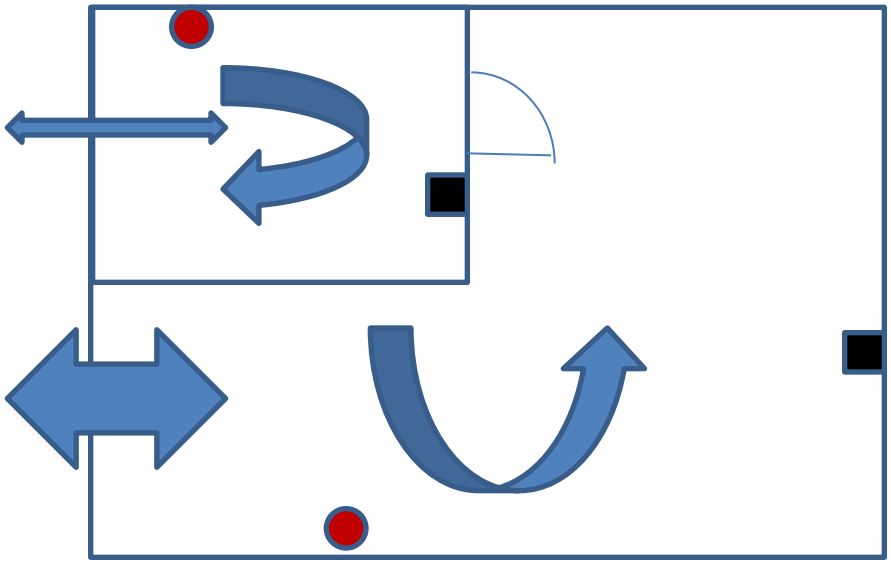
Natural ventilation
Air change rate

Natural ventilation

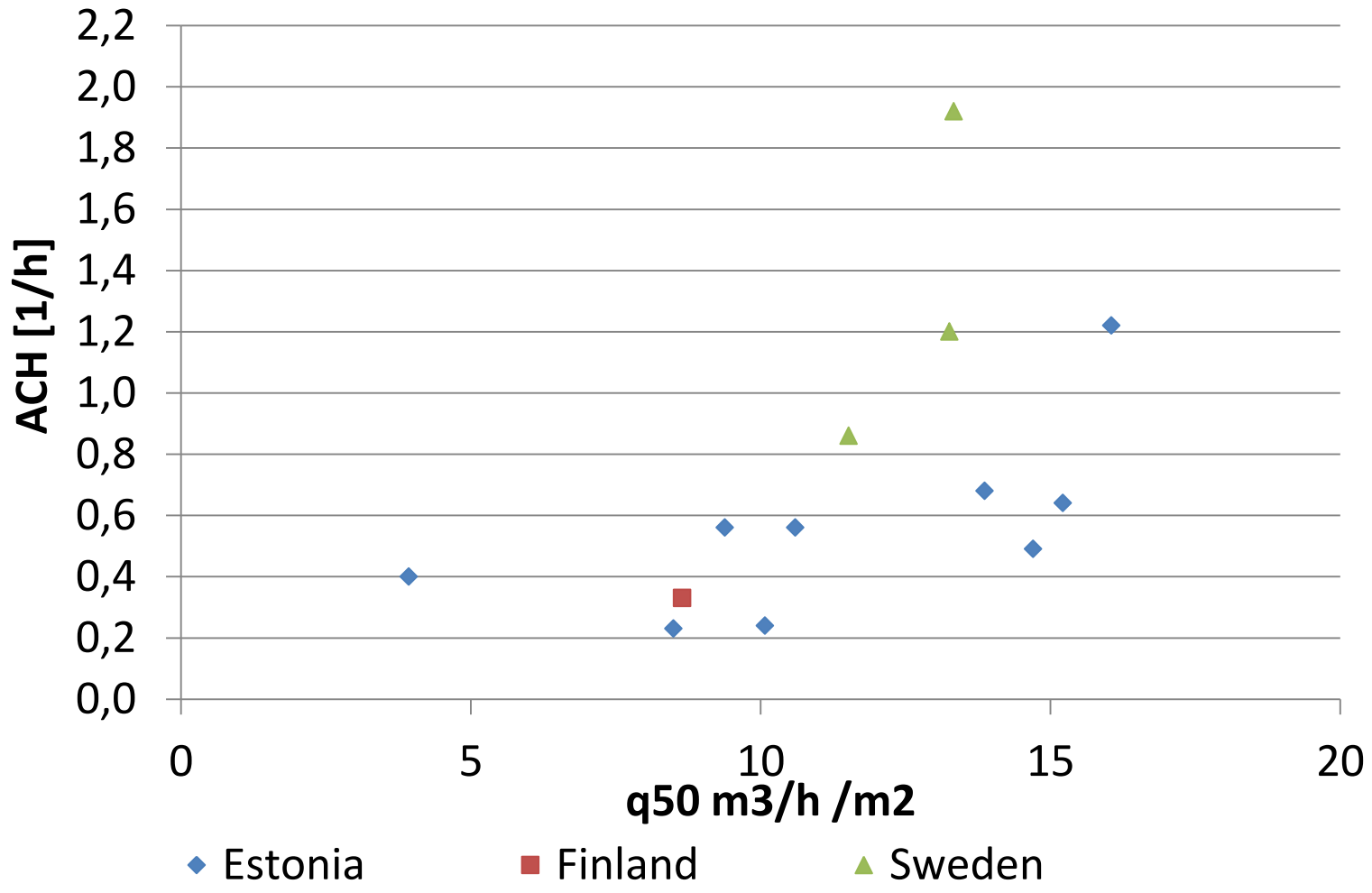
- The air change in natural ventilation is based on density differences caused by temperature drop between outdoor and indoor air and the effect of the wind.
- The air flows change according to weather conditions.
- The performance problem of natural ventilation is that there is no air flow when there is no temperature difference or wind.
- Air tightness of the envelope and leakage routs effect to ventilation rate and energy consumption.

