

The typology of the residential building stock in Albania and the modelling of its low-carbon transformation

Albania

Support for Low-Emission Development in South Eastern Europe (SLED)

REGIONAL ENVIRONMENTAL CENTER

WITH FUNDING FROM
AUSTRIAN DEVELOPMENT COOPERATION

The typology of the residential building stock in Albania and the modelling of its low-carbon transformation

Support for Low-Emission Development in South Eastern Europe (SLED)

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December 2015

REGIONAL ENVIRONMENTAL CENTER

WITH FUNDING FROM

AUSTRIAN DEVELOPMENT COOPERATION

ACKNOWLEDGEMENTS

We would like to express our gratitude to policy makers and experts from Albania who provided comments and data that helped us to improve the results of our work. In particular, we are grateful to Artan Leskoviku of the National Agency of Natural Resources (AKBN); Aheron Hizmo of the Open Regional Fund for South Eastern Europe – Energy Efficiency; and Mirela Kamberi of the United Nations Development Programme (UNDP) Climate Change Programme.

We are also grateful to Jozsef Feiler and Agnes Kelemen of the Regional Environmental Center for Central and Eastern Europe (REC), who managed and navigated our work in South Eastern Europe.

We would also like to thank Robert Goda and GDA Ltd. for their important contribution to the project.

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Copyediting and proofreading: **Rachel Hideg**
Publisher: **The Regional Environmental Center for Central and Eastern Europe (REC)**
Photo credits: **iStock**

The REC is implementing the project "Support for Low-Emission Development in South Eastern Europe" (SLED) to help policy makers in the project countries (Albania, the former Yugoslav Republic of Macedonia, Montenegro and Serbia) to establish realistic but ambitious decarbonisation pathways for their electricity and building sectors by 2030.

The SLED project is funded by the Austrian Development Cooperation through the Austrian Development Agency (ADA). Special thanks are due to Hubert Neuwirth and Monika Tortschanoff of ADA.

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Executive summary

Energy demand in the residential building sector represents a big challenge for Albania. In 2013, the sector was responsible for 30 percent of the country's final energy consumption and 60 percent of the country's electricity consumption. The quality of energy services delivered to residential buildings is low. Albanian homes are only heated partially, for just a few hours a day, while the continued use of outdated woodstoves results in numerous environmental and health problems.

As a contracting party to the Energy Community Treaty, Albania is obliged to introduce EU energy efficiency legislation. However, achieving the related targets requires more ambitious policy efforts and bigger investments in demand-side energy efficiency than are being made at present.

The aim of the present publication is to provide information that will assist in the design of energy efficiency and climate mitigation policies for the residential building sector in Albania. We describe 20 representative categories of residential buildings; calculate their thermal energy performance in three climate zones; design standardised retrofitting packages; and calculate the possible energy savings and investments required by building type. We identify the current and future level and structure of final energy consumption by building age category, building type, climate zone and energy end use. We suggest two packages, in addition to the present policies, which aim to transform the residential building stock to zero energy and carbon levels by 2050. We estimate the level of effort required to achieve these goals in terms of the floor area affected and the necessary investments by actor and by policy tool. Finally, we evaluate energy savings, saved energy costs, CO_2 emissions avoided, and the cost-effectiveness of the packages.

In order to carry out the analysis at sector level, we designed and applied a bottom-up simulation model that is applicable in the period up to 2030. We assessed only thermal energy services delivered to residential buildings — namely space heating, space cooling and water heating — but did not cover energy use for operating electrical appliances, lighting and cooking. We considered both direct and indirect CO_2 emissions in our analysis.

The model itself, with all the underlying input data, is provided to national policy makers and experts to use and modify according to their needs. It is also available on request to other experts, subject to proper referencing and acknowledgement.

What are the current levels and future trends in final energy consumption and CO_2 emissions in the residential building sector?

According to our estimates, in 2015 final energy consumption in the residential building sector for thermal energy services was 4.9 billion kWh, comprising 54 percent electricity, 37 percent wood and 9 percent liquefied petroleum gas (LPG). The sector was responsible for 96,000 tonnes of CO_2 emissions associated with LPG consumption. Final energy consumption, calculated on the basis of the geometrical and thermal characteristics of buildings, as well as the characteristics of the installed energy systems, differed significantly from the energy balance available from the official macro statistics. For this reason, final energy consumption was calibrated to the balance, correcting for the current level of thermal comfort — that is, partial floor area heated and cooled and the duration of space heating and cooling.

In the business-as-usual reference scenario, final energy consumption for thermal services is expected to decline by 17 percent between 2015 and 2030, reaching 4.1 billion kWh in 2030. Following market trends, we assume a very rapid increase in electrical heating in existing buildings. For this reason, between 2015 and 2030 electricity consumption will grow by around 2.2 percent each year, while wood and LPG consumption will decrease by around an annual 11 percent and 10 percent respectively. In 2030, CO_2 emissions will be at 23 percent of their 2015 level, mainly influenced by the fuel switch from LPG. Energy demand in existing buildings is expected to decline despite the increase in thermal comfort due to business-as-usual improvements. Business-as-usual improvement occurs once during the lifetime of a building, which results in a business-as-usual building retrofitting rate of 2.8 percent per year.

What are the priority sector segments for policy making?

From a long-term perspective, it is important to ensure that buildings constructed after 1991 are retrofitted, as they will be responsible for around 43 percent of final energy consumption in the sector in 2030. New buildings will be responsible for 18 percent of final energy consumption in 2030. This is why it is important to prioritise the introduction and enforcement of building codes in order to avoid the need to retrofit these buildings in the future.

Detached and semi-detached houses are a clear priority for policy making: in 2030, such buildings will be responsible for 72 percent of final energy consumption for thermal energy uses. In 2030, half of final energy consumption will originate from climate zone B (medium zone), followed by climate zone A (coastline) and climate zone C (mountains).

At present, space heating represents the highest share of final energy consumption, but it will decrease in the future. By contrast, the share of space cooling is expected to increase significantly. Overall, in 2030, space heating, water heating and space cooling will be responsible for 56 percent, 15 percent and 29 percent of final energy consumption respectively.

What policy packages are possible?

According to the SLED moderate scenario, by 2050 the performance of all new and existing buildings will correspond to performance after standard improvement 1, as defined in the present publication. This improvement implies not only lower energy consumption, but also higher thermal comfort than is considered in the business-as-usual improvement.

According to the SLED moderate scenario, in 2016 Albania adopts a building code that affects the performance of newly constructed buildings. The requirements envisioned by the building code correspond to the characteristics of the measures in standard improvement 1.

In order to ensure that all existing buildings that remain in use in 2050 are retrofitted by this date, we assume that Albania will introduce financial incentives for investments in the residential building sector. These include the introduction of low-interest loans for 90 percent of households living in detached and semi-detached houses, and the introduction of grants for the remaining 10 percent of households. They also include, starting from 2016, the introduction of loans for 10 percent of households in terraced (row) houses and multi-dwelling apartment buildings. This share is assumed to reach 90 percent by 2050. The remaining households in terraced houses and multi-dwelling apartment buildings would obtain grants (90 percent in 2016, then the remaining 10 percent by 2050).

Due to the high upfront investment costs, we recommend coupling the thermal efficiency improvement of existing buildings with their business-as-usual renovation, when it is possible to take advantage of costs that are anyway being incurred. The retrofitting rate in the SLED moderate scenario is the same as the retrofitting rate in the reference scenario, which allows the maximum use of business-as-usual investments. We assume that financial incentives will be provided to cover the share of eligible investment costs for better buildings, which is approximately equal to the share of incremental investment costs in improvement 1 as compared to the business-as-usual improvement.

The SLED ambitious scenario implies that by 2050 the performance of the majority of new and existing buildings will correspond to the performance following ambitious improvement 2, as defined in the present publication. Improvement 2 implies even higher thermal comfort than improvement 1.

According to the scenario, in addition to the 2016 building code Albania would also introduce a more stringent building code in 2022, with requirements no lower than those that correspond to the measures in improvement 2. In order to prepare the market, from 2016 Albania would introduce low-interest loans for the construction of new buildings that achieve the performance required by the 2022 building code. Similar to the SLED moderate scenario, the SLED ambitious scenario assumes the retrofitting, by 2050, of all existing buildings remaining in use at this time. The retrofitting would be carried out according to improvement 1 up to 2022, and according to improvement 2 from 2023 until 2050.

To ensure that the retrofitting is carried out, Albania would introduce financial incentives for investors in the residential building sector. Up to 2022, financial incentives would be provided in order to achieve a level of performance according to improvement 1. Between 2023 and 2050, incentives would be provided in order to achieve a level of performance according to improvement 2.

Similar to the SLED moderate scenario, the SLED ambitious scenario takes advantage of the business-as-usual costs that occur in the reference scenario. The retrofitting rate in the SLED ambitious scenario coincides with the business-as-usual retrofitting rate in the reference scenario. The structure of the financial incentives and the definition of eligible costs are the same for the SLED moderate and ambitious scenarios.

How large are the associated final energy savings and CO_2 emissions reductions?

According to the SLED moderate scenario, final energy consumption for thermal energy services would decrease to 3.0 billion kWh, or 27 percent lower than the business-as-usual level in 2030. The associated CO_2 emissions would be 73 percent lower than the respective business-as-usual level. The scenario would lead to a 44 percent reduction in the business-as-usual electricity consumption.

The majority of final energy savings will originate from buildings constructed between 1991 and 2000, and new buildings. In terms of building type, the biggest share of final energy savings will be in detached houses. Climate zone B (medium zone) dominates in terms of potential final energy savings, followed by climate zone A (coastline), and climate zone C (mountains). The biggest energy savings would be associated with space heating.

According to the SLED ambitious scenario, final energy consumption for thermal energy services would decrease to 2.7 billion kWh, or 35 percent lower than the business-as-usual level in 2030. The associated CO_2 emissions would be 73 percent lower in 2030 than the business-as-usual level in 2030. The scenario allows for a 49 percent reduction in the business-as-usual electricity consumption. Other conclusions are similar to those of the SLED moderate scenario.

How much would such efforts cost the government and other actors?

In the SLED moderate scenario, 1.6 million m^2, or 2.5 percent of the total building floor area, are retrofitted per year between 2015 and 2030. In addition, all new floor area — that is, 1.1 million m^2 per year — is included in the scenario. This transformation requires significant investments that need to be distributed among different actors.

Total investment costs for building retrofits are EUR 2.3 billion between 2015 and 2030, or EUR 153 million per year. The biggest investments are needed in buildings constructed between 2001 and 2015. When the costs of the reference scenario are deducted from the costs of the SLED moderate scenario, the incremental costs of building retrofits in the SLED moderate scenario are EUR 1.1 billion between 2015 and 2030, or EUR 72 million per year. In addition, the incremental investment costs in new buildings are EUR 593 million between 2015 and 2030, or EUR 40 million per year. In the case of newly constructed buildings, the scenario investment costs include only the incremental investment costs, since construction anyway assumes the business-as-usual costs of the building components and systems.

Assuming a discount rate of 4 percent, the annualised incremental cost of the SLED moderate scenario between 2015 and 2030 is EUR 2.3/m^2. Saved energy costs are on average EUR 3.8/m^2 of new or retrofitted floor area over this period. This means that investments in the SLED moderate scenario are profitable. It is important to note that the saved energy costs are higher than the annualised investment costs for the scenario as a whole at country level, but not for all building categories. For a few building categories, saved energy costs are lower than the annualised incremental investment costs, thus the incremental investments do not pay back. Raising the discount rate higher than 9 percent would make the investment unattractive for the whole scenario. The analysis is carried out assuming a likely increase in energy prices.

The eligible investment costs in building retrofits that investors should borrow are EUR 550 million between 2015 and 2030, or EUR 37 million per year. Assuming a market loan interest rate of 15 percent, a subsidised interest rate of 0 percent, and a loan term of 10 years, the government would provide EUR 600 million to commercial banks as compensation for lowering the interest rate. Grants cost the government EUR 327 million between 2015 and 2030, or EUR 22 million per year. In addition, investors would bear EUR 593 million between 2015 and 2030, or EUR 37 million in incremental investment costs per year as compared to the business-as-usual practice in order to comply with the building code to be adopted in 2016.

In the SLED ambitious scenario, the affected floor area is the same as in the SLED moderate scenario. The total investment costs are EUR 2.7 billion between 2015 and 2030, or EUR 179 million per year. The biggest investments are required for the retrofitting of buildings constructed between 2001 and 2015. The incremental investment costs of the SLED ambitious scenario for building retrofits are EUR 1.5 billion between 2015 and 2030, or EUR 99 million per year. In addition, the incremental investment costs of the SLED ambitious scenario in new, more efficient buildings are EUR 1.1 billion between 2015 and 2030, or EUR 72 million per year.

Assuming the same discount rate, the annualised incremental costs of the SLED ambitious scenario between 2015 and 2030 are EUR 3.5/m^2. Saved energy costs are EUR 4.1/m^2 of new or retrofitted floor area over this period. This means that investments in the SLED ambitious scenario will pay back. Raising the discount rate higher than 5.5 percent would make the scenario investment unattractive. Similar to the SLED moderate scenario, the saved energy costs are higher than the annualised investment costs in the SLED ambitious scenario as a whole at country level, but not for all building categories.

The eligible costs of building retrofits that investors should borrow are EUR 1.1 billion between 2015 and 2030, or EUR 74 million per year. The eligible investments in more efficient construction that should be borrowed are EUR 612 million between 2016 and 2022, or EUR 38 million per year. Given the same assumptions as in the SLED moderate scenario, the government would provide EUR 802 million to commercial banks as compensation for lowering the interest rate on loans for building retrofits, and EUR 516 million as compensation for lowering the interest rate on loans for building construction. Grants cost the government EUR 451 million between 2015 and 2030, or EUR 30 million per year. In addition to the cost of compliance with the 2016 building code, investors would bear EUR 75 million in incremental investment costs per year starting from 2023 as compared to the business-as-usual practice in order to comply with the building code to be adopted in 2022.

I. Introduction

Background

Following a steep decline in the 1990s, Albania experienced economic growth reaching 7.5 percent per year in 2008 (World Bank online). In the years following the global financial crisis, economic growth declined but since 2014 has once again been on the rise. In order to maintain high rates of economic growth, Albania, on the one hand, needs access to a long-term, secure, affordable and sustainable energy supply. On the other hand, the country needs to use its available energy resources or purchased energy in the most efficient and rational way.

Energy demand in the residential building sector represents a particular challenge. In 2013, final energy consumption in the sector was 30 percent of the national total (EUROSTAT 2015), and the sector was responsible for using 60 percent of the electricity available for final energy consumption (*ibid*.). The quality of energy services delivered to residential buildings is far lower than the European Union average. Most notably, Albanian homes are heated partially, for only a few hours a day. The continued use of outdated wood stoves results in high levels of indoor air pollution and, as a result, high rates of respiratory disease (Legro, Novikova and Olshanskaya 2014). Cutting down Albanian forests for residential heating and cooking purposes leads to numerous environmental problems, such as deforestation, biodiversity loss, air pollution and soil degradation (*ibid*). If no new forests are planted, there is no compensation for the greenhouse gas emissions released by the burning of this biomass.

Albania is a contracting party to the Energy Community Treaty and is thus obliged to introduce EU energy efficiency legislation. As of April 2015, the country had transposed Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services (ESD) and Directive 2010/30/EU on the Labelling of Energy-Related Products (Recast Directive 92/75/EEC). It is expected that Directive 2010/31/EU on the Energy Performance of Buildings (EPBD) and Directive 2012/27/EC on Energy Efficiency (EED) will be transposed in 2016: the implementing by-laws are to be prepared and adopted. In accordance with the ESD, the country has to meet an energy-saving target equal to 9 percent of total energy sales in 2018 as compared to 2010. According to the EED, Albania will have to achieve an annual 1.5 percent energy sales savings compared to the recent three-year period through the use of a utility obligation scheme or other alternative approach. Achieving these targets requires more ambitious policy efforts and bigger investments in demand-side energy efficiency than are being made at present.

Alignment with EU energy efficiency legislation also supports measures required under the United Nations Framework Convention on Climate Change (UNFCCC). Examples include nationally appropriate mitigation actions (NAMAs), where developing countries are invited to contribute voluntary actions that help create low-carbon development strategies with the aim of promoting mitigation efforts; and intended nationally determined contributions (INDCs). Such measures require the introduction of a wide range of energy efficiency and low-carbon policies.

Although there are many opportunities for energy efficiency improvements in the residential building sector, the policy mix in Albania to take advantage of these opportunities could be significantly improved. However, designing an intelligent policy package is made more difficult by the fact that energy efficiency potential is spread among different types of buildings and fragmented among end users. There is a lack of understanding about how to structure the building sector in terms of policy making; how much potential there is for energy saving and CO_2 emissions reductions; where this potential is located; and how much it would cost to realise it.

Aims and structure of the present publication

The present publication aims to answer the questions posed above and to contribute to the evidence-based design of energy efficiency and climate mitigation policies in Albania that target the residential building sector by providing the necessary information.

The book comprises two parts. The first part addresses the following questions:

- How should existing residential buildings in Albania be classified according to age and type? What are the representative building types in the Albanian residential building stock? How many buildings and homes are there according to such a building typology?
- For each representative building type, what are the energy demand; the delivered energy by energy source; primary energy consumption; and CO_2 emissions from space heating, water heating and space cooling?

- What are the possible retrofitting options and packages of options by representative building type? What are the investment costs per retrofitting measure and per building by representative building type?

The second part of the book addresses the following set of questions:

- What are the future trends in energy consumption and CO_2 emissions in the residential building sector in Albania? What are the key influencing factors? What are the priority segments in the sector for policy making?
- What policy packages are possible and what level of policy effort is required to make residential buildings low energy and low carbon in the medium and long term? How big are the associated energy savings and CO_2 emissions reductions? How much would such efforts cost the government and other actors?

PART 1

The typology of residential buildings, possible retrofitting packages and associated investment costs

II. Building typology of existing buildings

This section is based on information and data provided by the Albanian SLED expert team (Simaku, Thimjo and Plaku 2014a, 2014b, 2014c and 2014d).

The building typology was created with the help of Albanian experts based on the last census data from 2011 (Simaku, Thimjo and Plaku 2014a, 2014b; INSTAT 2011). We used openly available data from the Albanian statistical office. As the census was not designed specifically to obtain data for an energy evaluation of the building stock, some data were not available at the required level of detail. Estimates were needed in order to extrapolate data to the existing building stock.

We established a typology comprising 20 building types, based on the following considerations:

- Building type. The statistics distinguish between detached houses; semi-detached houses; row (terraced) houses and apartment buildings.
- Construction period. Buildings are classified according to six construction periods — before 1960; 1961–1980; 1981–1990; 1991–2000; and 2001–2011.
- Size of building. Data were available for the number of dwellings in the building — buildings with one dwelling; two dwellings; three to four dwellings; or five or more dwellings.
- Number of floors. Buildings are classified into those with one floor; two floors; three to five floors; and six or more floors.

Further aspects were also analysed, but as statistical data were not available per building type these aspects were not incorporated directly into the matrix:

- Climate zone. All data were given at national level and for each prefecture.
- Construction materials. Limited data were available.
- Heating systems and energy sources. National data were available.

Originally, 24 building types were established by the Albanian experts (Simaku, Thimjo and Plaku 2014a, 2014b), but we decided to reduce the number of types by merging buildings constructed between 2001 and 2005 with those constructed between 2006 and 2011. The Albanian building typology is presented in Table 1.

Statistical data on the building stock

The total number of residential buildings in Albania was 598,267 according to the 2011 census, for a population of 2,821,977 (53.5 percent of the population live in urban areas and 46.5 percent in rural areas) (INSTAT 2011, 2013 and 2014a). The number of dwellings was 1,012,062, of which only 709,865 were inhabited. The number of private households in inhabited dwellings was 722,262.

We classified the building stock into 20 building types. Figures 1 and 2 show the number of buildings and dwellings in each building type. Detached houses built between 1991 and 2000 (type D1) represent the largest group, with 108,752 buildings. Apartment buildings from 1961–1980 and 1981–1990 are another significant group in terms of number of dwellings. Figure 1 also shows the number of residential buildings where the date of construction is not known, and the number of non-inhabited buildings.

RESIDENTIAL BUILDINGS BY BUILDING TYPE

Detached houses represent the highest share in the building stock, at 83.7 percent of all buildings (Figure 3). Apartment buildings represent only 3.7 percent of the building stock, although these multi-storey buildings include a large number of dwellings, representing about 35 percent of all dwellings (Figure 4). The share of semi-detached houses is 9.4 percent, while the share of row/terraced houses is less significant.

RESIDENTIAL BUILDINGS BY CONSTRUCTION PERIOD

Figure 5 shows the number of residential buildings by construction period. Only 7 percent of the existing building stock was constructed before 1960 (Figure 6). After World War II, and from 1960 in particular, there was an upswing in the construction sector, especially the construction of large, multi-family apartment buildings. Twenty-four percent of buildings and 32 percent of dwellings were constructed between 1961 and 1990 (Figure 7). After 1990, another boom in the construction sector can be observed, although there is a shift towards detached houses and away from apartment buildings. After 2000, the number of new apartment buildings began to rise once again. In the case of 13 percent of the building stock, the construction period is not known, and there is a large share of non-inhabited buildings where, again, the construction period is not known (17 percent of buildings).

Table 1 **Albanian residential building typology** (Simaku, Thimjo, and Plaku 2014b)

	1. Detached houses Dtch	2. Semi-detached houses Sem_Dtch	3. Row (or terraced) houses Row_Terr	4. Multi-family apartment Mult_Fam_Ap
A before 1960	 Dtch_20–60	 Sem_Dtch_20–60	 Row_Terr_...60	 Mult_Fam_Ap...60
B 1961–1980	 Dtch_61–80	 Sem_Dtch_61–80	 Row_Terr_61–80	 Mult_Fam_Ap_61–80
C 1981–1990	 Dtch_81–90	 Sem_Dtch_81–90	 Row_Terr_81–90	 Mult_Fam_Ap_81–90
D 1991–2000	 Dtch_91–00	 Sem_Dtch_91–00	 Row_Terr_91–00	 Mult_Fam_Ap_91–00
E 2001–2011	 Dtch_01–11	 Sem_Dtch_01–11	 Row_Terr_01–11	 Mult_Fam_Ap_01–11

Figure 1 **Number of residential buildings and dwellings by building type and age** (based on INSTAT 2011)

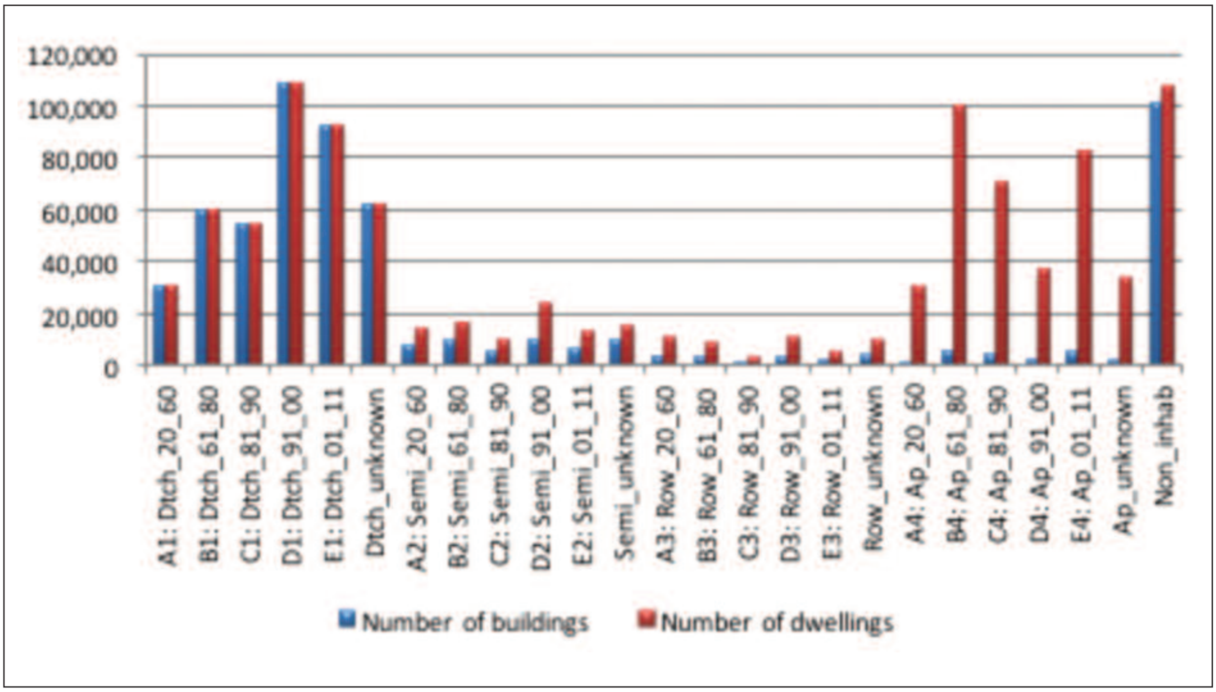
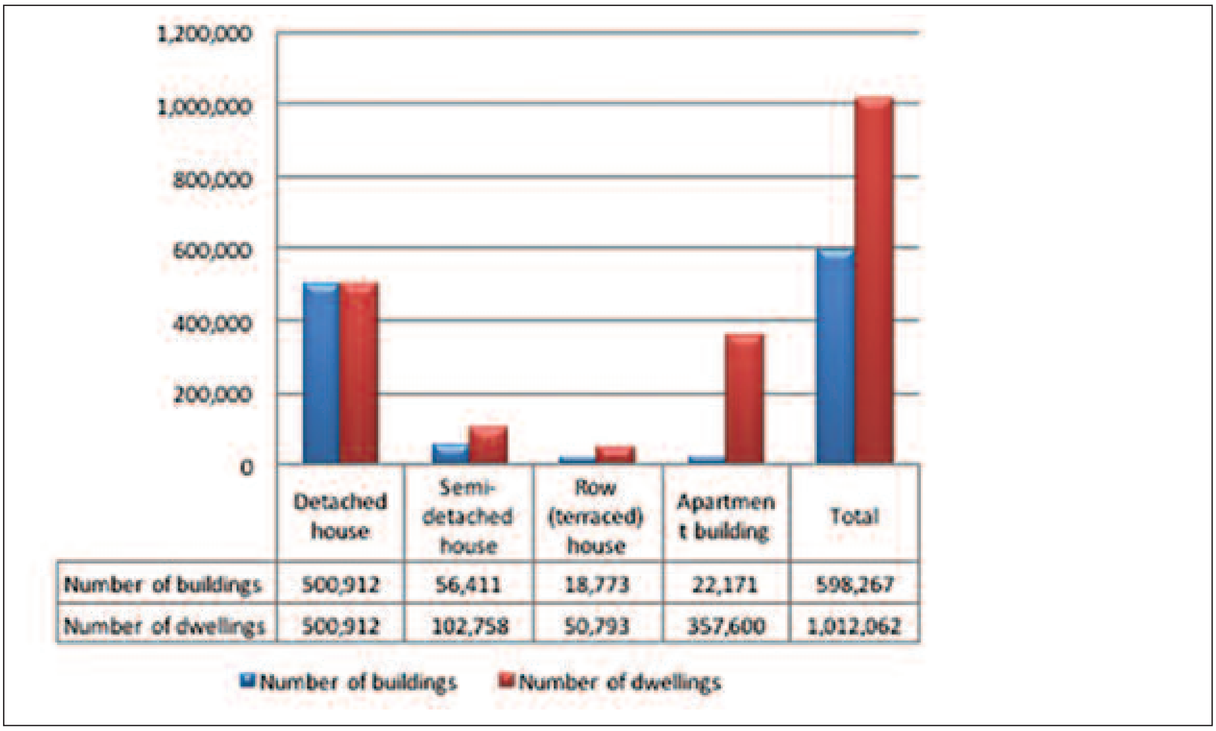


Figure 2 **Number of residential buildings and dwellings by building type** (based on INSTAT 2011)



	Detached house	Semi-detached house	Row (terraced) house	Apartment building	Total
Number of buildings	500,912	56,411	18,773	22,171	598,267
Number of dwellings	500,912	102,758	50,793	357,600	1,012,062

Figure 3 **Share of residential buildings by building type** (based on INSTAT 2011)

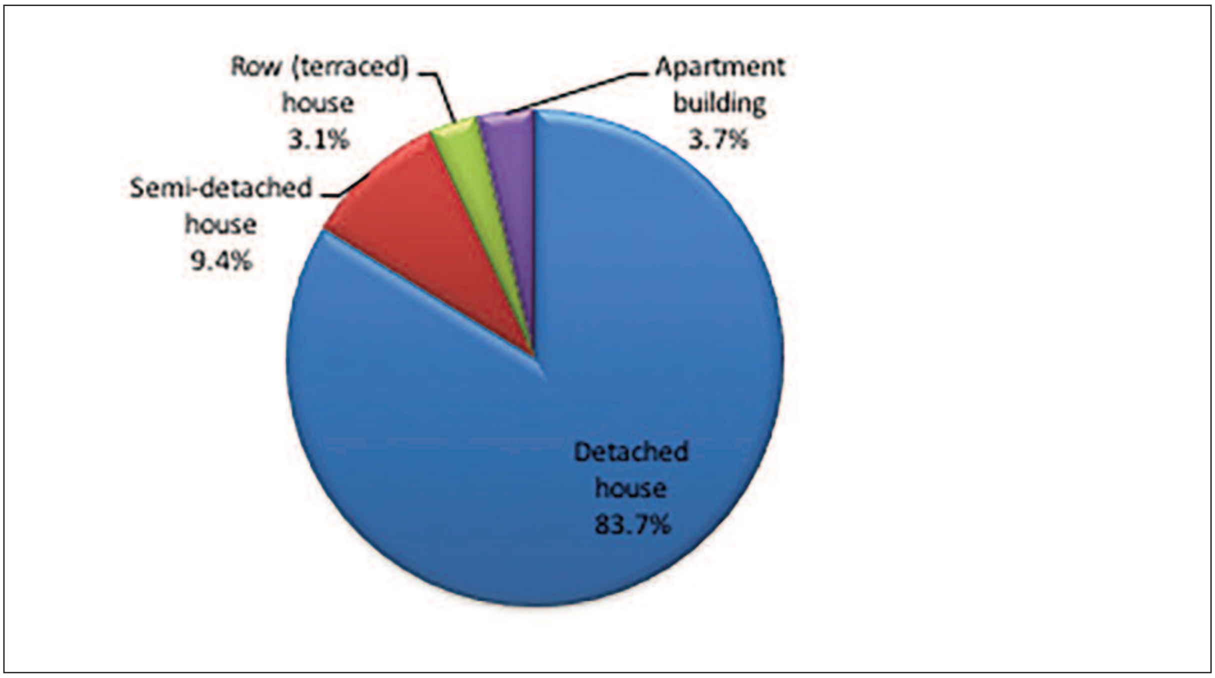
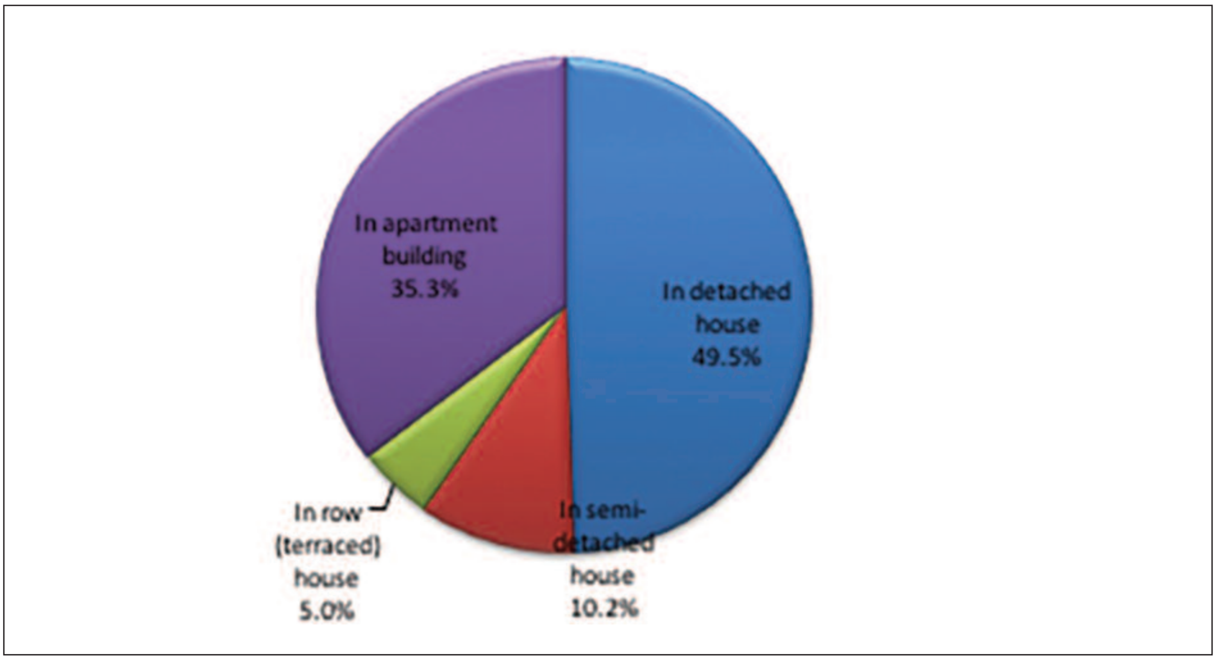


Figure 4 **Share of dwellings in residential buildings by building type** (estimate based on INSTAT 2011)



DETACHED HOUSES

Most detached houses were constructed after 1960, with a peak in 1991–2000 when about 22 percent of existing detached houses were constructed (Figure 8). The first decade of the 21st century also saw high construction rates (19 percent). As Figure 9 shows, about 18 percent of detached houses are non-inhabited.

SEMI-DETACHED HOUSES

The construction rate of semi-detached houses has been relatively constant: since 1960, between 5,000 and 10,000 buildings of this type have been constructed each decade, with the largest numbers built between 1991 and 2000 (see Figures 10 and 11).

ROW (TERRACED) HOUSES

After 1960, between 1,300 and 3,500 row houses were built each decade, with the lowest number in 1981–1990 and the highest in 1991–2000 (Figures 12 and 13).

APARTMENT BUILDINGS

The number of apartment buildings by construction period is shown in Figure 14. Only 7 percent of apartment buildings were constructed before 1960 (Figure 15). The boom began after 1960, when large numbers of prefabricated buildings were erected during the communist era. The construction of apartment buildings slowed after 1990, but between 2001 and 2011 the rate more than doubled compared to the previous decade.

NUMBER OF FLOORS

Of the total residential building stock in Albania, 85 percent are one-floor buildings, 10 percent have two floors, 4 percent three to five floors, and only 1 percent six or more floors (Figure 16).

Since 2005, the rate of construction of buildings with one to two floors has decreased, the construction of medium-sized buildings has remained fairly constant, and the number of high-rise buildings with six or more floors, and especially the number of buildings with more than 11 floors, has significantly increased (Simaku, Thimjo and Plaku 2014a; INSTAT 2012).

The crisis around 2008 affected the construction sector, and especially the construction of tall buildings. The high prices of units and the large number of empty dwellings also reduced the demand for tall buildings (INSTAT 2012).

NON-INHABITED BUILDINGS AND DWELLINGS

The high number of non-inhabited buildings and dwellings is remarkable. A total of 101,368 buildings are not inhabited, while the number of non-inhabited dwellings is 302,197. This includes 83,493 dwellings for secondary purposes or seasonal use; 218,514 vacant dwellings; and 190 dwellings inhabited only by persons not covered by the census. Vacant dwellings accounted for 21.6 percent of dwellings in 2011, compared to only 11.3 percent in 2001 (Figure 17).

The number of non-inhabited dwellings is far higher than one would estimate based on the number of non-inhabited buildings. This suggests that there are many non-inhabited dwellings in inhabited buildings.

CLIMATE ZONES

The territory of Albania is divided into three climate zones: zone A is the mildest, along the sea coast; zone B is the medium zone; and zone C is the coldest, in the mountainous area. Around half the buildings are located in climate zone B, and around one-third in climate zone A (Figure 18). The smallest number of buildings, about 16 percent of the building stock, are located in climate zone C (Figure 19). The situation is similar in terms of number of dwellings (Figure 20).

TRENDS

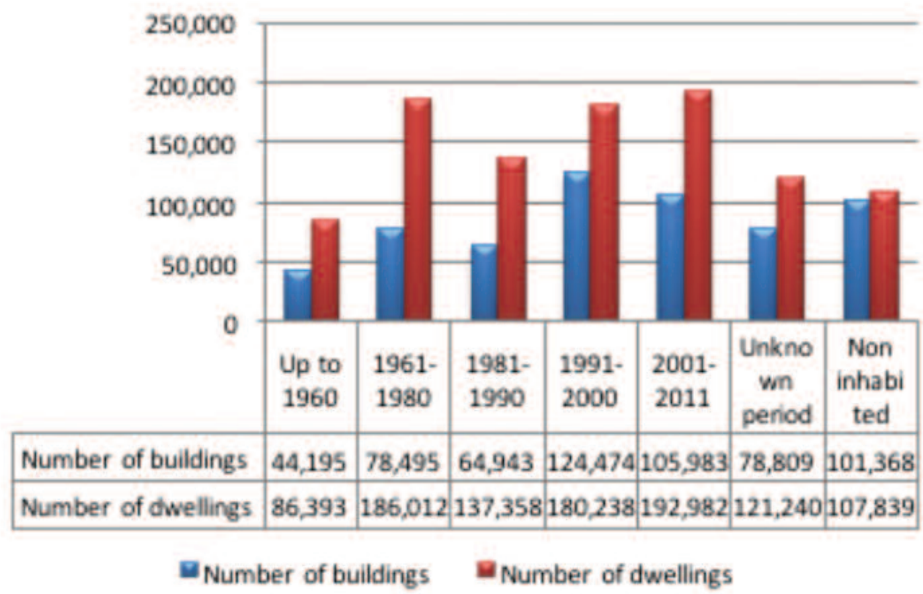
The population of Albania is decreasing: in the last decade it fell by 9 percent from 3,069,275 to 2,821,977. The number of private households also decreased compared to the previous census.

The number of residential buildings in 2011 was 598,267, which is not much higher than the 2001 figure of 512,387, although the respective number of dwellings in 2011 was 1,012,062 compared to 785,515 in 2001.

There are large regional differences within the country. The Tirana region is the most affluent, and the buildings located here are in better condition. The urbanisation process is rapid: 46.4 percent of dwellings were located in urban areas and 53.6 percent in rural areas in 2001, while in 2011 the respective shares were 53.9 percent and 46.1 percent. There is also a high rate of internal migration in the country, especially towards the coastal area and Tirana.

Figures 21 and 22 show the number of building permits issued, and the related floor area, for new residential buildings. No statistical data are available for the demolition rate of buildings.

Figure 5 **Number of residential buildings by construction period (dwellings estimated only)** (based on INSTAT 2011)



	Up to 1960	1961-1980	1981-1990	1991-2000	2001-2011	Unknown period	Non inhabited
Number of buildings	44,195	78,495	64,943	124,474	105,983	78,809	101,368
Number of dwellings	86,393	186,012	137,358	180,238	192,982	121,240	107,839

Figure 6 **Share of residential buildings by construction period** (based on INSTAT 2011)

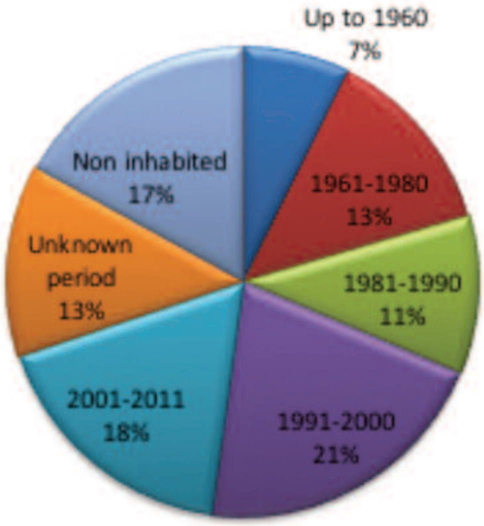


Figure 7 **Share of dwellings in residential buildings by construction period (estimates only)** (based on INSTAT 2011)

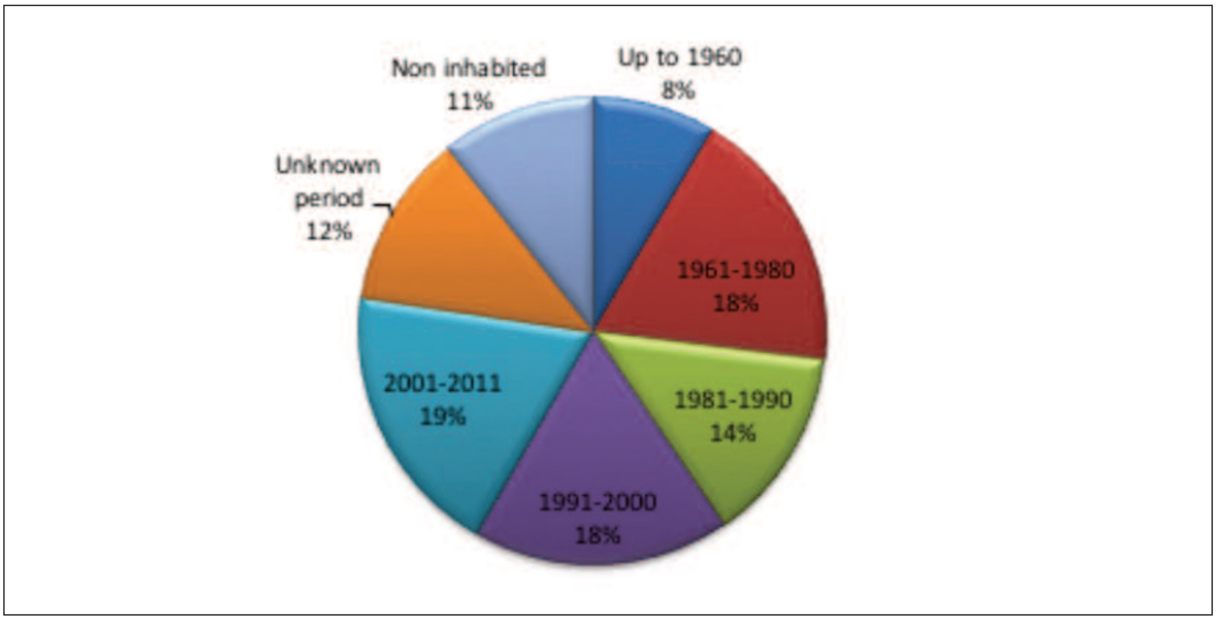


Figure 8 **Number of detached houses by construction period** (based on INSTAT 2011)

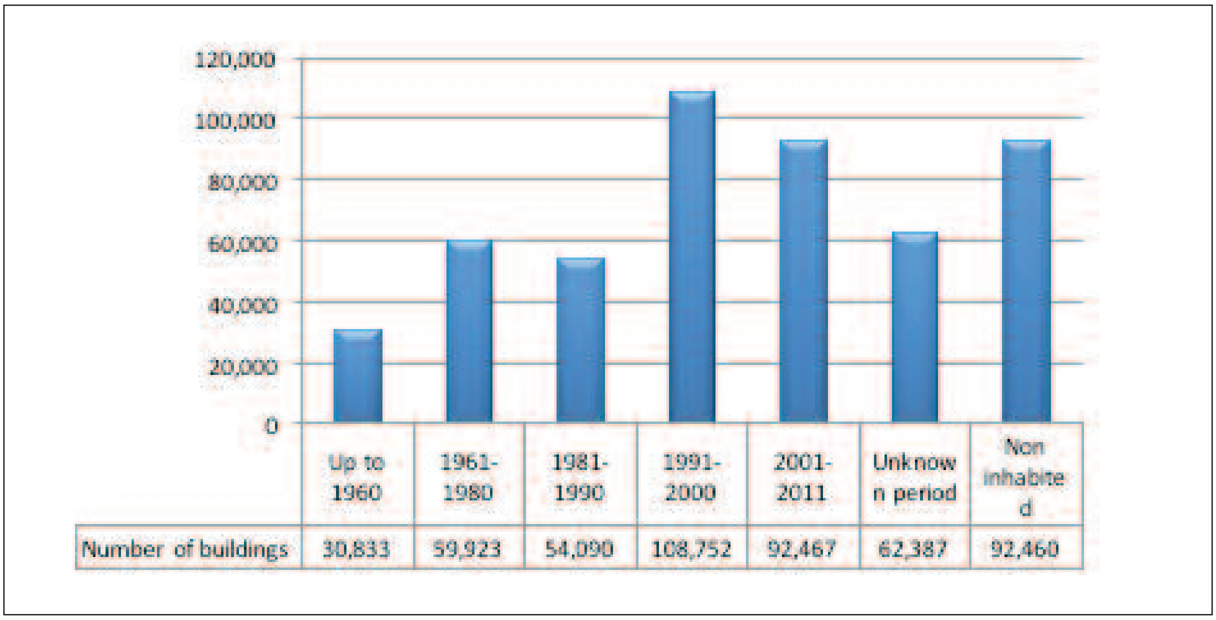


Figure 9 **Share of detached houses by construction period** (based on INSTAT 2011)

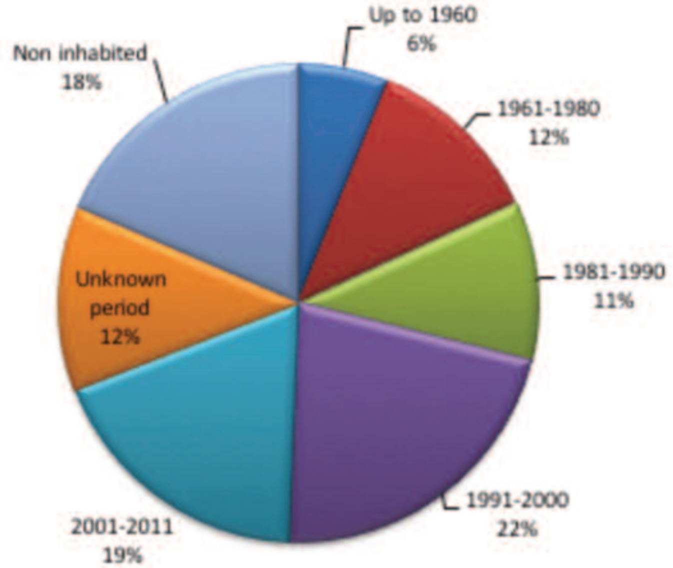
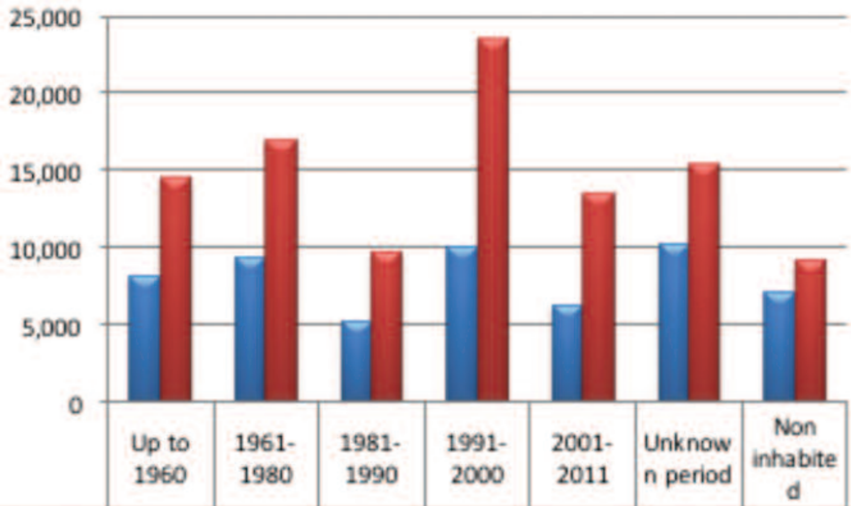


Figure 10 **Number of semi-detached houses and dwellings in semi-detached houses by construction period (dwellings estimated only)** (based on INSTAT 2011)



