4 ENERGY CERTIFICATION OF BUILDINGS

The purpose of the EPBD is to reduce the use of energy in buildings. One of the ingredients in this enormous task is to determine numeric indicators for buildings so that goals can be defined both when constructing new buildings and renovating existing ones. However, the greatest savings potential can be found in existing buildings and this requires the status of these buildings to be investigated to find the available improvement potential. The provision of energy certificates is one way in which this can be achieved.

Put briefly, energy certification of a building means that the energy performance of the building can be determined and compared to numeric indicator values. The building can then be rated in relation to other buildings, in an individual member state, and suitable recommendations can then be made to reduce energy use.

Where most dwellings and commercial buildings are concerned, a valid energy certificate will be required to be displayed when they are built, sold or rented out. In this way it is hoped that the market itself will contribute to the initiation of energy saving measures, as there will be a significant value in having an energy-efficient building. In the case of public buildings, this value will be even more obvious, as their owners will be expected to set a good example and because they will be obliged to have the energy performance certificate available and clearly visible either in or on the building.

4.1 What does the Directive say?

In principle, the Directive, in Articles 7, 10 and 15, comprises the following overall framework for energy certification:

- An energy certificate, not more than 10 years old, must be made available when a building is constructed, sold or rented out.
- The general exceptions regarding buildings (see Chapter 3) are applicable.
- The energy certificate must include reference values so that it will be

possible for consumers to compare and assess the energy performance of a building.
- The energy certificate must be accompanied by recommendations for energy performance improvements that can be carried out in a cost-effective way.
- In public buildings with useful floor areas over 1000 m² and which provide public services for a large number of people, an energy certificate, not less than 10 years old, must be placed clearly visible in a prominent place.
- The certification of buildings and drafting of recommendations must be carried out in an independent manner by qualified and/or accredited experts.
- The Directive must be implemented via legislation and regulations by 4 January 2006. However, the introduction of energy certification may take an additional three years, if there are too few independent experts.

Thus the Directive describes, in brief, the minimum requirements regarding energy certification of buildings. It is then up to each and every member state to draft more detailed guidelines.

The following sections provide an overview of the implementation and application of energy certification in Sweden and four other member states.

4.2 Sweden

The introduction of energy certification in Sweden, based on the articles of the Directive, has resulted in the following documents:
- SFS 2006:985, *The Energy Declaration of Buildings Act* (passed by the Swedish Parliament)
- SFS 2006:1592, *The Energy Declaration of Buildings Ordinance* (passed by the Swedish Government)
- BFS 2007-4 BED1, *Regulations for Energy Certification of Buildings* (issued by *Boverket*, the National Board of Housing, Building and Planning)

– BFS 2007-5 CEX1, *Regulations for Accrediting Energy Experts* (issued by *Boverket*)
– BFS 2007-14 BED2, *Regulations Regarding Changes to the Regulations for Energy Certification of Buildings* (issued by *Boverket*)

These mandatory documents, described in brief below, thus regulate the energy certification process in Sweden.

4.2.1 BUILDINGS

The Energy Declaration of Buildings Act defines the buildings that have to be certified, according to the instructions given in the Directive. From 1 January 2009, an energy certificate, not more than 10 years old, must be available when:
– A building is sold.
– When a building is constructed, if planning permission is applied for after 1 January 2009. However, certification is not required until two years after the building has been taken into use.

In addition, for certain buildings, a valid energy certificate, not more than 10 years old, must be available and posted clearly visible in a prominent place. This certificate is required for:
– Buildings that are rented out.
– Special buildings with a usable floor space over 1000 m^2.

As pointed out previously, the term 'rented out' applies to all types of blocks of flats (rented or owner-occupied) as well as other buildings that are rented out to users, even if only part of a building is rented out. The term 'special buildings' means public buildings used for public services. See Chapter 3 for a more detailed description. All special buildings over 1000 m^2 and blocks of flats must, by law, have been certified by 31 December 2008. For more information regarding the time schedule for certification, see Chapter 6.

