European survey of the energy performance of buildings and related policies – results and lessons learnt

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Abstract

Buildings present one of the highest energy saving potentials which if realised, can bring significant benefits to the economy, overall energy security, environmental and social benefits. In the EU, improving energy efficiency of buildings can substantially contribute to Europe's 2020 strategy and 2050 roadmap targets. This requires the transformation of the existing building stock, a complex process requiring an understanding on the current status of the building stock as well as strategic guidance and co-ordinated efforts from key stakeholders. Based on an extensive country-by-country survey carried out across the EU, an analysis of key characteristics of the EU building stock and status of current building-related policies is carried out. The paper presents the selected results of the survey with a focus on policy tools. It then discusses the data gaps and their impact on policy evaluation in the building sector. A special focus to building codes is given. As Europe strives towards increasing building energy performance, the need of defining tailor-made policies will become increasingly important in Europe and elsewhere.

Introduction

It is widely recognised that the building sector in Europe is one of the key contributors for CO2 emissions and its respective potential of energy savings is high. In parallel, buildings present a unique opportunity for the EU not only for addressing its commitment to keep the global temperature rise below 2°C and reaching its 20-20-20 targets, but also for improving energy security, boosting competitiveness and creating new jobs. The need to intensify major efforts in order to improve the building energy efficiency, particularly for existing buildings, is thus greater and more relevant than ever before. Whilst EU policy frameworks are in place, the process of policy implementation at MS level is complex.

In order to identify the practical implementation of the energy policies in buildings, BPIE has carried out an extensive country-by-country survey in order to analyse key characteristics of the EU building stock and status of current building-related policies. The methodology chosen involves consulting experts at MS level and gathering detailed information ranging from policy, regulatory and financial to technical and statistical data from all 27 Member States. The paper presents the main results of the survey at the EU and MS level with a focus on policy tools. The paper discusses the data gaps and their impact on policy evaluation in the building sector. Significant efforts are required in order to close current data gaps and harmonize monitoring, reporting and evaluation.

The structure of the paper is as follows. After the introduction, the methodology used in the survey is described and the key figures on the EU building stock as derived from the survey are presented. The paper presents the selected results of the survey with a focus on policy tools. A special focus is given to the current developments of building codes. Then the paper provides an insight on some of the many challenges faced in the compilation of data. Finally recommendations and conclusions are drawn in the last section.

Methodology

Based upon climatic, building typology and market similarities, the EU27 countries together with Switzerland and Norway have been divided into three regions: North & West, South and Central & East. Existing data on the building stock and its policies has been collected for each country through a large survey exercise undertaken using a team of country experts. The data collected were mainly extracted from official statistics and studies at Member State level supported by expert estimations wherever official data were unavailable. Information on the typology, characteristics (such as age, size, and ownership profile) and energy performance of the building stock have been collected in addition to existing policies, regulations and incentives. The dataset represents one of the most comprehensive assembled in Europe to date and ranges from residential to non-residential buildings.

Table 1. Regions and building types considered in the survey

South	CY, EL, ES, IT, MT, PT
Central & East	BG, CZ, EE, HU, LT, LV, PL, RO, SI, SK
North & West	AT, BE, CH, DE, DK, FI, FR, IE, LU, NL, NO, SE, UK

Residential	(a) Single Family Houses (b) Apartment blocks
Non-residential	(c) Offices (d) Educational buildings (e) Hospitals (f) Hotels and restaurants (g) Sports facilities (h) Wholesale & retail trades services (i) Other types

Key figures on the EU building stock

Through the collected data, it has been estimated that the gross floor space in the EU27, Switzerland and Norway could be concentrated in a land area equivalent to that of Belgium. Half of the total estimated floor space is located in the North & West region of Europe while the remaining 36% and 14% are contained in the South and Central & East regions, respectively. It has also been deduced that the non-residential sector accounts for 25% of the total stock in Europe where the retail and wholesale buildings comprise the largest portion of the non-residential stock.

At the European level, the data show that 64% of the residential floor area is located single family houses and 36% in apartments. Economic wealth, culture, climate, scale of commerce, increased demand for single occupancy housing are some of the factors affecting the size of spaces we live and work in. It has been found that the floor area per capita is the highest in countries in the North & West while the countries of Central & Eastern Europe have the lowest residential space standards both in single family houses and apartment blocks (see Figure 1).

A substantial share of the stock in Europe is older than 50 years with many buildings in use today that are hundreds of years old. More than 40% of our residential buildings have been constructed before the 1960s when energy building regulations were very limited. Countries with the largest components of older buildings include the UK, Denmark, Sweden, France, Czech Republic and Bulgaria. A large boom in construction in 1961-1990 is also evident through our analysis where the housing stock, with a few exceptions, more than doubles in this period.

