# Performance-based approaches for ventilation requirements in dwellings

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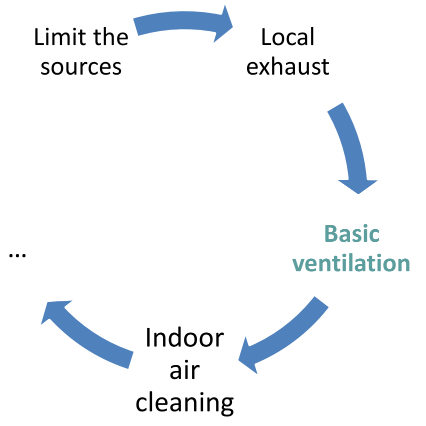
## **PREVENT project** in Belgium: Development of new standard for dwelling ventilation

- Hot topics : DCV, natural & hybrid ventilation, …
- But also: **Feasability of performance-based approach**
- Objectives of this presentation
  - **Comparison** of different performance-based approaches
  - **Lessons learned** from our experience of performance-based approach in the context of EP-calculation

## Ventilation is part of a broader IAQ strategy




- But the design of ventilation is always necessary at a given moment



## Different aproaches are possible to set ventilation requirements

- Requirements in the form of
  - Flow rates?
  - IAQ criteria?
- 2 extreme examples
  - Flow rates and prescriptive rules: current ventilation standard for dwellings in Belgium (NBN D 50-001)
  - Maximum CO2 concentration during use: new regulation for workplaces in Belgium

## Extreme example 1: flow rate requirements and prescriptive rules for dewllings in Belgium (NBN D 50-001)

- Approach
  - Minimum flow rates (based on type and surface of the spaces)
  - One flow path is authorized: supply → transfer → exhaust
  - 4 systems: A, B, C, D
  - Prescriptive rules (for natural ventilation systems)

    Ex. Design of natural ventilation openings for $\Delta P$ = 2 Pa



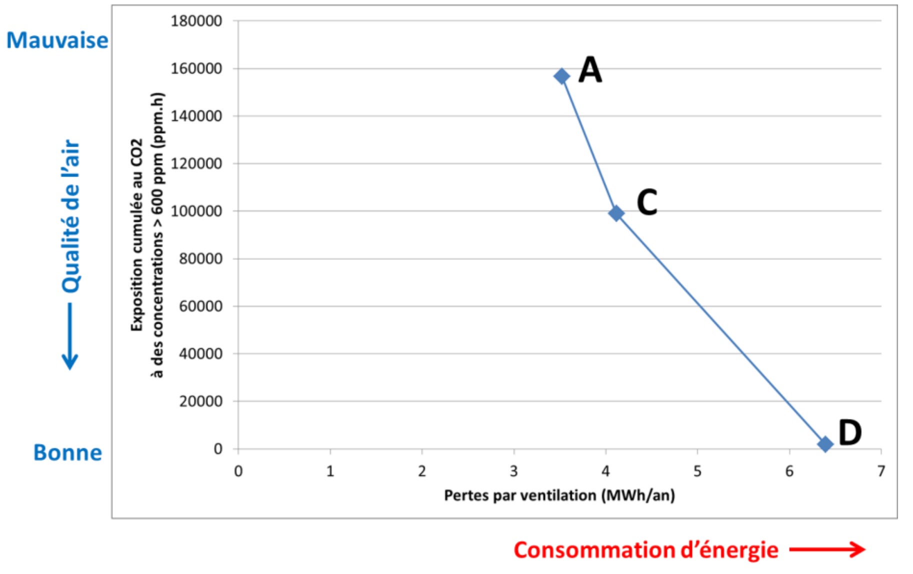
## Extreme example 1: flow rate requirements and prescriptive rules for dewllings in Belgium (NBN D 50-001)

- Pros
  - Easy to design ventilation systems (manufacturers, designers,…)
  - Easy to check conformity
- Cons
  - Non equivalency between natural and mechanical systems

    Could be partly solved by improved descriptives rules
  - Block innovation (flow path, DCV, natural systems,…)

