AIVC WORKSHOP WELLINGTON
TOWARDS HIGHER-PERFORMING BUILDINGS:
THE ROLE OF AIRTIGHTNESS AND VENTILATION

DEMAND CONTROLLED VENTILATION:
DESIGN GUIDELINES AND PERFORMANCE CHARACTERISATION IN BELGIUM

A. Janssens, J. Laverge, S. Caillou, N. Heijmans
THE SUCCESS OF 10 YEARS EPB FOR NEW DWELLINGS

- Building energy assessment is a key driver in the transition towards a carbon neutral housing stock
- Evolution E-level: new single family houses (300,000 reports)
AIR TIGHTNESS OF NEW DWELLINGS

Mean air permeability ($\text{m}^3/\text{h}/\text{m}^2$)

Share of dwellings with reported blower door test (%)

Year of building application
RESIDENTIAL VENTILATION SYSTEMS

- Prescriptive design rules in standard NBN D50-001:1991
  - Fresh air supply to habitable ‘dry’ rooms, extraction from ‘wet’ rooms
  - Compulsory as part of EPB-regulation
- Fresh air supply flow rates based on floor area
  - Generally 3.6 m³/h/m² (=1 l/s/m²)
- 4 simplified systems allowed, permanent operation
  - 2 systems dominate the market
SHARE OF VENTILATION SYSTEMS IN NEW DWELLINGS (VEA 2015)

- Mechanical extraction ventilation (MEV) dominates the market
- Increased share of mechanical ventilation with heat recovery (MVHR)
PRINCIPLE OF EQUIVALENCE

- Goal:
  - Allow for innovation of systems for which energy performance assessment is not included in regulatory calculation method
  - Introduce flexibility and provide temporary alternative solutions within a rigid regulatory framework

- Demand controlled ventilation for residential applications
  - Alternative assessment methods have been developed since 2007-2014 under principle of equivalence
  - Methodology has evolved over time
    - Assessment of mean ventilation heat loss reduction compared to standard systems
    - On condition of equivalent IAQ as provided by standard systems
    - Monte Carlo analysis based on dynamic multizone simulations with stochastic inputs for reference dwelling
  - Integrated in regulatory calculation since 2014

INTEGRATION OF DCV IN REGULATORY EPB-CALCULATION

- Heat loss reduction factor for DCV $f_{\text{reduc}}$ taking a representative occupation into account
- Offices-schools: MD 2012
  - Default values $f_{\text{reduc}}$ related to control categories EN13779
- Residential: MD 2014
  - By 2014: 35 DCV-systems rated under principle of equivalence, mainly MEV (90%)
  - Development of DCV-classification method and default values $f_{\text{reduc}}$ in regulatory calculations
DEMAND CONTROLLED VENTILATION

– Definition in regulations:
  
  *Ventilation system with automatic control comprising at least following elements:*
  
  – *Detection of ventilation needs*
  
  – *Control of ventilation flow rates as a function of the needs*

– Definition applies to both residential and non-residential

– Performance depends on:
  
  – Type and locations of detection
  
  – Type and locations of flow rate controls
TYPE OF DETECTION CONSIDERED (RESIDENTIAL)

- In the ‘dry’ habitable rooms (occupancy, acceptability)
  - CO₂
  - Presence detection
- In the ‘wet’ rooms (humidity, odours)
  - RH: kitchen, bathroom, laundry,…
    - alternative: CO₂ in stead of RH, only in kitchen
  - Presence detection: rooms with WC
    - alternative: light switch or VOC in stead of presence detection
- Locations:
  - Local: detection in every room, or in extraction duct serving individual rooms
  - Semi-local: detection in some rooms (eg night vs day zone)
  - Central: detection in main extraction duct
TYPE OF FLOW RATE CONTROLS CONSIDERED

– Which flow is controlled?
  – Supply only
  – Extraction only
  – Supply and extraction

– Where?
  – Local: every room independent of others (eg room specific valves or fans)
  – Semi-local: at least day and night zone
  – Central (eg frequency controlled fan)
### General approach

- **Detection in wet rooms and control of extraction flow rates**

<table>
<thead>
<tr>
<th>Detection and control</th>
<th>Local detection and non-local control</th>
<th>No or other detection</th>
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<tbody>
<tr>
<td><strong>Local</strong> detection and control</td>
<td>$f_{\text{reduc}} = ?$</td>
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<td><strong>Central</strong> detection and control</td>
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<td><strong>No or other detection</strong></td>
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**Detection in dry rooms and control of supply flow rates**

60 variations defined
MULTI-ZONE SIMULATIONS CONTAM

- Reference geometry:
  single floor
  appartement

- Simulate exposure to:
  - CO₂ (occupants)
  - RH (occupants-activities)
  - VOC (materials)
  - Odour (tracer WC)
PRESCRIBED CONTROL SET-POINTS

- Eg extraction flow control as a function of relative humidity
DEFINITION OF $F_{\text{REDUC}}$ FOR DCV RESIDENTIAL

- Reference: standard systems with manual control

$$f_{\text{redu}}c = \frac{X_1}{X_2}$$

Exposure to excess CO$_2$ above 600 ppm (ppm.h/year)

Ventilation heat loss (MWh/year)
## PERFORMANCE CHARACTERISATION

- **General approach**

Detection in **wet rooms** and control of **extraction flow rates**

- **Detection in dry rooms** and control of **supply flow rates**

<table>
<thead>
<tr>
<th>$f_{\text{reduc}}$</th>
<th><strong>Local</strong> detection and control</th>
<th>Local detection and non-local control</th>
<th><strong>No or other</strong> detection</th>
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</thead>
<tbody>
<tr>
<td><strong>Local</strong> detection and control</td>
<td>0.35</td>
<td>0.38</td>
<td>0.42</td>
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<td>...</td>
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<td><strong>Central</strong> detection and control</td>
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<td>0.87</td>
<td>0.93</td>
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<tr>
<td><strong>No</strong> or other detection</td>
<td>0.90</td>
<td>0.95</td>
<td>1.00</td>
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</tbody>
</table>

60 variations defined
TYPICAL DCV-SYSTEMS ON MARKET

- Mechanical extract ventilation (MEV)
  - Natural supply (window ventilators) habitable rooms, no control
  - Central mechanical extraction (fan) wet rooms, individual RH- and presence detection control

- Mechanical extract ventilation (MEV)
  - Natural supply (window ventilators) habitable rooms, no control
  - Central mechanical extraction (fan) wet rooms and bedrooms, with individual CO₂-control

\[ f_{\text{reduc}} = 0.90 \quad f_{\text{reduc}} = 0.50 \]
DETECTION AND CONTROLS IN EXTRACTION DUCT CONNECTORS: SYSTEM EXAMPLES

• Automatic operation: extraction rate adapted according to measured values and algorithm

• Control valve with integrated sensors (RH, VOC, CO₂)
  Sensor type selected for most important pollutant in room
Kit slaapkamer - 30 m³/h
CO₂ : 900ppm

Kit slaapkamers - 105 m³/h
CO₂ : 800ppm

BEDROOM
CONCLUSIONS

– The Belgian ventilation market is driven by energy performance regulations.
– Regulations allow for the application of demand controlled ventilation to improve indoor air quality and energy efficiency
  – Principle of equivalence
  – Generic DCV-classification method and default values $f_{\text{reduc}}$ in regulatory calculations

Thank you for your attention!
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