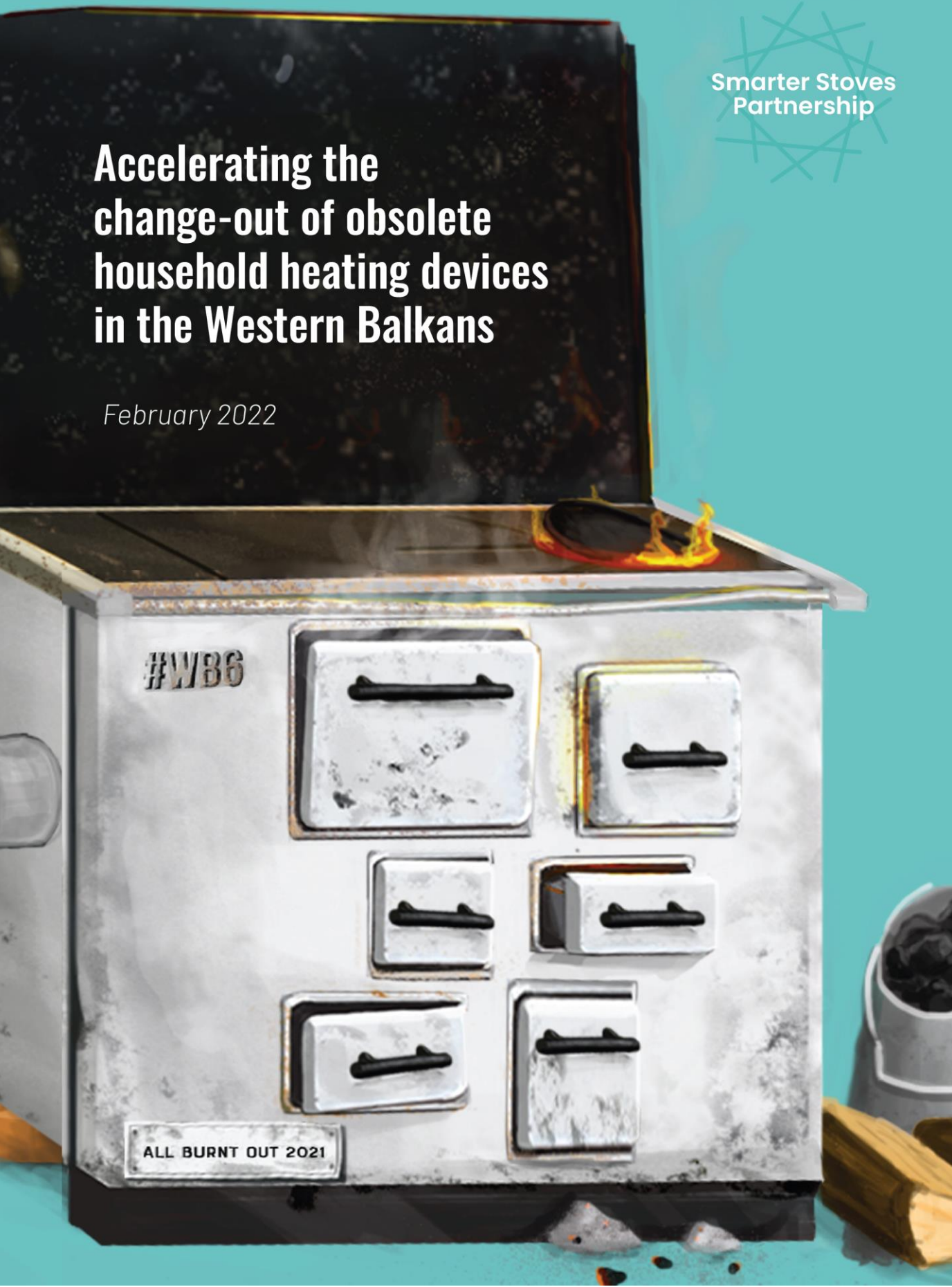
Smarter Stoves Partnership

Accelerating the change-out of obsolete household heating devices in the Western Balkans

February 2022



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Attitudes and opinions expressed in this report are solely the views of the author(s) above and of **Aleksandar Macura** and **Stevan Vujasinović** of the RES Foundation project implementation team, who have collated this content with own contributions to the final text. **Ilija Jovančević**, **Dr Maja Pupovac**, **Zorica Popović** and **Tanja Popovicki** were members of the RES Foundation team who greatly contributed to the preparation of the report.

Attitudes and opinions herein do not necessarily represent the views of the project's donors.

