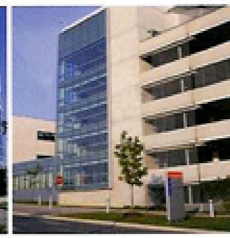
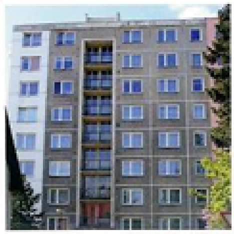




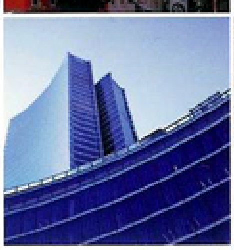
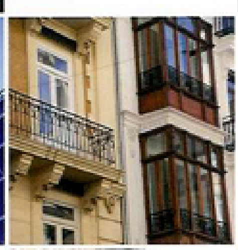
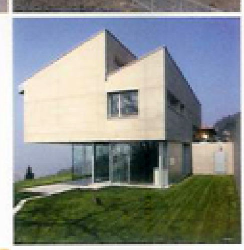


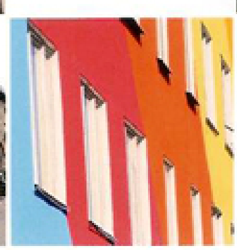

EUROPE'S BUILDINGS UNDER THE MICROSCOPE

A country-by-country review of the energy performance of buildings







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FOREWORD

Buildings are at the pivotal centre of our lives. The characteristics of a building, its design, its look and feel, and its technical standards not only influence our productivity, our well-being, our moods and our interactions with others, they also define how much energy is consumed in and by a building, and how much heating, ventilation and cooling energy is needed to create a pleasant environment.

We know that buildings cause a significant amount of greenhouse gas emissions, mainly CO_2, altering our planet's climate. By renovating buildings to high standards of efficiency we can demonstrate that ambitious climate change mitigation actions and improvements in living quality can go hand in hand. The European building stock with its unique mix of historical and modern architecture provides both significant opportunities and challenges.

Effective policies and incentive schemes to reduce the climate change footprint of buildings require a solid understanding about the current building stock. The Buildings Performance Institute Europe intends to contribute to an improved understanding with this report – gathering facts and figures about the European building stock and aggregating the findings to allow meaningful analysis.

BPIE recognizes that the availability of data is far from ideal, and that dynamic policy processes in the EU Member States will outdate very quickly some of the information on policies and financial support schemes. This is why we are committed to providing updates on certain issues at regular intervals, and I hope that we can count on the collaboration of many experts in the field.

Today, the challenge of climate change does not get the same political and media attention as it did some years ago. However, that does not mean that the problem has gone away, quite the opposite. But to limit the discussion about energy efficient buildings only to climate change considerations would ignore the many additional benefits which are created through the retrofitting of the European building stock. The revitalisation of urban quarters, improved comfort levels and quality of living and working spaces, helping people out of fuel poverty and creating long term employment are just some of the many positive effects of a European renovation 'wave' which is modelled in the final part of this report.

In this respect, this report wants to encourage a wider debate on how stakeholders in the building sector can collaborate to transform the European building stock into a highly efficient living and working environment which enables society to become more sustainable, in all aspects of the word's meaning. BPIE proactively seeks dialogue with the many interested parties, and is looking forward to receiving your reaction.

Oliver Rapf
Executive Director
Buildings Performance Institute Europe

CONTENTS

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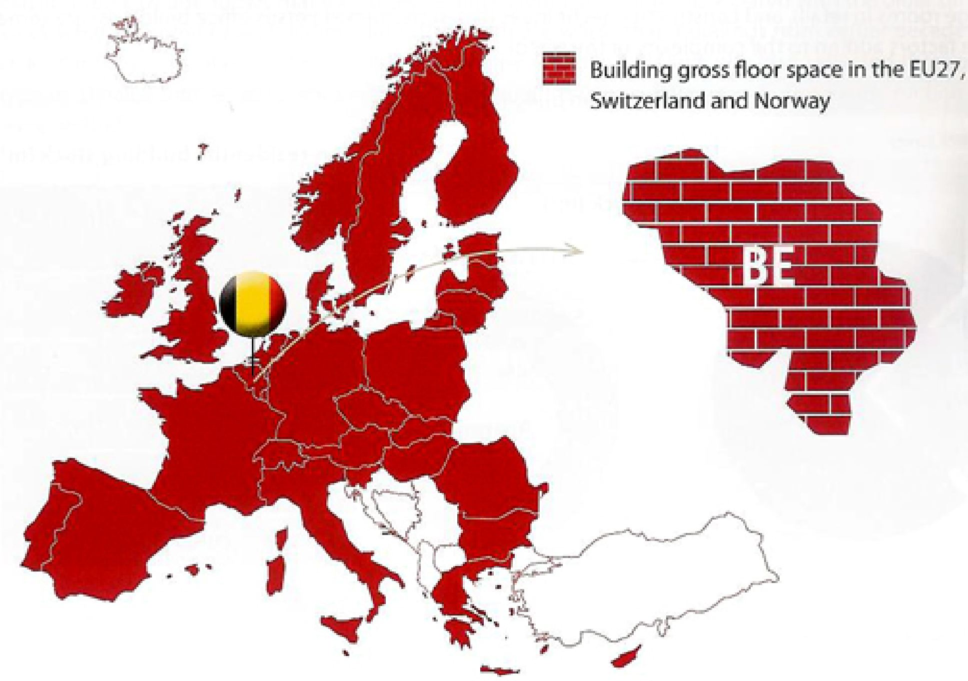
EXECUTIVE SUMMARY

From the emotional to the architectural value, buildings occupy a key place in our lives and society as a whole. Yet, the energy performance of our buildings is generally so poor that the levels of energy consumed in buildings place the sector among the most significant CO_2 emissions sources in Europe. While new buildings can be constructed with high performance levels, it is the older buildings, representing the vast majority of the building stock, which are predominantly of low energy performance and subsequently in need of renovation work. With their potential to deliver high energy and CO_2 savings as well as many societal benefits, energy efficient buildings can have a pivotal role in a sustainable future.

Achieving the energy savings in buildings is a complex process. Policy making in this field requires a meaningful understanding of several characteristics of the building stock. Reducing the energy demand requires the deployment of effective policies which in turn makes it necessary to understand what affects people's decision making processes, the key characteristics of the building stock, the impact of current policies etc.

