NEW METHOD TO TEST AIRTIGHTNESS OF NEARLY ZERO ENERGY DWELLINGS

Wouter Borsboom, TNO
Timothy Lanooy, ACIN
Wim Kornaat, TNO
Willem de Gids, VentGuide

TNO innovation for life

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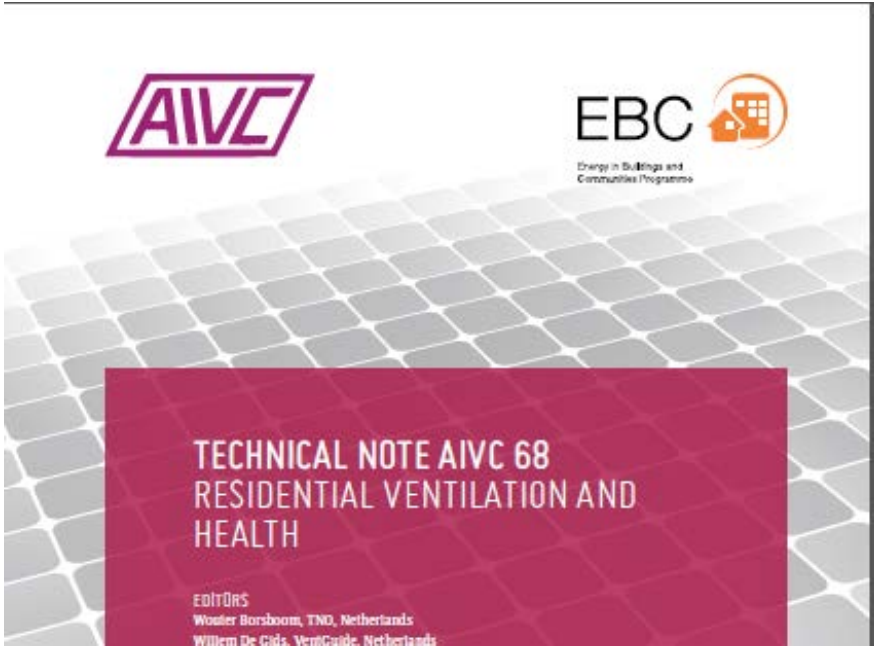
WOUTER BORSBOOM, TNO

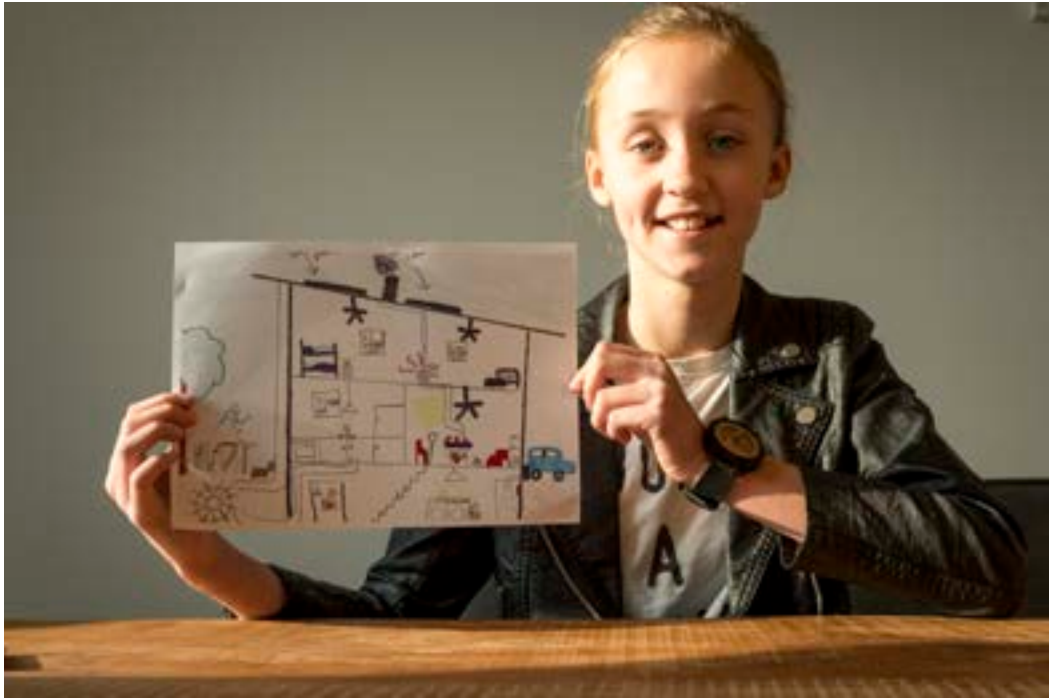
Business consultant, energy built environment.



