Energy performance regulations: small scale comparison between Flanders, the Netherlands, Germany and France

Subreport 4
Some lessons learned about comparing EP-requirements
version: 22 September 2008

Peter D'Herdt – Dirk Van Orshoven – Peter Wouters

Division Energy and Climate

Belgian Building Research Institute, BBRI

with the collaboration of

Marleen Spiekman & Bas Zwaan

Built Environment and Geosciences

TNO, the Netherlands

Hicham Lahmidi

Centre Scientifique et Technique du Bâtiment

CSTB, France

Heike Erhorn-Kluttig & Hans Erhorn

Fraunhofer Institute of Building Physics

IBP, Germany

Table of contents

1. Introduction

The original scope of the present study was only to compare 3 practical buildings: see subreports 1 to 3. On the basis of this experience, some general impressions emerge, though. Although it is beyond the task of the study, a preliminary attempt is made in this additional subreport to distil some first methodological conclusions from the practical experiences of the present exercise. These findings are formulated in a rather rudimentary manner, and certainly do not constitute a fully developed and well balanced analysis. The main purpose is to document these initial observations for possible further investigation later.

Before reading this subreport 4, it is advised to first take cognizance of the other subreports, in particular subreport 1 on the single family dwelling, which contains many practical illustrations, with corresponding analysis and discussion. It will help to better understand the rather abstract wording of this subreport 4.

2. Methodology and practical aspects.

1. In every country, every EP-determination method has its own rules with respect to the schematization of a building. E.g. whether a garage or an unheated, windowless attic must be/may be/or must not be included in the volume for which the EP-calculation is performed. Such initial geometric divergences may blur all further comparisons. Designing a building so that it avoids beforehand all possible national divergences, may be very difficult. An iterative process to arrive at a design that suits all national rules may be unavoidable. As the number of countries involved increases, this might become increasingly unpractical, and maybe in certain cases even impossible if there would be contradictory imperatives with respect to the schematization.
   Also, by narrowing down the building designs to those that can be handled uniformly by all EP-methods, a number of geometries that may be frequent and common practice in a certain country/region will be excluded systematically from comparisons, so that potentially important impacts of such basic choices will never be revealed.
2. In regions bordering each other, it can be expected that the conventional climate used for the EP-determination doesn't differ too much. However, as more countries with different climates get involved in comparisons, a design for a particular climate may be totally inappropriate for another (e.g. Mediterranean versus Scandinavian). Maybe this method only allows for comparisons within more or less homogeneous climate zones.
3. The description of the building is not always self-evident:
   a. Since every EP-method may have its own conventions with respect to sizes (internal/external/... dimensions, etc.), a given set of plans may not contain in an explicit manner all necessary measures, or may not allow to easily/accurately determine them[1].
   b. Much more important is the information about the materials and technical installations. Since input data to a specific EP-method (e.g. the calculation value

[1] This problem might be solved by providing all geometric information in full detail through original CAD-files that can be read by all people involved in the study by means of a free viewer.

of the thermal conductivity) should be determined according to the specific national method, in the most general case, the product characteristics are not given as such, but only the product description/identification is communicated. The specific characteristics are subsequently determined country by country. However, this may cause several practical problems, see next point. Only when the product characteristics that serve as an input to the different EP-calculation methods are determined on an identical basis (e.g. common European standardised test methods), can correct information be given a priori.

c. The products can be described either in qualitative terms or by specifying the brand and a unique product identification.