	Up to 1960	1961-1980	1981-1990	1991-2000	2001-2011	Unknown period	Non inhabited
Number of buildings	8,140	9,376	5,268	9,995	6,315	10,254	7,063
Number of dwellings	14,495	16,930	9,784	23,516	13,435	15,492	9,106

Figure 11 **Share of semi-detached houses by construction period** (based on INSTAT 2011)

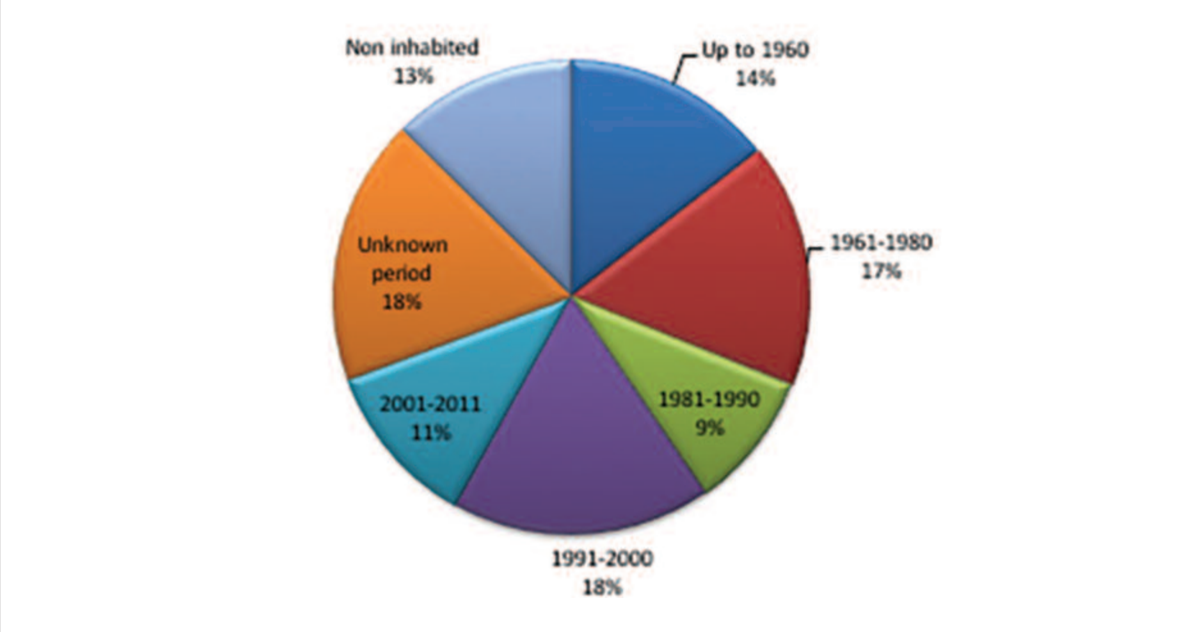
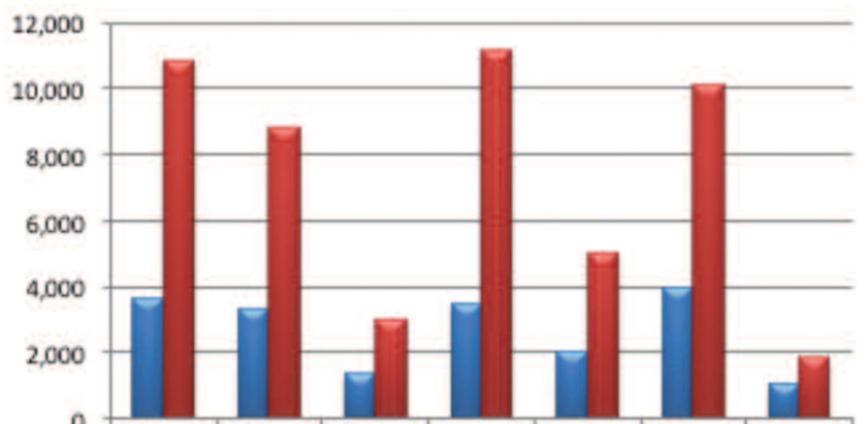


Figure 12 **Number of row (terraced) houses and dwellings in these buildings by construction period (dwellings estimated only)** (based on INSTAT 2011)



	Up to 1960	1961-1980	1981-1990	1991-2000	2001-2011	Unknown period	Non inhabited
Number of buildings	3,618	3,284	1,343	3,475	2,006	3,953	1,094
Number of dwellings	10,832	8,790	2,989	11,170	5,029	10,129	1,855

Figure 13 **Share of row (terraced) houses by construction period** (based on INSTAT 2011)

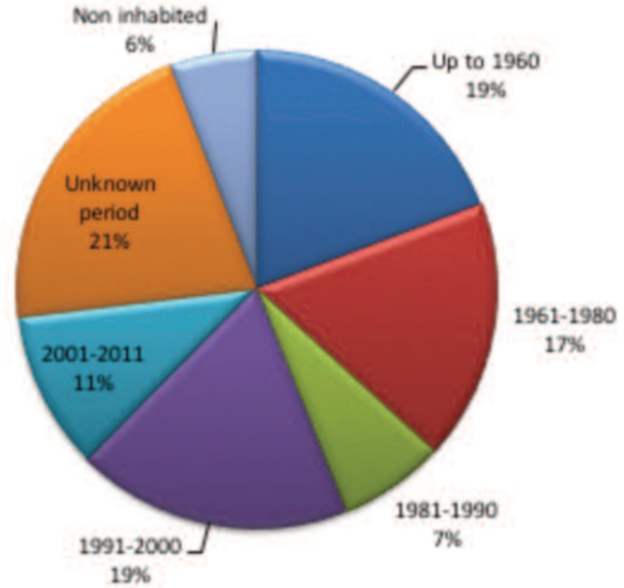
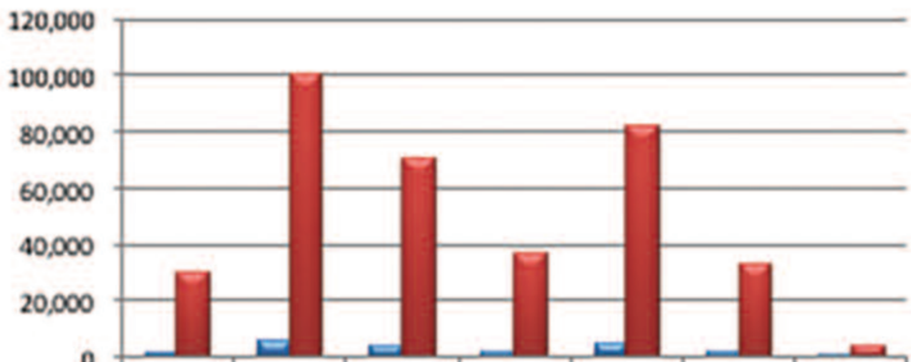


Figure 14 **Number of apartment buildings and dwellings in these buildings by construction period (dwellings estimated only)** (based on INSTAT 2011)



	Up to 1960	1961-1980	1981-1990	1991-2000	2001-2011	Unknown period	Non inhabited
Number of buildings	1,604	5,912	4,242	2,252	5,195	2,215	751
Number of dwellings	30,234	100,370	70,495	36,800	82,051	33,232	4,418

Figure 15 **Share of apartment buildings by construction period** (based on INSTAT 2011)

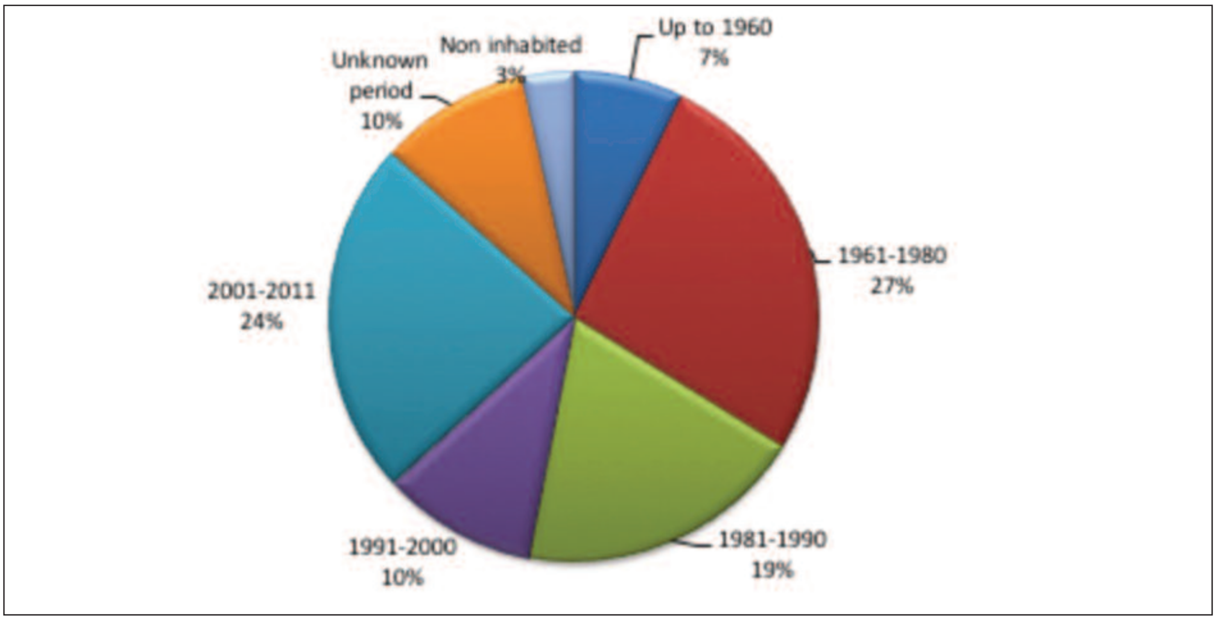


Figure 16 **Share of residential buildings by number of floors** (based on INSTAT 2011)

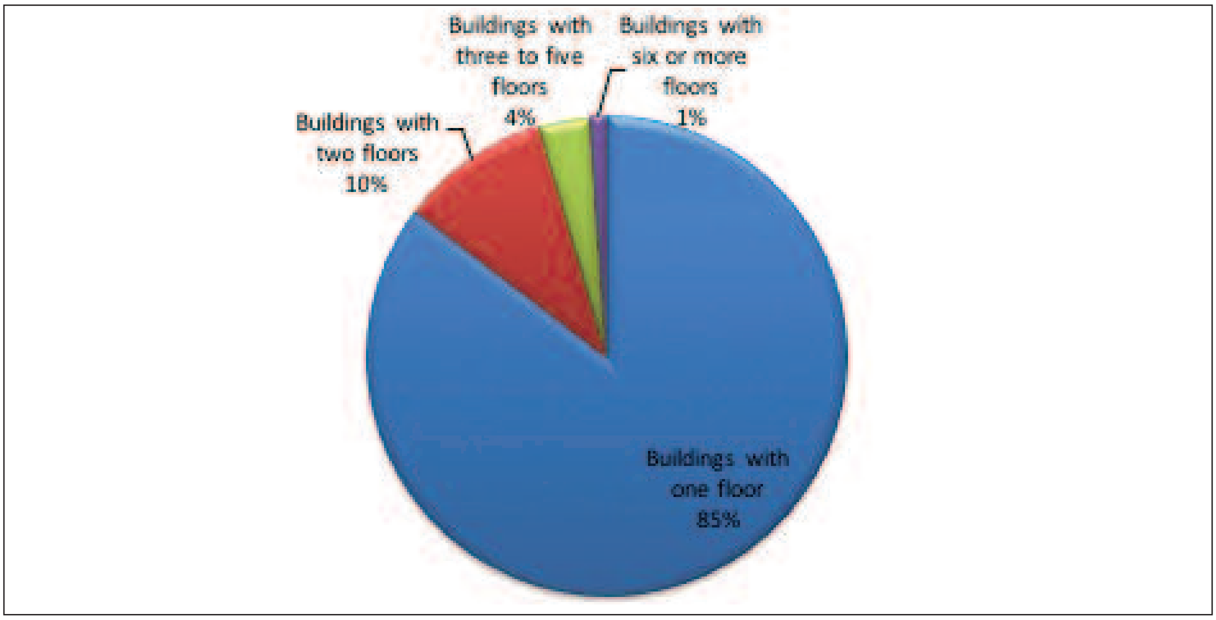


Figure 17 **Share of dwellings by occupancy** (based on INSTAT 2011)

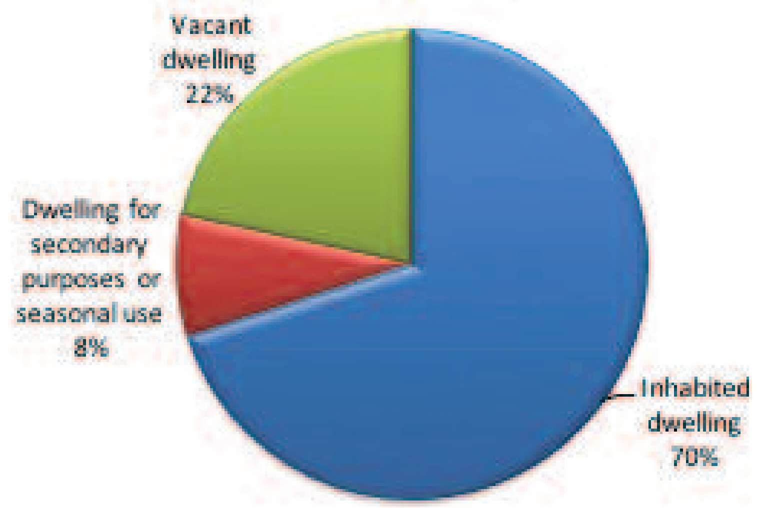
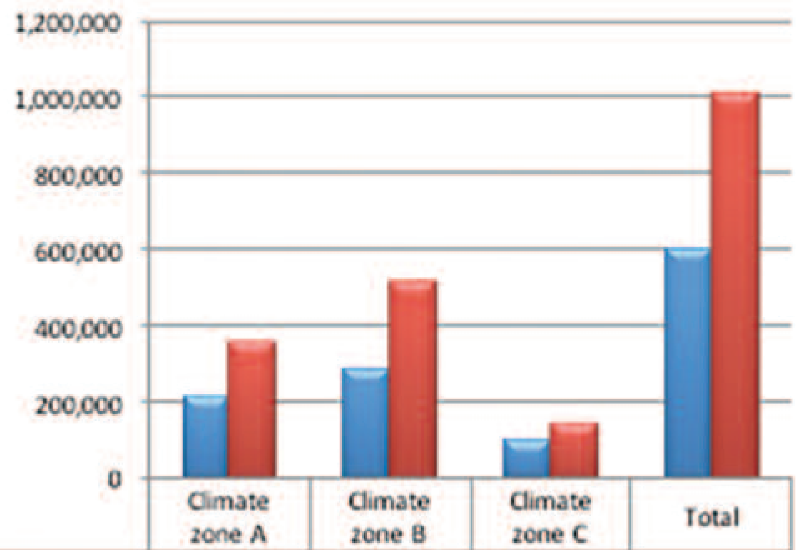


Figure 18 **Number of residential buildings and dwellings by climate zone (dwellings estimated only)** (based on INSTAT 2011)



	Climate zone A	Climate zone B	Climate zone C	Total
Number of buildings	214,136	285,570	98,561	598,267
Number of dwellings	352,612	515,706	143,744	1,012,062

■ Number of buildings ■ Number of dwellings

Figure 19 **Share of residential buildings by climate zone** (based on INSTAT 2011)

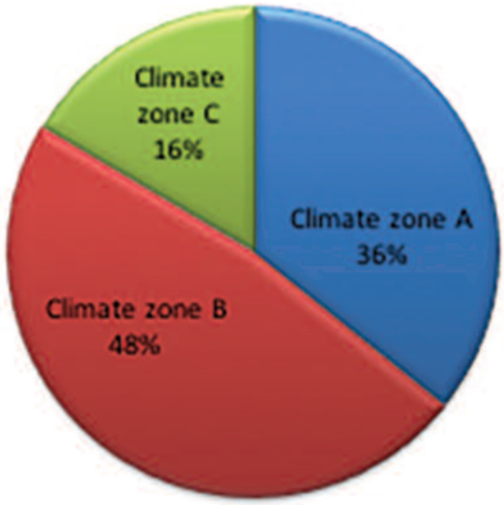


Figure 20 **Number of dwellings by climate zone and occupancy** (based on INSTAT 2011)

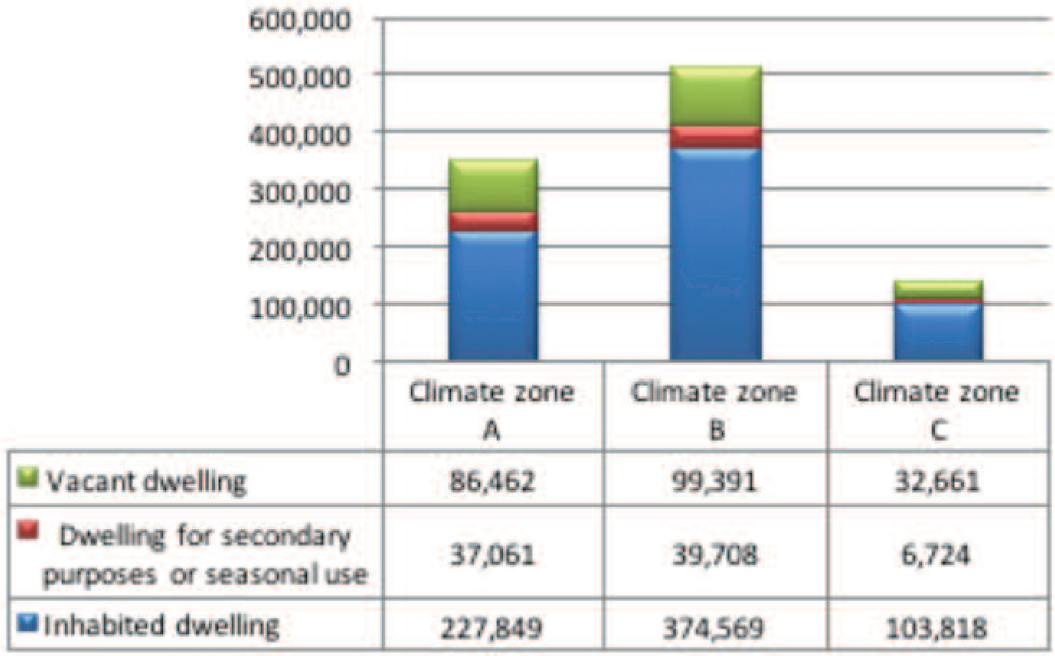


Figure 21 **Number of building permits issued for new residential buildings** (based on INSTAT, n.d.)

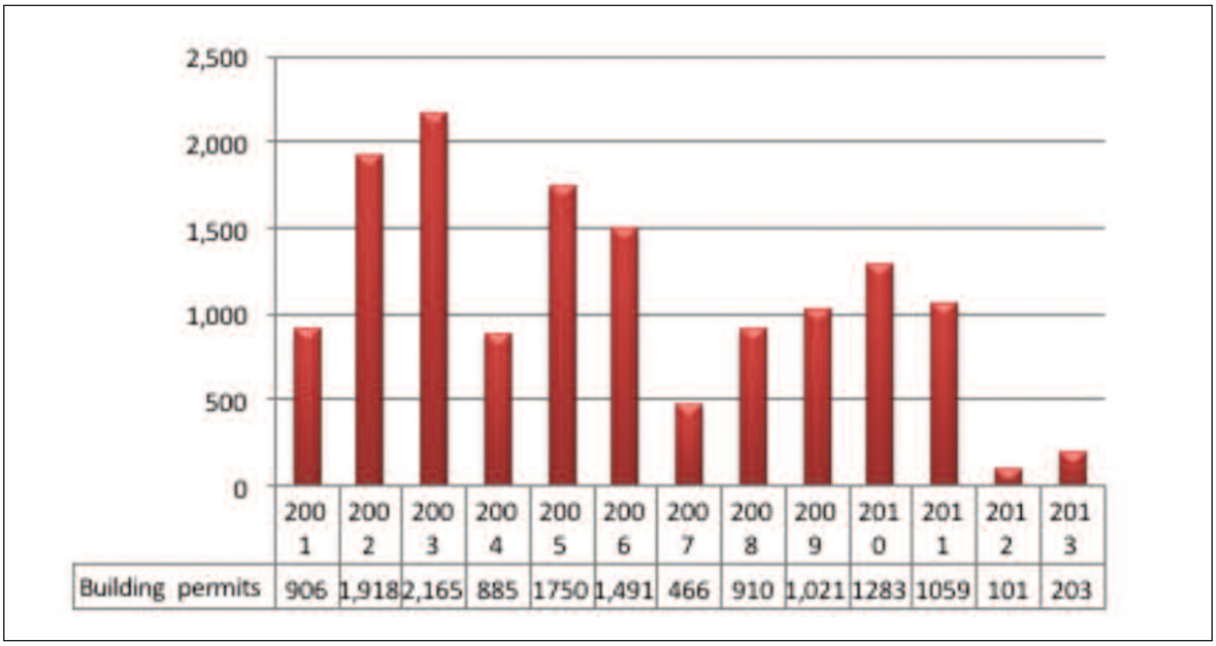
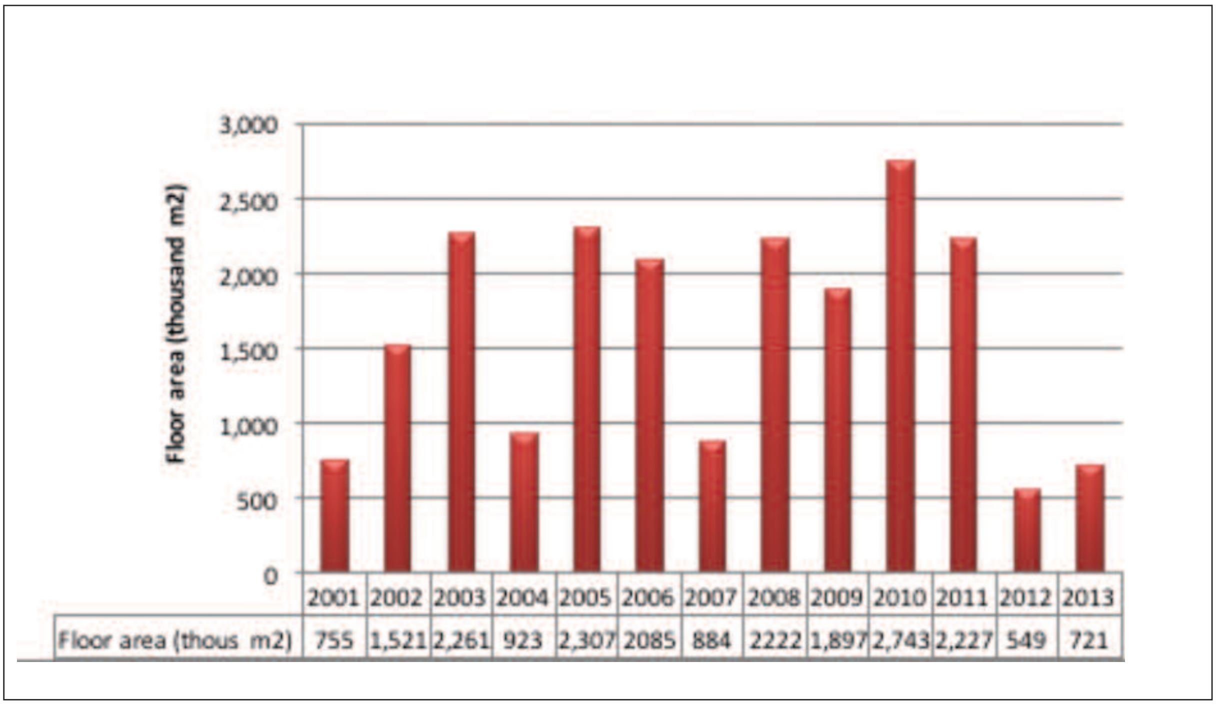


Figure 22 **Floor area of building permits issued for new residential buildings** (based on INSTAT, n.d.)



Statistical data on construction materials

We were unable to find data on construction materials in the 2011 census, although some data were available in the 2001 census. At that time, according to the census, there were 507,180 buildings in Albania. The majority of the building stock was constructed from brick or stone (88 percent), and 5 percent was prefabricated (Figure 23). Even though the number of prefabricated buildings is lower than that of masonry buildings, they are usually multi-storey buildings that contain many dwellings (Figure 24). Most of the apartment buildings constructed after 1960 were built using this technology. "Other" construction materials include clay and adobe (Figure 24).

ENERGETIC QUALITY

Apartment buildings constructed after 1960 using prefabrication technology usually have some insulation, as this was part of the sandwich wall construction. Buildings constructed during the boom in the 1990s are only partly or insufficiently insulated (Simaku, Thimjo and Plaku 2014c). Even in the 2000s, building codes were not sufficiently strict and many buildings did not comply even with these requirements. Buildings are usually poorly insulated and have high energy consumption.

Part of the building stock has already been refurbished. The most common interventions are roof insulation and the replacement of single glazing with double glazing (Simaku, Thimjo and Plaku 2014c).

Figure 23 Share of buildings by main construction material (based on INSTAT 2001)

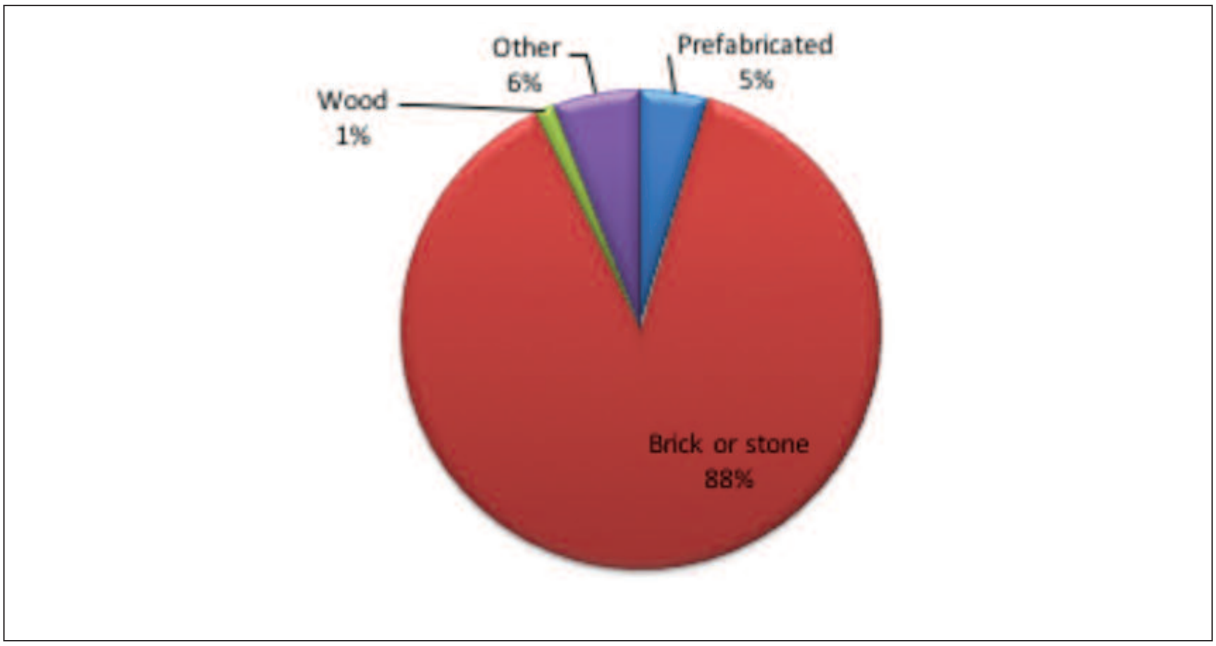
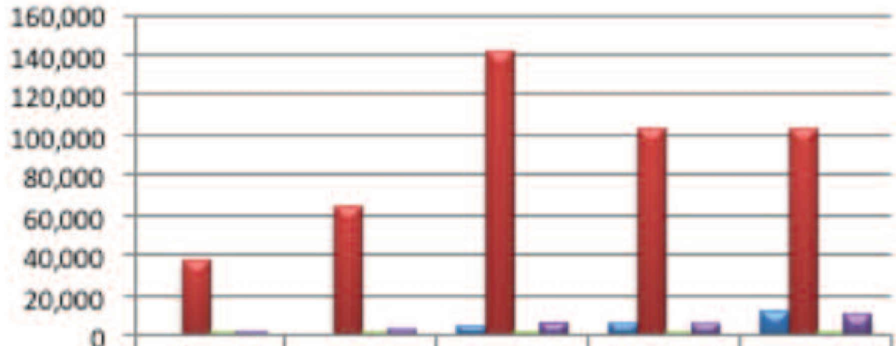


Figure 24 **Number of buildings by construction period and main construction material** (based on INSTAT 2001)



	before 1945	1945-1960	1961-1980	1981-1990	1991-2001
Prefabricated	0	0	4,601	5,993	12,351
Brick or stone	37,416	63,870	141,174	102,198	103,135
Wood	462	1,205	1,821	1,273	1,977
Other	2,560	3,393	7,105	6,263	10,383

Statistical data on building service systems

The census data provide an overview of the heating systems and energy sources typical in Albania. Unfortunately, these data are not available at the desired level of disaggregation, so it is not possible to apply them directly to building typology. Data are available for private households/inhabited dwellings by prefecture, but they are not assigned to construction periods and building types.

ENERGY SOURCES USED FOR HEATING

Data on the main type of energy used for heating are available for private households. According to the 2011 census, the most common energy source was still wood (57.5 percent), followed by gas (20.8 percent) and electricity (15.4 percent) (Figure 25). Solar heating and other energy sources, such as coal and oil, are negligible. About 6 percent of households are not heated.

There is a large difference between rural and urban regions: in rural areas, wood is far more dominant as a heating fuel than in urban areas. Wood-based heating systems are used in 85 percent of rural households. Poverty and inequality are serious problems. In cities, the situation is more balanced: wood (36.3 percent), electricity (24 percent) and gas (31.3 percent) are the three main energy sources (Figure 26).

A difference can also be observed between the three climate zones. In the mountainous region, climate zone C, wood is predominant, being used by 96 percent of private households (Figure 27). In climate zones A and B, about half the households are heated with wood, but electricity and gas also have a significant share. In the milder climate zone A, about 9 percent of households have no heating.

Statistics from the National Agency of Natural Resources (AKBN), however, present a different picture regarding the share of fuels (Figure 28). The share of electricity is far higher than in the census data. Electricity use also shows an increasing trend: its share grew from 44 percent in 2012 to 50 percent in 2013. The consumption of wood and LPG is slowly decreasing. Regarding the climate zones, electricity is dominant in climate zone A and wood in climate zone C. However, the values are rather different from the census.

Based on consultations with local experts, the difference can be explained by two factors. Firstly, the census asked for information about the main type of energy source in the household. Nowadays, many households in Albania purchase a secondary heating system, which is usually a heat pump, to increase thermal comfort in their dwellings. These secondary heating systems are not included in the census, but they are probably being used for an increasing number of hours as their operation is more convenient than wood burning. Secondly, some energy use by households may be misreported in the census. Thirdly, the AKBN figures show the breakdown of energy sources for space heating but not the breakdown of households by energy sources for space heating, which are not proportional.

HEATING SYSTEMS

Corresponding to the main energy sources, stoves are the most typical heating systems (63.3 percent), followed by electric heaters (8.5 percent) and air heat pumps (air conditioners) (6 percent). Only 3.2 percent of private households have central heating (building or dwelling heating), while 4.4 percent have a fireplace (Figure 29). According to the experts, even where central heating systems exist, there is a lack of metering and of controls for adjusting temperature levels (Simaku, Thimjo and Plaku 2014c).

In terms of the differences between urban and rural areas, the same tendency can be observed as for energy sources: in rural areas, stoves are predominant (81 percent), followed by fireplaces (7 percent) (Figure 30). In urban areas, half the households use stoves, fuelled by wood or gas. Electric heaters, heat pumps and other types of heating each account for about 10 percent in households.

Similar to the energy sources, there is also a difference in the heating systems between climate zones. In climate zone C, 95 percent of households use stoves for heating, using wood as an energy source (Figure 31). In climate zones A and B, around 60 percent have stoves with most of the appliances operating with wood, although there are also other types of stoves. In the milder climate zone A, fireplaces are also common (8 percent). Electric heaters (9 percent) and heat pumps (4 percent) have a significant share in climate zone A, and in climate zone B (9 percent and 11 percent respectively). In climate zones A and B, the share of other types of heating is around 10 percent.

There are no other statistics available on heating systems, although based on the AKBN data for energy sources it can be assumed that the number of air heat pumps is higher than reported in the census.

HEATED AND UNHEATED AREAS

Traditionally, several generations would share one building, occupying two to four rooms in a house (Simaku, Thimjo and Plaku 2014c). In winter, the “main room” or sitting room, usually the biggest room, was the only heated room, where a fire was kept lit during the daytime in an open fireplace or wood stove. The bedrooms were not heated. This custom remains, and in many buildings only part of the living area is heated.

According to the AKBN, in 2008 only 35 percent of the living area was heated in buildings on the coast, and about 70 percent in buildings in the mountains. The trend is for the heated area to increase. In 2012, about 45 percent of the living area was heated in buildings on the coast and 80 percent of buildings in the mountainous region.

MECHANICAL COOLING SYSTEMS

According to the census, 6 percent of households are equipped with air conditioners: in climate zone A, 4 percent of households have an air conditioner, and in climate zone B 9 percent (INSTAT 2011). In the census questionnaire, air conditioners are listed as a type of heating. In general, most cooling units are reversible and can be used for both heating and cooling. According to the AKBN statistics, however, the penetration of air conditioners is far higher (Table 2). Nevertheless, the use of these units as cooling devices cannot be supported by statistical data.

DOMESTIC HOT WATER

The census did not include any questions about hot water supply, although a general characteristic of an Albanian household is that water is heated for sanitary purposes using an electric boiler. This is supported by data from the AKBN, according to which, as a national average, 62 percent of energy for water heating comes from electricity, 23 percent from wood, 10 percent from LPG and 5 percent from solar power. In climate zone C, the share of wood is higher than in other climate zones, similar to space heating (Figure 32).

Figure 25 Share of private households by main type of energy used for heating (based on INSTAT 2011)

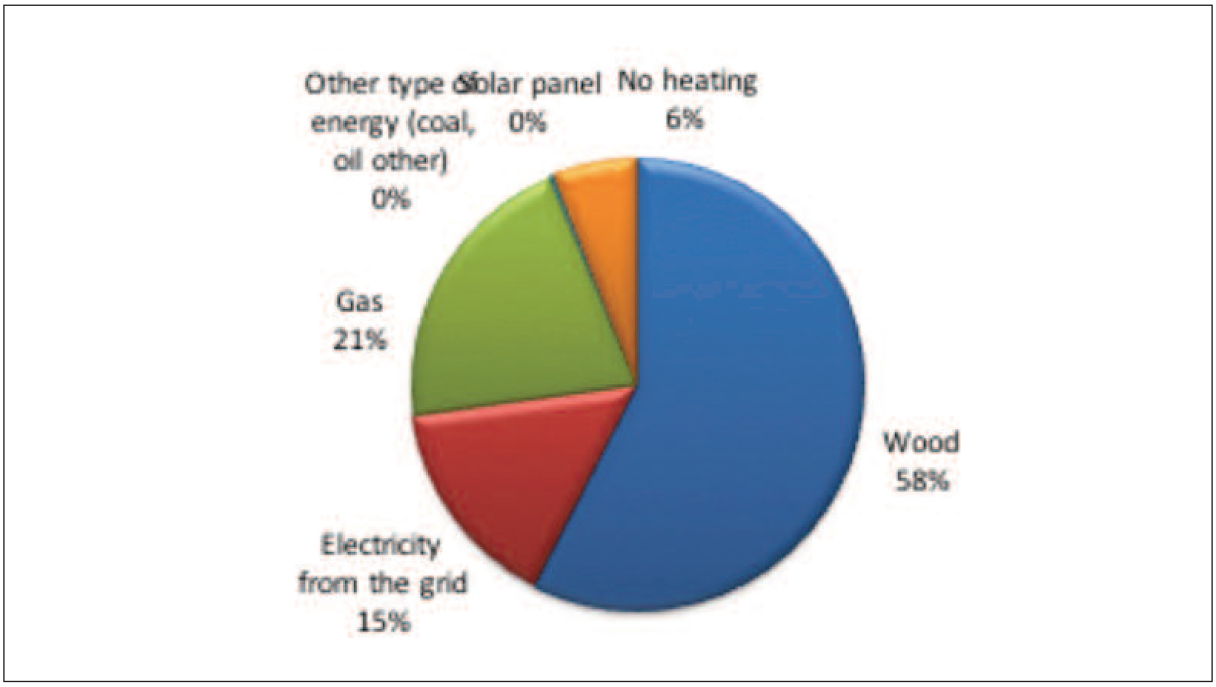


Figure 26 Share of private households by main type of energy source used for heating in urban and rural areas and the national average (based on INSTAT 2011)

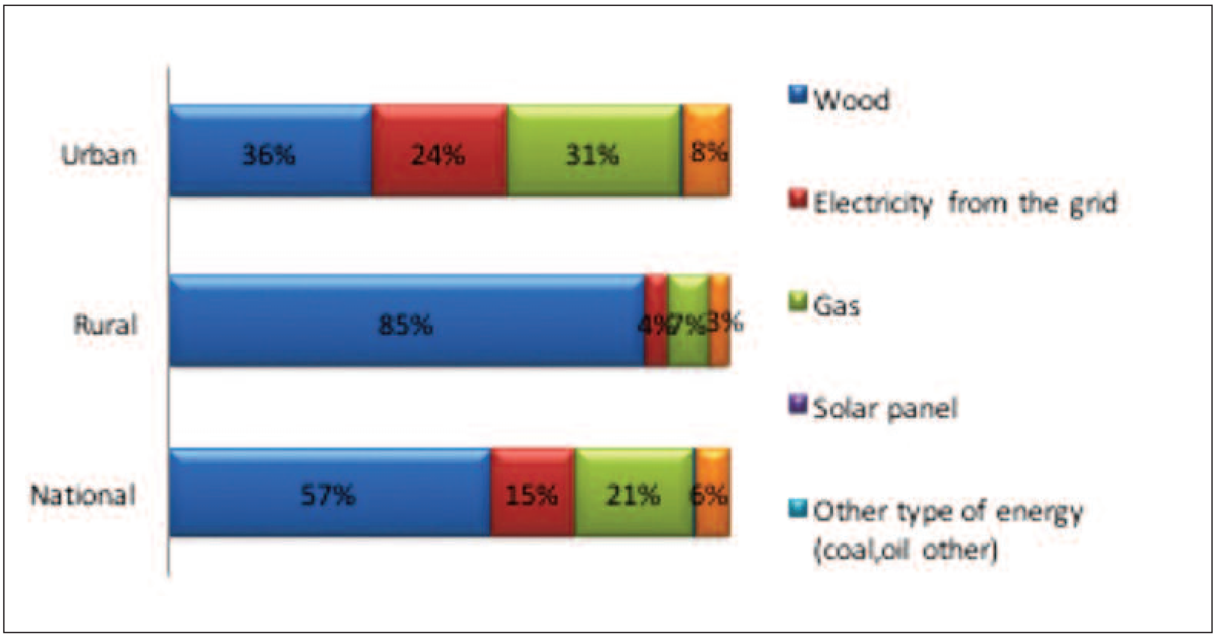


Figure 27 Share of private households by main type of energy source used for heating according to climate zone, based on census data (based on INSTAT 2011)

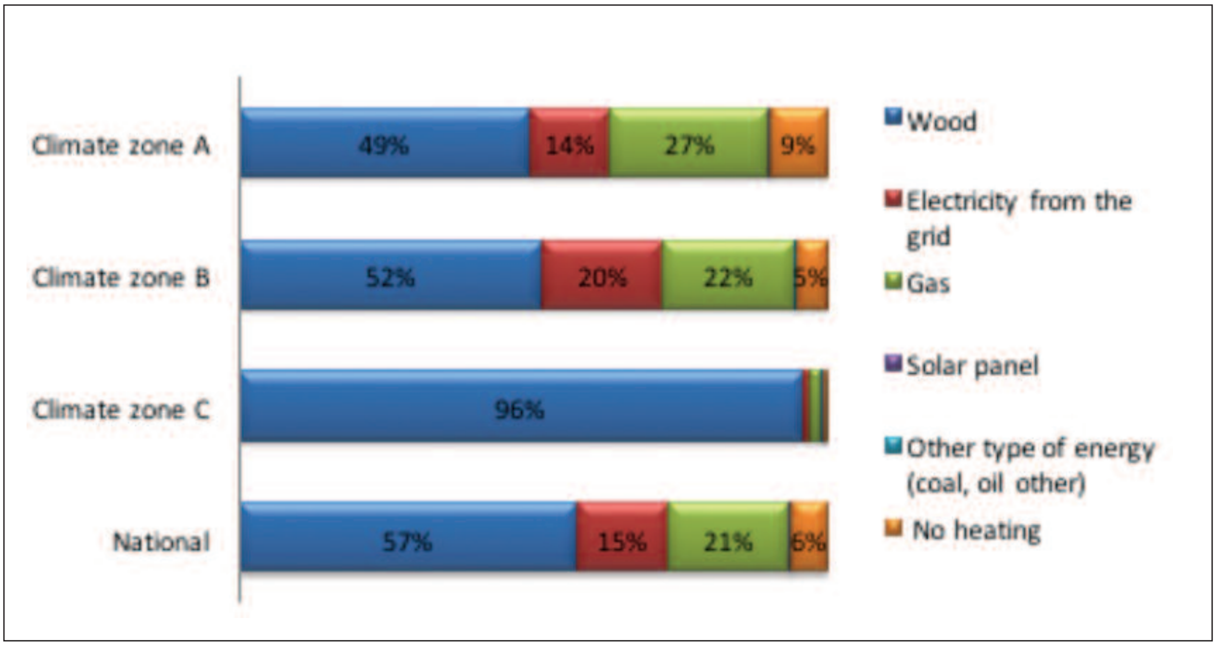


Figure 28 Fuel mix for space heating by climate zone in 2013, based on AKBN data (Kelemen et al. 2015)

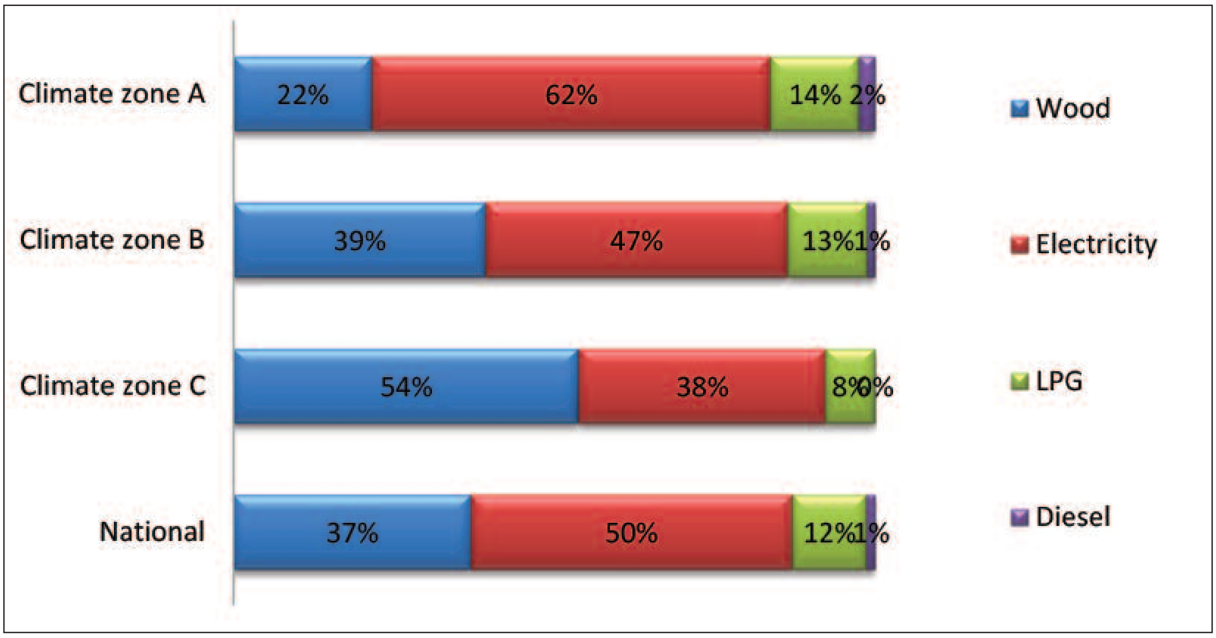


Figure 29 **Share of private households by main type of heating** (based on INSTAT 2011)

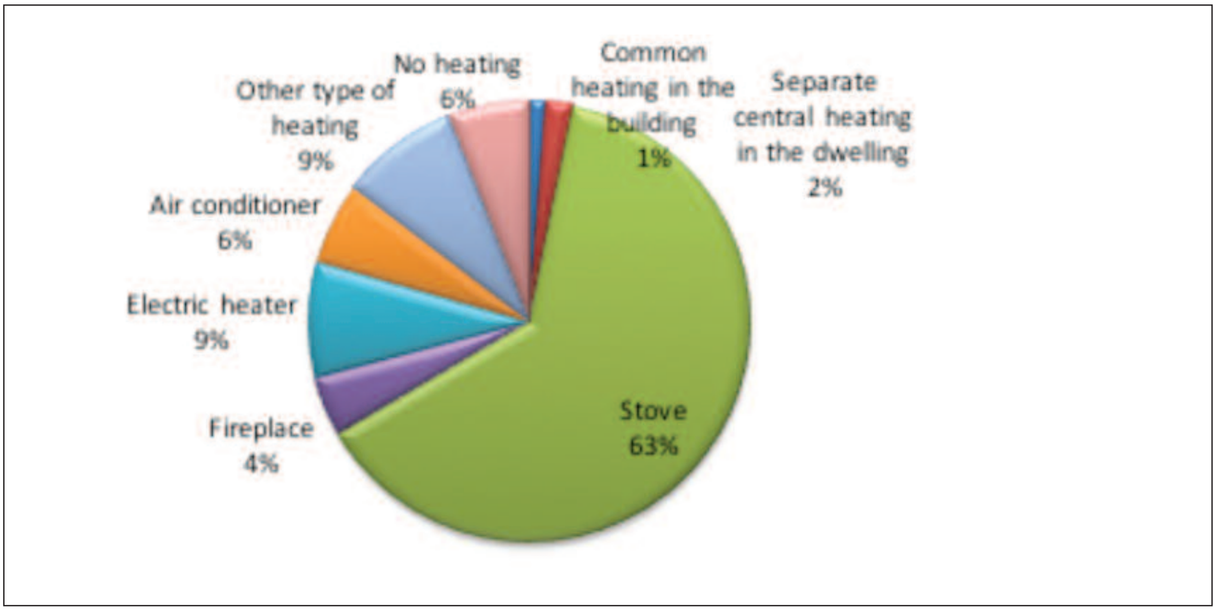


Figure 30 **Share of private households by main type of heating in urban and rural areas** (based on INSTAT 2011)

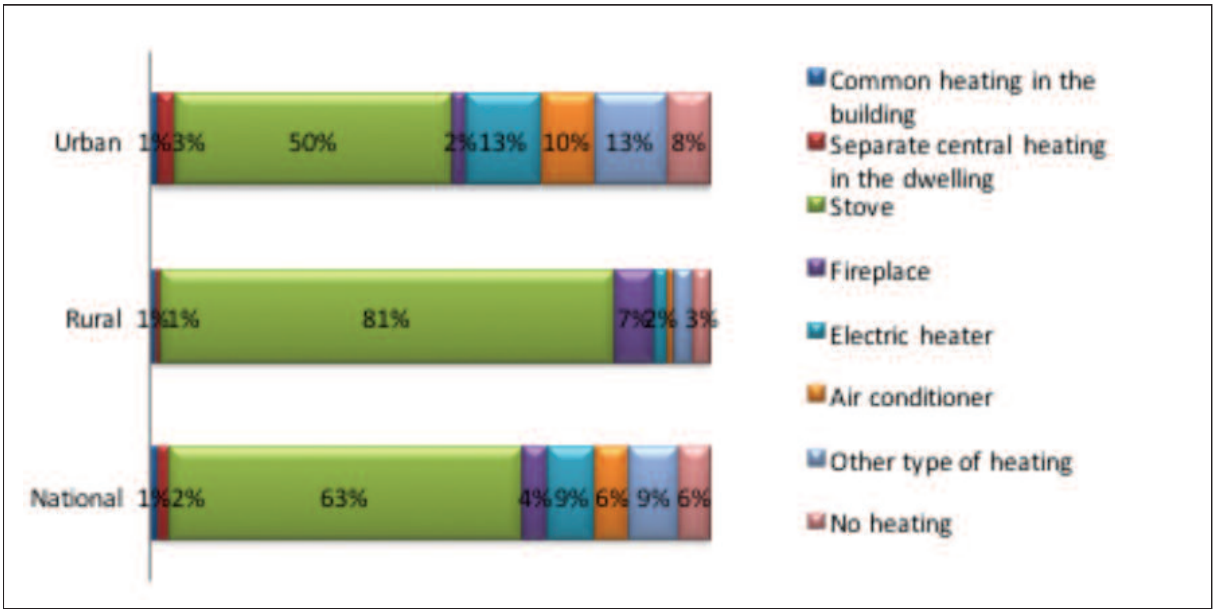


Figure 31 Share of private households by main type of heating according to climate zone (based on INSTAT 2011)

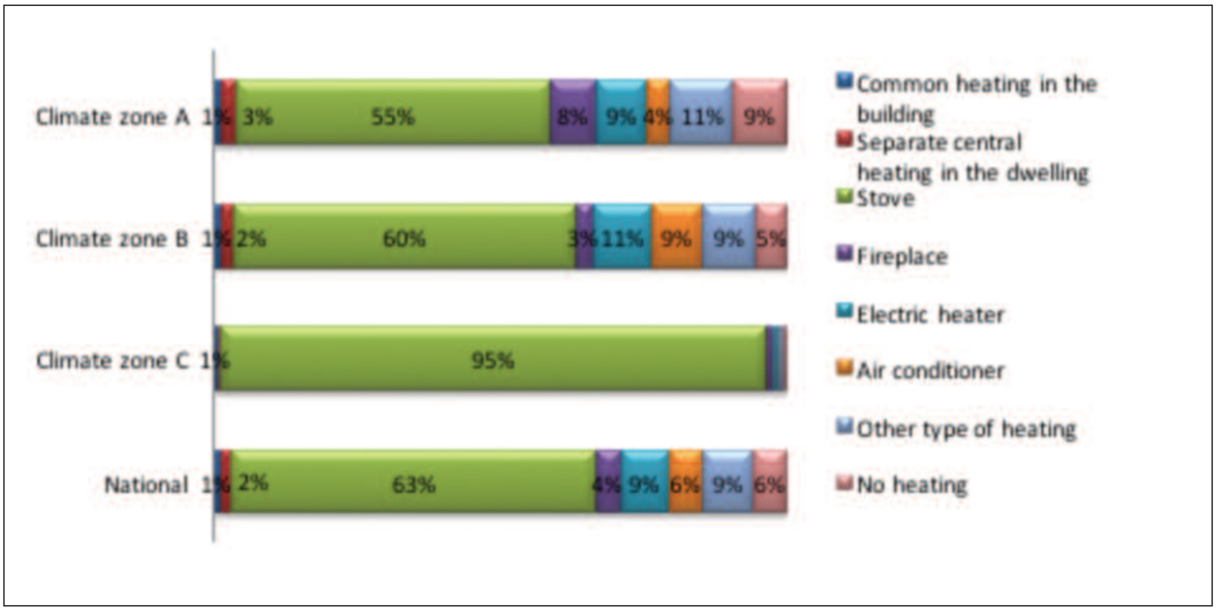


Figure 32 Fuel mix for water heating by climate zone in 2013, based on AKBN data (Kelemen et al. 2015)

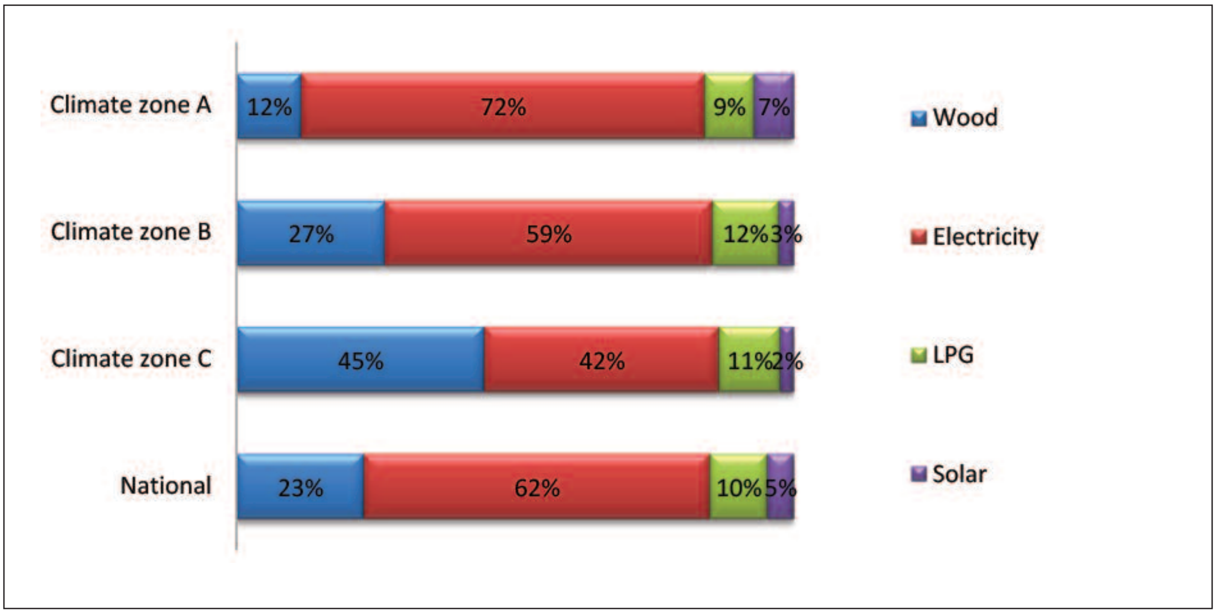


Table 2 Share of households with air conditioning in each climate zone, based on AKBN data (Kelemen et al. 2015)

Zone A	
Urban	40%
Rural	15%
Zone B	
Urban	25%
Rural	10%
Zone C	
Urban	15%
Rural	5%

Table 3 Assumptions on the number of residential buildings by the number of dwellings in the building and building type

Number of dwellings in the building	Building type: Detached houses	Semi-detached houses	Row/terraced houses	Apartment buildings	Total number of buildings	Number of dwellings in one building	Total number of dwellings
1	500,912	10,064			510,976	1	510,976
2		46,347	9,942		56,289	2	112,578
3-4			8,831	5,463	14,294	3.5	50,029
5 or more				16,708	16,708	20.3	338,479
Total	500,912	56,411	18,773	22,171	598,267		1,012,062

Main assumptions for the disaggregation of statistical data

The main source of statistical data used in this study is the 2011 census data provided by the Albanian Statistical Office. A lot of data were available for the establishment of a building typology, although some were not disaggregated at the required level for our calculations. We therefore tried to further disaggregate the data based on certain assumptions.

