Innovative technologies

Experiences from new buildings

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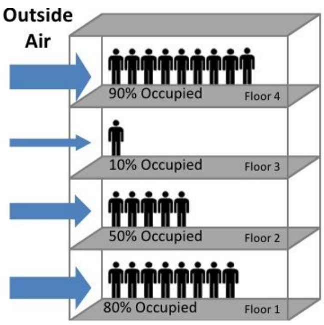
Introduction

The move towards Nearly Zero-Energy Buildings (NZEB) in the Member States has allowed for innovative technologies to be steadily introduced into the building markets over the last few years. The purpose of this factsheet is to collect and present initial experiences with new technologies in the Member States. Information has also been gathered on how Member States incorporate these technologies into their national Energy Performance (EP) calculation methods. The innovative technologies discussed in this context are demand-controlled ventilation, home-automation systems, reversible heat pumps (for cooling in summer), and advanced solar-shading systems.

Considering all four technologies, system variations, how commonly they are used, and in which types of buildings, differ widely among the participating countries. Also, the system's impact on the building energy use is calculated differently from country to country and from technology to technology. An exchange of viewpoints between countries, as well as with the "*European Committee for Standardization*" (CEN), is expected to contribute to the broader use of innovative technologies.

Demand-controlled ventilation



Demand-controlled ventilation includes mechanical exhaust systems and balanced mechanical ventilation systems, with heat recovery coupled with different control strategies such as CO_2, temperature or humidity control. Several countries report a high ratio (>50 %) of mechanical ventilation systems in new buildings. The calculation is often performed by the use of a detailed method as part of the standard calculation method, although a few countries use rough estimates. The main advantage of demand-controlled ventilation is seen through improved indoor climate. Disadvantages include high maintenance efforts and the need for a better design of the mechanical ventilation systems in many cases.

Some technologies are not covered by national calculation methods, thereby discouraging the uptake of these systems, unless an alternative assessment procedure is made available. This hampers market penetration even when the market for the technology is mature. One such example is demand-controlled ventilation; when looking at alternative procedures, consideration must also be given to indoor air quality as to how to assess the energy-saving potential of the system.

In France, Belgium and the Netherlands, there are specific procedures that allow the integration of demand-controlled ventilation in the EPC calculation method. In France, a default value for humidity-controlled ventilation is provided, but a better result is possible if a technical advice document is available (this is delivered by the Scientific and Technical Centre for Building (CSTB). In Belgium (from 2014), a table for residential demand-controlled ventilation systems with default values is provided in the EPC calculation method; it is no longer possible to obtain better results by means of alternative values. In the Netherlands,

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the principle of equivalence is foreseen in the building decree for all technical building systems and advanced envelope components. At present, demand-controlled ventilation systems can be incorporated into the calculation using a detailed table, and at the same time it is possible to prove better results by carrying out a specific study. Although there has been some convergence regarding the specifications for such studies, they can still be carried out in different ways by competing providers.

While there are certain similarities between the approaches used in the three countries, there are also substantial differences, and in particular in terms of procedures to be followed and results obtained for specific systems. And though all three have stimulated innovation, the differences between the approaches nonetheless form barriers to innovation.

Two special versions of demand-controlled ventilation are discussed in more detail in the following sections.

Exhaust ventilation

The exhaust-only and balanced ventilation systems are incorporated into the national EPBD calculation by use of a detailed method in Germany, Poland, Portugal, Norway (for large residential buildings and non-residential buildings), as well as Estonia, Italy, Malta and Belgium (for some dwellings, dependent on the details of sensors and system operation). Instead of a detailed calculation, rough estimates are used in Norway (for small houses), Lithuania and Belgium (for non-residential and for some residential buildings, dependent on the details of sensors and system operation). The calculation method should also take into account systems with more advanced controls, such as those based on a combination of temperature and CO_2 controls, which are common in Italy.

The main advantage of exhaust-only systems in particular is thought to be their lower energy consumption (for operating the system) compared with balanced mechanical systems, and the need for fewer vents in the building envelope. However, the lower energy consumption of exhaust-only systems may not fully compensate for the loss of energy, which could have been recovered from the exhaust air using a balanced system. The main disadvantage identified with exhaust-only systems was the greater difficulty in handling the needs of more complex buildings (e.g., blocks of flats).

