GLOBAL CONTEXT OF AIRTIGHTNESS CHALLENGES AND THE TIGHTVENT EUROPE INITIATIVE

Peter Wouters

TightVent Europe

Manager INIVE EEIG

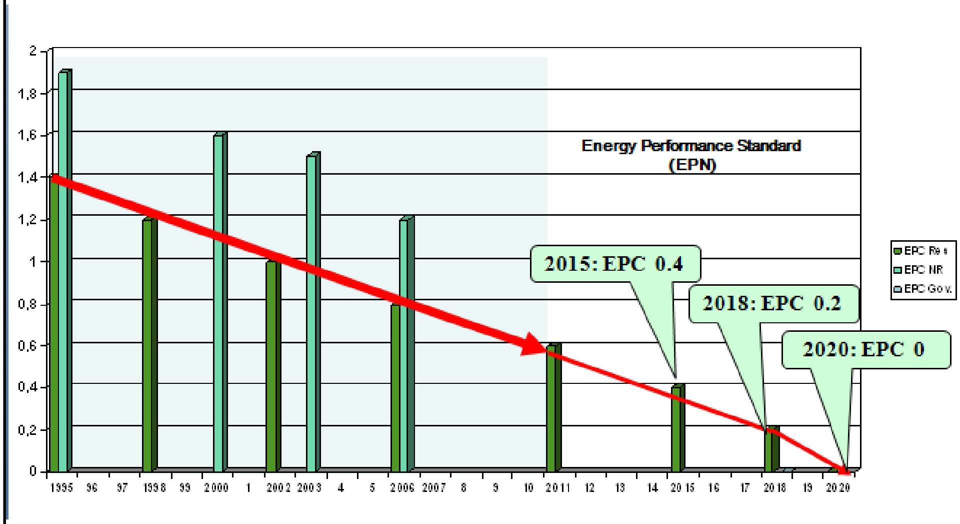
Structure of the presentation

- Challenges for nearly-zero energy buildings
- What is TightVent Europe?
- What about ductwork airtightness?
- What about building airtightness?
- Conclusions

The future

Before 2020 :
Many countries will impose near zero energy buildings

Example : Netherlands



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The future

Before 2020 :
Many countries will impose near zero energy buildings

BUILD Tight
VENTILATE Right

Building Airtightness *will implicitly become a mandatory point of attention*

Energy efficient ventilation systems will become mandatory

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International workshop on

"Large scale national implementation plans for building airtightness assessment : a must for 2020!"

"We should start now to be ready in 2020"

June 14-15 2010 in Hotel Crowne Plaza – Brussels (Belgium)

An initiative of AIVC and INIVE

Conclusions from Brussels June 2011 workshop

- It seems very useful to have international collaboration on the topic of building and ductwork airtightness
- The European countries have a common challenge which justifies a common platform
- Important to have a platform in which all stakeholders can participate

➔ ***Launch of TightVent Europe***

Website

www.tightvent.eu

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Objectives in starting up phase?

1. Awareness raising about the importance
2. Awareness raising about the existing approaches
3. Identifying a long term action plan

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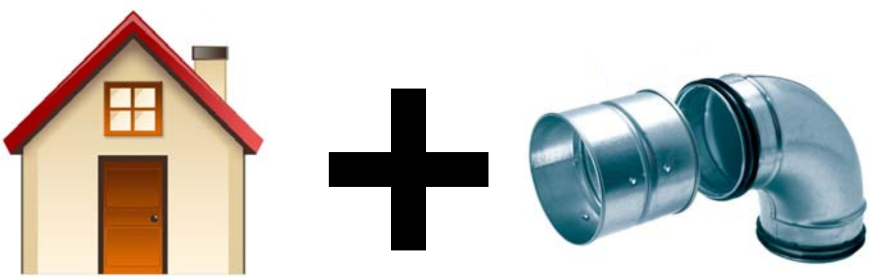
Airtightness strategy...



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Funding partners

Lindab

BPIE BUILDINGS PERFORMANCE INSTITUTE EUROPE

Wienerberger

European Climate Foundation

eurima
European Insulation Manufacturers Association

TREMCO illbruck

SOUDAL

INIVE

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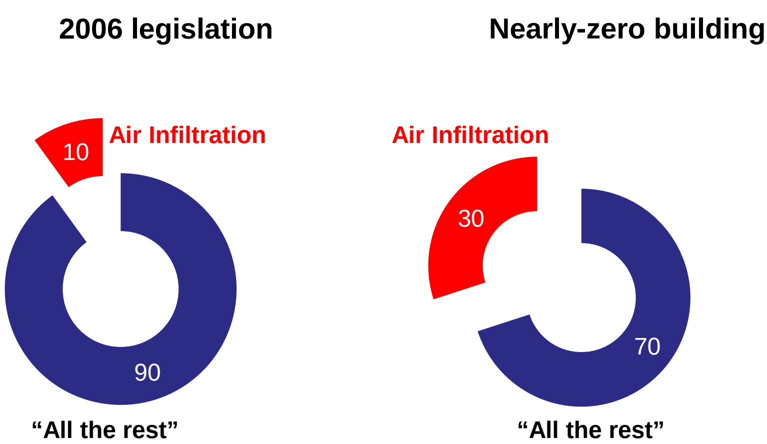
Activities

- Publications
- Conferences
- Webinars
- Newsletter
- BUILD UP community on airtightness
- Website
- …

Building Airtightness

Importance of building airtightness?



