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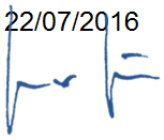
Signature:	

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Abbreviations and acronyms

AC	Air conditioning
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CEN	European Committee for Standardisation
CRI	Color rendering index
DE	Germany
DHW	Domestic Hot Water
EFFESUS	Energy Efficiency for EU Historic Districts Sustainability
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EPI	Energy Performance Index
ES	Spain
HU	Hungary
IECC	International Energy Conservation Code
ISO	International Organisation for Standardisation
IT	Italy
KPI	Key Performance Indicator
LCC	Life Cycle Costing
NZEB	Nearly Zero Energy Buildings
PE	Primary Energy
PMV	Predicted mean vote
PPD	Predicted percentage dissatisfied
RES	Renewable Energy Sources
RESNET	Residential Energy Services Network
SE	Sweden
TR	Turkey
UK	United Kingdom
WP	Work Package

1 Summary

This report presents the results of Task 8.2 Outline energy certification scheme for historic buildings within WP 8 of the EFFESUS project. The objective of Task 8.2 is to propose an outline of an energy certification scheme for historic districts taking into account relevant existing energy efficient districts certification, tools, policies and regulations.

The findings presented in this report begin with an introduction on the implementation of EPBD in some EU partner countries. It continues with presenting a review and analysis of existing certification schemes, policies, regulations as well as EU projects, known methodologies and tools which served as a source of information and database. For the mentioned analysis mainly the countries in which the case studies have taken place - Germany, Hungary, Italy, Spain, Sweden, Turkey and UK-Scotland - were taken into account.

The remainder of this report presents the EFFESUS proposition for a historic district certification procedure in order to facilitate the implementation of measures that can improve the energy performances in historical buildings in Europe.

2 Introduction

This deliverable has been prepared under the task 8.2: Outline energy certification scheme for historic buildings.

The objective of this report is to propose a European harmonised methodology for evaluating the energy efficiency of historic districts.

This report contains the collection of available information on energy performance certifications, energy policies, regulations and national systems in EFFESUS partner countries, moreover district certification methodologies as well as online tools related to districts and buildings taking into account their historical importance.

EFFESUS is a research project investigating the energy efficiency of European historic urban districts and developing technologies and systems for its improvement. The term “historic urban district” in the context of EFFESUS, is defined as a significant grouping of “old” buildings built before 1945 and representative of the period of their construction or history, not necessarily protected by heritage legislation.

Energy performance certification of buildings is a key policy instrument that can assist governments in reducing energy consumption in buildings and help achieve national energy targets and enhance environmental, social and economic sustainability in the building sector.

Certification can be applied to both new and existing buildings, while the focus, methodology, application, output and impact of certification may differ for new and for existing buildings:

- For new buildings, energy certification can demonstrate compliance with national building energy regulations and provide an incentive for achieving a better standard compared with buildings of the same type.
- For existing buildings, energy certification attests to the energy performance of the building, and provides information that may increase demand for more efficient buildings, thereby helping to improve the energy efficiency of the building stock in the country.

Energy performance certification provides a means of rating individual buildings – whether they be residential, commercial or public – on how efficient (or inefficient) they are in relation to the amount of energy needed to provide users with expected degrees of comfort and functionality. The degree of efficiency depends on many factors including: local climate; the design of the building; construction methods and materials; systems installed to provide heating, ventilation, air condition or hot sanitary water; and the appliances and equipment needed to support the functions of the building and its users.

In summary, certification is a complex procedure, requiring in-depth knowledge of building components. It also reflects increasing recognition of the need to think of buildings as "integrated systems", rather than simply the sum of their parts.

3 Implementation of EPBD in the EFFESUS EU partner countries

The 2010 Energy Performance of Buildings Directive (EPBD2010), first published in 2002, is one of the EU's main legislation when it comes to reducing the energy consumption of buildings.

Under the EPBD2010:

- Energy performance certificates are to be included in all advertisements for the sale or rental of buildings
- EU countries must establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect
- All new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018)
- EU countries must set minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.)
- EU countries have to draw up lists of national financial measures to improve the energy efficiency of buildings

Whilst most Member States already had some form of minimum requirements for thermal performance of building envelopes before the introduction of the EPBD, few had any prior requirements for certification, inspections, training or renovation. Indeed, the absence of these requirements meant that entirely new legislative vehicles were required in most Member States, often with responsibilities split across different government departments, and in many cases, devolved to regional authorities.

The implementation of the Energy Performance Certificate (EPC) schemes has been graduated in almost all Member States due to the nature of application of the certificates (Figure 1). While most countries set up the first certification relating to new buildings, the scheme for renovated, existing and new existing public buildings were usually left for later implementation.

Figure 1. Implementing the Energy Performance of Buildings Directive across the EU

Major topics covered by the EPBD across Europe are:

- Certification
- Inspections
- Training
- Energy performance requirements using cost-optimal levels
- Towards 2020- Nearly Zero Energy Buildings
- Compliance and control
- Effectiveness of Support Initiatives

The following sub-chapters 3.1 – 3.8 present EPBD implementation states for energy efficient buildings of the seven countries in which the EFFESUS case studies take place (Germany, Hungary, Italy, Spain, Sweden, UK-Scotland and Turkey) and Norway.

3.1 Germany

In Germany, the transposition of the recast Energy Performance of Buildings Directive (EPBD) is mainly processed via an amendment of the Energy Saving Ordinance (EnEV).

3.1.1 Responsibility

The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, together with the Federal Ministry for Economic Affairs and Energy, are responsible for the implementation of the EPBD. The Renewable Energy Heat Act, which sets a quota for renewable energy used for heat generation in buildings, as well as some aspects of the “Energiewende”, and the inspection of boilers are the responsibility of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.

3.1.2 Energy performance (EP) requirements

The current Energy Saving Ordinance 2012 implements two steps of strengthening requirements concerning the energy performance of buildings in Germany for the years 2014 and 2016. The maximum primary energy demand is lowered two times by 12,5% each and the maximum heat transmission will be cut down in two steps of 10% each.

For existing buildings, the already strict requirements of 2009 are kept in place to a limit of economic feasibility.

The use of renewable energy for heating in new buildings has been compulsory nationwide according to the Renewable Energy Heat Act (Erneuerbaren-Energien-Wärmegesetz). This obligation has even been expanded to certain refurbishments of existing buildings in some federal states.

For all new buildings, primary energy requirements are specified by means of a virtual reference building in geometry, usable area, orientation and basic conditions to use. Due to this reference building approach, each new building has an individual EP requirement that takes its specific details into account. In addition there is

also an obligatory minimum requirement for the energy efficiency of the building fabric. The latter ensures a suitable energetic quality for the envelope, also in cases of heat supply with a very low primary energy factor.

For all new buildings, a certain share of Renewable Energy Sources (RES) to cover the heating and Domestic Hot Water (DHW) demand is mandatory. The exact ratio depends on the chosen energy source, the given default solutions vary in share from 15%, e.g., in the case of solar thermal power, to 50% in the case of geothermal heat.

3.1.3 Energy Performance Certificate (EPC)

In Germany EPCs can be grouped into two categories according to the type of assessment method: certificates on the basis of calculated demand and certificates on the basis of metered consumption. In doing so, all new buildings and cases of major renovation must have an EPC based on a calculation methodology.
The simpler metered energy consumption method only applies for:

- Existing residential buildings with at least 5 apartments, where the influence of individual user behaviour is sophistically balanced by the large number of users
- Smaller existing residential buildings, which at least conform to the first German Thermal Insulation Ordinance for thermal insulation (1977)
- All existing non-residential buildings

The mandatory standard form of the EPC consists of five pages plus an annexed “template for the EPC display”.

Validity of 10 years from the date of issue.

3.1.4 Inspection requirements: heating systems, air conditioning

In the course of the implementation of the first EPBD (Directive 2002/91/EC), Germany decided to have different approaches for heating and boiler inspections on the one hand, and the inspection of air-conditioners on the other.

Regular inspection of boilers is mandatory. Energy aspects concern the flue-gas losses of the boilers, the proper insulation of pipes in unheated spaces and the boiler temperature control, which should take into consideration the outside temperature and the hour of the day.

Improvement of control equipment, pipe insulation and efficient pumps are already common standard in Germany heating systems. Yearly maintenance is signed by the owners on a voluntary basis.
Since the 1st of October 2007, regular inspections are mandatory for AC.

3.1.5 Conclusions

The scheme is advanced already and still under permanent development, a new generation of DIN standards has been decided in 04/2016.

3.2 Hungary

In Hungary, the implementation of the Directive 2002/91/EC on the Energy Performance of Buildings (EPBD) was carried out in several steps between 2006 and 2008. Some of the procedures, however, only became binding in January 2012.

3.2.1 Responsibility

The Ministry of Interior is responsible for the implementation of the EPBD.

3.2.2 Energy performance (EP) requirements

The requirement system has three facets, as far as new buildings and major renovations are concerned. Maximum permitted values are set for the U values of elements and the specific heating energy need ($W/m^3 \cdot K$) as a function of the surface to volume ratio. It is to be emphasized that, the application of elements with the allowed U values does not guarantee the fulfilment of the specific heating energy need requirement: depending on the ratio of wall, window and roof area, stricter insulation requirements must often be applied. The losses from thermal bridges are also considered. Finally, the specific yearly primary energy need must not exceed a limit, which depends on the surface to volume ratio and the type of use of the building. Maximum permitted values are given for a few typical uses (residential, school, office), whereas, in case of mixed use, a reference building is to be considered. The primary energy needs include heating, domestic hot water, cooling and, for non-residential buildings, lighting needs.

3.2.3 Energy Performance Certificate (EPC)

The Energy Performance Certificate (EPC) assigns an EP label to residential and non-residential buildings or building units and it lists cost-effective measures for improving their energy performance.

The practical benefit of energy performance certification is found in the recommendations that are provided to the building owner. These are summarized on page 2 of the certificate. The suggestions include a short description of improvements specific for the building proposed and the impact on the energy rating, if all measures were to be implemented.

Starting from January 2012, all existing residential and non-residential buildings need to be certified when sold.

New buildings must fulfil the requirements of the relevant decree (7/2006 (V.24.) TNM rend.). Those buildings will reach label ‘BB’ or label ‘CC’ depending on some additional conditions (e.g. application of renewable energy). The same rule applies in the case of major renovations.

EPCs are valid for 10 years.

3.2.4 Inspection requirements: heating systems, air conditioning

Hungary has adopted option a) of article 8 of the EPBD, establishing a regular inspection of boilers. The legislative basis is the Governmental Decree 264/2008 of the 6th of November “Governmental Decree on the inspection of heat generation equipment and air-conditioning systems” which has been in force since the 1st of January 2009. The following deadlines were defined:

- 1st of January 2011 - inspection of all heating installations, 15 years and older, with boilers with an effective rated output of over 20 kW
- 1st of January 2013 – first inspection of boilers and AC systems that were installed before the 1st of January 2007
- 1st of January 2015 – first inspection of boilers and AC systems that were installed after the 1st of January 2007

Though the deadlines of the first inspections have expired the inspection of boilers and air-conditioning (AC) systems has not yet been finished. Inspections are on-going and in order to speed them up the National Energy Efficiency Action Plan was established (in accordance with Act LVII of 2015 on energy efficiency).

3.2.5 Conclusions

The recommendation made by experts in the certificate are important guidelines that the owner of the building can make good use of, either in the context of a renovation, or as an individual cost effective measure.