   - If they are described in qualitative terms, it is likely that the description will correspond to the classification for default values according to the method of origin. Such information may be insufficient to classify it for the use in the other EP-methods.
     This can be solved by giving the precise product name, so that in principle all necessary information can be searched for in every country/for every calculation method. Still, it may be difficult to find the required information because for some countries/methods the necessary data for the national classification may not be readily available.
     Also, this may be wrongly understood as an implicit demand not to calculate with the default value, but with the product specific value. If such is not the purpose, it might be necessary to explicitly mention this every time again.
   - Specific products may not be on the market in all countries involved in the comparison. In that case, the required input characteristics (according to national specifications) may not be available at all, and default values may not always be foreseen, or it may not be desirable to use them in order to avoid biasing of the comparison by the use of incoherent, too negative values. Moreover, even if the required national data are in principle available, it may be very time consuming to obtain them from the supplier (e.g. DHW boiler in the NL), or they may not be available in the right language.
   - Specific products may have different names dependent on the country where they are sold. This may have commercial reasons or may have come about historically. It is necessary to clarify this beforehand in order to find the right product at hand in every country.

4. For various parameters fixed values are used, which will differ per country. This is the case for user behaviour (e.g. the set point temperature), but also for various building/component parameters, to reduce or simplify the amount of input data. These fixed parameters are based on average national values, which again can differ hugely from country to country.

   An example: the diameter of the pipes to the bath and shower in the semi-detached dwelling in this study is 18 mm, whereas in the NL such pipes are generally much smaller. ,So in the Dutch methodology the largest pipe diameter is the category "> 10 mm", which implicitly calculates with a fixed value of 13 mm.

5. The calculation should be done by someone with a very thorough knowledge of the national EP-method. Often, a building design from another country will in several aspects differ from common national construction practice. It may then not be possible to use standard simple calculation rules and more precise analysis may be necessary (e.g.

because the thermal bridge effect cannot be found in the catalogue with standard national details).

From all the above, it is evident that the entire process, from the earliest building selection/design to the final reporting, is very time consuming, and often iterative. However, not taking care of minimal quality of the work throughout the entire process, may result in unreliable, false conclusions.

A practical difficulty is also that every country has its own EP-determination rules and definitions, which in practice results in a lot of confusion/misunderstandings/... throughout the entire communication process (incl. in reporting) due to different terminology, EP-concepts, ...

3. Conclusions with respect to relative strictness of the EP-requirements.

From the present study, it can be learned that great caution must be exercised when the EP-requirement levels in different countries are compared.

3.1 Comparison of the absolute requirement levels.

In a first instance people sometimes tend to compare the absolute requirement levels.

a) When the basic input parameters are identical in 2 countries, it is possible to evaluate in which country the absolute value for the EP-requirement is strictest. E.g. in FL and DE the basic input variables for the maximum primary energy consumption for dwellings are the (external) volume and envelope area. In the case of FL and DE, it is thus possible to draw a 3D-graph with the maximum allowed consumption as a function of those variables, and to look for which country the highest value is attained.
b) If the input variables are different, it is still possible to calculate the maximum for (one or more) building geometries (or extra other variables, if needed). E.g. in the NL the maximum depends on the net floor area and a "modified" envelope area. In FR it depends on the building geometry (with some limiting rules on reduced window areas when these are large, etc.).

Whether a continuous comparison following method a) or a (large number of) punctual comparison(s) according to b) is used, one can thus always get an indication of the relative strictness of the absolute values, without the need to calculate the actual EP of (one or more) projects.

However, even in countries with a similar (or even identical) climate, these numeric values cannot be compared with one another, since the EP-determination methods also vary strongly. An identical building can result in strongly different calculated energy consumptions, as has been illustrated throughout the examples. The requirement levels must thus always be considered in conjunction with the calculation method. Reasons for the differences include:

i. other types of consumptions may be considered in the different countries/EP-methods, e.g. domestic lighting or not, (fictitious) cooling or not, etc.

ii. the calculation model for each of the types of consumption (space heating, domestic hot water, auxiliary devices, ...) is different in the different countries/methods
iii. the totality of explicit and implicit assumptions that are embedded in each EP-method, e.g. set-point temperatures, the internal gains, DHW needs, solar shading conventions, efficiencies, etc.
iv. the climate (outside temperatures, solar radiation) especially if differing strongly
v. …

So even if the concept and the units are the same (e.g. MJ primary energy consumption) the numeric values only make sense in conjunction with a specific EP-method. **Maximum values corresponding to different EP-methods thus cannot be compared among each other**[2]. (Exactly the same holds true for project values.)