Example : Flemish legislation – typical dwelling – no assessment of airtightness

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Ductwork Airtightness

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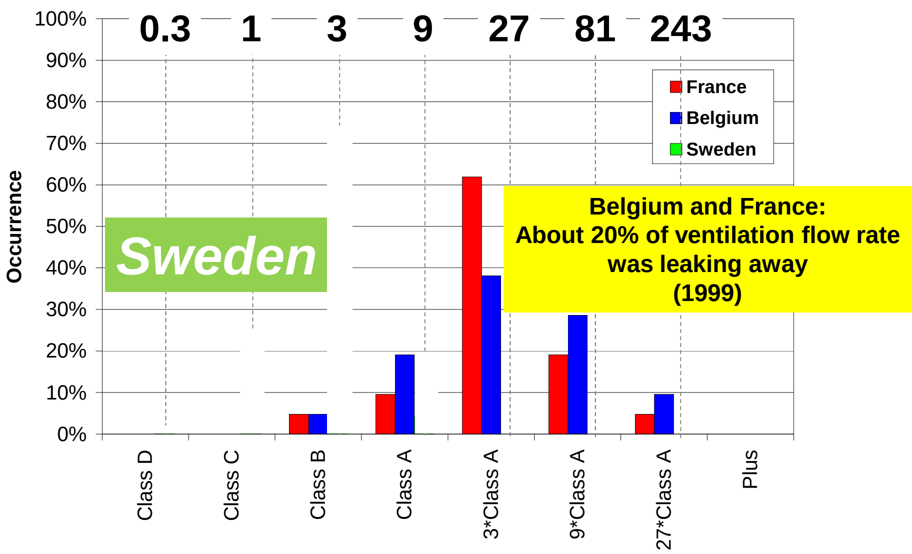
What about ductwork airtightness ?



Duct leakage data from the SAVE-DUCT project (Carrié and collaborators, 1999). 21 systems tested in Belgium, 21 in France, 69 in Sweden.

Impact on market…

Brussels, Belgium
Hotel Crowne Plaza Brussels
12–13 October 2011

Joint Conference
32nd AIVC Conference and 1st TightVent Conference

Towards Optimal Airtightness Performance

In cooperation with :

Conclusions

- Building and ductwork airtightness is one of the key challenges for the future
- TightVent Europe has the ambition to be the meeting place for airtightness issues in close collaboration with all relevant initiatives
- In particular building airtightness is a complex issue since it involves nearly all stakeholders and complex liability and cost issues
- An ingelligent and pragmatic framework for compliance is CRUCIAL!

Potential impacts of ductwork and envelope leakage

Rémi Carrié and Peter Wouters

TightVent Webinar
Airtightness and ventilation perspectives in Romania

21 June 2011

Presentation outline

- Ductwork leakage
  - Good and bad examples
  - Typical leakage rates
  - Potential implications
- Envelope leakage
  - How does it work?
  - Possible airflow rate impacts
- Conclusions

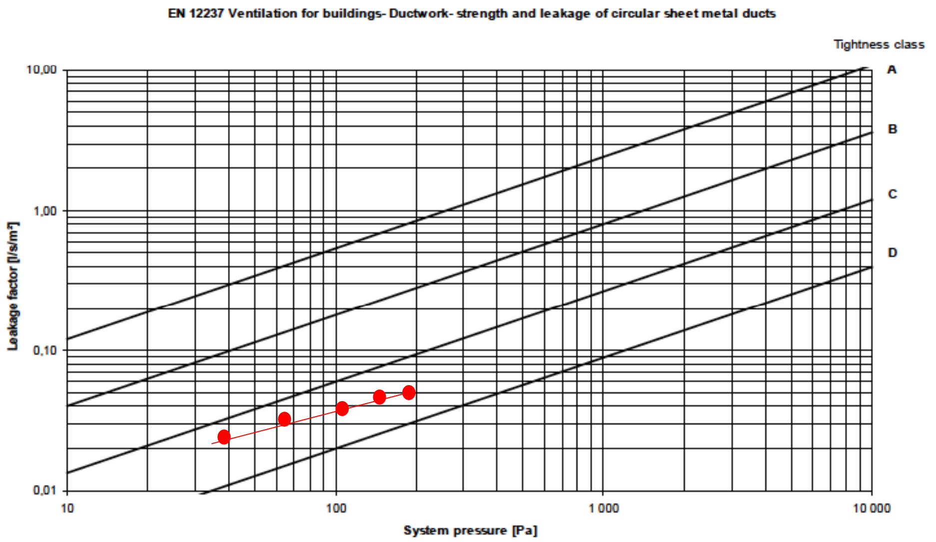
Ductwork leakage

Ductwork can look like this

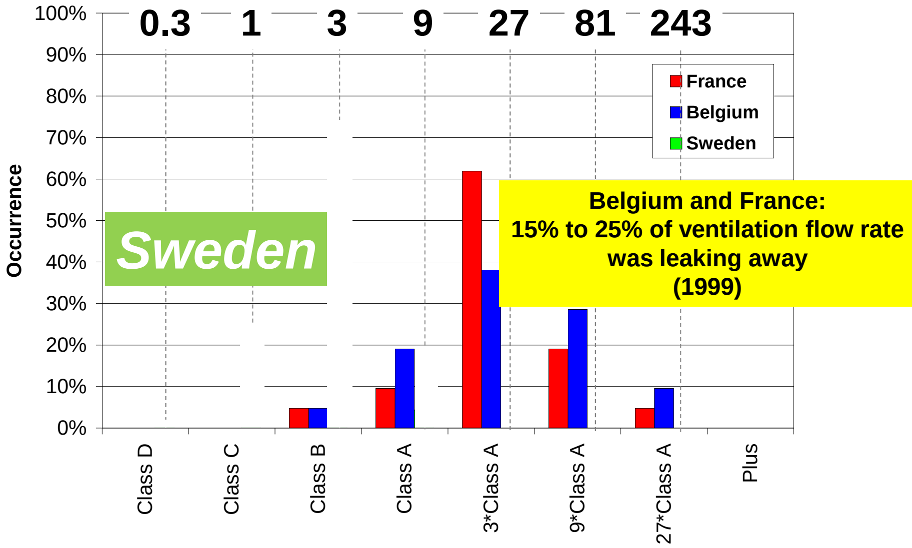
It can also look like that

Ductwork leakage classes

- Leakage classes are defined in EN 12237



Field observations



Duct leakage data from the SAVE-DUCT project (Carrié and collaborators, 1999). 21 systems tested in Belgium, 21 in France, 69 in Sweden.

