State of the art of Energy Performance Certification in EU sport buildings

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Preface

In Europe, there are around one million and half sports facilities, which represents 8% of the overall building stock. Most of them were built before 1980 and need refurbishment because no considerable changes have been made to the initial conditions. The project STEP-2-SPORT aims to support the refurbishment of the existing sport buildings through step by step renovation towards nearly zero energy buildings (NZEB), contributing to the EU energy objectives. Energy audits and energy performance certification (EPC) will be performed in at least 22 pilot sport facilities from 7 different countries (Sweden, Poland, Portugal, Spain, Italy, Greece and Bulgaria) in order to identify energy improvement opportunities as well as to determine their energy rating. The analysis of the existing EPC schemes among the countries involved, as well as five environmental assessment methods that include energy performance as part of the assessment, will provide evidence of the most appropriate systems for assessing energy performance implemented in the European countries.

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1. Introduction

1.1 Background

This report is developed in the framework of the STEP-2-SPORT project, a European project co-funded within the Intelligent Energy Europe (IEE) program. The project aims to support the refurbishment of the existing sport buildings through step by step renovation towards nearly zero energy buildings (NZEB).Energy audits and energy performance certification (EPC) will be performed in at least 22 pilot sport facilities from 7 different countries (Sweden, Poland, Portugal, Spain, Italy, Greece and Bulgaria) in order to identify energy improvement opportunities as well as to determine their energy rating.

This report is part of Work Package 2(WP2) activities, and involves the analysis of existing methods for assessing energy performance in buildings. There are two different types of assessment methods for energy performance analysed in this report. The first type is the existing energy performance certification schemes that are in place in the consortium countries, as part of the requirements in the Energy Performance of Buildings Directive (EPBD).It is worth mentioning to readers of this report that the energy performance certification schemes will, in this report, be abbreviated as EPC schemes, which should not be confused with other common meanings of the same abbreviation such as Energy Performance Contracting. The other type of assessment method for energy performance analysed in this report is environmental assessment methods for buildings, and in particular those that focus on energy performance, at least in some part. The environmental assessment methods analysed are: LEED, BREEAM, Green Building, Passive House Institute (PHI) and one method which is under development called CEC5. The results obtained from the analysis of both the EPC schemes and the environmental assessment methods, will provide evidence of the most appropriate methods for assessing energy performance implemented in the European countries. Therefore, the results of this analysis will be valuable input data feeding into the activities foreseen in the STEP-2-SPORT project. One of the coming tasks is to provide recommendations for a common EU certification scheme of sport buildings.

1.2 Methods

To collect information on the EPC schemes, each of the participating countries has completed a document of information. The EPBD reports of the participating countries have also been an important source of information. A report “Market study for a voluntary common European Union certification scheme for the energy performance of non-residential buildings” developed under the tender no. ENER/C3/2012-436 was meant to be an important source of information for the analysis of the environmental assessment methods. This report was delayed and not published until after the first publication of this report and therefore it has only been partly used as an inspiration for the revised version of this report.

In order to determine the number of certified sport buildings energy agencies have been consulted. In the case of the environmental assessment methods, online databases have been used to find the necessary information.

SWOT analysis has been used to assess Strengths, Weaknesses, Opportunities and Threats of EPC schemes as well as environmental assessment methods. SWOT analysis has been chosen as a useful tool in this report because it makes it easy to get an overview about strong and weak aspects of each system.

2. Energy performance certification – EPC

2.1 Energy Performance certification (EPC) in Europe

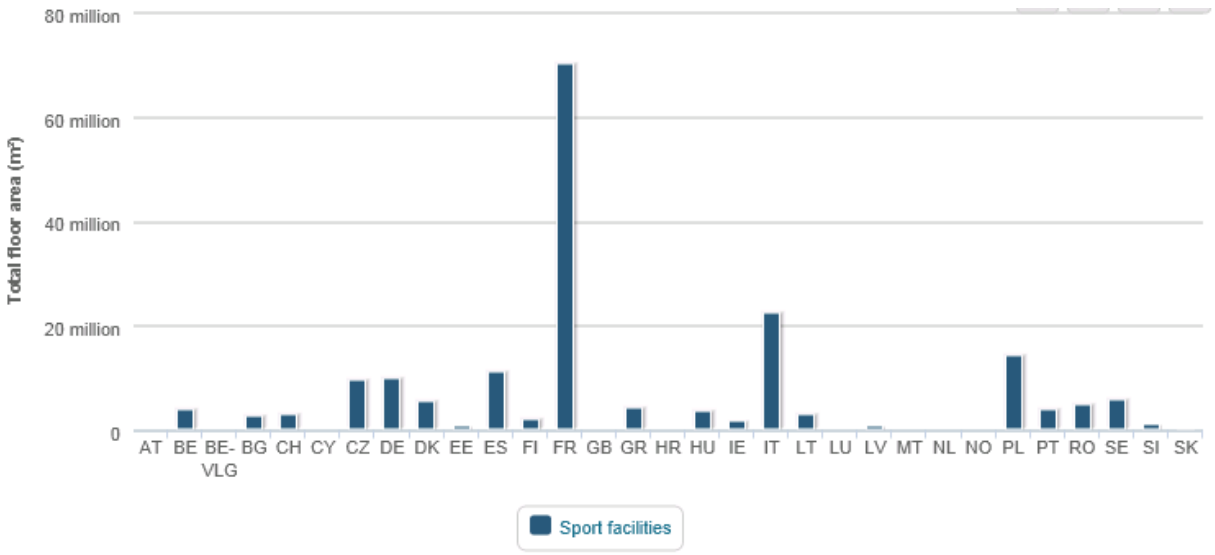
In Europe, there are around one million and half sports facilities (Figure 1). Most of them were built before 1980 and need refurbishment because no considerable changes have been made to the initial conditions. Approximately 40 % of the energy consumption in Europe is energy use in buildings. Within the sector of Sport and Recreation Buildings, studies in the UK have estimated that the sector can account for up to 10 % of annual energy consumption, and that it represents 8 % of the building stock in some counties and regions. Statistics at the European level of this nature, specifically for sport facilities do not yet exist and further analysis is needed. Case studies and EU funded projects have highlighted that energy consumption can be reduced in this type of buildings by 30 % or more (1).

Figure 1. EU dimension of the Sport and Recreation Building Stock

Source:EnergyEfficiencyfor European Sport Facilities, SportE² Available online at: http://www.sporte2.eu/documents/15982/20836/D7.1+-+Market+Analysis.pdf/a6a67ae6-c412-4a74-842c-fced962816b4?version=1.0

Figure 2 illustrates the amount of the floor area distributed between the different countries in the EU sport building stock.

Figure 2. Breakdown of the EU sport building stock expressed in total floor area.



Source: Data Hub for the Energy Performance of Buildings. BPIE. Available online at: http://www.buildingsdata.eu/data-search

No data is available for this parameter in Austria (AT), Belgium - Flanders (BE-VLG), Croatia (HR), Netherlands (NL), Norway (NO) and United Kingdom (GB).

The progress and current status of EPC on public and large buildings visited by public in the Member States (MS) of Europe.

The report "Implementing the Energy Performance of Building Directive" (EPBD), Featuring Country Reports 2012, was published October 2013. Each of the MS has made their own report of the status of implementation of the EPC schemes in their country. The report indicates that all countries have implemented the EPC under the subdivision "Public and large buildings visited by public", some in the very beginning of the regulation, and some more recently. Not all countries, but most of them have also expanded the regulation to include buildings with a floor area of more than 1000 m² by including buildings larger than 500 m² or 250 m².

The EPBD report describes the issue of compliance and control, regarding both the presence of EPC and quality control of the inspections, throughout the MS, as being an area with room for improvement. There are regulations and sanctions in place in many of the MS, although this is stated to be more of a theoretical option, rather than something that is applied in practice. Since the end of 2012, the situation has hopefully improved, but there is no comprehensive data to prove this, at the time of this report. The participating countries in the STEP-2-SPORT project, and in particular energy agencies, have been consulted in order to determine the presence of EPC in sport buildings, as a percentage of the total number of sport buildings. This information is presented in the country specific passages 2.1.1 – 2.1.7, where available. In some countries it has not been possible to collect this information due to the fact that the databases are not able to differentiate sport buildings from other tertiary buildings.

2.1.1 Portugal

Since the EPC scheme was launched in July 2007, more than 555 000 buildings' EPCs have been issued until December 2012. Since 2009 around 2 500 EPCs for new building and 9 000 EPCs for existing

buildings are being issued every month. 10 % of the database of certified buildings is non-residential buildings. In Portugal the definition of public building includes all non-residential buildings owned by private or public entities (2).About 22% of total building floor area in Portugal (PT) is located in non-residential buildings. The non-residential stock is distributed across different building types of which Sport facilities represents 4.2% (3).In Portugal, 575 sport facilities have been certified since the scheme was launched in July 2007.

By 30th November 2013, 542 sport facilities were certified since the scheme was launched in July 2007. Energy label distribution for certified existing buildings (CE), certified new buildings (CE/DCR) and buildings with DCR (a kind of pre-certificate) is showed below.

Table 1. *EPC in sport facilities in Portugal –old legislation (DL 78/2006, 4 April)*

Classe Energética	A+	A	B	B-	C	D	E	F	G
DCR									
Clubes desportivos com piscina	5	11	27	74					
Clubes desportivos sem piscina	8	28	55	87					
CE/DCR									
Clubes desportivos com piscina	1	2	7	18					
Clubes desportivos sem piscina	1		3	16					
CE									
Clubes desportivos com piscina	2	4	8	31	48	15	9	2	12
Clubes desportivos sem piscina	7	9	13	22	22	10	5		1

Clubes desportivos sem piscina (Sports clubs without Swimming pool)
Clubes desportivos com piscina (Sports clubs with Swimming pool)

33 sport facilities were certified since the scheme under the new legislation was launched in 2013. Energy label distribution for certified buildings (CE) and buildings with a pre-certificate (PCE) is showed below:

Table 2. *EPC in sport facilities in Portugal – new legislation (DL 118/2013, 20Th August)*

Classe energética	A+	A	B	B-	C	D	E	F
PCE								
Clubes desportivos sem piscina			3					
Clubes desportivos com piscina			2	1				
CE								
Clubes desportivos sem piscina		2	5	6	9	1		
Clubes desportivos com piscina			1		1			
Piscina coberta aquecida					2			

Clubes desportivos sem piscina (Sports clubs without Swimming pool)
Clubes desportivos com piscina (Sports clubs with Swimming pool)
Piscina coberta aquecida (heated indoor swimming pool)