According to Ordinance SFS 2006:1592, exceptions can be made with regard to Act SFS 2006:985 for a number of building categories. These comprise the general exceptions, given in the Directive, as well as

a number of other buildings, but only where energy certification is concerned. These exceptions have already been specified in Chapter 3.

4.2.2 ENERGY CERTIFICATION

In most cases, an accredited energy expert carries out the energy certification on site, although the work is simplified, and costs reduced, if the client, i.e. the property owner, can produce relevant documentation, such as measured energy use, drawings and reports from mandatory ventilation inspections (OVK) and radon measurements. In the energy certificate that is then compiled, and electronically registered at *Boverket*, the following must be stated:

– The measured energy performance of the building

The use of energy comprises the corrected average yearly amount of bought energy for heating, comfort cooling, domestic hot water, service installations and other electrical energy for building services (the electricity used for the activities/operations carried out in the building and for domestic purposes are thereby excluded). The energy performance is to be stated in kWh/m², where the floor space in the building is defined using the term A_{temp} (A_{temp} is the floor area in a temperature-regulated space, within the interior of the building envelope, that is intended to be heated up to more than 10 °C).

– Reference values

Three reference values are given in the energy certificate:

1. *The energy use of the building is graded according to where it is placed on a scale comprising the contours of seven buildings placed within one another, see figure 4.2, representing the energy performance of the whole of the building stock and in which the best rating is 50 kWh/m² and the worst is 400 kWh/m². This scale may be revised when more buildings have been energy-certified.*
2. *The requirements stipulated in the Swedish building regulations for new buildings are to be stated.*
3. *A typical range of values for buildings, similar to the building in question, is to be stated. The range is drawn up with the help of statistical data for a building located in the town of Eskilstuna, with the*

values corrected for the building depending on its type, age, locality, heat source and use of cooling, if applicable. The range is determined by increasing or decreasing the corrected statistical values by 10 percent or 20 percent, depending on the type of building.

– Recommendations (if possible)

An independent energy expert shall first assess whether it will be possible to propose recommendations for cost-effective measures to such a degree that a survey of the building is justified. If not, the expert may give general advice about improving energy efficiency. If a survey is carried out, the proposed measures must be cost-effective and not lead to negative consequences with regard to the indoor environment or the cultural value of the building.

– Information regarding the mandatory ventilation inspection (OVK) certificate and radon measurements

If a mandatory ventilation inspection has been carried out, this must be stated on the energy certificate. However, the results of the inspection need not be disclosed. The same applies to radon measurements.

– Information about the air-conditioning system

If a building is equipped with an air-conditioning system with an effective cooling power output greater than 12 kW and which is mainly electrically powered, this system must be inspected and the following data determined and stated in the certificate:

- *The energy efficiency of the air-conditioning system.*
- *The size of the air-conditioning system in relation to the building's cooling needs.*
- *Whether it would be possible to achieve greater energy efficiency when running the system, either the existing one or a new one.*

– Information about the geographical location of the building
– The date of certification
– The name of the independent expert who carried out the certification assignment

– A summary

The results of the energy certification process are to be summarized in an energy certificate in which the energy classification of the building, its energy performance and the appropriate reference values are clearly stated.

4.2.3 CLASSIFICATION

In addition to the certification process resulting in a report, a summary is also produced, in the form of a certificate. Iin the case of special buildings and buildings that are rented out, the certificate must be displayed in a visible place. The certificate states the energy classification of the building. How the classification is determined and illustrated graphically is up to each member state. In the EU, the classical model, also used for white goods, dominates and shows the energy efficiency rating of a building on a scale from A to G (sometimes with the addition of extra classes, such as A+ and A++). A so-called speedometer is also sometimes used to illustrate the rating on a horizontal scale.