Why bother ?

- **Fan flow is not adjusted to compensate leakage air flow rate**

  - *No increased energy losses*
  - *Bad indoor air quality*

- **Fan flow is adjusted to obtain correct air flow at terminals**

  - *Energy losses by:*
    - *increased ventilation load*
    - *increased fan power demand*

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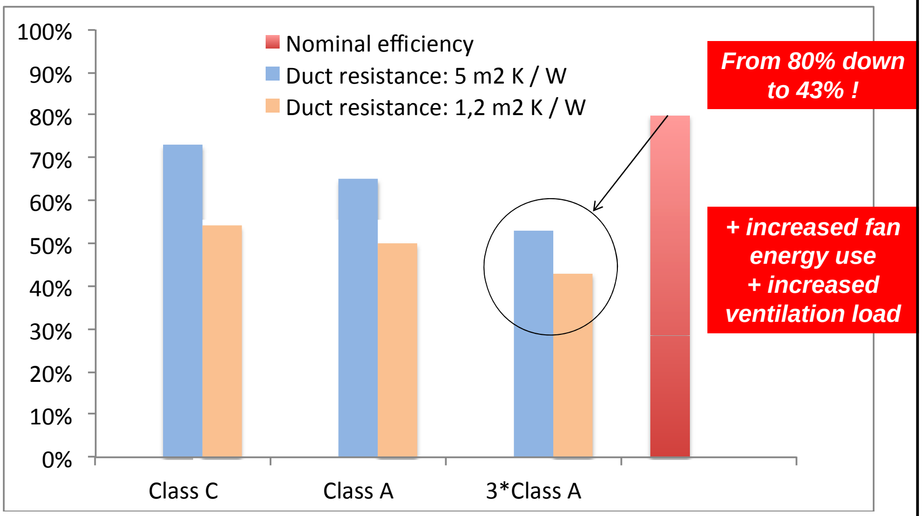
Results on one test case



SE system with ducts located in unconditioned spaces. Reference : Proceedings of the BUILDAIR 2011 symposium, auhtors: Carrié and Leprince

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Envelope leakage

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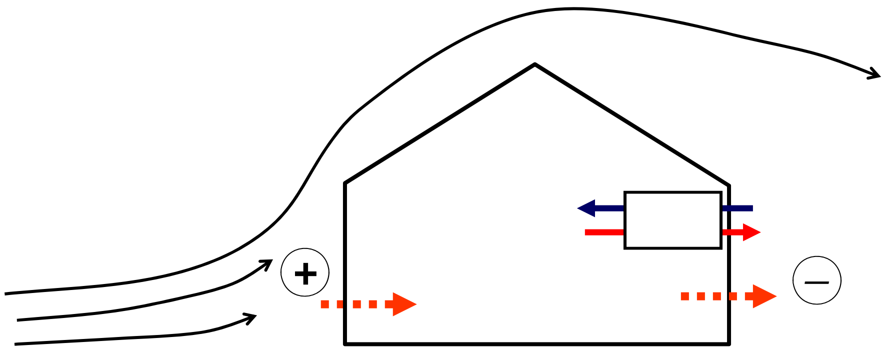
Envelope leakage

- How does it work ?
  - Wind and stack effect increase the total ventilation airflow rate
  - If there is a HR system, it may be short circuited



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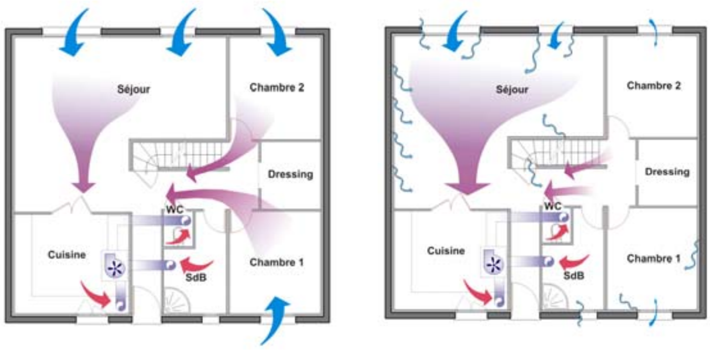
Envelope leakage

- How does it work ?
  - Disturbance of flow patterns
  - BUILD TIGHT, VENTILATE RIGHT !



Background

- Airtightness can be characterized with leakage flow rate at 50 Pa divided by the building's volume (not the only indicator used in practice) :