ESTIMATION OF THE NUMBER OF DWELLINGS

Only the number of buildings was available for each building type, not the number of dwellings, so we tried to estimate it. The following data were available on a prefecture level:

- the number of residential buildings by construction period and building type (detached house, semi-detached house, row/terraced house, apartment building); and
- the number of residential buildings by the number of dwellings in the building (buildings with one dwelling, two dwellings, three to four dwellings, and five or more dwellings) and the construction period.

The basic assumption for the estimation of the number of dwellings by building type was that detached houses include one dwelling, semi-detached houses two dwellings, most row houses and small apartment buildings between three and four dwellings, and apartment buildings more than five (Table 3).

The problem is that, according to the statistics, there are 510,976 buildings with one dwelling, which exceeds the number of detached houses (500,912). We therefore assumed that the difference is made up by semi-detached houses with only one dwelling, while the remaining semi-detached houses comprise two dwellings. This is problematic, as semi-detached houses consist of two dwellings by definition.

Regarding row houses, the problem is again that the number of buildings with two dwellings exceeds the remaining number of semi-detached houses, thus we assumed that some row houses contain two dwellings. However, there is a discrepancy, since according to the definition in the census questionnaire, row houses are buildings with at least three linked dwellings, each with a separate entrance. The remaining row houses contain three or four dwellings.

We assumed that all buildings containing five or more dwellings were apartment buildings, and the rest had three or four dwellings. From the total number of dwellings we deduced that large apartment buildings include, on average, 20.3 dwellings.

There may be a mistake in the number of buildings with one dwelling, which causes these discrepancies.

DISAGGREGATION OF DATA ACCORDING TO CLIMATE ZONE

The Albanian Statistical Office provides data at national level, and also at prefecture level. For our calculation, prefecture data were not required, although disaggregation according to climate zone was desirable. The territory of Albania is separated into three climate zones (see Table 4) (based on heating degree days for a base temperature of 17.5°C).

- Zone A: degree days are fewer than 1,500. In this zone, a south-west subzone is distinguished with degree days fewer than 900.
- Zone B: degree days are between 1,501 and 2,300.
- Zone C: degree days are more than 2,300.

Based on this information, and on advice from Albanian experts, prefectures were classified according to the three climate zones (Table 4). This method for the disaggregation of statistical data involves some error, as some prefectures belong to more than one climate zone (see Figure 33).

Figure 33 **Climate zones and prefectures in Albania** (Simaku, Thimjo and Plaku 2014d; Wikipedia 2015; Wikimedia 2015)

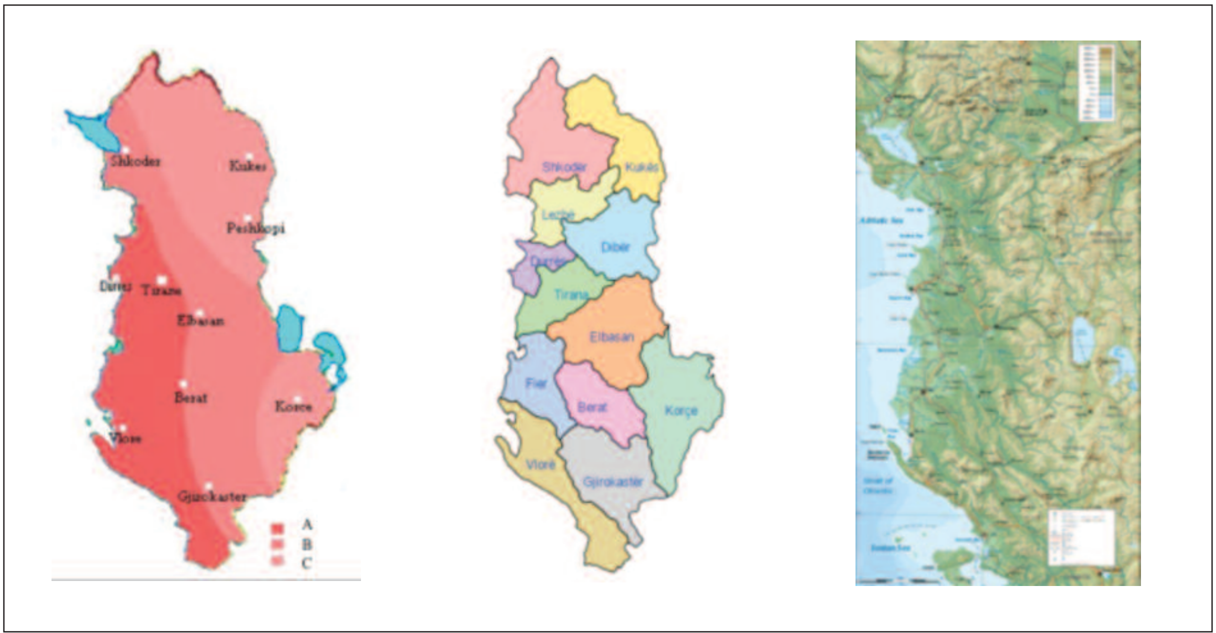


Table 4 **Prefectures by climate zone** (Simaku, Thimjo and Plaku 2014d)

Prefecture	Climate zone
Berat	B
Dibër	C
Durrës	A
Elbasan	B
Fier	A
Gjirokastër	B
Korçë	C
Kukës	C
Lezhë	A
Shkodër	B
Tiranë	B
Vlorë	A

III. Energy demand calculation method and main assumptions

Energy calculations

The energy consumption of Albanian building types in their present state and after retrofitting was estimated using the Passive House Planning Package (PHPP) software developed by the German Passivhaus Institut. Although the tool was specially developed for passive houses, it is also suitable for energy calculations in conventional buildings. We chose this tool because it delivers reliable results not only for heating energy demand, but also for cooling. However, as there is a high level of uncertainty in the input data, the results should be regarded as estimates only.

In the baseline option, we calculated the energy demand of all building types for the climate of Tirana (climate zone B) and adapted the results to the other climate zones by correction factors based on heating and cooling degree days. For heating, we calculated a full and a partial heating option, and for building service systems we calculated several options (heat pump, LPG stove and wood stove). The partial heating option assumes that only the living room of the dwelling is heated (with a stove/split-system heat pump). The full heating option assumes that the whole dwelling is heated to the set-point temperature. Central heating exists in only a very few buildings in Albania, thus for full heating individual heating equipment is assumed but a higher heating power is required to reach the capacity to heat the whole dwelling. The set-point temperature was assumed to be 20°C for heating and 26°C for cooling. The results need to be corrected if different set-point temperatures are assumed. Correction factors also need to be applied in the case of intermittent heating — for example if heating is on only for part of the day (e.g. evening and morning, as is common in the case of wood stoves).

Definition of retrofitting options

In the model, three renovation options were developed for all building types, two of them representing a complex renovation package. The complex packages consist of measures for upgrading the building envelope and the heating, cooling and domestic hot water systems.

The "business-as-usual" option (BAU improvement) includes the currently most frequently applied renovation option — that is, the changing of windows. In this case, a simplified estimate of 20 percent energy savings was taken into account for all building types. In addition, the installation of standard heat pumps was assumed.

The "standard" option (improvement 1) includes interventions related to each building component in order to comply with the minimum requirements foreseen in the case of major renovation. In the case of buildings constructed before 2000, major renovations are rather likely. The standard option in this case therefore includes a set of interventions for upgrading the building envelope from an insulation point of view. In addition, efficient building service systems are introduced: in climate zones A and B this means heat pumps with better coefficient of performance (COP), and in climate zone C efficient wood pellet stoves. In terms of water heating, solar hot water systems are introduced to cover at least 40 to 70 percent of hot water demand.

The "ambitious" option (improvement 2) goes beyond building regulations regarding the building envelope. The applied building service systems are still based on two main energy sources (wood and electricity), but better system efficiencies are considered. In all cases central solar heating systems are introduced for hot water production.

Climate data

As there were no climate data for Tirana available in the PHPP, we defined the necessary inputs based on data for Tirana from the Meteonorm database (diffuse and direct radiation, air and dew point temperature, and wind speed) (Table 5). Missing data were approximated from the PHPP climate data for the Italian city of Bari, which has a very similar climate (difference in air temperature of 2 percent, and difference in radiation of 5 percent).

The baseline calculations were performed for Tirana, in climate zone B. As already explained, Albania is divided into three climate zones: zone A is the mildest along the coastline, zone B is the medium zone, and zone C is the coldest in the mountainous region. For climate zones A and C, heating and cooling energy use were corrected with the degree days of the corresponding climate zone (Table 6).

Table 5 Climate data for Tirana (climate zone B)

Heating season (H_T)	125	d/a
Degree hours (G_t)	35	kKh/a
Global radiation North	68	kWh/(m²a)
Global radiation East	170	kWh/(m²a)
Global radiation South	373	kWh/(m²a)
Global radiation West	172	kWh/(m²a)
Global radiation horizontal	260	kWh/(m²a)

Table 6 Heating and cooling degree days (HDD: base temperature 17.5˚C; CDD: base temperature 18.5˚C)

Degree days	Zone A	Zone B (Tirana)	Zone C	Data source
HDD (17.5°C)	1,330	1,534	2,600	Albanian regulations
CDD (18.5°C)	870	760	350	www.degreedays.net

Building structures and parameters

Albanian experts provided information on the typical composition of the building structure (Simaku, Thimjo and Plaku 2014a and 2014b). Currently, with the exception of buildings constructed in the last decade, Albanian buildings have no insulation. The standard renovation includes the addition of 5 cm of insulation for both walls and roofs, and the changing of windows to double-glazed units. The ambitious option involves 10 cm of insulation for walls, 12 cm for roofs and 5 cm for floors, along with triple-glazed windows. In most cases, expanded polystyrene with a thermal conductivity of 0.037 W/mK was assumed (Table 7).

THERMAL BRIDGES

The PHPP tool calculates with the external dimensions of the building envelope, but we decided to use the internal dimensions corrected with the effect of thermal bridges. Heat losses due to the thermal bridge effect were assumed to be 20 percent for the walls and 10 percent for the floors and roofs (Table 8).

ORIENTATION

For the calculation of solar gains, we assumed an average orientation with all the windows facing East/West, 75 percent glazing fraction, average shading in the winter (75 percent reduction factor) and temporary external sun protection for the summer (41 percent reduction factor).

VENTILATION

We considered poor airtightness due to leaky windows, resulting in an average air change rate of 1.5 l/h in the winter (infiltration + natural ventilation through window openings). In recently constructed buildings (building type E), the air change rate was assumed to be 0.7 l/h, since the quality of the windows is presumably better. For the retrofitting options, an average air change rate of 0.5 l/h was considered, as infiltration is expected to decrease significantly due to the replacement of the windows.

For the summer, effective cross-ventilation at night was taken into account:

- First, we made assumptions about the number of windows where cross-ventilation is possible based on the architectural drawings (dwellings with windows on different facades, windows on the same facade but at different levels).

Table 7 Added insulation in the retrofitting options

Building type	Present state	Standard retrofit	Ambitious retrofit
A1	No insulation, single-glazed windows	Walls 5 cm, roof 5 cm, double-glazed windows	Walls 10 cm, roof 12 cm, floor 5 cm, triple-glazed windows
A2			
A3			
A4			
B1	No insulation, single-glazed windows	Walls 5 cm, roof 5 cm, double-glazed windows	Walls 10 cm, roof 12 cm, floor 5 cm, triple-glazed windows
B2			
B3			
B4			
C1	No insulation, single-glazed windows	Walls 5 cm, roof 5 cm, double-glazed windows	Walls 10 cm, roof 12 cm, floor 5 cm, triple-glazed windows
C2			
C3			
C4			
D1	No insulation, single-glazed windows	Walls 5 cm, roof 5 cm, double-glazed windows	Walls 10 cm, roof 12 cm, floor 5 cm, triple-glazed windows
D2			
D3			
D4			
E1	Limited insulation, double-glazed windows	Walls 5 cm, roof 5 cm, double-glazed windows	Walls 10 cm, roof 12 cm, floor 5 cm, triple-glazed windows
E2			
E3			
E4			

Table 8 Main building input data

	Present state	Retrofit
Thermal bridge losses: Walls	20% extra	
Thermal bridge losses: Floors	10% extra	
Ventilation	1.5 l/h	1.5 l/h
Internal heat gains	6.6 W/m^2	
Design temperature: Winter	20˚C	
Design temperature: Summer	26˚C	

Table 9 National share and efficiency of heating systems and energy sources in the present state, BAU, standard and ambitious retrofitting options

	Building type	Present state	BAU	Standard retrofit	Ambitious retrofit
Climate zone A	Detached houses	Heat pump and direct electric heating, 70%, SCOP = 1.77*	Heat pump 100%, SCOP = 2.2	Heat pump 100%, SCOP = 3	Heat pump, multi-split 100%, SCOP = 4
		Wood stove 20%, η_b = 0.6			
		Gas 10%, η_b = 0.8			
	Row houses and multi-family apartment buildings	Heat pump and direct electric heating, 70%, SCOP = 1.77*	Heat pump 100%, SCOP = 2.2	Heat pump 100%, SCOP = 3	Heat pump, multi-split 100%, SCOP = 4
		Wood stove 10%, η_b = 0.6			
		Gas 20%, η_b = 0.8			
Climate zone B	Detached houses	Heat pump and direct electric heating, 65%, SCOP = 1.74*	Heat pump 100%, SCOP = 2.2	Heat pump 100%, SCOP = 3	Heat pump, multi-split 100%, SCOP = 4
		Wood stove 25%, η_b = 0.6			
		Gas 10%, η_b = 0.8			
	Row houses and multi-family apartment buildings	Heat pump and direct electric heating, 80%, SCOP = 1.74*	Heat pump 100%, SCOP = 2.2	Heat pump 100%, SCOP = 3	Heat pump, multi split 100%, SCOP = 4
		Wood stove 5%, η_b = 0.6			
		Gas 15%, η_b = 0.8			
Climate zone C	Detached houses	Heat pump and direct electric heating, 20%, SCOP = 1.72*	Heat pump 100%, SCOP = 2.2	Centralised heating system with wood pellet boiler and automatic regulation of temperature and hot water preparation 100%, η_b = 0.85	Centralised heating system with wood pellet boiler and automatic regulation of temperature and hot water preparation 100 % η_b = 0.85
		Wood stove 65%, η_b = 0.6			
		Gas 15%, η_b = 0.8			
	Row houses and multi-family apartment buildings	Heat pump and direct electric heating 30%, SCOP = 1.72*	Heat pump 100%, SCOP = 2.2	Centralised heating system with wood pellet boiler and automatic regulation of temperature and hot water preparation 100%, η_b = 0.85	Centralised heating system with wood pellet boiler and automatic regulation of temperature and hot water preparation 100% η_b = 0.85
		Wood stove 60%, η_b = 0.6			
		Gas 10%, η_b = 0.8			

* Efficiency is calculated from the assumed share of heat pumps and direct electric heaters (efficiency of direct heater = 1; efficiency of heat pump = 2.2; assumed shares: climate zone A 64% heat pump; 36% direct heater; climate zone B 62% heat pump, 38% direct heater; climate zone C 60% heat pump, 40% direct heater)

Table 10 Definition of present state and retrofitting options for cooling systems in Albania

	Existing state and BAU	Standard retrofit	Ambitious retrofit
Climate zone A	Heat pump, EER = 2	Heat pump, EER >3	Heat pump, EER >3
Climate zone B	Heat pump, EER = 2	Heat pump, EER >3	Heat pump, EER >3
Climate zone C	Heat pump, EER = 2	Heat pump, EER >3	Heat pump, EER >3

- During the day windows were only opened for one hour, and during the night all windows were opened.
- Boundary conditions were assumed to be 4 K temperature difference and 1 m/s wind speed during the day, and 1 K temperature and no wind during the night, and the air change reduction factor was 80 percent.

DESIGN PARAMETERS

Internal gains were assumed to be 6.6 W/m^2 (Simaku, Thimjo and Plaku 2014a). This is higher than the standard 5 W/m^2, but the standard occupant density in Albania is quite high (19.5 m^2 floor area/occupant). The internal design temperature was assumed to be 20°C in winter and 26°C in summer in the baseline option.

Space-heating systems

The three most typical energy sources were modelled for the present situation: electricity (air-to-air heat pumps and direct electric heating), wood (mostly wood stoves) and LPG (stoves). In climate zone C wood is dominant, while in climate zones A and B all three energy sources are significant.

Data were available for the national share of the energy sources in each climate zone, but no information was available for the distribution of energy sources per building type. The share per building type was estimated with the help of Albanian experts, and corrected to suit the national energy balance resulting from a top-down approach (see Section VIII for details), as shown in Table 9.

The BAU option assumes that households will install electric heat pumps in every building type and climate zone. In the standard and ambitious retrofitting options, in climate zones A and B heat pump systems are assumed, and in climate zone C wood pellet central heating systems are assumed.

Space-cooling systems

The penetration of air conditioners is increasing in Albania. According to the 2011 census, 4 percent of households in climate zone A and 9 percent in climate zone B had air conditioning. However, the AKBN data show a larger penetration already. We assumed a share of 45 percent in climate zones A and B, and 15 percent in climate zone C.

In Albania, air-conditioning systems are predominantly decentralised systems (split units). Most of the cooling units are reversible, thus they are also used for heating, although this cannot be supported by statistical data. For the present state, and for the BAU option, a low energy efficiency ratio (EER) of 2 was taken into account. For the standard and ambitious retrofitting options, reversible systems with an EER of 3 were considered. Reversible split systems are typically applied for heating in Albania. As a consequence, cooling is available without extra measures.

Partial heating and cooling

In Albania, typically only a part (one or two rooms) of a dwelling is heated in order to save energy and costs. Technically this is easy, as most systems operate per room. It is also typical for a heating system not to be turned on all day long. Overnight heating is rare. The maximum time that heating is on in a household is therefore 24–6=18 hours. The daily heated hours are typically in the morning and evening, although no statistics are available to support this. The same applies to air conditioning: it can be assumed that only one or two rooms are cooled, and only for one period of the day.

Although the mild winters in climate zones A and B make it relatively easy to use intermittent and partial heating and to put up with a lower level of comfort, it is predicted that, in the future, thermal comfort

Table 11 Assumptions for partial and intermittent heating in the present state, BAU, standard and ambitious retrofitting options

	Building type	Energy source	Present state	BAU	Standard retrofit	Ambitious retrofit
Climate zone A	Heated floor area (%)		50	75	100	100
	Daily heated hours (h)	Electricity	10	16	18	18
		Wood	6	-	-	-
		LPG	6	-	-	-
Climate zone B	Heated floor area (%)		60	80	100	100
	Daily heated hours (h)	Electricity	10	16	18	18
		Wood	6	-	-	-
		LPG	6	-	-	-
Climate zone C	Heated floor area (%)		80	100	100	100
	Daily heated hours (h)	Electricity	10	16	18	18
		Wood	6	-	16	18
		LPG	6	-	-	-

Table 12 Assumptions for partial and intermittent cooling in the present state, BAU, standard and ambitious retrofitting options

	Building type	Present state	BAU	Standard retrofit	Ambitious retrofit
Climate zone A	Cooled floor area (%)	50	80	100	100
	Daily cooled hours (h)	12	12	12	14
Climate zone B	Cooled floor area (%)	60	80	100	100
	Daily cooled hours (h)	12	12	12	14
Climate zone C	Cooled floor area (%)	60	80	100	100
	Daily cooled hours (h)	12	12	12	14

requirements will increase. Underheating will thus be less frequent, and the significance of underheating and partial heating in the calculations will therefore decrease. In the retrofitting options we therefore assumed an increase in the heated floor area and in the daily heated hours. It should also be mentioned that in well-insulated buildings the impact of internal heat flows is greater, and the indoor air temperature is more balanced.

Real energy consumption for heating and cooling is thus significantly lower than the theoretical figures given by the model, assuming full heating. The heated/cooled floor area and daily heated/cooled hours applied in the modelled options are detailed in Tables 11 and 12. Longer heating periods were assumed for electricity, as it is easier and more convenient to regulate electric heating. The correction factors for partial heating were derived from PHPP by taking into account the heat losses of unheated spaces based on the relevant standard (EN 12831). However, it is important to emphasise that the estimated figures should be handled with caution, since no statistics are available on partial heating and cooling. It is recommended to carry out statistical surveys in order to obtain a more accurate picture.

Domestic hot water systems

In existing buildings, sanitary hot water is usually provided by electric water heaters (mainly 80 l capacity and 2.5 kW electrical power), but there is also a share of wood (Table 13). In the BAU option, electric water heaters are assumed. In the standard and ambitious options, central sanitary water heating (SWH) systems are considered. Solar-powered systems cannot meet the heat demand for domestic hot water (DHW) throughout the year, thus auxiliary heating is necessary. Auxiliary heating for DHW is provided by heat pumps in climate zones A and B, and by central wood pellet boilers in climate zone C. There is a small share of LPG, which was neglected in the calculations.

The net DHW heat demand is calculated based on daily hot water consumption per person, taking into account the average number of people in a dwelling. A demand of 30 l/day/person was applied (Simaku, Thimjo and Plaku 2014b). The water temperature considered was 45°C (average temperature difference 28 K). The country average result, taking into account the number of people per building type and the number and size of dwellings per building type, was 18 kWh/m²/year. This weighted average figure was applied for all further calculations.

Table 13 National share and efficiency of water-heating systems and energy sources in the present state, BAU, standard and ambitious retrofitting options

	Building type	Present state	BAU	Standard retrofit	Ambitious retrofit
Climate zones A and B	Detached houses	Electric boiler 90%, $\eta_b = 1$	Electric boiler 100%, $\eta_b = 1$	Heat pump 100%, SCOP = 3	Heat pump 30%, SCOP = 4
		Wood stove 10%, $\eta_b = 0.6$		Solar collector 70%	Solar collector 70%
	Row houses and multi-family apartment buildings	Electric boiler 100%, $\eta_b = 1$	Electric boiler 100%, $\eta_b = 1$	Heat pump 60%, SCOP = 3	Heat pump 60%, SCOP = 3
				Solar collector 40%	Solar collector 40%
Climate zone C	Detached houses	Electric boiler 60%, $\eta_b = 1$	Electric boiler 100%, $\eta_b = 1$	Wood pellet boiler 30%, $\eta_b = 0.85$	Wood pellet boiler 30%, $\eta_b = 0.90$
		Wood stove 40%, $\eta_b = 0.6$		Solar collector 70%	Solar collector 70%
	Row houses and multi-family apartment buildings	Electric boiler 60%, $\eta_b = 1$	Electric boiler 100%, $\eta_b = 1$	Wood pellet boiler 60%, $\eta_b = 0.85$	Wood pellet boiler 60%, $\eta_b = 0.90$
		Wood stove 40%, $\eta_b = 0.6$		Solar collector 40%	Solar collector 40%

System efficiencies

Delivered energy is calculated using the net heating energy demand (Q_{ND}) per energy source:

$$Q_{delivered} = \frac{Q_{ND}}{\eta_t}$$

The system efficiency (η_t) of the energy supply systems was calculated as follows: $\eta_t = \eta_b \cdot \eta_p \cdot \eta_c$

where:

η_b = boiler (source) efficiency;

η_p = piping (distribution) efficiency; and

η_c = control (regulation) efficiency.

Taking into account that there are no further data concerning the characteristics of heating devices per building type (no survey has been carried out in connection with these data in Albania), in the building type models the most frequent systems were incorporated. The assumed boiler efficiencies are summarised in Tables 11 and 12.

In climate zones A and B, both direct electric heaters and heat pumps are common. To simplify the modelling, these two systems were modelled together with a virtual efficiency calculated according to the ratio of the dwellings with direct electric heating and heat pump, assuming an efficiency of 1 for direct electric heating and 2.2 for heat pumps.

Primary energy factors and CO_2 emissions

Primary energy consumption ($Q_{primary}$) is the sum of the delivered energy ($Q_{delivered}$) multiplied by the primary energy factors ($f_{p,source}$) of the energywares:

$$Q_{primary} = \sum Q_{delivered} \cdot f_{p,source\ i} \quad \left[{kWh}/{year} \right]$$

Annual CO_2 emissions for space heating and DHW are determined as follows:

$$m_{CO2} = \sum Q_{delivered} \cdot f_{CO2,source\ i} \quad \left[{kg}/{year} \right]$$

where: $f_{CO2,source\ i}$

= the CO_2 emission factor of the energyware used by heat generator *i*.

The conversion factors for the determination of annual primary energy and specific CO_2 emissions per energy carrier are shown in Table 14. As there was no information available for the primary energy factors and specific CO_2 emissions, standard values were used for wood and LPG, and the values determined from the electricity sector modelling scenarios for electricity (Szabó et al. 2015). The low values for electricity can be explained by the fact that electricity supply in Albania is based on hydro generation.

Table 14 **Primary energy factors and CO_2 emission factors for Albania** (IPCC NGGIP online and Szabó et al. 2015)

Energy carrier	Primary-to-final energy factor	Specific CO_2 emissions
	(kWh/kWh)	(kg/kWh)
Wood biomass	0.20	0.00
Electrical energy	1.01	0.00
LPG	1.10	0.227
Solar energy	0.00	0.00

IV. Calculation results

The results of the detailed energy demand calculation for the existing building stock are provided in the Excel file Albania_types_energy.xls, available at www.sled.rec.org. This file contains the most relevant input data and the results for heating, hot water and cooling energy demand in each building type.

Net energy demand of the existing building stock and the retrofitting options

In the summary diagrams of the results (Figures 34 to 38), buildings are assumed to have a wood or LPG stove for heating, or inefficient reversible split systems for heating and cooling according to the shares defined in Section III (page 49). This can be regarded as the typical situation. The first diagram assumes the heating of the entire building, and the second assumes partial heating.

The progress in net heating demand shows that the thermal characteristics of the building stock have improved somewhat over time, although significant improvement can be seen only in the last decade. In general, detached house have higher heating demand than large buildings due to their unfavourable surface to volume ratio. In most building types, heating is dominant in the total energy demand, with the exception of recently constructed dwellings.

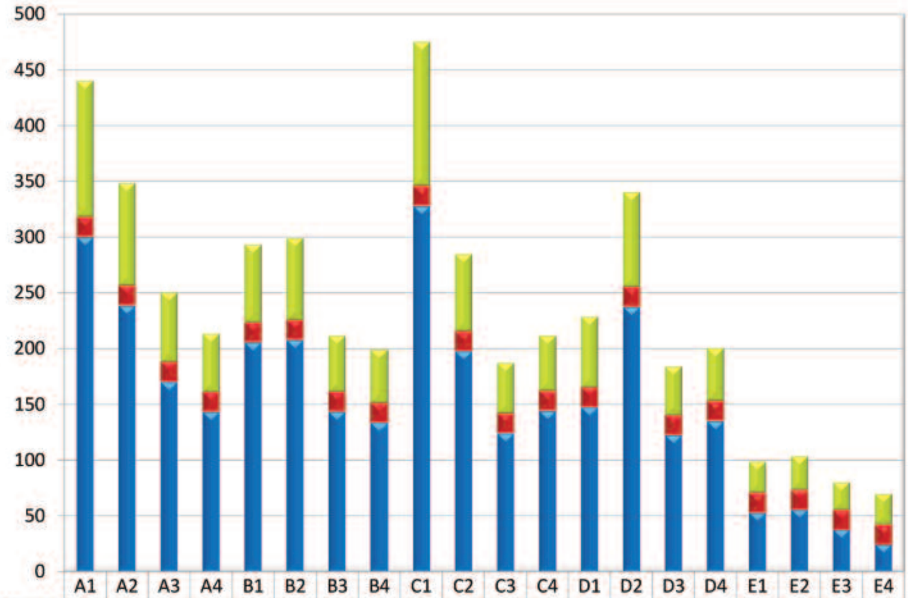
In the partial heating option, space-heating demand is only 25 to 45 percent of the values for full heating. These values are more realistic and better match the energy balance (see Section VIII). As no correction factors were applied for DHW, its relative significance increases and it becomes dominant in recently constructed large buildings.

The values for cooling must be considered with caution. The building typology was created to model heating, because heating is the most important area of energy end use in Albanian households. This typology is not appropriate to model cooling, because the most important factors that determine cooling demand — that is, the ratio of glazed surfaces, orientation, shading devices and the neighbouring environment — were not considered (due to a lack of statistical data). However, as cooling is of far smaller significance in the national energy balance than heating, and because there are no appropriate statistical data to construct a building typology for modelling the building stock for cooling, we decided to apply the same typology for cooling and heating. For the more appropriate modelling of cooling demand, a different typology should be defined, but before this can be done statistical data must be collected concerning the building characteristics that determine cooling demand.

As a result of the retrofitting packages, heating energy demand is drastically reduced to a low-energy building standard in the complex retrofitting options. Hot water demand remains the same. Cooling energy demand also significantly decreases. However, in the calculations we assume shading of the windows during the day and efficient night ventilation to cool the building at night. If this ventilation cannot be provided, there is a high risk of overheating, and cooling energy demand will be far higher.

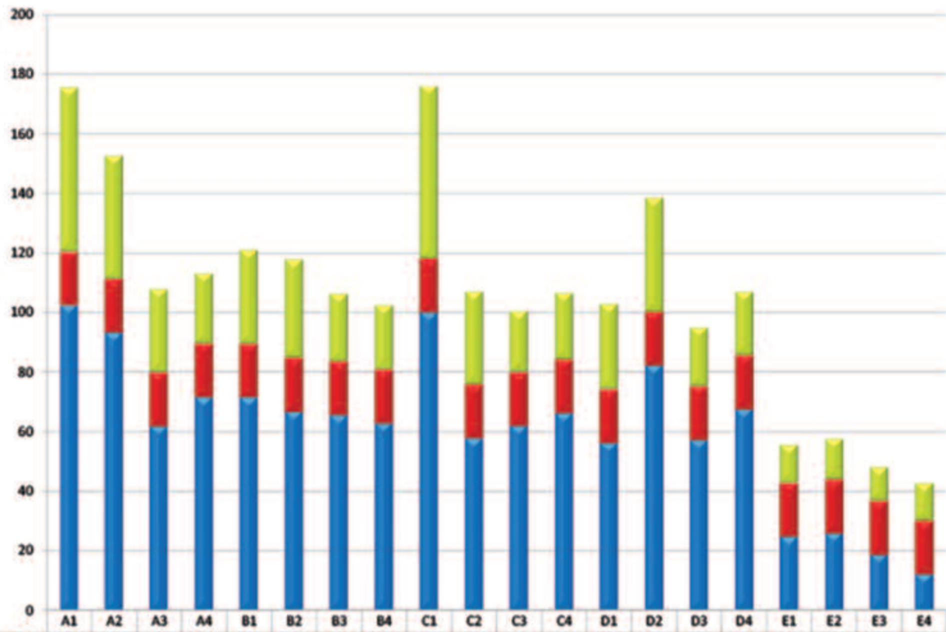
Results for all climate zones can be found in the file Albania_types_energy.xls, available at www.sled.rec.org.

Figure 34 Net energy demand of building types (present state, full heating, climate zone B)



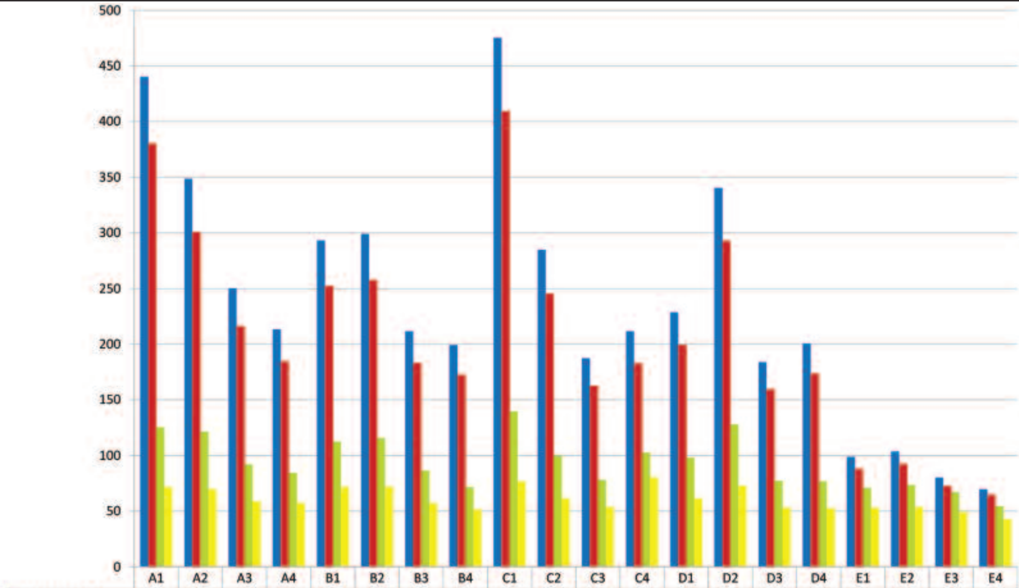
	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4
Cooling [kWh/m2a]	122	92	62	52	70	73	50	48	129	69	45	49	63	85	44	47	28	30	25	27
DHW [kWh/m2a]	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Heating [kWh/m2a]	300	239	170	143	206	208	143	133	328	198	124	144	147	237	122	135	53	56	38	24

Figure 35 Net energy demand of building types (present state, partial and intermittent heating, climate zone B)



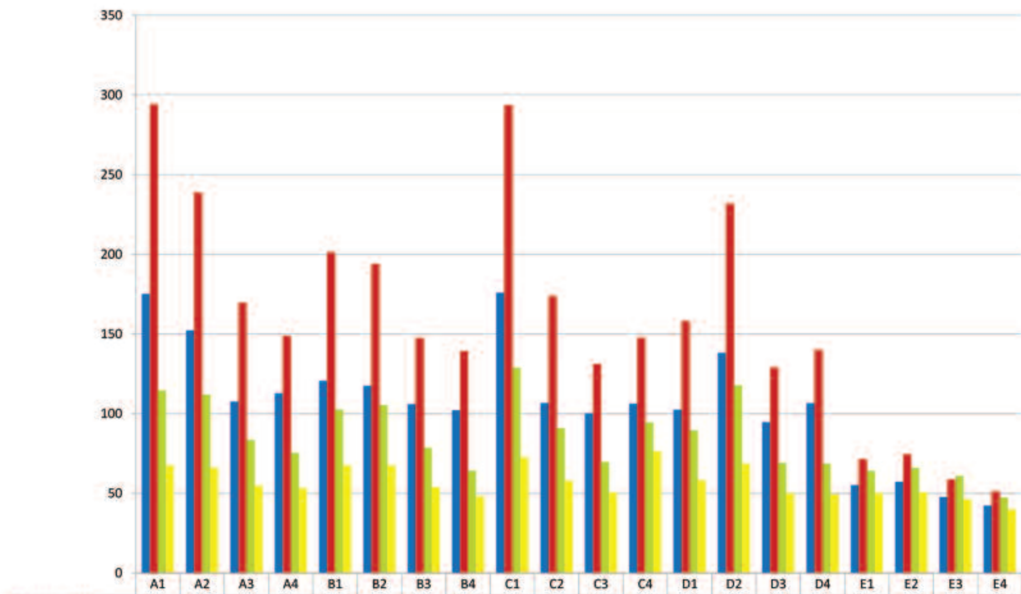
	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4
Cooling [kWh/m2a]	55	41	28	23	31	33	23	21	58	31	20	22	28	38	20	21	12	13	11	12
DHW [kWh/m2a]	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Heating [kWh/m2a]	102	93	62	71	71	67	65	63	100	58	62	66	56	82	57	67	25	26	19	12

Figure 36 Net energy demand of building types (present state and retrofitted states, full heating, climate zone B)



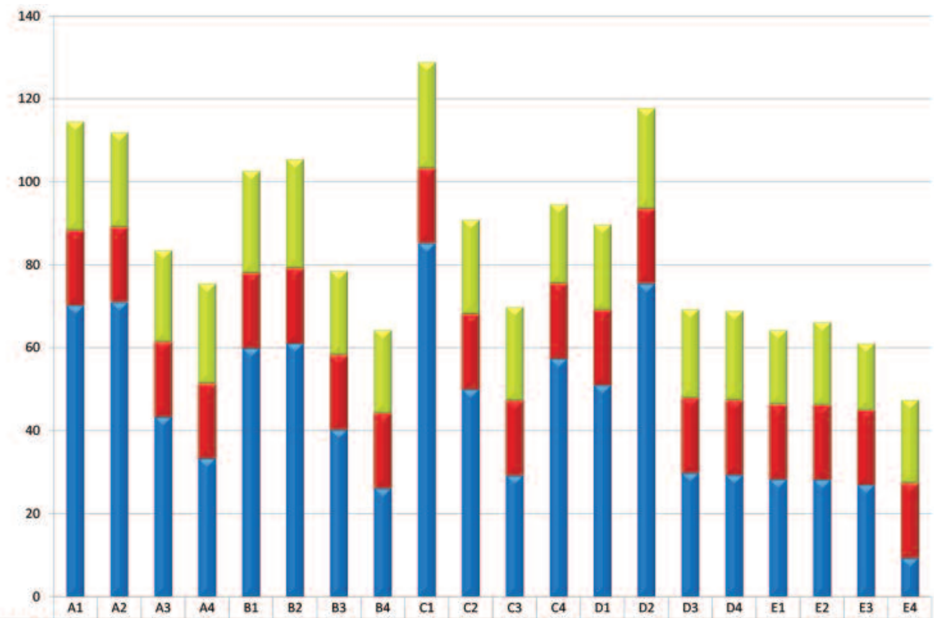
	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4
present state	440	349	250	213	293	299	212	199	475	285	187	212	229	340	184	201	99	104	80	70
improvement BAU	380	301	216	185	252	258	183	172	410	245	162	183	199	293	159	173	88	92	73	65
improvement 1	125	121	92	84	112	116	86	72	140	100	78	102	98	128	77	77	71	73	67	54
improvement 2	72	70	59	57	72	72	57	51	77	62	54	80	62	73	53	53	53	54	49	43

Figure 37 Net energy demand of building types (present state and retrofitted states, partial and intermittent heating, climate zone B)



	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4
present state	175	152	108	113	121	117	106	102	176	107	100	106	103	138	95	107	55	57	48	42
improvement BAU	294	239	170	149	201	194	148	139	293	174	131	148	158	232	129	140	71	75	59	51
improvement 1	115	112	83	75	103	105	79	64	129	91	70	95	90	118	69	69	64	66	61	47
improvement 2	68	66	55	53	68	68	54	48	73	58	51	77	58	69	50	50	50	51	46	40

Figure 38 Net energy demand of building types (standard retrofit – improvement 1, partial and intermittent heating, climate zone B)



	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4
Cooling [kWh/m2a]	26	23	22	24	25	26	20	20	26	23	23	19	21	24	21	21	18	20	16	20
DHW [kWh/m2a]	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Heating [kWh/m2a]	70	71	43	33	60	61	40	26	85	50	29	57	51	76	30	29	28	28	27	9

Delivered energy consumption per energy source

For the sectoral analysis it is important to know the delivered energy consumption per energy source. For the present state, we used the estimates per building type based on national statistics for the proportions of energy sources. In the retrofitted cases, the most probable options were taken into account, depending on building type.

All results can be found in the file Albania_types_energy.xls, available at www.sled.rec.org.

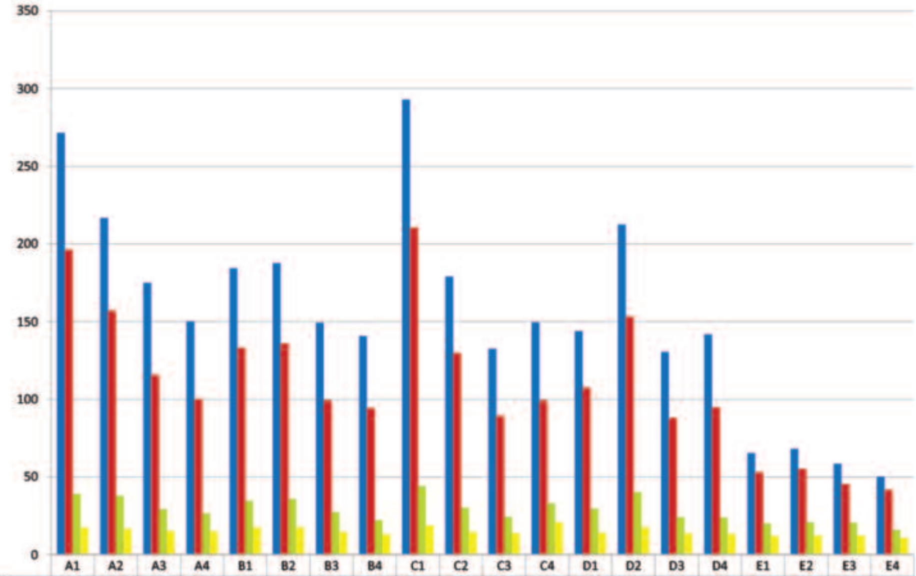
Primary energy demand

Savings in terms of primary energy consumption are even greater than in terms of net energy demand due to the changing of building service systems to efficient systems (Figures 39 and 40). The primary energy factor for electricity is 1.01, which is very low compared to the European average. Solar energy was considered renewable, with a primary factor of zero, which further reduced the primary energy demand for hot water production.