Reviewed aspects

Table 3. Reviewed aspects within the Portuguese EPC scheme

Category	***Indicators***
Building characteristics	• Postal identification (address, localization, county, parish, GPS) • Building identification (Registry Office identification, cadastral registration number, Registry Office inscription number, building or building unit) • Additional information (total useful floor area (m^2)) • Photos of the building • Summary description of the building and its compartments and/or different areas (localization, sea distance (if relevant), floor(s) and respective area(s), activity (ies)/zones per floor) • Average nº of users and respective activity (ies)/zones per floor (distinguishing, if possible, between permanent or occasional users, for the permanent users specify hours of utilization). • Identification, location and summary description of the technical systems (HVAC systems, lighting, preparation of hot water, renewable energy, elevators and escalators) • Construction solutions, Walls, roof, floors and thermal bridges: Description (Localization, thermal insulation type and thickness for walls, roofs and floors), Total area (m^2), U-value ($W/m^2.\circ C$) • Glazing: Description (Localization, thermal insulation type glazing, frame and solar shading), Total area (m2), U-value ($W/m^2.\circ C$), solar factor
Energy performance	• Digital/paper copies of the: - Duly updated design - Diagrams (Schematic of HVAC systems and other technical building systems, monitoring system (yes or no)) - Technical data about the installed systems - 36 - 12 month period of actual use of energy, gas. • IEE - Energetic Efficiency Indicator (kWh EP/m^2.year); - IEEs – Energetic Efficiency Indicator for s consumption (kWh EP/m^2.year); (see Table 4) - IEEt - Energetic Efficiency Indicator for t consumption (kWh EP/m^2.year); (see Table 4) - IEE ren - Renewable Energetic Efficiency Indicator (kWh EP/m^2.year); - Eren, ext - Energy produced from renewable energy (kWh/year);
Ventilation	• Description (Use, Type of system, Localization, Air Flow (m^3/h))

	• PORTARIA N.º 353-A/2013 (December 2013) establishes the minimum value in terms of fresh airflow rate per person and per unit of floor area, the thresholds protection and the terms of reference for pollutants • Radon measure in mandatory in buildings located in granitic zones (Braga, Vila Real, Porto, Guarda, Viseu e Castelo Branco).
Heating systems (and other technical systems)	• Description (Use, Type of system, Localization, Consumption (kWh/year), Nominal Power (kW), Nominal performance) • Heating system - Type of energy source, energy consumption (kWh/year), nominal power (kW), efficiency, thermal heating power (kW), Quota heating of hot water. Split - Standard / Reversible Split Type Units, energy consumption (kWh/year), nominal power (kW), efficiency, thermal heating power (kW - COP) and thermal cooling power (kW - EER) • Renewable Solar Energy - Thermic system (use, collector and tank specification, energy production, total area (m^2), productivity (kWh/m^2 collector area) - Photovoltaic system (panel and inverter specifications, energy production, total area (m^2), productivity (kWh/m^2 panel)
Electricity	• Electricity use for different types of heat pumps, • Property electricity (electricity for all the common functions in the building), • Household electricity, • Operational electricity, • Electricity for comfort cooling.
Emissions	• In determining the CO_2 emissions associated with energy consumption in buildings, the conversion factors of primary energy to CO_2 emissions are those presented in Despacho n.º 15793-D/2013. Reduced emissions of carbon dioxide due to recommended actions
Measures	• The implementation of energy efficiency measures that show economic viability are mandatory when the respective study shows that: a) There are no apparent constraints or technical limitations, legal or administrative installation; b) The simple payback period (PRS) is equal to or less than 8 years

Climatic zoning	• The climate zoning is based on the third division level of territorial units used in statistics nomenclature (NUTS III). Winter and summer climate conditions are the criteria to select 30 units from Portugal mainland and islands. • Important items: Altitude (m), Degrees day (18 ◦C), Outdoor medium temperature (I/V (◦C), Winter Climatic Zone (I1,I2,I3), Summer climatic zone (V1,V2;V3)
Maintenance Plan	• TIM and contacts (TIM - technical person responsible for the installation and maintenance of buildings and systems) • Company responsible for the maintenance and contacts • Detailed description of preventive maintenance procedures depending on the various types of equipment and features specific components and their potential sources of air pollutants; • Frequency of preventive maintenance and cleaning operations and the level professional qualifications of the technicians who perform them; • Registration of preventive and corrective maintenance performed, with indication of the technicians or technical that performed;
Rules for determining the energy class (more details above)	• The rating of energy class of a service building is based on the energy ratio (RIEE) given by Despacho No 15793-J/2013, 3 December. • The energy class of the building is defined by the interval of eight classes, which fits the ratio of energy class (RIEE) (Despacho No 15793-J/2013, 3 December).
Other	• Using software tool for calculation
Excluded Public buildings/Sport facilities?	Yes, public buildings with area <500 m² (<250 m^2 from 1 July 2015)

Rating system:

Since the 31st of December 2013 and according to Despacho No.15793-J/2013 the rating of energy class of a service building is based on the energy ratio (RIEE) given by:

Figure 3. Equation of energy class.

$$R_{IEE} = \frac{IEE_S - IEE_{REN}}{IEE_{ref,S}}$$

IEE_S - Energy Efficiency Indicator for s consumption (kWh EP/m^2.year)
IEE_{REN} - Energy Efficiency Indicator (renewable energy)(kWh EP/m^2.year)
$IEE_{Ref,S}$ - Reference Energy Efficiency indicator for s consumption (kWh EP/m^2.year)

Energy consumption is categorized as IEEs and IEEt, which is explained in Table 4.

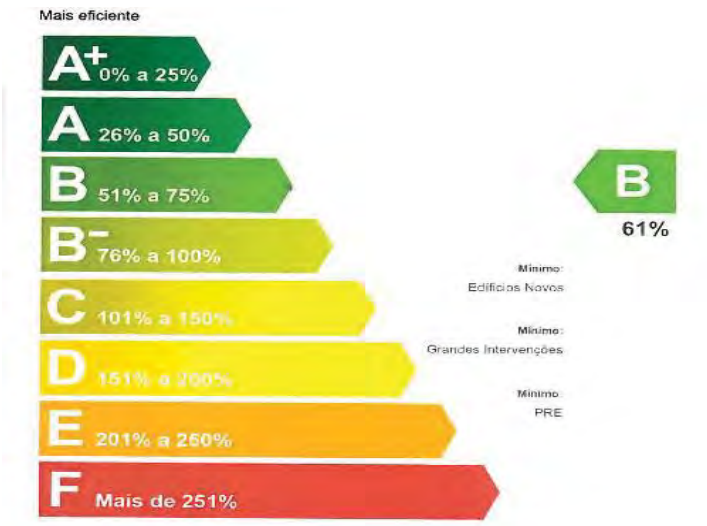
Table 4. Energy consumption included in IEEs and IEEt

Energy consumption included in IEEs	Energy consumption included in IEEt
• Heating and cooling, including humidifying and dehumidifying • Ventilation and HVAC pumping system • Pool and hot domestic water heating • Interior lightning • Elevator, escalators, moving walkaways (after 1/1/2016) • Exterior lightning (after 1/1/2016)	• Non HVAC pumping system • Refrigeration equipment (non HVAC) • Dedicated lighting and occasional use • Elevator, escalators, moving walkaways (before 31/12/2015) • Exterior lightning (before 31/12/2015) • All the remain equipment and systems not include in IEEs

Table 5. Value of energy performance ratings of the Portuguese EPC scheme

Class	R_{IEE} Value
A+	$R_{IEE} \leq 0,25$
A	$0,26 \leq R_{IEE} \leq 0,50$
B	$0,51 \leq R_{IEE} \leq 0,75$
B-	$0,76 \leq R_{IEE} \leq 1,00$
C	$1,01 \leq R_{IEE} \leq 1,50$
D	$1,51 \leq R_{IEE} \leq 2,00$
E	$2,01 \leq R_{IEE} \leq 2,50$
F	$R_{IEE} \geq 2,51$

Figure 4. Energy classes of the EPC scheme in Portugal.



SWOT analysis

Table 6. SWOT analysis of Portugal's EPC scheme

Internal	**Strengths** - Includes average nº of users and activity/-ies per zone of the building - Demands clarification on the building's monitoring system - Stating COP factor for heating and cooling is compulsory - Extensive solar energy data included in the template for EPC - Determining the CO_2 emissions - Contact of technical person responsible for the installation and maintenance of buildings and systems - The implementation of energy efficiency measures that show economic viability are mandatory - Internal air quality - Common rating system	**Weaknesses** - Obtaining a good energy classification is relatively easy for older buildings or if there is a large share of renewable energy
External	**Opportunities** - The demand to keep records, enables easier monitoring of results from installations and maintenance - The formula for calculating energy performance favours renewable energy strongly	**Threats** - For non-public indoor sport buildings the EPC is only mandatory for indoor facilities ≥1000 m^2. - The formula for calculating energy performance does not consider the energy efficiency for renewable energy

2.1.2 Sweden

Sweden has a central register of the EPC of buildings since 2007. The *Law of Energy declarations for Buildings* came in to force 2006. The regulation initially covered certification of all buildings, rental, sold or public buildings. The original declaration of public buildings included public buildings equal to or larger than 1000 m². Since 2012 this has been upgraded to 500 m² (4). The floor area of the non-residential stock, represents around 20 % of the total floor area in Sweden. The non-residential stock is distributed across different building types of which sport facilities represents 4.76% (3).According to

personal correspondents with Annelie Svensson, Swedish National Board of Housing, by 23th June 2014, 2071 sport facilities were certified since the scheme was launched in 2006, which represents about 70% of all indoor sports facilities in Sweden (5).

Reviewed aspects

Table 7.Reviewed aspects within the Swedish EPC scheme

Category	***Indicators***
Building characteristics	• Percentages of different activities, • Year of construction, • Simple or complex building, • Number of floors, • Type of building (detached or not), • Heated area (deliberately heated above 10˚ C), • Installed electricity for heating of hot water (yes or no).
Energy performance	• 12 month period of actual use of energy, • Performance per square meter, • Long term correction, • Reference data (similar buildings and new construction requirement), • Solar heating (yes or no), • Solar electricity (yes or no).
Electricity	• Electricity for hydronic heating systems, • Electricity use for different types of heat pumps, • Property electricity (electricity for all the common functions in the building), • Household electricity, • Operational electricity, • Electricity for comfort cooling.
Heating system	• Type of energy source: - district heating, - oil, - natural gas, - wood, - biomass fuel. Quota heating of hot water.
Cooling	• Addition comfort cooling (calculated due to energy source and kind of cooling system). • Air-condition with installed power above 12 kilowatts (yes or no)
Ventilation	• Is the building subject to mandatory recurring inspections (yes or no). • Is there an approved inspection made at the time of

	visit (yes or no). • Type of system: Natural ventilation, Extract air, Heat recovery, Supply air.
Emission	• Radon concentration measured (yes or no). • Reduced emissions of carbon dioxide due to recommended actions.
Measures	• Recommendations on cost effective measures.
Other	• Energy performance is measured in (bought energy) kWh/year. • Emissions of carbon dioxide are measured in tons/year and areas in square meters.
Excluded Public buildings/Sport facilities?	Yes, public buildings with area <500 m²

Rating system:

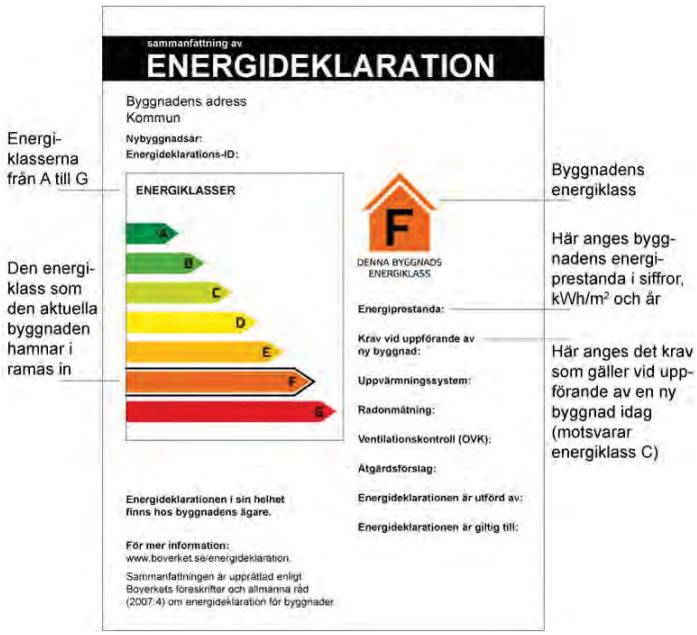
Since the 1st of January 2014 a new system has been implemented, with seven different classifications on buildings: A, B, C, D, E, F and G. Class A and B are for low-energy buildings, meaning buildings which consume less energy than the requirements for new buildings (which is class C). Existing and older buildings will end up in class D-G. The most common class for older buildings is believed to be class E. The energy rating considers only the energy that is related to the normal operation of the building. Energy that is considered to be used for the specific activities within the building is to be excluded. Such excluded energy could for example be energy for office and kitchen equipment, other types of machinery, and heating of pool water.