3.3 Italy

In Italy, the first decree setting the basis for the national legislative EPBD framework was enacted in 2005.

3.3.1 Responsibility

The Ministry for Economic Development is responsible for the implementation of the EPBD.

3.3.2 Energy performance (EP) requirements

The Legislative Decree 28/2011 has drawn the general framework for the transposition of the EPBD at national level, setting the minimum requirements for the Energy Performance (EP) and the U-values for windows, walls, floors and roofs, in case of new buildings and major renovations. In 2009, the Presidential Decree n. 59 extended the calculation methodologies and minimum requirements to the summer EP of cooling and lighting systems. It also updated the minimum requirements for the EP of buildings and of heating systems.

With the Legislative Decree 28/2011 transposing the Renewable Energy Services (RES) Directive, the requirements regarding the share of renewable energy for the new buildings and major renovations were increased, establishing a calendar with a progressively larger share of renewable quota for Domestic Hot Water (DHW) heating and cooling energy demand.

3.3.3 Energy Performance Certificate (EPC)

Regional authorities may implement autonomous transpositions of the EPBD, and regional EP certification schemes, as long as these do not contradict the general principles and requirements provided by national and EU regulations.

The legal validity of an energy certificate is 10 years. The EPC needs to be updated whenever the building envelope or systems are modified.

3.3.4 Inspection requirements: heating systems, air conditioning

According to the existing national inspection scheme, the building owner/user is responsible for the periodic maintenance of the heating system, which has to be performed by qualified maintenance staff. The measurement of combustion efficiency, among other maintenance operations and safety checks, is carried out according to the National UNI Standard 10389. Maintenance and energy efficiency assessment are compulsory, their frequency varying according to fuel used, boiler nominal power, age, and specific safety requirements.

An inspection report is filled out by the maintenance staff and is delivered to the Local Administration which is in charge of the compliance control.

Regions and Autonomous Provinces have further detailed the national rules. Local Administrations are in charge of implementing a report inventory.

3.3.5 Conclusions

The recent Decree for the promotion of energy efficiency measures in public buildings, the “Conto Energia Termico” sets the conditions for providing public authorities with the financial resources for getting the desirable leading role in the improvement of Energy Performance (EP9 of public buildings, as called for the EPBD). The public administrations can recover up to 40 % of the investment costs for thermal insulation and refurbishment.

3.4 Norway

Directive 2002/91/EC on the Energy Performance of Buildings (EPBD) has been fully implemented in Norway since 2010.

3.4.1 Responsibility

The Norwegian Water Resources and Energy Directorate, NvE - until 2016, The Norwegian Energy Agency (Enova) – from 2016 is responsible for the implementation of the EPBD.

3.4.2 Energy performance (EP) requirements

Norwegian building regulations refer to both residential and non-residential buildings, divided into 13 building categories. The energy performance requirement are given as an energy frame for each building category, measured in kWh/(m2yr) of net energy demand. In addition, there are minimum requirements to thermal insulation and air tightness of the building envelope. The regulation covers new buildings and buildings under major renovation.

3.4.3 Energy Performance Certificate (EPC)

EPC has to be presented at an earlier stage in the process, when a sale or renting of the building or part of the building takes place. The certificate shall be presented to the presumed renter or buyer.

Norway has a central register for certificates since 2010.

The certificates are valid for 10 years.

3.4.4 Inspection requirements: heating systems, air conditioning

Inspection of boilers every 4 year for systems over 20kW, and every 2nd year for systems over 100 kW.

Inspection of cooling systems every 4 year for system over 12 kW or that serves over 500 m2 floor area.

Energy assessment of heating system based on fossil fuels if the boiler is older than 15 years, within a year, and for systems over 20 kW.

3.4.5 Conclusions

Regarding the energy certification and inspections, the most obvious development ahead is to move, from mere guidance, to control and sanctions.

3.5 Spain

Since the publication of the EPBD, Spain has worked to implement its transposition into national law. In particular, Royal Decree 235/2013 set out the new procedure for building certification and the RITE (Royal Decree 1027/2007) was updated through Royal Decree 238/2013, with tightening of energy efficiency requirements, and the review of the scope of the maintenance system. The Technical Building Code was updated through the Order 1635/2013.

3.5.1 Responsibility

The Ministry of Industry, Energy and Tourism and of the Ministry of Public Works and Transport are responsible for the implementation of the EPBD.

3.5.2 Energy performance (EP) requirements

The transposition of the EPBD related to the Energy Performance (EP) requirement consists of the Royal Decree 314/2006 approving the TBC. It sets the minimum requirements that must be met by all new buildings (residential, non-residential, public and private buildings), as well as by existing buildings undergoing a renovation of more than 25% of their area.

3.5.3 Energy Performance Certificate (EPC)

According to the Royal Decree 235/2013 on the Energy Certification of Buildings, the Autonomous Communities are in charge of the registration, inspection and control of the Energy Performance Certificates (EPCs). All the legislation in force can be downloaded from the website of the ministries in charge of the EPBD.

The registration of the energy certificates, as well as the quality control to be applied on the certificates, falls within the competence of the Autonomous Communities.

The external control carried out on the project certificates and on the finished building project includes a verification of the information specified in the project, what was really executed in the building works, and a comparison with the data introduced in the certificate. Apart from this control, the regional Administration is also entitled to an independent inspection of any certificate, should it be deemed necessary.

3.5.4 Inspection requirements: heating systems, air conditioning

The energy efficiency inspection of cold and heat generators is regulated by the Regulation of Thermal Installations in Buildings, compulsory for all heat generators with a nominal heating capacity over 20 kW, and for all cold generators whose nominal capacity is over 12 kW.

3.5.5 Conclusions

The process of revision of the current regulations (RITE) and the rules concerning the Energy Performance Certificate (EPC) has already started. The Spanish normative will be tightened gradually, to achieve the Nearly Zero Energy Buildings (NZEB) objectives by 2020.

The legislation related to the certificate registration and the external control will also be extended to all the Autonomous Communities, which are also working in coordination with the ministries and group created specifically to address issues concerning the building energy certification.

3.6 Sweden

Swedish regulations of energy management in new and renovated houses have existed on national level since 1948. Regulations on the Energy Performance (EP) certification, known in Sweden as “energy declaration”, came into force in October 2006. The first energy experts were certificate in the summer 2007, and the first accredited company registered the first Energy Performance Certificate (EPC) in the national register in September 2007.

3.6.1 Responsibility

The National Board of Housing, Building and Planning is responsible for the implementation of the EPBD.

Regarding information part within the articles 14 and 15, by the Swedish Energy Agency, on behalf of the Ministry of Enterprise, Energy and Communication.

3.6.2 Energy performance (EP) requirements

Swedish building regulations refer to both residential and non-residential buildings. Also, they cover both new buildings and buildings under renovation. Public buildings are included in non-residential buildings. Furthermore, the Swedish building code on energy is divided into different climatic zones and has different requirements for electrically heated buildings including heat pumps and buildings heated with other heating sources.

Since 2006, the Swedish building regulations have been based on measured energy consumption. The measured values for heating, cooling, hot water and auxiliary energy are summed up to an energy usage figure.

3.6.3 Energy Performance Certificate (EPC)

EPC has to be presented at an earlier stage in the process, when a sale or renting of the building or part of the building takes place. The certificate shall be presented to the presumed renter or buyer.

Sweden has a central register for certificates since 2007. This register will also be used for futures validation checks.

The content of the certificates includes recommendations of cost-effective measures.

The certificates are valid for 10 years.

3.6.4 Inspection requirements: heating systems, air conditioning

Sweden started off with option b) for boilers, as well with an inspection scheme for air-conditioning (AC) systems with an output above 12 kW. There is also an inspection scheme for mandatory ventilation checks. One of the problems has been that there is no control of the location of the few cooling systems that are not attached to ventilation systems. Therefore, Sweden decided that a broad information campaign would have bigger effect regarding those systems.

3.6.5 Conclusions

Swedish now continue to work hard towards an energy efficient society, taking the example of the past into account, the Swedish authorities this time have to analyse the measures from different points of view to avoid future failure.

3.7 Turkey

The EPBD is dedicated to the EU countries therefore there is none to be mentioned for Turkey.
The information related to the implementation of the EPBD in Turkey was received from the Turkey project partner.

3.7.1 Responsibility

Law No. 5627 “Energy Efficiency" and accordingly issued "EPBD Regulation" which is called as “Binalarda Enerji Performansi Yönetmeliği” in Turkish.

3.7.2 Energy performance (EP) requirements

New buildings must fill the requirements minimum Class C, there is no this restriction for the existing buildings. Reference building (100/D) values are used for comparing.

Energy class	EP ranges:
A	0-39
B	40-79
C	80-99
D	100-119
E	120-139
F	140-174
G	175-…

3.7.3 Energy Performance Certificate (EPC)

Energy Performance Certificates, which is called as EKB in Turkish, are using for all buildings except for the following structures:

- Production activities carried out in industrial areas, buildings,
- The planned duration of use, buildings with less than two years,
- Total usable area of 50 m2 which is under the buildings,
- Greenhouses, Workshops,
- Individually built and heating, cooling unneeded warehouse, warehouse, barn, stables, buildings,
- Outside of the contiguous area of 1000 m2 or less, and buildings with a total construction area.

All of the new buildings must have the EPC from 01.01.2011. Existing buildings must have it no later than 02.05.2017.

3.7.4 Inspection requirements: heating systems, air conditioning

Heating (TS 2164), cooling (TS EN 378), water heating, renewable energy and air conditioning systems should meet the necessary requirements within the context of the Energy Efficiency Law/EPBD Regulation.

3.7.5 Conclusions

All of the regulations was prepared based on ***2002/91/EC.***

3.8 UK-Scotland

The history and current status of implementation of the EPBD (Directives 2002/91/EC and 2010/31/EC), highlighting main advances since 2012.

3.8.1 Responsibility

The Department for Communities and Local Government (CLG) and Scottish Building Standards Division are responsible for the implementation of the EPBD.

3.8.2 Energy performance (EP) requirements

In Scotland, the relevant regulations are: the Building (Scotland) Act 2003, the Building (Scotland) Regulations 2004, the Building (Procedure) (Scotland) Regulations 2007, the Building (Forms) (Scotland) Regulations 2007 and the Energy Performance of Buildings (Scotland) Regulations 2008, as amended.

Technical Handbooks provide guidance on these performance standards.

3.8.3 Energy Performance Certificate (EPC)

The EPC provides a rating of the overall energy efficiency of the building on a scale from A to G. This is an asset rating, based on the characteristics of the building itself, its services and a standardised occupancy profile.

The EPC for residential buildings also contains an environmental impact rating, which is a measure of a home´s impact on the environment in terms of carbon dioxide (CO2) emission. The EPC includes a list of cost effective

recommendations to improve the energy ratings specific to the dwelling, and indicates the potential energy efficiency and environmental impact ratings for all cost-effective measures were installed.

In Scotland, the asset rating methodology has been adopted for all EPCs, including certificates for display in public buildings, and has been incorporated in the software packages approved for use in Scotland, including SAP, RdSAP, SBEM, and DSMs.

3.8.4 Inspection requirements: heating systems, air conditioning

Requirements were phased between 2009 (for systems > 250 kW) and 2011 (for systems > 12 kW). Inspections may only be carried out by members of those organisations that have entered into protocol with The Scottish Government.

As in England and Wales, the frequency of inspections is five years and CIBSE TM44 may be used as guidance to undertake inspections, subject to the provisions set out in the TM44 Scottish addendum.

