Building and ductwork airtightness requirements in Europe – Comparison of 10 European countries

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ABSTRACT

Mandatory building airtightness testing has come gradually into force in the UK, France, Ireland and Denmark. It is considered in many other European countries because of the increasing weight of the energy impact of building leakage on the overall energy performance of low-energy buildings.
This study analyses recent developments in 10 Europeans countries on the following aspects:
- requirements regarding building airtightness in EP- regulation
- requirements in specific energy programmes
- airtightness testers schemes
- field airtightness measurement databases
- increasing awareness regarding building airtightness, main motivations and progress needed.

The same type of analyses has been done with ductwork airtightness. Information has been collected through a questionnaire sent to TAAC (TightVent Airtightness Associations Committee) members.
Regarding building airtightness, we found that 7 out of the 10 countries have minimum requirements that have to be justified by testing or another mean, either in the context of the EP-regulation (for 3 of them) or in specific energy performance programmes. Minimum requirements mostly apply to new buildings, only three countries have a regulation or programme dealing with the airtightness of refurbished buildings. 7 countries out of 10 now have a quality framework for building airtightness testers; the number of qualified testers in Europe has almost doubled in 4 years. Field measurement data are available in 6 countries out of 10. Most of the time, databases are managed by testers' qualification bodies and contain mainly data of new residential buildings. All respondents acknowledge that awareness regarding, building airtightness has grown in their country in the last 5 years. The main motivation remains energy use, however, work on this topic is still needed to better quantify the impact of airtightness on energy use.
Conversely, ductwork airtightness does not seem to be taken into account (neither in regulation nor in energy performance programmes) in most European countries. In our survey, only France and Belgium take into account ductwork airtightness in their energy performance calculation. Progress is needed to better understand the impact of ductwork airtightness on energy use (fan, cooling and heating) and indoor air quality.

KEYWORDS

Airtightness measurement, Regulation, European comparison, competent tester schemes

1 INTRODUCTION

Building airtightness is a key issue to achieve low- and very low-energy targets. Therefore, an increasing number of tests are performed in European countries for various reasons: compliance to the energy performance regulation; compliance to a specific energy programme; or will of the building owner. For instance, to our knowledge, measuring the airtightness of all new buildings or at least part of them is required by the energy performance regulation in UK, France, Ireland and Denmark. Besides, specific energy programmes (such as Passivhaus or Minergie) that require or encourage building airtightness testing are

increasingly popular in many other countries. Likely, within a few years, over a million tests will be performed every year in Europe.
This study analyses recent developments in 10 Europeans countries on the following aspects:

- requirements regarding building airtightness in EP- regulation;
- requirements in specific energy programmes;
- airtightness testers schemes;
- field airtightness measurement databases;
- increasing awareness regarding building airtightness, main motivations and progress needed.

The same type of analyses has been done with ductwork airtightness.

2 APPROACH

This work has been done in the context of the TightVent Airtightness Associations Committee (TAAC). TAAC is a European working group, set up and hosted within TightVent Europe. The scope of this working group includes various aspects such as:

- airtightness requirements in the countries involved;
- competent tester schemes in the countries involved;
- applicable standards and guidelines for testing;
- collection of relevant guidance and training documents.

At present, the participants are from Belgium, Czech Republic, Estonia, France, Germany, Latvia, Ireland, Poland, Sweden, UK and Spain (Spain has not provided feedback in the questionnaire).
A questionnaire has been developed within the committee to compare building and ductwork airtightness awareness in a broad manner, ranging from requirements to progress needed to promote building airtightness. One or two representative(s) from each country has kindly accepted to answer the questionnaire. This document summarizes their answers.
Other comparison surveys have been done within the TAAC working groups and results have been published in (Leprince & Carrié, 2014), (Leprince & Carrié, 2014).

