Climate-KIC is supported by the EIT, a body of the European Union

Building Market Brief

Poland, 2020

1st Edition

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Publisher
CUES Foundation.
E-mail: info@cuesanalytics.eu
Web: www.cuesanalytics.eu

Local Partner
National Energy Conservation Agency (NAPE)

Partners
Knowledge and Innovation Community on Climate (Climate-KIC)
World Business Council for Sustainable Development (WBCSD)
Royal Institution of Chartered Surveyors (RICS)

Acknowledgements*
Richard Barker, Katrin Bienge, Construction21, Justus von Geibler, Peter Graham, Ian Hamilton, Katrin Hauser, Raphael H. Heiberger, Lena Hennes, Michael Klippel, Arjen Meijer, Paul Ruyssevelt, Sybren Steensma, Pierre Touya, Henk Visscher, Elise Vonk, Matthew Watkins, Stefan Wiesendanger, Zeno Winkels, Daniel Zimmer, Zrzeszenie Audytorów Energetycznych.

Printed with paper from well-managed forests:

FSC FOREST STEWARDSHIP COUNCIL

Building Market Briefs

ISBN 978-90-827279-8-2, 1st Edition, 2020

This document is funded by the Building Technology Accelerator (BTA) flagship within the Knowledge and Innovation Community on Climate (Climate-KIC) funded by the European Institute for Technology (EIT) under the Horizon 2020 framework of the European Union.

This report should be cited as:
This report should be cited as:
Ostermeyer, Y.; Jakob, M.; Camarasa, C.; Catenazzi, G.; Saraf, S.; Naegeli, C.; Palacios, A.; Wiszniewski, A.; Komerska, A.; Goatman, D. "Building Market Brief Poland 2020", ISBN 978-90-827279-8-2

*in alphabetical order

Prelude

In light of the necessary global transformation towards a low-carbon economy, the building sector is facing dramatic changes and a dire need for innovation in the years to come. These changes come with risks as well as opportunities, and a solid and region-specific understanding is needed in order to minimise the former and to maximise the latter when designing, investing in, or implementing low-carbon solutions.

Global greenhouse gas emissions from the building sector have more than doubled since 1970. In Europe, buildings are responsible for 40% of energy consumption and 36% of emissions. As such, a low-carbon transformation of the building sector and the refurbishment of the existing building stock is a key component of the EU Roadmap 2050.

With a European perspective in mind, one of the major barriers inhibiting large-scale investments into low-carbon technologies in the built environment is the lack of comparable cross-country market data. Such data would enable investors, low-carbon technology suppliers, and other key stakeholder in the built environment to exchange knowhow and to transfer solutions across borders. This is especially true for the building sector, which is commonly described as one of the most fractured and regionally coloured industries with habits, traditions, and stakeholder setups often preventing innovative knowledge transfer simply because the respective parties' situations are not known to each other.

It is exactly this gap in understanding and data availability that the Building Market Brief series addresses. On a limited number of pages, the condensed essence of a country's building sector and its spirit is summed up and quantified with indicators aligned across countries.

The series of reports thereby provides a reliable basis for low-carbon innovation, investments, and adoption by offering a pan-European market understanding and by providing comparable insights into the sector. In addition, the series aims to document a holistic understanding taken from multiple perspectives, market experts, models, and statistical data.

The reports address not only low-carbon innovation suppliers and entrepreneurs who are looking for suitable markets for their ideas or for inspiration for their developments, but also investors and policy makers who would benefit from a better pan-European overview that allows for benchmarking and cross-country experience exchange.

I am confident that the information and insights provided in this series of reports will contribute to the transition to a low-carbon economy as one of the key challenges of this century.

York Ostermeyer
Editor in chief

Executive summary

Economic framework conditions

With a population of 38 million (2015), Poland is the 6th largest of the EU28 member states with 7.4% of the EU28's population. The nominal GDP of the country is zł 1800.2 billion or € 430 billion in 2015, and it grew at an average annual growth rate of 6.2% nominal and 3.9% real from 2005 to 2015. This also makes Poland one of the fastest growing economies of the EU. Its GDP per capita increased from zł 25 955/capita or € 6 450/capita in 2005 to zł 46 814/capita or € 11 315/capita in 2015, while the disposable income per capita grew at an average annual growth rate of 5.3% in the same period. The population of Poland decreased at an annual average of 0.04% from 2005 to 2015 (Section A1).

The monthly consumption expenditure per household grew 32.4% from 2005 to 2015, while that spent on housing and energy grew by +28.5% in the same period. This represents an annual average increase of 2.9% and 2.6%, respectively. As a proportion of the total consumption, the monthly housing and energy expenditure marginally decreased from 22.1% in 2005 to 21.5% in 2015. (Section A1).

The construction sector in Poland contributes 8% (2015) to its GDP. In 2015, some zł 149.2 billion (€ 35.7 billion) was spent on building construction-related expenditure, including both residential and non-residential construction. The total investments in building construction increased at an average annual rate of 8.1% starting in 2005 (Section A5). The number of households in Poland at the end of 2016 amounted to ca. 14.1 million, while the total number of existing housing units was ca. 14.3 million. Almost 80% of the housing stock belongs to private owners, which is one of the highest owner-occupier rates in Europe. As in many Eastern European countries, owning property is still a deep-rooted custom among Poles (Section A6).

Poland spends 1% of its GDP on R&D (2015), which is half of the EU28 average of 2.03%. In the European Innovation Scoreboard 2018, it was grouped in the "Moderate Innovator" category (Section A1).

The structure of the building sector in Poland

Of the total floor area in Poland, around 68% (1 063 million m²) belongs to the residential sector, of which 69% was built before the 1990s. Single-dwelling buildings (SDBs) represented the majority in terms of floor area in 2015 (58%), while they have had a more even share with multi-dwelling buildings (MDBs) in recent years (51% in 2019) (Sections A2 and C1).

Some 85.5% of the residential dwellings in Poland are privately owned, and 55.3% of them are occupied by the owners themselves. More than a quarter of the residential dwellings are occupied by private tenants (including those rented to family relations), and 16.1% are social housing dwellings (Section A2).

The proportion of building investments in SDBs and MDBs has varied over the last decade. In 2015, 74% of the construction costs for new residential buildings could be attributed to SDBs and the remainder to MDBs. Investments in MDBs increased at an average annual growth rate of 10% from 2005 to 2015 (Section A5).

The age distribution of the residential building stock still shows a large share of old buildings, with about 37% of the heated floor area built before 1970, including a large share built before 1945. On the other hand, a large proportion of the built floor area stems from a construction boom in the 1970s and 1980s, characterised by Soviet-style apartment blocks, when about 32% of the current floor area was added to the stock. The absence of building codes and the fast building techniques used in MDBs during the Soviet era (which included very little or no insulation at all) translated into a large share of very poorly insulated buildings. In recent years, a trend towards more energy-efficient buildings can be seen for both typologies (MDBs and SDBs) as a result from more stringent building codes. However, the overall stock added is still far from meeting the targets of nearly zero-energy buildings, with only 1% having and energy demand below 50 kWh/m² year.

The efforts made to refurbish the stock have not been largely applied so far, and the retrofit measures have often only targeted single components instead of comprehensive retrofits, leading to only marginal improvements in the efficiency of the buildings.

The low efficiency of the majority of buildings, together with the large share of fossil fuels in the Polish energy mix, translates into a building stock heavy in GHG emissions. (Section C1).

Policy framework and other demand side drivers

Poland believes fossil fuels (such as coal) to be an important part of its energy system and an energy security issue, but the country also aligns itself with EU climate and energy policies and objectives. The 2009 'Polish Energy Policy until 2030' (Polityka Energetyczna Polski do 2030 r.) is a strategic document that outlines the policy priorities of the country. The fourth National Energy Efficiency Action Plan (NEEAP) of 2017 defines the energy efficiency target for 2020 as reducing primary energy consumption from 2010 to 2020 by 13.6 Mtoe. This requires decreasing the energy intensity of the economy through investments in enterprises and district heating, increasing the efficiency of end-use sectors, and reducing electricity losses.

In the building sector, The Act on Support for Thermal Modernisation Projects (1998) aims at reducing the energy needs of buildings for space heating and hot water. Also, the energy efficiency obligation scheme ('white certificates') obliges energy suppliers to help end-consumers save energy. These savings, as confirmed in the certificate, can be further redeemed. The suppliers can also meet this obligation by paying a fee that is eventually used to support end-users' energy efficiency. A revised building renovation strategy entitled 'Supporting Building Refurbishment Investments' has also been presented in the NEEAP 2017 (Section A4).

Most of the buildings without thermal insulation were built before 1989, when the rules regarding insulation and their enforcement were less rigorous. Many of these buildings also require renovation. It is estimated that renovating half of the existing Polish building stock over a 20-year period would require raising the current renovation rate of less than 1% of floor area per year to 2.5% per year, with an estimated annual cost of € 5 billion (Section A2 and A5).

Housing and derived energy demand and carbon emissions are also driven by changing family and household structures, along with personal needs that together entail a demand for more dwellings and increased floor area (Section A1). By 2030, a net addition of 5% to the residential floor area is expected according to the modelling results. In the following years, this development slows downs resulting in only a 2% increase in 2050 compared with 2030. This is mainly driven by the decreasing trend in population, which experiences a total reduction of 9% by 2050 (Section C3).

Energy, carbon, and market trends

Although the total floor area increases by 2030, final energy demand for heating, hot water, and ventilation is expected to be 7% lower than present values in 2030 and 40% lower in 2050 under current and decided policies (what is called the Reference Scenario (RS) in this report). With more stringent policies and regulations (the 2-Degrees Scenario (2DS)), the reduction would reach 17% in 2030 and 65% in 2050 (Section C3). The main factors responsible for these reductions are building code requirements for new construction and increased refurbishment activities.

At present, the majority of the residential floor area in Poland (79%) emits more than 50 kg CO_2-eq per m². A shift occurs after 2030, resulting in almost half of the stock emitting less than 20 kg CO_2-eq per m² in the RS, and a vast majority of the stock emitting less than 20 kg CO_2-eq per m² in the 2DS. This as a consequence of more stringent building codes and the renovation (at least partially) of most of the building stock at that point (Section C4), fostered by greater availability of subsidies and loans and the introduction of a CO_2 tax in the 2DS. Targeted policies to phase out fossil fuels as well as the decarbonisation of the Polish district heating and electricity mix are also responsible for the better emission performance of the building stock in the 2DS. Heat pumps and other renewable energy sources are expected to compensate for the demand for fossil fuels that will no longer be attractive when retrofitting or constructing new buildings (Sections A4 and C3).

From the market perspective, this transformation will have an important impact on the market volumes for energy sales and low-carbon technologies. According to calculations with the building stock model (BSM), the total market volume of the energy and GHG-related building market, including energy sales, amounts to € 14 billion per year in 2019. The majority of this market volume comes from energy sales, even though electricity sales for household appliances are not included. The total market volume is expected to increase in the medium term in both scenarios, but not necessarily for the same reasons. For the RS, the increase in energy sales is mainly responsible, while in the 2DS it is the increase in the sales of more efficient building technologies. The latter is triggered by the implementation of policies and programmes that support the phase out of fossil-fuel heating systems and the consequent shift to renewable energy systems such as heat pumps and solar collectors (Section C5).

In 2050 the overall market volumes are still higher than present values, but decrease in both scenarios compared with 2030. The reduction in energy demand in the building sector in both scenarios leads to a decreased market volume in energy sales, which cannot be offset by the increase in other markets. The market for the building envelope increases in both scenarios, with a substantial increase in the 2DS compared with 2019 (87%), which can be explained by a significant increase in refurbishment activities and which is reasonable to expect considering the age structure of the building stock. Particularly for the 2DS, the further development of programmes and policies to implement higher building standards and more stringent policies is also a driving factor (Section C6). On the other hand, the market volume for building technologies starts to shrink in both scenarios and is expected to be 25% lower than 2030 values for the 2DS. The reduction in new construction activities and cost reductions for heating systems (e.g., heat pumps) are some of the reasons behind this decrease (Section C7).

Regarding the split of the market in terms of material and labour costs, unlike other European countries where the split of the market is more or less even, in Poland the majority of the market volume (75%) comes from material and technology sales, and the rest comes from labour costs that include installation, engineering, and technical planning (Section C5).

Stakeholders' perspectives on energy efficiency and low-carbon technologies

The BMB survey conducted in Poland capture some interesting findings reflected in Chapter B. The supply side in Poland, particularly enablers, suppliers, and demand-side actors, consider the heating systems to be the approach with the greatest potential to contribute to climate-protection goals in Poland, both for new construction and for retrofit projects. The ventilation system was also selected as a promising approach in both types of projects (Section B6). However, the large-scale deployment of heating systems such as heat pumps, district heating, and wood-based heating systems often faces barriers related to economic aspects, such as low energy prices, lack of subsidies, and lack of affordable products. The lack of trust or awareness in comfort improvement and the lack of a comprehensive regulatory framework were also selected as perceived barriers. On the other hand, the main drivers identified to have the greatest potential to scale these technologies were technical and economic factors (Sections B7 and B8).

The most-implemented technologies in retrofit projects vary a bit depending on the depth of the retrofit and the building typology. The types of measures implemented in (partial) retrofit projects do not vary substantially across building typologies, and the upgrade of walls and roofs is the most popular measure for both SDBs and MDBs. In comprehensive retrofit projects, however, they do vary a bit more, with SDBs undergoing more actions than MDBs. In such projects, the most often-implemented measures in SDBs are related to the walls, followed by the heating systems, while in MDBs they are related to windows followed by walls. However, the single most popular measure for SDBs is the installation of a new heating system, while in MDBs it is the upgrade of the outer wall (Section B4).

Regarding the decision process behind the selection of the technologies, the BMB survey showed that demand-side actors (i.e. property owners) are one of the stakeholder groups having the greatest influence on the decision regarding the technology selection for all types of retrofit projects. For (partial) retrofit projects the demand-side actors share the power with public authorities in SDBs, while in MDBs the power is shared with the architects and the engineers. In terms of communication, the groups with the highest numbers and frequencies of connections for SDBs are the demand-side actors, the technology and material providers, and the installers; for MDB, demand-side actors are also the ones with the highest level of interactions, followed by engineers. In comprehensive retrofit projects, demand-side actors are again among the most relevant groups for both typologies in terms of power and communication. In MDBs, the architects share the power in the decisions and follow closely in terms of communication. Although not with the same level of power and communication in the process, there are many other stakeholders involved, such as banks (or other financial service companies), investment or development agencies, public authorities, etc. (Section B5).

Conclusion and outlook

The Polish residential stock is far from being considered energy efficient. High initial investment and poor availability of technologies, among other economic, technical, and social aspects, are some of the barriers that need to be overcome in order to transform the building stock in the coming years (Section B6). The fast building techniques used in MDBs during the Soviet era and the large share of coal in its energy mix make the Polish stock particularly heavy in terms of CO_2 emissions. Also, the projected increase in floor area despite the projected shrinking population increases the challenge of reducing the total GHG emissions. Moreover, the rehabilitation programmes have not been largely applied, and the retrofit measures have often only targeted single elements instead of comprehensive retrofits, thus leading to only marginal improvements in the efficiency of the buildings (Sections C1 and C3).

This report provides evidence for improvement potential, placing the residential stock as one of the key sectors to help Poland reach its climate goals from both the demand and the supply side. The model calculations foresee substantial decreases in terms of energy demand and emissions under the current and decided policies (RS), but in order to meet the climate commitments, more stringent instruments and enforcement are needed (2DS). While in both scenarios the renovation rate is fairly similar, the depth is considerably higher in the most ambitious scenario, coming mainly from higher standards for renovation that entail the use of renewable energy sources. This, together with higher standards for new construction, results in an extra 25% reduction in the energy demand and a 31% extra reduction in GHG emissions in 2050 (Sections C3 and C4).

This transformation demands a building sector that is prepared to provide the necessary expertise and technologies to deliver a more energy-efficient and low-emission building sector that can also ensure the comfort and health of its inhabitants.

From the market perspective, this transformation will have an important impact on the market volumes for energy sales and low-carbon technologies. The model predicts important growth in the building technology market up to 2030, especially for renewable heating systems such as heat pumps, which is supported by the views of stakeholders, who place it as the technology group with the greatest potential to reach climate-goals in Poland. In turn, the related reduction in the demand for fossil fuels suggests that energy and technology providers should be prepared to diversify their activities and to carefully manage their infrastructure assets (Sections C7, C8 and B7).

2DS:	2-Degrees Scenario
BGK:	Bank Gospodarstwa Krajowego
BSM:	Building Stock Model
CCKP:	The Climate Change Knowledge Portal, World Bank
CSO:	Central Statistical Office
DH:	District Heating
ECB:	European Central Bank
EMF:	European Mortgage Federation
EPBD:	Energy Performance Building Directive
EPC:	Energy Performance Certificate
EU(28):	European Union
EUROSTAT:	European Statistical Office
GDP:	Gross Domestic Product
GHG:	Greenhouse Gas(es)
GUS:	Główny Urząd Statystyczny
HDD:	Heating Degree Days
INDC:	Intended Nationally Defined Contribution(s)
KWh:	Kilo Watt Hours
Ktoe:	Kilo tonnes of oil equivalent
LCA:	Life Cycle Assessment
MDBs:	Multi-Dwelling Buildings, also called Multi-Family Houses
MEPS:	Minimum Energy Performance Standard
NEEAP:	National Energy Efficiency Action Plan
NFOSiGW:	National Fund for Environmental Protection and Water Management
nZEB:	nearly Zero Energy Building(s)
OECD:	The Organisation for Economic Co-operation and Development
R&D:	Research & Development
RES:	Renewable Energy Sources
RS:	Reference Scenario
SDBs:	Single-Dwelling Buildings, also called Single-Family Houses
SME:	Small and Medium-sized Enterprises
t CO_2-eq.:	Tonne CO_2 equivalent
TJ:	Terajoule
TWh:	Tera watt hour
UN:	United Nations

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A

Market overview

A

Aim

Chapter A provides an overview of the country's building market, its background conditions, and current trends and market mechanisms behind the demand for low-carbon building products and solutions.

The chapter begins by providing a brief introduction to the country's economy and society showcasing trends in GDP, population, and incomes. Next, a characterization of the building stock is presented alongside climate factors that will likely have an impact on the future of the building stock. Energy and emission profiles of the country are also summarized, including trends, grid mixes, emission factors, and the implications of climate goals. This is followed by an overview of the current framework of policy incentives in the building sector, including thermal standards and financial support measures. Trends in employment, building costs, and investments are also described. The final sections delve into issues such as demand, supply, and affordability of housing.

This chapter is based on an extensive study covering a wide range of literature and data sources. These include European statistical data, the respective countries' own statistical offices, national and international public reports, scientific publications, and market information such as prices and sales volumes. The main contribution is, therefore, the collection and summarization of this information, which is currently only available in a fragmented manner. All the data sources are clearly indicated to allow the reader to access more detailed information as needed. The complete list of sources can be found in the annex of the report.

A1

Introduction
Poland's economy and society

USEFUL READING:

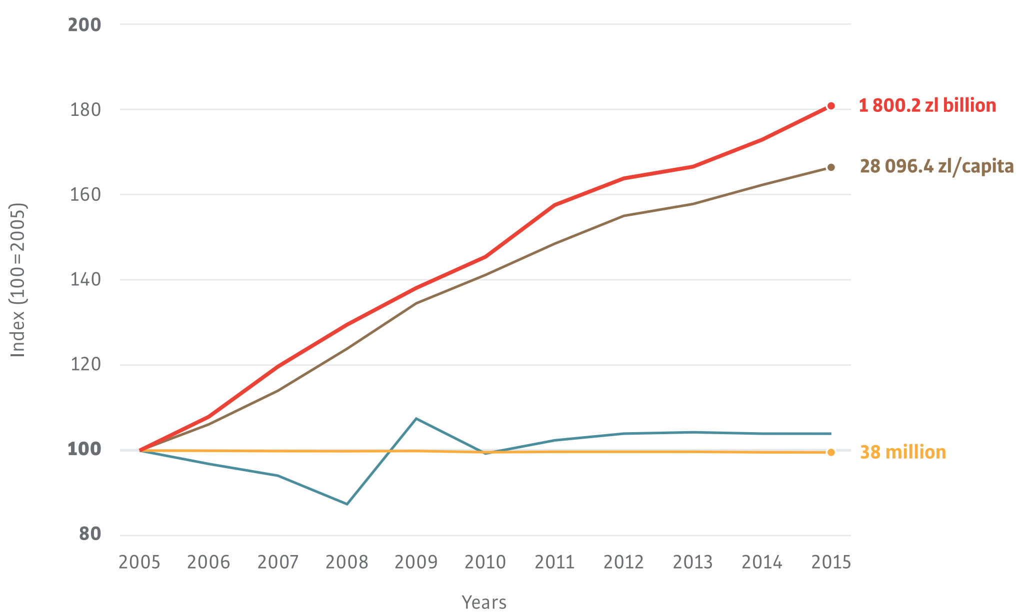
McKinsey & Company 2015. Poland 2025: Europe's new growth engine.
www.mckinsey.com

With a population of 38 million (2015), Poland is the 6th largest of the EU28 member states with 7.4% of EU28's population. The nominal GDP of the country is zł 1800.2 billion (€ 430 billion in 2015), and it grew at an average annual growth rate of +6.2% (nominal, Figure A1.1) and +3.9% (real) from 2005 to 2015. This also makes Poland one of the fastest growing economies of the EU. Its GDP per capita increased from 25 955 zł/capita (6 450 €/capita in 2005) to 46 814 zł/capita (11 315 €/capita in 2015), while the disposable income per capita grew at an average annual growth rate of +5.3% in the same period[1 2]. Between 2005 and 2015 the population of Poland remained relatively stable[3].

Figure A1.1
Trends in Poland's GDP, disposable income, and population.

Source: EUROSTAT, GUS

While the population remained constant, the GDP as well as disposable incomes increased rapidly.



NOTE

GDP index depicted in the graph is in current złoty. The Polish zloty is the official currency of Poland. Currency exchange in 2015: 1 Euro = 4.18 Zloty.

Since Poland's adoption of a market economy in 1989, the GDP of the country has more than doubled. Going by the current state of commentary on the economic growth of the country, the sentiments are upbeat. Investments are expected to pick up underpinned by the disbursement of EU structural funds, while the growth in wages will spur domestic demand[4]. The services sector contributed 63.4% of the gross value added in 2015, followed by industry & manufacturing and agriculture (2.4%)[5]. SMEs play a vital role in the Polish economy with a 69% share in employment and 52.3% share in the value added, and 99.8% of the enterprises are SMEs in conformation with the EU28 average[6]. Poland spends 1% of its GDP on R&D (2015), which is half of the EU28 average of 2.03%[7]. In the European Innovation Scoreboard 2018, Poland has been grouped in the "Moderate Innovator" category, with a rank of 25 and innovation performance well below the EU average[8].

Poland was ranked 24th in the Global Cleantech Innovation Index 2017[9], which was a remarkable jump from the 37th rank it held in the year 2014. The rise in rank is primarily attributable to good performance in cleantech-specific drivers along with higher public sector expenditures in cleantech R&D and supportive governmental policies. Poland's patent-filing scores also conform to the global averages. The scope for improvement lies in Poland's below-average renewable energy consumption and low late-stage investments in cleantech companies. Some 1.4% of the total private equity investments (or € 10.1 million or zł 44 million) in the year 2016 were made in Polish energy & environment companies[10].

The monthly consumption expenditure per household grew by +32.4% from 2005 to 2015, while that spent on housing and energy grew by +28.5% in the same period. This represents an annual average increase of +2.9% and +2.6%, respectively (Figure A1.2). As a proportion of the total consumption, the monthly housing and energy expenditure marginally decreased from 22.1% (2005) to 21.5% (2015). On an aggregate national level, the total household consumption expenditure grew by 69.3% (2005–15) and that on housing and energy grew by 64.3.9% (2005–15)[11].

The total household expenditure and expenditures on housing and energy have moved in parallel. In 2015, 49.8% of Polish households were 1 and 2 persons strong.

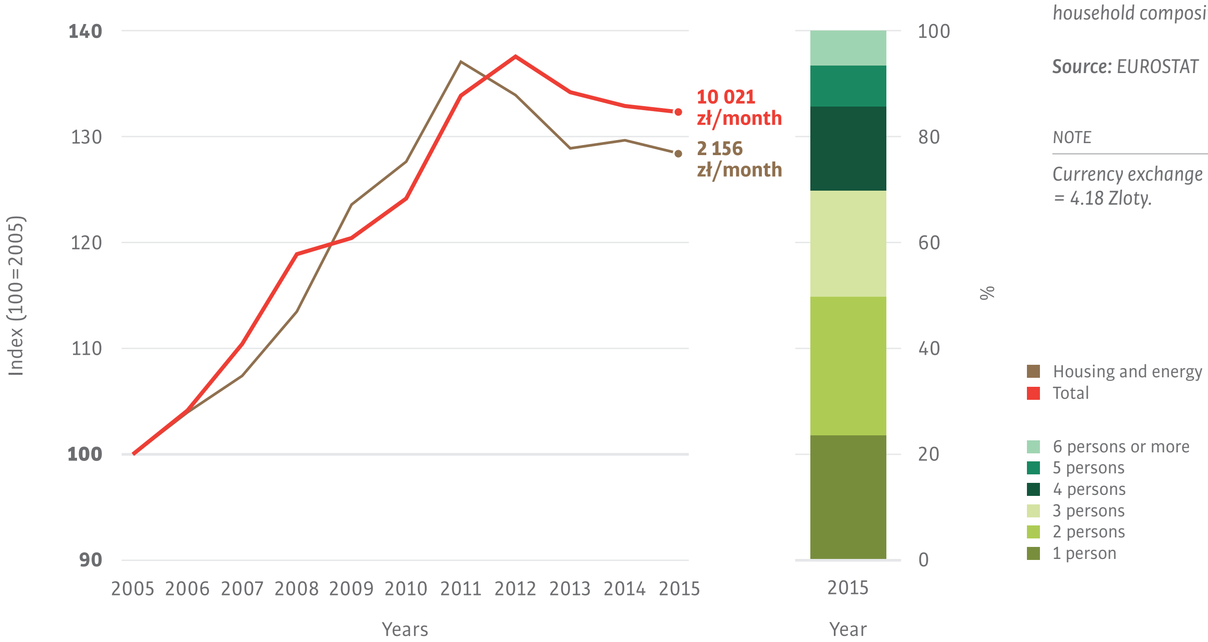


Figure A1.2
Trends in Polish household expenditure and status of household composition.

Source: *EUROSTAT*

NOTE

Currency exchange in 2015: 1 Euro = 4.18 Zloty.

From 2005 to 2015, the proportion of 1-person households marginally decreased from 24.8% to 23.9%. At the same time, 2-person households increased from 23.2% to 25.9%. This brings the total of 1 and 2-person households in Poland to the 50% mark (Figure A1.2). Overall the composition of households from 2005 to 2015 did not reveal a firm trend in favour of a particular household type. Given that the household composition will remain constant, the future housing needs of the country will be largely shaped by population trends, which suggest a gradual negative trend.

A2

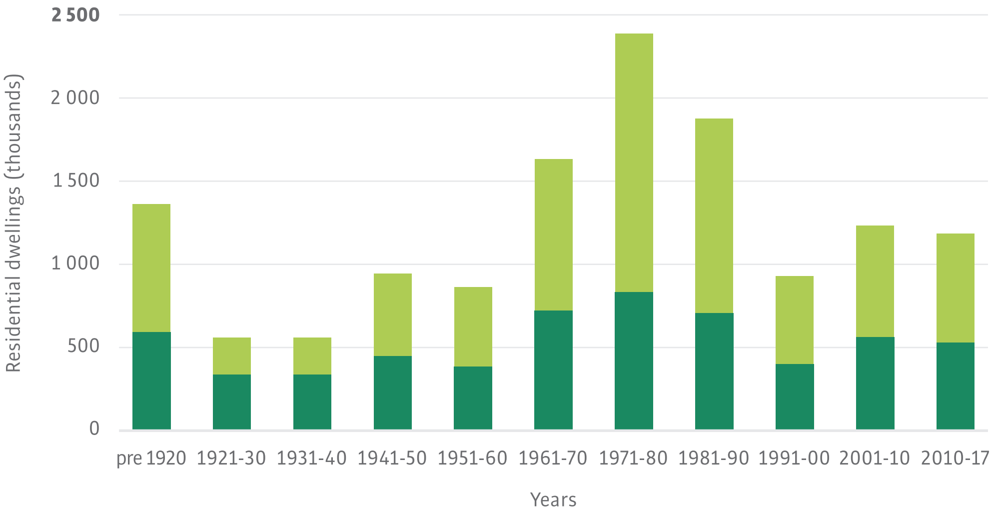
Building stock
Building characteristics and influencing climate factors

The total number of residential dwellings in Poland exceeds 14.4 million, and around 58% of this residential stock was built before the 1980s (Figure A2.1). In the 1990s there was a slight slump in residential construction due to the changing nature of legislation and the flow of capital to securities. However, the emergence of mortgage-based lending made real estate an attractive investment avenue, and the general demand for housing has led to an influx of funding into the real estate market leading to an increase in the pace of construction[12]. The average living area per capita in Poland has increased from 23.2 m²/capita in 2005 to 27 m²/capita in 2015. This change was primarily led by an increase in the useful floor area of buildings[13 14].

Figure A2.1
Residential building space trends.

Source: Główny Urząd Statystyczny (GUS), CUES

The proportion of newly built multi-family dwellings has gradually increased over the past few decades.

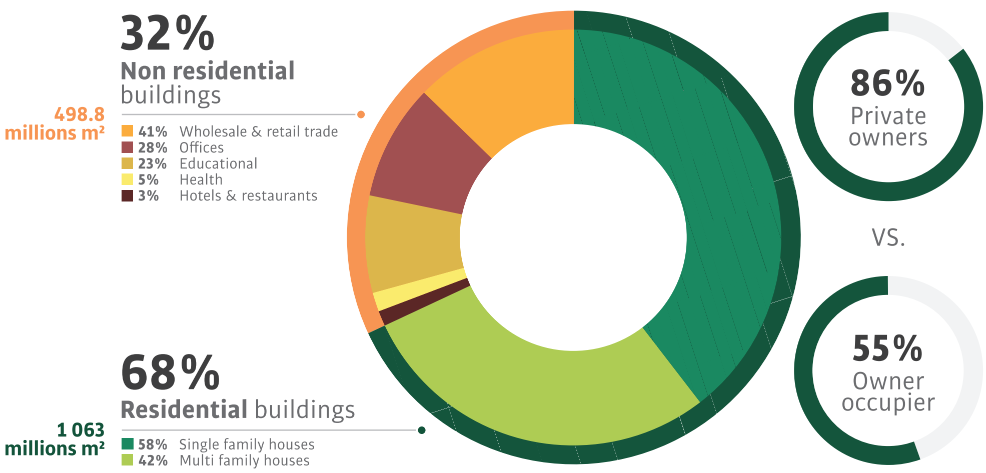


A total of 68% of the total floor area (or 1063 million m²) in Poland belongs to the residential sector. The remaining 32% or 499 million m² is held by the non-residential sector. Of the residential building floor area, single-dwelling buildings (SDBs) account for 58% of the total residential building stock in the country[14 15] (Figure A2.2).

Figure A2.2
Polish building stock.

Source: GUS, RentalCal, EU Building Observatory

The Polish residential building stock is characterised by high private ownership and owner-occupancy.