The benefits of joint inspection (AC and F-gas) will be considered in consultation with the industry in 2013.

3.8.5 Conclusions

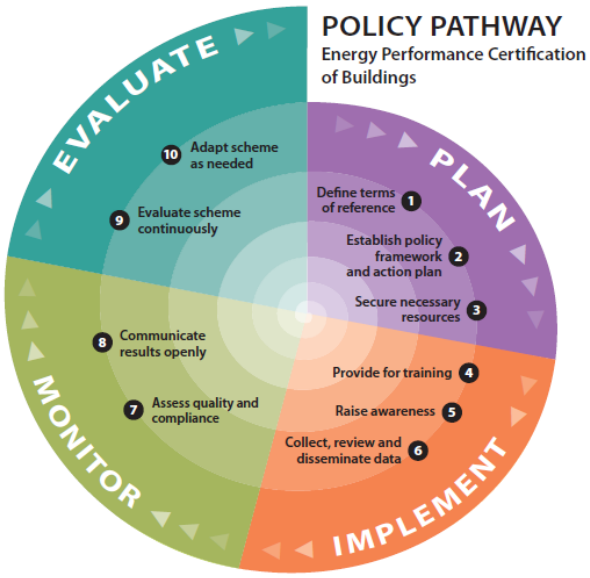
The UK jurisdictions have adopted various approaches to transpose the requirements of the Energy Performance of Buildings Directive (EPBD) and its recast. The English approach has been mirrored in most jurisdictions, or wholly adopted e.g., EPCs in Wales. In a few instances, the four jurisdictions have adopted a common approach, namely for heating systems and cost-optimal requirements.

4 Description of existing certification systems

4.1 Energy Performance Certifications in the EFFESUS EU partner countries

The EPC has an important role because it informs potential buyers and tenants about the energy performance of a building unit or an entire building, and allows for comparing building units and buildings. The EPC is, most of all, a communication tool that informs owners or tenants how their buildings perform, or can be expected to perform.

The pathway to energy certification of buildings involves four stages – Plan, Implement, Monitor and Evaluate – under which fall ten critical steps (Figure 2).



Four phases	Ten critical elements	Thirty-eight steps
PLAN	❶ Define the terms of reference	• Define objectives in relation to targets, local requirements, and existing codes and standards. • Determine the scope in terms of type of buildings, and number of new and existing buildings. • Determine the appropriate method of assessment depending upon scope, targets and approach. • Decide whether to include other environmental issues.
	❷ Establish policy framework and action plan	• Determine if scheme will be voluntary or mandatory. • Develop a comprehensive action plan and establish an implementation group. • Involve all stakeholders at an early stage. • Set a realistic time frame for implementation. • Adopt the action plan and stick to it.
	❸ Secure the necessary resources	• Develop a comprehensive administrative system with integrated data collection capabilities. • Assess institutional capacity. • Allocate financial and human resources. • Test systems and processes in advance of launch.
IMPLEMENT	❹ Provide for training	• Develop a training strategy at the earliest possible stage. • Assess capabilities of existing professionals, and of existing training accreditation systems and programmes. • Demand high pre-qualification standards for assessors and establish an appeal system. • Retain control of training modules and materials, and of examination and registration processes. • Ensure sufficient assessors are trained before launching the certification scheme.
	❺ Raise awareness	• Ensure all stakeholders have access to relevant information. • Develop ongoing information campaigns that target the general public.
	❻ Collect, review and disseminate data	• Collect data centrally in a comprehensive administrative system. • Use the data to monitor and review the certification process. • Review data and use to foster greater overall energy efficiency.
MONITOR	❼ Assess quality and compliance	• Develop an overall quality assurance approach to include training and national examinations, validation of certificates and auditing processes. • Establish a comprehensive quality assurance system including complaint and appeal procedures. • Develop an initial auditing system within the centralised administration system. • Train specialists to undertake desk reviews and practice audits. • Provide support for assessors.
	❽ Communicate the results openly	• Communicate both positive and negative results to retain confidence in the certification scheme. • Translate energy savings into cost savings so that stakeholders can readily understand the benefits. • Communicate openly any weaknesses or errors uncovered through auditing.
EVALUATE	❾ Evaluate the scheme continuously	• Undertake continuous evaluation to ensure high quality and compliance with national buildings regulations. • Maximise the benefits through revisions of the scheme. • Adapt calculation methodologies to integrate stricter building standards.
	❿ Adapt the scheme as needed	• Link the certification scheme to other energy efficiency policies for buildings. • Consider implementing life-cycle assessments to determine the full impact on energy use or emissions (carbon footprint). • Assess the possibility to include other environmental effects on energy, water and land use, global warming and ozone depletion, toxic emissions (to air, land and water), and the impact on human health (environmental footprint). • Utilise whole energy performance or environmental building performance schemes to feed into larger policy goals.

Figure 2. The policy pathway for energy performance certification of buildings[1]

[1] IEA Policy Pathway; 2010; Energy Performance Certification of Buildings: https://www.iea.org/publications/freepublications/publication/buildings_certification.pdf

Table 1 presents the core content of EPCs in different EU countries, in which the EFFESUS case studies take place, i.e.: Germany, Spain, Hungary, Italy, Sweden, Turkey and UK-Scotland.

Table 1 : Content of EPC

	DE	ES	HU	IT	NO	SE	TR	UK-Scotland
Type of buildings	All existing and new buildings	New buildings (residential, non-residential, public and private buildings) as well as existing buildings undergoing a renovation	New buildings it started in January 2009. Existing buildings was launched in January 2012 although it has been in effect since 2008 on a voluntary basis.	New buildings and major renovations Existing buildings Residential Non-residential	New buildings and buildings under major renovation. Residential and non-residential buildings (includes public buildings)	New buildings and under renovation. Residential and non-residential buildings (includes public buildings)	All existing and new buildings	New buildings Existing buildings (is planned)
Energy Label Classes	Sliding scale	A B C D E F G	A++ (High energy efficiency) A+ A B C D E F G H I J (poor efficiency)	A+ A B C D E F G	A B C D E F G Also color label for energy supply system	A B C D E F G	A B C D E F G	A (efficient) B C D E F G (the least efficient)
Energy units	kWh/m^{2}a	kWh/m^{2}a	kWh/m^{2}a	kWh/m^{2}a (for residential	kWh/m^{2}year	% of requirements	kWh/m^2 year	Percentage by band

				buildings) kWh/m^3a(for non-residential buildings)				
Label present situation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recommendations	Yes	No specific information	No specific information	Yes	Yes	Yes	No specific information	Yes

Overview of key elements of EPC system in the selected countries, in which the EFFESUS case studies take place, i.e.: Germany, Spain, Hungary, Italy, Sweden and UK-Scotland are presented in Table 2.

Table 2 : Overview of key elements of EPC system in the selected countries (BPIE 2014[2] and EPBD[3])

Country	Bodies responsible	Methods of quality control	EPC registers	Overview of the methodologies used for the energy performance of buildings	Type of software for the energy performance	Upload of EPC data	EPCs databases	Public access to EPC databases
Germany (DE)	Central and regional governmental bodies	Desk audit of statistically significant sample of EPC (random sampling) based on the information provided by qualified expert; Detailed check of the EPC is implemented at regional level.	Central EPC register	Asset and operational rating • Energy label • Continuous scale	Private software	Manual and automatic registrations EPC data (through online platform and standardised data protocol e.g. XML, editable PDF)	In order to secure data privacy for property owners, the control system has to work without general data retention in a central database. A commissioned and authorised body "Deutsches Institut für Bautechnik" holds a central EPC register without collecting the contents of the EPC. In Germany there is no official software for energy certificates. Software developers are acting free on the market.	No public access
Hungary (HU)	Professional association	Desk audit of 2% of EPC issued (random sampling): input data and the results; on-site visits for 0.5% of the EPC issue (only the building's	Central EPC register	Asset rating	Private software (online)	Manual and automatic registrations EPC data (through online platform and standardised data protocol e.g. XML, editable PDF)	National central database was developed and became operational in 2013. The database, also known as the Electronic Submission System, is managed by LECHNER (previously named VATI), acting on behalf of the Ministry of Interior.	Access for some organisations

[2] BPIE; October 2014; Energy Performance Certificates Across the EU. A mapping of National Approaches.
[3] EPBD; October 2013; Implementing the Energy Performance of Buildings Directive (EPBD)

		exterior is examined).					The estimation of the Energy Performance is made through one of the several calculation software packages developed on a commercial basis and manual calculations are not common.	
Italy (IT)	Regional governmental body	In some regions automatic quality checks are performed in the EPC database, in others are adopted: random checks, or checks excluding values out of a reasonable range, or formal control of the information by third parties.	Regional and planned on central level	Asset rating	Private and public software	Depends on region	The Italian EPC administration system is based on regional systems with distinct registries and databases. Six regional EPC databases have been put in place until the end of 2012, while 11 will be implemented in the future.	Depends on Region
Norway (NO)	Third party body for commercial buildings. For dwelling by owners or by third party.	Automatic check of input and output data in the database, Detailed desk audit (Random checks; Checks for extreme values)	Central EPC register	Asset and operational rating • Energy label • Continuous scale	Private softwares or public software	Automatic registration of EPC data	EPC database since 2010. Through the website of the database management authority, NVE, energimerking.no	Public access with protected privacy
Spain (ES)	Regional governmental body	Depends on the region	Regional and planned on central	Asset rating	Private and public software	Depends on region	EPCs database in pdf. The certificate for new buildings came into force in November 2007 and after	Depends on Region

			level				2010 for existing buildings. CALENER is the name of the software that implements the official calculation methodology.	
Sweden (SE)	Third party body	Automatic check of input and output data in the database, Detailed desk audit (Random checks; Checks for extreme values) of at least 1% EPC issued	Central EPC register	Asset and operational rating • Energy label • Continuous scale	Private software	Automatic registration of EPC data (through standardised data protocol e.g. XML, editable PDF)	EPC database since 2007. Through the website of the database management authority, BOVERKET, all issued EPCs are accessible to everyone and searchable by building address. Only fields that are publicly available are the following: building address, ID-number of the EPC and the date when it was issued, the energy performance of the building given as a single value of specific energy consumption in kWh/m² per year and finally, information on whether radon measurement and control of the ventilation system have been executed.	Public access with protected privacy
Turkey (TR)	Ministry, municipalities	By ministry - no information	By EPC agencies, EPC specialists	An energy assessor inspects the property to prepare the EPC file and this data are uploaded on the online government energy certification	Building Energy Performance Software (BEP-TR)	By registered inspectors via using main software	Online database on the BEP-TR software	No

				system called BEP-TR.				
UK-Scotland (UK)	Third party body	Depends on region; Desk audit of 2% of EPC issued (random sampling): input data, results and recommendations.	Regional EPC register	Asset and operational rating • Energy label • Continuous scale	Private and public software	Automatic registration of EPC data (through standardised data protocol e.g. XML, editable PDF)	Until October 2012, only EPCs for existing dwellings were lodged on a national register: the Home Energy Efficiency Database (HEED). From January 2013, a new register will be used for all future lodgements, for new and existing buildings. The register www.scottishepcregister.org.uk is accessible by nominated individuals of Approved Organisations and Local Authorities. A suit of software tools (including free Government – sponsored and proprietary tools) are available to accredited energy assessors to produce regulatory output. Regulatory outputs are lodged on a national register. Residential buildings register: www.epcregister.com Non-residential buildings register: www.ndepcregister.com	Public access with protected privacy

EU Member States have set up EPC databases to monitor implementation of EPBD, to control the energy certification process and to collect data on the building stock in order to provide data for decision making. As it is shown in Table 2, utilisation of opportunities depends on how access to the EPC database is regulated and whether EPC information can be linked with other data. Some countries have chosen an open access system to limited or selected EPC information, while in other MSs access is only possible for the authorities, or granted to selected organisations, such as research entities.