3 RESULTS OF THE STUDY

3.1 Airtightness reference value

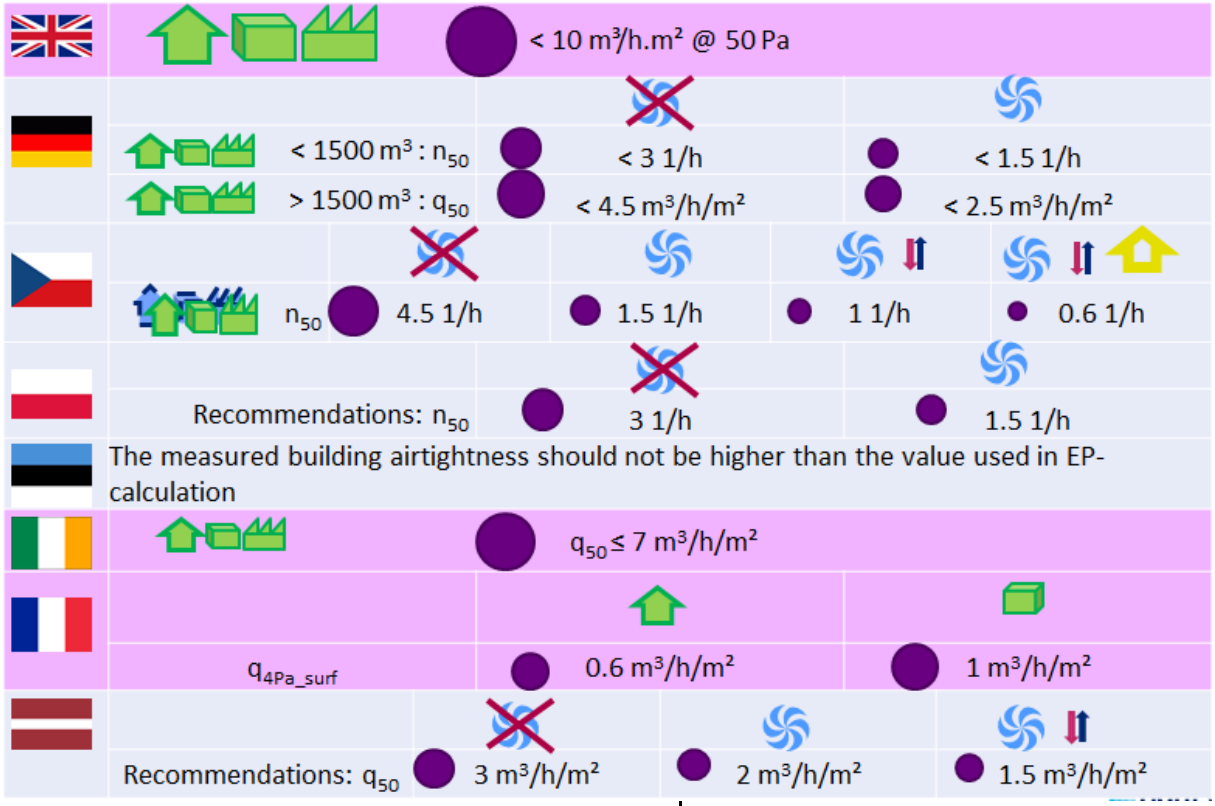
To compare requirements between countries, it is useful to know which airtightness indicators are used. It is interesting to note that the air change rate at 50 Pa, n_{50}, is no longer the primary indicator: 8 out of 10 countries have at least one indicator that uses the envelope area as reference value. However, the envelope area is not always calculated as defined in ISO 9972; for example in France the reference area excludes the lowest floor and is calculated according to Energy Performance (EP-) calculation. In Germany two reference values are used: either the internal volume for small buildings (below 1500 m^3) or the envelope area for bigger ones. 9 out of 10 countries have a reference pressure value at 50 Pa; only France has an indicator at 4 Pa.

3.2 Airtightness in EP-regulation

In 3 countries (Czech Republic, Sweden, and Latvia) out of 10, building airtightness is not taken into account in the EP-calculation; however, in one of these countries (Czech Republic) there exist minimum requirements on airtightness.
In 6 countries out of 10 (Czech Republic, Estonia, France, Germany, Ireland and UK) there are minimum requirements for building airtightness in EP-regulation. However, those minimum requirements do not necessarily need to be justified. Only France, Ireland and UK require systematic justification of airtightness level either by testing or by applying a certified approach. Table 1 summarizes requirements regarding building airtightness in European regulations. Names and details about regulations are given in Table 3.

In Belgium, there is no minimum requirement but the default value for airtightness is so high that 30-50% of new buildings are tested in order to improve the result in EP calculations. In Germany, even if the test is not required, it is done in most new buildings.

