Dwelling air-tightness in a 55 years old estate

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- The estate
- Energy consumption
- Air-tightness
  - Methodology
  - Results
  - Comparison with other data sets
  - Infiltration and ventilation
- Conclusion

Built 1952-1957

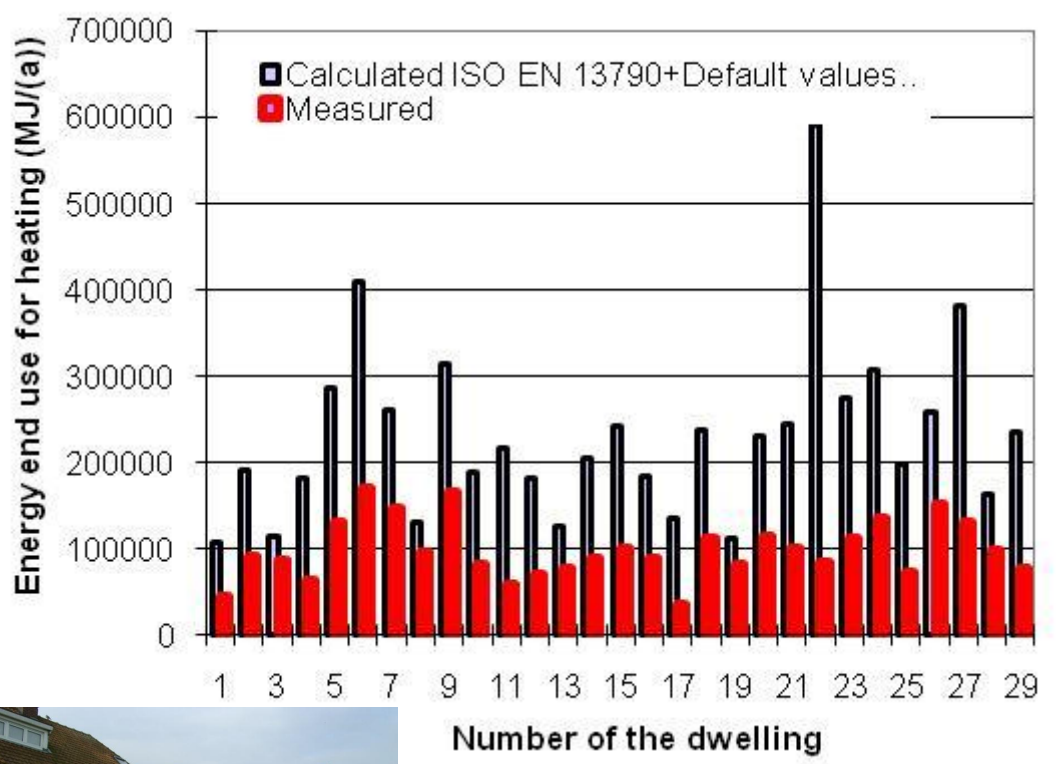Traditional construction

Loadbearing masonry, concrete floors

Unfilled cavity walls, tiled roofs

Single glass

No insulation

Heating

Energy end use for heating (MJ/(a)) vs. Number of the dwelling

Legend:
- □ Calculated ISO EN 13790+Default values..
- ■ Measured

Not reality

Important direct rebound compared with ISO EN 13790 with following default values:

Total protected volume heated at 18°C

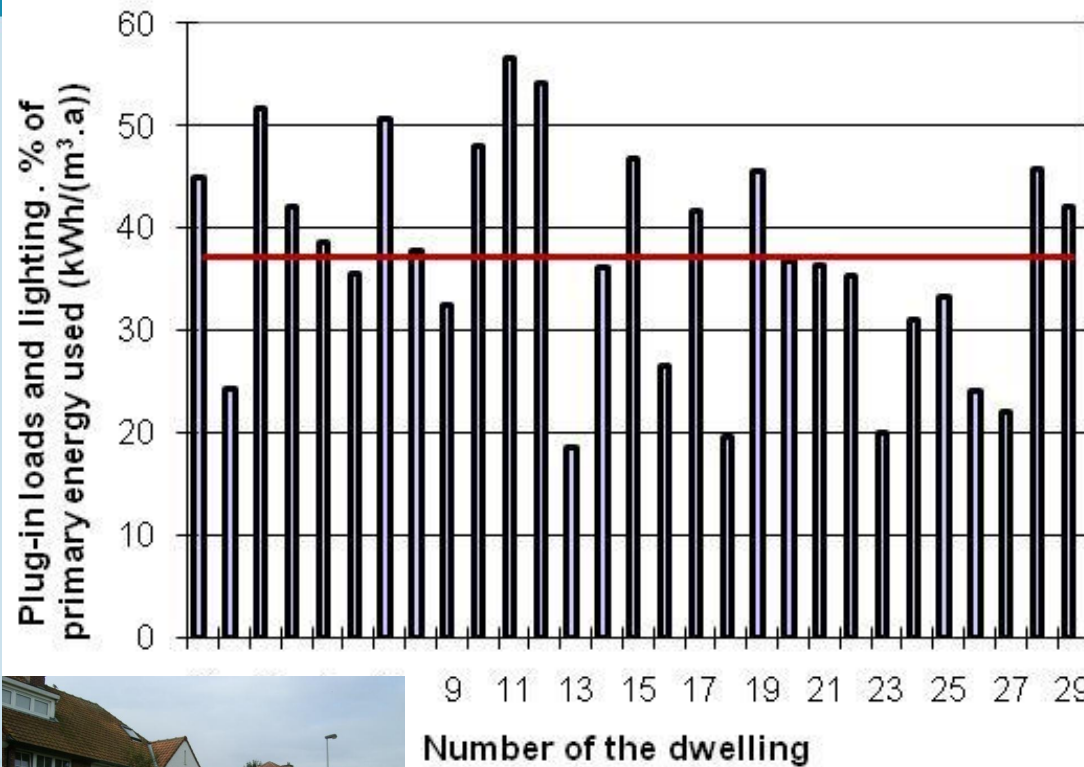Ventilation $1.5[0.2 + 0.5\exp(-V/500)]V$

v_{50}=12 m³/(m².h)

Internal gains $220 + 0.67V (W)$

Primary energy

Lighting + plug-in loads important part total annual primary energy use
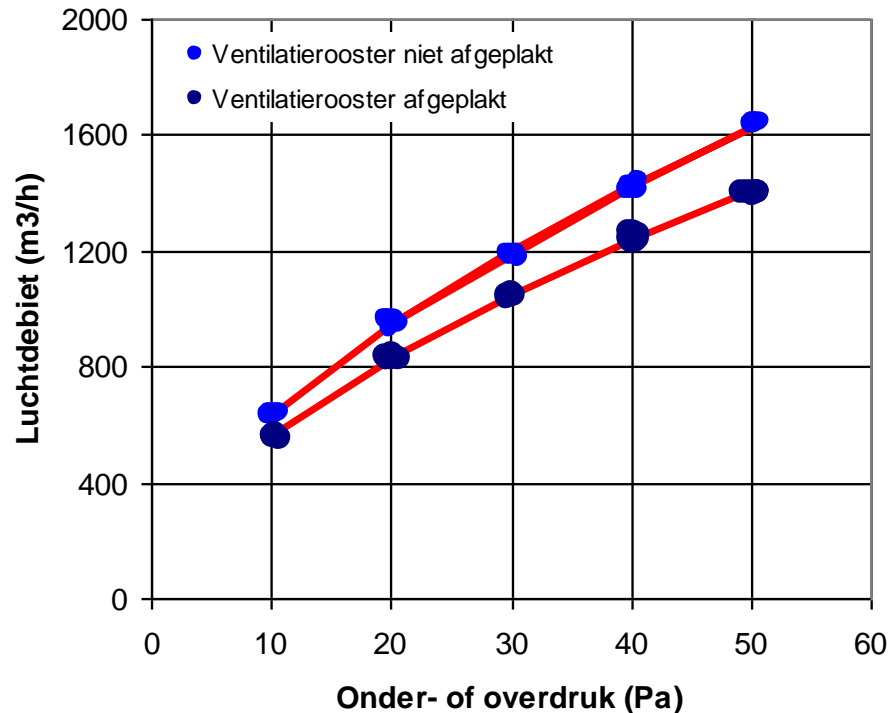Underlines importance energy efficient lighting and appliances

