Smarter Stoves
Partnership

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Renovation Scenarios for Buildings in the Western Balkans

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1. OVERVIEW OF THE RESIDENTIAL SECTOR IN THE WESTERN BALKANS

1.1 WESTERN BALKAN REGION CONTEXT

Countries in the Western Balkans are in the process of EU accession. Currently, four of six Western Balkan countries have been granted Candidate Country status: North Macedonia, Montenegro, Serbia, and Albania, while Bosnia and Herzegovina and Kosovo* have the status of Potential Candidate. The accession negotiations have already started, and negotiations have begun on EU acquis with Montenegro and Serbia, while negotiations kick-off with Albania and North Macedonia is under preparation.

Figure 1-1 Western Balkan countries and EU accession process

Source: European Commission

On the basis of statistical evidences of the countries analyzed for this Study the following is used:

Table 1-1 Basic data on the Western Balkan countries

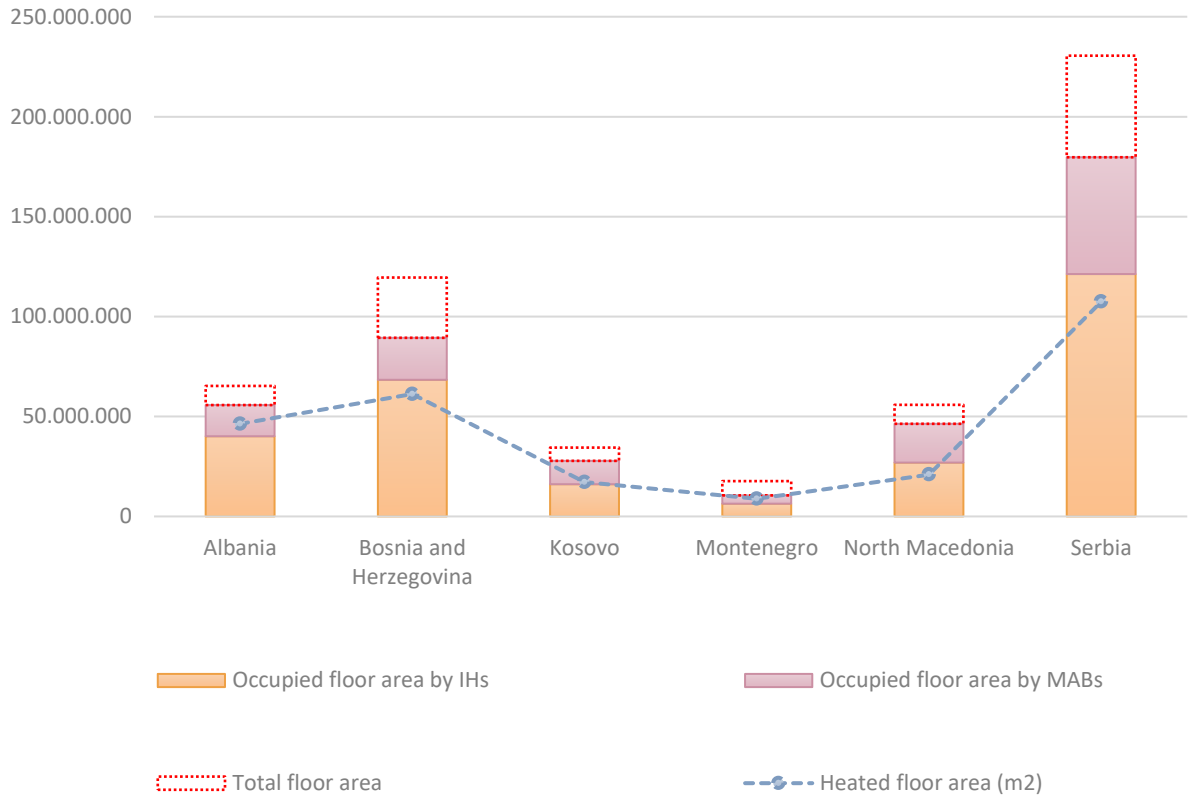
Country	Surface Area (km²)	Population (2019)	GDP for 2019 (billion EUR)	GDP per Capita (EUR)
Albania	28,748	2,880,917	13.64	4,735
Bosnia & Herzegovina	51,197	3,373,158	17.91	5,309
Kosovo*	10,908	1,771,604	7.1	4,007
Montenegro	13,812	622,159	4.66	7,490
North Macedonia	25,713	2,071,278	10.7	5,166
Serbia	77,474	7,095,383	45.94	6,475

Source: Statista 2020, World Bank

1.2 EXISTING HOUSING STOCK

Scanning the building inventory on country level is the significant input in determination of energy performance of residential sector and the potentials in energy savings through implementation of energy efficiency measures. In Western Balkan 6 (WB6) countries, residential sector is presented with approximately 523 million m^2 total floor area organized in ~7.4 million dwellings. The residential buildings are divided into two types of housing, individual housing (IHs) and multi apartment buildings (MABs).

Figure 1-2 Overview of residential floor area (m^2)

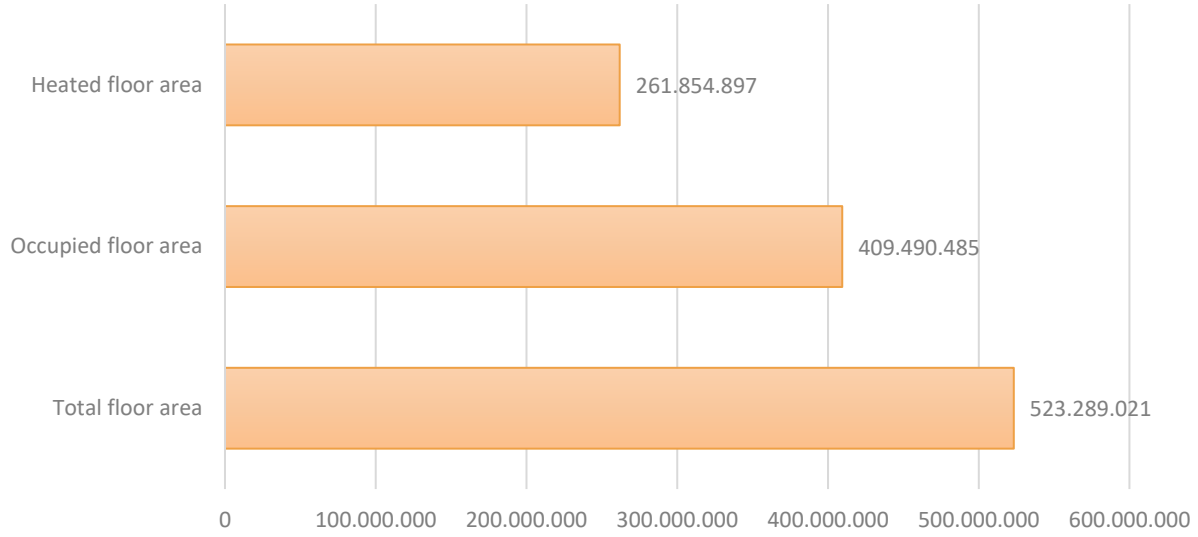


Source: Consultant's compilation

The high number of non-inhabited dwellings is remarkable. The data gathered in the study suggest that around 26 percent of dwellings are temporarily vacant or uninhabited. This includes dwellings for vacation and recreational purposes. Temporarily and permanently abandoned housing stock burdens the building stock, as it prevents the planning of energy efficiency measures, does not participate in the energy balance of the total stock of buildings with energy consumption, and reduces the energy intensity of the housing sector and savings potential. The calculation models are therefore based on the usable area of the inhabited fund of residential buildings, in order for the energy intensity to realistically reflect the condition of the fund.

From the occupied dwellings, the heated area is around 64% of the total occupied area. This small share of heated part of the dwellings is a result of energy poverty existing in this region and represents the actual consumption as a percentage of the comfort level.

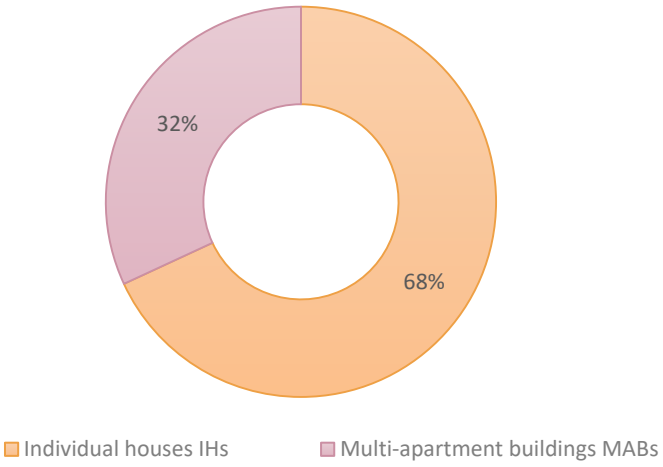
Figure 1-3 Comparison between total, occupied and heated residential floor area in WB6 (m^2)



Source: Consultant's compilation

Of the total residential building stock, a significant share of dwellings is represented by the multi – apartment buildings (MABs); the average of the Western Balkans is 32% in MABs and 68% in individual houses (IHs).

Figure 1-4 Shares of housing types in the WB6 (%)



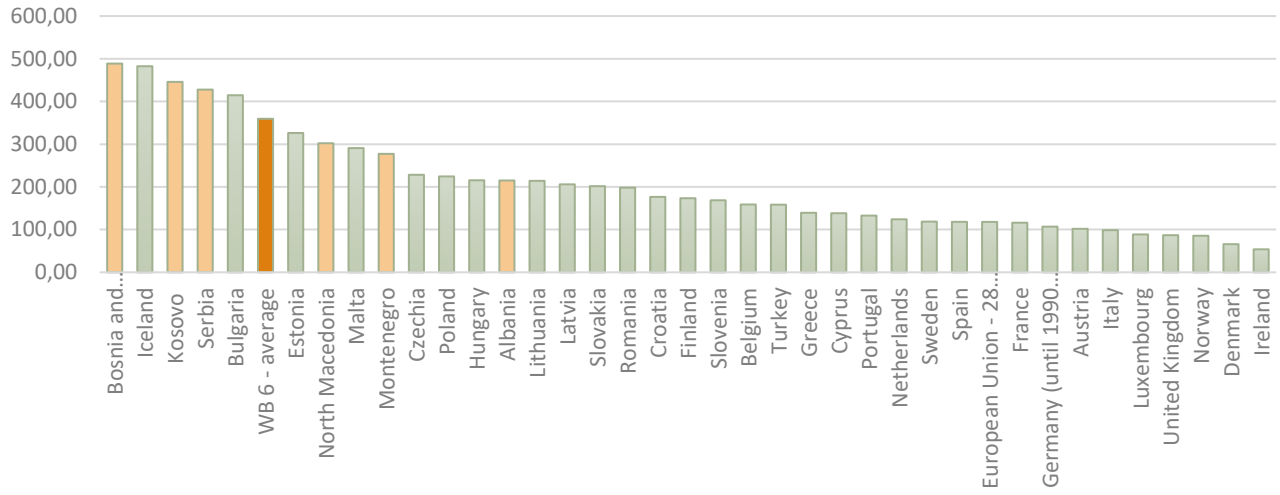
Source: Consultant's compilation

Overview of the building stock per country is given in the fourth section with full building inventory organized in age cohort with relevant references.

1.3 ENERGY CONSUMPTION IN THE RESIDENTIAL SECTOR

Western Balkan countries on average, have one of the highest energy intensities across Europe with 360 kgoe (kilograms of oil equivalent) per 1000 euros of GDP, or 3 times higher than the EU 28 average for 2018. This is a consequence of the fact that, although energy use per capita was approximately half of the EU average, the average GDP per capita is still much lower than the EU average.

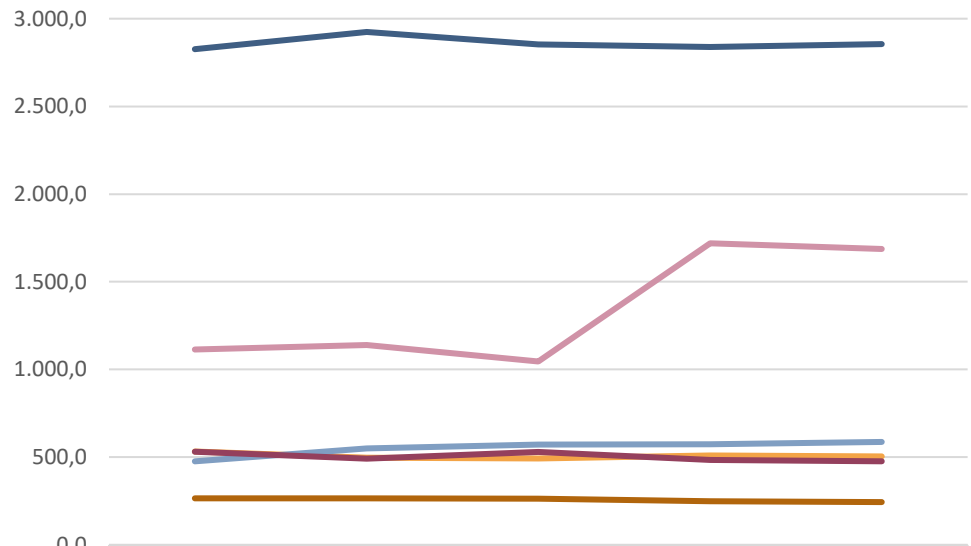
Figure 1-5 Energy intensity of GDP across Europe in 2018 (kgoe per 1000 euros)



Source: Eurostat

In the past five years, the residential sector in all WB 6 has been evolving without significant deviations. For this period, in Albania, Montenegro and North Macedonia, the energy consumption has been decreased between 5-10 %, while Serbia has very steady course. On the other hand, residential sector in Bosnia and Herzegovina, as well as in Kosovo*, records increasing based on the new approach in calculation of biomass in the energy balances. State Statistical Offices of these two countries are in process of modification of energy balances backwards in accordance with the new approach adopted for the biomass.

Figure 1-6 FEC in Residential sector in WB 6 for period 2015 – 2019 (ktoe)

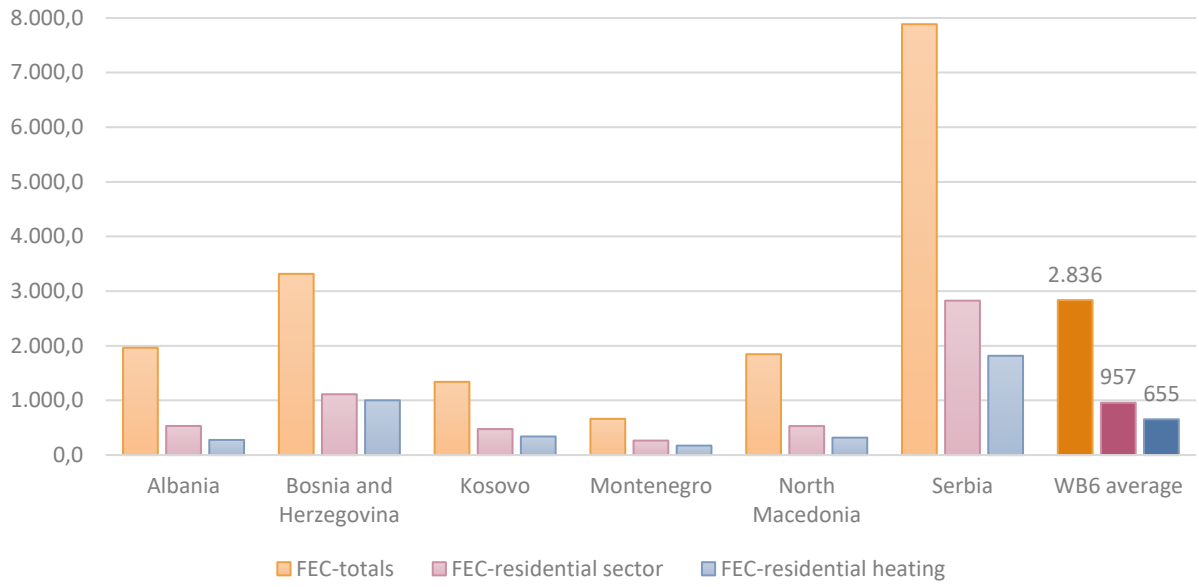


	2015	2016	2017	2018	2019
Albania	532,3	496,4	492,6	510,5	505,0
Bosnia and Herzegovina	1.113,0	1.139,4	1.045,6	1.719,4	1.686,6
Kosovo	476,4	549,4	571,5	573,4	586,9
Montenegro	265,4	264,6	263,2	248,0	244,0
North Macedonia	531,1	491,6	529,1	483,6	476,5
Serbia	2.826,2	2.924,3	2.853,6	2.838,4	2.854,7

Source: Eurostat's Energy Balances 2015-2019

As for total final energy consumption (FEC), residential sector share goes from 27% in Montenegro to 40% in Albania, or on average it covers 34% from the total FEC. The heating branch covers the largest share among the others branches of FEC (cooling, cooking, DHW, lighting and appliances) with average share of around 52% -75%. In this Report, the Base Year for modeling starts from 2015, while the period until 2019 is used for calibration of the models built per country. The results are calibrated against the Eurostat Energy Balance Sheets[1] 2021 edition.

Figure 1-7 Final energy consumption in WB 6 for the Base year 2015 (ktoe)



Source: Eurostat's Energy Balances 2015

In this Report, the heating branch among households is being assessed against the heating technologies installed in the residential sector followed by ones that are presently sold on the market.

[1] Eurostat Energy Balance Sheets https://ec.europa.eu/eurostat/web/energy/data/energy-balances

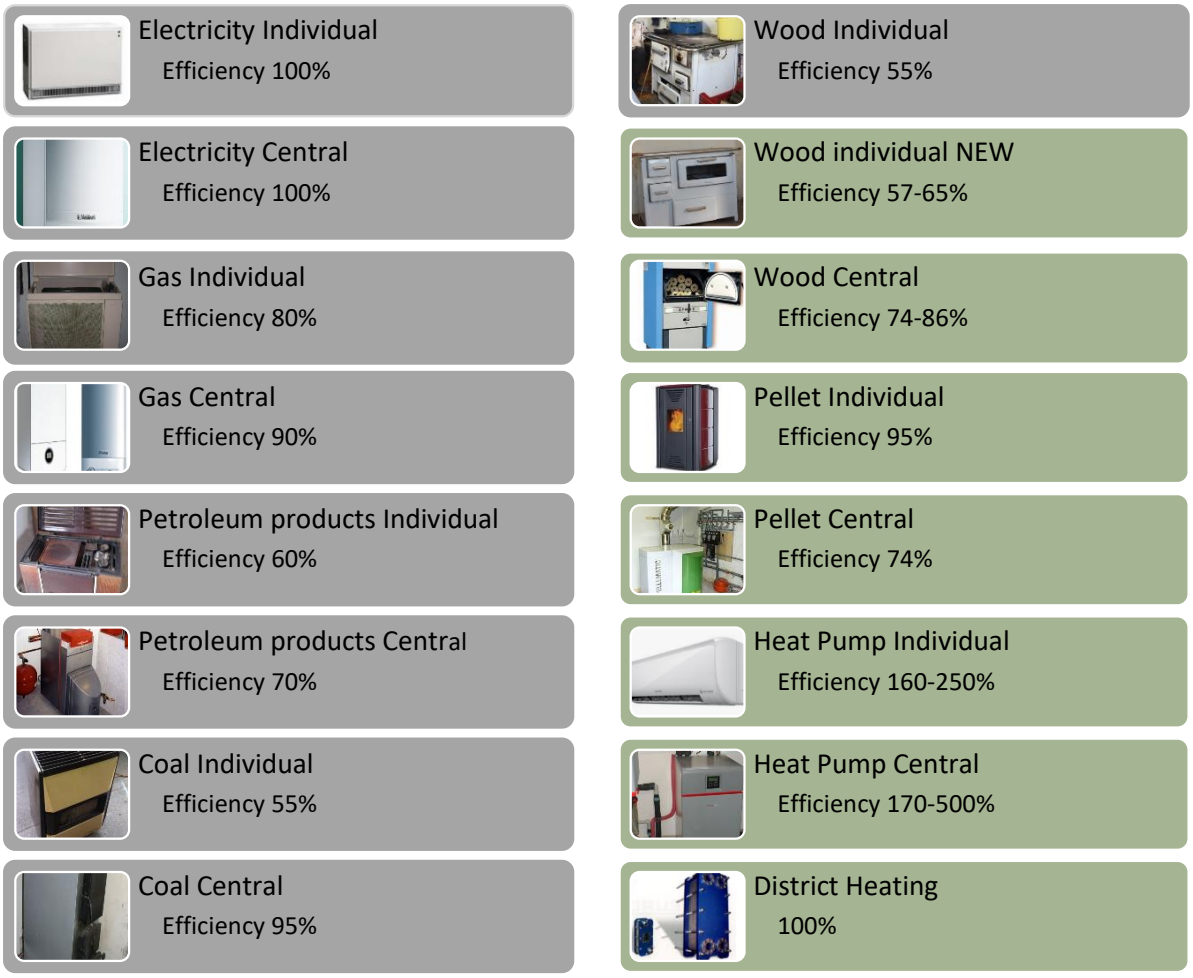
2. HEATING ALTERNATIVES ASSESSMENT

2.1. HEATING TECHNOLOGY OVERVIEW

For all the WB countries, identical approach has been applied in terms of determination of the existing and penetration of new technologies with adoption of devices efficiencies and life cycle of the heating devices.

The prevailing systems approximated for the region are visualized as presented on the following picture. The life span considered for the heating system is 20 years. The efficiencies of each system were estimated meticulously to obtain energy balance total final energy consumption corresponding to the share for typical systems. The main assumptions in favor of the main objective of this report is that old technologies, represented in grey color are the subject of decommissioning, while green represent the new ones.

Figure 2-1 Heating technologies overview



Source: Consultant's compilation

The penetration of new technologies on the market results in elemental investments in new heating systems. Beside the capital costs, in the further consideration are taken also the maintenance costs as well as costs for decommissioning of the old heating devices.

Table 2-1 Indicative capital and maintenance costs for heating systems in residential sector (EUR)

Measure	Capital costs in EUR (excl. VAT and incl. labor costs)	Maintenance costs in EUR
Wood Individual new	319	30 €/year
Wood Central	1,300	50 €/year
Pellet Individual	336	36 €/year
Pellet Central	1,600	50 €/year
Gas new	700	50 €/year
Heat pumps Individual	468	30 €/year
Heat pumps Central	2,353	80 €/year
DH central	300	/

Source: Consultant's compilation

For old, outdated heating technologies, the decommissioning costs have been also taken into account in range between 20 – 50 EUR per device.

2.2. CALCULATION APPROACH

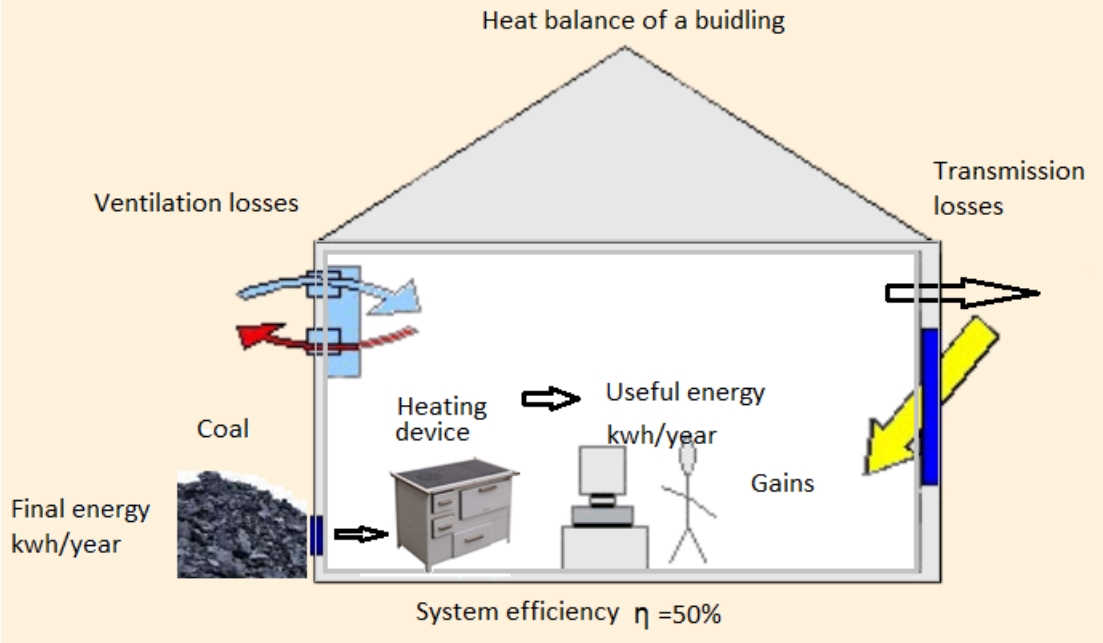
Key assumptions in the modelling analysis include:

- The Baseline Year for calculation is 2015, as year where building inventory for each country can be evidenced on the existing national documents and concluded surveys. The basis for developing the renovation wave were therefore 2015 building stocks inventories. After 2015 it is assumed that the countries only partially apply energy renovation in accordance with the requirements in the Directive 2010/31/EU on the energy performance of buildings and Directive 2009/28/EU to increase the share of energy from renewable energy sources. As a rebuttal to this point it can be convincingly argued that most of the Western Balkan Countries, have adopted the rulebooks for setting the minimum requirements of energy performance of buildings but in reality they seldom apply it for renovation of existing buildings. In this context, for the 2030EU Climate Target Plan, the reductions will be compared to the 2015 levels.
- Scenarios' trajectory cover the period between the Baseline Year 2015 and End Year 2030 with perspective until 2050, where years 2016, 2017, 2018 and 2019 are used for calibration of the modeling process.
- All prices are without VAT included.
- Energy prices, current and projected over the lifetime of the measures: The annual energy inflation rate is assumed at 2%.
- Indicative capital costs, plus maintenance costs as well as replacement costs for the various energy efficiency upgrades of the heating systems are provided based on the existing market prices and assumptions were made on a capital investment mark-up.
- Useful lifetimes of measures: The assumed useful lifetime of the measures is 30 years for the envelope and 20 years for technical energy systems.
- Primary energy factors are assumed to remain constant. Without a clear view on generation investment over the studied horizon, the CO2 grid emissions factor is assumed to remain at its current level based on the country specifics as presented in the tables bellow.

The main data used for calibration of final energy consumption (FEC) were official Eurostat Energy Balances. Usually the energy balances are expressed in thousands of tons of oil equivalent (ktoe)[2].

