Building airtightness in Norway: Design, market transformation and cost considerations

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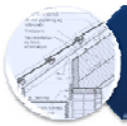
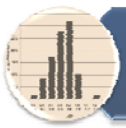

Building practices & design

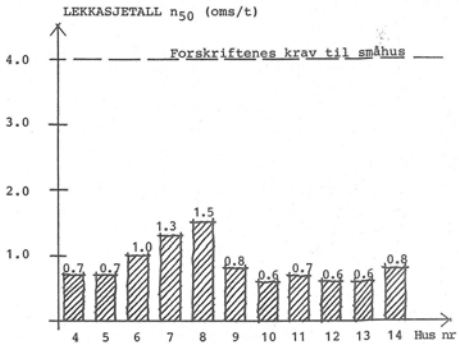

Market transformation & costs


Airtightness requirements & statistics


Measurement & standardization

30 years ago…

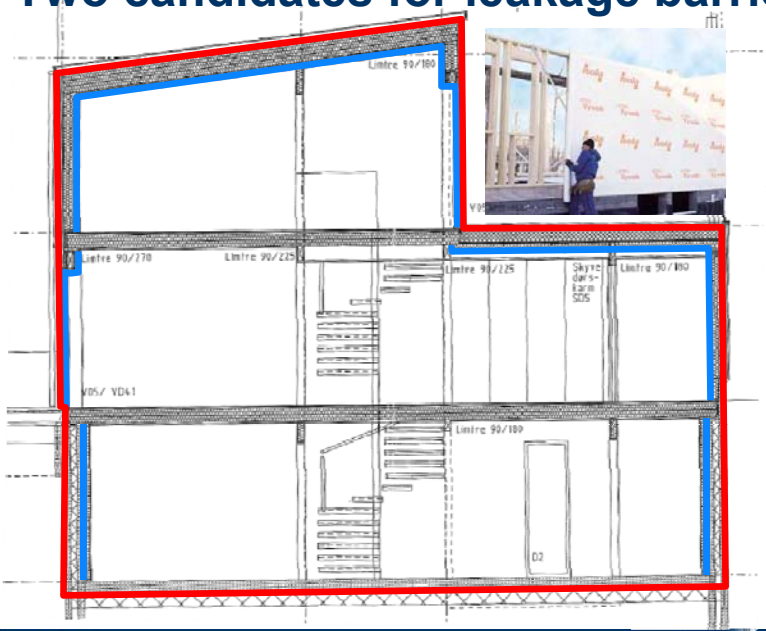
- Air-tightness was introduced in building regulations
- International awareness of the problem
- Good details (mostly)
- Pressurization tests were developed