Amid the current political discussions at EU level, BPIE has undertaken an extensive survey across all EU Member States, Switzerland and Norway reviewing the situation in terms of the building stock characteristics and policies in place. This survey provides an EU-wide picture of the energy performance of the building stock and how existing policies influence the situation. The data collected was also used to develop scenarios that show pathways to making the building stock much more energy efficient, in line with the EU 2050 roadmap.

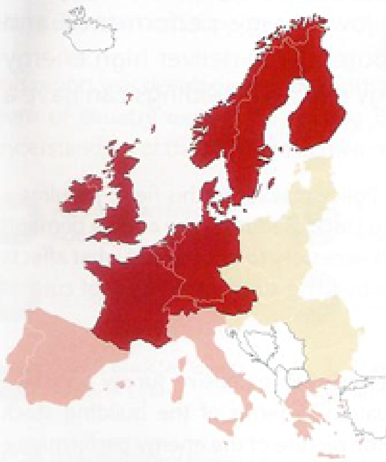
Building floor space in Europe



A VITAL PICTURE OF THE EUROPEAN STOCK

It is estimated that there are 25 billion m² of useful floor space in the EU27, Switzerland and Norway. The gross floor space could be concentrated in a land area equivalent to that of Belgium (30,528 km²). 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[i]. Annual growth rates in the residential sector are around 1% while most countries encountered a decrease in the rate of new build in the recent years, reflecting the impact of the current financial crisis on the construction sector.

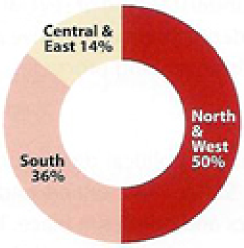
Regions considered in the study



North & West	AT, BE, CH, DE, DK, FI, FR, IE, LU, NL, NO, SE, UK	Population: 281 million
Central & East	BG, CZ, EE, HU, LT, LV, PL, RO, SI, SK	Population: 102 million
South	CY, GR, ES, IT, MT, PT	Population: 129 million

Floor space distribution

Source: BPIE survey

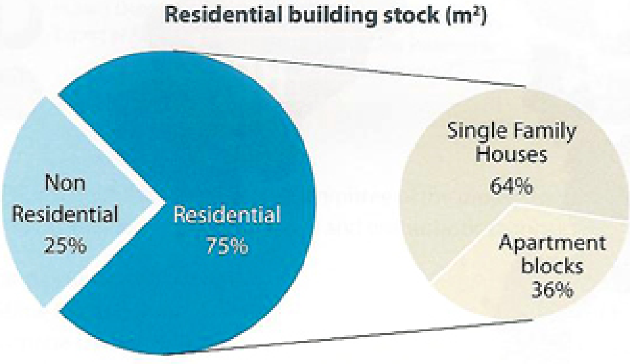


Non-residential buildings account for 25% of the total stock in Europe and comprise a more complex and heterogeneous sector compared to the residential sector. The retail and wholesale buildings comprise the largest portion of the non-residential stock while office buildings are the second biggest category with a floor space corresponding to one quarter of the total non-residential floor space. Variations in usage pattern (e.g. warehouse versus schools), energy intensity (e.g. surgery rooms in hospitals versus to storage rooms in retail), and construction techniques (e.g. supermarket versus office buildings) are some of the factors adding to the complexity of the sector.

European buildings at a glance

Source: BPIE survey

Residential building stock (m²)



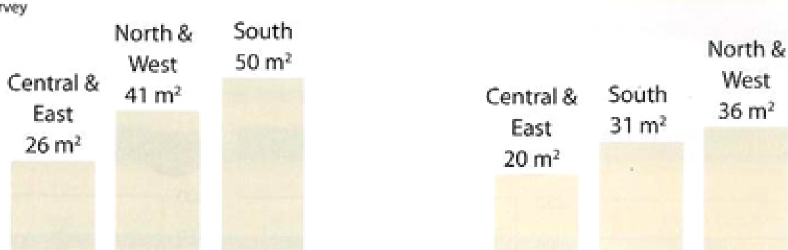
Non-residential building stock (m²)

[i] The European countries have been divided based on climatic, building typology and market similarities into three regions

Space standards (expressed through the floor area per capita) are 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. 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. The general tendency however is to seek larger floor spaces over time. This along with the increasing population projections has clear implications on future energy needs, emphasising the subsequent urgency for improving the energy performance of our buildings.

Residential floor space standards in Europe

Source: BPIE survey



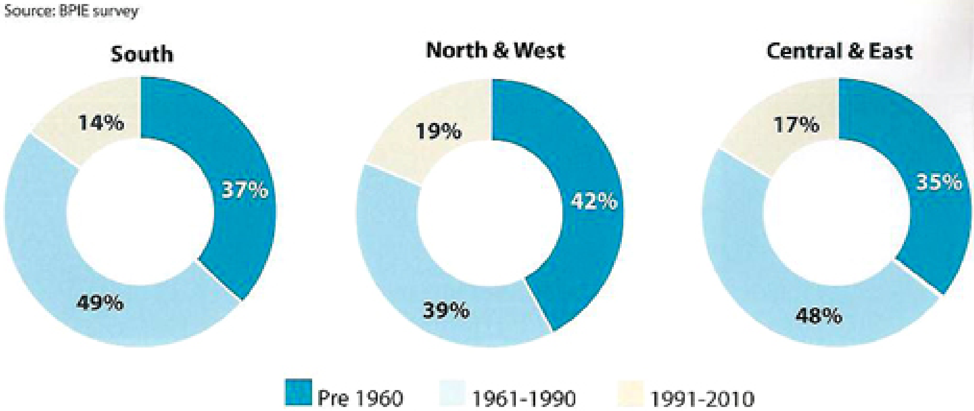
Single family house floor space per capita **Apartment floor space per capita**

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.

The performance of buildings depends on a number of factors such as the performance of the installed heating system and building envelope, climatic conditions, behaviour characteristics (e.g. typical indoor temperatures) and social conditions (e.g. fuel poverty). Data on typical heating consumption levels of the existing stock by age shows that the largest energy saving potential is associated with the older building stock where in some cases buildings from the 1960s are worse than buildings from earlier decades. The lack of sufficient insulation of the building envelope in older buildings was also reflected through the historic U-value data which comes with no surprise as insulation standards in those construction years were limited.