Final energy in the context of relevance for this study is explained on the following figure.

Figure 2-2 Flow of heat in a conditioned area of a house (or an apartment)



Usually, there is a heating device (a typical stove used for both heating and cooking as presented on figure above), supplied by energy carrier, in this case the coal being transported to a storage room near the house.

Relevant parameters are:

- Final energy

Energy consumed before final transmission – in this case it is energy content of consumed coal over a year. If, for example, a kilo of coal contains 5 kwh of heat energy, and if over a heating season 4 tons of coal is consumed by the heating device then total final energy *is (4.000 x 5) = 20.000 kwh*. This is reflected in official Eurostat balance within households' sector under coal as energy carrier.

- System efficiency η

The stove has its efficiency the way if for very same example depicted on Figure 1, final energy of consumed fuel (energy contained in the coal in this case) is E_{fin}=20.000 kwh/year, and if the efficiency is 50% then the useful energy[3] or *quantity of heat needed* is Q_{hnd}=10.000 kwh/year.

$$\eta = \frac{Qhnd}{Efin} \text{ or } Qhnd = \eta \cdot Efin$$

- Useful energy (or quantity of heat needed)

This one compensates all heating losses like those for transition and ventilation incorporating the gains of heat obtained from humans and devices in the house. In some countries this specific value divided by total floor conditioned area is used to express energy certification schemes. If for very example, total conditioned area of the house presented on the previous figure is 100 m^2 then the specific energy

[2] 1 ktoe=11630000 kWh

[3] Usully named as energy need or Qhnd, the quantity of energy needed for heating.

need (Q_{hnd} ") is 10.000 divided by 100 i.e. 100 kwh/m^2 a year. In some WB6 countries this is still used as main energy certification indicator.

A Primary Energy Factor connects primary and final or delivered energy. It indicates how much primary energy is used to generate a unit of electricity or a unit of useable thermal energy. For electricity and district heating depends on the fuel mix used for generation of unit of electricity or heat per country. For example, when the country uses more renewables in electricity generation processes, these electricity primary energy factors are lower compared with countries whose electricity generation depends on coal or other fossil fuels.

Additionally, CO2 emission have been calculated based on the used energy carrier. The conversion factors for CO2 are taken from the IPCC 2006 protocol together with National Regulations consulted regarding the CO2 emission from the electricity generation and district heating where applicable.

Table 2-2 Primary energy and CO2 conversion factors

Energy source	Primary energy factor kWh/kWh	CO2 conversion factors tCO2/MWh
Biomass	1.5	0
Light heating oil	1.2	0.267
Natural gas	1.0	0.202
Heavy heating oil	1.1	0.279
LPG	1.1	0.227
Coal	1.3	0.364
Electricity	*Country specific*	*Country specific*
Albania	1.01	0
Bosnia and Herzegovina	3.0	0.7595
Kosovo*	3.07	1.438
Montenegro	2.5	0.59
North Macedonia	2.5	0.915
Serbia	2.5	1.036
District heating	*Country specific*	*Country specific*
Albania	/	/
Bosnia and Herzegovina	0 - 1.3	0.364
Kosovo*	1.3	0.406
Montenegro	/	/
North Macedonia	1.2	0.259
Serbia	1.0 – 1.8	0.53

Source: IPCC and National Rulebooks

3. ENERGY PERFORMANCE APPRAISAL

In this chapter, a baseline profile of the heating energy performance status of the existing residential buildings stock in WB6 is presented for each country separately based on the country's specifics. This was achieved by adapting data produced by previous studies and surveys and applying this data through a modelling process. Eurostat's energy balances for period 2015-2019 are crucial in adjusting the baseline to the real, actual energy consumptions in the region. As a result of developing the baselines, the present heating fuel mix as well as heating systems mixture will be recognized to serve as a base for developing the renovation scenarios.

Concretely, overview of the 2021 energy prices on the country level is presented and utilized as input in further calculations of cost savings. In the projections till 2050, 2% annual inflation of the fuel prices has been applied.

Furthermore, housing stock based on cohort age and building type is assed depending on the national building typologies while evolution of the stock has been predicted based on the historic data for its development.

At the end of this chapter, based on the energy balances, baseline heating inventory has been prepared with presentation of the available heating technologies and its shares per country. Key input for the analyses is market research on national sales of heating devices. In the countries overview, market sales for 2020 (together with change in stock) are appropriated. The values are given from the vendors and represents total sales through all sectors residential, commercial and public sector. From these values, experts' estimations could extract heating devices sales applied only in residential sector. This market sales survey were used in formulating the Baseline scenario with applying the presented heating technologies each year for the period 2015-2050. With this, from the 2015 inventory, heating technology penetration in the residential sector till 2050 in parallel with decommissioning of the old, outdated heating devices could have been developed.

Consultant's approach as well as presentation of the findings differs between the countries based on data availability. In case of leak of data, assumption have been made based on consultant's experiences and relevant technical practices. Beside presentation per country, summarized energy performance appraisal is presented at the end of this chapter as overview of the Western Balkan Region.

3.1. ALBANIA

3.1.1. ENERGY PRICES IN THE RESIDENTIAL SECTOR

Table 3-1 Energy prices in the residential sector in Albania, 2021

Fuel	Price (€/kWh)	Source and assumptions
Coal/Lignite	/	/
Diesel	0.14	Global petrol prices[4]
Fuel oil and by products	0.14	Global petrol prices
LPG	0.085	Global petrol prices
Natural gas	/	/

[4] https://www.globalpetrolprices.com/Albania/electricity_prices/

Biomass	0.02	SLED[5]
Heat (District heating)	/	/
Electricity	0.093	Global petrol prices

3.1.2. HOUSING STOCK

The main source for validation of data are:

1. Initial typology of the residential building stock in Albania and the modelling of its low-carbon transformation, SLED
2. Available reports on Albania achievements on Energy Community – part related to EE[6]
3. National Energy Efficiency action plan NEEAP of Albania, 2018[7]
4. National Renewable Energy Action Plan NREAP of Albania[8]

The SLED document provides valuable data based on census in 2011, scenarios up to 2030, and other data related to building types, energy consumption for Albania, its main climatic regions and expected energy consumption for residential sectors per main branches of consumption.

The following table presents the main data collected from the SLED used for estimation of number of buildings and dwellings.

Table 3-2 Initial figures of residential buildings in Albania against the dwellings

Number of dwellings in the building	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 to 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	27	1,012,062

Source: SLED

Arranged in age cohort, the building types covered with the 2011 Census are presented in the following figure.

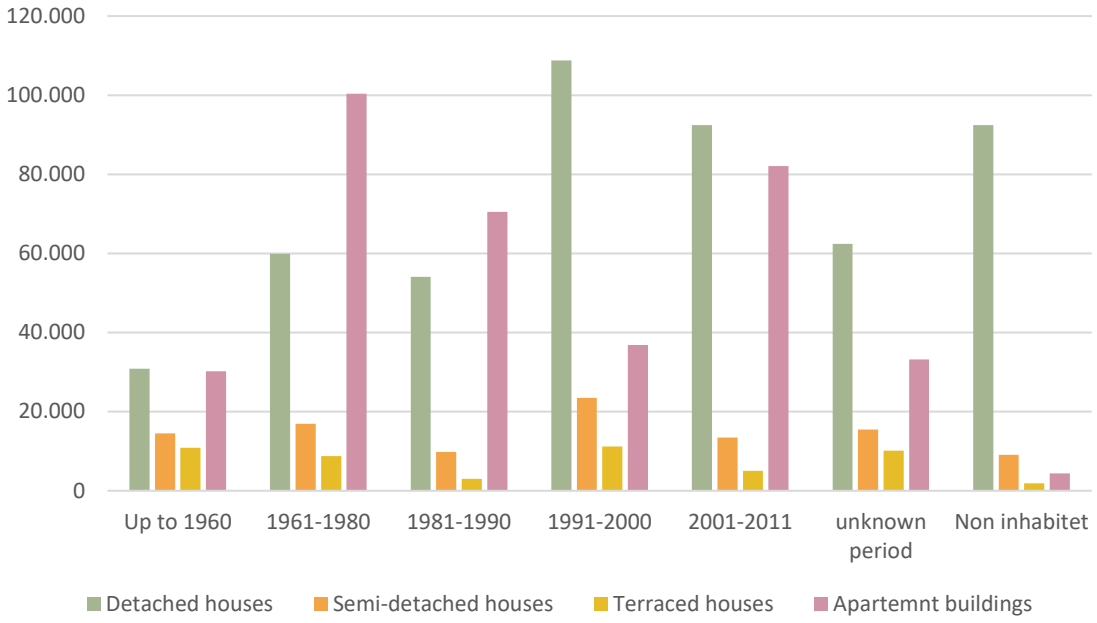
[5] http://sled.rec.org/documents/SLED_Albania_BUILDING_ENG.pdf

[6] https://www.energy-community.org/implementation/Albania.html

[7] Available in pdf

[8] Available with experts

Figure 3-1 Period of construction of the building inventory expressed in number of dwellings



Source: Census 2011

The total number of households in Albania is estimated at 758.935 in 2015 that was the basis for all further analysis of total number of heating devices (hereinafter referred as devices).

The data related to expected growths of population and total occupied and heated area were considered being corrected with the data presented in the "Albania population and population dynamics"[9] for its matching with estimated number of persons and households and officially registered employees in the country and energy data from Eurostat. In addition, the data on relative poverty of households given in the survey are quite relevant for the study[10].

Total number of residential buildings in Albania was 598,267 according to the 2011 census for the population of 2.821.277 people (53% of the population lived in urban area and 46.5 in rural areas - Report 2011[11]).

The data appear to suggest that total conditioned area i.e. heated was more than 46 million square meter in 2015 reaching more than 50 million m^2 in 2020. This means that average heated area per an apartment increased from about 61 m^2. Given square meters correspond to the data of official census documents and the national energy efficiency action plan 2016-2018. According to the SLED it is estimated that the building floor area in 2015 was 65.3 million m2 and that it would reach 72.5 million m2 in 2030. However, the data for relevance is total heated area which is lower, especially for

[9] https://unstats.un.org/unsd/demographic/sources/census/wphc/Albania/03-analysis.pdf

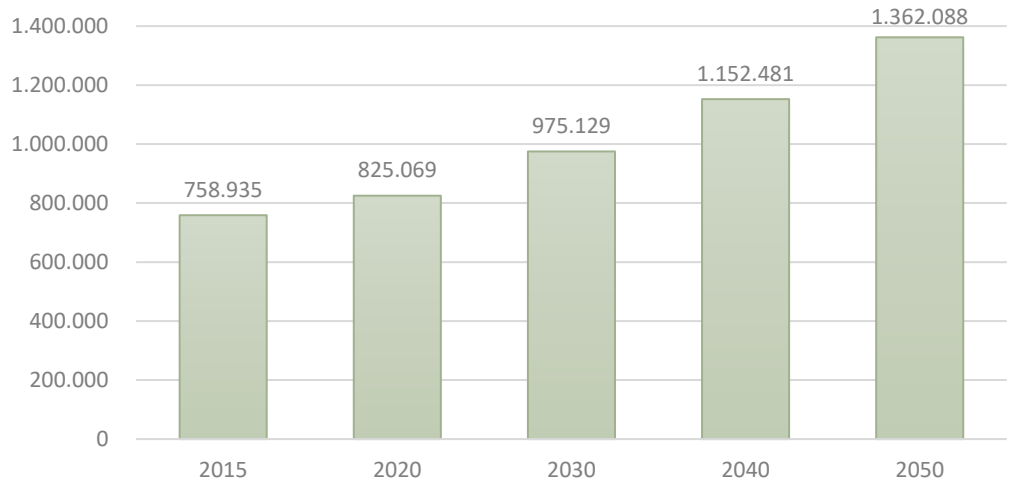
[10] Various authors have stated that Albania has a higher life expectancy than could be anticipated based on its general living standard. For instance, INSTAT (2004b), in the assessment of living conditions and poverty conclude: "Albanians, known for their high life expectancy at a 'very low cost' continue to have good health even after the collapse of Communism. Life expectancy has increased, and they report a good overall health". A test was set up to check whether this is indeed the case and if so, by how much Albania's life expectancy is higher compared to other similar countries.

[11] Financing Energy Efficiency Retrofits in the Built Environment in Albania: BARRIERS AND OPPORTUNITIES, https://library.fes.de/pdf-files/bueros/albanien/14582.pdf

prevailing individual houses, and for given estimated average heated apartment it is estimated that total heated area is around 46 million square meters.

Annual evolution of the building stock (number of dwellings) is projected to growth with 1% each year resulting in 1,362,088 occupied dwellings in 2050.

Figure 3-2 Dwellings evolution in period 2015-2050



Source: Consultant's projections

After applying the primary and mission factors, overview for the residential sector has been prepared with focusing on heating as end user. The values are taken as starting point for further development of the scenarios.

Table 3-3 Summary of residential baseline figures, Albania

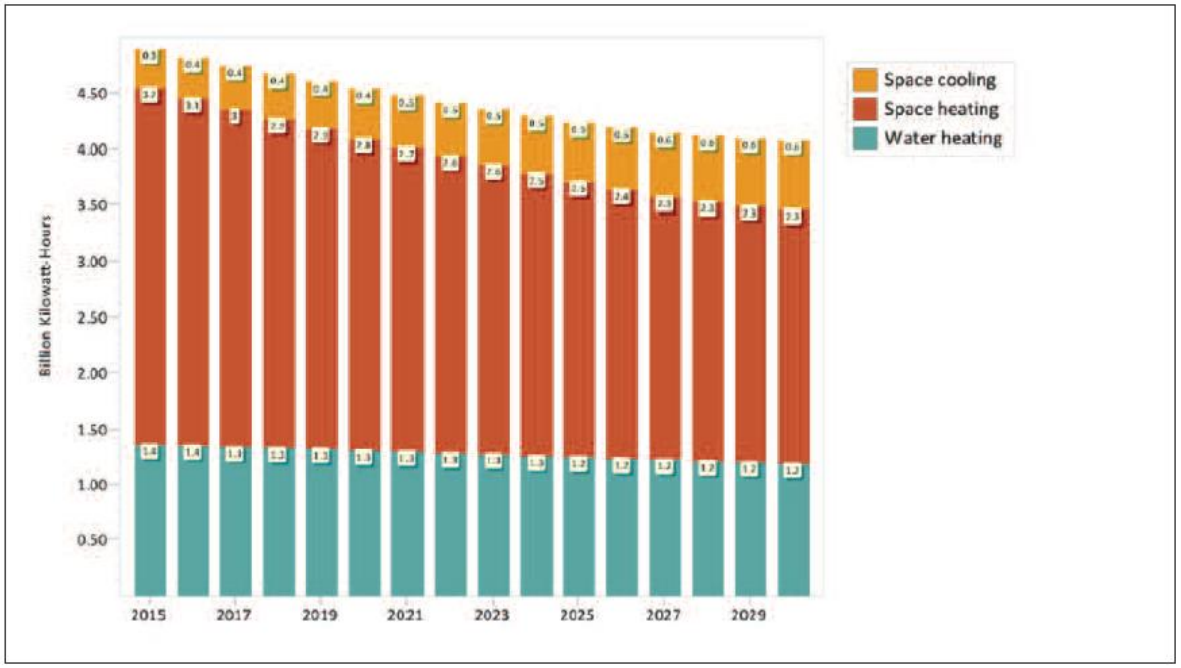
Parameters	Value	Unit
Number of occupied dwelling units	758,935	#
Total heated floor area	46.3	million m^2
Final energy consumption for heating	3,134	GWh/year
Average annual energy consumption for heating per dwelling	4,129	kWh/dwelling
Average energy intensity	68	kWh/m^2 year
Average energy need per heated area	48.6	kWh/m^2 year
CO2 emissions for heating in Residential sector	152,808	tCO2/year
Average annual CO2 emissions from heating per dwelling	0.2	tCO2/dwelling year
Total annual energy costs for the heating end use in residential sector	166.2	€ million/year
Average annual energy cost per dwelling	219	€/dwelling year

Source: Expert's calculations

3.1.3. BASELINE HEATING INVENTORY

Calibration was made between total FEC (Final energy consumption) and for residential heating it is estimated to be around 52% of total FEC, which also includes energy needed for DHW, appliances and cooking, and the energy balance. This was calibrated with data on energy consumption from Figure 60 of the SLED report given in the next figure.

Figure 3-3 Final energy consumption by end use in the reference scenario, 2015–2030



Source: SLED

Nevertheless, since most prevailing stoves are individual stoves, a part of final energy used for cooking is attributed to energy needed for heating.

Concretely it is calculated that total energy need for heating was around 275 ktoe for residential sector in 2015 when total households' energy consumption was 532 ktoe. This ratio is acceptable because of large amount of energy used for heating and cooling from air-to-air heat pumps all over Albania.

Additionally, the NREAP of Albania[12] confirmed that forests all over Albania, especially in mountainous areas, serve as a source of livelihood and income. Firstly, the firewood gathered by villagers, not to mention most of the population in urban areas supplied with firewood, is vital for heating and cooking almost all over the year. **Firewood is an important commodity for Albania**, because they are used for heating by most households, and in rural areas they are also used for cooking, and thereby for heating too. They now cover 36% of energy demand for heating and 12% of energy for cooking. This means that firewood is still indispensable source of energy and will continue to be important. Larger groups of consumers of firewood are families, but public institutions, manufactures of charcoal and limestone also consume large volumes of firewood.

Eventually following ratios of the main energy carrier's consumption for 2015 were adopted.

[12] National Action Plan for Renewable Energy Resources in Albania 2015-2020 copy available with the Team.

Table 3-4 Final energy consumption for residential heating sector for Albania in 2015

Carrier	Adjusted for report (kwh)
Electricity	995,664,794
LPG	483,408,647
Woos	1,680,090,458
Solar	38,229,444
Total (kwh)	3,197,393,343
Total ktoe	275

Source: Consultant's approach

For annual evolution of the heating technology, market sales values have been consulted based on the market survey conducted within this project. Total value corresponds to the total market sales through all sectors (in commercial and public sector included). With expert's estimation, values in residential sectors have been projected.

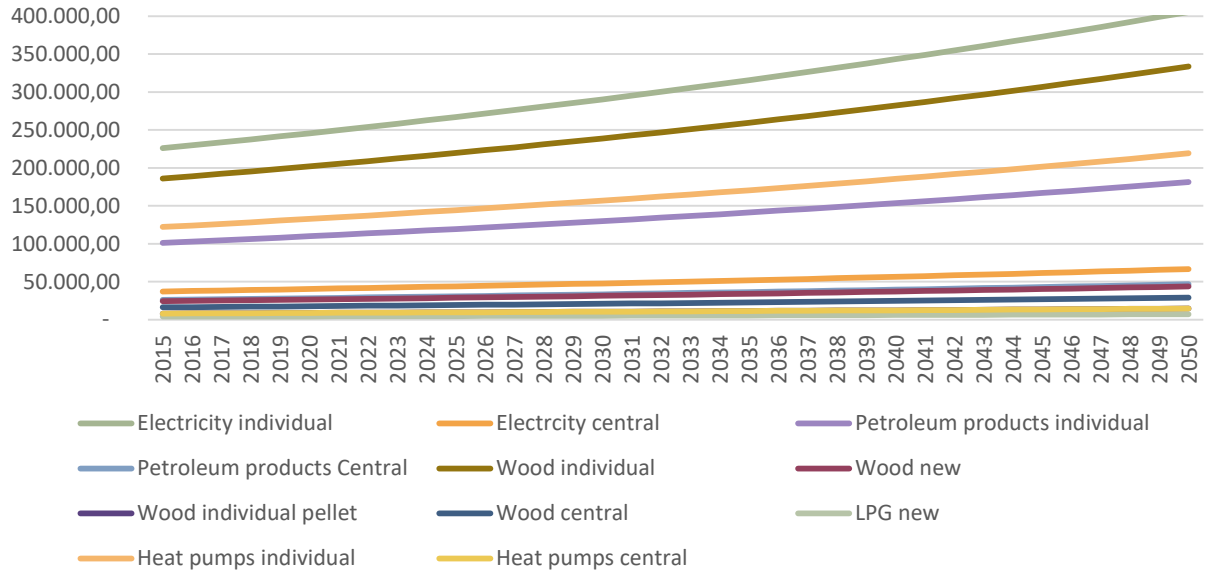
Table 3-5 Market sales of heating technologies for 2020 in Albania (pieces)

Type of heating technology	Total value (pcs)	Value only for residential sector (pcs)
solid fuel stove manufacturer	12,205	2,755
pellet stoves manufacturer	220	1,377
inverter air conditioning, manufacturer	Not available	10,330
gas boilers	Not available	244
electric boilers	80	104
heat pumps	Not available	677
Total	**12,505**	**15,847**

Source: Market sales survey and expert's estimation

With baseline year values together with annual sales, baseline scenario has been developed with heating technologies penetration through the years as presented on the following diagram.

Figure 3-4 Heating technology overview in residential sector 2015-2050 for Baseline scenario



Source: Expert's calculations and projections

For better understanding, tabular overview has been prepared, noting values for the milestone years. Again the old replaced technologies are marked in grey and the new ones in green.

Table 3-6 Heating technology evolution 2015-2050, Baseline scenario (in numbers)

Heating technology	2015	2020	2030	2040	2050
Electricity individual	225,917	245,604	290,273	343,067	405,462
Electricity central	37,157	40,395	47,742	56,425	66,688
Gas Individual	0	0	0	0	0
Gas central	0	0	0	0	0
Petroleum products individual	101,068	109,875	129,859	153,477	181,391
Petroleum products Central	26,010	28,277	33,420	39,498	46,681
Coal individual	0	0	0	0	0
Coal central	0	0	0	0	0
Wood individual	185,787	201,977	238,712	282,127	333,439
Wood individual new	24,410	26,537	31,363	37,068	43,809
Wood individual pellet	8,137	8,846	10,454	12,356	14,603
Wood central	16,273	17,691	20,909	24,712	29,206
LPG new central	3,988	4,336	5,124	6,056	7,158
Heat pumps individual	122,049	132,685	156,817	185,338	219,046
Heat pumps central	8,137	8,846	10,454	12,356	14,603
DH central	0	0	0	0	0
Totals	**758,934**	**825,068**	**975,128**	**1,152,479**	**1,362,087**

Reduced	**/**	(13,300)	(15,719)	(18,578)	(21,957)
Increased	**/**	13,299	15,718	18,577	21,956

Source: Expert's calculations and projections

Analyzing the Baseline situation, the total reduces are ~1.6% per year compared to the Base Year value, while the total increases are ~1.6% of the total Base Year value.

Heating technology with its shares through the investigated period is presented in the following table.

Table 3-7 Heating technology evolution 2015-2050, Baseline scenario (in %)

Heating technology	2015	2020	2030	2040	2050
Electricity individual	29.8%	29.8%	29.8%	29.8%	29.8%
Electricity central	4.9%	4.9%	4.9%	4.9%	4.9%
Gas Individual	0.0%	0.0%	0.0%	0.0%	0.0%
Gas central	0.0%	0.0%	0.0%	0.0%	0.0%
Petroleum products individual	13.3%	13.3%	13.3%	13.3%	13.3%
Petroleum products Central	3.4%	3.4%	3.4%	3.4%	3.4%
Coal individual	0.0%	0.0%	0.0%	0.0%	0.0%
Coal central	0.0%	0.0%	0.0%	0.0%	0.0%
Wood individual	24.5%	24.5%	24.5%	24.5%	24.5%
Wood individual new	3.2%	3.2%	3.2%	3.2%	3.2%
Wood individual pellet	1.1%	1.1%	1.1%	1.1%	1.1%
Wood central	2.1%	2.1%	2.1%	2.1%	2.1%
LPG new central	0.5%	0.5%	0.5%	0.5%	0.5%
Heat pumps individual	16.1%	16.1%	16.1%	16.1%	16.1%
Heat pumps central	1.1%	1.1%	1.1%	1.1%	1.1%
DH central	0.0%	0.0%	0.0%	0.0%	0.0%
Total share	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Expert's calculations and projections

Final energy consumption (FEC) per energy carrier for heating has been calculated based on the heating technology evolution as well as corresponding CO2 emissions for the heating sub sector.

Table 3-8 Overview of heating sub sector evolution in the Baseline scenario for Albania

Parameter	2015	2020	2030	2040	2050
No of heating devices	758,935	825,069	975,129	1,152,481	1,362,088
FEC for heating (MWh/year)	3,134,279	2,785,121	3,009,365	3,251,665	3,513,474
Energy costs for heating (million €/year)	166.2	163.3	210.9	277.8	366

Average annual energy cost per dwelling €/dwelling year	219.0	197.9	216.3	241.0	268.6
CO2 emissions (tCO2/year)	152,808	158,841	171,630	185,449	200,380

Source: Expert's calculations and projections

Penetration of new technologies with pointed intensity based on the market survey has revealed the Baseline values for final energy consumption reaching 3,514 GWh in 2050. Also, the energy costs for heating are increasing from EUR 166.2 million in 2015 to EUR 366 million in 2050 with taking into consideration of constant inflation rate of 2% annually.

If capital costs for each technology are applied for new technologies and decommissioning costs for the old ones based on the inputs elaborated in chapter 3.1., the total investment predicted till 2050 or time period of 28 years should consider around EUR 414 million CAPEX investments in the Baseline scenario.

3.2. BOSNIA AND HERZEGOVINA

3.2.1. ENERGY PRICES IN THE RESIDENTIAL SECTOR

Table 3-9 Energy prices in the residential sector in Bosnia and Herzegovina, 2021

Fuel	Price (€/kWh)	Source and assumptions
Coal/Lignite	0.015	Market research
Diesel	0.053	Market research
Fuel oil and by products	0.042	Market research
LPG	0.078	Market research
Natural gas	0.050	Market research
Biomass	0.049	Market research
Heat (District heating)	0.038 to 0.06	Market research
Electricity	0.064	Market research

3.2.2. HOUSING STOCK

The main source for validation of data are:

- BiH Building Typology published on faculty of Architecture of Sarajevo[13]
- The books *Three* and *Five* on households and accommodation from the **Census 2013-2015** related building stock[14] and
- Results on Survey on the consumption of households from 2015[15] have been utilized.

[13] http://af.unsa.ba/pdf/publikacije/Typology_of_Residential_Buildings_in_Bosnia_and_Herzegovina.pdf

[14] *http://popis.gov.ba/popis2013/knjigePregled.html?lang=bos*

[15] http://www.bhas.ba/ankete/TB_HBS%202015_SR.pdf

- National Energy efficiency action plans 2016-2018[16]

The total number of households in Bosnia is 1,033,452 that was the basis for all further analysis of total number of heating devices (hereinafter referred as devices). The data yielded by this Report provides convincing evidence that using the survey consumption results as the most relevant for the Situation Analysis is appropriate for its matching of estimated number of employed persons, potential future loan takers/grants beneficiaries, and officially registered employees in the country and energy data from Eurostat.