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ACRONYMS AND ABBREVIATIONS

PM	Particulate Matter
OGC	Organic Gaseous Carbon
BaP	Benzo[a]pyrene
WB	Western Balkan
IH	Individual Houses
MAB	Multi Apartment Building
EUROSTAT	Statistical Office of the European Union
CRES	Centre for Renewable Energy Sources
GHG	Greenhouse Gases
IEA	International Energy Agency
TSP	Total Suspended Particles
PAH	Pulmonary arterial hypertension
CO	Carbon oxide
NOx	Nitrogen oxide
ELM	Energy Ladder Model
EBRD	European Bank for Reconstruction and Development
KfW	Kreditanstalt Für Wiederaufbau
UNSD	United Nations Statistic Division
EE	Energy Efficiency

nZEB	nearly Zero Building
SDG	Sustainable Development Goal
FEC	Final Energy Consumption
CapEx	Capital Expenditures
AC	Air-conditioning
SWOT analysis	Strengths, Weaknesses, Opportunities, and Threat analysis
UNECE	United Nations Economic Commission for Europe
IPCC	Intergovernmental Panel on Climate Change
ESCO	European Skills, Competences, Qualifications and Occupations
NECP	National Energy and Climate Plan
HOA	Homeowner's Association
MGT	Management

EXECUTIVE SUMMARY

Biomass is the fuel that mankind may grow. Biomass is the only fuel whose usage may bring about negative carbon balances. Biomass is renewable fuel that may produce dispatchable electricity. Biomass supply chains may provide for the employment of large number of people directly and indirectly. In times when perception on security of energy supply is bleak, and energy prices are high, it is not likely that biomass consumption will sharply fall. On the other hand, poor management of the resource can cause significant damage to the society. For all these reasons biomass management requires more diligence and more information.

Biomass is the fuel of choice for the biggest share of households in the WB. Biomass represents the largest quantity in household energy in general, and in household space heating in the contracting parties to the Energy Community Treaty. Individual heaters (stoves, ovens, masonry stoves) are the most widespread devices used for heating in the WB. Almost 3 million households rely on heat produced in such devices.

Household heating is the main source of particulate matter (PM) emissions in the Western Balkans.

Biomass will continue to be used for heating in the Western Balkans for the foreseeable future regardless of anything one thinks or does about it.

Using biomass for heating in an efficient manner is a skill mostly taken for granted, yet in short supply or neglected among the Western Balkan users.

Real life efficiency of devices used is estimated to be in the range from 30-40%. 65% seasonal efficiency is minimal type test efficiency required for eco-design certified appliances while benchmark value set by the regulation is 86%. Even when we take into consideration deviations of real-life efficiency from lab tests, we see significant space for improvement. Real life efficiency may be increased in certain instances by 100% and more.

Real life emissions of PM, OGC and BaP when measured vary dramatically, due to various reasons including type of testing and operator's skills. From what we know, replacement of the devices with eco-design certified, may bring reductions in emissions that may go as high as 90%. Wood moisture can influence the increase of emissions of particulate matter by a factor of 8 in new appliances.

While burning wood is considered as carbon neutral, wood burning efficiency yields significant climate benefits. Saved wood may continue to grow in the forest and capture the same and increasing amounts of carbon before harvested, may end in wooden products, and continue to capture carbon or may displace other energy sources.

5% annual wood savings due to increased efficiency of heating may lead to more than 4 million tonnes of CO2 saved in the Western Balkan in year 5 after the initiation of the programme.

Vendors from the region started to produce eco design-compliant devices.

A Serbian household in fifth decile of consumption with median annual energy expenditure of 510 EUR may procure 5.9 stacked metres of fuel wood and 2,717 kWh of electricity annually to power and heat its 76.9 m2 dwelling. If it operates an individual wood heater, which most probably it is, it will provide only 4,347 kWh of useful heat annually.

Most users do not consider their solid-fuel stove as a problem that needs fixing.

Most users and health professionals in the Western Balkans are not aware of how detrimental wood-fired stoves are to both the users'- and to public health.

Most users of solid–fuel, wood-fired stoves have little or no knowledge of alternatives.

Only around or up to approx. 20% of existing users of inefficient wood-fired stoves in the Western Balkans (with slight variations in individual markets that make-up the region) understand the benefits of upgrading their device and are ready to replace their current device - now.

Data and information on devices and fuels used across the region are still being improved, so one should be in the habit of double-checking facts before making costly policy decisions.

Each individual sale of a new inefficient wood-fired stove is a missed "sales opportunity" for an upgrade to a more efficient device that's less damaging to health, to the environment and to climate.

Each of the more than 125.000 such missed opportunities every year (which is how many new inefficient devices are sold across the Western Balkans) is an advertisement to friends, family and neighbours for staying stuck in the past, instead of being "lighthouse" multipliers, allowing friends, family and neighbours access to trusted testimony of improvement - the key determinant of user interest and motivation for upgrading own device.

One in five households decide to also improve energy efficiency of the building when replacing heating devices.