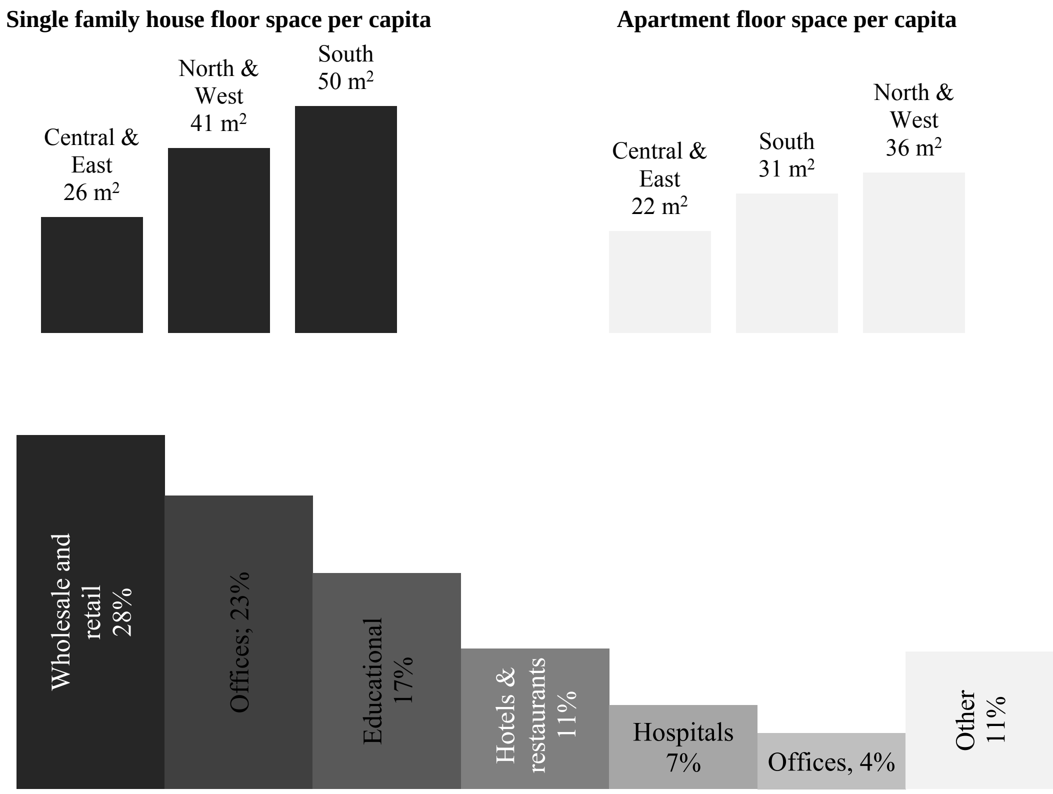

Figure 1. The residential and non-residential sector in Europe

Buildings vary remarkably in terms of size where large variations are expected in the non-residential categories. From our data, we can see that policy measures applied only to non-residential buildings over 1,000 m2 in floor area would miss a substantial portion of buildings in many countries, especially in educational buildings, hospitals and offices. The structure of ownership and occupancy has also a significant relevance on the ability to renovate. The largest share of the residential stock is held in private ownership while 20% is allocated to ‘pure’ public ownership. Social housing is typically fully owned by the public sector but there is an increasing trend towards non-public involvement as is the case in Ireland, England, Austria, France and Denmark while in the Netherlands social housing is fully owned by private sector. Moreover, at least 50% of residential buildings are occupied by the owner in all countries. Countries with the biggest share of private tenants are Switzerland, Greece and Czech Republic and countries with significant portions of public rented dwellings are Austria, the UK, Czech Republic, the Netherlands and France. The ownership profile in the non-residential sector is more heterogeneous and private ownership can span from as low as 20% to 90% from country to country.

Current status of energy-efficiency policies

Building codes

Strong building energy codes can ensure substantial CO2 savings and reduced energy bills at a low cost but also provide more comfortable occupant conditions, more employment opportunities and increased energy security. Requirements imposed through building energy codes can apply to the building envelope and/or systems covering end uses such as heating, ventilation, air conditioning, lighting and water heating. The Energy Performance of

Buildings Directive (EPBD, 2002/91/EC) was a major step forward through which Member States (MS) introduced requirements based on a “whole building” approach. Below, prescriptive- and performance-based regulations are discussed in more detail.

Performance-based requirements

A detailed overview of the energy performance requirements is provided in Table 2 for a number of countries. It can be seen that many different approaches have been applied and no two countries have adopted the same approach. Malta, Latvia and Romania have no performance-based requirements for new or renovated buildings to date. For the rest countries, a variety of calculation methods are used and major differences exist in definitions (e.g. definitions of primary and final energy, heated floor area, carbon conversion factors, regulated energy and total energy requirement etc.). The performance requirements are normally based on either an absolute (i.e. not to exceed) value, generally expressed in kWh/m2a, or on a percentage improvement requirement based on a reference building of the same type, size, shape and orientation. Some countries (e.g. Belgium) express the performance requirement as having to meet a defined “E value” on a 0 to 100 scale and others in terms of CO2 emissions (e.g. UK). Typically, these requirements cover heating consumption levels while in some cases more end-uses are included. It is also interesting to note that in many countries the requirements extend only to certain building types, usually covering the residential sector and a few non-residential building types.