    Could be partly solved by others rules, but it is always temporary
  - …

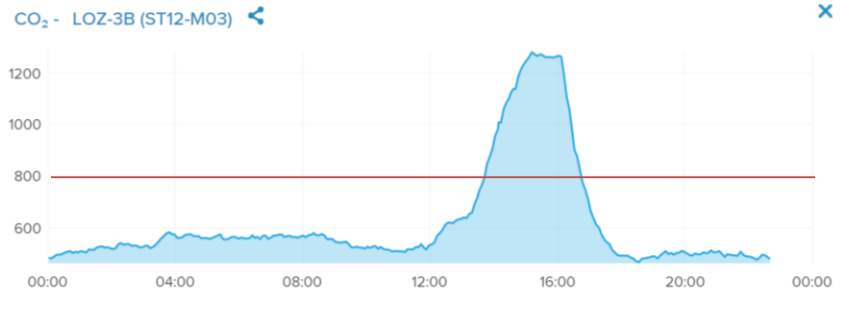
# (Non-)equivelency between systems






## Extreme example 2: Maximum CO2 concentration during use (new regulation for workplaces)

- Approach
  - Maximum CO2 concentration of 800 ppm (absolute)



## Extreme example 2: Maximum $CO_2$ concentration during use (new regulation for workplaces)

- Pros
  - Performance-based approach
- Cons
  - Only one pollutant (rather tracer)
    Could be partly solved using other IAQ metrics
  - Difficult to design ventilation systems
    Hypothesis and finally flow rates are needed
  - Dispersed responsibility
    Occupants (use of spaces, overcrowded)
    Building operator (here, the employer)
    Building and ventilation designers and installers/contractors



## Intermediate conclusions

- Prescriptive approach
  - Block innovation
- Extreme performance-based approach
  - Is maybe an illusion?
  - Hypothesis are necessary to design ventilation
    These hypothesis could preferably be part of the requirements
    → equivalency approaches

## Between these 2 extreme examples, intermediate equivalency approaches are possible

- Several equivalency approaches exist for EP-calculation
  - France, The Netherlands, Spain, US, Belgium
    → see previous presentation of Gaelle Guyot
- Could also be used for IAQ/ventilation requirements
- General idea: numerical simulations
  - Ex. Multizone models (Contam,…)



## What we need for such simulations

- Simulation tool
- Weather data
- Building(s): geometry, airtightness, etc.
- Occupant profile(s)
- IAQ criteria (and IAQ metrics)
- Ventilation system to be tested: components, regulation, etc.
- And what we get from these simulations
  - Flow rates (eventually reduction factors for EP-calculation)
  - Conformity against IAQ criteria

## Examples of possible equivalency approaches

- (1) Product approach
  - Reference building(s)
  - Reference profile(s)
  - Ventilation systems to be tested
- (2) Building approach
  - **Real building**
  - Reference profile(s)
  - Ventilation systems to be tested
- (3) Building + occupants/sources approach
  - **Real building**
  - **Real occupants/sources**
  - Ventilation systems to be tested



Ex: France, Spain, Belgium,…

## (1) Product approach

- Approach
  - Equivalent IAQ criteria
  - Simulations carried out on products (ventilation systems)
    - On one or more reference building(s)
    - With standard/reference conditions
- Can be applied on large scale (products)
- Challenges
  - Not for combination building + ventilation system: see building approach
  - See example of Belgium (next slides)

Ex: Spain

## (2) Building approach

- Approach
  - Simulation of the real building + ventilation system

    Also possible to evaluate natural ventilation (building + system)
  - Reference occupant/sources profile(s)
- Challenges
  - More expensive?

    Simulation per building in place of per product



No example?