Example nearly zero energy dwelling: Rc=5-6, N50 ach 0.8, heat recovery, heat pump, PV -> can be built without subsidies

WHAT SHOULD A HEALTHY ENERGY EFFICIENT DWELLING OFFER?

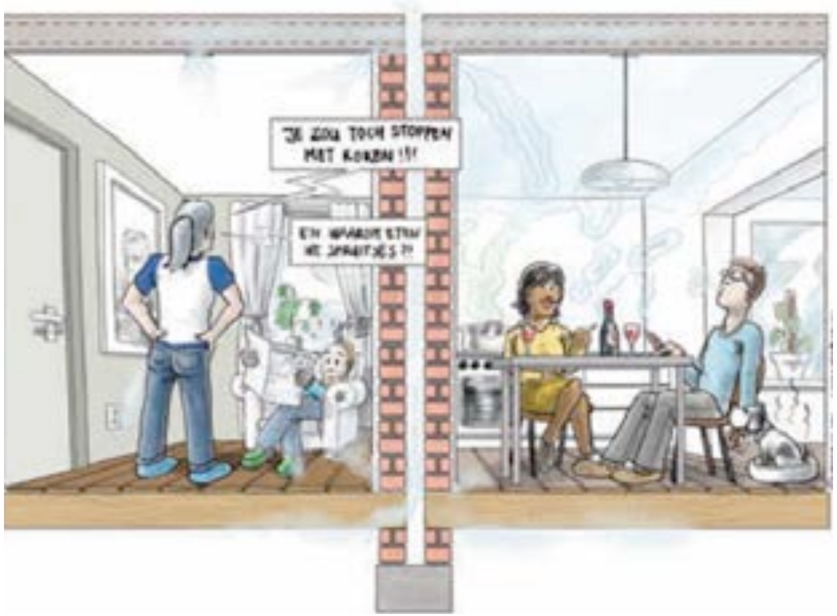
- A dwelling with sufficient ventilation
- A cool house in the summer
- A dwelling with less exposure to conterminants



GOOD PERFORMANCE OF VENTILATION NEEDS AIRTIGHT DWELLINGS

- Airtightness at least N50 < 4
- High preformance dwelling are mostly airtight **N50 < 1 to**:
  - **Reduce the installed capacity** heating / cooling
  - **Reduce energy demand** Heating & Cooling

Darling, you told me that you stopped smoking..

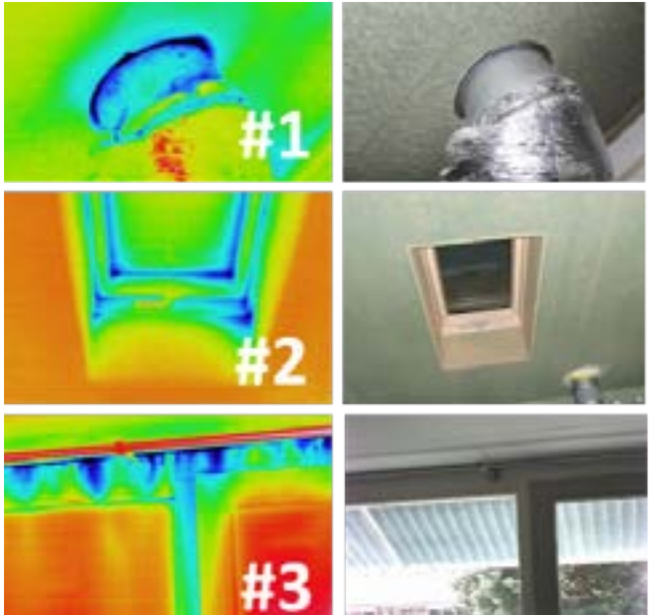


Bron: Willem Koppen, Koppen Bouwexperts

PROBLEMS IN QUALITY CONTROL

- Specified airtightness is not met in many cases
- **Effects**:
  - **Roomset points is not met** through insufficient capacity
  - **Thermal comfort**
    - temperature control
    - draught
  - **Reduced indoor air quality** trough advantitious ventilation
  - **Increased energy bill** through extra heating and cooling demand
  - Example renovation: **design ach 3, but realized ach 15**