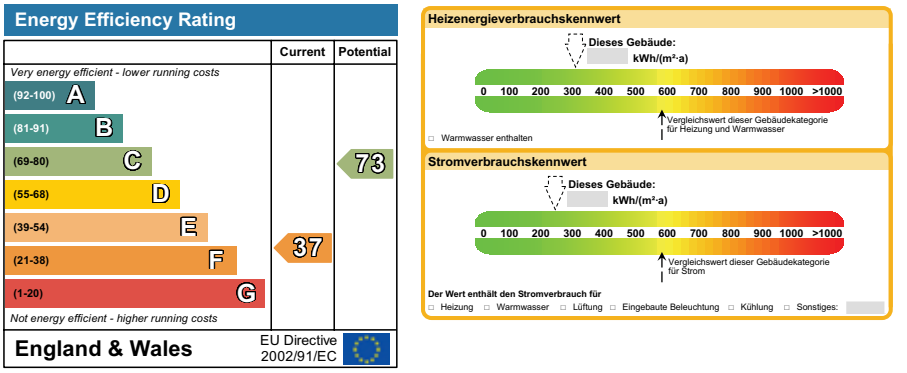


Figure 4.1 Energy certificate design used in the EU. See pages 104, 105.

In Sweden, however, an own version of the certificate is used comprising 7 stylized building contours placed within each other, see below, in which the innermost and smallest building corresponds to the best rating (less than 50 kWh/m^2), while the outermost and largest building corresponds to one with the lowest energy use rating (greater than

400 kWh/m²). The position of a small building silhouette indicates the rating of the building in question. In addition to this certification, the building's use of energy is stated and shown in relation to the minimum requirements stipulated for new construction and also in relation to the reference range for similar buildings.

Figure 4.2 Energy certificate (summarized) used in Sweden. See page 106.

A Swedish standard, which will supplement the European standard (SS-EN 15217), for energy certification of buildings is, however, now being produced. This will recommend a graphical design of the classification in accordance with the white goods model with rating classes from A to G. The standard will also recommend the use of four different indicators for the building in question:

– The calculated heating power requirement at the design outdoor temperature.
– The measured energy performance (excluding electrical energy used for domestic purposes and/or for activities/operations in the building).

– The assessed environmental impact (based on weighted energy use).
– The measured use of electrical energy for domestic purposes and/or for running the activities/operations in the building.