Some 85.5% of the residential dwellings in Poland are privately owned, while 55.3% are occupied by the owners themselves. A total of 25.2% of the residential dwellings are occupied by private tenants (including those rented to family members), 16.1% belong to housing cooperatives, and the remaining 3.4% belong to others, including social houses[14 16] (Figure A2.2).

The impact of climate change on the Polish building stock requires a careful study. Most of the buildings without proper thermal insulation were built before 1989, when the rules regarding insulation and their enforcement were less rigorous. Housing construction intensified between 1946 and 1990, and in the mid-1960s there was brisk development in large-panel technologies to build apartment blocks. Many of these buildings also require renovation to be prepared for expected increases in annual average mean temperatures, as has already been observed with a 24.8% reduction in annual heating degree days (HDDs) since 1980 (Figure A2.3)[17 18].

MARKET EXPERT COMMENT

'In 2017-2019 the Ministry of the Environment in cooperation with project Partners and contractors developed adaptation plans to the observed and prognosed climate changes for 44 polish largest cities. More information available under following link: http://44mpa.pl/?lang=en'
*- **Szymon Firląg**, WUT.*

Substantially reduced heating demand due to increasingly warmer mean temperatures.

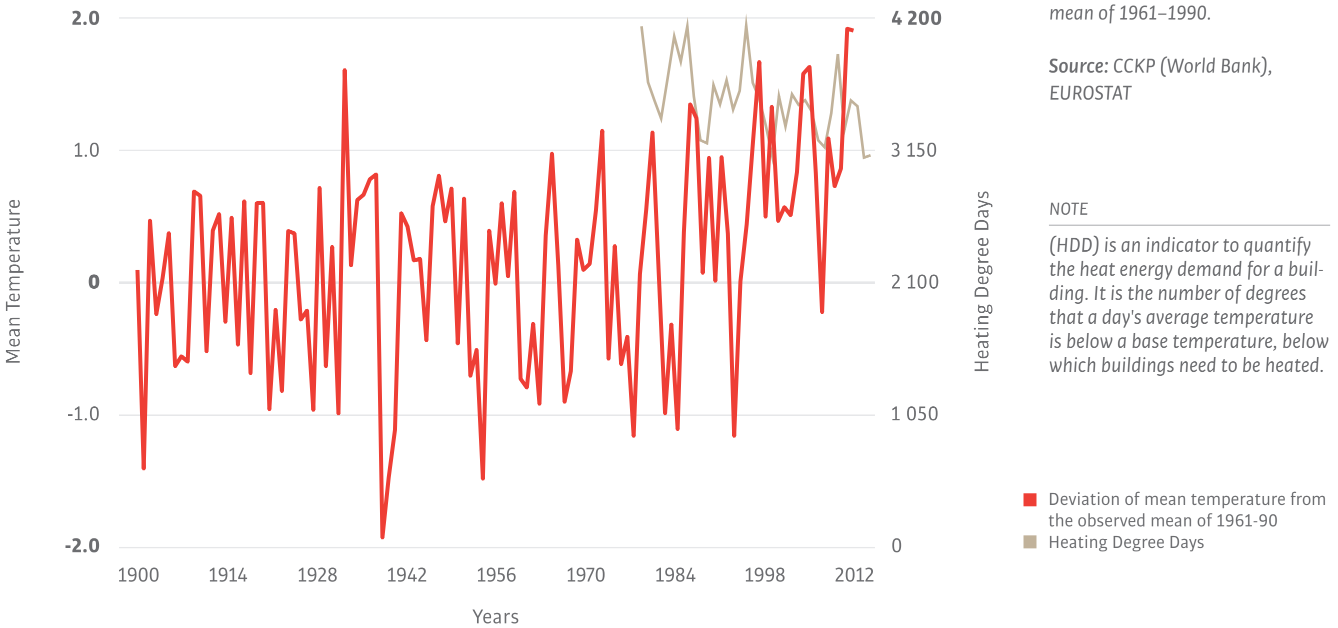


Figure A2.3
Trends in annual mean temperature divergence from the mean of 1961–1990.

Source: CCKP (World Bank), EUROSTAT

NOTE

(HDD) is an indicator to quantify the heat energy demand for a building. It is the number of degrees that a day's average temperature is below a base temperature, below which buildings need to be heated.

Highly variable weather, regional weather disparities, and significant seasonal fluctuations are characteristics of the Polish climate. The long-term evolution of climate, though, is on an upward trajectory when it comes to the temperature. Added to this, more frequent appearances of extreme weather events such as floods and droughts, among others, have been observed. These observations and future trends effectively communicate the need for building-market stakeholders to take appropriate action. Market participants such as policy makers, owners, material or technology suppliers, and investors need to acknowledge the risks that climate change poses and thus proactively work towards developing a resilient building stock.

USEFUL READING:

BPIE 2014. Renovation strategies of selected EU countries. Buildings Performance Institute Europe, Brussels.
www.bpie.eu

BPIE 2011. Europe's buildings under the microscope. Buildings Performance Institute Europe, Brussels.
www.bpie.eu

A3

Energy, emissions, and climate goals
Introduction to the energy mix, emission profiles, and the implications of climate goals

NOTE

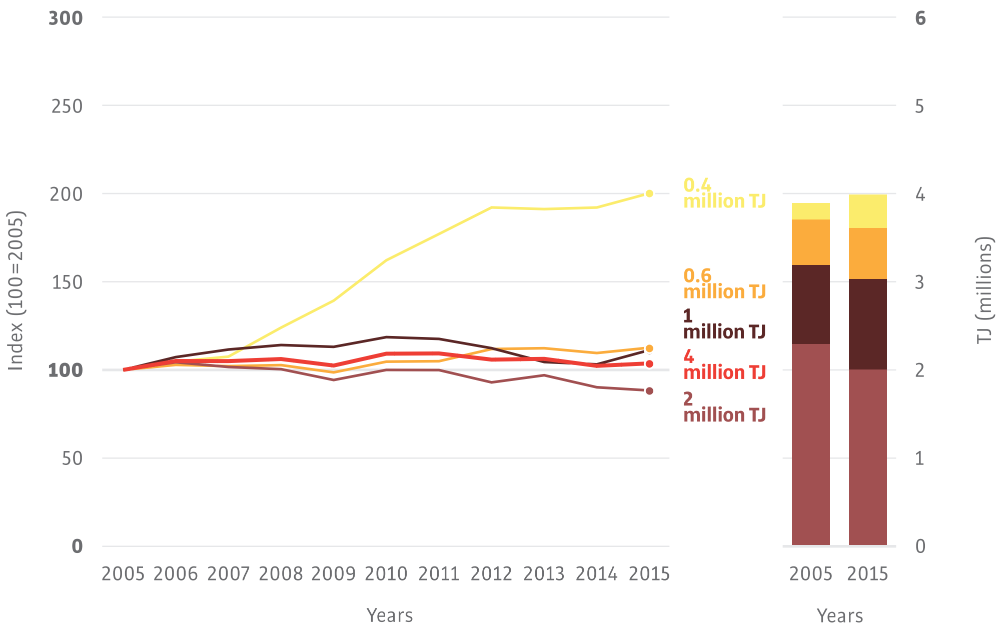
Gross inland consumption, is the total energy demand of a country or region. It represents the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration.

Poland is heavily dependent on fossil fuels to meet its energy needs, and the gross inland energy consumption of the country is dominated by solid fuels and petroleum products. In 2015, solid fuels made up 50.5% of the gross inland energy consumption, followed by petroleum products (25.2%) and gas (14.4%). The gross inland energy consumption increased at an average annual rate of +0.4% from 2005 to 2015[19]. In the same period the share of renewable energy in gross final energy consumption rose from 6.9% (2005) to 11.7% (2015)[20] (Figure A3.1).

Figure A3.1
Gross inland energy consumption trends and categorization.

Source: EUROSTAT

In the decade since 2005, Poland's total gross inland energy consumption increased by +3.7%.



In 2015, Poland consumed 127.8 TWh of electrical energy, which was higher than the 105 TWh it consumed in 2005. Coal's share in Polish electricity generation was a humongous 81% in 2015[21]. The resulting emission factor for the electricity consumed was 1.191 kg CO_2-eq/kWh, while the emission with an LCA approach was 1.185 kg CO_2-eq/kWh . The average electricity price (including taxes) for medium-size households in Poland was around 0.1444 € (0.6 zł)/kWh_{electr} and that for medium-size industry was 0.0833 € (0.35 zł)/kWh_{electr}[23], and the residential share was 21.8% of the entire electricity consumption (2015)[24].

The overall residential energy consumption was around 792 025 TJ in 2015, or 30.3% of the final energy consumption[19]. The household energy consumption was dominated by solid fuels (33% in 2015), followed by derived heat (20.6%), gas (16.8%), and electricity (12.9%)[25]. Space heating was the dominant usage of residential energy (64.7%), followed by water heating (17%) and lighting & appliances (10%). Solid fuels, which have a dominant use in Poland, are also a major energy source for space heating (45.5%), closely followed by derived heat (20.8%). Derived heat is the major energy source in water heating (42.3%)[25]. The share of renewable energy in heating & cooling in Poland increased to 14.5% (2015), up from 10.2% in 2005[26]. The resulting emission factors range between 0.20 to 0.40 kg CO_2-eq/kWh_{heat} depending on the heat source, while the prices range between 0.01 € (0.04 zł) to 0.07 € (0.29 zł)/kWh_{heat}[27 28].

The energy consumption by households and commercial institutions can be attributed to building-related emissions, which stood at 44.5 Mt CO_2eq in 2015 (over 11.5% of the total emissions). Since 1990, building sector emissions fell by –7%[29] (Figure A3.2).

Since 1990, total direct CO_2 emissions in Poland decreased by 17.6%, while building-sector emissions decreased by 7%.

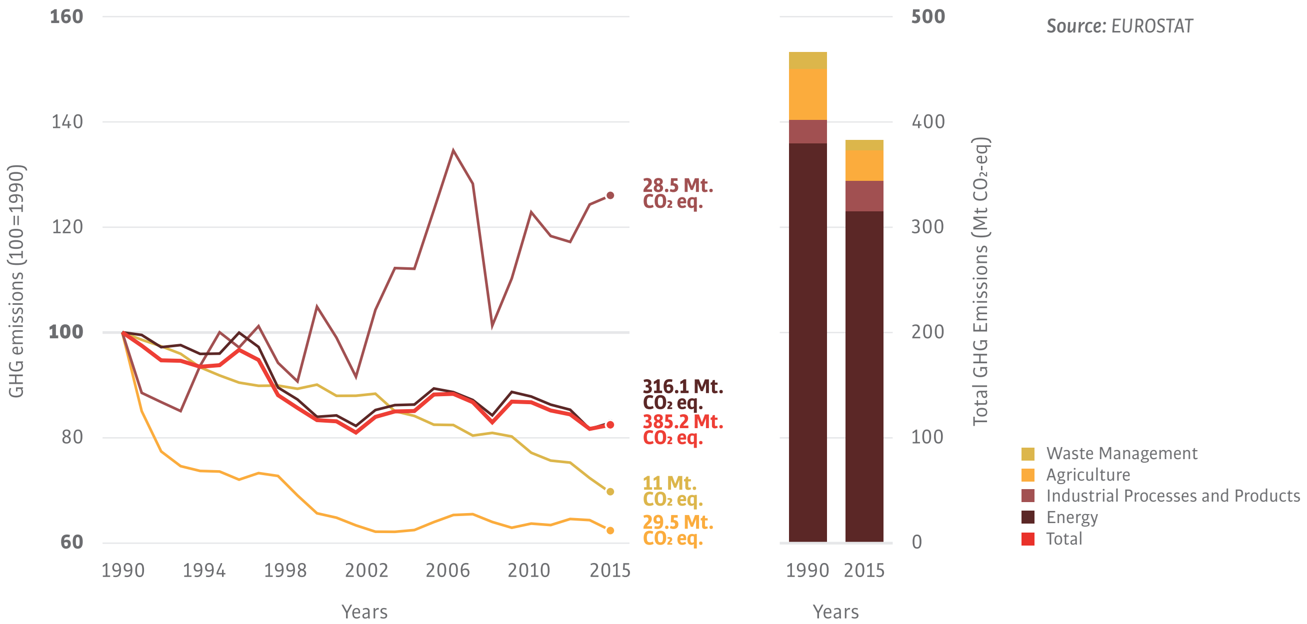


Figure A3.2
The GHG emission trends and categorization.

Source: EUROSTAT

From 1995, the residential building space to be heated increased by 44% (standing at 1041.8 million m² in 2016) and the population remained constant (at 38 million). Despite this, the overall emissions declined due to several energy efficiency measures that were adopted.

Under the Kyoto Protocol, the emissions reduction target for Poland for the period 2008–2012 was –6% compared to 1988 for CO_2, CH_4, and N_2O and compared to 1995 for F-gases. Poland surpassed these targets through domestic efforts alone. By 2020, Poland has an emissions growth target of 14% compared to 2005, according to the Effort Sharing Decision (ESD). The 'Polish Climate Policy Strategies to reduce greenhouse gas emissions in Poland until 2020' was published in 2003 and had three timeframes of goals and measures: 2003–2006, 2007–2012, and 2013–2020[30]. In 2013, Poland published its 'National Strategy for Adaptation to Climate Change' (NAS 2020) that lays down the direction and objectives of the adaptation actions required to be undertaken by 2020 in sectors that are vulnerable to climate change. Poland has the same commitments as that of the EU (mentioned in its directives) to reduce emissions (compared with 1990) by at least 40% by 2030 and by at least 80%–95% by 2050. This was also laid out in the EU's INDC to the UN[31] [32] [33].

NOTE

The emissions under the 'Energy' category are further sub-categorised. Of these sub-categories, 'Household' and 'Commercial and Institutional sector' are used to refer to building related emissions.

USEFUL READING:

INDC of EU and Member States.
www4.unfccc.int

A4

Policy framework
Building sector norms and a legal framework

MARKET EXPERT COMMENT

'Currently a Ministry of Climate is finalising the Energy Policy of Poland until 2040. A draft of the document was published by the Ministry of Energy in 2018 and passed for public consultation. The strategy presented in this document was widely criticized by experts as a political move adopted in a favour of state coal- energy corporations, instead of promoting the distributed energy model. It neglected the requirements of climate policy, departed from the global energy transformation model, and turned into coal/nuclear power marginalizing the importance of RES. In the recent version of the document, nuclear power is still supposed to partially replace coal after 2030 through construction of 6 nuclear power plants with nominal power of 6-9 GW.'
- Anna Komerska, NAPE/WUT.

Poland believes fossil fuels (such as coal) to be an important part of its energy system and an energy security issue. The country also aligns itself with EU climate and energy policy and objectives. The 2009 'Polish Energy Policy until 2030' (Polityka Energetyczna Polski do 2030 r.) is a strategic document that outlines the policy priorities of the country. The fourth National Energy Efficiency Action Plan (NEEAP) of 2017 defines the energy efficiency target for 2020 as reducing primary energy consumption from 2010 to 2020 by 13.6 Mtoe (158.2 TWh). This requires decreasing the energy intensity of the economy by investments in enterprises, reducing electricity and district heating losses, and increasing efficiency in the end-use sectors[33 34].

In the building sector, The Act on Support for Thermal Modernisation Projects (1998) aims at reducing the energy needs of buildings for space heating and hot water. For encouraging energy-efficiency, there is the energy efficiency obligation scheme, requires obligated parties (such as enterprises selling energy to end users) to purchase and redeem 'white certificates'. The Energy Regulatory Office (ERO) selects projects, through tendering, which can achieve energy savings of at least 10 Toe per year, for issuing certificates. The enterprises which win the

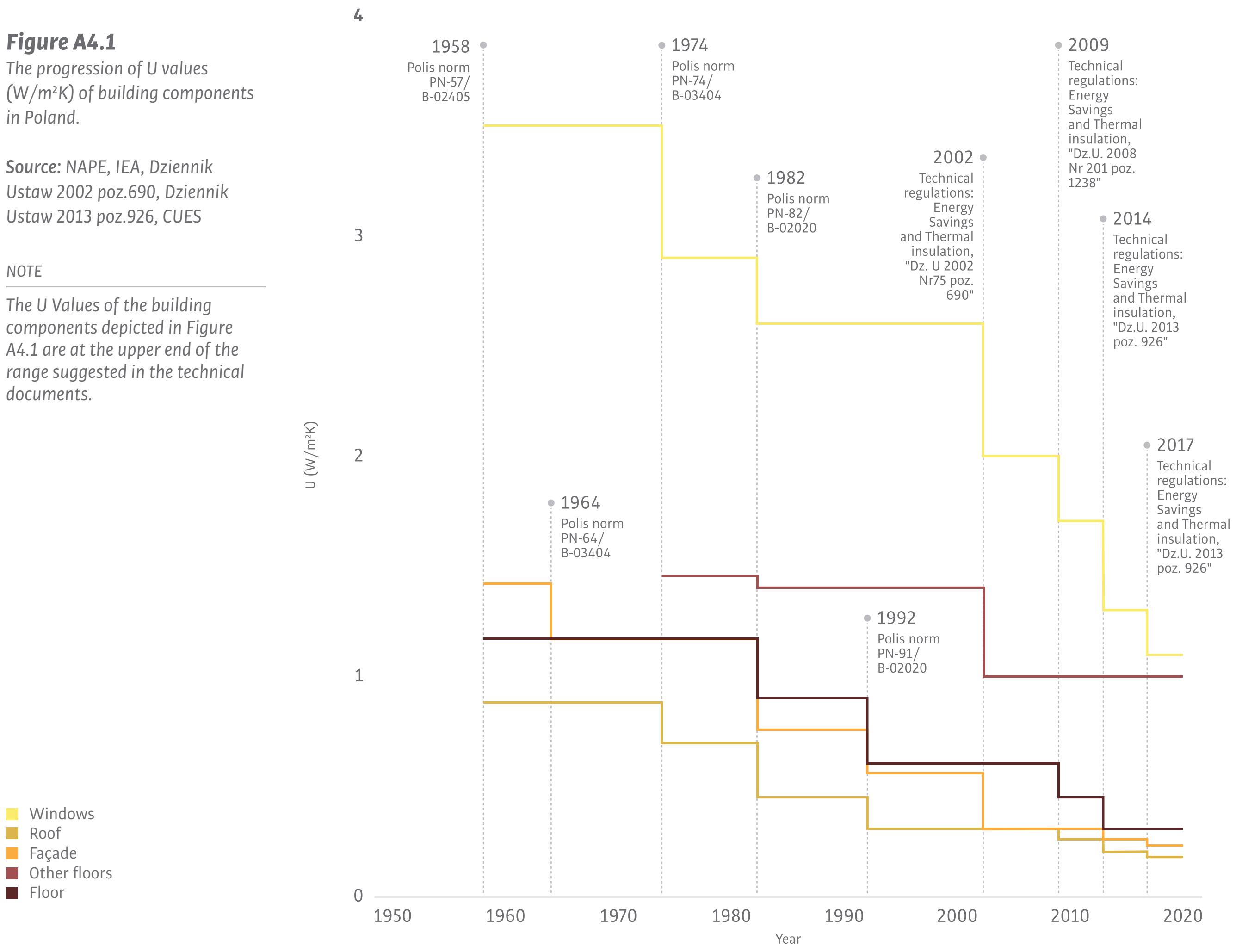
The efficiency requirements for building components have become increasingly stringent.

Figure A4.1
The progression of U values (W/m²K) of building components in Poland.

Source: NAPE, IEA, Dziennik Ustaw 2002 poz.690, Dziennik Ustaw 2013 poz.926, CUES

NOTE

The U Values of the building components depicted in Figure A4.1 are at the upper end of the range suggested in the technical documents.



certificates are obliged to complete the said project and can redeem the certificates with ERO. A revised building renovation strategy entitled ‘Supporting Building Retrofit Investments’ has also been presented in the NEEAP 2017[38].

Building Standards

The Energy Performance of Buildings Directive (EPBD) aims by 2020 to have all new buildings follow the nearly zero-energy standards and that all public buildings follow these standards by 2018. Poland has been making building-related energy savings legislations and technical standards increasingly stringent. A draft on the energy performance of buildings was accepted by the Council of Ministers on 16th April 2013 and put into force as legislation in 2014, and this requires new buildings, retrofitted buildings, and buildings for sale to have mandatory energy performance certificates[38]. Building energy standards and all building regulations are specified in a legal act called *Rozporządzenie Ministra Infrastruktury z dnia ozporządzenie Ministra Infrastruktury z dnia 12 kwietnia 2002 r. w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie* (Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions that should be met by buildings and their locations). It also introduced the maximum values of energy performance or primary energy for heating, cooling, and lighting systems[35] (Figure A4.1).

Financial Support Measures

There are several financial incentives to improve building energy efficiency. As early as 1989, the National Fund for Environmental Protection and Water Management (NFOSiGW) was established, which still provides funding support to environmental programmes. The Ekofundusz (1992–2010) programme operated under the ‘climate protection’ framework and co-financed projects for modernisation of the heat supply systems. The Thermo-modernisation and Repairs Fund supported projects with up to a 20% premium of the loan paid by the state[36]. In the years 1999–2015, approximately 38,000 thermo-modernisation initiatives were awarded, which by 2015 produced annual savings of approximately zł 900 million in energy costs[37]. Until 2011 around 98% of all investments made for improvement of building energy performance were made with the support of this programme. Multi-dwelling buildings (MDBs) accounted for 94% of all the applications, while SDBs accounted for only about 2% of all applications. Despite the large scale of this programme, aid went to only 7% of all MDBs and 0.01% of all SDBs.

An ‘Energy Efficiency in Houses’ or ‘Kawka’ programme that started in 2013 grants subsidies or loans to households for improving the energy efficiency of their houses. With an overall budget of zł 300 million (approx. € 71.7 million), the NFOSiGW-supported programme could help renovate 12 000 apartments. A similar programme focused on public buildings (LEMUR- Energy Efficiency in Public Buildings) is operational until 2020 and has €70 million earmarked for its operations[38]. Preferential loans for improving energy efficiency of MDBs can also be obtained through The Operational Programme Infrastructure and Environment (OPI&E) 2014–2020. With a budget of € 225.6 million, it is expected to help renovate 56 000 dwellings[30]. The recently started Clear Air Programme (Program Czyste Powietrze)[39] will financially support SDBs with co-financing from 30% to 90% of the project amounting to zł 10 billion per year from 2018 to 2029. The programme includes thermo-modernisation and the replacement of old solid-fuel boilers in the case of existing buildings.

NOTE

The policy support for thermal modernisation projects was first introduced by the act:
Ustawa z dnia 18 grudnia 1998 r. o wspieraniu przedsięwzięć termo-modernizacyjnych
Or the Act on supporting thermo-modernization investments of the 18th of December 1998

Later it was replaced by another act:
Ustawa z dnia 21 listopada 2008 r. o wspieraniu termomodernizacji i remontów
Or Act on the Promotion of Thermomodernisation and Renovation of 21 November 2008

MARKET EXPERT COMMENT

‘The Act on Support for Thermal Modernisation Projects also aimed at promotion of renewable energy sources by substitution of non-renewable. Although it was rarely applied. The solar heat collectors was considered in energy audits.’
- Dariusz Heim, Lodz University of Technology.

NOTE

The last update on the draft on the energy performance of buildings was in 2017:
www.prawo.sejm.gov.pl

The act related to Building energy standards and regulations is abbreviated as WT 2014, WT2017, WT2021, in Poland. This act is updated every few years with the large update regarding building energy was introduced on 5th July 2013 and it describes the minimal requirements that must be met from 1.01.2014, from 1.01.2017 and from od 31.12.20

For SDBs, the main source of funds was own financial resources, which is the reason for this program to be structured.

USEFUL READING:

The Buildings Performance Institute Europe (BPIE), Buildings modernisation strategy: Roadmap 2050 Summary in English available under following link:
www.bpie.eu

A5

Investment and employment *Construction costs and jobs in the building sector*

The construction sector of Poland contributes 8% (2015) to the country's GDP[40]. In 2015, some zł 149.2 billion (€ 35.7 billion) was spent on building construction-related expenditures, including both residential and non-residential construction. The total investments in building construction increased at an average annual rate of 8.1% since 2005. The construction sector also makes a significant contribution to the employment in the country. In 2005, for every million zł that was thus invested around 5.5 jobs were created that could be directly linked to building construction, and this fell to 3.5 jobs in 2015[41 42] (Figure A5.1).

Figure A5.1

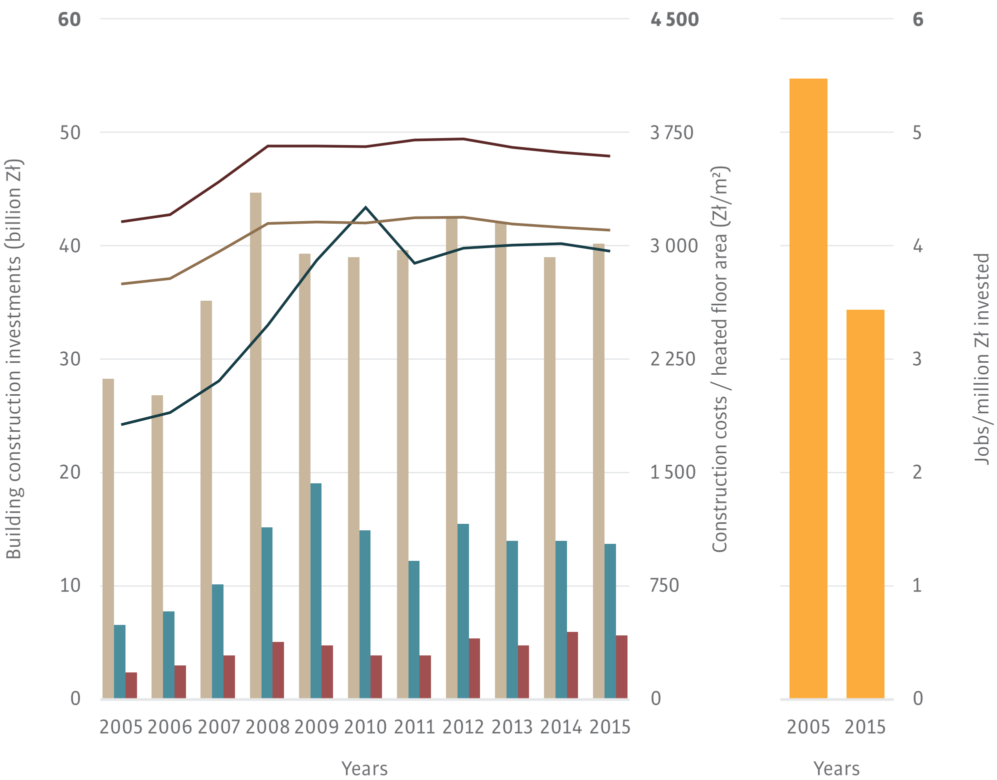
Total construction investments by type of development (billion zł), along with jobs attributed to construction-related investment.

Source: *GUS, EUROSTAT, NAPE, CUES*

NOTE

Investments numbers are in current zł. Currency exchange in 2015: 1 Euro = 4.18 Zloty.

The construction jobs per million zł invested decreased substantially in the 10 years from 2005 to 2015.



New SDBs investments
New MDBs investments
New office investments
SDBs construction costs/heated floor area
MDBs construction costs/heated floor area
Office construction costs/heated floor area
Construction of buildings

The flow of investments in the building sector in Poland is a result of various factors. Due to the opening up of the economy and the increase in the number of households, there is a greater demand for more floor space for both residential and commercial use. From 2005, the proportion of building investments in construction of new SDBs and MDBs has varied, and a gradual increase can be observed in the proportion of money invested in MDBs. In 2015, 74% of the construction costs for new residential buildings could be attributed to SDBs and the remaining to MDBs. Investments increased at an average annual growth rate of +10% in MDBs from 2005 to 2015. In terms of building construction costs on a per heated floor area basis, office construction costs are the highest[43 44]. To facilitate the meeting of climate and energy goals, an estimated annual expenditure of € 5 billion over a 20-year period would be required to raise the current annual renovation rate of less than 1% of the floor area to 2.5%. This also requires developing appropriate skills in the employed workforce[45].

Of the 15.8 million total employment in Poland in the year 2015, roughly 9.4% was attributed directly to the construction sector (including building construction) or sectors that relate to the construction activity. The latter include professional services such as architecture or building engineering and specialised construction activities such as retrofit. In 2015, the hourly labour cost was zł 31.4 (€ 7.5) in construction, zł 33.4 (€ 8) in real estate activities, and zł 49.7 (€ 11.9) in professional, scientific, and technical activities (which includes architecture and engineering services)[46]. The costs of labour and materials in construction are roughly split 50:50[47].

While there was a phenomenal increase in total construction investments, the total employment related to construction did not rise as much.

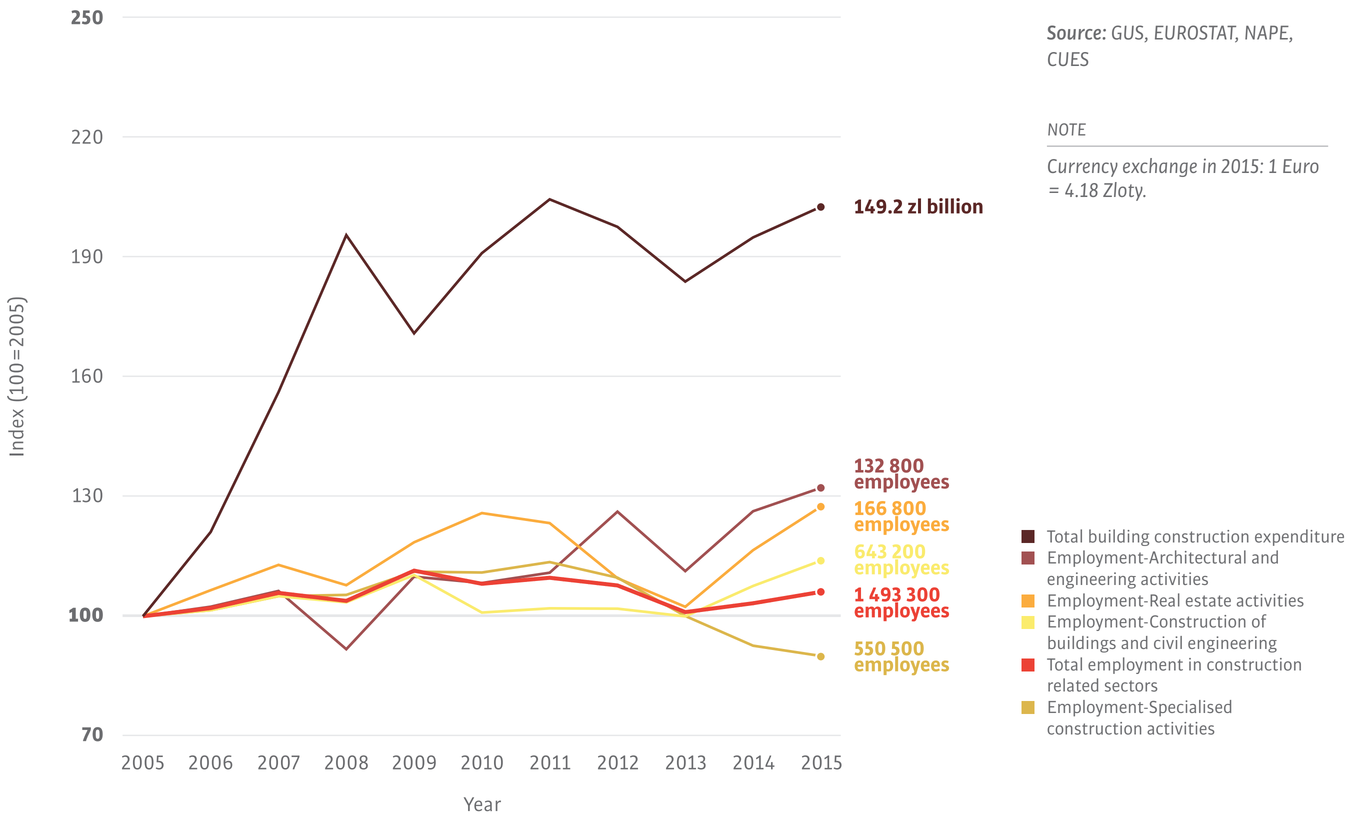


Figure A5.2
Index of employment and investment (2005 = 100).

