ENPER-EXIST

Applying the EPBD to improve the Energy Performance Requirements to Existing Buildings – ENPER-EXIST

WP1: Final report

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ENPER-EXIST project information

The ENPER-EXIST project was initiated and is coordinated by the Centre Scientifique et Technique du Bâtiment (CSTB) in the frame of the Intelligent Energy Europe (EIE) programme in the part SAVE of the European Commission, DG TREN. It involves partners from 7 countries on the topic of energy performance standardization and regulation. Contract EIE/04/096/S07.38645. Duration: 01/01/2005 - 30/07/2007.

The Energy Performance of Building Directive (EPBD) sets a series of requirements specifically dedicated to existing buildings but the member states are facing difficulties to implement quickly these requirements. The main goal of the ENPER-EXIST project is to support the take off of the Energy performance of building directive (EPBD) in the field of existing buildings.

ENPER-EXIST has 4 main objectives:

1. To de-fragment technical work performed on existing buildings. Indeed actions already launched in CEN to apply the EPBD are de-fragmented but mainly focus on new buildings. On the other hand different projects on certification procedures are going on at the European level but are not coordinated.
2. To de-fragment work on legal, economical and organisational problems such as the analysis of certification on the market, the human capital and the national administrations.
3. To achieve a better knowledge of the European building stock.
4. To define a roadmap for future actions regarding existing buildings.

ENPER-EXIST uses an intensive networking of existing national and international projects to reinforce efforts to solve these issues. It works in close coordination with the Concerted Action set up by Member States to support the application of EPBD. The work program is split in 4 technical work packages in addition to dissemination and management activities.

WP1: Tools application
WP1 analyses how existing buildings are taken into account in technical tools such as CEN standards, national calculation procedures. Recommendations on how to improve the consideration of existing building are be defined.

WP2: Legal economical and organisational impact
WP2 analyses the impact of the certification procedures and regulations of existing buildings on the market, on the human capital and on the national administration. Surveys are carried out in the different member states and recommendations are drawn up.

WP3: Building stock knowledge
WP3 analyses the level of information available in each country regarding the existing building stock. A procedure enabling to refine this information and ways to use the certification procedure as a tool to collect data regarding this stock is developed.

WP4: Roadmap
An overview of possible legal measures for existing buildings is written. Indications are given about alternative strategies to improve on a wide scale the energy efficiency of existing buildings. Possibilities (including pro's and cons) to widen the scope of the EPBD in case of a future revision of the requirements of the directive are described.

A website, newsletters and workshops enable a strong interaction between ENPER-EXIST and different interest groups and a wide dissemination of ENPER-EXIST results. The workshops are organised with the different actors involved in the application of the EPBD.More information on the project website: www.enper-exist.com

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Executive summary

There are several reasons why the assessment of energy use for existing buildings cannot be totally the same as the assessment of energy use for new buildings. For starters the goal of the assessment is different: The calculation procedures are needed in the context of different EPBD requirements and these different EPBD requirements have different objectives and therefore demand different boundary conditions. Partly this has to do with legal issues, but also other aspects are involved. Secondly the energy use in buildings changes when buildings become more energy efficient, but not every contributor to this energy use changes in the same proportion to all the others. This creates a shift in energy uses which need more attention. And last but not least, a key issue is the input data and the data acquisition. The level of information available for the assessment is different and the way information is gathered (the data acquisition) is different as well. So a focus on the assessment of energy use for new buildings results in gaps for the usability of the method for existing buildings.

The CEN working groups have done a tremendous job to deliver a huge amount of EPBD CEN standards to guide the implementation of the EPBD in the member states. But because of lack of time and priority it has been inevitable that most of the working groups have had more focus on new than on existing buildings. ENPER Exist has jumped into this gap and has provided assistance to the EPBD CEN standards within the task “Tools application”.

Within the task various courses have been taken to provide this assistance:

1. The expert knowledge of the participants of the project is used to analyse the most important CEN standards. This has been a desk research.
2. The usability of the CEN standards on existing buildings has also been tested in practice in a pilot test which focussed on the gathering of the input data.
3. The third practical test has been the performance of some detailed calculations with the CEN standards and with a national alternative.
4. The knowledge of the developers of existing EP methods for existing buildings (on national level and on EU level) is used to find alternative solutions for gaps which were found during the project.

The results of these four courses have been documented in the four working documents which belong to this study on the applicability of EPBD CEN methods on existing buildings. The reports can be found on www.enper-exist.com, under “Results / reports” and then under “Work package 1: Tools application”.

In short, the results of the four studies are described below:

1. We started the work in this task by analysing the most important EPBD CEN standards, covering the topics space heating and cooling, ventilation, domestic hot water, combustion systems and lighting. The study resulted in technical comments which were directly sent to the working groups of CEN, so they could make the suggested changes in the CEN EPBD standards. Typical comments concerned:
   - making default values for various input parameters which are hard to gather in practice, e.g. typical values for internal heat sources, infiltration and ventilation rates;
   - simplifications of certain aspects of the calculation, e.g. concerning thermal bridges, sunspaces and solar shading;
   - adding aspects of aging to the methodology, e.g. for glazing;

- development of simple tables to replace and in this way simplify parts of the calculation method.