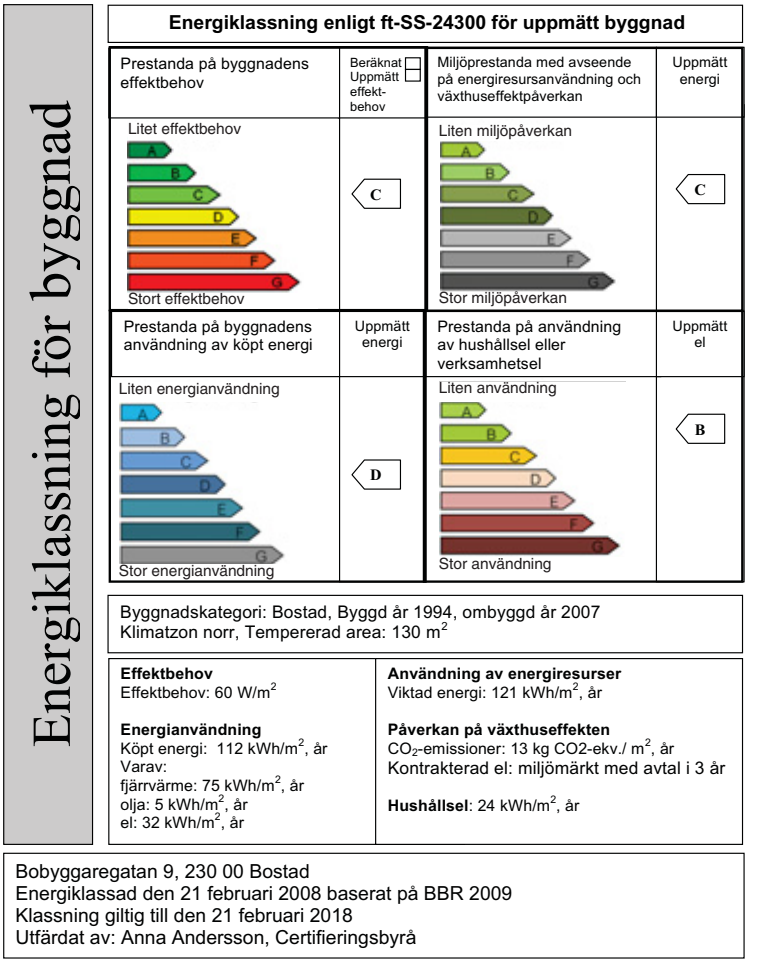


Figure 4.3 Preliminary design for the new Swedish energy certificate according to SS-EN 15217. See page 107.

Environmental impact is assessed based on a weighted use of energy in which different factors are used for different energy sources. Consequently, the weighting factor for oil and electricity might be significantly

greater than the factor for bio-fuels, although this will be decided based on political standpoints.

4.2.4 INDEPENDENT EXPERT

According to the Directive, a qualified and/or accredited expert must be engaged to carry out the energy certification work. This expert must also operate independently. In Sweden, this is achieved by ensuring that certain basic requirements are fulfilled with regard to the expert's knowledge and experience.

There are three different approval levels for energy experts:
- Standard *(for simple buildings)*
- Qualified *(for complex buildings)*
- Air-conditioning *(not for buildings, only for air-conditioning systems)*

In addition to general requirements for all the qualification levels, every level has its own list of requirements that must be fulfilled and these are specified in the *Boverket* regulations for certification of energy experts (BFS 2007-5 CEX1). The expert must also pass a test to become a certified energy expert. The certification is valid for 5 years, after which a new test must be taken. This test can, however, be somewhat simpler than the first test, depending on whether, and by how much, the regulations have been changed. In Sweden, there are four certification institutions that have been approved to set these tests and that are allowed to certify energy experts:
- SWEDCERT AB
- DNV *(Det Norske Veritas Certification AB)*
- INCERT *(Installations Certifiering i Stockholm AB)*
- SITAC AB

These four are, in turn, accredited by SWEDAC, the Swedish Board for Accreditation and Conformity Assessment. Companies offering energy certification services must also be accredited by SWEDAC and have at least one employee who is a certified energy expert. These companies are called accredited inspection agencies.

4.2.5 REGISTERING ENERGY CERTIFICATES

When an energy expert has carried out an assessment of a building the data is compiled on an electronic form and is registered in a database, known as GRIPEN, at *Boverket*, where all energy certification data is stored. The input data results in an automatic calculation of the reference values and a complete energy certificate, which the energy expert can then hand over to the client. The last page of the certificate is a summary, including the energy classification, which, in the case of special buildings and buildings that are rented out, must be publicly displayed.

As more and more energy certificates are issued, the reference values, which, today, are calculated using data based on a building located in Eskilstuna, will be revised and instead be based on the measured values derived from existing buildings.

4.2.6 REGULATORY BOARD

The regulatory board is the local municipal authority and it has the power to impose fines on a property owner who has not displayed an energy certificate (in summary) in a building where one is required. For buildings in which energy certificates need not be displayed, there is no regulatory board. However, when a building is sold the buyer can order an energy certificate to be produced at the seller's cost, if the seller cannot produce a valid certificate. More detailed information about the regulatory procedures for energy certificates is given in Chapters 7 and 8.

4.3 Denmark

Energy certificates for buildings in Denmark are, as previously mentioned, not new. They have, in fact, been prescribed by law for a number of years before the adoption of the EU Directive. Originally, there were two different types of energy certificates:

– The ELO (EnergiLedelsesOrdningen, the Danish Energy Management Scheme) certificate – applicable to buildings over 1500 m^2.
  The energy certificate was based on measured values and contained a plan for remedial measures. The certificates were renewed every year (or every three years in the case of buildings which were highly rated with respect to energy use).

