IEE SAVE ASIEPI

ASIEPI

ASsessment and **I**mprovement of the **EP**BD **I**mpact
(for new buildings and building renovation)

www.asiepi.eu

The final recommendations of the ASIEPI project:

How to make EPB-regulations more effective?

Summary report

IEE SAVE ASIEPI project

31 March 2010

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Intelligent Energy Europe

This report is a compilation of the summary reports on each of the 6 topics that have been studied in the ASIEPI project. Part 1 gives a general description of the project. Parts 2 to 7 are the topical summary reports. Part 8 lists the organisations and persons that have participated in the project, as well as the sponsors, associates and funding partners.

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GENERAL TABLE OF CONTENTS

PART 1

ASIEPI

ASsessment and **I**mprovement of the **EP**BD **I**mpact
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1. General project description

1. INTRODUCTION

ASIEPI is the acronym of the full project name:

ASsessment and **I**mprovement
of the **EP**BD **I**mpact
(for new buildings and building renovation)

The project took two and a half years and was completed in March 2010.

The main objective of the ASIEPI project has been to formulate suggestions to policy makers on how to improve the quality and the impact of the regulations on the energy performance of buildings with respect to 6 specific issues:

- intercomparison of the levels of the EP-requirements
- impact, compliance and control of legislation
- effective handling of thermal bridges
- stimulation of good building and ductwork airtightness
- support for the market uptake for innovative systems
- stimulation of better summer comfort and efficient cooling

Several major aspects of each of the topics have been analysed. The results are documented in a full suite of project data. Among others, these data provide insight in the potential problems and give guidance with respect to possible solutions. However, as the project had to conform to the objectives of the IEE-SAVE programme, no new, ready-to-use methods were developed, but instead awareness of the challenges was raised and existing best practice to achieve more effective EPB-regulations were highlighted.

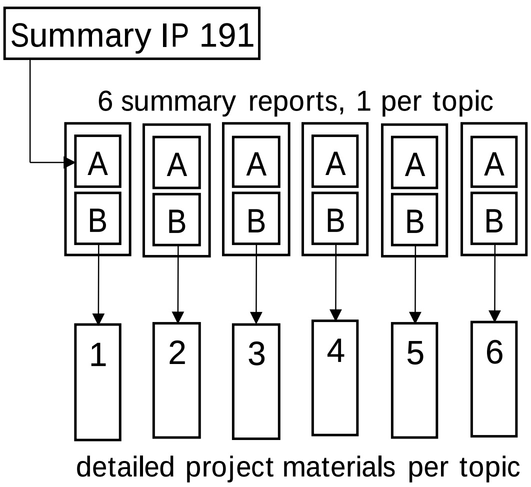
2. PROJECT MATERIALS

The ASIEPI project has produced a broad set of dissemination materials.

As illustrated in the figure, the project results are structured as follows:

- An information paper (IP191) briefly summarises the main conclusions and constitutes the gateway to the project.
- The present document is 1 out of the 6 summary reports, each dealing with 1 of the topics listed above. Parts A of these final reports describe the major findings and the final recommendations.

  Parts B give a synthetic overview of all the other information that the project has made available on that topic.



- Finally, a wide range of information materials provide a more comprehensive, in-depth coverage of many different aspects of each of the topics.

The different project outcomes come in a variety of electronic formats:

- summary reports
- detailed technical reports
- information papers
- recordings of internet information seminars
- presentations-on-demand
- conference abstracts and papers
- other related material, such as documents supplied by third parties

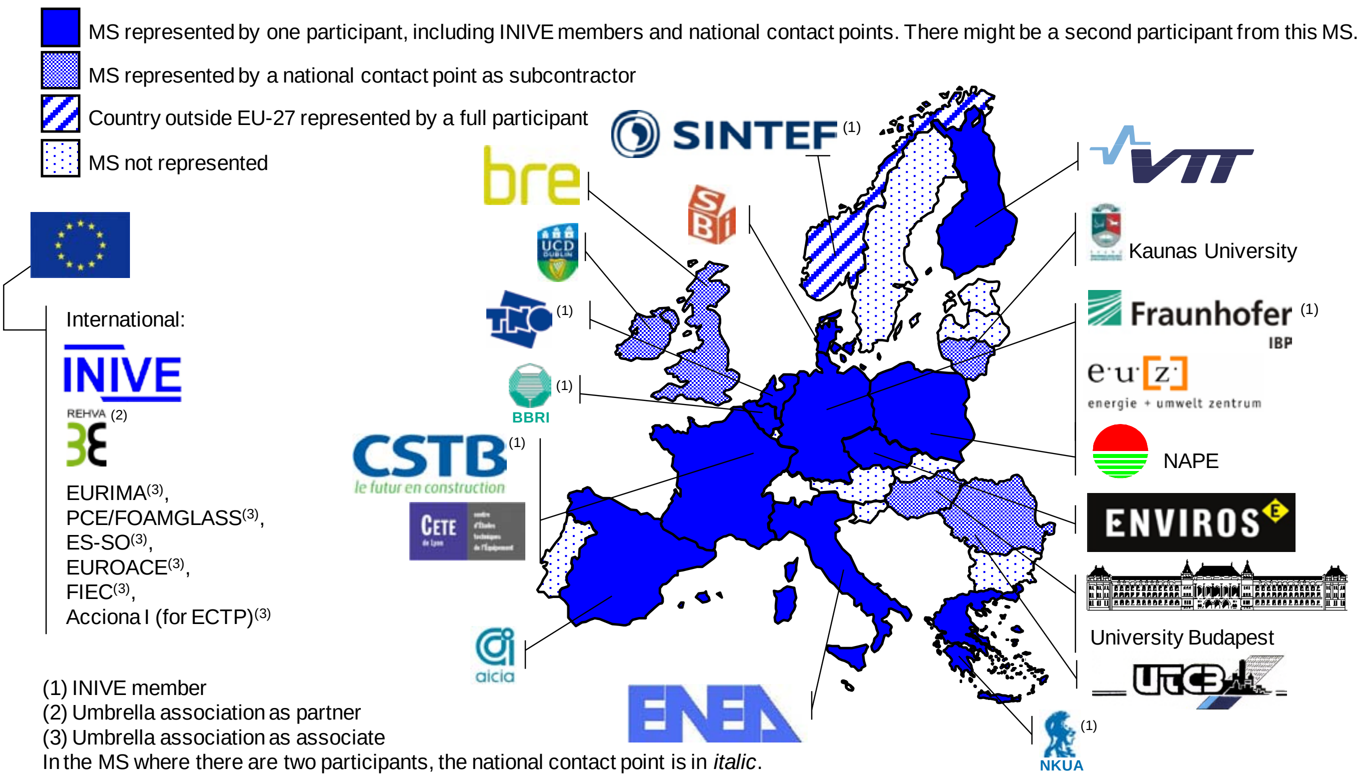
All materials are available on the project website www.asiepi.eu.

3. PROJECT PARTNERS

As shown in the figure, the project had full partners in 12 countries and subcontractors in 5 more countries. The chapter "Acknowledgements to contributors" lists all the organisations, together with their contributing collaborators.

Furthermore, there were 6 Europe-wide associations acting as associated partners. These are listed in the chapter "Acknowledgements to sponsors, other associates and funding partners", which also lists the national cofunding agencies.

Through this large number of countries involved, a good reflection was obtained of the EPB-practices across all of Europe at the time of the project. For most topics, surveys have been made in these countries in order to see how the EPB-regulations deal with each of the issues.



(1) INIVE member
(2) Umbrella association as partner
(3) Umbrella association as associate
In the MS where there are two participants, the national contact point is in *italic*.

PART 2

ASsessment and **I**mprovement of the **EP**BD **I**mpact
(for new buildings and building renovation)

**The final recommendations
of the ASIEPI project:**

How to make EPB-regulations more effective?

2. Comparison of energy performance requirement levels: possibilities and impossibilities

Main author:

Marleen Spiekman, TNO

SUMMARY

The main recommendations, which are described in more detail in part A, can be summarised as follows.

Comparing the energy performance (EP) requirement levels among the countries of Europe constitutes a major challenge. From the comparison of for instance the present Dutch requirement level (EPC) of 0,8 with the present Flemish level of E80, you can easily see that direct comparison is not possible. Within ASIEPI we developed a method for comparing EP requirement levels and while doing so, we learned several lessons which lead to the following conclusions and recommendations:

- Although at first sight it may seem easy to make a comparison of EP requirement levels among countries, in fact it is difficult to propose a fair and robust comparison method. In that respect: be careful when interpreting results of comparison studies, since it is hard to completely understand a comparison study if you don't know all boundary conditions and since conclusions might therefore be misleading.

- Countries take into account a different set of energy uses in the assesment method of the EP requirements. Some only take into account heating and cooling needs, while others also incorporate heating and cooling systems, hot water, various auxiliaries and/or lighting. This is a problem when making a comparison since the methods are overall performance methods not component methods: A moderately insulated house with an efficient hot water boiler can be as good as a house with much insulation and a less efficient hot water boiler. If the water boiler is not taken into account in some countries, by definition this means comparing apples with oranges.

- In addition, there is no harmonised way of assessing building components and systems. Current standards often mix common procedures with national choices, which make comparing assessment results far from evident.

- The previous two issues **make a robust comparison at this stage simply not possible**. The situation might partly change due to the recast of the EPBD which (again, but now explicitly) demands that countries enlarge the scope of their EP assessment to include technical systems and hot water. It is recommend to continue the development of harmonised CEN Standards because these are crucial for proper comparison. Measures which clearly influence the energy efficiency of a building in a country should be a variable part of the national EP methods and also CEN Standards should address all these relevant national measures (even if they are only relevant in only a small part of Europe), so a uniform assessment is possible. For this it is important that all countries support the European methods. Developing European methods should be done by the intensive involvement of the Member States.

- The severity of energy performance requirement levels varies within countries with, for example, building types, shapes, and system choices. Therefore, a simple rank among countries does not exist, which makes comparison prone to unfair comparisons or even manipulation.

- The method developed within ASIEPI is far from perfect, but taking into account the complexity of the task, it is a good start. It is designed to suit expected future developments, e.g. within CEN and ISO, which will make the comparison method more

suitable in the future. The method includes an index to incorporate the severity of the climate.

In general a precision of say more than 20% will probably never be achievable for a comparison, even if in the future better boundary conditions, such as more uniform EP-methods, would be in place.

- Since the need for European and worldwide comparison of energy use will expand, we recommend to further develop the climate severity index and eventually incorporate it within CEN and ISO.

Part B gives an overview of all project material that is available on this topic.

2. COMPARISON OF ENERGY PERFORMANCE REQUIREMENT LEVELS: POSSIBILITIES AND IMPOSSIBILITIES - TABLE OF CONTENTS

Part 2.A: Final recommendations

1. INTRODUCTION

EP stands for Energy Performance. This term is abbreviated throughout this rest of this report.

For outsiders, a national EP **requirement level** is quite a black box. It is almost impossible to have an idea of what such a national requirement level means exactly when one is not working with the national calculation method in question regularly. For instance, the EP requirement level for residential buildings in Flanders (Belgium) is presently E80, whereas the Dutch EP requirement level (EPC) is presently 0,8. What do these levels mean? What does it mean that recently in Flanders the EP requirement level has been tightened from E100 to E80? And is this step comparable, bigger or smaller compared to the planned tightening in the Netherlands from EPC 0,8 to 0,6?

The **calculation methods** to assess the EP levels differ from country to country. This is partly due to the fact that the EPBD is a good example of application of the subsidiarity principle: the framework is set in the directive, but the Member States have the control over the details. And even if in the future the EP methods will be fully harmonised by CEN, there are a lot of national differences which influence the energy use, as for instance national health regulations influence the building ventilation rates. Also more obvious differences between countries, like building use, indoor climate conditions, outdoor climate, construction traditions, availability, usability and cost of technologies and labour, to name a few, make a comparison of the requirement levels between the Member States far from evident. This is especially true in a legislative environment.

That energy uses calculated by national methods give incomparable results can be illustrated by a study performed for the Flemish Government (1) where the energy use of a single family house was calculated with the Flemish, Dutch, French and German method. Given that the climate in these neighbouring countries is very nearly the same, the energy uses should be more or less similar, which they were not, see figure 1. Taking into account the fact that in the Netherlands and France energy use for lighting was part of the total energy use, which wasn't the case in the other two countries, the results clearly show that the national methods give incomparable results. A uniform method to assess the energy use in a similar way is necessary (but not enough) for a robust comparison.

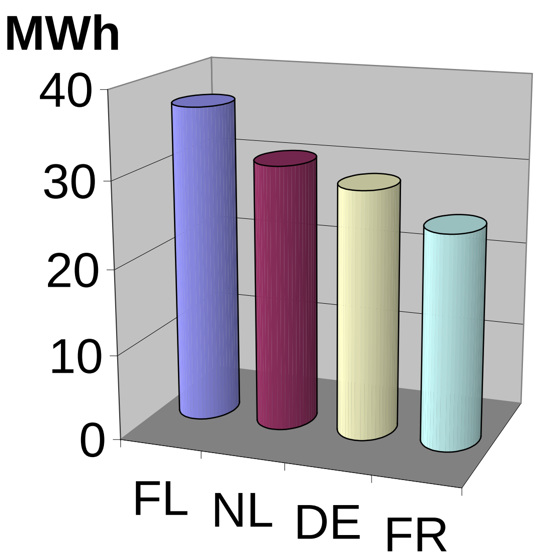


Figure 1: Energy use of the same single family house, calculated with 4 national EP calculation methods

A **method for comparing** EP requirement levels is an important tool for several groups.

- The ambition of the European Commission is for new European buildings to become 'near zero energy buildings' in 2020. Monitoring the progress of the individual countries and comparing the interpretation of this ambition among the countries of Europe is crucial to determine where extra resources are necessary to be able to reach the common goals.
- It would enable Member States to get an impression about where their EP requirement levels stand compared to their neighbours.
- And in the rapidly evolving European playing field of improving EP requirement levels, it is important that industrial companies and branch organisations are informed on the relative tightness among the countries: the EP requirement levels influence the market potential of energy saving products in countries.

Within ASIEPI we developed a method for comparing EP requirement levels and while doing so, we learned several lessons. The method and these lessons learned are summarised in the next paragraphs together with the conclusions and recommendations we drew from our experiences.

2. LESSONS LEARNED

2.1 INTRODUCTION

Developing a method to compare EP requirement levels is a challenging task. One of the most valuable results of this development probably isn't the actual method itself, but the lessons learned during the process. These lessons l provide an important source of information about possible pitfalls related to the comparison of energy uses and EP requirement levels among countries. This knowledge is crucial for a proper comparison, to avoid assessors stepping into various traps, and therefore form a crucial part of the comparison method.

Pilot studies
This chapter will focus on these lessons and will illustrate them with results of the pilot studies which were performed.

2.2 THE EP-REGULATIONS ARE DYNAMIC

It is important to realise that EP policies, methods and procedures are dynamic. During the ASIEPI project several countries tightened their EP requirement levels and changed, or are in the process of changing, the EP calculation method, like Italy, Germany, Denmark, France, Belgium and the Netherlands.
This has several consequences:

- The continuously and rapidly changing methods make a detailed analysis of the formulas used in the EP calculations for comparison reasons unrealistic. The CENSE project (2) has shown that at the moment various formulas incorporated by national standards are comparable globally, but vary in the details. That differences in details can have a significant effect can be seen from a comparison between the Dutch and the Flemish method. These two methods are quite similar, more similar than many of the other national methods in Europe, but of course they vary on details. The impact of these details can be seen in figure 1 in the introduction: The energy use of the house calculated by the Flemish method is higher than the energy use of exactly the same house calculated by the Dutch method. And this difference becomes even bigger if you would exclude the energy use for lighting, which is taken into account in the Dutch, but not in the Flemish calculation (and which doesn't fall in the category 'details'). During the particular comparison study (1) an effort was made to compare the Dutch and Flemish method in detail to see what exactly produced these differences. Even though the methods were written in the same language and the developers of both methods were involved themselves, a satisfying answer wasn't found. This illustrates that comparing formulas is difficult in the first place, because the differences will mainly be in the details, not only in the general philosophy of the methods. Adding to the fact that methods are changing rapidly, sometimes even continuously, the conclusion is that comparing methods on formula level is unrealistic.

- Another consequence of the rapidly changing national methods has been that the results of the studies done in this project age quickly as well. Some examples:
  - *During the project the EP requirement levels in Germany and Flanders were tightened. Part of the comparison studies done in ASIEPI give a too conservative picture of the German and Flemish requirement level.*
  - *During the project the Polish method became official. The official method differs drastically from the draft-method, which had been used in the first part of this study, while awaiting the formal method.*
  - *In the last phase of the project, the Italian method expanded, among other things, the energy uses which are taken into account.*

The result is that some comparison results within ASIEPI are outdated: The current situation of some countries may have changed to better insulation levels.

In conclusion, the lesson is clear: since national EP calculation methods and EP requirements are changing rapidly, the comparison method should be relatively simple (as opposed to comparing methods on formula level), and in any case the results will have a limited tenability.

2.3 NATIONAL METHODS CONTAIN DIFFERENT ENERGY USES

The first pilot study which was performed by all partners, gave crucial insight. In the first pilot study all partners were asked to perform an EP calculation for a specific single family house. A drawing of this house is given in figure 2.

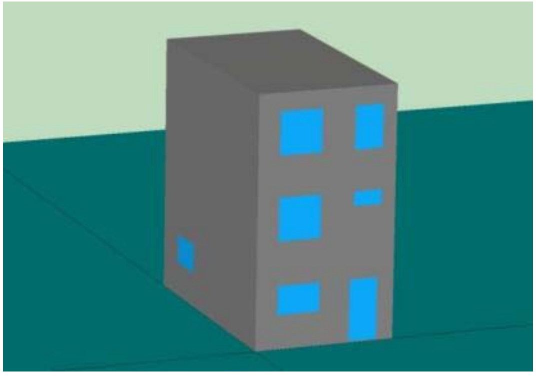


Figure 2: Pilot house

The task was to equip the house with a set of energy saving measures so as to fulfil the EP requirement level in their country. The result was a general list with energy saving measures for every country, like boiler types, insulation values, window types, etc. Two things were clear from these results:

1. Comparing these sets of measures would only be possible with fully harmonised CEN standards and experience from a previous study (1) learned that even than a precision of say more then 20% will probably never be reached.
2. In several countries various sets of energy saving measures needed to fulfil the national EP requirement level didn't contain heating and cooling systems, measures to reduce the energy use for domestic hot water and/or measures to reduce the energy use for lighting. This finding made it clear that a comparison of EP requirement levels in Europe isn't possible at this stage, since the

performances which would be compared have completely different definitions.

For instance: In Finland the EP requirement is based on the heating need only, while in the Netherlands the EP requirement is based on the energy use for heating, cooling, domestic hot water and fans, including the energy use of the systems. To reach the EP requirement level in the Netherlands a relative poor efficiency of the domestic hot water boiler can be compensated by better insulation of the building and vice versa, while in Finland the efficiency of the domestic hot water boiler is no issue in the EP requirement level of a building. The insulation levels of the Finnish and Dutch building cannot be compared: a lower insulation level in the Netherlands could mean that the EP requirement is less tight, but it could for instance also mean that the energy requirement is more tight because the domestic hot water boiler has a very good efficiency which more than compensates for the lower insulation level.

This second aspect makes it impossible to compare EP requirement levels at this moment, therefore the results of all the ASIEPI pilot studies cannot be used for comparison. However, they are still useful in the process of developing an assessment method for comparing EP requirement levels in the future, once the issue of different energy uses is solved.

2.4 ONE REQUIREMENT LEVEL DOESN'T MEAN ONE SEVERITY OF ENERGY SAVING MEASURES

By performing several pilot studies in a systematic way important issues were discovered related to the severity of the sets of energy saving measures in the different countries.

An important lesson was that there is not 1 level of energy saving measures for all situations attached to an EP requirement level in a country. It would have been nice if there was only one level of energy saving measures per building function, since ultimately many people like to rank all countries simply on one scale. But in fact some houses need more severe energy saving measures to reach the EP requirement than other houses.

Before further analysing this issue, the pilot studies briefly are explained: Because it wasn't possible to compare the sets of energy saving measures in the first step (see 2.3), the strategy was changed. In a second step, all partners were given a set of cases, including a detached house, a semi-detached house and a row house. All houses are equipped with a specific boiler, a specific ventilation system and a specific hot water system. The question to the partners was: "What is the average insulation level needed in the houses to fulfil the EP requirement in your country?." Each country representative thus needed to make an EP calculation for each of the three cases with his national EP method.
The result for one of the houses (the same house as shown in figure 2) can be seen in table 1.

MS	$U_{average}$ (W/m²K)
BE	0.54
CZ	0.50
DE	0.47
DK	0.36
ES	0.80
FI	0.25
FR	0.56
IT	0.70
NO	0.23

Table 1: Average insulation levels, needed to fulfil the EP requirement level in various countries for a specific semi-detached house (values for 2008).

Note that a low U-value means a high insulation level.

Based on the results in table 1 in a first instance one could think that the EP requirement level is higher in Norway than in Italy because the insulation level is much higher in the former. But due to climate differences it is not as easy as it looks, as is shown later in this chapter.

One out of many aspects that influence the level of energy saving measures is the loss area and the way countries deal with loss area compensation. Table 2 illustrates different country approaches to heat loss area compensation. The table shows the average U-value for floor, roof and facades which is needed to reach the EP requirement in each country for a detached house, semi-detached house and row house of the same size and form.

(Due to the fact that the ratio of window to opaque construction area differs among the three house types and the fact that these different ratios influence the average U-value and with this interfere in the comparison of the insulation levels, table 2 contains values of the average opaque U-level only.)

Detached house		semi-detached house		row-house	
MS	U_{opaque}	MS	U_{opaque}	MS	U_{opaque}
ES	0,55	ES	0,52	ES	0,47
DE	0,33	DE	0.35	DE	0,38
BE	0,30	BE	0,33	BE	0,39
FR	0,34	FR	0,32	FR	0,29
FI	0,17	FI	0,15	FI	0,13
NO	0,11	NO	0,13	NO	0,16

Table 2: Average insulation levels of the opaque areas (floor, walls roof), needed to fulfil the EP requirement level for a specific detached, semi-detached and row house (values for 2008/2009, U-values in W/m²K)).

In this example, in Germany, Belgium and Norway a detached house needs more insulation than a row house, which makes sense since the energy losses are higher for a detached house. In Spain, France and Finland it is the other way around in this example: the detached house needs less insulation than the row house, due to other compensation rules. Differences in compensation rules can for instance occur when countries deal differently with the fact that different building shapes often have different window to wall ratios.

Another example of an aspect that influences the level of energy saving measures is the effect of the compensation of certain heating system types. Table 3 shows the average insulation needed to fulfil the EP requirement level for a specific house with a condensing boiler versus an electric resistance heater in Germany, Belgium and France. When calculating the absolute primary energy use of the houses in the three countries the primary energy uses increases strongly in all three countries when changing from a condensing boiler to an electric heater. But the amount of insulation needed in France doesn't change in this example, because the maximum allowed primary energy use also increases (since the reference house then also assumes electric resistance heating). This contrasts with Germany and Belgium where the amount of extra insulation to compensate for the electric heating is so big, that it is not realistic in practice.

CB = Condensing boiler

MS	$U_{average}$ (W/m²K)
DE	0.42
BE	0,42
FR	0,56

EH = Electric heating

MS	$U_{average}$ (W/m²K)
DE	Impossible*
BE	Impossible*
FR	0,56

*Not possible, even when house is better insulated than the house with the condensing boiler

Table 3: Average insulation levels, needed to fulfil the EP requirement level for a specific house with a condensing boiler versus an electric heater (values for 2009).

In conclusion: although there might be only one EP requirement level for houses in a country, the severity of the sets of energy saving measures will vary from 1 house to another, due to aspects as compensation of the loss area and compensation of certain heating system types.

2.5 CLIMATE SEVERITY IS A CRUCIAL FACTOR IN THE INTERCOMPARISON

It is clear that climate differences among the countries complicate the comparison. This is easily seen when the insulation level needed to reach the EP requirement level is compared between for instance Italy and Finland for a similar house. Table 1 shows that in Finland more insulation is used than in Italy: The U-value for the specific Finnish semi-detached house is 0,25 W/m^{2}K, while the U-value for the specific Italian semi-detached house is 0,70 W/m^{2}K (and all other energy saving measures are more or less comparable). But in figure 3 it can be seen that the energy use of the Finnish house is higher than the energy use of the Italian house, despite the extra insulation.

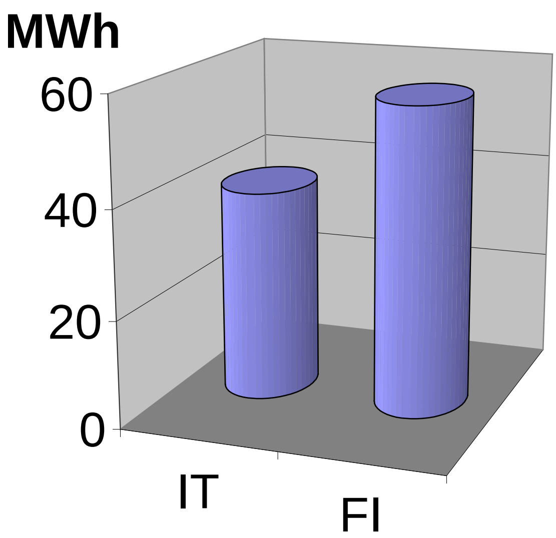


Figure 3: Energy use of a Italian house with an average U-value of 0,70 W/m^{2}K and a Finnish house with an average U-value of 0,25 W/m^{2}K.

So the question remains: in which country is the requirement level the most tight?