2. The next topic in the task was to test the CEN standards in practice. This has been tested via a pilot study, which was focussed on installation standards. The usability differs from standard to standard. Some parts, like the tabulated method for space heating distribution and the tap requirements for hot water appear to be usable. The typology method to determine the space heating generation of combustion systems is an example of a method which is very suitable to be used as the bases for the development of a tabulated method. Some methods are usable in existing buildings with some simplifications or improvements: so does addition of some defaults within the quick method for lighting to make this method very easy to use in existing buildings. And the development of a method based on ventilation profiles appears to be necessary to make the calculation method for the energy use for ventilation easy to use.
3. The third practical test has been the performance of some detailed calculations with the CEN standards. Together with the pilot study on data acquisition this is the ultimate test of the usability of the standards in practice. In the scope of this study calculations were performed related to the hourly heating and cooling need, the ventilation flow, energy use for lighting and the generation efficiency of boilers. The results differ per standard. In addition some calculations with a national alternative have been performed, to see if the methods are in line and to see whether cross-pollination can be established:
   - Calculation of energy use for space heating and cooling using the hourly calculation method (ISO/DIS 13790) can be used to existing building only in the case the inspection of the buildings allows to gather the most important necessary data or default values are available. More guidance to define default values according to the observations will make the method more useful.
   - For existing buildings the liability of the EP calculation increases when standard conditions for the ventilation flow are used, in stead of using the calculation of ventilation air flow supply according prEN 15242.
   - The simple lighting method (prEN 15193) in general represents a good framework for a quick estimation procedure. Nevertheless the default values as currently contained in prEN 15193 seem to be not suited to provide realistic and reliable lighting energy demands. A more detailed and refined set of default parameters might in future provide more realistic scenarios.
   - Regarding the generation efficiency of boilers, this study shows that it is possible to use the case specific method to develop a table method for the efficiency of boilers for existing buildings.
4. Finally, the knowledge of the developers of existing EP methods for existing buildings (on national level and on EU level) has been used to find alternative solutions for gaps which were found during the project. These solutions often are a compromise: there are almost always pro's and con's to the different approaches. The result contains a wealth of experiences and suggestions how to solve possible problems with the assessment of energy use for existing buildings.

   The main issues which have been addressed are alternative methods when input data is not available, alternative methods when input data is available but it will take too much time to gather all the details and alternative methods when the situation typical for existing buildings are not addressed by the calculation method for new buildings.

   Most alternative methods describe a way to simplify the method and with this reduce the amount of input data. Often the introduction of default values or tables is suggested. The main advantage is that the method is easier usable in practice; the main disadvantage is the loss of accuracy.

> The disadvantage of losing accuracy can be discussed. Incorrect measurements or observations are also a potential source of large errors. Using more detailed input data introduces the appearance of accuracy, but it can be questioned if this accuracy is met in practice. Less input means less accurate results, but also less measurement and observation errors. It is important to realise that there is an optimum between these two.

Because a lot of problems with the assessment of energy use of existing buildings have already been addressed we recommend the developers of EP tools for existing buildings (CEN experts and national experts) to take into account this existing experience. The risk of not using this experience is that the methods will become too academic or, by trying to avoid this, too simple. By running case studies this risk can be reduced.

1. Why this study on the applicability of EPBD CEN methods on existing buildings?

There are several reasons why the assessment of energy use for existing buildings cannot be totally the same as the assessment of energy use for new buildings. For starters the goal of the assessment is different: The calculation procedures are needed in the context of different EPBD requirements and these different EPBD requirements have different objectives and therefore demand different boundary conditions. Partly this has to do with legal issues, but also other aspects are involved. Secondly the energy use in buildings changes when buildings become more energy efficient, but not every contributor to this energy use changes in the same proportion to all the others. This creates a shift in energy uses which need more attention. And last but not least, a key issue is the input data and the data acquisition. The level of information available for the assessment is different and the way information is gathered (the data acquisition) is different as well. So a focus on the assessment of energy use for new buildings results in gaps for the usability of the method for existing buildings.

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Within ENPER Exist various courses have been taken to provide this assistance:

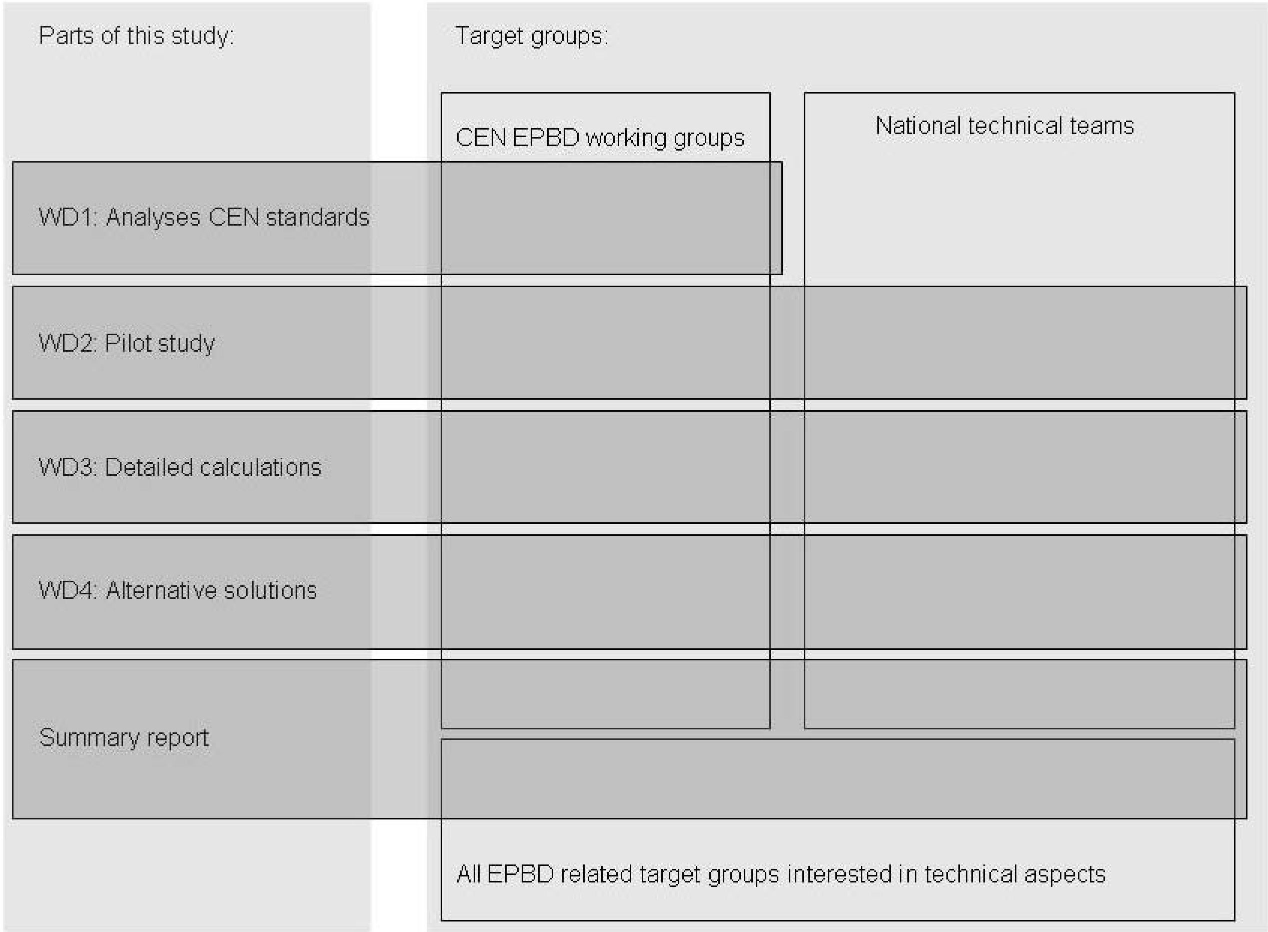
- The expert knowledge of the participants of the project is used to analyse the most important CEN standards. This has been a desk research.
- The usability of the CEN standards on existing buildings has also been tested in practice in a pilot test which focussed on the gathering of the input data.
- The third practical test has been the performance of some detailed calculations with the CEN standards.
- The knowledge of the developers of existing EP methods for existing buildings (on national level and on EU level) is used to find alternative solutions for gaps which were found in the previous tasks.