$$n_{50} = \frac{\text{Airflow rate at 50 Pa}}{\text{Heated volume}}$$

Units : 1/h

Airflow rate impacts

- Typical values of infiltration airflow rate, n_{inf}

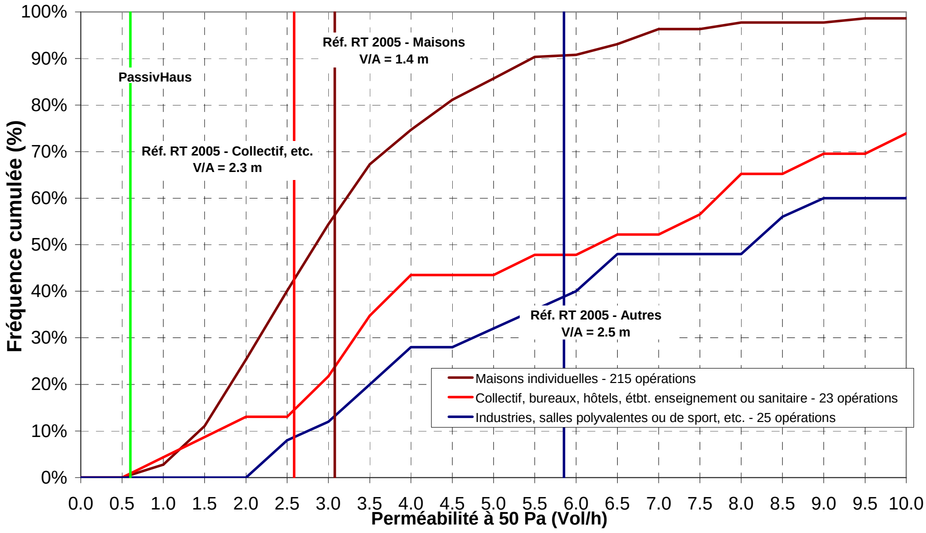
$$\frac{n_{50}}{30} \longleftrightarrow n_{\text{inf}} \approx \frac{n_{50}}{20}\ ^{*} \longleftrightarrow \frac{n_{50}}{10}$$

- Rule of thumb, see Drubul, 1988; Kronval, 1978.

Rough approximation however useful to see orders of magnitudes

Air change rate (1/h)	Assumed airtightness (n50, 1/h)	Infiltration airflow rate (1/h)	Infiltration airflow rate divided by air change rate (%)
0,5	3	0,15	30%
0,6	3	0,15	25%
0,7	3	0,15	21%
0,8	3	0,15	19%

Typical n50 values ?



Source : Extraction de la base de données du CETE de Lyon - Juillet 2006

MININFIL project

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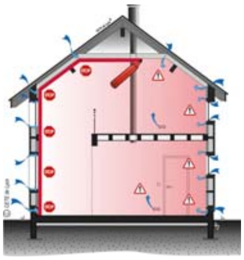
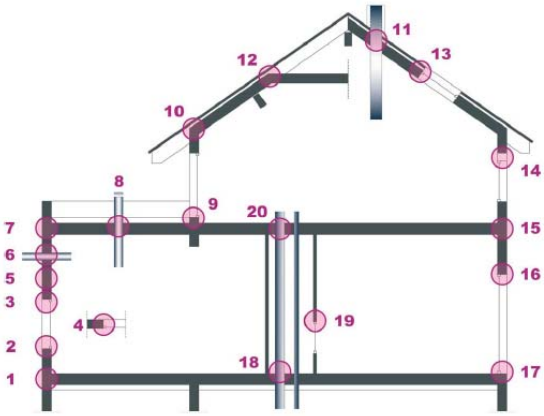
MININFIL project

- Large effort initiated by (CETE de Lyon) to help designers and workers, both on the methodology and on the technical solutions





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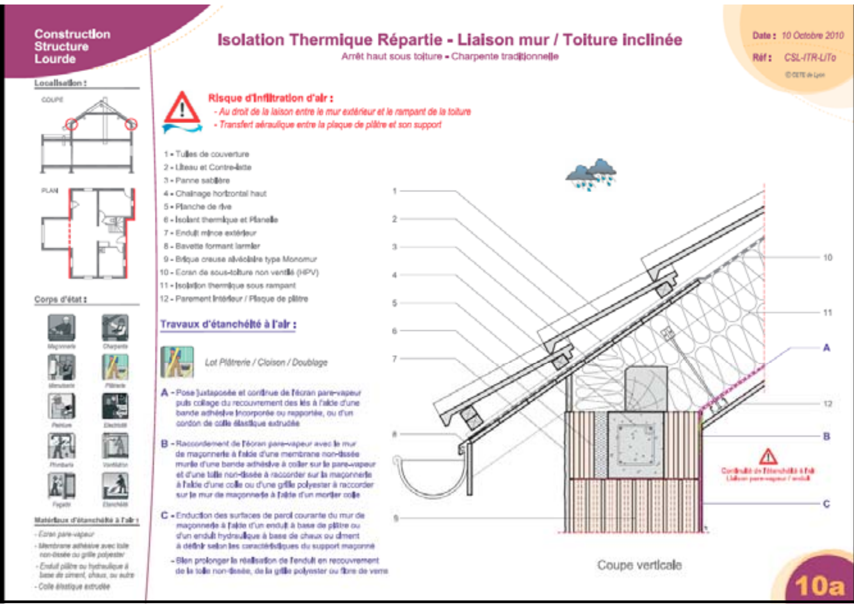
MININFIL project



Construction Structure Lourde

Isolation Thermique Répartie - Liaison mur / Toiture inclinée

Arrêt haut sous toiture - Charpente traditionnelle

Date : 10 Octobre 2010

Réf : CSL-ITR-LiTo

© CETE de Lyon

Localisation :

COUPE

PLAN

Risque d'infiltration d'air :
- Au droit de la laison entre le mur extérieur et le rampant de la toiture
- Transfert aéraulique entre la plaque de plâtre et son support

1 - Tuiles de couverture
2 - Liteau et Contre-latte
3 - Panne sablière
4 - Chainage horizontal haut
5 - Planche de rive
6 - Isolant thermique et Planelle
7 - Enduit mince extérieur
8 - Bavette formant larmier
9 - Brique creuse alvéolaire type Monomur
10 - Ecran de sous-toiture non ventilé (HPV)
11 - Isolation thermique sous rampant
12 - Parement intérieur / Plaque de plâtre

Corps d'état :

Travaux d'étanchéité à l'air :