Table 1: Comparison of requirements on building airtightness in European countries



Single-family house/multi-family building/ non-residential building Blue: Retrofitted; Green: New	Relative area. Proportional to the q50 or calculated q50 if the requirement is not expressed in q50 (assuming V/S=1.1m).
Without mechanical ventilation /With mechanical ventilation / With heat recovery	Countries for which EP-regulation require a minimum airtightness level that has to be justified
Passive house	

3.3 Airtightness in EP-programmes

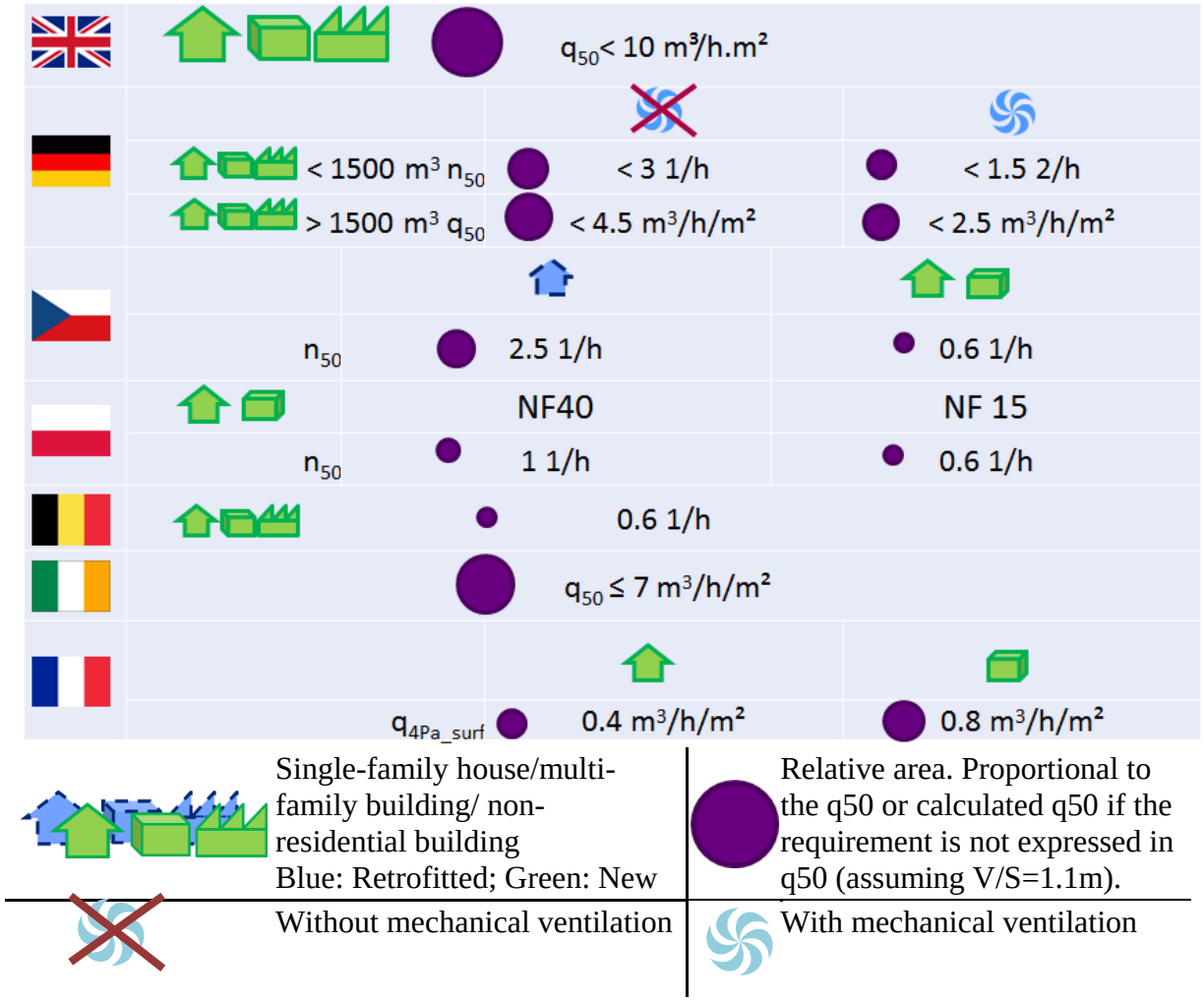
In 8 countries out of 10, EP-calculation for specific programmes depends on airtightness; in the Czech Republic, airtightness is not taken into account in regulatory EP-calculation but is in the programme calculation.