The results of these four courses have been documented in the four working documents which belong to this study on the applicability of EPBD CEN methods on existing buildings [1], [2], [3], [4].

This document provides a summary of the knowledge gained by this study.

Target groups

The main target groups of this study on the applicability of EPBD CEN methods on existing buildings are 1) the CEN EPBD working groups and 2) the national technical teams concerned with the development of the calculation methodology underlying the energy performance certificate of existing buildings. The four working documents are especially interesting for these two target groups. This summary document is written for a broader audience and is interesting for all EPBD related target groups who are interested in technical aspects of the development of models to calculate the energy performance of existing buildings, see the figure below.



Asset rating, operational rating and metered rating

CEN started with making a difference between asset rating, operational rating and metered rating. The definition of the ratings appeared to be confusing and therefore CEN changed this distinction into:

- Calculated energy rating and
- Measured energy rating

CEN has focussed the development of the standards on calculated energy rating. Therefore within Enper Exist we have done the same. Some guidelines for the use of energy measurements are given.

2. Three reasons why the assessment of energy use for new and existing buildings is not the same and their consequences

When developing a method to assess the energy performance of buildings, it appears logical that only one method should be developed for new and existing buildings. After all, the physics in new buildings do not change when the building is used and becomes an existing building.

Nevertheless, the calculations methods developed for new buildings can not be used one to one for existing buildings. In this chapter we will discuss the main reasons why there might be differences between the methods for these two purposes.

Globally there are three reasons why the assessment of energy use for new and existing buildings is not the same:

1. The two methods have different objectives;
2. The two methods have a different level of input data
3. The two methods have a different level of legal impact

These reasons are discussed in the next paragraphs.

2.1 Different objectives

The objective of the energy assessment for new and existing buildings is not entirely the same. In general the EPBD distinguishes two goals for which an assessment method for energy use of a building should be developed, namely for the minimum EP requirements and for the EP certificate.

The objectives for a method concerning minimum EP requirements are:

- To enable the national or regional authorities to enforce a minimum energy performance level of buildings that are new or undergoing major renovations.
- To enable the designer to make correct choices in energy design and technologies, covering the most relevant energy saving and renewable energy measures.
- To produce results that allow comparison of the energy performance between buildings of the same function within same country or region

The objectives for a method concerning an EP certificate are:

- To enable a correct evaluation of status and recommendations for cost-effective improvements of the energy performance of existing buildings.
- To produce results that allow comparison of the energy performance between buildings of the same function within the same country or region

The differences in objective result in different boundary conditions. Some conditions go hand in hand and some are in conflict with one another. When it concerns conflicting conditions within one method, a proper balance should be found. E.g. the method concerning minimum

EP requirements should be accurate on one hand, but also transparent. Detailed calculations improve the accuracy, but decrease the transparency, so a good balance is needed here.

The balance for the method for new buildings can be different from the balance for the method for existing buildings. Several implications of the objectives are discussed below.

Legal implications versus provision of information

Depending on the application, the calculation procedures have different characteristics and different legal implications. When the calculation procedures are applied to judge compliance with the minimum energy performance requirements, the result has **legal implications:** non-compliance may lead to denial of the building permit (e.g. the Netherlands), or to a financial penalty (e.g. Flanders, B) and/or to a summon from the national or local authorities. The objective of the EP certificates on the other hand is limited to the **provision of information**.

The fact that the results of the EP calculation for new buildings and major renovation have legal implications means there are several boundary conditions to which such a method has to apply. The consequences are discussed in paragraph 2.3. These consequences do not apply to the method related to the certificate.

Proving minimum EP level versus correct estimated effect of measures

One of the main objectives for the method for new buildings is to test if a building applies to the requirements. When input is not known, the estimations need to be conservative: you need to be absolutely sure that by using the estimation it will not be easier to apply to the regulations that by using the real input. The same is possible to simplify the method: a detailed method can be replaced by a simple method as long as this method is conservative. In both cases we are sure that a building meets the minimum EP level in reality when it meets the minimum EP level based on conservative estimations: the real EP level of the building will definitely be better.

For existing buildings such a conservative calculation is often not preferable. When the basic EP level of a building is estimated in a conservative way, the real energy use of the building will be lower. The problem with that is that the estimation of the energy saving effect of measures in that case will be too positive. The effect of these measures will be lower in reality and so will be the cost-effectiveness of the measure. For existing buildings it is important that the calculation is as close to reality as possible.

This subject is discussed in more detail in chapter 4 on considerations on simplifications.

2.2 Different level of input data

In general, for new buildings more detailed information is available. Design and/or construction drawings are available and also the product information and sometimes results of measurement data are accessible.