– The EM (EnergiMærkningsOrdningen, the Danish Energy Labelling Scheme) certificate – applicable to buildings under 1500 m².
The energy certificate was based on calculated values and was not to be more than 3 years old when a building was sold.

Since 2005, the *Danish Energy Board* has been responsible for the implementation of energy certification of buildings according to the EU Directive. There are now three types of energy certificates, one for each of the following building categories:
– Single-family dwellings
– Multiple-unit dwellings
– Non-residential buildings (including public buildings)

All certification is based on calculated values, although measured values are also given (for heating in dwellings, and for heating and electrical energy in non-residential buildings).

Large buildings, over 1500 m², must have been able to produce an energy certificate (not more than 5 years old) since 1 January 2006.

Energimærkning

SIDE 1 AF 10

Energimærkning for følgende ejendom:

Adresse: Rolighedsvej 22
Postnr./by: 9990 Storstaden
BBR-nr.: 123-123456
Energimærkning nr.: 122780
Erstatter energimærkning nr.: 111111
Gyldigt 5 år fra: 1. juli 2006
Energikonsulent: Jens Pedersen **Firma:** Aktuel Energirådgivning

EKSEMPEL

Energimærkningen oplyser om ejendommens energiforbrug og mulighederne for at opnå besparelser. Energimærkningen udføres af beskikkede energikonsulenter for enfamiliehuse og er lovpligtig.

Beregnet varmeforbrug

- **Udgift inkl. moms og afgifter:** 70.500 kr./år
- **Forbrug:** 5.400 liter olie/år, 13.800 kWh/år

Det varierer, hvor meget varme den enkelte husejer bruger. Det afhænger bl.a. af vejret, husstandsstørrelse, forbrugsvaner, og ønsket temperatur i boligen. Derfor har energikonsulenten beregnet hvor stort normalforbruget er i denne bolig. Beregningen baserer sig på en række faste forudsætninger, se afsnittet på næstsidste side.

Energimærke

Lavt forbrug

A
B
C
D
E
F
G

G

Højt forbrug

A er det bedst opnåelige energimærke, herefter B osv. og G er det dårligste.

Besparelsesforslag

Her er energikonsulentens forslag til at reducere energiforbruget i bygningen. Forslagene er opdelt i to dele. Først vises besparelsesforslag med god rentabilitet. Her er energibesparelsen er så stor, at den betaler investeringen tilbage inden for en periode, som er kortere end to tredjedele af energibesparelsens levetid. De øvrige energibesparelsesforslag har dårligere rentabilitet. Se evt. flere forslag på næste side. Forslagene uddybes i afsnittet om bygningsgennemgangen.

	Besparelsesforslag med god rentabilitet	Årlig besparelse i energienheder	Årlig besparelse i kr. inkl. moms	Skønnet investering inkl. moms	Tilbagebetalingstid
1	Efterisolering på loft af hanebånd og skunkrum	300 liter olie 1.200 kWh	4.600 kr.	33.000 kr.	7 år
2	Hulmursisolering af ydervægge og efterisolering af radiatornicher	840 liter olie 3.200 kWh	12.700 kr.	26.800 kr.	2 år
3	Nye forsatsrammer på alle vinduer med lavenergiglas + tætning af vinduer	600 liter olie 2.400 kWh	9.300 kr.	91.000 kr	10 år

Figure 4.4 A typical Danish energy certificate. See page 108.

In the case of public buildings over 60 m² and other buildings over 1000 m², an energy certificate, not older than 5 years, must be available by 1 July 2009.

In addition, from 1 July 2009, an energy certificate must also be made available, or one must be issued, when a building is constructed, has undergone extensive renovation, is sold or is rented out. The certificate must not be more than 5 years old. This is, of course, also the case with respect to multi-unit dwellings/blocks of flats, for which the energy certificate applies to the whole building. However, a sub-certificate must also be provided for every dwelling unit, in which its specific energy use is stated.