In 7 out of the 10 countries, a programme with requirements on building airtightness exists. For all of them, the airtightness value has to be justified:

- either by systematic testing (in Belgium, Czech Republic, Ireland, Germany and UK);
- or by systematic testing or by applying a certified approach (France);
- or by testing some buildings selected by a third party (Poland).

Table 2 summarizes requirements regarding building airtightness in European energy performance programmes. Names and details about programmes are given in Table 3.

Table 2: Comparison of requirements on building airtightness in programmes in Europeans countries



3.4 Airtightness tester schemes

7 countries out of 10 have now a quality framework for building airtightness testers (excluding Estonia, Latvia and Poland). In 4 countries out of the 7, this qualification is required for testing either in the context of the regulation (Belgium Ireland and France) or in the context of a programme (Ireland, France and Poland). In the UK, the qualification is not required by the regulation, however, if a test is performed by a qualified tester a "standardised certificate" is automatically issued and the tester does not need to write a full report.

The evolution of number of testers per countries is given in Figure 1. For Germany, the figure only includes Flib testers, however, other qualifications exist.

As regards the Czech Republic, it is not exactly a qualification, but there exists an association with an ethical code; rules to become a member of the association have tightened in the last 4 years and hence some testers have decided to quit the association.

Names and details about qualifications are given in Table 3.