Table 8. Value of energy classes of the Swedish EPC.

Class A	< 51% of the requirements for new buildings
Class B	Between 51 and 75% of the requirements
Class C	Between 76 and 100% of the requirements
Class D	Between 101 and 125% of the requirements
Class E	Between 126 and 150% of the requirements
Class F	Between 151 and 175% of the requirements
Class G	> 175% of the requirements

Source: EPBD report 2012(6)

Figure 5. Energy classes of Sweden.



Source: www.boverket.se

SWOT analysis

Table 9. SWOT analysis of Swedish EPC system.

Internal	**Strengths** - Energy classification scale is the same for all buildings, which means that old buildings need to reach the same energy performance as new buildings to get a high classification. - The criteria of the scale will develop so that the C level always corresponds to the minimum requirements in the legislated building code for new buildings. -Relatively easy calculations to determine classification and establish benchmarking	**Weaknesses** - Primary energy not included as a factor - Does not calculate CO_2 emissions - Energy use related to the specific activities within the building is excluded when determining energy performance - Not mandatory to carry out any of the proposed energy measures - Poor monitoring of the quality of EPC
External	**Opportunities** - Monitoring of EPC has shifted to central government, which could lead to higher quality monitoring	**Threats** - Previous lack of central monitoring means quality of EPC differs. This could have led to poor confidence in the system and lack of good energy saving measures in some action plans.

2.1.3 Greece

Since 2011 an EPC is required for all existing building in order to be rented or sold. This also applies to new buildings, residential and non-residential as well as existing buildings of all uses when renovated. Since the starting date of implementation until November 2012, approximately 245 000 EPCs were issued and stored into a national database. About 13% of EPCs issued are for non-residential buildings. When it comes to public building the implementation of EPC is going quite slow with only a small number of buildings certified by the end of 2012 (6). The floor area of the non-residential stock represents around 36 % of the total floor area in Greece. The non-residential stock is distributed across different building types of which sport facilities represent 3.21 % (3).

The number of certified sport buildings per category (A-G), is shown in Table 10 below. The data on EPC in Greek sport facilities is from 2014, and shows that category D is the most common category followed by C. No sports facilities have yet reached the highest category A.

Table 10. EPC in sport facilities, Greece

Number of EPCs per Energy Category (Greece)

	A	B	C	D	E	F	G	*TOTAL*
Indoor gyms	0	5	127	154	61	10	6	*363*
Indoor swimming pools	0	0	9	9	3	2	0	*23*
TOTAL	**0**	**5**	**136**	**163**	**64**	**12**	**6**	**386**

Source: Ministry of Reconstruction of Production, Environment and Energy, Greece

Reviewed aspects

Table 11. Reviewed aspects within the Greek EPC scheme

Categories	***Indicators***
Building characteristics	• Building envelope (walls, roofs, floors), doors, windows, shading from horizon obstacles, overheads and lateral obstacles, colour and roughness of envelope surface, heated area & volume, cooled area & volume • Solar orientation • Climatic zone • Construction year (3 time periods - before 1979, between 1979 and 2010, after 2010)
Energy performance	• The energy performance calculation is based on the monthly methodology of EN13790 and is defined by a set of Technical Guides prepared by the Technical Chamber of Greece (TEE) in 2010 and updated in 2012, namely TOTEE 20701-1-2-3-4-5/2010. Performance is calculated in primary energy consumption per m^2 per year broken down in building uses: - residential: heating, cooling, domestic hot water - non-residential: heating, cooling, domestic hot water (where applicable), lighting
Electricity	• For lighting (only for non-residential building uses), complementary systems of heating, cooling, and electrical consumptions of ventilation (only for non-residential building uses) • Usage of photovoltaic systems for own consumption
Heating system	• Efficiency of heating is broken down into the following categories: - production system: type, fuel, power, efficiency, operation months

	- distribution system: distributed power, efficiency - emission system: efficiency - complementary electrical consumptions: pumps, generators etc. - Solar heating/cooling
Cooling	• Efficiency of cooling is broken down into following categories: - production system: type, fuel, power, efficiency, operation months - distribution system: distributed power, efficiency - emission system: efficiency - complementary electrical consumptions: pumps, generators etc.
Ventilation	• Efficiency of ventilation is broken down into following categories: - heating: air flow, %recovery, %recirculation - cooling: air flow, %recovery, %recirculation - humidification: %recovery of humidity - electrical consumption
Emission	• Efficiency of emission systems (radiators etc.) is reported under heating and cooling
Measures	• Energy auditors have to propose 1 to 3 measures (and their cost) that improve energy performance of building. On the EPC one can see for each measure - primary energy efficiency Kwh/m^2 - % primary energy efficiency - savings (euro/kwh) - CO_2 emissions saved (kg/m^2) - Return of investment period
Other	• Using software tool for calculation
Excluded Public buildings/Sport facilities?	Yes, buildings with area < 50 m^2 and temporary constructions

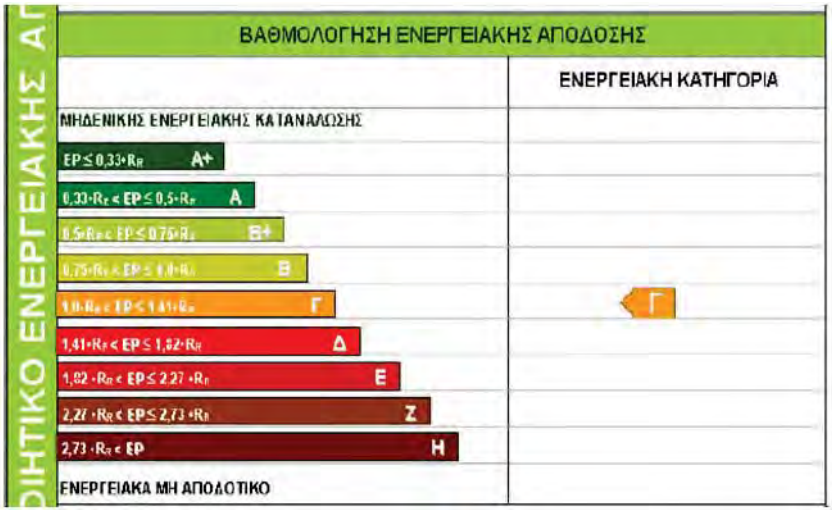
Rating system

The classification of buildings in 9 energy classes is done according to the following scale where E.A. stands for total primary energy consumption of the existing building and K.A. refers to the total primary energy consumption of the reference building. The reference building is a theoretical building with the same positional, geometrical and usage characteristics as the existing building and reference U-values and efficiency rates. Class B is the minimum acceptable class for new buildings and buildings under major retrofits.

Table 12. Value of energy classes of the Greek EPC scheme.

Class	Limits
A+	E.A. ≤ 0.33K.A.
A	0.33 K.A. < E.A. ≤ 0.50 K.A.
B+	0.50 K.A. < E.A. ≤ 0.75 K.A.
B	0.75 K.A. < E.A. ≤1.00 K.A.
Γ	1.00 K.A. < E.A. ≤ 1.41 K.A.
Δ	1.41 K.A. < E.A. ≤ 1.82 K.A.
E	1.82 K.A. < E.A. ≤ 2.27 K.A.
Z	2.27 K.A. < E.A. ≤ 2.73 K.A.
H	2.73K.A. < E.A.

Figure 6. Energy classes of the Greek EPC scheme



SWOT analysis

Table 13. SWOT analysis of the Greek EPC scheme

Internal	**Strengths** - All existing buildings covered by the system - Criteria for heated floor area and volume of building - Criteria for consumption of electricity, specifically for lighting and ventilation - Heating, cooling and ventilation efficiency is calculated individually - The rating system is easy to understand in comparison to the reference building - Information included on recovery and recirculation in the ventilation system	**Weaknesses** - So far, very few public buildings have undergone certification - Not mandatory to carry out any of the proposed energy measures
External	**Opportunities** - The demand of EPC at renovation could offer useful guidance at a natural point of investment - Relatively new system in Greece, useful experiences of EPC in Europe to have learnt from, which could mean the system is working better from start than in some other countries	**Threats** - Slow rate of certification in public buildings could mean authorities will miss opportunity to lead by example - High pressure to perform many EPCs in short time, could mean there is room for less serious consultants to join the EPC market as seen in some other countries

2.1.4 Spain

A classification of buildings under EPBD directive requirement has been gradually implemented:

- New buildings: mandatory since 1st November 2007
- Big refurbishments: mandatory since 1st November 2007
- Sold and rented buildings: mandatory since 1st June 2013
- Public buildings, with more that 500m² surface: mandatory since 1st June 2013

When the certificate for new buildings came into force in 2007, a software called CALENER was implemented as the official calculation methodology for new buildings. Since then, several additional new software tools have been implemented in the certification of existing buildings (7). The floor area of the non-residential stock represents around 14 % of the total floor area in Spain. The non-residential stock is distributed across different building types of which Sport facilities represents 3,97% (11). According to ICAEN (the Catalan Energy Institute), who is the competent body that manages the energy certification process in the region of Catalonia, there are around 720 sports facilities with indoor swimming pools in Catalonia and only 10 of them have an EPC. So, around 1.3% of the sports facilities have been certified. EPC is compulsory for new buildings and existing buildings that are going to be sold

or rented, which is not very frequent for most sport buildings, possibly explaining the slow rate of certification.