Age categorisation of housing stock in Europe

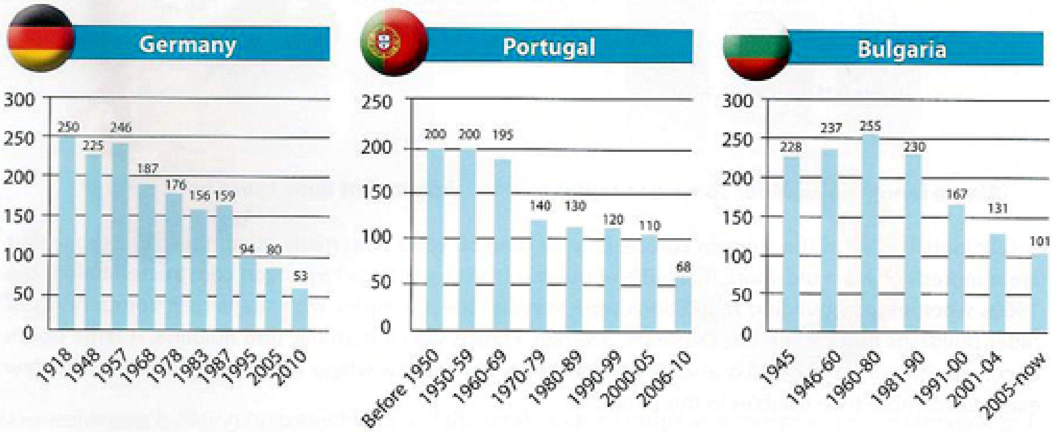
Source: BPIE survey



The building sector is one of the key consumers of energy in Europe where energy use in buildings has seen overall a rising trend over the past 20 years. In 2009, European households were responsible for 68% of the total final energy use in buildings[i]. Energy in households is mainly consumed by heating, cooling, hot water, cooking and appliances where the dominant energy end- use (responsible for around 70%) in homes is space heating. Gas is the most common fuel used in buildings while oil use is highest in North & West Europe. The highest use of coal in the residential sector is in Central & Eastern Europe where also district heating has the highest share of all regions. Renewable energy sources (solar heat, biomass, geothermal and wastes) have a share of 21%, 12% and 9% in total final consumption in Central & Eastern, South and North & West regions, respectively.

Average final consumption levels for heating (kWh/(m²a)) of single family homes by construction year

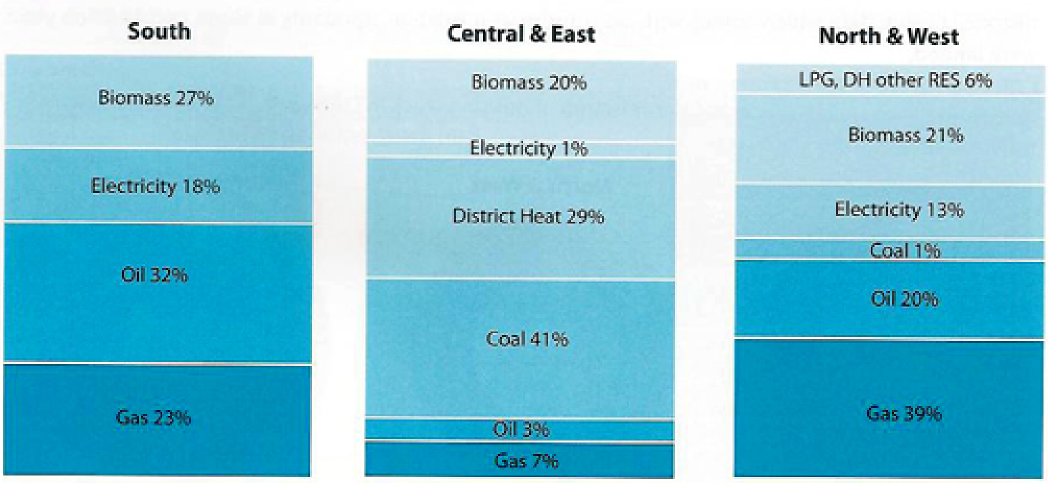
Source: BPIE survey



The average specific energy consumption in the non-residential sector is 280kWh/m² (covering all end-uses) which is at least 40% greater than the equivalent value for the residential sector. In the non-residential sector, electricity use over the last 20 years has increased by a remarkable 74%.

Energy mix in residential buildings by region

Source: Eurostat

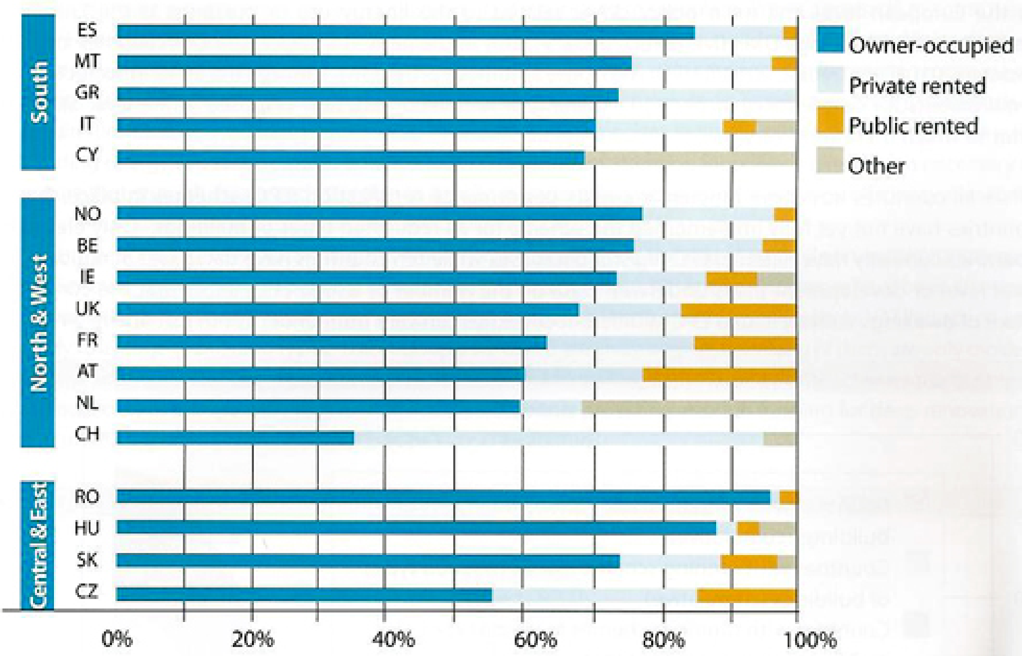


[i] Source: Eurostat

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[iii] 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.