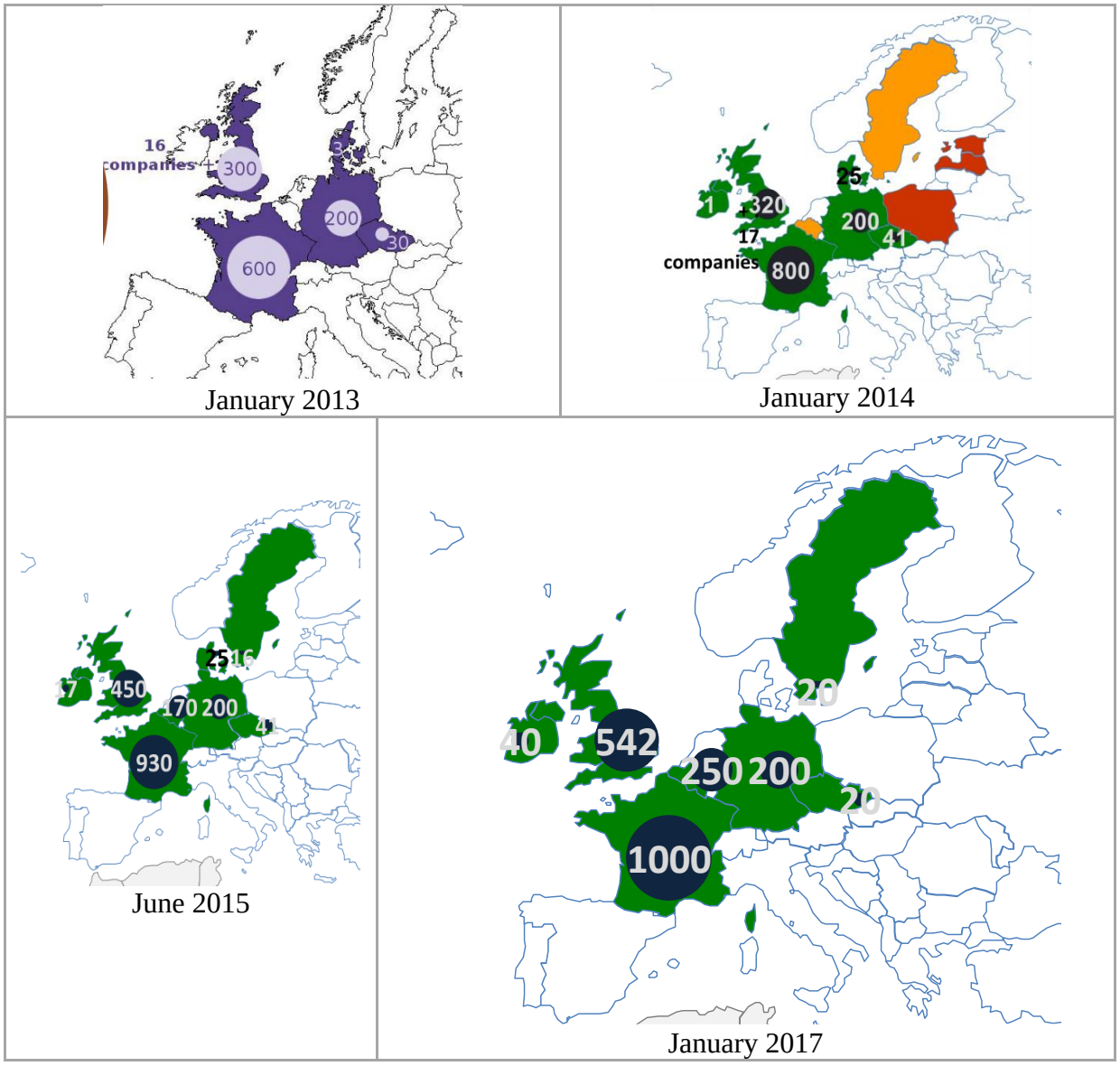


Figure 1: Increase of qualified airtightness testers in Europe in the the last 4 years

3.5 Guidelines for airtightness testing

4 countries out of 10 have issued guidelines for airtightness testing in addition to test standard ISO 9972 (Belgium, France, Germany, and UK). Names and details about guidelines are given in Table 3.

3.6 Databases

6 countries out of 10 have databases. They mainly contain data for new residential buildings tested by qualified testers. Figure 2 summarizes whether or not countries have a database available and the amount of measured data it represents. Details about databases are given in Table 3.

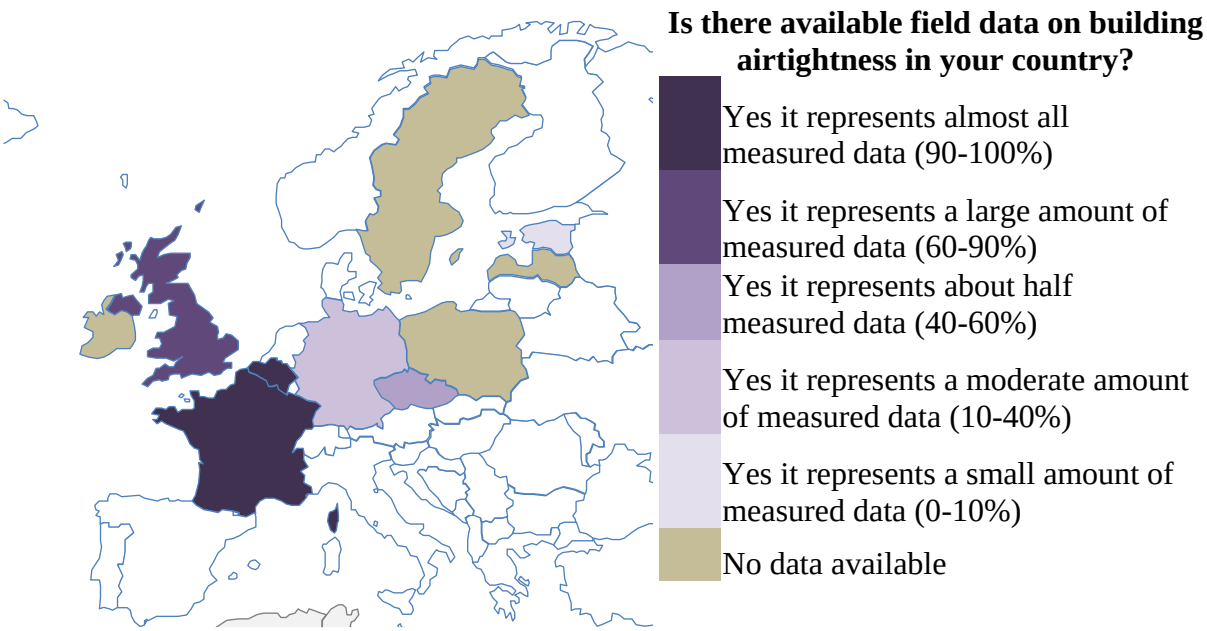


Figure 2: Database in countries and representativeness of measured data

3.7 Building airtightness awareness

In all countries, things have changed regarding building airtightness in the last five years. There has been either a significant or a moderate increase of awareness. There has been a new energy performance regulation in 6 out of the 10 countries (Belgium, Estonia, France, Germany, Poland and UK).