Reviewed aspects

Table 14. Reviewed aspects within the Spanish EPC scheme

Categories	***Indicators***
Building characteristics	• Building envelop: floor, facades, roof and window. • Type of building. • Solar orientation (N, W, E, S). • Climatic area and construction date
Energy performance	• Comparison versus standard building: same usage, building typology, climatic area and construction date.
Electricity	• Electricity for all the common functions of the building and also operational electricity. • Cooling demand, building equipment (fire-fighting, transportation, etc.), ventilation requirements, lightning, security and IT.
Heating system	• Type of energy source: district heating, natural gas, fuel, wood or solid biomass, biomass fuel
Cooling	• Cooling demand and typology of cooling system: Integrated with ventilation (yes/no), water-water systems, water -air systems, air-air systems
Ventilation	• Natural ventilation, ventilation demand related with: climate area, building usage, human activity rate.
Emission	• Reduction of carbon emissions due to recommended actions
Measures	• The calculated values are compared to a number of references values. • Proposal of energy saving measures under a compulsory cost analysis: ROI, energy cost, estimated savings, pay-back period.
Other	• Using software tool for calculation
Excluded Public buildings/Sport facilities?	Yes, public buildings with area < 500 m²

Rating system

Energy performance is based on computer simulation, six official software tools allow to compare the building with a reference building. This "reference building" is considered as an average building over more than 100.000 computer simulation, with the same building characteristics: usage, type of building, construction date, climatic area and solar orientation. All the official software tools are based on the same calculation tool, developed by the United States Department of Energy. The difference between

the software tools rely on the precision of the calculation, the more precise the more data input required from the software user. The Spanish EPC legal framework allows using simplified methods for the EPC calculation, depending upon the typology of the building. The indicators for energy performance is measured in kWh/m²year (primary energy) and CO_2/m²year.

Figure 7. Energy classes of Spain

Source: www.epc-spain.com/EXAMPLE-EPC.pdf

SWOT analysis

Table 15. SWOT analysis of the Spanish EPC system.

Internal	**Strengths** - Includes orientation of buildings - Thorough calculations and simulations - Primary energy, and CO_2 emissions calculated	**Weaknesses** - Complicated system for calculations with several different advanced software tools
External	**Opportunities** - Simplified calculation methods allowed for some building typologies - EPC demands on public buildings >250 m^2 from 2015 could encourage more measures in smaller buildings	**Threats** - Lack of high quality data inserted in the advanced software tools could give poor results

2.1.5 Bulgaria

The EPC classification of buildings under EPBD directive requirement was launched in Bulgaria 2009.

The EPC of buildings in operation intends to verify the current status of energy consumption in buildings, the energy performance and their compliance with the scale of energy classes defined in accordance with the Energy efficiency Act, Art. 31 para. 30 (8). Because of no supervision the requirement of EPC on rental or selling houses are seldom met (9).

Since the amendment of Ordinance №7 of 2004 on Energy efficiency, heat and energy savings in buildings on 14th April, 2015, ten building categories have been defined: sport, residential, administrative, hospital, school, hotel, university, trade, kindergarten and culture buildings. The requirements for energy efficiency of buildings are considered to be met when the value of the integrated indicator (the specific annual consumption of primary energy in kWh/m²), at least corresponds to the following class of energy:

- Energy class “B” for new buildings and for building in operation since 1st February, 2010
- Energy class “C” for buildings in put into operation until 1st February, 2010
- Energy class “A” for NZEB
- Energy class “A+” for buildings excessing the national NZEB requirements.

The floor area of the non-residential stock represents about 20 % of the total floor area in Bulgaria. The non-residential stock is distributed across different building types of which Sport facilities represents 4.88% (3).

Reviewed aspects

Table 16. Reviewed aspects within the Bulgarian EPC scheme

Categories	***Indicators***
Buildings characteristics	1) Type of the building - residential (single family house or building) , non-residential (administrative buildings, educational buildings, health buildings, hotel buildings, trade buildings, catering buildings, sports buildings, public buildings); 2) Year constructed; 3) Built up area; 4) Gross area; 5) Heated area; 6) Heated volume; 7) Area of refrigerant capacity; 8) Climate zone (9 zones);

Energy performance	• 36 months period of actual used energy, if information is available. The value of the integrated energy performance of the building and its reference value is expressed as a specific annual fuel consumed energy in kWh/m^2, and primary energy - kWh/m2; net energy consumed in the absence of internal loads and gross energy consumed including internal loads in kWh/m^2; total annual consumed energy in MWh, the total annual consumption of primary energy in MWh; the value of CO_2 emissions
Ventilation	• Type of ventilation systems: natural, mechanical, air showers and air curtains, local, air purification powder systems; • At the time of the visit an inspection of the ventilation system is carried out, otherwise the ventilation systems are subject to obligatory inspections once every 4 years - for systems with nominal power above 12 kW
Cooling	• The AC systems are subject to obligatory inspections once every: 4 years - for AC systems with nominal power above 12 kW;
Heating systems	• Type of heating transfer systems: water, steam-condensing, air. At the time of the visit an inspection of the heating system is carried out. The heating installation together with the heating boilers are subject to obligatory energy efficiency inspections once every: - 8 years - for boilers using liquid or solid fuel, with nominal power from 20 to 50 kW; - 4 years - for boilers using liquid or solid fuel, with nominal power from 50 to 100 kW; - 3 years - for boilers using liquid or solid fuel, with nominal power above 100 kW; - 8 years - for boilers using natural gas with nominal power of above 100 kW; For heating systems and boilers burning all types of fuel, in use for over 15 years, the energy efficiency inspection has to include assessment of the heating installation and has to be accompanied by recommendations for improving the energy efficiency,

<table>
<tr><td></td><td>replacement of the boilers and the heating system or other alternative solutions.
• Domestic hot water systems: Subject of an audit. Recommendations on cost effective measures.
• Renewables: The renewable energy in absolute terms and as a proportion of gross energy requirement for heating the building.</td></tr>
<tr><td>Electricity</td><td>• Household electricity
• Lighting: Subject of an audit. Recommendations on cost effective measures.</td></tr>
<tr><td>Emission</td><td>• There is no radon or other emission concentration measuring.
• The reduced emissions are based on the calculation done in the energy audit.</td></tr>
<tr><td>Measures</td><td>• Recommendations on cost effective measures.</td></tr>
<tr><td>Measuring and energy flow control devices</td><td>• The measuring and the energy flow control devices are subject of inspection during the visit.</td></tr>
<tr><td>Other</td><td>• All energy performance are measured in primary energy kWh/year, where the net energy is multiplied by a coefficient accounting losses for extraction / production and transmission of energy.
• The emissions of carbon dioxide are measured in annual generated CO_2 - tons/year.
• With the implementation of the energy efficiency act of 2015 the following coefficients are to be used:
<table>
<tr><th rowspan="2">Type of energy resource</th><th>Coefficient accounting losses</th><th>Coefficient of ecological equivalent</th></tr>
<tr><th>-</th><th>g CO_2/kWh</th></tr>
<tr><td>Industrial diesel oil and diesel</td><td>1,1</td><td>267</td></tr>
<tr><td>Fuel Oil</td><td>1,1</td><td>279</td></tr>
<tr><td>Natural gas</td><td>1,1</td><td>202</td></tr>
<tr><td>Propane-butane</td><td>1,1</td><td>227</td></tr>
<tr><td>Black stone coal</td><td>1,2</td><td>341</td></tr>
<tr><td>Lignite / brown coal</td><td>1,2</td><td>364</td></tr>
<tr><td>Hard Coal</td><td>1,2</td><td>354</td></tr>
</table></td></tr>
</table>

	Briquettes	1,25	351
	Pellets	1,05	43
	District heating	1,3	290
	Electricity	3	819

Rating system:

The energy performance rating of a building is determined by the energy consumption according to the ordinance of art. 15, para. 3 of the Energy Efficiency Act, using an A – G scale (8). Energy performance rating is determined based on the specific annual consumption of primary energy per square meter conditioned area or cubic meter conditioned volume, (kWh/m^2 or kWh/m^3), for heating, cooling, ventilation, hot water, lighting and appliances. The calculation of the specific annual consumption of primary energy, should at least include:

1. Orientation, size and shape of the building
2. The characteristics of the enclosing structures and components, interior spaces, including:
    a) Thermal and optical performance including interior construction components, heat capacity, insulation, passive heating, cooling components and thermal bridges;
    b) Air permeability
3. Moisture resistance and water impermeability
4. Systems for heating and DHW, including insulation characteristics
5. AC systems
6. Ventilation systems
7. Natural lighting and lighting installations
8. Passive solar systems and solar protection
9. Natural ventilation
10. RES
11. Climate conditions (9 climate zones), including the location and orientation of the building and the indoor climatic conditions.
12. The internal loads

The energy rating is determined according to building category, where sport buildings is one of the available categories. Shown below (Figure 8) are the energy rating levels compared to the energy rating levels of a few other building categories (Figure 9, Figure 10, Figure 11).

Figure 8. Energy rating levels, sport buildings

Клас	EPmin, kWh/m^2	EPmax, kWh/m^2	СГРАДИ ЗА СПОРТ
A+	<	88	A+
A	88	175	A
B	176	350	B
C	351	400	C
D	401	450	D
E	451	563	E
F	564	675	F
G	>	675	G

Figure 9. Energy rating levels, multifamily buildings

Клас	EPmin, kWh/m^2	EPmax, kWh/m^2	ЖИЛИЩНИ СГРАДИ
A+	<	48	A+
A	48	95	A
B	96	190	B
C	191	240	C
D	241	290	D
E	291	363	E
F	364	435	F
G	>	435	G

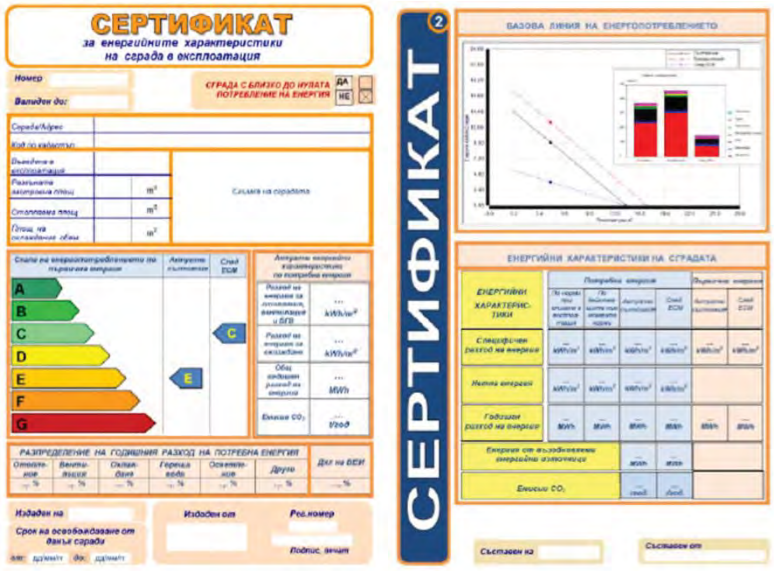
Figure 10. Energy rating levels, schools

Клас	EPmin, kWh/m^2	EPmax, kWh/m^2	УЧИЛИЩА
A+	<	25	A+
A	25	50	A
B	51	100	B
C	101	130	C
D	131	160	D
E	161	200	E
F	201	240	F
G	>	240	G