4.2 District certification methodologies and tools

On district level in the mostly known rating systems in Europe presently there are mainly rating schemes for newly-built districts.

This chapter presents an overview of current certification methodologies which are under way to extend the certification schemes to districts.

The following systems of the certification methodologies have been studied:

- AQUA – Bairros e Loteamentos
- BREEAM Communities
- CASBEE for Urban Development
- HQE – Aménagement (CERTIVEA)
- DGNB for Urban Districts
- GREEN STAR for Communities
- LEED for Neighbourhood Development

AQUA – Bairros e Loteamentos

AQUA – Bairros e Loteamentos, Developer: Vanzolini, this methodology was developed by teachers of the Polytechnic School of USP in 2007. Origin: Brazil (adapted from French methodology HQE - Haute Qualité Environnementale the Certivéa body with Brazilian technical reference).

Types of Certification: Housing Buildings; Office and School Buildings; Renovation; Lodging, Leisure, Wellness, Events and Culture; Neighborhoods and housing developments. Evaluation criteria are 14 criteria divided into 4 categories that evaluate the environmental management of the works and technical and architectural specificities: Eco-construction: building's relationship to its surroundings, integrated choice of products, building systems and processes, and construction site with low environmental impact; Eco-management: energy management, water, waste use and building operation and maintenance and permanence of environmental performance; Comfort: comfort hygrothermal, acoustic, visual and olfactory; Health: sanitary quality of the environment, air and water. Three audits are performed throughout the project and work. Benefits: user Quality of life; Saving water and energy; Waste disposal and maintenance; contribution to the socio-economic and environmental development of the region[4] .

BREEAM Communities

BREEAM Communities is an independent, third party assessment and certification standard based on the established BREEAM methodology. It was launched by BRE in 2012 and describes an environmental, social

[4] http://sustentarqui.com.br/dicas/selos-para-contrucao-sustentavel/

and economic performance standard against which large scale developments in the UK and internationally through the BREEAM Communities bespoke international process can be assessed, rated and certified.

CASBEE for Urban Development

The CASBEE for Urban Development has been developed and published in 2006 and revised in 2007 in Japan; it is a method for evaluating and rating the environmental performance of buildings.

CASBEE examines both the environmental quality (Q = Quality) and the environmental load on the exterior (L = Load), and uses Q / L to calculate Building Environmental Efficiency (BEE) as a comprehensive evaluation indicator.

CASBEE for Urban Development carries on the concepts of CASBEE (building scale) developed with reference to the Q3 (Outdoor Environment on Site) and LR3 (Off-site Environment) assessment items of CASBEE for New Construction. However, CASBEE for Urban Development is an environmental performance assessment tool for whole groups of buildings (urban scale), focusing on the phenomena that can accompany not only the conglomeration of buildings but also the outdoor spaces around the buildings.

HQE – Aménagement (CERTIVEA)

This international certification scheme was developed by Cerway in 2014. This document describes the requirements of the Project Management System (PMS) applicable to urban planning and development projects which take into account the challenges of sustainable development by incorporating environmental, economic and societal concerns. This management system can be applied to any urban planning and development project regardless of the type of developer (public or private), size, procedure, local context and location: renewal or expansion, urban or rural, residential and/or activities, mixed development zones or estates, large- or small-scale projects, etc.

DGNB for Urban Districts

This scheme was launched in 2012 and complies with the basic DGNB philosophy, taking the following fields into account: Environmental Quality, Economic Quality, Sociocultural and Functional Quality, Technical Quality, Process Quality and Site Quality. In its all-encompassing scope, the new scheme covers all of the relevant issues in sustainable building: from a district's structure to the proportion of open spaces, occupancy flexibility, sustainable mobility, and questions of maintenance, management, and cleaning. A life cycle assessment is also conducted for city districts as is done in the assessment system for buildings. The assessment focuses on the areas between buildings in a district, such as sidewalks, bike lanes, roads, and green spaces. In addition, overriding concepts are also taken into consideration, for instance for energy, water, and waste.

GREEN STAR for Communities

Green Star is a voluntary sustainability rating system for buildings in Australia. It was launched in 2003 by the Green Building Council of Australia. The Green Star rating system assesses the sustainability of projects at all stages of the built environment lifecycle. Ratings can be achieved at the planning phase for communities, during the design, construction or fit out phase of buildings, or during the ongoing operational phase.

The system considers assesses and rates buildings, fit outs and communities against a range of environmental impact categories, and aims to encourage leadership in environmentally sustainable design and construction,

showcase innovation in sustainable building practices, and consider occupant health, productivity and operational cost savings.

LEED for Neighbourhood Development

LEED for Neighbourhood Development is a certification scheme issued by the USGBC in 2009. The scheme offers a rating system for new land development projects or redevelopment projects containing residential uses, non-residential uses, or a mix. It considers the character of a neighbourhood, including its streets, homes, workplaces, shops and public spaces, affects quality of life. Green developments respect historic resources and the existing community fabric.

LEED for Neighbourhood Development emphasizes elements that bring buildings and infrastructure together and relates the neighbourhood to its local and regional landscape. Therefore it assesses the consequences for water resources, air quality and natural resource consumption caused by newly-built urban districts.

Comparison analysis of the district certification methodologies is presented in the table 3 and figure 3.

Table 3 : Comparison analysis of the different certification methodologies for districts[5]

AQUA - BL	BREEAM - C	CASBEE - UD	CERTIVEA (HQA - A)	DGNB - UD	GREEN STAR - C	LEED - ND
Processo AQUA CONSTRUÇÃO SUSTENTÁVEL	breeam	CASBEE	CertiVéA	DGNB	greenstar	U.S. GREEN BUILDING COUNCIL LEED USGBC
Brazil	Great Britain	Japan	France	Germany	Australia	United States
Main aspects assessed: • Eco-construction • Eco-management • Comfort • Health	Main aspects assessed: • Governance • Social and economic well being • Resource and energy • Land use and ecology • Transport and movement	Main aspects assessed: • Environmental aspects • Social aspects • Economic aspects • CO_2 emissions from energy sources • CO_2 emission from non-energy sources	Main aspects assessed: • Territorial integration • Environmental and Health Quality • Social and Economic life	Main aspects assessed: • Environmental Quality • Economic Quality • Sociocultural & functional Quality • Technical Quality • Process Quality	Main aspects assessed: • Governance • Livability • Economic Prosperity • Environment • Innovation	Main aspects assessed: • Smart location and linkage • Neighbourhood Pattern and Design • Green infrastructure and Buildings • Innovation Regional Priority
Not special reference for historic buildings	Not special reference for historic buildings	Not special reference for historic buildings	Sub-criteria: Historic Resource Preservation and Adaptive Use	New urban districts	Sub-criteria: Culture, Heritage and Identity	Sub-criteria: Historic Resources Preservation and Adaptive Use
Phase 1: Initial	Phase 1. Choice of development concept (Intermediate Certificate)	No clearly communicated process	Phase 1: Initial	Phase 1: Pre-Certification *Valid for 3 years*	5 Phases: • Eligibility Criteria • Certification Process • Certification fee • Certification Agreement • Registration Information	Phase 0: Examination of the prerequisites (optional)

[5] France GBC; November 2013 Sustainable Urban Planning. International Benchmark.

Phase 2: Initial Analysis	Phase 2: Mass design plan	Evaluation and analysis on grid points	Phase 2: Initial Analysis (Certification HQA-A)	Phase 2: Certification of infrastructure Min. 25% existing infrastructure *Valid for 5 years*	Submission of documents necessaries for the evaluation	Phase 1: Plan approved under conditions
Phase 3: Choice of targets (Certification AQUA-BL programmation)	Phase 3: Detailed design (Final Certificate)	Certification CASBEE-UD *is valid for 5 years*	Phase 3: Choice of targets (Certification HQA-A)	Phase 3: Certification DGNB-UD Min. 75% buildings *Unlimited validity*	Simple evaluation on grid points	Phase 2: Plan previously certified
Phase 4: Conception of the project (Certification AQUA-BL conception)			Phase 4: Conception of the project (Certification HQA-A)		Certification GREEN STAR for Communities *Must be obtained 3 years after the registration*	Phase 3: Certification LEED-ND *Within 3 years after the finalization*
Phase 5: Project execution			Phase 5: Project execution (Certification HQA-A)		*Renovation of the certification every 5 years*	
Phase 6: Balance-Capitalisation (Certification AQUA-BL)			Phase 6: Balance-Capitalisation (Certification HQA-A)			
Use Phase (Certification AQUA-BL optional)						

The comparison of assessment of different certification methodologies is presented in Figure 3.

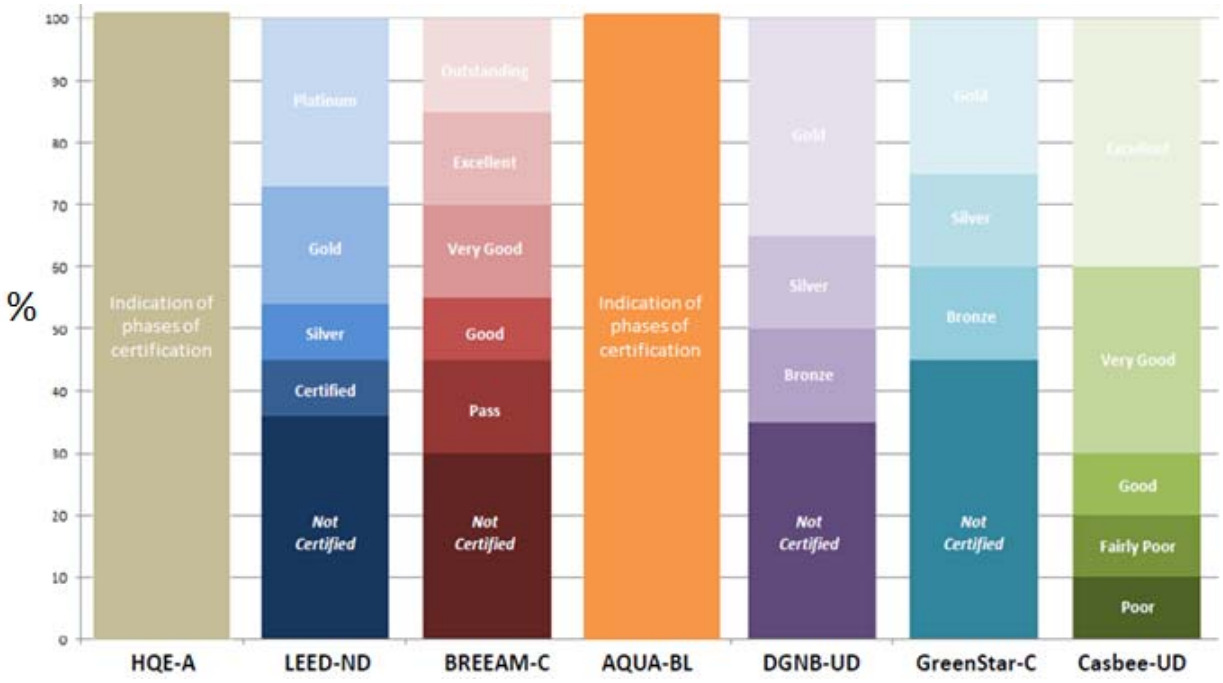


Figure 3. Comparison of certification methodologies for district level (expressed in percentage)