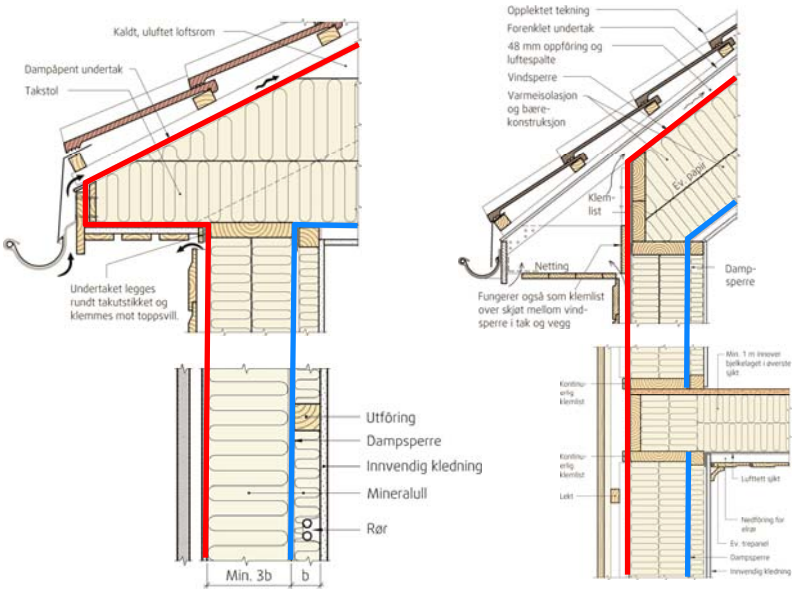
Airtightness in Norway today

- Envelope airtightness:
  - Default values: $n_{50} \leq 2.5$ for houses, $n_{50} \leq 1.5$ for all other buildings
  - Minimum value: $n_{50} \leq 3.0$
  - Optional passive house standard (NS 3700): $n_{50} \leq 0.6$
- Ventilation system airtightness
  - Most systems: Class C (round ductwork with prefitted gaskets)
  - Minimum value: Class B
- How do we document compliancy to air-tightness requirements?
- Documented design is *necessary*, but not *sufficient*
- Measuring is desirable

Two candidates for leakage barriers



Details



Early wind-tight stage pressurization tests

- Emphasis on wind barrier
- Well suited to normal construction order (windbarrier first)
- Leakage points easily detected visually & by feeling with hand (depressurized)
- Very easy and cheap repair at this stage

Compliance control

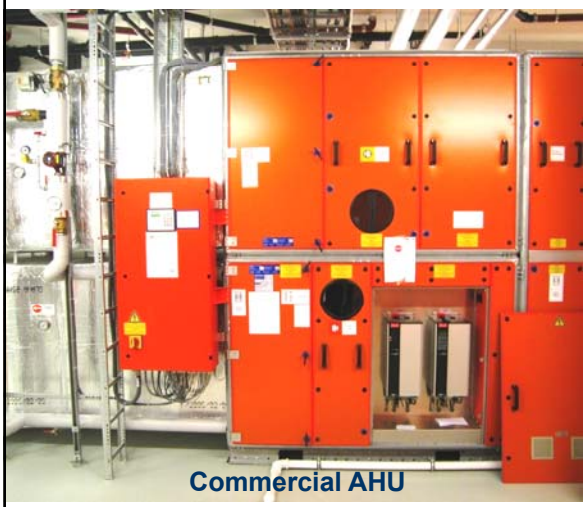
- Advocate use of simple & cheap test equipment for builders
- 3rd party control
  Required for Class A label.
- Better QA-schemes in future?

Simpler & cheaper test equipment for builders (examples)

approx € 700

approx € 700

Exploit ventilation system for pressure measurements

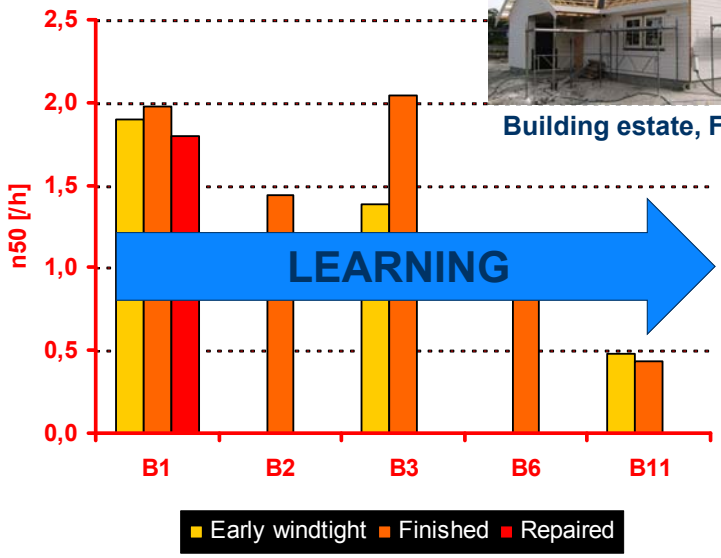


Commercial AHU

Residential AHU

It works :)