In addition, the data on relative poverty of households given in the survey are quite relevant for the study.

The survey's 1,033,452.00 households are living in apartments with average occupied surface areas of 76.52 m2, the large majority living in IHs. This means that total living area for households is around 80 million m2. However, for calibration of real energy consumption reflected in the energy balance the average heated areas is much smaller and is 58.3 m2, because most of the HHS living in the individual houses to not heat total areas Therefore the total heated area is around 60 million square meters that corresponds to data given in NEEAP, the national energy efficiency action plan 2016-2018.

Calibration was made between total FEC for residential heating estimated to be around 80% of total FEC for residential sector which also includes energy needed for DHW, appliances and cooking. However, since most prevailing stoves confirmed from the survey are individual stoves, good part of final energy sued for cooking is calculated with energy needed for heating.

The typology matrix of residential buildings in Bosnia and Herzegovina identified two categories of the housing stock: the single-family housing and four categories of multi-apartment buildings (MABs) as presented in following figure. However, since most prevailing stoves confirmed from the survey are

[16] https://fmeri.gov.ba/media/1245/apee_fbih_2016-2018.pdf

_http://www.mvteo.gov.ba/data/Home/Dokumenti/Energetika/14122018_APEE_BiH_2016_2018_BA.pdf

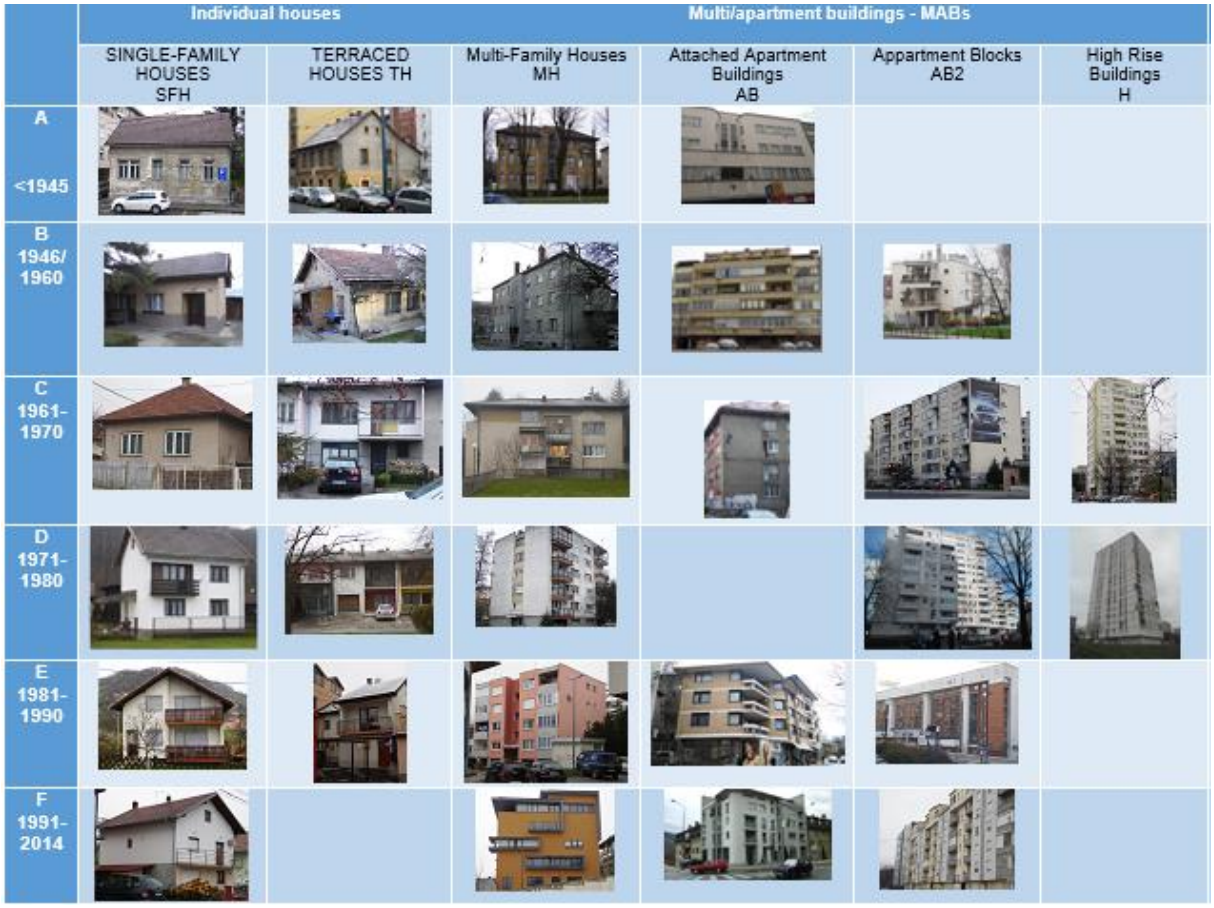
individual stoves, good part of final energy sued for cooking is calculated with energy needed for heating.

The typology matrix of residential buildings in Bosnia and Herzegovina identified two categories of the housing stock: the single-family housing and four categories of multi-apartment buildings (MABs) as presented in following figure.

However, since most prevailing stoves confirmed from the survey are individual stoves, a significant part of final energy sued for cooking is calculated with energy needed for heating.

The typology matrix of residential buildings in Bosnia and Herzegovina identified two categories of the housing stock: the single-family housing and four categories of multi-apartment buildings (MABs) as presented in following figure.

Figure 3-5 Building typology matrix for Bosnia and Herzegovina



Source: Building Typology of BiH

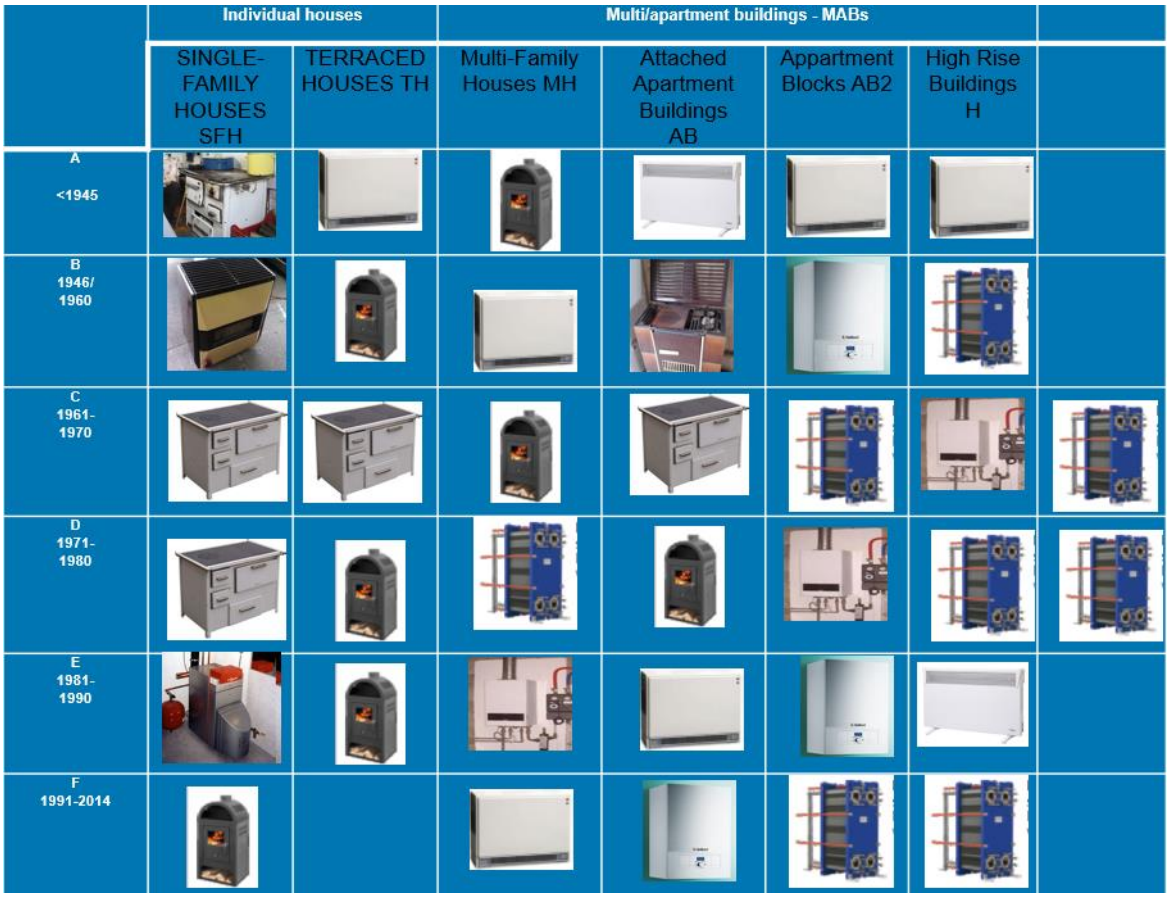
The buildings presented in this figure are the most prevailing residential building types in Bosnia and Herzegovina. Here are the definitions of the main building types:

- A single-family house (SH) is a building of individual housing with three floors maximum and up to three dwelling units positioned on a separate lot without bordering with an adjacent building.
- A terraced house (TH) is a building of individual housing with three floors maximum and up to three dwellings placed on a separate lot within a row of attached buildings.

- A multi-family house (MH) is a self-supporting building of collective housing with more than three floors, more than three dwelling units and two-house addresses maximum, placed on a separate lot without bordering an adjacent building.
- An attached apartment building (AB) in urban block is a building with more than three floors, which are in the framework of a row of buildings in an urban block attached to adjacent buildings.
- A large residential block (AB2) is a multi-floor building of great floor area, with three and more house numbers/addresses.
- A high-rise building (H) is a freestanding building with at least eight floors and with maximum two entrances/addresses.

As for the types of most prevailing devices among those given in the typology, they are presented on the figure below.

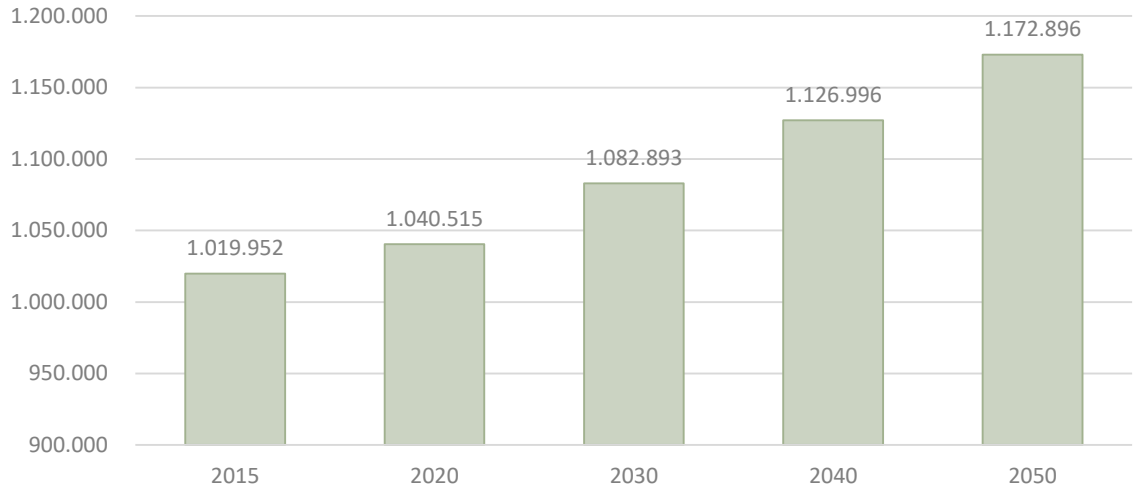
Figure 3-6 Most prevailing devices used for heating over different building types in BiH



Source: Building Typology of BiH

The housing stock is assumed to be increasing through the upcoming years with the following intensity.

Figure 3-7 Dwellings evolution in period 2015-2050



Source: Expert's projections

The following table summarizes the baseline data used in the analyses for the heating end user in the residential sector.

Table 3-10 Summary of residential baseline figures, Bosnia and Herzegovina

Parameters	Value	Unit
Number of occupied dwelling units	1,019,952	#
Total heated floor area	60.0	million m²
Final energy consumption for heating	15,052	GWh/year
Average annual energy consumption for heating per dwelling	14,758	kWh/dwelling
Average energy intensity	251	kWh/m² year
Average energy need per heated area	180	kWh/m² year
CO2 emissions for heating in Residential sector	6,935,918	tCO2/year
Average annual CO2 emissions from heating per dwelling	6.8	tCO2/dwelling year
Total annual energy costs for the heating end use in residential sector	753.7	€ million/year
Average annual energy cost per dwelling	739	€/dwelling year

Source: Expert's calculations

3.2.3. BASELINE HEATING INVENTORY

Since the main subject of the study are heating devices (also referred as stoves), all those prevailing in the country are calibrated with official energy balance, following the distributions of technologies'. Here it is assumed that most of the occupied conditioned areas are indeed conditioned i.e. heated.

Table 3-11 Distribution of the most prevailing heating devices in 2015

Technologies distribution over BIH heating 2015-2020	

Electricity individual	15%
Electricity central	10.0%
Gas Individual	1.0%
Gas central	0.7%
Petroleum products individual	0.1%
Petroleum products Central	0.1%
Coal individual	3.0%
Coal central	2.0%
Wood individual	45.0%
Wood individual new	4.5%
Wood individual pellet	2.5%
Wood central	2.5%
Heat pumps individual	1.0%
Heat pumps central	2.0%
DH central	0.6%

On the Base year inventory, market sales have been applied. The year sales are taken from the survey conducted for the markets sales in BiH together with change in stock for 2020 given from the vendors and represents total sales through all sectors residential, commercial and public sector. From these values, with expert estimations have been extracted heating devices sales concluded only in residential sector.

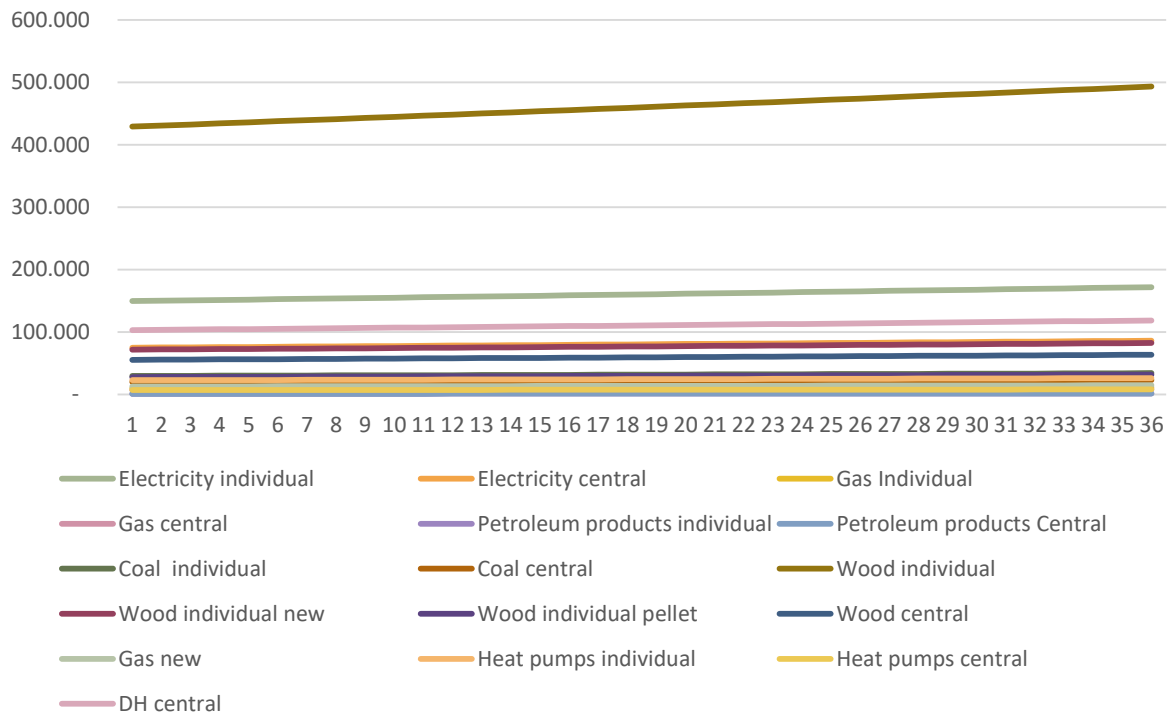
Table 3-12 Market sales of heating technologies for 2020 in BiH (pieces)

Type of heating technology	Total value (pcs)	Value only for residential sector (pcs)
solid fuel stove manufacturer	29,700	26,000
pellet stoves manufacturer	7,740	6,700
inverter air conditioning, manufacturer	20,000	2,300
gas boilers	3,000	2,500
electric boilers	1,000	/
heat pumps	700	700
Total	**62,140**	**38,000**

Source: Market sales survey and expert's estimation

The market sales survey will be used in formulating the Baseline scenario with applying the presented heating technologies each year in the period 2015-2050. With this, starting from the 2015 inventory, the heating technology penetration in the residential sector till 2050 in parallel with decommissioning of the old outdated heating devices, can be developed.

Figure 3-8 Heating technology overview in residential sector 2015-2050 for Baseline scenario



Source: Expert's calculations and projections

Same diagram expressed in numbers is given below with identified reduced "grey" devices with "green ones".

Table 3-13 Heating technology evolution 2015-2050, Baseline scenario (in numbers)

Heating technology	2015	2020	2030	2040	2050
Electricity individual	149,474	152,487	158,698	165,161	171,888
Electricity central	74,737	76,244	79,349	82,581	85,944
Gas Individual	9,486	9,677	10,071	10,481	10,908
Gas central	6,783	6,919	7,201	7,495	7,800
Petroleum products individual	1,014	1,034	1,076	1,120	1,166
Petroleum products Central	1,014	1,034	1,076	1,120	1,166
Coal individual	29,497	30,092	31,317	32,593	33,920
Coal central	19,665	20,061	20,878	21,728	22,613
Wood individual	429,145	437,797	455,627	474,184	493,496
Wood individual new	71,601	73,044	76,019	79,115	82,337
Wood individual pellet	27,666	28,224	29,373	30,570	31,815
Wood central	55,332	56,448	58,747	61,140	63,630

Gas new central	12,647	12,902	13,428	13,975	14,544
Heat pumps individual	22,643	23,099	24,040	25,019	26,038
Heat pumps central	6,854	6,992	7,277	7,573	7,882
DH central	103,015	105,092	109,372	113,827	118,463
Totals	**1,020,572**	**1,041,148**	**1,083,551**	**1,127,682**	**1,173,610**
Reduced		(38,798)	(40,378)	(42,022)	(43,734)
Increased		39,430	41,036	42,708	44,447

Source: Expert's calculations and projections

The numbers given in the table above is realistic number including the replacement based on an optimistic approach that "the largest number of populations replaces old stoves. For all the WB countries, identical approach has been applied in terms of determination of the existing and penetration of new technologies with adoption of devices efficiencies and life cycle of the heating devices.

The prevailing systems approximated for the region are visualized as presented on the following picture. The life span considered for the heating system is 20 years. The efficiencies of each system were estimated meticulously to obtain energy balance total final energy consumption corresponding to the share for typical systems. The main assumptions in favor of the main objective of this report is that old technologies, represented in grey color are the subject of decommissioning, while green represent the new ones.

Figure 2-1) by those in green color given in the same figure. As the matter of fact, most of the study is about replacing the fossil fuels based "grey" devices with environmentally friendly "green ones".

Analyzing the Baseline situation, the total reduces are ~3.7% per year compared to the Baseline Year value, while the total increases are ~3.79% of the total Base Year value. The differences between the reduced and new introduced technologies of 0.1% presents new heating technologies identified in the new building evolution stock.

Heating technology with its shares through the investigated period is presented in the following table.

Table 3-14 Heating technology evolution 2015-2050, Baseline scenario (in %)

Heating technology	2015	2020	2030	2040	2050
Electricity individual	14.6%	14.6%	14.6%	14.6%	14.6%
Electricity central	7.3%	7.3%	7.3%	7.3%	7.3%
Gas Individual	0.9%	0.9%	0.9%	0.9%	0.9%
Gas central	0.7%	0.7%	0.7%	0.7%	0.7%
Petroleum products individual	0.1%	0.1%	0.1%	0.1%	0.1%
Petroleum products Central	0.1%	0.1%	0.1%	0.1%	0.1%
Coal individual	2.9%	2.9%	2.9%	2.9%	2.9%
Coal central	1.9%	1.9%	1.9%	1.9%	1.9%
Wood individual	42.0%	42.0%	42.0%	42.0%	42.0%

Wood individual new	7.0%	7.0%	7.0%	7.0%	7.0%
Wood individual pellet	2.7%	2.7%	2.7%	2.7%	2.7%
Wood central	5.4%	5.4%	5.4%	5.4%	5.4%
Gas new central	1.2%	1.2%	1.2%	1.2%	1.2%
Heat pumps individual	2.2%	2.2%	2.2%	2.2%	2.2%
Heat pumps central	0.7%	0.7%	0.7%	0.7%	0.7%
DH central	10.1%	10.1%	10.1%	10.1%	10.1%
Total share	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Expert's calculations and projections

Final energy consumption (FEC) per energy carrier for heating has been calculated based on the heating technology evolution as well as corresponding CO2 emissions for the heating sub sector.

Table 3-15 Overview of heating sub sector evolution in the Baseline scenario for Bosnia and Herzegovina

Parameter	2015	2020	2030	2040	2050
No of heating devices	1,019,952	1,040,515	1,082,893	1,126,996	1,172,896
FEC for heating (MWh/year)	15,052,076	15,389,293	16,086,184	16,814,107	18,158,565
Energy costs for heating (million €/year)	753.7	770.6	962.6	1,226	1,615
Average annual energy cost per dwelling €/dwelling year	738.9	740.5	888.9	1,088.3	1,376.6
CO2 emissions (tCO2/year)	6,935,918	7,091,306	7,412,430	7,747,853	8,367,372

Source: Expert's calculations and projections

Penetration of new technologies with pointed intensity based on the market survey has revealed the Baseline values for final energy consumption reaching 18,159 GWh in 2050. Also, the energy costs for heating are increasing from EUR 753.7 million in 2015 to EUR 1,615 million in 2050 with taking into consideration of constant inflation rate of 2% annually.

If capital costs for each technology are applied for new technologies and decommissioning costs for the old ones based on the inputs elaborated in chapter 3.1., the total investment predicted until 2050 or time period of 28 years should consider around EUR 682 million investments in the Baseline scenario.

3.3. KOSOVO*

3.3.1. ENERGY PRICES IN THE RESIDENTIAL SECTOR

Table 3-16 Energy prices in the residential sector in Kosovo, 2021*

Fuel	Price (€/kWh)	Source and assumptions
Coal/Lignite	0.02	Building Renovation Strategy[17]
Diesel	0.091	Building Renovation Strategy
Fuel oil and by products	0.125	Building Renovation Strategy
LPG	0.65	Building Renovation Strategy
Natural gas	/	Building Renovation Strategy
Biomass	0.038	Building Renovation Strategy
Heat (District heating)	0.06	Building Renovation Strategy
Electricity	0.06	Building Renovation Strategy

3.3.2. HOUSING STOCK

Kosovo* is advanced in preparation of the building typology as well as in Building Renovation Strategy. In the Strategy are presented building stocks for residential, commercial and public sector with level of investments predicted per three scenarios. As baseline for Residential sector are considered 412,883 dwellings with total area of 34,442,579 m^2.

Table 3-17 Building inventory per dwellings type and age cohort, 2017

Construction period	Single family houses	Terraced houses	Multi-family houses	Apartments blocks	Totals per age	% per age
Pre-1960	6,602	410	588	0	**7,600**	**1.8%**
1960-1969	11,033	572	156	1,778	**13,539**	**3.3%**
1970-1979	28,930	2,197	3,216	7,092	**41,435**	**10.0%**
1980-1999	96,149	4,617	26,184	23,328	**150,278**	**36.4%**
2000-2017	96,334	9,849	9,120	84,728	**200,031**	**48.4%**
Totals per type	**239,048**	**17,645**	**39,264**	**116,926**	**412,883**	**100.0%**
% per type	**57.9%**	**4.3%**	**9.5%**	**28.3%**	**100.0%**	

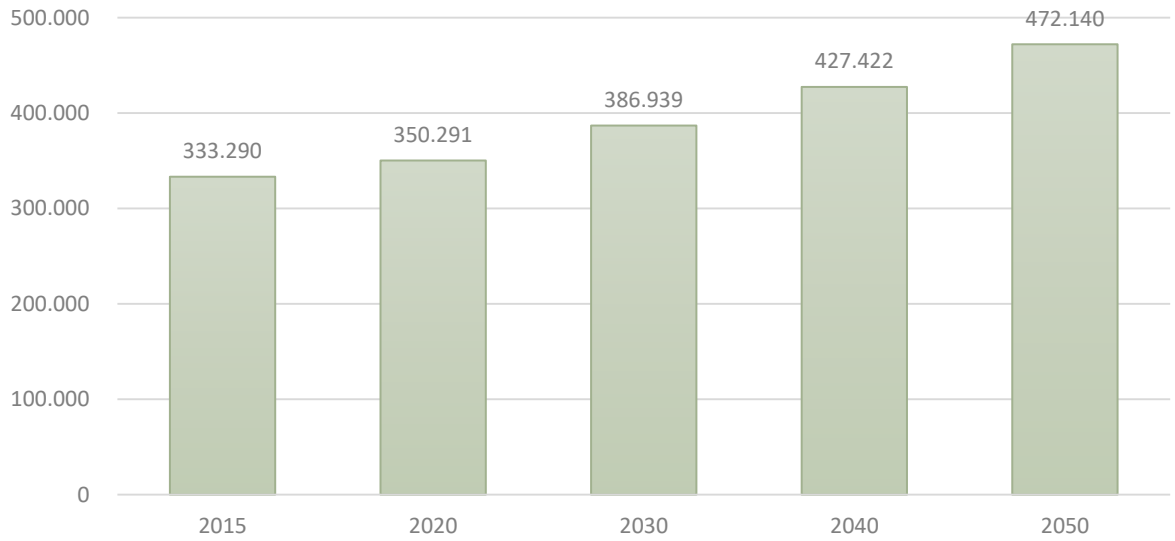
Source: Building Renovation Strategy

From total inventory, 81% are occupied dwellings (333,290 dwellings) with 51.6 m^2 heated floor area. In long term, the evolution of the building inventory is assumed to be around 1%. With applying this

[17] Building Renovation Strategy is draft version and can be send upon request

factor through the forecast period, till 2050, the occupied dwellings will increase to 472,140 dwellings in use.