On the market, there are several types of software tools which can be used to improve the energy and resource efficiency of districts, such as:

- District-ECA (www.district-eca.com)
- ECC
- Energy Performance of a District (EPL)
- Sustainable Profile of a Neighborhood (DPL)
- GPR Districts
- Transep-DGO tool

Table 4 : Review of assessment tools for district

Tool	Description	Developers	Country of origin	Language	Theme	Range of application				Outcome
						Buildings	Districts	New buildings	Existing buildings	
District-ECA	District Energy Concept Adviser funded by the Germany Ministry of Economy and Technology under the project no. 0327400N.	Fraunhofer Institute for Building Physics IBP	German	German	Tool for the energy assessment of districts, calculate the energy performance of various energy concepts on the demand and the supply side. The supply can be centralised like for example a local district heating system or decentralised with boilers or heat pumps but also in combinations of both.	x	x	x	x	Results are presented as delivered energy, primary energy and CO2 emissions
ECC	Regionally-specific tool utilized by land developers and local government agencies to promote smart growth, sustainable land development practices, and healthier communities	The Greater Atlanta Home Builders Association, the Atlanta Regional Commission, the Urban Land Institute Atlanta District Council, and Southface	USA	English	Site selection; water management; planning and design; preservation landscape; community engagement; green building		x			Minimally acceptable green development 100 points plus the pre-requisites
EPL	Energy Performance of a District	Dutch government	The Netherlands	Dutch	It is used in the design phase to		x	x	x	Total score: 1-10; where

					evaluate energy concepts. It is used for a new districts as well as existing districts					6.6 satisfies the building regulations; and 10 corresponds to a zero-energy district
DPL	Sustainability Profile of a Neighborhood	IVAM Environmental Research	The Netherlands	Dutch	For the planning phase of new built districts and for managing existing districts. Sustainability topics: e.g. energy, materials, water, waste management, soil, nuisance, safety, public transportation, liveability and flexibility		x	x		Low-scoring district, and high-scoring
GPR	Gerneentelijke Praktijk Richtlijn (Municipal practice guideline)	Local authorities of the Dutch city Tilburg	The Netherlands	Dutch	Simple tool. Main sustainability topics: energy, environment, health, liveability; and future value	x	x	x	x	Total score is converted in a scale 1-10 and the district´s CO2 exhaust, where 6 corresponds to the district requirements
Transep-DGO tool	The tool estimates the average annual energy demand per dwelling. This energy demand is used as input to calculate the PE (Primary Energy)	The EOS-LT Transep-DGO research project	The Netherlands	English	Excel sheet that describes and calculates sixteen energy concepts for districts, which are classified into five main energy		x			Self-sufficiency district – the annual import of energy that should be at

	demand of the assessed district with the applied techniques and their corresponding efficiencies for each energy concept.				concepts: 1) (Waste heat) district heating with biomass or geothermal, 2) Solar Thermal, 3) Solar Electric, 4) Conventional Heating, and 5) Hydrogen storage					least the annual generation of energy within the district´s boundaries. It is expressed in % .

5 Existing energy policies, regulation and national systems in EFFESUS partner countries

Overview of policies, regulations and national systems for districts and buildings taking into account historic buildings is presented in Table 5.

Table 5 : National policies and regulations related to the districts and buildings taking into account cultural heritage

Country	District	Historic buildings	Energy
Germany (DE)	• At district level there do not exist any mandatory energy regulations in Germany. District retrofitting projects are bounded to the same energy regulations as at building level • Homepages of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and Federal Ministry for Economic Affairs and Energy (BMWi) provide information about ongoing governmental projects and political statements in the field of Energy Saving in all corresponding sectors, such as Building and Housing, Transport and Mobility & Urban and Rural Areas. Together with the BMWi, the BMUB is in charge of transposing the Energy Performance of Buildings Directive (EPBD).	• The transposition of EPBD is mainly processed via an amendment of the Energy Saving Ordinance (EnEV). In 2011, the German Federal Government decided on the "transformation of the energy system" (known in German as the "Energiewende und Energiekonzept der Bundesregierung"), referring to the move towards the age of renewables and energy efficiency in Germany	• German Energy Saving Act 2009 (EnEG 2009) • German Energy Saving Ordinance 2009 (EnEV 2009) • The current Energy Saving Ordinance was approved in October 2013. It stipulates that new buildings built after the 1st of January 2016 have to reduce their annual primary energy demand by 25%, with a reduction of 20% of the thermal transmittance of the building envelope (U-values). For existing buildings, the already strict requirements of 2009 will be kept in place due to a limit of economic feasibility • German Renewable Energies Heat Act (EEWärmeG)
Hungary (HU)	• Existing district heating systems in Hungary are inefficient and expensive, so the current trend in building retrofit is to detach from the district heating systems which is a threat to the sustainability of the plants. Each settlement in Hungary should create their own Integrated Development	• Hungarian Governmental Decree 105/2012. (V. 24.) – Amendment of several governmental decrees about building affaires and territorial design • Act No. LXIV/2001 on the conservation of cultural heritage • Act No. LXXVII/2011 on the world heritage • Act No. LXXVII/1997 on the built environment and its conservation	• The Government Decree No. 43/2006 (XII. 23.). From the 9th of July, 2013 (§6 of Decree of Minister without Portfolio No. 7/2006 (V. 24.): By renovation of existing buildings, for energy saving purposes, the building components involved in the construction and assembly works shall comply with the requirements for the newly built building components • Decree of Minister without Portfolio No. 7/2006

	Strategy ((Integrált Településfejlezstési Stratégia - ITS) and within the ITS they need to dispose of the local energy supply and energy management, including district heating- and cooling systems, application of renewable energy sources and the improvement of the energy performance of public buildings. • Hungarian Governmental Decree 211/2012 (VII. 30.) amending the 253/1997 (XII. 20.) Governmental Decree about the National Requirements of Building and Town Planning (Building Code)	• Governmental Decree No. 393/2012 (XII. 20.) on the rules relating to the preservation of archeological and historic values • Governmental Decree No. 312/2012 (XI. 8.) on the procedures and controls of the constructions and construction´s supervision authorities, and on the services of the construction authorities • Decree of Ministry of Interior No. 80/2012 (XII. 28.) on the registration of archeological sites and historic buildings, their declaration to be protected, and on the detailed rules of archeological excavation • Decree of Ministry of Rural Development No.66/1999 (VIII. 13.) on professional rules of the protection of local architectural heritage	based on the EPBD • §6 of Decree of Minister without Portfolio 7/2006 (V.24.) By renovation for energy saving purposes, only the involved building components • Hungarian Decree of Minister of Interior 40/2012. (VIII. 13.) - The ammendment of the 7/2006. (V. 24) Decree of Minister without Portfolio About Determination of Energy Efficiency of Buildings
Italy (IT)	• Beside the traditional Urban Plan, Cities are adopting a new kind of tool: the City Energy Plan (PEC - Piano Energetico Comunale). The objective of this tool is to identify and measure at urban level the energy consumptions per sector (buildings, transports, etc.), to analyse the information and to define the necessary actions to improve the energy efficiency and the use of renewable energies at city level. The adoption of this kind of Plan is mandatory for all the cities with more than 50.000 habitants on the base of the national law 10/1991.	• The first regulation, issued in 2005, to set the general framework for the transposition of the first EPBD (2002/91/EC) at national level is the Legislative Decree 192. By means of this decree, the minimum requirements for the Energy Performance (EP) of buildings were identified and also the reference U values for the building envelope (walls, roofs, floors, windows) in case of new construction and major renovations. • The director of State Office for the Preservation of Historical Monuments determines the objects of particular artistic, historical, archaeological or ethnological value,	• In 2009, with the Presidential Decree n. 59, minimum requirements were defined for the Energy Performance in summer (cooling and lighting systems), This new decree updated also the minimum Energy Performance requirements of buildings and heating systems. • In 2011 the Legislative Decree n.28 transposed the EU RES (Renewable Energy Services) Directive. The requirements regarding the use of renewable energy for new buildings and major renovations where increased with the objective to enlarge the renewable quota for DHW (Domestic Hot Water), heating and cooling energy demand. By January 2017 a 50% renewable quota for all building permits will be mandatory.

		which must be placed under monument protection	
Spain (ES)	• The Spanish Technical Building Code, in section concerning building certification does not provide a methodology to reward buildings that are supplied by district networks, although there are several proposals that would allow developing it • Urban HVAC networks in Spain are still minority	• Royal Decree 314/2006, of the 17th of March, approving the Technical Building Code (TBC). • Royal Decree 1027/2007, of the 20th of July, approving the Thermal Building Regulations, modified by the Royal Decree 1826/2009, of the 27th of November. • A new Royal Decree was published in April 2013, replacing the Royal Decree 47/2007, for the legislation regarding the energy certification of existing buildings, taking into consideration the 2010/31/EU Directive (recast EPBD). The Royal Decree 235/2013 of the 13th of April, and the update of the Thermal Building Regulations with the Royal Decree 238/2013 of the 13th of April, were also published. • Spanish Technical Building Code - Order FOM/1635/2013, 10th of September 2013 • Historic environments declared of cultural interest should develop and approve a Special Plan of protection, rehabilitation and conservation. The plan is the tool for management of the historic city.	• *Royal Decree 1826/2009, of 27 November, that modifies the Regulation of heating systems in buildings, approved by Royal Decree 1027/2007, July 20th*. It applies to fixed heating systems HVAC (heating, cooling and ventilation) and hot water (thermal and sanitary) for new buildings and for existing buildings in terms of its alteration, maintenance, use and inspection. • *Royal Decree 616/2007 of 11th May on the promotion of cogeneration.* The purpose of the Royal Decree is to promote high efficiency cogeneration of heat and power based on useful heat demand and primary energy savings, increasing energy efficiency and improving security of supply, in accordance with Directive 2004 / 8/EC.
Sweden (SE)	• Swedish planning and building regulation (2011:338) • Swedish planning and building act (2010:900) o Zoning planning could be developed to include building ordinance • The Swedish Environmental	• Swedish planning and building regulation (2011:338) • Swedish planning and building act (2010:900) • Swedish building regulations (BFS 2011:6 with amendments up to 2011:26) • Swedish heritage legislation (1988:950)	• Swedish law on the energy certification of buildings (2006:985) • Swedish ordinance on the energy certification of buildings (2006:1592) • Swedish regulations and general advice on energy certification of buildings (2007:4) • Swedish regulations for energy experts (CEX 2007:5) • Sweden - Exemptions from the demand on

	Code plays a major role in heritage preservation. The Code mandates protection and preservation of valuable natural and historic environments. The Code also allows for the establishment of historic reserves on the same terms as nature reserve		investigation of alternative energy supply system (ALT 2013:8)
Turkey (TR)	Law No. 2863 "Conservation of Cultural and Natural Property". This law ensures the national protection of cultural property.	General Directorate of Monuments and Museums is the foundation within the ministry. The general directorate plays an important role in archaeological investigations, restoration works, establishment of museums, ensuring the protections of Turkish/Ottoman heritage outside Turkey, etc.	Turkish national legislation regarding energy performance and minimum energy requirements such as ventilation and air-conditioning systems, energy requirements for the production of hot water has been regularized according to EPBD. All updated specifications and standards are stated in Turkish Standards Institution (TSE) 3419.
UK-Scotland (UK)	• The Scottish Government published its *District Heating Action Plan* in May 2013. One of the priorities in the Action Plan was to set up the Heat Network Partnership to provide support to district heating projects at all stages from planning to procurement and implementation.	• Heritage-management and building-control authorities consult with each other when developing new governmental policies and legislation. Management: English Heritage (non-departmental public body reporting to UK government, Historic Scotland (agency of the Scottish Government) • UK – Scotland: Technical Handbooks: The Technical Handbooks provide guidance on achieving the standards set in the Building (Scotland) Regulations 2004 and are available in two volumes: Domestic buildings and Non-domestic buildings.	• UK – Scotland: The Energy Performance of Buildings (Scotland) Regulations 2008 (as amended): These Regulations further transpose Article 7 (energy performance certificates), Article 3 (adoption of a methodology) and partially transpose Article 4(3) of Directive 2002/91/EC of the European Parliament and of the Council ("the Directive") in Scotland.