The energy certificate, drawn up by an independent and accredited energy expert, will show the building's energy classification on a scale from A to G, where class B corresponds to the current building standards. Class A is subdivided into classes A1 and A2, applicable to low-energy buildings. A list of recommendations for improvements must also be drawn up and assessed.

4.4 UK (England and Wales)

In England and Wales, the *Department for Communities and Local Government* is responsible for energy certification of buildings and this is regulated in the Energy Performance of Buildings (Certificates and Inspections) Regulations 2007 that came into force on 19 April 2007. The regulations cover the implementation and issuing of two different types of certificates in England and Wales:

– The EPC (Energy Performance Certificate)
  The certificate is issued for dwellings and non-residential buildings and is based on calculated energy use.
– The DEC (Display Energy Certificate)
  The certificate is posted in public buildings over 1000 m² and is based on measured energy use.

From 1 October 2008, an EPC must be available, or issued, when constructing a new building, or renting out or selling a building. The EPC must not be more than 10 years old. This rule applies to all

dwellings and non-residential buildings, with few exceptions. A report with recommendations for improvements must be attached.

In the case of public buildings, a DEC must be issued and posted, if the building is over 1000 m² and is visited by a large number of people, i.e. people who are not just employed in the building. A report with recommendations for improvements must accompany the certificate. Although the DEC must be renewed every year, the recommendations need only be renewed every 7 years.

There are two types of EPCs, one for dwellings and one for non-residential buildings. Where dwellings are concerned, there are two types of ratings – one for calculated energy use and one for calculated environmental impact with regard to carbon dioxide emissions. It is also stated which rating the building could be given, if the recommendations for improvement were to be followed. Only one rating is given for non-residential buildings and this is for carbon dioxide emissions (normalized to the value for a similar typical building) where this typical building has been given the rating 100. This corresponds to the rating D on a scale from A+ to G. The certificates for both dwellings and non-resi-

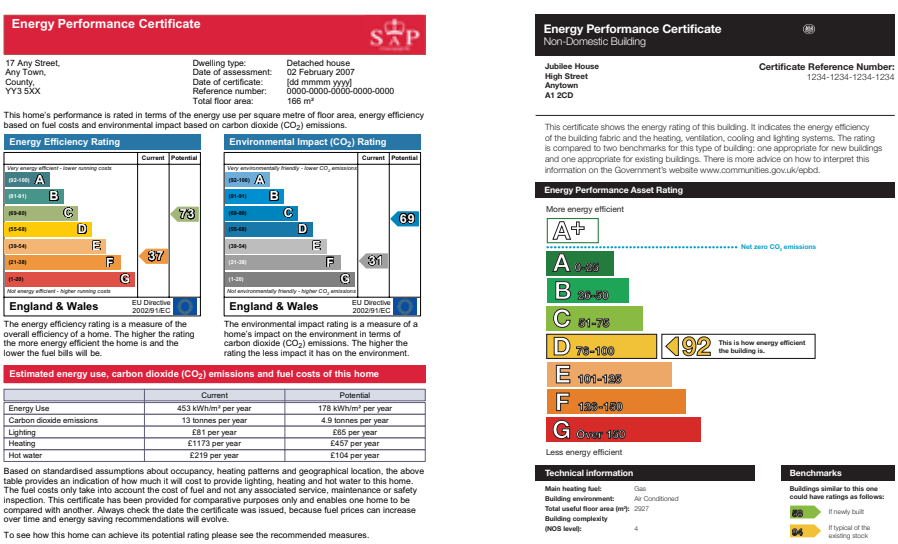


Figure 4.5 EPCs, Energy Performance Certificates, for dwellings and non-residential buildings in England and Wales. See pages 109, 110.

dential buildings also state two reference values – one for new buildings and one for similar buildings.

The contents of a DEC correspond, in principle, to those of an EPC for non-residential buildings but are based on measured values, which makes them considerably easier to update, compared to an EPC, when changes are made in a building or an air-conditioning system.