Source: GUS, EUROSTAT, NAPE, CUES

NOTE

Currency exchange in 2015: 1 Euro = 4.18 Zloty.

In 2015, 70% of the Polish population was of a working age (15–64 years)[48]. Employment in the construction sector and ancillary sectors that depend directly or indirectly on the construction activity, such as architectural & engineering services and real estate activities, witnessed gradual growth. Since 2005, while the total construction expenditure more than doubled (+102.9%) in 2015, the total employment in construction and ancillary sectors increased by a mere 6.1%. Of this, employment in architectural & engineering activities (a 32.3% increase since 2005) witnessed the most pronounced change (Figure A5.2).

The building construction sector of Poland will strengthen, fuelled by the economic boom of the country. With the increasing importance of energy-efficient and high-performance buildings, the industry will require specialised skills and a trained workforce going ahead.

USEFUL READING:

Instytut Badań Strukturalnych IBS, 2018, The labour demand effects of residential building retrofits in Poland. Available at IBS website: *www.ibs.org.pl*

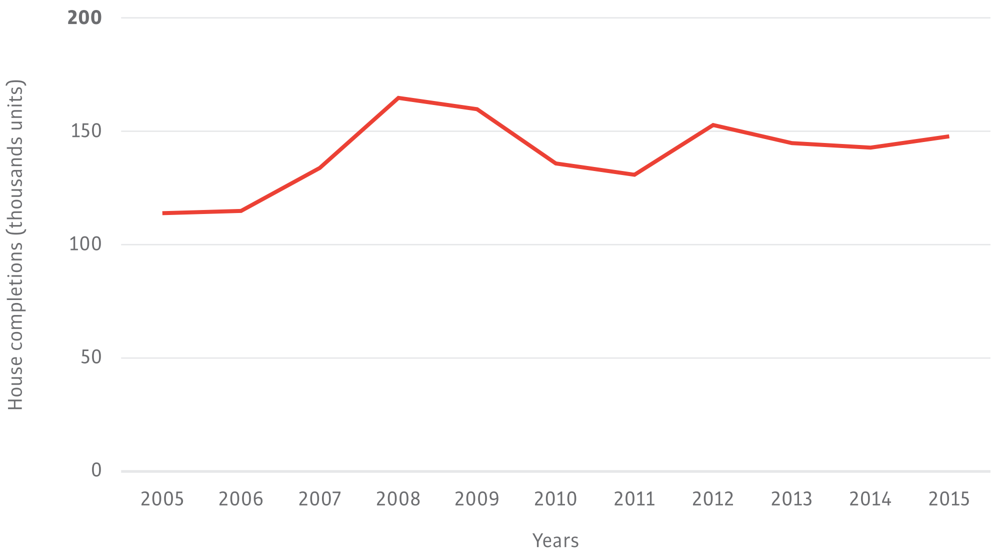
A6 Demand, supply, and affordability
Housing market conditions

According to Statistics Poland (GUS), over 150 000 housing units were delivered in 2012 (up by almost 17% compared to 2011), out of which 64 000 (42%) were constructed by developers and 81 000 (53%) by individuals (Figure A6.1). Housing cooperatives and municipalities, whose share remains marginal, delivered the remaining supply. The financial crisis in 2008 and implementation of the "Developer Act" in April 2012 resulted in a temporary slowdown in the number of new building sites in the following years. In terms of the number of new residential investments started, 2013 was the worst since the economic slowdown after the crisis recovery in 2011, but the construction of new housing units picked up again in 2014.

Figure A6.1
House completions in Poland.

Source: *European Central Bank*

The house completion levels decreased immediately after the recession and did not return to the same levels even as of 2015.



Self-builders and property developers, who are active mainly within the MDB housing sector, are the main sources of new housing supply in Poland, representing more than 90% of the primary market. Demand is driven mainly by owner-occupiers, although the number of buy-to-let investors is steadily increasing. It is estimated that buy-to-let investors represented approximately 10–13% of demand on the primary market in 2016.

The total number of residential dwellings in Poland was ca. 14.4 million. Almost 80% of the housing stock belongs to private owners[14], one of the highest owner-occupier rates in Europe. As in many Eastern European countries, owning property is still a deep-rooted custom among Poles.

About 21.4% of the dwelling stock comprises social, cooperative, and state-owned housing according to the 2011 National Census. Private investors, mainly in the largest cities, university cities, and resort towns, dominate the growing private rental sector, while an institutional rental market hardly exists.

In the last two decades, the development of the Polish residential market has been driven by the country's economy, mortgage financing development, and positive demographic trends. The economic boom of 2004–2007, triggered by the inflow of investment following Poland's

EU accession and historically low interest rates, reshaped the state of the residential market, pumping up the prices of housing and of residential land. Despite the continuing need for adequate housing, affordability became an issue. Moderation in late 2007 led to stagnation in 2008, which ultimately gave way to price decreases in 2009.

In the post-crisis period, a limited supply in the housing market was observed, especially among the most popular types of flats. In 2010, the number of transactions began to increase thanks to easier access to mortgages and the support granted to buyers by the governmental programme Rodzina na Swoim ("Family with Its Own Flat") (Figure A6.2).

While prices decreased after the recession, the number of housing transactions has increased in recent years.

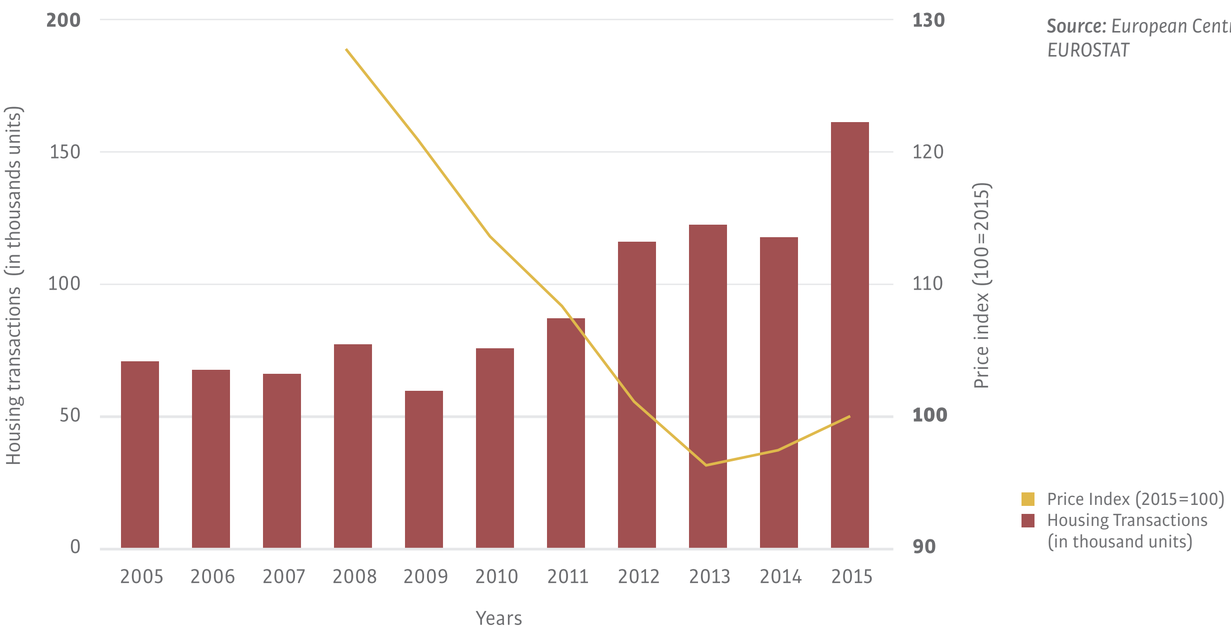


Figure A6.2
Number of transactions and housing price variations in Poland

Source: *European Central Bank, EUROSTAT*

Improvements in the economy in 2013 generated a strong demand in the real estate market, leading to rapid growth in both zloty-denominated and foreign currency-denominated housing loans. The launch of the housing subsidy programmes Mieszkanie dla Mlodych ("Apartments for the Young") and Fundusz Mieszkan na Wynajem ("Apartments to Rent Fund") in 2014 further boosted demand for housing.

Mieszkanie dla Młodych ("Flats for young") is a scheme for co-financing the mortgage for a first apartment by young couples or single individuals below the age of 35. Managed by the state-owned investment bank BGK (Bank Gospodarstwa Krajowego), the scheme co-financed 10% to 30% (depending on the number of children) of the purchase of the first apartment. The programme proved popular and was closed to new applicants in 2017 because the BGK had already earmarked 95% of the available funding. Its annual budget gradually increased from zł 600 million (€ 139 million) in 2014 to zł 746 million (€ 173 million) in 2017. A total of 21 883 mortgages for a total value of zł 3.9 billion (€ 910 million) were supported by this programme in 2015.

B

The Stakeholders' perspectives

B

Aim

The chapter “The stakeholders' perspectives” provides actors’ views on residential building projects in Poland. Based on a survey covering the whole value chain and building life cycle, this chapter captures stakeholders’ perceptions on low-carbon building concepts and solutions to support the development of business strategies and policy measures to foster the uptake of technology options. To ensure a comprehensive analysis of the building stock, this study encompasses all relevant types of building projects, ranging from light interventions such as repairs and upgrades of single elements to intense interventions such as comprehensive retrofits and new construction. Covered building typologies include both single-dwelling and multi-dwelling buildings.

Methodology

The data gathered in this chapter were obtained via an online survey. The scope and topic of the survey were based on exploratory interviews and findings from a literature review study.

Survey responses were collected in two rounds. The first round was from September to December 2018 and the second round was from June to August 2019. The survey covered stakeholders along the complete value chain of the building. To this end, a stratified sample approach was applied, thus providing a differentiated view of the market. The universe or population characterisation was developed by taking into consideration the numbers and types of enterprises present in the construction sector according to the statistical classification of economic activities in the European Community (NACE).

For the results presented in this chapter, the number of responses was normalised to give an equal weight to the stakeholder group addressed (i.e. architects, engineers, construction companies, installers, etc.), as indicated to the side of each graph where applicable. The results were used to quantify findings when a statistically relevant quota (number of responses) was available. To round out and contextualise the results, they were complemented with market-expert comments or additional sources of information such as reports and databases. These can be found in the side bar of each page.

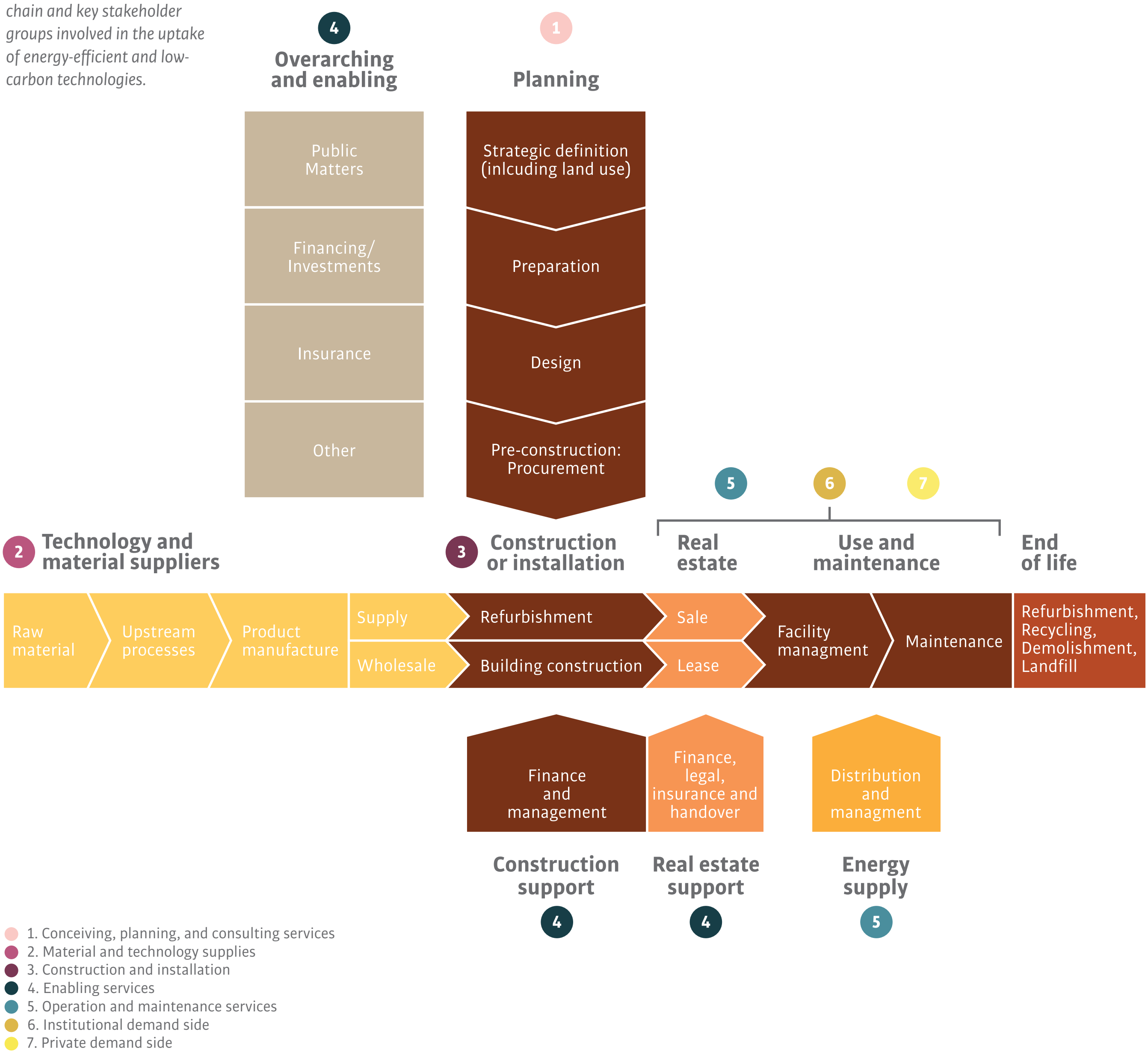
All data sources are clearly indicated to allow the reader to access more detailed information as needed. The complete list of sources, including those used in the literature review study, can be found in the annex to this report. Information on the survey questionnaire is also available in the annex. For further material on the method or questionnaire of the survey, please refer to *https://cuesanalytics.eu/*.

B1 *The building value chain*
Defining the scope

To provide a comprehensive understanding of the uptake of energy-efficient and low-carbon technologies, this chapter addresses the complete building value chain, where many stakeholders are involved, ranging from the material manufacturers to demolition and landfill workers. Each of them has a distinct role, responsibility, and interest within the building project. This study covers the views of all stakeholders involved, paying special attention to those actors who have an active role in the selection of energy-efficient and low-carbon technology solutions.

The main stages in the value chain and the key stakeholders involved in each stage are visualised in figure B1.1.

Figure B1.1
Residential building value chain and key stakeholder groups involved in the uptake of energy-efficient and low-carbon technologies.



All relevant stakeholder groups actively involved in the uptake of energy-efficient and low-carbon technologies in residential buildings were addressed in the survey.

Reference	Stakeholder group	Main involvement in the building value chain	No. responses in the survey
1	**Conceiving, planning, and consulting services** (Including architects and engineers)	Planning/Design, Construction/Installation	**85**
2	**Material and technology supply** (Including material and technology manufacturers and retailers)	Technology and Material supply	**24**
3	**Construction & installation** (Including construction companies and installers)	Construction/Installation	**42**
4	**Enabling services** (Including local authorities, banks, and other financial services)	Overarching & Enabling	**22**
5	**Operation and maintenance services** (Including energy suppliers/utilities and energy service companies (ESCO) and commercial, administrative, technical, and maintenance facility managers)	Usage & Maintenance	**18**
6	**Institutional demand side** (Including investors, developers, for-profit housing companies, and non-profit public/part Governmental housing companies)	Real Estate, Use & Maintenance	**86**
7	**Private demand side** (Including private house owners, apartment owners, and apartment renters)	Real Estate, Use & Maintenance	**195**

Figure B1.2
Number of survey responses per stakeholder group actively involved in the uptake of energy-efficient and low-carbon technologies in residential buildings categorised based on their perspective within the value chain.

NOTE

Stakeholder groups following NACE Rev. 2: Statistical classification of economic activities in the European Community.

See annex Building Value Chain: main activities and total of enterprises by number of employees, page 68.

Stakeholder groups active in the uptake of energy-efficient and low-carbon technologies are listed in table B1.2 categorised according to their role and indicating the number of responses gathered from the survey for each case. For each of the graphs in this chapter, the included stakeholder groups are indicated by listing their reference codes on the side of the graph where applicable. In the case of more than one stakeholder group, the responses were normalised for the selected groups, and equal weighting was given to all selected groups.

B2 Building typologies and project types
Defining the rationale

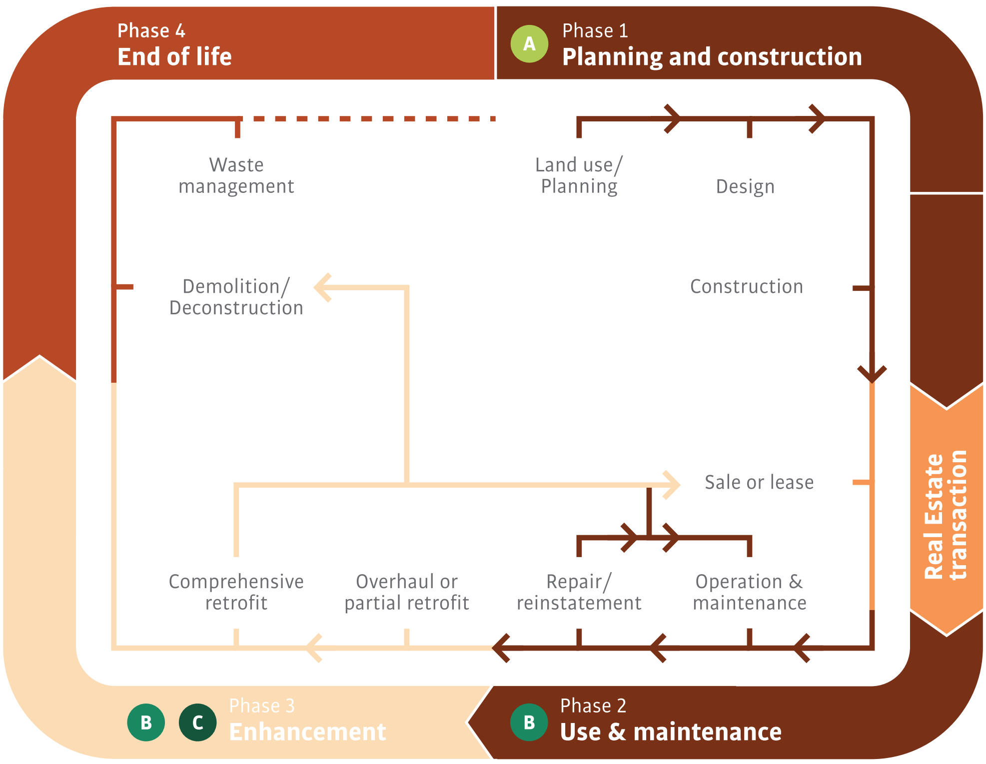
NOTE

Several definitions of technical terms can be found in the Glossary on page 72.

The building life cycle refers to the prospects of a building over the course of its entire life – encompassing everything from the design, construction, operation, maintenance, and modification of a building to its eventual demolition and waste management. In the residential building sector, the life cycle is typically divided into four main phases: planning/construction (phase 1); usage/maintenance, including repairs or reinstatements (phase 2); enhancement, encompassing different intensities of retrofits (phase 3); and end of life, including deconstruction or demolition and waste management (phase 4). The service life of a technology is embedded in phases 2 and 3, encompassing maintenance, retrofit, and upgrade of the technology, or even its replacement for a new one.

Within this chapter the project types are categorised into (A) ***new construction***, (B) ***retrofit***, and (C) ***comprehensive retrofit***. New construction is typically governed by national energy efficiency standards and, conceivably, accompanied by building codes covering a systemic evaluation of the energy and carbon performance of the project. Retrofit projects usually focus on isolated system upgrades (i.e. insulation or HVAC equipment), thus taking a single element perspective instead of a whole-building perspective. These projects often miss the opportunity to save energy in a more cost-effective manner through the synergy

Figure B2.1
Phases and types of projects over the life cycle of a building



A. New construction
B. Retrofit
C. Comprehensive retrofit

or combination of different measures. Deep or comprehensive retrofits generally achieve higher energy efficiency by taking a whole-building approach and addressing many systems at once.

Viable energy solutions can also vary substantially from one building typology to another. Characterising and identifying the building typology is, therefore, critical in the study of energy-efficient technology measures because this provides essential information about the building composition and viable technical measures that can be implemented. Building typologies within this chapter are clustered into two main groups according to the number of dwellings they contain as ***single-dwelling buildings (SDBs)***, including single-family houses, semi-detached houses, and row/terraced houses, or as ***multi-dwelling buildings (MDBs)***, encompassing small multi-dwelling houses/apartments and large multi-dwelling houses/apartments. Further definitions of each building typology can be found in table B2.2.

Figure B2.2
Building typology definition and acronym.

Building typology group	*Building typology*	*Definition*
SDBs Single-Dwelling Buildings	*Single-family house or detached house*	*A house for a single family or household that is not attached to any other building.*
	Semi-detached house, Twin house, or Duplex	*A semi-detached house/twin house/duplex is a house typically with two separate entry doors (sometimes with one) divided into two parts and housing two separate owners or tenants; this can be side-by-side or one over the other.*
	Row house or Terrace house	*A row house/terrace house is one of a series of houses, often of similar or identical design, situated side by side and joined by common walls.*
MDBs Multi-Dwelling Buildings	*Small multi-dwelling home or small apartment building*	*A small multi-family home/small apartment building is a building where multiple separate housing units (12 or less) for residential inhabitants are contained within one building or several buildings within one complex.*
	Large multi-dwelling home or large apartment building	*A large multi-family home/large apartment building is a building where multiple separate housing units (more than 12) for residential inhabitants are contained within one building or several buildings within one complex.*

Table B2.3 lists the resulting project type/building type combinations, the numbers of survey responses for each of them, and the reference code assigned to them. Within this chapter, graphs that are based on building projects list the included project type/building type combinations by listing the respective reference code on the side.

Figure B2.3
Number of responses per building typology and project type.

Reference	*Building typology*	*Project type*	*No. responses in the survey*
i	*Single-dwelling building (SDBs)*	*Partial or simple retrofit*	**137**
ii	*Multi-dwelling building (MDBs)*	*Partial or simple retrofit*	**94**
iii	*Single-dwelling building (SDBs)*	*Deep or comprehensive retrofit*	**89**
iv	*Multi-dwelling building (MDBs)*	*Deep or comprehensive retrofit*	**68**
v	*Single-dwelling building (SDBs)*	*New construction/building*	**81**
vi	*Multi-dwelling building (MDBs)*	*New construction/building*	**53**

B3

Technology competences
Level of familiarity with specific technologies

NOTE

Respondents were asked "How familiar are you with the following technologies?"

MARKET EXPERT COMMENT

'Both groups of stakeholders represent relatively high familiarity with most of building technologies. This could be related to more and more strict building codes that force both enablers and demand-side actors to apply diverse energy effective solutions, recommended for particular building type and case scenario. The survey shows that currently different technologies are applied and none of the mentioned solutions is substantially favourable by both stakeholders groups.'
***- Anna Komerska,** NAPE/WUT.*

In the building sector, large-scale deployment of energy-efficient and low-carbon building technologies will be required to meet European climate goals. The appropriate and competent selection, installation, and maintenance of building technologies is key to ensuring their effectiveness over their entire lifetime and for reaching decarbonisation ambitions. The level of understanding and know-how of these solutions differs across technology groups, markets, and stakeholder groups, resulting in a country-specific profile that greatly affects the scaling potential of the technologies. In this light, this section assesses the level of practical experience among stakeholders involved in building projects across the different energy-efficient and low-carbon technology groups. The insights are based on survey results and have been discriminated between ***enablers***, namely architects, engineers, construction companies, installers, local public authorities, and banks or other financial services, and ***demand-side actors***, including investors and developers, housing companies and private owners. The results in tables B3.1 and B3.2 were normalised for these stakeholder groups, showing the percentages of answers that have indicated the various levels of familiarity of the respondents with the listed technologies.

In Poland, among the enablers surveyed, there is a relatively high level of experience with most of the technologies, with around 20%–30% of respondents stating that these technologies are part of their day-to-day work (34% for insulation of walls and roofs). Another 20% of the respondents had worked with all the technologies several times, except for geothermal energy systems which was a bit lower (15%). "Worked with it once" was the most often-selected option across all technologies where geothermal energy systems and direct electric heating or storage heating were the most often-selected options.

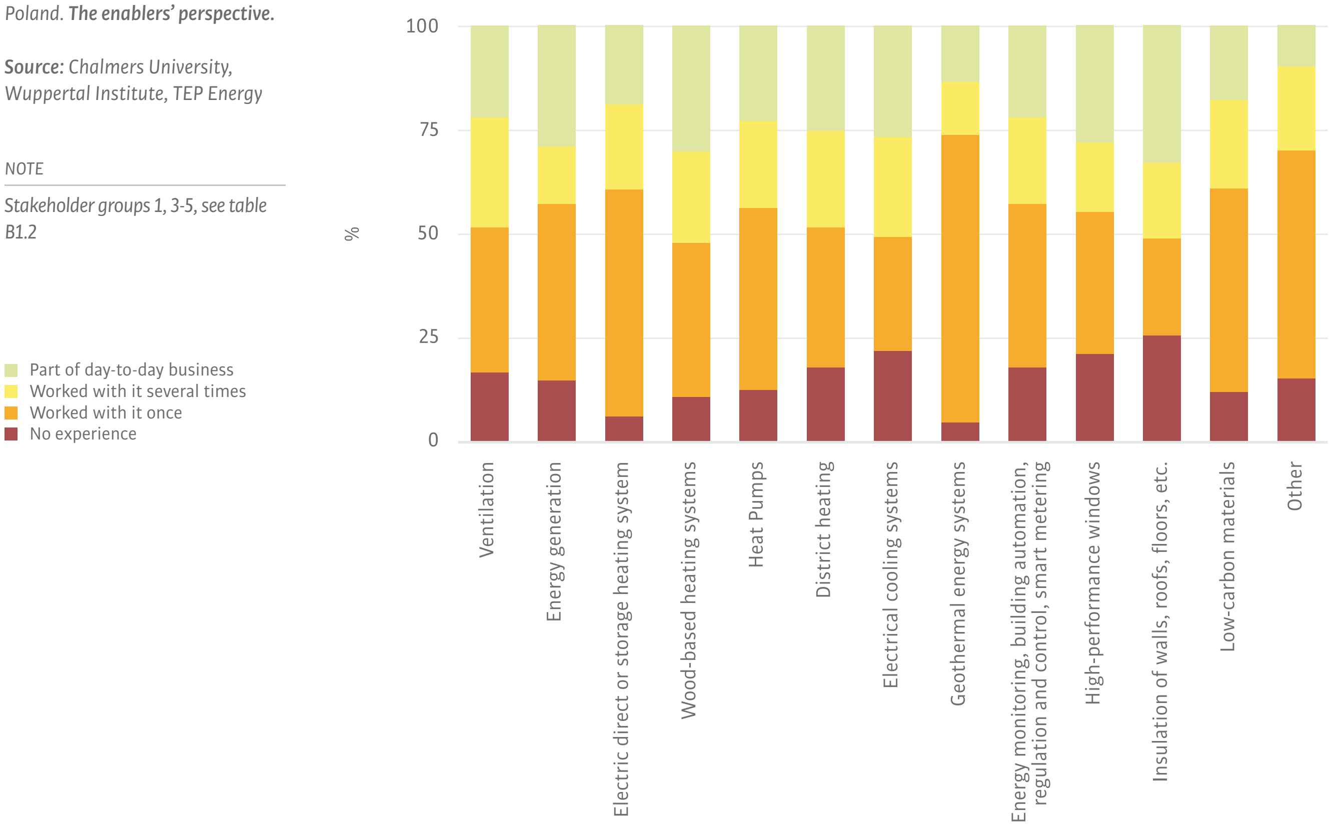
Figure B3.1
Familiarity level with energy-efficient and low-carbon technologies in Poland. ***The enablers' perspective.***

Around half of the surveyed enablers have worked with the selected technologies at least several times.

Source: Chalmers University, Wuppertal Institute, TEP Energy

NOTE

Stakeholder groups 1, 3-5, see table B1.2



How was this information gathered in the survey? ***See page 68.***

The high level of responses and familiarity with the category "other" in B3.1 indicates that more specific or niche technologies are playing an important role in this aspect of the construction sector in Poland.

Across all technology solutions, the demand-side stakeholders in Poland had a lower average level of familiarity in cases where they had any experience at all (Figure B3.2). "Worked with it once" was the dominating answer with around 60% of the responses while only 10%–20% of respondents indicated day-to-day familiarity. Insulation of walls stands out as the technology with the highest familiarity with 32% of respondent having worked with them several times, and 26% on a daily basis. The high level of responses and familiarity with the category "other" in B3.2 indicates that more specific or niche technologies are playing an important role in this aspect of the construction sector in Poland.

Most of the surveyed demand-side actors have worked with the selected technologies at least once.

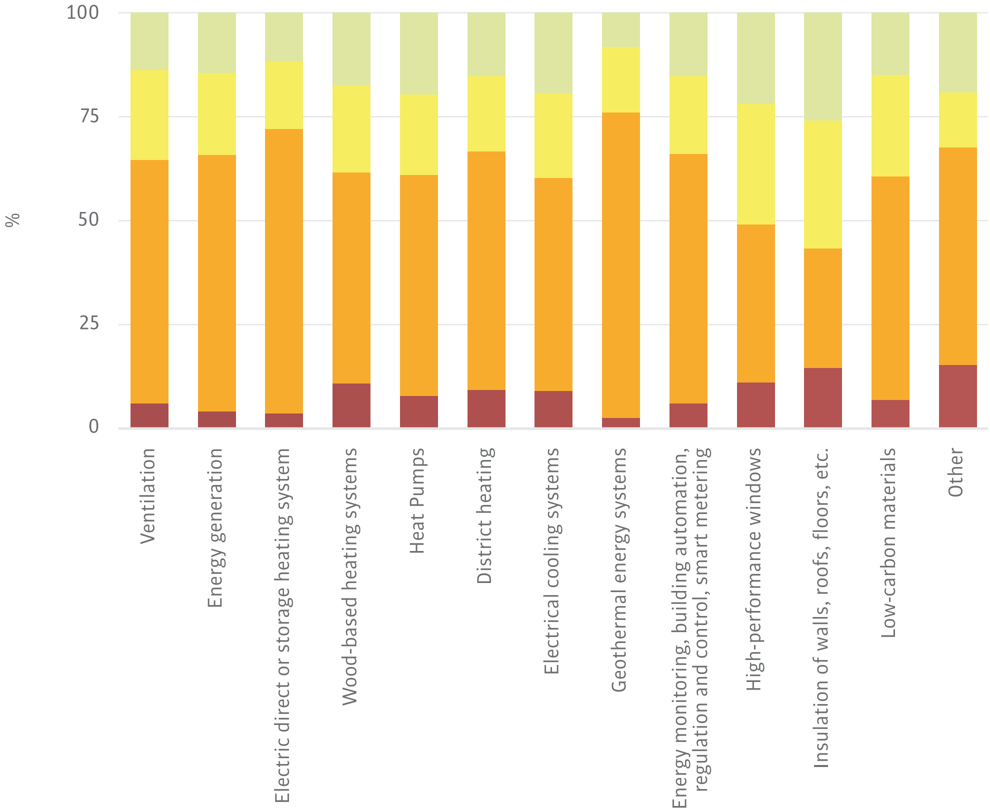


Figure B3.2
Familiarity level with energy-efficient and low-carbon technologies in Poland.
The demand-side's perspective.