CO_2 emissions

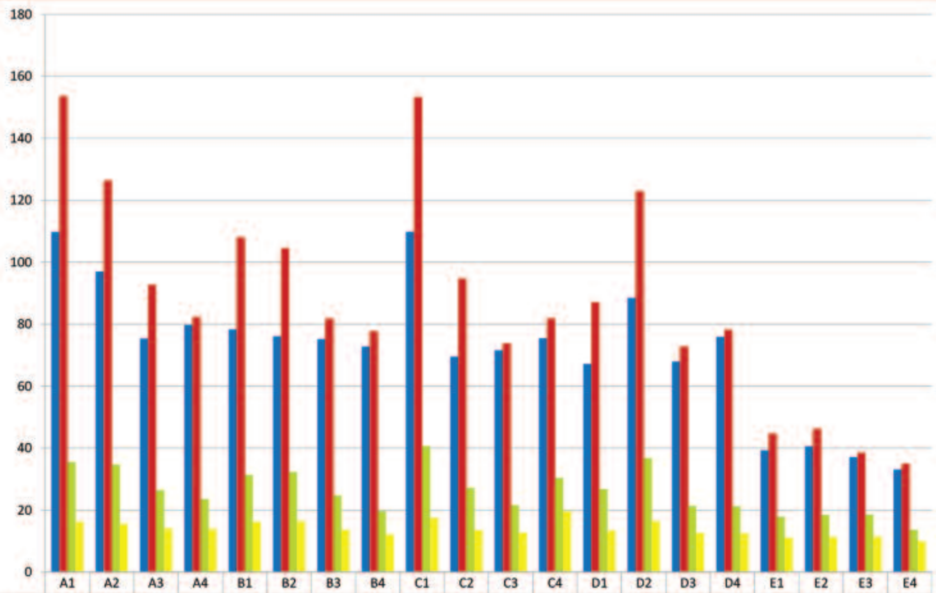
The results for CO_2 emissions appear different from the primary energy results, as in Albania both electricity and wood are considered carbon neutral. Even in the present state, only LPG stoves produce CO_2 emissions, which explains why the national emissions are so low. With the use of wood and electric heat pumps it is possible to achieve a carbon-neutral building stock.

Figure 39 Primary energy demand of building types (present state and retrofitted states, full heating, climate zone B)



	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4
present state	272	217	175	150	185	188	149	141	293	179	133	150	144	213	131	142	65	68	59	50
improvement BAU	196	157	116	100	133	136	99	94	211	130	89	99	108	153	88	95	53	55	45	42
improvement 1	39	38	29	27	35	36	27	22	44	30	24	33	30	40	24	24	20	21	21	16
improvement 2	18	17	15	15	18	18	15	13	19	15	14	21	14	18	14	14	12	12	12	11

Figure 40 Primary energy demand of building types (present state and retrofitted states, partial and intermittent heating, climate zone B)



	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4
present state	110	97	75	80	78	76	75	73	110	70	72	75	67	89	68	76	39	41	37	33
improvement BAU	154	126	93	82	108	105	82	78	153	95	74	82	87	123	73	78	45	46	39	35
improvement 1	36	35	26	24	31	32	25	20	41	27	22	30	27	37	21	21	18	19	19	14
improvement 2	16	16	14	14	16	16	14	12	18	14	13	20	13	17	13	13	11	11	12	10

V. Costs of the retrofitting options

Cost per measure: Building envelope

Investment costs were provided by the Albanian experts per building type and measure (Simaku 2014) (see Table 15). Average prices are given, which means that there is no differentiation between smaller and larger buildings. Prices include all system elements, although, depending on the present state of the building, there could be some additional work to remove the old installations. Prices include labour costs and VAT.

Table 15 Investment costs per measure by unit area for standard and ambitious retrofitting (Simaku 2014)

	External wall	Roof (floor construction in unheated attic)	Floor construction in unheated area (basement)	Window
Standard retrofit	EUR 14.10/m²	EUR 18.50/m²	-	EUR 85.00/m²
Ambitious retrofit	EUR 18.00/m²	EUR 22.00/m²	EUR 11.50/m²	EUR 110.00/m²

Table 16 Investment costs of building service systems per net floor area for standard and ambitious retrofitting, climate zones A and B (Simaku 2014)

Type	Name	Improvement 1				Improvement 2			
		Specific prices per floor area				Specific prices per floor area			
		Heating system		DHW		Heating system		DHW	
		Type	EUR/m²	Type	EUR	Type	EUR/m²	Type	EUR
A1	Dtch_20_60	Heat pump	42	SHW	13	Heat pump	53	SHW	15
A2	Sem_Dtch_20-60	Heat pump	42	SHW	11	Heat pump	53	SHW	14
A3	Row_Terr_20_60	Heat pump	42	SHW	10	Heat pump	53	SHW	15
A4	Mult_Fam_20_60	Heat pump	42	SHW	7	Heat pump	53	SHW	8
B1	Dtch_61_80	Heat pump	42	SHW	7	Heat pump	53	SHW	8
B2	Sem_Dtch_61_80	Heat pump	42	SHW	8	Heat pump	53	SHW	10
B3	Row_Terr_61_80	Heat pump	42	SHW	7	Heat pump	53	SHW	10
B4	Mult_Fam_61_80	Heat pump	42	SHW	7	Heat pump	53	SHW	7
C1	Dtch_81_90	Heat pump	28	SHW	7	Heat pump	42	SHW	13
C2	Sem_Dtch_81_90	Heat pump	42	SHW	11	Heat pump	51	SHW	15
C3	Row_Terr_81_90	Heat pump	42	SHW	15	Heat pump	53	SHW	15
C4	Mult_Fam_81_90	Heat pump	45	SHW	7	Heat pump	55	SHW	10
D1	Dtch_91_00	Heat pump	42	SHW	7	Heat pump	53	SHW	10
D2	Sem_Dtch_91_00	Heat pump	42	SHW	13	Heat pump	53	SHW	19
D3	Row_Terr_91_00	Heat pump	50	SHW	7	Heat pump	63	SHW	11
D4	Mult_Fam_91_00	Heat pump	42	SHW	5	Heat pump	53	SHW	9
E1	Dtch_01_11	Heat pump	31	SHW	5	Heat pump	38	SHW	8
E2	Sem_Dtch_01_11	Heat pump	45	SHW	6	Heat pump	53	SHW	11
E3	Row_Terr_01_11	Heat pump	45	SHW	5	Heat pump	56	SHW	8
E4	Mult_Fam_01_11	Heat pump	45	SHW	2	Heat pump	56	SHW	3

Cost per floor area: Building service systems

The building service system prices were provided by Albanian experts per building type and measure (Simaku 2014) (see Table 16). Prices include all system elements, although, depending on the present state of the building, there could be some additional work to remove the old installations. Prices include labour costs and VAT. In most cases heating is supplied by reversible heat pumps that can also be used for cooling purposes without additional costs.

Total specific investment costs

For the sectoral modelling it was more appropriate to provide investment costs per net floor area rather than by unit area, thus we calculated it per building type. The results are summarised in Tables 17 and 18.

Table 17 Investment costs per net floor area for standard improvement (climate zones A and B)

	Wall	Roof	Floor	Windows	Total (envelope)	Heating	Hot water	Total (systems)	Total (envelope + systems)
	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²
A1	23.80	18.50	0.00	12.90	**55.20**	42.00	12.70	**55.00**	**110.00**
A2	23.40	18.50	0.00	11.10	**53.00**	42.00	10.80	**53.00**	**106.00**
A3	14.90	9.30	0.00	13.70	**37.90**	42.00	10.20	**52.00**	**90.00**
A4	12.70	6.20	0.00	13.30	**32.10**	42.00	7.00	**49.00**	**81.00**
B1	27.80	9.30	0.00	13.90	**50.90**	42.00	7.00	**49.00**	**100.00**
B2	33.20	9.30	0.00	16.10	**58.50**	42.00	7.80	**50.00**	**108.00**
B3	17.00	9.30	0.00	8.00	**34.20**	42.00	7.00	**49.00**	**83.00**
B4	18.20	3.70	0.00	9.20	**31.10**	42.00	7.20	**49.00**	**80.00**
C1	27.40	18.50	0.00	11.10	**57.00**	28.00	6.50	**35.00**	**92.00**
C2	17.30	9.30	0.00	11.10	**37.70**	42.00	10.60	**53.00**	**90.00**
C3	10.00	3.70	0.00	17.10	**30.70**	42.00	15.20	**57.00**	**88.00**
C4	18.20	3.70	0.00	9.20	**31.10**	45.00	6.50	**52.00**	**83.00**
D1	20.60	9.30	0.00	9.00	**38.90**	42.00	7.00	**49.00**	**88.00**
D2	21.90	18.50	0.00	9.80	**50.20**	42.00	13.30	**55.00**	**106.00**
D3	18.90	3.70	0.00	16.90	**39.50**	50.00	7.00	**57.00**	**96.00**
D4	15.10	3.10	0.00	11.20	**29.40**	42.00	5.30	**47.00**	**77.00**
E1	19.10	18.50	0.00	10.60	**48.20**	31.00	4.90	**36.00**	**84.00**
E2	10.40	8.30	0.00	13.00	**31.70**	45.00	6.50	**51.00**	**83.00**
E3	24.40	9.30	0.00	13.10	**46.80**	45.00	5.00	**50.00**	**97.00**
E4	6.30	2.10	0.00	13.30	**21.70**	45.00	1.60	**47.00**	**68.00**

Table 18 Investment costs per net floor area for ambitious improvement (climate zones A and B)

	Wall	Roof	Floor	Windows	Total (envelope)	Heating	Hot water	Total (systems)	Total (envelope + systems)
	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²	EUR/m²
A1	23.80	18.50	0.00	12.90	**55.20**	55.00	12.70	**68.00**	**123.00**
A2	23.40	18.50	0.00	11.10	**53.00**	55.00	10.80	**66.00**	**119.00**
A3	14.90	9.30	0.00	13.70	**37.90**	55.00	10.20	**65.00**	**103.00**
A4	12.70	6.20	0.00	13.30	**32.10**	55.00	7.00	**62.00**	**94.00**
B1	27.80	9.30	0.00	13.90	**50.90**	55.00	7.00	**62.00**	**113.00**
B2	33.20	9.30	0.00	16.10	**58.50**	55.00	7.80	**63.00**	**121.00**
B3	17.00	9.30	0.00	8.00	**34.20**	55.00	7.00	**62.00**	**96.00**
B4	18.20	3.70	0.00	9.20	**31.10**	55.00	7.20	**62.00**	**93.00**
C1	27.40	18.50	0.00	11.10	**57.00**	55.00	6.50	**62.00**	**119.00**
C2	17.30	9.30	0.00	11.10	**37.70**	55.00	10.60	**66.00**	**103.00**
C3	10.00	3.70	0.00	17.10	**30.70**	55.00	15.20	**70.00**	**101.00**
C4	18.20	3.70	0.00	9.20	**31.10**	55.00	6.50	**62.00**	**93.00**
D1	20.60	9.30	0.00	9.00	**38.90**	55.00	7.00	**62.00**	**101.00**
D2	21.90	18.50	0.00	9.80	**50.20**	55.00	13.30	**68.00**	**119.00**
D3	18.90	3.70	0.00	16.90	**39.50**	55.00	7.00	**62.00**	**101.00**
D4	15.10	3.10	0.00	11.20	**29.40**	55.00	5.30	**60.00**	**90.00**
E1	19.10	18.50	0.00	10.60	**48.20**	55.00	4.90	**60.00**	**108.00**
E2	10.40	8.30	0.00	13.00	**31.70**	55.00	6.50	**61.00**	**93.00**
E3	24.40	9.30	0.00	13.10	**46.80**	55.00	5.00	**60.00**	**107.00**
E4	6.30	2.10	0.00	13.30	**21.70**	55.00	1.60	**57.00**	**78.00**

PART 2

Modelling the transformation to a low-carbon residential building stock

VI. Methodology

Modelling approach

In order to assist in developing energy efficiency and climate mitigation policies for the residential building sector in Albania, we designed and applied a bottom-up simulation model. The model aggregated information on energy consumption by end use at the level of representative buildings to a sector balance at country level. The model also calculated the costs of consumed energy. Assuming the retrofitting costs of the representative buildings, we calculated the retrofitting costs required at country level. The model also made it possible to run scenarios with different levels of policy effort, assuming the transformation of the building stock to a low-energy and low-carbon level by a particular target year or at a particular rate.

Building age

We classified the entire residential building stock into six age categories, four type categories and three climate zones. This classification followed the building typology prepared in Part 1 of the present book, with some differences. The first difference is that the age category 2001–2011 was extended to 2015. The second difference is that we added a category for buildings constructed after 2016. The geometrical characteristics of the buildings in these categories correspond to those of the buildings constructed between 2001 and 2011. We assumed that the new buildings would also be constructed according to the same distribution by climate zone as those constructed between 2001 and 2011.

The building age categories are construction dates:

- before 1960;
- between 1961 and 1980;
- between 1981 and 1990;
- between 1991 and 2000;
- between 2001 and 2015; and
- after 2016.

The building type categories are:

- detached houses;
- semi-detached houses;
- row or terraced houses; and
- multi-residential apartment buildings.

The climate zones are:

- climate zone A, coastline;
- climate zone B, moderate; and
- climate zone C, mountainous.

Thus altogether we considered 24 representative buildings located in three climate zones.

Modelling scope and boundaries

Our model assessed only thermal energy services delivered in residential buildings — namely space heating, space cooling and water heating. We did not cover energy use for electrical appliances, lighting and cooking. The latter three energy services are responsible for a large share of residential sector consumption, thus it is important to bear in mind that our calculated levels of energy consumption and CO_2 emissions are far lower than the total sector levels.

The retrofitting options include both the improvement of the thermal envelope and the changing of technical systems, which often imply a fuel switch. The improvement of the thermal envelope means the retrofitting of walls, roofs, floors and windows. Better technical systems include more efficient systems for water heating, space heating and space cooling. Depending on the technical and economic feasibility, households may switch to solar, biomass or electricity as energy sources. We do not consider the impacts of climate change on space heating and cooling patterns (see Part 1).

The model includes the illegal building stock but does not cover buildings used for temporary purposes (holiday buildings) or abandoned buildings. The model does include non-inhabited buildings (see Section VII for details of how they are treated).

The base year for our model is 2014, and it is calibrated to the latest energy balances available for 2010–2013. The model is only applicable up to 2030. We estimated the building stock turnover until 2050, but only in order to get an understanding of the number of existing buildings that remain by this time, and the number of new buildings.

In terms of environmental impacts, we calculated only CO_2 emissions and considered both direct and indirect emissions in our analysis. Direct emissions are those originating from fuel combustion that occurs in buildings (see Section III, page 52) for information on the emission factors for fuels used in residential buildings). Indirect emissions are those that are produced in the transformation sector and are accounted on the supply side according to the IPCC guidelines (IPCC NGGIP online), but which are associated with energy commodities consumed in energy-using sectors. In our case, indirect emissions include emissions from electricity use.

Modelling steps

Figure 41 illustrates the stepwise procedure of our modelling. Our team of national and international architects prepared the country's building typology, calculated building energy performance by end use, and assessed the possible building retrofitting packages and the associated costs at the level of individual representative buildings. This information is documented in detail in Part 1 of the present book.

In this section of the publication we focus on how we aggregated this information to the sector level and how we built future scenarios for sectoral energy consumption and CO_2 emissions for different levels of policy effort. We first developed a building stock model to estimate the building floor area and structure by representative building and climate zone up to 2050. We then married the data from the building stock model with the energy consumption by representative building in order to calculate the energy balance at sector level. The results obtained were compared and calibrated to the sector energy balances available from national public statistics.

Next, based on assumptions regarding likely technological, market and policy developments, we calculated the sector's energy consumption and associated CO_2 emissions for the business-as-usual reference scenario. Together with policy makers we then formulated policy packages aimed at ensuring that buildings become low energy and low carbon in the long-term future. Finally, we calculated energy savings, CO_2 emissions avoided, saved energy costs and investments required in the realisation of the packages.

Figure 41 Modelling steps

Part 1	Part 2
Step 1: Development of the building typology	Step 5: Construction of the building stock model
Step 2: Calculation of building energy performance at present	Step 6: Construction and calibration of the sector energy balance in the base year
Step 3: Calculation of possible retrofitting packages (business-as-usual, standard and ambitious options)	Step 7: Calculation of baseline energy consumption and CO_2 emissions until 2030
Step 4: Calculation of the cost of the retrofitting packages	Step 8: Formulation of policy packages and evaluation of their impacts and associated costs

Involvement of sectoral stakeholders

In order to ensure that the project results are useful for policy making in Albania, we communicated our progress to national policy makers and experts and incorporated their feedback into our work. We conducted interviews on adopted, forthcoming and other potentially useful policies and included this information into the business-as-usual and low-energy/low-carbon scenarios. We also presented modelling results in two rounds, during which we received additional data, comments and requests for the model.

The model itself, with the underlying input data, was provided to national policy makers and experts for their use and modification according to their needs. It is also available on request for use by other experts, subject to appropriate referencing and acknowledgement.

Modelling tool

As a modelling tool we used the Long-range Energy Alternatives Planning System (LEAP) software, developed by the Stockholm Environment Institute, which is widely used for energy policy analysis and climate change mitigation assessment. Figure 42 illustrates the Albanian model in this software.

Figure 42 The Albanian model in the LEAP software

VII. Building stock model

Household trends

The evolution of the building stock is driven, above all, by the country's demographic situation. For this reason we first calculated the number of households and their demand for dwellings over the modelling period.

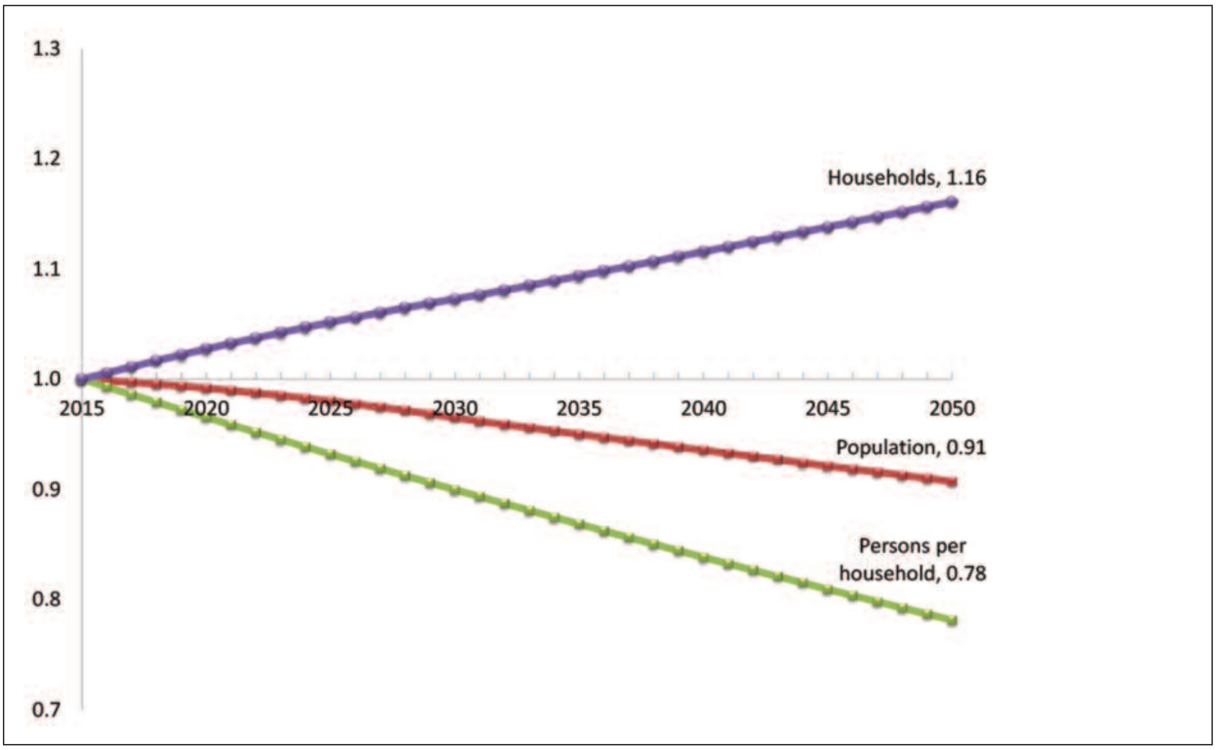
In order to calculate the number of households, we relied on past population data from the Statistical Office of Albania. We assumed the population growth until 2031 according to the medium growth scenario of INSTAT's population projections until 2031 (INSTAT 2014b). For 2032–2050, we assumed the continuation of past population trends. Based on these assumptions, the population will decline to 2.8 million in 2030 and to 2.6 million in 2050.

We assumed that, in line with overall European trends, the average number of persons per household in Albania would decrease. This change is due to factors such as population ageing, fewer children per family and the higher share of mono-parental households (European Commission 2011b). According to Albanian censuses (INSTAT 2001 and 2011), the average number of persons per household was 4.2 in 2001, and 3.9 in 2011. If this trend continues, in 2050 this indicator will reach 3.0 persons per household. According to the latest census (INSTAT 2011), there were 1.02 households living in each dwelling, and this number was assumed to remain constant over the modelling period.

Based on the expected trends in population growth and number of persons per household, we estimated the total number of households. Thus, according to our calculations, the number of Albanian households will reach 813,000 in 2030, and 880,000 in 2050.

Figure 43 shows indices for population size, persons per household and number of households up to 2050. In 2050, the population of Albania will be 91 percent of its 2015 level; the number of persons per household 78 percent of the 2015 level; and the number of households 16 percent higher than the 2015 level.

Figure 43 Key demographic indicators, 2015 = 1.0



Remaining stock of existing buildings and dwellings

Two Albanian censuses, carried out in 2001 and 2011 (INSTAT 2001, 2011), provide publicly available data on the number of buildings and the number of dwellings by building age and type in a similar format. The rate of demolition of residential buildings can therefore be calculated based on a comparison of these censuses. Figure 44 shows the number of one-dwelling buildings remaining in 2001 and 2011 that belong to three different construction periods. The figure illustrates that the demolition of the Albanian residential stock occurred at an extraordinarily high rate during that decade: 56 percent of the stock of residential buildings constructed before 1960 and remaining in 2001, for example, had been demolished by 2011.

If linear demolition at a similar rate is assumed, almost no buildings from the existing building stock would remain in the next two decades. Due to the short lifetime of residential buildings in Albania, rather than a linear approach we used a more precise approach to estimate the demolition of the building stock.

The mortality trends of many technologies tend to follow a so-called Weibull curve, even though the useful lifetimes of these technologies differ (Weibull 1951; Welch and Rogers 2010). The curve presents the fraction of remaining units and is described by the following equation:

$$Fraction\ of\ units\ remaining\ (t) = e^{-(\frac{t-c}{a})^{b}}$$

where:

t = year;

a = scale factor;

b = shape factor; and

c = location parameter.

The mean lifetime of units can be estimated as:

$$Mean\ lifetime = a \times \gamma(1 + \frac{1}{b})$$

γ = the value of the Gamma function.

Figure 45 illustrates the Weibull curves for different shape factors, assuming the location parameter 0. As we did not have sufficient data to estimate all the parameters of the Weibull curve for the Albanian building stock, we assumed a shape parameter of 2.5 and a location parameter of 0.

Figure 44 Number of one-dwelling buildings belonging to three different construction periods, according to the 2001 and 2011 censuses

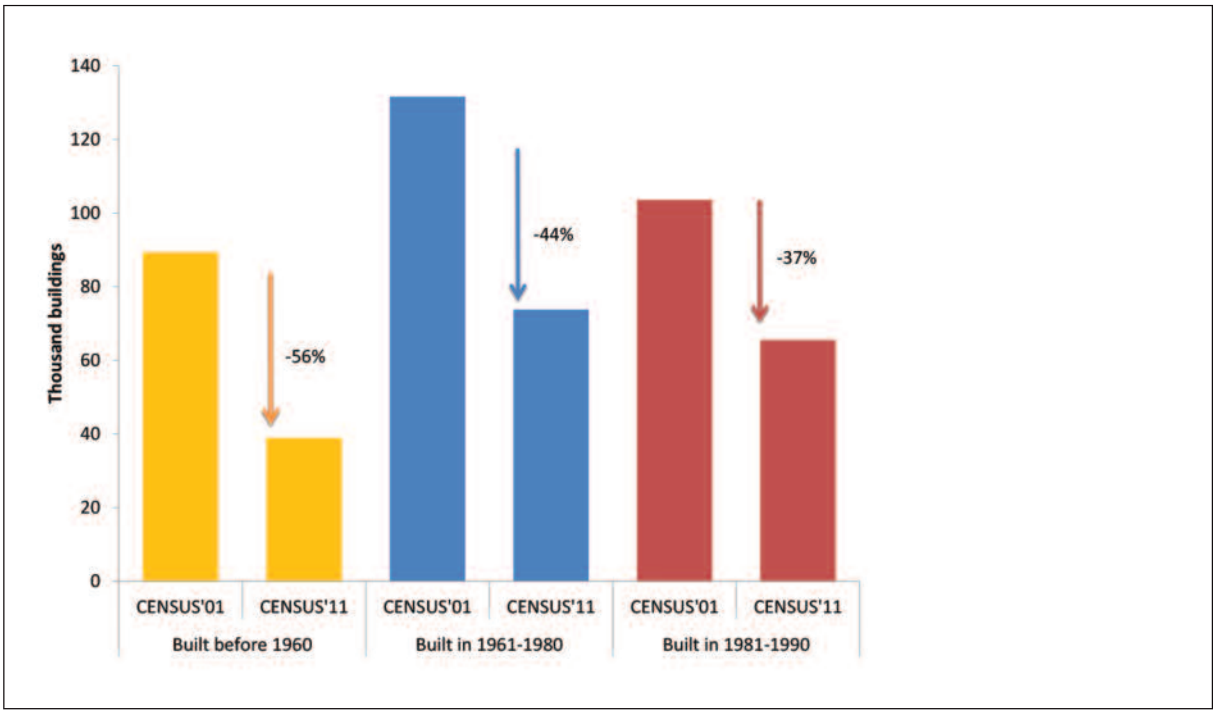
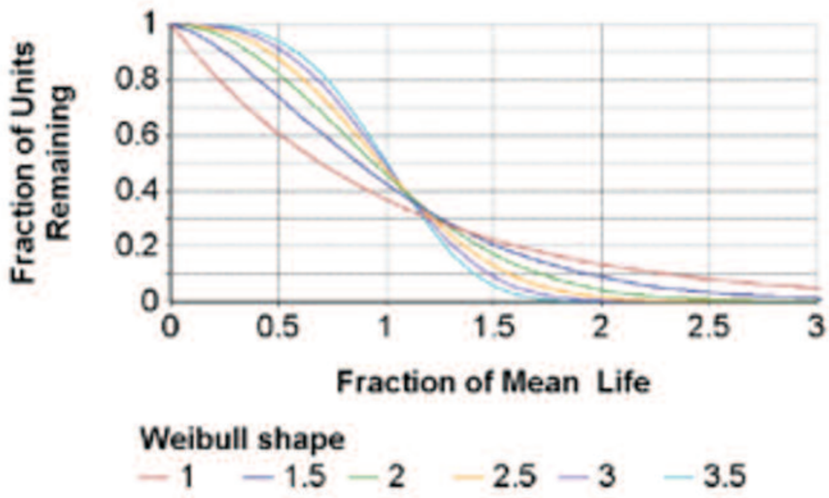


Figure 45 **The Weibull curve** (Welch and Rogers 2010)



Using the Weibull curve, we calculated the average lifetime of the existing residential buildings in Albania. For detached, semi-detached and row (terraced) houses in different age categories it ranged from 35 to 70 years. This is rather a short building lifetime, which is typical in developing countries with poor-quality buildings, which results in high building turnover. The calculated lifetime of existing multi-residential apartment buildings was between 100 and 150 years, which is in line with European practice.

Based on the ranges calculated, we assumed 60 years for the lifetime of existing detached, semi-detached, and row houses in all age categories. For the lifetime of new detached, semi-detached and row houses we assumed 70 years. The lifetime of existing multi-residential apartment buildings in all age categories was assumed as 80 years and the lifetime of new multi-residential buildings was assumed as 100 years.

Using the Weibull curve and the assumed above lifetimes, we calculated the number of remaining buildings by each building type and each age category until 2050. Applying assumptions on the number of dwellings per building made using the data from the 2011 census (INSTAT 2011), we also calculated the number of remaining dwellings by each building type and each age category until 2050.

Building stock habitation

In 2011, a total of 29 percent of dwellings in Albania were not inhabited (INSTAT 2011). In order to avoid overestimating energy consumption, we introduced correction factors for habitation. These correction factors differed by building type, because statistics for non-inhabited dwellings are also available at this level.

In 2011, the share of non-inhabited dwellings was 18.5 percent for detached houses, 24.5 percent for semi-detached houses, 30 percent for row (terraced) houses and 42.5 percent for multi-residential apartment buildings. Knowing the number of non-inhabited buildings, and therefore the number of non-inhabited dwellings within them, from the census, we calculated the remaining number of non-inhabited dwellings in inhabited buildings. Thus there are no non-inhabited dwellings in inhabited detached houses; 15 percent of dwellings are not inhabited in inhabited semi-detached houses; 26 percent of dwellings are not inhabited in inhabited row houses; and 40 percent of dwellings are not inhabited in inhabited multi-residential apartment buildings. Based on these figures, we assumed 100 percent as a correction factor for energy consumption in detached houses, 86 percent for semi-detached houses, 74 percent for row houses, and 60 percent for multi-residential apartment buildings. We excluded abandoned buildings from our model because they do not make an impact on the sector's energy consumption. We assumed that the share of non-inhabited dwellings does not grow in the future.

Construction of new buildings and dwellings

We estimated the construction of dwellings based on the gap between the demand for dwellings, represented by the number of households, and the remaining stock of existing dwellings. We assumed that new dwellings have the same structure by building type and climate zone as those built during the last 15 years.

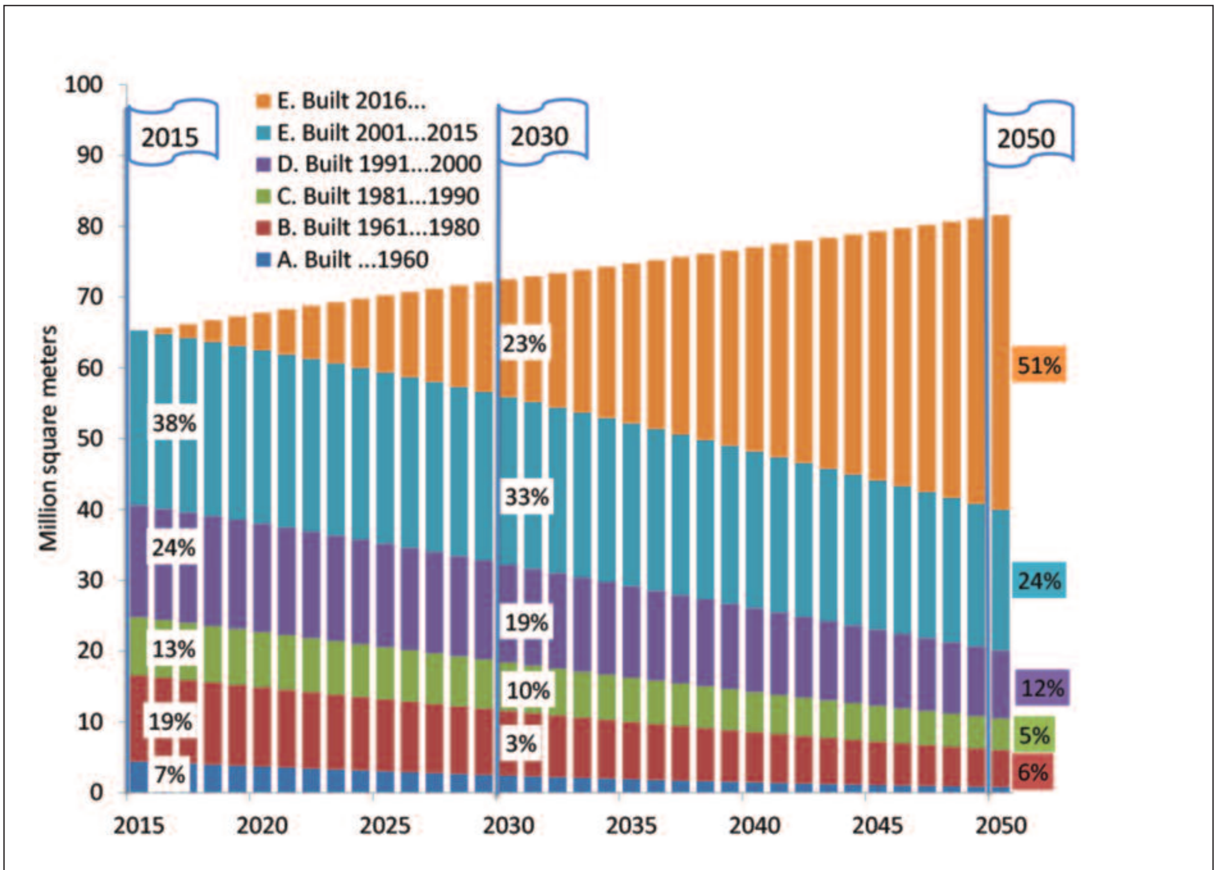
To calculate building floor area in 2015–2050, we multiplied the remaining dwelling stock by dwelling floor area by building age and type, as suggested by the building typology. For new dwellings we assumed the same floor area as for dwellings built during the last 15 years.

The calculated annual construction rate is 1.5 percent of residential building floor area between 2015 and 2030, and between 1.5 and 1.9 percent between 2030 and 2050.

Structure of building floor area in the future

We estimated that the building floor area in 2015 was 65.3 million m^2 and that it would reach 72.5 million m^2 in 2030 and 81.5 million m^2 in 2050. The structure of the building floor area will change due to the demolition of old buildings and the construction of new buildings.

Figure 46 Building floor area by building age category, 2015–2050



As Figure 46 shows, the share of new building floor area will reach 23 percent of the total in 2030 and 51 percent in 2050. It is therefore important to tighten the building code as soon as possible in order to avoid locking high energy consumption patterns into the long-term future. We can also conclude from the figure that a significant share of the building stock constructed between 2001 and 2015 will remain in the medium- and long-term future, thus it is essential to ensure that these buildings have a high energy performance following retrofitting.

The structure of building floor area by building type is also expected to change in the future. As Figure 47 illustrates, the share of multi-residential apartment buildings in the total floor area will grow. Such a change is in line with the overall urbanisation trends in Albania. Those moving to a city are more likely to live in a multi-residential building than a small house. This trend represents an additional challenge if the new, large buildings are not constructed according to high energy performance standards. The retrofitting of multi-residential buildings is more difficult to initiate than the retrofitting of small houses, due to organisational barriers. Furthermore, options for retrofitting large buildings in urban areas to meet low-carbon standards are more limited than in rural areas.

The migration of households in Albania takes place not only from rural areas to urban areas, but also from the most remote climate zone C to the more central climate zones A and B. As a consequence, the relative shares of the latter two climate zones increase in terms of total floor area (Figure 48).

Figure 49 presents the structure of the building floor area by building type and building age — that is, the shares of the 24 representative building types in building floor area — over the modelling period. The figure shows those representative building types with a share in the total floor area greater than 5 percent in 2030. As seen in the figure, the three largest categories are detached buildings constructed in 2001–2015, 1991–2000 and after 2016. Other significant categories that make up more than 5 percent of building floor area in 2030 are apartment buildings constructed in 1961–1980, 2001–2015 and after 2016, as well as detached buildings constructed in 1981–1990.

Figure 47 **Structure of building floor area by building type, 2015–2050**

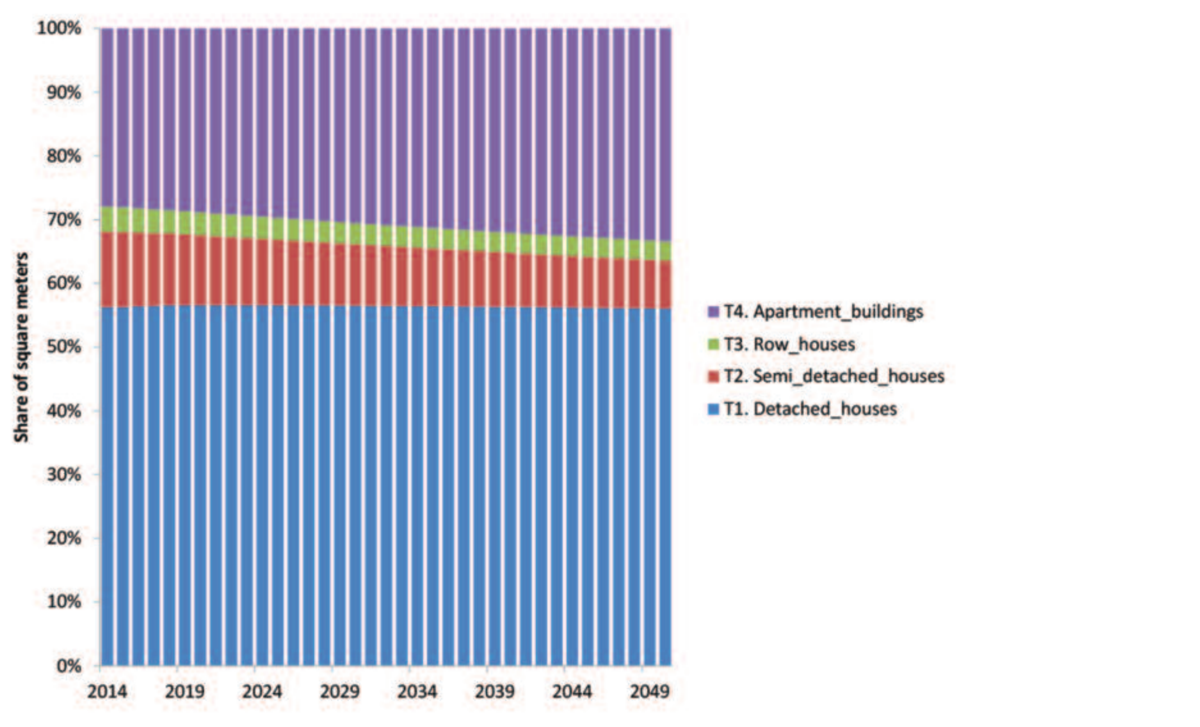


Figure 48 Structure of building floor area by climate zone, 2015–2050

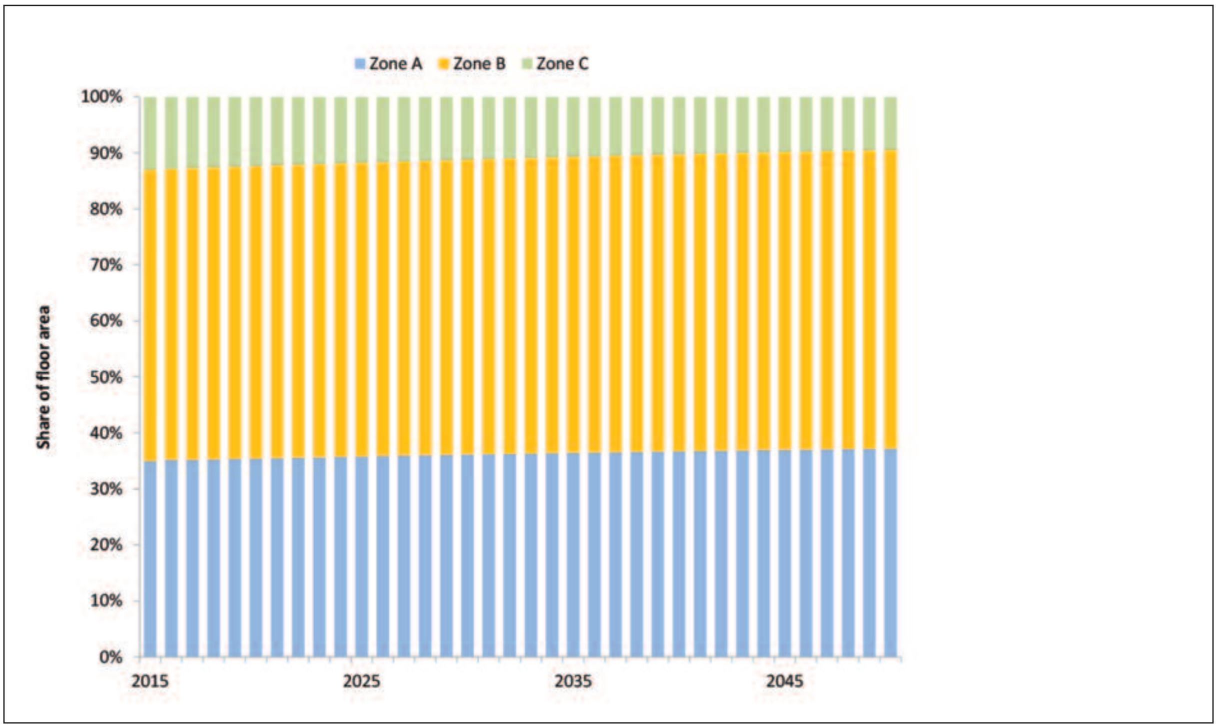
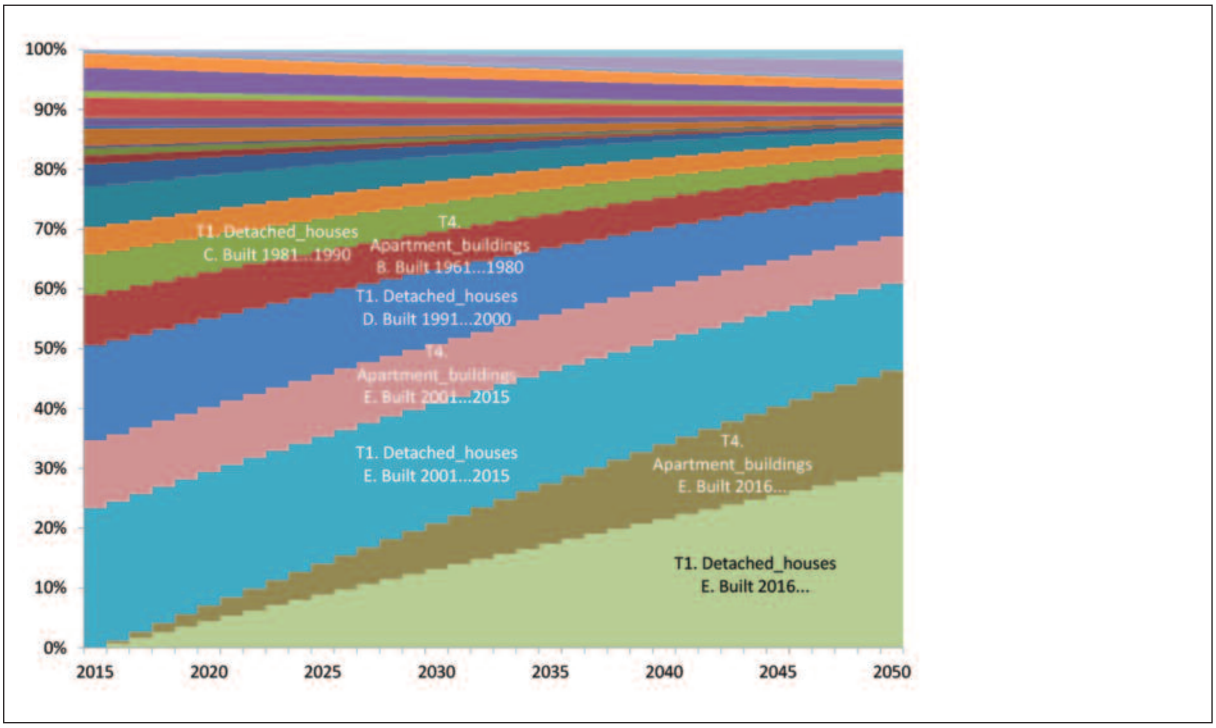


Figure 49 Structure of building floor area by building age and type, 2015–2030



VIII. Construction and calibration of the sector energy balance

In the next step, we calculated the final energy consumption at sector level in the base year (see Section IV of the present publication for a definition of final energy consumption [delivered energy] at building level). Final energy consumption in each representative building in each climate zone was estimated as the sum of its final energy consumption for space heating, water heating and space cooling. We then multiplied the number of representative buildings by their final energy consumption in each climate zone and added up the results across all climate zones, building types and building age categories.

By way of a check we compared the calculated final energy consumption with the sector energy balance available at the macro level. The latest (2013) energy balance for Albania (EUROSTAT 2015) almost coincides with the balances from national sources, meaning that either can be used. The calculated final energy consumption appeared significantly different from the sector energy balance. In the following two sections we discuss the reasons for this difference and the assumptions we made to calibrate our estimates to the top-down statistics.

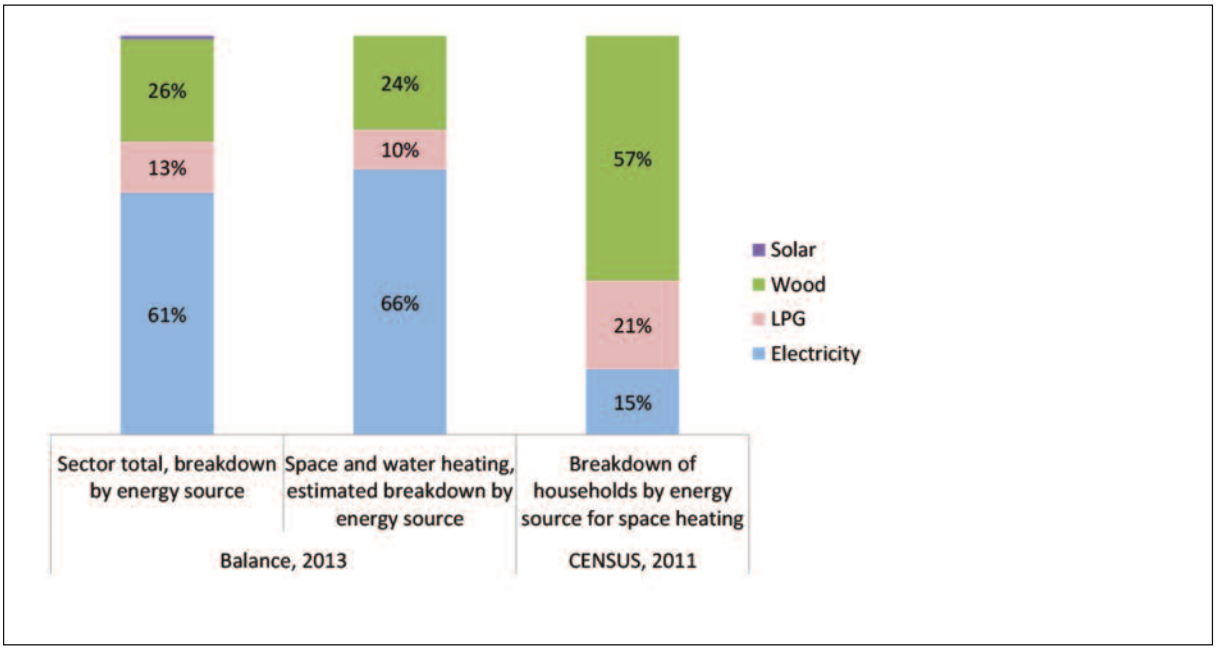
Calibration of the energy sources used in the residential sector

Initially, we based our calculations of the breakdown of households by energy source for space heating on the 2011 census (INSTAT 2011). The calculated share of wood in final energy consumption appeared to be very high when compared to the national balance. The share of electricity was, by contrast, very low. In consultation with national experts and policy makers, we uncovered the data conflict, which is presented in Figure 50.

The left-hand bar in Figure 50 presents the breakdown of the sector's final energy consumption by energy source in 2013 according to the EUROSTAT balance. The middle bar shows the breakdown of the sector's final energy consumption for space and water heating roughly estimated according to the energy balance. In order to make this estimate, we deducted from the total sector balance the assumed energy consumption for cooking, appliances and lighting, based on Albania's recent intended nationally determined contribution (INDC) submission (Kelemen et al. 2015).