If the specific consumption in kWh/m² is used (which is a fairly popular way of expressing the consumption), the national conventions with respect to the definition of the reference floor area add yet another factor of random divergence.

Sometimes an even more simplistic reasoning is followed, namely that the EP-requirement could be constant throughout Europe, whereby the varying needs for cooling and heating according to the climate would cancel out. It is self-evident that such approach is way oversimplified and not realistic at all.

3.2 Comparing strictness in relative terms, for individual projects.

From the previous, it is obvious that one must be careful to compare apples only with apples, pears with pears, etc. This was done in this study by comparing for a given case the calculated consumption with the maximum value and taking the ratio of both, method by method. However, the study has illustrated that still great care must be taken when comparing the relative strictness.

a) Some design choices may have a very different impact in different EP-methods. The following examples are taken from the case of the semi-detached dwelling (subreport 1).
   - Example 1: The flow of trickle ventilators for outside air supply is by convention evaluated at 20Pa in FR and 2Pa in FL. The design air flow rate is a direct input in the FR EP-method. Trickle ventilators sized to the FL requirements thus give a large calculated energy consumption in the FR method (because of the higher flow at 20Pa), but the FR EP-maximum has been chosen in accordance with FR ventilation design

[2] A kind of comparison: one cannot compare the cost of a product from different suppliers in dollars if some numeric values are expressed in USD, others in Canadian dollar, still others in Australian dollar, in ... dollar. Similarly, one cannot compare different volumes expressed in gallons if some are measured in British gallons, others in American gallons. Etc. Similarly, a kWh primary energy consumption doesn't make sense if it isn't specified whether is determined following RT2005, or EnEV2007, or NEN 5128:2004, ... These numeric values are not comparable among each other (and cannot simply be converted between different EP-methods). An EnEV-kWh is not the same as an RT-kWh, or a NEN-kWh, ...

rules, thus for lower flows. The FL dwelling therefore comes out poorly when calculated following the FR calculation method.

- Example 2: DHW combustion boilers are given a fixed (market average) efficiency in the FL method.
  In the NL method, a good boiler (as in the case of the semi-detached dwelling) can be valorised (with standard table values depending on efficiency category, or with special proof of even better performance), and thus leads to good results.
  In DE the efficiency used in standard calculations depends on the type of technology[3] and on the floor area, without further distinction between the individual quality of individual products. However, if proof is given by testing, better values can be used (which was not done in the present study).
- Example 3: self-regulating trickle ventilators get a bonus in the FL and NL methods, but not in the DE and FR methods. Although the impact is not very large, such effects will influence the numeric outcome and the conclusions

By simply comparing the final relative strictness in the different countries, one may not become aware of these latent effects of certain design choices. From the semi-detached dwelling case, it can be seen that such effects may result in variations of 20-30%. The results and conclusions may thus be influenced enormously by such effects.