Building estate, Fauske



Recent inspiration: ”Low energy” label

- Pressurization test a precondition for governmental funding
- n_{50} = **0,3** /h (windtight phase) Lofoten. Not too robust details, but very good work-manship
- n_{50} < **0,1** /h (windtight phase), Sola 2006. Robust details, and good workmanship

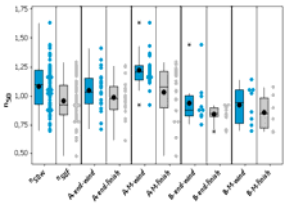
Foto: Erik Fjogstad

Case Jåtten Øst, near Stavenger

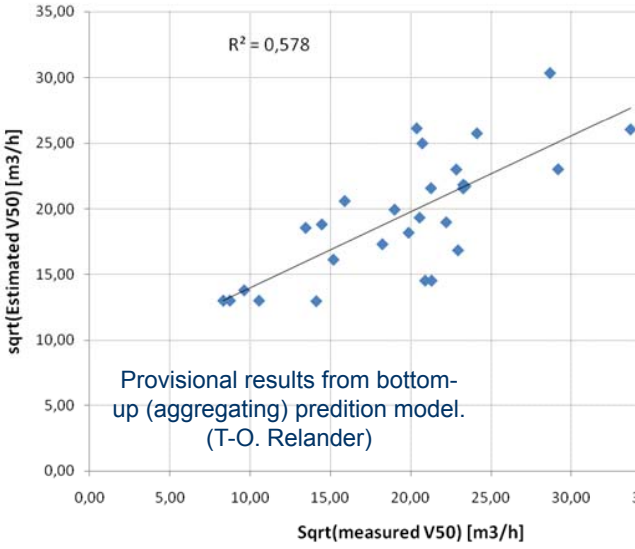
- 73 apartments
- Energy ambitions introduced late in planning:
  - Net energy demand: <106 kWh/m² (70% of regulations)
  - n_{50}< 1.0 h^{-1}
- No prior experience with airtightness measurements
- Foundations built by future homeowners

Case Jåtten Øst - Conclusions

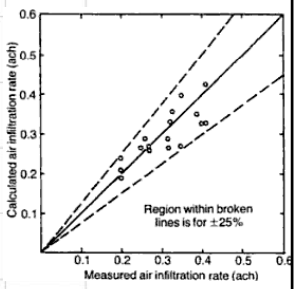
- Normal builders can do it. Repeatedly.
- Rough cost estimate 1350~1700 € per dwelling, including pressure testing.
- Testing is important!
  (Finished house with vapor barrier may be more or less tight)
- Planning for good airtightness could have reduced costs (and amount of expanding foam!) or improved result



Airtightness prediction modelling



Provisional results from bottom-up (aggregating) predition model. (T-O. Relander)



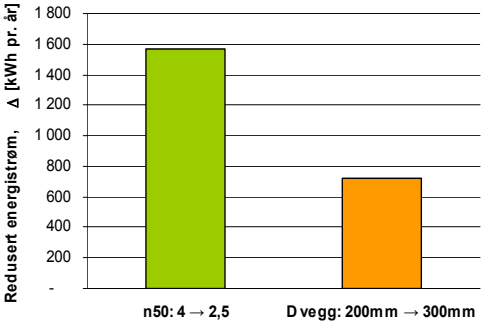
The LBL infiltration model compared with measurements
(© H.Awbi, 2003)

Costs related to achieving better airtightness

- Often no or small increase in cost
- **IF** there is minimum degree of awareness during building (awareness that measurements will be performed)
- **IF** *early wind tight measurement* is performed
- Small investment in measuring equipment

- Large cost, if high leakage number is surprisingly measured and one have to try to repair in after hand…

Energy saving potential



Improving airtightness compared to increasing wall insulation thickness by 50 mm (Norway)