Table 2. Examples of requirements applied for different building types in Europe

	Single Family Houses	Apartment Blocks	Offices	Educational Buildings	Hospitals	Hotels & Restaurants	Sports facilities	Wholesale & retail trade
AT	H: 66 kWh/m^{2}a	H: 66 kWdfdh/m^{2}a	H:22.75 kWh/m^{3}a C: 1 kWh/m^{3}a	H:22.75 kWh/m^{3}a C: 1kWh/m^{3}a	H:22.75 kWh/m^{3}a C: 1kWh/m^{3}a	H:22.75 kWh/m^{3}a C: 1kWh/m^{3}a	H:22.75 kWh/m^{3}a C: 1kWh/m^{3}a	H:22.75 kWh/m^{3}a C: 1kWh/m^{3}a
BE - WI	E<100, E_{spec}<170kWh/ m^{2}a , Overheating<17 500 kh/an	E<100, E_{spec}<170 kWh/m^{2}a, Overheating<175 00 kh/an	E<100	E<100				
BG	F:122-146 H&C: 82.5-102.5 kWh/m^{2}a	F: 90-146 H&C: 50.0-102.5 kWh/m^{2}a	F: 80-132 H&C:40.0-82 kWh/m^{2}a	F: 56-98 H&C: 40-82.0 kWh/m^{2}a	F: 180-242 H&C: 50-102.5 kWh/m^{2}a	F: 176-230 H&C: 50-102.5 kWh/m^{2}a	F: 90-134 H&C: 40-82 kWh/m^{2}a	F: 90-134 H&C: 40-82 kWh/m^{2}a
CZ	F: 142 kWh/m^{2}a	F: 120 kWh/m^{2}a	F: 179 kWh/m^{2}a	F: 130 kWh/m^{2}a	F: 310 kWh/m^{2}a	F: 294 kWh/m^{2}a	F: 145 kWh/m^{2}a	F: 183 kWh/m^{2}a
DK	P: 52.5+1650/A kWh/m^{2}a	P: 52.5+1650/A kWh/m^{2}a	P: 71.3+1650/ A kWh/m^{2}a	P: 71.3+1650/A kWh/m^{2}a	P: 71.3+1650/A kWh/m^{2}a	P: 71.3+1650/A kWh/m^{2}a	P: 71.3+1650/A kWh/m^{2}a	P: 71.3+1650/A kWh/m^{2}a
EE	P: 180 kWh/m^{2}a	P: 150 kWh/m^{2}a	P: 220 kWh/m^{2}a	P: 300 kWh/m^{2}a	P: 400 kWh/m^{2}a	P: 300 kWh/m^{2}a	P: 300 kWh/m^{2}a	P: 300 kWh/m^{2}a
FR - H_1	P_{FF}: 130kWh/m^{2}a P_{ESH}: 250kWh/m^{2}a	P_{FF}: 130kWh/m^{2}a P_{ESH}: 250kWh/m^{2}a	n/a	n/a	n/a	n/a	n/a	n/a
H U	P: 110-230 kWh/m^{2}a	P: 110-230 kWh/m^{2}a	P: 132-260 kWh/m^{2}a	P: 90-254 kWh/m^{2}a				
IE	MPEPC = 0.6 & MPCPC = 0.69	MPEPC = 0.6 & MPCPC = 0.69	MPEPC & MPCPC should not exceed 1	MPEPC & MPCPC should not exceed 1				
NL	P: 68388-68552 MJ/a	P: 35595-36855 MJ/a						
SE	F_E: 55-95 F_{NE} 110-150 kWh/m^{2}a	F_E: 55-95 F_{NE} 100-140 kWh/m^{2}a	F_E: 55-95 F_{NE} 100-140 kWh/m^{2}a	F_E: 55-95 F_{NE} 100-140 kWh/m^{2}a	F_E: 55-95 F_{NE} 100-140 kWh/m^{2}a	F_E: 55-95 F_{NE} 100-140 kWh/m^{2}a	F_E: 55-95 F_{NE} 100-140 kWh/m^{2}a	F_E: 55-95 F_{NE} 100-140 kWh/m^{2}a
SK	P: 80-160 H&C 42-86	P: 63-126 H&C: 27-53	P: 120-240 H&C: 16-56	T: 42-84 H&C: 28-56	T: 101-201 H&C: 27-70	T: 94-187 H&C: 14-71	T: 48-95 H&C: 28-56	T: 81-161 H&C: 27-70

	Single Family Houses	Apartment Blocks	Offices	Educational Buildings	Hospitals	Hotels & Restaurants	Sports facilities	Wholesale & retail trade
	kWh/m^{2}a	kWh/m^{2}a	kWh/m^{2}a	kWh/m^{2}a	kWh/m^{2}a	kWh/m^{2}a	kWh/m^{2}a	kWh/m^{2}a
UK	17-20 kgCO2	16-18 kgCO2	Other TER (Target carbon dioxide Emission Rate) values apply for non-domestic buildings					