Accuracy versus cost-effectiveness

In particular in case of inspection of ‘old’ existing buildings, if or where gathering the full required input would be too labour-intensive for the purpose, related to cost-effectiveness of gathering the input, national default values (or default simplified procedures) may need to be defined. For instance: for U-values and thermal bridges of old walls and roofs and for efficiency of (old) boilers.
On the other hand, the input should be sufficiently distinctive to see the effect of improvements in the energy performance.

So a certain level of accuracy is important for the energy assessment for the EP certificate. As we have seen earlier in the discussion: a proper estimation of the energy saving potential of measures is a main objective of the assessment for the EP certificate, and for this an accurate result is necessary. This would suggest that a detailed method with lots of input is preferable to a simple method with only rough estimations.
This argument seems to stand oposite to the argument of cost-effectiveness of gathering the input.

The accuracy of the result is however not only influenced by the level of detail of the method, but also by the accuracy of the input. (This is true not only for existing buildings, but also for new buldings by the way). In a recent study in the Netherlands this balance was researched for the Dutch EP method for the certificate. See figures 1 and 2: the graph to the left shows that the inspection time can be drasticly reduced by simplified input. Of course, this leads to decreased accuracy. On the other hand, the likelyhood to make errors (guesses, mistakes) is decreased. This leads to a higher reproducibility. If the higher reproducibility is included in the picture of the overall accuracy, one gets a graph as shown in figure 2.

Conclusion: the most detailed input is not necessarily the most accurate. A balance is needed (not forgetting that the method should be sufficiently ‘distinctive’). A fine role here is in store for labeling schemes of products, also see Chapter 4.

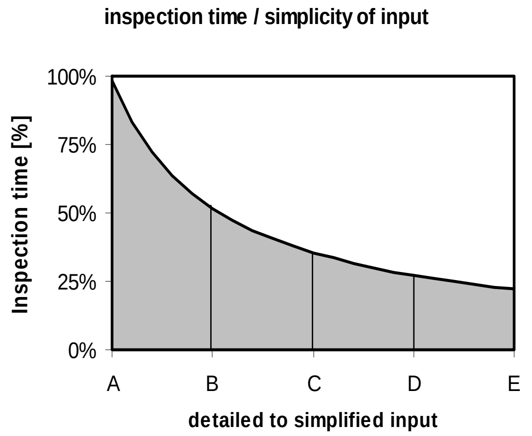


Figure 1 From A to E: less detailed input ➔ less accuracy, but also: less errors in input ➔ Optimum is somewhere in between (~ B, C)

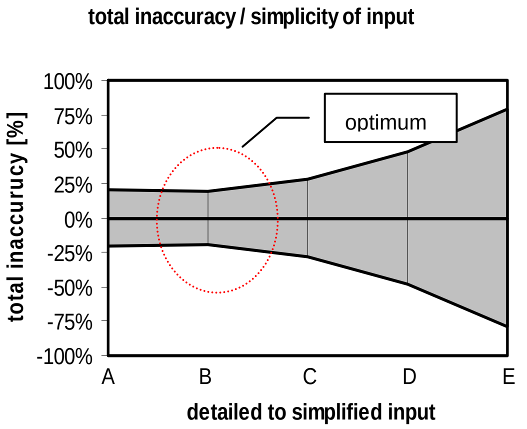


Figure 2 Balance between accuracy and quality of input for existing buildings with limited information

Both pictures: Courtesy: EBM-Consult (NL)

Simple input versus simple method

The discussion on simple input does not necessarily imply that the calculation method should contain only simplified methods. An alternative is to use a method in the same detail as the method would be for new buildings, but to provide a shell around this method which allows for a reduced set of input parameters and contains default values for the other inputs (or default estimations based on the reduced input), see figure 3.

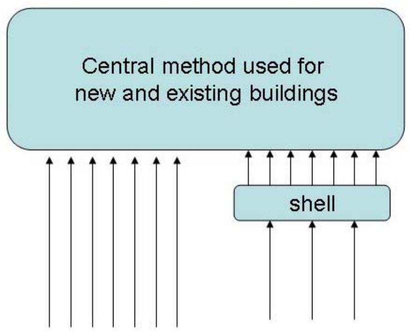


Figure 3 Principle of using the same method for new and existing buildings

An example of this approach is SAP and RD-SAP (Reduced Data SAP) used in the UK: The approach proposed for energy rating existing dwellings in the UK is to use the same calculation tool already developed for new dwellings, but with the difference that a greatly reduced set of data inputs is required. The intention is that the reduced data requirement will enable the following:

- The assessment time and hence cost can be kept to a reasonable level.
- The expertise demanded of assessors will be compatible with the potential pool of people wishing to become assessors and the scope of training programmes that can realistically be put in place.

- Last, but by no means least, the results will be less prone to data input errors and hence achieve better repeatability.

There is a general belief amongst modellers that the more comprehensive and complete a model is then the more reliable will be its predictions. Particularly as the computational facilities available to modellers have increased so too has the tendency to develop ever more complex representations of the situation. However it is not self obvious that the more comprehensive and complex model will actually result in a better performance – in the sense of giving more reliable predictions of building performance.

It is fairly well known that when the same building is analysed by different models a significant variation in predicted energy consumption results. It is also known that when a number of people familiar with a model enter the same building then another large variation in results occurs. The second case is more problematic since with the same building and the same computer model the variation is entirely due to differences in the data input. The differences in data input are due to either differences in interpretation, or measurement error or keyboard error – or some combination of all of these. Inevitably, the reliability of a data set decreases as more data is required from the user. (Also see the previous part of this paragraph).

To investigate if this approach is workable for existing buildings, to see what possible difficulties might arise and to see whether the approach for existing buildings will lead to comparable results related to the more comprehensive method, a study has applied the UK energy rating methodologies for both new and existing dwellings to 4 existing dwellings. Details of the two methods (SAP and RDSAP) and a description and the results of this study are presented in [4].

