Importance of building airtightness in overall energy efficiency strategies

R. Carrié
S. Berthault, J. Biaunier, S. Charrier, A. Huet, R. Jobert, V. Leprince, D. Limoges
CETE de Lyon

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

Brussels, 14-15 June 2010

Présent pour l'avenir

Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer

2020 target

- Many countries are taking steps to generalize near-zero energy buildings
- => For most climates, specific attention has to be paid to airtightness
- Envelope leakage has a large impact on the energy use of a building
  - Some very low energy labels have minimum requirements for building airtightness
    - e.g., PassivHaus, Minergie-P, BBC-Effinergie

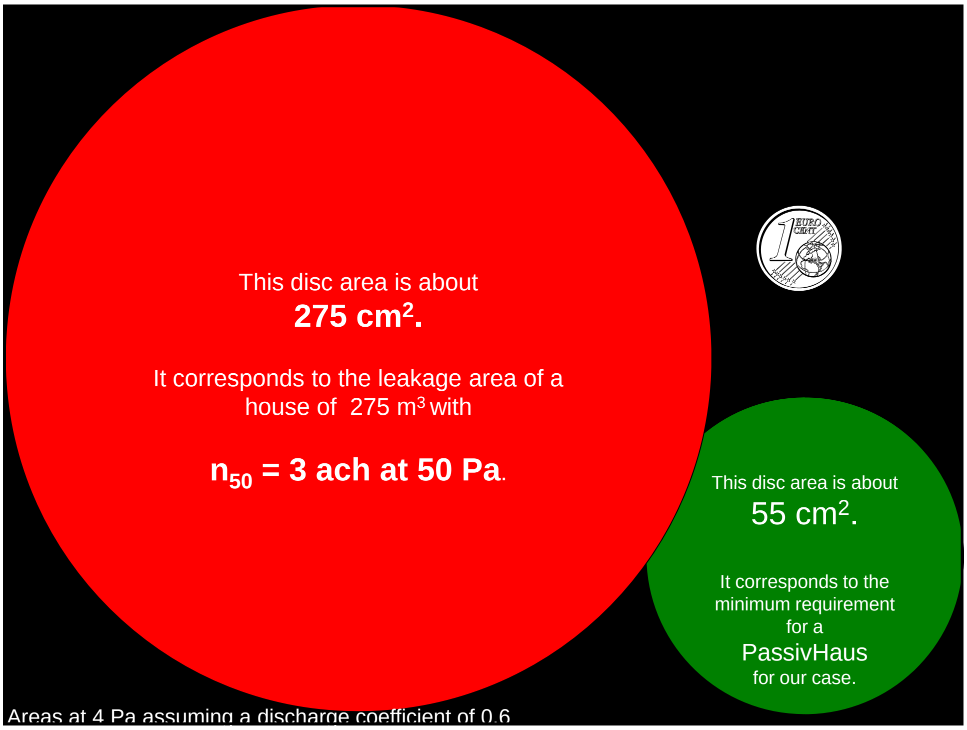
Background

- Airtightness can be characterized with leakage flow rate at 50 Pa divided by the building's volume :

$$n_{50} = \frac{\text{Airflow rate at 50 Pa}}{\text{Heated volume}} \qquad \text{Units : 1 / h}$$

Orders of magnitude

- Without specific attention:
  - Seems reasonable to say that airtightness is rarely below 3 ach at 50 Pa
  - Can easily be above 6 ach at 50 Pa
- Airtightness requirements for PassivHaus or Minergie-P :
  - < 0.6 ach at 50 Pa



Airflow rates impacts

- Infiltration airflow rate, n_{inf}^{*}

$$n_{\text{inf}} \approx \frac{n_{50}}{20}$$

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%

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

Energy impacts

- Can be deducted from the calculated infiltration rate and degree-days

$$E_{\inf} = \frac{24}{1000} 0.34\, n_{\inf}\, V_{bld}\ DD$$

  - where E_{inf} is expressed in kWh, V_{bld} is the building's volume, and *DD* is the number of degree-days in Kelvin days

n_{50} (1/h)	Degree-days (K.days)	Volume (m^3)	Einf (kWh/year)	CO_2 emissions * (kg/year)
6	2500	250	1530	328
5	2500	250	1275	273
4	2500	250	1020	218
3	2500	250	765	164