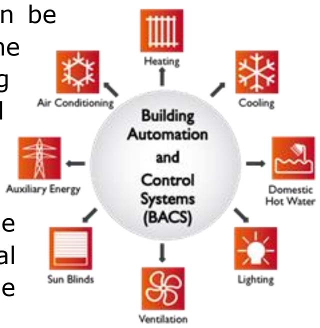
Balanced ventilation

Balanced ventilation systems with heat recovery can be handled directly in EPC calculation tools of most countries. However, in certain cases, more advanced systems with demand-controlled ventilation need to be addressed in more detail. In Denmark for example, demand-controlled ventilation is handled as a rough table of values in dwellings, while non-residential buildings require more detailed parallel calculations as input to the national calculation tool.

The main advantage of demand-controlled ventilation systems is that they have a positive impact on the indoor climate. Typical disadvantages include the needs for regular maintenance checks, for improvement of system design, and for users to understand the systems once they are in use, i.e. a user's guide is needed.

Building automation systems

Building automation systems for both residential and non-residential buildings can be grouped according to EN 15232 into classes A to D, with class A representing the most advanced holistic building automation systems, and class D representing simple manual controls. Classes A and B are mostly applied in new non-residential buildings.



The calculation of the impact of building automation systems varies between the use of fixed factors, e.g., rough estimates, detailed calculations within the assessment method, and the use of more advanced external tools. In several Member States, building automation systems cannot be assessed directly using the national method and, hence, the provision must be calculated in alternative ways.

The advantages of building automation are the general need for well-designed control in contemporary advanced buildings and the possibility of real-time monitoring. The calculated energy savings in assessment methods are regarded by the MS delegates as overestimated and they are only delivered after a thorough commissioning of the system. Users often do not understand the systems without a user's guide and it is difficult to find a programmer that can work with an existing, often poorly documented system. Investment and maintenance costs are considered to be high.

In Finland, a study in 2012 found that regulations usually do not take into account energy efficiency improvements which are due to building automation. Current standard practice is at the class B level, but there is no specific requirement for a high-level building automation system. Automation features meeting, at the very least, class C level could be required in the future. Experiences in Finland are that it is timeconsuming to provide evidence showing that a particular system is more efficient than the default figures which are otherwise used, and that such systems will not remain well-tuned and energy-efficient unless they are properly commissioned and maintained.

Additional experiences from Germany show that user satisfaction is achieved when users can noticeably influence the system and when controls and displays are easy to understand. User dissatisfaction occurs when the information given to users is insufficient in quantity or clarity, when automation is not reliable (especially if there is no manual override), or when regular user intervention is required.

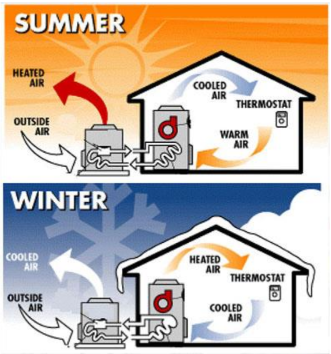
In Belgium, EN 15232 has not been applied (December 2015) and in Latvia there are no requirements for building atomisation systems.

Building automation systems are incorporated into the national EPBD calculation by use of a detailed method in Estonia (classes A, B and C) and Norway (for lighting only). Rough estimates are used instead of a detailed calculation in Estonia (class D), Poland, Greece, Belgium, Croatia (using CEN standards), France, Italy and Germany (classes A and B in non-residential buildings). These systems are not included at all in the national methods of Slovakia, Germany (in the simpler calculation method that can be used for residential buildings), Portugal, Austria and The Netherlands (except for non-residential lighting). An external calculation tool is used in Sweden (for classes A to C).

The main advantage of building automation systems seems to be the ability to monitor the building in real time and the energy savings produced. However, it seems that savings are often overestimated.

The main disadvantages are related to the typical complexity of the systems and the way that users interact with them. In particular, the importance of well-designed controls, especially for centralised ventilation and heating systems, is key. Difficulties with programming the systems correctly and in ensuring that users understand the systems, also need focus. The costs and time of maintenance and repair are considered to be high. These issues make it difficult to estimate the energy related benefits of home automation systems.