Lot Plâtrerie / Cloison / Doublage

A - Pose juxtaposée et continue de l'écran pare-vapeur puis collage du recouvrement des lés à l'aide d'une bande adhésive incorporée ou rapportée, ou d'un cordon de colle élastique extrudée

B - Raccordement de l'écran pare-vapeur avec le mur de maçonnerie à l'aide d'une membrane non-tissée munie d'une bande adhésive à coller sur le pare-vapeur et d'une toile non-tissée à raccorder sur la maçonnerie à l'aide d'une colle ou d'une grille polyester à raccorder sur le mur de maçonnerie à l'aide d'un mortier colle

C - Enduction des surfaces de paroi courante du mur de maçonnerie à l'aide d'un enduit à base de plâtre ou d'un enduit hydraulique à base de chaux ou ciment à définir selon les caractéristiques du support maçonné
- Bien prolonger la réalisation de l'enduit en recouvrement de la toile non-tissée, de la grille polyester ou fibre de verre

Matériaux d'étanchéité à l'air :
- Ecran pare-vapeur
- Membrane adhésive avec toile non-tissée ou grille polyester
- Enduit plâtre ou hydraulique à base de ciment, chaux, ou autre
- Colle élastique extrudée

Coupe verticale

10a

Conclusions

- The significance of envelope and ductwork leakage on energy use and ventilation system efficiency has been demonstrated in the past
- Their potential impact implies specific attention in the context of nearly zero-energy buildings
- There is obviously room for improvement:
  - Probably in most countries outside Scandinavia for ductwork systems
  - Probably in ALL countries for envelope airtightness
- There is a range of technical solutions available to overcome these problems

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Airtightness and ventilation in the Romanian regulation

Dr. Eng. Ioan Silviu DOBOȘI
Vice-president of ROMANIAN INSTALLATIONS ENGINEER ASSOCIATION
Vice-president of REHVA

1st TightVent national Webinar
21 June 2011
15:00-17:00(Bucharest) / 14.00-16.00 (Brussels)

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European Legislation/Regulation

- EPBD 2002/91/EU
- Recast EPBD 2010/31/EU
- CEN – EPBD Standards

- **Romanian Legislation/ Regulation**
  Building tightness
  - **1985 – STAS 6472/7-85 Building physics/Termotechnics Calculus of air permeability of building materilas and components**
  - **1995 – Law 10 – Quality of constructions**
  - **1997 – C107/1..7 – Requirements for new buildings**
    - correction for thermal bridges
    - R'min(Umax) [m2K/W] – comfort, energy
    - average global coefficient G [W/m3K] < GN

- **2005 – Law 372/13.12.05 – EPBD transposition**
  - new methodology – 01.01.2007
- **2005 – C107 (revised) - Requirements extended to renovation and extensions of existing buildings**
- **2006 – 20.12.06 – MC001 New EPB methodology according with pr CEN-EPBD,including:**
  - building's envelope MC001/1
  - certification MC001/3
  - energy audit (EPB solutions) MC001/3
- **2010 – C107/2010 annex 3 (revised) – Improving the thermal resintance values**

- **Romanian Legislation/Regulation**

Tightness of ventilations systems

- **2006 – 20.12.06 – MC001 New EPB methodology according with pr CEN-EPBD,including:**
  - building's services MC001/2
  - certification MC001/3
  - energy audit (EPB solutions) MC001/3
- **2009- SR EN 12237 Ventilation for building. Ductwork. Strehgth and leakage of circular sheet metal ducts**
- **2010 - Code I 5 – Normative document - The design, manufacture, and operation of ventilation and climate control systems**

Building tightness

- **Art. 4 – 2005 – Law 372/13.12.05 – EPBD transposition**
- **2006 – 20.12.06 – MC001 New EPB methodology**

"a) thermotechnical characteristics of the elements that make up the building envelope, interior partitions, including air-tightness;"

The envelope and airflow

- The exchange of air through the envelope can be a source of heat loss. Because warm air can contain large amounts of water vapor, air flow is also the main means through which moisture passes through the building envelope.
- In winter conditions, air is forced to pass through the building envelope. The air coming out carries heat and humidity, and incoming air which is dry and uncomfortable creates currents

The envelope and airflow

- Because the air passing through the building envelope, there must be an empty space (hole-door, open a window opening, a slot) and a pressure difference between inside and outside envelope. The pressure difference can be caused by any combination of:
  - Wind
  - Temperature difference leading to vertical thermal stratification phenomenon known as chimney effect
  - Equipment with burners or ventilation fans

The envelope and airflow

- Control air flow between inside and outside provides many advantages such as:
  - Save money and energy
  - Building more comfortable without cold spots and drafts.
  - Protection of building materials against damage caused by moisture
  - An increase of comfort, health and safety, remove clogged exhaust air and excess air and ensure necessary air to achieve safe combustion process.
  - A building cleaner and calmer.

The envelope and airflow

- Controlling airflow involves three basic activities that must be made at once:
  - Preventing uncontrolled leakage of air through the envelope,
  - Provide fresh air and exhaust poluted air,
  - Ensure the air circulation and the necessary air for combustion in the house equipments (chimney, stove, hot water boiler).

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Building tightness

- Tightness is important not only in terms of capitalization energy, and behaviors to ensure a good climate and building construction proper vapor barrier interior.
- The vapor barrier prevent the penetration of moisture inside in the building
- Humidity encourages mold growth, it generates over time, damage in the building on the one hand and the production of allergy in the building to the occupants on the other hand.