Not all users of wood-fired devices pollute the air equally. The poor are likely to have less skills and ability to use wood efficiently (e.g. timely prepared and dried wood).

Levelized cost of heat of possible individual heating replacement technologies puts eco-design compliant wood stoves, pellet stoves and most modern air to ait heat pumps close to each other. Depending on the night tariffs for electricity electric thermal accumulation heaters may compete as well. Other factors need to be considered as well, when deciding on replacement.

Pellet is a fuel which production needs large quantities of energy. Different research reveals that to have 10 units of energy in pellet fuel, we need to invest 1 to 5 units of energy, depending on the research results. Fuel wood production requires 6 to 30 times less energy than pellet production. Wood chip production requires 2 to10 times less energy than pellet production.

Existing schemes discriminate against- and prevent those in poverty to participate and benefit from public subsidies as required levels of co-investment of own resources exceed their purchasing power.

Most of the existing public subsidies support beneficiaries who already have income, access to retail banking, and are not considered risky customers for consumer credit, thereby exhausting limited public resources before any of the most polluting, poor households without access to financial services have had a chance to participate and/or benefit.

Existing public financial schemes need to be improved, their scope widened, their targets more focused, and their funds more accessible.

The same goes for retail financing schemes, but these will most likely be market driven. Even if that is the case, banks can use some incentive, and development assistance institutions need to assist local authorities in providing that incentive.

Current financial schemes in the region are not sufficient to eliminate the problem on their own.

Both private and public investment must be made to work for the future, not the past.

Targeting everyone is a waste of resources.

Publicly funded change-out schemes for wood-fired stoves must be conditional on the safe and efficient turnover, collection, and recycling of old devices.

MESSAGE FROM THE TEAM

As we in the Western Balkans join the rest of our continent to embark upon an ambitious journey to a carbon-neutral future, there is a growing realisation that we are not going to get there unless we solve the many interconnected issues related to the way in which we keep our homes warm.

The likelihood is that you are reading this because you are one of the many stakeholders trying to hack household heating in our region so it's efficient and friendly to our wallets, clean and safe for our health, sustainable to our environment and neutral to our climate.

It's not a small challenge. Around three million households in the Western Balkans[1] are estimated to burn firewood, often of low quality or wet wood, in outdated, inefficient, and air-polluting stoves in order to keep their homes warm. They all need to change to better household heating technologies and solutions. Most of them, however, will not be able to do so without help.

The first thing to do is to realise and admit that designing and implementing a publicly funded mass change-out scheme for outdated solid fuel household heating devices is a complex challenge. You will be told one thing by vendors of heat pump technology, another by companies producing devices for burning biomass, yet another by environmentalists. You will hear from national-level planners about the difficulty in advocating for more of public money to be allocated to a programme so badly understood. You will also hear from local - municipal managers, on the other hand, stressing about the growing gap between citizen expectations of them for something to be done urgently about the escalating air-pollution crisis and limited local government capacities.

Regardless of how you arrived at this challenge, we invite you to recognise the diversity of people who need to be helped and of the types of buildings they live in, and to match that diversity with a suitably diversified range of solutions, which are both effective in improving people's lives and realistic in addressing the many challenges which limit our options. Moreover, when you get that far, you will also have developed an informed appreciation of the need to design and employ diversified forms of financing for heating upgrades across our region. We will need more money to be invested than has been the case to date, but in ways which yield a higher and quicker return also.

Knowledge is power. We will present the knowledge we have collected about the problem so as to empower policy makers and analysts to approach the task of designing publicly financed schemes for heating upgrades in a better-informed fashion than has been the case to date. That knowledge includes understanding how homes are heated in our region today, how this can be improved in the foreseeable future and what vehicles can take us there.

[1] The term Western Balkans refers to six signatories to the Energy Community Treaty, namely Bosnia and Herzegovina, Montenegro, Serbia, Kosovo*, North Macedonia and Albania; throughout the report, this definition will apply to terms such as the Western Balkan, WB or WB6, also.

Further still, we will employ this growing body of knowledge to boldly propose two templates, which you are welcome to consider, adapt and use in your own (Western Balkans) policy environment: i) An outline of a "phase out policy paper" for devices which don't make the eco-design-directive[2] cut and ii) a communications blueprint to serve your phase-out policy and keep this conversation going in the right direction.

A final word of caution: You will not solve this alone! As you read on, you will be reminded time and again of the many interconnected levers that will need to be synchronised if we are to get this right and ensure that in trying to help, we do not make life even more difficult for our fellow citizens in situations of energy poverty. Remember: regardless of your own income, heating device and knowledge of heating technologies, regardless of your own station in government, business, or civil society - we share the horrendously polluted air we breathe just as we share the risks of runaway climate. In other words - we are in this together!