To answer this the climate severity index was introduced. This index is based on the method used in Spain where they face very hot climates in the south and rather mild climates in the north-west (8,11).
In short, the severity index is a sophisticated version of the degree days, taking into account the summer as well as the winter severity of a location. The higher the index is, the larger is the severity of the respective climate.

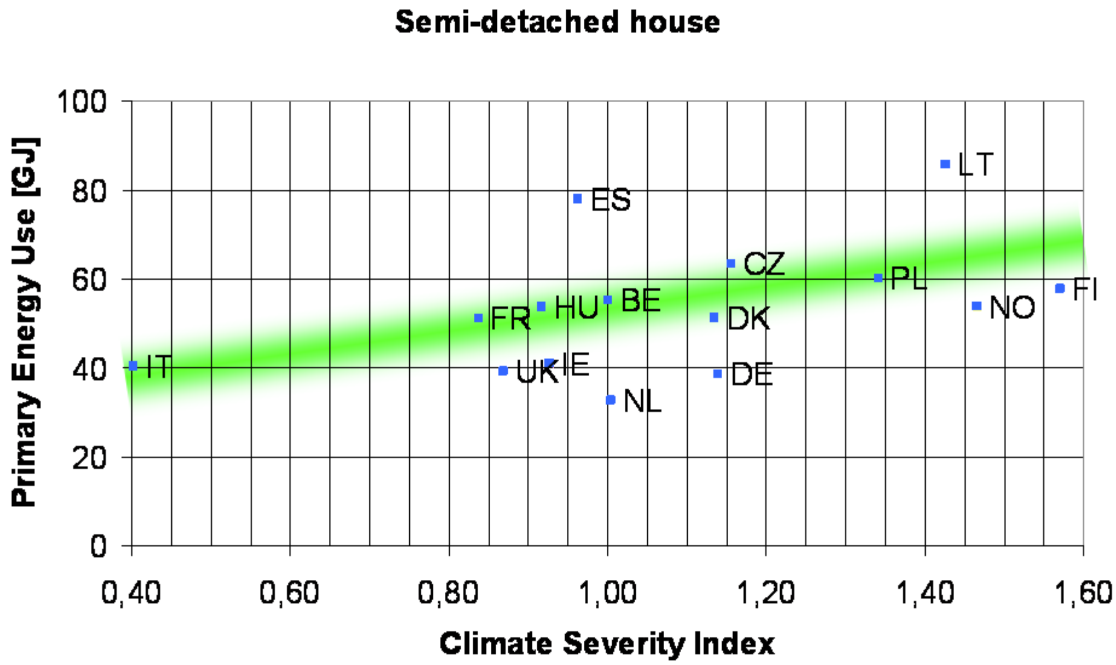


Figure 4: The graph shows the total primary energy use for the semi-detached houses used in the comparison method plotted against the climate severity indexes. Note that the results can only be interpreted in context of all remarks given in this report. Note that the figures in the graph should be handled with extreme care and can otherwise be misleading due to the fact that the energy performance calculations in some countries are based on energy needs and in other countries on total energy uses. Take for instance the case in Spain: in Spain the energy performance requirement is based on energy needs. The consequence is that mandatory measures on system level (like solar collectors) are not compensated within the energy performance requirement if they are left out, as has been done for the sake of the comparison study. In other countries, where solar collectors also are mandatory, but where the energy performance requirements are based on total energy uses, the lack of solar collectors in the comparison study is compensated by other measures. The consequence is that this results in a relatively higher energy use for Spain in the comparison. This example illustrates the fact that at this stage only apples and oranges are compared. The same holds for efficiencies of boilers and COP's of cooling systems.

Figure 4 illustrates how the severity index will work within the comparison method and contains the correlation between the severity index of the locations and the total energy use of a certain house on these locations. Every dot in the graph is a different city in Europe.

Instead of a relative ranking of all the countries in a list, the graph results in only 3 groups: the EP of all countries near the line is more or less equally tight, while the countries in the group above the line are a bit less tight than average and the group below the line are a bit more tight than average.

This '3 group approach' is seen as a big advantage of the method, since there are too many catches in the rest of the method to give a robust ranking of countries anyway.

Note that the method to determine the Climate Severity index is not yet fully developed and needs to be thoroughly evaluated and improved.

2.6 CONTEXT CANNOT BE OVERLOOKED

Another lesson which is discussed is the obvious fact that house typologies and the effectiveness of energy saving measures can differ largely per country or region.

Ideally, the comparison methodology is not based on a set of fixed cases, but on a free choice of house typologies and a free choice of energy saving measures per country or region.

At this moment though, there is no harmonised method available to calculate the total energy use of different houses with different energy saving measures on different locations in a completely uniform way.

For now the comparison method will use the simplified calculation method EPA-NR which has been developed within a European project some years ago (3). Of course EPA-NR is not a completely uniform, harmonised method, but an umbrella based on simplified approaches and estimated performance values for several components. By deliberately using fixed cases with a selected set of energy saving measures we try to minimize the disadvantages of not having a good uniform calculation method.

Once the 2nd generation CEN and ISO standards become available, the fixed choices can be replaced by country and region specific choices. This flexibility will make the comparison method more suitable in the future.

2.7 COMPLIANCE AND CONTROL

Within the ASIEPI project the issue of compliance and control has been addressed [9]. Control is handled differently in the Member States and also related to compliance large differences can be seen. The level of compliance and control is factor which can have an effect on EP requirement levels. Some examples:

- Some countries, for instance Flanders (Belgium) chooses to implement a moderate EP requirement level (compared to a severe level) in combination with a heavy control system in order to achieve a high compliance. Whereas in other countries the EP requirement level can be more severe, while the compliance in practice might be much lower. In such cases, comparing the EP requirement levels might not reflect the energetic quality of the houses build.
- A more concrete example: In the Netherlands air tightness is a variable parameter within the EP requirement of a building. To get a building permit a certain air tightness of the future building is claimed. The value claimed is almost never tested after construction, so there is no proof whether the building complies to the EP level which was promised in the request for the building permit. There is a reasonable chance the promised value will not be reached, and with this the severe EP requirement level will not be reached.

This example illustrates an EP requirement level itself does not say everything about the energetic quality of the houses build in a country.

2.8 CONCLUSIONS

During the development of the comparison method several lessons were learned regarding the development and use of EP calculation methods on national and European scale.
These lessons are worthwhile for developers of calculation methods related to legislation and policy makers, since it is important to know what the possibilities and the impossibilities are regarding the comparison of EP requirement levels. Knowledge of these lessons learned will help to avoid pitfalls in the actual comparison of energy uses and EP requirement levels. But also it will help to avoid pitfalls in developing methods and policies related to comparisons like this.

3. COMPARISON METHOD

3.1 INTRODUCTION

It is clear from the lessons learned that developing a comparison method is not easy. All the different methods, including the one we finally adopted, have their advantages, but also their disadvantages (a short overview of possible alternatives is given in [10]). Within the limits that exist at present, a fair and robust comparison seems impossible. However, to draw the conclusion that no comparison method should be delivered might be counter productive: there is a need for comparison and with or without the ASIEPI method people will compare.

Therefore ASIEPI presents a method which isn't completely fair and robust, but which is transparent about the pitfalls. The charm of the ASIEPI method is that it can be adapted in the future to expected developments, for instance within CEN and ISO. This will make the comparison method more suitable in the future.

The comparison method is divided into 5 steps. The following paragraphs describe each step and discuss various issues.

3.2 STEP 1: DESCRIPTION OF THE CASES

The first step contains several fixed cases: a detached house, a semi detached house and a row house. The houses are all equally large and all have the same shape. Figure 5 shows the floor plans and facades of the semi-detached house and Figure 2 shows a 3-D image of the same house.

The energy saving measures of the three houses are fixed to:

- A condensing boiler with an efficiency corresponding to the minimum imposed by the European Boiler Directive for heating and domestic hot water
- Natural ventilation supply and mechanical ventilation exhaust
- No cooling system, unless this is usual in a comparable house in a country
- No other energy saving measures as solar collectors, photovoltaics, heat pumps, etc

Figure 5: Floor plans and façades of the semi-detached house

At this moment it is necessary to fix the houses as well as the energy saving measures. The form of the houses as well as the energy saving measures have been chosen in such a way to facilitate comparison. The form of the house is simple to minimise measurement errors (complete elimination of these kind of errors appeared to be impossible even with these simple forms, as we found out during the project).

The energy saving measures were also chosen for simplicity and comparability. For instance, the assumption was made that basic condensing boilers would be more or less similar all over Europe. That this assumption could be made, was shown in a study performed within ASIEPI. In this study the efficiency was compared of the basic condensing boilers which were used by the countries in the pilot studies (4). The study showed that the respective efficiencies were close to one another.

To avoid comparison problems due to the

lack of harmonised assessment methods, the amount and complexity of systems and the complexity of the building physics was kept as low and simple as possible: no heat recovery, no additional active or advanced passive heating or cooling systems (besides a basic condensing boiler and, if needed, a mechanical vapour compression cooling machine).

This choice has several disadvantages which are accepted for now, due to lack of proper alternatives:

- House typologies and the effectiveness of energy saving measures can vary largely per country or region. By fixing these choices, the method might not be comparing realistic situations in various countries, which puts into question the results of the comparison.
- Since more advanced or complex energy saving measures are excluded, countries where the EP requirement level is very tight have trouble to participate in the comparison, since more advanced or complex measures simply are needed here to fulfil the EP requirement in these countries. Since the tightening down to EPC 0.8 in 2006, the Netherlands faces these difficulties. And since Germany tightened its EP requirement in the fall of 2009, also for that country the fixed measures start to become a problem. So, in the near future, as the EP requirement level in more countries becomes tighter and tighter, new fixed measures are needed, along with good and harmonised methods to assess the efficiency and effect of these measures.
- Even though the main energy saving measures are fixed in a way to make the national calculations as comparable as possible, many details cannot be excluded or fixed in this way. These aspects will introduce an error in the comparison study. Two of these aspects are for instance the severity of thermal bridges and the level of air tightness. The impact of these aspects can be quite large, therefore a study was performed into how they could be taken into account in the comparison (5, 6). Since the results were inconclusive, these aspects are not taken into account for now. The same goes for many other details, often related to building use.

It is expected that with future developments of harmonised CEN and ISO standards, it will be possible to make a shift from fixed house typologies and fixed energy saving measures to free choices of both for each country or region. This eliminates the first two disadvantages. And with these developments also the third disadvantage would be reduced, because more and more aspects can be properly taken into account. But these developments won't eliminate this problem entirely: In general a precision of say more than 20% will probably never be achievable for a comparison, even if in the future better boundary conditions, such as more uniform EP-methods, would be in place.

3.3 STEP 2: NATIONAL CALCULATIONS OF AVERAGE INSULATION LEVELS

The second step is that all countries calculate the average insulation level needed to fulfill the EP requirement level in their country. This is calculated for each of the three houses from step 1. For each country the calculations are performed with the respective national EP calculation method. The result is a list of average insulation levels for each house and each country of which examples are given in table 1 and table 2.

This lists of average U-values form a good basis for comparing the EP requirement levels, although of course the issues described in step 1 should always be kept in mind. A direct comparison of the U-values makes no sense for countries with different climates, therefore step 3 is necessary.

3.4 STEP 3: UNIFORM CALCULATED ENERGY USE

To make the results comparable, the total primary energy use of the houses is calculated for each country, taking into account the country's or region's climate and the average U-value needed to fulfil the EP requirement level in each country or region.

Since there is no good and fully harmonised method available to do such calculation, for now EPA-NR is used. EPA-NR (3) was developed within a European project some years ago. It is not a completely uniform, harmonised method, but an umbrella based on simplified approaches and estimated performance values for several components. Although a good and fully harmonised method is preferred, EPA-NR is a reasonable alternative as long as the comparison method uses simple cases only.

3.5 STEP 4: CLIMATE SEVERITY INDEX

But also total energy uses are not comparable directly, as could be seen in paragraph 2.5. Therefore the energy uses are correlated with the climate severity index, as described in the same paragraph, resulting in a graph for each house typology, as illustrated in figure 4. For each house typology it can now be determined if a country or region has an average, a bit worse or a bit better EP requirement level, compared to the other countries.

To show the potential of the Climate Severity Index, within ASIEPI a first attempt has been made to determine the Climate Severity Index for the countries involved in ASIEPI, which resulted in the indices given in table 4. The methodology used to determine these figures is described in (7) and (8).

Country	City	CSI_H	CSI_C	CSI_T
BE	Brussels	1.00	0.00	1.00
CZ	Prague	1.16	0.01	1.17
DE	Berlin	1.14	0.02	1.16
DK	Copenhagen	1.13	0.00	1.13
ES	Madrid	0.52	0.44	0.96
FI	Helsinki	1.57	0.00	1.57
FR	Paris	0.84	0.05	0.89
HU	Budapest	0.92	0.23	1.15
IE	Dublin	0.93	0.00	0.93
IT	Rome	0.40	0.45	0.85
LT	Vilnius	1.43	0.01	1.43
NL	De Bilt	1.00	0.00	1.00
NO	Oslo	1.47	0.00	1.47
PL	Warsaw	1.34	0.00	1.34
UK	London	0.87	0.01	0.88

Table 4: Climate Severity Index for heating (CSI_H), cooling (CSI_C) and both (CSI_T), as determined with the provisional method (not generally usable for instance for non-residential buildings)

It should be noted that the climate severity index derived for this purpose has not yet been thoroughly evaluated, so the use of these values should be handled with extreme care. Looking at the potential strengths of the climate severity index, and the expectation that the need for European and worldwide comparison of energy use will expand, it is highly recommended to further develop the climate severity index and eventually incorporate it within CEN and ISO.: With a thorough foundation, a proper evaluation and wide international support, the climate severity index can become a powerful tool in the comparison of energy uses among different climates.

3.6 STEP 5: QUALITATIVE EVALUATION

As discussed before, making a fair and robust comparison method seems impossible at this moment (see 3.1) and it should be clear that the proposed method of ASIEPI is a pragmatic method. Although designed with care to reduce the error resulting from these pragmatic choices, unwanted differences between countries cannot be avoided. With this a certain amount of "comparing apples with oranges" will take place.
Therefore the final step in the comparison method is a qualitative assessment: all countries are able to review the results of step 1 to 4 for all countries and comment on the findings. This qualitative evaluation will not be able to change the quantitative results, but they can put them in perspective. It is stressed that quantitative results of the ASIEPI comparison method can never be judged without the qualitative feedback of the countries and the results should always be nuanced with this.

3.7 CONCLUSIONS

The proposed comparison method developed by ASIEPI clearly is a pragmatic method. The fact is that at this moment there are no good and harmonised measurement and calculation methods available to assess the energy use of buildings in a comparable way despite contextual differences. This lacuna makes a fair and robust comparison impossible. By being transparent about the issues related to the comparison method, by focusing on lessons learned and by giving room to a qualitative evaluation of possible differences, the ASIEPI method tries to deal with this lack in the best possible way.
The ASIEPI method is designed in a way that future developments within for instance CEN and ISO can be incorporated. These future adoptions will make the method more fair and robust, gradually shifting towards the original goal. Although it needs to be emphasised again that a precision of say more than 20% will probably never be achievable for a comparison, even if in the future better boundary conditions, such as more uniform EP-methods, were be in place.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

From the previous chapters the following can be concluded:

It is clear that making a comparison of EP requirement levels among countries is easy, but making a fair and robust comparison is not. **At this stage a robust comparison is not possible** due to the variety in the types of energy uses which is taken into account in the various national methods and due to a lack of a harmonised way of assessing building components and systems.

There is not one level of energy saving measures for all situations attached to an EP requirement level in a country. A simple order among countries does not exist, which makes comparison prone to unfair comparisons or even manipulation.

And the final conclusion is that although the developed comparison method is far from perfect, it is designed to suit expected future developments, for instance within CEN and ISO, which will make the comparison method more suitable in the future. Although one should realize that in general a precision of say more than 20% will probably never be achievable for a comparison, even if in the future better boundary conditions, such as more uniform EP-methods, were in place.

4.2 RECOMMENDATIONS

This leads to the following recommendations:

Be careful when interpreting comparison studies: it is hard to completely understand an intercomparison study if you don't know all boundary conditions and conclusions might therefore be misleading.

It is recommended to continue the development of high quality and harmonised CEN Standards because these are crucial for proper comparison. And to expand the comparison method developed within ASIEPI with these harmonised methods.

All energy saving techniques that are relevant in a given country should be included in the national EP-methods. And CEN Standards should incorporate all these relevant national techniques, so a uniform assessment is possible.
For this it is important that all countries support the European methods. Developing European methods should be done by the intensive involvement of Member States and can never be a one man job.

And finally, since the need for European and worldwide comparison of energy use will expand, it is recommended to further develop the climate severity index and eventually incorporate it within CEN and ISO.

5. REFERENCES

(1) Flemish study: small scale comparison of the EP-requirements between Flanders, the Netherlands, Germany and France. Links to several reports related to this study can be found on: *http://www.asiepi.eu/wp2-benchmarking/related-information.html*

(2) "Why we need a 2nd generation of CEN standards on energy performance of buildings", Presentation of Dick van Dijk (TNO) on ASIEPI web event "Comparing Energy Requirements Across Europe", February 24, 2010.

(3) Website of EPA-NR

(4) Pilot study EP comparison. Step 4: Comparison of components by experts. (Space heating and domestic hot water systems, fans). Heike Erhorn-Kluttig, Hicham Lahmidi

(5) Pilot study EP comparison. Step 4: Comparison of components by experts. Quantification of air tightness. Antoine Tilmans, Dirk Van Orshoven

(6) Pilot study EP comparison. Step 4: Comparison of components by experts. Quantification of thermal bridges. Antoine Tilmans, Dirk Van Orshoven

(7) "Climate influence on Energy Performance levels - Towards a new (simplified robust and transparent) version of the Climate Severity Index approach", Dick van Dijk, Marleen Spiekman (TNO) and Servando Alvarez and Jose Luis Molina (AICIA), PowerPoint presentation, March 31, 2010

(8) "Comparison between minimum requirements for different climates", Servando Alvarez and Jose Luis Molina, AICIA- University of Seville, December 2009

(9) Website ASIEPI on Compliance and Control: *http://www.asiepi.eu/wp-3-compliance-and-control.html*

(10) '"Comparing Energy Performance Requirements over Europe: Tool and Method (ASIEPI deliverable D2.1c)", Marleen Spiekman (TNO), 31 March, 2010

(11) "How can we deal with climate differences? Experiences from Spain and adaptation to Europe", Presentation of Servando Alvarez (AICIA) on ASIEPI web event "Comparing Energy Requirements Across Europe", February 24, 2010 *http://www.asiepi.eu/fileadmin/files/WebEvents/WebEvent_2.2/ASIEPI_WP2_WebEvent2_04_ClimateDifferences.pdf*

Part 2.B: Bird's eye view of the project results

6. INTRODUCTION

To develop a method for comparing EP requirement levels, various steps have been taken, like the development of a set of reference buildings and the development of several pilot studies, resulting in lessons learned about possibilities and impossibilities of the comparison and resulting in a first impression of a cross section overview of EP requirement levels in Europe. All these steps resulted in 3 main topics :

1. The comparison method itself, with background information on main aspects of the method, like the climate severity index used within the method;
2. The cross section overview of EP requirement levels in Europe, although it should be noted that from the lessons learned mentioned before it is clear that at this stage a robust cross section overview of EP requirement levels is not possible;
3. The description of the set of European reference building, which initially was developed to be used in the comparison method, but is useful in European wide energy calculation and comparison studies in general.

This information was made available in the following publications.

7. PUBLISHED RESULTS

7.1 TECHNICAL REPORTS

A summary on the main results related to the development of for comparing EP requirement levels are described in the final report: Comparison of Energy Performance Requirement Levels: Possibilities and Impossibilities - Part A: Final recommendations, published 31 March 2010 (see part A of this document). This final report contains a global description of the comparison method developed within ASIEPI and the lessons learned during the development process.

In addition to the final report three working reports and an Excel Tool have been published (*>link)*:

- *"Reference buildings for EP calculation studies"*, published in November 2009. The choice of the building geometry is often one of the first determinations during comparison studies of energy performance levels over Europe, but also during other European calculation studies. With this in mind, one of the subtasks of ASIEPI has been to gather a set of reference buildings. The aim of the set of reference buildings is to give an idea of typical houses build in Europe. When we make calculations on the European level, we often extrapolate the results of one house, without the results that houses in Finland might look totally different from houses in Spain. Of course it is not possible to determine a typical house for a whole country. With this report a handle is given for information on the variety of typical houses in Europe.

- *"Comparing Energy Performance Requirements over Europe: Tool and Method"*, was published in March 2010. One of the challenging tasks of the ASIEPI project was to develop a method to compare the energy performance requirement levels of the countries of Europe. We found that all alternatives we considered have their advantages and disadvantages. And although the method we finally developed is far from perfect, it is designed to suite expected future developments, for instance within CEN and ISO, which will make the comparison method more suitable in the future. This report describes the ASIEPI comparison method and accompanying tool.

- "*ASIEPI Excel Tool*", was published in March 2010. The comparison method is accompanied by the ASIEPI Excel Tool. The tool is based on EPA-NR and is a first step in harmonising the total primary energy calculations of the houses used in the comparison approach.

- "*Comparing Energy Performance Requirements over Europe: Cross section overview*", was published in March 2010. During this development of the comparison method several pilot studies were performed. These give a global impression of the severity of the energy performance requirement levels for dwellings of the participating countries. Although one of the main conclusions of the development of the comparison method was that a robust comparison of energy performance requirement levels at this moment is not possible, this report shows a first impression of a cross section overview of EP requirement levels in Europe.

In addition to the working reports some expert material has been produced:

- As part of the pilot studies performed for the development of the comparison method three reports have been produced on detailed comparison of components:

  - *"Pilot study EP comparison. Step 4: Comparison of components by experts. (Space heating and domestic hot water systems, fans)"*, published March 2010.

  - *"Pilot study EP comparison. Step 4: Comparison of components by experts. Quantification of air tightness"*, published March 2010.

  - "Pilot study EP comparison. Step 4: Comparison of components by experts. Quantification of thermal bridges.", published March 2010.

- Also as part of the development of the comparison method first development steps have been taken to incorporate a climate severity index in the method. Information on the role of the climate severity index in the comparison method can be found in the final report *"Comparison of Energy Performance Requirement Levels: Possibilities and Impossibilities - Part A: Final recommendations"* (as described above, see part A of this document) and the working report *"Comparing Energy Performance Requirements over Europe: Tool and Method"* (as described above). More information about the climate severity index can be found in the following material:

  - *"Climate influence on Energy Performance levels - Towards a new (simplified robust and transparent) version of the Climate Severity Index approach"*, PowerPoint presentation, March 31, 2010.

- *"Comparison between minimum requirements for different climates",* December 2009.

- *"How can we deal with climate differences? Experiences from Spain and adaptation to Europe"*, Presentation on ASIEPI web event "Comparing Energy Requirements Across Europe", February 24, 2010

Finally, also a brainstorming document has been drawn up that deals with the tightening of the EP requirement levels in relation to economic aspects:

- *"Tightening the EPB-requirements: turning the potential into reality"*, published in March 2010. The work programme of ASIEPI, as established in 2006, set as objective to investigate possible methods to compare the energy performance requirements among different countries. In the mean time, the recast of the EPBD has been developed. Observing that comparing the requirements between countries is not only extremely difficult at the present time, but also not the most relevant approach (given the different boundary conditions in different countries, e.g. for costs of labour and materials), the recast now calls for an internal economic analysis within each country in order to establish requirements that are cost-optimum or better. This new approach was outside the contractual scope of the ASIEPI project, and not many resources could be allocated to study the issues related to this different way of doing. Still, based on the general familiarity of the project partners with EPB-regulations, some elementary considerations on this complementary topic have been put onto paper in the framework of the project. This brainstorming paper may serve as an inventory of some of the many challenges in order to achieve a sustained reduction of the energy consumption in reality.

7.2 INFORMATION PAPERS

Four Information Papers have been published (*> link*):

- **P065** *"Comparing Energy Performance Requirements over Europe",* published in March 2008. This information paper summarises the aims of the study on comparing the energy performance requirement levels between the EU Member States, which is one of the tasks in the ASIEPI project. For everyone involved in the discussion on the comparison of energy performance requirement levels in Europe, it is crucial to understand the challenges involved in this task. Therefore this paper gives an overview of the most important lessons learned from a preliminary comparison study of the EP requirement levels in four Member States.

- **P158** *"A set of reference buildings for energy performance calculation studies"*, published in March 2009. The choice of the building geometry is often one of the first determinations during comparison studies of national energy performance requirements. Experiences with intercomparisons carried out show that the results are influenced already by this choice as they can depend on the type of the building and because of different calculations methods for floor and envelope areas also on the building geometry. ASIEPI has collected possible reference buildings from various EU Member States which are presented in this paper. Earlier intercomparison studies have shown that already the calculation of floor areas, envelope areas etc. lead to different results when national calculation standards of several European Member States have to be followed. In most cases one or several representative buildings for the country that launched the study have been used for the comparison. As many influence factors are related to the floor area, other areas or volumes (e.g. default values for internal gains or the ventilation losses), this can produce the first differences regarding the energy performance results. Also the results of the comparison can be quite dependent on the type of building that has been chosen as reference building. This is valid for different types of dwellings (single-family house vs. multi-family house) as well as for residential vs. non-residential buildings.