According to the respondents, energy use and national policy are the main drivers for change, building damages and European directives are secondary drivers, indoor air quality came last.

According to respondents progress needed to promote building airtightness include (by order of priority):

1. Quantified impact in terms of energy use
2. Long-term performance
3. Impact of poor envelope airtightness in mild/hot climates inc. mould issues
4. Quantified impacts in terms of indoor environmental quality

Table 3: Summary of EP-regulations, programmes, qualification schemes, guidelines and database in Europe

		UK	Germany	Belgium	Czech Republic	Poland	Estonia	Ireland	France	Sweden
EP-regulation	**Name**	Approved Document L of the Building Regulations in England and Wales. Technical Handbook 6 in Scotland.	Energieeinsparverordnung EnEV 2014	EPB	ČSN 73 0540-2 Thermal performance of buildings - Part 2 – Requirements	Regulation of the Minister of Infrastructure on the technical conditions that should be met by buildings and their location	Methodology for calculating the EP of buildings, regulation of Minister of Economic Affairs and Communications. Minimum requirements for energy performance, regulation of Government	EPBD -->Ireland 2011 Part (L) --> verified via DEAP software programme from government body SEAI	RT2012	

Database		Qualification and Guidelines		Programmes	
Access to this database or studies	**Database source**	**Guidelines beyond ISO 9972**	**Qualification tester schemes**	**Name**	
For ATTMA: A case must be made to explain why you want the data, who you are and what you intend to do with it. For iATS: Access would have to be arranged with co-operation from iATS directors. Please contact manager@iats-uk.org	Both iATS and ATTMA maintain a lodgement scheme for completion results.	ATTMA TSL1 2016 (Dwellings), ATTMA TSL2 (Non-Dwellings) 2010 (currently under revision)	Air Tightness Testing & Measurement Associations (ATTMA) The Independent Airtightness Testing Scheme (iATS)	SAP - Standard Assessment Procedure	**UK**
http://www.flib.de/presse/2015/05/2015_05_Meld_Statistik15_I.pdf	Flib asks its members for rough figures	EnEV 2014	There are some certification schemes. I.e. FLiB-certification.	DIN V 4108-6/ DIN V 4701-10; DIN V 18599	**Germany**
databases are not public	BCCA database, EPBD database	STS-P 71-3 2014	Kwaliteitskader Luchtdichtheid	Passiefhuis	**Belgium**
contact person: Jiri Novak, jiri.novak.4@fsv.cvut.cz	Database of test results collected by the members of Association Blower Door CZ		Membership in the Association Blower Door CZ	New Green Savings Programme (state subsidies programme for construction of energy efficient buildings)	**Czech Republic**
				NF15 and NF40 by National Fund for Environmental Protection and Water Management	**Poland**
https://www.etis.ee/File/DownloadPublic/3cf0f211-274f-4bcf-a63a-6f01651e48b9?name=Fail_Raport.pdf&type=application/pdf http://dx.doi.org/10.1016/j.buildenv.2006.06.001	Overview of measurements, 2008.				**Estonia**
	Only via individual testers		The National Standards Authority of Ireland- NSAI (95% of testers), The Irish National Accreditation Board - INAB and we also recognise the British ATTMA	Irish Building Regulations Technical Guidance Document Part (L) - Conservation of Fuel & Energy	**Ireland**
Various articles available on airbase (AIVC database): key authors are Mélois, Bailly, Guyot, Carrié, and Leprince.	Data collection via Qualibat qualification	FD 50-784, 2016	Qualibat 8711	Effinergie +, BEPOS Effinergie	**France**
		"ByggaL "(to be published in 2017)	Diplomerad lufttäthetsprovare (diplomaed airtightnestester)		**Sweden**

3.8 Ductwork airtightness

Only 4 respondents have answered the ductwork airtightness questionnaire (Belgium, France, Latvia and Germany). The Czech Republic and Poland have answered that ductwork airtightness was not really considered in their country.

Among the respondents only France (RT2012) and Belgium EPB consider ductwork airtightness as an input in the EP-regulation but there are no minimum requirements. In France, if a value better than the default value is used then it has to be justified (either by test performed by a qualified tester or by certified quality approach). In France, the programmes Effinergie + and Effinergie BEPOS require a justified class A for ductwork airtightness.