Source: *Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

Stakeholder groups 6 and 7, see table B1.2

MARKET EXPERT COMMENT

'As most of the answers show quite a homogeneous level of familiarity among different technologies, a higher "no experience" share in insulation of walls and roofs could be a little surprising. Especially that this measure is widely practised and extremely common in all building sectors. This odd outcome of the survey could result from not quite proper understanding of the question - some of the people could associate this option with modern insulation solutions e.g. VIP panels, very rarely used in Poland. Another explanation is related to the construction of the question itself, which asks the responders about their experience than for their expertise and knowledge. Among enablers, stakeholder groups such as local public authorities, banks or other financial services might not directly be involved in working on a particular technology, despite their familiarity in this topic.'
- *Anna Komerska,* NAPE/WUT.

B4

Current status of the building stock
Measures implemented across building typologies

NOTE

Respondents were asked "What measures were implemented in your latest project?"

In most European countries, the current state of the building stock is mostly unknown due to limited monitoring of past and present retrofit measures. Insights into what measures are being implemented in the market, differentiated by building typologies and project types, are thus critical to better understand the building stock condition as well as current trends in technology diffusion. The goal of this section is, therefore, to quantify the building technology measures implemented in the sampled residential projects classified according to the different building typologies and project types. The results have been clustered between retrofit projects, and comprehensive retrofit projects. All responses of stakeholders active in the building value chain (Figure B1.1) and with practical experience in building projects are encompassed in this section.

In Poland, according to the sampled projects from the survey, the types of measures implemented in retrofit projects do not vary substantially across building typologies, i.e. SDBs and MDBs (Figure B4.1). In both cases, the most often addressed building elements are related to the building envelope (such as the outer walls, roofs and windows), along with the heating system. The most often implemented measure in SDBs is the upgrade and maintenance of outer walls, along with an upgrade of the roof or attic. Similarly, in MDBs, the most often implemented measure is the upgrade of the outer walls and the roof or attic. The least often addressed building technologies in both SDBs and MDBs are systems related with cooling.

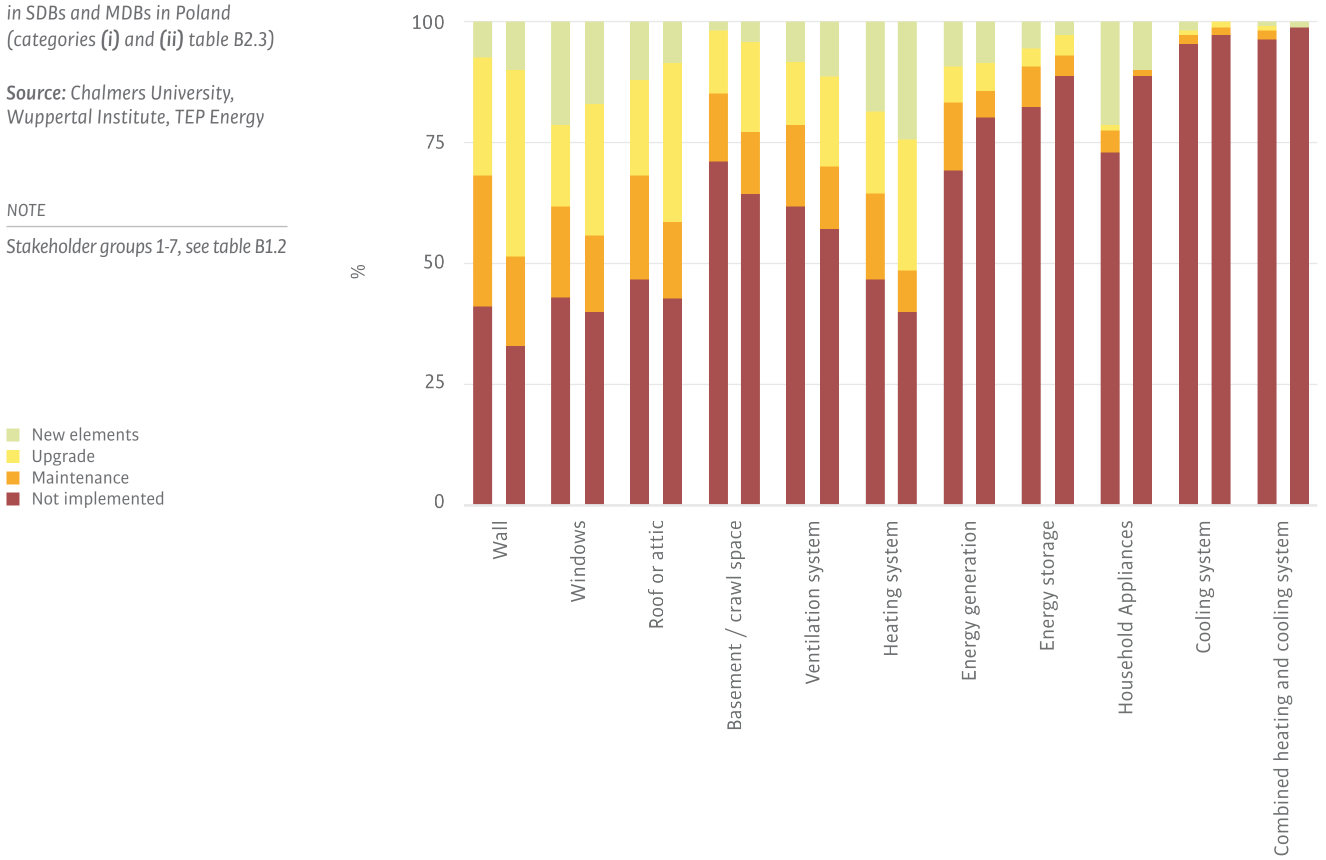
Figure B4.1
Measures implemented in the sampled retrofit projects (n=231) in SDBs and MDBs in Poland (categories **(i)** *and* **(ii)** *table B2.3)*

Source: *Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

Stakeholder groups 1-7, see table B1.2

The upgrade of the outer wall is the most often implemented measure in comprehensive retrofit projects.



How was this information gathered in the survey? ***See page 68.***

In Poland, the types of measures implemented in comprehensive retrofit projects can vary across building typologies (Figure B4.2). Overall, more actions are undertaken in SDBs than in MDBs. In SDBs the most often implemented measures are the addition of a new heating system or new windows or the upgrade of the existing walls. When it comes to MDBs, the most often implemented measures are also the upgrade of the existing walls, including windows and roof, as well as the upgrade of the heating system. In both cases, the most often addressed building elements are related to the building envelope (such as the outer walls, windows, or roofs), along with the heating system. The least often addressed building technologies in both SDBs and MDBs are cooling and combined heating and cooling systems.

Upgrade of the outer wall is the most often implemented measure in comprehensive retrofit projects.

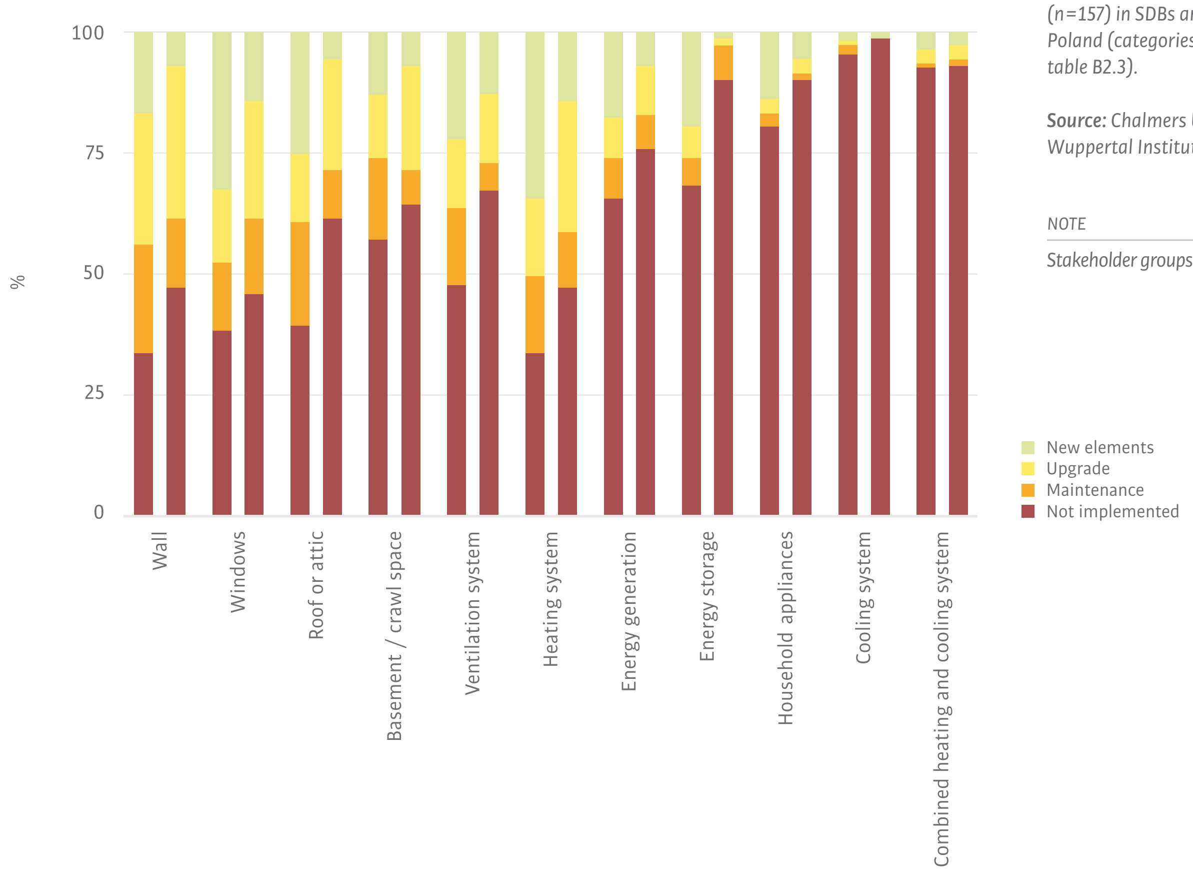


Figure B4.2
*Measures implemented in comprehensive retrofit projects (n=157) in SDBs and MDBs in Poland (categories **(iii)** and **(iv)** table B2.3).*

Source: *Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

Stakeholder groups 1-7, see table B1.2

B5

The technology selection
Insights into the stakeholders' power and interactions

NOTE

The respondents were asked "Who were the most important actors you were in contact with for the technology selection? What was the level of influence and interest of the following stakeholders on the technology selection in your last project? How often did you assume the actors communicated with each other for the technology selection?"

MARKET EXPERT COMMENT

'The Stakeholder interactions in the technology selection for renovation of the MDBs differ from SDBs. The use of the support programs for retrofit of MDBs forced to fulfil specific requirements. Due to the scale of the investment as well as administrative regulations, it was necessary to include an architect, engineer or a consultant in the renovation process.'
- *Anna Komerska*, NAPE/WUT.

The construction process involves a wide variety of stakeholders with different backgrounds, roles, and interests within the same project. Knowing which stakeholder groups are involved in the action leading to the technology selection, as well as their level of power in the decision, is essential to better understand the decision-making environment. This information can be of great value for marketing campaigns aiming to scale energy-efficient technologies by enabling the identification of key players and potential influencers. This section maps and assesses the stakeholders involved in the technology selection process, as well as the level of power of each agent in these decisions.

In order to examine and visualise the stakeholder setup in the technology selection, social network analysis (SNA) is utilised. SNA is the process of investigating social structures using networks and graph theory. Networks consist of nodes (individual actors or stakeholders within the network) and edges or links that connect them (relationships or interactions). Examining patterns between certain types of nodes and/or edges reveals perspectives of all stakeholder groups present in the building value chain based on their practical experience in building projects.

For figures B5.1 and B5.2, the circles represent the different stakeholder groups. The size of the circle represents the level of power in the decision, and the bigger the circle the greater the level of power. Power in this context is defined by the conjunction of interest and influence. The intensity of communication among stakeholders during the technology

Figure B5.1
Stakeholder interactions in the technology selection in retrofit projects in Poland in SDBs ***(left)*** *and MDBs* ***(right)****.*

Source: *Chalmers University, University of Stuttgart, TEP Energy*

NOTE

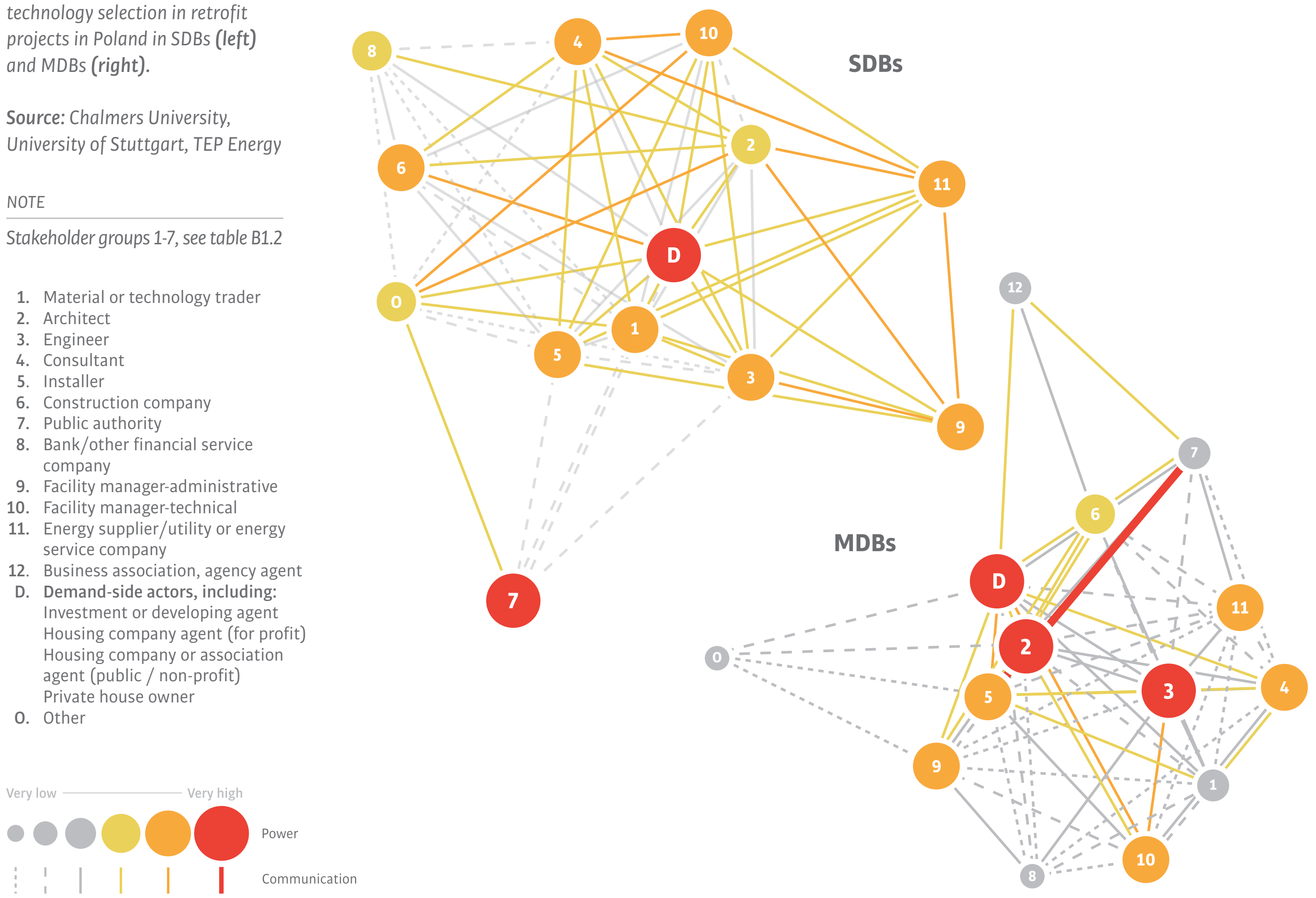
Stakeholder groups 1-7, see table B1.2

1. Material or technology trader
2. Architect
3. Engineer
4. Consultant
5. Installer
6. Construction company
7. Public authority
8. Bank/other financial service company
9. Facility manager-administrative
10. Facility manager-technical
11. Energy supplier/utility or energy service company
12. Business association, agency agent

D. Demand-side actors, including: Investment or developing agent, Housing company agent (for profit), Housing company or association agent (public / non-profit), Private house owner

0. Other

Architects, engineers and demand-side actors have a high level of power in the technology selection in retrofit projects in MDBs.



*How was this information gathered in the survey? **See page 68.***

selection is represented by a line. The thickness and type of line represents the level of communication, from communicating on a regular basis ("Daily") to seldom communicating ("1" in the Likert scale). In the case of no communication at all ("Never"), no line is drawn.

In ***retrofit projects*** and SDBs in Poland, most of the stakeholders have a high level of power in the technology selection. As in the case of Germany, the most powerful actors in this process are the demand-side actors and the public authorities. In terms of level of communication, demand-side actors, material or technology providers, and installers are the stakeholders having the highest number of connections, followed by architects and engineers. In MDBs, demand-side actors have the highest level of power in the process, along with architects and engineers. In terms of communication, again demand-side actors have the highest level, followed by the architects.

In ***comprehensive retrofit*** in SDBs, the highest level of power goes to the demand-side actors and the installers. In terms of communication, demand-side actors and architects have the highest number of communications, followed by the technology providers. On the other hand, in MDBs the consultants and the demand-side actors have the highest level of power in the selection. These are closely followed by engineers and construction companies. Also, the highest level of communication is seen for the demand-side actors, followed by the architects, the technology or material providers, and the engineers.

MARKET EXPERT COMMENT

'The incising awareness of human influence on the environment combined with more stringent regulations will most probably lead to more common comprehensive refurbishments. In the future it is very likely that the importance of the experts will further increase. The deep renovation will need to be performed by a qualified team to fulfil requirements for deep renovation strategies financially supported by public money.'
- Andrzej Wiszniewski, NAPE/WUT.

NOTE

The location of the nodes within the network is based on principles of equilibrium. Among other aspects, the centrality of a node can be defined by the number of links it has. Typically, the higher number of connections the more central the node will be in the graph. Further information can be found in Bannister, M. et al. (2012).

In comprehensive retrofit projects, the demand-side actors have the highest level of power.

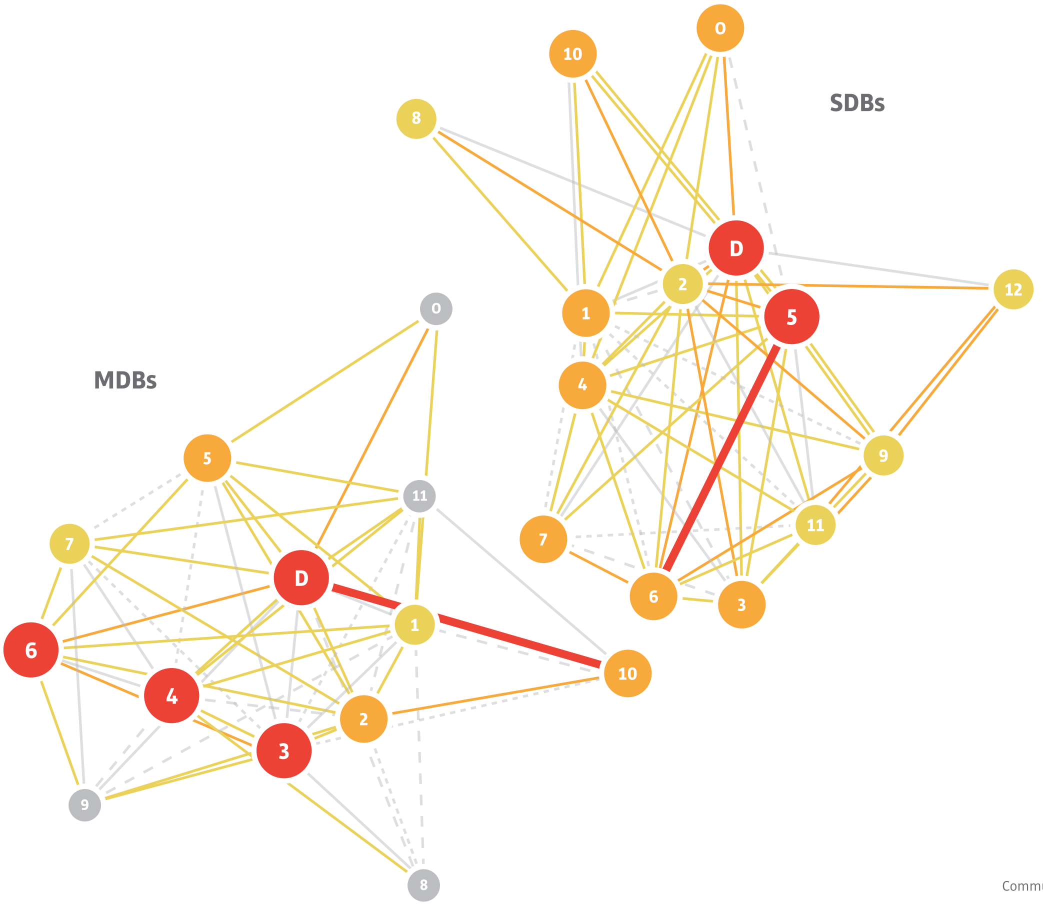


Figure B5.2
*Stakeholder interactions in the technology selection in comprehensive retrofit projects in Poland in SDBs **(right)** and MDBs **(left)**.*

Source: *Chalmers University, University of Stuttgart, TEP Energy*

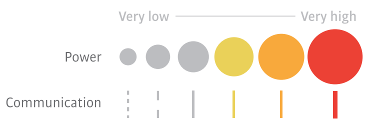
NOTE

Stakeholder groups 1-7, see table B1.2

1. Material or technology trader
2. Architect
3. Engineer
4. Consultant
5. Installer
6. Construction company
7. Public authority
8. Bank/other financial service company
9. Facility manager-administrative
10. Facility manager-technical
11. Energy supplier/utility or energy service company
12. Business association, agency agent

D. **Demand-side actors, including:**
Investment or developing agent
Housing company agent (for profit)
Housing company or association agent (public / non-profit)
Private house owner

0. Other



B6

Motivations and obstacles to energy-efficient and low-carbon technologies
The demand-side's perspective

NOTE

The respondents were asked "What were the main motivations for your project?"

MARKET EXPERT COMMENT

'Buildings refurbishment is still a relatively expensive process. Especially deep modernisation requires high investment resources, comprehensive engineering approach and qualified installers. According to some studies cost of the deep refurbishment of a SDB in Poland might reach the level of 800–1000 zł/m² (source: Izolacje, Warszawa, 2019, Termomodernizacja budynków, ISBN 978-83-64094-08-8). High initial costs together with too low energy costs are often discouraging enough for house owners. For this reason the majority of performed building modernisations are only light renovations with partial retrofit (source: Bank Gospodarstwa Krajowego).'
- Anna Komerska, NAPE/WUT.

Motives for initiating or developing building projects tend to differ significantly across stakeholder groups. Insights on ambitions, interests, and inclinations of demand-side actors (such as developers, housing companies, and owners) are fundamental to better understanding their decision-making criteria when deciding on building projects. This information, in turn, can serve as a valuable basis to develop marketing campaigns for technologies tailored to stakeholders' needs and requirements. In this light, the following section describes stated motivations behind residential building projects across project types. This information is complemented with hindering factors for not pursuing "higher"-performing buildings – meaning even more energy-efficient or lower carbon solutions within their projects. The results reflect the demand-side perspective, including non-professional organisations (such as private house owners) and professional organisations (such as investors, developers, and housing companies). The results have been clustered between simple and comprehensive retrofit projects.

In Poland, the reported motivations of demand-side actors behind ***retrofit projects*** were, in most cases, economic aspects (28%) such as "Increase of the value of the building (or respective part)" or "Lower energy and/or operating costs" (Figure B6.1, left). Environmental matters, like "Saving energy" or "Reducing CO_2 emissions" were also strong arguments for dwelling or portfolio owners (24%). Social and technical matters also play an important role (19% and 18%, respectively) in the motivation behind the project. The least often selected as catalysts behind the building project were legal aspects (11%).

In terms of barriers for not implementing (even) more energy-efficient or low-carbon technologies in retrofit projects, economic aspects (33%) were the most often-selected option (Figure B6.1, right), with common selected arguments being "Alternatives were too expensive" or "Alternatives had a too long payback time". The second most often-selected matters were technical items, closely followed by social items (19% and 16% of the responses, respectively). Some of the often-selected options for technical matters were "The technology chosen was the best available technology" and for economic barriers

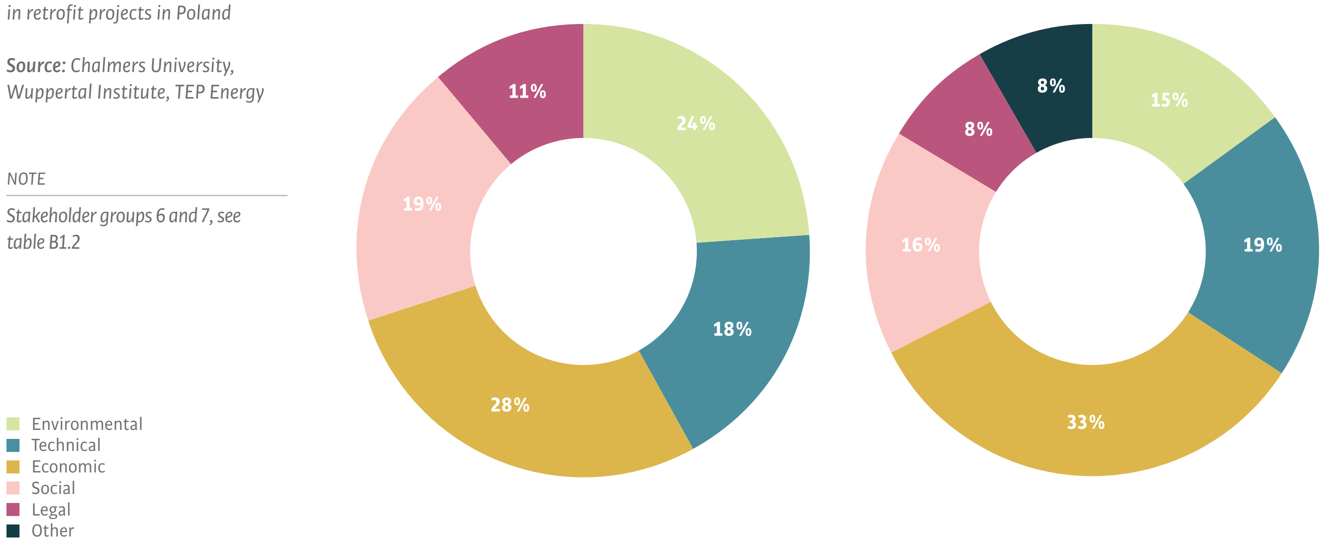
Figure B6.1
*Main motivations behind projects **(left)** and barriers for not implementing more energy-efficient and low-carbon technologies **(right)** in retrofit projects in Poland*

Source: *Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

Stakeholder groups 6 and 7, see table B1.2

Economic aspects are the most important motivations behind retrofit projects, as well as barriers for not implementing (even) more energy-efficient and low-carbon technologies.



How was this information gathered in the survey? ***See page 69.***

were "Energy cost saving and low running costs". The most often-selected barrier related to environmental issues was "Energy input such as electricity, district heat, gas, oil should be produced more from renewable energy sources".

As in the case of partial retrofit projects, reported motivations of demand-side actors behind ***comprehensive retrofits*** in Poland were, in most cases, economic aspects (27%) such as "Lower energy and/or operating costs" followed by environmental aspects (25%), for instance, "Reducing CO_2 emissions" or "Saving energy" (Figure B6.2, left). Legal aspects were, once again, perceived as the lowest incentives for initiating deep retrofit projects. Only "Compliance with legal standards" was identified as a potential ambition behind projects, with 12% of the responses.

When looking at arguments for not implementing (even) more energy-efficient or low-carbon technologies in comprehensive retrofit projects (Figure B6.2, right), again economic matters (27%) such as "High initial costs" were perceived as one of the biggest hurdles. These were followed by technical, social, and environmental matters (21%, 17%, and 17%, respectively). As in the case of the motivations, legal aspects were the least often-preferred option (10%). The 8% of responses choosing "Other" means that some barriers were not addressed within the answer options. When looking at the answers provided by the surveyed sample, the lack of information was oftentimes mentioned.

USEFUL READING:

Buildings modernisation strategy: Roadmap 2050. Summary. Kraków, 2014.
www.bpie.eu

Economic aspects are the most important motivations behind comprehensive retrofit projects, as well as barriers for not implementing (even) more energy-efficient and low-carbon technologies.

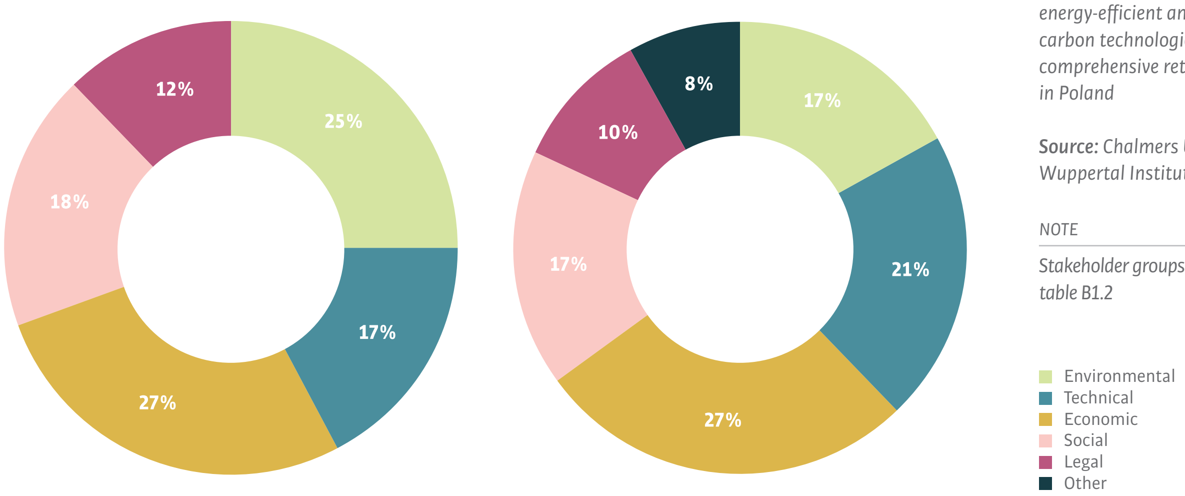


Figure B6.2
*Main motivations behind projects **(left)** and barriers for not implementing more energy-efficient and low-carbon technologies **(right)** in comprehensive retrofit projects in Poland*

Source: *Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

Stakeholder groups 6 and 7, see table B1.2

B7 Promising approaches to achieving climate goals
Potential in new and existing buildings

NOTE

The respondents were asked "What technology or approach has the highest potential to contribute to reach ambitious climate-protection goals in Poland?"