Tenure of residential buildings in Europe

Source: BPIE survey



NOTES

Units are in number of dwellings except France which is in m².

AT: Data up to 2001.
CH: 'Other' consists of members of a building cooperative and others.
CY: Data up to 2001. 'Other' consists of 13,9% of rented (mixed ownership) and 17,9 of other arrangements.
CZ: Based on estimations.
HU: Data up to 2005. 'Other' includes public and private empty dwellings and other
IT: Data up to 2001
NL: 'Other' consists of social housing associations owned by private bodies for which conditions (e.g. rental prices) are heavily regulated by the government.
MT: Other consists of dwellings held by emphyteusis (notarial contract) and other used free of charge.
RO: Data up to 2002
SK: Based on 2001 data
ES: Social housing is mainly delivered through the private sector and is controlled through subsidies, subsidized loans and grants for both developers and buyers
UK: 'Other' consists of Registered Social Landlords (often referred to as housing associations) which are government-funded not-for-profit organisations that provide affordable housing.

[iii] The involvement of non-public providers acts on a not-for-profit or limited-profit basis.

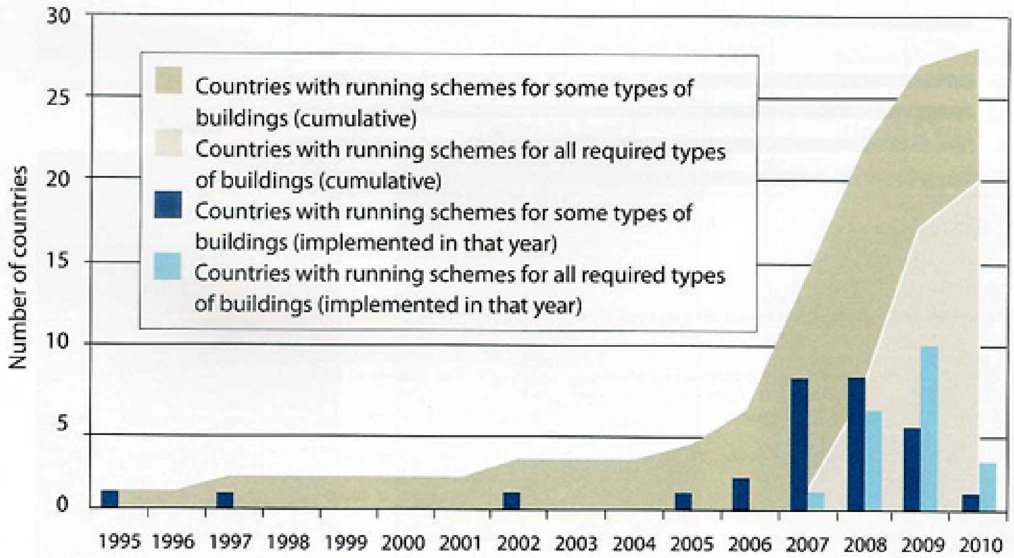
THE EUROPEAN POLICY SCENE

There are many reasons why investments in energy saving measures in buildings are often overlooked, rejected or only partially realised. Experience over several decades has identified numerous barriers that hinder energy saving investments. Financial, institutional and administrative, awareness/information and split incentives are the main categories of barriers identified by the BPIE survey which have a particular impact on existing buildings. Although financial barriers were one of the highest ranking barrier category among the country responses, alternative investments are in many cases preferred to energy saving measures due to the lack of awareness, interest or in fact, 'attractiveness' of energy efficiency as an investment option. For the market to work well, correct and appropriate information is essential. Ambitious renovations comprise a major decision and can only work if the right advice is available for the consumer. In addition, energy efficiency service industries should be fully capable of delivering those measures; and ultimately sufficient satisfaction levels should be guaranteed for the consumer. The split incentive is probably the most long-lasting barrier, particularly due to the complex structure of occupancy both in terms of the residential and non-residential sector.

At the European level, the main policy driver related to the energy use in buildings is the Energy Performance of Buildings Directive (EPBD, 2002/91/EC). Implemented in 2002, the Directive has been recast in 2010 (EPBD recast, 2010/31/EU) with more ambitious provisions. Through the EPBD introduction, requirements for certification, inspections, training or renovation are now imposed in Member States prior to which there were very few.

While all countries now have functional energy performance certification (EPC) schemes in place, five countries have not yet fully implemented the scheme for all requested types of buildings. Only eleven countries currently have national EPC register databases while ten countries have databases at regional/ local level or development plans underway. Data on the number of issued EPCs show that the current share of dwellings with an issued EPC in different countries can vary from under 1% to just above 24%.

Implementation timeline of EPC scheme (EPBD, 2002/91/EC)



The absence of previous requirements in most Member States meant that entirely new legislative vehicles were required and consequently that the first EPBD was typically implemented in stages over a number of years, from around 2006 to 2010. Despite the fact that significant developments happened over the last years, current EU legislation only partially covers the field of buildings renovation. The EPBD stipulates the implementation of energy saving measures only in case of deep renovation of the building without specifying the depth of renovation measures. It is clear that more targeted measures are required for fostering the deep renovation of the existing building stock.

A key driver for implementing energy efficiency measures are the building energy codes, through which energy-related requirements are incorporated during the design or retrofit phase of a building. While several Member States had some form of minimum requirements for thermal performance of building envelopes in the 1970s, the EPBD was the first major attempt requiring all Member States to introduce a general framework for setting building energy code requirements based on a "whole building" approach. Examining the requirements set by each Member State, it is clear that large variations exist in terms of the approach each country has taken in applying building energy codes. In some countries two approaches exist in parallel, one based on the whole building approach and the other one on the performance of single elements. In others, the single element requirements act as supplementary demands to the whole building approach. In some cases the requirements for renovating buildings can be as ambitious as the new build requirements. Major changes are expected through the application of the cost-optimality concept in energy performance requirements as introduced by the recast EPBD which should also gradually converge to nearly zero energy standards, a requirement for new buildings from 2020 onwards. An appropriate level of enforcement compliance with building energy codes should also be of concern and a point of attention for policy makers as it is necessary to ensure that enough rigour and attention to detail are undertaken when applying energy efficiency measures.

As Europe strives towards increasing building energy performance, the role of available financial programmes and innovative mechanisms become increasingly important. About 333 financial schemes have been screened through the BPIE survey. These cover a wide range of financial instruments from grants to VAT reduction and apply to a range of building types. 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.