6 National and EU projects for district and historic buildings

The balancing between different interests with a focus on energy efficiency and built heritage on a level of the building and/or district has been the topic for several research and development projects in a wider international/European context.

Short summary of the objectives of some crucial EU and national projects for districts and/or historic buildings is presented in Table 6.

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Table 6 : Overview of related EU and national projects

Name of the project	Responsible coordinator/ EFFESUS Partners	Type of the project	Brief description and relation with EFFESUS project	Website
A2PBEER- Affordable and adaptable public buildings through energy efficient retrofitting	Tecnalia D'Apppolonia	FP7	Focus on demonstrating existing and innovative energy efficient retrofitting solutions for public buildings and districts.	http://www.a2pbeer.eu/
BRICKER- Energy Reduction in Public Building Stock	Acciona Eurac Tecnalia	FP7	Focus on retrofitting solutions for existing public buildings.	http://www.bricker-project.com/
CommONEnergy- Converting EU Shopping Malls into Beacons of Energy Efficiency	Eurac Acciona D'Appolonia AMS Fraunhofer	FP7	Focus on shopping malls. The main idea of CommONEnergy is to shift from single-action refurbishments to deep – energy performing - retrofitting. The basis for doing this is a systemic approach involving technology solution sets and innovative methods and tools: • Integrated design process guidelines, • An integrative modelling environment, • Energy-economic evaluation tools, • Lean construction and management procedures, • A continuous commissioning approach and • An environmental and sociocultural impact assessment.	http://www.commonenergyproject.eu/
Ecoshopping- Energy efficient and cost competitive retrofitting solutions for shopping buildings	EnergoSys CNR RED	FP7	"EcoShopping" project aims at building a holistic retrofitting solution for commercial buildings to reduce primary energy consumption	http://ecoshopping-project.eu/
3ENCULT- Efficient energy for EU cultural heritage	Eurac University of Stuttgart	FP7	The project 3ENCULT bridges the gap between conservation of historic buildings and climate protection. One of the objectives aimed at developing an	http://www.3encult.eu

			international certification scheme and assure the quality of the interventions, in order to prevent low quality interventions and promote transparency on the market.	
Climate for Culture- Damage risk assessment, economic impact and mitigation strategies for sustainable preservation of Cultural Heritage in times of climate change	Fraunhofer CNR Uppsala University Acciona	FP7	Focus on historic buildings. The Climate for Culture project estimates the impacts of changing climate conditions on historic buildings and their vast collections in Europe and the Mediterranean.	http://www.climateforculture.eu/
STEP UP- Strategies Towards Energy Performance and Urban Planning	University of Strathclyde	FP7	STEP UP aims to bring together excellence in energy planning and low carbon energy projects from the four partner cities (Ghent, Glasgow, Gothenburg, Riga) to create a coherent and easy-to-use model for energy planning for dissemination across Europe.	http://www.stepupsmartcities.eu
MESSIB- Multi-source energy storage system integrated in buildings	Acciona CNR Tecnalia D'Appolonia Fraunhofer	FP7	The project is focused on the study of multi-source energy storage systems integrated in buildings. A particular section is devoted to historical buildings.	http://www.messib.eu
OPENHOUSE- Benchmarking and mainstreaming building sustainability in the EU based on transparency and openness (open source and availability) from model to implementation.	Acciona Fraunhofer D'Appolonia	FP7	The OPEN HOUSE project aims to merge existing methodologies for sustainability assessment of existing office buildings towards a common view. The OPENHOUSE methodology is evaluated and refined by the feedback resulting from case studies and real sustainable public procurement cases and other stakeholders inputs	http://www.openhouse-fp7.eu/
LEAF- Low Energy Apartment Futures	Changeworks Fraunhofer Uppsala University	Intelligent Energy – Europe program	LEAF aims at improving the energy efficiency of apartment blocks. It aims to overcome a number of key barriers to retrofitting these properties such as the limitations of Energy Performance	http://www.lowenergyapartments.eu/

			Certificates (EPCs) and difficulties associated with buildings under multiple ownership	
Annex 51 Energy Efficient Communities: Case Studies and Strategic Guidance for Urban Decision Makers	VOLKSWOHNUNG GmbH	EBC Research Programme (Energy in Buildings and Communities Programme)	The scope of the project covers the design of long-term energy conservation and greenhouse gas (GHG) mitigation strategies and their continuous optimisation either on a community level or on the level of a municipal quarter. A holistic approach to evaluate the dependencies between energy supply and energy demand within the communities. . Another part of this approach is the use of modern management methods using delegation of responsibilities, marketing and conflict resolution.	http://www.annex51.org/
EnERGo- Annex 46 Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Building	Energy Branch US Army Corps of Engineers	EBC Research Programme (Energy in Buildings and Communities Programme)	The scope of the project is the decision making process for energy retrofitting of Government non-residential building. The final output of the project is an energy assessment and analysis methodology/protocol and a toll “Energy Assessment Guide for Energy Managers”.	http://www.ecbcs.org/annexes/annex46.htm
CA EPBD- Concerted Action EPBD		Intelligent Energy – Europe program	It involves those representatives of national ministries or their affiliated institutions charged with preparing the technical, legal and administrative framework for the EPBD in each country. The key aim is to enhance the sharing of information and experiences from national adoption and implementation of this important European legislation.	http://www.epbd-ca.eu/
Cheap-GSHPs – Cheap and efficient application of reliable ground source heat exchangers and pumps.	CNR-ISAC Tecnalia RED	H2020	The project is focused on the development of more efficient and safe shallow geothermal systems and the reduction of the installation costs. Particular solutions will be for the application in historical	www.cheap-gshp.eu

			buildings and districts.	
METRICS	D'Appolonia	National project funded by POR	Methodologies and technologies for the management of requalification of historical building and districts.	N/A
FASUDIR- Friendly and Affordable Sustainable Urban Districts Retrofitting	Tecnalia Acciona Fraunhofer IBP D'Appolonia Consorcio de Santiago	FP7	FASUDIR aims to provide an Integrated Decision Support Tool (IDST) based on a new methodology supported by a software tool that will help decision makers to select the best energy retrofitting strategy to increase the sustainability of the whole district.	http://fasudir.eu/
EPISCOPE - Energy Performance Indicator Tracking Schemes for the Continuous Optimisation of Refurbishment Processes in European Housing Stocks	Institute for Housing and Environment Budapest University of Technology and Economics Norwegian University of Science and Technology	Intelligent Energy – Europe program	The overall strategic objective is to make the energy refurbishment processes in the European housing sector transparent and effective. This will help to ensure that the climate protection targets will actually be attained and that corrective or enhancement actions can be taken in due time, if necessary. The required transparency shall be obtained by installing bottom up monitoring procedures in each European country in different fields: in energy certificate databases, representative surveys, regional or national census, heating or energy bills, strategic asset development, energy management. The concerted set of energy performance indicators developed during the project will enable key actors and stakeholders on different levels (national, regional and local level) to ensure a high quality of energy refurbishments, the compliance with regulations, to track and steer the refurbishment processes in a cost-efficient way and to evaluate the actually achieved energy savings.	http://episcope.eu/welcome/
PIME'S (CONCERTO program)	ROGALAND	FP7	CONCERTO initiatives:	http://www.pimes.eu/

	County Council Acciona Tecnalia		Large-scale integration of renewable energy sources: biomass CHP, high efficiency solar thermal systems, photovoltaic solar systems, small hydro power station and wind installations integrated in residential areas.	
Spara och Bevara (Save and Preserve)	Uppsala University	Swedish National research program	It is focused on energy efficiency in historic buildings in Sweden	www.sparaochbevara.se

N/A= Not applicable

7 EU Standards for district level

Sets of indicators have been also developed at European level with the standardization technical committee **EN/TC 350 Sustainability of construction works**, Table 7.

Table 7 : CEN/TC 350 Indicators

CEN/TC 350 - Indicators		
Main Pillar	**Main Theme**	**Indicator**
Environmental Performance EN 15643-2 2010	Environmental impacts (LCIA impact categories)	Global warming potential, GWP
		Depletion potential of the stratospheric ozone layer, ODP
		Acidification potential of land and water; AP
		Eutrophication potential, EP
		Formation potential of tropospheric ozone photochemical oxidants, POC
		Abiotic resource depletion potential for elements, ADP_elements
		Abiotic resource depletion potential of fossil fuels, ADP_fossil fuels
		Biodiversity
		Ecotoxicity
		Human toxicity
		Land use change
	Indicators for resource use (environmental aspects)	Use of renewable primary energy excluding energy resources used as raw material
		Use of renewable primary energy resources used as raw material
		Use of non-renewable primary energy excluding primary energy resources used as raw material
		Use of non-renewable primary energy resources used as raw material
		Use of secondary material
		Use of renewable secondary fuels
		Use of non-renewable secondary fuels
		Use of net fresh water
		Use of non-renewable resources other than primary energy
		Use of renewable resources other than primary energy
	Indicators for additional environmental information (environmental aspects)	Hazardous waste disposed
		Non-hazardous waste disposed
		Radioactive waste disposed
		Components for re-use
		Materials for recycling
		Materials for energy recovery (not being waste incineration)
		Exported energy
		Use of environmentally sustainably managed materials (grouped per material type: e.g. PEFC, FSC, responsibly sourced materials BS 8902:2009)
		Use of environmentally sustainably managed fuels (grouped per fuel type: e.g. Sustainability criteria for bio-fuels ISO 13065)
Social Performance EN 15643-3:2012	Accessibility	Accessibility for people with specific needs
		Access to building services
	Adaptability	Ability to accommodate individual user requirements
		Ability to accommodate the change of user requirements
		Ability to accommodate technical changes
		Ability to accommodate the change of use
	Health and Comfort	Acoustic characteristics
		Characteristics of indoor air quality
		Characteristics of visual comfort
		Characteristics of water quality
		Electromagnetic characteristics
		Spatial characteristics
		Thermal characteristics
	Loadings on the neighbourhood	Noise
		Emissions to outdoor air, soil and water
		Glare and overshadowing
		Shocks and vibrations
		Localized wind effects

	Maintenance	Maintenance operations
	Safety / Security	Resistance to climate change
		Resistance to accidental actions
		Personal safety and security against intruders and vandalism
		Security against interruptions of utility supply
	Sourcing of materials and services	Responsible sourcing and traceability of products and services
	Stakeholder involvement	Opportunity for interested parties to engage in the decision-making process for the realisation of a building
Economic Performance EN 15643-4:2012	Economic issues	Life cycle costing: Economic performance expressed in cost terms over the life cycle
		Financial value over the life cycle: Economic performance expressed in terms of financial value over the life-cycle
		Ratio of market value to capital cost: calculation of ratio of market value to capital cost at point of completion
		Indicators for future proofing long-term value/ stability of economic value
		Indicators representing economic risk: Assessing risks is essentially the same as assessing stability of value, just from another point of view
		External costs: cost factors that allow the factoring in of CO2 related costs or health related costs resulting from the construction of a building or consequential environmental impacts
		Consequential economic aspects

ISO/DIS 37120: Sustainable development and resilience of communities — Indicators for city services and quality of life

The "ISO/TC 268 Sustainable development in communities" was initiated in 2012 in order to encourage the development and implementation of holistic, cross-sector and area-based approaches to sustainable development in communities. It will include requirements, guidance and supporting techniques and tools to help all kind of communities become more resilient and sustainable and demonstrate achievements in that regard.