In Belgium, the leakage flow according to EN 14134 is used as an airtightness indicator whereas, in France, it is the airtightness class according to EN 12237 (ductwork area is estimated with flat rate based on building area or ventilation flowrates).
Among the respondents, only France has a qualification for ductwork testers (Qualibat 8721) with 35 qualified testers. A specific guideline for testing has been set (FD E 51-767, 2014). There are no field data available in France yet but there should be by the end of 2017.

Among the respondents, only France has had changes regarding ductwork airtightness in the last 5 years with a new regulation, a new programme, a new qualification, an increase in the number of tests, and an increase of awareness.

The awareness on ductwork airtightness has increased moderately in France, Belgium and Germany. In Belgium, this is likely to happen in the near future because of the mandatory control of every ventilation system in new buildings and extensive renovation projects; there is broader awareness regarding the efficiency of ventilation system.

As for building airtightness the main driver for change will probably be the impact on energy use therefore progress is needed to quantify the impact of ductwork airtightness on cooling, heating and fan energy use. Studies on the impact of ductwork airtightness on indoor air quality were also requested.

4 DISCUSSION

In most countries building airtightness is now taken into account in the EP- calculation. The number of tests in Europe is increasing (Leprince, Carrié, & Kapsalaki, 2017) either due to:

- requirements on building airtightness with mandatory justification;
- programmes; or
- incentive rewards

Required values are most of the time much easier to achieve than the famous n_{50}=0.6 vol/h. The objective seems to be the growth of awareness rather than the hardness of the constraint. However, in 3 countries the building airtightness is not taken into account in the EP-calculation; in those cases it may be hard to promote it.
Airtightness tester schemes now exist in 7 out of the 10 countries. The number of testers in Europe has almost doubled in 4 years and is increasing rapidly in Belgium, Ireland, France and UK, either because they are requiring airtightness testing (FR, UK, IE) or because they are promoting airtightness by rewarding the EP-calculation if a test is performed (BE).
The development of airtightness testers' schemes goes together with the development of databases; in 5 out of the 7 countries with tester schemes the qualification bodies manage a database. In the UK, qualification bodies provide tools for automatic lodgement of data which automatically collect data from more than 500 tests per working day.
The benefits of a database managed by qualification bodies are:

- collecting reliable data as they are provided by qualified testers
- representing a large amount of measured data if the qualification is required by regulation or programmes.

It is interesting to notice that having a quality framework for testers' qualification does not require specific guidelines for airtightness tests: the Czech Republic and Ireland have a quality framework but no specific guidelines. However guidelines have been developed only in countries where quality framework exist.

Every country agreed that things have changed in the last 5 years regarding building airtightness. The main driver is energy and more work is needed on the field to better:

- quantify the impact of airtightness on energy use; and
- take into account airtightness in the EP regulation.

The durability of airtightness is also a pending question that needs to be further studied. There is a little past and ongoing research on this subject but it gives heterogeneous results (Leprince, Carrié, & Kapsalaki, 2017).

Regarding ductwork airtightness, concern is still low in the field. Progress is needed to better understand the impact of ductwork airtightness on the energy use (fan, cooling and heating) to promote it and include its impact on the energy performance calculation.

5 CONCLUSIONS

Regarding building airtightness, we found that 7 out of the 10 countries have minimum requirements that have to be justified by testing or another mean, either in the context of the EP-regulation (for 3 of them) or in specific energy performance programmes. Minimum requirements mostly apply to new buildings and only three countries have a regulation or programme dealing with airtightness of refurbished buildings. 7 countries out of 10 now have a quality framework for building airtightness testers; the number of qualified testers in Europe has almost doubled in 4 years. The development of qualification has induced the development of databases. Field measurement data are now available in 6 countries out of 10. Most of the time, databases are managed by testers' qualification bodies and contain mainly data of new residential buildings.

All respondents acknowledge that awareness regarding, building airtightness has grown in their country in the last 5 years. The main motivation remains energy use, however work on this topic is still needed to better quantify the impact of airtightness on energy use.

Conversely, ductwork airtightness does not seem to be taken into account (neither in regulation nor in energy performance programmes) in most European countries. In our survey; only France and Belgium take into account ductwork airtightness in their energy performance calculation. And only France has an EP- programme with requirements on ductwork airtightness and a qualification for testers. Progress is needed to better understand the impact of ductwork airtightness on energy use (fan, cooling and heating) and indoor air quality.

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