Notes:	
AT	Based on gross floor area and gross building volume
BG	Based on assumption of DD=2100, A/V=0.2 for SFH, A/V=0.8 other, 32% share of glazing for upper limit and DD=330, A/V=1.2, 32% glazing for lower limit
DK	A denotes the gross heated floor area in the Danish formulate, example 73.1 P @80m2 58 P @300m2
EE	Heated floor area
FI	For a single family house with building volume 522m3, gross floor area 163m2, and height between floors 3m.
FR	H_1 represents one of the three climatic regions in France. Other requirements apply for the other regions H_2 and H_3
IE	MPEPC and MPCPC denote the Maximum Permitted Energy Performance and Maximum Permitted Carbon Performance Coefficients used in the Ireland scheme
SK	Based on assumptions for shape factor, internal air temperature, floor to floor height, air change rate, degree days, etc.
UK	The UK requirements are based on achieving a % reduction in CO2 emissions over a notional building of the same size/shape.

Prescriptive-based requirements for new buildings

Different prescriptive requirements also exist in relation to maximum U-values, minimum/maximum indoor temperatures, requirements for minimum ventilation rates and boiler and/or air-conditioning system efficiency. In some cases, the single element requirements are just supplementary demands to the energy performance requirements ensuring the efficiency of individual parts of a building is sufficient (e.g. Denmark). In others, they act as alternative methods where the two approaches exist in parallel (e.g. Norway, Spain, Poland, Switzerland); the first based on the performance of single elements and the second on the overall performance of a building. Typically in these cases, the single-element approach is preferred in major renovation projects while the performance-based in new constructions. In Europe, around 40% of the existing building stock was constructed before the 1960s when building energy codes were minimal (BPIE, 2011). Enforcing energy-related requirements during renovations is, hence, of crucial importance.

Most countries have introduced requirements to ensure minimum levels of ventilation within buildings. These are generally based upon metabolic rates and activity within the building. The requirements associated with ventilation relate principally to health, comfort and productivity; however they do have direct impact on energy requirements. Examples of different ventilation-related requirements in country building codes are presented in Table 3. These may apply as technical requirements on the ventilation systems (e.g. ventilation systems with heat recovery) or specified ventilation rates in designated areas of buildings. Given the increasing use of mechanical ventilation system, the fan power requirement in low energy buildings is becoming an increasingly important issue. A number of countries (e.g. Austria, Denmark, France, Estonia and Poland) have introduced minimum requirements for specific fan power (generally expressed in W/l.s or kW/m3.s.). Non-quantitative requirements also exist in some countries like Latvia and Hungary. The thermal performance of buildings is directly related to airtightness and the requirements for ventilation. As excessive or insufficient ventilation can lead to considerable energy wastage and uncomfortable conditions, many countries have introduced requirements to limit the air permeability/air-tightness of buildings.

Most countries have requirements associated with the minimum performance of boilers and air-conditioning systems. Examples include minimum boiler efficiency levels and in some cases like Germany ban of old inefficient boilers (see Table 4). Additionally, many building codes require minimum levels of daylight to be achieved within buildings, whilst ensuring that solar gains do no result in significant overheating and/or the requirement for air conditioning. Building requirements associated with limiting solar gains vary from simple approaches (e.g. limiting window areas on building aspects exposed to solar gains) through to requirements for complex modelling and simulation to demonstrate that effective measures have been adopted to provide solar protection. The Concerted Action report1 recommended that much greater attention should be given to the issue of estimating the impact of summertime overheating in the methodology in order to reduce the rapid increase in demand for air-conditioning.

Although most of the countries have now inspection schemes for boilers and/or air conditioning systems, data collection on the number of inspections done by each Member State is still at a very low level. Insufficient data makes it difficult to formulate an appropriate evaluation. Finland, France, Ireland, the Netherlands, Slovenia, Sweden and the UK have opted for option b (advice to the users) of article 8 regarding the EPBD requirement for inspection of boilers.

Table 3. Examples of different (non-exhaustive) ventilation-related requirements in codes

AT	Mechanical ventilation systems must be equipped with a heat recovery system when installed in new buildings or when renewed in the course of a renovation procedure. In major renovated or newly constructed non-residential buildings, the maximum heating energy consumption is reduced by 2 kWh/m³a or 1 kWh/m³a, if not more than half of the useful area is supplied by a mechanical ventilation system with heat recovery. In major renovated residential buildings, the maximum permitted calculated heating energy consumption is reduced by 8 kWh/m²a.
DK	Mechanical ventilation systems must meet the following requirements for specific electricity consumption for air transportation: • 1800 J/m³ in constant air volume (CAV) systems • 2100 J/m³ a max air volume for variable air volume (VAV) systems • 800 J/m³ for exhaust ventilation systems • 1000 J/m³ for ventilation systems for one dwelling
LV	Ventilation systems shall be designed and installed: • to protect human health using the space as intended; • to ensure adequate air quality, sanitary requirements and standards of comfort level; • in order to ventilation system does not encourage a flame or smoke spread and to prevent explosive gas and vapour mixture formation.
PL	Ventilation (in-blow) fan: Complex AC installation 1.60 Simple ventilation installation 1.25 Draught fan: Complex AC installation 1.00 Simple ventilation installation 1.00 Air out-blow installation 0.80
ES	Minimum ventilation by person: IDA 1.- hospitals, clinic, laboratories and day-care centers → 20 dm3/s IDA 2.- office, reading rooms, museums, rooms of courts, classrooms of education and swimming pools → 12,5 dm3/s IDA 3.- commercial buildings, cinemas, theaters, assembly halls, rooms of hotels, restaurants, bars and similar, gymnasiums and rooms of computers → 8 dm3/s IDA 4.- air of low quality → 5 dm3/s