Types of financial programmes and incentives on the energy performance of buildings

There are steps underway to improve the availability of new financing instruments. Innovative approaches include Energy Supplier Obligations, energy service companies, the use of EU Structural Funds more effectively and possible targets to renovate specific building sub-sectors (e.g. the proposal in the draft Energy Efficiency Directive to Member States to renovate a certain percentage of public buildings annually) which will require Member States to "unlock" funding for such renovations.

THE WAYS FORWARD

Building energy performance needs to be significantly improved in order to reduce overall energy demand and, importantly, reduce carbon dioxide emissions in line with the cost-effective potential and Europe's GHG emissions objectives. The question for policymakers is how to proceed.

To help policy makers determine the appropriate way forward, a renovation model has been specifically developed for this project. The scenarios illustrate the impact on energy use and CO_2 emissions at different rates (percentage of buildings renovated each year) and depths of renovation (extent of measures applied and size of resulting energy and emissions reduction) from now up to 2050. The model has assessed energy saved, CO_2 saved, total investment required, energy cost savings, employment impact and a range of cost-effectiveness indicators. These assessments allow policy makers the opportunity to focus on what they consider the highest priorities. The model considers features such as the age of buildings and quality of building energy performance. When considering the share of buildings that can undergo low energy renovation, a practical limit is applied in the residential and non-residential building sectors in the 2011 to 2050 timeframe. This practical limit is affected by a number of considerations such as demolitions, heritage buildings, recent renovations and new buildings. The model applies different discount rates, learning curves and future energy prices (based on Eurostat and Primes forecasts) in order to derive how costs will evolve from now until 2050. Two decarbonisation pathways are considered, a slow pathway based on what has been witnessed since 1990 and a fast pathway based on what is needed to achieve the levels of carbon reduction assumed in the EU 2050 Roadmap.

The model was used to create scenarios with various speeds (slow, medium and fast) and depths of renovation (minor, moderate, deep and nearly zero energy). All but one scenario assume that a building will be renovated once between 2010 and 2050. The so-called two-stage scenario allows for a second renovation during the 2010-2050 period. Individual scenarios combine different speeds and depths, and are compared to a business-as-usual scenario, which assesses what would happen if there were no changes from the approach taken today.

The results vary considerably as can be expected. Considering the results for 2020, the annual energy savings range from 94 TWh in the business-as-usual case to 527 TWh for the most ambitious deep scenario (and 283 TWh for both the medium and two-stage scenarios). In 2050, the corresponding annual energy savings of the deep and two-stage scenarios are 2795 TWh and 2896 TWh respectively while only 365 TWh annual savings are achieved in the business-as-usual case.

The results look significantly different for CO_2 savings where the deep and two-stage scenarios are much closer in impact. Under the assumption of fast decarbonisation of electricity and fossil fuels, the 2050 savings of the deep and two-stage scenarios correspond to the 90% which are in line with the European CO_2 reduction targets[iv]. These levels of savings can only be achieved given that both renovation and power sector decarbonisation strategies are adopted. Yet, there is a significant difference in investment costs (on a present value basis). For the deep scenario the investment is €937 billion, while a significantly lower €584 billion for the two-stage scenarios is needed.

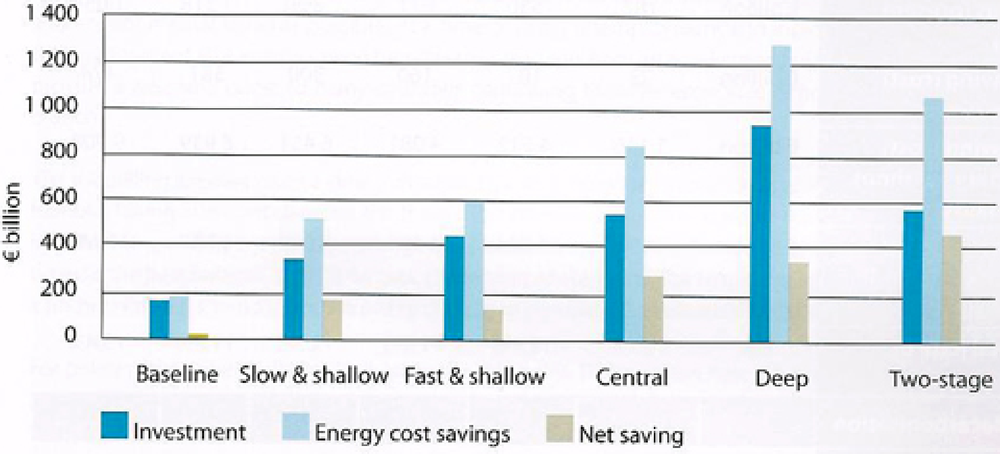
[iv] Source: European Commission (2011). *A Roadmap for moving to a competitive low carbon economy in 2050*, COM(2011) 112 final.

It is, however, not sufficient to only consider investment costs. These investments lead to a range of savings for individuals and society which are summarised in the figure below.

The figure below compares the present value investment and energy cost savings – the difference providing the net savings to consumers. While both the deep and the two-stage scenario achieve broadly the same level of CO_2 reduction, the deep scenario requires a significantly higher absolute investment level. In return, it also generates higher energy cost savings; however, the net savings are smaller than in the two-stage scenario. The high investment needs of the deep scenario are caused by a fast increase of deep renovation measures in the first decade. The two-stage scenario requires a lower investment due to a slower increase in the number of deep renovations while benefitting from a longer learning period which leads to cost reductions.

Lifetime financial impact for consumers (present value)

Source: BPIE model



The table on the next page gives an overview of the key results of each scenario. Beyond energy, CO_2 and cost savings, significant positive employment effects can be achieved, directly depending on the level of investment.