Figure 3-9 Dwellings evolution in period 2015-2050



Source: Expert's projections

As base assumption in the modelling is that each occupied dwelling has only one heating device as primary heating source. Consequently, presented evolution of the occupied dwellings at the same time represents the evolution of the heating devices inventory too. With this approach, in 2030 it is expected 386,939 heating devices to be in use through the Residential sector. With applying the factors presented in the chapter 3.2, baseline figures for Kosovo* are derived and presented on the following table.

*Table 3-18 Summary of residential baseline figures, Kosovo**

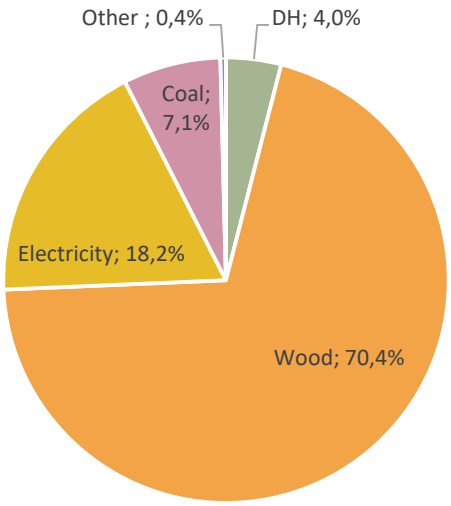
Parameters	Value	Unit
Number of occupied dwelling units	333,290	#
Total heated floor area	17.19	million m^2
Final energy consumption for heating	3,956	GWh/year
Average annual energy consumption for heating per dwelling	11,870	kWh/dwelling
Average energy intensity	230.1	kWh/m^2 year
Average energy need per heated area	148	kWh/m^2 year
CO2 emissions for heating in Residential sector	3,388,322	tCO2/year
Average annual CO2 emissions from heating per dwelling	10.2	tCO2/dwelling year
Total annual energy costs for the heating end use in residential sector	163.7	€ million/year
Average annual energy cost per dwelling	491	€/dwelling year

Source: Expert's calculations

3.3.3. BASELINE HEATING INVENTORY

Based on the 'Survey on energy consumption in households[18]', published by the Kosovo* Agency of Statistics in 2015, the heating inventory has been developed for the base year. Additionally, the share of each heating technology has been calibrated toward fuel share presented in the Eurostat's energy balances for the same year.

Figure 3-10 Heating technology share in residential sector 2015 (%)



Source: 'Energy consumption in households' survey

A very important step in the analyses is market research on national sales of heating devices. Following table presents the market sales (together with change in stock) for 2020 given from the vendors and represents total sales through all sectors residential, commercial and public sector. From these values, with expert estimations have been extracted heating devices sales concluded only in residential sector.

Table 3-19 Market sales of heating technologies for 2020 in Kosovo (pieces)*

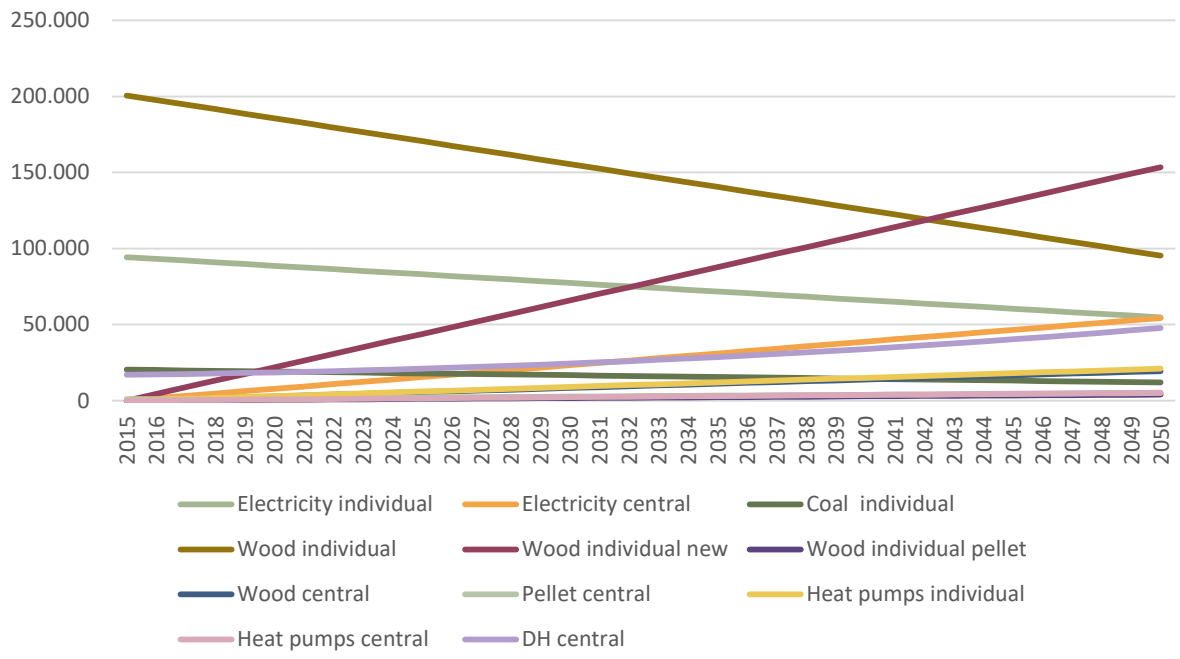
Type of heating technology	Total value (pcs)	Value only for residential sector (pcs)
solid fuel stove manufacturer	16,467	4,940
pellet stoves manufacturer	500	225
inverter air conditioning, manufacturer	6,000	600
gas boilers	/	/
electric boilers	15,500	1,550
heat pumps	/	/
Total	**38,467**	**7,315**

Source: Market sales survey and expert's estimation

[18] https://ask.rks-gov.net/en/Kosovo*-agency-of-statistics/add-news/energy-consumption-in-households-2015

The pointed market penetration is applied on the 2015 heating technology stock resulting in inventory evolution in the period 2015-2050 as presented in the following figure. For heat pumps, there is no information available for market penetration, consequently, the annual sales of heat pumps for residential use is assumed to be 150.

Figure 3-11 Heating technology overview in residential sector 2015-2050 for Baseline scenario



Source: Expert's calculations and projections

In numbers, the same diagram is presented in the following table:

Table 3-20 Heating technology evolution 2015-2050, Baseline scenario (in numbers)

Heating technology	Number of reduced/increased devices per year	2015	2020	2030	2040	2050
Electricity individual	(1,130)	94,321	88,671	77,371	66,071	54,771
Electricity central	1,550	0	7,750	23,250	38,750	54,250
Gas Individual	0	0	0	0	0	0
Gas central	0	0	0	0	0	0
Petroleum products individual	0	0	0	0	0	0
Petroleum products Central	0	0	0	0	0	0
Coal individual	(240)	20,331	19,131	16,731	14,331	11,931
Coal central	0	0	0	0	0	0
Wood individual	(3,009)	200,641	185,596	155,506	125,416	95,326

Wood individual new	4,385	0	21,925	65,775	109,625	153,475
Wood individual pellet	113	0	565	1,695	2,825	3,955
Wood central	555	0	2,775	8,325	13,875	19,425
Pellet central	113	1,000	1,565	2,695	3,825	4,955
Gas new central	0	0	0	0	0	0
Heat pumps individual	600	0	3,000	9,000	15,000	21,000
Heat pumps central	150	0	750	2,250	3,750	5,250
DH central	246	16,998	18,564	24,342	33,955	47,803
Totals	3,333	333,290	350,291	386,939	427,422	472,140
Total reduces	(4,379)	/	-21,895	-65,685	-109,475	-153,265
Total increased	7,712	/	38,896	119,334	203,607	292,115

Source: Expert's calculations and projections

Analyzing the Baseline situation, the total reduces are ~1.3 % per year compared to the Baseline Year value, while the total increases are ~2.3% of the total Baseline Year value. The differences between the reduced and new introduced technologies of 1% presents new heating technologies identified in the new building evolution stock.

If same approach is applied, the heating technology will have the following share through the investigated period.

Table 3-21 Heating technology evolution 2015-2050, Baseline scenario (in %)

Heating technology	2015	2020	2030	2040	2050
Electricity individual	28.3%	25.3%	20.0%	15.5%	11.6%
Electricity central	0.0%	2.2%	6.0%	9.1%	11.5%
Gas Individual	0.0%	0.0%	0.0%	0.0%	0.0%
Gas central	0.0%	0.0%	0.0%	0.0%	0.0%
Petroleum products individual	0.0%	0.0%	0.0%	0.0%	0.0%
Petroleum products Central	0.0%	0.0%	0.0%	0.0%	0.0%
Coal individual	6.1%	5.5%	4.3%	3.4%	2.5%
Coal central	0.0%	0.0%	0.0%	0.0%	0.0%
Wood individual	60.2%	53.0%	40.2%	29.3%	20.2%
Wood individual new	0.0%	6.3%	17.0%	25.6%	32.5%
Wood individual pellet	0.0%	0.2%	0.4%	0.7%	0.8%

Wood central	0.0%	0.8%	2.2%	3.2%	4.1%
Pellet central	0.3%	0.4%	0.7%	0.9%	1.0%
Gas new central	0.0%	0.0%	0.0%	0.0%	0.0%
Heat pumps individual	0.0%	0.9%	2.3%	3.5%	4.4%
Heat pumps central	0.0%	0.2%	0.6%	0.9%	1.1%
DH central	5.1%	5.3%	6.3%	7.9%	10.1%
Total share	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Expert's calculations and projections

Final energy consumption (FEC) per energy carrier for heating has been calculated based on the heating technology evolution as well as corresponding CO2 emissions for the heating sub sector.

*Table 3-22 Overview of heating sub sector evolution in the Baseline scenario for Kosovo**

Parameter	2015	2020	2030	2040	2050
No. of heating devices	333,290	350,291	386,939	427,422	472,140
FEC for heating (MWh/year)	3,941,540	4,053,747	4,297,556	4,573,899	4,886,180
Energy costs for heating (million €/year)	163.7	169.2	216.6	284.5	376
Average annual energy cost per dwelling €/dwelling year	491.2	482.9	559.8	665.7	795.6
CO2 emissions (tCO2/year)	3,388,322	3,505,079	3,747,815	4,007,718	4,286,592

Source: Expert's calculations and projections

If capital costs for each technology are applied for new technologies and decommissioning costs for the old ones based on the inputs elaborated in chapter 3.1., the annual engaged capital is 3.3 million €/year. With this approach, without including financial or economic analyses, the total investment predicted till 2050 or time period of 28 years should consider around EUR 99.2 million CAPEX investments in the Baseline scenario.

3.4. MONTENEGRO

3.4.1. ENERGY PRICES IN THE RESIDENTIAL SECTOR

Table 3-23 Energy prices in the residential sector in Montenegro, 2021

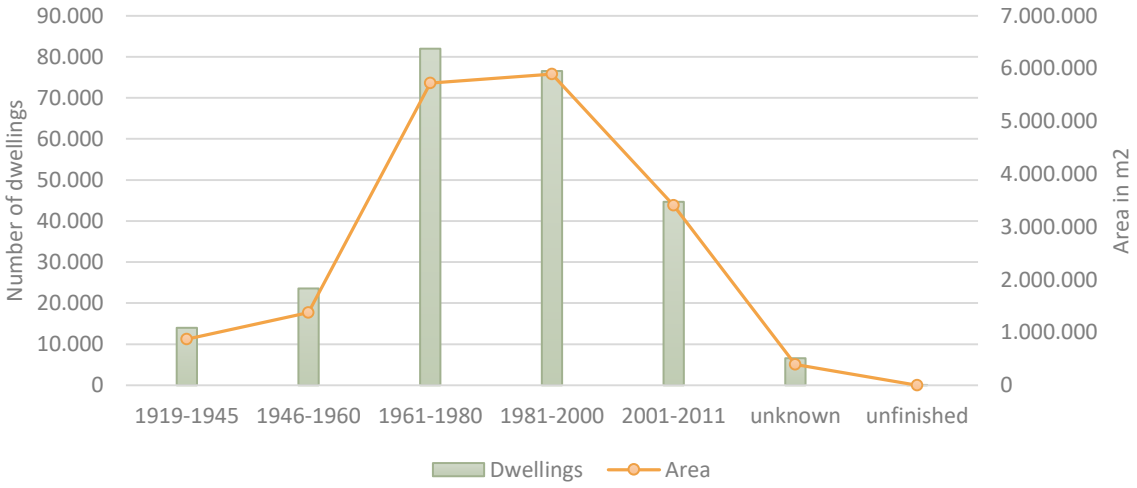
Fuel	Price (€/kWh)	Source and assumptions
Coal/Lignite	0.024	Market research
Fuel oil and by products	0.120	Market research
LPG	0.11	Market research
Natural gas	/	
Biomass	0.014	Market research

Heat (District heating)	/	
Electricity	0.0524	Elektroprivreda Crne Gore[19]

3.4.2. HOUSING STOCK

The housing stock in Montenegro has been captured through Census[20] concluded in 2011. According to the data in the census reports, there were 247,354 dwellings constructed in different periods as presented in the following diagram.

Figure 3-12 Period of construction of the building inventory 2011



Source: Census 2011

In accordance to the "The typology of the residential building stock of Montenegro and modelling its low-carbon transformation[21]" published 2015, the number of dwellings was 315,670, of which only 188,376 or ~60% were inhabited. This report states that only 50 % of the total floor area in Montenegro is heated, resulting in 46.9 m^2 floor area to be heated area per dwelling.

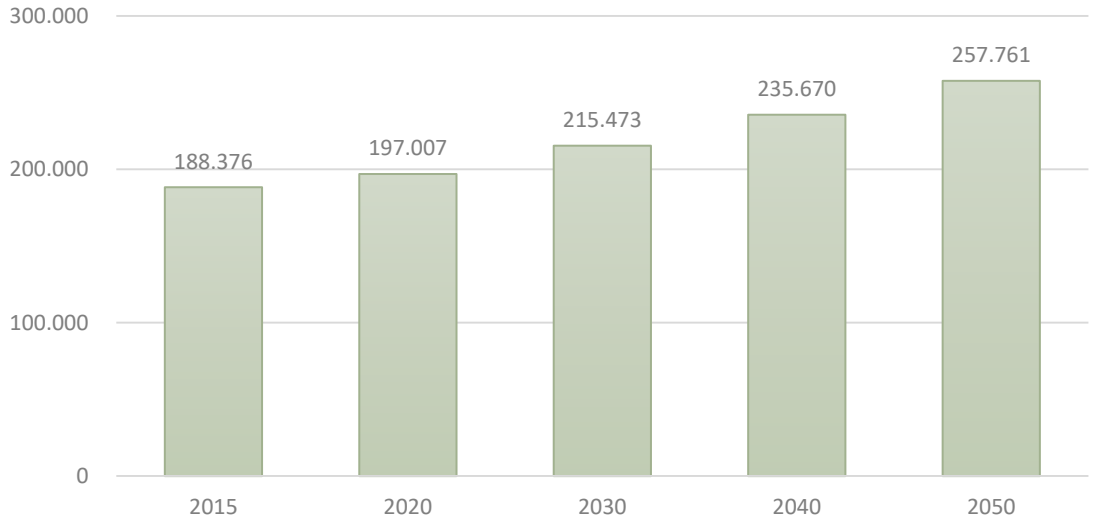
Annual evolution of the building stock (number of dwellings) is projected to growth with 0.9% each year resulting in 257,761 occupied dwellings in 2040.

[19] Dated from 01.01.2021
https://www.epcg.com/sites/epcg.com/files/multimedia/gallery/files/2014/04/cijene_za_snabdijevanje_krajnjih_kupaca_elektricne_energije_01.01.2021_-_31.12.2021._godine.pdf

[20] https://www.monstat.org/userfiles/file/popis2011/saopstenje/STANOVI%20Saopstenje%20IV-2.pdf

[21] https://www.buildup.eu/sites/default/files/content/sled_montenegro_building_eng.pdf

Figure 3-13 Dwellings evolution in period 2015-2050



Source: Expert's projections

The following table summarizes the baseline data used in the analyses for the heating end user in the residential sector.

Table 3-24 Summary of residential baseline figures, Montenegro

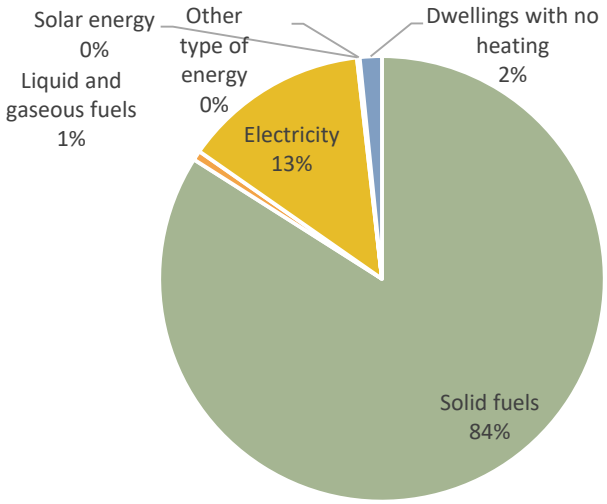
Parameters	Value	Unit
Number of occupied dwelling units	188,376	#
Total heated floor area	8.8	million m^2
Final energy consumption for heating	2,014	GWh/year
Average annual energy consumption for heating per dwelling	10,690	kWh/dwelling
Average energy intensity	228	kWh/m^2 year
Average energy need per heated area	157	kWh/m^2 year
CO2 emissions for heating in Residential sector	279,447	tCO2/year
Average annual CO2 emissions from heating per dwelling	1.5	tCO2/dwelling year
Total annual energy costs for the heating end use in residential sector	36.5	€ million/year
Average annual energy cost per dwelling	194	€/dwelling year

Source: Expert's calculations

3.4.3. BASELINE HEATING INVENTORY

Following the 2011 Census, the shares of floor area in residential sector is given by energy source used for heating.

Figure 3-14 Fuel share for heating in residential sector in 2011 (%)



Source: Census 2011

For this Report, the presented shares have been calibrated toward Eurostat energy balance for 2015. With this, the mayor share of the dwellings is represented by the individual stoves on fire wood with 71%, followed by individual devices on electricity represented by heat pumps individual with 24%.

Market sales of heating technology through all sectors is presented in the following table along with expert's projection of sales only in residential sector.

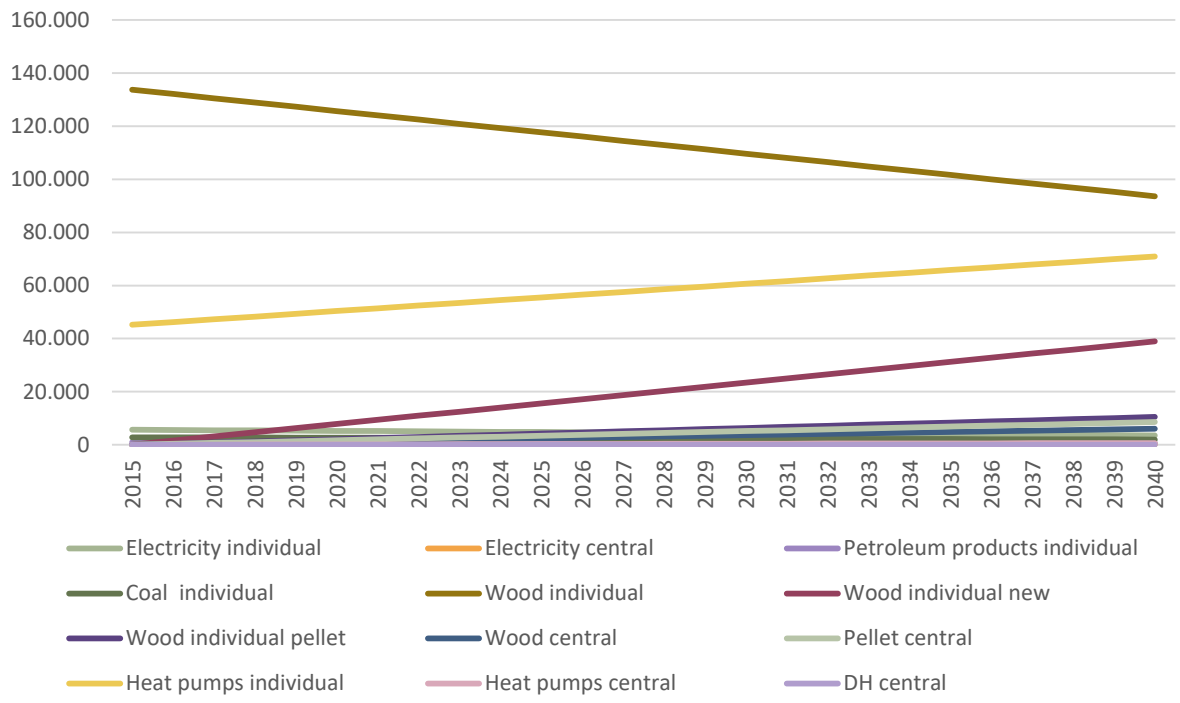
Table 3-25 Market sales of heating technologies for 2020 in Montenegro (pieces)

Type of heating technology	Total value (pcs)	Value only for residential sector (pcs)
solid fuel stove manufacturer	6,000	1,800
pellet stoves manufacturer	1,690	761
inverter air conditioning, manufacturer	10,300	1,030
gas boilers	/	0
electric boilers	50	5
heat pumps	500	25
Total	**18,540**	**3,621**

Source: Market sales survey and expert's estimation

This market sales survey will be used in formulating the Baseline scenario with applying the presented heating technologies each year in the period 2015-2050. With this, from the 2015 inventory, it can be developed heating technology penetration in the residential sector till 2050 in parallel with decommissioning of the old, outdated heating devices.

Figure 3-15 Heating technology evolution 2015-2050, Baseline scenario



Source: Expert's calculations and projections

Or in table overview, previous diagram of the heating system stock would be:

Table 3-26 Heating technology evolution 2015-2050, Baseline scenario (in numbers)

Heating technology	Number of reduced/increased devices per year	2015	2020	2030	2040	2050
Electricity individual	(85)	5,651	5,226	4,376	3,526	2,676
Electricity central	5	0	25	75	125	175
Gas Individual	0	0	0	0	0	0
Gas central	0	0	0	0	0	0
Petroleum products individual	(11)	942	887	777	667	557
Petroleum products Central	0	0	0	0	0	0
Coal individual	(34)	2,826	2,656	2,316	1,976	1,636
Coal central	0	0	0	0	0	0
Wood individual	(1,605)	133,747	125,722	109,672	93,622	77,572
Wood individual new	1,560	0	7,800	23,400	39,000	54,600

Wood individual pellet	419	0	2,095	6,285	10,475	14,665
Wood central	240	0	1,200	3,600	6,000	8,400
Pellet central	342	0	1,710	5,130	8,550	11,970
Gas new central	0	0	0	0	0	0
Heat pumps individual	1,030	45,210	50,360	60,660	70,960	81,260
Heat pumps central	25	0	125	375	625	875
DH central	0	0	0	0	0	0
Totals	1,886	188,376	197,806	216,666	235,526	254,386
Reduces	(1,735)	/	-8,675	-26,025	-43,375	-60,725
Increased	3,621	/	18,105	54,315	90,525	126,735

Source: Expert's calculations and projections

Analyzing the Baseline situation, the total reduces are ~0.9 % per year compared to the Baseline Year value, while the total increases are ~1.9% of the total Baseline Year value. The differences between the reduced and new introduced technologies of 1% presents new heating technologies identified in the new building evolution stock.

Heating technology with its shares through the investigated period is presented in the following table.

Table 3-27 Heating technology evolution 2015-2050, Baseline scenario (in %)

Heating technology	2015	2020	2030	2040	2050
Electricity individual	3.0%	2.6%	2.0%	1.5%	1.1%
Electricity central	0.0%	0.0%	0.0%	0.1%	0.1%
Gas Individual	0.0%	0.0%	0.0%	0.0%	0.0%
Gas central	0.0%	0.0%	0.0%	0.0%	0.0%
Petroleum products individual	0.5%	0.4%	0.4%	0.3%	0.2%
Petroleum products Central	0.0%	0.0%	0.0%	0.0%	0.0%
Coal individual	1.5%	1.3%	1.1%	0.8%	0.6%
Coal central	0.0%	0.0%	0.0%	0.0%	0.0%
Wood individual	71.0%	63.6%	50.6%	39.8%	30.5%
Wood individual new	0.0%	3.9%	10.8%	16.6%	21.5%
Wood individual pellet	0.0%	1.1%	2.9%	4.4%	5.8%
Wood central	0.0%	0.6%	1.7%	2.5%	3.3%
Pellet central	0.0%	0.9%	2.4%	3.6%	4.7%
Gas new central	0.0%	0.0%	0.0%	0.0%	0.0%

Heat pumps individual	24.0%	25.5%	28.0%	30.1%	31.9%
Heat pumps central	0.0%	0.1%	0.2%	0.3%	0.3%
DH central	0.0%	0.0%	0.0%	0.0%	0.0%
Total share	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Expert's calculations and projections

Final energy consumption (FEC) per energy carrier for heating has been calculated based on the heating technology evolution as well as corresponding CO2 emissions for the heating sub sector.

Table 3-28 Overview of heating sub sector evolution in the Baseline scenario for Montenegro

Parameter	2015	2020	2030	2040	2050
No of heating devices	188,376	197,007	215,473	235,670	257,761
FEC for heating (MWh/year)	2,015,146	2,042,441	2,110,202	2,194,387	2,294,238
Energy costs for heating (million €/year)	36.5	37.3	46.6	59.7	77
Average annual energy cost per dwelling €/dwelling year	193.9	189.1	216.1	253.2	298.0
CO2 emissions (tCO2/year)	279,447	295,261	328,660	364,725	403,809

Source: Expert's calculations and projections

Penetration of new technologies with pointed intensity based on the market survey has revealed the Baseline values for final energy consumption reaching 2,294 GWh in 2050. Also, the energy costs for heating are increasing from 36.5 million euros in 2015 to EUR 77 million in 2050 with taking into consideration of constant inflation rate of 2% annually.

If capital costs for each technology are applied for new technologies and decommissioning costs for the old ones based on the inputs elaborated in chapter 3.1., the annual engaged capital is 2.3 million €/year. With this approach, without including financial or economic analyses, the total investment predicted till 2050 or time period of 28 years should consider around 52.6 million EUR investments in the Baseline scenario.