Table 4. Examples of different (non-exhaustive) heating system requirements in codes

BG	Minimal efficiency requirements for boilers are in % and function of the boiler nominal capacity(Pn) in kW: 1. standard boilers - 87 + 2 log Pn; 2. low temperature boilers - 90 + 2 log Pn; 3. condensing boilers - 93 + 2 log Pn
DE	Prohibited use of boilers filled with liquid or gaseous fuels which were installed or set up before October 1, 1978. Prohibited use of electrical thermal storage systems according to the provisions if the heating in the buildings is produced exclusively by electrical thermal storage systems.
DK	Oil boilers must have an efficiency, according to CE-labelling scheme not less than 93% at full load and 98% at part load. Gas boilers must be condensing with an efficiency, according to CE-labelling scheme not less than 96% at full load and 105% at part load.

Enforcing energy requirements during the design or retrofit phase of a building is a key driver for implementing energy efficiency measures in the building sector. It is generally accepted that compliance and enforcement of building energy codes is undertaken with less rigour compared to other building regulations such as structural integrity and fire safety. Whilst data on compliance levels are scarce, studies suggest that non-compliance in Europe can reach up to 50% levels in certain regions (Fraunhofer ISI et al., 2009). As the energy performance requirements become stricter (e.g. in line with EPBD recast provision on nearly zero-energy buildings), the gap between the theoretical performance during design phase and the actual energy performance in-situ may increase considerably. It is therefore clear that if the EU Member States are to deliver the climate and environmental targets related to buildings in the coming years, there should be more focus an on the establishment of effective control and enforcement procedures.

Other policies

Energy Performance Certificates

By the end of 2010, all countries except 9 have operational certification schemes for all buildings required by the EPBD back in 2002. Greece, Romania, Spain, Luxembourg, Lithuania and the Brussels Region of Belgium were due to implement the remaining requirements still in 2011, while Hungary is due in 2012 and the Flanders Region of Belgium in 2013. Latvia and Slovenia have not reported planned date to have running EPC schemes for all the buildings required by the EPBD and the EPC scheme is still only voluntary in Switzerland. Also, less than half of the countries have a functional database for the registered EPCs. Although the certification schemes have been working for only a couple of years, our findings show that the proportion of dwellings not yet certified remain above 90% for all countries with the exception of The Netherlands and the United Kingdom (note that The Netherlands has had a certification scheme for new buildings in operation since 1995).

Financial programmes and economic incentives

In the survey, information has been collected on the range of financial instruments that are implemented in the focus countries. This was completed with information available in recent studies and on-line databases. About 333 financial schemes have been screened covering a wide range of financial instruments from grants to VAT reduction for a range of building types.

It can be seen from Figure 2 that direct financial support in the form of grants or subsidies is the most common measure. Many countries support residential as well as non-residential buildings, both new build and existing (though not necessarily in the same programme), while others focus on renovating the existing building stock. A number only support residential buildings. There are also many schemes that target specific technologies, such as insulation, boiler scrappage, renewables, or specific building categories, such as social housing, the public sector, panel buildings. There are several schemes that provide support for new passive buildings. Various forms of loans and tax incentives are used in many countries. These are usually available for individuals as well as businesses, thereby covering most of the building stock outside the public sector. Somewhat less popular are energy supplier obligations/white certificate schemes, audits and third party financing, used in only a handful of countries, though the use of energy supplier obligations could become mandatory across all EU Member States if the current proposal in the draft Energy Efficiency Directive is approved.