Methodology

Minneapolis blower door

Airflow as f(air pressure difference)

Allows calculating C and n

$$n_{50} = \frac{C50^n}{0.8V}$$

Results

Mean: 9.3 ach, stadev: 6.5 ach
Spread very large
Why unclear
Possible reasons: old windows
in some houses, letterboxes

Dwelling/ Heated vol./envelope m^3/m^2	Situation	C $m^3/(Pa^n.h)$	n	n_{50} ach
1/ 365/215	Attic and basement door closed, no leaks tightened	2524	0.29[1]	27.3
	Attic and basement door closed, major leaks tightened	2606	0.14[1]	15.2
2/ 573/354	Attic and basement door closed, no leaks tightened	2577	0.21[1]	13.0
3/ 469/483	Attic and basement door closed, no leaks tightened	301	0.49	5.5
4/ 513/544	Attic and basement door closed, no leaks tightened	709	0.56	15.5
5/ 768/642	Attic and basement door closed, no leaks tightened	248	0.65	5.1
	Attic and basement door closed, major leaks tightened	165	0.67	3.6
6/ 408/301	Attic and basement door closed, no leaks tightened	365	0.55	9.8
	Attic and basement door closed, major leaks tightened	324	0.56	8.9
7/ 599/406	Attic and basement door closed, no leaks tightened	192	0.75	7.5
8/ 536/440	Attic and basement door closed, major leaks tightened	373	0.62	11.3
9/ 586/353	Attic and basement door closed, major leaks tightened	159	0.68	4.9
10/ 435/243	Attic and basement door closed, major leaks tightened	88	0.55	2.2
11/ 459/314	Attic and basement door closed, no leaks tightened	158	0.67	5.9
12/ 553/470	Attic and basement door closed, no leaks tightened	241	0.79	11.9
13/ 551/418	Attic and basement door closed, no leaks tightened	300	0.58	6.9
14/ 869/760	Attic and basement door closed, no leaks tightened	194	0.64	3.5
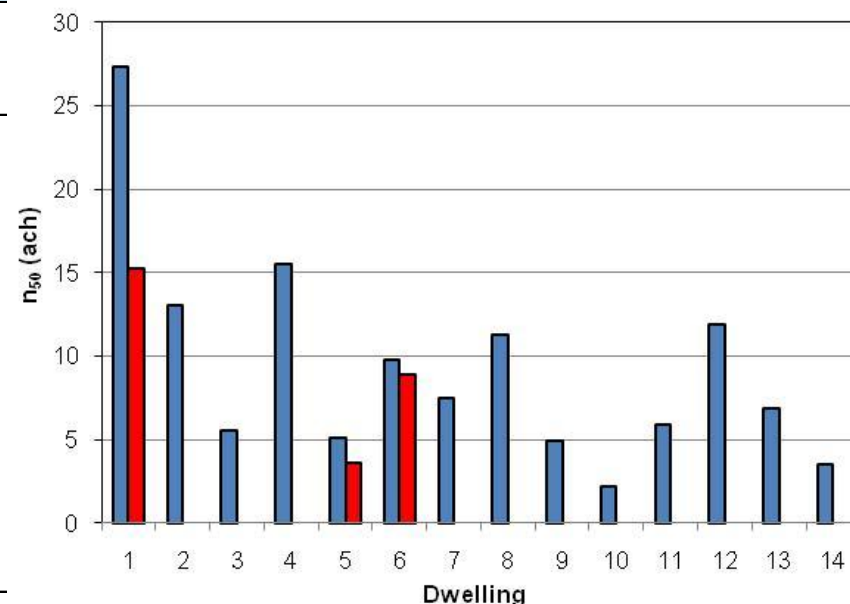
Comparison with other data sets