The main conclusion from the study is that the reduced data set gave results which were close to the results based on the full data set. The reduced set of data inputs does seem to strike a reasonable balance between capturing sufficient detail to enable a reasonably representative energy rating, while minimizing data capture requirements to a practical level. So this approach of reducing the amount of input parameters, without changing the formula structure of the method, seems to be a realistic option to improve the balance between accuracy and assessment time.

2.3 Different level of legal implications

Because of the bigger consequences when minimum EP requirements are involved, objectivity and legal security are more important for the method for new than for existing buildings. Legal security means that the method is in accordance with national regulations, which can e.g. mean that the effect of household appliances should be excluded and e.g. that legal principles on rights and duties with respect to adjacent buildings should be respected. For existing buildings those regulations are less of an issue and it might be that the balance here will dip to the side of being more close to reality.

For objectivity it is important that the method is transparent and reproducible. Transparency means that the market parties, the users and the authorities should be able to understand the overall result and the results at components level, to understand and accept the effect of choices (input) on the calculation result. Reproducibility means that the method is unambiguous: For a specific case the method leads to the same result; independent of subjective or arbitrary choices, independent of the user and all interested parties agree on the input, applied method and results. This requires that all options be specified in a concrete and unambiguous way, with no open ends.

Transparency and reproducibility are very important qualities when calculating the energy performance in the context of building regulations, in particular when judging compliance with the minimum energy performance requirements for new buildings and major renovations.
The transparency and reproducibility are of interest for persons applying the method, because the method enables them to understand the method (fast learning curve), protects them against wrong use and provides the insurance that the calculation result will be accepted without discussion.
But also for persons judging calculation results for legal issues, e.g. civil servants judging building permit requests, for whom avoiding ambiguities and disputes is also a major concern.
And, last but not least, also for persons involved in (further) development and/or evaluation of the method and providers of the input data, for whom keeping track of the procedures is essential.
Reproducibility may be most important in case of EP requirements (new buildings and major renovations), because in case of strict requirements the economic pressure is high to find and apply the method that gives the best EP value for the lowest investment in energy technologies. This can lead to comparisons between different alternative calculation methods in order to find the best EP value ("shopping behaviour"), instead of comparing alternative energy efficient technologies.
In light of legal security these aspects are less important for existing buildings. But it is clear that these qualities are valuable for existing buildings too. It is e.g. not preferable that due to ambiguity, buildings switch from one EP level (A, B, C, …) to another. And for advisors and consumers to understand and accept the certificate and the measures suggested, transparency is of great importance as well.

A legal aspect which is not (or less?) an issue for existing buildings is that EU law does not allow connections between national legislation and market labels, like e.g. labels for high insulating glazing and high efficiency condensing boilers. For existing buildings these labels are very important to make the data acquisition less time consuming and more accurate.

Another legal implication is that for new buildings the input must be verifiable: All interested parties can check the input and all input data should be available for verification at the appropriate time. Proof and justification for every input should in principle be present. For existing buildings the claimed input sould be verifiable as well, but it can be acepcted that the proces of control will be different: because there are less legal implications, the verification can be less of an objective check and more of a subjective check to see if the advisor has done a good job.

Of course when in the future more legal implications are introduced for existing buildings as well, the quality aspects of the method for the certificate might turn more towards the method for minimum requirements.

3. What gaps occur between EP methods for new and existing buildings?

Within Enper Exist we have in different ways assessed the gaps which can occur with EP methods for new buildings that make them difficult to use in existing situations. Generally seen three gaps occur:

1. Situations where input data is not available
2. Situations where input data is available but it will take a lot (too much) time to gather all the details
3. Situations which are typical for existing buildings and which are not addressed in methods for new buildings

The first two situations occur the most. There are no general rules what parameters can and cannot be detected (easily) in practice. This should be analysed for all input parameters needed in the method. We refer to work documents 2 and 4 ("Pilot test of data acquisition" [2] and "Investigation of alternatives" [4]) of this study within the Enper Exist project for concrete input parameters within CEN which will give problems when using the standards in existing situations.

There are various solutions when input parameters of a method cannot be assessed in practice. These are described in paragraph 3.1.

The third category which is mentioned is the category of issues which are typical for existing buildings and which are not addressed in methods for new buildings. Paragraph 3.2 will go into this category.

3.1 What to do when input is not (easy) available

When input data is not (easy) available in existing buildings, there are several solutions possible on various levels. In the overview given below various options are given with an example and some of the pro's and con's. For concrete solutions to concrete unavailable input parameters within the CEN standard we again refer to the two work documents [2] and [4].

Determine a default value

The simplest solution when input is not available is to use a default value.

Example:

- An example of a situation where a fixed default can be used in stead of actual data is the following:

  To determine the distribution losses for domestic hot water pipe lengths need to be taken into account. A default value for the pipe length can be determined which can be used when the assessment of the actual pipe length is to labour intensive. This default value is based on assumptions of the distance from the boiler to the tapping points. Even though this quite varies from dwelling to dwelling, one default independent of the situation can be derived for houses, e.g.

- a fixed pipe length of 6 to 8 meters from the boiler to the bathroom (per bathroom) and
- a fixed pipe length of 8 to 10 meters from the boiler to the kitchen sink (per kitchen sink)
- Circulation pipes are separately taken into account (no default!)
- Other hot water tapping points are assumed to be taken into account within the default pipe lengths of bathroom and kitchen.

Pro's:

- This is a very simple solution and will speed up the data acquisition process of existing buildings a lot.
- It prevents advisers from making guesses which in practice might be more besides the truth than the default value which is hopefully an educated guess and near a mean occurring value. So large mistakes which badly influence the accuracy of the calculation are prevented this way

Con's:

- The drawback is that the educated guess is per definition not corresponding with the truth, so the default will also influence the accuracy of the result. When the input parameter has a large impact on the calculation result, the use of a default value is less obvious. But sometimes even then it is better to use a default than to let an advisor make an even worse guess.
- Diversity between situations is less. This is mainly a problem when this lack of diversity prohibits energy saving measures from being stimulated.
- The default needs to be derived during the development stage of the method. A study is needed, to derive a educated mean value. At best, there are already figures available which can be used to derive this value.