Top 3 air-leakages in 13 nearly zero energy dwellings



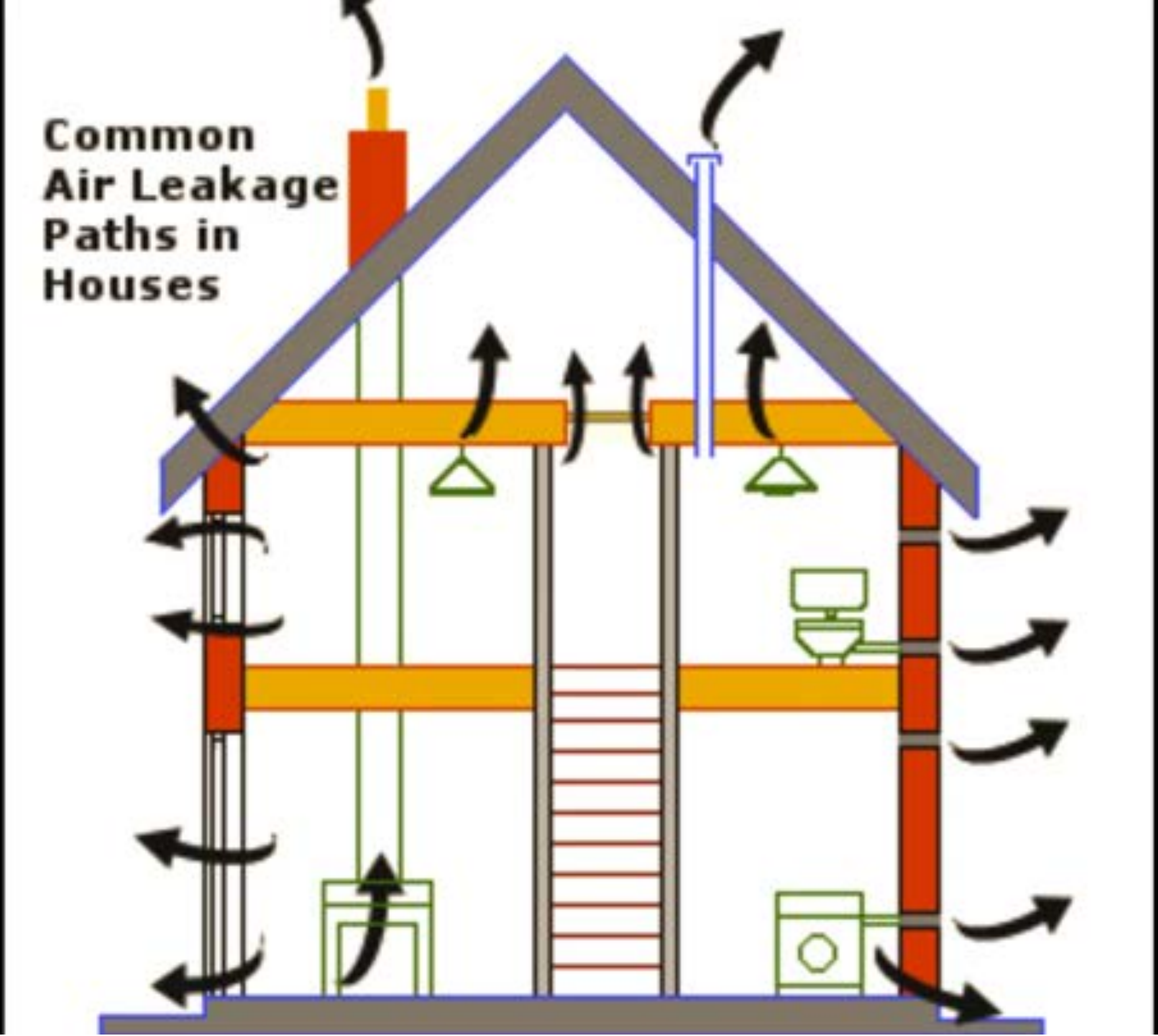
NEED FOR 100% QUALITY CHECKS AIRTIGHTNESS