Thus, please read this report with partnerships in mind. If you have not had to join forces with someone already, you are very likely to begin working on this with new, value-adding partners very soon.

The good news is: Together - we got this.

The RES Foundation
Smarter Stoves Partnership team

[2] https://study.com/academy/lesson/the-european-ecodesign-directive-description-intent-importance.html

ENERGY PROFILES

Contracting Parties of the Energy Community from the Western Balkans rely mostly on coal and oil for their primary energy supply. Renewables also take part in the energy mix primarily through traditional use of biomass in inefficient domestic devices, followed by large hydro. Modern sources of renewable energy are at an early stage of development. Energy and carbon intensity of the region is comparatively high both to the EU and the World average values. This points to significant space for improvement in the efficiency of the energy use and production. Import dependency of the region is below the EU average. Currently the region depends on imports of natural gas from Russia.

Table 1 *Basic data on Contracting Parties*

	Population (million)	Number of households (census data)	GDP (billion/ constant 2015 USD)	TPES (TJ)	Import Dependency	GHG emissions per capita (tCO2/capita)
Albania	2.9	722,262	13.0	97,473	32%	1.2
Bosnia and Herzegovina	3.3	1,155,736	18.4	301,974	27%	6.81
Kosovo*	1.8	297,090	7.6	111,614	31%	4.98
Montenegro	0.6	192,242	4.8	45,590	34%	4.18
North Macedonia	2.1	564,296	11.1	117,327	59%	3.45
Serbia	6.9	2,487,886	45.6	640,289	36%	6.58

Figure 1 *Energy and carbon intensity of the Contracting Parties and the EU*

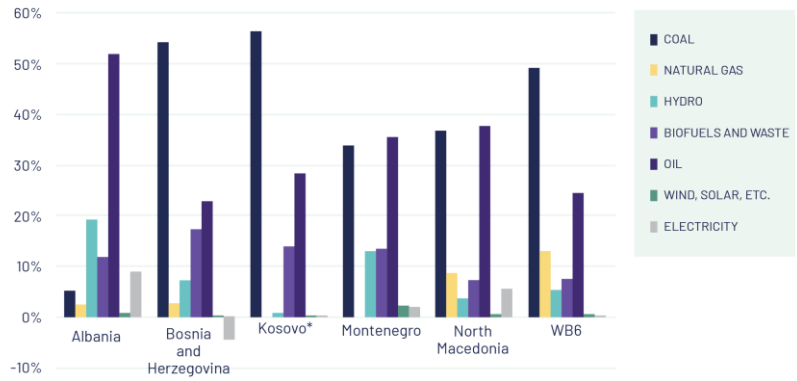


Figure 2 *Total energy supply in the contracting parties in 2019, shares by source (%). Source: IEA*

In terms of final energy consumption, the largest consumers in all the Contracting Parties are residential and transport sectors, followed by industry.

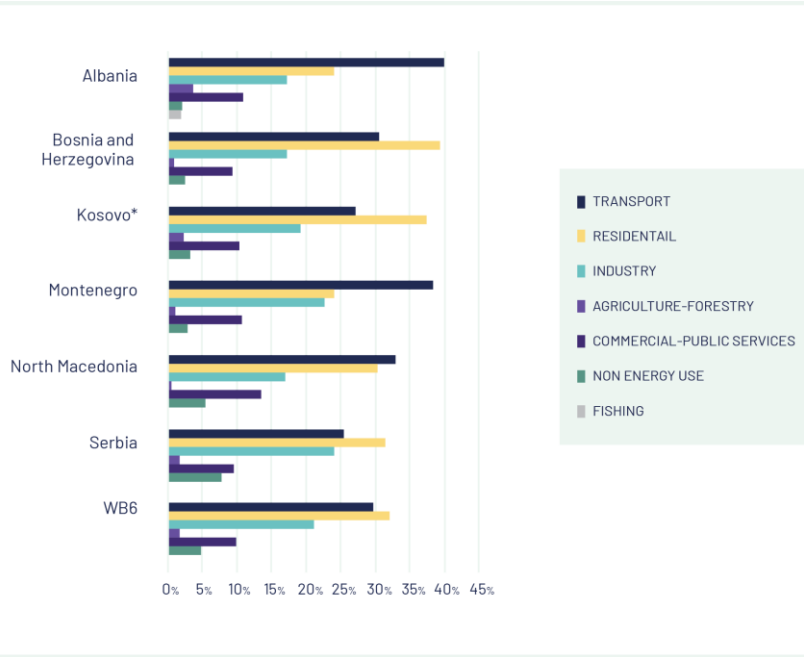


Figure 3 *Total final energy consumption in the Contracting Parties in 2019, shares per sector (%). Source: IEA*

Energy is mostly used in the form of oil products, followed by electricity. Significant share of final energy is consumed in the form of traditional biomass. Newest preliminary energy balance data for the largest country in the region, Serbia, indicate further significant increase in biomass share due to better data coverage. The consumption of natural gas in the region is limited.