Air change rate measurement

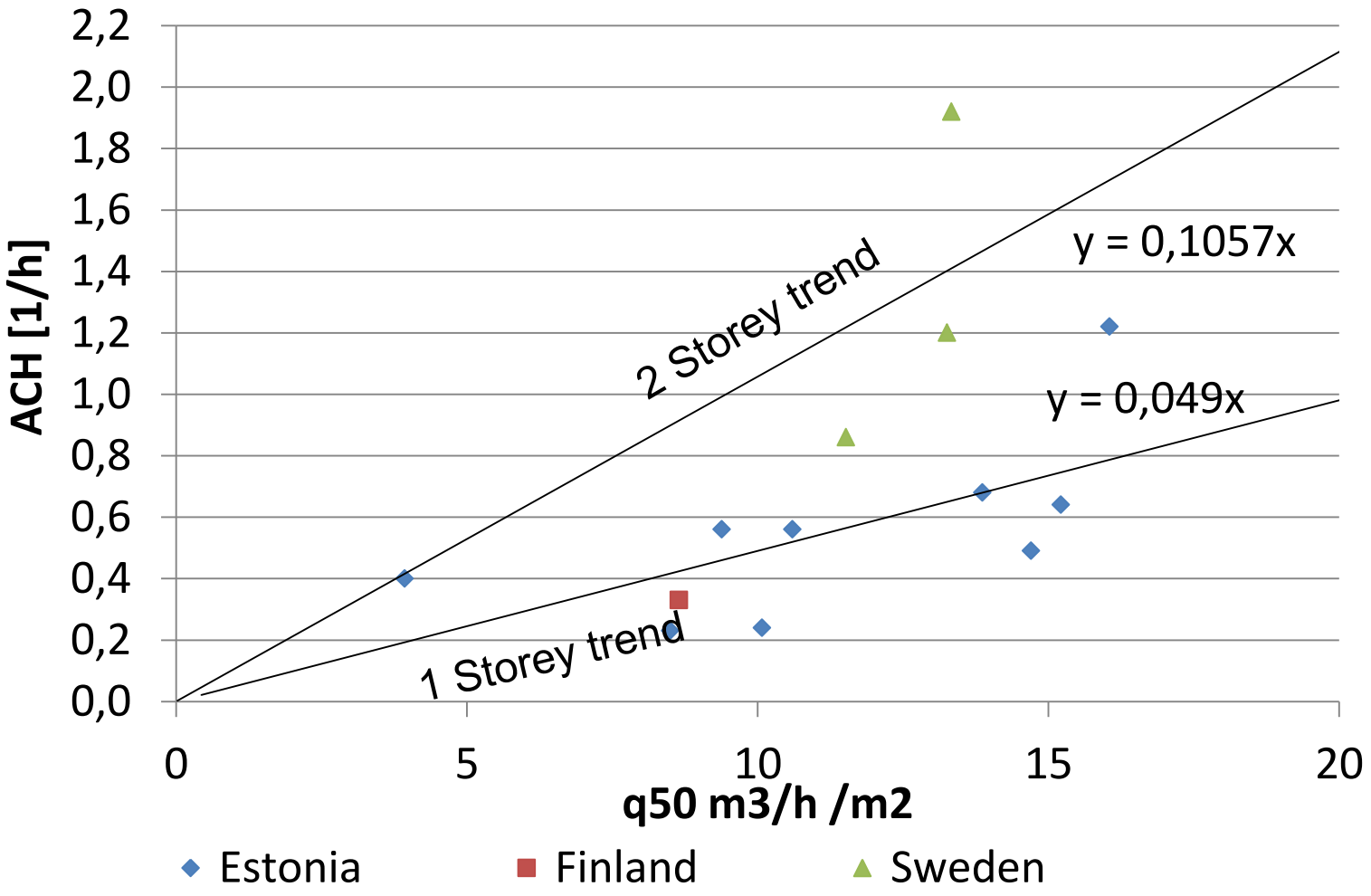
- Passive tracer gas method
  - Sources and samplers are located in every room
  - Measurement period 2-4 weeks
  - Average air change rate (ACH) [1/h]