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Building tightness

- Do not forget that a completely tight building is unhealthy, even dangerous

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■ Tightness of ventilations systems

Normative document - Code I 5/ 2010

Air-tightness requirements for air pipes

Static pressure [Pa]		100	200	300	400	500	600	700	800	900	1000	1200	1500	1800	2000
Air loss [l/s .m²] [m³/h.m²]	Class A	0.54 1.94	0.84 3.04	1.10 3.96	1.32 4.78	1.53 5.52	1.73 6.22	1.91 6.87	2.08 7.49	2.25 8.09	2.41 8.66	2.56 9.75	3.13 11.3	3.53 12.7	3.77 13.6
	Class B	0.18 0.65	0.28 1.01	0.37 1.32	0.44 1.59	0.51 1.84	0.58 2.07	0.64 2.29	0.69 2.5	0.75 2.7	0.80 2.89	0.85 3.25	1.04 3.76	1.18 4.23	1.26 4.53
	Class C	0.06 0.22	0.09 0.34	0.12 0.44	0.15 0.53	0.17 0.61	0.19 0.69	0.21 0.76	0.23 0.83	0.25 0.9	0.27 0.96	0.30 1.08	0.35 1.25	0.39 1.41	0.42 1.51
	Class D	0.02 0.07	0.03 0.11	0.04 0.15	0.05 0.18	0.06 0.20	0.06 0.23	0.07 0.25	0.08 0.28	0.08 0.30	0.09 0.32	0.01 0.36	0.12 0.42	0.13 0.47	0.14 0.50

Maximum air losses admissible for the 4 classes of air-tightness

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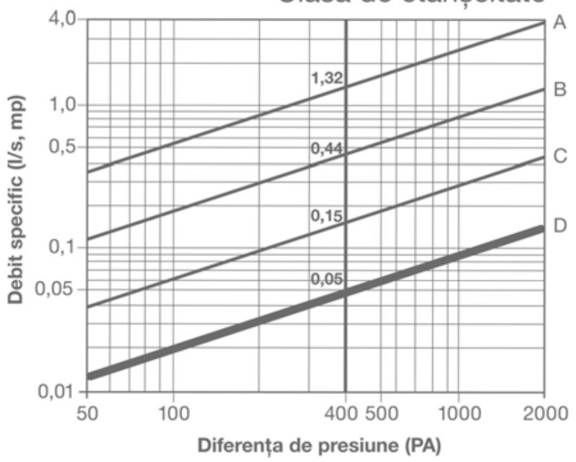
Class of air-tightness

Air-tightness requirements for air pipes

Clasa de etanșeitate



Maximum air losses admissible for the 4 classes of air-tightness

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■ Carrying out works related to ventilation and climate control systems

Air-tightness of ventilation/climate control systems

Class of air-tightness	Static pressure limit [Pa]		Maximum speed [m/s]	limit values for air losses [l/sm²]
	Positive	Negative		
Class A Low pressure	500	500	10	$0.027\ p^{0.65}$
Class B Medium pressure	1 000	750	20	$0.009\ p^{0.65}$
Class C High pressure	2 000	750	40	$0.003\ p^{0.65}$
Class D (special) High pressure	2 000	750	40	$0.001\ p^{0.65}$

Air pipe classes and limit values for air losses in pipes

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Air-tightness of ventilation/climate control systems

The following steps shall be taken to test the degree of air-tightness of the air pipes:

- air pipes belonging to class A do not require testing;

- air pipes belonging to class B shall be tested within the limit of 10 % of the parts within a network, chosen at random. If these parts do not comply with the limit values given in Slide 13, the tests shall be repeated using another 10 % of the parts within the network;

- pipes belonging to classes C and D shall be 100 % tested.

- Setting into operation, acceptance, and commissioning
- Operation of ventilation and climate control systems

Buildings with very low energy consumption /nZEB

- Passive buildings, is the next stage in Romania, in order to achieve the goal of nZED
- Buildings designed to ensure a high standard of energy efficiency and environmentally friendly buildings are called passive buildings.
- Designing passive buildings in general without traditional heating systems and installation of air conditioning active, the result is the energy savings of 70-90% compared with the current housing fund.

- The main elements contributing to this low power consumption, taking into account the severe demands on the health, comfort and cost are:
  - Very high energy efficiency building envelope
  - Very high thermal resistance
  - Avoid thermal bridges
  - Excellent tightness
  - Controlled ventilation and energy efficient

- Examples of definitions and specifications for passive buildings in the European countries:
  - German Passive House Effinergie ®
  - (France), Minergie ®
  - MinergieP ® (Suise)
  - buildings with low energy class 1 (Denmark)

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- **Definition**

  A passive house is a building with thermal insulation quality which maintain a pleasant indoor climate, using as main source of heating energy "passive" free, capture solar energy and heat from appliances.

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- **Determining features of a passive house:**
  - **- Quality insulation**
  - **- Triple-glazed windows Low-e**
  - **- Without thermal bridges**
  - **- Controlled ventilation with efficient heat recovery**
  - **- Sealing - sealing**
  - **- Optimum building orientation for maximum solar energy capture and protection from prevailing winds**
  - **- Appliances with low power consumption**
  - **- Annual heat consumption up to 15 kWh per square meter. Total primary energy consumption is limited to 120 kWh/m2 a year.**

Dr. Eng. Ioan Silviu DOBOȘI

Thank you for your attention

ioansilviu@dosetimpex.ro
id@rehva.eu

Vice-president of ROMANIAN INSTALLATIONS ENGINEER ASSOCIATION
Vice-president of REHVA

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Progress needed on ventilation and air tightness in Romania

Horia Petran

INCD URBAN-INCERC
(INCERC Bucharest)
hp@incerc2004.ro

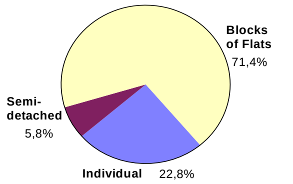
TightVent Webinar
Airtightness and ventilation perspectives in Romania
21 June 2011