- **P164** *"Developing a Method for Comparing Energy Performance Requirement Levels among Europe"*, published in December 2009. Within ASIEPI a methodology was developed to make possible a comparison of energy performance requirement levels among Member States of the EU. An unexpected finding has been that far from all the EU countries consider all energy uses in their energy performance calculation method required by the EPBD (Energy Performance of Buildings Directive). The energy use for fans, domestic hot water and cooling are among the energy uses which are not taken into account by various countries. This largely complicates the comparison over Europe. What also complicates the comparison is that sets of energy saving measures are not equally relevant in all climates in Europe. The paper summarises the difficulties in comparing the national regulations and presents options for the comparison.

- **P192** *"Comparing Energy Performance Requirement Levels: Method and Cross Section Overview"*, published in March 2010. One of the challenging tasks of the ASIEPI project was to develop a method to compare energy performance requirement levels. During this development pilot studies were performed. These give a global impression of the severity of the energy performance requirement levels for dwellings of the participating countries. This information paper describes the comparison method which has been developed during the project and shows the results of the cross section overview.

7.3 WEB EVENTS

In a series of 10 web event organised by ASIEPI, two web events were held on the topic of comparison of EP requirement levels, being web event no. 2 and web event no.10 (*> link*):

- **ASIEPI web event 2** on *"Comparing Energy Performance Requirements Across Europe"*, was held in January 2009. This web event on January 27 has given a glance of some pilot study results of the comparison of requirements and share with you why comparing the requirements among the countries in Europe isn't evident. For everyone involved in the discussion on the comparison of energy performance requirement levels in Europe, it is crucial to understand the challenges involved in this task.

  The strictness of the requirement levels is set on national level- Already the Member States are obliged by the EPBD to tighten the energy performance requirement levels every few years on national level. This development of the EP requirement levels in the Member States will be monitored. The results of the ASIEPI project will contribute to this monitoring.

To increase the impact of the Energy Performance of Buildings Directive (EPBD) the EPBD is being recast. A proposal of the recast was published two months ago. The key issues of the recast has been discussed during this web event.

Introduction
Welcome and Introduction, *by Peter Wouters, BBRI, coordinator of the ASIEPI project*
Presentations
EU Energy Policy for Buildings - Recast Directive proposed *by Gergana Miladinova, DG TREN*
Introductionr to the comparison study *by Marleen Spiekman, TNO, WP5 leader*
Lessons learned from comparing Germany, France, Netherlands and Flanders *by Peter D'Herdt, BBRI*
Comparing EP requirements over Europe. First results of ASIEPI project *by Marleen Spiekman, TNO*
Discussions
Questions
Conclusion and closure *by Peter Wouters, BBRI*

Program of ASIEPI web event n°2

- **ASIEPI web event 10** on "*Comparing Energy Performance Requirements across Europe: possibilities and impossibilities*", was held on February 2010. The tightness of the energy performance (EP) requirement levels is a hot topic in a lot of European countries. For instance Germany just tightened its EP requirements with 30% per October 1 and various other countries, like the Netherlands and Denmark have a long term planning for tightening their EP requirements in several steps. But how can we compare these EP requirements among the countries of Europe? Within the EU project ASIEPI we have developed a method for comparison. This second webevent on this topic gives an update on the results of the development of the method, addressing several issues like: how can we deal with climate differences and what is happening with the European Standards, how will the recasted EPBD change and what are challenges ahead. It also gives a glimpse of what is happening in the U.S. in the field of Energy Performance of Buildings.

Introduction
Welcome and introduction to ASIEPI *by Marleen Spiekman, TNO*
Presentations
Recast of the EPBD: How will the EPBD change and what are challenges ahead? *by Eduardo Maldonado, CA-EPBD coordinator, with an intervention of Martin Elsberger, DG TREN*
Developing a method for intercomparison of EP-requirement levels: Did we succeed? *by Marleen Spiekman, TNO*
How can we deal with climate differences? Experiences from Spain and adaption to Europe *by Servande Alvarez, AICIA*
Intercomparison of EP requirements without harmonized Standards? Why we need a 2nd generation CEN standards *by Dick van Dijk, TNO & Coordinator CENSE project*
How does Europe deal with Energy performance requirements for renovation and public buildings? Results from an European enquiry *by Anna Wiszniewska, NAPE*
Energy performance in the U.S. developments at ASHRAE *by Jaap Hogeling, CEN*
Discussions
Questions
Conclusion and closure *by Marleen Spiekman, TNO*

Program of ASIEPI web event n°10

7.4 PRESENTATIONS-ON-DEMAND

The following presentation-on-demand are available:

- **ASIEPI presentation-on-demand 1** "*Inter-comparison of requirement levels in Member States*", published in

2

January 2009, gives an overview of the development of the comparison method at the time the presentation was published. Although the presentation dates from the middle of the project, it gives an explanation of the two first pilot studies conducted in the development of the method. Many interesting lessons can be learnt from these pilot studies and this information stays current. (*> link*).

- **ASIEPI presentation-on-demand 6** "*Main lessons learned and recommendations from the IEE SAVE ASIEPI project*", published in March 2010 in several different languages, focuses on guidelines for Member States on all the topics ASIEPI has focussed on. (*> link*).

7.5 ABSTRACTS AND CONFERENCE PAPERS

Two conference abstracts were accepted for the AIVC conference 2009:

- "*Comparing Energy Performance requirement levels among Member States of Europe (EU ASIEPI project)*", was presented at 30th AIVC Conference "Trends in High Performance Buildings and the role of Ventilation". Held in Berlin, Germany, in October 2009. Abstract:: For outsiders, a national energy performance (EP) requirement level is quite a black box. Within the EU ASIEPI project (www.asiepi.eu) we are developing a methodology to make a comparison of EP requirement levels possible among member states of the EU. An unexpected finding was that far from all EU countries consider all energy uses in their EP method required by the EPBD (Energy Performance of Buildings Directive). The energy use for fans, domestic hot water and cooling are among the energy uses which are not taken into account by various countries. This largely complicates the comparison over Europe. What also complicates the comparison is that sets of energy measures are not equally relevant in all climates in Europe. The recast of the EPBD proposes to take into account a cost optimal level. This might be a way of properly reflecting local issues, although developing such a method on European level is a big challenge.

- *"Treatment of envelope airtightness in the EPB-regulations: some results of a survey in the IEE-ASIEPI project."*, was presented at 30th AIVC Conference "Trends in High Performance Buildings and the role of Ventilation". Held in Berlin, Germany, in October 2009. Abstract: One of the topics studied in the European IEE-ASIEPI project (www.asiepi.eu) is the way envelope airtightness is dealt with in the EPB-regulations of the Member States. To this end, a number of surveys was made among the participating countries. Also a quantitative comparison on a sample building was performed. The results of this study are used in the development of an instrument to compare the energy performance requirement levels among the Member States. The results illustrate that the different national EPB-calculation methods show different tendencies, revealing sometimes diverging underlying philosophies. Notably the concept and numeric figures of a default value are different, as well as the treatment of very good airtightness: in some methods the stimulus to do better than a certain threshold value becomes very small or is nil. In other countries, the incentive remains proportional all the way to the limit value of perfect air tightness. All these observations are illustrated and explained in the paper.

PART 3

ASsessment and Improvement of the EPBD Impact
(for new buildings and building renovation)

The final recommendations of the ASIEPI project:

How to make EPB-regulations more effective?

3. Impact, compliance and control of legislation

Main author:

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SUMMARY

While the European Energy Performance of Buildings Directive (EPBD) imposes Member States (MS) to set requirements, it does not specify the severity of those requirements, nor the measures to be taken to control implementation. Consequently, MS can fulfil the requirements of articles 4 through 6 without increasing the existing levels of requirement and without carrying out any kind of control. The main goal of this task of the project was to provide a good view about the impact of the present EPBD on the requirements and how MS deal with the respect of requirements. Compliance and control are essential parts of successfully implementing the EPBD. The main recommendations and findings from reports collected vary significantly regarding EPBD implementation, the large potential for further savings, the needs for infringement procedures by the European Commission, the importance of an integrated approach to buildings and their systems, support for innovative technologies, the necessity of investment in awareness and motivation actions.

3. IMPACT, COMPLIANCE AND CONTROL OF LEGISLATION - TABLE OF CONTENTS

Part 3.A: Final recommendations

1. INTRODUCTION

1.1 OVERVIEW

While the EPBD imposes Member States to set requirements, it does not specify the severity of the requirements, nor the measures to be taken to control implementation. Consequently, Member States can fulfil the requirements of articles 4 through 6 without increasing the existing levels of requirement and without carrying out any kind of control. The aims of the study were:

1. To obtain a good view on how EPBD implementation has changed (or is changing) the national requirements.
2. To obtain a good overview of the way Member States deal with compliance handling and control measures. This includes not only governmental actions, but also non-governmental actions.
3. Identification of interesting approaches and possible bottlenecks for improved compliance and control.
4. Recommendations regarding independent control systems and penalties, as listed in the proposal by the European Commission for recast of the EPBD.

1.2 WORKSHOP

An international workshop was organised on September 1-2, 2009 in Brussels. This open workshop was attended by around 80 participants from 17 countries. The participants came from industry, research and governmental organisations.

The workshop programme consisted of expert presentations on the issue of impact, compliance and control in 13 Member States (Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Portugal, Spain), -four presentations from European Federations (ES-SO, EuroAce, EURIMA and REHVA) and four synthesis presentations on the previously-mentioned four topics. At the end, there was a brainstorming session regarding pros and cons, as well as concerns regarding the envisaged recast of the EPBD.

This document has been prepared and reviewed by the ASIEPI partners, taking into account suggestions expressed during the workshop. In annex, there is a pdf file containing all final expert reports on each country's status. All country reports, as well as the four synthesis reports, are published as Information Papers and available on www.asiepi.eu and www.buildup.eu .

2. FINDINGS AND RECOMMENDATIONS FOR THE RECAST

2.1 GENERAL REMARKS

The findings below are summarised from presentations and information papers on country status reports that address the control and compliance issues. Full reports are available on (1). The general recommendations reviewed by project partners are as follows:

1. The various reports show significant disparity in EPBD implementation, with big differences in impact, compliance and control. Some variation can be justified because of MS diversity. However, emphasising consistent and sound implementation can or could release the large potential for further savings. The proposed recast may accelerate this process.
2. Several MS have performed lifecycle cost analysis studies before tightening the building code requirements. This is the case in both past and present. Various MS have developed roadmaps for further improving the energy efficiency of new and existing buildings.
3. Not all countries have yet fulfilled all the requirements imposed by EPBD. As guardian of the European Treaty, the European Commission must continue its efforts regarding infringement procedures. (2)
4. It is essential to have an integrated approach that covers all energy-related building components and service systems to achieve cost-efficient (cost-optimised) energy performance targets. Indoor climate aspects must also be taken into consideration.
5. In several MS, innovative compliance and control approaches exist, which do not increase the administrative burden. These approaches depend strongly on cultural aspects.
6. In addition to compliance and control measures, it is also important (to continue) to invest in awareness and motivation actions, e.g. educational and information campaigns.
7. In several countries, there is a difference between the national requirements and the cost-optimum requirements concerning U-values of the building envelope.
8. There are success stories showing a major change in the energy performances of the new building stock due to the EPBD-related regulations. At the same time, there are also success stories regarding market uptake of innovative systems and technologies, in which the EPBD regulations have had a catalysing effect (3).

2.2 COST-OPTIMAL REQUIREMENTS (ARTICLE 5 OF RECAST MARCH 2010)

The cost-optimal requirements are referred to in the text of RECAST in several places. Provision 10, in box below, describes its meaning. The following, most important aspects have been raised in this regards by project participants:

1. The definition of cost-optimal levels is crucial and requires further discussion.
2. The calculation methodology for determining the cost-optimal levels of energy performance is an essential element of the recast. A consultation with the MS and stakeholders is felt to be important, and the validity of a method should be proven for the intended application(s).
3. Given the importance of guaranteeing good indoor climate conditions, combined with the increasing evidence of poor indoor climate conditions in many buildings, MS are expected to report on the actions undertaken in relation to indoor climate.
4. In order to facilitate an efficient and cost-effective implementation and to allow the various stakeholders to

It is the sole responsibility to set minimum requirements for the energy performance of buildings and building elements. The requirements should be set with a view to achieving the cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building, without prejudice to the right of Member States to set minimum requirements which are more energy efficient than cost-optimal efficiency levels. Provision should be made for the possibility for Member States to regularly review their minimum energy performance requirements for buildings with regard to technical progress. **(Provision 10)**

prepare properly, it is very important that each MS develops a detailed roadmap for tightening the national requirements.

2.3 INDEPENDENT CONTROL SYSTEM (ARTICLE 18 AND ANNEX II)

The main features foreseen for an independent control system, in line with RECAST, should be characterised by the following.

1. The competent authorities, or the bodies to whom the competent authorities have delegated the responsibility for implementing the independent control system, shall make a random selection of at least a statistically significant percentage of all the energy performance certificates issued annually, and subject these to verification. Given the major differences in regulatory systems, political visions and cultural aspects, alternative approaches should be justified on the condition that the MS can prove that the approach is effective.
2. The effectiveness of any control scheme largely depends on the intrinsic quality of the overall implementation, i.e. how the criteria are expressed, the unambiguity of the requirements, etc. Therefore, attention should be drawn to the fact that regulations should be thoroughly checked regarding the possibilities for carrying out controls and, if necessary, imposing sanctions.

2.4 PENALTIES (ARTICLE 24)

One of the reasons for RECAST is the lack of execution power for EPBD regulations (Article 24). Two following recommendations are crucial in this case:

1. Additional control activities should not extend the administrative burdens in the MS.
2. Sanctions in the case of non-compliance of building specifications can take different forms: financial penalties, the obligation to put the building in-line with the specifications, prohibiting occupancy of the building, withdrawal of professional rights, etc. Allowing a flexible sanction handling in order to best fit the cultural behaviour differences of the MS is advisable.

Member States shall lay down the rules on penalties applicable to infringements of the national provisions adopted pursuant to this Directive and shall take all measures necessary to ensure that they are implemented. The penalties provided for must be effective, proportionate and dissuasive. Member States shall communicate those provisions to the Commission by* at the latest and shall notify it without delay of any subsequent amendment affecting them. **(Article 24)**

3. REFERENCES

(12) materials from Workshop: www.asiepi.eu/wp-3-compliance-and-control/workshop.html

(13) Identification of interesting approaches and possible bottlenecks for improved compliance and control: http://www.asiepi.eu/information-papers.html http://www.buildup.eu/publications/7126

(14) Overview of national approaches for the assessment of innovative systems in the framework of the EPBD: http://www.asiepi.eu/wp-6-innovative-systems/related-information-and-first-re.html#c82

Part 3.B: Bird's eye view of the project results

4. BIRD'S EYE VIEW OF THE PROJECT RESULTS

The research on impact, compliance and control of EPBD regulations in Member States (MS) was organised in three steps:

1. One of the main tasks of the research was to determine the state of the art for impact, compliance and control in countries represented by ASIEPI project partners and subcontractors, in the form of country reports. Every report includes the following: the impact of EPBD on national requirements, compliance and control of requirements and certification schemes.

2. Four synthesis reports based on country reports and additional information provided by partners on the following subjects:
   - Evaluation of the impact of national EPBD implementation in MS,
   - Evaluation of compliance and control in the different MS,
   - Barriers and good practice examples,
   - Identification of interesting approaches and possible bottlenecks for compliance and control of regulations

3. An international workshop was organised for September 1-2, 2009 in Brussels, with industrial organisations and approximately 80 attendees

5. PUBLISHED RESULTS

5.1 COUNTRY REPORTS

The structure of country reports includes a description of the impact, compliance and control of new, EPBD-related, national requirements and certification schemes. Country reports prepared by ASIEPI partners and subcontractors in Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Greece, Italy, Lithuania, Netherlands, Norway, Poland, Spain are in the form of Information Papers and can be found either on www.buildup.eu or on www.asiepi.eu/wp-3-compliance-and-control/

In addition, two subcontractors, for Hungary and Lithuania, prepared reports that can also be found on the ASIEPI and BuildUp sites.

5.2 SYNTHESIS REPORTS

Additional analysis is provided in the four synthesis reports prepared based on country status reports and additional data collected from ASIEPI partners:

1. Synthesis report on the identification of interesting approaches and possible bottlenecks for compliance and control of regulations.
2. Synthesis report evaluating the handling of compliance and control in the different MS.
3. Synthesis report evaluating the impact of national EPBD implementation on the severity of requirements.
4. Synthesis report on barriers and good practice examples.

The synthesis reports are available under the IP numbers in the table below, on www.asiepi.eu and www.buildup.eu.

5.3 WORKSHOP

The workshop programme consisted of expert presentations on the issue of impact, compliance and control in 13 Member States (Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Portugal, Spain), four presentations from European Federations (ES-SO, EuroAce, EURIMA and REHVA) and four synthesis presentations. At the end, there was a brainstorming session regarding pro and cons as well as concerns regarding the envisaged recast of the EPBD.

The presentations reflect the views of the persons/institutions that have prepared them, but may be not in line with the official position of the MS. The table below presents the programme of the workshop together with references to country reports prepared by 12 project partners and Portugal, and additional contributions from Hungary and Lithuania that were prepared after the workshop.

Introduction	**PPT**	**IP**
General welcome INIVE – Presentation of AIVC & ASIEPI *by P. Wouters, INIVE*	[01]	-
Proof of Performance: Supporting the quest for efficient and effective compliance *by A.-G. Sutherland, EACI*	[02]	-
Objectives of the workshop *by A. Panek, NAPE*	[03]	-
The EPBD Concerted Action *by E. Maldonado, ADENE*	[04]	-
Country presentations	**PPT**	**IP**
Belgium *by A. Tilmans, BBRI*	[BE]	P174
Netherlands *by M. Spiekman, TNO*	[NL]	P169
Greece *by M. Santamouris, M. Papaglastra, NKUA*	[GR]	P173
Germany *by H. Erhorn, H. Erhorn-Kluttig, Fraunhofer IBP*	[DE]	P177
Norway *by P. Schild, SINTEF*	[NO]	P170
Portugal *by P. Santos, ADENE*	[PT]	-
Italy *by M. Zinzi, G. Fasano, M. Citterio, ENEA*	[IT]	P168
Spain *by J.L. Molina, AICIA*	[ES]	P172
Poland *by A. Panek, M. Popiolek, NAPE*	[PO]	P171
Finland *by J. Shemeikka, M. Haakana, VTT*	[FI]	P167
Denmark *by K. Engelund Thomsen, S. Aggerholm,* SBi	[DK]	P175
France *by R. Carrié, G. Guyot, W. Lecointre, CETE de Lyon*	[FR]	P176
Czech Republic *by J.*	[CZ]	P166

3

Pejter, ENVIROS s.r.o.		
Hungary *by A. Zöld, Budapest University of Technology and Economics*	-	P182
Lithuania *by R. Bliudzius, Institute of Architecture and Construction of Kaunas University of Technology*	-	P184
Industry point of view	**PPT**	**IP**
EURIMA *by R. Bowie*	[07]	-
ES-SO *by D. Dolmans*	[12]	-
EuroACE *by K.E. Eriksen*	[16]	-
REHVA *by M. Virta*	[21]	-
Lessons learned from country status reviews (syntheses)	**PPT**	**IP**
Evaluation of EPBD impact on requirements *by M. Papaglastra, NKUA*	[22]	P180
Evaluation of compliance and control in Member States *by H. Lahmidi, CSTB*	[23]	P179
Barriers and good practice examples *by M. Papaglastra, NKUA*	[24]	P181
Interesting approaches and bottlenecks *by M. Spiekman, B. Poel, L. van den Brink, TNO*	[25]	P178

A pdf file with all the presentations is available on www.asiepi.eu .

PART 4

ASIEPI

ASsessment and **I**mprovement of the **EP**BD **I**mpact
(for new buildings and building renovation)

The final recommendations of the ASIEPI project:

How to make EPB-regulations more effective?

4. An effective Handling of Thermal Bridges in the EPBD Context

Main authors:

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SUMMARY

The Intelligent Energy Europe project ASIEPI 'Assessment and Improvement of the EPBD Impact (for new buildings and building renovation)' has collected and analysed international and national information from up to 17 EU Member States plus Norway on the topic of thermal bridges in buildings. Seven different tasks have been addressed ranging from EU Member States approaches in regulations to quantification of thermal bridge effects to the energy balance, used software tools and thermal bridge atlases, available good practice guidance and promotion of good building practice to the execution quality and advanced thermal bridge driven technical developments.

For many of these items it can be said that to some degree high quality material is available in most of the EU Member States (like software tools for calculating thermal bridges, thermal bridges atlases and promotion of good practice guidance). It would be desirable that the material is used more often by building practitioners and that some countries catch up with the others. Software for calculating thermal bridges should be validated and the validation results published.

All EU Member States plus Norway consider thermal bridges in the energy performance assessment of new buildings, but to a lesser extent in the assessment of existing buildings that undergo major renovation. A detailed assessment of thermal bridges allows for compensation of other energy influences due to better building junction solutions. The use of default values on the other hand makes the calculation of energy performance faster.

Several Member States have included specific requirements concerning the quality of building junctions in their regulations. These can be maximum linear thermal transmittances or minimum dimensionless temperature factors.

Some countries have a meticulous check of details during or after the design phase of a building. Few countries have a detailed quality assurance of the execution quality on the construction site. ASIEPI has collected ways to assess the execution quality, but also possible sticks and carrots to improve the realisation of building junctions.

The search for thermal bridge driven industry developments was not an easy task. However, the report contains some products that can reduce thermal bridges in buildings significantly. It has to be mentioned that most of these products are produced and used in central Europe. A regulation that allows the detailed assessment of building junctions and is up-to-date with innovations supports these kinds of solutions (see also ASIEPI topic ‘The EPBD as support for market uptake for innovative systems’).

The main recommendations, which are described in more detail in part A, can be summarised as follows.

- Policy makers:
  - Include the assessment of thermal bridges in the energy performance calculations for new buildings, but also with at least a simplified approach for existing buildings in case of major renovation.
  - Set minimum requirements or at least recommendations for inner surface temperatures.

- Include a quality assurance procedure for the design and the realisation of building junctions in your national building regulations.
- Offer to use values lower than the default value for thermal bridges according to the result of detailed calculations. Due to that improved joints can be used as a method to improve the energy performance of buildings, similar to better insulation, more efficient systems, etc.
- Explicitly require that thermal bridge software used in the context of the EPBD-regulation must satisfy the validation cases of EN ISO 10211.

▪ (National) standardisation bodies:
  - Include simplified and detailed assessment methods for thermal bridges in the national energy performance assessment standards.
  - Develop a procedure for setting minimum requirements on the energy quality of building joints that covers the energy impact and - even more importantly - includes the guarantee that no moisture or mould problems occur.
  - The impact of thermal bridges in winter (heating energy demand and heating load) and, depending on the boundary conditions partly on the summer performance of buildings (cooling load) cannot be neglected and should be included in the national calculation methods either using default values and/or detailed calculations.
  - Provide best practice guidelines as part of standards or accompanying information.

▪ CEN/ISO:
  - Publish in the short term a corrigendum for the errors in case 3 of annex A (and elsewhere in the text) of EN ISO 10211:2007. *In the meantime CEN has decided to correct the errors!*
  - In a future revision of EN ISO 10211, a more comprehensive set of validation test cases seems warranted (more complex boundary conditions, non-rectangular geometries and air layers).

▪ Building practitioners:
  - Include the detailed assessment of the building junctions in the calculation of the energy performance of buildings.
  - Have a thorough look at building junctions during the design of the building, but also during the realisation on the construction site.
  - For high-performance buildings the impact of thermal bridges can become significant.
  - Especially for renovation projects building junction solutions have to be checked in order to prevent moisture/mould problems.

Part B gives an overview of all project material that is available on this topic.

AN EFFECTIVE HANDLING OF THERMAL BRIDGES IN THE EPBD CONTEXT - TABLE OF CONTENTS

4

Part 4.A: Final recommendations

1. INTRODUCTION

1.1 THERMAL BRIDGES IN BUILDINGS

Thermal bridges can occur at various locations of the building envelope and can result in increased heat flow, which causes additional transmission losses, lower inner surface temperatures and possibly moisture and mould problems. The additional transmission losses lead to a higher heating energy need and use and are becoming especially important in the case of so-called low energy or high performance buildings. Here, the energy loss due to thermal bridges can be even higher than, for example, the energy benefit provided by thermal solar collectors for domestic hot water. The public awareness of this fact is however very low.

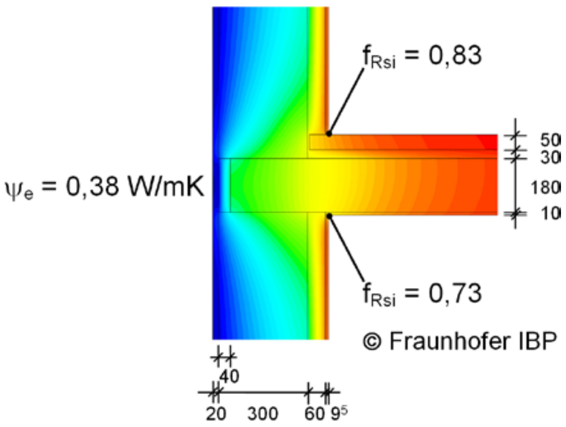

Fig. 1: Example of a thermal bridge effect at a concrete ceiling embedded in the external wall. Calculation of the linear thermal transmittance and the dimensionless temperature factor. The colours illustrate the temperature distribution within the construction.

1.2 TYPES OF THERMAL BRIDGES

Four different types of thermal bridges can be distinguished:

1 Repeating thermal bridges within a construction element (structure or frame constructions). They are included in the overall U-value calculation of the element.

2 Thermal bridges at corners and junctions incl. windows and doors, wall/roof, wall/wall corners. The linear thermal transmittance (psi-value) is multiplied by the length of the thermal bridge.

