Renewable Energies in Energy Performance Calculation for Buildings

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ABSTRACT
This paper discusses the status of standards and regulations concerning performance calculation methods for renewable energies systems in the built environment. The outcome of a European wide inquiry on this topic, carried out in the frame of the European project on Energy Performance Regulations (EnPeR) will be presented. In addition an overview is given of the renewable energies systems that are considered under these regulations and the consequences of the new Energy Performance Directive.
In general the European standard for Thermal Performance of Buildings EN832 describes the calculation method for the building envelope. However the consensus is to review renewable energies in the built environment as added installed equipment, such as for ventilation or lighting is performed. The common calculation methods for solar thermal and electrical systems will be discussed in the light of the overall energy performance of the building.
The paper concludes that a long way is to go to have all Member States working with a harmonized calculation method for energy performance of renewable energies systems in the built environment.

KEYWORDS
renewable energies, energy calculation, energy performance, buildings, solar energy

INTRODUCTION

In the proposal [1] for a Directive on the Energy Performance of Buildings (abbreviated to EPD), regulations are presented that describes effective tools to reduce energy consumption in buildings and improve indoor environmental quality. A sustained environment, in which a clear place is reserved for renewable energies, is offered to the European citizen.

The EPD states that the energy performance of buildings should be calculated on the basis of a methodology that integrates, in addition to thermal insulation other factors that play an increasingly important role also, such as heating/air-conditioning installations, application of renewable energy sources and design of the building. Energy performance of a building is defined as: the total energy efficiency of a building, reflected in one or more numeric indicators which have been calculated, taking into account insulation, installation characteristics, design and positioning, own energy generation and other factors that influence the net energy demand.

Concerning the calculation itself, the positive influence of the following aspects shall in this calculation be taken into account: solar systems and other heating and electricity systems based on renewable energy sources.

The work performed in the SAVE - EnPeR project is to obtain an overview of national regulations and calculation methods aiming to define the requirements for a harmonised methodology. Presented in this paper is the outcome of the work, concerning renewable energies in the built environment.
In the European standard for Thermal Performance of Buildings, EN832 (that is under revision at present) the calculation method for the building envelope is described. Only for applications that integrate renewable energies systems in the envelope, that method can be used for thermal performance calculation. The prEN13790 is for residential and non-residential buildings and is at present reviewed also.

RENEWABLE ENERGIES IN THE BUILT ENVIRONMENT

According to the EPD, as renewable energies systems in the built environment will be considered only, solar thermal (for domestic tap water production and space heating) and solar electrical systems (roof and façade, grid connected photovoltaic systems). Installed solar energy systems are expected to be 10 to 15 times more in 2010 than at present, which represents a relative big increase. For these systems, different applications and system technologies have to be considered with consequences for the calculation method in respect to the energy performance of a building.

Figure 1. Roof integrated solar thermal and electrical collectors

The market penetration of renewable energies in general is very low at present but is expected to increase in the coming 10-20 years. In a communication titled “Energy for the Future: Renewable Sources of Energy”[1], the European Commission presented its “White Paper for a Community Strategy and Action Plan”, in order to promote a European initiative. Several strategy reports from industry and international organisations indicate that it is a serious projection. For both technologies, solar thermal and solar electrical, a yearly increase is expected between 25 and 30%, representing in any case a boom for industry.

[1] COM (1997) 599, 26.11.1997

Solar thermal
According to ASTIG (Active Solar Thermal Industry Group) the thermal water collectors are used for tap-water or space-heating, respectively 80% and 15%; only 5% are mixed systems. Most of these systems are placed on the roof of the building. Germany, Austria and Greece are the countries with the highest number of installed systems (represents about 75% of EU installed installations). By the year 2010 a total of 100 million m^2 is expected to be installed. Note the uncorrelation between market penetration and standardised calculation rules (see table 1).

The following solar thermal systems are taken into account.