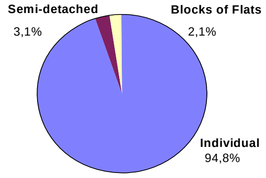
Contents

- Airtightness of current building stock in Romania
  - Potential / impact of ventilation
  - Envelope permeability
  - Testing methods and current investigations
- Ventilation issues in the Thermal Rehabilitation Program
  - Context and instruments / schemes
  - Key actors involved
  - Impact on indoor air quality
- Ventilation of low energy buildings / nZEB
  - Requirements and weight of ventilation in energy balance
  - Towards efficient solutions
- Indoor air quality in educational buildings
  - Requirements
  - Current situation
  - Challenges

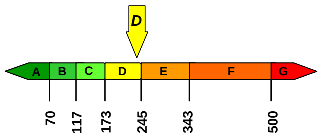
Air tightness of current building stock in Romania

- **Potential – RO building stock (BS):**
  - **Residential: > 4.8 Mil. buildings**
    > 8 Mil. dwellings
    (3.1 Mil. dwel. in ~84.000 blocks = **70% of BS**)
    > 450 Mil. m²
    > 22 Mil. people
  - **Tertiary: > 230 Th. Buildings**
    > 70 Mil. m²
  - **Energy use (heating): 100-300 kWh/m²y**





- **Energy strategy – Bucharest 2008:**
  - **~ 800.000 dwellings + tertiary**
  - **Energy use (heating): ~ 7,9 TWh/y**
  - **Potential for ventilation: ~ 2,4 TWh/y**



Air tightness of current building stock in Romania

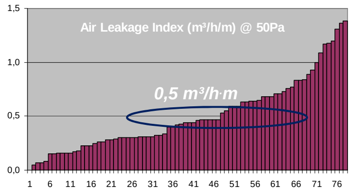
- Most RO buildings do **not** have **mechanical ventilation** (except limited kitchen or bath exhaust systems) → rely on:
  - infiltration (i.e., leakage through the building envelope) and
  - natural ventilation (i.e., window opening)

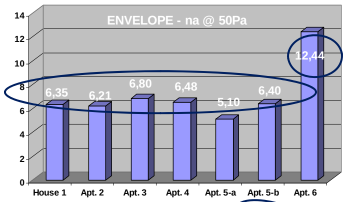
  to maintain acceptable indoor air quality

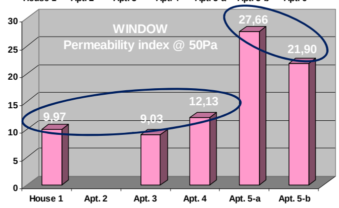
- **Envelope permeability**
  - **Air permeability of building components and building elements**
    - Index / joint length (m³/h/m) @ 50Pa
  - **Air permeability at building level**
    - Index / envelope area (m³/h/m²) @ 50Pa

Air tightness of current building stock in Romania

- **Testing methods and investigations:**
  - Fan pressurization method → **blower door**
  - Thermal imaging (thermography) → **air leaks**
  - **Ventilation system functionality** surveys
  - **Indoor climate** surveys
- **Windows testing (INCERC):**
  - **79 components: 0.1 - 1.35 m³/h/m @ 50Pa (average 0,51 m³/h/m @ 50Pa)** – current market
- **Building testing (INCERC):**
  - **1 individual house + 5 apartments**
  - **na @ 50Pa = 5.1 … 6.8; 12,4 h^{-1}**
  - **Envelope: 3.2 … 6.8 m³/h/m² @ 50Pa**
  - **Windows: 9.0 … 27 m³/h/m @ 50Pa**
- **Relevance of values @ 50Pa?**





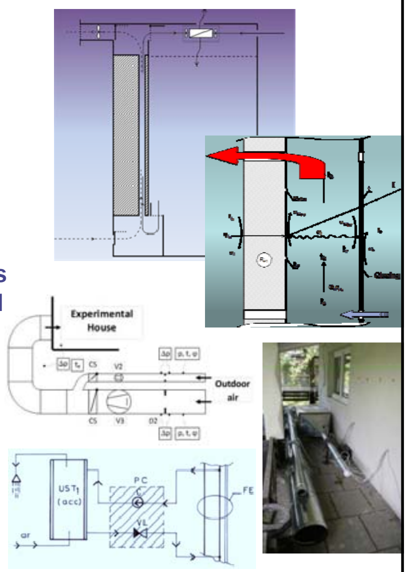


Ventilation issues in the Thermal Rehabilitation Program

- **Context and instruments / schemes**
  - **Blocks-of-Flats built in 1950-1990**
  - **Investment: 80% ensured by State and Local Budget + 20% ensured by the owner**
  - **Financed solutions: thermal insulation building components, windows replacement and other envelope works** → **<u>NO money for ventilation system</u>**
- **Key actors involved**
  - **Finance source (GOV, Local auth.)**
  - **Designers, experts**
  - **Beneficiary (Owner Associations)**
- **Impact on indoor air quality**
  - **Interventions on existing natural ventilation**
  - **Occupants behaviour → use of open-flame source, not sufficient window opening → risk of Sick Building Syndrome**