The right-hand bar in Figure 50 shows the breakdown of households by energy sources used for space heating, according to the 2011 census (INSTAT 2011).

Figure 50 **Official energy balance of the sector and breakdown of households by energy source for space heating according to the 2011 census** (estimates based on EUROSTAT 2015 and INSTAT 2011)



According to these data, the majority of households use wood for heating their dwelling. The wood stoves currently used in Albania are far less efficient than electrical heating systems. The latter include mainly electric heat pumps, and direct heaters to a lesser extent. The share of wood in final energy consumption for space heating should therefore be higher than the share of wood-heated households. The middle bar shows not only final energy consumption for space heating, but also final energy consumption for water heating and space cooling. However, final energy consumption for space heating in Albanian households is higher than final energy consumption for water heating and space cooling, which is why the estimated breakdown of final energy consumption for space and water heating as well as space cooling should be closer to the breakdown of final energy consumption for space heating.

Due to the apparent overestimation of the number of wood-heated households and the underestimation of households heated by electricity, we could not rely on the statistics from the 2011 census (INSTAT 2011). Instead, we came up with an expert estimate of the breakdown of energy sources used for space heating in existing and new dwellings through consultation with national experts and policy makers (Table 19). Our estimates appear to be comparable with the data in Albania's recent INDC submission (Kelemen et al. 2015), which we obtained at the end of our project.

Calibration of the energy consumption level

A second problem was that the calculated final energy consumption for thermal services appeared to be significantly higher than the sector energy balance. Based

Table 19 Assumed breakdown of energy demand in representative buildings addressed by different energy sources

	Building type	Zone	Wood (%)	Electricity (%)	LPG (%)
Existing buildings	T1. Detached houses	A	20	70	10
		B	25	65	10
		C	65	20	15
	T2. Semi_detached houses	A	20	70	10
		B	25	65	10
		C	65	20	15
	T3. Row houses	A	10	70	20
		B	5	80	15
		C	60	30	10
	T4. Apartment buildings	A	10	70	20
		B	5	80	15
		C	60	30	10
New buildings	T1. Detached houses	A	5	85	10
		B	10	70	20
		C	70	20	10
	T2. Semi_detached houses	A	5	85	10
		B	10	70	20
		C	70	20	10
	T3. Row houses	A	5	85	10
		B	5	85	10
		C	70	20	10
	T4. Apartment buildings	A	10	70	20
		B	10	70	20
		C	10	65	25

on consultations with national experts, we identified two key factors causing such a difference. First, Albanian households heat and cool only part of their dwellings; and second, they heat and cool their dwellings for only part of the day.

With respect to the first factor, supporting results were obtained in the AKBN study referenced by our national consultants (Simaku, Thimjo and Plaku 2014b), according to which in 2012 about 45 percent of the dwelling area was heated in climate zone A, and about 80 percent in climate zone B.

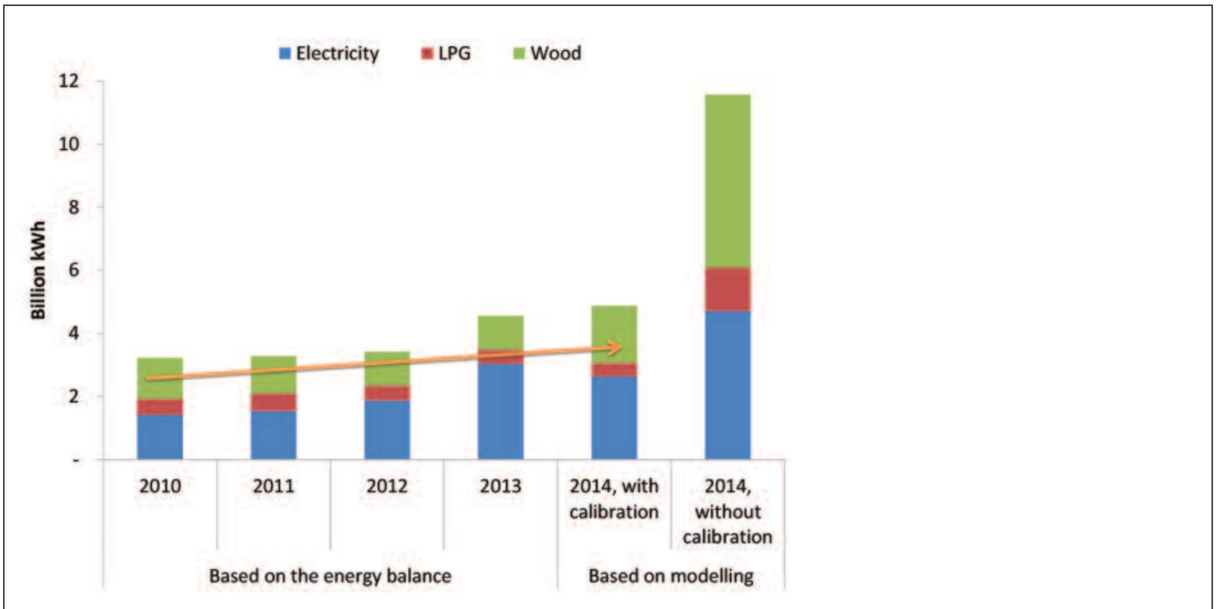
We were unable to find any evidence for the second factor, although there is universal agreement among national experts that the duration of heating/cooling is less than 24 hours in Albania. It is likely that households do not continue heating overnight, and that some households heat for only part of the day.

To correct the calculated final energy consumption for heating we assumed that 50 percent of the existing dwelling area is heated in zone A, 60 percent in zone B, and 80 percent in zone C. Next, we assumed that households using wood or LPG stoves heat for six hours per day, and households using electricity heat for 10 hours per day. Similarly, we corrected the final energy consumption for cooling assuming that 60 percent of the dwelling floor area is cooled for around 12 hours a day.

Also, during the consultation process we concluded that some Albanian households have double heating. They are likely to use their traditional wood stoves during the coldest part of the year and heat their dwellings using electricity, usually heat pumps, when the temperature is moderate. For this reason, our model calculated the sector's final energy consumption based not on the breakdown of households using different energy sources for space heating, but on the breakdown of energy demand addressed by different energy sources in order to allow for more than one source of heating per household.

Figure 51 compares the energy balance of Albania in 2010–2013 and the calculated energy consumption for thermal energy uses with and without calibration to partial heating/cooling and the duration of heating/cooling. The non-calibrated energy consumption is more than double the calibrated energy consumption. This difference represents an important message for policy makers. If Albanian households were to heat the entire floor area of their dwellings during the whole day, final energy consumption for thermal energy comfort would be at least double. As the standard of living among the Albanian population will rise in the future, households will wish to heat larger floor areas for longer periods of time. For this reason it is important to reduce the demand for energy by retrofitting existing buildings, to ensure the high energy performance of new buildings, and to install advanced technical systems as soon as possible in order to avoid an increase in energy demand due to rising living standards.

Figure 51 Sector energy balance and calculated energy consumption, 2014



IX. Formulation of the reference and low-energy/low-carbon-emission scenarios

In order to formulate the business-as-usual and low-energy/low-carbon-emission scenarios, we reviewed the barriers to the penetration of energy efficiency in the residential building sector in Albania, as well as existing, planned and other potential relevant policies aimed at overcoming these barriers. The review presented is as of April 2015.

National policies prior to Albania signing the Energy Community Treaty

Albania had already elaborated some energy efficiency legislation before signing the Energy Community Treaty (Simaku, Thimjo and Plaku 2014b). In 2005, Law No. 9379 on Energy Efficiency introduced a legal framework for the promotion and improvement of the efficient use of energy. The law covered such aspects as the development of national energy efficiency programmes, energy audits, energy labelling, and financing through an energy efficiency fund (Islami 2013). The adoption of a certain amount of secondary legislation was required for the enforcement of this law, although no such legislation has yet been developed (Energy Charter Secretariat 2013).

In 2000, the Council of Ministers issued Decision No. 584 on Energy Saving and Conservation in Buildings. Following this decision, Law No. 8937 on Heat Conservation in Buildings was adopted in 2002. The law established the legal basis for setting up secondary rules and taking action for the conservation of thermal energy in buildings (Islami 2013). Subsequently, in 2003, Decision of the Council of Ministers (DCM) No. 38 on the Norms, Regulations, Design and Construction Conditions for Heat Generation and Energy Saving in Dwellings and Public Buildings was introduced, which regulates general transmission heat losses in new buildings (Simaku 2011). The regulation is known as the Albanian Energy Building Code (EBC).

The National Energy Strategy for 2003–2010 was approved in 2002 (Republic of Albania 2003) and updated in 2005 and 2009. The draft of the next update has been prepared and is expected to be consistent with EU energy efficiency legislation.

Commitments under the Energy Community Treaty

Becoming a contracting party to the Energy Community Treaty prompted the adoption of many energy efficiency policies in Albania. In accordance with the treaty, the country has committed to adopting the EU energy acquis, including energy efficiency legislation. This commitment implies the transposition of the following directives:

- The Energy Performance of Buildings Directive (EPBD) 2010/31/EC by September 30, 2012 (European Commission 2010b)
- The Directive on the Indication by Labelling and Standard Product Information of the Consumption of Energy and Other Resources by Energy-Related Products (Energy Labelling Directive) 2010/30/EU, as well as a set of implementing directives/delegated acts, by December 31, 2011 (European Commission 2010a)
- Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services (Energy Services Directive, or ESD) by December 31, 2011 (European Commission 2006)
- The Energy Efficiency Directive (EED) 2012/27/EU by September 30, 2016 (European Commission 2012)

Even though Directive 2009/125/EC on Eco-design Requirements for Energy-Using Products (Eco-design Directive, European Commission 2009) is also referred to among EU energy efficiency legislation, the Energy Community Treaty does not require its transposition. The EED amended the Labelling and Eco-design directives and replaced the ESD, with the exception of Article 4, which remains in force.

In addition to these pieces of EU legislation directly linked to energy efficiency in buildings, legislation that regulates energy prices for final consumers has an indirect impact on energy efficiency. According to the guidelines of the Energy Community Treaty on the reform of regulated electricity prices in the Energy Community (Energy Community Secretariat 2012), contracting parties should ensure from July 31, 2013, that regulated electricity prices for all customers, including households, are cost reflective. The reform of other energy markets is expected in future phases.

Implementation of the Energy Services Directive

The Ministry of Energy and Industry has prepared a draft revision of the new Energy Efficiency Law (Republic of Albania 2014a), which is in line with the ESD. The law ensures the transposition of the 9 percent energy savings target in 2018 and the monitoring of its implementation by an agency.

The first Albanian National Energy Efficiency Action Plan (NEEAP) for the period 2010–2018 (Republic of Albania 2011), published in 2011, outlines policies and measures that should ensure that the 9 percent energy savings target is met in 2018. The implemented or partially implemented measures contained in the first NEEAP, reported by several sources (Singh, Limaye and Hofer 2014; Republic of Albania 2011; Islami 2013), are as follows:

- financial incentives supported by several banks for energy efficiency improvements to the thermal envelopes of buildings, space and water heating, and air-conditioning systems;
- awareness campaigns on energy efficiency in the residential sector by the National Agency of Natural Resources (AKBN) and the Energy Efficiency Centre Al-EU; and
- the development of an energy advice network.

Measures planned according to the first NEEAP but not yet implemented are:

- the revision of energy efficiency building codes for new buildings;
- the better enforcement of existing building codes;
- a package of promotional instruments for the installation of solar water heating in households;
- the implementation of a new legal framework for condominium houses that foresees monthly payments to building repair funds;
- a subsidy scheme for comprehensive retrofits in multi-residential buildings that implies minimum performance levels to be achieved, a progressive level of support for better buildings, and additional support for poor households;
- legislation and the implementation of a legal framework for labelling household appliances, including air-conditioning systems, water heaters and boilers;
- the introduction of minimum standards for electrical appliances, including air-conditioning systems, water heaters and boilers;
- further education and training for professionals;
- the certification of buildings; and
- the creation of a government agency to develop, implement and monitor energy efficiency policies and programmes, including the NEEAP.

Islami (2013) prepared a report on energy savings in energy-consuming sectors during 2010–2012, in which energy savings achieved from the implementation of the first NEEAP are calculated. Albania has not submitted its official progress report towards the implementation of the first NEEAP but the country has submitted the draft of the second NEEAP, which has not yet been published.

As of November 2014, a nationally appropriate mitigation action (NAMA) for the implementation of the first NEEAP in the residential and commercial building sector was under preparation, with the technical assistance of the UNDP Programme on Climate Change in Albania (Republic of Albania, Ministry of Environment 2014).

Implementation of the Energy Performance of Buildings Directive

The final draft of the Law on the Energy Performance of Buildings (Republic of Albania 2014b), which transposes the EPBD, has been prepared but is not yet in force. The draft law defines the frameworks for:

- a methodology for calculating the integrated energy performance of buildings and building units;
- minimum energy performance requirements for existing buildings applied at the point of renovation or reconstruction;
- minimum energy performance requirements for new buildings and their elements, including technical building systems;
- minimum energy performance requirements for new, retrofitted or replaced building envelopes and technical systems;
- the evaluation of high-efficiency alternative systems (decentralised renewable, cogeneration, heat pumps, district heat and cooling systems) for

new and existing buildings at the point of renovation;

- national plans for increasing the number of nearly zero-energy buildings with the perspective of having new buildings nearly zero-energy starting from 2021, including the consideration of financial incentives;
- the energy certification of buildings;
- the regular inspection and certification of heating and air-conditioning systems and the production of inspection reports; and
- requirements for licensing independent experts and establishing a system for building energy certificates and inspection reports.

Following the draft law, the existing energy building code is undergoing a revision in order to achieve compliance with the requirements of the EPBD. The law does not apply to residential buildings that are used for less than four months per year or for a limited time, if the expected energy consumption is less than 25 percent of the normal use during the whole year, nor does the law apply to stand-alone buildings with a useful floor area less than 50 m^2. The implementing secondary legislation is under development.

Implementation of the Energy Efficiency Directive

A revised draft of the Energy Efficiency Law was prepared in line with Directive 2012/27/EC. The draft law defines the frameworks for:

- setting the energy-saving indicative target for 2020;
- developing the NEEAP every three years, which analyses the achievements of the previous NEEAP and provides a strategy for meeting final and intermediary targets;
- monitoring the implementation of NEEAPs through an agency;
- providing final energy users with individual meters through an agency;
- raising awareness among building tenants and owners and training governmental officials through an agency;
- minimum energy performance requirements for new buildings or existing buildings undergoing major renovation and for building elements;
- minimum energy performance requirements for technical building systems;
- the inspection of heating and air-conditioning systems;
- minimum energy efficiency requirements for energy-related products;
- energy audits of applicants for programmes financed by the Energy Efficiency Fund;
- the provision of energy services by energy service companies (ESCOs);
- the establishment and financing of the Energy Efficiency Fund;
- the establishment of an agency responsible for energy efficiency; and
- the provision of consumer data on real-time and historical energy consumption through individual metering, adopted by Law 68/2012 on Power Consumption Information and Other Resources Impacts on Energy Products. The implementing secondary legislation of the Energy Efficiency Law is to be developed.

Implementation of the Energy Labelling Directive

The previous version of the Energy Labelling Directive 92/75/EEC was transposed in 2009 by Law No. 10113 on the Indication by Labelling and Standard Product Information of the Consumption of Energy and Resources by Household Appliances. The new requirements of the Energy Labelling Directive 2010/30/EU were adopted in 2013 by the new Law on Information on the Consumption of Energy and Other Resources by Energy-Related Products.

Law No. 10113 provides the legal basis for the transposition of the secondary implementing legislation through decisions of the Council of Ministers. The adoption of the secondary legislation is in process. The labelling of space and water heating systems and air-conditioning systems, with relevance to the SLED project, has not yet been adopted.

Implementation of the Eco-design Directive

Although the transposition of the Eco-design Directive is not required, Albania is voluntarily working on its transposition, which is expected through the forthcoming Energy Efficiency Law. Three implementing measures/directives have already been transposed: for fluorescent lighting ballasts, household refrigerators and freezers, and water boilers (Republic of Albania 2011).

Implementation of energy pricing reform

Electricity and natural gas pricing in Albania currently excludes environmental and energy taxes (Singh, Limaye and Hofer 2014). The electricity generation price still has to be deregulated and no significant annual increase is envisioned (e.g. more than 3 percent per year over five years, *ibid*).

The requirement in the EU's third Energy Package to define and protect vulnerable customers still needs to be transposed. At present, household customers supplied by the dominating distribution system operator and public retail supplier OSHEE are eligible for reduced tariffs for amounts of consumed electricity below 300 kWh per month.

Energy efficiency financing

Despite government plans to provide financing for energy efficiency, no budget line has been available so far for this purpose, and none was planned in the first NEEAP (Energy Charter Secretariat 2013). Islami (2013) prepared a comprehensive review of energy efficiency financing provided by international financial intermediaries and commercial banks in Albania. The author identified several loan products available in Albania for energy efficiency in the residential sector, provided by the following financial institutions:

- Leading lender: ProCredit Bank.
- International financial corporations via big partner banks: Credins Bank, Societe Generale.
- International financial corporations via smaller financial institutions: Fondi BESA, NOA Finacojme.

In addition to these specialised energy efficiency loan products, several other banks have offered loans for home improvements (e.g. Raiffeisen Bank, Intesa Sanpaolo Bank, NBG). These loans are not specifically targeted to energy efficiency, but could also be used for this purpose.

Summary of barriers and existing, planned and relevant policies

Table 20 presents a summary of existing barriers to the penetration of energy efficiency in residential buildings in Albania, and of the policies aimed at overcoming them. The policies labelled "E" are existing policies — that is, policies that have already been elaborated, adopted and implemented. Policies that are currently being planned and adopted according to the requirements of the EU energy acquis are marked "P". Finally, policies that are required for the transposition and implementation of the EU acquis but that are not yet planned, as well as additional feasible policies, are labelled "F".

The summary was prepared on the basis of a review of existing barriers to energy efficiency penetration (Singh, Limaye and Hofer 2014; Ryding and Seeliger 2013; Legro, Novikova and Olshanskaya 2014; Simaku, Thimjo and Plaku 2014b); the commitments accepted by Albania upon signing the Energy Community Treaty, as discussed above; existing and planned policies in Albania also discussed above; and policies recommended in the literature (Lucon et al. 2014; Ürge-Vorsatz et al. 2012; Bürger 2012; Ryding and Seeliger 2013; Singh, Limaye and Hofer 2014).

Table 20 Policies on the residential building stock in Albania tailored to the main barriers (as of April 2014)

Households:	not interested in thermal retrofitting		interested in thermal retrofitting		undergoing thermal retrofitting	
	Barriers	Policy	Barriers	Policy	Barriers	Policy
All types of dwellings						
Market failures: Imperfect information	Lack of knowledge, attention, interest	Information campaigns (E), energy tariff reform (P) and taxation, detailed bills (F), free mini-audits (F), building codes (E), appliance standards (E, P), obligations to retrofit (F)	Lack of practical knowledge and skills in technical/financial analysis	Detailed bills (F), building codes (E), appliance standards (E, P), building certification (P), appliance labelling (P), desk advice (E), comprehensive audits (F)	Lack of reliable technical advice	Comprehensive audits (F), desk advice (E)
Behavioural barriers	Ignorance of benefits	Information campaigns (E), energy tariff reform (P) and taxation, detailed bills (F), free mini-audits (F), building codes (E) and appliance standards (E, P), obligations to retrofit (F)				
	Culture, tradition					
Financial barriers			High discount rates for households	Concessionary loans (E), grants (F), tax incentives, obligation to retrofit at the point of general renovation (F)		
			High up-front costs			
			Lack of access to capital	Concessionary loans (E)		
			High cost of capital from lenders	State guarantees to banks (F)		
			Unwillingness to incur debts	Tax incentives		
			No rise in property sales price and uncertain resale after retrofitting	Building certification (P), obligation to retrofit at the point of transaction (F)		
	Regulated price of energy, lack of internalisation of external costs			Tariff reform (P), energy taxation		
	Heating tariffs linked to the living floor area			Consumption-based billing for heating (P)		
Hidden costs and benefits	Information search costs	Information campaigns (E), detailed bills (F), free mini-audits (F), building certification (P), appliance labelling (P)	Costs of searching for the right option	Free mini-audits (F), desk advice (E), subsidised comprehensive audits (F)	Costs of searching for installation advice	Free mini-audits (F), desk advice (E), subsidised comprehensive audits (F)
			High transaction costs due to small size	Project bundling by ESCOs (F)		
Market failures: Organisational barriers	Low level of implementation and enforcement of policies			Capacity building (P), education and training (P), integration with other policies (F)		
			Unstable financing of programmes	Back-up of state programmes with other sources (P), raising finance from commercial banks (P)	Lack of skilled providers	Apprenticeship (E), master training (E), further education (F), accreditation of contractors through branded quality standards (F)

Table 20 Policies on the residential building stock in Albania tailored to the main barriers (cont.)

Households:	not interested in thermal retrofitting		interested in thermal retrofitting		undergoing thermal retrofitting	
	Barriers	Policy	Barriers	Policy	Barriers	Policy
All types of dwellings						
Market failures: Technological risks					Lack or low quality of technologies	Building codes (E) and certification (P), product standards and labelling (P)
Market failures: Technological risks					Risks of failure, heterogeneous retrofit outcomes	Quality standards, qualified retrofit plans (F)
Rented dwellings						
Organisational barriers			Landlord–tenant dilemma	Cost and benefit allocation rules between tenants/landlords (F), rent reduction claims of tenants in case retrofitting not carried out by landlords		
Dwellings in multi-residential buildings						
Organisational problems			Collective decision problems	Obligation to retrofit at the point of general renovation (F)		
Organisational problems			Access to capital	Requirement to homeowner associations to establish retrofitting funds (P)		
Organisational problems			Low creditworthiness of homeowner associations	State guarantees for commercial banks (F)		
Illegal dwellings						
Behavioural barriers			Disregarding construction rules	Legalisation of dwellings (P)		
Financial barriers			Ineligibility for finance	Grants and concessionary loans (F)		
Low-income households						
Financial barriers			Lack of capital	Grants (P), state guarantees for commercial banks (F)		

Notes: E – adopted and implemented policies; P – policies being planned and adopted according to the EU acquis; F – policies required under the EU acquis but not yet planned, and additional feasible policies.

Assumptions and policy package in the reference scenario

In the reference scenario, we assumed business-as-usual technological, policy and market changes. According to these changes, new buildings are constructed according to the practices in 2001–2011 — that is, more or less in line with the building code introduced in 2003. The only difference is that the share of living area heated and the duration of heating are greater than in the past — namely, the same as in the business-as-usual improvement.

Following a consultation with national policy makers and experts, we assumed a very rapid increase in electrical heating in dwellings in existing buildings. All dwellings that currently heat with energy sources other than electricity will switch to electrical heating within 10 years. All installed electrical heating systems are heat pumps.

We also assumed that existing buildings are retrofitted at least once during their lifetime. Since the lifetime of detached, semi-detached and row houses is about 60 years and the lifetime of multi-residential apartment buildings is around 80 years, it was assumed that on average retrofitting takes place 35 years after the building was constructed. In other words, the business-as-usual retrofit rate is 1/35 or 2.85 percent per year. We estimated that, after this business-as-usual retrofit, building energy demand decreases by 20 percent. We also assumed that all households that undergo retrofitting start using space cooling.

The business-as-usual retrofit implies the improvement of thermal comfort in dwellings. We therefore assumed that 75 percent of the dwelling area will be heated in zone A, 80 percent in zone B, and 100 percent in zone C. After retrofitting, households will heat dwellings for around 16 hours a day. No increase in the duration of space cooling was assumed, but the share of floor area cooled was increased to 80 percent. Consumption of hot water was assumed to grow from the current level of around 30 litres a day to around 35 litres a day in 2050.

It is likely that some buildings will undergo retrofitting more than once during their lifetime. We considered only the first retrofitting, starting from the present moment, during the modelling period.

Assumptions and policy packages in the SLED moderate and ambitious scenarios

Policy tools for energy efficiency improvement are often classified into regulatory tools, fiscal/financial incentives, market-based tools and information (Ürge-Vorsatz et al. 2012). The group of regulatory tools, which includes construction and renovation norms or building codes, has proved to be the most cost-effective (*ibid*.). The EU experience, however, attests that building codes are not sufficient to reduce energy consumption in existing buildings at the desired speed. A comprehensive package of policy tools, comprising "carrots", "sticks" and "tambourines", should therefore be adopted to tackle the challenge.

Our policy package explicitly models the impact of regulatory policy tools and financial incentives ("sticks" and "carrots"). The impact of "tambourines", or information policies, is difficult to model explicitly using the bottom-up approach. For this reason, this type of policy is assumed to be included into our policy package as one of its success factors. The designed package represents a simulated package, rather than the best or optimal package. It indicates what level of effort is required in order to achieve the low-energy and low-carbon transformation of the building sector.

We formulated our policy packages in accordance with EU energy efficiency legislation. The packages are aimed at achieving transformation to a more efficient building stock by 2050, corresponding to the targets of the EU Energy Roadmap 2050 (European Commission 2011a). We assumed two levels of ambition in such a transformation. In the first, we assumed that by 2050 all new and existing buildings would achieve at least the level of standard improvement 1, defined in Part 1 of the present book. In the second we assumed that by 2050 the majority of new and existing buildings would achieve the level of ambitious improvement 2. We refer to the policy package related to the first ambition as the SLED moderate scenario, and to the policy package related to the second ambition as the SLED ambitious scenario.

Figure 52 illustrates the SLED moderate scenario. According to this scenario, in 2016 Albania adopts a building code (Republic of Albania 2014b) that primarily affects new buildings. The requirements envisioned by the building code correspond to the characteristics of the measures of standard improvement 1.

Even though existing buildings will be required to comply with the new building code in the case of major renovation (more than 25 percent of the value of the building), it is unlikely that many such retrofits will be classified as major renovations. In order to ensure the retrofitting of the entire existing building stock, we assume that in the SLED moderate scenario all buildings remaining by 2050 will be retrofitted at least once to the level of the first improvement. This improvement implies not only lower energy consumption, but also higher comfort. The heated floor area will be increased to 100 percent and dwellings will be heated for at least 18 hours per day with electricity and 16 hours with wood. The cooling floor area will increase to 100 percent and the duration of cooling will remain at 12 hours a day.

In order to ensure the implementation of these retrofits, we assume that Albania introduces financial incentives for stakeholders in the residential sector. Households in detached and semi-detached houses face lower organisational and legal barriers to obtaining the investment capital than households in row houses and multi-residential apartment buildings. This is why, for the majority of households in detached and semi-detached houses, the introduction of low-interest loans is relevant. For households living in such houses, and which are considered low income, we suggest the introduction of grants. We assume the share of low-income households as 10 percent of the total household stock.

We assume that only 10 percent of households in row houses and multi-residential apartment buildings are currently able to overcome the organisational barriers and obtain low-interest loans for building retrofits. We assume that the remaining households in these buildings are eligible for grants. As the market cumulates the experience of providing loans for retrofitting in multi-residential buildings, the share of households that are able to obtain loans will grow to 90 percent by 2050. For the remaining households, which are considered low income, the government will continue to provide grants.

Figure 53 illustrates the SLED ambitious scenario. We assume that, in addition to the 2016 building code, Albania will also introduce a more stringent building code in 2022. The requirements of the new building code correspond to the characteristics of the measures of standard improvement 2, described in Part 1 of the present book. Until 2022, the previous building code will remain in force.

In order to prepare the market for the new, more ambitious building code, in 2016 Albania introduces low-interest loans for new buildings that achieve high energy/carbon performance according to improvement 2.

Similar to the SLED moderate scenario, in the SLED ambitious scenario we assume that all buildings remaining until 2050 will be retrofitted at least once. The retrofits will be conducted according improvement 1 until 2022, and according to improvement 2 from 2023 up to 2050. Improvement 2 implies even higher thermal comfort. The heated floor area will be increased to 100 percent, and dwellings will be heated for 18 hours a day. The cooling floor area will be 100 percent, and the duration of cooling will increase to 14 hours a day.

To ensure the implementation of these retrofits, we assume that Albania introduces financial incentives for stakeholders in the residential sector. Up to 2022, financial incentives are provided in order to achieve a level of performance according to improvement 1. From 2023 up to 2050, incentives are provided in order to achieve a level of performance according to improvement 2. The structure of the financial incentives is the same for the SLED moderate and ambitious scenarios.

We assume that all new buildings comply with the requirements of the building code in both scenarios, which is ensured by the approval of construction plans ex-ante and the issuing of building performance certificates ex-post. Likewise, we assume that low-interest loans for new, efficient buildings, as well as low-interest loans and grants for retrofits, are provided according to the same conditions.

Figure 52 The policy package in the SLED moderate scenario

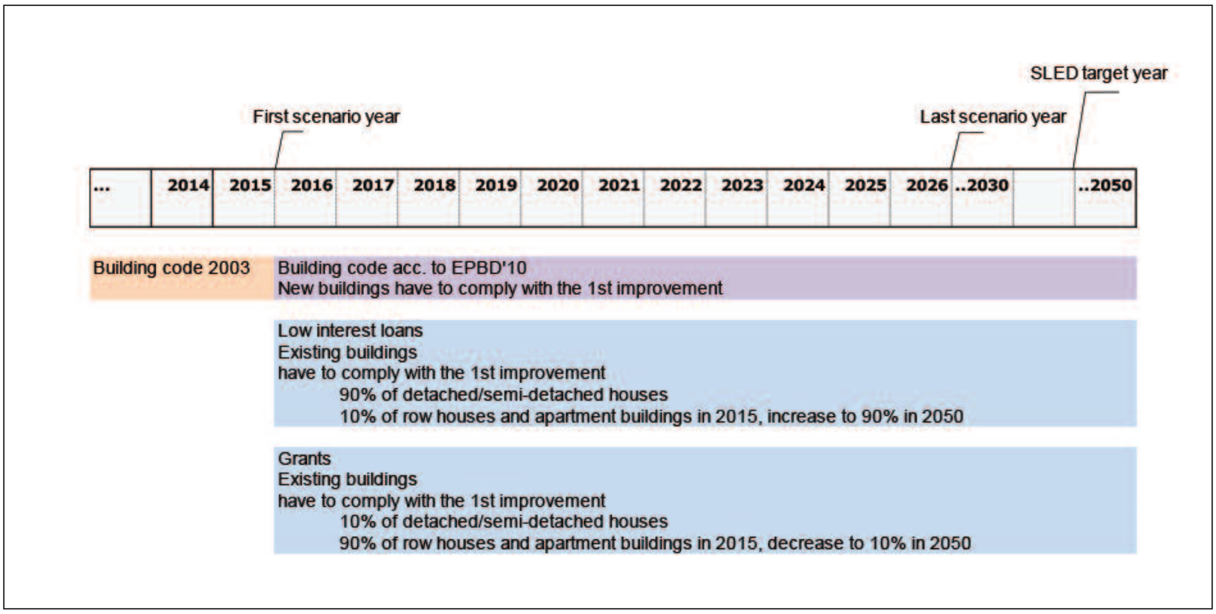
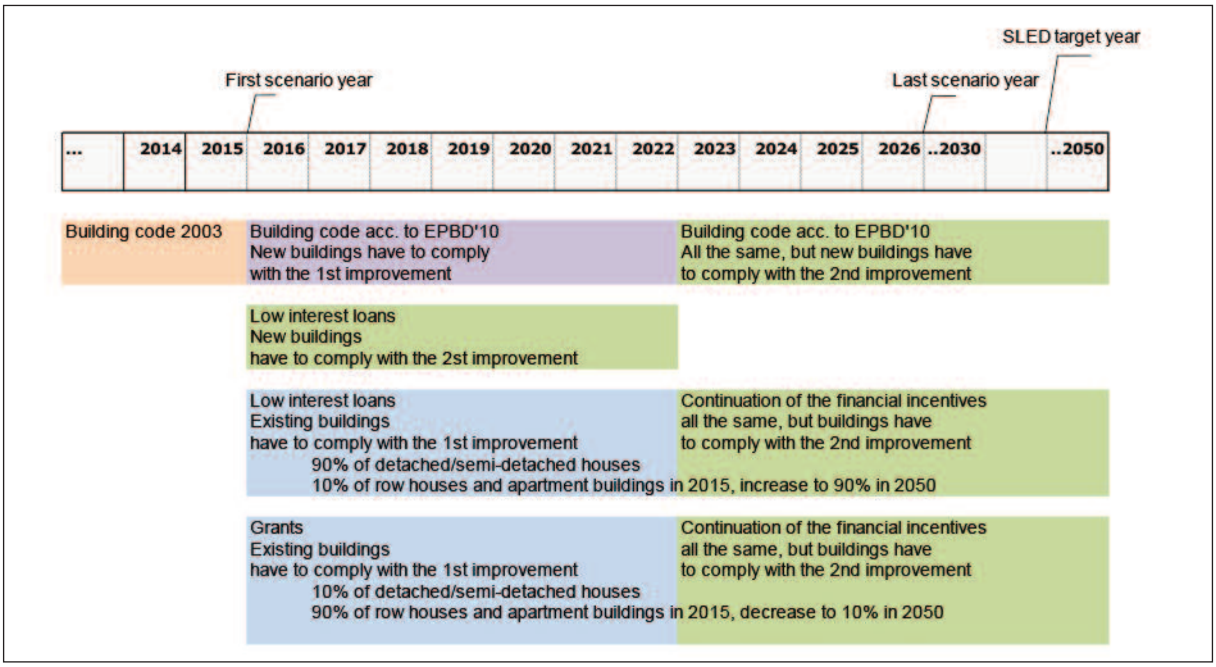


Figure 53 The policy package in the SLED ambitious scenario



X. Reference scenario: Results

Final energy consumption

Figure 54 shows that in 2015, final energy consumption in the residential sector for thermal energy services was 4.9 billion kWh. Final energy consumption will decline by 17 percent over the modelling period and will reach 4.1 billion kWh in 2030.

Figure 55 presents final energy consumption by energy source. In 2015, it comprised 54 percent electricity, 37 percent wood and 9 percent LPG. The figure illustrates the impact of a fuel switch for space and water heating on the sector's future energy consumption trends. The low price of electricity and the relatively high efficiency of heat pumps compared to traditional wood or LPG stoves make electrical heating attractive. Due to the differences in efficiencies, far less electricity is needed for space heating than either wood or LPG. This explains why electricity consumption increases at a slower rate than the decrease in wood and LPG consumption. The figure also shows that electricity consumption will increase by around 2.2 percent per year during 2015–2030, while wood and LPG consumption will decrease by around 11 percent per year and 10 percent per year respectively.

We would like to highlight once again that the calculated trends in final energy consumption do not fully reflect the picture for the entire residential sector. The growth in electricity consumption at sector level is likely to be even higher than is indicated above for thermal energy uses. First, there is a far lower penetration of electrical appliances in Albanian households than in households in the EU. Due to the naturally growing demand for electrical goods, and to market development, the penetration of electrical appliances will move closer to the EU average, and this factor will boost electricity consumption. Second, a large share of energy demand for cooking is currently addressed by LPG and wood. Due to the penetration of more efficient and convenient electrical cooking stoves and the low price of electricity, it is likely that a fuel switch will also take place for cooking. According to Albania's INDC submission (Kelemen et al. 2015), cooking is responsible for an unusually high share of final energy consumption in Albania compared to the European average, which will also make the impact of this fuel switch significant.

Figure 56 shows final energy consumption by building age category. The figure illustrates that final energy consumption in existing buildings is expected to decline, largely because a large share of existing buildings will be demolished by 2030. While the business-as-usual improvement of existing buildings implies a 20 percent reduction in energy demand, these savings are offset by higher thermal comfort.

The figure also suggests priorities for improving energy efficiency in residential buildings. From a long-term perspective, it is important to ensure the retrofitting of recently constructed buildings, for example those built in or after 1991, as they will be responsible for around 43 percent of the sector's final energy consumption in 2030. New buildings will be responsible for 18 percent of final energy consumption in 2030, even though their floor area represents 23 percent of the sector's total floor area. This is why it is important to limit their energy consumption at the construction phase in order to avoid the need for future retrofitting.

We found that the breakdown of final energy consumption by building type will remain almost the same over the modelling period. Even though the structure of the floor area changes towards a higher share of multi-residential apartment buildings (Figure 49, page 76), the share in final energy consumption of these buildings does not grow, because their energy demand per square metre is lower than in smaller buildings. As Figure 57 shows, in 2030 around 72 percent of final energy consumption for thermal energy uses will be in detached and semi-detached houses. Row houses and multi-residential apartment buildings will account for 3 percent and 25 percent of the total final energy consumption respectively.

Figure 58 presents final energy consumption in the residential sector by building age and type over the modelling period. The figure illustrates that the largest shares in final energy consumption in 2030 will originate from detached houses built in 1991–2000 (15 percent), 2001–2015 (13 percent), 1981–1990 (10 percent), and after 2016 (11 percent). The following building types also have high shares in final energy consumption in 2030 (more than 5 percent): detached houses and apartment buildings constructed in 1961–1980 (each 7 percent), and apartment buildings constucted in 2001–2015 and after 2016 (each 5 percent). This information gives us an understanding of key building categories to which standardised approaches for building efficiency improvements, and thus policies, can be applied.

Figure 59 illustrates the distribution of final energy consumption by climate zone. Our analysis illustrates that final energy consumption will significantly grow in climate zone B and will be responsible for around half the sector's total consumption. By contrast, due to migration to more central areas, final energy consumption in climate zone C is expected to decline to around 21 percent in 2030. The share of final energy consumption originating in climate zone A will slightly increase and will account for the remaining 31 percent.

Figure 60 presents final energy consumption broken down by energy use. It shows that, at present, space heating is responsible for the highest share of final energy consumption, but that it will decline in the future. By contrast, the share of space cooling is expected to increase significantly. Overall, in 2030, space heating, water heating and space cooling will be responsible for 56 percent, 15 percent and 29 percent of final energy consumption respectively.

Figure 54 Final energy consumption in the reference scenario, 2015–2030

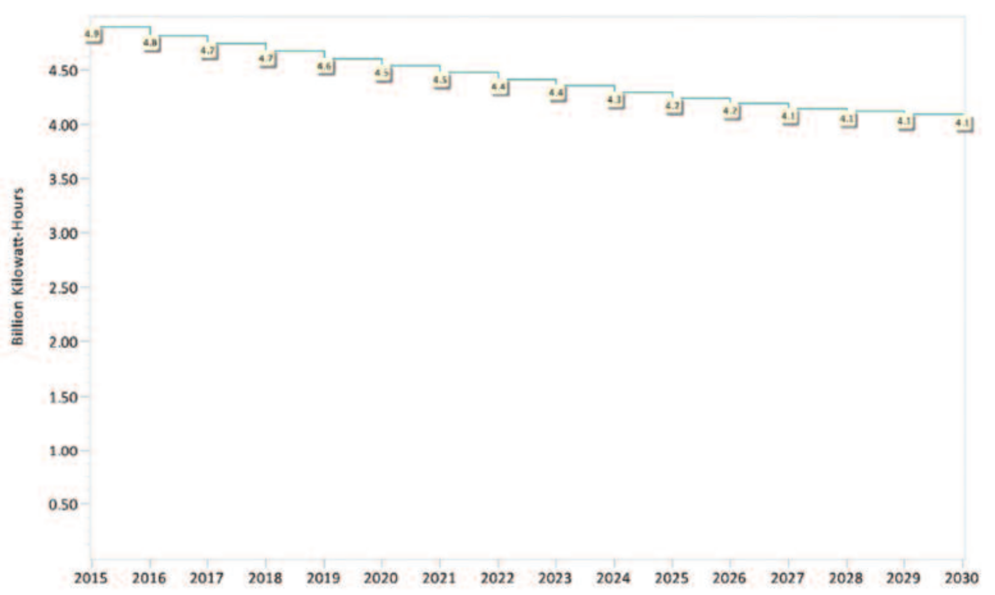


Figure 55 Final energy consumption by energy source in the reference scenario, 2015–2030

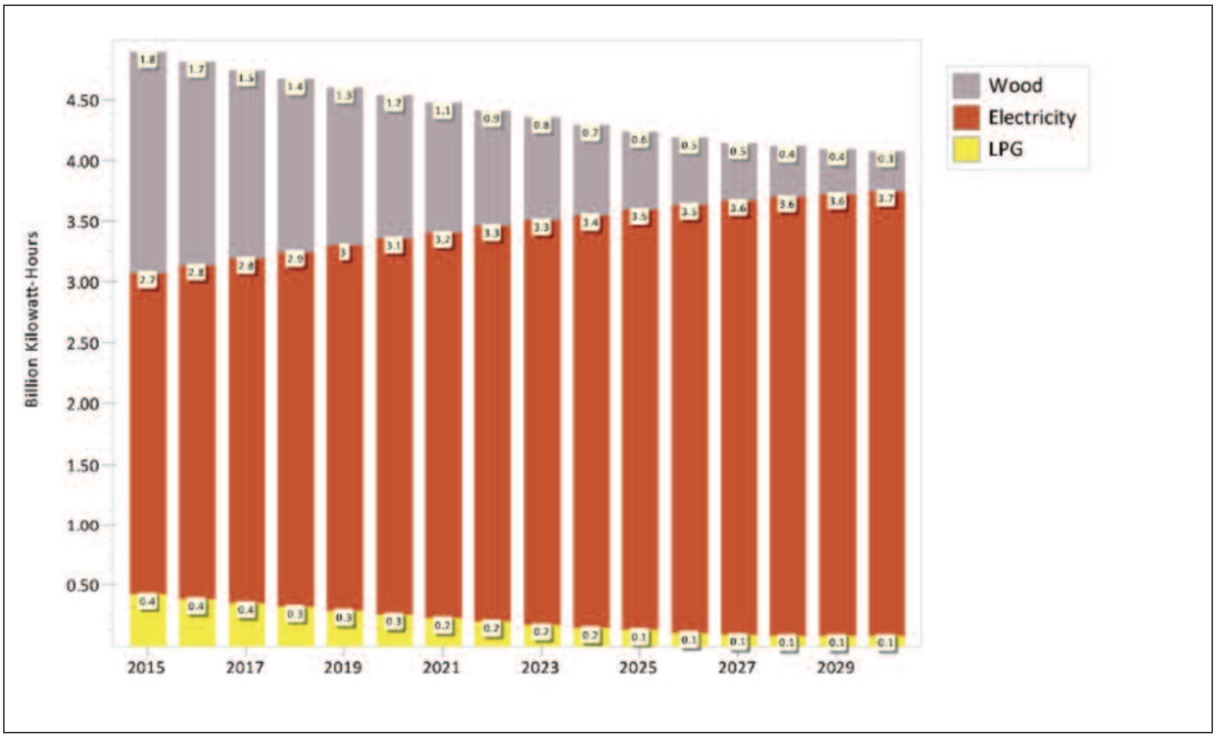


Figure 56 Final energy consumption by building age category in the reference scenario, 2015–2030

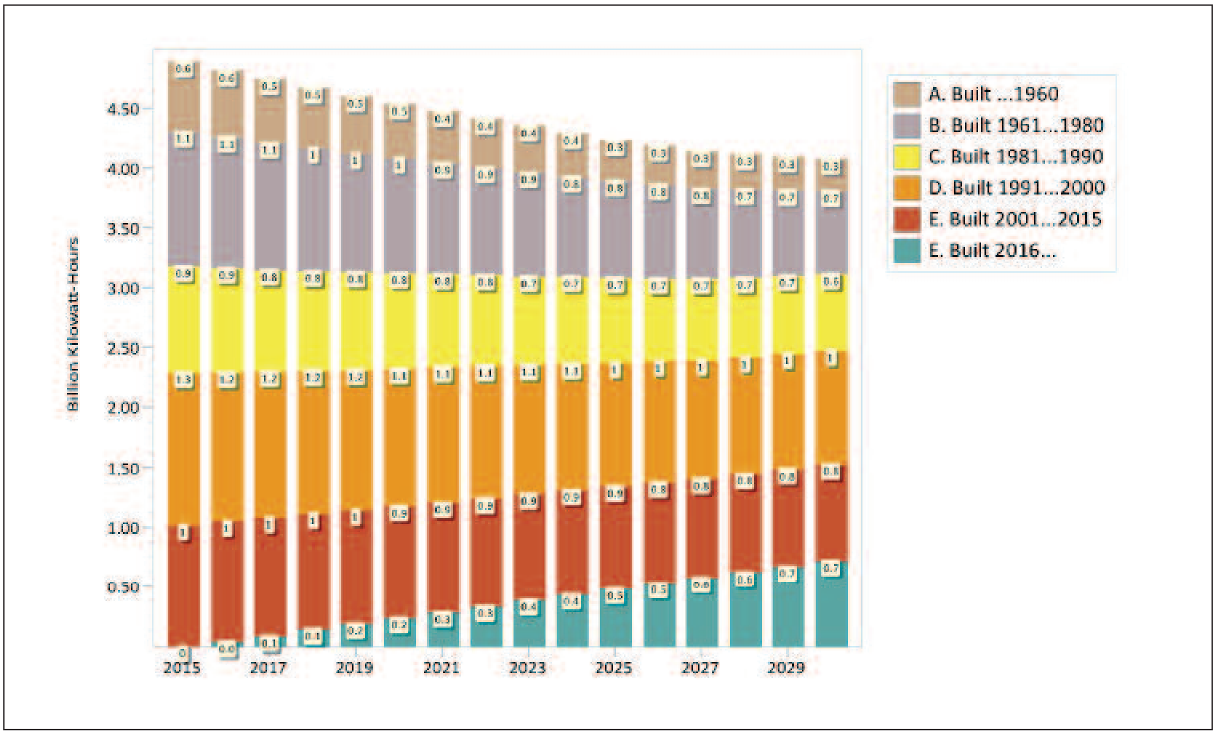


Figure 57 Final energy consumption by building type in the reference scenario, 2015–2030