The draft of ISO/DIS 37120:2014 includes a set of indicators to evaluate the city performance.

An overview of the indicators is given in the table 8.

Table 8 : ISO 37120 Indicators

ISO 37120 - Indicators	
Main category	**Indicator**
Economy	City's unemployment rate
	Commercial/Industrial Assessment as a percentage of total assessment
	Percentage of city population living in poverty
	Percentage of persons in full-time employment
	Youth unemployment rate
	Number of businesses per 100 000 population
	Number of new patents per 100 000 population per year
Education	Percentage of female school-aged population enrolled in schools
	Percentage of students completing primary education: survival rate
	Percentage of students completing secondary education: survival rate
	Student/teacher ratio
	Percentage of male school-aged population enrolled in schools
	Percentage of school-aged population enrolled in schools
	Number of higher education degrees per 100 000 population
Energy	Total residential electrical use per capita (kWh/year)
	Percentage of city population with authorized electrical service
	Energy consumption of public buildings as a percentage of total consumption in the city
	The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption
	Total electrical use per capita (kWh/year)
	Average number of electrical interruptions per customer per year
	Average length of electrical interruptions (in hours)
Environment	Fine Particulate Matter (PM 2.5) Concentration

	Particulate Matter (PM10) Concentration
	Greenhouse gas emissions measured in tonnes per capita
	NO2 (nitrogen dioxide) concentration
	SO2 (sulphur dioxide) concentration
	O3 (Ozone) concentration
	Noise Pollution
	Percentage change in number of native species
Finance	Debt service ratio (debt service expenditure as a per cent of a municipality's own-source revenue)
	Capital spending as a percentage of total expenditures
	Own-source revenue as a percentage of total revenues
	Tax collected as a percentage of tax billed
Fire and emergency response	Number of firefighters per 100 000 population
	Number of fire related deaths per 100 000 population
	Number of natural disaster –related deaths per 100 000 population
	Number of volunteer and part-time firefighters per 100 000 population
	Response time for emergency response services from initial call
	Response time for fire department from initial call
Governance	Voter participation in last municipal election (as a percentage of eligible voters)
	Women as a percentage of total elected to city-level office
	Percentage of women employed in the city government workforce
	Number of convictions for corruption/bribery by city officials per 100 000 population
	Citizens' representation: number of local officials elected to office per 100 000 population
	Number of registered voters as a percentage of the voting age population
Health	Average life expectancy
	Number of in-patient hospital beds per 100 000 population
	Number of physicians per 100 000 population
	Under age five mortality per 1 000 live births
	Number of nursing and midwifery personnel per 100 000 population
	Number of mental health practitioners per 100 000 population
	Suicide rate per 100 000 population
Recreation	Square meters of public indoor recreation space per capita
	Square meters of public outdoor recreation space per capita
Safety	Number of police officers per 100 000 population
	Number of homicides per 100 000 population
	Crimes against property per 100 000
	Response time for police department from initial call
	Violent crime rate per 100 000 population
Shelter	Percentage of city population living in slums
	Number of homeless per 100 000 population
	Percentage of households that exist without registered legal titles
Solid waste	Percentage of city population with regular solid waste collection (residential)
	Total collected municipal solid waste per capita
	Percentage of city's solid waste that is recycled
	Percentage of the city's solid waste that is disposed of in a sanitary landfill
	Percentage of the city's solid waste that is disposed of in an incinerator
	Percentage of the city's solid waste that is burned openly
	Percentage of the city's solid waste that is disposed of in an open dump
	Percentage of the city's solid waste that is disposed of by other means
	Hazardous Waste Generation per capita (tonnes)
	Percentage of the city's hazardous waste that is recycled
Telecommunication and innovation	Number of internet connections per 100 000 population
	Number of cell phone connections per 100 000 population
	Number of landline phone connections per 100 000 population
Transportation	Kilometres of high capacity public transport system per 100 000 population
	Kilometres of light passenger transport system per 100 000 population
	Annual number of public transport trips per capita
	Number of personal automobiles per capita
	Modal split (percentage of commuters using a travel mode to work other than a personal vehicle)
	Number of two-wheel motorized vehicles per capita
	Kilometres of bicycle paths and lanes per 100 000 population
	Transportation fatalities per 100 000 population
	Commercial air connectivity (number of non-stop commercial air destinations)
Urban planning	Green area (hectares) per 100 000 population
	Annual number of trees planted per 100 000 population

	Areal size of informal settlements as a percentage of city area
	Jobs/housing ratio
Wastewater	Percentage of city population served by wastewater collection
	Percentage of the city's wastewater that has received no treatment
	Percentage of the city's wastewater receiving primary treatment
	Percentage of the city's wastewater receiving secondary treatment
	Percentage of the city's wastewater receiving tertiary treatment
Water and Sanitation	Percentage of city population with potable water supply service
	Percentage of city population with sustainable access to an improved water source
	Percentage of population with access to improved sanitation
	Total domestic water consumption per capita (litres/day)
	Total water consumption per capita (litres/day)
	Average annual hours of water service interruption per household
	Percentage of water loss (unaccounted for water)

8 EFFESUS proposition for historic district certification procedure

The concept of the EFFESUS project arises from the need of an EU-harmonized holistic certification methodology that will integrate a heritage concept for the assessment of the districts. Therefore under the EFFESUS project the following five categories of indicators have been developed:

1. Indoor environmental conditions
2. Embodied energy
3. Operational energy
4. Economic return
5. Heritage significance urban level

The list of the final proposed indicators of evaluation criteria is presented in the table 9.

Table 9 : List of EFFESUS indicators

Category	Credit	Specific indicator
1. Indoor Environmental Conditions	1.1. Thermal comfort	Temperature
		Relative humidity
		Predicted mean vote (PMV) or Predicted percentage dissatisfied (PPD)
	1.2. Acoustic comfort	Indoor ambient noise levels in unoccupied spaces
	1.3. Visual comfort	Mean maintained illuminance
		Illuminance uniformity
		Color rendering index (CRI) for lighting
		Daylight factor
	1.4. Indoor air quality (IAQ)	Pollutants
		Microbial pollution
		Ventilation rate
2. Operational Energy	2.1. Electrical energy use	Total use /year
		Electricity use per m^2 building area
	2.2. Thermal energy use (heating and cooling)	Total use /year
		Thermal energy use per m^2 building area
	2.3. CO_2 emissions	Total for a building or a district
	2.4. Peak power demand	Total for a building or a district
	2.5. % RES: Electric Thermal	Fraction of energy supply from renewable energy sources
3. Embodied Energy	3.1. Comprehensive (life cycle) energy consumption	Total Primary Energy consumption (over 100 years)
		Total Primary Energy consumption (over 100 years) per year
		Total Carbon emissions (over 100 years)
		Total Carbon emissions (over 100 years) per year
	3.2. Comprehensive (life cycle) energy saving	Total Primary Energy saving (over 100 years)
		Total Primary Energy saving (over 100 years) per year
		Total Carbon emissions (over 100 years)
		Total Carbon emissions (over 100 years) per year
4. Economic Return	4.1. Cost of Retrofit Measures	Cost in euros
	4.2. Value of energy saved	Value in euros
	4.3. LCA (Life Cycle	Combined Environmental Impact Indicator: Life Cycle

	Analysis)	Cost (LCC)
	4.4. NPV (Net Present Value)	Value over time
	4.5. ROI	Efficiency of investment
	4.6. Public Domain Benefits	GDP
		Health care costs
		Health benefits
	4.7. Overall Payback Period	Payback time taking into account of all benefits
	4.8. Energy Payback Period	Payback time only taking account of costs of energy
5. Heritage significance urban level	5.1. Settlement pattern	Visual, physical and/or spatial impact
	5.2. Roof-scape	Visual, physical and/or spatial impact
	5.3. Street-scape	Visual, physical and/or spatial impact
	5.4. Public spaces	Visual, physical and/or spatial impact
	5.5. Private spaces	Visual, physical and/or spatial impact
	5.6. Architectural element (balconies, curtilage, stairs etc	Visual, physical and/or spatial impact

In order to compare an approach developed under EFFESUS with other existing certification schemes, tools, EU and national projects the mapping of these all concepts is presented in the tables 10 and 11.

Table 10 : Roadmap to existing certification, tools, EU and National projects

EFFESUS Categories	EPCs	Tools and EU standards	EU Projects	National Projects
Indoor Environmental Conditions		ECC, GPR CEN/TC 350 ISO 37120	CommONEnergy, 3ENCULT, OPENHOUSE, FASUDIR, PIME´S	
Operational Energy	German EPC, Hungarian EPC, Italian EPC, Norwegian EPC, Spanish EPC, Sweden EPC, UK-Scotland EPC, Turkey EPC	District-ECA, EPL, DPL, GPR, Transep-DGO CEN/TC 350 ISO 37120	A2PBEER, BRICKER, CommONEnergy, Ecoshopping, 3ENCULT, Climate for Culture, STEP UP, MESSIB, OPENHOUSE, Cheap-GSHPs, FASUDIR, EPISCOPE, PIME´S	LEAF, ANNEX 51, EnERGo
Embodied Energy	German EPC, Hungarian EPC, Italian EPC, Norwegian EPC, Spanish EPC, Sweden EPC, UK-Scotland EPC, Turkey EPC	District-ECA, EPL, DPL, GPR, Transep-DGO CEN/TC 350 ISO 37120	A2PBEER, BRICKER, CommONEnergy, Ecoshopping, STEP UP, MESSIB, Cheap-GSHPs, FASUDIR, EPISCOPE, PIME´S	LEAF, ANNEX 51, EnERGo
Economic Return	Hungary EPC, UK-Scotland EPC	CEN/TC 350	CommONEnergy, Ecoshopping, OPENHOUSE,	

			Cheap-GSHPs, FASUDIR, EPISCOPE, PIME´S	
Heritage significance for building and district level		EPL, DPL	3ENCULT, Climate for Culture, MESSIB, Cheap-GSHPs, METRICS	Spara och Bevara (Save and Preserve)

The table below is showing the mapping of EFFESUS KPIs to existing certification schemes for district level.