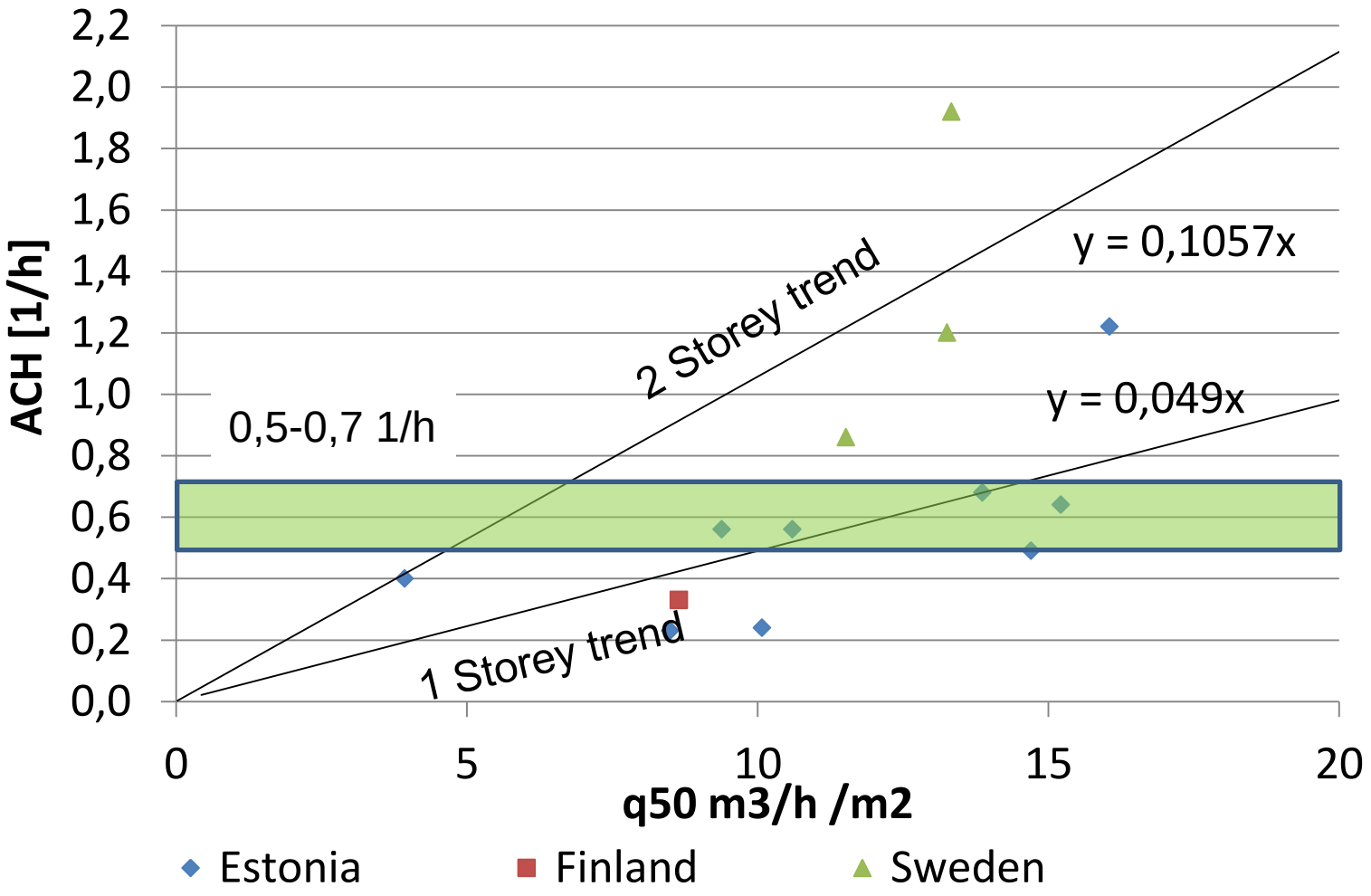
Air tightness and air change rate



Air tightness and air change rate



Air tightness and air change rate



Air tightness and ventilation problems in historic houses

- Natural ventilated house with sufficient ventilation rate can’t be air tight.
- Heat recovery can’t be used with natural ventilation.
- Uncontrolled air leakage is waste of energy.
- Natural ventilated house with sufficient ventilation rate and good indoor climate can’t be energy efficient.

Conclusions I
Air tightness and leakage

- Measured houses have wide range in air tightness from 3,4 to 35.2 $m^3/h\ m^2$ (average q50 is 14,9 m^3 /h m^2).
- Distribution of air tightness measurement results in Estonia, Finland and Sweden is similar.
- In leakage distribution analysis the leakage pathways were found in the joints between the wall and the floor and between the floor and ceiling, also corners turned out to be leaky.
- The wall, floor and ceiling structures itself proved to be minor pathways to air leakage compared to junctions.
- Sealing the building envelope is a way to reduce air leakage and energy consumption.

Conclusions II
Ventilation

- Measured houses have wide range in ventilation rates, from 0,2 to 1,9 1/h. Average air change rate is 0,7 1/h.
- Air tightness has effect to ventilation rate.
- If air tightness is decreased, also the ventilation rate is going to decrease.
- In natural ventilated houses air tightness value q50 should be between 5 and 15 $m^3/h\ m^2$ to ensure sufficient ventilation rate.
- With q50 value lower than 5 $m^3/h\ m^2$, mechanical ventilation shoud be considered.

Thank you!

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