1986: 70 dwellings
n_{50}: mean 10 ach, stadev 7 ach, max. 40 ach, min. 1 ach
Mean and stadev close to 55 years old estate

Mid-eighties: 2 identical low energy houses
n_{50}: 9.5 and 10.2 ach
Reason: not plastered concrete block inside leafs

Comparison with other data sets

Early 2000th: low energy estate
Balanced ventilation with heat recovery
Requirement: $n_{50} <= 1$ ach
Reality disappointing, mean: 5.2 ach

Houses, Apartments Heated vol./envelope m^3/m^2	Situation	C $m^3/(Pa^n.h)$	n	n_{50} ach
1/ 384/298	All ventilation slots covered	48.3	0.76	3.1
	All window sashes tightened	45.6	0.73	2.5
2/ 154	All ventilation slots covered	56.1	0.64	5.6
3/ 154	All ventilation slots covered	27.1	0.75	4.1
4/ 185	All ventilation slots covered	47.8	0.56	6.0
5/ 187	All ventilation slots covered	43.9	0.71	4.9
6/ 299	All ventilation slots covered	113	0.73	8.3
	Leaks sealed			4.6
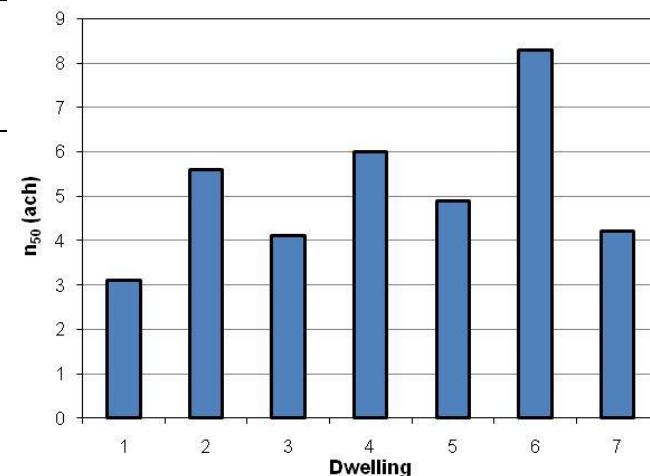
Comparison with other data sets

Passive dwellings

Requirement: $n_{50} <= 0.6$ ach

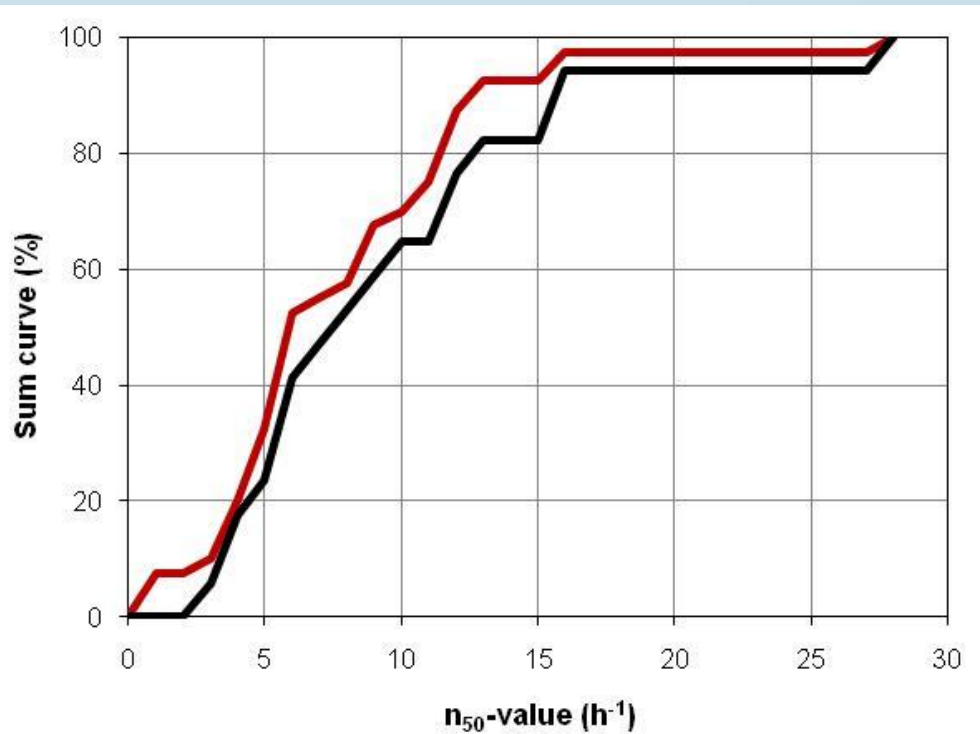| Dwelling	C	n	n_{50} h^{-1}
1	4,2	0,84	0,2
2			0,24
3			0,67