3 Isolated thermal bridges, like balconies penetrating insulation layers. The punctual heat loss is multiplied by the number of thermal bridges. Many national energy performance calculation procedures do not request the inclusion of the isolated thermal bridges into the energy performance calculation.

4 Air movements within the structure, or between the structure and the outside, or between the structure and the inside (but without direct air transfer all the way from the inside to the outside). Obviously, these (semi) internal air flows affect the transmission heat losses. They can be considered as a form of thermal bridging in a broader sense.

1.3 STANDARDS FOR THERMAL BRIDGES

The international standard EN ISO 10211 [1], [2] is dealing with thermal bridges, but there are national standards available in nearly every European Member State that cover calculation, requirements and good practice solutions.

1.4 ASPECTS OF THERMAL BRIDGES ANALYSED WITHIN IEE ASIEPI

Within the ASIEPI work on thermal bridges the following aspects have been addressed:

- EU Member States approaches in regulations
- Quantification of thermal bridge effects on the energy balance
- Software tools and thermal bridge atlases
- Good practice guidance
- Promotion of good building practice
- Execution quality
- Advanced thermal bridge driven technical developments

1.5 GENERAL APPROACH OF WORK

The approach used in the IEE ASIEPI work was to start with a basic questionnaire answered by experts from up to 17 EU Member States and Norway followed by a collection of more detailed information such as existing national experiences and studies per task.

Based on this various information material documenting the gathered national and international knowledge has been published as listed in Part B.

2. EU MEMBER STATES APPROACHES IN REGULATIONS

2.1 CHALLENGE AND APPROACH

Though thermal bridges are not explicitly mentioned in the Energy Performance of Buildings Directive (EPBD) [3], they are part of the thermal characteristics of the building shell which is one of the aspects that have to be included in the methodology of calculation of energy performances of buildings.

The first aspect within the ASIEPI work on thermal bridges was therefore to analyse if and how the EU Member States' building energy performance regulations deal with thermal bridges and to gather and document the approaches and existing minimum requirements.

The starting point for analysing the countries' calculation procedures and requirements was a questionnaire. The overview of the answers by experts from 13 different Member States was split by geographical and climatic region. Questions were asked concerning the following topics:

- National regulations considering the influence of thermal bridges in new buildings
- National regulations considering the influence of thermal bridges on the renovation of buildings
- Explicit calculation or simplified approach for new buildings

- Explicit calculation or simplified approach for renovation of buildings
- Maximum values for thermal bridges given in national regulations
- Realisation of details checked by authorities during design
- Realisation of details checked by authorities during realisation

The results of the questionnaire [4] could be partly mirrored and discussed at an EPBD Concerted Action [5] meeting with national representatives from all 27 EU Member States.

2.2 CONCLUSIONS

While the assessment of thermal bridges is part of most national calculations of the energy performance of new buildings, many countries do not cover this issue for major renovations in new buildings. Some countries do not set minimum requirements for the energy quality of building junctions. The quality control of the design, but also the execution of building junctions is carried out in different ways. In some Member States there are no controls at all.

3. QUANTIFICATION OF THERMAL BRIDGE EFFECTS ON THE ENERGY BALANCE

4

3.1 CHALLENGE AND APPROACH

The ASIEPI project tried to answer the following questions:

- How big are the transmission losses due to thermal bridge effects in absolute and relative values?
- What is the influence on the total final or primary energy consumption of a building?
- Should an energy performance assessment method for buildings include an option for a detailed calculation of the impact of thermal bridges?

Thus ASIEPI has collected and analysed studies dealing with the influence of thermal bridges on the energy performance of buildings which have been performed in different European Member States [6].

3.2 CONCLUSIONS

Most of the collected studies compare existing default values for thermal bridge impacts in national standards with detailed thermal bridge calculations of improved junctions. Other analyses present as results the (total) impact of the thermal bridges on the energy performance without comparing it to default values. Also the number of junctions analysed, the building geometry, the climate, etc. vary between these studies. Still, the results can be summarised as follows:

- The total impact of thermal bridges on the heating energy need is in general considerable and can be as high as 30 %.
- The impact on the cooling energy need is significantly lower. There can be, however, a significant influence regarding the maximum cooling load. Since both cooling needs and cooling loads are strongly related to the “control” strategy of ventilation and cooling (such as night ventilation, use of thermal mass) it can be assumed that

these boundary conditions do influence the limited number of studies and experiences available regarding the impact of thermal bridges on the cooling energy issues. Probably there is no simple conclusion concerning the increase/decrease of cooling energy and cooling load based on the impact of thermal bridges. This analysis has to be made for the specific building including building construction, the specific cooling, shading and ventilation strategy, and the specific climate.

- Countries with national default values for thermal bridges have mostly set those values in order to be on the "safe side", meaning that these are likely to produce slightly higher impacts compared to detailed junction analyses using 3D-simulation programs.

- If national default values are compared with improved junctions with regard to the energy quality, the heating energy impact can be as high as 11 kWh/m²a heating energy need or 13 kWh/m²a primary energy. Another study showed an influence of 18 kWh/m²a primary energy.

- The relative impact of improved junctions compared to national default values on the primary energy for heating can amount to 15 %.

4. SOFTWARE TOOLS AND THERMAL BRIDGE ATLASES

4.1 CHALLENGE AND APPROACH

Detailed evaluation of the linear or point thermal transmittance can be realised either by numerical calculation software or by thermal bridge atlases. The ASIEPI project has collected and categorised software and atlases used in the EU Member States [7]. A major action has been to motivate the software producers to validate their tools with the relevant method as presented in ISO standard EN ISO 10211.

4.2 CONCLUSIONS

With 26 different software producers, 29 software tools and 26 mostly national thermal bridge atlases as listed in the specific information paper and the final thermal bridge report of ASIEPI (see Part B); there are many tools available for the evaluation of thermal bridges. The software tools can be distinguished by the capabilities (heat transfer only, heat, air and moisture transfer, general/multi-physics), 2D or 3D, steady state or transient, free form or rectangular, possibility for the automatic calculation of the linear thermal transmittance (ψ-value), free or commercial and validated (and documented) or not.

<u>Thermal bridge assessment software:</u>

The main problem encountered at the start of the enquiry was the lack of systematic and up-to-date proof of validation. At the time of publication of this report, some software still did not have documented validation. There lingers a certain degree of doubt over the calculation results of such non-validated software. Their use in the framework of energy performance of buildings regulations of Member States should be therefore better avoided.

As a reaction to the motivation by ASIEPI, 4 software producers updated the available information for in total 9 software tools. 5 additional producers presented the validation for 5 tools for the first time on the internet.

<u>Thermal bridge atlases:</u>

A considerable collection of such documents is available. Most of them are written in the language of their country of origin and have not been translated. Of course, this may be one of the main reasons that make the use of such documents in other countries rather difficult. However, the available thermal bridge atlases mostly show design solutions that are used in a specific Member State, which might be an argument against the translation into other languages. The construction of buildings is still influenced by the cultural and historical boundary conditions. This might result in a limited applicability of a translated thermal bridge atlas.

5. GOOD PRACTICE GUIDANCE

5.1 CHALLENGE AND APPROACH

Most areas of Europe need good thermal insulation in order to conserve energy and to improve indoor climate. Minimising thermal bridges is an important part of achieving this aim. However, even in well-insulated buildings, thermal bridges are often neglected. Good practice guidance documents published by either building authorities, standardisation bodies, energy agencies or organisations planning to publish or update their own construction details can help to improve the situation.

The work on this topic resulted in two information papers, one dealing with suggestions for what should be covered in good practice guidance, how it can be structured and presented and the other one showing a selection of good examples from different countries. The papers have been published together with an electronic archive containing over 60 reference documents with clickable hyperlinks for opening the individual documents [8], [9].

5.2 CONCLUSIONS

Best practice guidelines are a very useful means to stimulate better building details concerning thermal bridges and airtightness. There are various good approaches available in different EU Member States which are presented in this chapter, but there are also many Member States that have limited or no good practice guidance for building details.

A guideline for developing a good practice guidance concerning structure and content was developed and can be used in countries without yet available good practice guidance.

Good practice guidance can be developed as official documents in connection with the building regulation (as for example in UK and Ireland) but also by building practitioners or the building industry. In some countries good practice guidance or tailored thermal bridge atlases have been developed for specific building industry companies, e.g. for pre-fabricated houses. This should be transferred to other companies and other countries.

6. PROMOTION OF GOOD BUILDING PRACTICE

6.1 CHALLENGE AND APPROACH

On the basis of the answers given to the questionnaire circulated in the starting phase of the project, ASIEPI collected promotion means for good building practice used in the countries. The experts from 17 Member States and Norway came up with

10 different possibilities for promotion. Positive examples for the different possibilities are presented in the final ASIEPI report of thermal bridges [10]. It also became clear that in a few countries good building practice seems not to be promoted at all.

6.2 CONCLUSIONS

In the 17 EU Member States and Norway good building practice or more detailed solutions to reduce thermal bridges in buildings are promoted by the following means:

- Special courses for practitioners
- Parts of courses on good application of current building regulation
- Parts of courses on high performance buildings
- Parts of student curricula
- Public relation activities of industry companies and associations
- Workshops/Internet information sessions organised by projects
- Handbooks with example details (see also chapter 5)
- Publications in journals
- Road shows/exhibitions
- Presentations/papers at conferences

Though there are various promotion means for bringing thermal bridges in building envelopes to the awareness of standardisation bodies, policy makers, building practitioners, etc., they are not widely used in the EU Member States, according to the questionnaire in ASIEPI. It is most important that the building practitioners and the future architects and civil engineers, namely the students, will receive good lectures on the impact of thermal bridges and learn how to successfully reduce or even avoid them.

7. EXCECUTION QUALITY

7.1 CHALLENGE AND APPROACH

Execution quality can have a significant effect on the energy consumption of buildings. The occurrence of thermal bridges due to faulty execution can dramatically increase heat losses and, in the worst case, even result in moisture problems seriously affecting the indoor climate. At present, there is little or no information available on this topic. Therefore a study [11] was initiated to quantify the effect of thermal bridges due to faulty execution. The study encompasses two different analyses:

1. A survey conducted among the participating Member States concerning previous, individual national studies on the influence of execution quality and
2. A questionnaire containing questions pertaining to methods for assessing and stimulating execution quality, i.e. an attempt to quantify which factors actually are affecting the execution quality.

7.2 CONCLUSIONS

In the Member States represented in ASIEPI only a few studies have been carried out concerning the relationship between execution quality and thermal bridge effects. These studies indicate that there is a need for increased focus on execution quality.

The Member States use more or less similar methods for assessing and stimulating improved execution quality. Infrared thermography is used to some extent, but is not yet a legal requirement anywhere. Inspections during and after the building process are used quite extensively in all Member States, especially for large buildings. Most countries have legal requirements regulating inspections; however, these do not focus on energy consumption or thermal bridges. There are only very few alternatives to inspections and infrared thermography and they include gas concentration measurements on windows and pre-building process inspections of drawings by specialists. Finally, most Member States use sanctions rather than incentives to ensure good execution quality.

8. ADVANCED THERMAL BRIDGE DRIVEN TECHNICAL DEVELOPMENTS

8.1 CHALLENGE AND APPROACH

In order to inform about actual technical developments to reduce the thermal bridge impact in buildings, the Intelligent Energy Europe project ASIEPI has worked closely together with the building industry via the associated industry partners. Good examples for industry developments have been gathered and have been found and presented by ASIEPI [12]. Though the collected examples do not provide a full market survey they give an idea of the variety of the different currently available developments:

- Thermal breaks for external building components
- Thermals break elements for basement junctions
- Products for mounting insulations material to the wall with reduced thermal bridge impact
- Thermal bridge solutions for window/wall junctions
- Warm-edge spacers for double-glazed and triple-glazed windows

8.2 CONCLUSIONS

Though there are many examples for high quality building junctions published in different good practice guidances that are based on good (architectural/engineering) design, it has to be concluded that not that many products exist that were especially developed to reduce thermal bridges in buildings. A possibility to stay informed, but also to inform others on new technical developments regarding the avoidance of thermal bridges is the new community "Thermal Bridges Forum" on the EU portal for energy efficiency in buildings BUILD UP (http://www.buildup.eu/communities/thermalbridges).

9. RECOMMENDATIONS

9.1 POLICY MAKERS AND STANDARDISATION BODIES

The assessment of thermal bridges needs to be included in the energy performance calculations for news buildings, but also for existing buildings in case of major renovation. Detailed assessment by calculations with computer software, evaluation based on thermal bridge atlases or use of default values are possible methods than can be integrated in the energy performance calculations.

By setting minimum requirements for the energy quality of building component junctions and other types of thermal bridges, the buildings will reach a higher quality concerning the energy consumption, but even more importantly also guarantee that no moisture or mould problems will occur.

The possibility of using lower thermal bridge impact values, based on detailed calculations in comparison to standard default values will encourage the practitioners to further develop the component joint details. A clear regulatory framework should be created that gives a fair assessment of improved product solutions, compared to poor solutions with a strong thermal bridge effect.

A quality assurance procedure for both the design and the realisation phase will motivate the building practitioners and the building owners to pay attention to the correct realisation of building component junctions. Having inspections before, during and after the building process would be the best solution; however, for economic reasons this will not be viable for all new buildings. The extent of the inspections should be adjusted for each building project, yet energy specialists should always be involved. By increasing the number of mandatory blower door tests, building contractors will be forced to focus on execution quality. The airtightness test should be combined with infrared thermography for detecting thermal bridges. Introducing the possibility of withdrawing the license of a designer/contractor for repeatedly providing poor execution quality could significantly centre their focus on this issue. However, the question arises whether this could function in practice. Instead, the public availability of information concerning a contractor's level of execution quality – both good and bad – could have a more positive effect on execution quality. Funding programmes are powerful incentives for increasing focus on execution quality, and previous experience has clearly shown that economic incentives are working well. The reduction of green taxes and/or interest rates for low energy/ passive houses will further reduce the operational cost of the houses. This in turn will increase the demand for this type of houses and thereby decrease their price, meaning that construction companies can cover the extra expenses associated with low energy buildings.

We recommended to explicitly require that thermal bridges software used in the context of the energy performance of buildings regulation at least satisfies the validation cases specified in the most recent version of EN ISO 10211. At present, this is 2007 edition.

It seems highly desirable to publish in the short term a corrigendum for the errors in cases 3 and 4 of annex A (and elsewhere in the text) of EN ISO 10211:2007. (Note: CEN/ISO has decided to correct the errors). In order to avoid repetition of such type of errors in future standards/revisions, structural improvements and systematic quality checks in the process of establishing standards might be advisable. This may require additional funding. In a future revision of the EN ISO 10211, a more comprehensive set of validation test cases seems warranted, e.g. also encompassing more complex boundary conditions, non-rectangular geometries and air layers.

Window U-values should take into account the installation of windows. This would motivate manufacturers to have stronger guidelines for installation and thereby more training for installers.

The number of offered good building practices guidance should be increased especially in countries where few or no such documents exist.

9.2 BUILDING PRACTITIONERS, ARCHITECTS AND BUILDING OWNERS

Better junctions do not only reduce thermal bridge losses but can also improve the airtightness of the building.

If a national regulation foresees the possibility of using lower thermal bridge impact values, based on detailed calculations in comparison to standard default values these low material cost design effort can compensate for more expensive technologies, especially in high performance buildings.

Check whether the software used by you was validated with the most recent version of EN ISO 10211.

Good building practice documents can be very helpful as a basis for good quality building junctions in design and realisation. It is important to stay informed on up-to-date solutions for avoiding thermal bridges on construction sites.

9.3 SOFTWARE DEVELOPERS

In order to improve the reliability of thermal bridge assessment software they should be validated systematically and continuously according to the latest versions of European and International standards and other benchmarking methods, and any proof of validation (including calculation files) should be published on the Internet. The further improvement of the capabilities and user friendliness of thermal bridge software should be continued.

9.4 BUILDING INDUSTRY

A few industry companies have developed specific best practice guidance concerning the reduction of thermal bridge impact for their products. This includes for example prefabricated building companies that have worked together with researchers and designers to optimise their component junctions. This example should be followed by other building industry companies where applicable.

The developments regarding thermal bridge driven details should be increased. Improved solutions should be developed for fixing external loads like balconies, for mounting insulation and/or cladding and for solving re-occuring problematic component junctions. A simple application of the products should also be in the focus of the developments.

9.5 UNIVERSITIES AND OTHER EDUCATIONAL INSTITUTIONS

High quality information on thermal bridges needs to be included in the lectures for architectural and civil engineering students. Educational institutions, but maybe also the building industry should offer courses for building practitioners about the impact of thermal bridges including practical examples on how to reduce/avoid them.

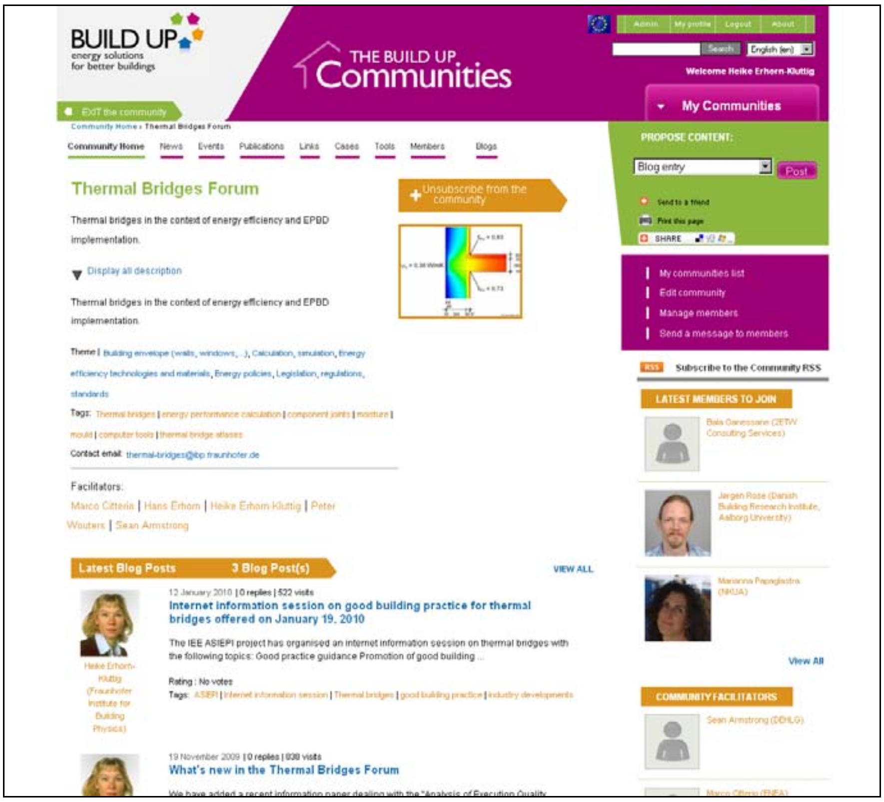

Fig. 2: Screenshot of the BUILD UP community ‘Thermal Bridges Forum’ that contains together with other relevant information all publications of ASIEPI on the topic thermal bridges.

10. REFERENCES

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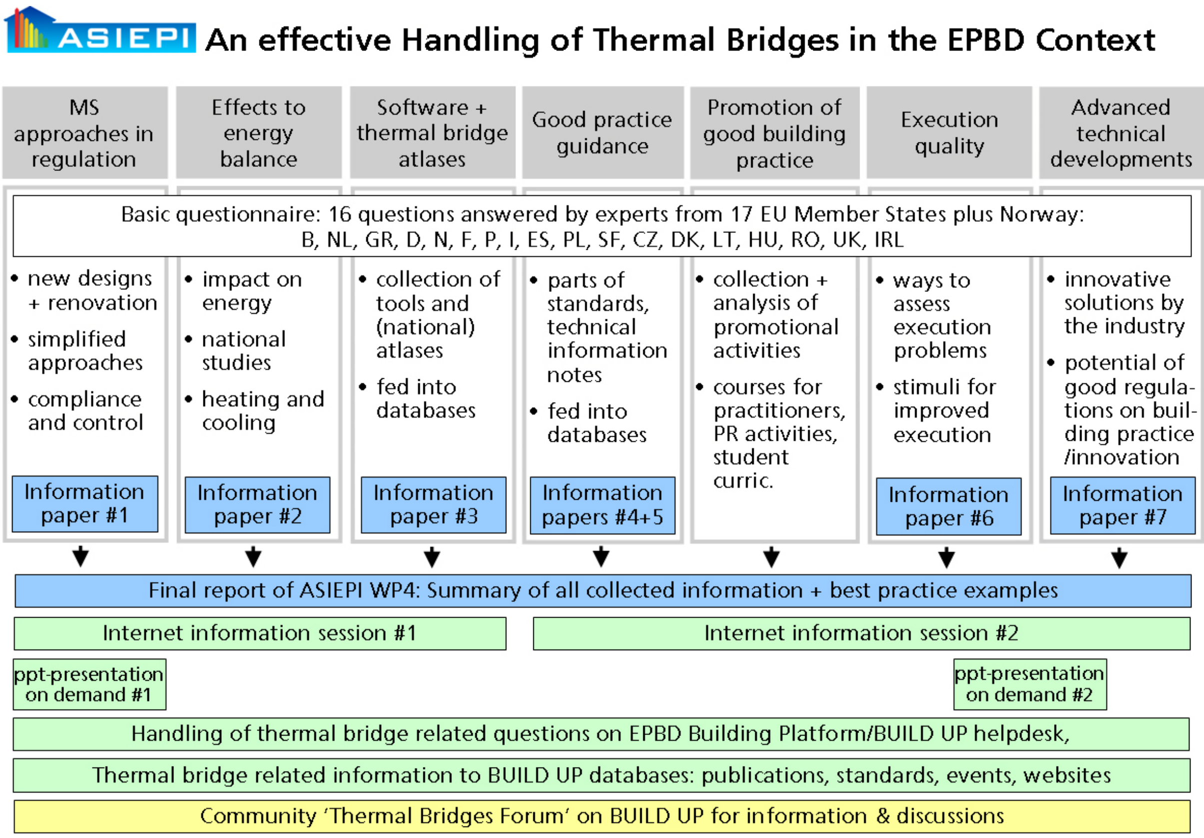
Part 4.B: Bird's eye view of the project results

11. INTRODUCTION

Within the ASIEPI work on thermal bridges the following aspects have been addressed:

- EU Member States approaches in regulations
- Quantification of thermal bridge effects on the energy balance
- Software tools and thermal bridge atlases
- Good practice guidance
- Promotion of good building practice
- Execution quality
- Advanced thermal bridge driven technical developments

The corresponding knowledge, experience and available information material of up to 17 Member States plus Norway has been gathered and made available in various publications and other dissemination means as presented in the scheme below and listed in the following:



12. PUBLISHED RESULTS

12.1 FINAL REPORT

The summary of all collected information and best practice examples on all aspects is presented in the final report of the ASIEPI work on thermal bridges *'An effective handling of thermal bridges in the EPBD context - Final report of the IEE ASIEPI work package 4'*. The report was published in April 2010 and is available via the project website and the BUILD UP portal. It contains detailed recommendations to policy makers, standardisation bodies, building practitioners, building owners, software producers, universities and other educational bodies and the building industry about what they can do to reduce thermal bridges in buildings. The report is the basis of the summary report at hand.

12.2 INFORMATION PAPERS

The work on thermal bridges has resulted in 7 information papers, which are all available on the BUILD UP portal:

- P064 '*Thermal bridges in the EPBD context: overview of MS approaches in regulations*', published in May 2008, summarises the Member States approaches on how to deal with thermal bridges during the energy performance assessment of buildings, but also during the design and realisation phase.

- P148 '*Impact of thermal bridges on the energy performance of buildings*', published in June 2009, presents available national studies regarding the influence of thermal bridges on the energy demand of buildings for both heating and cooling. The possible range of impact is analysed for both, conventional and high performance buildings.

- P197 '*Software and atlases for evaluating thermal bridges*' was published in August 2009. It contains collections of thermal bridges atlases and thermal bridges assessment software used in the EU Member States. It also discusses the relevant EN ISO standard for the validation of thermal bridge assessment software and shows which software tools are presented together with actual validation documents on their websites.

- P188 '*Good practice guidance on thermal bridges and construction details – Part 1: Principles*', published in March 2010 presents a guideline for creating high quality good practice guidance on thermal bridges by proposing relevant content, how the guidance should be made available, what kind of illustrations they should contain, etc.

- P189 '*Good practice guidance on thermal bridges and construction details - Part 2: Good examples*', published in March 2010, highlights several examples of good practice guidance for thermal bridges from United Kingdom, Ireland, Norway, Germany, Belgium, Austria, The Netherlands and Romania. An interactive list of all nationally available thermal bridge guidance is accompanying P188 and P189.

- P159 '*Analysis of execution quality related to thermal bridges*', published in October 2009, presents results of three view available national studies on executions quality of building component junctions with regards to thermal bridges. Additionally possible methods analyse the execution quality, but also to motivate or punish building practitioners for good and bad realisation on construction sites are listed.

- P190 '*Advanced thermal bridge driven technical developments*' was published in April 2010. The paper highlights exemplary thermal bridge related industry development for the following items: thermal breaks for external building components, thermals break elements for basement junctions, products for mounting insulations material to the wall with reduced thermal bridge impact, thermal bridge solutions for window/wall junctions and warm-edge spacers for double-glazed and triple-glazed windows.

12.3 CONFERENCE PAPERS

At the AIVC Conference 2009 in Berlin, the paper '*Thermal bridges in the EPBD context*', presented three different issues in connection with thermal bridges:

- National requirements and calculation procedures (detailed and simplified) in the Member States (MS) participating in ASIEPI. In order to facilitate a correct comparison amongst MS regulations, the overview is split per geographical and climatic area: Northern, Central and Southern Europe.