3.5. NORTH MACEDONIA

3.5.1. ENERGY PRICES IN THE RESIDENTIAL SECTOR

Table 3-29 Energy prices in the residential sector in North Macedonia, 2021

Fuel	Price (€/kWh)	Source and assumptions
Coal/Lignite	0.019	Market research
Diesel	0.092	Market research
Fuel oil and by products	0.120	Market research
LPG	0.040	Market research
Natural gas	0.056	Market research

Biomass	0.035	Market research
Heat (District heating)	0.055	District heating company BEG - Skopje
Electricity	0.083	Energy and water services regulatory commission of the Republic of North Macedonia[22]

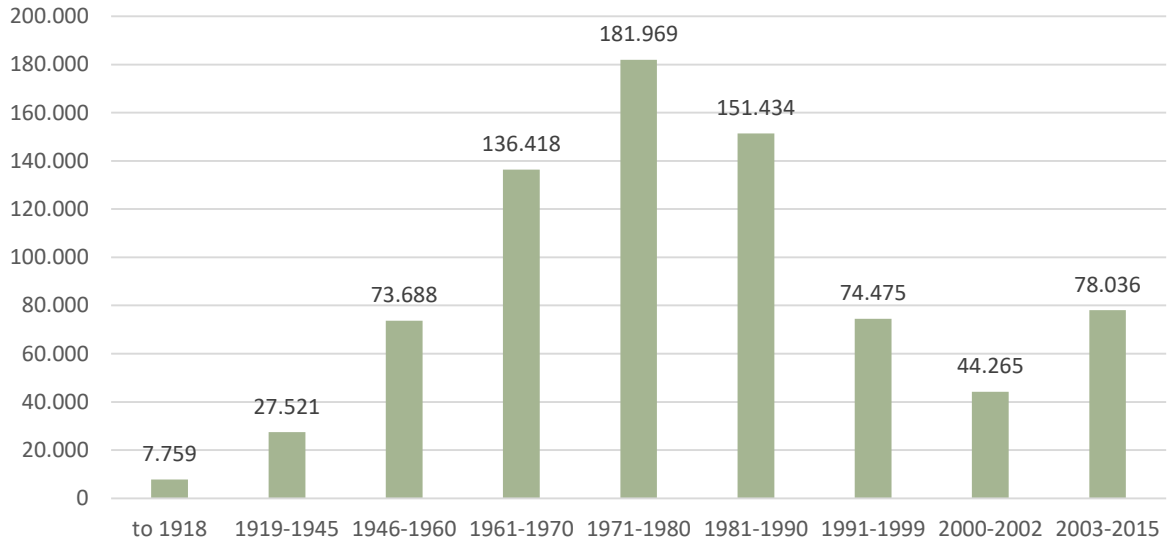
3.5.2. HOUSING STOCK

In North Macedonia, building typology is still in phase of preparation, together with the building renovation strategy. Consequently, this Report has been based on another available data as follows:

- Latest Census data from 2002[23]
- MAKStat database from State Statistical Office[24]
- Survey on energy consumption in Households from 2015[25]

From the available data for 2015, it can be noted that there are 775,565 dwellings with total floor area of 55,832,715 m^2 built in the following historic period.

Figure 3-16 Period of construction of the building inventory till 2015



Source: Census 2002 amended with MAKStat database

From the total inventory, around 72% are presenting occupied dwellings with average heated area of 37.4 m^2. Annual evolution of the building stock (number of dwellings) in the period 2016-2018 is ~0.71% or in terms of floor area is ~ 0.86%. These trends are taken from the Annual Reports published by the National Agency for Spatial Planning[26] and applied for the whole analyzed period 2015-2040.

[22] https://www.erc.org.mk/

[23] Available on the Makstat database

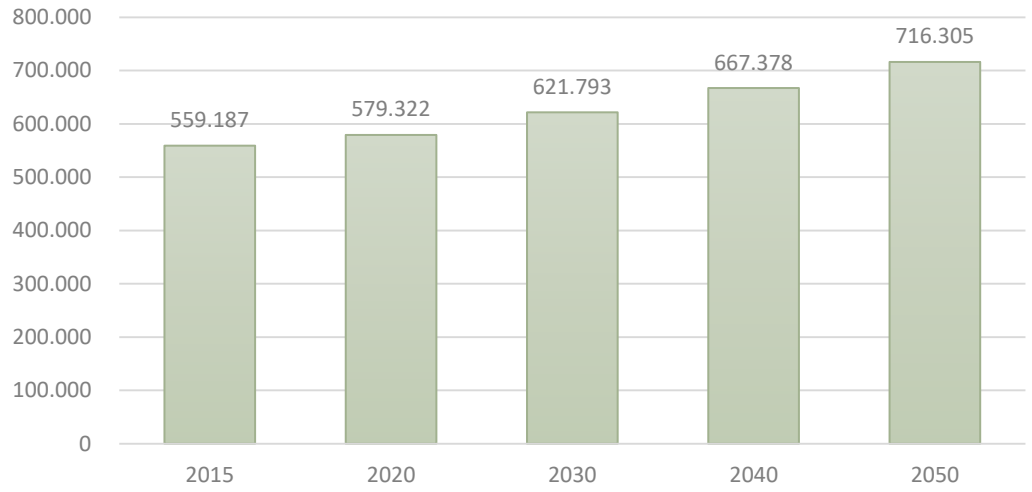
[24] http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/

[25] https://www.stat.gov.mk/PrikaziPoslednaPublikacija_en.aspx?id=74

[26] https://www.moepp.gov.mk/?page_id=4149

The number of occupied dwellings in the residential sector also indicates the number of heating devices used in the dwellings with assumption made only for the first used heating technology. With this approach, in 2050, it is expected the number of heating devices to reach level of 716,305 as totals in the residential sector.

Figure 3-17 Dwellings evolution in period 2015-2050



Source: Expert's projections

The following table summarizes the baseline data used in the analyses for the heating end user in the residential sector.

Table 3-30 Summary of residential baseline figures, North Macedonia

Parameters	Value	Unit
Number of occupied dwelling units	559,187	#
Total heated floor area	20.9	million m^2
Final energy consumption for heating	3,706	GWh/year
Average annual energy consumption for heating per dwelling	6,627	kWh/dwelling
Average energy intensity	177.3	kWh/m^2 year
Average energy need per heated area	128	kWh/m^2 year
CO2 emissions for heating in Residential sector	1,747,112	tCO2/year
Average annual CO2 emissions from heating per dwelling	3.1	tCO2/dwelling year
Total annual energy costs for the heating end use in residential sector	180.8	€ million/year
Average annual energy cost per dwelling	323	€/dwelling year

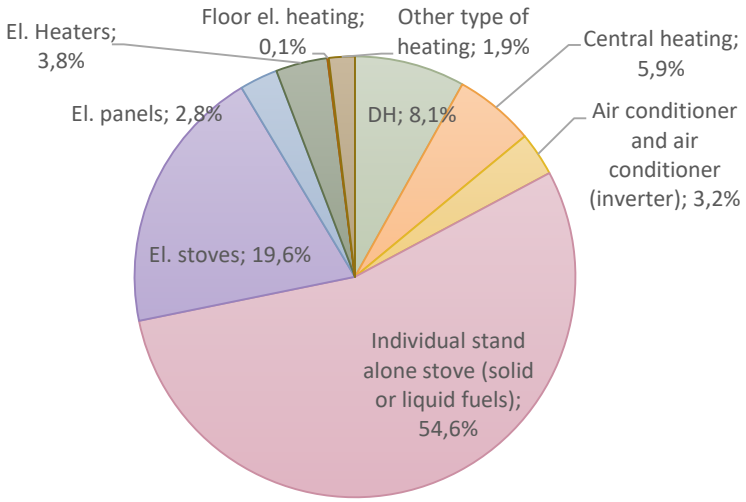
Source: Expert's calculations

3.5.3. BASELINE HEATING INVENTORY

Based on the 'Survey on energy consumption in households', published in 2015, the heating inventory has been developed for the base year. The mayor share of the dwellings is represented by the

individual stoves on solid fuels with 54.6%, followed by individual devices on electricity represented by thermal storage heaters with 19.6%.

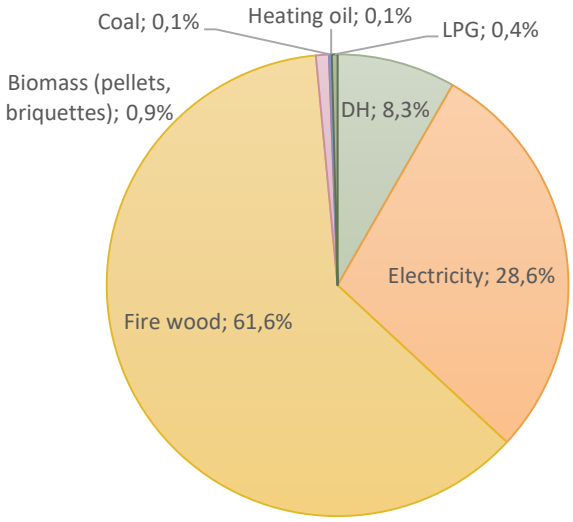
Figure 3-18 Heating technology share in residential sector 2015 (%)



Source: 'Energy consumption in households' survey, 2015

In the same survey, the energy carrier for heating is also expressed with leading fire wood (61.6%) followed by electricity with 28.6%.

Table 3-31 Shares of fuels for heating



Source: 'Energy consumption in households' survey, 2015

The share of each heating technology has been calibrated toward fuel share presented in the Eurostat's energy balances for the same year. With this, from total 559,187 dwellings, around 81% are equipped with individual systems, than 6.8% with central heating system and the rest are connected to the district heating network.

As very important step in the analyses is market research on national sales of heating devices. In the following table is presented the market sales (together with change in stock) for 2020 given from the vendors and represents total sales through all sectors residential, commercial and public sector. From

these values, with expert estimations have been extracted heating devices sales concluded only in residential sector.

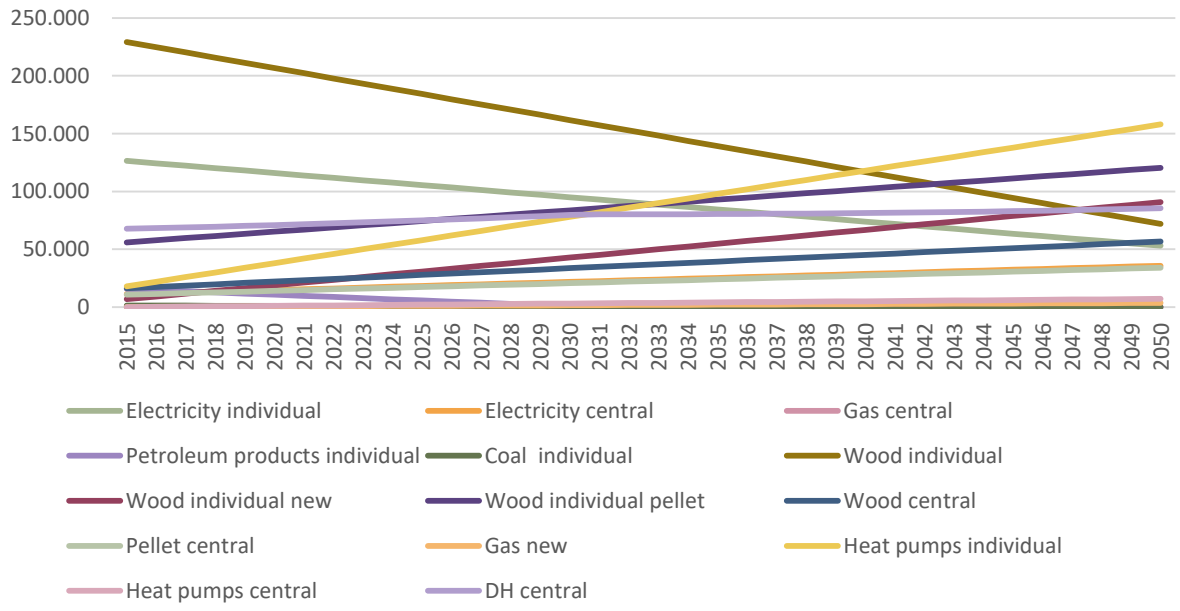
Table 3-32 Market sales of heating technologies for 2020 in North Macedonia (pieces)

Type of heating technology	Total value (pcs)	Value only for residential sector (pcs)
solid fuel stove manufacturer	11,850	3,555
pellet stoves manufacturer	5,580	2,511
inverter air conditioning, manufacturer	40,000	4,000
gas boilers	100	100
electric boilers	7,000	700
heat pumps	4,000	200
Total	**68,530**	**11,066**

Source: Market sales survey and expert's estimation

This market sales survey will be used in formulating the Baseline scenario with applying the presented heating technologies each year in the period 2015-2050. With this, from the 2015 inventory, heating technology penetration in the residential sector till 2050 can be developed in parallel with decommissioning of the old outdated heating devices.

Figure 3-19 Heating technology evolution 2015-2050, Baseline scenario



Source: Expert's calculations and projections

For better understanding the values in the Figure 3-19, next table has been prepared with separately presented reduced/increased devices per year, as well as cumulative reductions and cumulative enlargements in different time horizons.

Table 3-33 Heating technology evolution 2015-2050, Baseline scenario (in numbers)

Heating technology	Number of reduced/increased devices per year	2015	2020	2030	2040	2050
Electricity individual	(2,000)	126,432	115,932	94,932	73,932	52,932
Electricity central	700	11,184	14,684	21,684	28,684	35,684
Gas Individual	0	0	0	0	0	0
Gas central	0	224	224	224	224	224
Petroleum products individual	(1,000)	15,657	10,657	657	0	10
Petroleum products Central	0	0	0	0	0	0
Coal individual	(90)	1,398	948	48	0	10
Coal central	0	0	0	0	0	0
Wood individual	(4,500)	229,267	206,767	161,767	116,767	71,767
Wood individual new	2,400	6,710	18,710	42,710	66,710	90,710
Wood individual pellet	1,845	55,919	65,144	83,594	102,044	120,494
Wood central	1,155	16,216	21,991	33,541	45,091	56,641
Pellet central	666	10,625	13,955	20,615	27,275	33,935
Gas new central	100	0	500	1,500	2,500	3,500
Heat pumps individual	4,000	17,894	37,894	77,894	117,894	157,894
Heat pumps central	200	0	1,000	3,000	5,000	7,000
DH central	494	67,662	70,917	79,628	81,258	85,505
Totals		559,187	579,322	621,793	667,378	716,305
Reduces	(7,590)	/	-38,450	-115,350	-182,055	-248,035
Increased	11,560	/	58,585	177,956	290,246	405,153

Source: Expert's calculations and projections

Analyzing the Baseline situation, the total reduces are ~1.38% per year compared to the Baseline Year value, while the total increases are ~2.1% of the total Baseline Year value. The differences between the reduced and new introduced technologies of 0.71% presents new heating technologies identified in the new building evolution stock. In numbers for 2050, from the total 405,153 new technologies introduced in the period 2015-2050, exactly 157,118 devices will be new devices inside new built homes, while the rest of 248,035 devices will be new devices which replaces the old ones.

In the following table are presented shares of each heating technology in the projected period.

Table 3-34 Heating technology evolution 2015-2050, Baseline scenario (in %)

Heating technology	2015	2020	2030	2040	2050
Electricity individual	22.6%	20.0%	15.3%	11.1%	7.4%
Electricity central	2.0%	2.5%	3.5%	4.3%	5.0%
Gas Individual	0.0%	0.0%	0.0%	0.0%	0.0%
Gas central	0.0%	0.0%	0.0%	0.0%	0.0%
Petroleum products individual	2.8%	1.8%	0.1%	0.0%	0.0%
Petroleum products Central	0.0%	0.0%	0.0%	0.0%	0.0%
Coal individual	0.3%	0.2%	0.0%	0.0%	0.0%
Coal central	0.0%	0.0%	0.0%	0.0%	0.0%
Wood individual	41.0%	35.7%	26.0%	17.5%	10.0%
Wood individual new	1.2%	3.2%	6.9%	10.0%	12.7%
Wood individual pellet	10.0%	11.2%	13.4%	15.3%	16.8%
Wood central	2.9%	3.8%	5.4%	6.8%	7.9%
Pellet central	1.9%	2.4%	3.3%	4.1%	4.7%
Gas new central	0.0%	0.1%	0.2%	0.4%	0.5%
Heat pumps individual	3.2%	6.5%	12.5%	17.7%	22.0%
Heat pumps central	0.0%	0.2%	0.5%	0.7%	1.0%
DH central	12.1%	12.2%	12.8%	12.2%	11.9%
Total share	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Expert's calculations and projections

Final energy consumption (FEC) per energy carrier for heating has been calculated based on the heating technology evolution as well as corresponding CO2 emissions for the heating sub sector.

Table 3-35 Overview of heating sub sector evolution in the Baseline scenario for North Macedonia

Parameter	2015	2020	2030	2040	2050
No of heating devices	559,187	579,322	621,793	667,378	716,305
FEC for heating (MWh/year)	3,704,031	3,684,247	3,656,789	3,672,326	3,708,089
Energy costs for heating (million €/year)	180.8	177.5	204.9	251	310
Average annual energy cost per dwelling €/dwelling year	323.3	306.3	329.6	376.3	433.3
CO2 emissions (tCO2/year)	1,747,112	1,751,678	1,764,574	1,792,752	1,827,350

Source: Expert's calculations and projections

Penetration of new technologies with pointed intensity based on the market survey has revealed the Baseline values for final energy consumption, which is decreasing instead of increased number of

heating devices. This tendency is a result of the better efficiencies of the new entered devices than the old ones. On the other hand, the CO2 emissions are going up following new fuel share where electricity share is increased instead of fire wood individual devices that are commissioned.

If capital costs for each technology are applied for new technologies and decommissioning costs for the old ones based on the inputs elaborated in chapter 3.1., the annual engaged capital is 6.7 million €/year. With this approach, without including financial or economic analyses, the total investment predicted till 2050 starting with 2022 or time period of 28 years should consider around EUR 170.2 million CAPEX investments in the Baseline scenario.

3.6. SERBIA

3.6.1. ENERGY PRICES IN THE RESIDENTIAL SECTOR

Table 3-36 Energy prices in the residential sector in Serbia, 2021

Fuel	Price (€/kWh)	Source and assumptions
Coal/Lignite	0.04	Energy Agency[27]
Fuel oil and by products	0.1	Energy Agency
LPG	0.1	Energy Agency
Natural gas	0.03	Energy Agency
Biomass	0.02	Energy Agency
Heat (District heating)	0.054	Market research
Electricity	0.047	Elektroprivreda Srbija[28]

3.6.2. HOUSING STOCK

Republic of Serbia has already prepared 'National Typology of Residential Buildings' in accordance to the TABULA methodology. Meanwhile, Serbia has also prepared the final draft of 'Long term building renovation strategy' and its adoption is expected to be finalized this year.

Based on the building typology, in Serbia there are 2,246,320 buildings with 3,188,414 dwellings forming total floor area of 289,684,720 m^2. From this, 67.5% are individual houses while 32.5% are collective housing buildings. In the following matrix, the building inventory in term of dwellings is presented based on the building type and period of construction.

[27] https://www.aers.rs/g/vesti/file/Dokumenti/2020_10_12%20Grejanje%20CENE%20Okt_2020.pdf

[28] https://www.aers.rs/FILES/Odluke/OCenama/2021-02-01%20Cene%20GS%20EPS%20Odluka%20za%20sajt.pdf

Table 3-37 Building inventory per dwellings type and age cohort, 2017

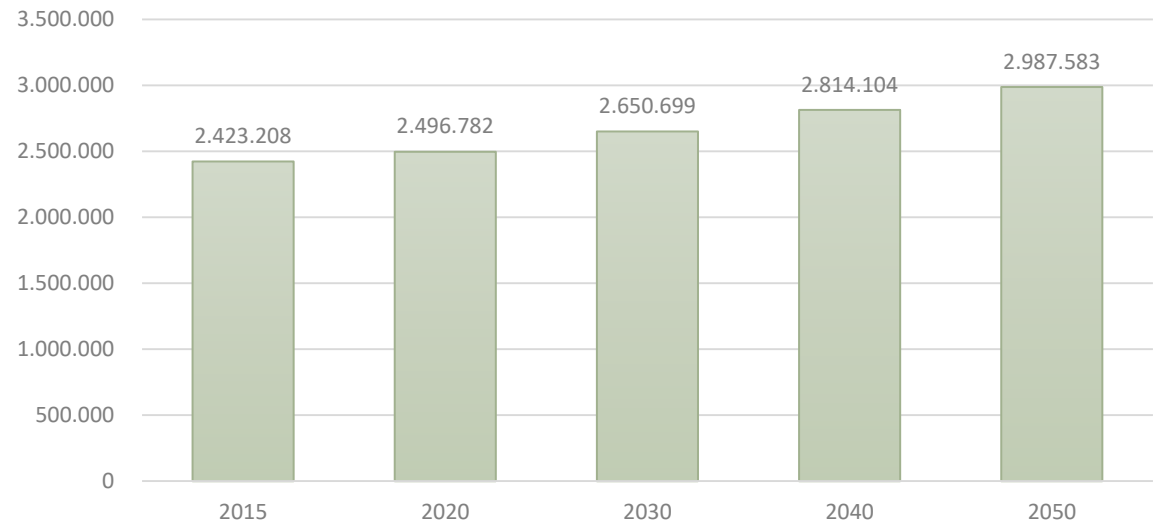
Construction period	Single family houses	Terraced houses	Multi-family houses	Apartments blocks	Totals per age	% per age
<1919	117,985	17,394	4,078	567	140,024	4.4%
1919-1945	195,812	11,078	30,507	2,457	239,854	7.5%
1946-1960	289,604	12,139	36,545	15,510	353,798	11.1%
1961-1970	379,607	23,490	91,109	47,846	542,052	17.0%
1971-1980	494,751	22,444	132,801	131,135	781,131	24.5%
1981-1990	435,469	22,951	122,302	90,846	671,568	21.1%
1991-2011	291,304	13,679	112,689	42,315	459,987	14.4%
Totals per type	2,204,532	123,175	530,031	330,676	3,188,414	100.0%
% per type	69.1%	3.9%	16.6%	10.4%	100.0%	

Source: National Typology of Residential Buildings

In accordance to the 'Typology of the residential building stock in Serbia and modelling its low-carbon transformation (SLED)', there are 2,423,208 occupied dwellings with 179,703,282 m^2. On the other hand, when analyzing the heated area, there are different shares for individual and collective housing; for individual housing the heated area is only 50 % of the total occupied area while in collective housing this percent is around 80%. With this, the total heated floor area in Serbia is calculated to be 107,380,975 m^2 or average 44.3 m^2/dwelling.

Taking into consideration the tendency in the last five years, the evolution of the building inventory is considered 0.6% on annual level in terms of number of dwellings. This percent has been applied for calculation of dwelling stock in the investigated period 2015 – 2050.

Figure 3-20 Dwellings evolution in period 2015-2050



Source: Expert's projections

The following table summarizes the baseline data used in the analyses for the heating end user in the residential sector.

Table 3-38 Summary of residential baseline figures, Serbia

Parameters	Value	Unit
Number of occupied dwelling units	2,423,208	#
Total heated floor area	107.4	million m^2
Final energy consumption for heating	21,130	GWh/year
Average annual energy consumption for heating per dwelling	8,720	kWh/dwelling
Average energy intensity	197	kWh/m^2 year
Average energy need per heated area	138	kWh/m^2 year
CO2 emissions for heating in Residential sector	10,971,500	tCO2/year
Average annual CO2 emissions from heating per dwelling	4.5	tCO2/dwelling year
Total annual energy costs for the heating end use in residential sector	755.1	€ million/year
Average annual energy cost per dwelling	312	€/dwelling year

Source: Expert's calculations

3.6.3. BASELINE HEATING INVENTORY

In the 'Typology of the residential building stock in Serbia and modelling its low-carbon transformation (SLED)[29]', for heating, biomass is the most widely used option (27.7 percent), followed by district heating (12.8 percent). Coal, natural gas and LPG are also notable.

Table 3-39 Assumed energy source mix for heating used in SLED model

In %	Natural Gas	Electricity	Coal	Oil	Wood	District heating
General use	9	17	7.5	3	63.5	0
Buildings with district heating	0	0	0	0	13	83

Source: Typology of the residential building stock in Serbia and modelling its low-carbon transformation (SLED), table 5

For this report, heating technology inventory has been prepared based also on the Eurostat Energy Balance for 2015, calibrated for the 2016, 2017, 2018 and 2019.

Furthermore, for establishing the heating technology inventory in the upcoming period, for baseline scenario were considered market sales for 2020 given from the vendors and represents total sales through all sectors residential, commercial and public sector. From these values, with expert estimations have been extracted heating devices sales concluded only in residential sector.

[29] https://www.ikem.de/wp-content/uploads/2016/01/SLED_Serbia_BUILDING_ENG.pdf

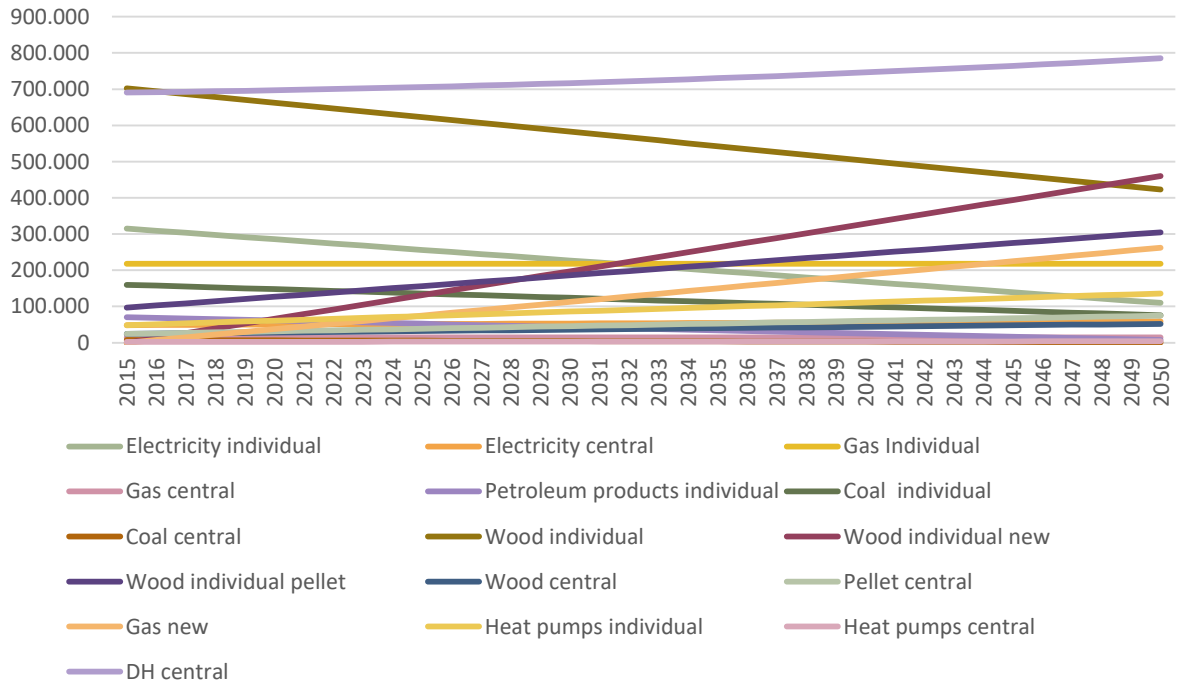
Table 3-40 Market sales of heating technologies for 2020 in Serbia (pieces)

Type of heating technology	Total value (pcs)	Value only for residential sector (pcs)
solid fuel stove manufacturer	46,450	13,935
pellet stoves manufacturer	16,400	7,380
inverter air conditioning, manufacturer	25,000	2,500
gas boilers	15,000	7,500
electric boilers	3,000	300
heat pumps	800	40
Total	**106,650**	**31,655**

Source: Market sales survey and expert's estimation

With applying the presented heating technologies each year in the period 2015-2050 the following baseline scenario and heating technology penetration is being prepared.