Comparison with other data sets

All data together (red line)
55 years old estate (black line)
Both distributions close together
Hardly any learning curve visible

Infiltration and ventilation

Rule of the thumb: $n_{50}/30 < n < n_{50}/10$

Reality more complex

Depending on location and prevailing wind direction:

33.1/12.8/38.3/17.3

n_{50}, h^{-1}	Ventilation strategy
$n_{50} \geq 8$	Adventitious ventilation possible
$4 < n_{50} < 8$	Purpose provided natural ventilation system
$1 < n_{50} \leq 5$	Mechanical ventilation system (exhaust)
$n_{50} \leq 1$	Balanced ventilation with heat recovery
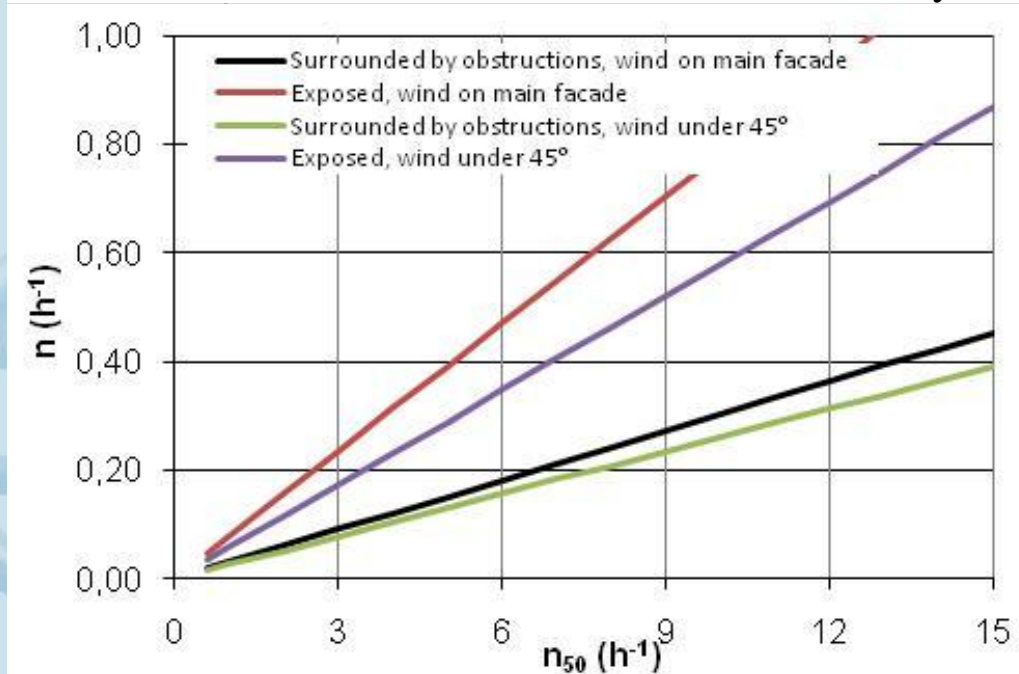
Conclusion

❏ Achieving acceptable air-tightness still a challenge

❏ Not much changed since the fifties

❏ n_{50} realized a lucky shot.

❏ Main reasons lacking design knowledge and lacking workmanship

❏ Passive house construction proving much better is possible

❏ Urgent demand for standard details and instructions for correct workmanship.