Figure 11. Energy rating levels, administrative buildings

Клас	EPmin, kWh/m^2	EPmax, kWh/m^2	АДМИНИСТРАТИВНИ
A+	<	70	A+
A	70	140	A
B	141	280	B
C	281	340	C
D	341	400	D
E	401	500	E
F	501	600	F
G	>	600	G

Figure 12. EPC for existing buildings in Bulgaria



SWOT analysis

Table 17. SWOT analysis of the Bulgarian EPC scheme

Internal	**Strengths** - Includes passive solar heating and shading - The buildings U-values, COP of heat and cooling and volume of building included - Audit of lighting system required - Type of building needs to be stated, sport building is one option - Primary energy and CO_2 emissions calculated	**Weaknesses** - Newly revised scheme where the categorization of buildings is one of the key challenges. - So far, few buildings have been certified
External	**Opportunities** - Developing the supervision of EPC could increase trust in the system, encourage more energy saving measures and increase interest in buying an energy efficient building	**Threats** - Lack of supervision of EPC in existing buildings, which likely could promote further certifications

2.1.6 Italy

The EPC classification of buildings under EPBD directive requirement was launched in Italy 2005 and covers all buildings, new, existing, rental, sold or public buildings (3). Regional authorities can make their own autonomous transposition as long as the European legislation of EPBD is followed. Public buildings include buildings owned by the State, Regional or Local Administrations, or other public organisations. In some regions there is now a time limit when the EPBD of public building is required (10). The floor area of the non-residential stock represents about 15 % of the total floor area in Italy. The non-residential stock is distributed across different building types of which sport facilities represents 5,81 % (3).At present, it is presumable that the percentage of sports buildings with EPC is between 2% and 4% of the total stock of sports buildings.

Reviewed aspects

Table 18. Reviewed aspects within the Italian EPC scheme

Categories	***Indicators***
Building characteristics	• BUILDING CHARACTERISTICS - Characteristics of the building envelope; - Orientation, size and shape of the building; - Heating and DHW system (yes/no); - Cooling system (yes/no); - Ventilation system (yes/no); - Lighting system; - Passive solar system and sun protection; - Natural ventilation; - RES (yes/no); - Internal and external conditions. • METHOD OF CALCULATION FROM THE PROJECT - OR STANDARDIZED CALCULATION - Assessment of the energy performance from the data input related to: - the climate and use standard of building; the characteristics of the building, as well as detectable by the energy project of the building. (Refers to the technical report related to the building project. This report presents the compliance with the requirements for energy savings in buildings and their heating systems.) • METHOD OF CALCULATION FROM THE RELIEF OF THE BUILDING - The energy performance assessment is carried out starting from the input data directly derived from surveys on the existing building.

Energy performance	• The L.D. no. 63/2013 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.
Electricity	• All uses related to the common functions in/of the buildings.
Heating system	• According to the D.P.R 74/2013, the building owner/user is responsible for the periodic maintenance of the heating system, which has to be performed by qualified maintenance staff. Heating systems are: - catalogued by their power and sources; - subjected to inspection in order to verify their energy efficiency. • The regions may have more restrictive criteria and shorten periods of submission to the supervisory bodies of the Energy Efficiency Report.
Cooling	• According to the D.P.R 74/2013, AC systems are subject to obligatory inspections at least every 4 years - for AC systems with nominal power above 12 Kw. The regions may have more restrictive criteria and shorten periods of submission to the supervisory bodies of the Energy Efficiency Reports.
Ventilation	IN THE EVALUATION OF THE PROJECT AND THE EVALUATION STANDARD STANDS OUT AMONG: • Reference ventilation: based on natural ventilation even when there is a system of mechanical ventilation. • Effective ventilation: considers effective mode of ventilation, whether natural, mechanical or hybrid for the calculation aimed at the estimation of the primary energy required.
Emission	• The reduced emissions are based on the calculation done in the energy audit.
Measures	• According to national minimum requirements that regions may extend/ enlarge.
Other	• All energy performance are measured in kWh/year. • Emissions of carbon dioxide are measured in tons/year and areas in square meters. • The overall energy performance index (EP tot) take into account: - energy requirements for winter heating and summer cooling, for the production of domestic hot water and lighting;

	- energy supplied and the energy of the auxiliary plant systems, including systems for energy use, also produced outside of the building in question, of the cogeneration systems, district heating and the exploitation of renewable energy sources.
Excluded Public buildings/Sport facilities?	Yes, public buildings with area < 500 m²

Rating system

The EPC is mandatory for all public buildings with total useful floor area equal or greater than 500 m². From 9 July 2015, the limit will be 250 square meters.

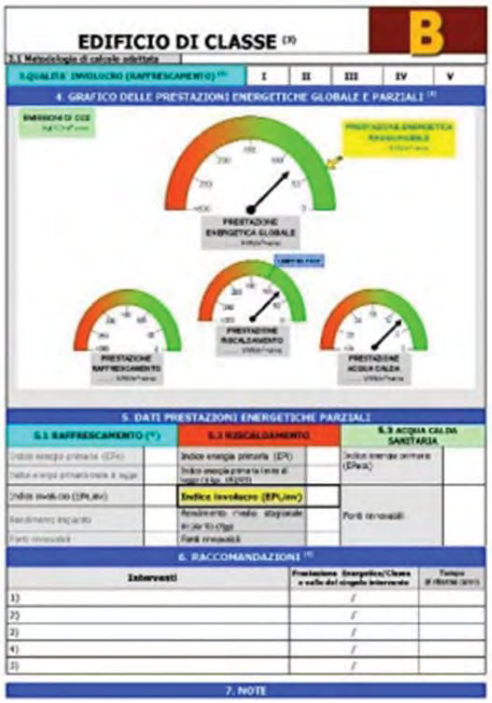
The EPC is also mandatory for all public or private buildings in the case of:

- New buildings.
- Major renovations that cover at least 25% of the external surface of the housing.
- Leases and sale, or any other transfer, whether free or not.

Table 19. Value of energy classes of the Italian EPC scheme.

edificio	EPH [kWh/m²]	EPH [kWh/m³]	Punteggio
Classe A+	EPH < 14	EPH < 3	10
Classe A	14 < EPH < 29	3 < EPH < 6	9
Classe B	29 < EPH < 58	6 < EPH < 11	8
Classe C	58 < EPH < 87	11 < EPH < 27	7
Classe D	87 < EPH < 116	27 < EPH < 43	6
Classe E	116 < EPH < 145	43 < EPH < 54	5
Classe F	145 < EPH < 175	54 < EPH < 65	4
Classe G	175 < EPH < 220	65 < EPH < 80	3
Classe G	220 < EPH < 280	80 < EPH < 100	2
Classe G	280 < EPH < 350	100 < EPH < 130	1
Classe G	EPH > 350	EPH > 130	0

Figure 13. Energy classes of Italy.



SWOT analysis

Table 20. SWOT analysis of the Italian EPC scheme

Internal	**Strengths** - Energy performance rating is simple to understand and also includes volume - Clear definition of what counts as major renovation - Includes passive solar energy, shading and U-value - Periodic maintenance of heating system required	**Weaknesses** - Different energy labelling than the European standard makes international benchmarking difficult - Different regional adaptions makes national comparisons difficult
External	**Opportunities** - EPC demands on public buildings >250 m^2 from 2015 could encourage more measures in smaller buildings - Promotes energy efficiency measures at renovation	**Threats** - Different regional adaptations of the criteria could make it difficult for experts to perform correct EPCs - Few sport buildings have been certified

2.1.7 Poland

The EPC classification of buildings under EPBD directive requirement was launched in Poland 2009 and covered new, existing, rented, sold private and public buildings. However in case of existing buildings, energy performance certificates are only required when a building undergoes a large reconstruction (a reconstruction that requires a building permit) and when a building is sold and the buyer requests a certificate. In such case, energy performance certificates shall be provided by sellers (not common practice).

The floor area of the non-residential stock represents about 30 % of the total floor area in Poland. The non-residential stock is distributed across different building types of which sport facilities represents 4% (3).

Reviewed aspects

Table 21.Reviewed aspects within the Polish EPC scheme

Categories	***Indicators***
Building characteristics	• Energy performance of building envelope (considering shape and energy quality of walls, roofs, etc.) calculated according to the methodology, including efficiency of heating system and hot tap water system divided into separate functional areas and zones of buildings with separate heating systems. • Electric energy considered for lighting, cooling and subsidiary energy purposes. • Separate functional areas with regulate level of indoor temperature higher than 8°C.
Energy performance	• Compare to the new construction requirement (similar buildings and new construction requirement) based on calculated energy performance only for statistical weather data (reference statistical weather year defined for 63 towns/cities in Poland). No performance characteristic based on measured energy consumption. • Renewable energy sources considered as source for reduction of primary energy demand for all energy purposes.
Electricity	• Electricity for lightning and subsidiary purposes (water and circulating pumps, electronic control systems, ventilation units, heat pumps, solar collectors, cooling devices, etc.) taken from country power system (mix based on hard coal with ratio w = 3,00 for calculation of primary energy demand).
Heating system	• Type of energy source: district heating, oil, natural gas, wood, biomass fuel. • Solar collectors can be considered. • Also concerning heating of hot water.

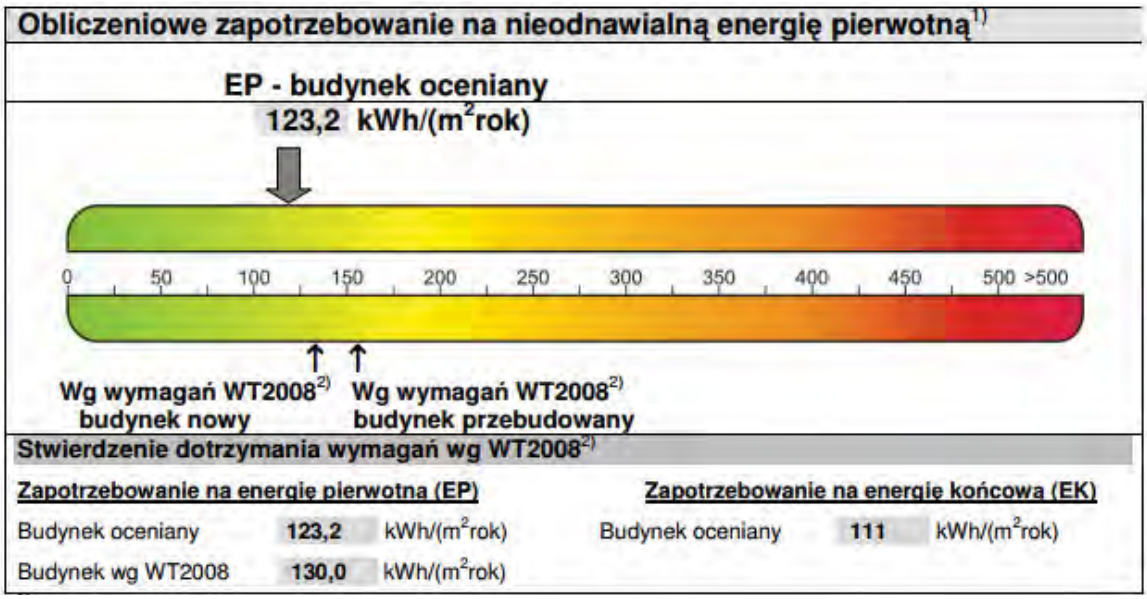
Cooling	• Additional comfort cooling if building equipped with adequate devices (calculated due to energy source and kind of cooling system specific for assessed building). Only systems cooling more than one space area/room have to be considered in calculation. Only calculated values according to the methodology.
Ventilation	• Based on calculation methodology considering requirements for air quality and minimum value of ventilated air stream. • No requirements for recurring inspections focused on energy performance.
Emission	• There is no obligation to calculate potential for emission reduction.
Measures	• Only recommendation on potential profitable investment measures. No calculation of potential for heat and energy demand reduction, no CO2 reduction calculation.
Other	• Nothing is measured. Energy performance based on calculation methodology.
Excluded Public buildings/Sport facilities?	• No. According to the separate regulation only sport facilities with the use for the specific military purposes can be released from fulfilling the common requirements.