- Impact of thermal bridges on the energy performance of buildings. Studies that analyse the influence of detailed calculations of thermal bridges in comparison of neglecting the influence, but also in comparison with default values for thermal bridges, have been gathered for both summer and winter conditions.

- Thermal bridge atlases and software to calculate thermal bridge effects. An overview and a categorisation of available atlases and software products have been made.

12.4 WEB EVENTS

Two web events were held in connection with the ASIEPI work on thermal bridges (http://www.asiepi.eu/wp-4-thermal-bridges/web-events.html):

1. On March 4, 2009 a 1.5 hour web event '*An effective handling of thermal bridges in the EPBD context*' presented the results of the first three working aspects (Member States approaches, impact on the energy performance and software tool and thermal bridge atlases) together with an industry presentation by one the project sponsors. 56 people attended the event and based on the resulting poll it achieved an overall satisfaction of 4.2 (from 1 – 5 with 5 as highest grade). The programme was as follows:

Introduction
Welcome *by Hans Erhorn, Fraunhofer-IBP, WP4 leader*
Brief presentation of the ASIEPI project *by Hans Erhorn*
Introduction into thermal bridges as covered in ASIEPI by Hans Erhorn
Technical discussions
Overview on Member States approaches *by Marco Citterio, ENEA*
Impact of thermal bridges on the energy performance of buildings *by Heike Erhorn-Kluttig, Fraunhofer-IBP*
Software tools and thermal bridge atlases *by Antoine Tilmans, BBRI*
The industry point of view, expressed by an ASIEPI sponsor
Thermal breaks – challenges for hygro-thermal constructions to meet every requirement *by Piet Vitse, PCE*
Discussions
Questions
Conclusion and closure *by Hans Erhorn, Fraunhofer-IBP*

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2. On January 19, 2010 the second web event '*Good building practice to avoid thermal bridges*' concentrated on the remaining four tasks, namely the good practice guidance documents, the promotion means for good practice guidance, the execution quality control and the technical industry development connected to thermal bridges. It was attended by 76 persons and the total satisfaction was 4.3 (of maximum 5). Also here presenters from the industry have been invited. The programme is shown below:

Introduction
Welcome and introduction to ASIEPI *by Hans Erhorn, Fraunhofer-IBP, WP4 leader*
The ASIEPI work on thermal bridges *by Hans Erhorn*
Technical discussions
Good practice guidance: what should a guidance document contain and national examples for good guidance documents *by Peter Schild, SINTEF*
How is good building practice promoted in EU Member States *by Heike Erhorn-Kluttig, Fraunhofer-IBP*
Execution quality realised in some EU Member States and possibilities of how to check and improve it *by Kirsten Engelund Thomsen, SBi*
The industry point of view
Exemplary industry developments in the field of thermal bridge effect reduction: Isokorb and Novomur *by Ute Schroth, Schöck*
Exemplary industry developments in the field of thermal bridge effect reduction: Flex Systemwall *by Lars Baungaard Andersen, Rockwool*
Discussions
Questions
Conclusion and closure *by Hans Erhorn, Fraunhofer-IBP*

The presentations and the recordings are available on the project website www.asiepi.eu. (http://www.asiepi.eu/wp-4-thermal-bridges/web-events.html).

12.5 PRESENTATIONS ON DEMAND

The following presentations-on-demand are available:

- ASIEPI presentation-on-demand 3 '*Thermal bridges in the EBPD context: overview on MS approaches in regulations*', published in March 2009. It gives an overview on how the different Member States handle the thermal bridges issues in the context of their EPBD regulation. http://www.asiepi.eu/wp-4-thermal-bridges/presentation-on-demand.html

- ASIEPI presentation-on-demand 6 "*Main lessons learned and recommendations from the IEE SAVE ASIEPI project*", published in April 2010 in several different languages. It presents the results of the work on 6 different technical issues analysed in ASIEPI:
    - intercomparison of national energy performance requirements
    - impact compliance and control
    - thermal bridges
    - airtightness
    - innovative systems
    - summer comfort and cooling

12.6 WORKSHOPS

Within the EPBD Concerted Action platform the project ASIEPI presented and discussed its first results at a technical session of the Core Theme 'Procedures'. The session was called '*An effective handling of thermal bridges in the EPBD context*' and collected in workshop-style further information from the participating experts of the different EU Member States.

12.7 HANDLING OF THERMAL BRIDGE RELATED QUESTIONS ON TWO INTERNET PLATFORMS

The project foresaw to try to answer any thermal bridge related question on the Building Platform helpdesk and the BUILD UP portal. No specific questions to thermal bridges were received.

12.8 SUBMITTED THERMAL BRIDGE RELATED INFORMATION ON EXISTING DATABASES

ASIEPI submitted various information material such as the reports, the information papers, the conference papers, the software tools and thermal bridge atlases, relevant national standards, the list of best practice guidances, the available studies on the energy impact and the analysis of the execution quality, etc. on the BUILD UP portal and on the AIVC website.

12.9 THE INFORMATION PLATFORM ON THERMAL BRIDGES

The project started in May 2009 a community on BUILD UP dealing especially with thermal bridges related information: '*Thermal Bridges Forum*'. Members can discuss problems and questions, specific publications, news, events, tools and blogs can be found. All ASIEPI information related to thermal bridges is available in the community. http://www.buildup.eu/communities/thermalbridges

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PART 5

ASsessment and **I**mprovement of the **EP**BD **I**mpact
(for new buildings and building renovation)

The final recommendations
of the ASIEPI project:

How to make EPB-regulations more effective?

5. Stimulation of good building and ductwork airtightness through EPBD

Main authors:

G. Guyot, CETE de Lyon

R. Carrié, CETE de Lyon

P.Schild, SINTEF

SUMMARY

Building and ductwork leakage are detrimental to energy conservation, comfort, hygiene. They can cause building damage and it can prevent proper control of the ventilation airflow rates. Today, more than ever, with the objective of all new constructions being "nearly zero energy buildings" in 2020, **policy makers** need to know how better airtightness can be stimulated. Within ASIEPI, we have come to the following recommendations, which are developed in part A of this summary report.

To the question "How to promote a market transformation of envelope airtightness ?" the following 3 main recommendations can be formulated:

- to include airtightness with fair reward in the EP calculation methods of the member states, combined with compulsory measurements and/or quality management approaches for claiming such reward in the EP-calculation, in labels and in subsidies;
- to promote cooperation with building professionals through development of practical tools and through pilot and research projects;
- to roll out a global dissemination strategy specifically tailored to each of the target groups as owners, builders, designers, craftsmen, and measurement technicians.

To the question "How to support a market transformation of ductwork airtightness ?" Based on the Scandinavian success stories the following 3 main recommendations can be formulated:

- *Market pull*: Improve the competence of building professionals (especially HVAC professionals) on the benefits of good ductwork airtightness, to convince them that airtight round duct systems with prefitted seals have many additional benefits (lower costs, space efficiency, etc.) over both rectangular duct systems and round ducts without pre-fitted seals;
- *Technology push*: Support industrial development of efficient products because a technology push was clearly observed in Scandinavia where 90-95% of ductwork installed are spiral-seam steel circular ducts with factory-fitted sealing gaskets;
- *Regulatory push*: Include requirements on airtightness (and possibly also pressure testing) in national regulations, with penalties for non compliance, and to develop well-explained technical guidelines and/or building standards.

Major contributions of ASIEPI on the "building and ductwork airtightness" issue are described in part B of this summary report. They include :

- A review of regulations requirements, partly based on a questionnaire submitted to experts with the 13 countries represented in the consortium, and summarised in one conference paper;
- A focus on 5 countries where a market transformation is underway, with 2- to 4-page reports that analyse the market transformation mechanisms;
- A focus on technical issues, with a series of information and conference papers on very-low energy buildings, calculation and measurement methods;
- Awareness raising, namely through several national and international workshops, internet sessions, and presentations in conferences.

STIMULATION OF GOOD BUILDING AND DUCTWORK AIRTIGHTNESS THROUGH EPBD - TABLE OF CONTENTS

Part 5.A: Final recommendations

1. INTRODUCTION

Today, more than ever, with the objective of all new constructions being “nearly zero energy buildings” in 2020, **policy makers** need to know how better airtightness can be stimulated.

Building and ductwork leakage are detrimental to energy conservation, comfort, hygiene and can cause building damage. Good envelope and ductwork airtightness allows one to better control ventilation airflow rates. Therefore, it makes it possible to minimize energy use while maintaining a good indoor environment.

To provide a rough idea, studies report that envelope leakage can increase the heating needs by 5 to 20 kWh/m²/year in a moderate climate (2500 to 3000 degree-days) given today’s levels of airtightness.

Regarding ductwork, the SAVE-DUCT project has shown on a sample of 42 systems in Belgium and France that on average 20% of the air flowing through these systems was leaking out of the ducts.

One objective of ASIEPI was also to give a clear picture to policy makers regarding the way better envelope and ductwork airtightness had been or could be stimulated in the member states, including indications - where available - on the impact of the measures taken to transform the market.

2. WHY PROMOTE DUCTWORK AND ENVELOPE AIRTIGHTNESS ?

2.1 IMPACTS ON ENERGY LOSSES AND INTEREST IN VERY LOW ENERGY BUILDINGS

Impact of envelope and ductwork airtightness on energy losses is recognized as being significant (42): in Belgium and in Germany, it is estimated that envelope airtightness accounts for about 10% of the current energy performance level, a similarly gain as the installation of solar collectors; in France, the impact of envelope airtightness is estimated at 2 to 5 kWh/m²/year per unit of n50 for the heating needs, the impact of ductwork airtightness is estimated at 0 to 5 kWh/m²/year for the heating needs; in Scandinavia the impact might be around 10 kWh/m2/year per unit of n50.

In the case of low energy buildings (36)(37) (38), comparisons between envelope airtightness and insulation thickness have been made and as a result, infiltration losses is identified as a significant factor (Figure 6). In such buildings, airtightness measurement results show what can be achieved in practice.

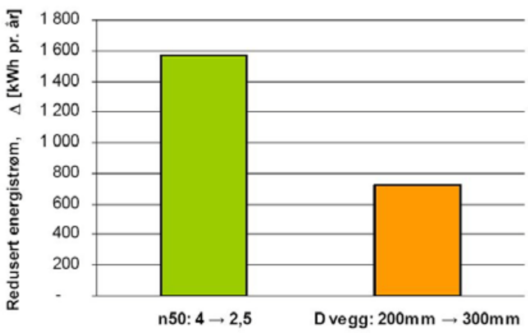

Figure 6 . Relative energy saving from building more airtight (green) compared with the energy saving from building according to the new standard for wall insulation in Norway, for a normal single family dwelling. Source : (41)

2.2 OTHERS IMPACTS ON VENTILATION, INDOOR AIR QUALITY AND BUILDINGS PATHOLOGY

It is also known (40)(41)(44) that poor envelope and ductwork airtightness may have consequences on ventilation systems efficacy, leading to increased energy use, poor indoor air quality, and buildings pathologies.

Some systems like ventilation with heat recovery systems are especially sensitive to bad quality of envelope and ductwork airtightness.

2.3 OVERVIEW IN EUROPE

Through the ASIEPI project, we have identified that while some key elements for a market transformation on envelope airtightness are under development in many countries, status quo seems to prevail for the duct market.

3. HOW TO PROMOTE A MARKET TRANSFORMATION OF ENVELOPE AIRTIGHTNESS ?

Through this work, we have identified 3 practical recommendations to promote better envelope airtightness through a combination of measures that push and pull the market:

Figure 7 . Three components for a market transformation of envelope airtightness, according to Rennings approach (2005)

3.1 FAIR REWARD IN THE EP REGULATION AND MEASUREMENT AND/OR QUALITY MANAGEMENT APPROACH AS A PRECONDITION FOR CLAIMING REWARDS, LABELS OR SUBISIDIES

Airtightness has been included and can be rewarded in the EP calculation method of the majority of the states investigated (Figure 8) as it represents both a key element to achieve low-energy buildings (even in some Southern climates) and a cost-effective measure to reduce energy use. Combined with compulsory airtightness measurements at commissioning for claiming a reward in the EP-calculation, this has been identified as a major push for an airtightness market transformation. Recent experience (France, Finland) with the implementation of quality management approaches as proof of compliance including measurement of random samples is also promising.

This also applies to labels or subsidies.

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In Germany, success stories regarding the airtightness market can be mostly explained by over two decades of regulatory push including: taking into account airtightness in EP regulation, developing standards, developing low energy-labels with a requirement on the envelope airtightness and subsidies (41).

Focusing on the label issue, the German experience with the PassivHaus label, and more recently, the French experience with the regulation-based BBC-Effinergie label are interesting examples that illustrate this recommendation. The number of companies offering measurement services in France grew from about 10 in 2007 to over 100 in 2009. The BBC-Effinergie label became operational in 2008.

A side-effect of the pre-requisites for claiming benefits is that some craftsmen in Germany, Norway or France for instance have bought their own device to control airtightness during construction. In Germany, practical experience in achieving extremely airtight envelopes has been demonstrated. Estimates on the number of passive houses around the world range from 15,000 to 20,000 (41).

Concerning the subsidies, one example comes from Norway where the governmental House Bank gives economic incentives to low energy buildings, with a condition for payments: energy relevant characteristics must be documented. Airtightness measurement is also regarded as a way of documenting this property (41).

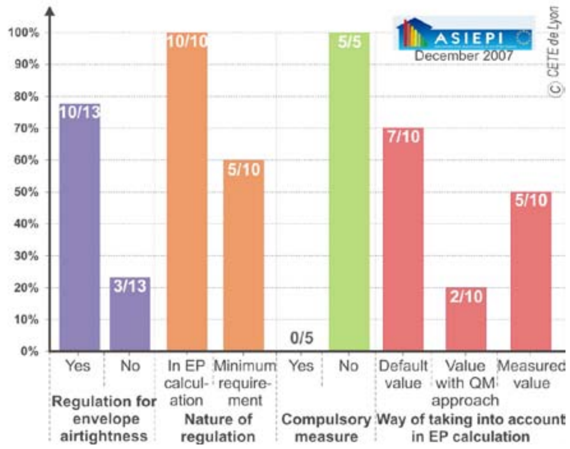

Figure 8. Envelope airtightness : results of a questionnaire of 13 Europeans experts involved in the ASIEPI project

3.2 PROMOTE COOPERATION WITH BUILDING PROFESSIONALS AND INDUSTRY, THROUGH PILOT AND RESEARCH PROJECTS & PRACTICAL TOOLS

In the member states we observed a multiplication of low energy buildings pilot projects arousing the attention of actors on envelope airtightness issues (32). Often supported by regional and national bodies, they significantly drove the market. Among those, there are passive houses pilot projects in Germany, Belgium, France, Czech republic, Poland, etc… Nine experts (of the 13 questioned) consider that those pilot and research projects are significant drivers for a market transformation. Those projects, showing very concrete and practical experience, are of interest to a large scope of building professionals, including designers, builders, craftsmen, and industries.

Some pilot projects were coupled with measurement campaigns (Norway, Germany, France) and such campaigns are also performed to characterise the quality of the building stock (Belgium, Finland). In Belgium, such a large study carried out in 1995-1997, including an envelope airtightness measurement on 50 dwellings, is considered as a very important step to what became the EPB regulation (41).

There is also a common concern regarding the help building professionals need for an effective market transformation and the lack of practical local tools (e.g., catalogues of construction details) with relevant recommendations to build airtight starting at the design stage. To remedy this problem, the German association for airtightness FliB published recommendations in 2001. There is a strong interest for such guidelines in other countries such as Belgium, France, or Norway for instance. The draft recommendations developed in the framework of the PREBAT-MININFIL project in France (Figure 9) experience a great success among professionals.

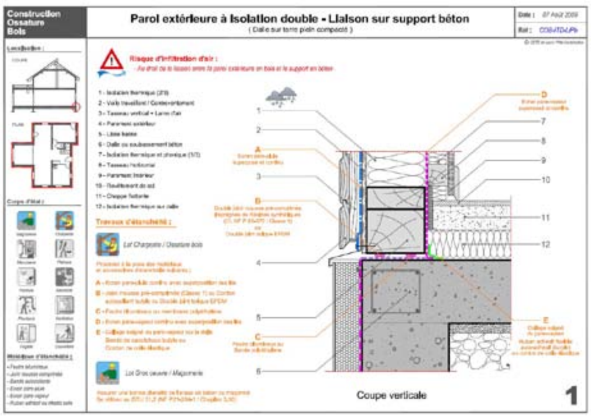

Figure 9. Buildings details, airtight materials and coordination of craftsmen. Source: CETE de Lyon, PREBAT Project MININFIL

3.3 PROMOTE A GLOBAL DISSEMINATION STRATEGY

The dissemination strategy can include trainings, communication and events regarding pilot and research projects, practical tools, very-low energy labels, or the EP regulations. The dissemination material and actions should be specifically tailored towards each of the target groups such as owners, builders, designers, craftsmen and measurement technicians.

In Germany (41), through dissemination and training (and thanks to the availability of measuring companies and sealing products), nearly everybody who is working in the building sector has heard about air tightness measurement, has seen a measuring procedure, has also a basic knowledge about the fault-prone building details like the joints of construction elements.

In this member state, the Blower Door Symposium is organized since 1993 and there are well-organised trainings and certification processes for planners, craftsmen and measurers. It also shows that it is important to develop a dissemination strategy firstly to initiate, and secondly to go with the market transformation.

3.4 SOME PITFALLS UNDERLINED

Thanks to our focus on 5 countries - Norway, Finland, Germany, Belgium and France (41) – some pitfalls were underlined as barriers to a good development of the envelope airtightness market.

The main pitfall to avoid is to underestimate the challenge.

Standardising good envelope and ductwork airtightness for every construction is a tremendous challenge that calls into question traditions in the design and erection of buildings. It requires the need to revisit trainings of architects, engineers and craftsmen, quality assurance processes, regulations (calculation methods and requirements), and to develop specific regulation or certification frameworks for example, for rewarding quality management approaches, or for performing reliable measurements.

Most countries are just starting to realize the challenge they have to overcome.

The second pitfall lies in the barriers to a social and economic acceptance of airtight envelopes

In Norway (41), it was observed that some builders would like to avoid measurement due to the costly repairs needed when a measurement shows that airtightness does not meet the initial requirements.

Erroneous or misleading statements such as “who would live in a plastic bag ?” by influential persons have great potential for slowing down, stalling, or even reversing a market transformation. This problem has been clearly identified in Finland and Norway.

While airtightness is favourable to the overall building quality, bad designs or workmanship (for example, absence of natural or mechanical ventilation system, inadequate strategy concerning combustion devices, absence of capillary breaks, or water leaks) can worsen damage.

Clear information must be given at every stage (decisions makers, owners, builders, designers, craftsmen, measurement technicians) to avoid mistrust or misunderstandings of these kinds.

A third pitfall concerns the technical difficulties associated with the measurement protocol

There exist two very similar standards covering envelope airtightness measurement with fan pressurisation (EN 13829 and ISO 9972). However, there remain many unanswered questions regarding the way a test should be performed (31). For example, the intentional openings to be sealed during the test depending on the calculation method, or in case of large or multi-family buildings. This could distort competition between measurement technicians, designers and builders. Within ASIEPI, we have written a draft position paper (30) for the revision of standard ISO 9972 based on existing technical documents from Belgium, France, and Germany which was presented at the 2009 AIVC/BUILDAIR conference.

Promoting a global dissemination strategy would also help to avoid those both pitfalls.

4. HOW TO PROMOTE A MARKET TRANSFORMATION OF DUCTWORK AIRTIGHTNESS ?

Regarding ductwork airtightness, we got most of following information from a previous SAVE project called SAVE-DUCT (27) and from the ASIEPI information paper "Duct System Air Leakage - How Scandinavia tackled the problem (44)". Except in Scandinavia, many European countries have very leaky ventilation systems. Figure 11 shows that while Swedish systems typically comply with class B on the sample analysed, they are 5 to 10 times leakier in Belgium and in France.

Airtightness class	Limiting leakage (ℓ/s)/m²
A - worst	< 1.32
B	< 0.44
C	< 0.15
D - best	< 0.05

Figure 10. Duct airtightness classes, measured at a test pressure of 400 Pa. Area is calculated according to EN 14239. Source : (44)

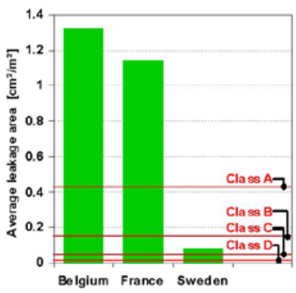

Figure 11. Comparison of average measured duct system leakage in Belgium, France & Sweden (1999). Source : (27)

A focus on the Scandinavian success stories allowed us to propose 3 recommendations to support a market transformation of ductwork airtightness.

Figure 12. Three components for a market transformation of ductwork airtightness, according to Rennings approach (2005)

4.1 DEVELOP DISSEMINATION ON BENEFITS CONNECTED TO GOOD DUCTWORK AIRTIGHTNESS TO THE BUILDING AND INDUSTRY PROFESSIONAL COMMUNITIES

Increased awareness of the building and the industry professional communities about duct leakage impacts is an important step for a market transformation.

The building community should be more informed about the impacts of poor ductwork airtightness on energy efficiency, but also about other impacts, namely on comfort, indoor air quality, ventilation efficiency, fire protection. In Scandinavia good ductwork airtightness has largely been promoted together with indoor air quality benefits. Note that the Swedish VVS AMA guideline not only deals with energy issues related to duct airtightness but also with safety and indoor environment.

Another crucial point is to inform industries and after that to convince them that airtight round duct systems have many additional benefits (low costs, space efficiency) over both rectangular duct systems and round ducts without pre-fitted seals.

4.2 SUPPORT INDUSTRIAL DEVELOPMENT OF EFFICIENT PRODUCTS

A technology push was clearly observed in Scandinavia where 90-95% of ductwork installed are spiral-seam steel circular ducts with factory-fitted sealing gaskets, which have a better quality of tightness (Figure 13).

In Norway, while the minimum requirement is normally class B, 90% of installed ductworks is class C or better, because it is what ductwork suppliers deliver. What are the reasons behind this? It is quite simple : such ductwork are known to have many other benefits over rectangular ductwork, including space efficiency and cost !

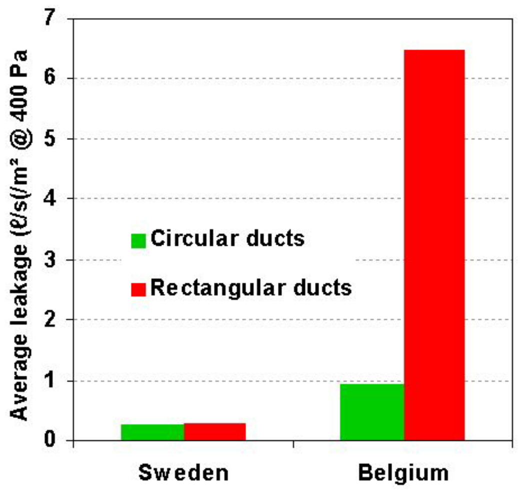

Figure 13. Rectangular versus circular ductwork in Sweden and Belgium. Source : (27)

4.3 INCLUDE REQUIREMENTS IN NATIONAL REGULATION, WITH PENALTIES FOR NON COMPLIANCE.

In Finland (41), the ductwork air tightness requirement has been in the EP regulatory framework since the 1980's. Swedish and Finnish regulations require minimum class C ductwork. These requirements are also connected to regular inspections (except single family dwellings in Finland). Guidelines and Standards are also necessary to be considered as references with technical information and precisions. Such technical guidelines and/or standards exist in every Scandinavian country. There is the VVS AMA in Sweden; the national standard NS 3420 in Norway; the Danish code DS 447.

As a result, requirements and references to guidelines are commonly included in building contracts, it is practically always the case in Sweden, and great attention is paid to commission all ventilation and air conditioning systems.

Penalties on the building energy label, for instance in case of higher leakage, are also one way to encourage building professionals to pay attention to duct leakage.

4.4 BARRIERS IN MIDDLE AND SOUTHERN EUROPE

The five short country reports (41) give also some information about barriers in France and Germany. In France and in Germany, despite some pilot projects and the fact that ductwork airtightness is now explicitly taken into account in the EP-regulation, little has changed with regard to the interest paid by professionals on this issue. Reasons identified behind this status quo might be : the poor reward given to ductwork airtightness; the lack of pilot projects and dissemination on this issue over the past 5 years, as opposed to envelope airtightness; the little use of round steel components pre-fitted with seals which may be encouraged by the lack of attention given to ductwork and ventilation system design. It is estimated that half of the ventilation ducts assembled in Germany are not being installed according to the current standards.

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Part 5.B: Bird's eye view of the project results

6. INTRODUCTION

Major contributions of ASIEPI on the "building and ductwork airtightness" issue are turned on four directions :

4. A review of regulations requirements, practices and barriers in Europe, partly based on a questionnaire submitted to experts with the 13 countries represented in the consortium, and summarized in one conference paper (**Paper n°3**);
5. A focus on 5 countries - Norway, Belgium, Germany, Finland, France - where a market transformation is underway, with short reports that analyse the market transformation mechanisms, through success stories and also some pitfalls to avoid;
6. A focus on technical issues, with a series of information and conference papers on very-low energy buildings, calculation and measurement methods;
7. Awareness raising, namely through several national and international workshops, internet sessions, and presentations in conferences.

This collected and produced information was made available in the following publications.