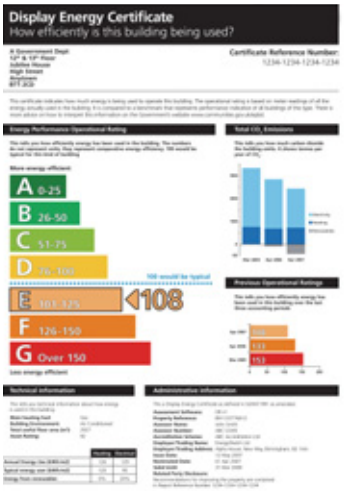


Figure 4.6 A DEC, Display Energy Certificate, for a public building in England or Wales.
See page 111.

The independent energy experts who carry out the energy certification work have different qualification levels depending not only on whether they carry out EPC certification or DEC certification but also depending on the type of building, i.e. if it is a dwelling, a non-residential building, or whether it is categorized as being simple, complex, new or old.

4.5 Czech Republic

The implementation of the EU Directive in the Czech Republic has resulted in legislation (Act 406/2006) regarding energy management in buildings. The implementation of energy certification is regulated in a Decree (148/2007) issued by the *Ministry of Industry and Trade*.

Energy certificates must be available from 1 January 2010 for new buildings, and when selling or renting out a building. For non-residen-

tial buildings, when sold or rented out, and for public buildings, an energy certificate must be available from 1 January 2009.

Until the end of 2005, energy inspections of buildings were, in certain instances, mandatory (as set out in Act 406/2000), which meant that many buildings in the Republic had already been subject to extensive inspections and provided with recommendations for improvements. The former inspection reports were based on measured energy use, whereas the new energy certificates are based on calculations. In the future, energy inspections will be carried out in parallel to energy certification. Energy inspections will therefore often form a basis for future energy certification, which only in exceptional cases will be carried out on site.

To be able to carry out energy certification work, the person involved must be accredited according to Decree 148/2007. Authorization is gained by meeting requirements concerning education/training and experience, and by passing tests. It is most probable that a great proportion of the present 300 energy inspectors will apply for authorization to carry out energy certification.

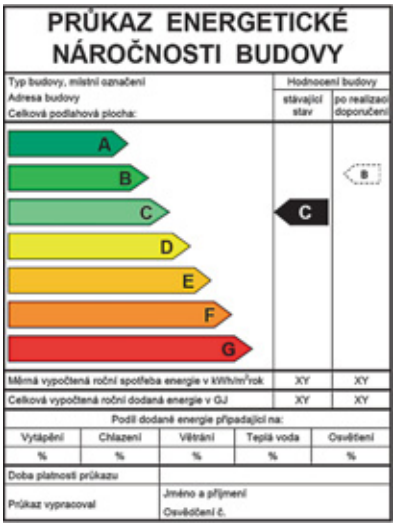
Only one type of energy certification is used in the Czech Republic, no matter what sort of building is involved. Certification is based on calculated energy use for heating, cooling, ventilation, domestic hot water and lighting. Reference values have been defined for 8 different building categories, with 7 energy classes, on a scale from A to G, for each one.

Building Category	A	B	C	D	E	F	G
Single-family Houses	<51	51–97	98–142	143–191	192–240	241–286	>286
Apartment Blocks	<43	43–82	83–120	121–162	163–205	206–245	>245
Hotels & Restaurants	<102	102–200	201–294	295–389	390–488	489–590	>590
Offices	<62	62–123	124–179	180–236	237–293	294–345	>345
Hospitals	<109	109–210	211–310	311–415	416–520	521–625	>625
Education Buildings	<47	47–89	90–130	131–174	175–220	221–265	>265
Sports Facilities	<53	53–102	103–145	146–194	195–245	246–297	>297
Wholesale & Retail Trade Services Buildings	<67	67–121	122–183	184–241	242–300	301–362	>362

Figure 4.7 Energy classes for different building categories in the Czech republic.

New and renovated buildings must reach at least Class C standard according to their energy certificates. There are no requirements regarding energy class where existing buildings are concerned.