Rating system

The energy performance coefficient measured in primary energy demand for heating, ventilation, hot water, cooling and lightning is presented on the top of a comparative scale. Below the scale two reference values are presented fulfilling commonly valid requirements based on Building Law. The first reference value is valid for new buildings and the second value is valid for existing buildings undergoing significant reconstruction.

In the graphic presentation of the EPC, there is a scale showing the primary energy demand compared to the building code, and also a table where the detailed value of the primary energy demand indicator (EP) and the end energy demand indicator (EK) as well as the reference value of EP for new buildings is presented as kWh/m^2. In Poland there is no applied classification in energy classes for buildings.

Figure 14. Energy rating system in Poland.



SWOT analysis

Table 22. SWOT analysis of the Polish EPC scheme

Internal	**Strengths** - EPC required before large renovations, which offer energy saving advice at a natural point of investment - Calculates both primary energy and end use energy in the building	**Weaknesses** - EPC not required for existing buildings, unless they undergo large reconstructions or are being sold and the buyer requests one - Only looks at calculated energy of the building, not the actual used energy - Does not calculate CO_2 emissions from the energy consumption - Does not use the same classification and EPC label as is commonly used in EU, which makes benchmarking more difficult
External	**Opportunities** - Efforts to inform or train potential buyers of buildings, private or companies, could result in an increased number of EPCs being performed	**Threats** - When EPCs for buildings being sold are only done at the buyer's request, there is a risk it is neglected due to lack of knowledge of the system from the buyer

2.2 Comparison and conclusions

There are many different ways to determine and define energy performance, within EPC systems present in the examined countries. Several countries share a similar labelling of energy performance, (the A-G scale),but this does not mean that it is possible to compare the energy performance of sport buildings just using this scale. A sport building with an energy performance rating of e.g. D from one country can be very different from another sport building with the same rating from another country.

There are pros and cons to each system as described in the SWOT analysis. Based on the SWOT analysis it is possible to take out the best parts of the various EPC schemes examined, to provide a basis for the upcoming task within the STEP-2-SPORT project, of giving recommendations for a common EU certification scheme of sport buildings. In the list below, a summary of key aspects from the SWOT analysis is presented, indicating from which country's SWOT each aspect is cited, as well as some more general conclusions from reviewing all of the EPC schemes.

Strengths and opportunities (Examples from the SWOTs)

- Primary energy and CO_2 emissions calculated (Spain, Bulgaria, et al.)
- Heating, cooling and ventilation efficiency is calculated individually(Greece)
- The implementation of energy efficiency measures that show economic viability are mandatory(Portugal)

Strengths and opportunities (General conclusions)

- EPC mandatory for large part of the building stock e.g. all buildings >500 m^2, and also required at renovation
- Energy performance rating label easy to understand

Weaknesses and threats (Examples from the SWOTs)

- EPC not required for existing buildings, unless they undergo large reconstructions or are being sold and the buyer requests one(Poland)
- Not mandatory to carry out any of the proposed measures (Greece, et al)
- Energy use related to the specific activities within the building is excluded when determining energy performance (Sweden)

Weaknesses and threats (General conclusions)

- Slow rate of implementation of EPCs, due to poor monitoring

The number of certified sport buildings varies between the countries with Portugal and Sweden having a fairly high share of certified sport buildings, while Greece, Spain, Bulgaria, Italy and Poland have fewer sport buildings certified or are lacking the data. This shows the importance of adequate systems for monitoring the EPC process to make sure that buildings are being certified at the expected rate.

3. Environmental assessment methods

Aside from the energy performance certification scheme present in the EU as part of the EPBD directive, there are also other methods for assessing energy performance in buildings. Some of these methods exclusively examine energy performance while some methods examine energy performance as part of a wider range of sustainability aspects. This report will present an overview of some of the most well-known and commonly used methods, assess their strengths and weakness (through SWOT analysis) and identify what aspects of their energy performance assessment that would be especially useful in a sport building context. The purpose is also to show to what extent these methods already are in use in European sport buildings.

It is important to note that some of the environmental assessment methods examined include a wide range of sustainability aspects besides energy performance. If the goal of a sport building owner is to exclusively examine and enhance the energy performance of his/her building, it is not recommended to use one of these wider scope methods. Nevertheless it is of interest to examine the parts of these methods that do examine energy performance, in order to make a more complete analysis of the state of the art.

The environmental assessment methods examined in this report, (and their scope) are:

- LEED (wider sustainability perspective)
- BREEAM (wider sustainability perspective)
- Green Building (energy performance only)
- Passive House Institute (energy performance only)
- CEC5 (wider sustainability perspective)

3.1 LEED- Leadership in Energy and Environmental Design

The LEED™ Green Building Rating System was introduced in 1999, developed and administered by the non-profit Association U.S. Green Building Council (USGBC). The various versions of LEED can be used to classify different types of buildings throughout their lifecycle and it can be used to classify dwellings, local buildings, and entire areas as well as an entire building alternatively only the shell or operations. LEED is not specifically adapted to the conditions and laws of European countries. Therefore, the American standards are being followed. According to statistics from the USGBC, there are 67 750 certified LEED projects by the 1st of June 2014 (11).

Reviewed aspects

The classification process in accordance with LEED occurs within seven categories with different items that is rated with a number of points depending on the system used (Table 23).Energy performance is reviewed in the first category “Energy and atmosphere”, which is the category with most points. The other five categories do not directly review energy performance.

Table 23. The LEED classification categories

Category	***Indicators***
Energy and atmosphere (max 35 points)	- Fundamental commissioning of building energy systems (required) - Minimum energy performance (required) - Fundamental refrigerant management (required) - Optimize energy performance - On-site renewable energy - Enhanced commissioning - Enhanced refrigerant management - Measurement and verification - Green power building energy performance through innovative strategies
Sustainable sites (max 26 points)	- Construction activity pollution prevention (required) - Site selection - Development density and community connectivity - Brownfield redevelopment - Alternative transportation - Site development - Storm water design - Heat island effect - Light pollution reduction
Indoor environmental quality (max 15 points)	- Minimum indoor air quality performance (required) - Environmental Tobacco Smoke (ETS) control (required) - Outdoor air delivery monitoring - Increased ventilation - Construction IAQ management plan - Low-emitting materials - Indoor chemical and pollutant source control - Controllability of systems - Thermal comfort - Daylight and views
Water efficiency (max 10 points)	- Water use reduction (required) - Water efficient landscaping - Innovative wastewater technologies - Water use reduction
Innovation (max 6 points)	- Innovation in design - LEED Accredited Professional
Regional priority (max 4 points)	(If available for your region)

Principals of Certification

Canada, India and Cuba have made local adjustments of the LEED system, while in other countries the certification process needs to go through the U.S. Green Building Council, which means that the American standard is used (11).

There are four levels of certification (Figure 15) and the number of points that a project earns determines the level of LEED certification that the project will receive. A minimum of 40 points is required in order to certify a building and the maximum score in all versions is 100 points + any bonus points for innovation and regional concerns. Within each of the credit categories, there are specific prerequisites that the projects must satisfy and a variety of credits that the projects can pursue to earn points (12). The highest points achievable are within the credit categories of "Energy and atmosphere" as well as in "Sustainable sites" (Table 23).

Figure 15. The four levels of LEED certification and the points required to reach the different level of certification

Rating system to be used for athletic facilities – new and existing buildings.

According to personal correspondents with Sue Clarc, Leed manager at SGBC, LEED has two systems to consider.

1. LEED for Existing Buildings: Operations and Maintenance. This system is for the operations phase of the building and it must be fully operational for at least one year. The certification is based on actual performance on a range of factors, including energy consumption, water, waste and purchasing.
2. LEED for New Construction. This system can be used for new athletic facilities, and has been used to certify indoor ice hockey arenas, indoor swimming pools, school gymnasia etc. All of the Olympic venues, such as the skating oval and training facilities, for the 2010 games in Vancouver were LEED certified.

Fees and Expenses

There is a registration fee and a fee for the examination of the building (area dependent). Furthermore, there is an additional fee for the documentation and compilation of the application. The total cost varies widely between projects, depending on the experience of the applicant, the local conditions and which credits and grades the building is aimed to achieve. Therefore, a LEED certification usually leads to increased production costs. A more cost-effective certification procedure can be achieved, by using

strategies that aim to collect easy points in the beginning of the certification process and carefully analysing possible synergies where minor actions can generate a lot of points. LEED projects with "Gold" or "Platinum" certifications (Figure 15), might achieve lower construction costs due to e.g. lower risk of costly construction errors (12).

LEED certified projects of sport buildings

The LEED database, found online at http://www.usgbc.org/projects, was consulted in order to determine the number of certified LEED projects, specifically for sport buildings. The following keywords were used:

- *Sports:* 47
- *Stadium:* 126
- *Arena:* 49
- *Swimming*: 4
- *Football*: 14
- *Tennis*: 23
- *Athletic*: 56
- *Gym*: 33
- *Leisure*: 2

The real number might be different but this gives an approximate number of how many sport buildings are certified with LEED, world-wide. The number of certified European sport facilities is not determined because in the LEED database it is not possible to easily filter sport buildings per country. It is likely though, that the majority of these LEED certified sport facilities are located in the US.

SWOT analysis

Table 24. SWOT (Strength Weakness Opportunities Threats) analysis of LEED certification system.