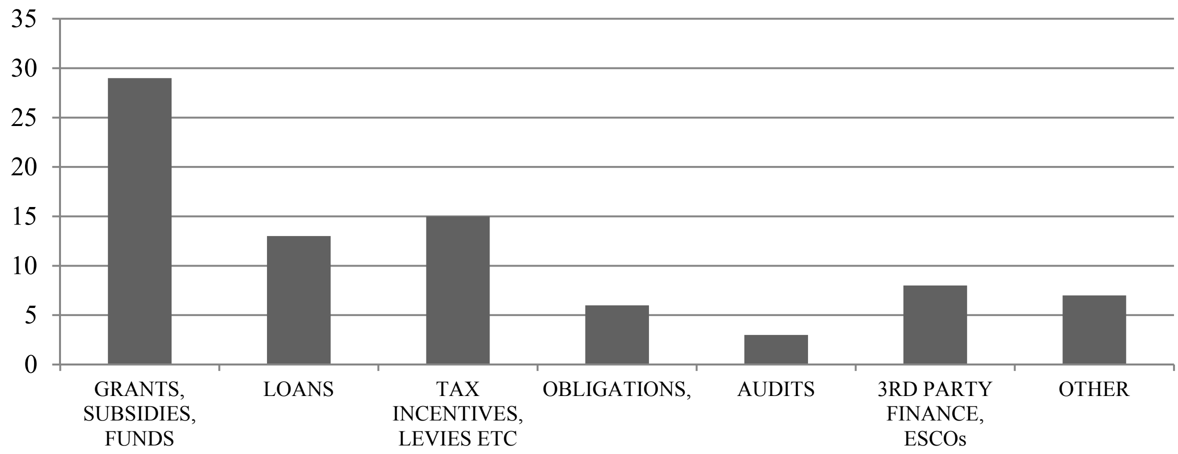

Figure 2. Financial programmes and incentives across Europe indicating number of countries with measures in each category

Through our survey, information on the impact of the financial schemes has collected based on existing ex-ante or ex-post assessments. Relevant information has not been always available. It is clear from Figure 3, that only 32% of the 38 programmes analysed had information on ex-ante and 29% on ex-post assessment. Moreover, the impact was reported mainly by energy savings (62%), sometimes in CO2 savings and less frequently in terms of jobs created. The measures surveyed are encouraging, but many of them are only modest in their ambition.

The major concern is that the use of financial instruments today only achieves the business-as-usual case in Europe with very few financial instruments providing enough funding for deep renovations, and ultimately do not correspond to Europe's 2050 aspirations. As Europe strives towards increasing building energy performance, the role of available financial programmes and innovative mechanisms and relevant level of ambition become increasingly important.

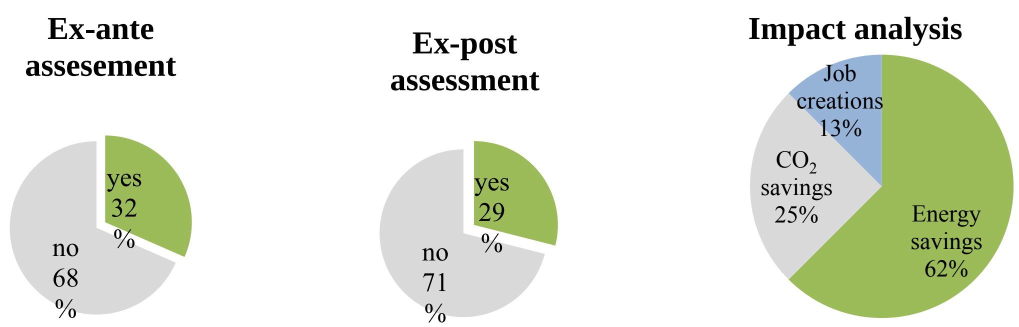

Figure 3. A random sample of 38 financial programmes surveyed in the study and share of them with assessment information and impact measurement

Gaps, challenges and impact

Compiling data from different countries has been a challenge due to many inconsistencies, different ways of measurements and definitions. This section gives an insight on some of the many challenges faced during the exercise undertaken by BPIE to compare country data. The reported answers of the survey have indicated several data gaps and quality issues. We have carried out an analysis to examine the data availability from 3 principal axes: completeness, comparability/consistency and quality/source credibility.

To investigate the quality of the data, we have analysed the sources of information we have received on the construction activity in the building sector. Answers were reported for the annual new build and renovation rates for the entire building stock and/or for each building type wherever possible. An overview of data completeness and source on annual build rates for new constructions and renovated buildings is shown in Figure 4. Information on the new build rates has been more complete, with higher share of data coming from official sources (such as statistics). The weakest responses were in reporting information on the national renovation activities whereby gaps were more frequent and sources relied more on studies, estimations or guestimates. Moreover, it was rare to receive indication of the renovation activity linked with information on the respective level of energy efficiency improvements. This is a critical importance given the recent policy developments of 3% annual renovation rates of public-owned buildings and the potential requirement of national renovation roadmaps for Member States. Without sufficient data or request for data collection, tracking and monitoring progress on such measures or targets would be impossible.

Data have been gathered on the floor area of the building stock where 25 countries reported residential and 19 reported non-residential floor area data in full. A further four countries reported partial data for the floor area of non-residential buildings. The reported totals represented 92% of the total floor area in the countries looked at and the final 8% have been estimated. Information on non-residential building types was less complete and this was a pattern observed in other sets of data. In many cases, the non-residential data covered partially the non-residential stock where the highest frequency of returns was on data on offices or schools. Many countries have reported a large component in the category of 'other' buildings and this probably indicates that further effort is required in the future to separate this floor area into one or more of the other categories wherever possible. In cases where information was available from more than one sources, there was not necessarily convergence on the provided answers, highlighting possible quality issues. Information on the share of the non-residential stock which is owned by public authorities was also scarce as shown in Figure 5. This has an important political impact given the importance of the public sector in European policies. In terms of floor areas of existing buildings, countries with discrepancies included Denmark, Sweden and Romania.