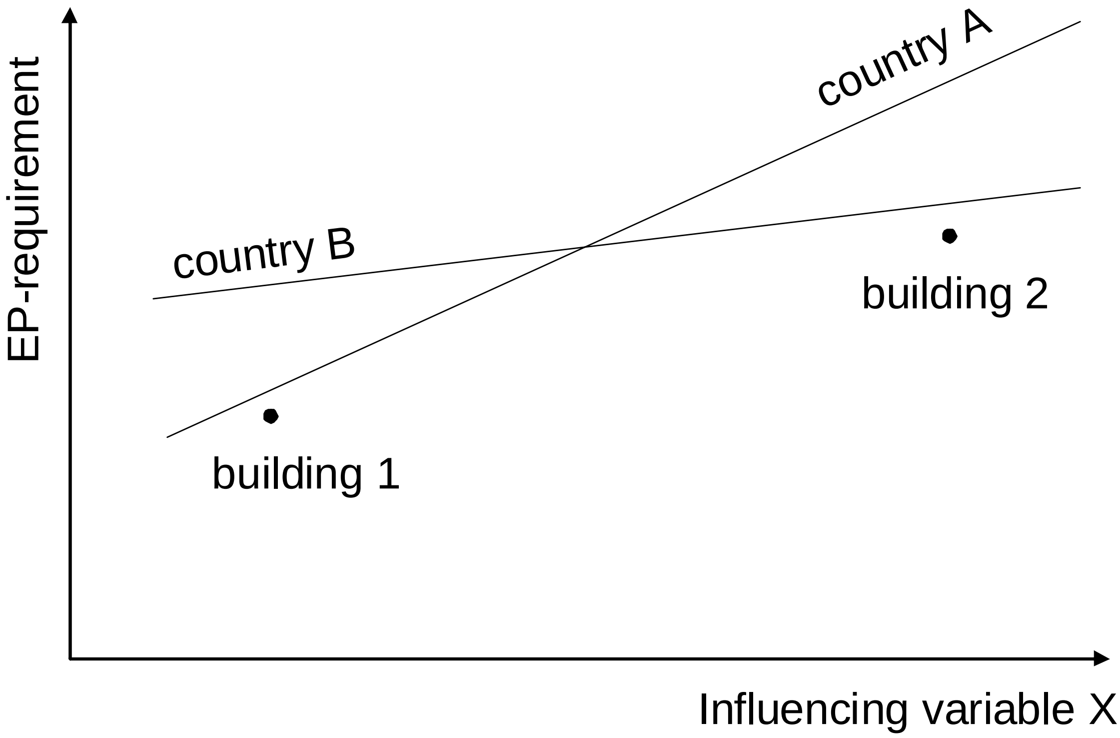
In order to make the comparison more reliable, and get a better feeling of the uncertainty, several building variations (both in terms of geometry and technical installations) should be calculated and compared. This, of course, multiplies the required time and effort.

b) Within a given EP-method, there may be a range of calculation choices, e.g. a simple default value and (one or more) detailed calculation methods. All these options are equally valid. The numeric results that are obtained following the different options may vary strongly, though. Generally, default values are rather negative, and detailed calculations (requiring more work and more project specific input data) give better results. Systematically opting for the default or the detailed route, may result in important variations of the final result. There is thus a certain degree of arbitrariness following the choices of the individual calculator in each country. This person to person variation adds to the uncertainty in the overall comparison.
By giving instructions to the different national calculators, for which parts of the calculation to use default methods, and for which parts to use more detailed methods, the degree of arbitrariness can to a certain extent be reduced. However, since each national EP-method has its own particularities, it seems not realistically achievable to fully streamline everything. Certain choices will always remain at the individual discretion of the national calculator.

c) The 2 previous elements (a and b above) concern the uncertainties related to the comparison of specific individual buildings. An even greater issue, however, is the fact that individual buildings may not be representative for the average of all new buildings. The following graph illustrates in a very simple manner one of the problems of principle.

[3] The categories considered are: constant temperature boilers, low temperature boilers, condensing boilers, improved condensing boilers and two combined boiler types used for DHW without external storage.

For the purpose of simplicity for this illustration of principle, it is assumed that the calculation of the EP itself would be 100% identical in both countries (including climate). Suppose the EP-requirement depends on a certain variable X (among many other influencing variables), but the dependence is very different depending on the country/EP-method, as illustrated in the graph. (In some countries the variable X may even not have any importance at all, and then the line would be horizontal.) A practical example (tough not concerning the overall EP-requirement itself) would be the requirement for the mean U-value as a function of the compactness of the building, which is used in many countries.