- Thermo-Siphon systems
- Integral collector storage model (ICS)
- Open loop active systems
- Drain down systems
- Closed loop active systems
- Drain back closed loop systems
- Air systems (only in Greece)

Solar electrical
Recent published reports show that the photovoltaic industry is preparing for a considerable increase in production. Some expect 3TWh of installed PV systems by the year 2010. In 2001 a worldwide production of 380 MWp was shipped of which is 85% poly- or mono crystalline silicium. About 12% are thin-film modules. Japan is the biggest producer and expects an increase of the production by 25% per year. The outcome of the PV CITY GUIDE project (DG RESEARCH) indicates that more than 50% of PV installations will be in urban areas, mainly on roofs of buildings, but large facades are expected to become interesting objects as well.

Integration of PV in the built environment should be considered from different points of view. It is a complex issue, since it produces electricity and at the same time it might have its impact on the insulation level of the building. In addition and depending on the application, it might influence other aspects of the overall building performance as well, leading to the conclusion that it should be considered as a building component for which its intended, such as shading device (passive component), window (gA value), cladding (retrofitting) or as a special device for pre-heating of air.
Concerning the produced electricity the requirement to the feed it into the grid is set by law. The Renewable Electricity Directive [2] states that in the coming years the Member States will have to put in place a ‘green electricity’ certification scheme that should certify the origin of the renewable energy source. As a consequence all RE produced energy is traced (quite accurate data is obtained) and feed into the grid, whereas the tenant of the house buys it from one or more electricity providers. RE-electricity produced by the building will therefore not appear in the EP of the house (as is stated for example by Germany). At the same time it will create conflicts with the so-called low-energy house supporters taking away a big deal of their energy balance for the house.

RE CALCULATION STANDARDS; STATUS

Within the frame of the SAVE - EnPeR project two enquiries were prepared to obtain an overview of the present and the expected situation concerning the calculation methods for renewable energies systems in national building regulations. Few countries could provide information on the Renewable Energies calculation requirements in their building energy regulations for the very simple reason that it is a relative new technology. From France and Belgium draft proposals for standard were received. Italy, Germany and the Netherlands have calculation method in the standard. The obtained information is not enough to make a conclusion that tells how the calculation methods are implemented. Concerning solar electrical the conclusion will be that at present only one country has implemented a specific method that can fulfil the expectations, but it under revision again.
Concerning solar thermal one may distinguish between two approaches: a label approach and a calculation method. The trend is however that several countries are looking into the matter, regarding the proposals for a calculation method that are mentioned.

TABLE 1.
Overview of available standards that include calculation for Renewable Energies

Standard	Tap water	Space heating	Electrical	Calculation period	Unit
NL, NEN5128	simple	simple	yes	year	MJ
BE, proposal	simple	simple	yes	month	MJ
DE, DIN4701-10	detailed	no	-	year	kWh
FR, proposal	f-chart	f-chart	-	Month, 3 zones	kWh
IT, UNI8477-2	f-chart	no	-		
GR	label	label	-	n.a.	n.a.

Often references are reported to EN832 [3], but that does not include calculation rules for RE and therefore is not considered.

Apart from collecting available standardised calculation methods the following questions were raised:

- Should Renewable Energies be considered at building level or at installation level?
- Are there at present incentives for the use of Renewable Energies?
- What information is available about benchmark values of RE?
- Are there simplified methods available to assess the impact of RE?
- What is/should be the driving force behind Renewable Energies? :

Renewable Energies at building level or at installation level?
The standard EN-832 is based on the building envelope. It remains a matter of definition how to deal with RE. As a consequence, one may review the RE technologies in the building in two ways:

- As a part of the building envelope (building construction product; IEC is working towards a certification for PV products for both safety and performance)
- Building added installed equipment (such as for lighting, mechanical ventilation systems, etc.)

Both options have advantages and disadvantages.
There was not a clear reply. Some countries like to consider RE at installation level, but problems were mentioned as well with such approach, like: electricity feed into grid and water collectors for space heating. There was no consideration of envelope PV integration, leaving out the problem of thermal impact on the overall building performance.

Are there at present incentives for the use of Renewable Energies?
Subsidiary schemes for thermal solar and some countries for electrical solar systems are reported; most are based on tax-reduction schemes and sometimes put in place at regional levels.