Table 11: Mapping of EFFESUS KPIs (from D5.4) to existing certification schemes for district level

EFFESUS		AQUA-BL	BREEAM-C	CASBEE-UD	HQE – A	DGNB-UD	GREEN STAR-C	LEED-ND
Criteria	**Sub-criteria**							
Indoor Environmental Conditions	Thermal comfort	Comfort hygrothermal	-	Adequate quality of housing	-	-	-	-
	Acoustic comfort	Comfort acoustic	Noise pollution	Adequate quality of housing	-	Noise protection and sound insulation	-	-
	Visual comfort	Comfort visual	-	Adequate quality of housing	-	Aesthetic quality: • Urban integration • Urban design, • Use of existing structures • Art in public space	-	-
	Indoor air quality (IAQ)	Comfort olfactory Sanitary quality of the environment, air and water	-	Air	-	-	-	Construction activity pollution prevention
Operational Energy	Electrical energy use	Energy management Building systems and processes	Energy strategy	-	Energy and climate Material and equipment	Energy-efficient development layout Energy technology		Building energy efficiency Infrastructure energy efficiency
	Thermal energy use (heating and cooling)	Energy management	-	-			-	District heating and cooling

		Building systems and processes						
	CO_2 emissions	Construction site with low environmental impact	Low impact materials	CO_2 absorption by forests Contribution in CO_2 reduction in other region		Life cycle assessment	Greenhouse strategy	-
	Peak power demand	-	-	-	-	-	Peak Electricity Demand Reduction	-
	% RES: Electric Thermal	-	-	-	-	Total primary energy demand and renewable	-	-
Embodied Energy	Comprehensive (life cycle) energy consumption	Energy management	-	-	-	-	-	Minimum building energy efficient
	Comprehensive (life cycle) energy saving	Energy management	-	-	-	-	-	-
Economic Return	Cost of Retrofit Measures	-	Economic impact	-	Economics of the project	Life cycle costs	-	-
	Value of energy saved	-		-			-	-
	LCA (Life Cycle Analysis)	-		-			-	-
	NPV (Net Present Value)	-		-			-	-
	ROI	-		-			Return of Investment	-
	Public Domain Benefits	-		-			-	-
	Overall Payback Period	-		-			-	-
	Energy Payback Period	-		-			-	-
Heritage Significance and Conservation Principles	Urban	-	-	-	Heritage, landscape and identify	-	-	-
	Building Exterior	-	-	-		-	-	-
	Building Interior	-	-	-		-	-	-

The assessment of correlating indicators (Table 11) shows that in most cases the indicators are different and calculated through different methodologies, due to the different set of location standards.

Moreover almost all existing certification schemes are developed to work on the building level which makes it necessary to harmonize the schemes to work on a district level. Existing certification methodologies for district level are mostly focused on the environmental aspect rarely taking into account economic aspects and energy consumption as well as the age or the cultural significance of the buildings. To be able to do so inspiration from methodologies with a wider and more holistic approach is necessary. This suggestion is influenced on environmental impact assessment methodologies where both direct and indirect effects of the strategies for energy efficiency measures are identified and described in relation to the change they can cause to the historic urban district. But influences have also derived from the process like step by step procedures that is developed in CEN standards and in other planning processes on strategical level.

This chapter presents EFFESUS proposition of a certification procedure in order to facilitate the implementation of measures that can improve energy performances in historical buildings in Europe.

Based on the EFFESUS methodology defined in the Task 5.4, a guide for KPIs and the associated DSS tool should be developed to define EFFESUS certification methodology and provide recommendations to improve the certification achieved (Figure 4).

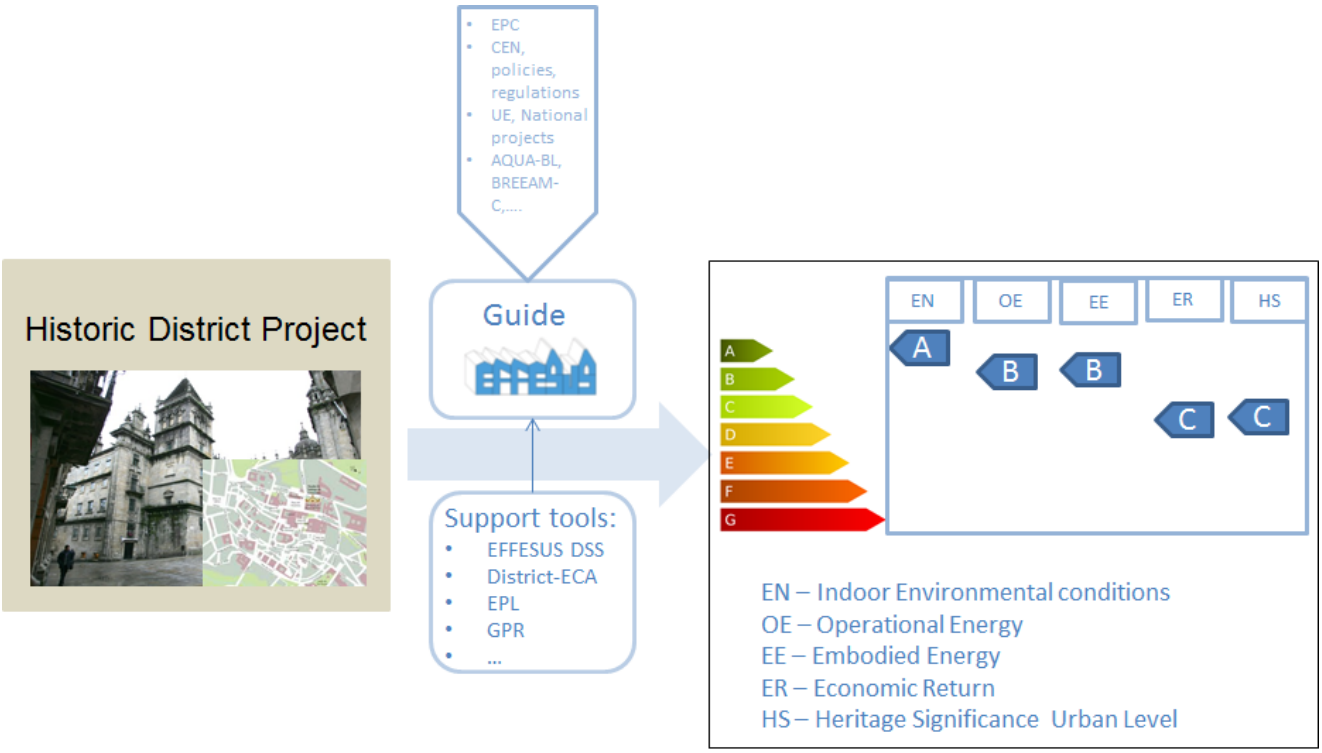

Figure 4. EFFESUS Certification concept

The proposed European harmonized methodology for evaluating the energy efficiency of districts should be:

- Holistic approach composed of the five main aspects: indoor environmental conditions (EN), operational energy (OE), embodied energy (EE), economic return (ER) and heritage significance for urban level (HS)
- EU-harmonized: certification should integrate best practices of existing tools, EPC, EU and National project as well as existing district certification methodologies
- The support and advice from CEN (responsible for standardization in EU), EU and national policies and regulations should be always considered as a reference
- For each aspect, a classification from the most efficient “A” to the least one “G” should be defined in order to create an easy to identify ranking of certification, such as AAAAA to the least efficient GGGGG.

The proposed schedule of the certification methodology is presented in the Figure 5.

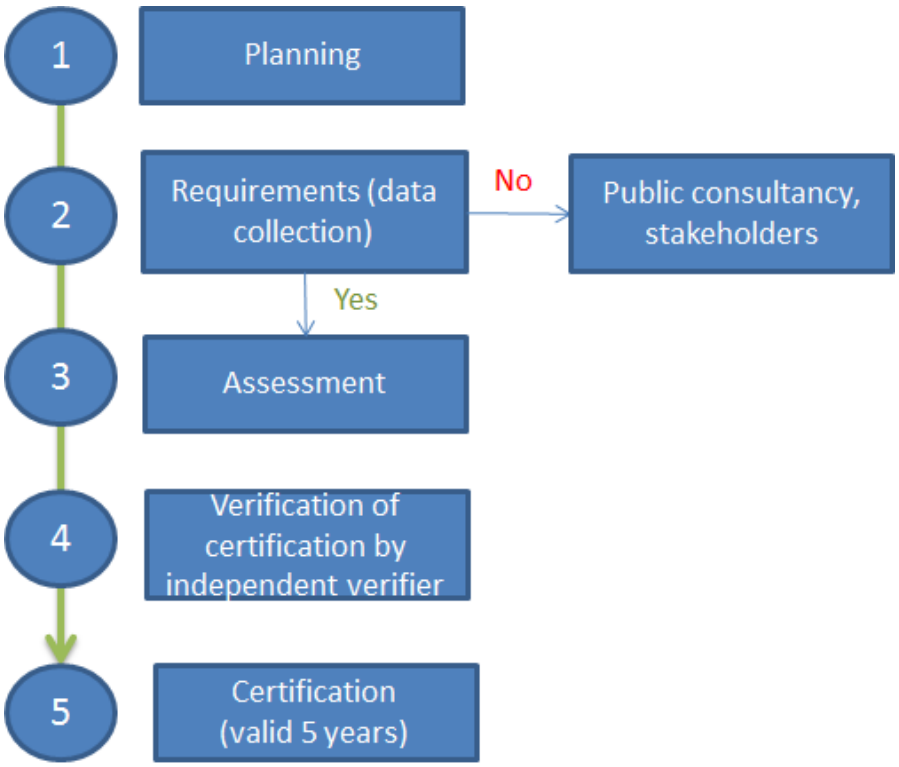

Figure 5. Process of certification methodology

The proposed district certification process consists of the following steps:

1. Planning: definition of scope and objective in terms of the studied district, develop a comprehensive action plan, involve stakeholders, identification of policies, regulation.
2. Requirements: data collection. Data that is needed for the certification of a historic district can mainly be obtained from the data providers, such as : administrative bodies of the municipalities and federal states, Energy Performance Certificates, on-site inspection, building owners, EU and national projects

3. Assessment: adapt calculation methodology to the studied district and the number of KPIs included in the certifications.
4. Verification of certification by independent verifier: it is necessary that the certification assessment will be reviewed by independent verifier.
5. Certification: validity time depends on the country .

Main activities proposed for an implementation plan :

The proposed implementation activities are divided into the following groups:

1. ***EU EFFESUS platform:*** this activity is aimed at preparing the European wide implementation process to coordinate and harmonise EU initiatives and developments related to EFFESUS.
2. ***Market analysis:*** the main goal is to determine the opportunities for EFFESUS methodology.
3. ***Stakeholders engagement***: is aimed at engaging with interested parties for certification related activities (certification owners, software developers, certification bodies, etc.) and to seek out sector actors to endorse and commit to the EFFESUS approach.
4. ***Organisation Development Certified:*** this activity is aimed at completing the EFFESUS methodology and certification system.
5. ***EFFESUS methodology development****:* the methodology is developed in WP5. The development needs to be tailored to stakeholder requirements. Moreover a guide for the EFFESUS methodology is required.
6. ***Standardisation:*** standardisation activities are required to align the EFFESUS approach to relevant standards and to incorporate it into standards.

9 Conclusions

This report provides an overview of the Energy Performance Certificate of the EFFESUS case studies countries, as well as EU projects, certification methods and tools for districts and historic buildings.

The matching between EFFESUS key performance indicators developed under the project and indicators of the seven commercial methodologies of the district certification was carried out in this report. This analysis shows that almost all existing methodologies are mostly focused on the environmental aspect rarely taking into account economic aspects or energy consumption. Therefore a new holistic certification such as the EFFESUS approach in terms of the five pillars: indoor environmental conditions, operational energy, embodied energy, economic return and heritage significance at urban level is recommended for future evaluation of energy efficiency for historic districts.

The EFFESUS proposition of an implementation scheme of certification for historic districts is presented in chapter 8. It must be noted that in the planning process as well as requirements stage a deep interaction and communication between all involved stakeholders is necessary.

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