Who is responsible:

- Default values can be derived in CEN or on national level. The advantage of the development by CEN is that the figures can be used in all MS, while letting MS be responsible, 27 countries need to do the same study. Often though, climate or other country specific situations make the development of defaults on CEN level too general.
- Sensible would be to derive the procedure and boundary conditions on European level and perform the actual analyses to derive the default value on national level. This way the default values are country specific, but are uniformly derived over Europe and not every MS needs to re-invent the wheel.

  Since there are few resources for specific studies within CEN, a study how to develop the procedure to determine default values is a good subject for European collective research.

Determine a table with default values depending on characteristics of the situation/installation/etc

This solution is very similar to the previous one, with the difference that not one default value is derived, but various characteristics of the individual situation can be taken into account. These characteristics can be many things:

- The typology of the installation, e.g. AC or DC ventilators (as long as the distinction which is made is easily detectable in practice.)
- Characteristics of the building, including building age: see the example below.
- Etc.

The result is therefore not one figure but a table with various options.

Example:

- An example of a situation where default tables can be used in stead of actual data is the following:

  In stead of using ‘real’ infiltration rates (based on e.g. measurements in the existing situation) a default table can be derived which states the infiltration rate as a function of building height and building age. E.g.:

Date of construction	**Height of building *h*** m	**Infiltration rate $q_{ve;inf}$** dm^3/s
≥ 2000	0 tot 10 m	0,15
	10 tot 20 m	0,15
	> 20 m	0,18
≥ 1995 en < 2000	0 tot 10 m	0,15
	10 tot 20 m	0,22
	> 20 m	0,42
<1995	0 tot 10 m	0,26
	10 tot 20 m	0,38
	> 20 m	0,72

Pro’s:

- The same pro’s apply as for the default value (simple, saves time with data acquisition, being a more educated guess and less dependent on the expertise of the advisor), provided that the choice options are easy to detect in the building. If not, the table will not make life easier.
- An extra advantage is that greater diversity is possible, because of the different characteristics of the building/installation/component which can be taken into account.

Con's:

- Here also goes that the educated guess is per definition not corresponding with the truth, although slightly more nuance can be used because of the characteristics which can be taken into account. This also increases the diversity compared to the single default value.
- The development of such a method might be more complex.

Who is responsible:

- Here the same applies as for the default value: it can be developed on CEN or on national level (for pro's and con's : see 'who is responsible' under 'default value').

Develop simplified tables to be used in stead of a set of input data

Very similar, but mentioned separately is to develop a table with default values as a function of various relevant categories, so not to replace one input value, but to replace a group of input values. This is preferred when too many input parameters in a method are unknown or not easy to gather. In that case, of course it is possible to replace the individual parameters with default values, but at some point it becomes illogical to remain the level of details, when most or all the inputs are fixed. An alternative at that point is to develop a more simple method, being in this case a simple table.

Example:

- In stead of the detailed methods described in one of the CEN standards to determine the generation efficiency of a boiler, a simple table can be developed based on the typology of the boiler. This reduces an entire group of formula's, including many input parameters into a table with clear choosing options. A condition is that the classes within the categories in the table should be easy to detect in existing building practice. E.g.:

Heating boiler	**Generation efficiency η**	
	Supply temperature	
	≤ 55°C	>55°C
Conventional boiler	0,75	0,75
Improved efficiency boiler	0,80	0,80
Condensing boiler HR-100	0,925	0,90
Condensing boiler HR-104	0,95	0,925
Condensing boiler HR-107	0,975	0,95

The discussion on pro's and con's etc, is the same as for the development of a table with default values to replace individual input parameters. This discussion is not repeated here.

Develop a different (often more simple) formula, with less or other input parameters

An alternative for replacing a (part of a) method with a simple table, is developing a simplified method in stead. The differences between these options are small. Of course a table works with categories, where a simple method (formula's) work with continuous inputs.

Example:

- An example of replacing a detailed method with a more simple one is the following:

  When you want to take into account an unconditioned space to reduce the transmission loss from your heated space to the outdoor environment, the CEN standards have a detailed method worked out for this, based on a lot of information of the unconditioned space. As an alternative it is possible to derive a simple factor which can also take into account the heat loss reduction, based on the thermal transmittance of the partition construction only (and of course using average parameters of an average unconditioned space). E.g.

> The reduced temperature difference compared to heat transmission to the external environment is taken into account by an adjustment factor $b_{\mathrm{tr},x}$ that reduces the heat transfer coefficient. A default value for the adjustment factor, $b_{\mathrm{tr},x}$, for dwellings is defined as follows:
>
> $b_{\mathrm{tr},x}$,= 1 / (1+Uk/5)
>
> where Uk = thermal transmittance of partition construction [W/m2K]

Pro's:

- Again this is much simpler than the alternative of a detailed method, less input is needed. Also this will again speed up the data acquisition process of existing buildings a lot.
- It prevents advisers from making guesses which in practice might be more besides the truth than the default value which is hopefully an educated guess and near a mean occurring value. So large mistakes which badly influence the accuracy of the calculation are prevented this way
- Another advantage is that this reduces the formula structure, making the method more orderly and comprehensible.

Con's:

- The drawback of course also here is the reduction of accuracy in the sense that the result is more averaged and less a reflection of the individual situation, so inevitably it will not correspond with 'the truth'. Of course simplifying the method is useful mainly when the variety within the method is not of very large impact. But note that when the variety has a large impact, it still can be a good decision to simplify the method, when (part of) the comprehensive input will be a wild guess in practice. The accuracy which seems to be larger with more input parameters in those cases is only accuracy in appearance.
- Diversity between situations is less. This is mainly a problem when this lack of diversity prohibits energy saving measures from being stimulated.

- The simplified method needs to be derived during the development stage of the method. A study is needed for this.

Who is responsible:

- Simplified methods can be derived in CEN or on national level. The advantage of the development by CEN is that the methods can be used in all MS, while letting MS be responsible, 27 countries need to do the same study. It is not always possible to derive the method in European level, because of differences in climate, building typology and other country specific situations.
- Sensible would be to derive the general simplified method on European level and perform the actual analyses to fill in the constants on national level. This way the formula's are country specific, but are uniformly derived over Europe and not every MS needs to re-invent the wheel.