Ventilation of low energy buildings / nZEB

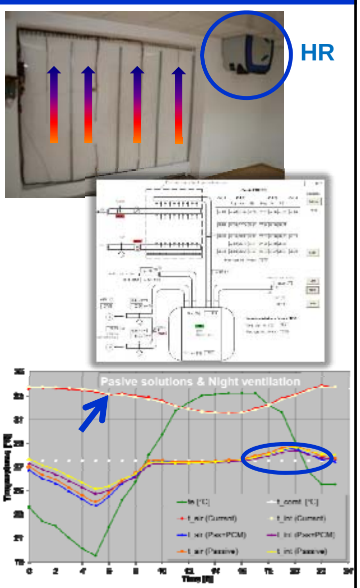
- **Ventilation requirements**
  - Very airtight envelope
  - Controlled ventilation is essential in highly airtight buildings
  - Air tightness of ductwork
  - Heat recovery (>80%)
- **Weight of ventilation in energy use**
  - Energy use for ventilation > Exergy loss by transmission (high envelope thermal performance) → from <30% to >50%
- **Towards efficient solutions**
  - Intelligent (adaptive) envelopes
  - Ventilated envelopes (int. / ext.)
  - Ventilation coupled with active/passive solar design
  - Night ventilation



TightVent Europe
BUILDING AND DUCTWORK AIRTIGHTNESS PLATFORM

Ventilation of low energy buildings / nZEB

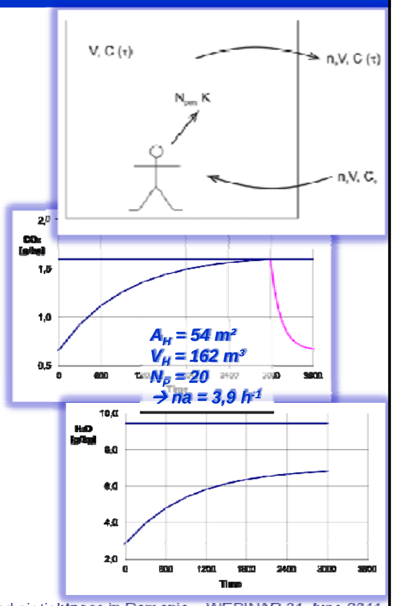
- **Efficient solutions (ex.)**
  - Ventilated envelope system: wall with parietal-dynamic effect on the exhausted air from occupied spaces →Variable envelope thermal resistance
  - Ventilated solar space (preheating ventilation air)
  - Active or passive ventilated façades → use of PV panels as active covering and preheating the fresh air while cooling down PV elements
  - Night ventilation in summer → cooling passive or active elements: building mass, TABS, PCM)



INCERC
Horia Petran – Progress needed on ventilation and air tightness in Romania – WEBINAR 21 June 2011

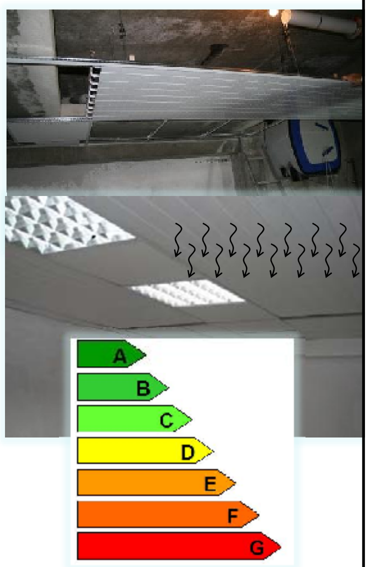
Indoor air quality in educational buildings

- **Requirements**
  - Minimum air flow per person
  - Ventilation needs are much higher → people concentrated in closed spaces over extended periods of time
  - Need for *intelligent* ventilation system
  - Need for low ventilation for long breaks
- **Current situation**
  - Direct and natural ventilation is not effective for adequate indoor air quality
  - Major program for schools rehabilitation → increased air tightness, but no controlled ventilation
- **EPB evaluation – EP Certification**
  - Wrong ventilation strategy is used often in EPC elaboration →…
  - Right na, but penalties for ‘no system’



Indoor air quality in educational buildings

- **Challenges**
  - Detail and clarify legislation on ventilation & EP certification
  - Training of the experts involved (architects, designers, energy auditors, inspectors) + building workforce
  - Raising awareness – GOV, Inspectorates, Teachers → Education !
- **Adapted / tailored technological solutions:**
  - Monitoring indoor air quality in classrooms
  - Ensuring comfort: thermal + physiological
  - Prediction – correction → control strategy and system

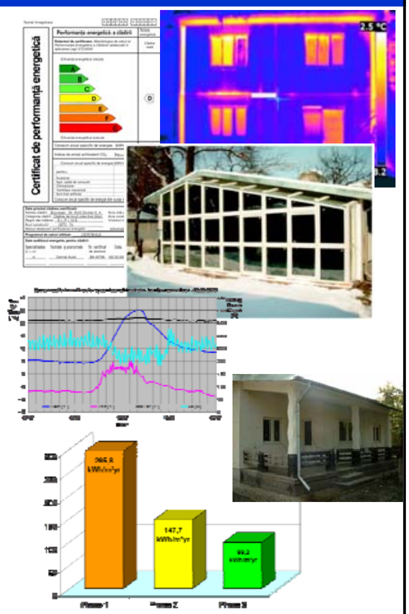


CONCLUSIONS

- Significant potential for ventilation
- Not one identified problem with one potential solution
  - Envelope permeability → low EPB
  - Envelope air tightness + no ventilation + behaviour → SBS
  - Low EB → correct ventilation + adaptive solutions (ENV + systems)
  - Indoor air quality → <u>to be</u> high priority within rehabilitation schemes
- Strategy of “Build it tight. Ventilate it right”
- Indoor air quality → ventilation strategies + systems
- Importance of right ventilation in schools:
  - Ensuring ventilation <u>when</u> is needed
  - Low exergy systems → high EPB
  - Efficiency of ventilation and indoor comfort (incl. thermal, acoustical) → mixed radiative & convective systems
- nZEB → heat recovery, pressure balancing, passive strategies, night ventilation, PCMs, renewable sources etc.

Progress needed on ventilation and air tightness in Romania

Thank you !



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