Internal	**Strengths** - Internationally recognized system, strong brand - Firmly established, extensive experience - Separate versions of the program available for many different types of buildings -Includes management and utilization -Rewards innovative solutions	**Weaknesses** - A uniform system of common requirements across the world can be problematic due to different national regulations, climate, etc. - No national adaptions to European countries available - The information on LEED Online is only available in English - Based on American standards and units - Unnecessarily complicated and costly certification system for a medium sized property owners - No requirements on monitoring of the building's energy consumption in use except in the manual for existing buildings.
External	**Opportunities** - A well-known and consistent international system could attract future potential buyers of the building working in an international market - Developing national adaptions of LEED based on the metric system and other relevant units as well as offering information in several languages would simplify the usage of the system	**Threats** - Lack of recognition in Europe could lead to fewer certifications performed

3.2 BREEAM- BRE Environmental Assessment Method

BREEAM is an international environmental classification system developed by the British organization BRE (Building Research Establishment Ltd) and the BREEAM assessment system has certified 260 000 buildings since it was introduced in 1990 (13). The BREEAM assessment system uses recognised measures of performance, which are set against established benchmarks, to evaluate a building's specification, design, construction and use. The aspects reviewed represent a broad range of categories and criteria from energy to ecology. The BREEAM assessment system can be adapted to different countries, but the minimum level is always set above the local legislation. BREEAM can be used in most types of buildings throughout their life cycle, but is most common for commercial buildings, office buildings and industrial buildings. Other building types can be classified, but this requires a specially adapted version, BREEAM Bespoke, tailored for the unique building (12) (14).

Reviewed aspects

The classification in accordance with BREEAM focuses on ten categories with different indicators that can give a number of points. The Energy category can yield the highest number of points of the categories, but there are nevertheless nine other categories that do not directly review energy performance.

Table 25. The BREEAM classification categories (4).

Category	***Indicators***
Energy (max 25 points)	- Reduction of CO_2 emissions credit follows the energy hierarchy of; 1. Reduced energy demand (built form/fabric efficiency) 2. Reduced energy consumption (systems efficiency) 3. Reduced carbon (use of low and zero carbon energy) - Energy efficient transportation systems - Energy efficient laboratory - Energy efficient equipment
Health & Wellbeing (max 17 points)	- Visual comfort - Indoor air quality - Thermal comfort - Water quality - Safety and security
Materials (max 15 points)	- Life cycle impacts - Re-use of façade and structure - Responsible sourcing - Insulation - Designing for robustness
Management (max 17 points)	- Sustainable Procurement - Stakeholder participation
Pollution (max 12 points)	- Refrigerants - NOx emissions - Surface water run-off - Reduction of night time light pollution

	- Noise attenuation
Land Use & Ecology (max 10 points)	- Site selection • Re-use of land • Contaminated land - Biodiversity
Waste (max 7 points)	- Construction waste management - Recycled aggregates - Operational waste - Speculative floor & ceiling finishes
Transport (max 9 points)	- Cyclist facilities - Provision of Public Transport - Proximity to amenities - Alternative modes of transport - Travel Plan - Maximum Car Parking Capacity
Water (max 9 points)	- Water consumption - Water leak detection and prevention - Water efficient (process) equipment - Sustainable on-site water treatment
Innovation (max 10 points)	

Principals of Certification

In the BREEAM assessment system the scores are categorised by six ratings, ranging from 'Acceptable' (one star) to 'Outstanding' (six stars) (Table 27) and certain categories are mandatory depending on the rating claims. BREEAM requires that the certification must be conducted by an approved "Assessor" and that certain standards, industry guidelines, calculation tools, etc. must be approved by BRE in order to be used in the certification process.

To determine the rating score, the individual environmental category scores within an assessment part are adjusted with a pre-determined weighting, unique to the category and assessment part, and totalled; providing the overall BREEAM score. See Table 26for an example of calculation of BREEAM score and rating system (12) (14).

Table 26. Example BREEAM score and rating calculation.

BREEAM Section	Credits Achieved	Credits Available	% of Credits Achieved	Section Weighting	Section score
Management	7	17	41%	0.12	4.94%
Health & Wellbeing	11	17	64%	0.15	9.70%
Energy	10	25	40%	0.19	7.60%
Transport	5	9	55%	0.08	4.44%
Water	4	9	44%	0.06	2.68%
Materials	6	15	40%	0.125	5.00%
Waste	3	7	43%	0.075	3.21%
Land Use & Ecology	4	10	40%	0.10	4.00%
Pollution	5	12	42%	0.10	4.17%
Innovation	1	10	10%	0.10	1%
Final BREEAM score				**46,74 %**	

Source: SGBC (Sweden Green Building Council) English manual BREEAM SE V1

Table 26 illustrates an example of the BREEAM rating score, adjusted with a pre-determined weighting.

Table 27. The BREEAM assessment ratings.

Assessment Score(%)	Assessment Rating	Star Rating
< 10	Unclassified	-
≥ 10 to <25	ACCEPTABLE	*
≥ 25 to <40	PASS	* *
≥ 40 to <55	GOOD	* * *
≥ 55 to <70	VERY GOOD	* * * *
≥ 70 to <85	EXCELLENT	* * * * *
≥ 85	OUTSTANDING	* * * * * *

Source: Sweden Green Building Council (SGBC)

Table 27 illustrates the scores categorised by the six ratings, ranging from 'Acceptable' (one star) to 'Outstanding' (six stars). The ratings show overall performance of the asset and its management systems".

Rating system to be used for athletic facilities new or existing buildings.

According to personal correspondents with Anders Danielsson, assignment Manager, WSP Environmental in Malmö, BREEAM has several systems to consider:

1. *BREEAM International New Construction*, can be used to assess the sustainability of new buildings and for major refurbishments projects at the design and construction stages of a project. The scheme can be used to assess commercial buildings (i.e. office, retail, industrial) and

residential buildings. Buildings which fall outside the scope of the standard scheme require bespoke criteria development. A new sport facility or a major refurbishment project of an existing sport facility will probably fall outside the scope of the standard scheme and therefore require a bespoke criteria development.

2. *BREEAM Europe Commercial,* remains the current methodology for assessing the refurbishment or fit-out of office, retail and industrial buildings in Europe and EU Member states. If the refurbishment or fit-out of a building falls outside this scope, the *BREEAM International Bespoke* scheme should be used.
3. *BREEAM In-Use,* is a scheme to help building managers, investors, owners and occupiers reduce the running costs and improve the environmental performance of existing non-domestic buildings. It consists of a standard, assessment methodology and an independent certification process that provides a route map to improving sustainability credentials of existing buildings.
4. Some countries have national adapted BREEAM Schemes. If the building that is going to be assessed fall within the scope a country specific scheme this scheme should always be used instead of the internationally BREEAM-schemes mentioned above. Countries that today have national BREEAM schemes are: UK, Germany, Netherlands, Norway, Spain, Sweden and Austria.

Fees and Expenses

Fees are charged for registration or certification in the design stage as well as in the finished building. Fees vary depending on the size of the building. The registration fee for a building in size from 5 000 m² to 50000 m², is e.g. 1 200 EUR. The certification fee in the design stage is2 400 EUR and the certification fee for the finished building is about 1 200 EUR. There are also extra costs for analysis, calculations and documentation. Furthermore, a BREEAM certification includes that action must be taken which can lead to increased production costs.

In order to achieve the most cost-effective certification possible the strategy may be to collect easy points first, and then analyse the measures that can generate a lot of points individually or together with other measures (12).

Certified projects of public, sport building

The BREEAM database, (http://www.greenbooklive.com/search/scheme.jsp?id=202), was consulted in order to determine the number of BREEAM certified sport buildings in Europe. The following keywords were used:

- *Sport, sports*: 51 facilities (49 in UK, 1 in Belgium and 1 in Netherlands)
- *Stadium*: 4 facilities (3 in UK, and 1 in Hungary)
- *Arena*: 15 facilities (2 in Sweden, 1 in Netherlands, 10 in UK and 2 in Spain)
- *Swimming*: 1 facility (UK)
- *Football*: 4 (UK)
- *Tennis*: 0
- *Athletic*: 2 (UK)
- *Gym*: 9 (UK)
- *Leisure*: 26 (UK)

From these keyword searches in database 86 sport facilities were found. The real number might be different but this gives an approximate number of how many sport buildings are certified with BREEAM.

SWOT analysis

Table 28. SWOT analysis of BREEAM certification system.

Internal	**Strengths** - Internationally recognized system, strong brand -Firmly established, extensive experience -Includes management and utilization -Rewards innovative solutions - Local adaptions available for several countries	**Weaknesses** - Complicated and costly certification system for medium sized property owners - Too many sustainability aspects reviews, if the main goal of the certification is to reach nearly zero energy buildings - Requires certified consultants - Reviews aspects that could be outside of the property owners control
External	**Opportunities** - A well-known and consistent international system could attract future potential buyers of the building - Special adapted scheme, BREEAM Bespoke, tailored for the unique building.	**Threats** - Lack of recognition in Europe could lead to fewer certifications performed

3.3 Green Building

In 2005 the European Commission launched the Green Building Programme (GBP). Green Building is a programme aiming to improve the energy efficiency of non-residential buildings in Europe on a voluntary basis. The ranking system only applies to non-residential buildings, but can also be used for non-residential buildings containing housing up to 49% of the building's surface. The programme addresses owners of non-residential buildings to realise cost-effective measures which enhance the energy efficiency of their buildings in one or more technical services. The programme covers both existing and new buildings. There are 968 buildings registered on EU: Green Building website (15).

Reviewed aspects

The Green Building classification has only one category, energy, with a set of six indicators (Table 29).

Table 29. The Green Building classification categories.

Category	***Indicators***
Energy	- Heating - Lighting - Water heating - Ventilation - Air-conditioning - Office equipment

Principals of Certification

The Green Building certification does not have different rating levels of classification as many other certification systems do. There are no requirements on how the required energy performance is achieved, only that it will be achieved. Regulatory requirements concerning air quality and the thermal environment shall always be met. The measures, calculations and measurements made should always be reported in an application. A Green Building certification also means that the property owner agrees to annually report energy usage data. All buildings with a Green Building certificate must have an energy management system linked to the building (12) (15).

Certification criteria:

- Refurbishment of one or more existing non-residential buildings, which will result in the reduction of the total primary energy consumption of at least 25% (if economically viable), total or related to the end-use or subsystem, which is being upgraded.
- New constructed non-residential buildings, which consume 25% less total primary energy (if economically viable) than the building standard in force at the time, or below the consumption levels of “conventional” buildings presently constructed.
- Buildings already renovated or refurbished, if the total primary energy consumption is reduced by at least 25% or the buildings consume 25% less energy than required by the building standard in force at that time.

Fees and Expenses

In order to certify a building according to the GREEN Building project there are fees for registration, reviewing and fees for late additions and extra checks to concerned Green Building Council (GBC). The fee differs between newly built and existing buildings and also depending on the building complexity. The fee for registration, reviewing and certification is between 1100 and 3600 EUR, for members of the GBC, depending on the complexity of the building. The cost for non-members is 43% higher. In addition to these costs, increased production costs might arise due to the strict energy requirements (12).

Certified sport buildings

In the European Green Building Projects Catalogues, for January 2006 through August 2012, there are seven certified projects categorized as sports facilities (16) (17).

SWOT analysis

Table 30. SWOT analysis of Green Building certification system.