- Both new and retrofitted dwellings
- Meet European Carbon reduction targets
- Last week in the Netherlands **statement** “healthy living without gas heating” by the **building industry,** 21 companies and associations to perform a **100% check of airtightness** and ventilation and **N50 < ach 1,5**

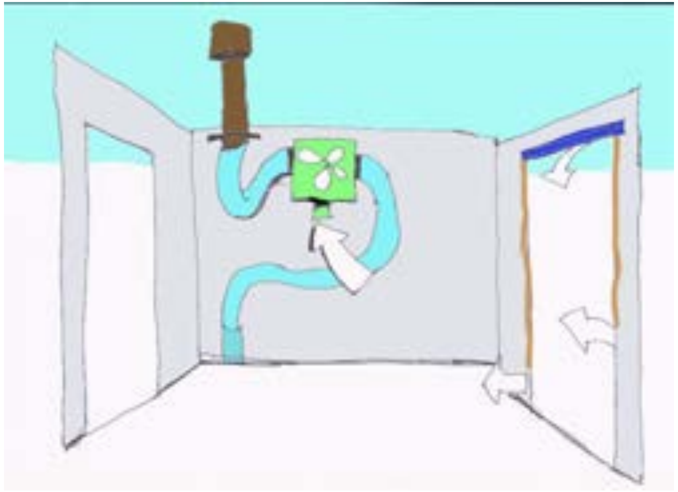
QUICK & SIMPLE AIRTIGHTNESS TEST

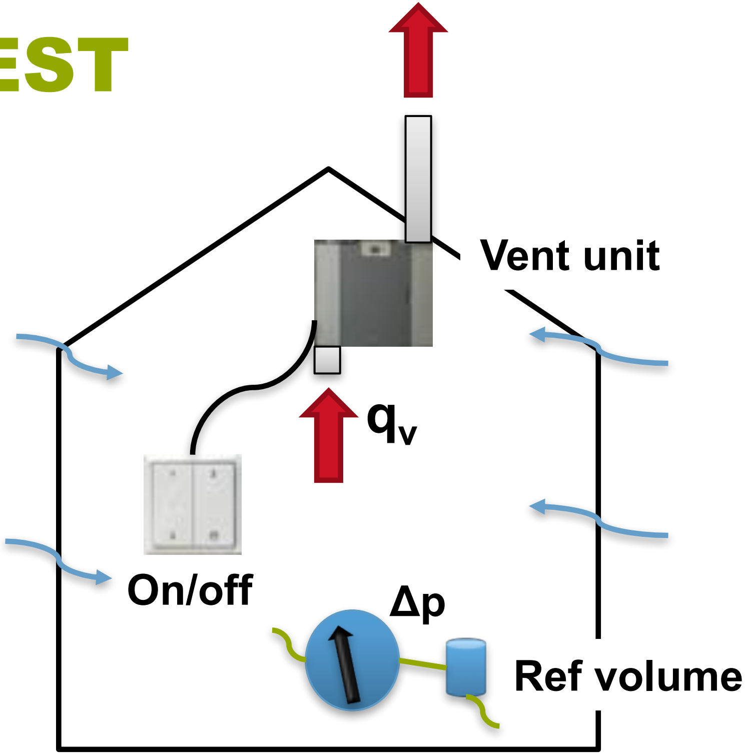
Reason of the research:
The association of manufactors of ventilation systems and installers joint forces: The challenge is to make **an airtightness test method suitable for all kind of craftsmen and inspectors.**