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7. PUBLISHED RESULTS

7.1 TECHNICAL REPORTS

Six working reports have been published (> link):

- The **report 1** *"Stimulation of good building and ductwork airtightness through EPBD*", published in March 2009, with an updated version published in April 2010, presents the work done within ASIEPI project on the "airtightness issue", the acknowledgments dressed through the different deliverables and productions, from October 2008 until April 2010, with conclusions in the form of recommendations for policy makers.
- The **report 2** "*Report on the building airtightness measurement method in European countries*", was published in March 2009, with an updated version published in February 2010. The European standard EN 13829:2000 describes different variants of measurement of building airtightness (for example method A, B, etc.). In the framework of the ASIEPI project, a survey has been made of the existance of additional specifications to this standard for the envelope airtightness measurement in EU countries. The results are reported in this paper, which reflects the state at the time of the enquiry, i.e. fall 2009, and which present also the additional specifications to the standard developed in Belgium in the context of the EPB-regulation.
- The **report 3** "*Brainstorming document on the envisaged ISO 9972 revision*", was published in September 2009. In its meeting of 4 May 2009 in Zürich,

the working group ISO/TC163/SC1/WG10 has decided to launch the revision process of the ISO 9972:2006. It was also decided that the revision work should be conducted in the harmony with related standards, i.e. the EN 13829, which is currently based on the ISO 9972:1996 with modifications. In the framework of the IEE-ASIEPI project a brainstorming has been initiated on possible improvements to these standards. The present state of discussion is described in this paper.

- The **report 4** "A*n overview of the market transformation on envelope and ductwork airtightness in 5 european countries*", published in March 2010, gives an overview of the mechanisms that have led to a market transformation on envelope and ductwork airtightness in five countries - France, Germany, Finland, Belgium, Norway - and emphasize the key elements that could inspire other member states. It consists in a collection of papers written by participants to the ASIEPI project at the end of 2008. It gives an interesting insight into success stories and difficulties to overcome.

- The **report 5** "*Synthèse du questionnaire ASIEPI : État des pratiques européennes concernant l'étanchéité à l'air de l'enveloppe et des réseaux" (in French), Synthesis of ASIEPI's questionnaire : Practices about envelope and ductwork airtightness in Europe*, published in March 2010, summarizes the results of a questionnaire submitted to 13 experts in the 13 countries (BE, CZ, DE, DK, ES, FI, FR, GR, IT, NL, NO, PL, PT) represented within the ASIEPI consortium in November 2007. The survey included 22 questions dealing with the way envelope and ductwork airtightness is taken into account in the regulation; the market uptake of better envelope and ductwork airtightness and reasons behind; and the major barriers towards better airtightness.

- The **report 6** "*Methods in the national EPB-calculation procedures to determine the ventilation heat transfer coefficient"*, published in April 2010, gives the following information: an english translation of excerpts of the national EPB-regulations to determine the ventilation heat transfer coefficient, sometimes also some background information.

7.2 INFORMATION PAPERS

Six Information Papers have been published (> link):

- **P072** "*Implementation of energy performance regulations: opportunities and challenges related to building airtightness*", published in May 2008, discusses some critical aspects that have to be dealt with to stimulate the market towards better envelope airtightness in the Member States. This includes how airtightness may be taken into account in an energy performance regulation as well as the role of standards, low-energy labels, professional networks, financial incentives, industry, training, and regulatory control in helping the market uptake.

- **P147** "*International comparison of envelope airtightness requirements & success stories that could inspire the EC and other MS*", published in September 2008, discusses international comparison of envelope airtightness requirements and brings out success stories that could inspire the EC.

- **P157** "*Airtightness requirements for high performance building envelopes*", published in March 2009, presents an overview on the existing building surface airtightness requirements in different European countries and compares them to the requirements for high performance buildings. Airtightness measurement results of realised high performance buildings show what can be achieved in practice. Indeed, especially for high performance buildings, which go beyond national energy performance requirements, infiltration losses become a significant factor for the energy performance.

- **P165** "*Airtightness testing of large and multi-family buildings in an Energy Performance regulation context*", published in December 2009, discusses subsequent practical issues for large and multi-family buildings, especially regarding the test procedures that must be harmonized to allow a homogenous evaluation of the air tightness value that will be used as input in the energy performance calculation. The paper illustrates that the measurement of airtightness is possible in practice for large buildings.

- **P187** "*Duct System Air Leakage - How Scandinavia tackled the problem*", published in March 2010, describes the Scandinavian situation, giving recommendations on how it can be adopted in other countries. Apart from Scandinavia, many countries in Europe have generally very leaky ventilation systems. Most people are unaware of this 'out-of-sight' problem. Inferior rectangular ductwork is widely used and poorly installed, yielding leakage rates up to 30 times higher than is observed in Scandinavia. Duct leakage is detrimental to indoor air quality (IAQ), comfort, and energy efficiency. It is often accompanied by other problems, such as inferior commissioning and cleaning. Airtight circular (round) ductwork is known to have many other benefits over rectangular ductwork, including cost. But why do designers, installers, and building owners forego airtight duct systems? It is due to: (i) lack of awareness of the benefits, (ii) lack of performance requirements and penalties for noncompliance, and (iii) no one is found accountable, as there is no commissioning. Conversely, in Scandinavia, high-quality airtight systems are the norm. 90~95% of ductwork in Scandinavia is now circular steel ductwork with factory-fitted airtight gasket joints (Class C or better). Sweden has spearheaded this development. This impressive result has come about after the problem of leakage was first identified in the 1950s, leading to the first contractual requirements on ductwork airtightness in the 1960s (e.g. Swedish VVS AMA). Since then, the requirements have been tightened concurrently with advances in duct technology. There is strict control in Sweden, Finland and Denmark, so most installations comply with these stringent requirements after commissioning.

- **AIVC VIP29** "*An overview of national trends in envelope and ductwork airtightness*", published in August 2008, summarises presentations and discussions that took place during the workshop entitled "Trends in national building ventilation markets and drivers for change" held in Ghent, Belgium, in march 2008 with a specific focus on envelope and ductwork airtightness. Before this workshop, experts were asked to provide information regarding the trends in ventilation in their country and the difficulties they felt to improve the situation in terms of market penetration of innovative systems, indoor air quality and energy use requirements, and compliance check schemes. This has resulted in a body of literature published as Information Papers which can be downloaded from the EPBD buildings platform. Based mostly on these papers and on the workshop discussions, this paper starts summarising energy savings estimates and energy regulation measures ; it continues with a number of issues that have been stressed by the experts such as indoor air quality impacts, airflows through insulation layers, airtightness databases and metrics, and finally, ways to explore to achieve good airtightness.

7.3 WEB EVENTS

Two web events were held (> link):

- During the **ASIEPI web event 1** "*Ways to stimulate a market transformation of envelope airtightness - Analysis of on-going developments and success stories in 4 European countries*", held in December 2008, the objective was to give an overview of increasing interest for this issue in some other European countries, with interesting developments to further stimulate the market in Belgium, France, and Norway and a feed-back on the German experience, where there has been a continuous effort on this issue during the past two decades.
- This web event was attended by 49 people from 13 countries. Following the 32 answers given to the survey, the overall satisfaction (asked on a free format) can be estimated around 4.5/5.0, with a lot of very positive comments. 31 (out of 32) people wanted to be informed about next meetings.

Introduction
Brief presentation of the ASIEPI project *by Rémi Carrié, CETE de Lyon, WP5 leader*
Introduction in the building airtightness issue bridges as covered in ASIEPI *by Rémi Carrié, CETE de Lyon*
Analysis of on-going developments and success stories in 4 European countries
Airtightness revival in Norway *by Aurlien Tormod, SINTEF*
Recent steps towards the generalization of airtight buildings in France *by Rémi Carrié, CETE de Lyon*
Recent market trends in Belgium *by Nicolas Heijmans, BBRI*
Over two decades of experience with airtight buildings in Germnay *by Bernd Rosenthal, E-U-[Z]*
Discussions
Questions
Conclusion and closure *by Rémi Carrié, CETE de Lyon, WP5 leader*

Program of ASIEPI web event n°1

- During the **ASIEPI web event 7** "*How to improve ductwork airtightness - Ongoing developments and success stories in Europe*", held in December 2009, the objective was to give: an overview of energy impacts and calculation procedures; an overview of duct leakage measurement methods; a feed-back on the Scandinavian experience and how it can be applied in others countries.

  This web event was attended by 55 people from 20 countries. The overall satisfaction was 4.3/5.0.

Introduction
Introduction to the event by Dr. Peter Schild, SINTEF Buildings & Infrastructure, Norway
Presentations
Duct leakage problems & consequences in EU by Samuel Caillou, BBRI, Belgium
Including leakage in energy calculations by Dr. Jean-Robert Millet, CSTB, France
Leakage testing methods/requirements by Dr. Peter Schild, SINTEF Buildings & Infrastructure, Norway
Practical solutions for airtight ductwork by Lars Åke Mattsson, Lindab, Sweden
The Scandinavian success story by Jorma Railio, FAMBSI, Finland
Discussions
Questions
Conclusion and closure by Dr. Peter Schild, SINTEF Buildings & Infrastructure, Norway

Program of ASIEPI web event n°7

7.4 PRESENTATIONS-ON-DEMAND

The following presentation-on-demand are available:

- **ASIEPI presentation-on-demand 2** "*Envelope airtightness: How to stimulate a market transformation?*", published in April 2009, gives an overview of ongoing developments in Europe (> link).
- **ASIEPI presentation-on-demand 6** "*Main lessons learned and recommendations from the IEE SAVE ASIEPI project*", published in 2010 in several different languages, focuses on guidelines for Member States.

7.5 ABSTRACTS AND CONFERENCE PAPERS

Seven conference abstracts have been accepted and 1 abstract has been submitted at the end of the project for the AIVC conference 2010 (> link):

- **Paper n°1** "*International comparison of envelope airtightness measurements*", was presented at the 3rd European BlowerDoor Symposium. Held in Kassel, Germany, in May 2008. This paper aims to collect recent measurement results of whole building airtightness from different European Member States, to present a comparable analysis among them and to identify specific trends. For this purpose, a total of 1,094 n50 values from field airtightness measurements from 7 European countries were brought together.
- **Paper n°2** "*Testing the airtightness of large or mutliple-storey-buildings in an EU-regulation context*", was presented at 3rd European BlowerDoor Symposium. Held in Kassel, Germany, in May 2008. This paper presents operational difficulties associated with the measure of large buildings (installing the fans, tasks in preparing for the test), describes sample methods used in Germany and U.K for the measure of multi-family dwellings, concludes on the necessity of a standardisation of the measurement method in Europe.
- **Paper n°3** "*Stimulating better envelope and ductwork airtightness with the Energy Performance of Buildings Directive*", was presented at 2008 AIVC Conference, held in Kyoto, Japan, in October 2008. The paper is based on the analysis of the **questionnaire** submitted within ASIEPI project to experts in 13 countries as well as interviews and a literature review. The paper also describes the mechanisms that have been used in some countries, with a special focus on success stories which could inspire other member states. The measures include actions directly related to the EP regulation as well as accompanying private or public initiatives (e.g., pilot projects, training). Full results of the questionnaire are also detailed in **Report 5** (only in French).
- **Paper n°4** "*Airtightness requirements for high performance buildings*", was presented at 2008 AIVC Conference, held in Kyoto, Japan, in October 2008. The paper presents an overview on the existing airtightness requirements in different European countries and especially for high performance buildings as well as insights in how strong the impact of improved airtightness can be regarding the net, final and primary energy demand of a building. See also the "*Brainstorming document on the envisaged ISO 9972 revision*" (**Report 3**) .
- **Paper n°5** "*Measurement of building airtightness in the EPB Context : specific procedure and sources of uncertainties*", was presented at the

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BPS symposium, held in Leuven, Belgium, in October 2008. Because it is necessary to enssure that the same procedure is used by everyone and that the uncertainties on the result are limited, the aims of this paper is: to present additional specifications to the measurement European standard NBN EN 13829 developed in Belgium in the scope of the EPB regulation; to compare them to the usual practices in other European countries; to describe the main sources of uncertainties for airtightness, including the random errors (variability of experimental conditions), the systematic errors (instrument calibrations and corrections used in calculations), and other uncertainties related to the calculation and interpretation of the final result (divergence between overpressure and underpressure, error from volume or area calculation, etc). See also "*Report on the building airtightness measurement method in European countries*" (**report 2**).

- **Paper n°6** "*Treatment of envelope airtightness in the EPB-regulations: some results of surveys of the IEE-ASIEPI project*", was presented at Buildair conference, held in Berlin, Germany, in October 2009. Based on an instrument developed within ASIEPI to compare the EP requirement levels among the Member States, this paper illustrates that the different way envelope airtightness is dealt with in the EPB-regulations and in the EPB-calculation of the Member States can reveal sometimes diverging underlying philosophies. Notably the concept and numeric figures of a default value are different, as well as the treatment of very good airtightness: in some methods the stimulus to do better than a certain threshold value becomes very small or is nil. In other countries, the incentive remains proportional all the way to the limit value of perfect air tightness.

- **Abstract n°7** "*Envelope and ductwork airtightness in the revision of the French energy regulation: calculation principles and potential impacts*", was submitted at 2010 AIVC Conference, in Seoul, South Korea. This paper analyses the energy impact of envelope and ductwork leakage estimated with the regulatory calculation method for different building and ventilation system types, in the context of the revision of the energy performance regulation scheduled to be gradually in force between 2011 and 2013 depending on building types. The objective is to generalise low-energy buildings whose market share is increasing rapidly with the current regulatory label named BBC-Effinergie. Given that envelope and ductwork airtightness are the key in these types of buildings, significant efforts are made to better take into account these issues in the calculation methods as well as to define schemes to encourage better airtightness. These include the tuning of the default values and minimum requirements as well as quality management approaches or craftsmen and measurement technicians certification.

- **Paper n°8** "*Airtightness requirements for high-performance buildings*", was presented at the AIVC conference, held in Berlin, Germany, in October 2009. Based on the work in the project ASIEPI, it presents an overview on the existing airtightness requirements in different European countries and the US. These requirements are opposed to airtightness requirements for high performance buildings in Germany (passive house), France (effinergie label) and the US (energysmart home, RESNET). Measurements of the envelope airtightness right after construction and some years later show the practicability of the requirements.

7.6 WORKSHOP

The "envelope and ductwork airtightness" issue was discussed during the international AIVC workshop "***Trends in national building ventilation markets and drivers for change***", which was held in Ghent, Belgium, in March 2008 (> link). The objectives of this workshop were:

- to inform interested parties (industry, regulators,…) of the latest changes in national building ventilation markets, with attention not only for IAQ and energy issues, but also on airtightness and assessment of innovative systems issues,
- to identify the drivers for changes,
- to discuss the status in a round table with industry representatives.

The discussions on envelope and ductwork airtightness were summarised in **AIVC VIP29**.

Opening of workshop
Opening of the workshop and welcome
Presentation of IEE SAVE ASIEPI
Presentation of IEE SAVE BUILDING ADVENT
Presentations of national situations and discussions
Denmark, *P. Heiselberg (Aalborg University)* Finland, *J. Kurnitski (Helsinki Un. of Technology)* Norway, *M. Eriksson (Norwegian Ventilation Contractors)*
USA, *M. Sherman (LBNL)* Brazil, *P. Lamberts (Un. Of Santa Caterina)* Portugal, *E. Maldonado (FEUP)*
Korea, *Y. Lee (KICT)* Japan , *T. Sawachi (NILIM)* UK, *M. Kolokotroni (Brunel University)*
Netherlands, *W. De Gids (TNO)* France, *F. Durier (CETIAT)* Germany, *H. Erhorn (Fraunhofer-IBP)* Poland, *J. Sowa (Warsaw Univ. of technology)*
Belgium, *N. Heijmans (BBRI)* Czech Republic, *P. Charvat (Brno University of Technology)* Greece, *M. Santamouris (NKUA)*
History of airtightness measurement and development in construction: documented by 10 years of BlowerDoor conferences on building airtightness, *B. Rosenthal (E-U-Z)*
Round table with industry representatives
Synthesis and discussion on national trends
Innovative systems issues, *P. Heiselberg, N. Heijmans* IAQ issues, *M. Sherman, M. Liddament* Airtightness issues, *R. Carrié, B. Rosenthal* Energy issues, *E. Maldonado, P. Wouters*
Conclusions and next steps, *P. Wouters, AIVC*

Program of AIVC workshop held in Ghent, in March 2008

PART 6

ASIEPI

ASsessment and **I**mprovement of the **EP**BD **I**mpact
(for new buildings and building renovation)

**The final recommendations
of the ASIEPI project:**

How to make EPB-regulations more effective?

6. The EPBD as support for market uptake for innovative systems

Main authors:

Nicolas Heijmans, BBRI

Marleen Spiekman, TNO

SUMMARY

In the context of EPB regulations, *innovative systems (or technologies)* are defined as systems (or technologies) that, in most cases, improve the building's energy performance AND whose performance cannot be assessed by the standard EPB calculation procedure in a particular country.

If a Member States does not want its EPB regulation to be a barrier to innovation, it should have a kind of framework to allow the assessment of innovative systems (as defined here above). This is vital for the industries (as demonstrated for instance by the European project RESHYVENT) and this why this issue was addressed by ASIEPI.

The main recommendations, which are described in more detail in part A of this summary report, can be summarised as follows (but the reader is kindly invited to read part A to understand the nuances behind those recommendations):

1. It is important that Member States explicitly foresee the possibility of assessing technologies not covered by the standard calculation procedure, so that their EPB regulation does not become a real barrier for innovation.
2. As this alternative assessment procedure should be the exception rather than the rule, different approaches should be combined (if legally possible) to limit its use.
3. Given the need for quality and the complexity of a coherent assessment of innovative systems, it is important to have a framework that can ensure the quality of the studies.

Part B gives an overview of all project material that is available on this topic.

THE EPBD AS SUPPORT FOR MARKET UPTAKE FOR INNOVATIVE SYSTEMS - TABLE OF CONTENTS

Part 6.A: Final recommendations

1. INTRODUCTION

1.1 SHORT PROBLEM DESCRIPTION

The EPBD is one of the European Union's tools to reduce its energy consumption. New and innovative products, systems and technologies may help to achieve this final goal. **It is therefore of vital importance that EPBD related regulations don't become barriers to innovation**.

The EPBD requires that each Member State defines EPB calculation procedures. Member States are free to develop calculations as they want; the EPBD itself only gives a list of parameters that should be included. In some Member States, calculations are based on a simplified monthly steady state approach; in other Member States, calculations are based on dynamic simulations. But, independently of the complexity of the calculation procedures, they cannot cover all types of building systems or technologies that will be invented in the future – and they probably do not cover all those that are already on the market.

This is a real problem for such technologies, as reported by a manufacturer: *"The fact that our products are not included in the national EPB calculation procedure is a barrier to their market uptake because the architects firstly try to fulfil the EPB requirements. After having paid for this, they don't have money left for products that saves energy, even if these products have good return on investment."*

Consequently, if a Member State does not want its EPB regulations to be a barrier to innovation in the building sector, it should design its EPB regulations in such a way that the assessment of innovative systems (or buildings) is legally and technically possible.

In order to increase or even to create enough awareness on this important issue, it was decided to analyse this in the IEE SAVE ASIEPI project.

1.2 DEFINITIONS

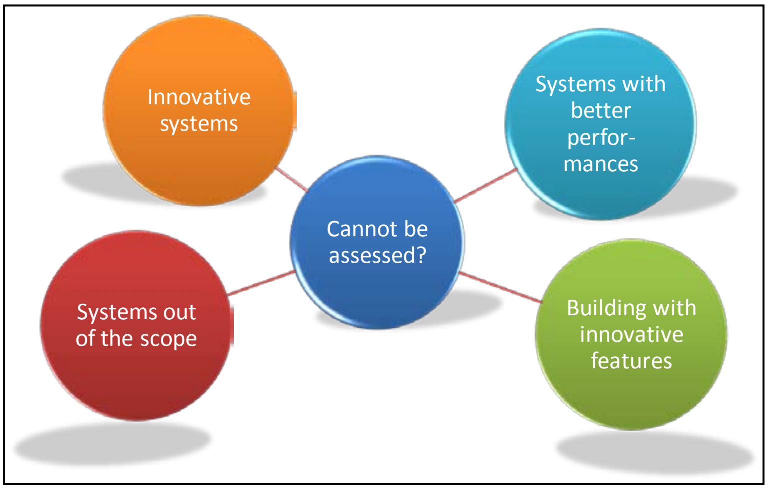
In the context of EPB regulations, *innovative systems (or technologies)* are defined as systems (or technologies) that, in most cases, improve the building's energy performance AND whose performance cannot be assessed by the standard EPB calculation procedure in a particular country.

The alternative assessment framework for the assessment of innovative systems or buildings is often called the *Principle of Equivalence*. This comes from The Netherlands, where the *Gelijkwaardigheid Principe* is well established. However, it must be noticed that the concept of principle of equivalence may vary from country to country; in some Member States, it does not apply to EPB regulations only, but to the whole building code.

However, the definition mentioned above does not cover all situations. Indeed, three other situations may occur.

- There are systems that have better performances than the one mentioned in the standard calculation procedure, but that cannot prove these better performances because the standard calculation procedure does not mention how to prove them. In some countries, the principle of equivalence may be used to prove better performances, whereas in others, it may not be used.

- A third category might be *(innovative) buildings* that use special features, designed specifically for them, and that cannot be assessed by the standard calculation procedure due to their novel/unconventional design.



- The last category concerns systems that perform better than the usual systems, but for a purpose that is not integrated in the calculation procedures. An example would be an intelligent lighting system for residential buildings, as most of the Member States does not consider this type energy use in residential buildings. The "principle of equivalence" is not expected to take such kind of systems into account.

2. KEY POINTS OF ATTENTION THAT COULD INSPIRE MEMBER STATES

On basis of the analyses carried out by ASIEPI, some key points of attention have been identified and will be discussed below.

2.1 REMARKS

- The way the "principle of equivalence" is implemented in a country depends on several national factors. Consequently, not all points of attention are applicable in all Member States.
- The information provided is mostly based on personal experiences of the partners involved in the ASIEPI project and therefore does not necessarily reflect the official position of a country.

2.2 EPB REGULATIONS SHOULD NOT BE A BARRIER TO INNOVATION

Independently of the approach they have implemented, several Member States included in this analysis have reported as the main advantage that *"a principle of equivalence allows any product to get a chance to be taken into account, which is necessary for innovation to have an impact"*.

Therefore, **it is important that Member States explicitly foresee the possibility of assessing technologies not covered by the standard calculation procedure, so that their EPB regulations do not become a real barrier for innovation.**

Several options are available to achieve this goal. However, in any case, the following points of attention should be considered.

2.3 EXTENSION OF THE STANDARD CALCULATION METHOD

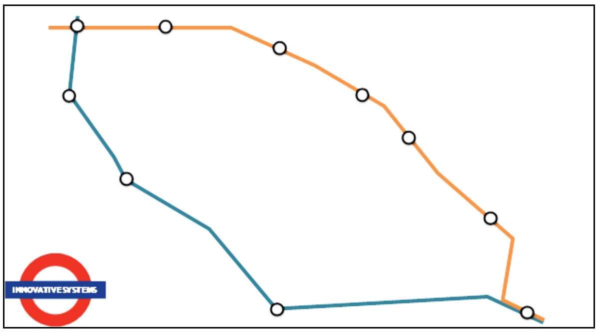
The "principle of equivalence" approach should be considered as an extention of the standard calculation method.

Therefore, **it is important that the "principle of equivalence" approach is implemented in accordance with the EPBD implementation.**

For instance:

- the way the equivalence studies are carried out should be compatible with the way the standard calculation procedures was set up; this might require defining a so-called "technical framework", as discussed below

- if a Member States has implemented a strict control scheme, the "principle of equivalence" must not be an escape route to it, and it must also be kept under control,



- ideally, it should be possible to introduce the results of the equivalence studies directly into the EP calculation tool(s), especially if the EP calculation tool has to be used to electronically report the EP calculations to the authorities. In this case, the EP calculation tool(s) must be designed in such a way that the result of the equivalence studies *can* be introduced.

- ...

2.4 AN EXCEPTION, NOT THE USUAL APPROACH

The use of the "principle of equivalence" approach should be the exception, not the rule.

As the use of the "principle of equivalence" approach has it own disadvantages (see the country situations in annexes), it should be the exception, not the rule.

By definition, the need to use the "principle of equivalence" approach is reduced if the standard calculation procedure includes as many technologies as possible. This is shown by the German calculation procedure, which includes several systems or technologies which are not included in many other Member States (see D6.1). Consequently, the number of equivalence studies is rather limited.

To achieve this, **Member States should improve the EPB standard calculation procedures on a regular basis.**

On the one hand, when the standard calculation procedures specify a fixed or a default value, it should also specify how to prove the better performances than this default value (e.g. "the efficiency has to be measured according to EN 12345").

On the other hand, the existing equivalence studies could be used to identify the technologies that should be integrated in priority into the standard calculation procedures, and could be used as basis for procedure updates. (Technologies that appeared to save energy on paper only could possibly be integrated in such a way that their use is discouraged.)

2.5 NEED FOR QUALITY AND MANAGEMENT OF COMPLEXITY

One of the main disadvantages reported by every Member States where the studies can be performed by anyone (DE, DK, FI, FR, ES, NL) is that *"allowing anyone to make the equivalence study might lead to* *significant differences in the quality of the studies and also to studies of poor quality"*. This disadvantage can be further increased if the evaluation of the equivalence study is the responsibility of the municipalities.

Therefore, **given the need for quality, and the complexity of a coherent assessment of innovative systems, it is important to have a framework that can ensure the quality of the studies**.

One option would be to have a single body authorised to perform the studies, but this would not match the practice and/or the legal framework of many Member States and also has its own disadvantages (see D6.2).

Fortunately, there are other options. Some are related to the way the studies must be carried out, others to the way the studies must be evaluated.