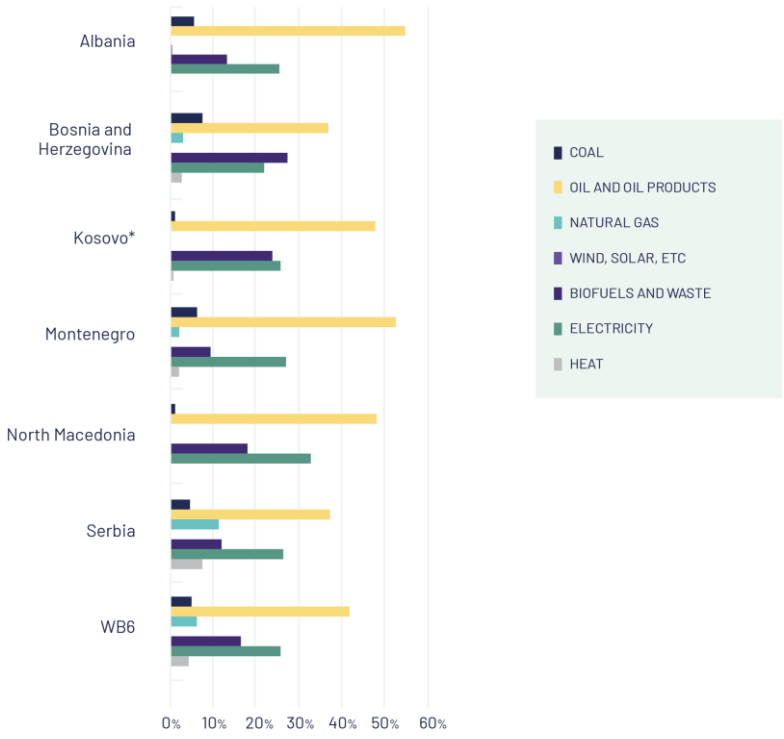


Figure 4 *Total final energy consumption in the Contracting Parties, by fuel (%)*

CURRENT HOUSEHOLD HEATING

BUILDING STOCK

Many efforts have been taken in the past decade to discover the characteristics of the building stock that may he us guiding renovation efforts. We would like to learn about the numbers and types of buildings total floor area, occupied floor area, heated floor area, heat energy demand, usage patterns and other characteristics. These efforts should help us understand the opportunities for energy efficiency improvements and to quantify the investment needed. Our methodologies are constantly improving but still we are frequently in situation to calculate energy savings that are higher than entire energy consumption that we captured in our energy balances. Nevertheless, we need to continue improving our knowledge of the housing stock. In this report we present information compiled by the projects' consultants but in the section dedicated to scenarios we will also provide comparison with the scenarios recently presented by the World Bank.

Households in the Western Balkans's contracting parties of the Energy Community (contracting parties) occupy more than 400 million m^2 out of total more than 520 million m^2 of gross floor area of their dwellings. More than two thirds (ranging from 58% in Kosovo* to 72% in Albania) of this space is in the individual households (IH) while less than one third is in multi-apartment buildings (MAB) with some differences in structure across the contracting parties.

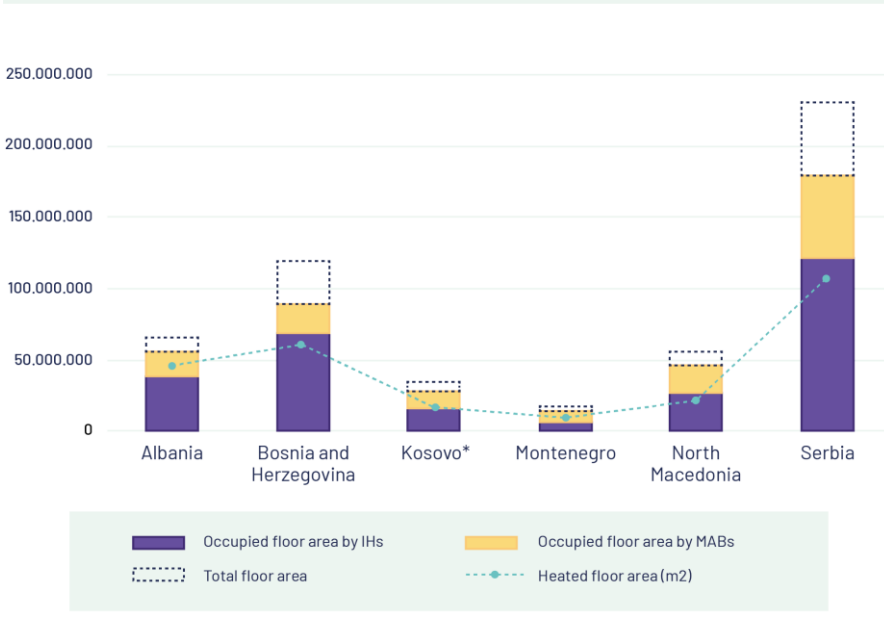


Figure 5 *Building stock in the Western Balkan contracting parties of the Energy Community. Source: Consultant's compilation.*