Care has been taken in the compilation of the data required to make additional estimations. For example, floor areas were reported at times in net floor area and other times in gross, net, useful or heated as shown in Figure 6. Inconsistencies in the definitions exist and inevitably there are differences on the treatment and measurement of areas such as basements, garages, attics etc. These definitions are sometimes inconsistent even within a country depending on the building/construction type. Examples of definitions of floor area types provided by country experts are given in Table 3. A small number of countries collect data on building volume and in any case it can be even more difficult to define, especially in the non-residential sector with suspended ceilings and raised floors complicating the measurement. In our analysis, conversion factors were applied to aggregate all data in useful floor areas considering typical wall thickness levels as well as percentage floor space of buildings, which are non-heated and non-habitable areas. These factors were defined for different types of buildings. Comparisons are further complicated by inconsistent definitions of many building typologies where assumptions had to be made in order to broadly divide the reported data in the above function types. In some cases, appropriate division was not possible. For example, some countries reported industrial buildings in "other types of energy consuming buildings" while others did not. In those cases, it was not possible to extract or estimate the portion of industrial buildings in order to provide consistent information for this function type across all countries.

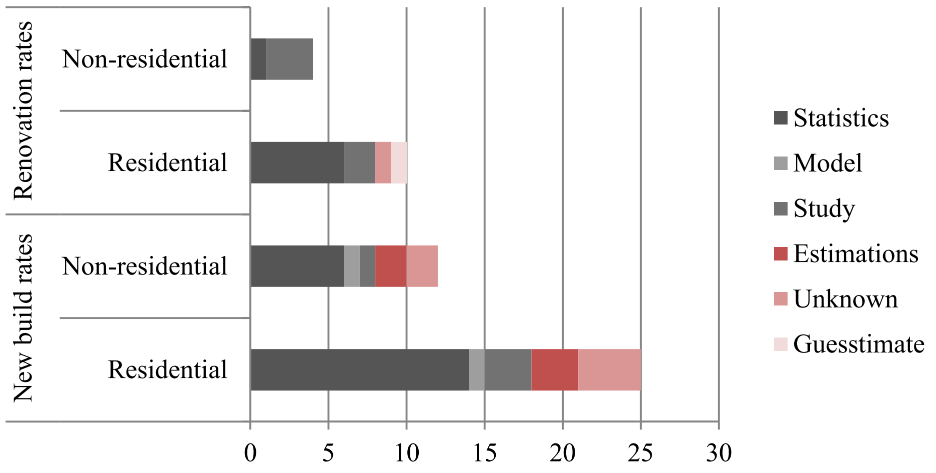

Figure 4. Overview of the completeness and source of data on annual build rates for new constructions and renovated buildings across the 29 countries

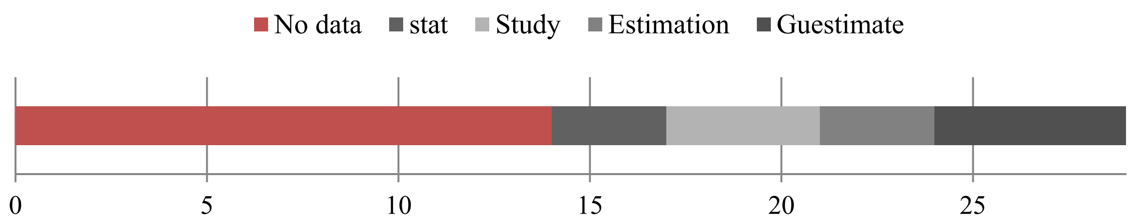

Figure 5. Completeness and source of data on ownership for non-residential building types