2.6 HOW SHOULD AN EQUIVALENCE STUDY BE CARRIED OUT?

Some Member States (FR, NL) reported that "the assumptions of the equivalence study have to be similar to the assumptions of the standard calculation procedures". In France, where this also applies, it has been reported that, "as no technical example was presented [as annex of the Title V legislation], the first equivalence study was incomplete and unclear". However, once a template was provided, several studies were performed.

Moreover, this is only possible if the assumptions of the standard calculation procedures are published, which is probably not always the case, especially as by definition, innovative systems are systems not included in the standard calculation procedures.

Even if this may be a difficult task, **it might be useful that Member States that do not have a technical framework for the assessment of innovative systems analyse the necessity to define one, at least a minimal one**....

This technical framework could include the following elements: the type of calculations to be done, the characteristics of the buildings to be simulated, the occupancy pattern, the outdoor climatic conditions, the pollutant emissions, the internal gains...

This technical framework should be in line with the standard calculation procedure; if both have not been written by the same people, at least a close collaboration between them is required.

2.7 HOW TO EVALUATE THE STUDIES?

In some Member States (DE, DK, FI, NL, NO), the alternative assessment is evaluated at municipal level. All those Member States have reported that having an assessment at municipal level is one of the main disadvantages of the system. To overcome this disadvantage, **a first option could be to approve the alternative assessment studies at a sufficiently high administrative level.** However, the implementation of this option can be difficult, as it might need a (more or less drastic) change in the general legal framework.

A second option (if the first one is not possible) could be to have an appropriate support infrastructure for local authorities. For instance, it might be possible:

- to set up a consultative central body that would establishes a technical framework to perform the studies and criteria to accept them,
- to set up a consultative central body that would provide advice on the studies, on request of the municipalities,
- to publish the list of accepted studies, as it this the case in France and

Belgium (Flemish Region), where the evaluation is centralised.

A list of criteria for accepting studies would be helpful for both the municipalities and for the experts that make the studies, as obviously they would respect them if they knew that their studies would be evaluated at least on the points mentioned in the list.

It must be noted that the municipalities might be reluctant to publish to studies they have accepted, as they might have accepted poor quality studies. However, a centralised publication of accepted studies would not only help municipalities to take a decision, but it would also increase the transparency of the system and it would help the experts in charge of the EP calculations. This is compulsory in Spain.

2.8 COMMUNITY SUPPORT

In order to have the required community support, it might be useful to have a structured approach for interaction with the market.

For instance, some kind of public consultation might be organised if a technical framework is defined (just as public consultation has been organised for the standard calculation procedure...). This happens in Spain and Belgium.

2.9 MARKET INFORMATION

It is important to **pay attention to inform the market about the possibilities offered by the "principle of equivalence" and to provide information on approved systems.**

As said previously, a centralised publication of accepted studies would increase the transparency of the system.

2.10 DELAY AND COSTS ISSUE

It is important to **pay attention to the costs for carrying out studies of equivalence and the time for assessment of innovative systems.**

Some Member States reported that there could be a long delay (BE, DK, FR, ES), up to 6 months or 1 year. Only one Member State (NO) reported that the delay could be short. The fact that the system is open or closed seems not to be a determining factor for the delay (it is interesting to note that two Member States with a more open approach reported different delays for obtaining approval for a study).

2.11 NEXT EPBD REVISION

The issue of the assessment of innovative systems is not addressed in the EPBD. However, **as the EPBD should act as a driver for innovation and surely not create barriers to innovation, this issue could be integrated in the next EPBD revision.**

Article 3 could require Member States to have a legal framework for the assessment of building technologies that cannot be assessed by the national or regional calculation methodology. It must be noticed that such a legal framework, exists already in several Member States...

As a first suggestion, the following paragraph could be added to Article 3: "*In order to stimulate the market uptake of innovative technologies, Member States shall adopt a legal framework for an alternative assessment of building technologies that are not covered by the (national) calculation methodology set in accordance with the first subparagraph of this paragraph.*"

2.12 CONCLUSIONS

From the various ways innovative systems are handled by the national EPB approaches, some key points of attention have been identified, as shown in the figure.

These could inspire both the Member States that do not have a framework for the assessment of innovative systems and those that have one but would like to improve it.

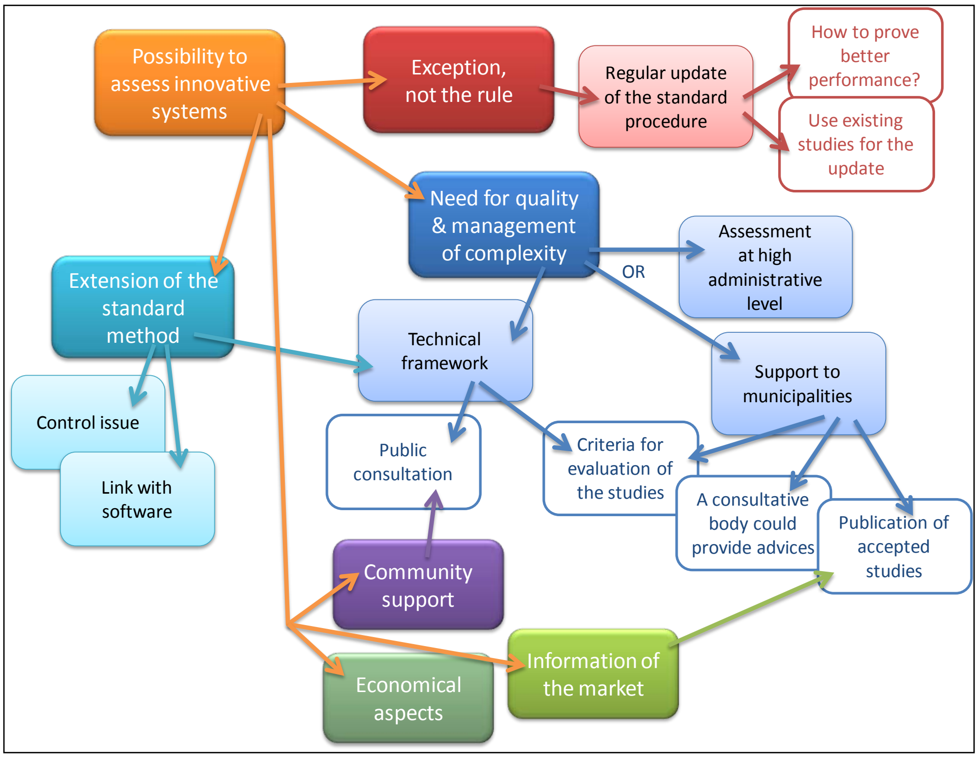
The three main points of attention could be summarised as:

4. It is important that Member States explicitly foresee the possibility of assessing technologies not covered by the standard calculation procedure, so that their EPB regulation does not become a real barrier for innovation.

   If a legal framework is defined, the extent of its application should be clearly defined. Is it applicable to systems not covered by the standard calculation procedure only? Is it also applicable to prove a better performance than the one included in the standard calculation procedure? Is there also an approach for "innovative buildings" (which are only valid for a single building)?

5. As this alternative assessment procedure should be the exception rather than the rule, different approaches should be combined (if legally possible) to limit its use. The standard calculation procedure should be updated on a regular basis (on basis of the equivalence studies) and should include the specifications to prove a better performance than the default value.

6. Given the need for quality and the complexity of a coherent assessment of innovative systems, it is important to have a framework that can ensure the quality of the studies. Several options have been identified to go in that direction: e.g. the assessment of the study should not be performed by the municipalities but by at sufficiently high administrative level, a technical framework could be defined,...



Part 6.B: Bird's eye view of the project results

3. INTRODUCTION

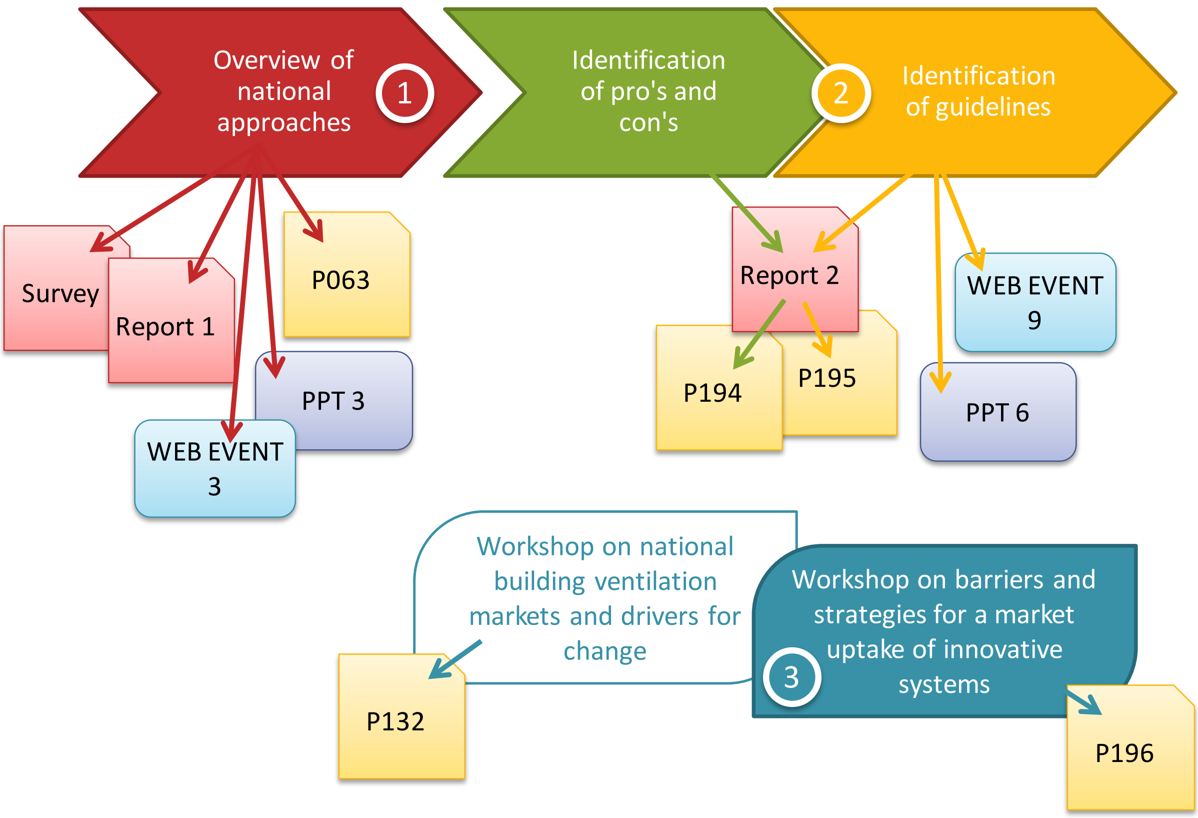
The "innovative systems" issue was articulated in three main steps.

1. The first step was to make an overview of the current situation regarding the assessment of innovative systems across EU. To achieve this goal, a survey was launched amongst the ASIEPI participants, as well amongst some industrial partners.

2. Based on the collected information, pro’s and con’s for the various approaches were identified, and guidelines made available, allowing Member States to accelerate the realisation of a qualitative environment for the assessment of innovative systems in the EPBD context. (These guidelines cover legal and technical issues. However, as SAVE is not a framework for technical projects, ASIEPI did not intend to develop new methodologies to assess the performance of innovative systems.)

3. A workshop related to barriers and strategies for an accelerated market uptake of innovative systems was organised.

This information was made available in the following publications.



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4. PUBLISHED RESULTS

4.1 TECHNICAL REPORTS

Two technical reports were published:

- The report D6.1 (> link) "*Overview of national approaches for the assessment of innovative systems in the framework of the EPBD*", published in March 2009, summarises some key facts of the national approaches for the assessment of innovative systems in the framework of the EPBD or, more precisely, in the framework of the national Energy Performance of Building (EPB) regulations. It is based on the results of a survey (> link) launched amongst ASIEPI participants.

- The report D6.2 (> link) "*Stimulating innovation with EPBD - What countries can learn from each other*", published in 2010, summarises the pro's and con's of the various approaches and the proposed guidelines for Member States.

- **P194** "*Stimulating innovation with EPBD - What countries can learn from each other*", published in 2010, discusses the pro's and con's of the national approaches of several countries.

- **P195** "*Stimulating innovation with EPBD - Key points of attention for Member States*", published in 2010, identifies some key points of attention or guidelines for the Member States on the "innovative systems" issue.

- **P196** "*National trends of innovative products and systems for energy-efficient buildings - Barriers and strategies for an accelerated market uptake*", published in 2010, summarises the discussion of the ASIEPI workshop "*National trends of innovative products and systems for energy-efficient buildings - Barriers and strategies for an accelerated market uptake*" that took place in Amsterdam, Netherlands, in March 2010.

4.2 INFORMATION PAPERS

Five Information Papers were published (> link):

- **P063** "*Assessment of innovative systems in the context of EPBD regulations*", published in March 2008, discusses the overall context of the "innovative systems" issue, as well as the approaches used in Netherlands, France, Belgium and Germany.

- **P132** "*An overview of national trends related to innovative ventilation systems*", published in November 2008, summarises the discussion related to innovative (ventilation) systems that took place at the AIVC workshop organised in Ghent, Belgium, in March 2008.

4.3 WEB EVENTS

Two web events were held (> link):

- During the **ASIEPI web event 3** "*Overview of national approaches for the assessment of innovative systems in the framework of the EPBD*", held in February 2009, the overall context of the "innovative systems" issue was discussed and the approaches used in Netherlands, France, Germany, Denmark and Belgium were presented; moreover, two industrial associations (ES-SO, EuroAce) have shared their point of view.

  This web event was attended by 51 people from 18 countries. The overall satisfaction was 4.0/5.0.

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The program of the web event is given in the next table.

Introduction
Welcome *by Peter Wouters, INIVE, project coordinator*
Presentation of the ASIEPI project *by Peter Wouters,INIVE*
What is the potential problem with EPBD and innovative systems? *by Peter Wouters*
Overview of alternative assessment procedures across EU *by Nicolas Heijmans, BBRI*
Examples of national approaches
Netherlands *by Marleen Spiekman, TNO*
France *by Hicham Lahmidi, CSTB*
Germany *by Heike Erhorn-Kluttig, IBP*
Denmark *by Kirsten Engelund Thomsen, SBi*
Belgium *by Nicolas Heijmans, BBRI*
The industry point of view, expressed by two ASIEPI sponsors
ES-SO *by Dick Dolmans, ES-SO*
EuroAce *by Jean-Luc Savin, AERECO (as member of EuroAce)*
Discussions
Questions
Conclusions and closure *by Peter Wouters, INIVE, project coordinator*

Program of ASIEPI web event n°3

- During the **ASIEPI web event 9** "*Stimulating innovation with EPBD*", held in February 2010, the problems and potential solutions of the national approaches were discussed; moreover, one industry and one consultant shared their practical experiences with the Dutch approach.

  This web event was attended by 39 people from 20 countries. The overall satisfaction was 4.1/5.0.

  The program of the web event is given in the next table.

Introduction
Welcome and introduction to ASIEPI *by Nicolas Heijmans, BBRI*
Importance of dealing with innovative systems in EPBD *by Nicolas Heijmans, BBRI*
National presentations
Advantages and disadvantages of the Danish approach *by Jorgen Rose, SBi*
Advantages and disadvantages of the Dutch approach *by Marleen Spiekman, TNO*
Advantages and disadvantages of the Belgian approach *by Nicolas Heijmans, BBRI*
Advantages and disadvantages of the French approach *by Charles Pele, CSTB*
Synthesis, problems and potential solutions *by Marleen Spiekman, TNO*
Practical experiences
What does industry see what goes right and wrong in their/other countries related to their market. What would they like to see? *by Rick Bruins, Zehnder*
Study on the use and control of the principle of equivalence in practice in the Netherlands: results and possible solutions *by Tom Haartsen, Climatic Design Consult*
Discussions
Questions
General guidelines, conclusion and closure *by Nicolas Heijmans, BBRI*

Program of ASIEPI web event n°9

4.4 PRESENTATIONS-ON-DEMAND

The following presentation-on-demand are available:

- **ASIEPI presentation-on-demand 4** "*The EPBD as support for market uptake of innovative systems*", published in April 2009, discusses the importance of the issue and identifies some first guidelines for Member States (> link).
- **ASIEPI presentation-on-demand 6** "*Main lessons learned and recommendations from the IEE SAVE ASIEPI project*", published in 2010 in several languages, focuses on guidelines for Member States.

4.5 WORKSHOPS

The "innovative system" issue was discussed during two international workshops.

- The AIVC workshop "***Trends in national building ventilation markets and drivers for change***" was held in Ghent, Belgium, in March 2008 (> link). The objectives of this workshop were:
  - to inform interested parties (industry, regulators,…) of the latest changes in national building ventilation markets, with an attention not only for IAQ and energy issues, but also on airtightness and assessment of innovative (ventilation) systems issues,
  - to identify the drivers for changes,
  - to discuss the status in a round table with industry representatives.

  The discussions were summarised in **P132**.

  The program of the workshop is given in the next table.

Opening of workshop
Opening of the workshop and welcome
Presentation of IEE SAVE ASIEPI
Presentation of IEE SAVE BUILDING ADVENT
Presentations of national situations and discussions
Denmark, *P. Heiselberg (Aalborg University)* Finland, *J. Kurnitski (Helsinki Un. of Technology)* Norway, *M. Eriksson (Norwegian Ventilation Contractors*)
USA, *M. Sherman (LBNL)* Brazil, *P. Lamberts (Un. Of Santa Caterina)* Portugal, *E. Maldonado (FEUP)*
Korea, *Y. Lee (KICT)* Japan , *T. Sawachi (NILIM)* UK, *M. Kolokotroni (Brunel University)*
Netherlands, *W. De Gids (TNO)* France, *F. Durier (CETIAT)* Germany, *H. Erhorn (Fraunhofer-IBP)* Poland, *J. Sowa (Warsaw Univ. of technology)*
Belgium, *N. Heijmans (BBRI*) Czech Republic, *P. Charvat (Brno University of Technology)* Greece, *M. Santamouris (NKUA)*
History of airtightness measurement and development in construction: documented by 10 years of BlowerDoor conferences on building airtightness, *B. Rosenthal (E-U-Z)*
Round table with industry representatives
Synthesis and discussion on national trends
Innovative systems issues, *P. Heiselberg, N. Heijmans* IAQ issues, *M. Sherman, M. Liddament* Airtightness issues, *R. Carrié, B. Rosenthal* Energy issues, *E. Maldonado, P. Wouters*
Conclusions and next steps, *P. Wouters, AIVC*

Program of the workshop n°1

- The ASIEPI workshop "***National trends of innovative products and systems*** *for energy-efficient buildings - Barriers and strategies for an accelerated market uptake*" was held in Amsterdam, Netherlands, in March 2010 (> link). The objectives of this workshop were:
  - to identify national trends and barriers for adoption of current and emerging energy-efficient technologies and products for buildings,
  - to outline strategies and drivers for change to incentives to increase adoption rate of these technologies, and accelerate the transition process towards a comfortable, healthy, and energy-efficient built environment,
  - to discuss what are emerging technologies with high potential to realize energy-efficient buildings and good indoor environments,
  - to document success stories and best practices that facilitated

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effective uptake and implementation of energy-efficient and innovative technologies in buildings, while taking high quality and healthy environments into account.

The discussions were summarised in **P196**.

The program of the workshop is given in the next table.

Session 1: Opening of workshop
General welcome *by TNO, Aart de Geus, Netherlands*
Welcome on behalf of AIVC and ASIEPI project, *by Peter Wouters, BBRI, Belgium*
Energy performance regulations and innovative systems: lessons learned from the EU SAVE ASIEPI project *by Nicolas Heijmans, BBRI, Belgium*
Session 2: Market uptake of emerging technologies
Cool roofs: what are the possibilities and opportunities? What about challenges and difficulties for market uptake? - European Cool Roof Council, *by Mat Santamouris, NKUA and European Cool Roof Council, Greece*
Assessment of innovative technologies – role of modern identification techniques, *by Hans Bloem, JRC Ispra and Henrik Madsen, DTU, Denmark*
Medium and long-term trends in innovative ventilations and the role of national energy efficient targets for new buildings in their market uptake, *by Wouter Borsboom, TNO*
Market uptake of innovative facades - experiences and view of a facade manufacturer&contractor, *by Henk De Bleecker, Group R&D Manager of Permasteelisa Group*
Panel Discussion
Session: 3 Long term performance of energy-efficient buildings and systems
Commissioning for Comfort in the Netherlands, *by Henk C. Peitsman, TVVL, Dutch society for building services*
Quality of innovative systems: the role of technical approval schemes and successful examples, *by Peter Wouters, BBRI*
Long term performances of building airtightness: Importance and possibilities, *by Stefanie Rolfsmeier & Jörg Birkelbach*
Dutch experiences on long term performances of ventilation systems, *by Willem de Gids, TNO*
Session: 4 Energy-efficient communities and standards
A new approach to energy efficient communities - examples from IEA Annex 51, *Reinhard Jank*
City of the sun - Heerhugowaard (Netherlands)
Is there need for research on energy-efficient buildings ? *by Bruno Smets, Philips*
Role of standards, *by Jaap Hoogeling, Chairman of CEN/TC 371*
Session 5: Overview of instruments for stimulating market uptake
The role of NL Agency within innovations in the built environment, *by Wim Berns, NL Agency*
Regulations and financial incentives – barriers or drivers for market uptake of innovative systems? *Peter Wouters BBRI*
Panel discussion - Representatives from industry and market
Conclusions and next steps

Program of the workshop n°4

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PART 7

ASIEPI

ASsessment and **I**mprovement of the **EP**BD **I**mpact
(for new buildings and building renovation)

**The final recommendations
of the ASIEPI project:**

How to make EPB-regulations more effective?

7. Stimulation of better summer comfort and efficient cooling by EPBD implementation

Main authors:

Marina Laskari, Mattheos Santamouris

National & Kapodistrian University of Athens

Two of the main goals of the ASIEPI project were:

a) To accelerate the awareness raising in Member States and among stakeholders about the importance of a correct handling of summer comfort and efficient cooling.

b) To provide guidance towards effective solutions.

In order to assist in the work conducted for the ASIEPI project, information from Member States and other non-EU countries was collected and analysed. The analysis of this information helped in drawing conclusions and giving recommendations for better summer comfort and efficient cooling implementation in the energy performance (EP) of buildings national regulations.

The recommendations address the following audience categories:

- Policy makers
- Developers of calculation methods
- Building practitioners
- Associations of architects and building practitioners; and
- Building owners

The main recommendations on summer comfort and efficient cooling in buildings, which are described in more detail in part A, can be summarised into 3 main points:

(1) Protect the building against overheating and against the need to install active cooling in the future.

There are many techniques and methods available that have a great potential in limiting the chances of active cooling system installation and overheating emergence in buildings in the future. As energy efficiency and reduced energy consumption during the cooling season have only recently become a primary concern for many countries, these techniques and methods still do not receive the attention they deserve in national EP regulations. These methods are critical mostly for buildings with no active cooling and they include: fictitious consumption for cooling, overheating analysis, use of floating conditions, comfort indicators (e.g. Balance Point Temperature indicator), use of the Adaptive Approach in non-air conditioned buildings.

(2) Make alternative cooling techniques a top priority in national regulations and practical applications rather than conventional cooling systems.

Alternative cooling techniques have great potential for reducing the cooling load and the cooling energy consumption in buildings. However, their implementation in EP regulations is not very robust at the moment, a fact that constitutes a hurdle to their use. Ways of reversing the current trend towards the use of conventional cooling systems are: establishment of financial incentives for alternative cooling systems; inclusion of more alternative cooling techniques along with their performance calculation methods in national regulations; but also mandatory requirements for using alternative cooling techniques, such as solar and heat protection and modulation and dissipation cooling techniques before using conventional systems.

(3) Improve the current national EP procedures and thus enhance energy savings from cooling.

There are many requirements that if integrated in the national EP procedures can result in decreased energy consumption for cooling and enhanced energy efficiency. Requirements that can be considered are: reduction of the oversizing capacity of the A/C installations during the design phase; minimum COP requirements and consideration of the COP of cooling systems during the peak and part load conditions instead of only under the nominal conditions; restrictions on the use of cooling during the peak periods; application of modular pricing policy for big cooling consumers.

Other recommendations for the refinement of EP-procedures that involve summer comfort and cooling include: attention to proper setting of default values, integration of all aspects that have an impact on the cooling energy consumption in the procedures, avoidance of complex input data, make alternative cooling techniques part of the thermal balance equations but also integrate them in the global calculation method.

Part B gives an overview of all project material that is available on this topic.

STIMULATION OF BETTER SUMMER COMFORT AND EFFICIENT COOLING BY EPBD IMPLEMENTATION - TABLE OF CONTENTS

Part 7.A: Final recommendations

1. INTRODUCTION

The recommendations resulting from the study of summer comfort and efficient cooling in ASIEPI address the following audience categories:

- Policy makers
- Developers of calculation methods
- Building practitioners
- Associations of architects and building practitioners; and
- Building owners

During the span of the ASIEPI project, information was collected from Member States and other, non-EU countries. The analysis of this information helped formulate the conclusions and recommendations for a better implementation of summer comfort and efficient cooling in the energy performance (EP) of buildings national regulations.

2. GENERAL CONCLUSIONS & RECOMMENDATIONS

2.1 GENERAL CONCLUSIONS

Although a good deal of attention is already given to the consumption for cooling in the national/regional EP-regulations, the relevant calculation methods cannot usually fall back on the same decade-long and detailed experience as exists for space heating calculation methods. Generally speaking, the continued further refinement of the calculation methods is therefore warranted so as to better evaluate the energy consumption of all possible means of cooling, and to include in particular the low energy cooling methods.