Table 2 *Occupied and unoccupied apartment floor area per contracting party by type of building. Source: Consultant's compilation.*

	Type of housing			
	Occupied floor area (m^2)	Occupied floor area by His (m^2)	Occupied floor area by MABs (m^2)	Unoccupied floor area (m^2)
Albania	55,731,019	40,126,334	15,604,685	9,568,981
Bosnia and Herzegovina	89,368,335	68,366,776	21,001,559	30,153,737
Kosovo*	27,802,954	16,125,713	11,677,241	6,639,625
Montenegro	10,546,503	6,389,309	4,157,194	7,126,738
North Macedonia	46,338,392	26,950,478	19,387,914	9,494,323
Serbia	179,703,282	121,272,169	58,431,113	50,815,132
Totals	409,490,485	279,230,779	130,259,705	

Households in the Western Balkans heat more than 260 million m^2 which represents 63.9% of occupied floor area and only 50% of the total floor area. Variations across the region are visible.

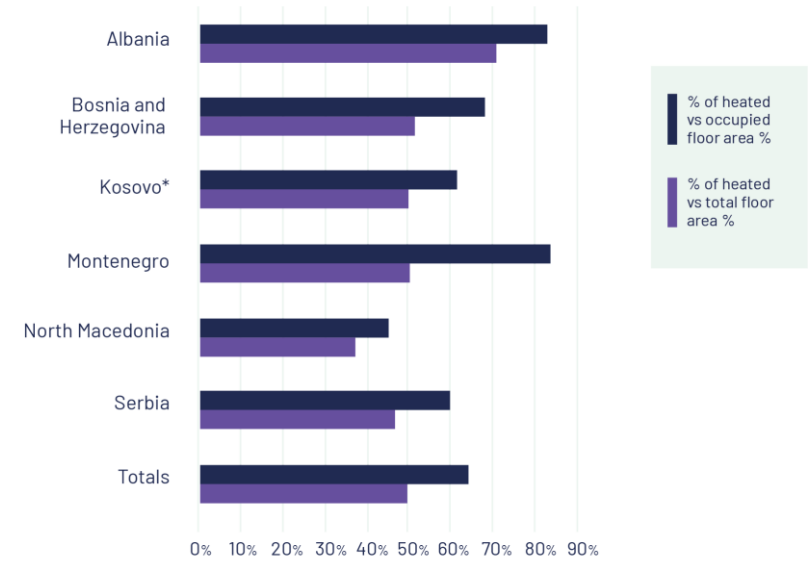


Figure 6 *Percentage of heated floor areas in households in contracting parties. Source: Consultant's compilation.*

Most robust data are data on the age of the buildings and decision makers need to understand the age cohorts of the buildings.

Table 3 *Overview of residential building age cohort in WB6 in number of dwellings (#) Source: Consultant's compilation.*

	Albania	Bosnia and Herzegovina	Kosovo*	Montenegro	North Macedonia	Serbia
Before 1919	86,393	19,275	7,6		7,759	140,024
1919-1945				13,989	27,521	239,854
1946-1960		87,575		23,573	73,688	353,798
1961-1970	186,012	240,318	13,539	81,967	136,418	542,052
1971-1980		437,609	41,435		181,969	781,131
1981-1990	137,358	370,287	150,278	76,526	151,434	671,568
1991-2000	180,238	464,122			74,475	503,504
2001-2015	279,345		200,031	112,991	122,301	
unknown	229,079			6,624		
Totals	1,012,032	1,619,186	412,883	315,67	775,565	3,231,931

As already explained estimated buildings' heating needs are usually larger than entire energy consumption of the residential sector captured by the energy balances. There could be several reasons behind such outcome including methodological reasons. It is important to remember that methodologies deployed may tend to overestimate savings. This is also relevant when comparing the effects of the investments in energy efficiency of buildings with the investments in heating improvements in cases where financing is not sufficient and there is urgency to reduce adverse effects of inefficiency in the chain of heat supply.