Overall results to 2050

Source: BPIE model

Scenario		0	1A	1B	2	3	4
Description		Baseline	Slow & Shallow	Fast & Shallow	Medium	Deep	Two-stage
Annual energy saving in 2050	TWh/a	365	1 373	1 286	1 975	2 795	2 896
2050 saving as % of today*	%	9%	34%	32%	48%	68%	71%
Investment costs (present value)	€ billion	164	343	451	551	937	584
Savings (present value)	€ billion	187	530	611	851	1 318	1 058
Net saving (cost) to consumers	€ billion	23	187	160	300	381	474
Net saving (cost) to society - without externality	€ billion	1 116	4 512	4 081	6 451	8 939	9 908
Net saving (cost) to society - including externality	€ billion	1 226	4 884	4 461	7 015	9 767	10 680
Internal Rate of Return	IRR	10.1%	12.4%	11.5%	12.5%	11.8%	13.4%
Fast decarbonisation							
Annual CO_2 saving in 2050	$MtCO_2/a$	742	821	814	868	932	939
2050 CO_2 saved (% of 2010)	%	71.7%	79.3%	78.6%	83.8%	89.9%	90.7%
CO_2 abatement cost	€/tCO_2	-20	-74	-68	-103	-136	-151
Slow decarbonisation							
Annual CO_2 saving in 2050	$MtCO_2/a$	182	410	391	547	732	755
2050 CO_2 saved (% of 2010)	%	18%	40%	38%	53%	71%	73%
CO_2 abatement cost	€/tCO_2	-89	-196	-185	-221	-238	-255
Average annual net jobs generated	Million	0.2	0.5	0.5	0.7	1.1	0.8

In all the scenarios, the estimated CO_2 emission reduction by 2050 is determined by the energy savings but also by the decarbonisation of the energy supply sector. It is interesting to note that in the deep and two-stage scenarios there is a 71-73% CO_2 emission reduction even under the slow decarbonisation assumption, a figure which is close to the CO_2 emission reduction for the slow and shallow scenario under the fast decarbonisation assumption. This highlights the role of renovation measures in the decarbonisation strategy. The decarbonisation of the energy supply sector is significantly eased by decreasing the energy demand of buildings and is importantly more sustainable. Moreover, the costs for decarbonising the energy generation system will be significantly less if the consumption patterns of the building sector will dramatically reduce.

Each of the scenarios 1-4 represent a significant ramping up in renovation activity compared to the current situation (i.e. the baseline scenario 0). When looked at purely in terms of the investment required, these range from around double the baseline level for scenario 1a, through to over 5 times the baseline level for the deep scenario 3. These are significant increases, but certainly achievable if governments across the EU were to agree and implement respective policies and market stimulation mechanisms. The current practice is clearly not sufficient to trigger a renovation wave across Europe which would deliver the societal, economic and environmental benefits possible. At a time of rising unemployment and increased energy dependency, the employment and energy saving benefits to consumers from an accelerated renovation programme would provide a welcome boost to many countries continuing to suffer economic difficulties following the credit crunch.

The modelling exercise gives a clear indication that an ambitious renovation strategy for Europe's buildings is feasible. Taking into consideration the three most relevant factors, i.e. achievement of CO_2 reduction targets, investment considerations and positive employment effects, it seems that the results of the two-stage scenario provide the best balance of these factors, comparing all scenarios. The two-stage scenario therefore illustrates a pathway which should influence policy choices to stimulate the renovation of the European building stock.

For policy makers the challenge only begins at this point. The question now is how to break the policy inertia and set the necessary policies in motion to achieve this. The complex nature of the buildings sector with its many actors in the value chain requires effective policy actions at both EU level and Member State level.

At EU level, the recast of the EPBD will have to be implemented in a way which secures large energy savings and it will have to be monitored for revision at the earliest possible date. Other Directives, from Ecodesign to the Energy Efficiency Directive proposed in June 2011, will have to be aligned to maximise ambition. At the same time, Member States need to make significant efforts to transpose EU regulation and to implement it in a way that stimulates deep renovation of the building stock.

Beyond policy regulation, financing frameworks need to be effective and adequate. Innovative approaches are needed since the initial up-front investment costs for ambitious renovations can be a real barrier. Supporting measures at all levels of the building value chain, from a well-trained workforce (from designers to tradesmen), to a continuing and growing range of energy-efficient products and to effective awareness and information programmes are essential. These strategies are inter-connected and need to be carefully designed to stimulate the necessary growth of the European deep renovation market. The following recommendations provide a strategic framework and starting point for decision makers at both the EU and national level.

Main policy recommendations

- **Data collection:** harmonise national data collection systems relating to the energy performance of buildings and ensure sufficient data availability. A reliable and continuous data collection process is a necessary prerequisite for reliable policy making.
- **Renovation roadmap:** strengthen the existing legislation at EU level through binding measures and establish a roadmap for the renovation of the building stock with interim and long term binding targets as well as monitoring and reporting plans. At Member State level, it is necessary to detail deep renovation plans comprising regulatory, financial, information and training measures, with renovation targets based on the national financial and technical potential and tailor-made roadmaps with different phases moving from voluntary to binding measures.
- **Financing:** establish an EU Deep Renovation Fund (possibly via the European Investment Bank and designed for different building types) which can complement the national financing schemes and share the risks, offering more financial flexibility and additional confidence to the private investors. EU expenditure for the renovation of the building stock (i.e. by Structural and Regional Development Funds) should introduce the minimum requirement for implementing measures at cost-optimal levels. The development of innovative financial instruments at Member State level can trigger increased private investment by providing guidelines for financing, promoting best practice and stimulating Member State cooperation;
- **Member State policies:** eliminate market barriers and administrative bottlenecks for the renovation of the building stock and to develop long-term comprehensive regulatory, financial, educational and promotional packages addressing all the macro-economic benefits.
- **Monitoring/compliance/enforcement:** establish proper monitoring systems of compliance, enforcement and quality control processes through a qualified workforce for all policy packages fostering deep renovation.
- **Energy Performance Certificates:** strengthen the implementation of the buildings energy certification and audit schemes which can increase the value of efficient buildings and can stimulate the real-estate market towards green investments.
- **Public sector:** ensure that the public sector takes a leading role in the renovation revolution as envisaged by the draft Energy Efficiency Directive, which should kick start the market for renovation and help bring costs down for private households and businesses.
- **ESCOs and savings guarantee:** remove market barriers for the ESCOs and facilitate a faster and better development of deep renovation programmes through regulatory frameworks, encouraging the set up and development of a well-functioning energy services market which is not limited to commercial buildings. An innovative guarantee system should be developed for the performance of efficiency measures in order to provide confidence for the quality level of renovation measures to consumers and investors.
- **Training and education:** increase the skills in the construction industry by ensuring appropriate framework conditions for the Internal Market of construction products and services, improving resource efficiency and environmental performances of construction enterprises, and promoting skills, innovation and technological development.