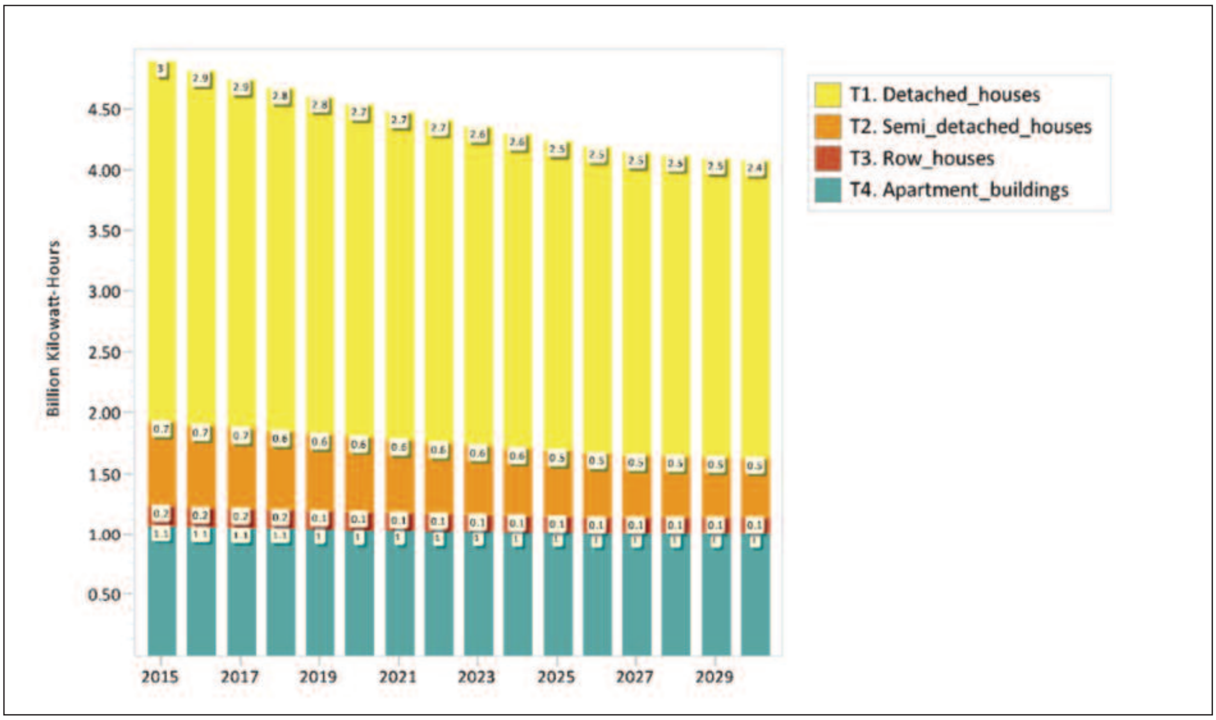


Figure 58 Final energy consumption by building age and type, 2015–2030

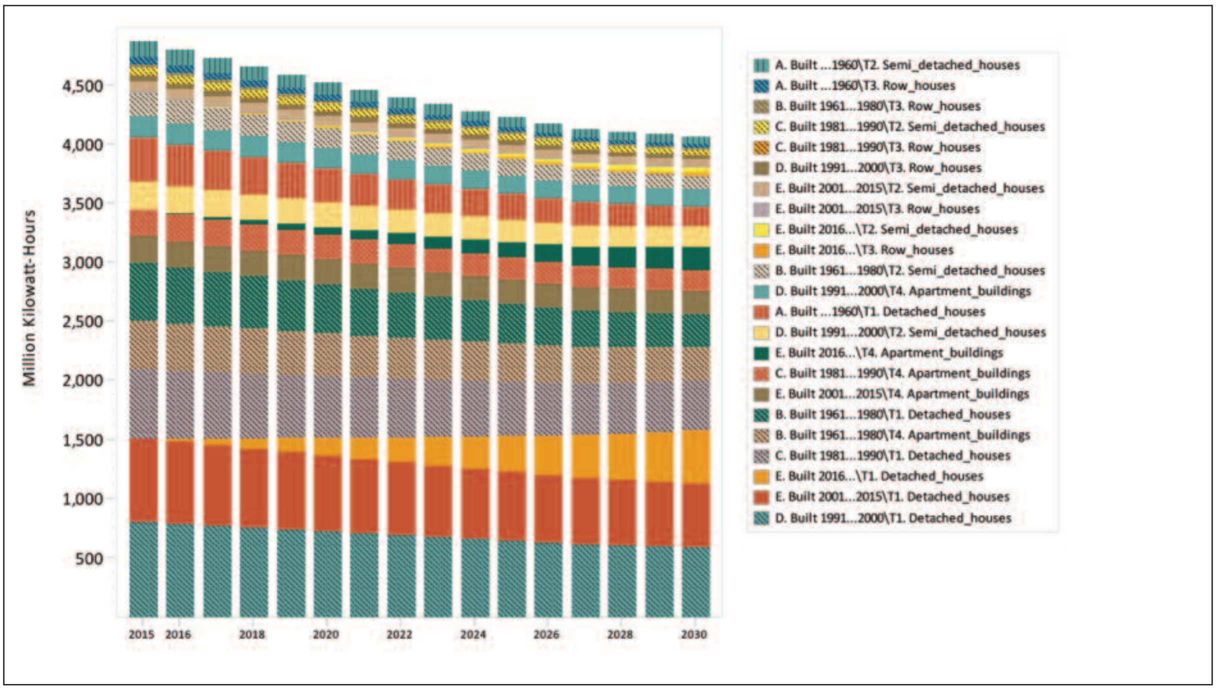


Figure 59 Final energy consumption by climate zone in the reference scenario, 2015–2030

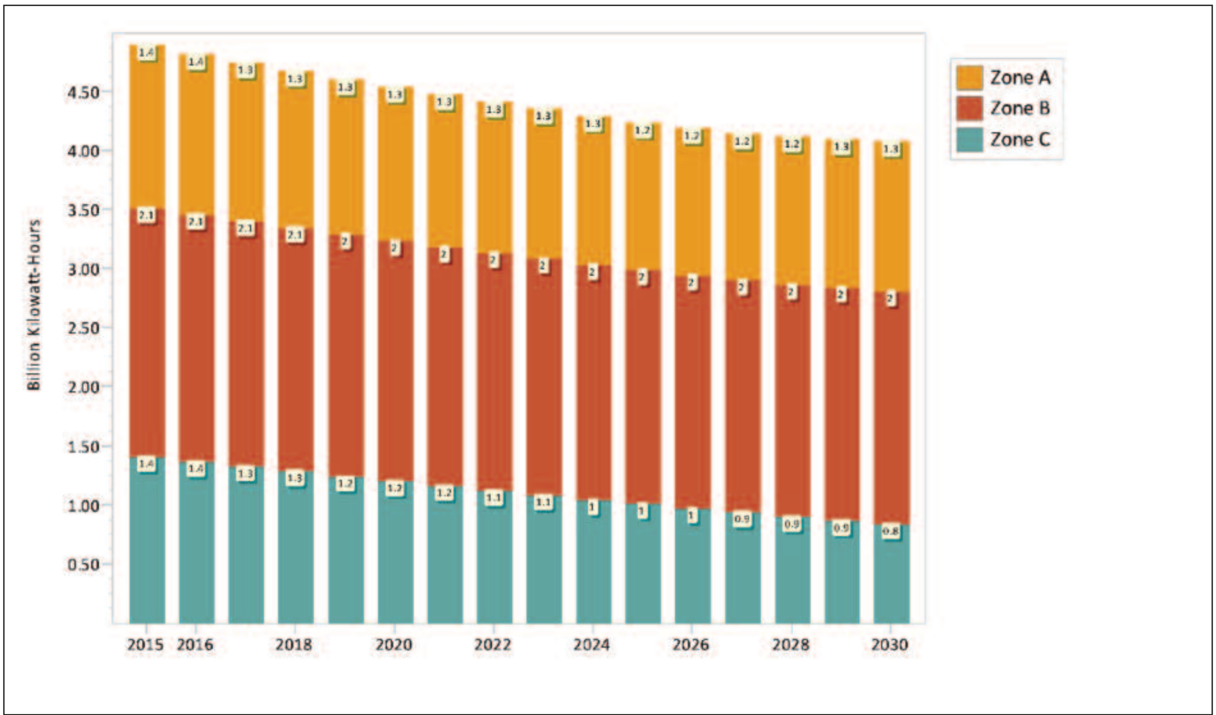
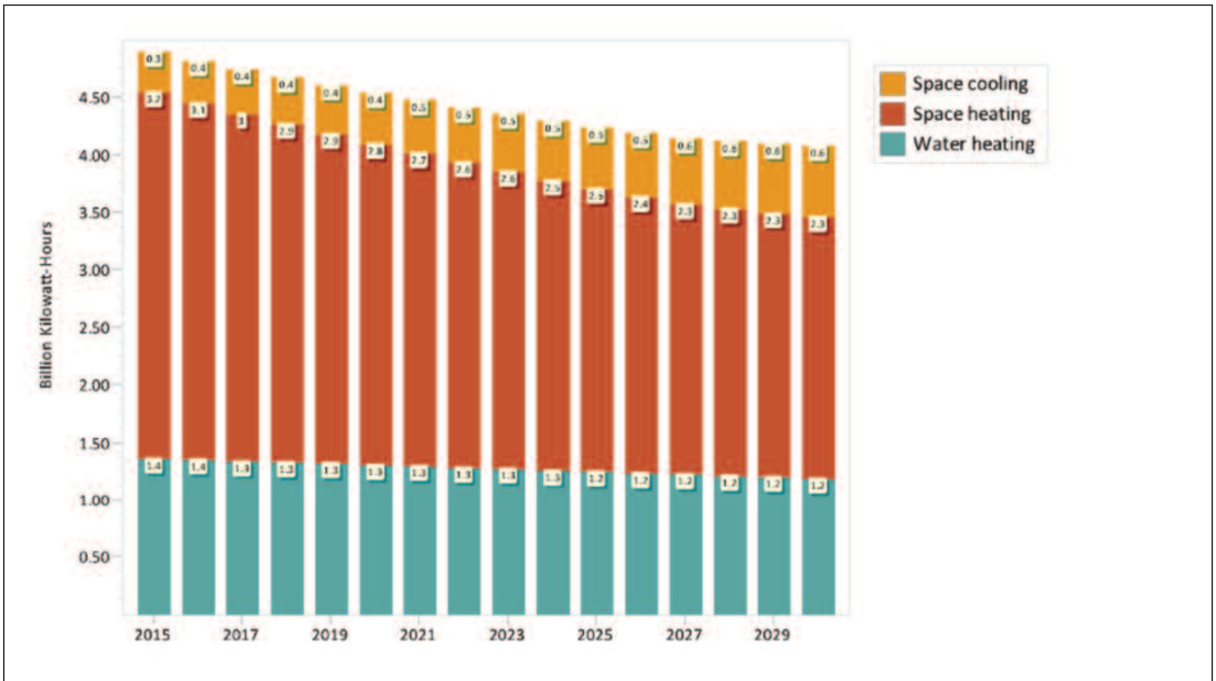


Figure 60 Final energy consumption by end use in the reference scenario, 2015–2030



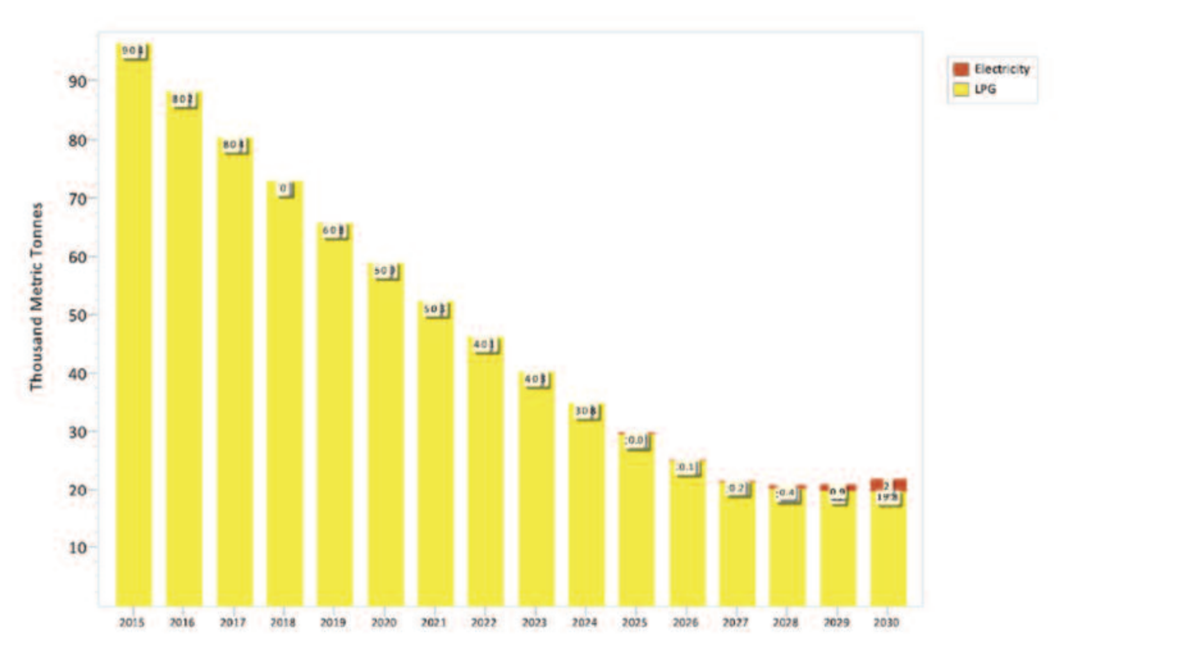
CO_2 emissions

Figure 61 presents the trends in CO_2 emissions associated with the residential building stock. Since, according to the IPCC guidelines, the emission factor for wood is zero (IPCC NGGIP online), there are no CO_2 emissions associated with wood combustion in our exercise.

As already discussed, CO_2 emissions from electricity are accounted in the transformation sector according to the IPCC guidelines (*ibid*.). However, since electricity is consumed in residential buildings, these emissions originate indirectly from this sector. At present, electricity consumed in residential buildings in Albania is produced by hydropower plants, which is why emissions associated with electricity are zero. In the future, due to the diversification of energy sources for electricity production, this emission factor will increase. The future emission factor is assumed to be as calculated in the reference scenario of the SLED decarbonisation modelling of the electricity sector (Szabó et al. 2015). This emission factor is corrected for transmission and distribution losses according to World Bank data (World Bank online).

At present, the only energy source responsible for CO_2 emissions from thermal energy services in the residential building sector is LPG. In 2015, we estimated that around 96,000 tCO_2 are emitted from this source. However, LPG-associated emissions will decline significantly in the future, as a result of the switch to electrical space and water heating. Overall, around 22,000 tCO_2 will be emitted in 2030 from both LPG and electricity consumption.

Figure 61 CO_2 emissions from electricity consumption in the reference scenario, 2015–2030



Energy costs

The price of electricity for residential users is currently EUR 0.0684/kWh (ACERC 2015). This price is almost equal to the electricity wholesale price calculated in the SLED electricity decarbonisation model (Szabó et al. 2015). This means that the current electricity price for households is regulated, which is unlikely to continue in the future due to the integration of the Albanian electricity market into the EU market. In 2012, on average in the EU, taxes and network costs accounted for 58 percent of the electricity price for households, whereas energy and supply costs accounted for 42 percent (European Commission 2014). The share of taxes and network costs continues to grow, and if Albania replicates this tendency the price of electricity will grow significantly.

We assume that in 2020 the price of electricity for residential consumers in Albania will continue to be regulated and will, in addition, include only average support for renewable energy sources, as suggested by the SLED electricity decarbonisation model (Szabó et al. 2015). From 2020, we assume a significant increase in the electricity price following Albania's accession to the EU. By 2030, the share of taxes and network costs in the electricity price will be around 42 percent of the electricity price — that is, as it is now in the EU on average. This represents a 6 percent per year increase in the electricity price between 2020 and 2030. In summary, the electricity price for residential consumers in our model is EUR 0.077/kWh in 2020, and EUR 0.137/kWh in 2030.

The current LPG price is EUR 0.45/litre (Global petrol prices online). We assume that in the future the LPG price will rise in line with oil prices. The rise in the price of oil is estimated at 4.4 percent per year between 2015 and 2030 according to the forecast of energy commodity prices provided by the World Bank (World Bank 2015).

The current price of wood is estimated at EUR 35/m^3. Since electricity is the main substitute for wood in the residential sector, we assume that the price of wood will increase according to the same trend as the price of electricity.

Taking into account these assumptions, in 2030 energy costs to residential consumers in the business-as-usual scenario will reach EUR 528 million, or will be more than double the costs in 2015 (Figure 62).

Figure 63 presents energy costs per square metre of the total building floor area. The figure illustrates that, in the business-as-usual scenario, in 2030 residential consumers will pay around EUR 7.3/m^2 for thermal services.

Figure 62 Energy costs in the reference scenario, 2015–2030

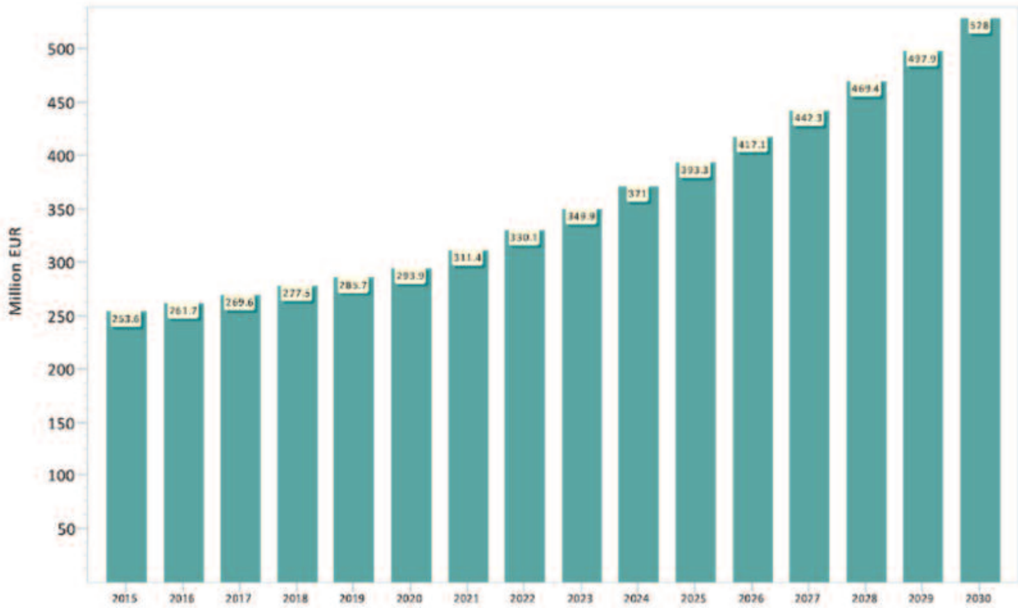
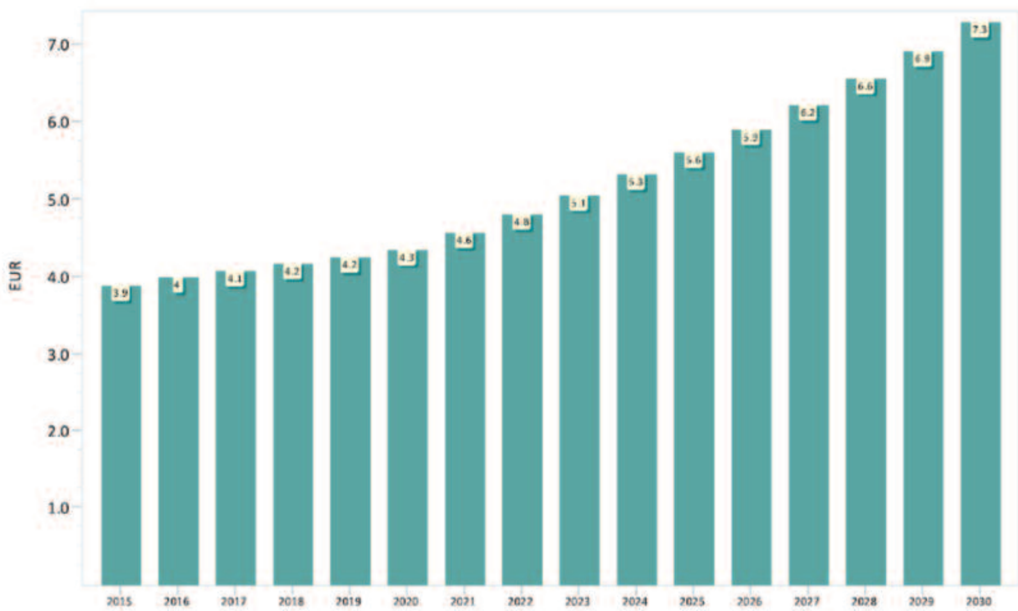


Figure 63 Energy costs per m² in the reference scenario, 2015–2030



XI. SLED moderate scenario: Results

Final energy consumption

In 2030, final energy consumption in the SLED moderate scenario will be around 3 billion kWh, or 27 percent lower than the business-as-usual level (Figure 64).

The biggest final energy savings are associated with electricity, as presented in Figure 65. Avoided electricity consumption is around 1.6 billion kWh, or 44 percent of the business-as-usual consumption in 2030 (Figure 66).

Figure 67 illustrates the structure of final energy savings by building type. The figure shows that the biggest share in final energy savings originates from buildings constructed in 1991–2000, followed by buildings constructed after 2016 and buildings constructed in 1981–1990. Buildings constructed in 1961–1980 also represent a large share of the potential, although if the potential is split by decade, their significance is halved.

Figure 68 presents the structure of final energy savings by building type. The figure shows that the majority of final energy savings originate from detached houses, which are a clear priority for policy making.

The breakdown of final energy consumption by building age and type, as presented in Figure 69, illustrates that the key categories for energy savings are detached houses built in 1991–2000 (14 percent of final energy savings), detached houses built after 2016 (13 percent), and detached houses built in 1981–1990 (12 percent). Other significant categories are apartment buildings constructed in 1961–1980 (8 percent), detached houses built in 1961–1980 (7 percent), detached houses built in 2001–2015 (7 percent), and apartment buildings built after 2016 (6 percent).

Climate zone B, which will occupy around 43 percent of the sector's floor area in 2030, holds around 57 percent of the sector's final energy savings. Only 5 percent of the sector's final energy savings originate from climate zone C. Climate zone A is responsible for the remaining 38 percent of final energy savings (Figure 70).

Figure 71 illustrates the final energy savings by building age and type and climate zone. The figure shows that the largest savings broken down to such a detailed level originate in detached houses built in 1991–2000 and located in climate zones A and B (8 percent and 6 percent of the total final energy savings respectively), followed by detached houses built after 2016 and located in climate zones A and B (7 percent each), detached houses built in 1981–1990 and located in zone B (6 percent), and apartment buildings built in 1961–1980 and located in zone B (5 percent).

As Figure 72 shows, the biggest final energy savings are possible in space heating (61 percent of savings). Around 23 percent of energy savings are due to more efficient air-conditioning systems, and the remaining 16 percent to better water-heating technologies.

The average final energy consumption per square metre will be 27 percent lower in 2030 as compared to the business-as-usual scenario, and will reach around 41 kWh/m^2 (Figure 73). The reduction in final energy demand per square metre originates mostly from the retrofitting of existing buildings.

Figure 64 Final energy consumption in the SLED moderate scenario and final energy savings vs. the reference scenario, 2015–2030

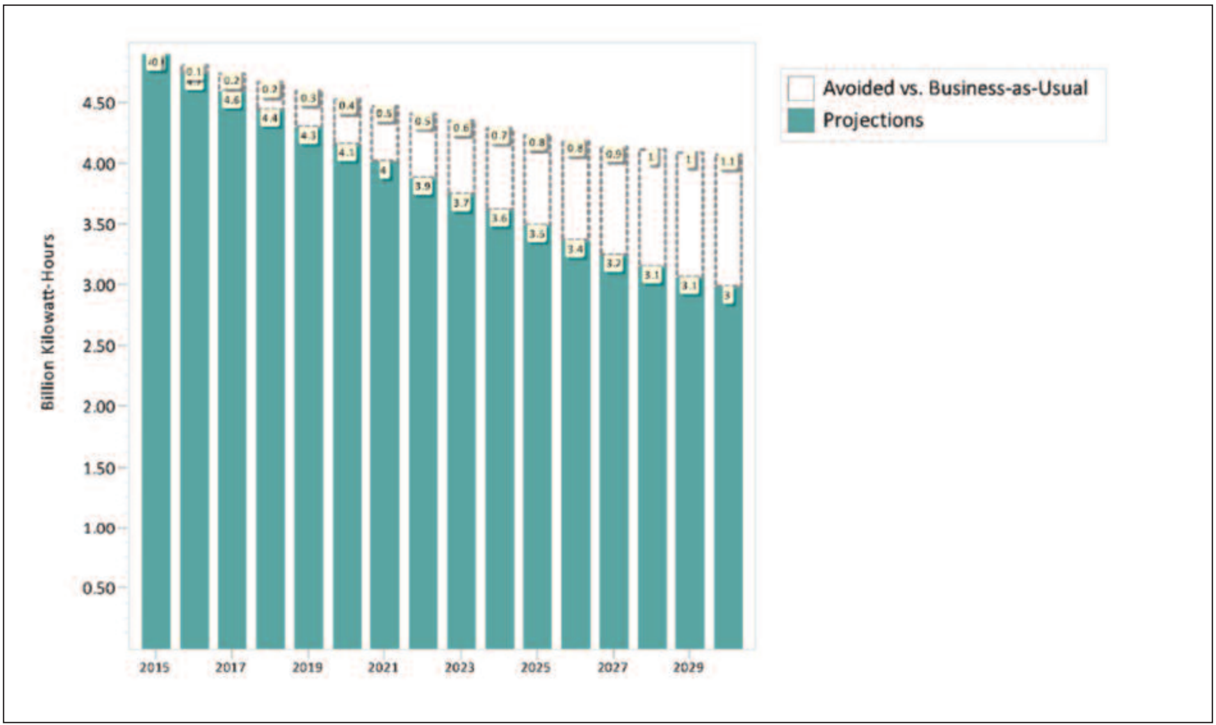


Figure 65 Final energy savings by energy source in the SLED moderate scenario vs. the reference scenario, 2015–2030

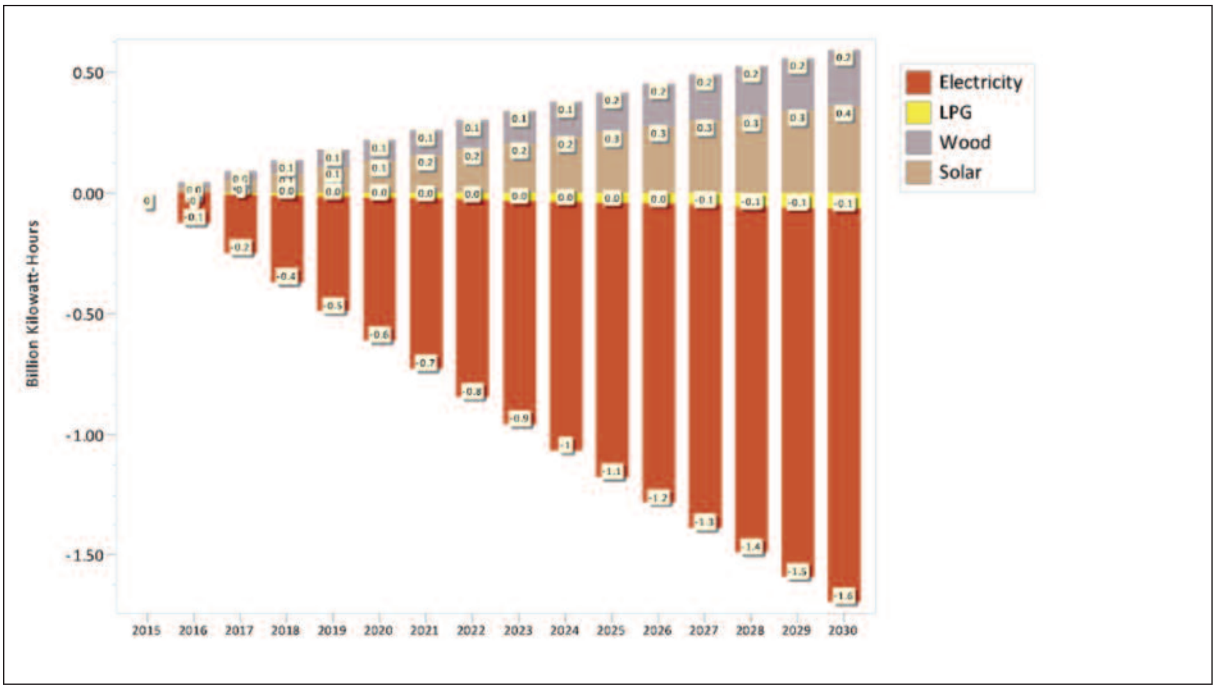


Figure 66 Electricity consumption in the SLED moderate scenario and electricity savings vs. the reference scenario, 2015–2030

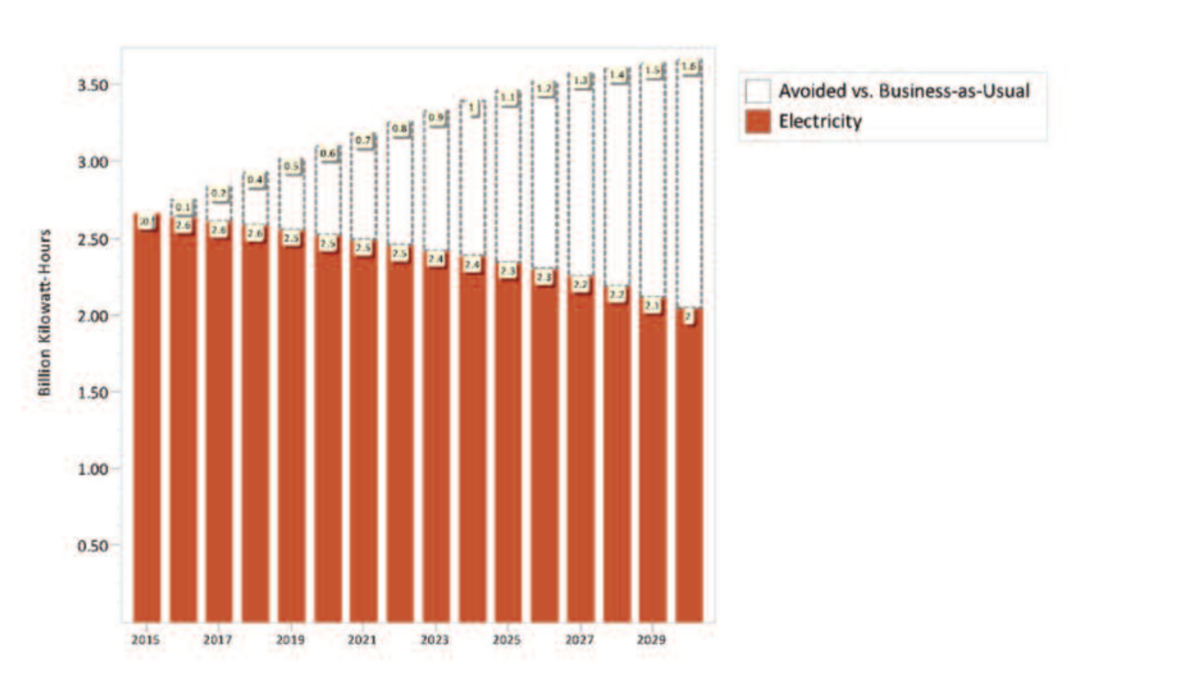


Figure 67 Final energy savings by building age category in the SLED moderate scenario vs. the reference scenario, 2015–2030

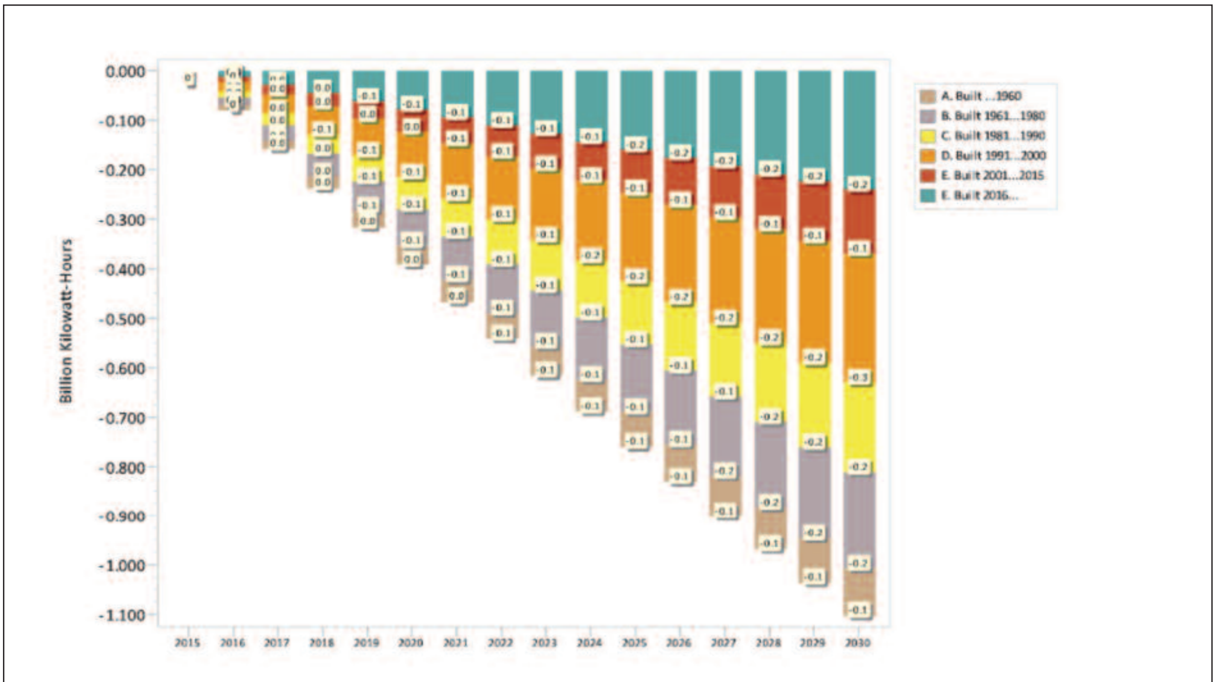


Figure 68 Final energy savings by building type in the SLED moderate scenario vs. the reference scenario, 2015–2030

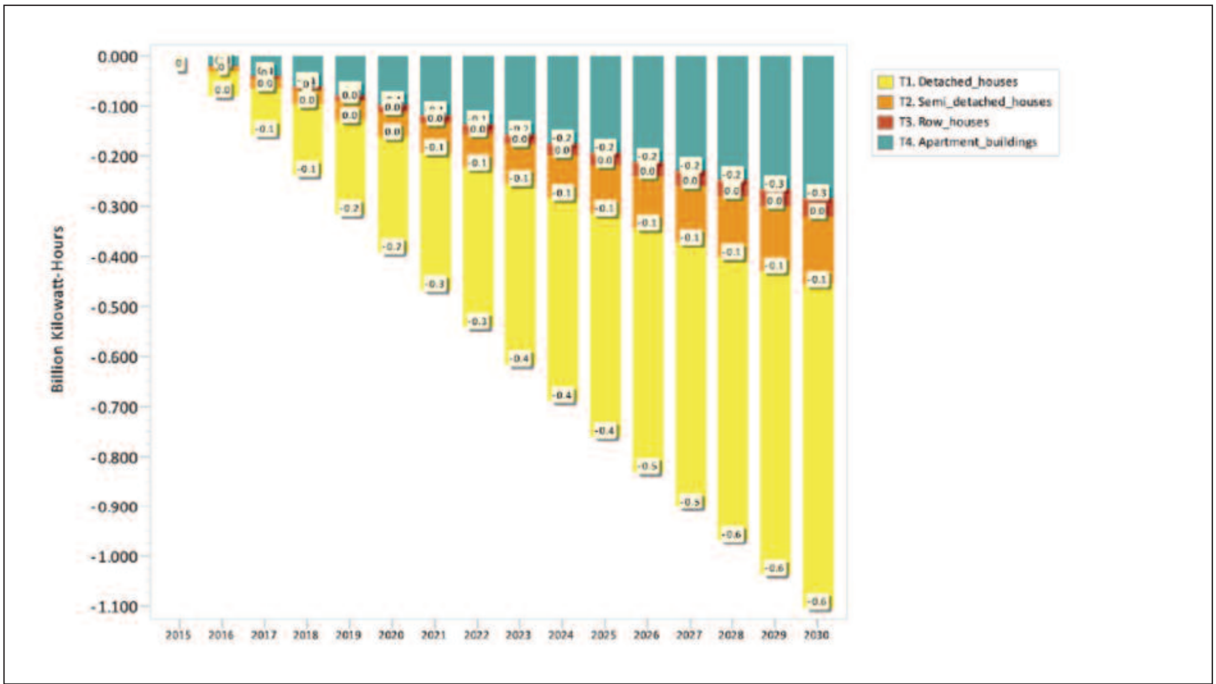


Figure 69 Final energy savings in the SLED moderate scenario vs. the reference scenario by building age and type, 2015–2030

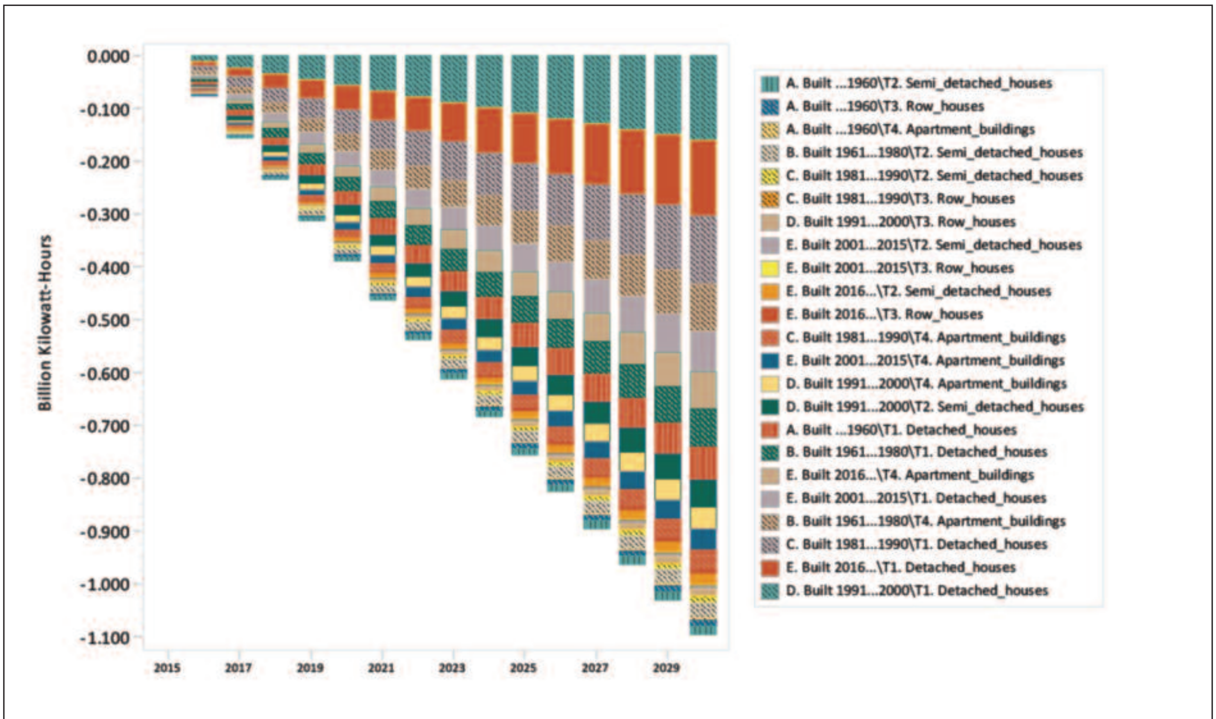


Figure 70 Final energy savings by climate zone in the SLED moderate scenario vs. the reference scenario, 2015–2030

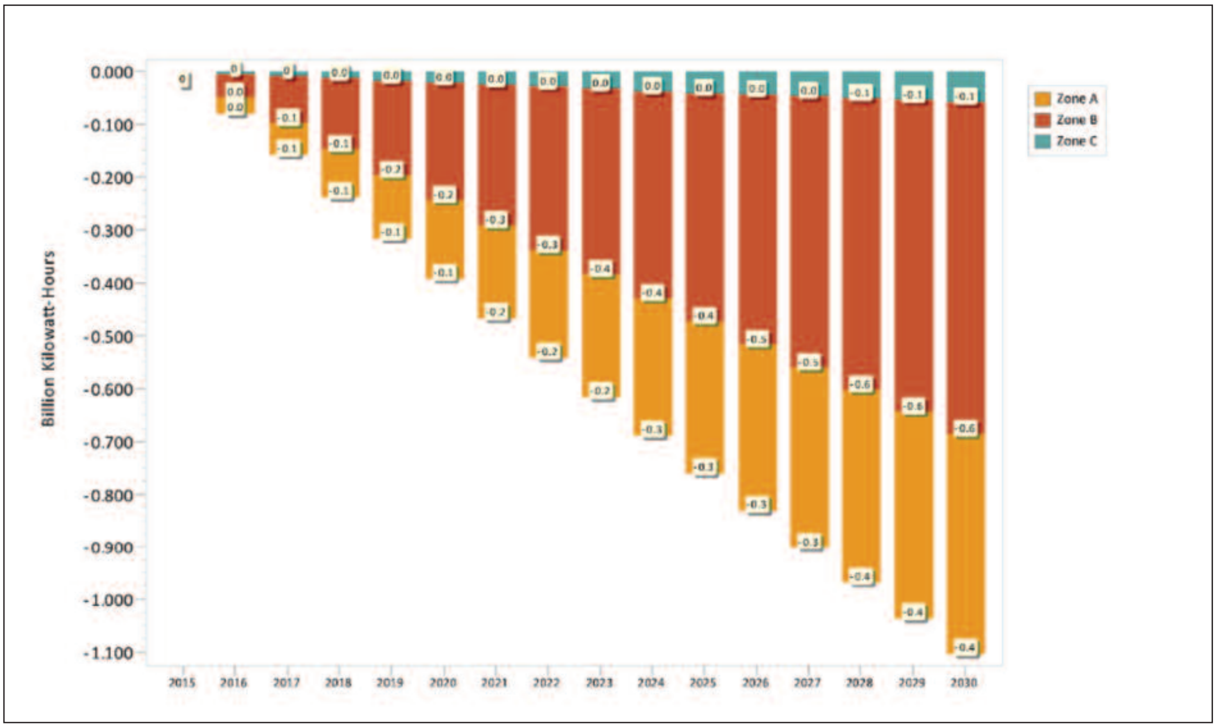


Figure 71 Final energy savings by building age and type and climate zone in the SLED moderate scenario vs. the reference scenario, 2015–2030

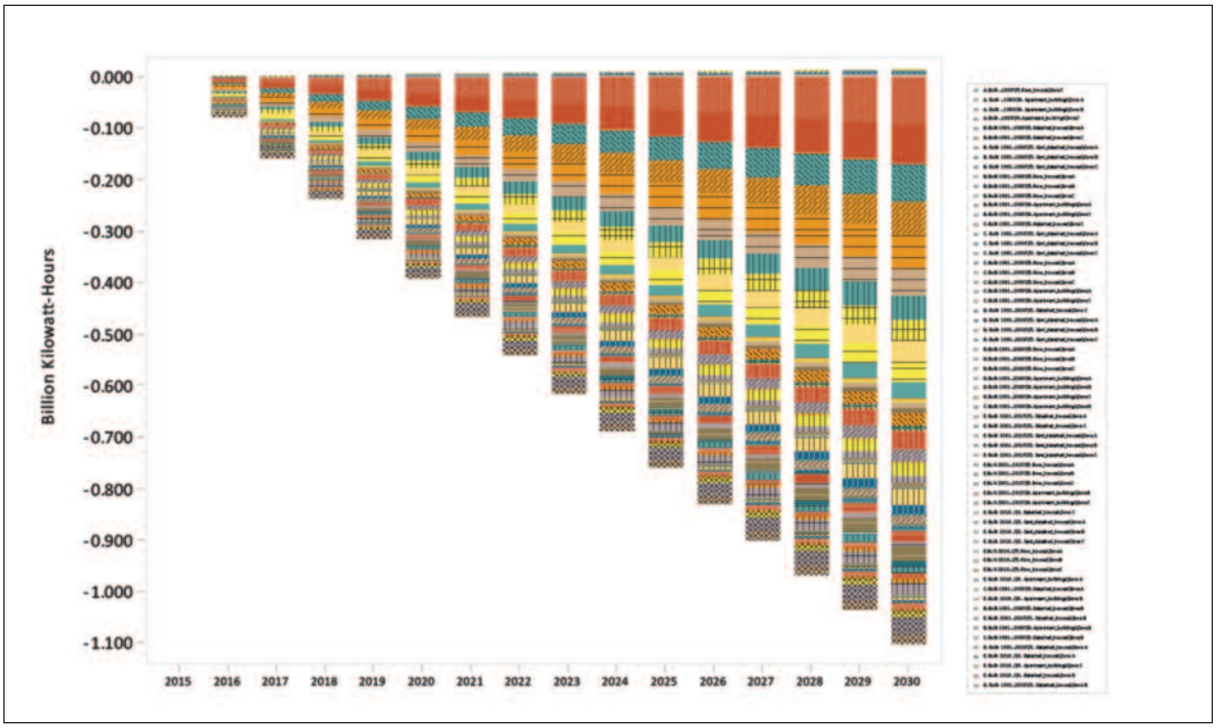


Figure 72 Final energy savings by end use in the SLED moderate scenario vs. the reference scenario, 2015–2030

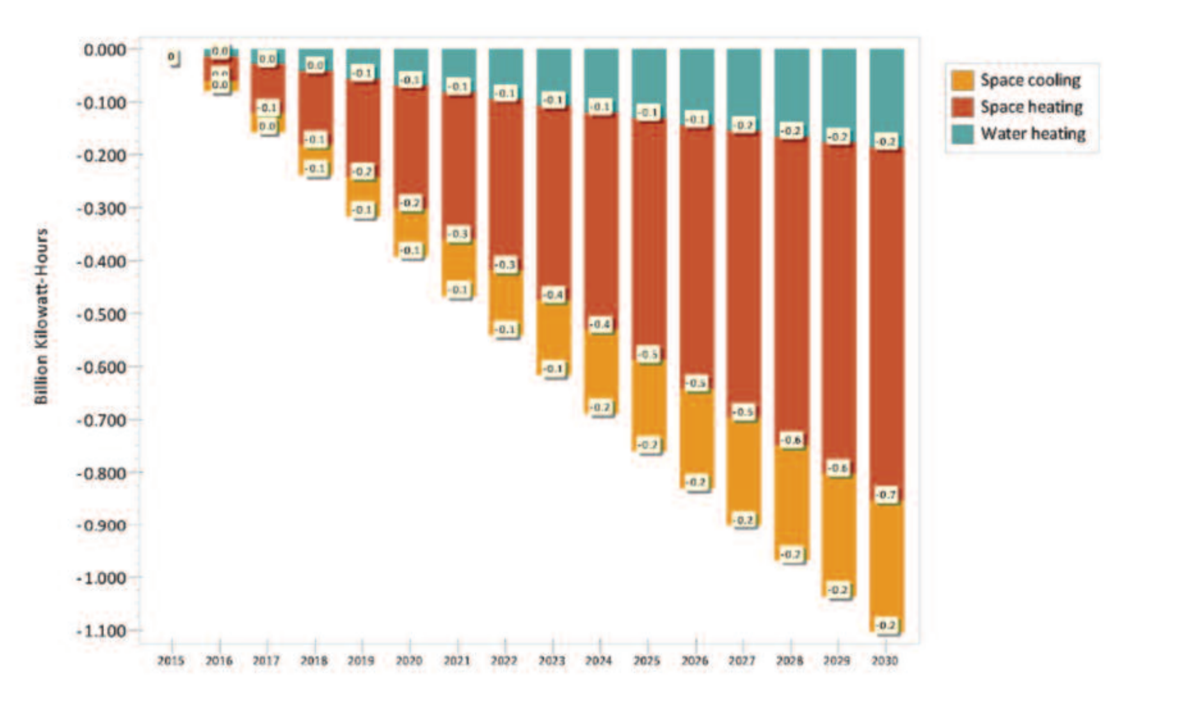


Figure 73 Final energy consumption per m² in the SLED moderate scenario and its reduction vs. the reference scenario, 2015–2030

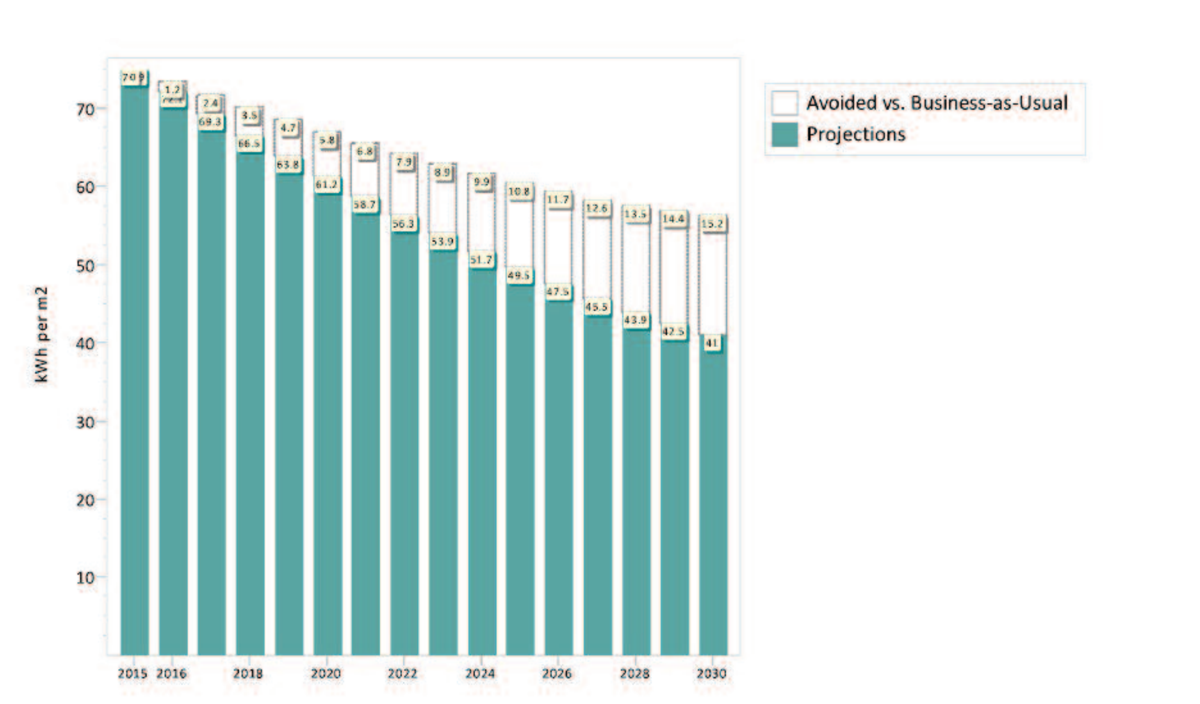
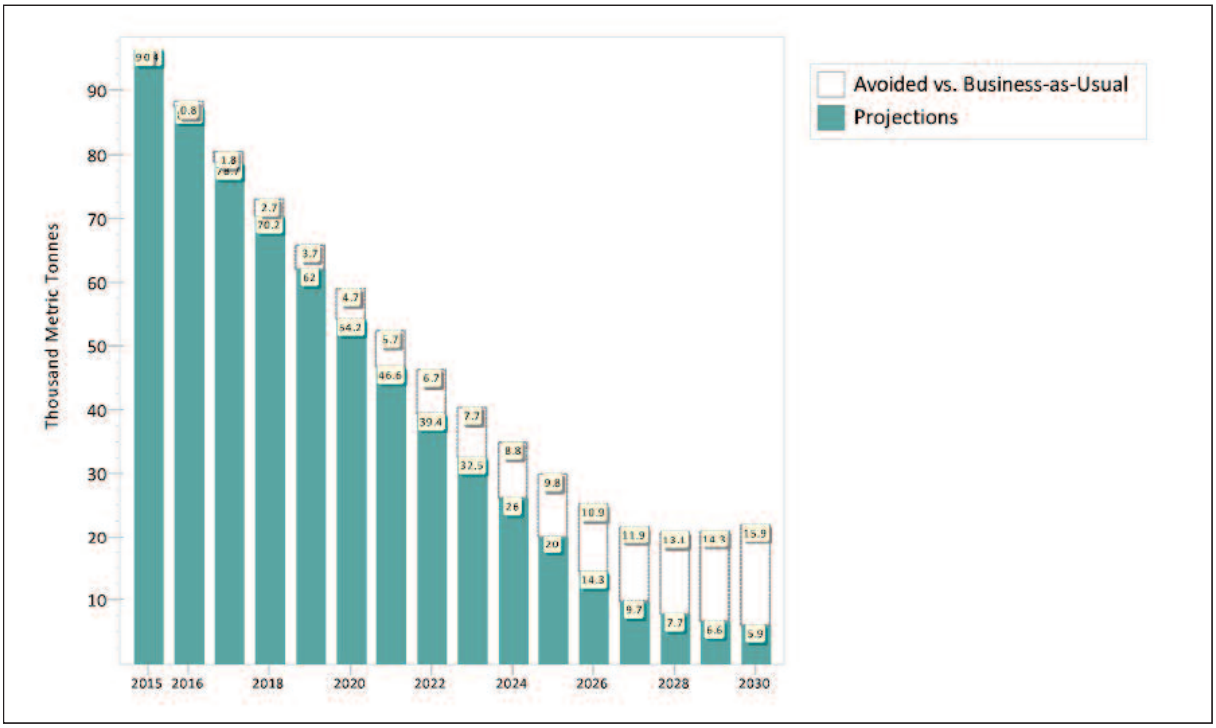


Figure 74 CO_2 emissions in the SLED moderate scenario and CO_2 emissions avoided vs. the reference scenario, 2015–2030



CO_2 emissions

The reduction in final energy consumption causes a reduction in the associated CO_2 emissions. As Figure 74 illustrates, emissions from the residential sector, which in Albania originate from LPG at present and from LPG and electricity in the future, will be 73 percent lower in 2030 versus their business-as-usual level.