Table 4 *Adjusted baseline building's heating needs and total residential energy consumption from official energy balances. Sources: Consultants' calculations, World Bank, International Energy Agency*

Contracting party	Buildings' heating needs: Smarter stoves project baseline adjusted estimation (GWh/a)	Buildings' heating needs: World Bank assessment baseline adjusted estimation (GWh/a)	Energy consumption (IEA) of residential sectors according to national balances for 2019. (GWh/a)
Albania	12,199	10,012	3,197
Bosnia and Herzegovina	22,420	26,505	15,052
Kosovo*	8,313	6,551	3,942
Montenegro	2,405	2,482	2,015
North Macedonia	13,529	10,936	3,706
Serbia	60,534	52,139	21,130

HEATING DEVICES AND FUELS

Biomass is the fuel of choice for the main share of households in the WB. Biomass represents the largest quantity in household energy balance in general, and in household space heating balance in the contracting parties. Individual heaters (stoves, ovens, masonry stoves) are the most widespread devices used for heating in the WB. Almost 3 million households rely on heat produced in such devices. More than 125,000 new solid fuel burning individual devices worth more than 38 million EUR are sold annually in the region. As these devices are not compliant with the requirements of eco-design directive it means that the region is investing in the past missing tens of thousands of opportunities every year to reverse the inefficiency and pollution trends.

Despite numerous uncertainties regarding the data provided by the official sources these statements are essential for understanding the policy and decision-making challenges in the energy transition, achievement of the Agenda 2030, implementation of the Green deal or any other development policy in the WB.

Three different categories of heating related data are required to understand the current heating mix: share of fuels in the energy balance of household space heating, statistics on main heating fuels for households and on auxiliary heating fuels for households, and statistics of main and auxiliary devices for heating in the households. These data need to be combined with socio-demographic data and data on buildings to enable informed policy and decision making.

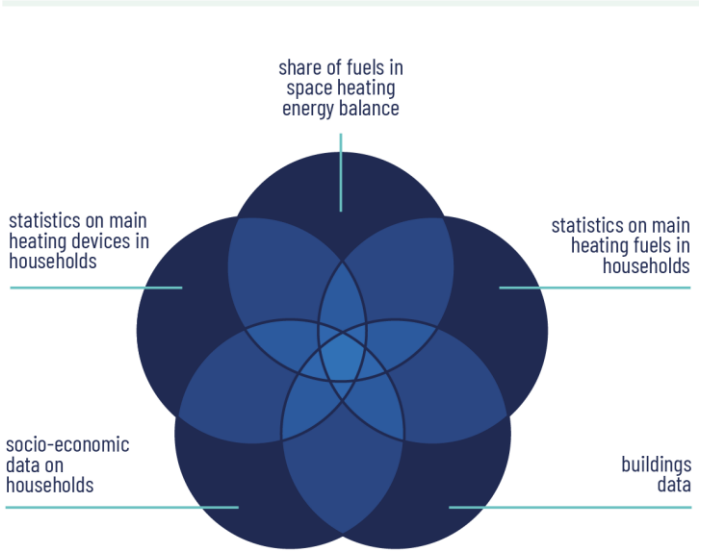


Figure 7 *Evidence base for policy making on sustainable heating*

As a rule, statistics on household energy use tend to underestimate biomass consumption. The development of biomass use statistics was incentivised by the Energy Community Treaty secretariat. The Biomass Consumption Survey Study conducted by CRES (Greece) during 2010-2011 had the main objective to determine biomass consumption for electricity, heating and cooling in the Contracting Parties based on:

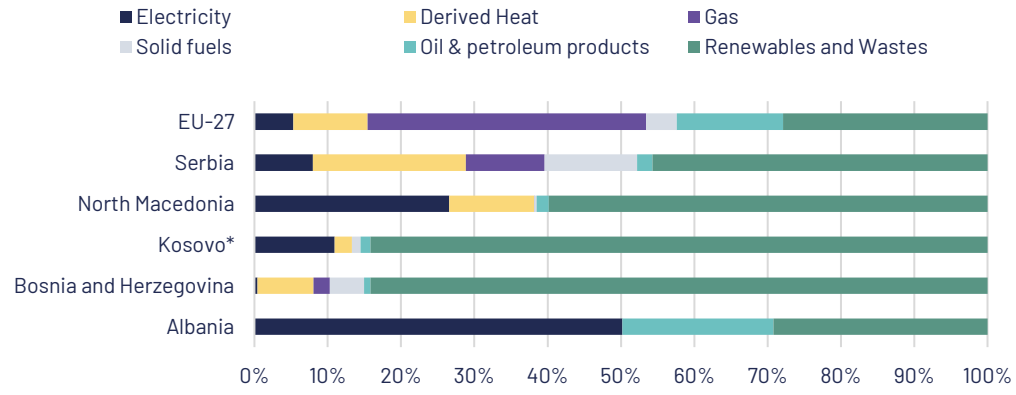
- biomass consumption surveys conducted for 2009 and 2010 based on a consistent sampling process with a focus on households.
- re-construction of the 2009 Energy Balances in EUROSTAT format with new biomass data.
- calculation of the share of biomass consumption in the gross final energy consumption in accordance with EUROSTAT methodology.