Figure 3-21 Heating technology evolution 2015-2050, Baseline scenario



Source: Expert's calculations and projections

For better understanding, the same diagram has been presented in table outlook as follows:

Table 3-41 Heating technology evolution 2015-2050, Baseline scenario (in numbers)

Heating technology	Number of reduced/increased devices per year	2015	2020	2030	2040	2050
Electricity individual	(5,860)	315,017	285,717	227,117	168,517	109,917
Electricity central	300	48,464	49,964	52,964	55,964	58,964
Gas Individual	0	218,089	218,089	218,089	218,089	218,089
Gas central	0	14,539	14,539	14,539	14,539	14,539
Petroleum products individual	(1,800)	70,273	61,273	43,273	25,273	7,273
Petroleum products Central	0	0	0	0	0	0
Coal individual	(2,400)	159,932	147,932	123,932	99,932	75,932
Coal central	(180)	7,270	6,370	4,570	2,770	970
Wood individual	(8,000)	702,730	662,730	582,730	502,730	422,730
Wood individual new	13,140	0	65,700	197,100	328,500	459,900
Wood individual pellet	5,940	96,928	126,628	186,028	245,428	304,828
Wood central	795	24,232	28,207	36,157	44,107	52,057
Pellet central	1,440	24,232	31,432	45,832	60,232	74,632
Gas new central	7,500	0	37,500	112,500	187,500	262,500
Heat pumps individual	2,500	48,464	60,964	85,964	110,964	135,964
Heat pumps central	40	2,423	2,623	3,023	3,423	3,823
DH central	1,212	690,614	697,113	716,880	746,135	785,464
Totals	**14,627**	**2,423,208**	**2,496,782**	**2,650,699**	**2,814,104**	**2,987,583**
Reduces	(18,240)	/	-90,300	-270,900	-451,500	-632,100
Increased	32,867	/	163,874	498,391	842,396	1,196,475

Source: Expert's calculations and projections

Analyzing the Baseline situation, the total reduces are ~0.75 % per year compared to the Baseline Year value, while the total increases are ~1.36% of the total Baseline Year value. The differences between the reduced and new introduced technologies of 0.6% presents new heating technologies identified in the new building evolution stock.

In the following table are presented shares of each heating technology in the projected period.

Table 3-42 Heating technology evolution 2015-2050, Baseline scenario (in %)

Heating technology	2015	2020	2025	2030	2035	2040
Electricity individual	13.0%	11.4%	8.6%	6.0%	3.7%	13.0%
Electricity central	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Gas Individual	9.0%	8.7%	8.2%	7.7%	7.3%	9.0%
Gas central	0.6%	0.6%	0.5%	0.5%	0.5%	0.6%
Petroleum products individual	2.9%	2.5%	1.6%	0.9%	0.2%	2.9%
Petroleum products Central	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Coal individual	6.6%	5.9%	4.7%	3.6%	2.5%	6.6%
Coal central	0.3%	0.3%	0.2%	0.1%	0.0%	0.3%
Wood individual	29.0%	26.5%	22.0%	17.9%	14.1%	29.0%
Wood individual new	0.0%	2.6%	7.4%	11.7%	15.4%	0.0%
Wood individual pellet	4.0%	5.1%	7.0%	8.7%	10.2%	4.0%
Wood central	1.0%	1.1%	1.4%	1.6%	1.7%	1.0%
Pellet central	1.0%	1.3%	1.7%	2.1%	2.5%	1.0%
Gas new central	0.0%	1.5%	4.2%	6.7%	8.8%	0.0%
Heat pumps individual	2.0%	2.4%	3.2%	3.9%	4.6%	2.0%
Heat pumps central	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
DH central	28.5%	27.9%	27.0%	26.5%	26.3%	28.5%
Total share	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Expert's calculations and projections

Final energy consumption (FEC) per energy carrier for heating has been calculated based on the heating technology evolution as well as corresponding CO2 emissions for the heating sub sector.

Table 3-43 Overview of heating sub sector evolution in the Baseline scenario for Serbia

Parameter	2015	2020	2030	2040	2050
No of heating devices	2,423,208	2,496,782	2,650,699	2,814,104	2,987,583
FEC for heating (MWh/year)	21,089,927	21,466,901	22,266,712	23,130,808	24,063,151
Energy costs for heating (million €/year)	755.1	752.7	896.6	1,094.4	1,342
Average annual energy cost per dwelling €/dwelling year	311.6	301.5	338.2	388.9	449.3
CO2 emissions (tCO2/year)	10,971,500	10,596,870	9,881,639	9,214,107	8,597,216

Source: Expert's calculations and projections

Although the number of devices are increasing as well as the final energy consumption, in the Baseline scenario, CO2 emission are going down ending with more than 2 million tons of CO2 reduction in period 2015-2050. This is result from the new energy mix which includes greener heating technologies with higher energy efficiency.

If capital costs for each technology are applied for new technologies and decommissioning costs for the old ones based on the inputs elaborated in chapter 3.1., the annual engaged capital is 17.4 million €/year. With this approach, without including financial or economic analyses, the total investment predicted till 2050 starting with 2022 or time period of 28 years should consider around EUR 469 million CAPEX investments in the Baseline scenario.

3.7. SUMMARIZED ENERGY PERFORMANCE

Based on the revealed approaches as well as on the exiting surveys and reports for each country separately referenced in the previous chapters, summarized energy performance of the residential sector will be presented.

Western Balkan's building stock is both unique and heterogeneous in its expression of the cultural diversity and history of our peninsula. The age cohort starts far before 1919 year, and with this study is covered till 2015, adopted as Baseline Year for the future projections.

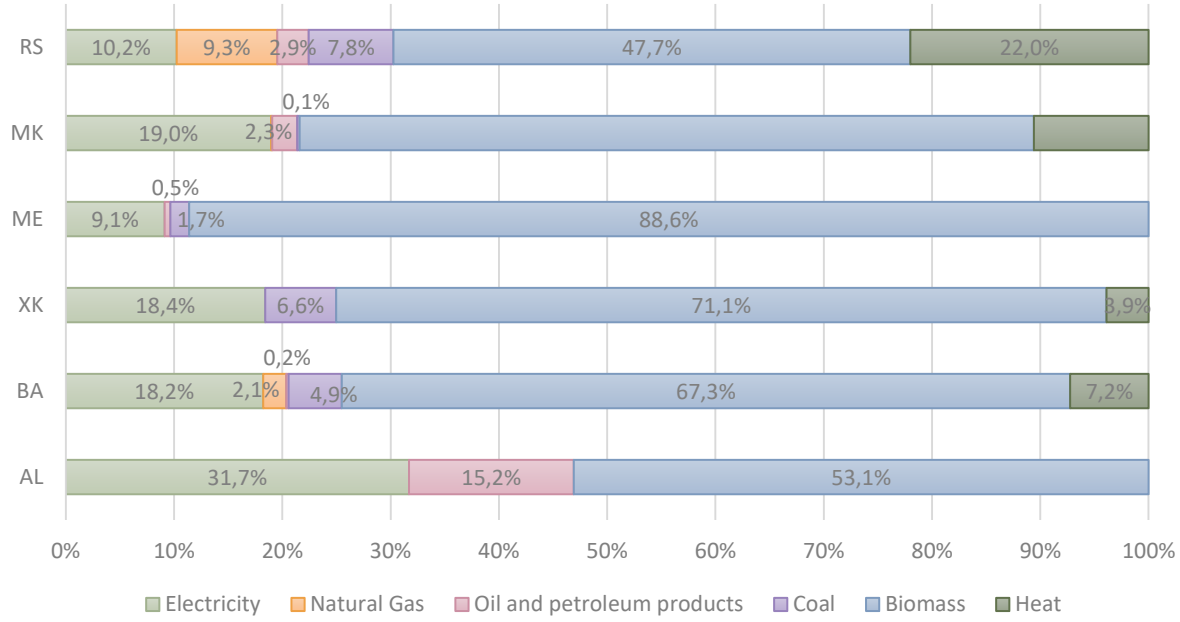
Table 3-44 Overview of residential building age cohort in WB6 in number of dwellings (#)

	Before 1919	1919 - 1945	1946 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991-2000	2001-2015	unknown	Totals
Albania	86,393			186,012		137,358	180,238	279,345	229,079	1,012,032
Bosnia and Herzegovina	19,275		87,575	240,318	437,609	370,287	464,122			1,619,186
Kosovo*	7,600			13,539	41,435	150,278		200,031		412,883
Montenegro		13,989	23,573	81,967		76,526		112,991	6,624	315,670
North Macedonia	7,759	27,521	73,688	136,418	181,969	151,434	74,475	122,301		775,565
Serbia	140,024	239,854	353,798	542,052	781,131	671,568	503,504			3,231,931

Source: Consultant's compilation

The residential sector in WB6 has tremendous impact on the overall energy demand of the countries especially when the heating energy consumption is put in question. From analyses, only heating demand is in range around 52% -75% of the final (delivered) energy consumption FEC of the residential sector. Fuel mix for heating is calculated based on input taken from the referenced surveys and studies separately for each country with adjustments made based on the Eurostat energy balances in period 2015 – 2019. With this approach, final energy consumption only for heating has been projected for period till 2050 signed as Baseline scenario. In the following figure, fuel mix for heating is presented for 2020 as first simulation year.

Figure 3-22 Energy carriers used as source for heating in 2020 (%)



Source: Consultant's compilation based on Eurostat energy balances

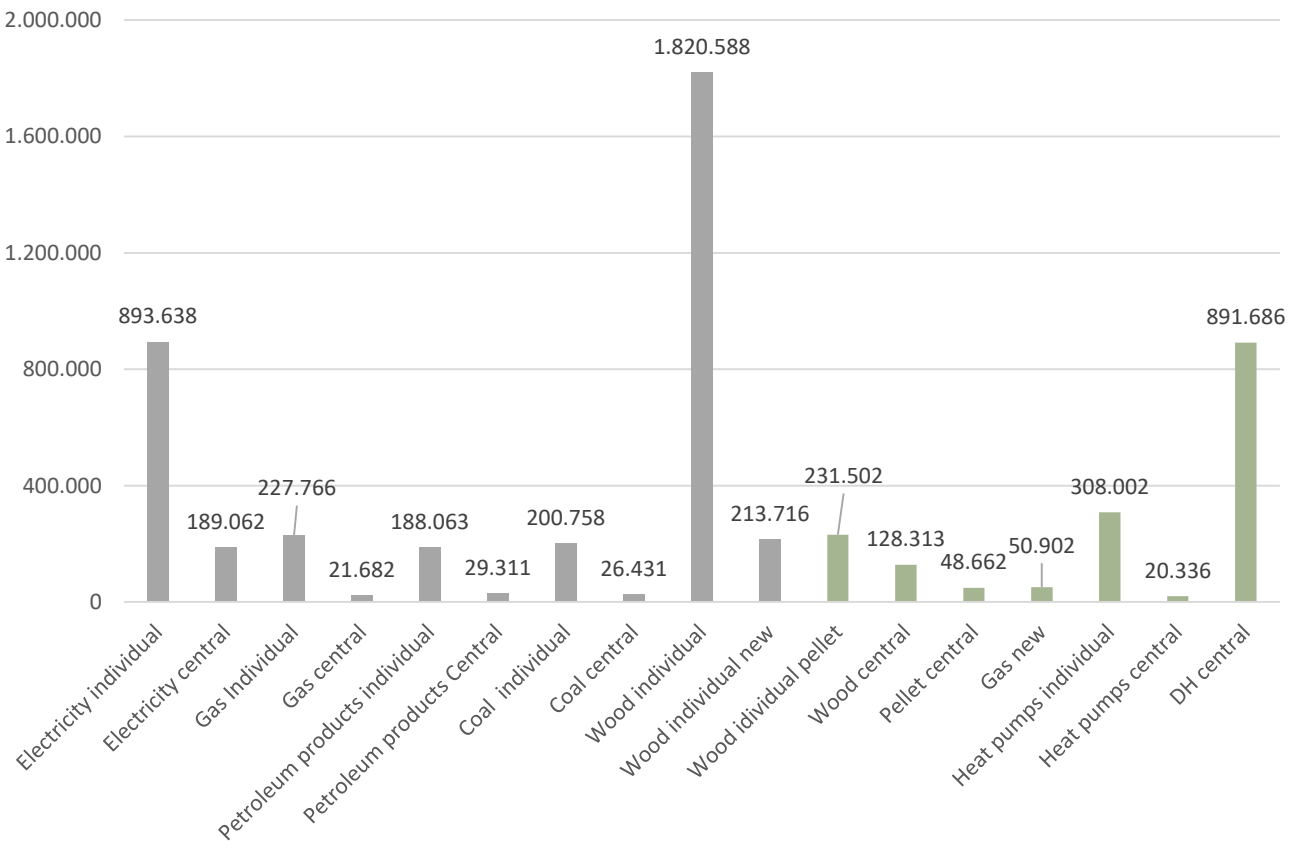
In the same context, heating technologies with adopted efficiencies (

For all the WB countries, identical approach has been applied in terms of determination of the existing and penetration of new technologies with adoption of devices efficiencies and life cycle of the heating devices.

The prevailing systems approximated for the region are visualized as presented on the following picture. The life span considered for the heating system is 20 years. The efficiencies of each system were estimated meticulously to obtain energy balance total final energy consumption corresponding to the share for typical systems. The main assumptions in favor of the main objective of this report is that old technologies, represented in grey color are the subject of decommissioning, while green represent the new ones.

Figure 2-1) have been calculated. The following figure presents the total heating technologies inventory for the WB region, for the first simulation year 2020.

Figure 3-23 Heating technologies in WB6 in 2020 (#)



Source: Consultant's compilation based on Eurostat energy balances

For heating, biomass[30] is a dominant energy carrier across the Western Balkans followed by electricity. District heating is present in Bosnia and Herzegovina, than in Kosovo* (Prishtina and Gjakovica), in North Macedonia (only in Skopje), and in Serbia.

The Baseline scenario is formulated based on the market sales of the new heating technologies. The new ones replace the old ones, but also one part of the new inventory is used for the new built homes. The share of new heating technologies in the new building stock follows the annual growth of new buildings.

This scenario is presenting the real, most likely replacements of the heating devices or 'rule 1:1' where the old 'grey' devices are replaced with new 'green' ones on the same fuel; for example family who uses old electrical thermal stove will replace it with new inverter, or the old wood stove will be replaced with eco stove on woods.

Figure 3-24 Annual reduced and introduced heating technologies in Baseline scenario (%)

Country	Annual reduced	Annual introduced	New annual heating systems at new building stock
Albania	1.60%	1.60%	0.00%
Bosnia and Herzegovina	3.70%	3.79%	0.09%

[30] Biomass covers fire wood as well as wood products as pellets, briquettes, etc. as stated in the EuroSTAT energy Balances

Kosovo*	1.30%	2.30%	1.00%
Montenegro	0.90%	1.90%	1.00%
North Macedonia	1.38%	2.10%	0.72%
Serbia	0.75%	1.36%	0.61%

Source: Consultant's projections based on market sales

Although the trend of 'green' heating technologies in new built homes is complementary with the annual evolution of the building inventory, reduction of the heating inventory is not in compliance with the renovation of the building stock. In other words, inhabitants, when moving in new homes, are installing new 'green' heating technologies recognized on the market. With this, as the number of new built dwellings is arising, with same annual rate is increasing the heating system inventory in the new homes.

On the other hand, the existing households not always simultaneously renovate building elements (windows, façade, roof, etc.) when they replace the old stove. Expert's estimation is that only 20% of households who are replacing the heating system are also conducting partial retrofits on the building envelope. These investments are assumed to be 51 EUR/m^2.

With this, can be approached to the engaged annual investments of the existing old building inventory as follows:

Figure 3-25 Annual renovation rate of building envelope in Baseline scenario

Country	Heated floor area	Annual reduction rate of h. systems	Annual renovation rate of building envelope	Annual renovated area	Renovated vs heated floor area	Specific CAPEX	CAPEX
Unit	m^2	%	%	m^2/a	%	€/m2 a	€, million/a
Albania	43,053,621	1.60%	20.0%	137,772	0.32%	51	7
Bosnia and Herzegovina	61,233,456	3.70%		453,128	0.74%		23
Kosovo*	17,191,098	1.30%		44,697	0.26%		2
Montenegro	8,836,621	0.90%		15,906	0.18%		1
North Macedonia	20,917,728	1.38%		57,733	0.28%		3
Serbia	107,380,975	0.75%		161,071	0.15%		8
Total	**258,613,498**			**870,306**	**0.34%**		**44**

Source: Consultant's projections

With this approach, it can be stated that 0.34% of the existing building stock is renovated each year on the region level, with ~EUR 44 million annual investments. In timeframe of 28 years, with this dynamic, it will be renovated around 10% of the homes that are heated today. If this approach is applied on the total occupied inventory, not on the heated one, then till 2050 will be renovated only 6% of the occupied buildings that shall be included in the renovation process.

The renovation of building envelope together with the heating systems are crucial in prevention of the countries from energy poverty and energy dependence. From these analyses can be derived one very crucial fact, although in this Report carbon taxes and health costs are not included, in the future period energy costs per dwelling will go up constantly.

4. EU RENOVATION WAVE IN WESTERN BALKANS CONTEXT

4.1. ENERGY EFFICIENCY IN BUILDINGS

As the building sector with over 40% of total energy consumption is one of the largest energy consumers, introducing energy efficiency in this sector will significantly contribute toward clean energy system and future decarburization among the WB6 countries.

The Directive 2010/31/EU on the Energy Performance of Buildings (EPBD) focuses on the energy efficiency potential in buildings, setting the minimum energy performance requirements for new and existing buildings, certification of buildings and requires regular inspections of heating and air-conditioning systems.

On November 30 2016, as part of the Clean Energy for All Europeans package, the European Commission proposed an update of EPBD to help promote the use of smart technology in buildings, to streamline existing rules and accelerate building renovation. On 19 June 2018 Directive (2018/844/EU) amending the EPBD was published. The revised provisions entered into force on 9 July 2018.

The new requirements of the revised EPBD are related to cost-effective deep renovation of buildings and relevant national actions tackling of energy poverty, supports electro-mobility infrastructure deployment in buildings' car parks and introduces new provisions to enhance smart technologies (incl. smart readiness indicator) and technical building systems, including automation and control.

This revision also introduces the Long-term Renovation Strategy provisions, with the vision of a decarbonized building stock by 2050, cost-effective transformation of existing buildings into nearly zero-energy buildings and the mobilization of investments.

In the Energy Community, this Directive is expected to be adopted at the Ministerial Council in November 2021 with an implementation deadline of approx. 18 months to transpose its provisions into national law.

The work on transposition of EPBD is currently ongoing in all WB6 as Contracting Parties of the Energy Community, with submission of Reports on the implementation on regular basis.

4.2. EU RENOVATION WAVE

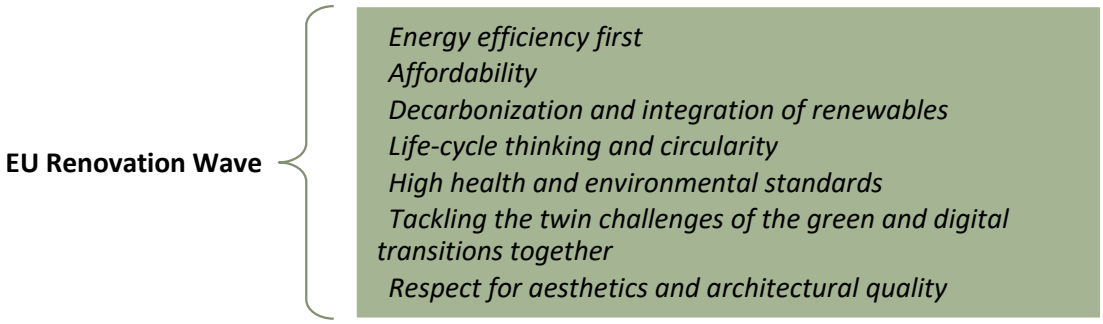
On October 14 2020 the European Commission adopted a new strategy to boost renovation called 'A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives[31]' with dual ambition of energy gains and economic growth. The objective is to reduce net greenhouse gas emissions by at least 55% in 2030 resulting in 35 million building units being renovated by 2030 and build the foundations for a climate neutral Europe by 2050.

This strategy aims to double annual energy renovation rates in the next 10 years resulting in reduction of emissions, improvement of life quality inside the buildings, and creation of green jobs in the construction sector. Its priorities are (i) tackling energy poverty as outlined in the 'Commission recommendation on energy poverty[32] and worst performing buildings, (ii) renovation of public buildings such as schools, hospitals and public administrations and (iii) decarbonisation of heating and cooling.

[31] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662

[32] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020H1563&qid=1606124119302

Figure 4-1 Key principles for building renovation inside the EU Renovation Wave



Today, annual energy renovation rate is low at some 1% while deep renovations that reduce energy consumption by at least 60% are carried out only in 0.2% of the building stock per year. Beside increased rate of renovation, this strategy fosters deep energy renovations with introducing 'deep renovation' standard in the future revision of the Energy Performance of Buildings Directive.

As stated in the Strategy, in the EU, around 80% of energy consumed in residential buildings is for heating, cooling and domestic hot water where two thirds of this energy comes from fossil fuels. Many systems are old and inefficient and half are beyond their service lifetime. Stand-alone systems provide up to 88% of heat supply and district heating systems supply the remaining 12%.

Based on the 2030 Climate Target Plan, the residential sector would have to undergo the highest reduction by 2030 with decreasing buildings' greenhouse gas emissions by 60%, their final energy consumption by 14% and energy consumption for heating and cooling by 18% compared to 2015 levels. The annual rate of replacement of heating equipment would have to reach around 4% in both the residential and services sector. During the same time period, the share of renewables and waste heat would have to increase to 38-42% to reach the objective.

In achieving the set targets in this strategy, many barriers have to be overcame. The renovation wave introduces policy instruments, funding and technical assistance, including:

- Information, incentives and legal certainty for owners and tenants
- Finance via NextGenerationEU and other EU and private funds
- Increased capacity for public authorities and training for workers
- Market development for sustainable construction products
- Neighborhood-based and community-led approaches

While the EU is riding the renovation wave toward set targets, many reports investigated whether the Renovation Wave action plan is coherent and target-oriented, putting the EU on a path to deliver the 2030 Climate Targets. In the BPIE Renovation Wave Analyses[33], it is shown that a higher renovation rate and depth is needed to contribute to the 2030 climate objective. The goal should be to increase the annual deep renovation rate from the current 0.2% to 3% as quickly as possible. In the same time, the Euro Cities' report[34] advices for successful Renovation Wave the renovation rate should be increased to at least 3% per year combined with an average energy demand reduction of 75% to reach climate neutrality in 2050 in full respect of the principle of subsidiarity.

[33] https://www.bpie.eu/wp-content/uploads/2021/04/BPIE_Renovation-Wave-Analysis_052021_Final.pdf

[34] https://ec.europa.eu/futurium/en/system/files/ged/eurocities-policy-paper-renovation-wave_final_10092020.pdf

4.3. APPLICABILITY OF THE EU RENOVATION WAVE IN THE WESTERN BALKANS

The European Commission proposed to expand the "EU renovation wave" to the Western Balkans. On October 10, 2020, the European Commission adopted "An Economic and Investment Plan for the Western Balkans", which identified flagship initiatives related to clean energy and the transition from coal. An overall budget of EUR 9 billion during 2021-2027 is proposed for the Plan's implementation (Green Agenda for the Western Balkans), of which a fair share is expected to finance buildings renovation and decarbonisation of heating and cooling sectors.

An additional political impetus was given at the 2020 Sofia Summit, in which the leaders agreed to:

(i) "Support private and public buildings renovation schemes, secure appropriate financing and full enforcement of the Energy Performance of Building Directive (adapted under the Energy Community framework)"; and

(ii) "Develop programmes for addressing energy poverty and financing schemes for household renovation and providing basic standards of living".

The topics that are included in the Green Agenda for the Western Balkans are:

- Clean energy and energy efficiency
- Circular economy and waste management (including waste prevention programmes, waste management and recycling strategies, waste management infrastructures)
- Smart and Sustainable Mobility (including railway, road infrastructure, e-mobility, logistics)
- Air quality
- Water quality and management (including wastewater treatment)
- Soil quality and management (including flood defense projects, etc.)
- Rural development and sustainable food systems
- Biodiversity: protection and restoration of ecosystems
- Smart specialization and other research and innovation strategies
- Regional cooperation programmes e.g. Interreg

Implementation of the 'Renovation Wave' in WB6 will require a significant amount of dialogue and holistic approach, including new or adopted legal and regulatory framework, to become an enabling factor for large scale investments in existing buildings. Realization framework will be through the Long-term Renovation Strategies prepared under the EPBD integrated in the EE dimension of National Energy and Climate Plans (NECPs). The countries should prepare their strategic documents (renovation strategies as well as NECPs) based on the 'Renovation Wave' targets while the existing ones will have to be updated reflecting the need for more ambitious renovation wave.