The energy certificate comprises 11 pages. On the first page, the energy classification is given by using a letter from A to G and, on the following 10 pages, the building, the calculated energy use and recommendations for improvements are described. At present there is no system in the Czech Republic for storing energy certificate data in a database.


PRŮKAZ ENERGETICKÉ NÁROČNOSTI BUDOVY

Typ budovy, místní označení Adresa budovy Celková podlahová plocha:	Hodnocení budovy stávající stav	 po realizaci doporučení
A		
B		B
C	C	
D		
E		
F		
G		
Měrná vypočtená roční spotřeba energie v kWh/m²rok	XY	XY
Celková vypočtená roční dodaná energie v GJ	XY	XY

Podíl dodané energie připadající na:				
Vytápění	Chlazení	Větrání	Teplá voda	Osvětlení
%	%	%	%	%

Doba platnosti průkazu	
Průkaz vypracoval	Jméno a příjmení Osvědčení č.

Figure 4.8 A typical Czech energy certificate. See page 112.

4.6 Austria

The authority responsible for implementing the Directive in Austria is the *Federal Ministry of Economics and Labour.* Energy certificates are issued in compliance with a federal law, the EAVG (Energieabgabenvergütungsgesetz, the *Law on the Rebate of Energy Taxes*). However, the Law is comparatively general, as every federal state in Austria is individually responsible for drafting its own laws and ordinances that apply to buildings. Consequently, the implementation of energy certifi-

cation can vary from place to place in the country, although common to all is the fundamental platform for calculating the energy performance of buildings. The calculation models have been developed by the OIB (Österreichisches Institut für Bautechnik, *Austrian Institute of Construction Engineering*) and are consequently known as the OIB guidelines.

There are three types of energy certificates, one for each of the following building categories:

- Dwellings
- Non-residential buildings
- Other buildings (for example, industrial buildings with air-conditioning systems)

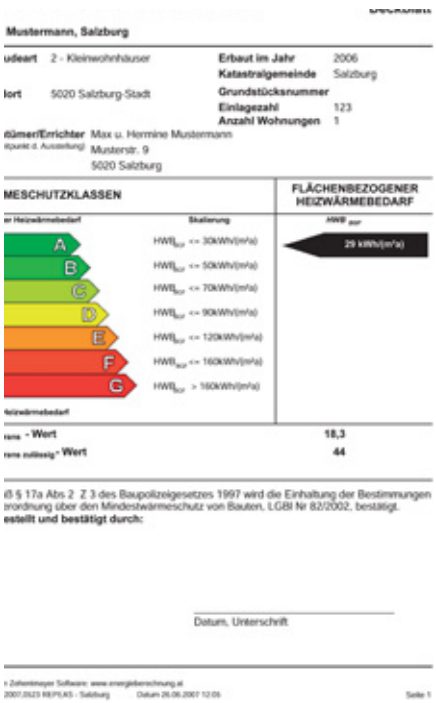


Figure 4.9 A typical Austrian energy certificate. See page 113.

The energy certificates for dwellings and non-residential buildings are quite similar in appearance, and use the same type of energy classification as for white goods. The difference is that, in the case of dwellings, focus is completely on the use of heat, while for non-residential buildings, energy used for cooling, ventilation and lighting is also specified. Recommendations for improvements must be drawn up for existing buildings – but only with regard to the technical aspects of a building's construction, such as additional insulation and replacing windows, etc. Recommendations regarding improvements to air-conditioning systems are not required!

Energy certification in the category 'Other buildings' is only based on a calculation of the U-value of the building. No energy classification is required for these buildings.

The classification scale on the energy certificate covers a range from A++ (0 to 10 kWh/m^2/year) to G (greater than 250 kWh/m^2/year) and the current rating for the building is calculated using the OIB guidelines.

Only organizations, institutions and similar bodies with building technology competence are allowed to issue energy certificates. Consequently, there is no individual certification by energy experts. The federal states are responsible for ensuring the quality of the certificates.