INTRODUCTION

A VITAL PICTURE OF THE EUROPEAN BUILDING STOCK

"If you cannot measure it, you cannot improve it"

Sir William Thomson, Lord Kelvin

Buildings are at the centre of our social and economic activity. Not only do we spend most of our lives in buildings, we also spend most of our money on buildings. The built environment is not only the largest industrial sector in economic terms, it is also the largest in terms of resource flow[1]. Buildings are intrinsically linked to Europe's societies, Europe's economies, and their future evolution.

Energy security and climate change are driving a future that must show a dramatic improvement in the energy performance in Europe's buildings. The 27 Member States have set an energy savings target of 20% by 2020, mainly through energy efficiency measures. The European Union has also committed to 80-95 % GHG reduction by 2050 as part of its roadmap for moving to a competitive low-carbon economy in 2050[2]. Buildings currently represent almost 40% of total final energy consumption and, therefore, can make a crucial contribution to these targets.

In the Energy Efficiency Plan 2011[3], the European Commission states that the greatest energy saving potential lies in buildings. The minimum energy savings in buildings can generate a reduction of 60-80 Mtoe/a[4] in final energy consumption by 2020, and make a considerable contribution to the reduction of GHG emissions. This will be achievable only if buildings are transformed through a comprehensive, rigorous and sustainable approach.

The European policy framework for buildings has been evolving since the early 1990s. A wide array of measures has been adopted across individual Member States to actively promote the better energy performance of buildings. After 2002, the issue gained strong momentum when the Directive on Energy Performance of Buildings (EPBD) [Directive 2002/91/EC] was adopted. The EPBD was recast in 2010 to make the goals more ambitious and to reinforce the implementation.[5]

As the Commission stated in its Communication proposing the 2010 revision: "The sector has significant untapped potential for cost effective energy savings."[6]. Realising this potential will depend crucially on the commitment of Member States, and the involvement of stakeholders from government, industry and civil society.

The European Union stretches over many different climate zones, landscapes and cultures. Some 501 million inhabitants spread over 27 countries[7] reside in a wide array of building types with an equally wide

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[1] Source: Hawken, P. (2005). Foreword. In Mendler, S. F., Odell, W., & Lazarus, M. A., (2005). *The HOK Guidebook to Sustainable Design* (2nd ed.)

[2] The European Parliament and the Council of the European Union (2010, May 19). Directive 2010/31/EU of the European Parliament and the Council on the energy performance of buildings (recast). *Official Journal of the European Union*. Note: the Directive entered into force in July 2010 but the repeal of the current Directive will only take place on the 1st February 2012.

[3] European Comission (2011). *Energy Efficiency Plan 2011*, COM(2011) 109 final.

[4] Source: European Commision (2008). *Accompanying document to the Proposal for a recast of the energy performance of buildings directive (2002/91/EC) - Summary of the impact assessment*, SEC(2008) 2865.

[5] The European Parliament and the Council of the European Union (2010, May 19). Directive 2010/31/EU of the European Parliament and the Council on the energy performance of buildings (recast). *Official Journal of the European Union*.

[6] European Commision (2008). *Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast)*, COM(2008) 780 final.

[7] The data collection and analysis also include Norway and Switzerland, two countries that work closely with the EU and implement much of its legislation.

range of thermal qualities, in a constantly expanding building stock. From styles of living – single-family dwellings or multi-family dwellings, for example – to policies for the construction of buildings, there are significant differences between countries.

National approaches to monitoring the building stock have also evolved separately. Information is not only needed to track the progress of policy implementation, better information and data are required to help develop a European pathway and roadmaps to more energy efficient buildings. In order to define the energy and CO_2 reduction potential, we need to study and evaluate the technical and economic opportunities, feasibilities and limits.

Indeed, it is a major obstacle to strong policy making at EU level that there is a lack of data on the building sector for Europe as a whole.

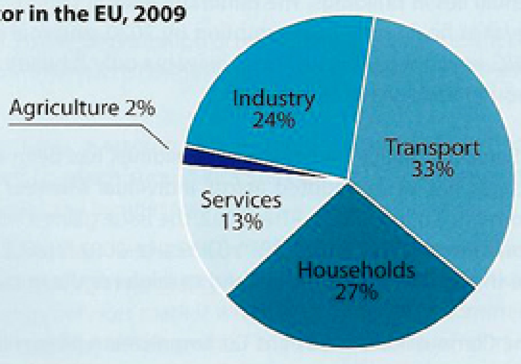
There has been significant Europe-wide legislation on buildings and there are several forthcoming initiatives underway to improve the energy performance of new and existing buildings. Yet, much of this is done with only a minimum of fact-based knowledge, analysis and evidence. As strategies for the energy performance of buildings evolve and become more complex, policy makers need more concrete and precise facts to be able to make cross-country comparisons and to put in place the monitoring systems that permit measurement of the progress of the various policy instruments.

Buildings in a European context

Buildings consume about 40% of total final energy requirements in Europe. In the context of all the end-use sectors, buildings represent the largest sector, followed by transport with 33%.

Figure 1. Final energy consumption by sector in the EU, 2009

Source: DG ENER



To create a sound basis for political debate and policy making at EU and Member State level, the Buildings Performance Institute Europe (BPIE) has embarked upon a major undertaking: to develop a vital picture of the European building stock, one that is as detailed and correct as possible. BPIE is convinced that effective policy making starts with an accurate picture of the challenge. This report is a first attempt at such a comprehensive approach.

THE CHALLENGE

Many experts agree that the most cost-effective way of meeting climate change targets is through improved energy efficiency. At this point, there is growing acceptance of this principle, but there is still an imbalance between the resources devoted to energy supply options and energy demand-reduction options. The scenarios usually developed are designed to highlight the potential for improved energy efficiency in buildings making a cost-effective contribution to achieving climate targets.

Typically, energy efficiency initiatives are crowded out by other more immediate priorities, in part because improving energy efficiency is a long-term policy commitment. In the buildings sector, policies are effective not over two or three years, but two or three decades. That is not easy to sustain. Today's headlines include financial crises in several EU Member States, wars in several countries and budget debates at national and European levels. While they all seem like competing priorities, in fact, improved energy efficiency could make a positive contribution to solutions in many policy areas while actually increasing rather than decreasing available resources.

Why improve energy efficiency in buildings?

The high level of energy consumption and GHG emissions in buildings in Europe makes this is an obvious sector to target in order to determine the potential and improve energy performance. While there has already been significant effort to improve energy performance in buildings, considerable potential still remains, as was noted by the European Commission's Communication on the proposal for the recast of the EPBD.