Reversible heat pumps



Information on seven different types of reversible heat pumps has been collected and discussed depending on the source and the sink. The use of the specific systems differs from country to country. In Sweden, reversible heat pumps can be calculated by using an external simulation tool. Other countries assess the impact of heat pumps either by using a detailed method within their calculation procedure, or by using a fixed factor as a rough estimate. The obvious advantage of a reversible heat pump is that only one system is needed for heating and cooling. However, the systems are considered to be rather expensive and may still be problematic in cases where fluorinated gases are used.

Approximately 700,000 air-to-air heat pumps are installed in Norway. Although cooling may not appear to be an issue based on monthly or yearly climate figures, the highest temperature recorded in Norway in 2014 was greater than 33 °C and energy demand in the summer has increased recently due to comfort cooling. Before 2007, it was typical for new buildings to have a large share of glass in the facades and in practice, these buildings often have a cooling demand which is at least twice the heating demand.

Low-energy buildings often use shared heat pumps, and sharing heat pumps between different building types allows heat to be transferred between buildings due to the different heating and cooling demand profiles associated with different building uses.

The countries including reversible heat pumps in their official EPC calculation procedure/tool using a detailed method are, among others, Belgium (for non-residential buildings), France, Lithuania, Croatia and Portugal. It should also be noted that Croatia's method is based on EN 15316-4-2. The countries including reversible heat pumps in their official EPC calculation procedure or tool through the use of fixed factors as a rough estimate instead of a detailed method are, among others, Belgium (for residential buildings), Greece, Cyprus, Poland, the Netherlands and Latvia. Additionally, Greece, Poland, the Netherlands and Latvia use monthly figures. In Sweden, reversible heat pumps can be modelled using an external simulation tool.

The main advantage of these systems is that no extra system is required for cooling, while the main disadvantage is that they are more expensive and may be subject to regulations regarding the use of fluorinated gases. Additionally, implementation of this kind of systems in buildings may lead to an increased energy consumption as comfort cooling becomes available in climate regions where cooling is not traditionally considered.

Advanced solar shading systems

There are several solar shading systems that are still considered innovative in the market, including shading in-between the glazing, semi-transparent PV, double façades with integrated shading, switchable sun-protection glazing and bio-shading. Most systems can be modelled only by using an external simulation tool. Bio-shading can be calculated using a rough estimate or an external simulation tool. However, most countries do not take bio-shading into account in their national calculation standards. Advantages and disadvantages strongly depend on the different systems.

In Sweden, all the above systems can be modelled using an external simulation tool. In addition, sun-protection glass and bio-shading are included in Italy's official EPC calculation procedure/tool through the use of rough estimates. A study on the assessment of semi-transparent PV is ongoing (2015) in Austria. Sun-protection glass is common in most countries and can be modelled using the traditional EPC tools.

Sun control and shading devices are important in many building design strategies for reducing cooling loads and glare, and improving thermal comfort. These devices can be external (more effective at controlling solar loads), or internal (often easier for users to manipulate, especially to control light). The use of more sophisticated systems to operate solar devices can increase energy saving results, especially when integrated with other systems, such as the HVAC system of the building. The use of shading devices can have a large impact on design, especially for non-residential buildings. New high-level (expensive) office buildings often use unusual shapes or movable devices with advanced control systems. Consideration should be given as to how the behaviour of these devices can be included in EPBD standards.

Advanced solar shading systems are generally not considered as cost-efficient as energy saving measures in northern Europe, however they are commonly used as glare protection in office buildings. The main advantages of double-facade systems are identified as the reduction of heat and noise and the protection of shading systems, however double facades are costly. The main advantage of sun protecting glazing is the low cost while the main disadvantage of sun-protection glass, especially in residential buildings without cooling demand in winter, is that it reduces solar loads in winter and can lead to increased heating demand.

In NZEB, solar shading may well become a necessity, even in climates where cooling is not normally considered a problem in residential buildings. Shading systems may well become a necessity in existing and regular new buildings as well. Correct inclusion of all kinds of solar shading in EP calculations is crucial to avoid unwanted use of mechanical cooling, e.g., in combination with reversible heat-pumps.

Conclusions

It is expected that new and/or innovative systems will become increasingly popular in both new buildings and existing buildings that undergo major renovations. However, the number and variety of systems handled in MSs' energy performance calculation procedures varies significantly, and many systems are excluded from standard calculation procedures. In order to support innovation, it is necessary to accommodate the effects of these systems in national calculation procedures, either by including them in the standard calculation tools, or by proving their effectiveness in external, more advanced tools.