Table 4-1 Strategic documents for building renovation initiation in WB6

Country	National Building Typology	National Building Strategy		NECP
Albania	✓	−		⊙
Bosnia& Herzegovina	✓	⊙	Draft version ● 1.0% renovation rate in light scenario ● 2.2% renovation rate in ambitious scenario ● 2.8% renovation rate in very ambitious scenario	⊙

Kosovo*	✓	⊙	Draft version ● 4.5% renovation rate in residential sector till 2040 ● 3% renovation rate in residential sector till 2050	⊙
Montenegro	✓	–		⊙
North Macedonia	⊙	–		⊙
Serbia	✓	⊙		⊙

Source: Energy Community

Legend

✓ *In place* ⊙ *In progress* – *Not in place*

For large scale building renovations to take place in practice, systematic preparation is needed with the following activities included:

- Initiation
  - Preparation/update of the strategic documents (Long-term strategies, NECPSs) for building renovation
  - Development/extension of the institutional infrastructure for project preparation and large scale renovations programme management
  - Home owners' association legislation amended or adopted to facilitate the implementation
  - Prepare logistics for applications, award, implementation of works
- Implementation
  - Identify priorities (worst-performing buildings) on national level
  - Mapping dwellings of people at risk of energy poverty
  - Training for skilled workers
  - Setting up a One stop shop for information
  - Implementation of deep renovations
- Financial framework
  - Analyze and map of national and regional financial mechanisms to implement strategies and improve the energy efficiency of buildings
  - Developing targeted financial solutions for lower-income households
- Monitoring and Reporting
  - Renovation targets, policy measures and link with NECPs
  - Monitoring and reporting under EE dimension in NECPs

At the Western Balkans Countries, the present renovation process is far from being advanced. Energy Community in its 'Energy Transition Tracker for Western Balkans[35]' has reported that between 2010-2021 approximately EUR 1.4 billion were invested in EE in all building categories, mostly public buildings. The figure is significantly lower in the residential sector, which due to the many barriers is considered a difficult market to serve as it is fragmented, with small scale investments, and riskier than the other building categories. Multi-apartment buildings face additional barriers when it comes to large

[35] https://www.energy-community.org/regionalinitiatives/WB6/Tracker.html

scale renovation programmes. Most of the barriers were identified by a recent study funded by USAID "Gap analysis of the housing sector in Western Balkans countries[36]", including:

- Legal and regulatory barriers for securing investments in MABs, such as:
  - The legal registration and liabilities related to common property (staircases, basement, roofs, etc.)
  - There is either a low level of buildings maintenance fees, or the collection rate is low, hence, the "repair and maintenance fund" of the building is not able to support significant renovation investments
  - Financial liabilities acquired by homeowner's associations (HOAs) cannot be legally secured
  - Complicated collective decision making – sometimes requiring 100% of owners 'approval.
- Poor institutional capacities of HOAs for managing and maintaining, designing, implementing complex investment projects and adequately procuring professional services;
- Limited cash flow generated by HOAs due to poor collections and persisting social vulnerability in the population;
- High upfront cost for renovations and diverse income of homeowners in MABs which may hinder affordability and decision-making;
- Split incentive between tenants and homeowners related to the benefit of EE renovations
- Bankers' and investors' perception of high risks in the HOA sector;
- Legal limitations in banks' lending rules related to unsecured lending, as long as most HOAs do not possess any assets subject for collateralization;
- Long payback periods of investments in aging MABs with a multitude of outstanding repair and maintenance-related issues, in addition to EE, such as structural, aesthetic, or functionality improvements;
- Low awareness of potential financial and comfort gains from EE investments among building occupants; and
- A lack of technical knowledge required to assess and define the technical scope for cost effective EE renovations

In order to be able to attract public and private financing in large scale programmes for MABs renovations, the above mentioned barriers need to be alleviated or even better, completely removed. Additionally, renovations in the residential sector should become a strategic priority for policy makers in the future towards expected contributions to 2030 energy and climate targets as well as climate neutrality planned for 2050.

[36] https://pdf.usaid.gov/pdf_docs/PA00X3QN.pdf

5. RENOVATION SCENARIOS DRIVEN BY RENOVATION WAVE

5.1. METHODOLOGY FOR DEVELOPMENT OF SCENARIOS

After revealed building stock for each Western Balkan country, and 'Renovation wave' principles, in this chapter several scenarios have been developed with different retrofit intensity. The main objective of this task is to consider application of the 'Renovation wave' principles in the WB6 context and with the recommendations of the European Commission with possible achieving of at least 55% reduction of net greenhouse gas emissions by 2030 compared to 1990 levels and a minimum of 80% reduction of greenhouse gas emissions by 2050. With application of different levels of retrofit actions, the aim is to analyze the results after entire building stock in the WB6 is retrofitted till 2050.

In order to select the optimal method of renovation of each of the categories of buildings, in accordance with the cost-effectiveness of EE and RES measures with regard to currently valid technical and financial parameters, the following scenarios of sustainable renovation of buildings are considered:

1. Scenario 1 - complete renovation of the building according to the minimum technical requirements ;
2. Scenario 2 - complete renovation of the building according to the requirements for 'deep renovations';
3. Scenario 3 - complete renovation of the building according to the nearly zero building (nZEB) construction standard

All three levels correspond with the EU requirements, and new principles that have been introduced with the 'Renovation wave'.

For adequate comparison, common approach is introduced in determination of energy and cost savings through defined set of measures and adopted common technical requirements for renovation among all WB6. The term 'deep renovation' is a relatively new concept, not yet defined in the national regulations in the analyzed countries. Also, the nZEB principles vary between the countries, moreover the nZEB requirement from the EU are not yet implemented in the Western Balkan Region. Therefore, for this report it has been consulted Croatian's national energy regulation as country from the region, with similar backgrounds before joining the EU family. In this term, the minimum technical requirements for the envelope elements has been set and are presented in annex 1 of this report.

All developed scenarios, are based on these requirements. Beside these limitations, in scenario 2, the limitation of the amount of annual required thermal energy for heating per unit area Q''H, nd [kWh / (m2 · a)] and annual primary energy Eprim [kWh / (m2 · a)] are also included. For scenario 3 of complete renovation according to the nZEB building standard, the same restrictions apply as scenario 2, but with more rigid limitations. The limitations for these two scenarios are given also in annex 1.

In the scenarios have been introduced package of measures applied on the two types of residential housing, individual housing IHs and collective housing in multi-apartment buildings MABs. The measures include retrofit of the building envelope (exterior doors and windows, exterior walls, Installation of thermal insulation of the roof / ceiling towards the unheated attic and Installation of thermal insulation of the ceiling towards the unheated basement, if any) as well as replacement and modernization of the heating systems with possible application of RES.

Climate data are also being included in the analyses resulting in grouping the countries in two climate categories, continental and coastal countries. In the first category are included: Bosnia and Herzegovina, Kosovo*, North Macedonia and Serbia while in the second group are Albania and Montenegro.

The basis for developing the renovation wave was building inventory established in 2015. After 2015 it is assumed to apply a complete energy renovation in accordance with the requirements in the Directive 2010/31/EU on the energy performance of buildings and Directive 2009/28/EU to increase the share of energy from renewable energy sources. In the most of the Western Balkan Countries, the rulebooks for setting the minimum requirements of energy performance of buildings are being prepared in the period after 2014, consequently the building stock built after 2015 is assumed to have high energy performance and it is excluded from the renovation statistics.

Additionally, from the total floor area, for further analyses are considered only the occupied areas in the residential buildings. Temporarily and permanently abandoned housing stock burdens the building stock, as it prevents the planning of energy efficiency measures, does not participate in the energy balance of the total stock of buildings with energy consumption, and reduces the energy intensity of the housing sector and savings potential. The calculation models are therefore based on the area of the inhabited fund of residential buildings, in order for the energy intensity to realistically reflect the condition of the fund.

Table 5-1 Building inventory in WB6 (m^2)

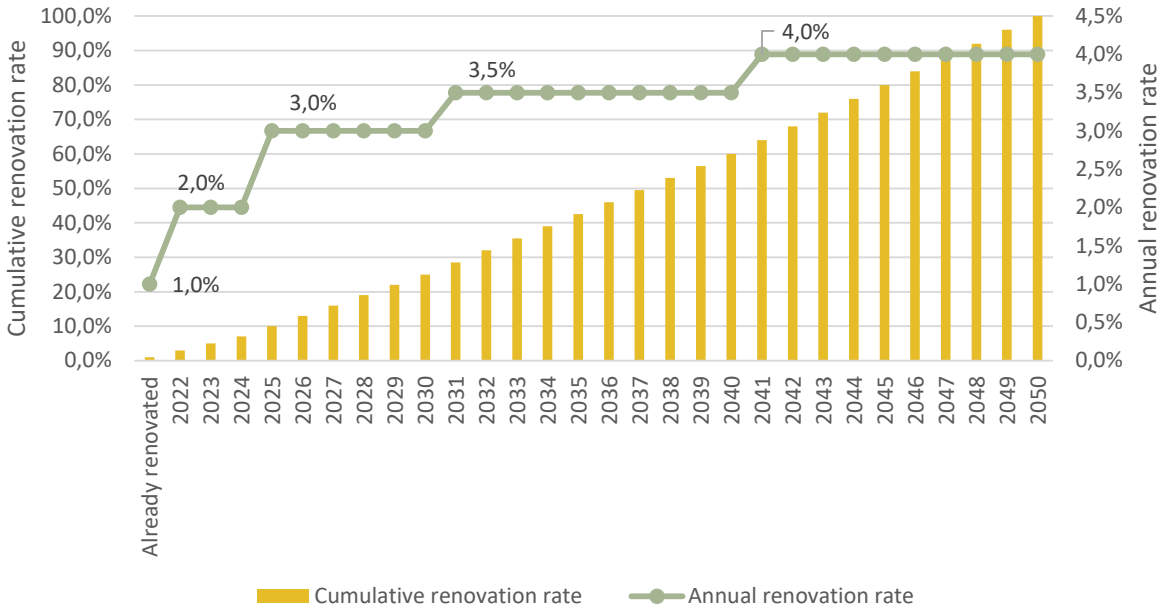
Gross floor area GFA	Total floor area	Occupied floor area	Individual households IHs		Multi-apartment buildings MABs	
			Share of IHs	Occupied floor area	Share of MABs	Occupied floor area
Unit	m^2	m^2	%	m^2	%	m^2
AL	65,300,000	55,731,019	72.0%	40,126,334	28.0%	15,604,685
BA	119,522,072	89,368,335	76.5%	68,366,776	23.5%	21,001,559
XK	34,442,579	27,802,954	58.0%	16,125,713	42.0%	11,677,241
ME	17,673,241	10,546,503	60.6%	6,391,181	39.4%	4,155,322
MK	55,832,715	46,338,392	58.2%	26,968,944	41.8%	19,369,448
RS	230,518,414	179,703,282	67.5%	121,299,715	32.5%	58,403,567
Totals	**523,289,021**	**409,490,485**		**279,278,663**		**130,211,821**

Source: Consultant's compilation

Period for projection is starting with 2022 as first simulation year when the measures can be applied and ends in 2050. As crucial, with milestone achievements is 2030 and special attention will be given on the targets achievement.

The main driver in the projection scenarios was 100% of occupied building inventory to be retrofitted till 2050, starting with 2022 and with assumption that 1% of the buildings built before 2015 have been already renovated till 2022. In the starting three years (2022, 2023 and 2024) the projected annual rate of renovation is 2% for starting the acceleration of the renovation to the set 3% with the 'Renovation wave' in the period 2025 – 2030. After this period, more efforts should be placed in the renovation process with learned experiences and aggregation of different financial supports. This should result in increased annual renovation of 3.5% in period 2031-2040 reaching 4% in the period 2041-2050. With this schedule, in 2050 complete building stock built before 2015 will be renovated in accordance with the requirements under each scenario.

Figure 5-1 Renovation rate in period 2022-2050 (%)



Source: Consultant's projection

The applied annual renovation rates are more ambitious than the existing long term renovation strategies from the region but are in line with the 'renovation wave' targeting. For example, Building Renovation Strategy of Kosovo* examines 3% flat rate till 2050 and 4.5% annual renovation rate till 2040 horizon. On the other hand, renovation strategy in Bosnia and Herzegovina is assuming 2.2% annual rate in the ambitious scenario. With this approach, the society will enter more smoothly in the renovation process with gradually increasing of the renovation rates till 2050.

For the calculation of energy savings with corresponsive investments, REGEA[37] project has been consulted. The energy savings differ based on the climate condition as well as of the type of the buildings.

Table 5-2 Specific energy savings of delivered energy (FEC) per area of the building (kWh/m² a)

[kWh/m2 a]	Continental countries		Continental countries	
	IHs	MABs	IHs	MABs
S1 - Minimum technical requirements	279	161	139	79
S2 - Deep renovation principle	294	167	152	83
S3 - nZEB standard	303	176	154	85

Source: REGEA project

After calculation of the energy saving in delivered energy (in final energy FEC), cost savings are calculated for each country separately, based on the price levels of the energy carriers. The fuel costs are taken for 2021 year with applying 2% inflation annual rate till 2050.

37 https://wiki.srce.hr/download/attachments/2785282/Dugoro%C4%8Dna%20strategija%20za%20poticanje%20ulaganja%20u%20obnovu%20nacionalnog%20fonda%20zgrada%20Republike%20Hrvatske.docx?version=1&modificationDate=1591103993000&api=v2

The CO2 reductions are also considered based on the fuel mix for each country and adopted primary and CO2 conversion factors presented in the Table 2-2 Primary energy and CO2 conversion factors.

For assessing the results, the crucial step is setting the Baseline scenario. In the previous chapter, the baseline energy appraisal has been delivered for each country separately. In line with the Eurostat's energy balances, final energy for heating with fuel mix is given as well as shares of heating technologies present in the residential sector. This Baseline scenario interpreters the real, actual situation among the residential sector with final energy consumption and the building area that is heated. The small share of heated area is an indicator for energy poverty. In the WB6 region, only 64% of the occupied floor area is heated or 50% of the total floor area (permanent inhabited, seasonally inhabited or non-inhabited).

Table 5-3 Share of heated floor area in the residential sector in WB6

Country	Total floor area	Occupied floor area (m2)	Heated floor area	% of heated vs occupied floor area	% of heated vs total floor area
Unit	m^2	m^2	m^2	%	%
AL	65,300,000	55,731,019	46,295,019	83.1%	70.9%
BA	119,522,072	89,368,335	61,233,456	68.5%	51.2%
XK	34,442,579	27,802,954	17,191,098	61.8%	49.9%
ME	17,673,241	10,546,503	8,836,621	83.8%	50.0%
MK	55,832,715	46,338,392	20,917,728	45.1%	37.5%
RS	230,518,414	179,703,282	107,380,975	59.8%	46.6%
Totals	**523,289,021**	**409,490,485**	**261,854,897**	**63.9%**	**50.0%**

Source: Consultant's compilation

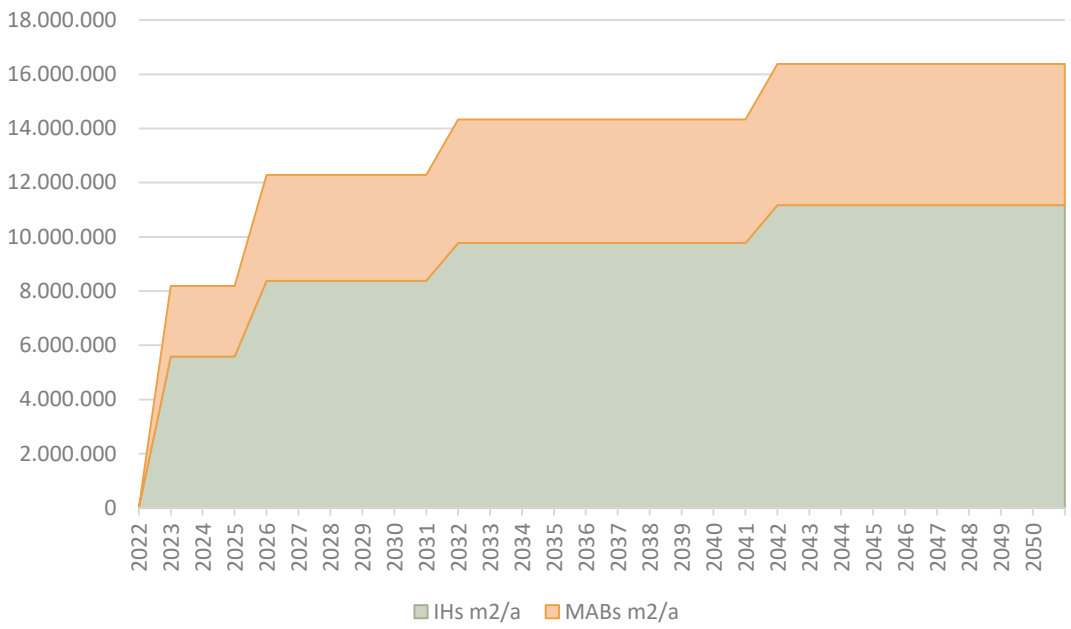
In the development of the scenarios, renovation process is applied on the whole buildings, covering the unheated parts too. For example, in renovation of the external façade, building is retrofitted with applying of thermal insulation on the total external wall, not only on the walls that formulate the heated area. In the calculation of scenarios, as described previously, is taken into account the occupied building stock, not only the heated area. Also, the comfort level is set to standardized values for these type of buildings with set point temperature of 20°C.

For comparison of the energy and cost savings through the scenarios, it is crucial for the Baseline scenario to be adjusted to the same input conditions as the remaining scenarios. Therefore, 'Baseline adjusted' scenario has been prepared with leveling the heated area in line with the occupied area and setting reference comfort conditions. The energy mix and heating technology mix is remaining the same as in the Baseline scenario and it will be used as bases for development of the three future scenarios.

5.2. RESULTS

After applying the annual renovation rates described in the previous section, till 2050 will be renovated 405 million m^2 building area across all Western Balkan countries or 99% of the whole occupied area in the region based on the assumption that 1% of the building stock has been already renovated before 2022. With the same approach, in 2030 it will be renovated 24% of the occupied area or 98 million m^2.

Figure 5-2 Overview of annual buildings renovation in WB6 (m^2)



Source: Consultant's projection

Distributed by country, it has the following outlook.

Table 5-4 Renovated area in 2030 and 2050 per country (m^2)

Country	Horizon 2030	Horizon 2050
Unit	m^2	m^2
AL	13,375,445	55,173,709
BA	21,448,400	88,474,652
XK	6,672,709	27,524,925
ME	2,531,161	10,441,037
MK	11,121,214	45,875,008
RS	43,128,788	177,906,249
Totals	**98,277,716**	**405,395,580**

Source: Consultant's projection

The EU targets are focused on reduction of green gas emissions through all sectors with 55% reductions in 2030 and carbon neutrality in 2050. As stated in the 'renovation wave', to achieve the 55% emission reduction target, by 2030 the EU should reduce buildings' greenhouse gas emissions by 60%, their final energy consumption by 14% and energy consumption for heating and cooling by 18% compared to the 2015 level.

In respect with the emission reductions, the biggest reduction is when applying the scenario 3 followed by scenario 2 and scenario 1. The reduction are given per country as well as totals for entire region.

Table 5-5 Cumulative CO2 reductions in 2050 (ktCO2)

Country	CO2 emissions 2015	CO2 savings and reductions vs 2015 levels

	BAU adjusted	Scenario 1				Scenario 2				Scenario 3			
	BAU adjusted	Horizon 2030		Horizon 2050		Horizon 2030		Horizon 2050		Horizon 2030		Horizon 2050	
Unit	ktCO2	ktCO2	%	ktCO2	%	ktCO2	%	ktCO2	%	ktCO2	%	ktCO2	%
AL	843	93	11.1 %	385	45.6 %	101	12.0 %	417	49.6 %	103	12.2 %	424	50.3 %
BA	12,463	2,483	19.9 %	10,244	82.2 %	2,611	20.9 %	10,769	86.4 %	2,700	21.7 %	11,136	89.4 %
XK	7,146	1,331	18.6 %	5,522	77.3 %	1,397	19.5 %	5,792	81.1 %	1,449	20.3 %	6,009	84.1 %
ME	334	44	13.3 %	197	59.0 %	48	14.4 %	213	63.8 %	49	14.6 %	216	64.8 %
MK	6,381	1,226	19.2 %	5,125	80.3 %	1,286	20.2 %	5,376	84.2 %	1,334	20.9 %	5,577	87.4 %
RS	31,491	4,790	15.2 %	17,617	55.9 %	5,030	16.0 %	18,501	58.7 %	5,209	16.5 %	19,160	60.8 %
Total	**58,657**	**9,968**	17.0 %	**39,089**	66.6 %	**10,473**	17.9 %	**41,068**	70.0 %	**10,843**	18.5 %	**42,521**	72.5 %

Source: Consultant's projection

Analyzing the results, it can concluded that EU target for 60% reduction till 2030 is hard to achieve with the pointed annual rates in this period. With the applied scenarios, in the period till 2030, CO2 emission are reduced by 17% to 18.5%, based on the scenario. On the other hand, if horizon 2050 is taken into consideration, the CO2 reductions are significant, reaching 89.4% in Bosnia and Herzegovina, 87.4% in North Macedonia and 84.1% in Kosovo* or on the region level are 72.5% within scenario 3. With this, residential sector can be on its path toward carbon neutrality till 2050.

Energy savings are calculated in terms of delivered or final energy in GWh for each scenario separately. For easy comparison, the cumulative energy savings in two time horizons are presented, for 2030 and for 2050 and have been compared with the 2015 levels. The scenario 3 has the most effective measures with highest energy savings among the scenarios.

Table 5-6 Cumulative energy savings per country (GWh)

Country	FEC	Cumulative energy savings											
	Baseline adjusted	Scenario 1				Scenario 2				Scenario 3			
	2015 level	Horizon 2030		Horizon 2050		Horizon 2030		Horizon 2050		Horizon 2030		Horizon 2050	
Unit	GWh/a	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
AL	12,199	1,634	13.4 %	6,742	55.3 %	1,775	14.5 %	7,320	60.0%	1,801	14.8 %	7,431	60.9%
BA	22,420	5,389	24.0 %	22,231	99.2 %	5,666	25.3 %	23,371	104.2 %	5,859	26.1 %	24,167	107.8 %
XK	8,313	1,531	18.4 %	6,315	76.0 %	1,606	19.3 %	6,624	79.7%	1,666	20.0 %	6,872	82.7%
ME	2,405	292	12.1 %	1,204	50.1 %	316	13.1 %	1,303	54.2%	321	13.3 %	1,324	55.1%
MK	13,529	2,554	18.9 %	10,536	77.9 %	2,679	19.8 %	11,052	81.7%	2,779	20.5 %	11,465	84.7%
RS	60,534	10,379	17.1 %	42,813	70.7 %	10,900	18.0 %	44,961	74.3%	11,288	18.6 %	46,563	76.9%
Totals	**119,399**	**21,780**	**18.2 %**	**89,843**	**75.2 %**	**22,941**	**19.2 %**	**94,632**	**79.3%**	**23,714**	**19.9 %**	**97,821**	**81.9%**

Source: Consultant's projection

From the table above, if we considered all Western Balkan countries together, the EU target for decreasing of energy consumption for heating and cooling by 18% until 2030 can be reached with all three scenarios. On country level, Bosnia and Herzegovina as well as Kosovo* and North Macedonia can reach this target even with implementation of the set of measures from the first scenario, Serbia is reaching with the second set of measures while the coastal countries are far from reaching the targeted reduction.

5.3. INVESTMENT DYNAMICS

Investment expenditures consist of three elements. The initial investment is the product of the number of square meters and the investment expenditure for reconstruction according to the requirements of the level of renovation. Replacement investments in heating systems are taken into account only after the expiration of twenty years after the initial installation. All investments are presented in constant[38] prices. Additionally, the investment are based on the types of housing, individual and collective as well as the climate conditions.

Table 5-7 Investment costs

Investment costs	IHs		MABs	
	CAPEX	Replacement costs	CAPEX	Replacement costs
	€/m2 a	€/m2 a	€/m2 a	€/m2 a
Continental countries				
S1	202	99	191	91
S2	206	99	195	91
S3	232	99	221	91
Coastal countries				
S1	202	99	191	83
S2	206	99	195	83
S3	232	99	221	83

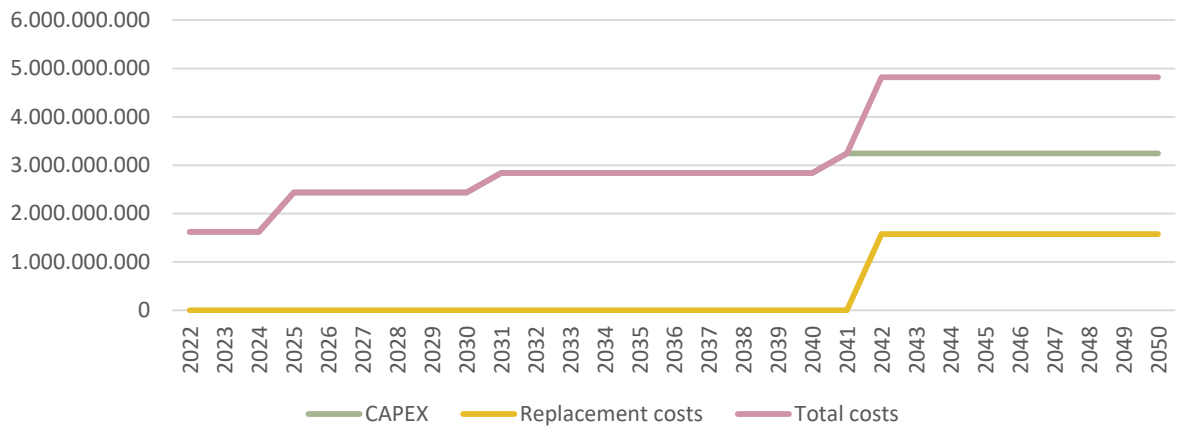
Source: REGEA project, 2017

Applying the investment costs on the annual renovated buildings, for each country is gathered the total investments needed in the 2050 horizon.

In scenario 1, total investment costs needed till 2050 is EUR 95 billion, from which EUR 65.7 billion in renovation of the individual houses and EUR 28.8 billion in multi-apartment buildings. In first eight-year period till 2030, the need of investment is EUR 20 billion.