  Example: In the example given above a simple formula is derived to take into account the reduced heat loss through an unconditioned space. Instead of deriving the concrete formula, a procedure can be derived which states that the heat loss reduction through the unconditioned space can be taken into account via a reduction factor b as a function of the thermal transmittance of the partition construction. The procedure needs to describe what the boundary conditions are how this function is derived. Within the procedure a worked out example can be given. This way, every national team can use the same procedure by inserting their national specific cases.

- Since there are few resources for specific studies within CEN, a study how to simplify the formula's for certain parts of the method is a good subject for European collective research.

Develop a method/procedure how to estimate the value in practice or how to recognise what type of system is installed

Finally a set of input parameters will remain (of course). These need to be gathered easily in practice. It is important that not much time is needed to gather them, but it is also important that the quality of the input data is good. This means that the input will not differ too much between advisors in the same situation. Various methods and procedures can help advisors to estimate the values in practice.

An efficient way to do this is the use of labelling. More on labelling is described in chapter 4.2.

3.2 Typical existing building issues

In our search of gaps between the energy performance calculation of new and existing buildings we came across only a few typical building issues. These issues are described in this paragraph.

Local heating system

A typical problem in old dwellings having local heating units in only one or two rooms is that these dwellings have very poor thermal comfort but, as a result, also a very low energy consumption. When the local heating units are being replaced by a more up-to-date central heating system (with up-to-date thermal comfort) the energy consumption will most probably increase considerably, thus not being an energy saving measure.

A solution to this problem is to make the EP calculation under standard conditions (e.g. standard interior temperature, number of people present etc.) to determine the energy label. For this standard calculation a local heating system (for space heating and/or DHW) is regarded as a simple central heating system with conventional efficiency also taking care of DHW. This implies that the result of the standard calculation is a higher energy consumption than in the actual situation and thus a poorer energy label (a penalty for the out-of-date thermal comfort). A disadvantage of course is that the calculated energy use is not corresponding with the 'real energy use'. But the advantage is that the two situations now can be compared, whereas with different comfort conditions an equal comparison could not have been made.

Aging of products

Another issue which comes into mind related to existing buildings is the fact that products age. Some products age more than others. This aging has to be taken into account somehow.

For some products aging is already taken into account for new materials: e.g. the procedure to determine the lambda values for insulation materials does already take into account the fact that the insulation value decreases in time. The lambda value which is declared after the tests is lower than the actual lambda value from the new material.

For other products, e.g. glazing with gas fillings, it is not known what the influence of aging will be on the performance of the product.

Conclusion is that on a component to component basis the effect of aging should be investigated. For some products no studies will be necessary, but for other products a lot still needs to be learned.

4. Considerations for simplifications

Some parts of the calculation ask a lot of input. This makes the data acquisition a time consuming task. In addition, it is not always possible to find al input parameters in existing situations. E.g. the insulation thickness often can only be detected by making a hole in the wall, which is not preferable to say the least. In the previous chapter various solutions are discussed which are an alternative when input parameters are unknown or time consuming to gather. Two of the options concern simplified formula's and the use of default tables.

In the next two paragraphs some considerations are given regarding simplified formula's and default tables. In relation to this, a very strong tool is labelling. The third paragraph therefore will discuss labelling of products.

Another alternative is measurement of the energy performance of buildings. The experience with measurement is limited. Lessons learned from these experiences are given in the last paragraph of this chapter.

4.1 Simplifications by making simple formula's

When we compare the existing tools which are specially developed for exiting buildings with methods for new buildings, we see that the main reason for using alternative methods is when input data is not available or when gathering the input data will take too much time. Most alternative methods describe a way to simplify the method and with this reduce the amount of input data. Often the introduction of default values or tables is suggested. The main advantage is that the method is easier usable in practice; the main disadvantage which is often mentioned is the loss of accuracy. An overview of the alternatives which are suggested based on existing EP methods for existing buildings (on national level and on EU level) is given in [4].

The disadvantage of losing accuracy can be discussed. Incorrect measurements or observations are also a potential source of large errors. Using more detailed input data introduces the appearance of accuracy, but it can be questioned if this accuracy is met in practice.

Less input means less accurate results, but also less measurement and observation errors(also see paragraph 2.2 for a discussion). It is important to realise that there is an optimum between these two:

- Too simple approaches will lead to too inaccurate assessment of the energy use of existing buildings
- A too academic approach in fear of losing too much accuracy will lead too input errors which will result in inaccurate results after all.

Should simplified methods always be conservative?

For new buildings appliance to the requirements needs to be proven. When simplified methods guarantee safe (conservative) results, a result which meets the requirements using the safe, simplified method will definitely meet the requirements when using the less conservative detailed method. Being certain a building meets the requirements is the first objective for the method for new buildings, and this is more important than being very close to reality.

For existing buildings being close to reality is more important, especially when judgement of the cost effectiveness of energy saving measures is concerned: when the energy use of a building is calculated in a conservative manner, the effect of energy saving measures is overestimated and the cost effectiveness in reality will be smaller. So it is not in the interest of the building owner to use conservative simplified methods. In addition a low energy label could have a negative effect on the rent or purchase price of the building. So in contrast to new buildings, making the calculation conservative is not necessarily “always good”.

4.2 Simplifications by making default tables

The same is true for making default tables: default values are nothing more than a simplification to make gathering of input easier. For new buildings, the default values should be conservative, to make sure that the real value will only make the energy performance better and the building will definitely meet the requirements. For the same reason mentioned in the previous paragraph, conservative values may not be the wisest choice for default values when existing buildings are concerned.

Another argument for conservative defaults is that free-riding is not possible. Free-riding occurs when default values are better than the values which belong to certain products: the products get a ‘free-ride’ by using the default in stead of their real value.

This can be a potential problem when more average values are used as defaults for existing buildings in stead of conservative ones.