*** Assuming 0.214 $kgCO_2$/kWh**

Energy impacts

- More detailed calculations based on coupled airflow rate and thermal hourly simulations give consistent results
  - i.e. on the order of 2-3 kWh/m^2/year per unit n_{50} for 2500 degree-days
- These simple calculations could be performed on a building stock
  - with the following inputs:
    - Number of new and renovated buildings for a given climate region (degree-days)
    - Average building volume for that region
  - and the following assumptions:
    - Fixed improvement of n50 for a given market share of the new stock
    - Fixed improvement of n50 for a given market share of the existing stock

Energy impacts

- *Preliminary* calculations for the European residential sector show that the impact is on the order of :
  - **several millions of tonnes of CO_2 per year**

Country	CO_2 emissions in $MtCO_2$ for the residential sector
Belgium	18.8
Bulgaria	1.1
Czech Republic	7.1
Denmark	3.4
Germany	85.9
Estonia	0.2
Total for EU-27	*499.2*

CO_2 emissions for the residential sectors in 6 European countries in 2007. Source : EU energy and transport figures (2010).

Other benefits of good envelope airtightness

- Controlled airflow rates, better ventilation
  - Better hygiene
  - Better comfort
  - => Build TIGHT, ventilate RIGHT
- Avoid building damage, especially humidity transfer through walls

What about ductwork airtightness ?

- Issue identified in many studies
- In Europe, SAVE-DUCT project included a comparison between BE, FR, SE
  - Very leaky systems in BE, FR
  - Very tight systems in SE
- Potentially large impacts
  - Estimates in the SAVE-DUCT project based on 5% of European dwellings equipped with mechanical ventilation
    - 1 to 10 TWh/year
    - => approximately 0.2 to 2 MtCO_2
  - These calculations need to be revised with the 2020 perspective

Conclusions

- Simple calculations show :
  - The large impact of envelope and ductwork leakage on energy performance of buildings
  - The large energy savings and CO_2 emission reduction potential with better envelope and ductwork airtightness
- These issues must be considered in ambitious energy efficiency strategies
  - They are key for the generalization of very-low-energy buildings

- Visit the ASIEPI website
  - www.asiepi.eu

Acknowledgements

The contribution of CETE de Lyon to the implementation of these quality frameworks is funded by the ministry for ecology, energy, sustainable development, and sea (MEEDDM).

The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the Ministry.

What about ductwork airtightness ?

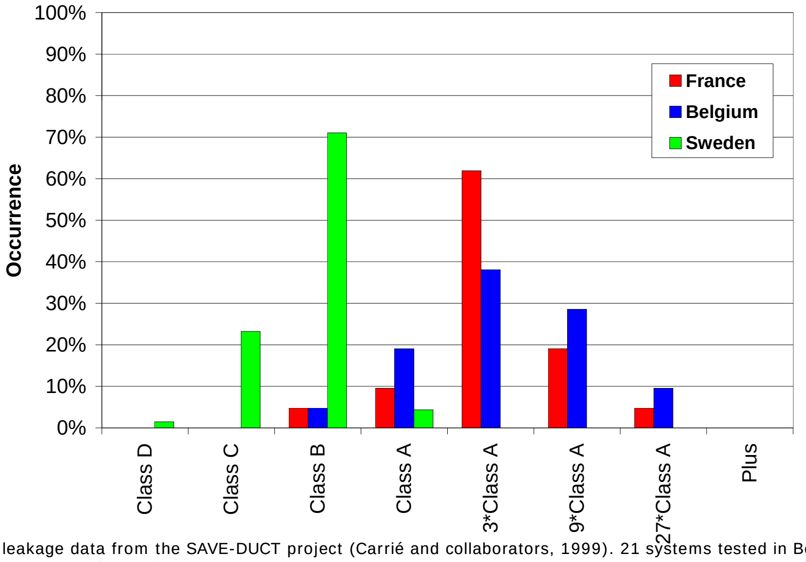
Fan flow is not adjusted to compensate leakage air flow rate

No direct 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

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.

What about ductwork airtightness ?

- Potentially large impacts
  - Estimates in the SAVE-DUCT project based on 5% of European dwellings equipped with mechanical ventilation
    - 1 to 10 TWh/year
    - => approximately 0.2 to 2 $MtCO_2$
  - These calculations need to be revised with the 2020 perspective