[38] Constant prices are in real value, i.e. corrected for changes in prices in relation to a base line or reference datum

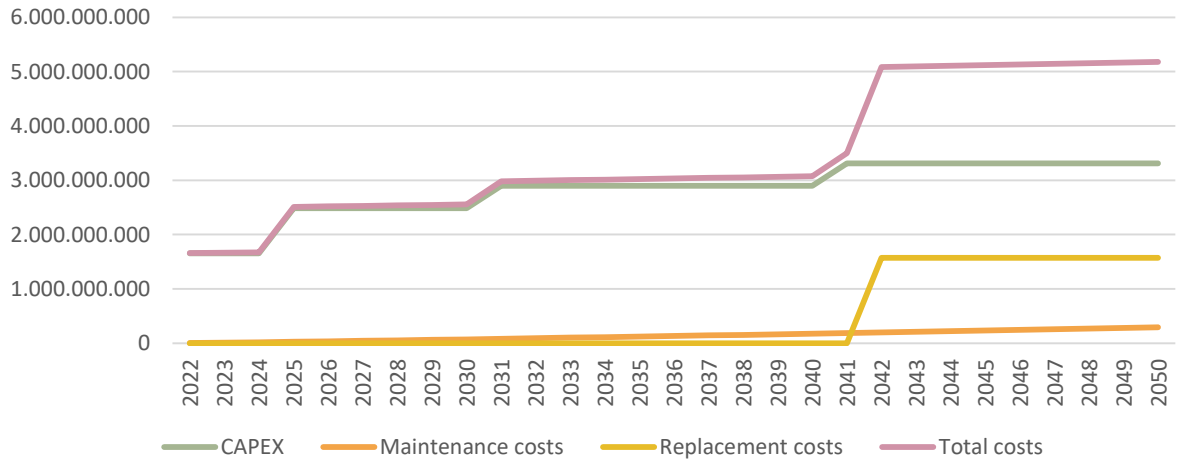
Figure 5-3 Overview of annual investment costs under Scenario 1 in WB6 (EUR)



Source: Consultant's projection

In scenario 2, the total investment costs till 2050 are EUR 100 billion divided into EUR 69.2 billion in individual housing and EUR 31 billion in collective housing. In 2030, the total investments are projected to be EUR 20.2 billion.

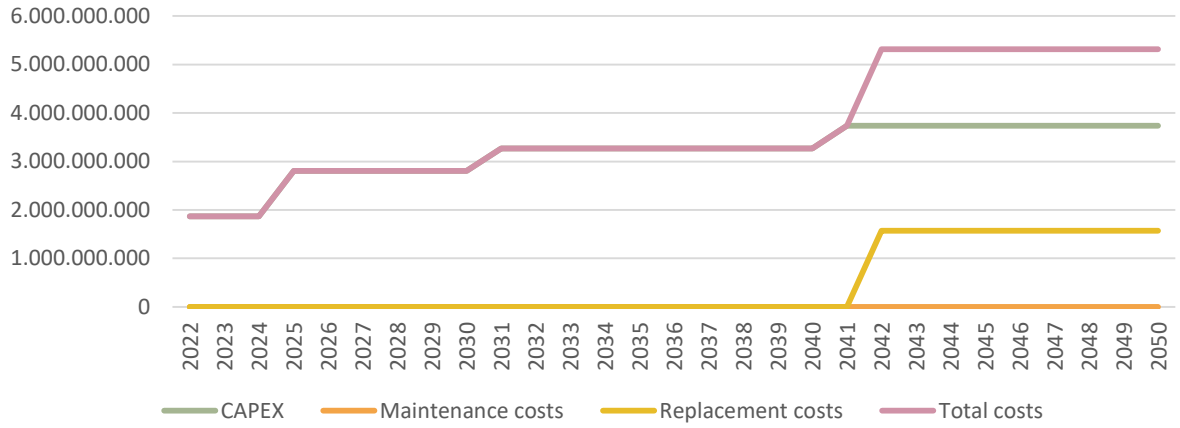
Figure 5-4 Overview of annual investment costs under Scenario 2 in WB6 (EUR)



Source: Consultant's projection

And finally, in scenario 3, the engaged investment capital for implementation of this measures is EUR 107 billion where renovation of IHs requires EUR 74 billion and MABs with EUR 32.7 billion. For 2030, the engaged capital should be EUR 22.4 billion.

Figure 5-5 Overview of annual investment costs under Scenario 3 in WB6 (EUR)



Source: Consultant's projection

The investment costs differ between the analyzed countries, the highest investments requires the bigger countries starting with Serbia, and the lowest investments are present in Montenegro with the smallest floor area of occupied buildings. Regarding the most intensive measures, Scenario 3 needs the highest investments for implementation of the total set of measures in order to obtain the nZEB requirements.

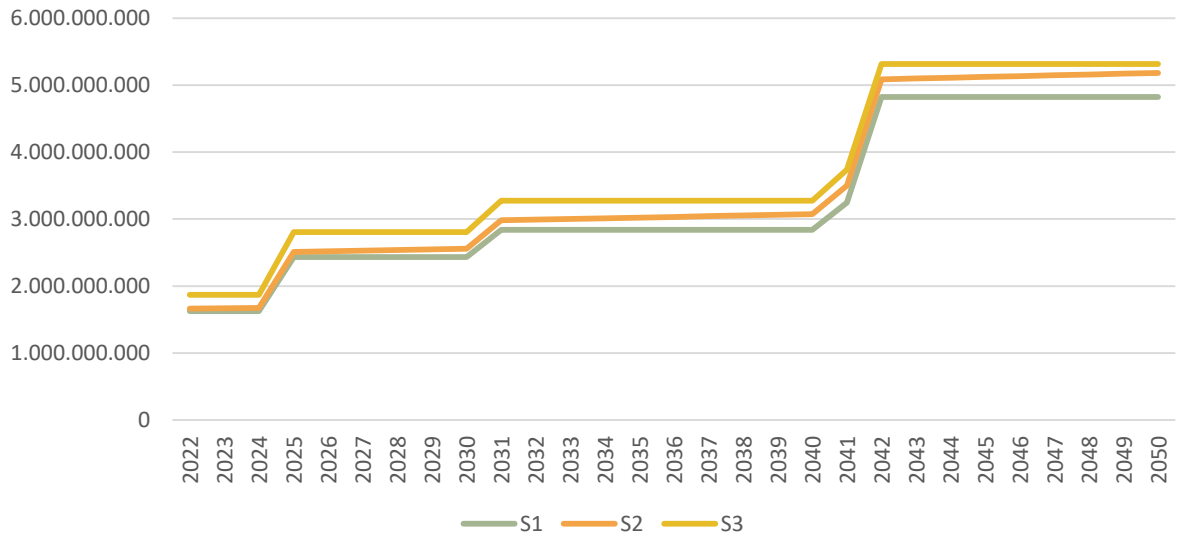
Table 5-8 Investments per country in WB6 (million €)

Country	Scenario 1		Scenario 2		Scenario 3	
	Horizon 2030	Horizon 2050	Horizon 2030	Horizon 2050	Horizon 2030	Horizon 2050
Unit	€, million	€, million	€, million	€, million	€, million	€, million
AL	2,656	12,850	2,711	13,080	3,059	14,514
BA	4,269	20,735	4,357	21,100	4,915	23,400
XK	1,315	6,383	1,671	10,508	1,516	7,211
ME	500	2,412	510	2,456	576	2,727
MK	2,192	10,639	2,238	10,827	2,527	12,019
RS	8,543	41,480	8,720	42,211	9,842	46,836
Totals	**19,475**	**94,499**	**20,208**	**100,181**	**22,434**	**106,708**

Source: Consultant's projection

Regarding the most intensive measures, Scenario 3 needs the highest investments for implementation of the total set of measures in order to obtain the nZEB requirements. Corresponsive diagram is presented below.

Figure 5-6 Total Investments needs in period 2022-2050 in WB6 (€/a)



Source: Consultant's projection

Apart from the obligation to maintain the building in usable condition in the Construction Act, there is no legal basis for initiating renovation or energy renovation of the building. The most probable moments in which the energy renovation of buildings is initiated are related to the change of ownership (purchase, inheritance, change of generations) of the majority part of the building or the dilapidation of the heating system. Due to the low purchasing power of the owners and at a very low rate of energy renovation, the biggest driving point of energy renovation are grants with a high percentage of co-financing of energy renovation works.

It is very crucial to indicate the needed capital in the next five year period (2022-2027), timeframe when the 'Green Agenda for the Western Balkans' should be implemented. The Green Agenda covers several topics, with clean energy and energy efficiency among them. The planned budged of EUR 9 billion during 2021-2027 is proposed for the Plan's implementation, of which a fair share is expected to finance buildings renovation and decarburization of heating and cooling sectors.

With this approach, in period 2022-2027 the total investments are between EUR 12 billion and EUR 14.0 billion, depending on the scenario. With the EU planned support, large share of the needed investments can be arranged toward acceleration of the renovation process of the residential sector.

Energy savings for heating and cooling in the housing stock is of great importance for the following reasons:

- reduction of carbon dioxide (CO2) emissions into the atmosphere
- security of supply - reducing the country's dependence on imported energy
- saving money for the supply of energy on the part of suppliers (state, companies)
- Prevention of energy poverty - reduction of energy costs on the part of users / consumers (households, population).

Renovation of buildings - a registered renovation area - allows the assessment of environmental, social and economic indicators of progress - greenhouse gas emissions, reduction of annual energy consumption, reduction of the part of citizens at risk of energy poverty, reduction of health problems and increase investment in renovation.

6. MORE REALISTIC APPROACH IN SETTING UP SCENARIOS

After analyzing the possible scenarios based on the 'Renovation wave' principle, in this chapter are presented most likely scenarios that are applicable for this region. The analyses will be postulated on the Baseline scenario, revealed in Chapter 3 - Energy performance appraisal and will predict scenarios that are most likely to happen.

6.1. LOW SCENARIO

Low scenario foresees increased number of replaced stoves for households to be supported by the state institutions in charge of energy efficiency followed by increased number of envelope reconstruction applied on the same households.

From the annual replacement share of heating devices indicated in the Baseline scenario, in this scenario will be impose 4.3% flat annual rate for all countries. Replacement will keep the same 'rule 1:1' as in the Baseline with decommissioning of 'grey' technologies and introducing new 'green' ones on the same fuel. For the new technologies assigned to new building stock, the same share will be kept as in the Baseline scenario.

Additionally, the share of households who are renovating buildings envelope together with the replacement of the heating system will be increased from 20% in the Baseline scenario in 25% in this scenario. Specific CAPEX investments only for retrofit of the envelope are set as 105 EUR/m^2 where are included renovation of exterior doors and windows, exterior walls, Installation of thermal insulation of the roof / ceiling towards the unheated attic and Installation of thermal insulation of the ceiling towards the unheated basement, if any.

Figure 6-1 Annual renovation rate of building envelope in Low scenario

Country	Heated floor area	Annual reduction rate of h. systems	Annual renovation rate of building envelope	Annual renovated area	Renovated vs heated floor area	Specific CAPEX	CAPEX
Unit	m^2	%	%	m^2	%	€/m^2 a	€,million/a
Albania	43,053,621	4.30%	25.0%	462,826	1.08%	105	49
Bosnia and Herzegovina	61,233,456			658,260	1.08%		69
Kosovo*	17,191,098			184,804	1.08%		19
Montenegro	8,836,621			94,994	1.08%		10
North Macedonia	20,917,728			224,866	1.08%		24
Serbia	107,380,975			1,154,345	1.08%		121
Total	258,613,498			2,780,095	1.08%		292

Source: Consultant's projections

From the results can be assumed that the existing heated stock will be renovated with ~1% on annual basis reaching 30% of this fund to be renovated in 2050, or in terms of occupied floor area it will reach 19%. The annual investments only for renovation of the envelope are EUR 292 million for whole WB6 region and will come over EUR 8 billion till 2050.

For heating technologies, decommissioned ones are 4.3% while the total increased heating technologies will be sum of the decommissioned and heating technologies in the new building evolving stock kept in this scenario same as in the Baseline.

Figure 6-2 Annual reduced and introduced heating technologies in Low scenario (%)

Country	Annual reduced	Annual introduced	New annual heating systems at new building stock
Albania	4.30%	4.30%	0.00%
Bosnia and Herzegovina	4.30%	4.39%	0.09%
Kosovo*	4.30%	5.30%	1.00%
Montenegro	4.30%	5.30%	1.00%
North Macedonia	4.30%	5.02%	0.72%
Serbia	4.30%	4.91%	0.61%

Source: Consultant's projections

Investments in heating technologies are presented in Table 2-1 Indicative capital and maintenance costs for heating systems in residential sector (EUR). Applied in this scenario, investments needed for decommissioning of the old ones and introducing new heating technologies on the market in accordance to the adopted percentage have been calculated. Additionally, the total investments together with the envelope renovation have been calculated and are presented on the following table.

Figure 6-3 Cumulative investments in Low scenario (€, million)

Scenario LOW	Horizon 2022	Horizon 2030	Horizon 2040	Horizon 2050
Country	€, million	€, million	€, million	€, million
Investments in heating systems				
Albania	12	117	272	426
Bosnia and Herzegovina	24	221	479	736
Kosovo*	8	69	145	169
Montenegro	6	52	95	108
North Macedonia	16	139	216	237
Serbia	65	560	722	787
Totals in heating system	**131**	**1,159**	**1,928**	**2,463**
Investments in heating systems and envelope				
Albania	61	310	633	956
Bosnia and Herzegovina	93	842	1,790	2,737
Kosovo*	27	240	506	720
Montenegro	16	142	285	398
North Macedonia	40	355	672	933
Serbia	186	1,649	3,021	4,296
Totals in h. system & envelope	**423**	**3,539**	**6,907**	**10,040**

Source: Consultant's projections

Within the Low scenario, the total cumulative investments in the heating systems until 2050 are projected to be EUR 2.5 billion on the regional level while together with the renovation of building envelope are reaching above EUR 10 billion.

6.2. HIGH SCENARIO

In High scenario, same approach as in Low scenario is applied, but with higher share of renovation process. Here, the reductions in the heating systems are set to 4.8%, from which 35% will also make substantial renovation on the building envelope with specific CAPEX of 110 EUR/m^2.

Figure 6-4 Annual renovation rate of building envelope in High scenario

Country	Heated floor area	Annual reduction rate of h. systems	Annual renovation rate of building envelope	Annual renovated area	Renovated vs heated floor area	Specific CAPEX	CAPEX
Unit	m^2	%	%	m^2	%	€/m^2 a	€,million/a
Albania	43,053,621	4.80%	35.0%	723,301	1.68%	110	80
Bosnia and Herzegovina	61,233,456			1,028,722	1.68%		113
Kosovo*	17,191,098			288,810	1.68%		32
Montenegro	8,836,621			148,455	1.68%		16
North Macedonia	20,917,728			351,418	1.68%		39
Serbia	107,380,975			1,804,000	1.68%		198
Total	258,613,498			4,344,707	1.68%		478

Source: Consultant's projections

In this case, annual renovation rate of the heated floor area is ~1.7% reaching almost half of the heated building fund in 2050 or 30% of the occupied floor area that should be subject of renovation. This renovation has EUR 478 million investments on annual level, or until 2050 the investments will override EUR 13 billion.

In terms of changing the heating technologies, the following rate will be achieved.

Figure 6-5 Annual reduced and introduced heating technologies in High scenario (%)

Country	Annual reduced	Annual introduced	New annual heating systems at new building stock
Albania	4.80%	4.80%	0.00%
Bosnia and Herzegovina	4.80%	4.89%	0.09%
Kosovo*	4.80%	5.80%	1.00%
Montenegro	4.80%	5.80%	1.00%
North Macedonia	4.80%	5.52%	0.72%
Serbia	4.80%	5.41%	0.61%

Source: Consultant's projections

For investments in High scenario, same approach as in Low scenarios has been applied and the results are the following.

Figure 6-6 Cumulative investments in High scenario (€, million)

Scenario HIGH	Horizon 2022	Horizon 2030	Horizon 2040	Horizon 2050
Country	€, million	€, million	€, million	€, million
Investments in heating systems				
Albania	14	133	309	484
Bosnia and Herzegovina	27	251	544	836
Kosovo*	9	76	152	170
Montenegro	7	57	103	116
North Macedonia	18	154	216	238
Serbia	72	618	716	780
Totals in heating system	**146**	**1,290**	**2,040**	**2,624**
Investments in heating systems and envelope				
Albania	94	474	963	1,451
Bosnia and Herzegovina	140	1,268	2,691	4,113
Kosovo*	41	364	760	1,098
Montenegro	23	201	407	580
North Macedonia	57	505	957	1,369
Serbia	270	2,400	4,478	6,522
Totals in h. system & envelope	**624**	**5,213**	**10,256**	**15,133**

Source: Consultant's projections

At the end, with High scenario the capital investments in the heating systems till 2050 are EUR 2.6 billion, while when energy efficiency measures in building envelope are included than the investments rise on EUR 15 billion.

7. CONCLUSIONS

Renovation of building envelope together with the heating systems are crucial arguments for prevention from energy poverty and energy dependence. The data gathered in this study confirmed strong evidence that energy prices in the residential sector are and will be increasing constantly. This is based on ample support to the claim that soon carbon taxation and cross border adjustment mechanisms will additionally burden the energy prices all over the Western Balkan Region.

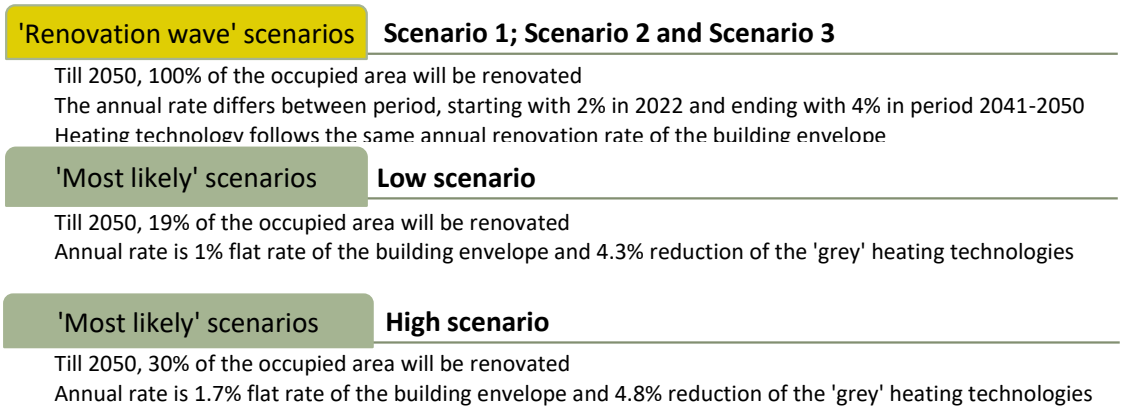
The building stock is both unique and heterogeneous in its relation to the cultural diversity and history of the WB peninsula. Not surprisingly, the stock is aged and subject to not rapid changes. More than 7 million dwellings were built till 2015 covering more than 523 million m^2 floor area. The annual renovation rate is very low, only 0.34% of the existing building are being renovated per year. This trend undoubtedly will continue till 2050 resulting in only 6% of the occupied buildings to be renovated if following the business as usual.

Western Balkans' households heat only 65% of their dwellings, but heating bills are a major share of their energy bills. These facts are also related to energy poverty in this region with a lack of incentives to solve it. As dominant heating fuel is Biomass[39], registered and not registered, followed by electricity. From the heating technologies, individual devices are predominant over the central systems. Almost 2,000,000 old individual stoves on firewood with efficiency max 55% are existing in the region. Electrical thermal storage stoves and electrical heaters are also present with around 16% of the total heating stock.

Investing in building renovation will mitigate the effects of the energy prices with introducing cost effective measures for reducing energy consumption. The main trigger of the energy consumption in the residential sector is heating (68% of the total FEC in this sector) so investing in 'green' heating technologies is more than needed.

With this Report, two approaches have been defined, developing scenarios driven by the 'renovation wave' and scenarios based on the most likely future developments. The base difference between the two approaches is the annual renovation rate applied to the existing building stock. While in "Renovation wave' approach, the entire floor area is under renovation till 2050, in the second approach the renovation rates relate to the real situation on field and investments capital that can be engaged.

Figure 7-1 Scenarios postulates



Upon the measures, with 'renovation wave' scenarios are covered three levels of renovation, which have set very high energy performance standards. With this scenarios, comfort levels inside of the

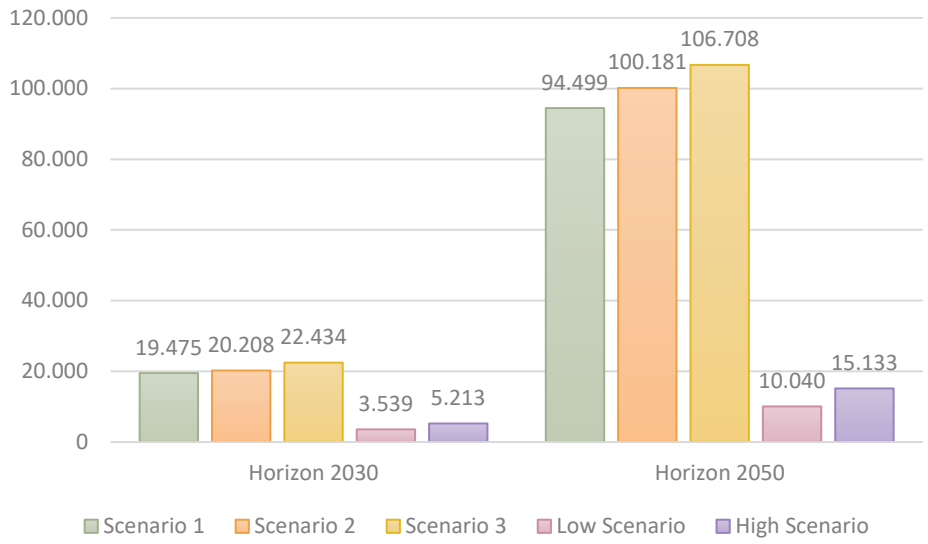
[39] Biomass covers fire wood as well as wood products as pellets, briquettes, etc. as stated in the EuroSTAT energy Balances

buildings are guaranteed while the energy savings are reaching the EU target for decreasing of energy consumption for heating and cooling by 18% till 2030.

The question whether the renovation wave is realistic for the WB countries has caused much debate among the experts. The data gathered on ongoing sales rates of heating devices to-households sales over the region was very encouraging and reflects positive initiatives based on regular change of the devices. A closer look at the data indicates that there is a significant share of BAU based total conditioned areas covered by "new green" technologies in the BAU. The idea is to utilize and foster this trend both in increased rate of new devices and by the EE measures on building envelope on the same buildings. In doing so the claim that "we need to improve BAU" is put forward.

When it comes to implementation of the energy efficiency measures, the initial investment capital is crucial. Knowing that in period 2010-2021, in WB6 in all types of building (mostly public building) are invested only EUR 1.4[40] billion, than the investment gap is more than obvious.

Figure 7-2 Investments through the scenarios (€, million)



Source: Consultant's projections

Apart from the obligation to maintain the building in usable condition in line with the Construction Act, there is no legal basis for initiating renovation or energy renovation of the building. The most probable moments in which the energy renovation of buildings is initiated are related to the change of ownership (purchase, inheritance, change of generations) of the majority part of the building or the dilapidation of the heating system. Due to the low purchasing power of the owners and at a very low rate of energy renovation, the biggest driving point of energy renovation are to-be-grants with a high percentage of co-financing of energy renovation works.

It is very relevant to indicate the needed capital in the next five year period (2022-2027), timeframe when the 'Green Agenda for the Western Balkans' should be implemented. The Green Agenda covers several topics, with clean energy and energy efficiency among them. The planned budget of EUR 9 billion during 2021-2027 is proposed for the Plan's implementation, of which a fair share is expected to finance buildings renovation and decarburization of heating and cooling sectors.

Within 'Renovation wave' scenarios, in the period 2022-2027 the total investments are between EUR 12 billion and EUR 14.0 billion, depending on the scenario. On the other hand, the engaged capital for the same period for the Low scenario is EUR 2.1 billion and for the High scenario is EUR 3.1 billion.

[40] https://www.energy-community.org/regionalinitiatives/WB6/Tracker.html

With the EU planned support, large share of the needed investments can be arranged toward acceleration of the renovation process of the residential sector.

8. ACRONYMS AND ABBREVIATIONS

	Definition
BAU	Baseline Scenario
EE	Energy Efficiency
FEC	Final Energy Consumption
ktoe	Kilo tons of oil equivalent
nZEB	Nearly Zero buildings
PEC	Primary Energy Consumption
WB	Western Balkan

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10. ANNEXES

10.1. ANNEX 1

Table 10-1 Minimum heat transfer coefficients of building components

Heat transfer coefficient of the building part[W/(m2K)]	Continental countries	Coastal countries
Exterior walls, walls towards the garage, walls towards the ventilated attic	0.30	0.45
Windows, balcony doors, skylights, other transparent elements of the building envelope	1.60	1.80
Glazed part of windows, balcony doors, skylights, transparent elements of the building envelope	1.10	1.40
Flat and sloping roofs above the heated space, ceilings towards the ventilated attic	0.25	0.30
Ceilings above the outside air, ceilings above the garage	0.25	0.30
Walls and ceilings towards unheated rooms and unheated staircase with a temperature of more than 0 oC	0.40	0.60
Walls to the ground, floors to the ground	0.40	0.50
Exterior doors, doors to unheated staircase, with opaque door leaf and glazed partitions to unheated or ventilated space	2.00	2.40
Blind box walls	0.60	0.80
Ceilings and walls between apartments or between different heated special parts of the building (business premises, etc.)	0.60	0.80
Domes and light strips	2.50	2.50
Windshields, observed in the direction of door opening	3.00	3.00

Table 10-2 Maximum limitations for renovated buildings under 'deep renovation' principle and nZEB standard

	Q''H,nd [kWh/(m2·a)]						Eprim [kWh/(m2·a)]	
	Continental countries			Coastal countries			Continental countries	Coastal countries
	$f_0 \leq 0.2$	$0.2 < f_0 < 1.05$	$f_0 \geq 1.05$	$f_0 \leq 0.2$	$0.2 < f_0 < 1.05$	$f_0 \geq 1.05$		
"Deep renovation" principle								
IHs	50.63	$40.49+50.73*f_0$	93.75	27.00	$19.24+38.82*f_0$	60.00	135.00	80.00
MABs	50.63	$40.49+50.73*f_0$	93.75	27.00	$21.59+27.06*f_0$	50.00	180.00	130.00
nZEB Standard								
IHs	40.50	$32.39+40.58*f_0$	75.00	24.84	$17.16+38.42*f_0$	57.50	45.00	35.00
MABs	40.50	$32.39+40.58*f_0$	75.00	24.84	$19.86+24.89*f_0$	45.99	80.00	50.00