4.3 Simplifications by using labelling

Labelling of products has a lot of advantages:

- It is a good communication tool for consumers: a consumer does not understand the technical specs of a product and cannot discriminate based on technical aspects which is a better product. But a consumer can understand that e.g. a A-label refrigerator is a better choice regarding energy efficiency than a C-label refrigerator.
- The label can stand for a series of input parameters, which would have been hard to detect without a label. E.g. stating that a heat recovery system has a high efficiency label, you state (for instance) that it has a heat recovery efficiency of 90% and that the ventilators which are installed are dc-ventilators. When these aspects are the inputs to the calculation, the input parameters are easily detected, and the chance that two advisors will find different inputs is reduced largely.
- By using a sticker on the product, the label is visible and can be detected easily. Of course not for all products a sticker is usable. E.g. on glazing, a sticker is no option. Here a mark inside the spacer will do: this is already used in e.g. the Netherlands, to mark whether the glazing has a coating and/or gas filling (the so called HR, HR+ and HR++ glazing). For other products, e.g. insulation material, a registration method could be developed which is placed in a fixed spot, like the meter box. This registration form should hold information about the type of the product used, but also on its location (it can for instance be the case that insulation material is placed in only part of the building).

Various labels have been derived until now, like labels for:

- Efficient boilers

- Heat pumps
- Insulating glazing
- Heat recovery systems for ventilation
- Thermal solar systems
- …

Example:

This is the ‘Gaskeur’ label, which is used on condensing boilers in the Netherlands. The label is related to the generation efficiency used in the EP calculation. When the label states ‘HR-100’, ‘HR-104’ or ‘HR107’ you know the boiler has an even a better efficiency, which of course can be taken into account in the EP calculation of the building.

Usually these labels are developed by the industry. A cooperation between industry and the developers of EP methods is desirable here, to make optimal use of the advantages of labelling schemes for the problems with gathering the inputs for energy performance calculations for existing buildings.

4.4 Guidelines for measuring the energy performance of existing buildings

The experience with the measurement of energy performance of buildings is limited. Some lessons from these experiences are the following:

- Measured energy use is almost always used in relation to some calculations, since the measurements are not only used to assess the energy performance, but the effect of measures needs to be estimated as well. The purpose of this fitting is to increase the accuracy of the estimation of energy saving measures based on measurements and calculations.
- The calculated energy use needs to be fitted to the measured energy use (or the other way around), meaning that for every type of use the measurement period needs to be the same as the calculation period.
- The metered period often is not exactly 12 months. For heating the measurement period should at least be during the period with heating demand. The small missing period or small overlap should be during summer. For cooling start and finish of the measurements should take place during winter. Consequence is that the assessment period for heating and cooling measurements will not be the same. This is not very practical.
- Not all energy uses have a period in which the use is near zero. The energy use can fluctuate during the year though. A good example is lighting, where the energy use will be much higher in winter than in summer. When the measured period is artificially extended or decreased for calculation purposes, this non-linear distribution over the months should be taken into account.
- For the calculation, climate data of the measurement period are used for a climate station near the location of the building. Another possibility is to recalculate the measurements into standard climate conditions. The advantage is that the estimation of the effect of energy saving measures is more logically with standard climate. Normally degree days are used for this recalculation. Correction for solar radiation has to be taken into account here as well.

- To obtain results which are less dependent on the variation of the climate, the measurement period can be increased to a longer period. A measurement period of 3 years is advised to reduce temporal climate effects.
- It is preferred to start with fitting the measured and calculated electricity use, since the electricity use influences the energy use for heating and cooling. The electricity use should be well fitted before the other uses are fitted.
- The following aspects can increase the accuracy of the fitting [5]:
    - Check the calculation and measurements on input mistakes: when a certain energy use is higher or lower than expected, check whether this is not due to errors in the input.
    - Vary uncertain input parameters: some input parameters can have a large effect on the energy use, even small differences sometimes have a small effect. By varying parameters which are uncertain within realistic boundaries important information is obtained about deviation between the calculated and measured energy use.

5. Conclusions

For various reasons there are differences between EP calculations for new and existing buildings.

For starters the objectives of the two calculations are different. For new buildings there will be legal consequences when the building does not meet the requirements while for existing buildings no requirements have to be met. For the method this leads to different boundary conditions related to transparency, reproducibility and unambiguity. The fact that for new buildings minimum requirements have to be reached, leads to the situation that the calculation has to give results which are conservative, while for existing buildings conservative results aren't favourable because here we like to have more realistic results. This has a direct consequence on default values and simplified methods.

Another issue is the different level of input data. In general for new buildings more detailed information is available. Of course for both methods goes that they should lead to accurate results, but there is also the issue of cost effectiveness. When input data is not available, very detailed input might be less accurate than more simple or default input. This is the case because the chance is that the detailed input will be estimated incorrectly, and that the accuracy is influenced more by wrongly estimated input than by less detailed input, which can be determined more easily. A proper balance between simplicity and level of detail in order to get the largest accuracy is an important issue to take into account when making simplified methods for existing buildings.

Simplifying a method can be done in various ways. Most options boil down to replacing individual input data or groups of input data with default values, simple tables or simplified formula's. The advantage is that less input and hopefully more easy to gather input is asked, which will speed up the data acquisition process and in the mean time will make the input data presumably more trustworthy. A drawback is that the diversity in results become smaller, which will reduce the accuracy of the method (but like is stated, this will be compensated by more trustworthy input data and in this way, more trustworthy results).

A promising way of simplifying input is by using labelling schemes.

An alternative is not to simplify the method, but to keep using the detailed method and to provide for a shell around this method which allows for a reduced set of input parameters and contains default values for the other inputs (or default estimations based on the reduced input). A pilot study where this was tested gave positive results. So this approach of reducing the amount of input parameters, without changing the formula structure of the method, seems to be a realistic option to improve the balance between accuracy and assessment time.

The development of simplified formula's, tables or defaults is often a national issue. Sensible would be to derive the general procedure and boundary conditions on European level and perform the actual analyses to derive the country specific data per Member State.

The development of the European part is for starters a CEN job. But in practice CEN has only few resources and is not in the opportunity to develop these kinds of new methods. Studies like this are a good subject for European collective research.

Literature

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