VLA UNETO-VNI


Common
Air Leakage
Paths in
Houses

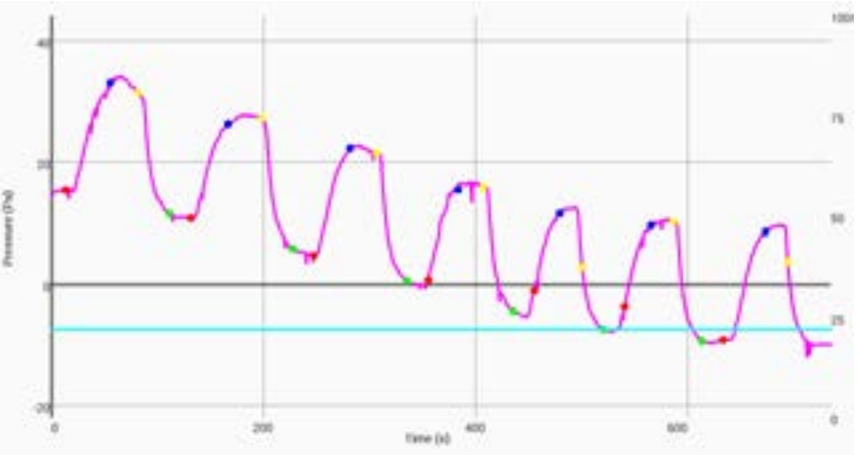
PRINCIPLE OF THE TEST



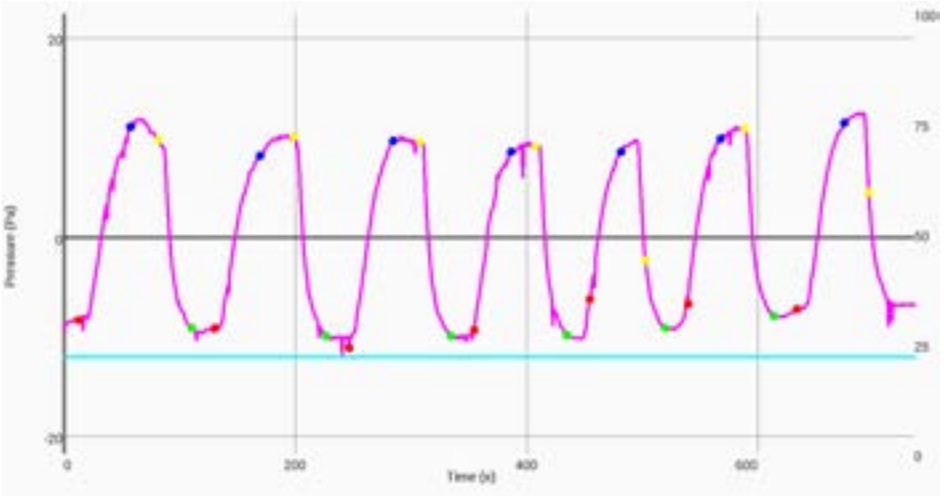


EXAMPLE TEST SIGNAL

- Measurement signal



- Corrected signal



PRACTICAL ISSUES

- Mechanical exhaust or supply, natural inlet or range hood
  - Closed grills

  or

- Balanced ventilation with heat recovery
  - Switch off the supply or exhaust and block it

SCOPE OF THE METHODOLOGY

- Required airtigthness **N50 < 4**
- Sufficient **mechanical flow > 20 l/s** to have a pressure of > 10 Pa
  - **Whole house ventilation** (20-70 l/s)
  - Or a **range hood**

Every country has it’s own rules how the measurements take place.
For instance how to handle fire place, open gas boilers etc.

LABORATORY CALIBRATIONS

Calibrated opening	$q_{v,}$blower door (l/s)	*n* (-)	$q_{v,system}$ (l/s)	$q_{v,new}$ (l/s)	$q_{v,new}$ (l/s)	Δq_v (l/s)	Δq_v (%)
			±1.0 l/s	*n measured*	*n* = 0.66		
Closed	17.0	0.68	49.0	18.6±0.5	19.1±2.8	1.6	9.4
	16.1	0.70	48.5	17.6±0.4	18.9±2.8	1.5	9.3
12.5	30.5	0.62	48.5	30.7±1.3	29.8±2.6	0.2	0.7
	34.6	0.58	48.5	32.4±1.6	30.8±2.7	-2.2	-6.4
25	44.7	0.58	48.5	47.5±1.5	47.3±1.8	2.8	6.3
	51.7	0.53	48.5	42.9±9.3	41.7±11.4	-8.8	-17.0
50	86.7	0.53	48.5	77.7±10.1	86.0±16.0	-9.0	-10.4
	77.7	0.52	48.5	66.6±26.5	72.5±38.5	-11.1	-14.3
	77.7	0.52	65.0	72.8±3.4	74.9±4.6	-4.9	-6.3
	77.7	0.52	104.0	79.3±2.6	73.7±4.9	1.6	2.1
75	101.7	0.51	49.0	82.5±18.6	96.2±30.2	-19.2	-18.9
	101.2	0.51	65.5	97.9±15.1	110.1±23.8	-3.3	-3.3
	101.2	0.51	104.5	106.9±6.7	107.6±8.7	5.7	5.6
	101.2	0.51	104.5	101.5±6.9	100.6±8.9	0.3	0.3