The justification for focusing on the energy efficiency in buildings can be summarised in the following arguments that relate to both the individual's point of view and the perspective of society as a whole:

- Security of energy supply; [Societal]
- Lower GHG emissions, which means a major contribution to climate change strategies; [Societal]
- Reduced energy costs for consumers, which can be important in avoiding "fuel poverty" (where energy costs represent a disproportionate and unsustainable share of disposable income); [Private]
- Cheaper than investing in increased energy capacity; [Societal]
- Improved comfort; [Private]
- Contribution to the rehabilitation of certain building types in the new Member States of Central and Eastern Europe; [Both]
- A major contribution to the objective of sustainable development, which is a formal commitment of European countries; [Societal] and
- Improving energy efficiency in buildings is important to the buildings energy service industries that are important employers in Europe. [Both]

Any assessment of the costs and benefits of building energy performance must account for the full range of benefits at both individual and societal level – which is often difficult to estimate.

One major challenge is changing the mind-set concerning buildings. If the building sector is to significantly contribute to the 80-95% GHG reduction target for 2050, each building, on average, will have to demonstrate very low carbon emission levels and consume very low energy in the context of a decarbonised power sector. For most of Europe's buildings, that probably means improving the current average energy consumption by a factor four or five and the installation of renewables. For some it could even mean a factor 10 improvement. This may be hard to imagine but is definitely doable.*

* The IEA analytical work related to policy recommendations show this could be both possible and economically rational. This has been presented, for instance at Climate Change: Global Risks, Challenges and Decisions, IOP Conf. Series: Earth and Environmental Science 6 (2009) in the paper "Global policy for dramatic reduction of energy consumption in buildings – Factor 3 is both possible and economic rational", by Jens Laustsen, International Energy Agency IEA.

Supporters of energy efficiency need better arguments which will encourage both the private and public sectors to take more interest in improving energy efficiency and to explain how this paradigm shift can occur. The main objectives of this study are to give policy-makers the facts and offer the arguments to make the case persuasively, and to provide useful data input to researchers who should base any political discussion upon science-based insights.

STRUCTURE

This report has three parts.

Part 1 surveys 27 Member States, together with Norway and Switzerland, examining the floor space area of residential and non-residential buildings, building typologies, characteristics and energy performance of current stock. The information is drawn from the statistical offices of national administrations and will be presented in a form that permits European comparisons and analysis. There are inevitably gaps, as certain administrations have not made a priority of this kind of data collection (c.f. Methodology chapter).

Part 2 provides detailed information and analysis relating to current barriers, the EPBD implementation, the European building codes and major programmes that are designed to improve energy performance in buildings.

In **Part 3** the available data were used to develop and assess the energy performance scenarios for the buildings sector in Europe with the aim of illustrating potential energy savings and CO_2 reduction pathways, reflecting the EU's 20% energy saving target for 2020, as well as the EU's long term 80-95% GHG emission reduction target for 2050.

The scenarios describe the impact of building retrofit strategies to achieve the 2020 and 2050 targets. The scenarios are built on different renovation rates and depths and illustrate the impact of different ambition levels regarding the European environment and economy.

METHODOLOGY

BPIE has recently screened all EU27 countries together with Switzerland and Norway with the aim of collecting existing data related to buildings and building policies. The exercise has been undertaken using a team of experts in each Member State plus Norway and Switzerland. The data collected were mainly extracted from official statistics and studies at Member State level supported by expert estimations wherever official data were unavailable. The information was gathered in the form of a questionnaire whose structure comprised five principal levels:

- Background
- Legal
- Financial
- Technical
- Monitor

The data have been used to give a fresh and up-to-date picture of where we stand in terms of the energy performance of our buildings and form the basis upon which our scenarios are built. Through the survey carried out by BPIE, information on the typology, characteristics (such as age, size, and ownership profile) and energy performance of the building stock have been collected for the EU27 countries together with Norway and Switzerland. The dataset represents one of the most comprehensive assembled in Europe to date and ranges from residential to non-residential buildings where the following categories were considered:

(a) Single family houses
(b) Apartment blocks
(c) Offices
(d) Educational buildings
(e) Hospitals
(f) Hotels and restaurants
(g) Sports facilities
(h) Wholesale and retail trade services buildings
(i) Other types of energy-consuming buildings

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. For the latter, estimates have been made by taking the prevailing average across the dataset for floor area per person for the missing building category and multiplying this by the population of the country in question.

Care has been taken in the compilation of the data required to make additional estimations. For example, floor area data were reported at times in net floor area and other times in gross, net, useful or heated. 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 were 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.

Data have also been gathered in terms of the age, size, ownership (private/public), tenure (owner occupied, private or social tenant) location (rural/urban) and typical energy performance levels of the building stock. Good responses have generally been obtained by several countries in residential stock while gaps in responses were more prominent in the characteristics of the non-residential stock.

THE CHALLENGES FOR THE FUTURE

As this is probably the first attempt to draw together a comprehensive and detailed picture of the residential and non-residential building stock throughout Europe, a number of issues have been identified, among which the two key issues are:

→ **Common definition of floor area:**

Countries often have different approaches to the measurement of floor area which can include external gross, internal gross, net, heated and treated parts of a building. The same term may not have the same meaning or definition in different countries. Moreover, assuming that two countries adopt the same definition, the different approaches for taking measurements (e.g. measuring the attic space) imply that comparing the resulting floor areas is difficult. For these reasons, it would be helpful to have agreement on a common measurement principle which should probably correspond to the concept of 'treated' floor area, referring to the portion of the building treated with some form of heating and/or cooling (but excluding areas such as plant rooms, car parks and other non-treated spaces). Some have proposed that building volume is a better metric when dealing with treated space because it is the volume of air that is heated or cooled. 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.

→ **Common building categories:**

Data were collected for this report using the above set of categories (a-i) for residential and non-residential buildings. Most countries were able to present data in the required format but several were only able to provide data broken down into nationally defined sets of categories. Agreement around a common set of building categories with a clear set of definitions of what should be included and excluded would make for more reliable and comparable data in the future, especially for non-residential types.

Addressing the above issues would require in many cases changes to the databases that countries are using and hence the underlying legislation. Although this would require considerable effort, monitoring and evaluating current policies related to buildings signify the urgent need for more data on the building stock. If the above issues are addressed in an appropriate way without overcomplicating the additional work, the case would be further reinforced for buildings being a driving sector for achieving the overall climate targets set for the EU. Without a solid foundation of data, it is difficult to monitor the impact and ultimately design effective policies.

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