MARKET EXPERT COMMENT

*'According to the report **Air Quality in Europe 2018**, Polish cities are one of the most polluted over the EU. In winter season, levels of several dangerous pollutants, such as PM10, PM2.5 and BaP, too often exceed the current emission standards. These high levels are mainly related to heat production as most of the houses are heated by burning coal and other solid fuels in individual stoves and boilers, quite often old and inefficient ones. www.polskialarmsmogowy.pl'*
***- Anna Komerska,** NAPE/WUT.*

'The fact that respondents perceive heating system and ventilation as having the greatest potential shows that heating demand is still perceived as the most contributing aspect in the building energy use. The three following most selected answers, despite their lower share, indicate that the respondents are aware of other factors influencing energy consumption, such as user behaviour or monitoring and control systems.'
***- Andrzej Wiszniewski ,** NAPE/WUT.*

Buildings are complex entities consisting of an extensive range of elements and components. The carbon and energy efficiency of a building depends not only on the performance of each of these components, but also on their design and operation within a whole building system and in relation to local conditions like climate and policy.

Local stakeholders' views on which energy-efficient and low-carbon building solutions are most promising can provide a valuable starting point in deciding which technologies should be promoted or prioritised or that have a scaling potential.

In this context, this section identifies which building concepts market actors judge to be most promising in their national context to reduce carbon emissions and achieve climate goals. Given that the technical solutions might vary across building typologies and project types, this section distinguishes between new buildings and retrofits. The results include the perspectives of all stakeholder groups present in the building value chain with practical experience in residential building projects.

In new buildings in Poland, the system perceived to have the greatest potential to contribute to reaching climate-protection goals was the heating system, with nearly a third of all of the responses (27%, Figure B7.1). This technology was followed by the ventilation system (16%) and centralised energy production (15%). Monitoring, regulation, and controls (11%) and decentralised energy production (10%) have some role in this ambition, though not a leading one. On the other side of the spectrum, efficient household appliances and heating systems were rarely selected as promising solutions towards climate conservation (4%).

The low number of responses dedicated to "Other" in B7.1 suggests that most of the technology options commonly applied in the construction sector in Poland were addressed with the technologies named explicitly in the survey.

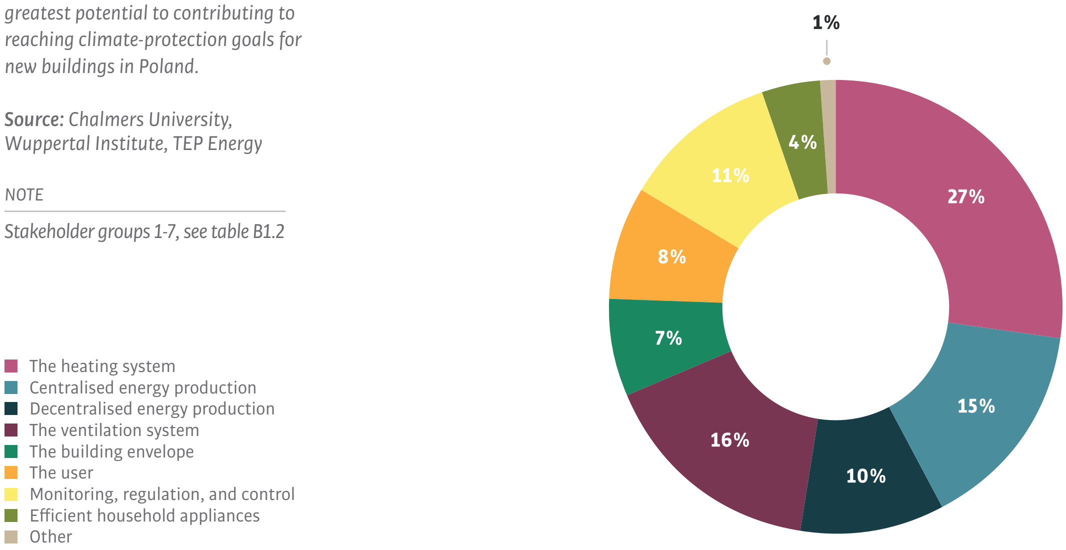
Figure B7.1
Technologies perceived to have the greatest potential to contributing to reaching climate-protection goals for new buildings in Poland.

***Source:** Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

Stakeholder groups 1-7, see table B1.2

The heating system is perceived to have the greatest potential in new building projects.



How was this information gathered in the survey? ***See page 69.***

In Poland, promising solutions for reaching climate goals do not differ significantly between new buildings and ***retrofit projects*** (Figure B7.2). In retrofit projects, the heating system was, once again, perceived to have the greatest potential to contribute to reaching climate-protection goals with more than a third of the responses (33%). Beyond the heating system, the remaining responses were distributed among the following options: the user (14%), the ventilation system (13%), the building envelope (10%), and centralised and decentralised energy production (both with 9%). As in the case of new buildings, efficient household appliances were seldom selected as having much promise for reaching climate goals (4%).

The low number of responses dedicated to "Other" in B7.2 suggests that most of the technology option were addressed with the technologies named explicitly in the survey.

MARKET EXPERT COMMENT

'One of the governmental strategies to fight the smog caused by individual heat sources is a subsidiary programme, named Clear Air Programme. This financial support is dedicated for single family households. Includes thermo-modernization and replacement of old solid fuel boilers, co-financing from 30 to 90 percent (depending on the income). 10 bln PLN/year for 10 years (2018-2029).'
- Anna Komerska, NAPE/WUT.

The heating system has the greatest potential in retrofit projects.

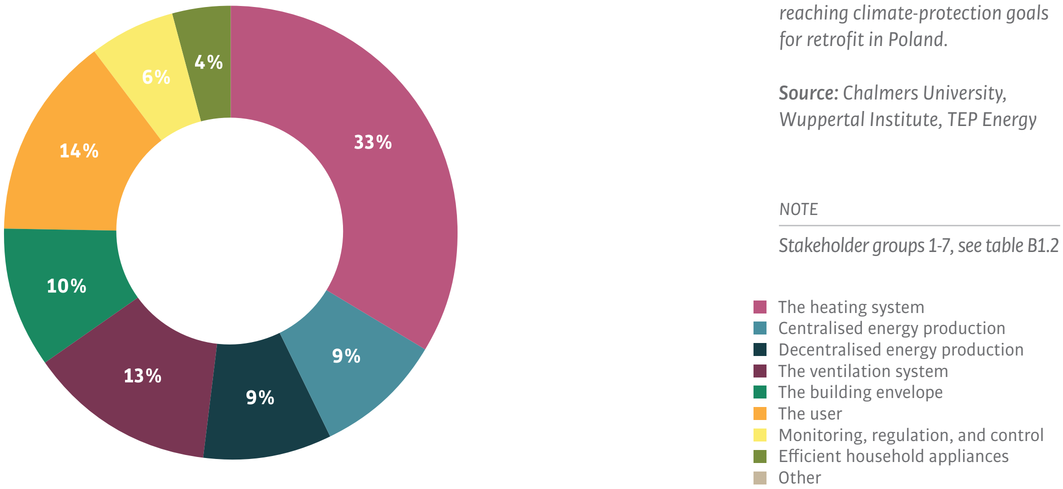


Figure B7.2
Technologies perceived to have the greatest potential to contribute to reaching climate-protection goals for retrofit in Poland.

Source: *Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

Stakeholder groups 1-7, see table B1.2

The high share of respondents choosing the heating system and the façade as some of the most promising measures to reach climate goals for both SDBs and MDBs, could reflect the poor energy standard of existing buildings. Many of them are characterized by low insulation thickness of external walls and outdated heating systems.

B8

Barriers & drivers to specific technologies

Bridging the gap towards climate goals

MARKET EXPERT COMMENT

'The modernisation of the heating systems, e.g. to upgrade it to the heat pump, is perceived as expensive, both in terms of the installation costs and later, in terms of operational costs. Coal is still the cheapest fuel comparing to electricity or gas. Moreover, in the old stoves and boilers any solid fuel can be burned, unfortunately including combustible waste. The economic problem is especially important for people affected by poverty and this group is still quite high in Poland. They often live in poor insulated houses, where the indoor air temperature is often below the comfort temperature. The option to connect the heating system to the district heating is often not possible, as SFH are often in the suburbs of the cities where there is no district pipeline. CO_2 tax does not exist in Poland so there is no external and legal pressure, apart from social, to encourage people to use more energy efficient and low-carbon solutions.'
*- **Anna Komerska,** NAPE/WUT.*

Various market barriers hinder the uptake of energy-efficient and low-carbon solutions. These are context specific and, therefore, vary considerably between countries, building typologies, stakeholder groups, and even the technologies themselves. Identifying hurdles for specific technologies is an essential first step to designing marketing instruments capable of overcoming these obstacles. The following section, therefore, describes stakeholders' perceived barriers to specific technology solutions. It showcases the technology group that has been identified as having the greatest potential in retrofit projects (Section B7). Figures B8.1 and B8.2 visualise the survey results for ***district heating, wood-based heating systems, and heat pumps,*** which represent promising technologies or solutions within ***the heating system*** approach that have the greatest potential in retrofit projects in Poland (according to the survey respondents). The results include the responses from all stakeholder groups that had expressed a medium to high level of practical experience in this technology.

In Poland, hurdles to large-scale deployment of ***district heating, wood-based heating systems, and heat pumps*** are mostly the same across these technologies (Figure B8.1). For all three of these technology solutions, economic-related aspects such as "low energy prices", "lack of subsidies", "lack of affordable products" and "lack of tax incentives" are among the most relevant barriers (ranging from 31% to 37%). Another important aspect impeding the uptake of these technologies includes social-related conditions, for instance, "Lack of trust in/awareness of higher acoustic comfort", 'Lack of trust in/awareness of heat comfort", and "Lack of interest in attractive design" (19% of the total survey answers in all three cases). On the other hand, legal aspects such as "Lack of a comprehensive legal framework" and "Lack of comprehensive building standards" were not perceived as major barriers in the selection and implementation of these technologies, with 8–14% of the responses.

Figure B8.1
Barriers to the heating system in Poland for:
a. District heating
b. Wood-based heating systems
c. Heat pumps

***Source:** Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

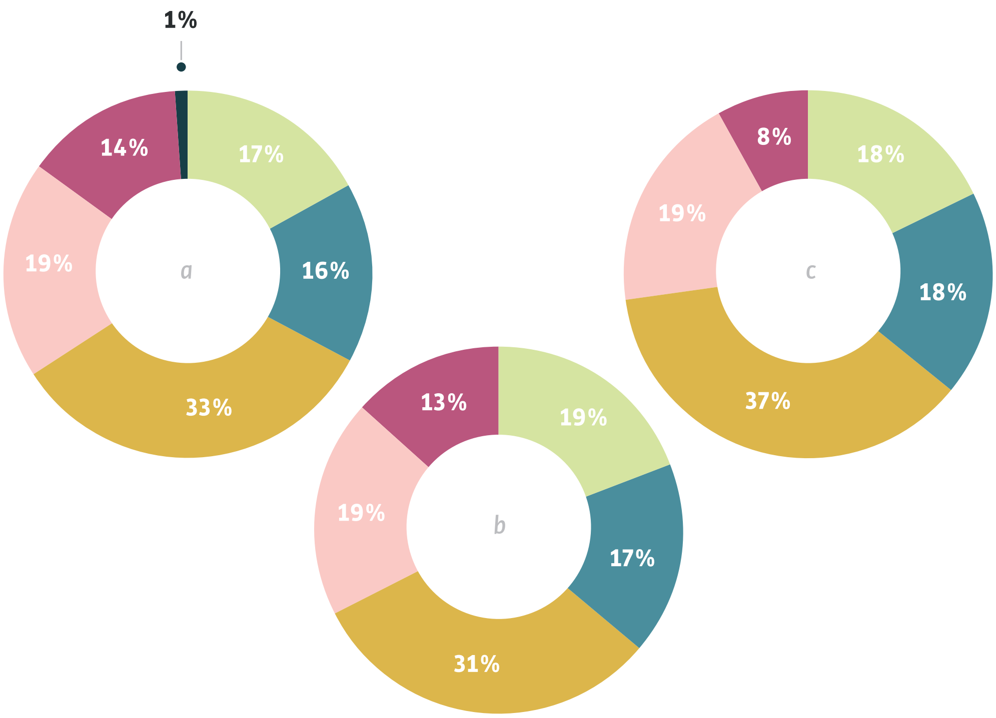
Stakeholder groups 1-7, see table B1.2

NOTE

The respondents were asked

"What is the biggest barrier for the scaling up of this technology in Poland? What needs to happen in order to scale up this technology in Poland?"

Economic aspects are the main barriers to large-scale implementation of the selected heating systems.



- Environmental
- Technical
- Economic
- Social
- Legal
- Other

How was this information gathered in the survey? **See page 69.**

The low number of responses allocated to "Other" (0%–1%) in B8.1 suggests that most of the barriers were addressed in the options offered in the survey.

As in the case of the barriers, drivers of energy efficient and low-carbon solutions can differ significantly depending on the building type, stakeholder group, and even on the technology. Identifying stakeholders' market-specific drivers and motivations towards low-carbon energy solutions is crucial to creating effective marketing campaigns to foster their uptake. The following section describes stakeholders' perceived drivers to the use of ***district heating, wood-based heating systems, and heat pumps*** as technology solutions within ***the heating system*** having the greatest potential in retrofit projects in Poland according to the survey respondents.

In Poland, the key drivers for ***district heating, wood-based heating systems, and heat pumps*** with the highest potential effect according to the stakeholders do not vary substantially across these technologies (Figure B8.2). Overall, the main drivers in favour address technical (22%–27%) and economic-related matters (21%–27%). Within technical matters, the most often-named were "Easier installation process" and "Improvement of reliability and functionality". In the case of economic matters, they were "Price decrease and shorter payback time" and "Energy cost saving and low running costs". The remaining responses were more or less evenly spread between environmental (16%–19%), legal (15%–20%), and social matters (15%–16%). When looking into the specific solutions, the biggest potential drivers for the uptake of district heating are economic arguments. Likewise, technical aspects are strong underlying motivations for wood-based heating systems, and techno-economic arguments are the strongest motivations when it comes to heat pumps. The low number of responses allocated to "Other" (0-1%) in B8.2 suggests that most of the drivers were addressed in the options offered in the survey.

MARKET EXPERT COMMENT

'The economic matter refers both to barriers and drivers. For people who can afford the modernisation costs, the comfort, environment and future energy costs are encouraging enough to improve the heating system. Especially taking into consideration the experts' prognosis of the forthcoming high increase of the energy prices.'
- Andrzej Wiszniewski, NAPE/WUT.

Techno-economic aspects are perceived to have high impact potential across the selected heating systems.

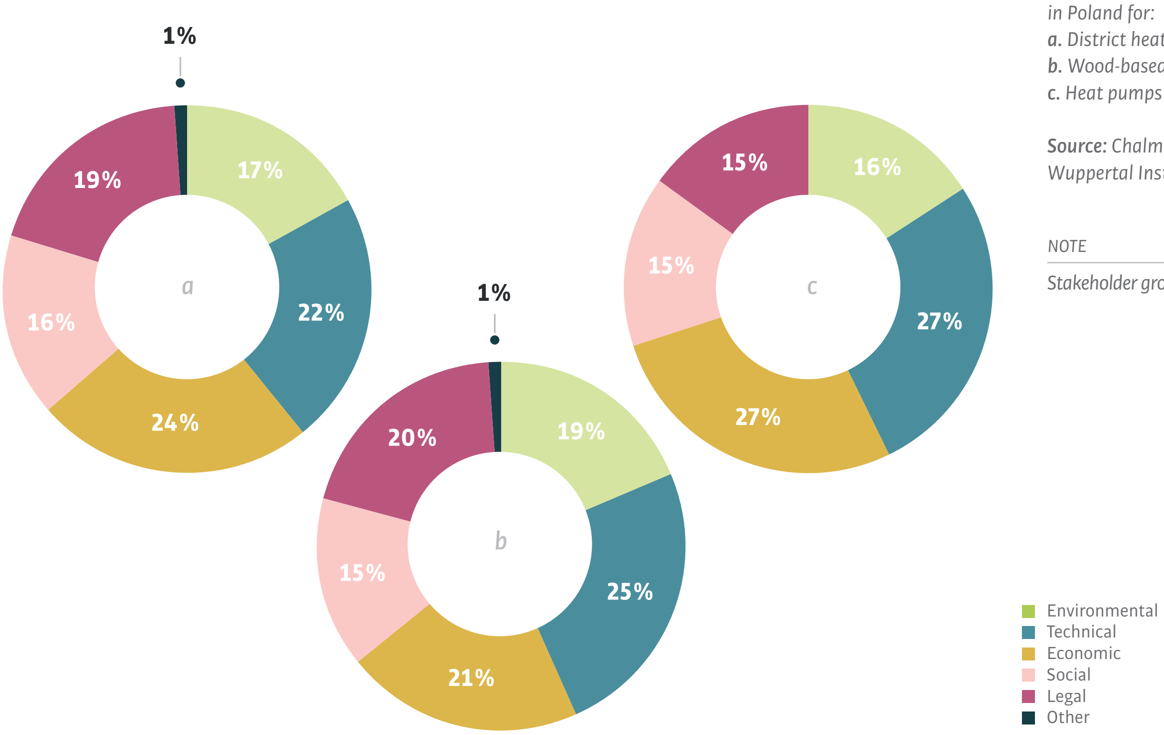


Figure B8.2
Drivers for the heating system in Poland for:
a. *District heating*
b. *Wood-based heating systems*
c. *Heat pumps*

Source: *Chalmers University, Wuppertal Institute, TEP Energy*

NOTE

Stakeholder groups 1-7, see table B1.2

C

Market volumes and economics

Aim

C

The chapter ‘Market volumes and economics’ provides data on the building stock’s greenhouse gas (GHG) emissions as well as annual market volumes of new constructions and building retrofits in the short, medium, and long term for two scenarios.

The first section of this chapter presents structural and GHG-related data on the building stock (Section C.1). The data on the building stock are collected from statistical sources, standards, and norms, and this information is complemented by interviews with market experts. A synthetic building stock inventory of 50 000 representative buildings is generated based on the data collected. To set up this inventory, the building stock model (BSM) integrates a parametric variation approach.

At its core, this chapter describes the market volumes for a Reference Scenario (RS) and a 2 Degrees Scenario (2DS). The RS reflects current and decided energy and climate policy instruments and some moderate reinforcements that could be expected (similarly to the EU Reference Scenario). Both European and national policies are taken into account. The 2DS is designed to achieve ambitious climate-change mitigation goals, and the <2°C goal of the Paris Agreement of 2015 serves as a guideline. National peculiarities and implementation approaches that might typically be expected are reflected in the scenario definition (Section C.2).

In both scenarios, the effects of an increase in energy efficiency and in the share of renewable energy sources (RES) have been considered, and the resulting market volumes for the various technology groups are listed. The aim is to provide realistic market volume estimates for different market segments depending on the different policy set-ups.

All data sources are clearly marked to allow the reader to access more detailed information as needed. The complete list of sources can be found in the annex to this report.

C1 Status quo of the building stock
Structure, energy, and greenhouse gas emissions

NOTE

In Poland, the emission factors for electricity and district heating are amongst the highest of the EU-28. Electricity: 0.79 kg CO_2-eq/kWh District Heating: 0.51 CO_2-eq/kWh

GHG intensity: GHG emissions from final energy consumption for heating, hot water, ventilation, and cooling from a life-cycle perspective. For example, 10 kg CO_2-eq/m² year is equivalent to 45 kWh/m² year in a gas-supplied building. GHG emissions embodied in the construction of the building are not included.

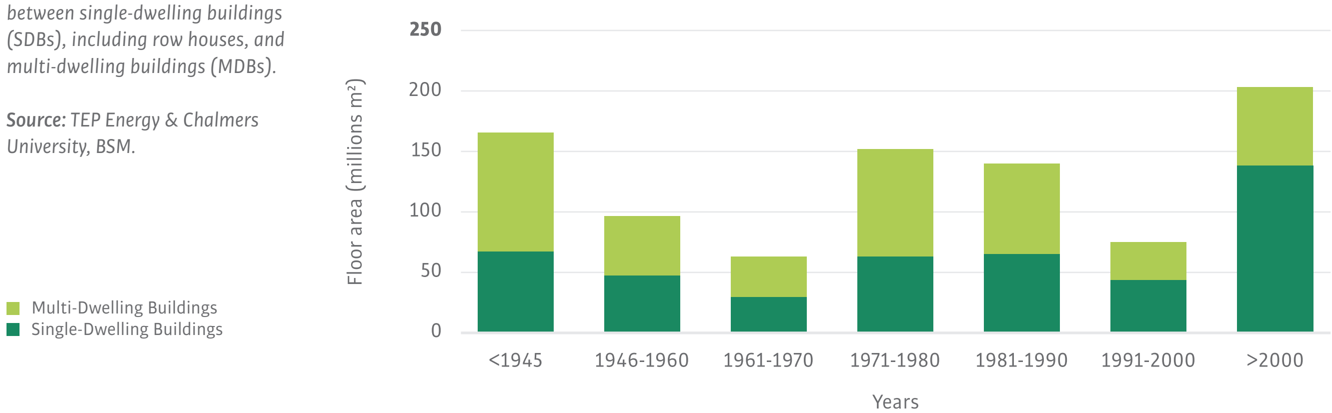
The residential building stock of Poland currently encompasses over 5.5 million buildings. The vast majority of these (86%) are single-dwelling buildings (SDBs), including row houses, while in terms of number of dwellings the most important share (64%) is located in multi-dwelling buildings (MDBs). The floor area is distributed almost evenly between the two typologies, with a small predominance of SDBs (51%) as a result of a trend to expand on this typology after the year 2000.

The age distribution (Figure C1.1.) still illustrates a large share of old buildings with 37% of the heated floor area having been built before 1970. This includes a large portion of 18% of the floor area of buildings built before 1945. Although many buildings in the cities were destroyed during the war, an increase of construction activity occurred in the period between the wars due to Poland gaining its independence. On the other hand, a large proportion of the built floor area stems from a construction boom in the 1970s and 1980s characterised by soviet-style apartment blocks when about 32% of the current floor area was added to the stock. In the 1990s, construction activity decreased again with only 9% added. Since the millennium, a large share of 22% of floor area has been added, characterised by an increase in living space per capita.

Figure C1.1
Age distribution of the building stock in 2019, differentiating between single-dwelling buildings (SDBs), including row houses, and multi-dwelling buildings (MDBs).

Source: *TEP Energy & Chalmers University, BSM.*

Since the millennium a large share of 22% of the floor area has been added, characterised by an increase of living space per capita.



NOTE

The energy demand is calculated following a bottom up approach based on the building geometry and efficiency of the components and systems of the building (U values, insulation thickness, efficiencies, etc.), and the target indoor temperature, for the case of heating. In addition, some behavioral aspects, as setting lower temperatures or closing the heating for certain rooms, are also considered. The final energy demand presented here includes heating, hot water, and ventilation. Domestic appliances and lighting are not included.

Figure C1.2 illustrates the carbon efficiency of the stock in terms of its GHG intensity. The building stock of Poland is heavy in terms of emissions mainly caused by the large share of fossil fuels in its energy mix. Buildings with more than 50 kg CO_2-eq/m² per year represent almost 80% of the total floor area (MDBs and SDBs combined) and only 2% emit less than 10 kg CO_2-eq/m² per year. Among the two, SDBs show a better performance than MDBs in terms of emissions, with almost 20% of their floor area emitting less than 30 kg CO_2-eq/m² per year, while only 4% of MDBs are below this level. The poorer performance of MDBs might be partially explained by the fast building techniques used during the Soviet era, which included very little or no insulation at all; on the other hand, the high emission factor for district heating in Poland, which is the main central heating system in MDBs for all periods, could explain the high level of emissions despite the increase in energy-efficient buildings in recent years.

Figure C1.3 illustrates the distribution of delivered final energy demand of the Polish housing stock and shows a majority of the floor area (60%) belonging to low-efficiency buildings (>200 kWh/m² per year) in both SDBs and MDBs. For both typologies it is possible to observe a trend towards more energy-efficient buildings starting at the 1980s as the result of more stringent building codes and retrofit efforts. Unfortunately, the energy efficiency of new buildings is still low, with only 1% of the building stock having an energy demand below 50 kWh/m² per year.

The emissions-intensive Polish building stock reflects the large share of fossil fuels in Poland's energy mix.

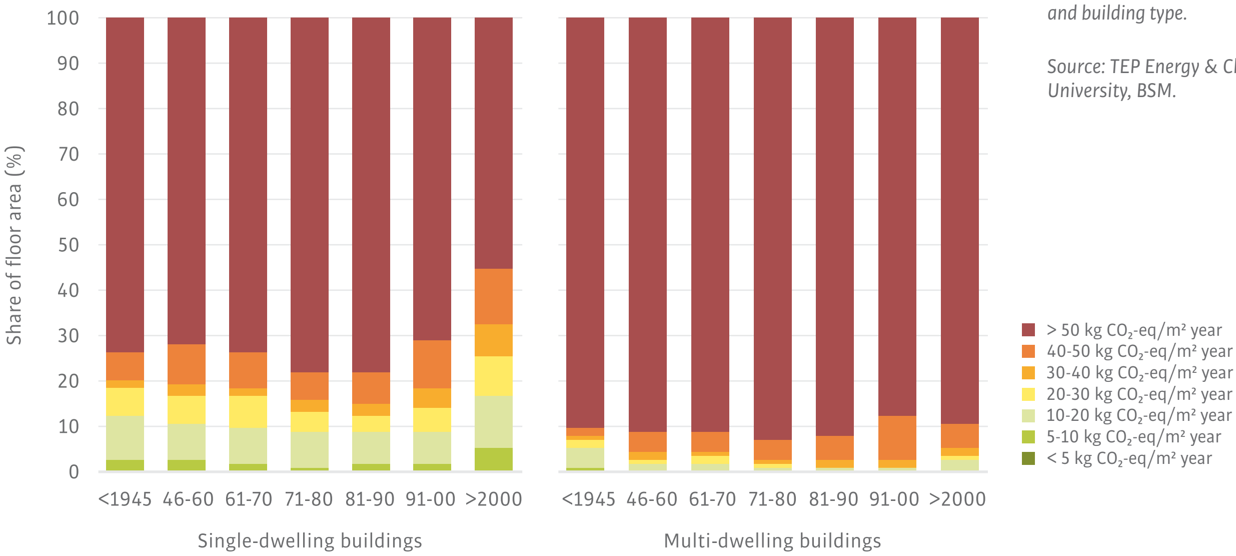


Figure C1.2
GHG intensity of the building stock in 2019 according to building age and building type.

Source: TEP Energy & Chalmers University, BSM.

The energy efficiency of new buildings is still low in Poland, with only 1% of the building stock having an energy demand below 50 kWh/m² per year.

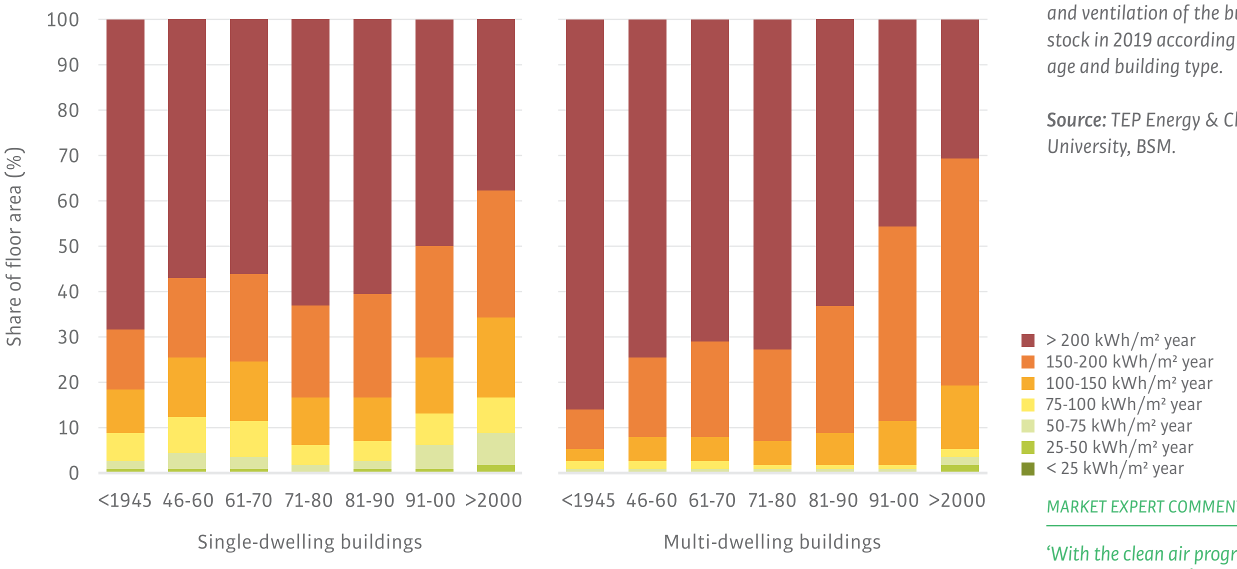


Figure C1.3
Specific final energy demand distribution for heating, hot water, and ventilation of the building stock in 2019 according to building age and building type.

Source: TEP Energy & Chalmers University, BSM.

The effects of the Polish rehabilitation programmes are slightly visible as small percentages of low-carbon buildings in the stock of older construction periods. However, the programmes have not been largely applied so far, and the retrofit measures have often only targeted single components (e.g., attic insulation, window replacement) instead of a comprehensive retrofit, leading to only marginal improvements in the efficiency of the building. This fact, together with the high share of houses that are heated by fossil fuels, results in a still significant number of buildings with high GHG emissions that need to be addressed, as well as a percentage of buildings built in recent decades that do not meet the targets of a nearly zero-energy building.

MARKET EXPERT COMMENT

'With the clean air program, 10 billion polish zlotys (2.6 billion euros) are available annually for thermal renovation. Sadly, the procedures are complicated and there is a lack of professionals to check the work done and certify that the conditions are met. Therefore, is very unlikely that this money will be spent in present conditions. There's a need to simplify the procedures and increase the qualified professionals'
*- **Andrzej Rajkiewicz**, NAPE/WUT.*

C2 Climate policy scenarios
To curb carbon emissions

NOTE

The Reference Scenario (RS) represents an upper bound of future carbon emissions. It consists of current and decided energy and climate policy goals and instruments and some moderate enforcement.

The 2-Degrees Scenario (2DS) is designed to achieve ambitious climate change mitigation goals. The <2ºC goal of the Paris Agreement of 2015 serves as a guideline. National peculiarities and implementation approaches that typically could be expected for Poland are part of this scenario.

MARKET EXPERT COMMENT

'The draft for Energy Policy of Poland until 2040 have been updated in November 2019. Although the strategy presented in this document includes increase of RES, the nuclear power is supposed to partially replace coal after 2030.'
- Anna Komerska, NAPE/WUT.