fixed and assumed *n*

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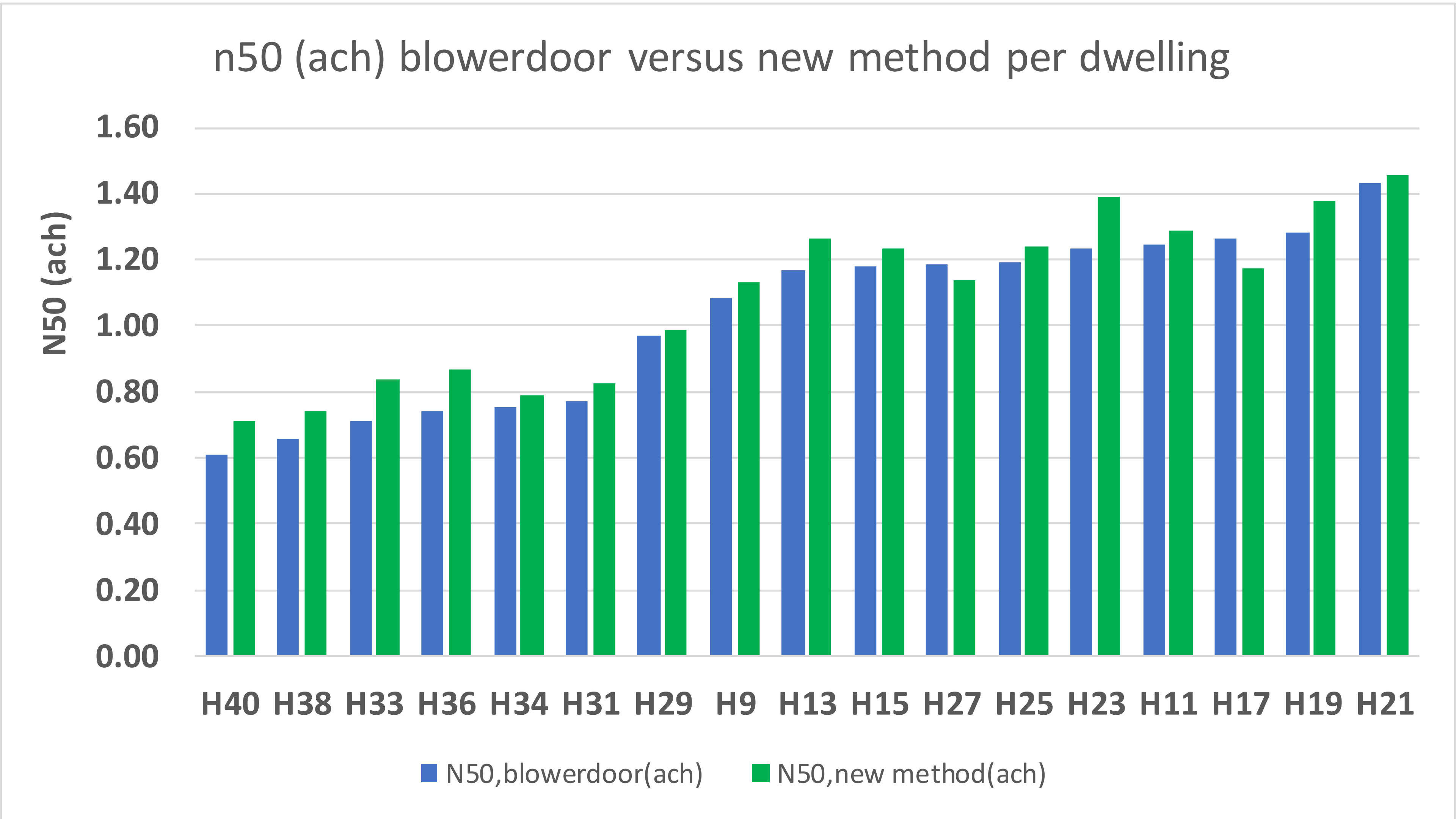
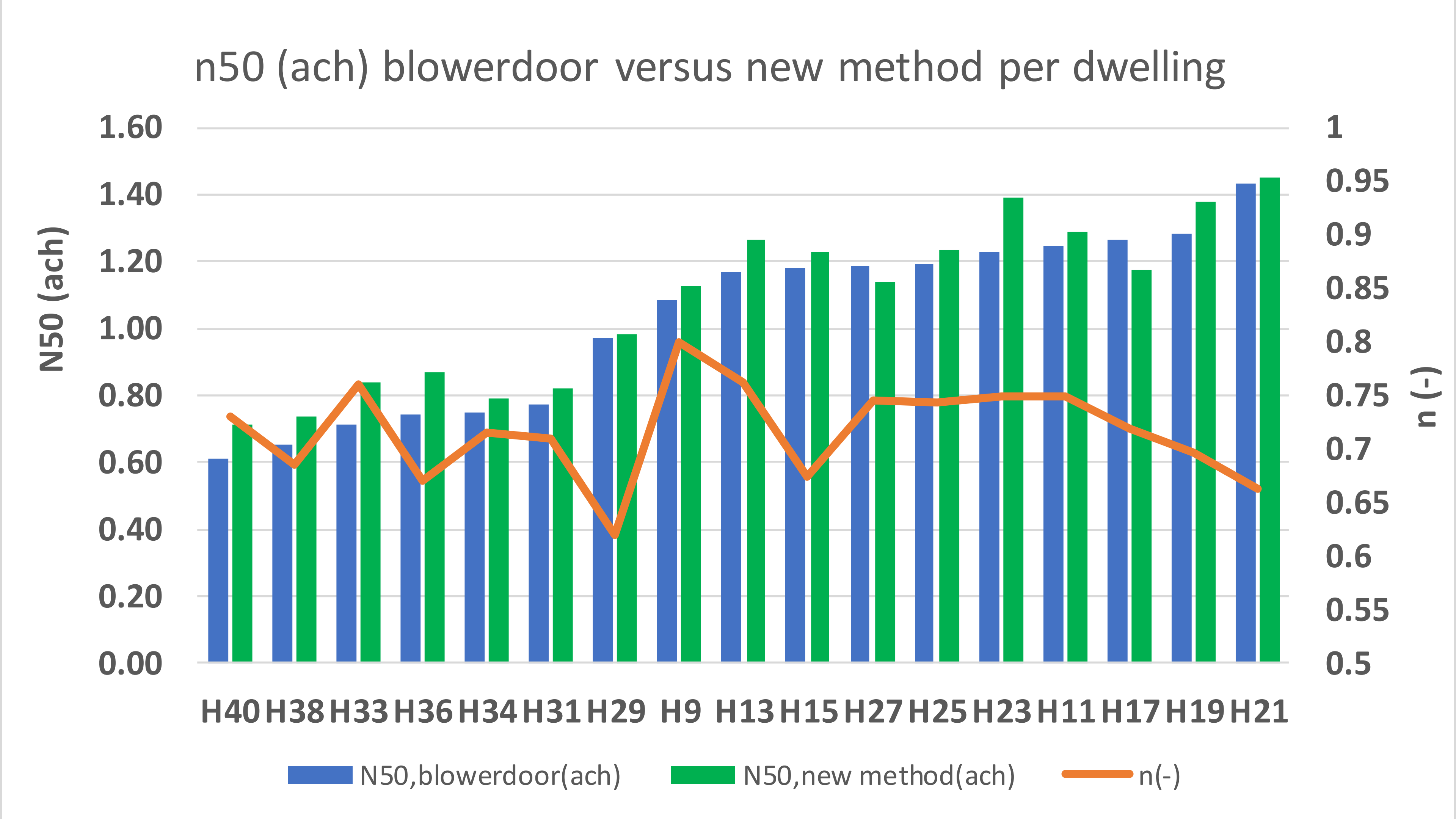
FIELD MEASUREMENTS