Internal	**Strengths** - International system - Easy to communicate - Easy to apply, simple principles - Cheap to use - Requires no certified consultants - Annual report of energy usage required by the property owner	**Weaknesses** - Not comparable between countries - Not comparable between different buildings - Relatively easy target to reach to receive certification for existing buildings with high energy consumption. - Target does not necessarily correspond to nearly zero energy buildings
External	**Opportunities** - Receiving certification could function as a motivator to implement energy saving measures and to finance coming investments - Allowing benchmarking between buildings of similar category, for instance sport buildings	**Threats** - Too many certified buildings with high energy consumption could lead to lower reputation of in the system.

3.4 Passive House Institute (PHI)

The Passive House Institute (PHI) is an independent research institute lead by Dr Wolfgang Feist, Germany. The first pilot project initiated (1990) was Europe's first inhabited multi-family house to achieve a documented heating energy consumption of below 12 kWh/ (m^2a). Since then, the PHI has assumed a leading position with regard to research on and the development of construction concepts, building components, planning tools and quality assurance for energy efficient buildings. Passive House (PH) Certification is not only available for buildings, but also for building components and professionals and the certification scheme is available for new and existing buildings, residential as well as non-residential buildings. At present there are about 2900 certified projects registered in the database of PHI (www.passivhausprojekte.de/index.php?lang=en) (12) (18).

Reviewed aspects

The Passive House classification only focuses on one category, energy, with a set of five indicators. (Table 31)

Table 31. The Passive House classification categories.

Category	***Indicators***
Energy	- Heating - Cooling - Primary energy - Air tightness - Requirements for individual building components

Principals of Certification

For existing buildings certification can be based on either 1) the requirement for the heating demand, or based on 2) the requirements for individual building components, such as opaque building envelope, windows, external doors and ventilation system. Exemptions for the heat transfer coefficient can be done at special circumstances e.g. historical buildings, legal requirements etc. Currently, only existing buildings located in cool, temperate climate (e.g. Central Europe) are being certified. The second option of the certification 2) is not available for new buildings (18).

Table 32. Energy performance certification criteria for residential and non-residential, new and existing Passive House buildings.

Criteria	**Residential**	**Non-residential**	**Refurbishment (residential and non-residential)**
Heating- Specific space heating demand or heating load	15 kWh/(m²a) or 10 W/(m²a)	15 kWh/(m²a) or 10 W/(m²a)	25 kWh/(m²a)
Primary energy	120 kWh/m²a	120 kWh/m²a	120 kWh/m²a
Air tightness at n50	0.6/ h	0.6/ h	Aim: 0.6/ h Limit: 1/h
Cooling including dehumidification		15 kWh/(m²a) + 0.3 W/(m²aK) × DDH (Dry Degree Hours) or cooling load 10 W/m²	

Fees and Expenses

There are no exact figures available for the certification fees according to the PHI. A normal certification fee for a single family house located in central Europe is approximately 1 800 EUR. For a preschool the equivalent amount is approximately 4 800 EUR and for larger premises 7 000 EUR (12).

Passive House certified projects of sport building

In the PHI database (found online at www.passivhausprojekte.de), there are 21 certified passive houses categorized as "*sports centre/ recreation centre*"

SWOT analysis

Table 33. SWOT analysis of PHI certification system.

Internal	**Strengths** - Quality assured passive house concept over 20 years - The certification includes basic and advanced energy criteria to be met. - High demands on energy efficiency	**Weaknesses** - Increased cost due to certified experts accredited by the Passive House Institute (PHI) are required - Currently, only existing buildings located in cool, temperate climate (e.g. Central Europe) are being certified
External	**Opportunities** - A well-known and consistent international system could attract future potential buyers of the building - Various opportunities to certify existing buildings	**Threats** -Competitors in the market - Demand for a broader certification scheme which covers more topics than energy

3.5 Central Europe Programme - CEC5

The CEC5 project is implemented through Central Europe Programme co-financed by the European Regional Development Fund (ERDF), and the full name of the project is "Demonstration of energy efficiency and utilisation of renewable energy sources through public buildings". The CEC5 project is a transnational project that includes partners from eight different countries. The overall goal is to create a model for public buildings to increase the demand for Nearly Zero Energy Buildings (NZEBs) on a large scale. In the project, the partners start with developing the joint transnational evaluation of assessment criteria for ecological public buildings and the development of the respective certification procedure. The partners define the model for the public bodies to refer to as far as the sustainable construction is concerned. It is, however, the implementation of the pilot examples in reality that make the results visible. The duration of the project is October 2011 until September 2014 (19).

Reviewed aspects

CEC5 focuses on five different categories as shown in Table 12.

Table 34. The CEC5 classification categories.

Category	Indicators
Energy demand and Supply(max 450 points)	- Heating demand PHPP* - Cooling demand PHPP - Primary energy demand indicator PHPP - Emissions of CO_2-equivalents according to PHPP - PV-power plant CO_2-equivalents - Differentiated documentation of Energy Consumption - Water consumption and use of rainwater *PHPP (PassivHaus configuration package)
Health and comfort (max 225 points)	- Thermal comfort in summer - Comfort ventilation - hygiene and soundproofing - Sunlight supply, daylight quotient
Process and planning quality (max 240 points)	- Decision-making and examination of alternatives - Definition of verifiable energetic and ecologic objectives - Simplified calculation of efficiency - Product management - using low-pollutant and low-emission building materials - Energetic optimization during the planning - User information
Building materials and construction (max 200 points)	- Ecological value of the thermal envelope Eco-index (OI3TGH-lc) - Ecological value of the total mass of the building (OI3BG3, BZF)
Quality of Location and Equipment (max 80 points	- Accessibility to public transport - Ecological quality of the building site - Bicycle parking

Principals of Certification

The CEC5 criteria catalogue promotes the documentation and evaluation of the energetic and ecologic quality for newly built and existing public buildings. Buildings, which can't become comprehensively modernized due to the requirements of the monument protection, are evaluated on the basis of a separate criteria catalogue. The evaluation of the buildings is based upon a point-scheme with achievement of maximum 1000 points (19).

Conclusion

The CEC5 project ended in September 2014. The overall goal of the project was to create a model for public buildings to increase the demand for nearly zero energy buildings (NZEBs) on a large scale. The report and evaluation of the CEC5 project could be an important source when considering a common EPC scheme for sport facilities in Europe in the STEP-2-SPORT project. Since the CEC5 project was not finished until the first publication of this report, there is no SWOT analysis done for this scheme.

3.6 Comparing environmental assessment methods

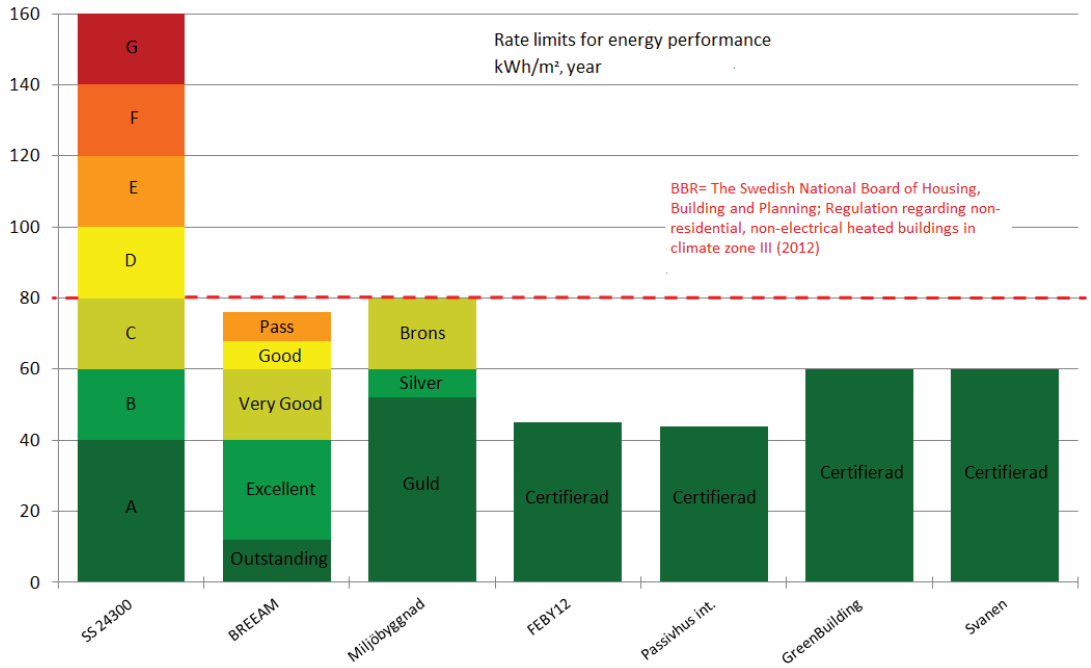
Aspects reviewed

Table 35. Comparing the reviewed sustainability aspects reviewed in LEED, BREEAM, Green Building, PHI and CEC5.

Category	LEED	BREEAM	Green Building	PHI	CEC5
Energy	×	×	×	×	×
Materials	×	×			×
Water	×	×			×
Pollution	×	×			×
Land Use & Ecology	×	×			×
Waste	×	×			
Transport	×	×			×
Management	×	×			×
Health & Wellbeing	×	×			×

Energy rating

Figure 16. Comparing the rate limits of energy performance of new, non-residential buildings



Source: Modified table of the report:"Energiochmiljöklassningi Sverige",2013 (Energy and Environment Certification in Sweden, 2013 (12))

The table compares the rate limits for energy performance of environmental assessment methods for new non-residential buildings compared to the Swedish legislation (BBR). SS24300, Miljöbyggnad, FEBY12 and Svanen are Swedish certification systems possible to use for both non-residential and residential buildings.

The LEED compares the cost (not the energy performance) of running a reference building, to the cost of a real building. Therefore it is not possible to make a simple comparison to the Swedish legislation (BBR). For this reason LEED is not included in Figure 16 (12). Even though it is difficult to compare LEED and BREEAM, in trials with both systems on a similar building, the conclusion is that BREEAM “Very Good” is comparable to the LEED “Platinum” (20).

3.7 Conclusions –environmental assessment methods

All of the environmental assessment methods reviewed can be used in sport buildings throughout. LEED and BREEAM offer a certification encompassing a wider scope of sustainability aspects. This makes LEED and BREEAM an unsuitable choice if energy performance is the only focus of the certification. Green Building and PHI focus only on energy performance, and would be a better choice in that case. The main focus of this report is the energy performance but a wider sustainability focus is not irrelevant. A majority, 67%, of environmental assessment scheme operators interviewed in a recent study thinks that current and potential customers need and want schemes which include wider sustainability issues (21). The same report concludes that the environmental assessment methods are primarily targeted towards the commercial market, and that the uptake is generally low with the largest part of the market being in Western Europe. The high cost of certification process is cited as one of the reasons for low uptake (21).

Based on the SWOT analysis of the environmental assessment methods in this report it is possible to take out the best parts of the various methods examined, to provide a basis for the upcoming task within the STEP-2-SPORT project, of giving recommendations for a common EU certification scheme of sport buildings.

Strengths and opportunities

- Wide recognition and a strong brand
- Local (national) adaptations available
- Easy to communicate
- Annual report of energy usage required by the property owner

Weaknesses and threats

- Costly certification process
- Based on American units
- Relatively easy target to reach to receive certification for existing buildings with high energy consumption.

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