Suppose the sample building chosen to make the comparison would happen to be building number 1. The conclusion would then be that the requirement in country A would be much stricter than in country B. However, if the building would by chance have happened to be number 2, the opposite conclusion would be drawn, i.e. that country B is stricter than A.

This very simple example illustrates that the choice of the building may condition the outcome. In principle, such effects can of course be attenuated by comparing a larger number of buildings over the entire "spectrum". In practice, however, this does not only greatly increase the amount of work, but it is also very difficult, if not impossible, to make a representative selection of sample buildings because the EP-requirements depend on a great number of variables in a way that is often not very transparent. This is particularly true when the requirements are expressed in terms of a reference building.

Another issue might be that the typical new construction may be different depending on the country. Suppose for instance that in country A mostly large, detached dwellings (left on the graph) are built, and in country B new construction is dominated by small row houses (right in the graph). Even if a large number of buildings, which would be a representative sample of the new construction in 1 country, would be compared (thus giving a representative average, and eliminating the problem of the effect of the random choice of an individual building), the conclusion will be determined by the country from which the sample is taken.

Of course, this example is rather theoretic and simplistic, but it illustrates as a matter of principle some issues that may bias any comparison, and that make it difficult to draw reliable, general conclusions. Readers of comparison studies who are not familiar with these problems, may not be able to put the results of 1 or a few example buildings in proper perspective, and draw too general conclusions.

Also, it should be kept in mind that the enforcement of the EP-regulations varies strongly from country to country. Of course, what really matters is the observance itself of the requirements. If good compliance is really achieved, it doesn't matter whether this comes about spontaneously or through strict enforcement. It is clear, however, that there is a difference between the situation where strict observance is standard and the situation where requirements are not rigorously applied. In the latter, it is easier to set stricter requirements (which aren't strictly followed) on paper. In theory, all this shouldn't matter of course, but in practice it really does.

Finally, also the time since the EP-regulation first came into effect is an important element when considering the strictness of the EP-requirements in different countries. The introduction of an EP-regulation engenders a whole new dynamics:

- all actors in the building sector slowly get more familiar with the EP-methodology
- stepwise, products get characterised and tested according the new specifications, and in a 2nd instance better products are being developed
- designers learn from experience in earlier projects, and are able to achieve better performance in new projects at lower cost
- contractors learn to apply new technologies
- etc.

As the entire construction market gradually transforms in reaction to the new EP-context, it becomes easier for the public authorities to stepwise tighten the EP-requirements. This transition element should certainly be taken into consideration when comparing the requirements in different countries.

4. General conclusion

The present study has shown that it is quasi impossible to draw rigorous general conclusions on the relative strictness of the EP-requirements in different countries with some degree of precision and confidence. And this even when the climates are nearly identical. It is very difficult to arrive at solid, well-founded conclusions that are representative for all new constructions and that can be relied upon. There is a great deal of uncertainty about the extent to which 1 or a few building geometries and system configurations are representative of the average of all new buildings. As shown, a great number of small, random details in the example building(s) may have a determining impact on the numeric outcome and the conclusions. At the cost of much extra time and effort, this degree of arbitrariness can be somewhat mitigated by making individual comparisons of a much larger sample of building shapes and technical systems, so as to obtain an average value and a feel for the spread of the results. However, even this approach will not solve a number of intrinsic methodological problems.

Nevertheless, even if it is not possible to draw definitive conclusions, making comparisons with neighbouring countries remains a useful exercise that does give some insights. It may illustrate methodological differences in the EP-calculation procedures and thus pinpoint to weaknesses and strengths of a given method, and possible ways for further improvements. It may also reveal unknown (and maybe undesirable) effects in the way the EP-requirements are expressed. Rough, sample indications of the strictness of the national EP-requirements compared to the neighbouring countries may also be 1 element in the discussion on tightening the requirements, together with considerations related to the economically optimal energy performance, the degree of compliance with the requirements, the maturity of the market, etc.