n50 (ach) blowerdoor versus new method per dwelling
N50 (ach)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
H40 H38 H33 H36 H34 H31 H29 H9 H13 H15 H27 H25 H23 H11 H17 H19 H21
N50,blowerdoor(ach)
N50,new method(ach)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1.40
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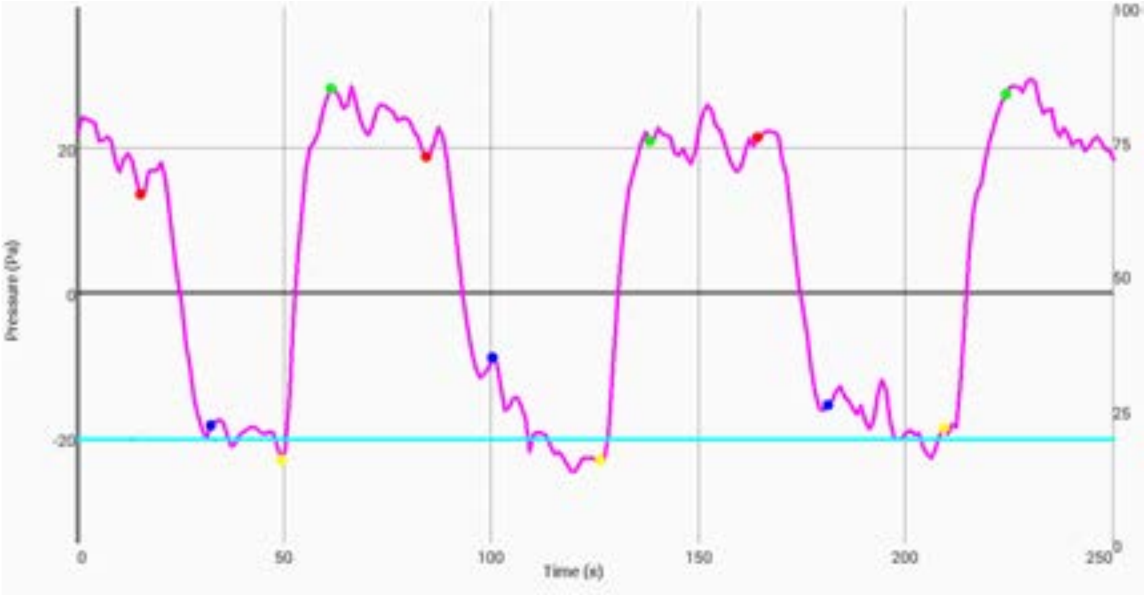
0.60
0.40
0.20
0.00
N50 (ach)
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
n (-)
H40 H38 H33 H36 H34 H31 H29 H9 H13 H15 H27 H25 H23 H11 H17 H19 H21
N50,blowerdoor(ach)
N50,new method(ach)
n(-)

MEASURING AT HIGH WIND SPEED



$q_{v,10}$ new = 34.2 l/s (N50=1,1)

Blowerdoor fan off 40 Pa

$q_{v,10}$ blower = 31.6 l/s at another day

RESULTS FIELD STUDIES

- **Flow** was **more difficult to measured** in the **field** studies due to summing up of flow of different outlets. A fault in the flow has a strong impact in overall accuracy
- Room for improvement to **calculate pressure difference**
- Average **difference** between blower door and new test methode up about 10%, max 20%

DISCUSSION

- Advantages
  - **Quick**, about 20 minutes
  - **Compact** can be placed in a bag pack
  - **Simple**
  - **Inaccuracy < 20%**

- Disadvantages
  - **Flow coefficient needs multiple** measurements with different flows
  - **Less visual impression smoke test** in cases with lower pressure
  - When ventilation flow is not measured by the ventilation unit, **multiple measurements of flows through valves leading to lower accuracy**

THANKS FOR YOUR ATTENTION

Contact:
Wouter Borsboom
wouter.borsboom@tno.nl

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