Saved energy costs

In 2030, energy costs to residential consumers in the SLED moderate scenario will be 42 percent lower than the energy costs in the business-as-usual case in 2030. In absolute terms, this difference represents EUR 220 million (Figure 75).

Figure 76 presents saved energy costs per square metre of the total building floor area. The figure shows that in the SLED moderate scenario, residential consumers will pay around EUR 3.0/m^2 less for thermal services in 2030 than in the business-as-usual case.

Figure 75 Energy costs in the SLED moderate scenario and saved energy costs vs. the reference scenario, 2015–2030

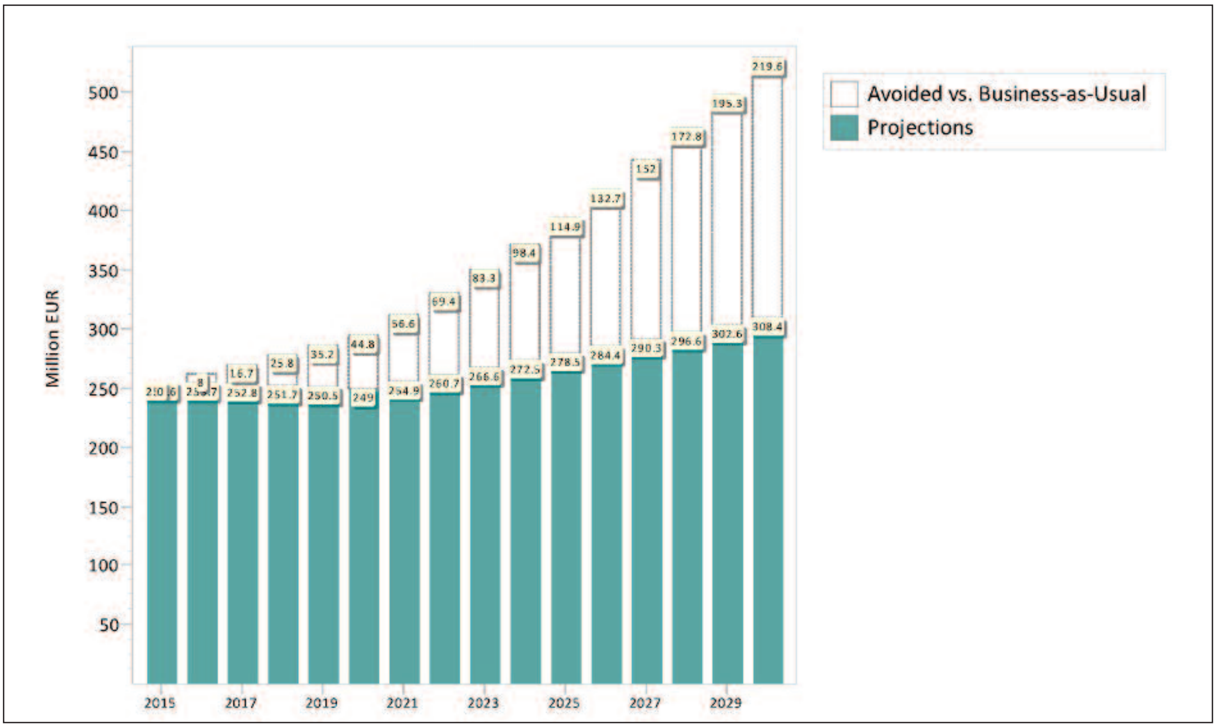
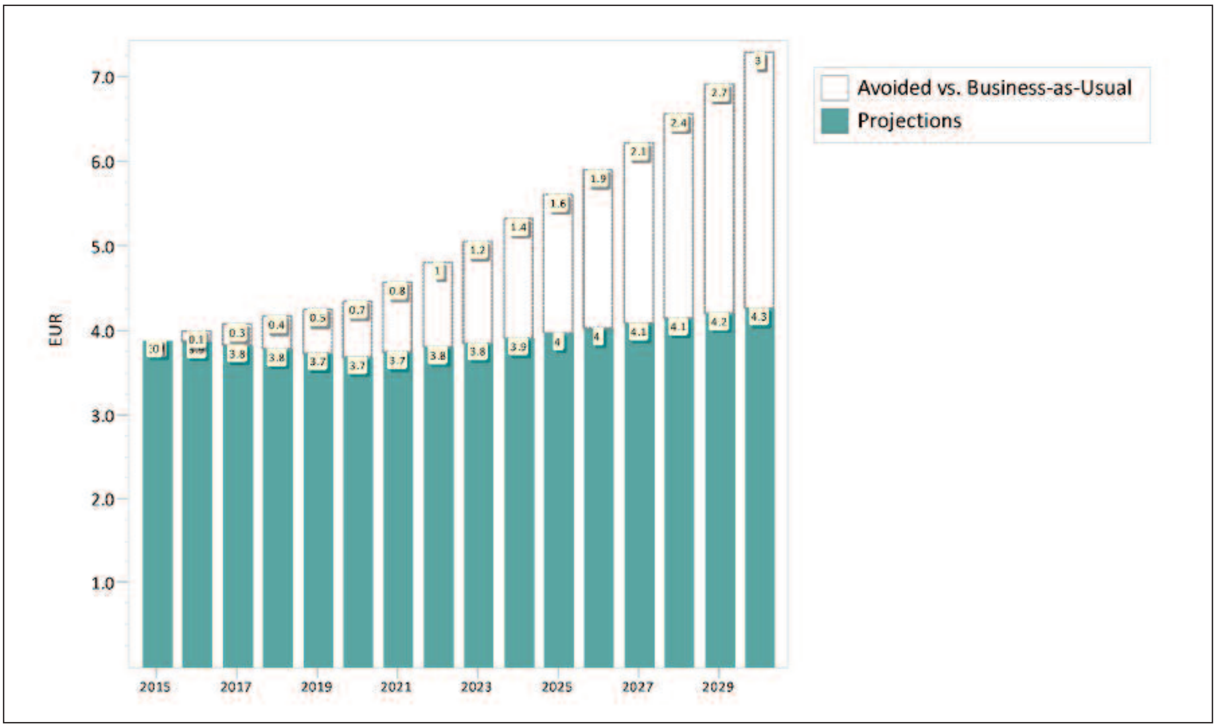


Figure 76 Energy costs per m² in the SLED moderate scenario and saved energy costs per m² vs. the reference scenario, 2015–2030



Investments

The transformation to a more efficient residential building stock in Albania requires significant investments. It is clear that the cost of such investments will not, and cannot, be borne by the public budget alone. The aim of the government is to introduce policy tools and to use the available public budget to leverage private investment in thermally efficient retrofitting and construction.

All buildings undergo renovation at least once during their lifetime for different reasons, which are not necessarily linked to energy efficiency. Such business-as-usual renovation costs often include plastering and painting, new floor tiles, new windows and doors of mediocre quality, and the changing of space- and water-heating systems. It is therefore very convenient and more cost-effective to combine thermal efficiency improvements to buildings with their business-as-usual renovation in order to take advantage of costs that are anyway incurred, and to pay in addition only the incremental costs of energy efficiency improvements.

Below, the total investment costs of the scenarios refer to the total costs of the scenarios without deducting the business-as-usual costs that are incurred in the reference scenario. By the incremental investment costs of the scenarios we understand the difference between the total costs of the scenarios and the business-as-usual costs of the reference scenario that are incurred anyway. The retrofitting rates of the reference scenario and the scenarios with additional measures may be different, which is why the scenarios with additional measures may include not only the incremental costs but also the total investment costs for a part of the stock that is not touched by the business-as-usual renovations.

The retrofitting rate of the SLED moderate scenario is the same as the retrofitting rate of the reference scenario, which is why the incremental costs of the SLED moderate scenario include only the incremental costs of the thermal efficiency retrofitting of retrofitted buildings. For newly constructed buildings, it makes sense to consider only the incremental costs of energy efficiency improvements, since the construction costs anyway include the business-as-usual costs of the building components and systems.

To calculate the retrofitting costs at sector level, we multiplied the costs of building improvements by the floor area affected by the SLED moderate scenario. The costs of building improvement 1 per square metre are documented in Section V. In consultation with national experts, the cost of the business-as-usual improvement of existing buildings was assumed as EUR 40/m^2 for apartment buildings, EUR 45/m^2 for row houses, and EUR 50/m^2 for detached and semi-detached houses.

Figure 77 shows the floor area affected by the SLED moderate scenario. According to the figure, annually 1.6 million m^2, or 2.5 percent of the total building floor area, are retrofitted between 2015 and 2030. Additionally, all new floor area — that is, around 1.1 million m^2 per year — is included in our scenario.

The retrofitting of the existing floor area is supported by low-interest loans and grants over the whole modelling period, as discussed in the assumptions in Section IX (page 88). The whole of the new building floor area is regulated by the building code.

For new buildings, we estimated that the average incremental investment in higher energy efficiency per square metre is between EUR 28 and EUR 58, depending on the building type and zone. For existing buildings, we found an average total investment cost per square metre in the range of EUR 68 to EUR 123, depending on the building age and type and the climate zone. If the business-as-usual costs are deducted from the total investment costs, the incremental costs of retrofitting existing buildings are between EUR 33 and EUR 73/m^2, depending on the building age and type and the climate zone.

Figure 78 presents the total investment costs in building thermal efficiency retrofitting over the modelling period. We estimate that on average these costs are around EUR 153 million per year between 2015 and 2030. The biggest investments are required in buildings constructed in 2001–2015. Over the modelling period, the cumulative total investment costs are around EUR 2.3 billion.

The model also provides an opportunity to break down the total investment costs into the technological measures required. According to this analysis, the largest share of the costs are for changing the space-heating system, followed by insulation costs, the cost of windows, and finally the cost of changing the water-heating system.

Figure 79 presents the incremental investment costs in building thermal efficiency retrofitting and advanced construction over the modelling period. The figure illustrates the clear benefit of coupling thermal efficiency improvement with the business-as-usual retrofitting of existing buildings. We estimate that the incremental investment costs in building retrofitting are on average EUR 72 million per year between 2015 and 2030. In addition, the incremental investment costs of new buildings are on average around EUR 39.5 million per year. The cumulative incremental costs over the modelling period are around EUR 1.1 billion in building retrofitting, and EUR 693 million in efficient construction.

Assuming a measure lifetime of 30 years and a discount rate of 4 percent, the annualised incremental cost of the SLED moderate scenario between 2015 and 2030 is EUR 2.3/m^2. The average saved energy costs are around EUR 3.8/m^2 of new or retrofitted floor area over the modelling period. This means that investments in better existing and new buildings are profitable. It is important to note that the saved energy costs are higher than the annualised investment costs for the scenario as a whole at country level, but not for all building categories. For a few building categories, the saved energy costs are lower than the annualised incremental investment costs, thus for them the incremental investments do not pay back. Raising the discount rate higher than 9 percent would make the scenario investment unattractive.

We also analysed the efforts of different actors if Albania aims to follow the SLED moderate scenario. We carried out this analysis assuming a market loan interest rate of 15 percent, a government-subsidised loan interest rate of 0 percent, a loan term of 10 years, and a discount rate of 4 percent.

In the model, we provided the option to assume eligible costs as a share of the total investment costs for each policy incentive in order to regulate the desired level of support. In our calculations, we assumed that around 50 percent of the total investment cost is supported by grants or low-interest loans, which is approximately equal to the share of the incremental investment costs in the SLED moderate scenario.

Figure 80 presents the cost to residential stakeholders of compliance with the building code that is likely to be adopted in 2016. On average, these stakeholders will bear EUR 37 million of incremental investment costs per year, or EUR 593 million in 2015–2030.

The mechanism of low-interest loans works in such a way that households borrow capital from commercial banks at a low interest rate and the government compensates the commercial banks for the difference between the market loan interest rate and the subsidised low interest rate. Figure 81 presents the financing borrowed by residential stakeholders for the purposes of building retrofits. Given our assumptions, the eligible costs of building retrofits that investors would need to borrow are around EUR 36.5 million per year, or around EUR 550 million over the modelling period.

Figure 82 shows the compensation paid by the government to commercial banks. Since the lending period is 10 years, the compensation paid by the government to commercial banks is at its highest after 10 years. After this point, the amount of compensation stays almost the same until the end of the modelling period. Over the modelling period, the government provides EUR 600 million to commercial banks as compensation for the low interest rate.

In addition, the government provides grants for the retrofitting of existing buildings, as described in the assumptions in Section IX. As Figure 83 shows, the value of these grants is around EUR 22 million per year, or EUR 327 million over the modelling period.

Figure 77 Floor area of new and retrofitted buildings in the SLED moderate scenario, 2015–2030

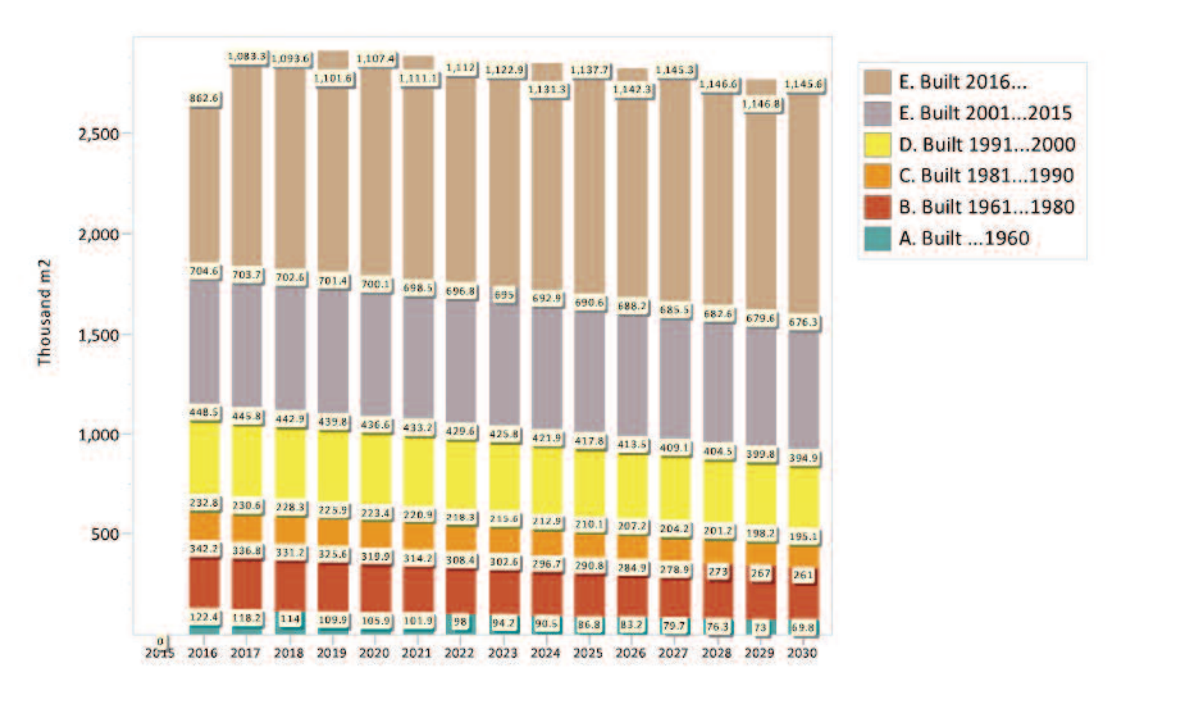


Figure 78 Total investment costs in the SLED moderate scenario, 2015–2030

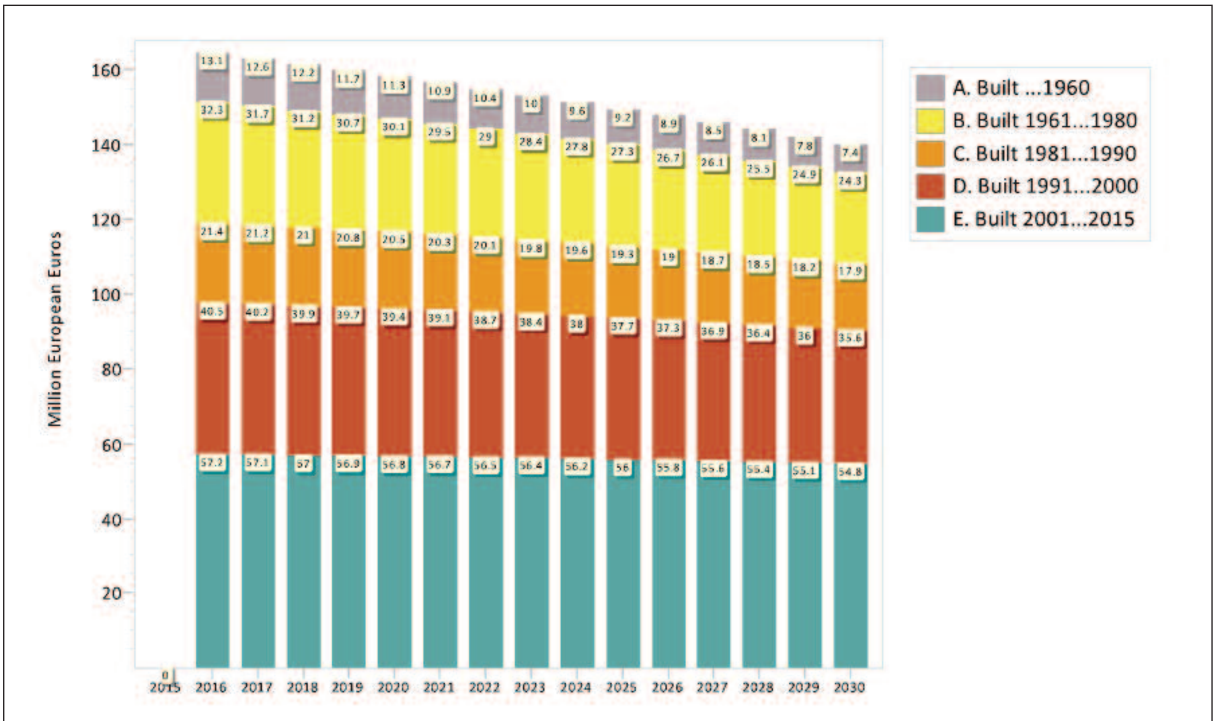


Figure 79 Incremental investment costs in the SLED moderate scenario, 2015–2030

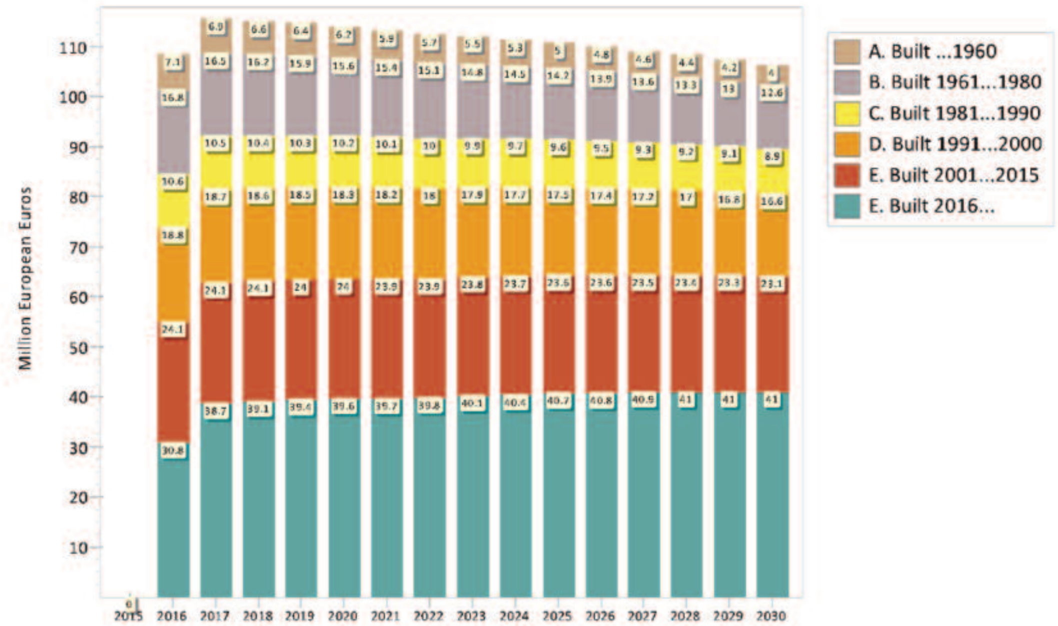


Figure 80 Private investments to achieve compliance with the building code in the SLED moderate scenario, 2015–2030

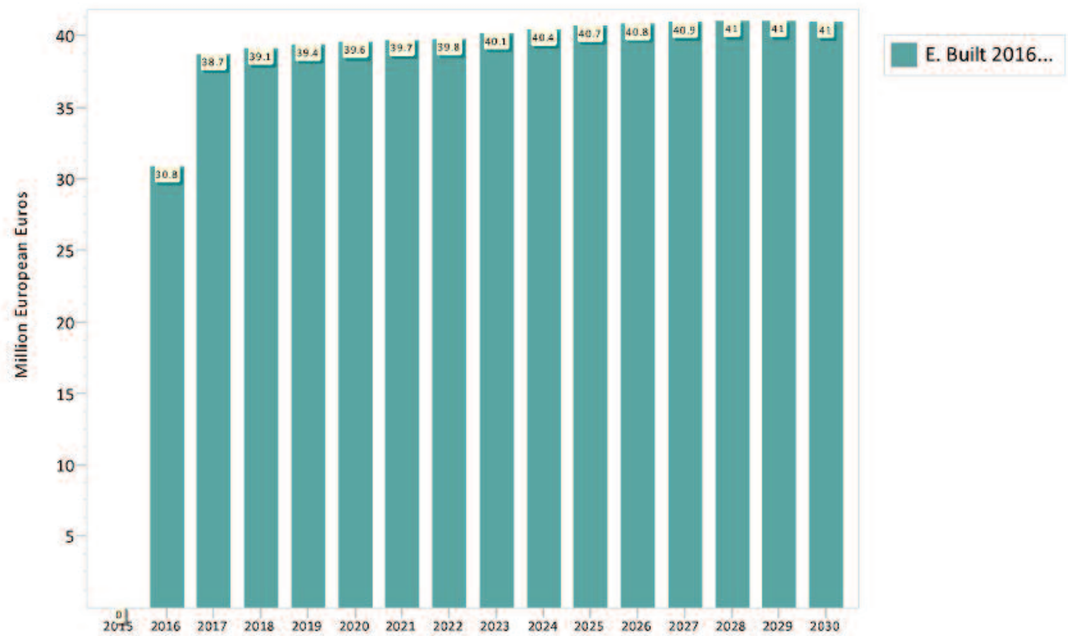


Figure 81 Private (eligible) investments stimulated by low-interest loans in the SLED moderate scenario, 2015–2030

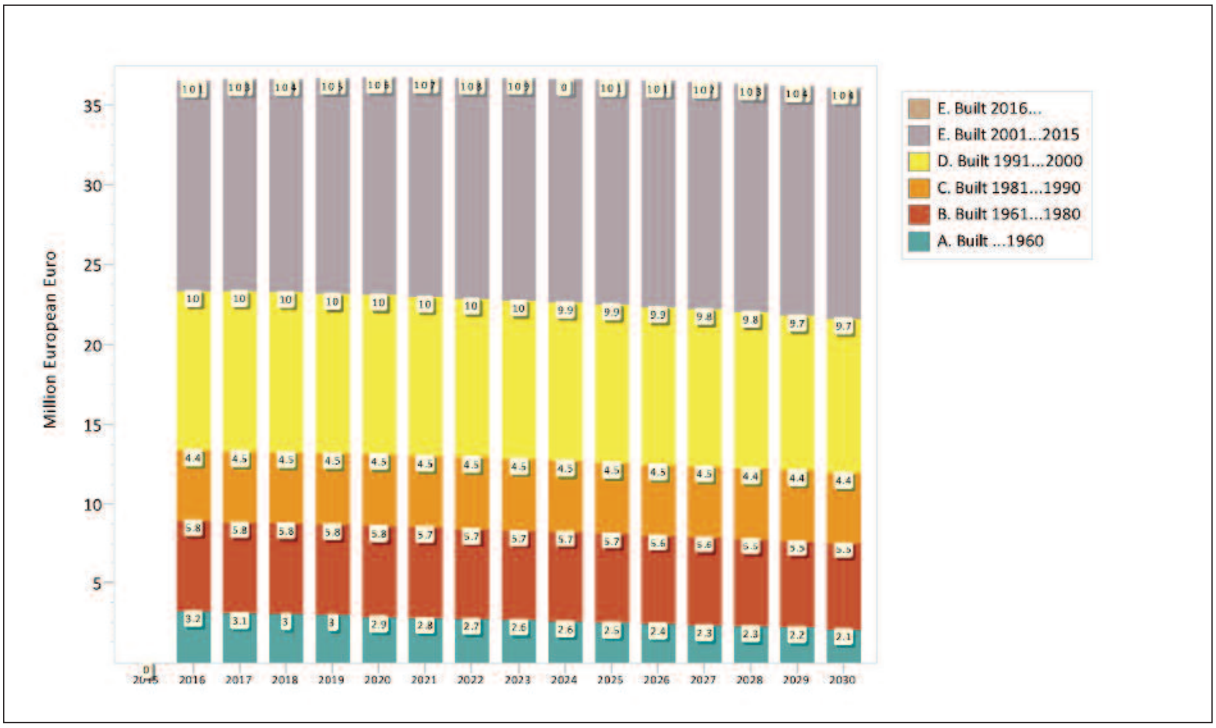


Figure 82 Cost to the government of low-interest loans in the SLED moderate scenario, 2015–2030

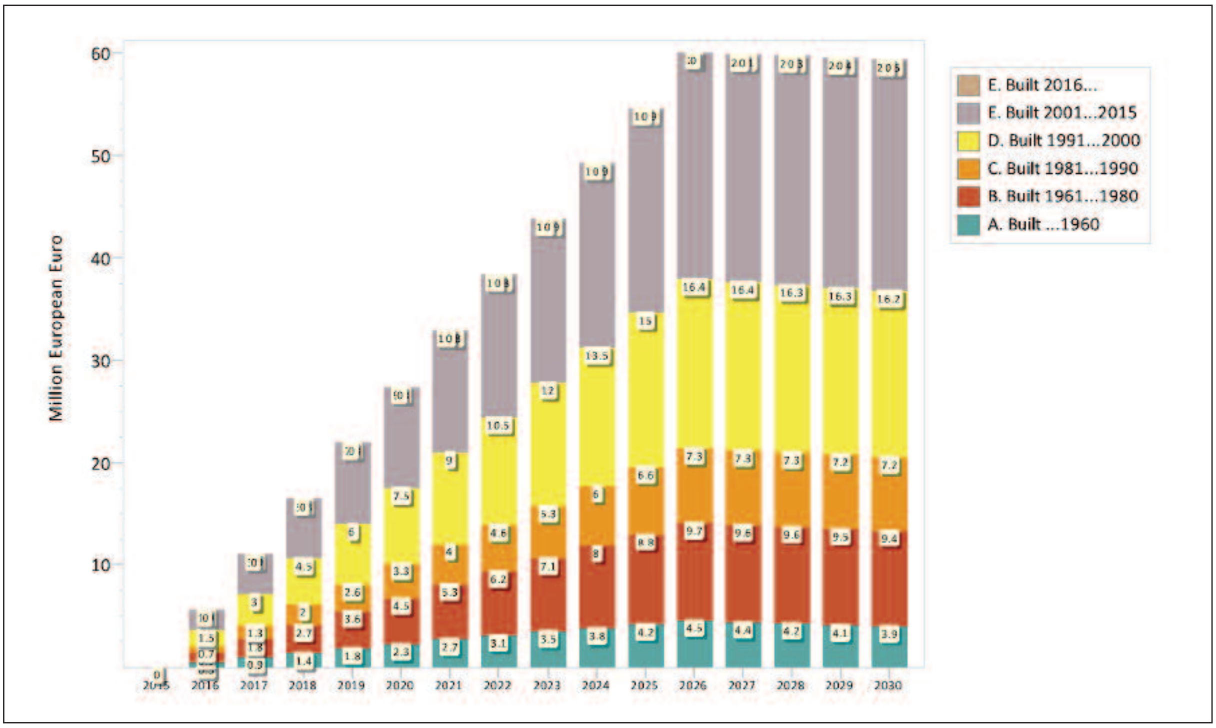
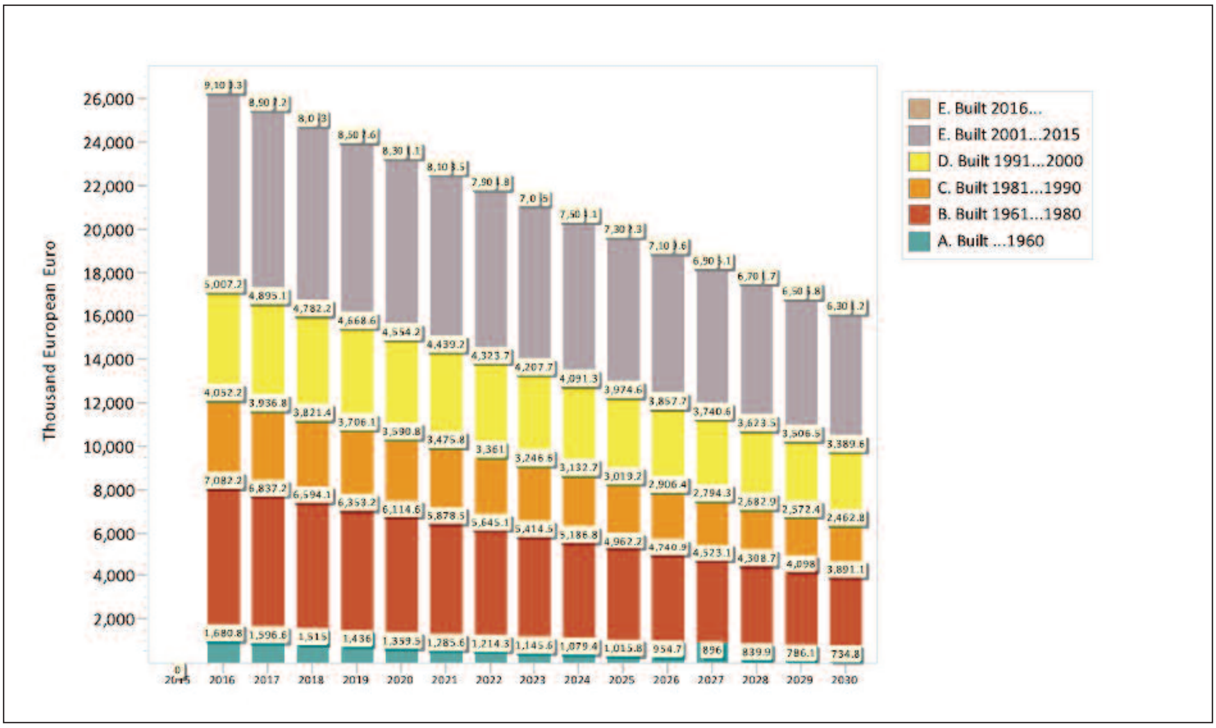


Figure 83 Cost to the government of grants in the SLED moderate scenario, 2015–2030



XII. SLED ambitious scenario: Results

Final energy consumption

In 2030, final energy consumption in the SLED ambitious scenario will be around 2.7 billion kWh, or 35 percent lower than the business-as-usual level (Figure 84).

The biggest final energy savings are associated with electricity, as presented in Figure 85. Avoided electricity consumption is around 1.8 billion kWh, or 49 percent of the business-as-usual consumption in 2030 (Figure 86).

Figure 87 shows the structure of final energy savings by building age category. The figure shows that the majority of final energy savings originate from buildings constructed after 2016 and buildings constructed in 1991–2000. Other age categories that are significant in terms of final energy savings are buildings constructed in 1981–1990 and 1961–1980. If the potential of buildings built in 1961–1980 were split by decade in order to be comparable to buildings from other construction periods, their significance would be halved.

Figure 88 presents the structure of final energy savings by building type. The figure shows that the majority of final energy savings originate from detached houses, which are a clear priority for policy making.

Climate zone B, where around 43 percent of the sector's total floor area will be located in 2030, holds around 53 percent of the sector's final energy savings. Only 11 percent of the sector's final energy savings originate from climate zone C. Climate zone A is responsible for the remaining 35 percent of final energy savings (Figure 89).

The breakdown of final energy savings by building age and type, as presented in Figure 90, shows that the key categories for energy savings are detached houses built after 2016 (16 percent of final energy savings), detached houses built in 1991–2000 (14 percent), and detached houses built in 1981–1990 (11 percent). Other significant categories are detached houses built in 2001–2015 (8 percent), detached houses and apartment buildings built in 1961–1980 (each 7 percent), apartment buildings built after 2016 (6 percent) and detached houses built before 1961 (5 percent).

Figure 91 illustrates the final energy savings by building age and type, and climate zone. The figure shows that the biggest savings broken down on such a detailed level originate in detached houses built after 2016 and located in climate zones A and B (7 percent and 8 percent of the total final energy savings respectively), then in detached houses built in 1991–2000 and located in climate zones A and B (5 percent and 8 percent), as well as in detached houses built in 1981–1990 and located in zone B (5 percent).

As Figure 92 shows, the biggest final energy savings are possible in space heating (65 percent of savings). Around 19 percent of energy savings are due to more efficient air-conditioning systems, and the remaining 16 percent to better water-heating technologies.

The average final energy consumption per square metre will be 35 percent lower in 2030 as compared to the business-as-usual scenario, and will reach around 37 kWh/m^2 (Figure 93). The reduction in final energy demand per square metre originates mostly from the retrofitting of existing buildings.

Figure 84 Final energy consumption in the SLED ambitious scenario and final energy savings vs. the reference scenario, 2015–2030

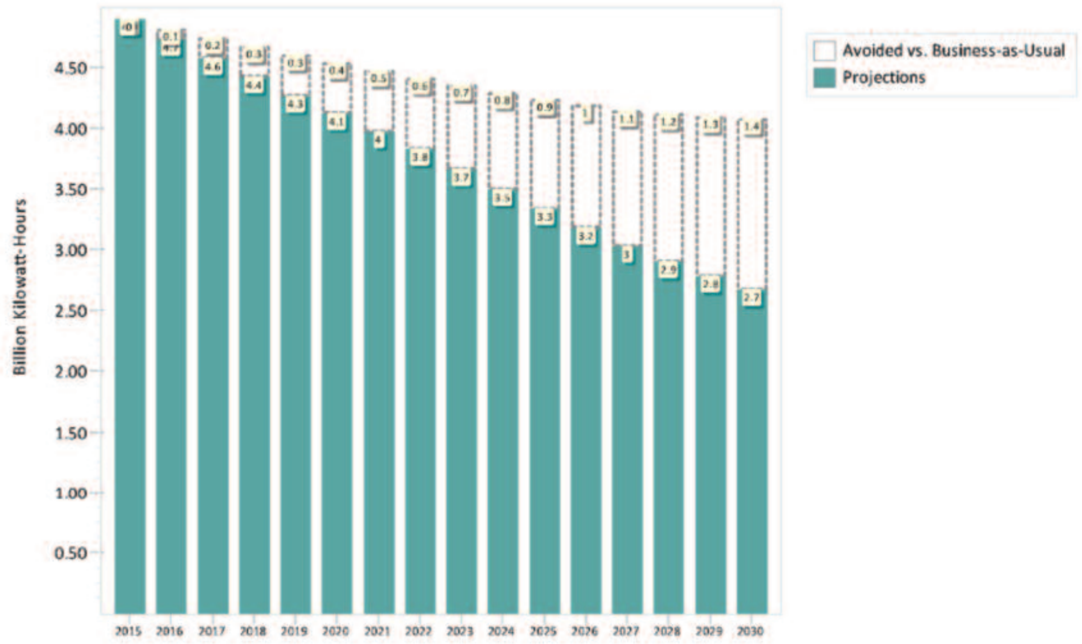


Figure 85 Final energy savings by energy source in the SLED ambitious scenario vs. the reference scenario, 2015–2030

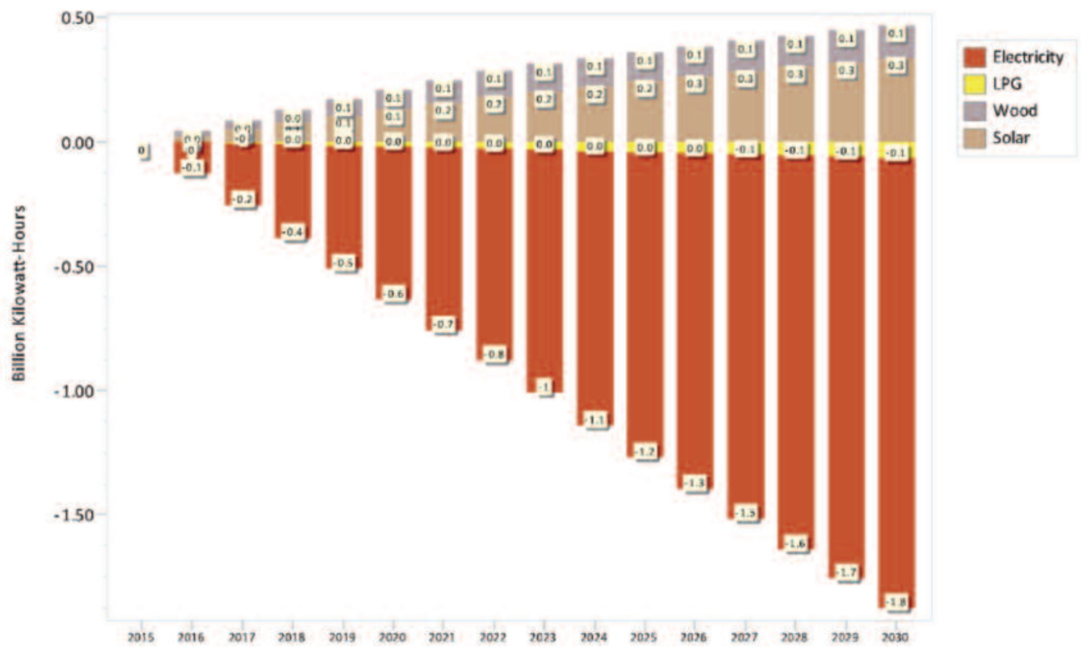


Figure 86 Electricity consumption in the SLED ambitious scenario and electricity savings vs. the reference scenario, 2015–2030

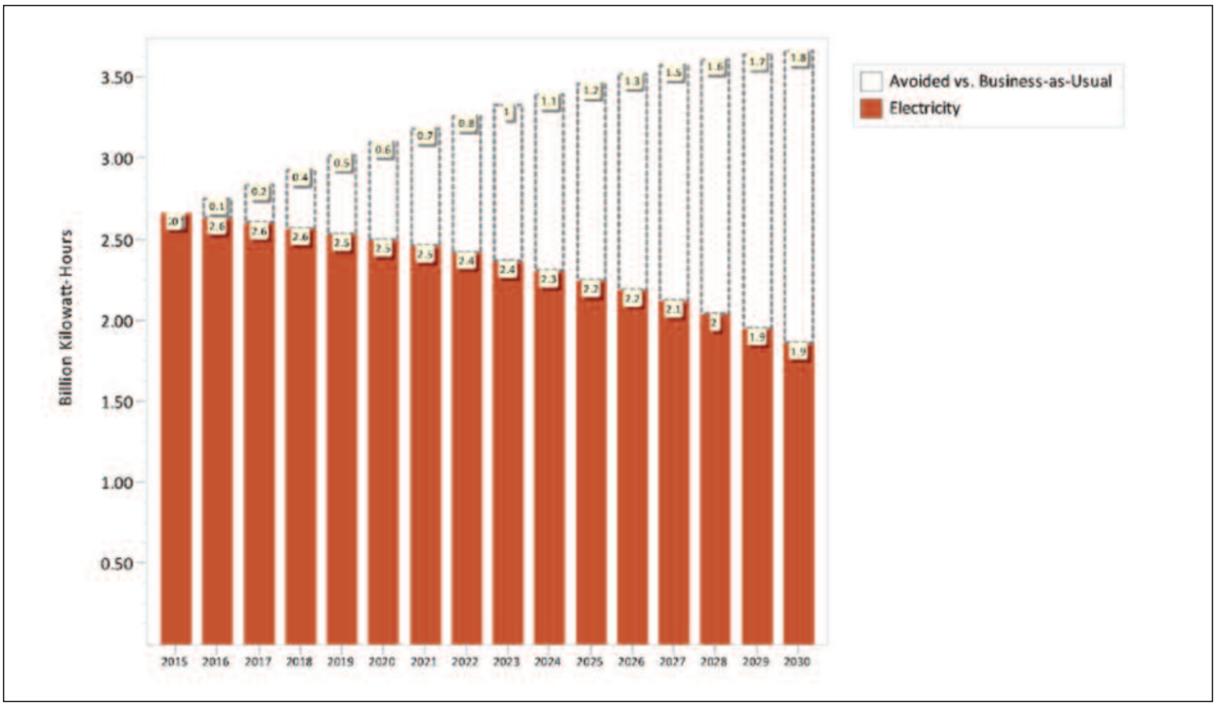


Figure 87 Final energy savings by building age category in the SLED ambitious scenario vs. the reference scenario, 2015–2030

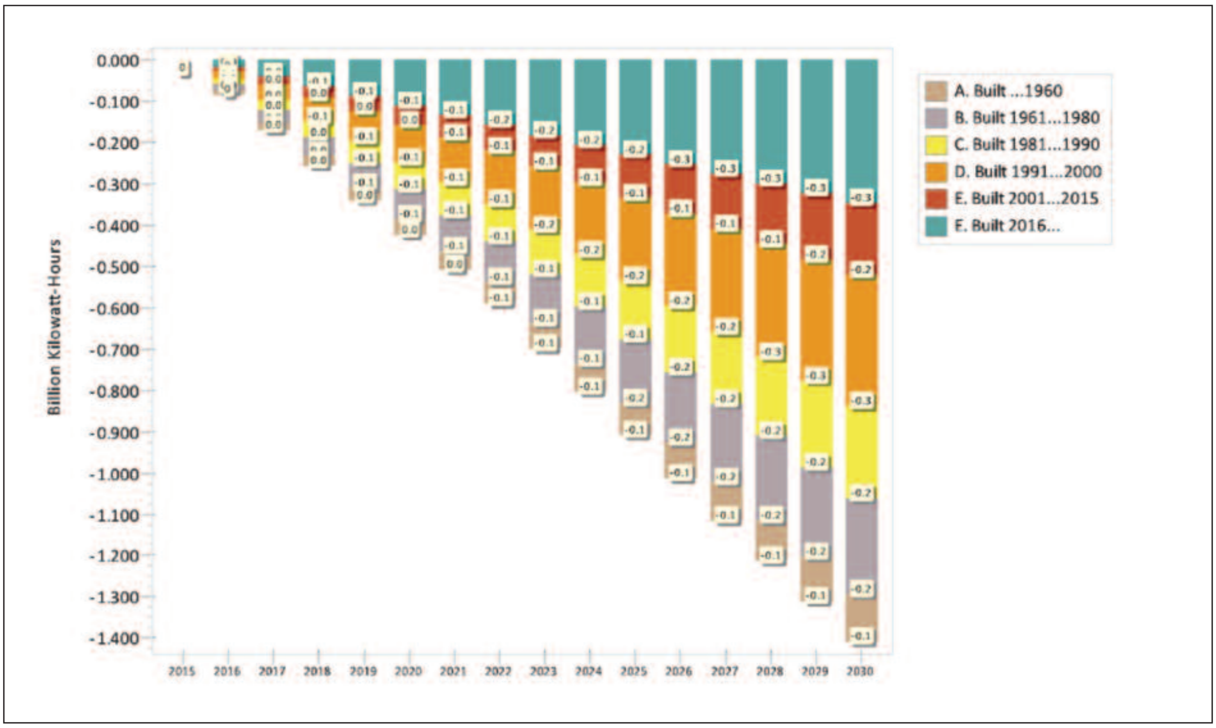


Figure 88 Final energy savings by building type in the SLED ambitious scenario vs. the reference scenario, 2015–2030