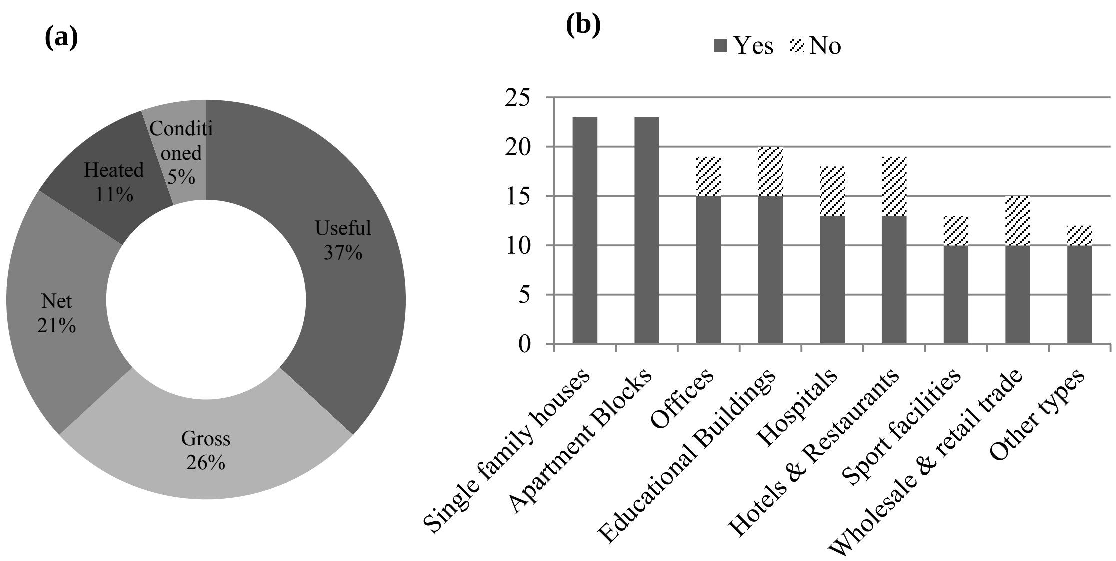

Figure 6. Country responses on floor area of existing stock: (a) types of floor area reported (b) number of countries which provided data on the floor areas by building types Notes: “yes” denotes number of countries with data breakdowns in age bands and “no” denotes number of countries with information only on the total floor area.

Table 3. Definitions of floor area types provided by country experts

PT	Conditioned	Sum of the areas measured by the inner perimeter of all conditioned spaces
AT	Gross	Sum of all floor spaces of the whole floor plan of a building. The gross floor area contains the net floor area and the construction area. (Definition according to ON B 1800 Determination of areas and volumes of buildings - Pictorial illustrations)
DK	Gross	Sum of all gross floor area, including basements and useable roof spaces, enclosed balconies, conservatories, connecting passages, etc.
LV	Gross	Floor area inside the building envelope and include the external walls (external walls, balconies, non-heated cellar and loft are not included). This include also staircases and all heated internal rooms.
SE	Heated	Area intended to heat to 10°C. = Atemp
DE	Net	Living space without econ. places (like stairs), only covered heated areas are considered and wall space is not included).
EE	Net	All areas are given in closed net area - area of closed rooms measured from inner surfaces. Does not include doors, windows nor any other gaps in the structure, neither balconies.
BG	Useful	The useful area include (according to NSI yearbooks): Living floor area – bedrooms, living rooms, cabinets, halls and kitchens with more than 5 sq. meters area PLUS Service floor area – bathrooms, entrances, kitchens with less than 5 sq. meters and offices
CH	Useful	The useful area include (according to NSI yearbooks): Living floor area – bedrooms, living rooms, cabinets, halls and kitchens with more than 5 sq. meters area PLUS Service floor area – bathrooms, entrances, kitchens with less than 5 sq. meters and offices
ES	Useful	Usable area measured inside external walls of the house, not realizing the basements, attics, storage rooms and uninhabitable attics. Nor are open terraces and gardens
HU	Useful	Overall useful area surrounded by plastered or tiled walls, where the inner height exceeds 1,90 m. In multi-dwelling buildings, beside total area of flats, it comprises the area of public premises as well.
HU	Useful	Overall area of a building used for the designated non-residential purposes excluding engine-rooms and passages.
PL	Useful	Useful floor area of a dwelling includes: Area of all rooms, kitchen, bathroom etc. The Central Statistical Office (our main data source) uses this definition. Statistics provide only info about useful floor area. There are a few definitions for different aspects. Additional clarification: in all analyses based on data from the Central Statistical Office useful floor area (i.e. Useful floor area of a dwelling includes: Area of all rooms, kitchen, bathroom etc.) is used in some cases (energy intensity of different types of buildings) term "floor area" refers to heated area of the building.
RO	Useful	the floor space of dwellings measured inside the outer walls, excluding cellars, non-habitable attics and, in condominiums, common spaces; it includes the living rooms, bedrooms, bathrooms, kitchens/kitchenettes, deposit areas and hallways

Conclusions and recommendations

The transformation of the building stock has important macro-economic benefits which can substantially contribute to the EU 2020 Strategy and 2050 roadmap targets. While policy frameworks and instruments have been in place for some years now, the desired effects have not been fully obtained and the market is yet operational. The political decision is the key factor in creating a favourable framework for private investors. Strong commitments with clear targets could offer long term predictability which would help trigger changes in investor/occupier behaviour and necessary market stimulation.

More targeted policy at national level is required as country-specific circumstances need to be taken into account when designing policy packages for buildings. Roadmaps and policy packages should be tailor-made according to building type and owner profile and any measures should be continuously evaluated and improved. To do so, detailed data should be collected to ensure close monitoring and sound analysis of the dynamic situation in each Member State. From our analysis it is clear that there is a need of harmonisation of national data collection systems relating to the energy performance of buildings and ensure sufficient data availability. The current levels of data availability/quality show drastic differences between the EU Member States. A reliable and continuous data collection process is a necessary prerequisite for reliable policy making. In order to improve the knowledge level and to be able to take effective measures to improve the energy performance of buildings, Member States should collaborate to implement a harmonised standard for collecting relevant data about the European building stock. Ultimately, good policy making requires reliable and sufficient knowledge about the status quo of building performance and the EU and its Member States should make significant efforts to close these data gaps and to harmonize monitoring, reporting and evaluation.

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