'The current Polish energy policy in the perspective until 2040 assumes that electricity and heat will be still produced from coal and assumes the implementation of nuclear energy with a slight increase in the share of RES. Such a strategy will not enable the country to transform into a carbon-free economy. For this reason the building stock model (BSM) adopts the implementation of new however, still realistic policies that will enable to achieve the ambitious climate change goals.'
- Anna Komerska, NAPE/WUT.

At present, Poland has already implemented some policy instruments to foster energy efficiency and the use of RES to curb CO_2 emissions (Section A4). These policies are mainly focused on more ambitious energy-efficiency standards for buildings and special financial instruments that indirectly foster the use of RES and low-carbon technologies in order to meet the minimum standards or the requirements for financial aid. The National Energy and Climate Plan for 2020–2030 presents the current situation and an assessment of the effects of planned policies and measures in the perspective of 2030.

The development of the market volumes very much depends on these economic and policy framework conditions and how they will develop. To reflect uncertainties in these framework conditions (arising, for instance, from decisions about policy instruments that are yet to be taken), two scenarios have been defined. Market volumes are then calculated for these two scenarios to constrain uncertainties. To ease comparison across the two scenarios, other drivers such as population growth and energy prices are kept the same in both scenarios (Section C3).

- Current and decided energy and climate policy goals and instruments are part of the RS. On the European scale, these are the Renewable Energy Directive[1], the Energy Efficiency Directive[2], the Directive on Energy Performance of Buildings[3], and the Ecodesign Directive[4]. On the national scale, building standards and regulations are found in the legal act Regulation of the Minister of Infrastructure on Technical Conditions of Buildings and their Location (12 April 2002), which is updated every few years. Important updates were introduced in 2013 when the minimum building standards were set for different starting periods (W2014, WT2017, WT2021)[5]. Also relevant are "Poland's Energy policy until 2030" (2009)[6], The 4th National Energy Efficiency Action Plan[7], and the Act of 29 August 2014 on the energy performance of buildings[8].
- The 2DS is designed to achieve ambitious climate change mitigation goals. The WT2021 building code is a significant step towards this, with more stringent standards for building elements and non-renewable energy consumption. However, to reach the <2ºC goal of the Paris Agreement of 2015 some farther-reaching measures are needed to cut direct CO_2 emissions (almost) completely from the buildings sector. To this end, new policies to achieve this target are part of this scenario. Key polices that are considered are an almost complete phase-out of fossil fuels by 2050 and a ban on fossil fuel-based heating systems in the case of new buildings. To facilitate the reduction of fossil fuels and the higher penetration of renewables, the decarbonisation of the district heating sources could be expected. In terms of existing buildings, tangible instruments are part of the 2DS, e.g. more stringent standards and scaling up the renovation by ensuring that the currently available financial programmes are used.

To achieve the aforementioned ambitious climate-change mitigation goals, concrete tangible policy instruments need to be implemented. Concrete and specific assumptions are made to substantiate input for the BSM calculation and to underpin the results regarding the short-, mid-, and long-term (2022, 2030, and 2050 respectively) development of different market segments.

- Building codes that are already ambitious in the RS shall be tightened in the 2DS. Nearly Zero Energy Buildings (nZEB) and a higher penetration of renewables are part of this scenario.
- More ambitious minimum energy performance standards (MEPS) are introduced in the 2DS in order to assure the efficient use of electricity consumption from RES, including self-produced solar energy (which is incentivised by net-metering and the trend for increasing energy prices). Moreover, a targeted innovation programme should drastically

reduce costs of building retrofitting, heat pump installation, and other RES.

— In the 2DS, extra effort will be undertaken to reinforce compliance with codes and standards and to secure the efficient operation of building technologies, particularly heating and hot water systems (e.g. by means of mandatory annual inspection).

— In order to foster the diffusion of low-carbon and efficient technologies and retrofitting measures, a CO_2 tax will be introduced after 2030. Tax revenues will be used to scale-up the existing retrofitting and RES subsidy programmes.

— The subsidy programmes for retrofitting and preferential loans will be maintained and reinforced.

— Based on urban energy planning, the district heating networks will be modernised, extended, and fuelled by an important share of RES such as solar, geothermal and residual heat, and waste combined with heat storage installations.

— The electricity generation will also be transformed, replacing coal-powered plants mainly with RES.

— These policy instruments will be complemented and underpinned with coherent information measures (e.g. energy and performance labels and certificates) and an education programme that includes builders, installers, and planners.

NOTE

The building stock model (BSM) simulates the dynamics of the building stock and the energy and climate-related decisions of building owners and tenants. Decisions, e.g. regarding choice of heating system or whether to retrofit, depend on:

- *technology prices and their energy performance,*
- *energy prices (including taxes),*
- *subsidies, tax exemptions, and other financial incentives,*
- *codes and standards, and*
- *availability (e.g. of RES and of energy infrastructure)*

NOTE

The policy scale highlights the current level of ambition in implemented climate policy (RS) in Poland and how this might be adapted in order to reach climate targets (2DS).

Conservative policy framework for the Reference Scenario in Poland.

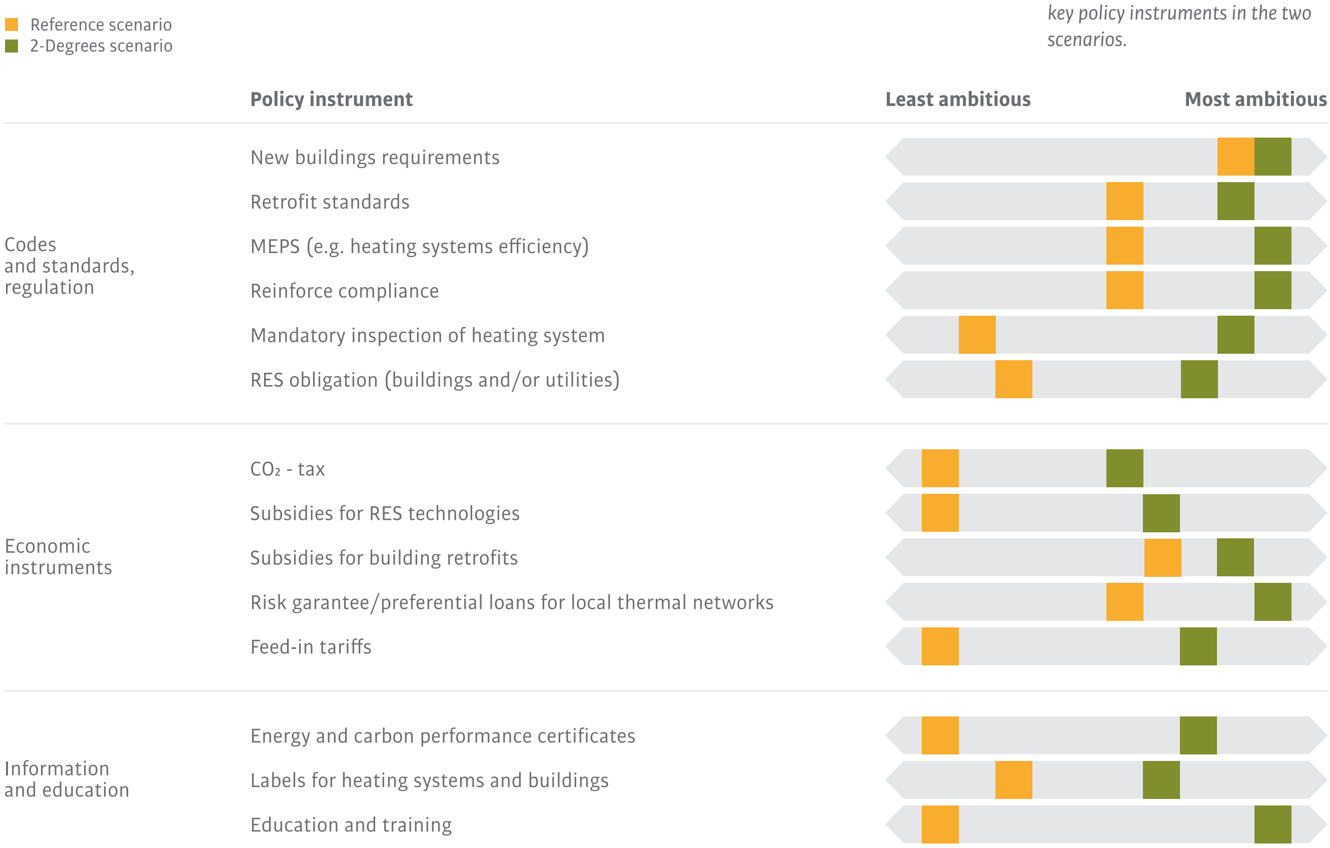


Figure C2.1
Overview of the ambitions for key policy instruments in the two scenarios.

C3

Development scenarios
Drivers and general implications

NOTE

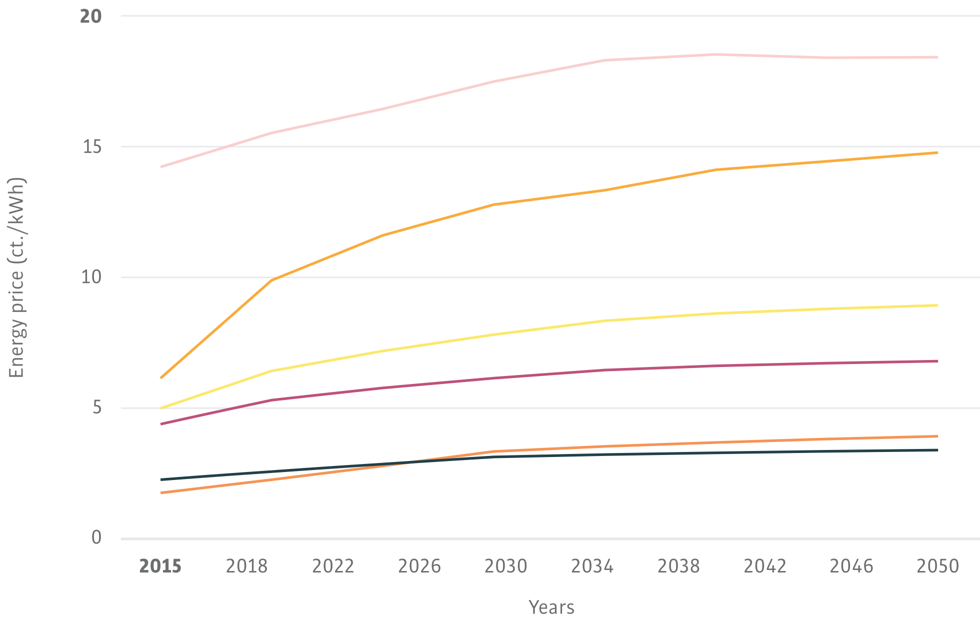
The impact of such drivers is highlighted in sensitivities analyses that are provided by the CUES foundation. For more information write us to: info@cuesanalytics.eu

Drivers such as population and energy price developments are kept the same in both scenarios in order to increase their comparability. The population development is based on the EU Reference Scenario[9] and is shown in Figure C3.1 along with the assumed energy price development. These drivers target different aspects, i.e. the population development mainly drives the new construction activity in the market, while energy price development is a key driver for the diffusion of low-carbon technologies and retrofitting activities.

Figure C3.1
Energy price development in the two scenarios.

Source: *EU Reference Scenario, EUROSTAT, ENERGIFORSK, TEP Energy and Chalmers University.*

Increasing trend for fossil energy prices.



MARKET EXPERT COMMENT

'Heat pumps still represent a very small market share. Especially in existing buildings they are very rarely installed. This assumption is very optimistic, however, a continuous and significant increase in sales of heat pumps has been observed in recent years.'
*- **Szymon Firląg,** WUT.*

On the basis of the framework conditions outlined above, the main findings on final energy demand and GHG emissions are illustrated in Figure C3.2 and can be summarised as follows:

— The population decreases by up to 2% by 2030; however, the total residential floor area increases by 5% over the same period due to an increase in the floor area per person. After 2030 the population continues to decline, with a total decrease of 9% by 2050 compared with present values. The development of the floor area slows downs with a moderate increase of 2% in 2050 compared with 2030.

— Although the total floor area increases by 2030, delivered final energy demand for heating, hot water, and ventilation decreases by 7% in the RS and by 17% in the 2DS. For 2050, the reduction reaches 40% in the RS and 65% in the 2DS (compared with 2019). This is due to building code requirements for new construction as well as retrofitting activities that take place in both scenarios. The higher reduction of delivered final energy demand in the 2DS, which includes RES, is due to increased retrofitting activities and more stringent standards. In this scenario, retrofitting activities are fostered as a consequence of subsidies and the assumption of the introduction of a CO_2 tax as well as a reduction in the costs for retrofitting and renewable heating systems through targeted innovation programmes.

— The reduction in the energy demand by 2050 is also reflected in the reduction of the GHG emissions by 55% in the RS and by 86% in the 2DS. The higher reduction in the 2DS is also the result of policies intended to decarbonise the energy mix by increasing the share of RES in centralised and decentralised electricity and heat production.

— Currently, fossil fuels are dominant in the Polish housing sector, particularly coal (Figure C3.3). In the RS, the demand for coal is reduced by almost half and gas demand by 82% by 2050. With the assumption of more ambitious policies, coal, fossil oil, and gas are phased out almost completely by 2050.

— Fossil fuels are mainly substituted by heat pumps, solar energy, and wood in the 2DS. The replacement with heat pumps leads to an increase in electricity sales from 8 to 26 TWh/year in 2050.

NOTE

Ambient Heat is the heat extracted by the heat pump from the air, ground, or groundwater to heat the building.

While floor area stabilises in the medium term, energy demand and GHG emissions are significantly reduced for both scenarios.

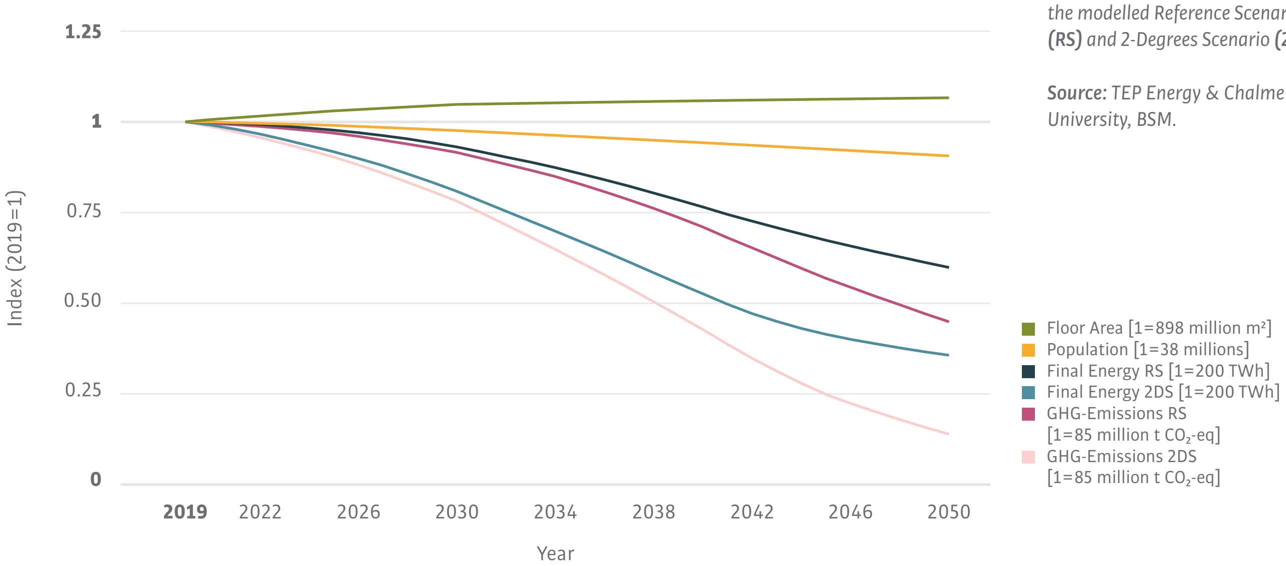


Figure C3.2
Development of floor area, energy, and GHG emissions according to the modelled Reference Scenario ***(RS)*** *and 2-Degrees Scenario* ***(2DS)****.*

Source: *TEP Energy & Chalmers University, BSM.*

Fossil fuels are mainly substituted by heat pumps and solar energy in the 2-Degrees Scenario.

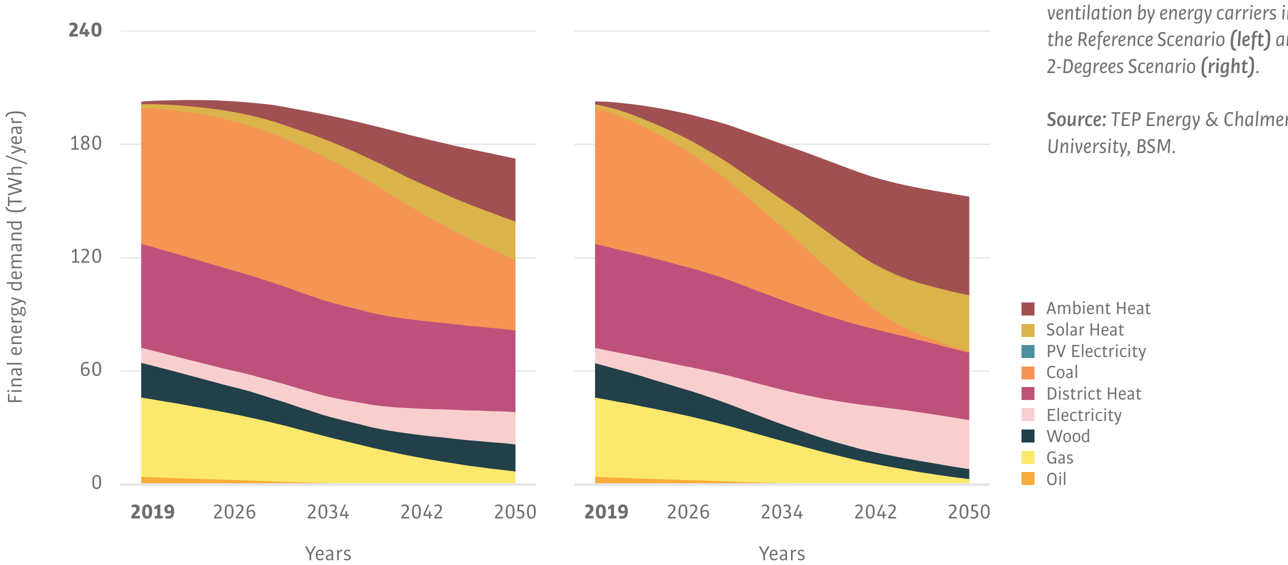


Figure C3.3
Development of the final energy demand for heating, hot water, and ventilation by energy carriers in the Reference Scenario ***(left)*** *and 2-Degrees Scenario* ***(right)****.*

Source: *TEP Energy & Chalmers University, BSM.*

C4

Development of the building stock
Structure, energy, and greenhouse gas emissions

NOTE

Partially retrofitted means that a building has 1 or 2 building components that have been retrofitted in an energy-efficient manner since 2015.

Comprehensively retrofitted means that a building has 3 or more building components that have been retrofitted in an energy-efficient manner since 2015.

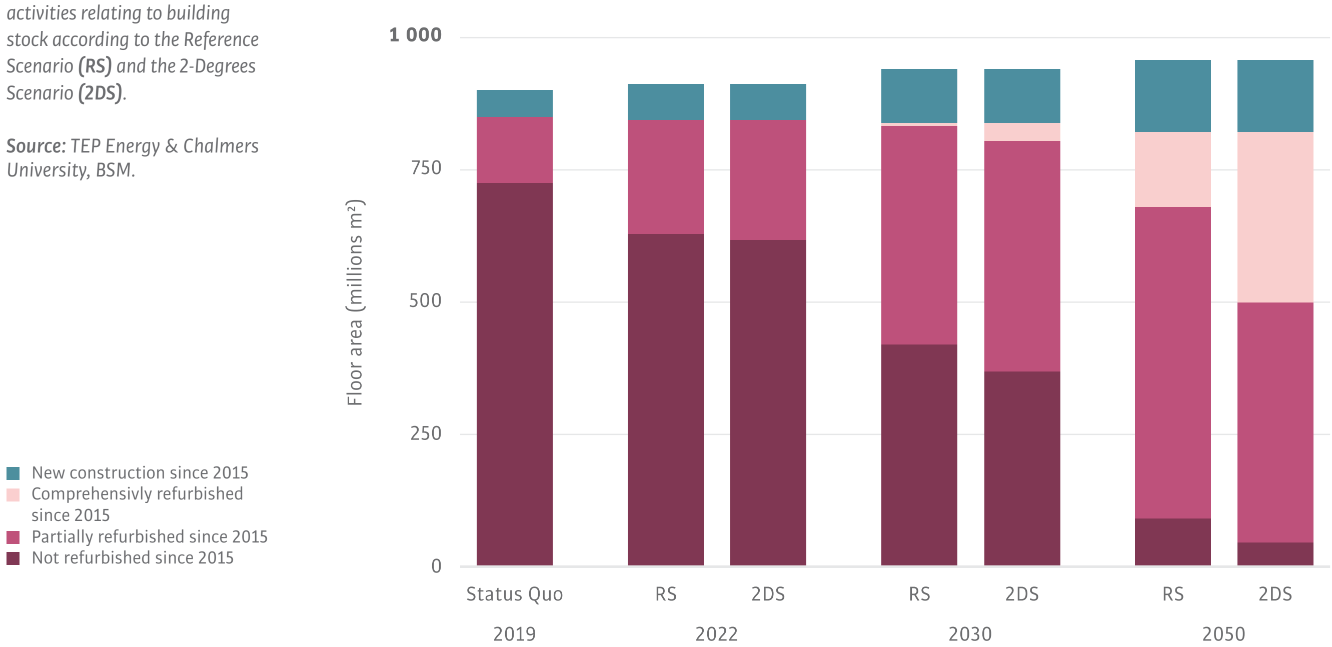
In both scenarios, the residential building stock of Poland is projected to grow from about 903 million m² of floor area to 963 million m² in 2050. The stock existing in 2019, however, is projected to decrease over this time period by 3% down to 873 million m² by 2050 as a result of demolition. This still means about a 10% net addition in floor area by 2050, with newly constructed buildings making up 9% of the floor area in 2050. This increase in floor area is driven by an increasing demand for floor area per person, which counteracts the overall shrinking population. This is mainly explained by the decrease in the average number of persons per dwelling due to a trend towards smaller household sizes.

The retrofit activities in the existing stock are an on-going process until 2050 (Figure C4.1), at which point both scenarios expect that most buildings will be at least partially refurbished. In the short term, the retrofit rate is projected to remain almost the same under both scenarios. Retrofits are carried out mainly as component-based retrofits resulting in similar percentages of partially refurbished buildings. In the medium term, the retrofit activity should increase more in the 2DS compared to the RS, in both quantity and depth of renovation, which is a consequence of subsidies, tax incentives, and the introduction of a CO_2 tax. This is reflected in the larger percentage of comprehensively refurbished buildings (4% of the stock) compared to the RS (1% of the stock). This trend continues in the long term until 2050, when a total of 36% of the stock is comprehensively refurbished in the 2DS, while only 16% is comprehensively refurbished in the RS.

Figure C4.1
Retrofitting and new construction activities relating to building stock according to the Reference Scenario **(RS)** *and the 2-Degrees Scenario* **(2DS)**.

Source: *TEP Energy & Chalmers University, BSM.*

By 2050 both scenarios expect that most buildings will be at least partially refurbished.



At present, the vast majority of the residential buildings in Poland (79%) emit more than 50 kg CO_2-eq/m² per year (Figure C4.2). In the short term (until 2022), both scenarios anticipate only minimal changes in the GHG intensity of the building stock, but in 2030 this percentage is reduced for both scenarios (66% for the 2DS) and there is a slight increase in the percentage of buildings emitting less than 20 kg CO_2-eq/m² per year. This is the result of the decarbonisation of the energy mix and to a smaller degree to retrofit efforts and the addition of new and more efficient buildings to the stock after 2019.

After 2030 the energy performance of buildings shows a significant improvement, resulting in a large share of the stock emitting less than 20 kg CO_2-eq/m² per year in both scenarios (48% for the RS and 81% for the 2DS) by 2050, and an important share emitting less than 10 kg CO_2-eq/m² per year (38% for the RS and 61% for the 2DS). Some buildings with less than 5 kg CO_2-eq/m² per year start to gain a presence in this period for both scenarios, representing more than 10% of the total floor area in the RS and 22% in the 2DS. The higher energy performance of buildings in the 2DS is mainly the result of policies dedicated to phasing out fossil energy from the heating sector, mainly driven by a shift from coal boilers to electrically driven heat pumps and solar energy, as well as the decarbonisation of the Polish district heating and electricity mix based on the EU reference scenario[10]. The continued efforts in building retrofitting also contribute to the better performance of the building stock in the long term.

NOTE

Emission factors for electricity (0.79 kg CO_2/kWh) and district heating (0.51 kg CO_2/kWh) are based on the current country mix and are changed over time based on the projected changes in the production technology according to the EU reference scenario. GHG emissions embodied in the construction of the building are not included.

Carbon-efficient buildings only start to gain a presence in the long term.

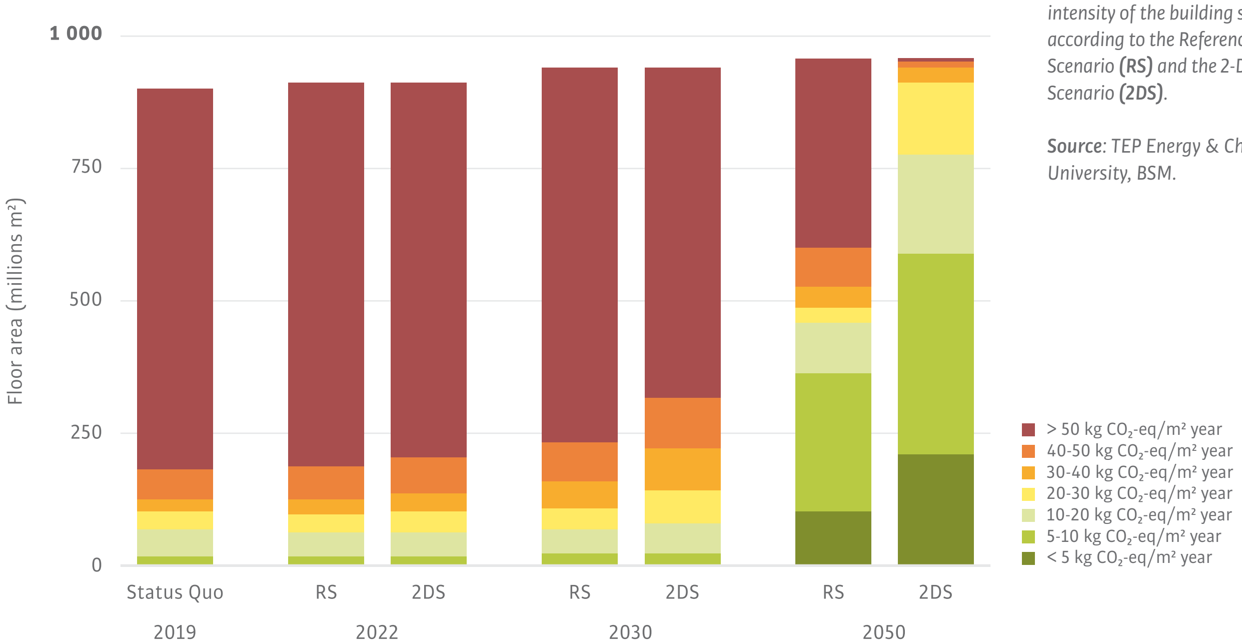


Figure C4.2

*Structural changes in the GHG intensity of the building stock according to the Reference Scenario **(RS)** and the 2-Degrees Scenario **(2DS)**.*

***Source**: TEP Energy & Chalmers University, BSM.*

C5

The building markets
Market volumes and development

NOTE

Construction activities not directly related to energy and GHG emissions (e.g. structural or interior work, kitchens, and bathrooms) are not included.

The market volumes presented in this and the next sections reflect the demand side. Possible shortages in capacity by the supply side to deliver (both in labour and material) are not explicitly taken into account.

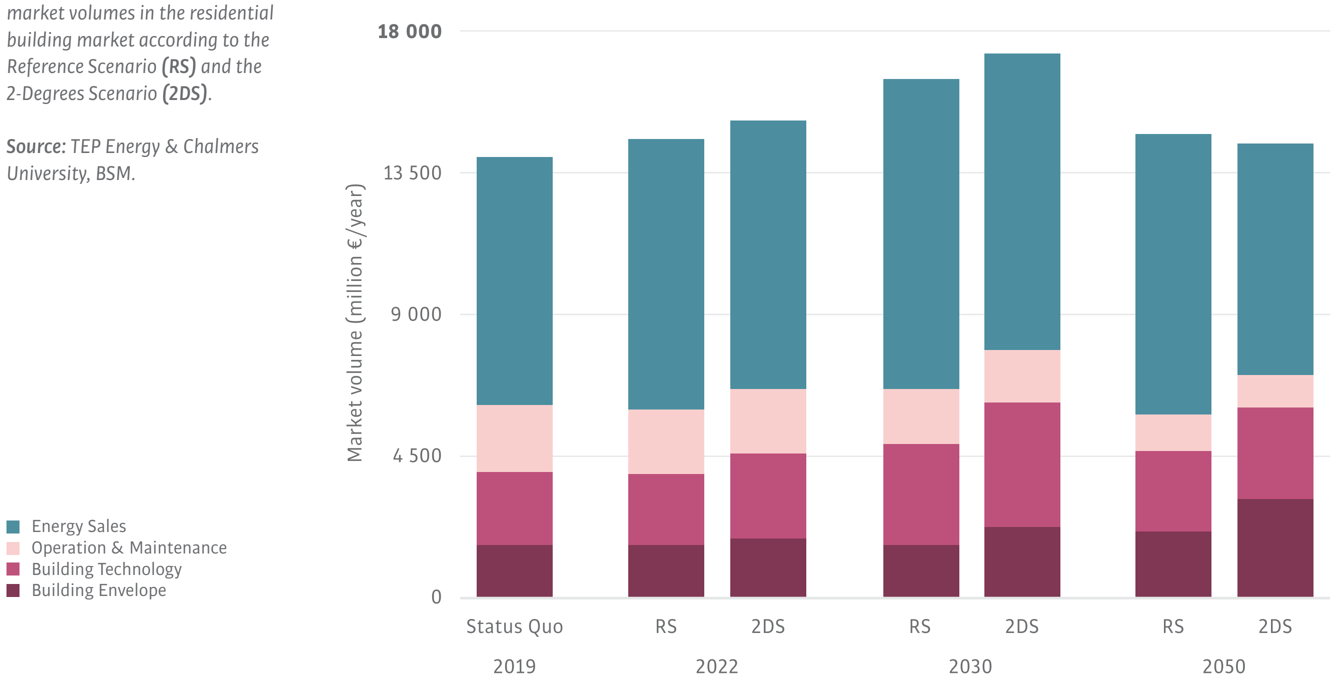
In this and the following sections, the energy and GHG-related building market demand is assessed. This includes the building envelope market, the building technology market, and related energy sales. Within this scope, the building envelope market encompasses all construction, retrofitting, reinstatement, and maintenance activities on building envelope components (walls, roofs, floors, and windows). The building technology market includes heating, hot water, and ventilation technologies. In the category of energy sales, all energy related to the building envelope and building technologies is included, whereas electricity sales from household appliances and CO_2 taxes are not. Hence, the entire value chain related to energy consumption and GHG emissions, including planning, installation, material and product sales, operation and maintenance, and the like is covered for both existing buildings through retrofit and the construction of new buildings.