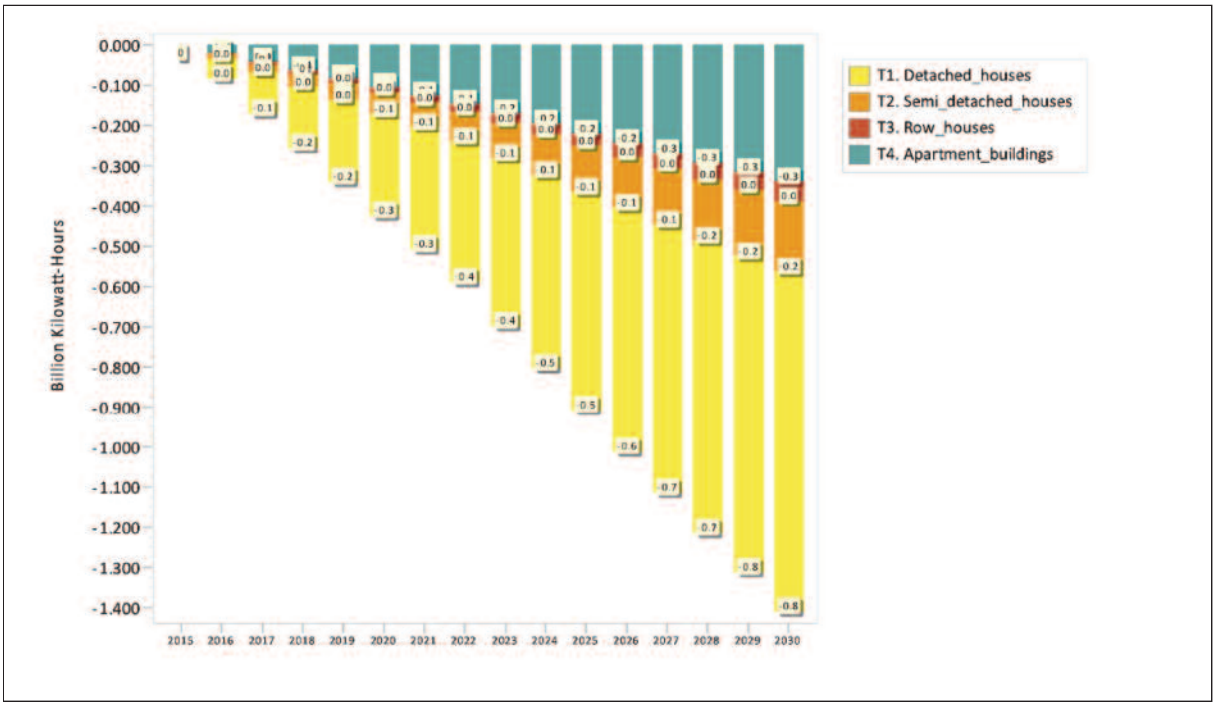


Figure 89 Final energy savings by climate zone in the SLED ambitious scenario vs. the reference scenario, 2015–2030

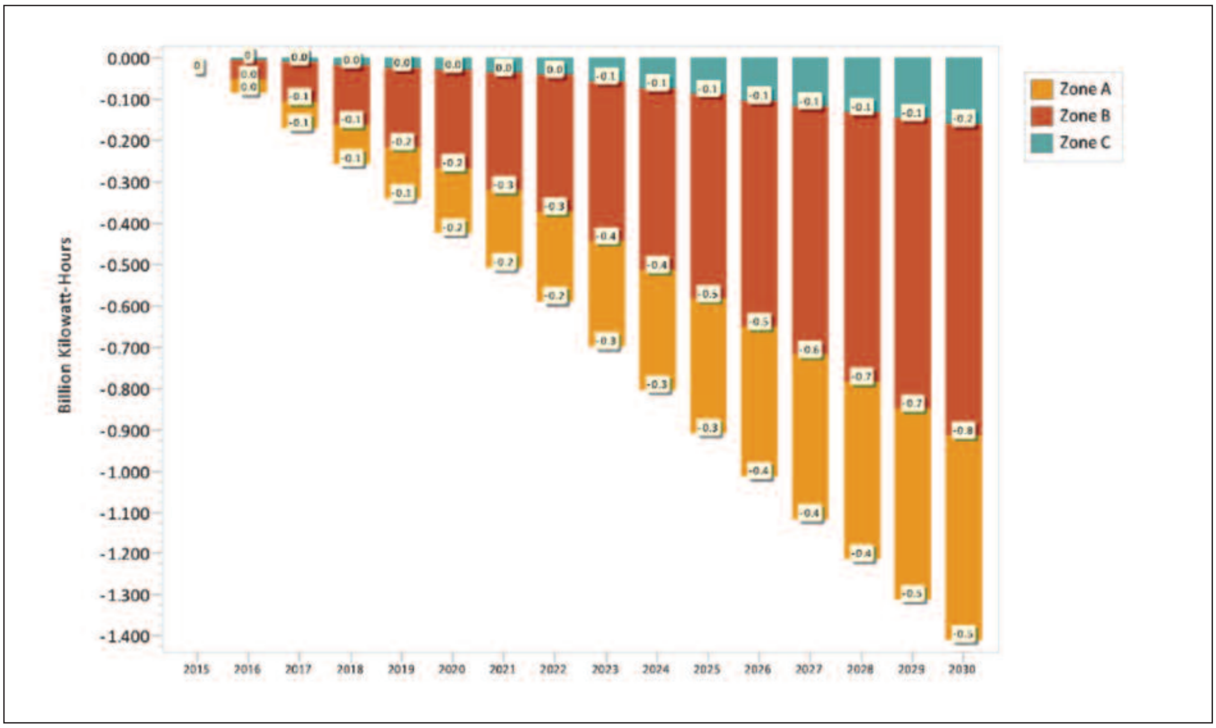


Figure 90 Final energy savings in the SLED ambitious scenario vs. the reference scenario by building age and type, 2015–2030

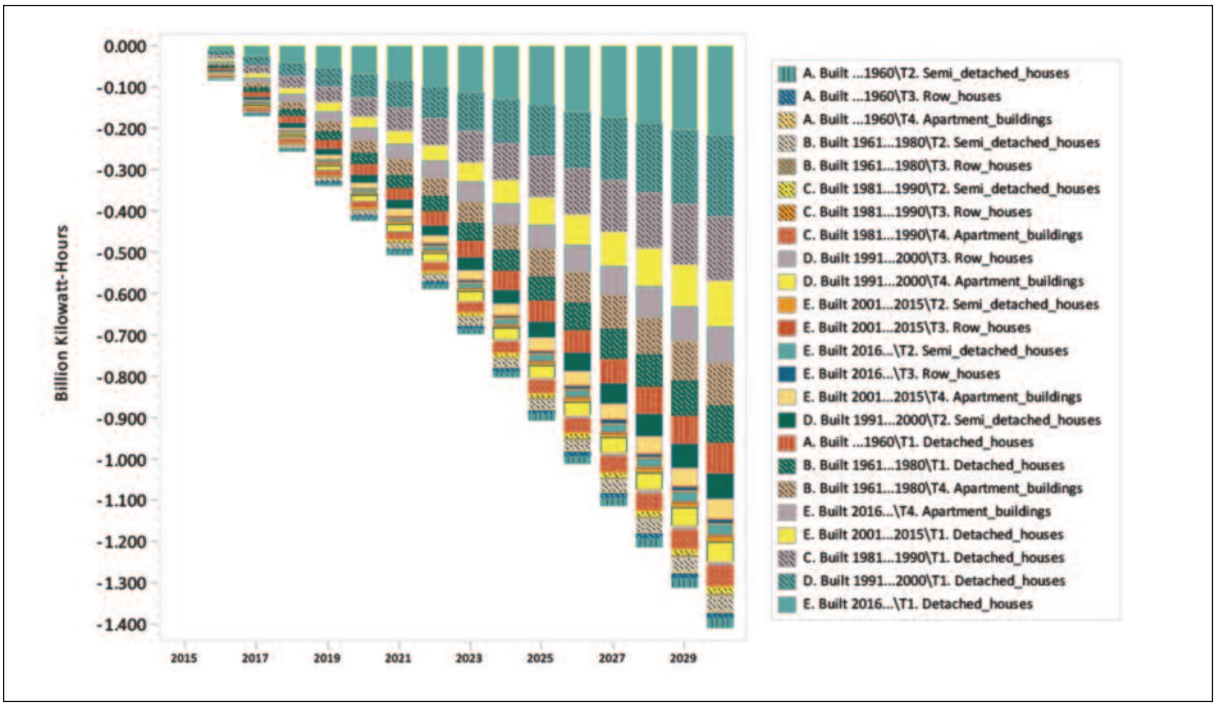


Figure 91 Final energy savings by building age and type and climate zone in the SLED ambitious scenario vs. the reference scenario, 2015–2030

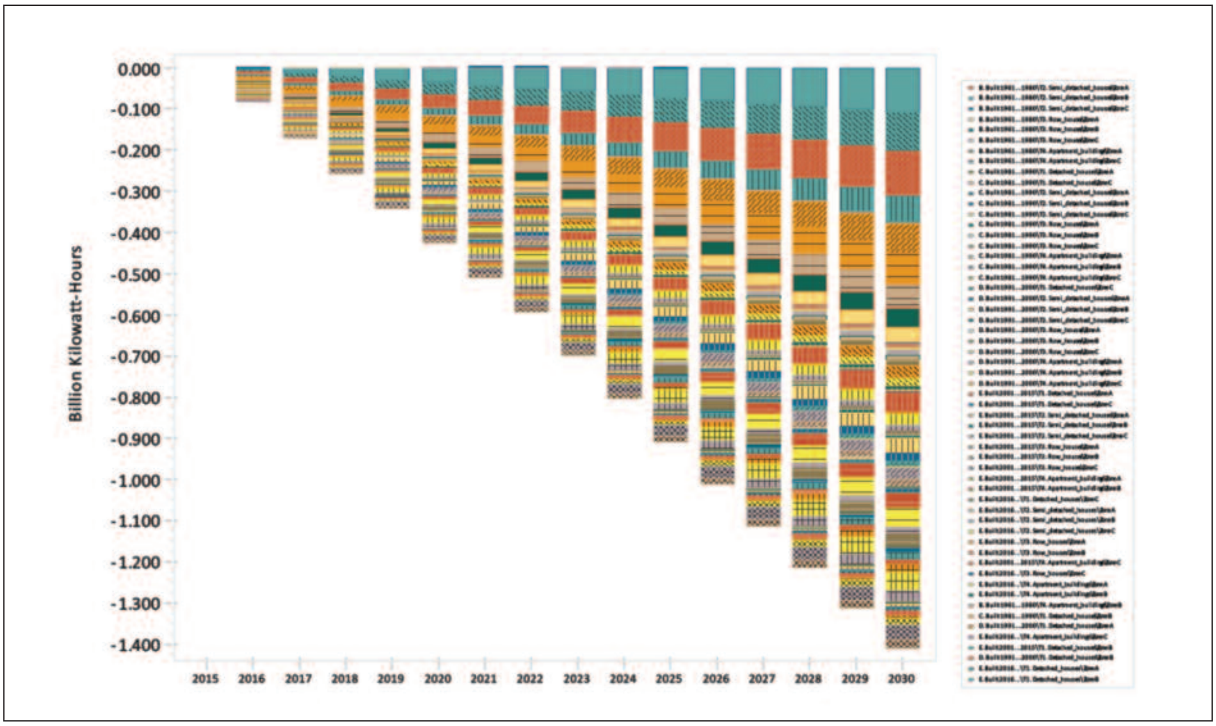


Figure 92 Final energy savings by end use in the SLED ambitious scenario vs. the reference scenario, 2015–2030

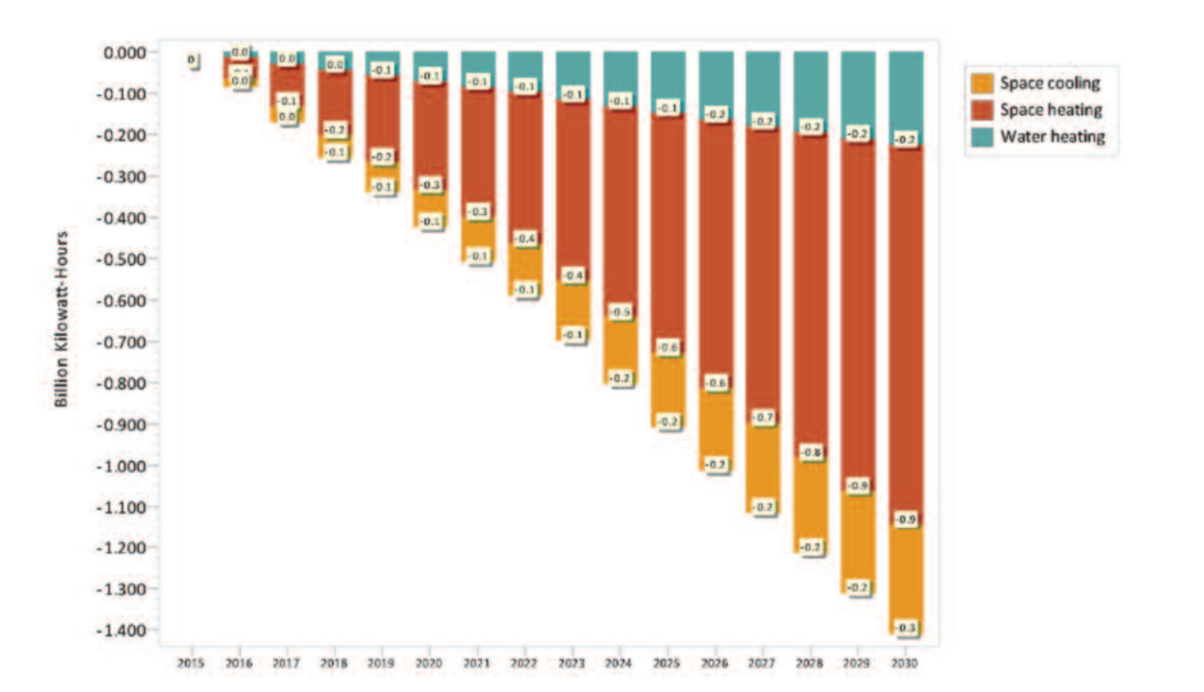
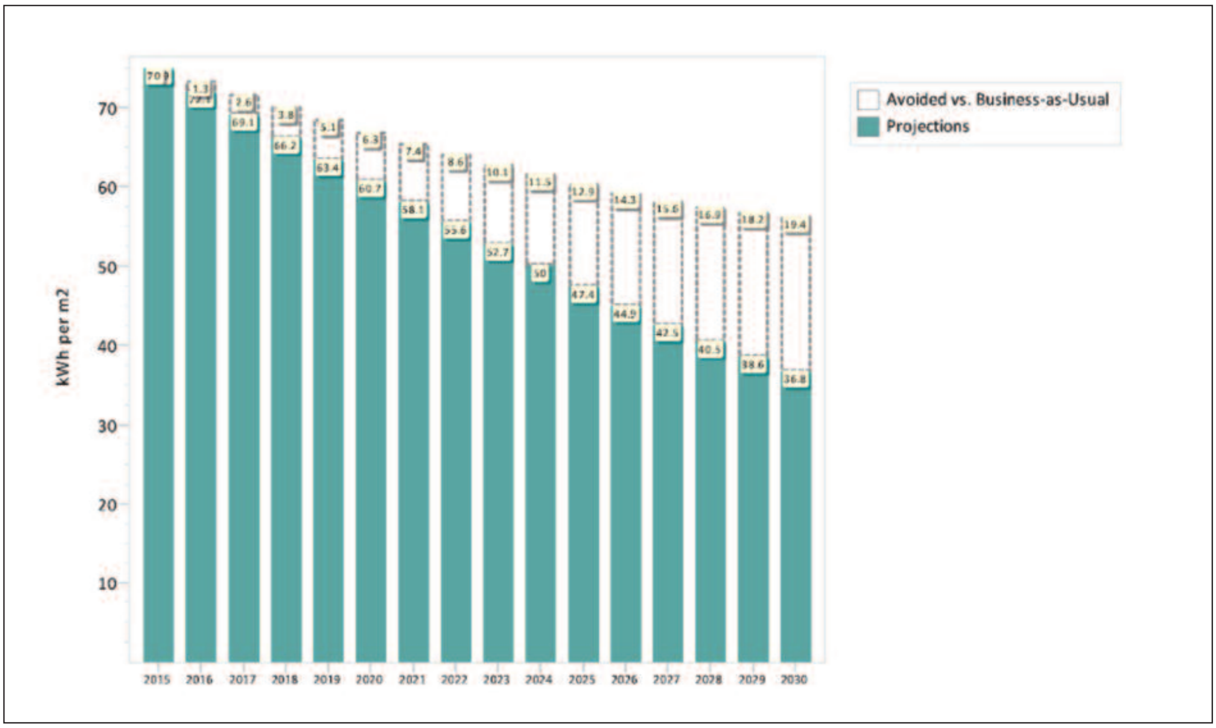


Figure 93 Final energy consumption per m^2 in the SLED ambitious scenario and its reduction vs. the reference scenario, 2015–2030



CO_2 emissions

The reduction in final energy consumption leads to a reduction in associated CO_2 emissions. As Figure 94 illustrates, emissions from the residential sector, which in Albania originate from LPG at present and will originate from LPG and electricity in the future, will be 73 percent lower in 2030 compared to their business-as-usual level.

Saved energy costs

In 2030, energy costs for residential consumers in the SLED ambitious scenario will be 47 percent lower than the energy costs in the business-as-usual case in 2030. In absolute terms, this difference represents EUR 250 million (Figure 95).

Figure 96 presents saved energy costs per square metre of the total building floor area. The figure shows that in the SLED ambitious scenario, in 2030 residential consumers will pay around EUR 3.4/m^2 less for thermal services than in the business-as-usual case.

Figure 94 CO_2 emissions in the SLED ambitious scenario and CO_2 emissions avoided vs. the reference scenario, 2015–2030

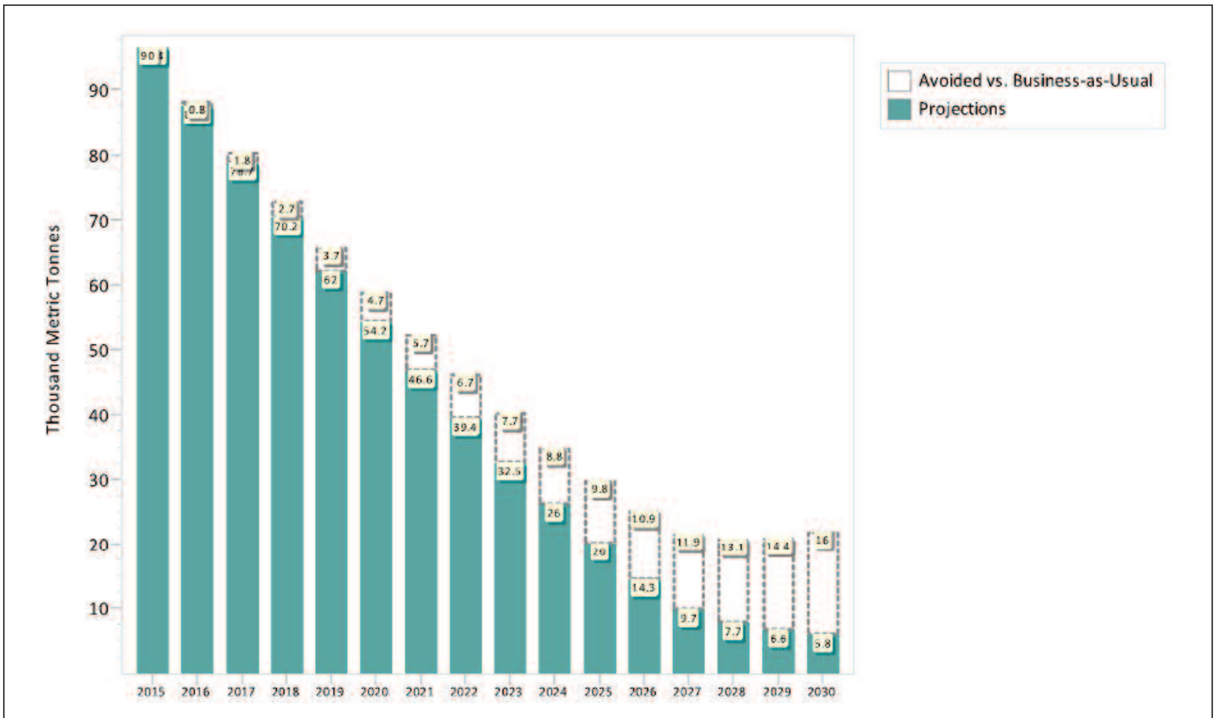


Figure 95 Energy costs in the SLED ambitious scenario and saved energy costs vs. the reference scenario, 2015–2030

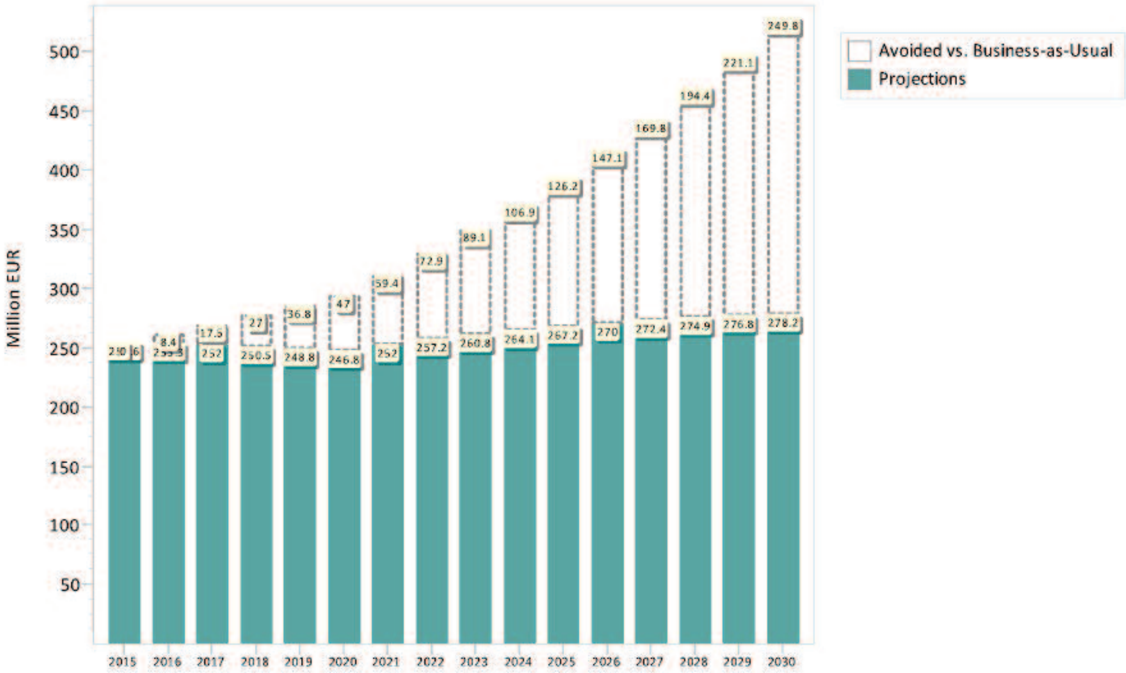
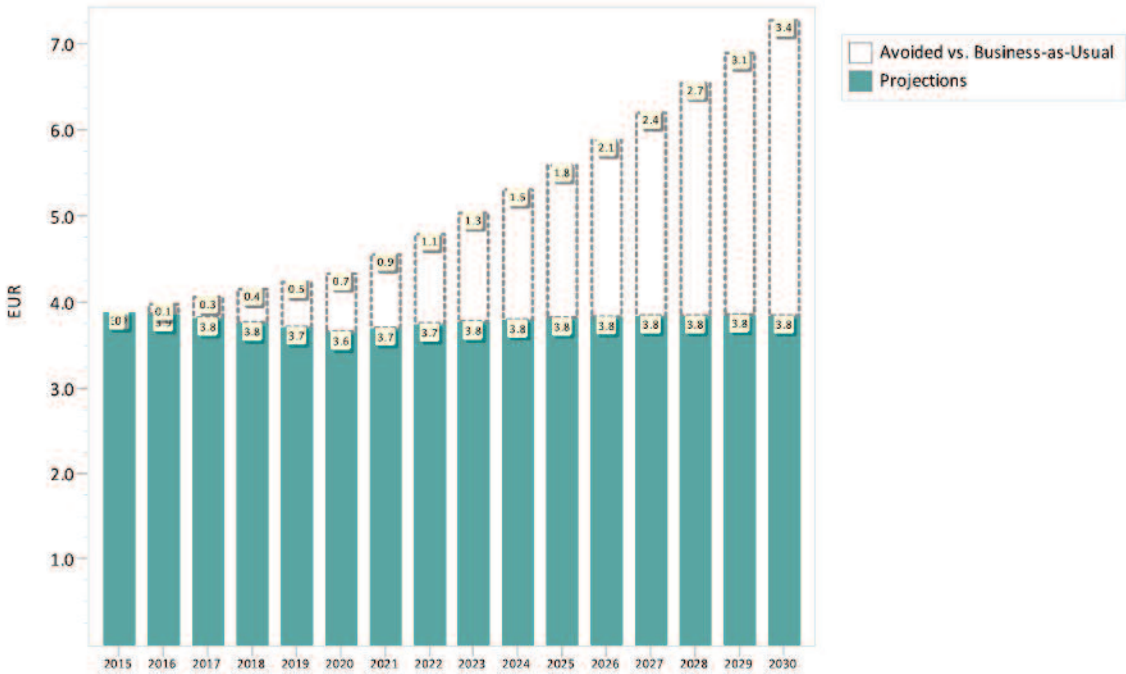


Figure 96 Energy costs per m² in the SLED ambitious scenario and saved energy costs per m² vs. the reference scenario, 2015–2030



Investments

The total and incremental investment costs of the SLED scenarios are defined in Section XI (page 109), thus the information is not repeated here. Section XI also elaborates on the importance and cost-effectiveness of incorporating building thermal efficiency improvements into business-as-usual renovations, which is assumed in the SLED ambitious scenario. The affected floor area in the SLED ambitious scenario is the same as in the SLED moderate scenario, which is why all assumptions about the incremental scenario costs of the SLED moderate scenario are also valid for the SLED ambitious scenario.

To calculate the retrofitting costs at sector level, we multiplied the costs of building improvement by the floor area affected by the SLED ambitious scenario. The costs of building improvement 2 per square metre are documented in Section V. The costs of the business-as-usual improvement of existing buildings are the same as in the SLED moderate scenario.

The retrofitting of the existing floor area is supported by low-interest loans and grants over the whole modelling period, as discussed in the assumptions outlined in Section IX (page 88). The entire new building floor area is supported until 2022 by low-interest loans in order to reach a level of performance in accordance with improvement 2. Starting from 2023, the entire new building floor area is regulated by the building code, corresponding to improvement 2 as discussed in the assumptions.

For new buildings, we estimated that the average incremental investment in higher energy efficiency per square metre is between EUR 48 and EUR 99, depending on the building type and zone. For existing buildings, we found an average total investment cost per square metre of between EUR 68 and EUR 122, depending on the building age and type and the climate zone between 2015 and 2022, and between EUR 88 and EUR 164 between 2023 and 2030. If the business-as-usual costs are deducted from the total investment costs, the incremental costs of retrofitting existing buildings are between EUR 28 and EUR 73/m^2, depending on the building age and type and the climate zone between 2015 and 2022, and between EUR 48 and EUR 114/m^2 between 2023 and 2030.

Figure 97 presents the total investment costs in the thermal efficiency retrofitting of buildings over the modelling period. We estimate that on average the total retrofitting costs will be around EUR 179 million per year between 2015 and 2030. The biggest investments are required in buildings constructed in 2001–2015. Over the modelling period, the cumulative total investment costs are around EUR 2.7 billion.

The model also makes it possible to break down the total investment costs by the different technological measures required. According to this analysis, the biggest share of the costs is for changing space-heating systems, followed by insulation and new windows, and finally for changing water-heating systems.

Figure 98 presents the incremental investment costs in the thermal efficiency retrofitting of buildings and advanced construction over the modelling period. The figure illustrates the clear benefit of coupling thermal efficiency improvements with the business-as-usual retrofitting of existing buildings. We estimate that the incremental investment costs of building retrofitting will be on average EUR 99 million per year between 2015 and 2030. The cumulative incremental costs of building retrofitting over the modelling period are around EUR 1.5 billion. In addition, the incremental investment costs of new buildings are on average around EUR 72 million per year, or EUR 1.1 billion over the modelling period.

Assuming a measure lifetime of 30 years and a discount rate of 4 percent, the annualised incremental cost of the SLED moderate scenario in 2015–2030 is EUR 3.5/m^2. The average saved energy costs are around EUR 4.1/m^2 of new or retrofitted floor area over the modelling period. This means that investments into better existing and new buildings will pay back. Similar to the SLED moderate scenario, the saved energy costs are higher than the annualised investment costs for the SLED ambitious scenario as a whole at country level, but not for all building categories. Raising the discount rate higher than 5.5 percent would make the investment unattractive.

We also analyse the efforts of various actors if Albania aims to follow the SLED ambitious scenario. All assumptions for the financial analysis in the SLED ambitious scenario are the same as the respective assumptions in the SLED moderate scenario. In the SLED ambitious scenario, we assume that around 60 percent of the total investment cost is supported by grants or low-interest loans, which is approximately equal to the share of the incremental investment costs in the SLED ambitious scenario.

Figure 99 presents the costs to residential stakeholders of achieving compliance with the building code that is likely to be adopted in 2022 according to the SLED ambitious scenario. On average, these stakeholders will bear EUR 75 million of incremental investment costs per year, or EUR 1 billion in 2023–2030.

Figure 100 shows the financing borrowed by residential stakeholders for the purposes of building retrofitting. Given our assumptions, the eligible costs of building retrofitting that investors would need to borrow are around EUR 73.5 million per year, or around EUR 1.1 billion over the modelling period. The eligible costs of more efficient construction are around EUR 38 million per year, or EUR 612 million over 2016–2022.

Figure 101 illustrates the compensation paid by the government to commercial banks. Since the lending period is 10 years, the amount of compensation is at its highest after 10 years. After this point, the amount of compensation for loans directed to building retrofitting remains almost the same until the end of the modelling period, while the compensation for loans directed to efficient construction decreases. Over the modelling period, the government provides EUR 802 million to commercial banks as compensation for subsidising low-interest loans for building retrofitting, and EUR 516 million as compensation for low-interest loans for more efficient construction.

The government also provides grants for the retrofitting of existing buildings, as described in the assumptions outlined in Section IX. As Figure 102 illustrates, the value of these grants is around EUR 30 million per year, or EUR 451 million over the modelling period.

Figure 97 Total investment costs in the SLED ambitious scenario, 2015–2030

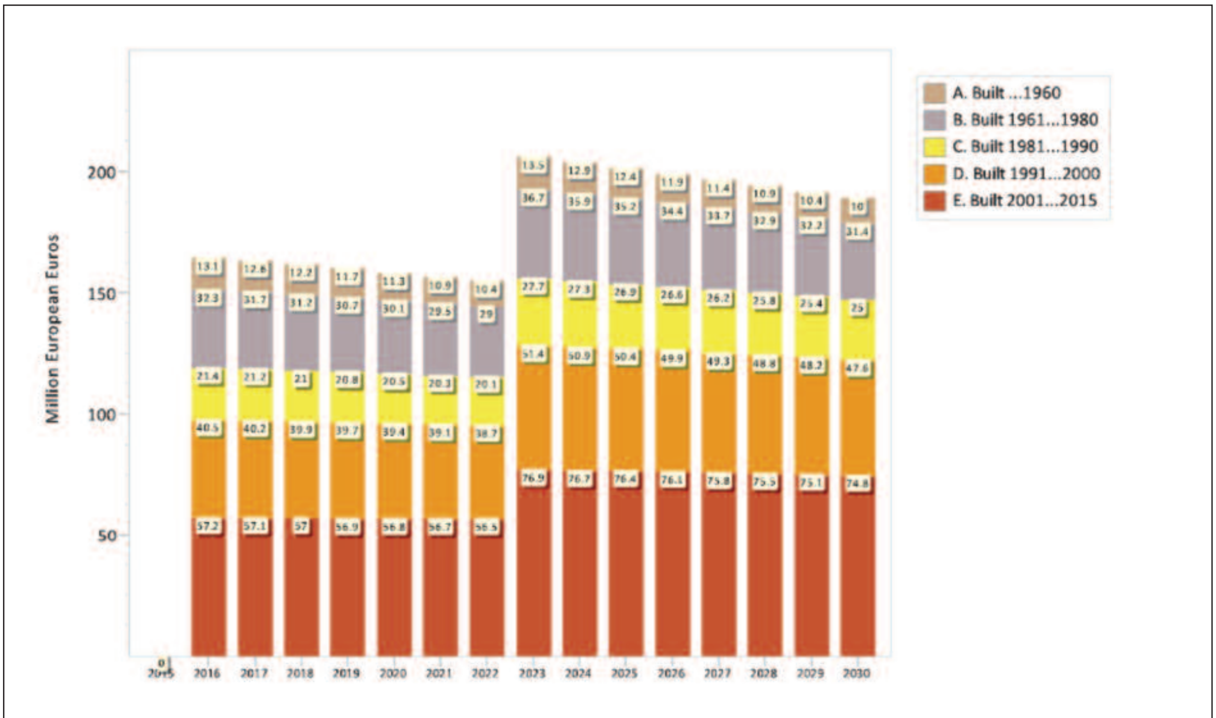


Figure 98 Incremental investment costs in the SLED ambitious scenario, 2015–2030

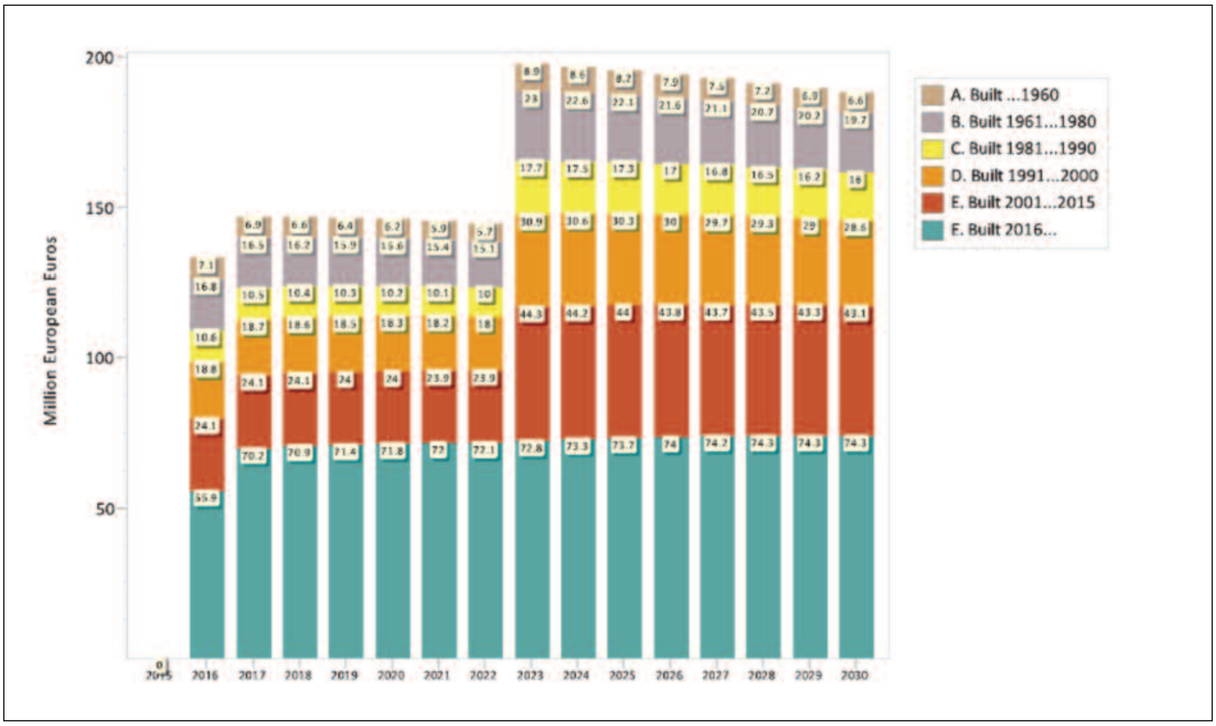


Figure 99 Private investments to achieve compliance with the building code in the SLED ambitious scenario, 2015–2030

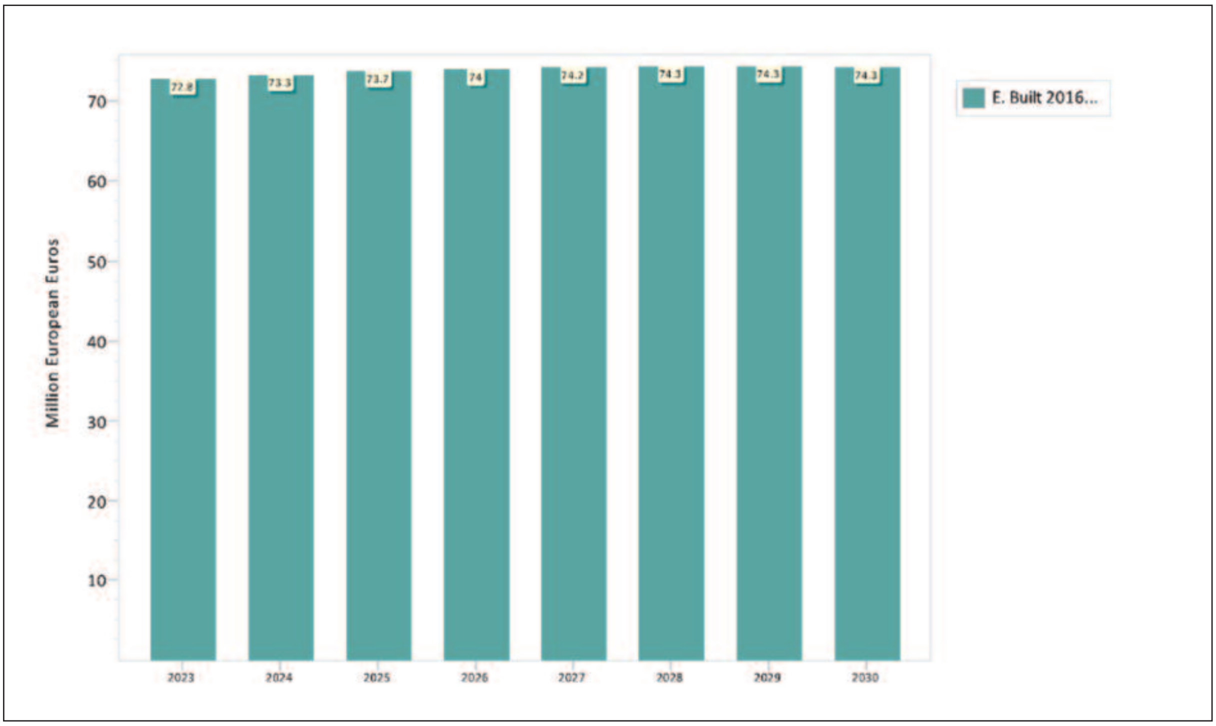


Figure 100 Private (eligible) investments stimulated by low-interest loans in the SLED ambitious scenario, 2015–2030

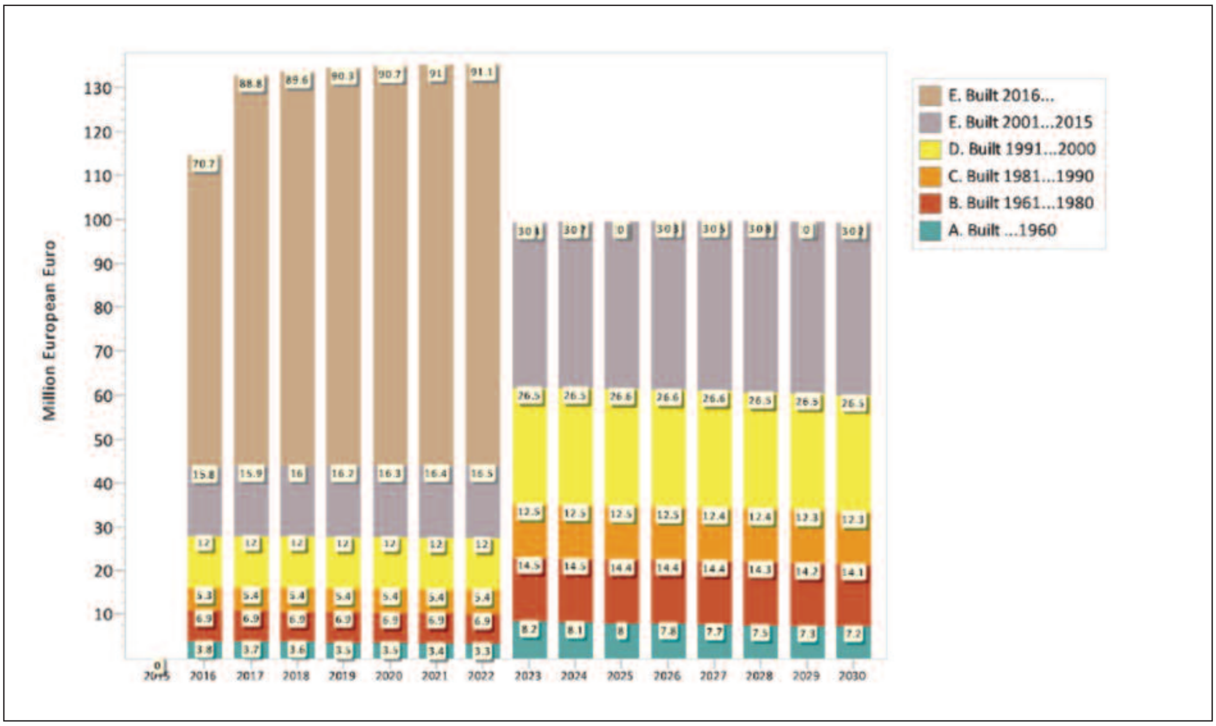


Figure 101 Cost to the government of low-interest loans in the SLED ambitious scenario, 2015–2030

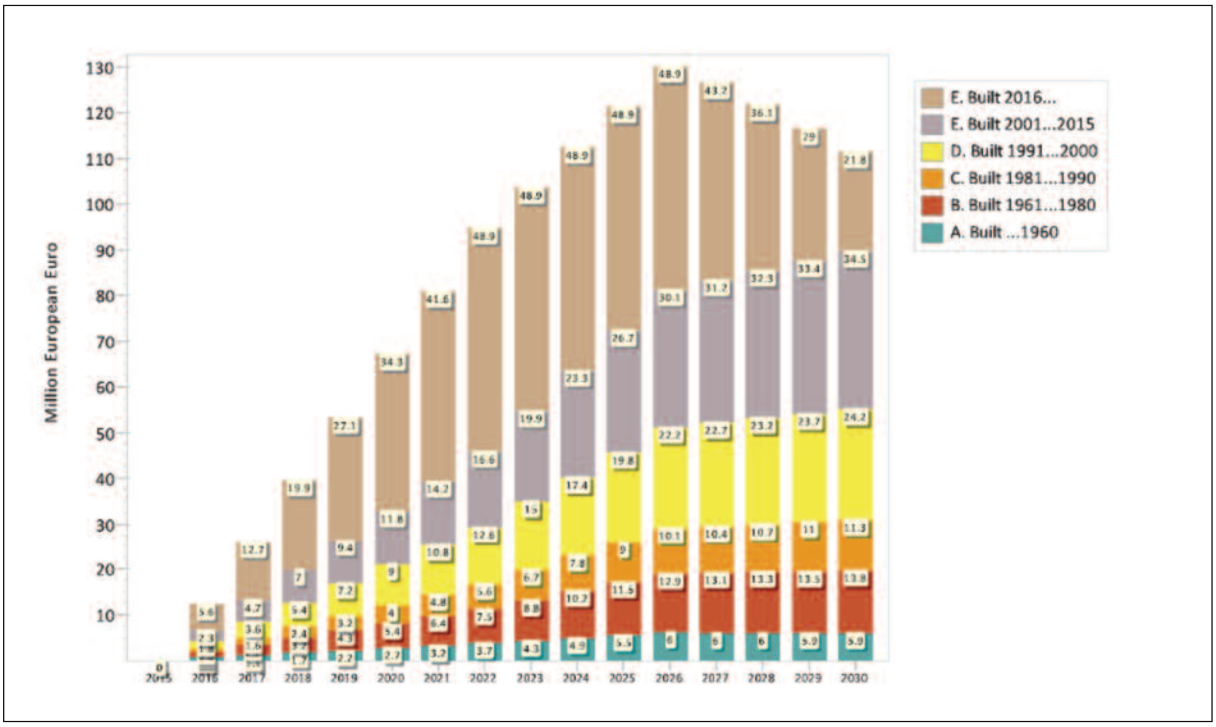
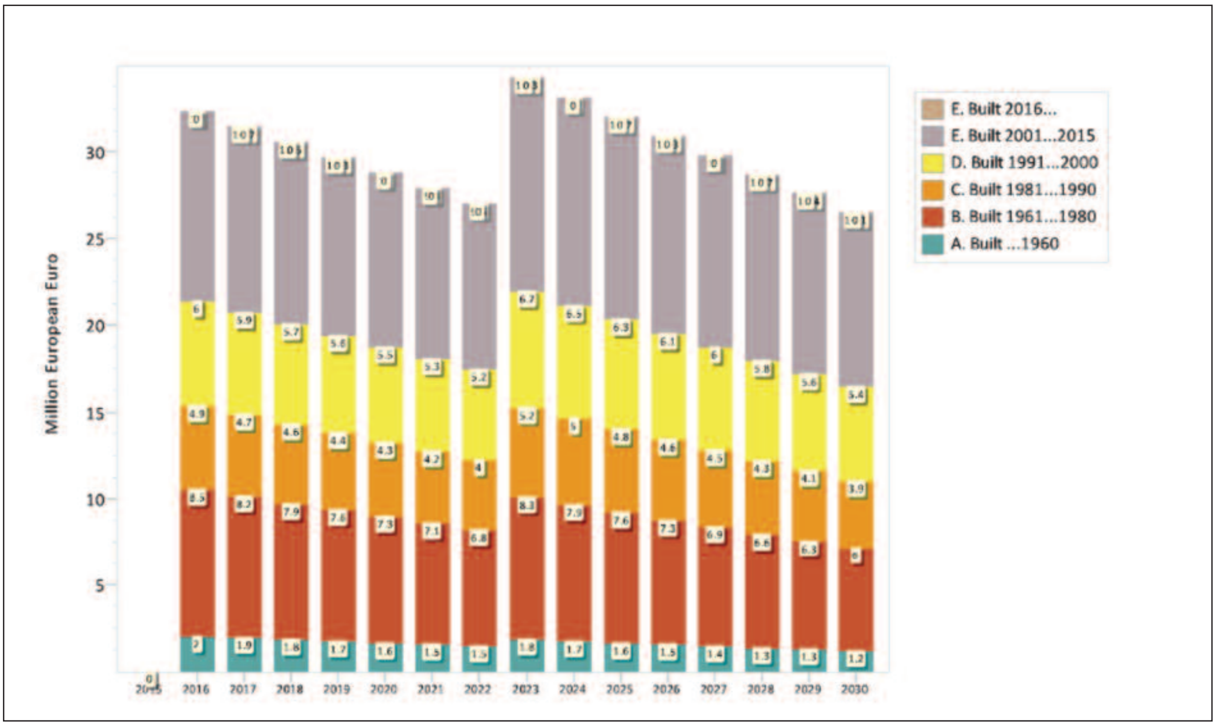


Figure 102 Cost to the government of grants in the SLED ambitious scenario, 2015–2030



XIII. Sensitivity analysis

Within the model it is easy to change a few key assumptions within given intervals and thus to obtain results where a sensitivity analysis is needed. We premodelled such assumptions as the discount rate, the business-as-usual retrofitting rate, the target year when the entire stock is retrofitted, the year in which the building code is adopted, the share of loans and grants, and the share of eligible costs in the package of financial incentives. Figure 103 shows a screenshot of the sensitivity analysis in the model.

In addition to the SLED moderate and ambitious scenarios, we premodelled scenarios with only building codes, only grants, and only low-interest loans. Within the model it is easy to change the content of these scenarios.

Figure 103 The sensitivity analysis in the Albanian SLED model

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