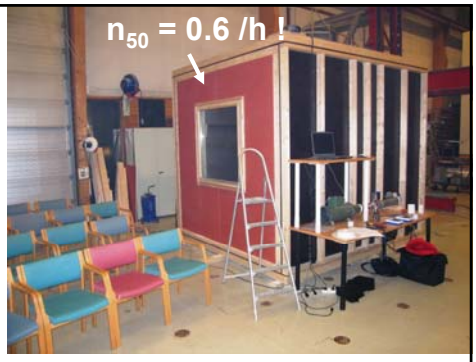
Other countries:

- 5 – 20 kWh/m^{2}y (BL)
- More cost effective than solar collectors (DE)
- Ca 5 kWh/m^{2}y pr unit n_{50} change (FR)

(data from ASIEPI project)

Campaign "KEEP TIGHT"

Training by demonstration



- Example: Single family dwelling 110 m^2 (V = 264 m^3)
- Requirements: $n_{50} \leq 2,5$ /h
- 2,5 /h x 264 m^3 = **660** m^3/h @ 50 Pa

Hole with diameter 100 mm ”leaks”
221 m^3/h @ 50 Pa

3 of these are allowed…

Measurement and standardization

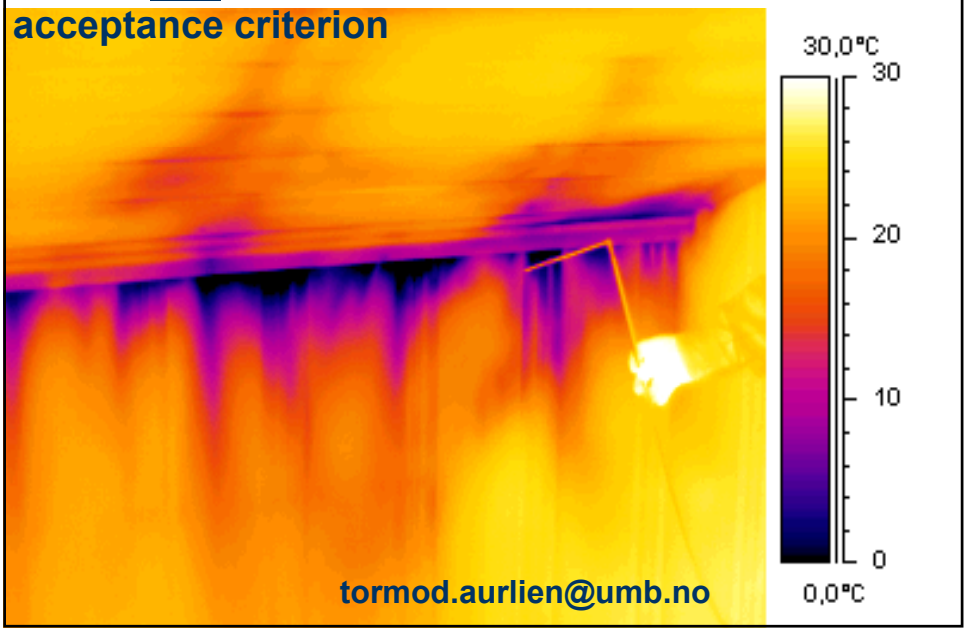
- There is much debate in Norway on standardization
- Harmonization of test methods
- Calculation of volumes, facade areas, etc.

- Tormod Aurlien is Norwegian delegate to the ISO 9972 revision & harmonization with EN 13829.
- We have written a position paper on the need for well-defined and harmonized measuring conventions.
- This is a **ongoing** process

Prediciton of potential drafts as part of leakage tests

- This is a contentious issue where some unprofessional testing contractors are using anemometers to locate potential points of drafts (e.g. with a threshold value of 1 m/s at the root of the leakage).
- Plan: MSc student to conduct experimental studies on this topic soon

Measurement of air speed in the root to the air leak should not be used as automatic (numeric) acceptance criterion



Existing challenges

- New solutions for particular details needed
- Focus on the building **process and training**
- Example: prefabricated bathroom modules
- Measurement issues