According to BSM calculations, the total market volume of the energy and GHG-related building market including energy sales amounts to €14 billion per year in 2019 (Figure C5.1). The majority of this market volume comes from energy sales (€8 billion per year) even though electricity sales for household appliances are not included. The rest is split between building technology (€2.3 billion per year), operation and maintenance (€2.1 billion per year), and building envelope (€1.7 billion per year).

Figure C5.1
Development of energy-relevant market volumes in the residential building market according to the Reference Scenario **(RS)** *and the 2-Degrees Scenario* **(2DS)**.

Source: *TEP Energy & Chalmers University, BSM.*

In the long term, the overall market volumes decrease in both scenarios following a reduction in the energy sales, which cannot be offset by the increase in other markets.



In the short term, the overall market volume slightly increases in the RS due to energy sales, while in the 2DS, the higher volume is the result of a more important increase in the building technology sales (16%).

The total market volume increases until 2030 in both scenarios, explained by higher energy and building technology sales (24% and 36%, respectively, for the RS compared with 2019) that in turn offset the decrease in the operation and maintenance market volume. The higher increase for the 2DS is explained by more important growth in the building technology and building envelope markets (67% and 35%, respectively, compared with 2019). This is mainly triggered by the beginning of the implementation of policies and programmes that support the phase out of fossil-fuel heating systems and the consequent shift of fossil-fuelled heating systems to heat pumps and solar energy.

In the long term until 2050, the overall market volumes decrease in both scenarios compared with 2030. The reduction in the energy demand in the building sector in both scenarios leads to a decreased market volume in energy sales, which cannot be offset by the increase in other markets. The market for the building envelope continues to increase in both scenarios, with a substantial increase in the 2DS of 87% compared with 2019 values as renovation efforts continue to take place to comprehensively renovate the building stock. These efforts are also visible in the RS, but the smaller depth of renovation carried out in this scenario translates into a much lower increase compared with present values (25%). On the other hand, the market for building technologies and energy sales starts to shrink, reaching a decrease of 25% and 22% for the 2DS compared with 2030 and a net decrease of 7% for energy sales compared with present values.

The market volume is split about 25%–75% between labour and materials due to lower labour costs in Poland.

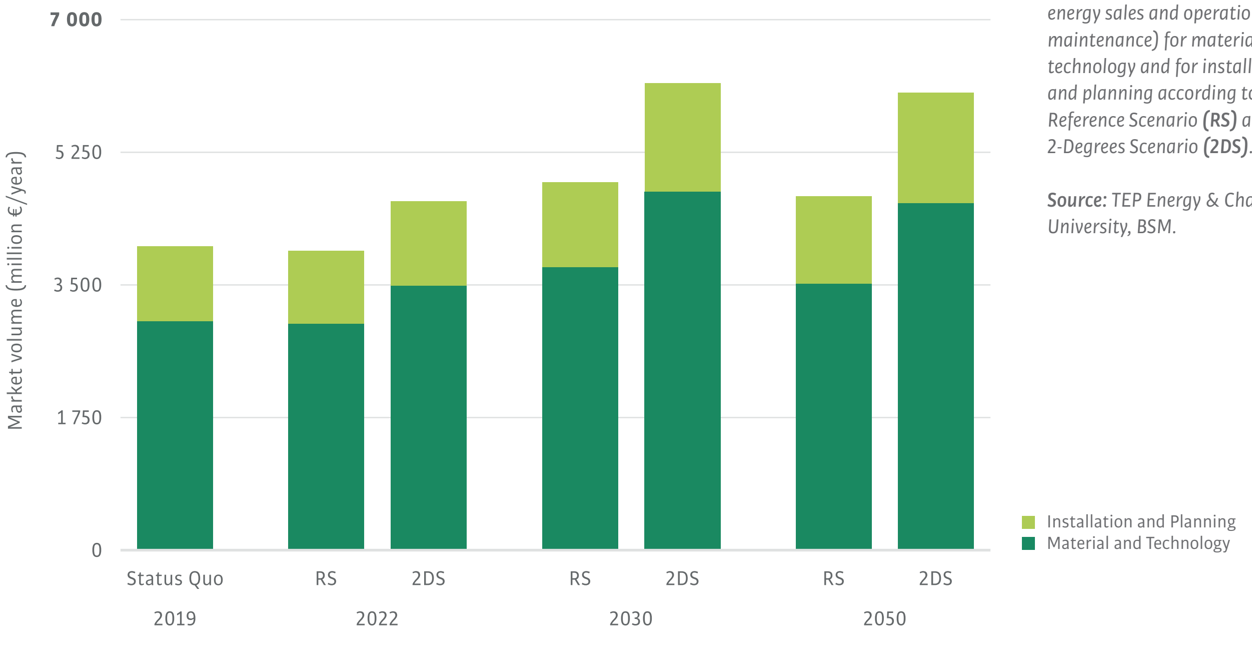


Figure C5.2
Development of energy-relevant market volumes (excluding energy sales and operation and maintenance) for material and technology and for installation and planning according to the Reference Scenario ***(RS)*** *and the 2-Degrees Scenario* ***(2DS)****.*

Source: *TEP Energy & Chalmers University, BSM.*

The building market volume in 2019 is split about 25%–75% between installation, engineering, and technical planning (€987 million per year) and material and technology (€3 billion per year) due to lower labour costs in Poland. In the medium and long term, it is expected that the market will keep increasing for both categories, reaching €4.8 billion per year (57%) for the material and technology category in 2030, and €1.4 billion per year (44%) for installation and planning in the 2DS by 2030, without much change until 2050.

C6 *The building envelope market*
Market volumes and development

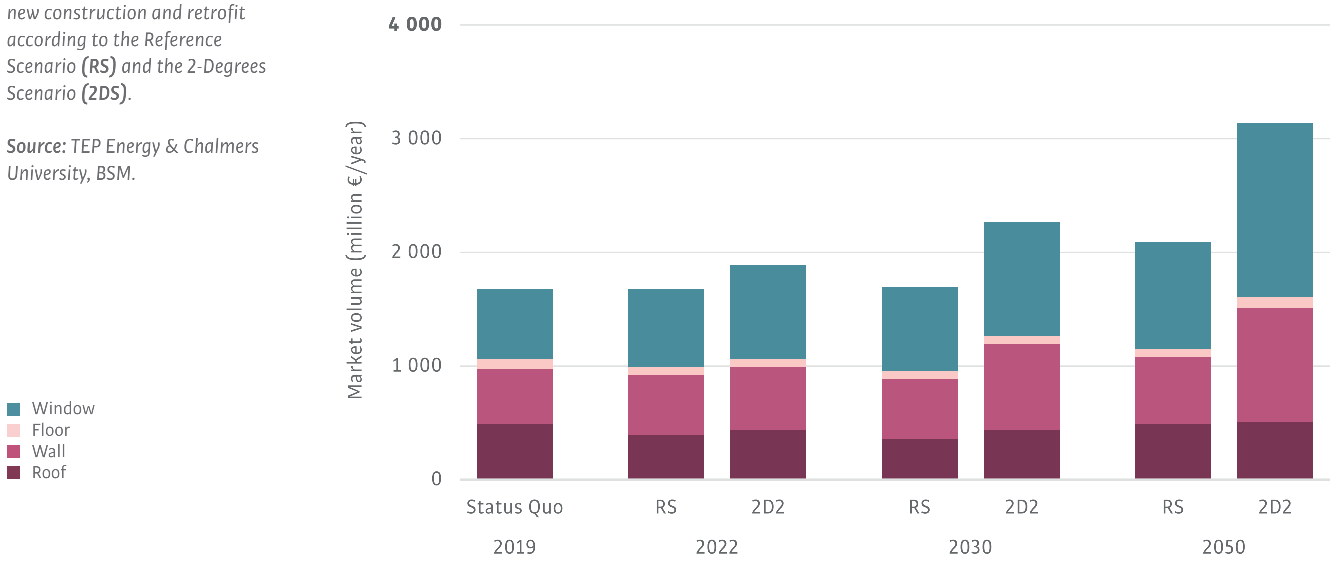
The current annual market volume in the building envelope market amounts to €1.7 billion per year and comprises different main building components (Figure C6.1). Window installation, replacement, and retrofit measures make up the largest share (€627 million per year, 37%), and the rest is split between wall (€497 million per year, 29%), roof (€484 million per year, 29%), and floor measures (€81 million per year, 5%).

In 2019, the majority of the building envelope market stems from activities related to retrofitting and renovation of existing buildings (53%) reaching a market volume of €892 million per year. New construction is also quite active at the moment, reaching a market volume of €797 million per year.

Figure C6.1
*Development of energy-relevant market volumes for various building components for both new construction and retrofit according to the Reference Scenario **(RS)** and the 2-Degrees Scenario **(2DS)**.*

Source: *TEP Energy & Chalmers University, BSM.*

In the medium and long term, the total market volume shows a growing trend for both scenarios as a result of increasing retrofit activities that compensate for the decreasing trend in new construction.



The envelope market volume remains more or less the same for the RS in the short term as the moderate increase in retrofit activities offsets the beginning of the decline in new construction activities. For the 2DS the situation is similar, but a higher activation of retrofit activities as related policies starts to take hold translates into a net increase in the total market volume for the envelope (12%). This increase comes mainly from market volumes related to windows and walls that offset small reductions in the volumes for floors and roofs.

In the medium term, the total market volume remains stable for the RS (+1%) and has a moderate to high increase for the 2DS (35%) compared with 2019 values, despite the continued decrease in new construction activities. The decline in new construction activities is expected considering the decreasing trend in population that is not compensated anymore by a higher living space per capita.

In the long run, up to 2050, market volumes keep increasing for both scenarios (25% for RS and 87% for 2DS compared to 2019 values), which is explained again by a significant increase in retrofit activities. This high level of retrofit activities is reasonable to expect considering that an important part of the building stock was added in recent years (after the 2000s), and some elements of the envelope will be in need of replacement and renovation by then.

The higher volume in the 2DS is the result of more stringent standards and deeper levels of renovation that translate into more expensive solutions. Moreover, the scaling up of national programmes and the increasing prices of fossil fuels work as drivers for retrofit.

The envelope market volume is split about 37% and 63% between labour and materials.

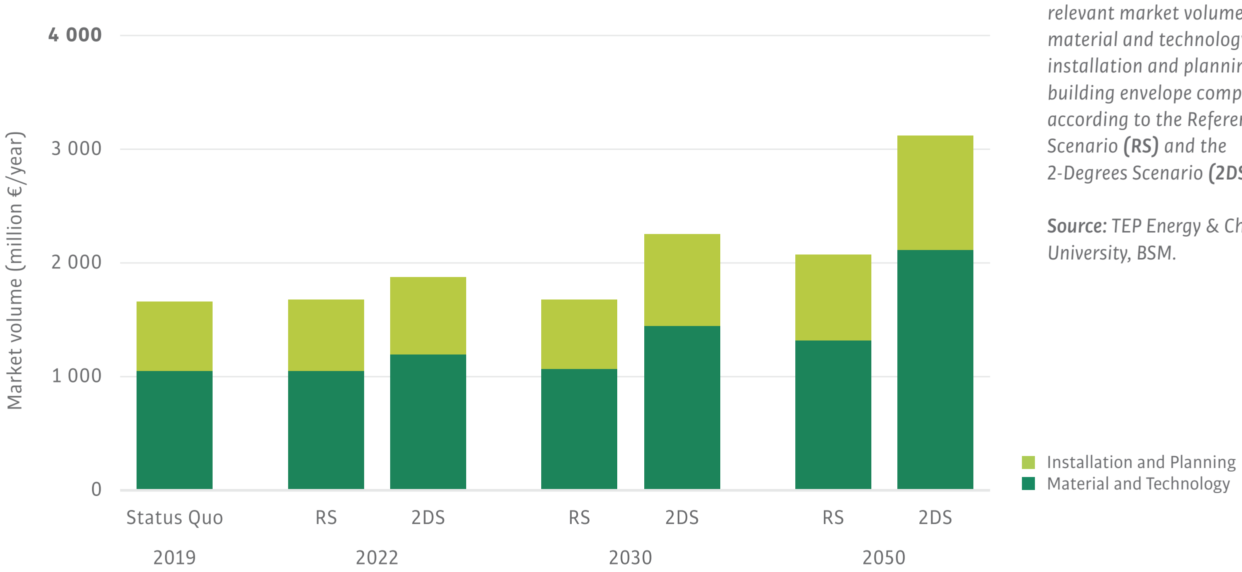


Figure C6.2
*Development of the energy-relevant market volume for material and technology and installation and planning for building envelope components according to the Reference Scenario **(RS)** and the 2-Degrees Scenario **(2DS)**.*

***Source:** TEP Energy & Chalmers University, BSM.*

The envelope market volume is split about 37% and 63% between installation, engineering, and technical planning (€613 million per year), and material and technology (more than €1 billion per year) (Figure C6.2). This proportion is maintained for the RS up to the long term, but the material and technology category gains more relevance in the 2DS as higher standards usually mean more expensive materials (68% instead of 63%).

In the short and medium term, the market volumes in the RS remain stable but in the 2DS start to grow (13% in 2022 and more than 30% in 2030 for both categories) as a result of a more important increase in retrofit activities that offsets the decrease in the volumes from new construction activities. For the 2DS, the market volumes from retrofit activities double for the category of material and technology (73% for installation and planning) reaching €1.6 billion per year. This is the result not only from the increase in retrofit, but also from an increase in the extent of retrofit (e.g., through the application of thicker insulation and more efficient windows) due to higher building standards.

In the long run, the market volumes increase for both scenarios. In the RS, material and technology increases to €1.3 billion per year (24% compared with 2019) and in the 2DS to €2.1 billion per year (100%). The installation and planning market volume increases to €769 million per year (25%) in the RS and to €1 billion per year (65%) in the 2DS. This is explained by the age of the building stock and the implementation of stringent building standards and policies that are much more developed after 2030.

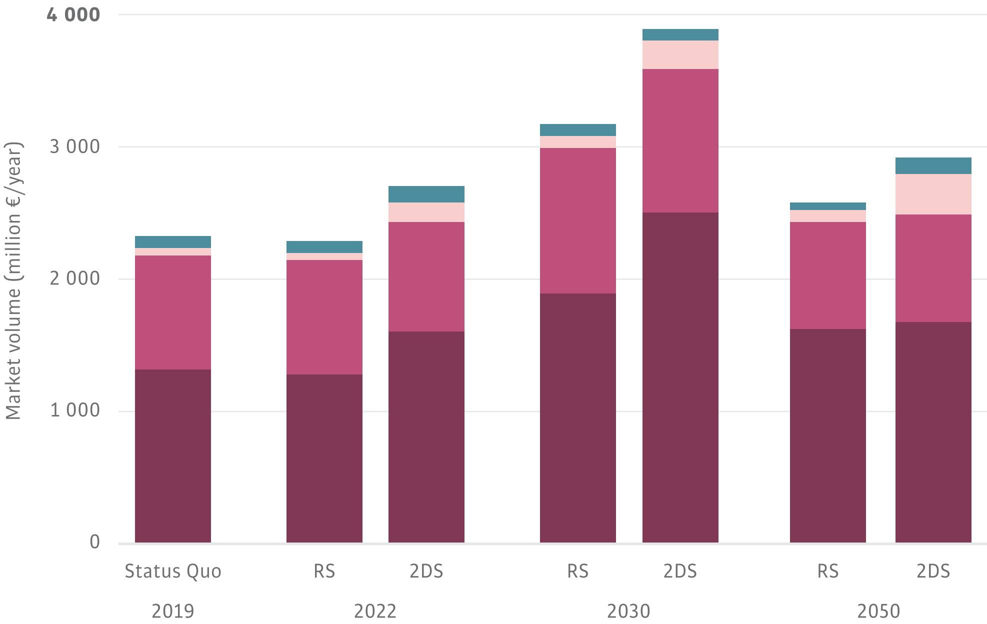
C7 The building technologies market
Market volumes and development

The current volume of the Polish residential building technologies market amounts to €2.3 billion per year. The majority of this market is made up of heating systems with €1.3 billion per year, followed by hot water systems with €882 million per year (Figure C7.1). The remaining market volume is split into ventilation systems and solar systems (both thermal solar collectors and photovoltaic systems) with about €95 and €48 million per year, respectively.

Figure C7.1
Development of energy-relevant market volumes for various building technologies for both new construction and retrofit according to the Reference Scenario **(RS)** *and the 2-Degrees Scenario* **(2DS)**.

Source: *TEP Energy & Chalmers University, BSM.*

Heating systems represent the higher individual share in the building technologies market.



NOTE

The market volume for ventilation systems covers mechanical ventilation systems with and without heat recovery. Cooling systems are currently not reported in the market volume for building technologies. However, the market volumes for heating systems (Section C8) include reversible heat pumps, which are used for cooling as well as heating.

In the short term, the market volume for building technologies sees a small decrease for the RS (2%) following the decrease in new construction activities. This decrease is reflected in the volumes from all technologies except solar systems, which show an increase of 39% compared with 2019. For the 2DS, retrofit activities offset the decline in new construction as the total market volume reaches €2.7 billion per year with a total net increase of 16%. Apart from the decrease in hot water systems (−6%), all market volumes increase. The most important absolute contribution comes from heating systems for which the volume increases by 23% for the 2DS, followed by solar systems. The volume for solar systems increases in both scenarios, reaching €67 and €142 million per year for the RS and 2DS, respectively. This is explained by the increasing demand for these systems in new constructions and in the replacement of old heating systems.

In the medium term until 2030, the total market volumes for both scenarios increase reaching €3.2 (36%) and €3.9 billion (67%) per year in the RS and 2DS, respectively. In the RS the sales go up for heating (45%) and solar systems (79%). The 2DS shows a significant increase compared with present values as the result of the stronger penetration of renovation programmes and greater compliance with the new building codes. Another possible driver is the change in energy prices due to the decarbonisation of district heating and the possible introduction of a CO_2 tax that lowers the economic viability of fossil systems. Moreover, the reduced cost of renewable heating systems through innovation programmes and subsidies helps to finance the shift towards more expensive heating solutions such as heat pumps. As a result, there is a large increase in the market volume for heating systems to €2.5 billion (91%) and solar systems to €203 million (320%) compared with present values.

In the long run towards 2050, the total market volume decreases for both scenarios compared with 2030 (−19% for RS and −25% for 2DS) as new construction activities decrease after 2030 (−61% and −58% compared with 2030 values for the RS and 2DS, respectively). Furthermore, the reduction is also due to the majority of the stock being at least partially refurbished in both scenarios (Figure C4.1). On the other hand, cost reductions (especially for heat pumps) lead to a reduced market volume for heating and hot water systems compared to 2030 values.

The materials cost for switching to more efficient building technologies remains higher than the planning costs.

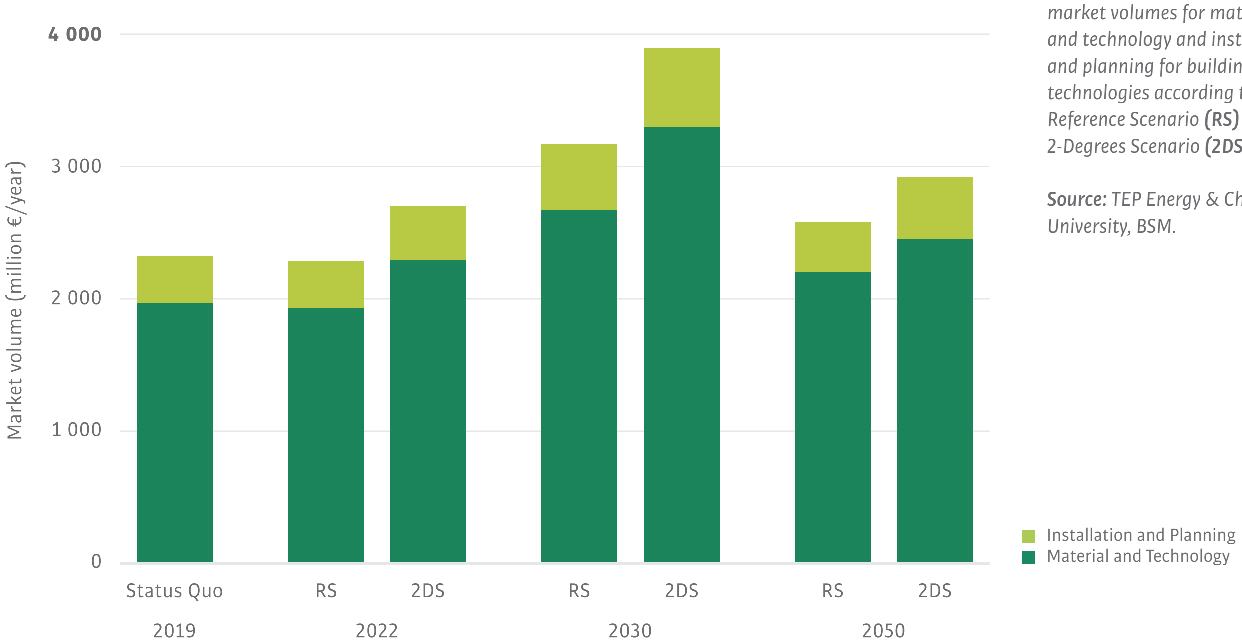


Figure C7.2
*Development of energy-relevant market volumes for material and technology and installation and planning for building technologies according to the Reference Scenario **(RS)** and the 2-Degrees Scenario **(2DS)**.*

Source: *TEP Energy & Chalmers University, BSM.*

The building technologies market volume (Figure C7.2) is made up of about 16% installation and planning (€373 million per year) and 84% material and technology (almost €2 billion per year). The variations in the short term maintain similar proportions, with a slight increase in material and technology (1%) for the 2DS.

In the medium term, market volumes peak as new construction activities have not yet drastically dropped and retrofit activities are fully engaged, particularly for the 2DS. In this scenario, the market volume increases up to €611 million per year (47%) for installation and planning and to €3.3 billion per year (51%) for material and technology. This is largely driven by the replacement of fossil heating systems and the resulting increase in sales of more investment-intensive heat pumps. Although higher planning efforts might be needed for switching heating systems (e.g., due to the change from coal to RES), the material cost of this remains higher.

In the long term, the market volume for both categories decreases. In the RS, market volumes fall to €2.2 billion per year (−18% compared with 2030) for material and technology and €386 million per year (−23%) for installation and planning, while in the 2DS the volumes drops to €2.5 billion and €459 million, respectively (−25% for both categories).

C8 *A deep dive into the heating system market*
Market volumes and development

NOTE

The market volumes shown in this chapter cover only the main heating system of the building. The market volumes from technologies used as complementary systems (as thermal solar in many cases) are not included here.

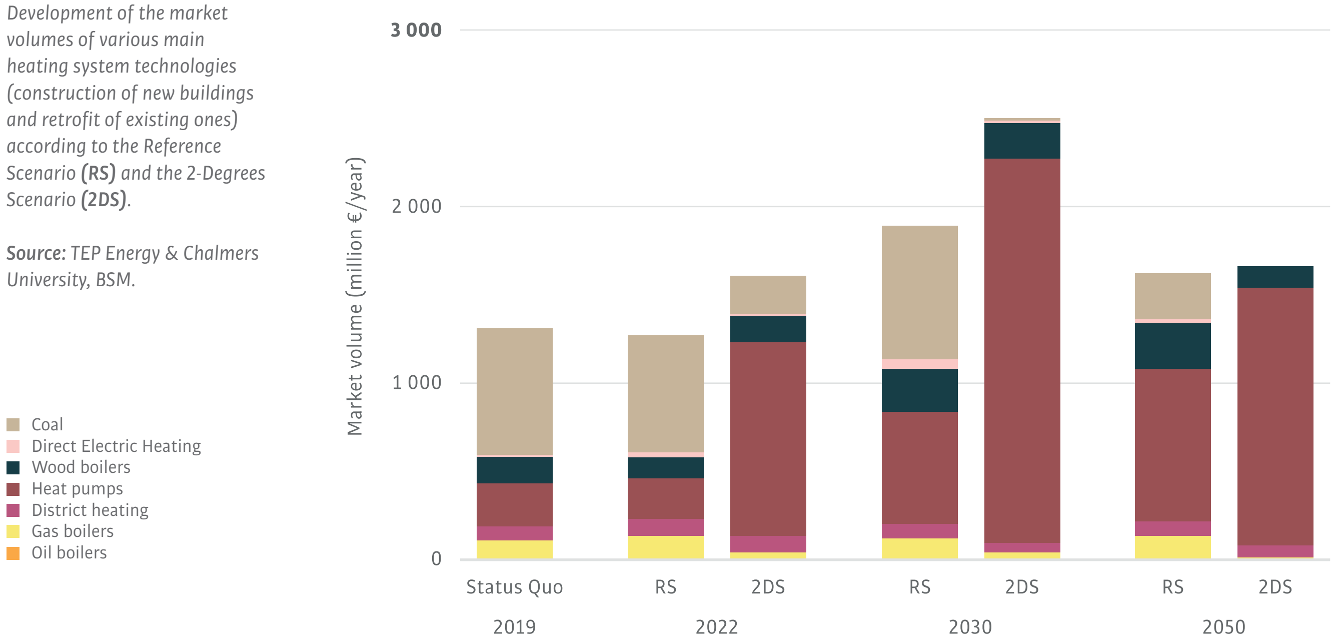
The current annual market volume for main heating systems amounts to €1.3 billion per year, the majority of which comes from sales and installation of coal boilers and stoves (included in the "Coal" category) with a market volume of €715 million per year. The second largest share comes from the sales and installation of heat pumps (€241 million per year) and the third from wood boilers (€153 million per year). The rest of the market volume is made up from gas boilers, district heating, and direct electricity (Figure C8.1).

In the short term, the total market volumes slightly decrease in the RS (3%) as a consequence of the decline in new construction. However, investments related to district heating and gas show a small increase. In the 2DS the overall market volume increases to €1.6 billion per year (23%) as retrofit activities are higher than in the RS and policies to promote alternatives to fossil fuels take effect. These systems are replaced mainly by heat pumps, for which the market volume shows important growth reaching more than €1 billion per year.

Figure C8.1
*Development of the market volumes of various main heating system technologies (construction of new buildings and retrofit of existing ones) according to the Reference Scenario **(RS)** and the 2-Degrees Scenario **(2DS)**.*

Source: *TEP Energy & Chalmers University, BSM.*

Heat pumps dominate the market early on in the 2DS, but also in the RS in the long term.



Until 2030, the RS shows an important increase in the total market volumes of 45% compared with 2019 (reaching €1.9 billion), which is characterised by an increase in the sales of heat pumps and wood boilers compared with 2019. For the 2DS, there is a greater increase (91% compared with 2019) reaching €2.5 billion per year, with a strong decline in the volumes for fossil fuels. This shift is compensated by heat pumps with a market volume of almost €2.2 billion per year.

Until 2050, heat pumps dominate the market for the RS, compensating for the decreasing sales for coal boilers, while gas and district heating investments remain more or less stable. On the other hand, total market volumes are reduced in both scenarios (−15% for RS and −33% for 2DS compared with 2030), but still higher than present values. This mainly is the result of the important reduction in new construction activities (especially after 2030), but also to the decrease in heating system replacement related to retrofit activities. Moreover, more efficient buildings (and consequently smaller-sized heating systems) and the overall reduction of costs for renewable heating systems also contribute to the reduction in market volumes. Indeed, these systems will rapidly diffuse in the 2DS and make up almost the entire market already in 2030, and they will dominate the market even in the RS by 2050. Heat pumps are the main alternative to fossil fuels in the 2DS, representing 88% of the total market volume, while in the RS, they have the non-negligible share of 53%.

While the retrofit sector is dominated by coal boilers and stoves, heat pumps have the largest share in the new construction sector.

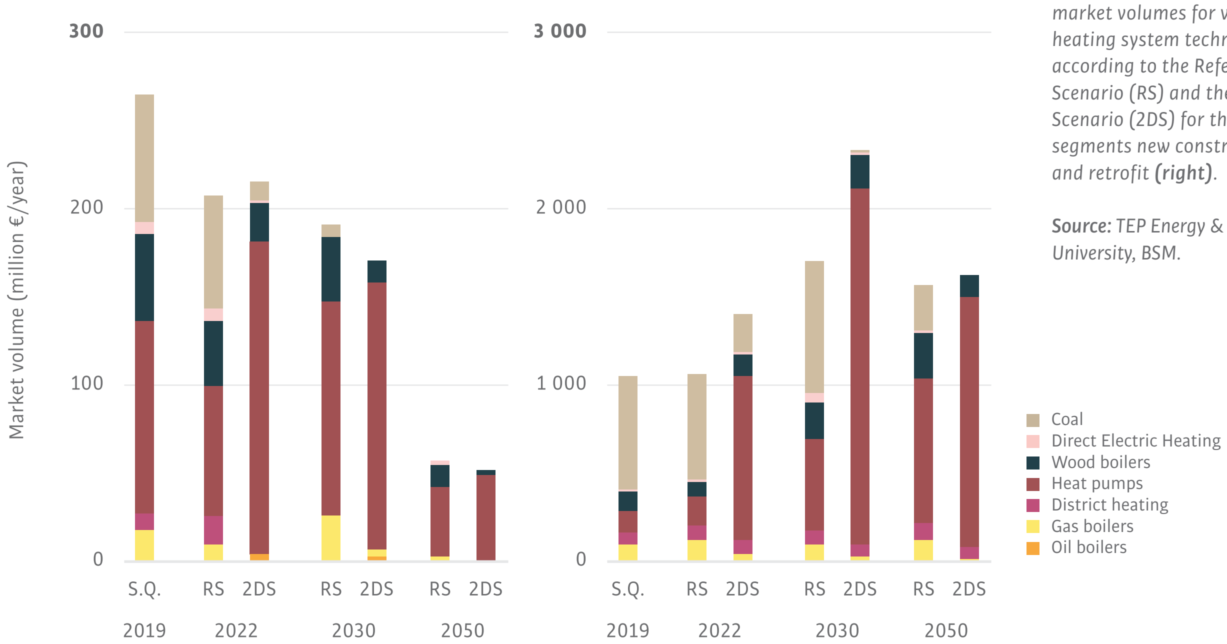


Figure C8.2
*Development of energy-relevant market volumes for various main heating system technologies according to the Reference Scenario (RS) and the 2-Degrees Scenario (2DS) for the market segments new construction **(left)** and retrofit **(right)**.*

Source: *TEP Energy & Chalmers University, BSM.*

In 2019, the heating system market (Figure C8.2) is made up of about 20% new construction (€266 million per year) and 80% retrofit (€1 billion per year). While the retrofit sector is dominated by coal boilers and stoves, which make up 61% of the market, heat pumps already have an important share in the new construction sector with 41% of the market. However, coal boilers and stoves still make up an important share of 28%, followed by wood (18%) and gas (7%) boilers.

In the short term, new construction activities decrease; however, the share of heat pumps used in new construction increases from 41% to 82% for the 2DS. In the 2DS, heat pumps make up a market volume of €177 million per year, while in the RS the resulting market volume amounts to €73 million per year. In the medium and long term, renewable heating systems dominate the market, while fossil fuels are almost completely phased out already by 2030 in the 2DS, and only minimal shares can be expected by 2050 for the RS.