What information is available about benchmark values of Renewable Energies?
Few countries could report figures. In general neglect able figures are reported, however the expected trend is a considerable increase until 2010 in particular PV (and wind)

Are there simplified methods available to assess the impact of Renewable Energies?
Several methods are reported for both solar thermal and solar electrical. How widespread they are and common in use is unclear.

What is/should be the driving force behind Renewable Energies?
A mixture of answers was the result: but mostly cost benefit. Some report energy consumption reduction as the driving factor. The latter is clear for solar thermal. For solar electrical it is more complex due to grid delivery requirements

CALCULATION METHOD FOR SOLAR ENERGY

In principle the calculation concerns the conversion of solar energy into useful thermal and electrical energy. The conversion takes place at component level with a component specific efficiency, whereas a further reduction takes place due to boundary conditions, system operation, utilisation and sometimes due to shading effects.

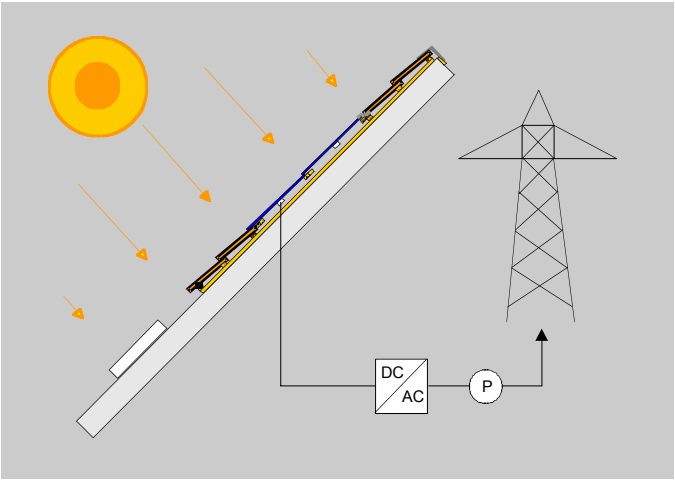

Figure 2. Schematic view of a grid connected PV roof system

The complexity of the calculation rule depends on the level of detail the system is represented. Nine corrections factors are distinguished in the German solar thermal calculation rule while the Dutch calculation rule has three reduction factors.
A simplified calculation rule is given below:

$$Q_{useful} = Q_{solar} * A_{area} * C_{conv} * RF_{reduction} * S_{shading}$$

Q_{useful}	Useful thermal or electrical energy
A_{area}	Effective thermal or electrical area
Q_{solar}	In falling solar energy / m^2
C_{conv}	Conversion factor at component level, 0 .. 1
$RF_{reduction}$	System reduction factor, 0 .. 1
$S_{shading}$	Reduction factor as an effect from shading, 0 .. 1

DISCUSSION AND CONCLUSION

How to deal with PV in renewable energy calculation for the energy performance in buildings?

This might leave the impact of RE integrated applications and installations at thermal level only. The PV should be considered as the construction component that it is substituting or represents the functionality (window, roof, shading device, etc.) that might be covered basically by EN 832 (as some of the participants to EnPeR are doing). However it is not that simple since it is difficult to assess the thermal characteristics of PV building components (PV industry is providing electrical characteristics) in the installation boundary conditions.

How to harmonise solar energy calculation rules? A first step towards harmonisation could be to apply the same databases for solar radiation, being the most important source for the calculation. The recently published European Solar Radiation Atlas (ESRA, ISBN:2-911762-21-5) could be that source. A second step could be to agree on a simplified calculation method that contains the principle parameters for reduction and to built a database that contains the essential parameters and calculation reduction factors, to describe the solar thermal and solar electrical systems.

It is a question often raised at various occasions within different groupings ranging from architects, decision makers, industry, research, etc., how to deal with PV components? Are they building components that produce electricity? Or are they simply components of building installations?

Concerning the renewable energy calculation methods, a long way is to go before all Member States agree upon a harmonised method.

REFERENCES

[1] Directive on the Energy Performance of Buildings Draft 16 April 2002
[2] Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity, market. OJ L 283, 27.10.2001, p.33
[3] EN 832 - Thermal Performance of Buildings; Calculation of energy use for heating – residential buildings.