## (3) Building + occupant/source approach

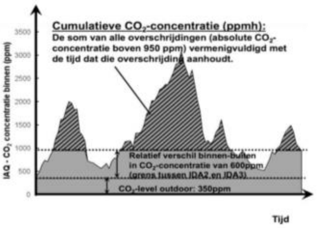
- Approach
  - Simulation of the real building + ventilation system
  - Also real occupant profile(s) and sources
- Challenges
  - Not only the building (design) but also the occupants and users

    → not building independent

    Occupant profile and building independent: not recommended

    Building sources: ok if sources are known + IAQ criteria

## Belgian example (Product approach in EPB)
## IAQ criteria




- Problem?
  - Initially: only CO2 criteria
  - But the required flow rates in the standard are

    not only for CO2

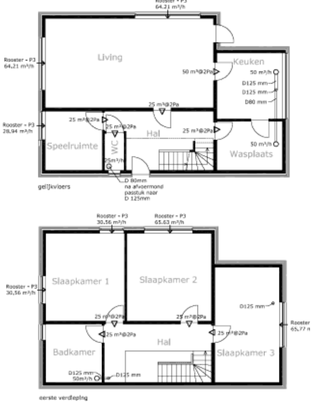
    but also to evacuate odors and humidity from services spaces
  - New IAQ criteria has been developed: odors + mold risk

- Wat can be learned?
  - Coherence needed between:

    Requirement (e.g. flow rate) ⇔ IAQ criteria



## Belgian example (Product approach in EPB)
## Reference building



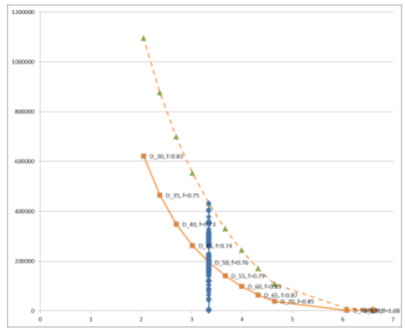

- Problem?
  - Only 1 reference building
  - But some systems can be largely influenced by the building

- Wat can be learned?
  - If influence of the building (e.g. natural systems):

    Or several reference buildings

    Or follow the « building approach »

## Belgian example (Product approach in EPB)
## Occupant profiles




- Problem?
  - Several profile(s), 2 to 6 persons
    + probabilistic approach → average
  - Meaing of the average?

- Wat can be learned?
  - Maybe 1-2 (well chosen) profiles is enough?
    Ventilation requirement: maximum occupancy (most unfavourable)
    EP-calculation: mean occupancy (statistically significant)

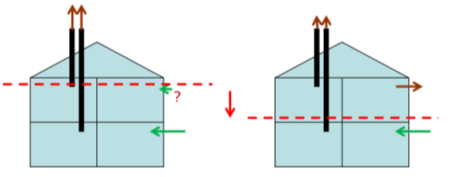


## Belgian example (Product approach in EPB)
## Input data


- Problem?
  - Differences between data used in the simulations
    and real data of the components/products
    Ex. accuracy of $CO_2$ sensors

- Wat can be learned?
  - Robust complicance framework is needed
    Reliable input data
    Who do the simulation? Who check them?

## Belgian example (Product approach in EPB)
## Simulation tool = black-box



- Problem?
  - Not logically expectd result
  - The limits of the model have been reached!

    Ex. A system with DCV: lower flow rate → largely better IAQ

- Wat can be learned?
  - Need explanation of the simulation result

    Reference systems to be simulated

    The results should be compared to and explained based on these references



## Equivalency approaches: challenges, recommendations, conclusions

- Simple approaches based on flow rate remain necessary

  To design simple buildings and systems on large scale and low price

  → combining both (flow rates + equivalency)

- Could be used for EP-calculation and for ventilation requirements
- Product approach

  Check influence of the reference building

  Use building approach if necessary

- Building + occupant/sources approach

  Occupant profile: not recommended?

  Building sources: ok if sources are known + IAQ criteria

## Equivalency approaches: challenges, recommendations, conclusions (2)

- Occupant profile(s)
  - Maybe 1-2 (well chosen) profiles is enough?
- Coherence between
  - IAQ criteria ⇔ flow rates requirements
- Compliance issues
  - Reliable input data for simulations (components, building,…)
  - Who do the simulations? Who check them?
- Black-box: how to avoid wrong result?
  - Simulate reference systems (nominal flow rates, in-/exfiltration,…)
  - Explain the results compared to these references
- Need of IAQ metrics



# Thank you for your attention

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