For the existing stock, coal-fuelled heating systems are still a major technology in the RS in the short term, representing 56% of the total market volume for retrofit activities. In the medium term, the market volume is mainly split between heat pumps and coal (30% and 44% respectively), showing a growing trend for low-carbon solutions even in this conservative scenario but still a strong dominance for fossil energy. In contrast heat pumps already dominate the market in the 2DS, with 87% of the total volume coming from investments related to this technology. In the long term, heat pumps dominate the market for both scenarios with €827 million for the RS (53% share) and €1.4 billion for the 2DS (87% share). In the latter, coal-fuelled heating systems are almost completely phased out.

In summary, the major share of the market for main heating systems will come from activities in existing buildings, with a clear trend towards heat pumps as the preferred technology to replace fossil-fuelled systems.

Conclusions and recommendations

This section provides conclusions and recommendations based on the findings presented in the preceding chapters about market and framework conditions (Chapter A), the stakeholders' perspectives (Chapter B), and future market developments for two different scenarios (Chapter C).

We aim these findings might be relevant for companies, utilities, and authorities that are active in the fields of construction, building technology, or the field of energy provision in the built environment.

Although the conclusions are as evidence-based as possible, the reader might have different views given his or her experience and the inherent uncertainty of the future. We, however, are convinced that exciting times are coming, and we are mighty to shape them together.

Conclusions and recommendations

The residential building sector in Poland is of high relevance, both with respect to economics and to GHG emissions. Indeed, households in Poland allocate about 22% of their expenditures to housing and energy, the energy and GHG-related market amounts to €14 billion per year, and the building sector accounts for about 12% of the country's GHG emissions (including upstream emissions stemming from electricity and district heat generation). GHG emissions originate directly from the dominant share of coal for heating as well as from the low energy efficiency of the building stock. This is also the reason for the high concentration of other pollutants in the air, causing the phenomenon of smog to be constantly present in inhabited areas of Poland. There are great challenges ahead for this sector given the age structure of both the buildings and the owners as well as the refurbishment backlog. An additional challenge is the poorly expressed determination of the state authorities to achieve climate goals. The retrofit of existing buildings and their provision with renewable energy is at the core of the challenge because the population in Poland is decreasing and the construction of new buildings will become less relevant in the upcoming years. From the analysis presented in this BMB, we conclude that these challenges and goals will not be met under current market trends and policy conditions.

— The construction of new buildings is still perceived as the most attractive activity in the construction sector. The opportunities of the retrofit market are often disregarded because they are considered a less attractive segment due to their complexity and associated risks. Building refurbishment is still a relatively expensive process, and without significant subsidies it is often not economically profitable.

— The energy-efficiency building retrofit rate is far too low to significantly curb the level of GHG emissions. This is a result from both demand side and supply side decision patterns. The majority of retrofit projects are limited to only the necessary improvements, and therefore existing fossil systems (mainly coal fired) are often replaced with the same type of system. Renewable energy systems are often perceived as having too long payback times based on present energy prices.

— Low retrofit rates are also the result of the fragmented structure of both owners, which to a large extent are private persons, and retrofit companies, which are predominantly small craft companies.

— Current policy instruments are not sufficient to significantly curb these trends. Building codes still very much focus on new buildings and comprehensive retrofits (which are uncommon). Subsidy programmes have been strongly focusing on partial retrofits of MDBs and public buildings and are not sufficiently funded. Environmental taxes such as the CO_2 levy have not yet been launched, and energy prices, especially coal, are too low to provide sufficient incentive for building retrofits.

However, there is a rising awareness regarding the influence of humans and of the building sector on the environment. This is mainly related to recent broad discussions in Polish media regarding health problems related to very poor air quality. Along with increasing societal awareness, it can be expected that changes will be implemented in the coming years. Moreover, the long-term challenge of affordable housing, and the trend of migration from the countryside into cities, increase the need for residential space, especially for middle- and low-income groups in urban areas. This is expected to be one of the drivers for the refurbishment markets. There is an urgent need for simplified planning and building solutions that allow faster and cheaper construction of high-quality building envelopes and renewable energy systems with substantially less labour – either through refurbishment or by substituting existing buildings with new ones.

To foster these changes, policy support is still needed to overcome various barriers and to bridge socio-economic, structural, and behavioural gaps. To achieve the goals of the Paris Agreement, which aims to constrain the global temperature increase below 2 degrees Celsius, we recommend implementing the following mix of policy instruments: (i) tighten the building codes, including a complete ban on fossil energy in the case of new buildings, (ii) implement mandatory energy-efficiency standards to ensure the efficiency of appliances and energy systems, particularly heat pumps, (iii) enforce compliance with codes and standards and secure the efficient operation of building technologies, particularly heating and hot water systems, (iv) increase the existing energy levy and existing subsidies and prolong grants and further develop them towards a carbon tax, (v) promote the extension and modernisation of existing and the creation of new thermal networks to connect buildings in urban areas with locally bound RES, and (vi) replace coal-powered combined heat and power with RES to transform the Polish energy mix. These policy instruments need to be complemented with coherent information (e.g. energy and performance labels and certificates – the existing EPC system has to be urgently upgraded and officially promoted) and marketing and with an education programme that includes builders, installers, planners, and architects. The effect of these policy instruments is modelled in the 2-Degrees Scenario (2DS).

— This more ambitious scenario shows, compared to the reference scenario, a substantially greater reduction of GHG emissions that stems mainly from increased retrofit activities that entail the use of modern technologies of thermo-insulation (including prefabricated systems) as well as broader implementation of RES. In this scenario, more than half of the old buildings are refurbished by 2030 and almost the whole stock by 2050.

— The building sector and its related energy market are gradually transformed, and the market volume of energy and O&M sales is shrinking (from €10 billion per year to €8 billion per year in 2050) and retrofit and renewable energy-related products, projects, and services gain relevance (from €4 billion per year to €6 billion per year in 2050). Decentralised heat pumps for SDBs and MDBs in less densely populated areas and central heat pumps in urban areas, the latter in connection with thermal grids, will play a prominent role in the 2DS. This transformation offers new and interesting opportunities for companies offering relevant technologies and services, and city and other energy utilities will likely adjust their business models and seek to cover a broader scope of the value chain by complementing their energy sales activities with related services or by supplying low-carbon energy systems (e.g. heat pumps) or energy carriers (e.g. district heating from RES). System integration and remote energy management is an opportunity both for technology providers and for energy utilities.

Even if Poland does not implement policy instruments in exactly the same way as proposed in this BMB, it is quite probable that significant changes will occur given that rising energy prices will provide more economic reasons for stakeholders to take action. Thus, they are recommended to anticipate these developments and to invest accordingly, keeping in mind that their role in this sector might change significantly due to changing market dynamics. They must find ways to deal with the fragmented market structure, to develop the market (e.g. with partnership models), and to respond to the needs and the (latent) motivations of building owners. This will lead to positive environmental and economic benefits and to the simplification of project implementation.

This BMB report provides evidence for the potential for improvement in the residential building stock, placing it as one of the key sectors to help Poland reach its climate goals from both the demand side and the supply side. This transformation demands a building sector prepared to provide the necessary expertise and technologies to deliver a more energy-efficient and low-emission building sector that can also ensure the comfort and health of its inhabitants.

Annex

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How was this information gathered in the survey?

B3
Technology competences
Level of familiarity with specific technologies

Respondents were asked ***"How familiar are you with the following technologies?"***. They were then provided with a pre-selected list of technologies and the answer options: "no experience", "worked with it once", "worked with it several times", and "part of day-to-day business" for all technologies.

Additionally, respondents were provided with the options of "I don't know" and "Other" and given the opportunity to add technologies they felt relevant in a free-entry field.

This question allowed participants to choose more than one answer option. Thus, the percentage of answers was calculated on the basis of the total number of options selected.

B4
Current status of the building stock
Measures implemented across building typologies

To gather the information presented in this section, respondents were first asked to define what type of project they had last worked on. They were provided with six answer options:

(a) construction of single-dwelling buildings
(b) construction of multi-dwelling buildings
(c) overhaul or partial retrofit of single-dwelling buildings
(d) overhaul or partial retrofit of multi-dwelling buildings
(e) retrofit or comprehensive retrofit project in single-dwelling buildings
(f) retrofit or comprehensive retrofit projects in multi-dwelling buildings.

They were then asked, ***"What measures were implemented in your latest project?"*** and provided with a table with 9 different elements covering all building components, which they had to choose from. Then they had to indicate what type of measure it was. The answer options were "Maintenance (including repair)", "Upgrade of existing elements or systems (including insulation and control)", and "New elements or systems". Additionally, they were provided the options of "I don't know" and "Other".

This question allowed participants to choose more than one answer option. Thus, the percentage of answers was calculated on the basis of the total number of options selected.

B5
The technology selection
Insights into the stakeholders' power and interactions

The participants of the survey were asked, referring to their latest project, ***"Who were the most important actors you were in contact with for the technology selection?"*** Based on the identified stakeholders, they were then asked, ***"What was the level of influence and interest of the following stakeholders on the technology selection in your last project?"*** Respondents were then provided with a Likert scale of the answer options from 0 to 5 (from "None" to "Very high", respectively). They were then asked, ***"How often did you assume the actors communicated with each other for the technology selection?"*** They were again provided with a Likert scale of answer options from 0 to 5 (from "Never" to "Daily", respectively). For all queries, respondents were also provided with the options of "I don't know" and "I had no contact with anyone".

The final responses are listed in B5.1 and B5.2, indicating the median value of the level of importance of each stakeholder group in the decision leading to the selection of the technology. For both the level of power (size of the circles) and the level of communication, the median value in the total responses was categorised into five main groups:

No power or communication (0 in the Likert scale), Very low level of power or communication (1 in the Likert scale), Low level of power or communication (2 in the Likert scale), Medium level of power or communication (3 in the Likert scale), High level of power or communication (4 in the Likert scale), Very High level of power or communication (5 in the Likert scale).

Further information on Social Network Analysis (SNA)
Two main types of networks exist in SNA, namely complete networks and ego-networks. A complete network implies studying all ties in an entire population. Given that the information used for the analysis is extracted from a survey, the network displayed in B5 corresponds to an ego-network. In the case of the graphs presented in this report, the ego is defined by demand-side actors, including investors or developers, housing companies (for profit), housing companies or housing associations, cooperatives (public/part governmental/non-profit), and private house owners (rented out or self-occupying).

B6 Motivations and obstacles to energy efficient and low-carbon technologies

The demand-side's perspective

B6.1 Respondents were asked ***"What were the main motivations for your project?"*** They were then provided with a pre-selected list of arguments structured into environmental, technical, economic, social, and legal clusters as well as the option to select "Other" or "I don't know".

B6.2. To identify what were the main barriers to not pursuing higher-performing technologies, survey respondents were asked ***"What were the hindering factors for not implementing more energy efficient or low-carbon technologies in your project?"*** They were then provided with a pre-selected list of arguments structured into environmental, technical, economic, social, and legal clusters as well as the option to select "Other" or "I don't know".

The results reflect the demand-side perspective, including non-professional organisations (such as private house owners) and professional organisations (such as investors, developers, and housing companies). The questions allowed participants to choose more than one answer option. Thus, the percentage of answers was calculated on the basis of the total number of options selected.

B7 Promising approaches to achieving climate goals

Potential in new and existing buildings

Survey respondents were asked, ***"What technology or approach has the highest potential to contribute to reach ambitious climate-protection goals in Poland?"***. They were provided with a preselection of 8 aspects as well as "Other", "I don't know", and "None", either for new buildings or for retrofit projects.

Participants could choose more than one answer option. Thus, percentages of answers were calculated based on the total number of options selected. Results are presented for new buildings and retrofit projects.

B8 Barriers & drivers to specific technologies

Bridging the gap towards climate goals

Respondents were asked to state for which specific technologies they had a level of practical experience (see B2). For those technologies they reported as having a high level of practical experience, they were asked in relation to the barriers, ***"What is the biggest barrier for the scaling up of this technology in Poland?"*** In relation to the drivers, survey respondents were asked, ***"What needs to happen in order to scale up this technology in Poland?"***. The answer options were clustered between environmental, technical, economic, social, and legal aspects. Additionally, they were provided the options of "I don't know" and "Other".

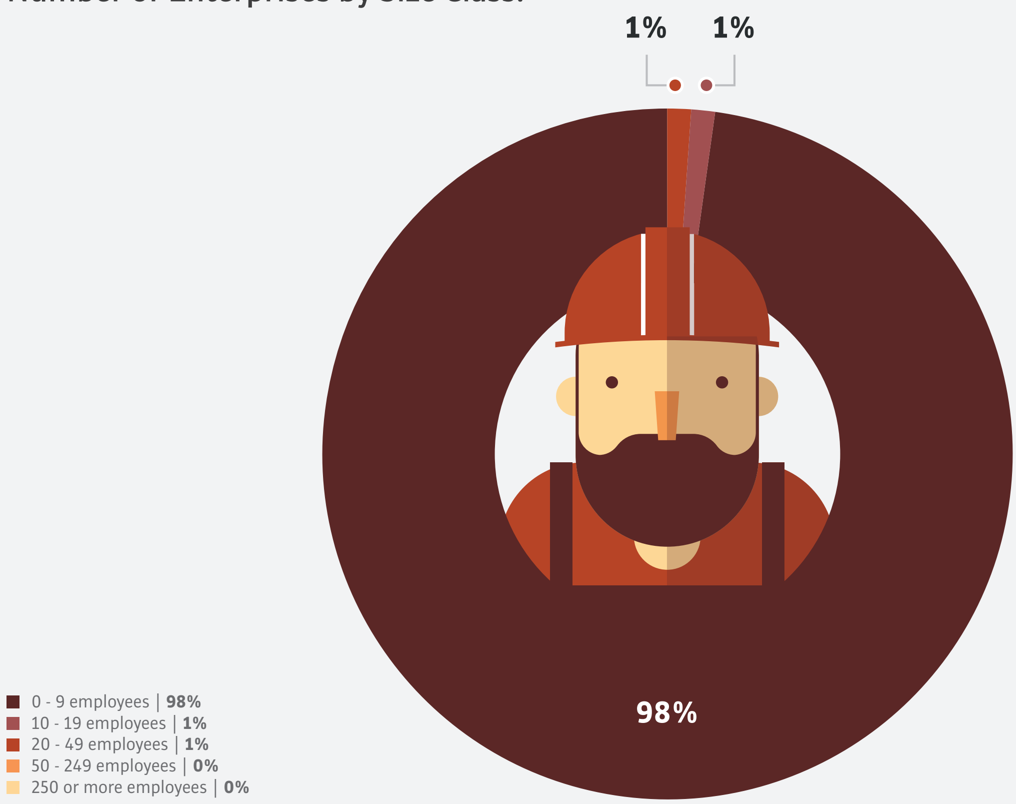
This question allowed participants to choose more than one answer option. Thus, the percentage of answers was calculated on the basis of the total number of options selected.

Building Value Chain
Main activities and total of enterprises by number of employees

Main activities and number of enterprises by size class

ACTIVITY/PROFESSION	SIZE CLASS BY NUMBER OF EMPLOYEES					TOTAL
	0 TO 9	10 TO 19	20 TO 49	50 TO 249	250 OR MORE	
CONSTRUCTION	257 141	3 349	2 188	813	79	263 570
CONSTRUCTION OF BUILDINGS	69 489	1 537	1 052	478	42	72 598
Development of building projects	17 711	244	136	63	6	18 160
Construction of residential and non-residential buildings	51 778	1 293	916	415	36	54 438
SPECIALISED CONSTRUCTION	187 652	1 812	1 136	335	37	190 972
Demolition and site preparation	11 277	161	71	14	2	11 525
Electrical, plumbing, and other construction installation activities	64 211	972	678	170	18	66 049
Building completion and finishing	81 432	312	154	39	1	81 938
Other specialised construction activities	30 732	367	233	112	16	31 460

Number of Enterprises by Size Class.



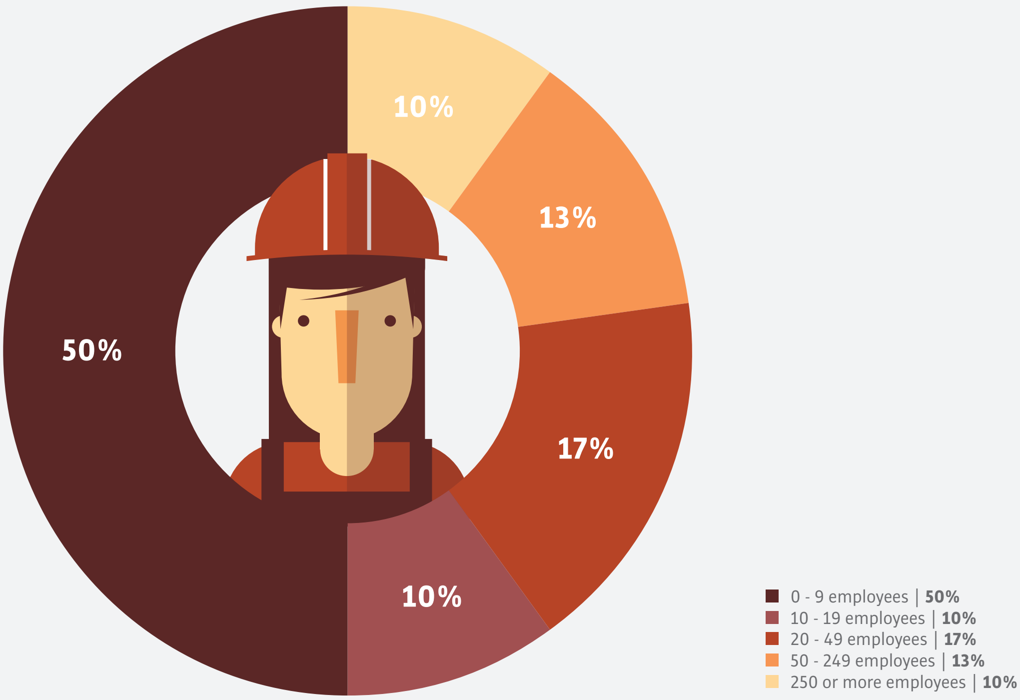
Source: Eurostat, data for 2017. Total for construction exclude civil engineering activities

Main activities and total number of employees by size class.

ACTIVITY/PROFESSION	SIZE CLASS BY NUMBER OF EMPLOYEES					TOTAL
	0 TO 9	10 TO 19	20 TO 49	50 TO 249	250 OR MORE	
CONSTRUCTION	233 112	46 923	60 323	76 083	47 306	463 747
CONSTRUCTION OF BUILDINGS	89 600	21 644	29 245	43 956	24 740	209 185
Development of building projects	21 855	3 442	3 907	5 771	2 755	37 730
Construction of residential and non-residential buildings	67 745	18 202	25 338	38 185	21 985	171 455
SPECIALISED CONSTRUCTION	143 512	25 279	31 078	32 127	22 566	254 562
Demolition and site preparation	13 717	NA	NA	NA	NA	19 363
Electrical, plumbing, and other construction installation activities	56 261	13 640	18 727	15 893	11 919	116 440
Building completion and finishing	46 332	NA	NA	NA	NA	58 656
Other specialised construction activities	27 202	5 154	6 536	NA	NA	60 103

"NA" – Data not avilable

Total Employees by Size Class.



Source: *Eurostat, data for 2017.*
Total for construction exclude civil engineering activities

Building Inventory Factsheet

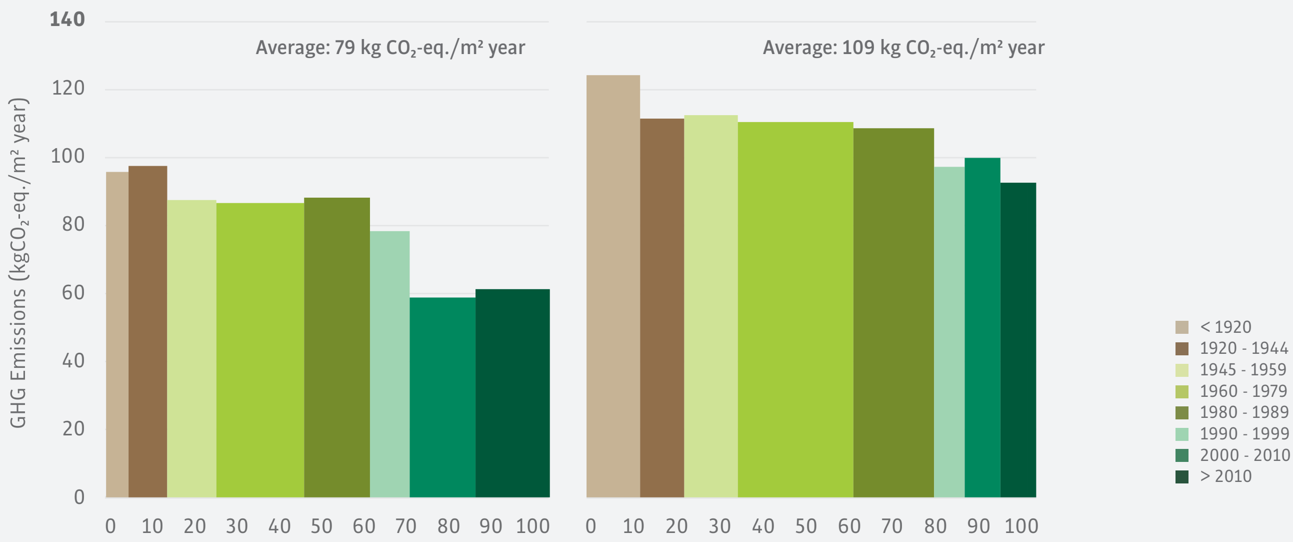
SDBs
Single-dwelling buildings

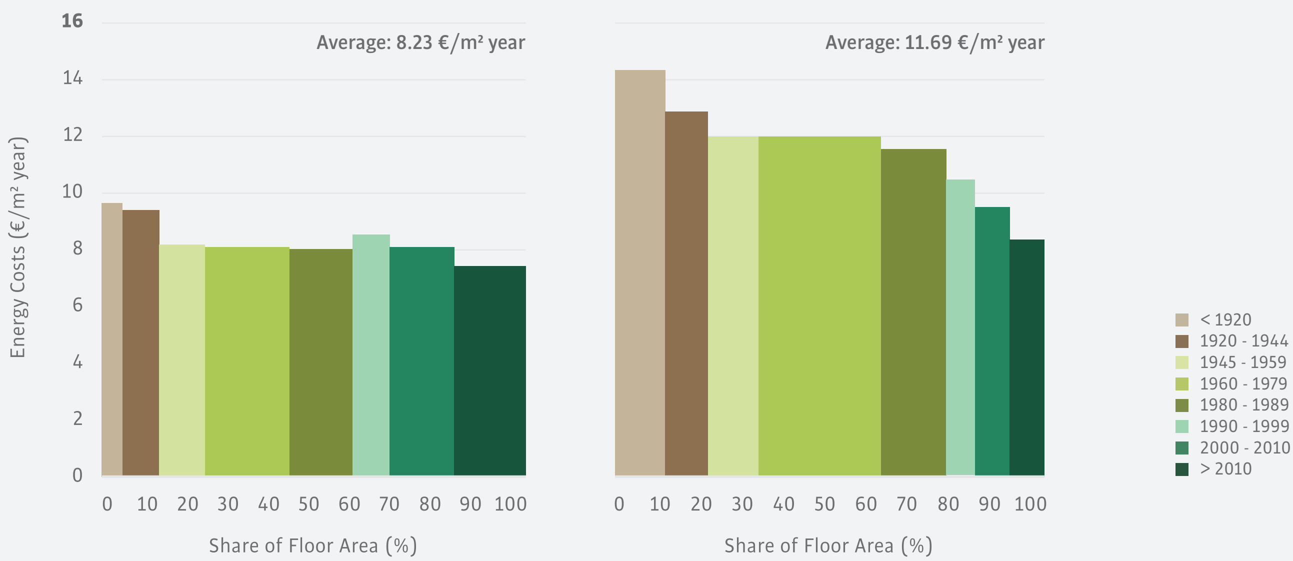
Building period	1920	1945	1960	1980	1990	2000	2010	
Details								
Cumulative floor area (million m²)	22.30	40.90	47.90	93.70	68.00	45.20	65.40	78.20
Heated floor area (m²)	76.70	72.90	75.10	83.90	105.60	118.60	128.30	134.80
Average number of floors (#)	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Envelope surface area (m²)	217.70	211.20	220.10	235.60	274.10	297.50	313.20	323.90
Window wall ratio (%)	30%	30%	30%	30%	30%	30%	40%	40%
U-Value (W/m² K)								
Wall	1.27	1.26	0.98	0.78	0.60	0.48	0.44	0.46
Roof	1.45	1.39	0.86	0.72	0.69	0.63	0.40	0.37
Floor	1.14	1.12	1.14	1.16	0.89	0.60	0.56	0.46
Window	2.50	2.49	2.51	2.51	2.49	2.50	2.03	1.92
Heating Systems								
Oil boiler	3%	2%	1%	0%	1%	2%	5%	3%
Gas boiler	8%	10%	14%	13%	12%	24%	24%	20%
District heating	1%	1%	0%	0%	1%	3%	1%	1%
Heat pumps	1%	1%	1%	1%	1%	2%	0%	7%
Wood boiler	21%	18%	11%	11%	11%	8%	19%	16%
Direct electricity	1%	1%	0%	0%	0%	0%	0%	1%
Coal boiler	65%	67%	73%	74%	74%	60%	51%	52%

MDBs
Multi-dwelling buildings

Building period	1920	1945	1960	1980	1990	2000	2010	
Details								
Cumulative floor area (million m²)	51.80	44.20	51.00	115.90	77.50	34.70	32.30	34.40
Heated floor area (m²)	360.00	268.70	443.60	619.20	895.20	1 040.60	1 089.30	957.40
Average number of floors (#)	4.60	5.20	5.70	5.70	5.60	5.40	5.40	5.90
Envelope surface area (m²)	553.00	411.10	554.30	714.60	948.70	1 039.80	1 068.50	941.80
Window wall ratio (%)	20%	20%	30%	30%	30%	30%	40%	40%
U-Value (W/m² K)								
Wall	1.31	1.29	1.08	0.86	0.69	0.50	0.42	0.45
Roof	1.71	1.60	0.89	0.76	0.61	0.41	0.38	0.33
Floor	1.14	1.13	1.15	1.16	0.91	0.60	0.55	0.49
Window	2.49	2.50	2.50	2.49	2.48	2.51	2.04	1.91
Heating Systems								
Oil boiler	8%	8%	1%	0%	0%	2%	1%	1%
Gas boiler	16%	15%	20%	22%	22%	21%	6%	4%
District heating	45%	34%	60%	66%	70%	68%	74%	58%
Heat pumps	1%	1%	0%	0%	0%	1%	0%	6%
Wood boiler	7%	6%	7%	6%	6%	4%	3%	8%
Direct electricity	16%	17%	18%	17%	13%	13%	21%	4%
Coal boiler	3%	1%	3%	3%	2%	1%	0%	0%

Single-Dwelling Buildings | Multi-Dwelling Buildings





Glossary

AMBIENT HEAT: Heat extracted from the environment (e.g. from the air, soil, or groundwater) through the use of heat pumps.

BUILDING ENVELOPE: The physical barrier between the conditioned and unconditioned environment of a building. Generally, the building envelope is comprised of a series of components and systems (walls, roofs, floors, and windows) that protect the interior space from the effects of the environment.

CONSTRUCTION (NEW): Site preparation and construction of entirely new structures and/or significant extensions to existing structures whether or not the site was previously occupied.

DELIVERED FINAL ENERGY: Total energy consumed by the end-user excluding energy produced onsite, such as ambient or solar heat and photovoltaic electricity.

DEMOLITION: To tear down a building or structure.

DETACHED HOUSE: A house for a single family or household that is not attached to any other building.

FINAL ENERGY: The total energy consumed by the end user. It is measured in the building as a system boundary and therefore excludes energy used in the supply chain (e.g. transmission losses) but does include losses within the building (e.g. conversion losses from the original energy carrier to heat) and energy produced on-site.

GREENHOUSE GAS EMISSIONS: Emissions of greenhouse gasses (including greenhouse gases other than CO_2) emitted both directly (from the building) and indirectly (from the supply chain) through the use of energy.

GROSS (OR NET) DISPOSABLE INCOME OF HOUSEHOLDS: Indicator used in national accounts that measures the income of households (wages and salaries, self-employed income, income from unincorporated enterprises, social benefits, etc.) in one country after taking into account net interest and dividends received and the payment of taxes and social contributions. It also includes the income of non-profit institutions that serve the households.

GROSS INLAND ENERGY CONSUMPTION: Sometimes abbreviated as gross inland consumption, the total energy demand of a country or region. It represents the quantity of energy necessary to satisfy the inland consumption of the geographic entity under consideration.

HEATING DEGREE DAYS: A proxy for the energy demand needed to heat a home or a business. It is defined relative to a base temperature — the outside temperature — below which a building is assumed to need heating.

HOUSEHOLD EXPENDITURE (TOTAL): All spending done by a person living alone or by a group of people living together in a shared accommodation and with common domestic expenses. It includes expenditures incurred on the domestic property (by residents and non-residents) for the direct satisfaction of individual needs and covers the purchase of goods and services, the consumption of one's own production (such as garden produce), and the imputed rent of owner-occupied dwellings.

HOUSING COMPLETIONS: Number of completed residential dwellings in a time period.

HOUSING TRANSACTIONS: Number of sales of residential dwellings in a time period.

MAINTENANCE: Routine work necessary to keep the structural and technical systems of the building in good condition.

MULTI-DWELLING BUILDING: A building that contains multiple separate housing units for residential inhabitants. A multi-dwelling building is considered "small" when having 12 or fewer housing units, and "large" when having more than 12.

NEARLY ZERO ENERGY BUILDING: A building that has very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by renewable sources, including sources produced on-site or nearby. As per the Energy performance of building directive (EPBD), member states have been given flexibility in defining this.

PV ELECTRICITY: Electricity generated on-site through the use of photovoltaic systems.

REFURBISHMENT: see *Renovation*.

REINSTATEMENT: Replacement or modification of a component with an identical one.

RENOVATION: An overarching term used to refer to modification and improvements to an existing building in order to bring it up to an acceptable condition. This can include elements of retrofit and energy renovation, such as adding extra insulation to the building envelope, new energy-efficient windows, solar cells, etc.

REPAIRS: Actions needed to restore to a good or sound condition any broken, damaged, or failed device, equipment, part, or property. Unlike maintenance, repairs are generally not planned in advance.

RETROFIT: Upgrade of the function of a building component. It usually involves the installation of new building systems, such as heating systems, but it might also refer to the envelope of the building, for example, retrofitting insulation or installing higher efficiency windows.

RETROFIT (DEEP, COMPREHENSIVE): Upgrade of the building to a higher standard (a better utility value from users' perspective, usually improving the energy efficiency of the building). It includes upgrading several building components and taking extra measures to ensure this standard. This can include some elements of renovation.

ROW HOUSE: Also called a terrace house, one of a series of houses, often of similar or identical design, situated side by side and joined by common walls.

SEMI-DETACHED HOUSE: Also called a twin house or duplex, a house typically with two separate entry doors divided into two parts and housing two separate owners or tenants. This can be side-by-side or one over the other.

SINGLE-DWELLING BUILDING (SDB): A building containing only one housing unit. This includes attached buildings such as row houses.

SINGLE-FAMILY HOUSE: See *Detached house*.

U-VALUE: The measure of the heat transmission through a building component (such as a wall or window) or through a given thickness of a material (such as insulation). Lower numbers indicate better insulating properties.

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