About half of the countries surveyed already include some kind of evaluation of the risk for overheating in their EPB-regulation. Interestingly, none of them is a Mediterranean country.

The most dominant technique for cooling is currently the mechanical vapour compression refrigeration cycle. This technology is capable of achieving high cooling capacities and of meeting the cooling requirements at almost all times, something that makes this conventional cooling technique a tough competitor for most of the alternative cooling techniques. Not only is this technique dominant in practical applications, it is also considered by all MS in their EP-calculation methods.

Many benefits accrue from the use of alternative cooling techniques, the most significant of which are: considerable energy and cost savings, reduced peak power demand, improved indoor air quality, life cycle cost effectiveness, reduced pollution emissions, use of refrigerants with limited or zero ozone depletion potential (ODP) and global warming potential (GWP).

Overall, MS consider more alternative cooling techniques in their EP-calculations for non-residential buildings than they do in their EP-calculations for residential buildings. In many cases, when a cooling technique is considered for all types of buildings, for the same country, the calculation method is often more detailed in the case of non-residential buildings and a more simplified approach is followed for residential buildings.

There are modelling levels and assumptions inherent to the current calculation methods and recommended in some of the CEN standards concerned that are not sensitive to relevant design decisions in summer performance. It is proven through the ASIEPI project (1) that some common assumptions of the calculation methods can become a barrier to the penetration of passive cooling in buildings.

2.2 RECOMMENDATIONS

2.2.1 POLICY MAKERS

First of all, by not giving an extra allowance for the maximum allowed primary energy consumption in the case that active cooling is applied (as compared to the situation without active cooling), the countries can stimulate the application of an as efficient as possible cooling system and/or the compensation for the extra consumption for cooling by extra savings in other domains (heating, lighting etc).

In the case of no active cooling, a fictitious consumption for cooling can nevertheless be considered, in particular when the risk for overheating is high. This takes into account that cooling may be installed later on during the life cycle of the building. By considering a fictitious cooling consumption in the EP-methods, it is stimulated that in the design stage proper attention to the summer situation in buildings without active cooling is given. The inclusion of fictitious cooling also facilitates the application of the first advice above, namely that the EPB-requirement is made independent of whether or not active cooling is installed.

For countries that already have an overheating analysis for some types of buildings it is worth considering whether it is appropriate to extend it to all building types. Also, it is recommended to include as many forms of central passive cooling as possible, including central systems (e.g. seasonal geothermal storage).

Countries that do not yet have an overheating analysis in effect in their regulations are advised to investigate whether such an analysis would be useful for them too. It may be a way to draw attention to the passive cooling means to avoid overheating, thus reducing the probability that an active cooling system will be installed later on in the building life cycle.

In order to reduce the energy consumption for cooling, to promote the use of passive cooling concepts and strategies and to anticipate global warming, it is strongly recommended to set:

a) A global EP-requirement for energy consumption and/or CO_2 emissions in which cooling must obviously be included.

b) Additional requirements limiting the cooling needs for air-conditioned buildings.

c) Additional requirements for non-air-conditioned buildings and air-conditioned dwellings limiting the overheating risk or, in a complementary way, clear indicators that allow identifying the necessity or not of air conditioning (for both residential and non-residential buildings).

d) The inclusions of such indicators about summer comfort should be based on indoor temperature levels consistent with the adaptive comfort criteria of EN 15251.

e) If practically feasible in the context of the national EPB-regulation, the inclusion of such indicators about summer comfort should be based on hourly calculations of the indoor temperatures at a zone level, due to the huge temperature differences that can exist between zones of the same building.

It is considered that requirements that are too prescriptive reduce the freedom of design and when their benefit is evaluated in conjunction with other variables (global level) their contribution is not as beneficial. Therefore, the use of additional requirements on a component level, or the necessity of using certain strategies (e.g. ventilation rates or thermal inertia) is not recommended in general.

Also, financial incentives, similar to those given for renewable energy (e.g. photovoltaics) could be given for the use of alternative cooling techniques. The greater the benefit in:

- Energy savings
- Emissions reduction
- Life cycle cost effectiveness
- ...

compared to conventional cooling systems or techniques, the greater the funding could be.

It is also recommended that more alternative cooling techniques are considered by the MS in their national EPB-regulations in order to further motivate their use in buildings and to stimulate a market transformation.

It is strongly advised that conventional cooling systems are put in second place in EPB-regulations as opposed to alternative cooling techniques, by requiring a mandatory report that justifies the selection of an active cooling system instead of an alternative cooling technique.

The possibility of decreasing the oversizing capacity of the A/C installations during the design phase could be considered in EPB-regulations as well, to avoid operation of the system in part load and to decrease the energy consumption

Also, a modular pricing policy could be applied for big cooling consumers to promote energy conservation and enhance the potential of the consumers to apply energy saving measures.

It is strongly suggested that solar and heat protection, modulation and dissipation cooling techniques and good building design are made obligatory above the use of mechanical cooling and air-conditioning systems to prevent overheating and reduce peak electricity demand and the overall energy consumption for cooling. For example, the use of shading and natural ventilation could be made mandatory in order for the installation of AC system to be allowed.

It is recommended to MS policy makers to apply the Adaptive Approach in non air conditioned buildings. Through this approach, good building design coupled with slightly higher but acceptable temperatures, as advocated by the adaptive approach, can result in a negligible cooling energy consumption in all European regions. It has been proven through the IEE CommonCense project that use of the adaptive approach may reduce the (fictitious) cooling demand by up to 40 % (51). It is worth mentioning that in some countries (notably NL and BE), the use of the concept of fictitious cooling has been found to constitute an extra stimulus for good design for summer comfort, going beyond the legal minimum requirements.

Also it is worth considering the COP of cooling systems during the peak and part loads conditions and not just under the nominal ones. This is important in order to avoid an oversizing of the systems and long operation of the AC under part load conditions.

Furthermore, the application of restrictions to the use of cooling during the peak periods to avoid unnecessary increase of the installed electricity generating and distribution capacity is also recommended, mostly for warmer countries. This can be achieved through the use of demand side management techniques. If not, peak electricity demand will increase continuously and additional power plants will need to be built. This can also increase the cost of the electrical energy.

For residential buildings, it is recommended that the assesment of the summer comfort conditions is performed using free floating conditions. The use of the cooling load as an indicator for summer comfort problems is best avoided, in order to prevent from giving the implicit message that the installation of a mechanical cooling system is necessary.

Restrictions relevant to the system efficiency, (minimum required EER) are also advised to be set. This is to avoid the use of low EER systems that increase the absolute cooling load, the peak electricity demand and have a much higher operational cost for the user.

2.2.2 Developers of Calculation Methods

The continued further refinement of the cooling calculation methods is warranted so as to better evaluate the consumption of all possible means of cooling, including and in particular the low energy methods.

Also, it is advised that attention is paid to the proper setting of default values. In particular, a differentiated approach between the heating and the cooling season is often justified, certainly for the variables that have a major impact, e.g. air tightness and thermal bridges.

It is important that all aspects that have an impact on the cooling energy consumption are integrated in the calculation methods, in particular those variables that can contribute to the reduction of the consumption and that are cost-effective in a given country. Important techniques that require further development are:

- Active cooling devices
- Natural, passive cooling

If no cooling system exists, the minimum requirements can refer to a comfort indicator, the limit value of which will be to demonstrate that no cooling will be necessary. For example the Balance Point Temperature Indicator (53) could be used. However, it is also worth considering these requirements even for the case of active cooling installation in order to limit the overheating risk during cooling off and to prevent people from installing active cooling intentionally to avoid this requirement.

Calculation methods may often be complex by themselves. However, it is recommended that the number and complexity of input variables to calculation methods remain limited. This will encourage the use of alternative cooling techniques and summer comfort evaluation.

It is recommended that alternative cooling techniques are as much as possible integrated in the standard EP calculation methods. If not, designers will avoid the implementation of such systems, the performance of which is not defined.

Alternative cooling techniques change the thermal balance of the building. Thus, it is also worth including them in the calculation methods for both the overheating evaluation and the cooling consumption.

Furthermore, it is recommended that as more experience is gained in the operation and performance of such techniques, their calculation methods are further developed.

Furthermore, it is important that developers of calculation methods base their calculation methods on the same EN standards and use the same nomenclature so as to ensure consistency between MS national regulations and facilitate the inter-comparison of outcomes.

The remainder of this paragraph (§2.2.2) is mainly applicable to in analyses where extensive input data (i.e. room geometry) are required:

Passive cooling concepts and strategies are based on a zone or even whole building level approach. Therefore the revision of the treatment of some parameters such as the solar distribution factors or the indoor convective heat transfer coefficients is suggested.

Solar heat gains attenuation strategies require, and it is therefore recommended, that the solar distribution factors are considered at least as dependent on the season of the year in order to evaluate properly the effect of the thermal inertia of every enclosure.

Night cooling dissipation strategies require consideration not only of the flow rate of outdoor air entering the building but also of the air flow pattern. The air flow pattern can increase significantly the convective heat transfer coefficients at some of the internal elements of the room as compared to the fixed values proposed in the CEN standards. The efficiency of the ventilation strategy is a direct function of how the structural inertia of the building is distributed on the elements of the enclosure with higher convective heat transfer coefficients. It is therefore recommended that calculation methods consider the expected variation of the indoor convective heat transfer coefficients for typical air flow patterns for representative rooms.

It is suggested that the assessment of summer comfort and the risk of overheating are not based on fixed levels of acceptable indoor temperature. The influence of the outdoor conditions on the acceptable indoor set-points temperature as proposed in EN15251 are recommended for the identification of buildings which do not require air conditioning.

In warm and hot locations, there is a significant potential for energy savings linked to the use of variable set-point ranges depending on outdoor temperatures. The practical implementation of the control strategy to set the variable set-point approach in a building can be easy and cost-effective, something that suggests further research on adaptive comfort for air-conditioned buildings. The calculation tool should therefore, be able to deal with this new approach.

Finally, regarding zoning, it has been concluded that significant differences of indoor temperatures can be expected in different spaces of a building during summer period and that average building level temperature (single-zone approach) is not valid for comfort assessment in summer. Consequently, in order to promote the use of passive cooling concepts and strategies, calculation methods are suggested to consider a multi-zone approach, if this is feasible on national level.

2.2.3 BUILDING PRACTITIONERS

In order to reduce the cooling requirements of a building and therefore ensure viability of alternative cooling techniques, it is important that building practitioners design the building in such a way that heat gains in internal spaces are minimised. This should also contribute to the minimisation of maintenance costs and the life cycle costs of the building.

Building practitioners are also advised to give priority consideration to passive cooling techniques for buildings in locations with reduced noise ingression and air pollution issues, and where in addition urban heat island occurrence is limited.

2.2.4 ASSOCIATIONS OF ARCHITECTS/BUILDING PRACTITIONERS

Associations of architects and building practitioners are advised to develop and distribute best practice guidelines on the use of alternative cooling techniques and summer comfort evaluation methods.

They are also advised to encourage the application of passive approaches referring to building design or elements that reflect the specific national building traditions and climate conditions. This means, however, that they cannot be fixed uniformly across Europe.

2.2.5 BUILDING OWNERS

Finally, it is not sufficient to declare that we want to conserve energy by means of e.g. higher thermostat settings (following the adaptive approach). Companies are advised to accompany this with a change in the acceptable dress code (example of 'Cool Biz' (54) and proper manual control of building services.

3. REFERENCES

(51) S. Alvarez, Alternative cooling calculation methods: Comparative simulations. http://www.asiepi.eu/wp-7-summer-comfort/available-reports.html

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(53) M. Santamouris, D.N. Assimakopoulos (Eds) : Passive Cooling of buildings. James and James Science Publishers, London, 1996

(54) Cool Biz campaign. Ministry of Environment, Government of Japan. http://www.env.go.jp/en/press/2005/1028a.html

Part 7.B: Bird's eye view of the project results

4. INTRODUCTION

People interested in the outcome of the ASIEPI project had many opportunities to become updated with the latest results throughout the length of the working process, through many means:

i. Technical reports

ii. Information papers

iii. Presentations-on-demand

iv. Web Events

v. Workshops

vi. Conferences

These means also served for the exchange of information between relevant IEE projects and between people involved in the work of ASIEPI.

All of the published results are available on the ASIEPI website (www.asiepi.eu)

5. PUBLISHED RESULTS

5.1 TECHNICAL REPORTS

Five technical reports have been produced (> link):

(1) **Report D7.1** *"Summer comfort and cooling determination methods"* is a compilation of 13 country approaches on how summer comfort and/or energy use for cooling are integrated in the overall calculation of the energy performance of a given building. The collection and analysis of these approaches was performed by the BBRI by means of an extensive questionnaire. Partners BBRI, Fraunhofer IBP, AICIA, CSTB, NKUA, ENEA, TNO and NAPE have contributed to this study, and the subcontractors reported on their country's status as well.

As the focus of the ASIEPI project is not on the development of new calculation methods, but on the optimization of the effectiveness of the building regulations, the survey focuses on the input variables and does not make an in-depth analysis of the details and formulas of each calculation method. At the end of the report conclusions are drawn and recommendations given on how the effectiveness of building regulations can be improved. These conclusions and recommendations are summarised in PART A of this report.

A summary of the results on the summer comfort and cooling determination methods along with further discussion and recommendations is also made in Information Paper IP163 "Summer comfort and cooling: calculation methods and requirements" (§5.2.1).

(2) The aim of **report D7.2** *"Additional requirements related to summer comfort and air conditioning"* is to analyze the information collected on the additional requirements related to summer comfort and air conditioning in line with Article 4 ("Setting of energy performance requirements") of the EPBD. It also gives guidance on how the effectiveness of these additional requirements can be enhanced. After

some iteration and clarification 12 consolidated and clarified answers were received and processed by the AICIA.

The questionnaire on which this report is based is included in the Annex of the report.

A summary of the results on the additional requirements related to summer comfort and cooling along with further discussion and the summer comfort and cooling determination methods is also found in Information Paper IP163 "Summer comfort and cooling: calculation methods and requirements" (§5.2.1).

(3) In the context of the ASIEPI project, alternative cooling techniques are considered to be the cooling techniques that improve summer comfort substantially, without (or in a very limited manner) increasing energy consumption and which in general do not rely on the vapour compression refrigeration cycle.

Report D7.3 *"Handling of alternative cooling techniques"* aims to evaluate the extent to which alternative cooling techniques are covered by the procedures used by the MS and the way this is done. At the end conclusions are drawn and recommendations given on how alternative cooling techniques can be better implemented in national procedures and the benefits that may occur from this implementation.

The results are based on the questionnaire prepared for the purposes of the report *"Summer comfort and cooling determination methods"* (§5.1.1), complemented with an additional descriptive inquiry.

(4) The aim of **report D7.4.1** *"Evaluation of the calculation methods for summer comfort and cooling"* is first of all to analyse the existing experience of MS on alternative cooling and summer comfort calculation methods and to indicate the advantages and disadvantages of these methods, as well as the pros and cons from their actual use.

Experiences were gathered from 7 EU countries and from 2 non-EU countries in December of 2008 and their compilation forms the basis of this report.

Finally recommendations regarding the more effective implementation of alternative cooling techniques and summer comfort calculation methods in the national procedures are formulated.

(5) For **report D7.4.2** *"Alternative cooling calculation methods: Comparative simulations"* the AICIA performed comparative building simulations using the present regulatory calculation methodologies as well as the alternative methodologies. The aim of these simulations was to assess the benefits of the alternative methods involving:

- o comfort criteria
- o zoning
- o solar control – Quality/scope of the solar control algorithms
- o heat amortization – Thermal mass (influence of distribution and absorption of solar radiation)
- o heat dissipation by intensive ventilation – Calculation of the air flow rates, role of the thermal mass

Emphasis was given on the assumptions typically included in the calculation methods that may be a barrier to the implementation of passive and low energy cooling.

5.2 INFORMATION PAPERS

Four Information Papers have been produced (> link):

(1) The Information Paper **P163** *"Summer comfort and cooling: calculation methods and requirements"* is a summary of the results of a survey on a dozen European countries with respect to the handling of summer comfort and energy consumption for cooling in the national/regional EPB-regulations.

(2) The Information Paper **P186** *"Innovative Solar Control Devices"* presents examples of innovative solar control devices and emphasizes their relevance to the energy performance of buildings.

(3) The Information Paper **P185** *"French handling of alternative cooling techniques: free cooling and ground heat exchanger"* focuses on providing general information on how EN 15241 and EN 15242 are implemented into the French regulations for the evaluation of passive cooling based on ventilation. An explanation of the calculation method with detailed information on input and output data is given.

(4) The Information Paper **P193** *"Experiences on passive cooling techniques for buildings"* presents relevant experiences on passive cooling techniques, showing their potential in mitigating the cooling energy consumption and in improving thermal comfort conditions in non-cooled buildings.

The experiences presented in this paper were selected according to the most relevant passive solutions for buildings, in particular:

- o Night ventilation
- o Ground cooling
- o Evaporative cooling
- o Cool roofs
- o Green roofs

5.3 PRESENTATIONS-ON-DEMAND

Two presentations-on-demand were produced:

(1) **ASIEPI presentation-on-demand 5** "Stimulation of better summer comfort and reduced energy consumption for cooling by EPBD implementation" explains the drivers and objectives of the study on summer comfort and cooling and its relation to the EPBD.

The presentation also includes an overview of the work carried out and the recommendations and conclusions drawn at the time that the presentation was prepared concerning Member States' calculation methods and requirements on summer comfort and cooling.

(2) **ASIEPI presentation-on-demand 6** "*Main lessons learned and recommendations from the IEE SAVE ASIEPI project*" focuses on guidelines for Member States and it was translated in different European languages.

5.4 Web events

Two web events were organised (> link):

(1) **ASIEPI Web event 5** *"Summer comfort and air conditioning in Europe: Current trends and future perspectives"* took place on June 17th, 2009. The aim of the web event was to provide an overview of the possibilities and barriers for the penetration of innovative and passive cooling techniques into the European market, including:

- discussion on the European thermal comfort standards.
- an analysis of the pro's and con's of the calculation methods emphasising the role of thermal mass, solar gains & shading, intensive night ventilation and the use of natural cooling techniques.
- major trends in the systems used and discussions about the existence of a framework for assessing passive cooling and low energy cooling systems.

The program of the web event was as follows:

Introduction
Welcome *by M. Santamouris, NKUA, WP7 leader*
Brief presentation of the ASIEPI project and Introduction into Summer Comfort and Cooling as covered in ASIEPI *by M. Santamouris*
Technical discussions
Thermal comfort standards for EU *by B. Olesen REHVA*
Common assumptions of the calculation methods that can become a barrier to the penetration of passive cooling in buildings *by S. Alvarez, AICIA-University of Seville*
The role of passive cooling in thermal comfort of buildings *by M. Santamouris, NKUA, WP7 leader*
The industry point of view
Trends and perspectives in innovative cooling techniques *by A. Thiemann, DAIKIN*
(See also the web event related to the assessment of innovative systems (http://www.asiepi.eu/wp-6-innovative-systems/web-events.html))
Discussions
Questions
Conclusion and closure *by M. Santamouris, NKUA, WP7 leader*

Program of the ASIEPI webevent n°5

The web event was attended by 66 people from 16 countries. The overall satisfaction was 4.2/5.0.

(2) **ASIEPI Web event 6** *"Thermal comfort and cooling demand in the air of climatic change"* was held on November 26th, 2009. The aim of the web event was to treat issues of thermal comfort and cooling emergence in the air of climatic change. The presentations provided an overview of the impact of climate change on thermal comfort and cooling demand in buildings. They also gave an overview of the available alternative technologies that may improve summer comfort along with the calculation methodologies that assess their impacts.

The program of the web event was as follows:

Introduction
Welcome *by M. Santamouris, NKUA (University of Athens)*
Brief presentation of the ASIEPI project and Introduction into Summer Comfort and Cooling as covered in ASIEPI *by M. Santamouris*
Technical discussions
Summer comfort and cooling: calculation methods and requirements, *by D.Van Orshoven, BBRI*
The role of climatic change and the impact of cooling in buildings *by M. Santamouris, NKUA*
The industry point of view
Solar shading: reducing the need for artificial cooling with quantifiable results *by D. Dolmans, ES-SO*
Energy certification of A/C - Results of the HARMONAC project *by Ian Knight, Cardiff University*
The energy cost of comfort and compatibility with EPBD *by Michael G. Hutchins, Sonnergy Ltd*

Discussions
Questions
Conclusion and closure *by M. Santamouris, NKUA*

Program of the ASIEPI webevent n°6

The web event was attended by 54 people from 20 countries. The overall satisfaction was 4.2/5.0

5.5 WORKSHOPS

The International Workshop **"Summer Comfort and Cooling"** was held in Barcelona, Spain on March 31st and April 1st, 2009 (> link). The workshop was an initiative of AIVC and was organized by INIVE EEIG, in collaboration with REHVA and with the European SAVE ASIEPI and SAVE BUILDING ADVENT projects.

The main purpose of the workshop was to present and discuss the evolutions in the national regulations related to summer comfort and cooling.

The program of the workshop is given in the next table.

Opening of workshop – session 1 Chairmen: M. Santamouris and J. Cipriano
General welcome INIVE – AIVC – ASIEPI : P. Wouters, INIVE
Welcome from CIMNE as host of the workshop: J. Cipriano, CIMNE
Objectives of the workshop : M. Santamouris, NKUA
Presentation of activities on summer comfort and cooling in the IEE ASIEPI Program : S. Alvarez, University of Seville
Presentation of IEE ADVENT Program : A. Cripps, Buro Happold
Presentation of the current state in Portugal: E. Maldonado, FEUP
Presentation of the current state in Finland: O. Seppänen, REHVA
Session 2 - Chairmen: E. Maldonado and O. Seppänen
Presentation by EURIMA: J. Solé Bonnet, URSA Insulation, EURIMA
Presentation of the current state in Czech Republic: K. Kabele, Czech Technical University of Prague
Presentation of the current state in Israel: S. Hassid, Technical University of Haifa
Presentation of the current state in the Netherlands: W. Borsboom, TNO
Discussion
Session 3 - Chairman: A. Cripps – K. Kabele
Presentation by EUROACE: M. Geremias, URSA Insulation, EUROACE
Presentation of the IEE Cool Roofs Project : M. Santamouris, NKUA
Presentation of the current state in UK: R. Hitchin, BRE
Presentation of the current state in Belgium: D. Van Orshoven, BBRI
Discussion
Session 4 - Chairmen: M. Sherman and W. Borsboom
Active cooling and energy efficiency – the view of a manufacturer : A. Thiemann, Daikin
Presentation of the HARMONAC Project: R. Hitchin, BRE
Presentation of the current state in Greece: M. Santamouris, NKUA
Presentation of the current state in Spain: J. Marti, CIMNE
Presentation of the current state in Italy: L. Pagliano, Politecnico Torino
Discussion
Session 5 - Chairmen: P. Wouters – M. Atif
Presentation by IBPSA: J. Hensen, IBPSA
Presentation by ES-SO: W. Beck, ES-SO
Presentation of THERMCO Project: D. Kalz, Fraunhofer-ISE
Presentation of the current state in France: J.R. Millet, CSTB
Presentation of the current state in Germany: H. Erhorn-Kluttig, Fraunhofer-IBP
Synthesis on summer comfort and cooling : M. Liddament, IJV

Program of the ASIEPI workshop n°2

All presentations from the workshop are available on the AIVC website (> link)

5.6 INFORMATION EXCHANGE WITH OTHER INITIATIVES

(1) The EPBD Buildings Platform (BUILDUP, > link) is the official EU information channel for EPBD related issues. Most material produced from the ASIEPI project has been uploaded on the BUILDUP website and is available for public downloading. In addition, other documents relevant to the ASIEPI content have been uploaded to the website. The keywords ASIEPI and EPBD are used to help locate these documents easier, amongst all the other documents not relevant to the topic of this project.

(2) A webex session for CA participants took place on March 15th, 2010. The recommendations on the implementation of better summer comfort and efficient cooling in national procedures, resulting from ASIEPI were presented, along with the other recommendations of the entire ASIEPI project.

(3) A number of common meetings were organized among IEE projects CENSE, ThermCo, Commonsense and ASIEPI to discuss project results and exchange knowledge on summer comfort.

Information on summer comfort and cooling was also exchanged with the COMMONCENSE project (Michael Hutchins) and the HARMONAC project (Ian Knight) at the ASIEPI web event 6 “Thermal comfort and cooling in the air of climatic change”. Feedback on the ASIEPI results from presentations was given by the BBRI and the NKUA (§5.4.2).

5.7 CONFERENCES

An abstract on the work on summer comfort and cooling in the ASIEPI project has been submitted for presentation at the 3rd Passive & Low Energy Cooling for the Built Environment (PALENC) international conference (> link). The conference is jointly organized with the 5th European Conference on Energy Performance & Indoor Climate in Buildings (EPIC 2010) and the 1st Cool Roofs Conference. It will focus on the application of passive cooling techniques in the urban environment and in buildings with emphasis on heat mitigation techniques.

PART 8

ASsessment and **I**mprovement of the **EP**BD **I**mpact
(for new buildings and building renovation)

The final recommendations
of the ASIEPI project:

How to make EPB-regulations more effective?

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1.1 PROJECT PARTNERS

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2.1 OVERALL PROJECT SPONSORS

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The European Alliance of Companies for Energy Efficiency in Buildings

www.euroace.org

eurima
European Insulation Manufacturers Association

www.eurima.org

ES-SO
EUROPEAN SOLAR SHADING ORGANIZATION
Energy Savings & Comfort

www.es-so.com

FOAMGLAS
Building

www.foamglas.com

2.2 PARTNER ASSOCIATIONS

FIEC
European Construction Industry Federation

www.fiec.eu

acciona

www.acciona.com for ECTP

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