Several contracting parties "discovered" more biomass in subsequent surveys and those discoveries have been captured by the official statistics or are being captured by the official statistics as it is the case with Serbia. As an illustration: preliminary energy balance for the Republic of Serbia for 2020 records 43% increase in wood fuels usage comparing to previous data which is 1 million t of wood[3]. Therefore, data on household energy use in WB should always be interpreted with a degree of precautious and should be double checked wherever possible before the decisions are made. These phenomena also point to the low relevance of biomass heating in the WB societies.

Existing data, even if imperfect, already point to the crucial role of biomass in provision of energy services to households in the WB. Biomass accounts for the largest share of energy balance for space heating in all contracting parties except Albania and accounts for very large share of energy balance for cooking.

[3] Charts presented below still do not capture this increase

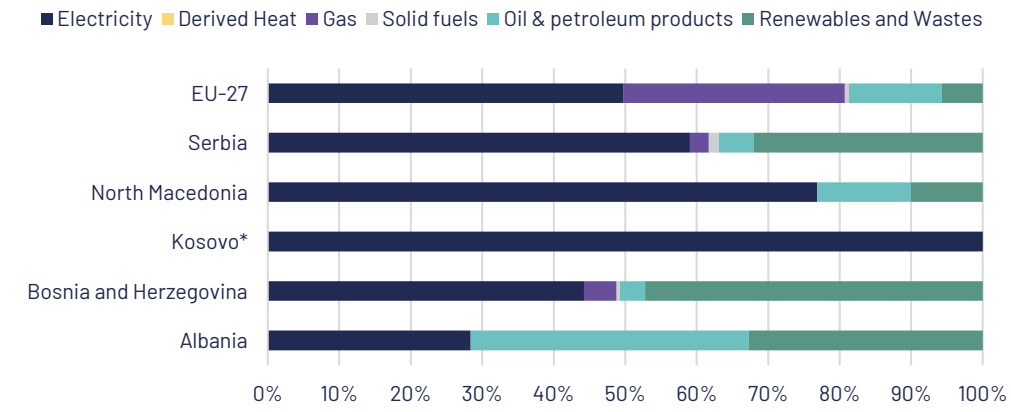
Table 5 *Share of fuels in the final energy consumption in the residential sector for space heating, 2019. Eurostat*[4]



	Albania	Bosnia and Herzegovina	Kosovo*	North Macedonia	Serbia	EU-27
Electricity	50,2%	0,4%	11,0%	26,6%	8,0%	5,3%
Derived Heat	0,0%	7,6%	2,3%	11,6%	20,9%	10,1%
Gas	0,0%	2,2%	0,0%	0,1%	10,7%	38,0%
Solid fuels	0,0%	4,7%	1,2%	0,3%	12,6%	4,2%
Oil & petroleum products	20,6%	0,9%	1,4%	1,7%	2,1%	14,5%
Renewables and Wastes	29,2%	84,2%	84,2%	59,9%	45,7%	27,9%

[4] Note: Includes data for North Macedonia from 2018, as data for 2019 was unavailable. The data on Montenegro was unavailable for both 2018 and 2019.

Table 6 *Share of fuels in the final energy consumption in the residential sector for cooking, 2019. Eurostat*[5]



	Albania	Bosnia and Herzegovina	Kosovo*	North Macedonia	Serbia	EU-27
Electricity	28,4%	44,2%	100,0%	76,9%	59,1%	49,8%
Derived Heat	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Gas	0,0%	4,6%	0,0%	0,0%	2,6%	31,0%
Solid fuels	0,0%	0,4%	0,0%	0,0%	1,4%	0,6%
Oil & petroleum products	38,9%	3,5%	0,0%	13,0%	4,9%	13,0%
Renewables and Wastes	32,7%	47,2%	0,0%	10,1%	32,0%	5,7%

Shares of energy balance attributed to biomass are important to understand the role of biomass in overall energy mix. We see that role is dominant. Share of households that rely on biomass for heating and cooking is important indicator for the social relevance of biomass use. We will see that its relevance is also dominant.

In addition to the uncertainty related to fuel use, official surveys in the past did not tend to cover the type of devices used for heating. Last survey performed in Serbia finally adopted the practice to capture the type of device used for heating[6].

Knowing the mix of devices used for heating is crucial to understand the real consequences of current domestic biomass use. Efficiency rates and emissions rate of devices in use may be very different.

RES Foundation included the question on the main type of heating device used in households in the survey performed within the framework of this project along with the questions of use of fuels for space heating and cooking. Thus, more information is available to facilitate the

[5] Note: Includes data for North Macedonia from 2018, as data for 2019 was unavailable. The data on Montenegro was unavailable for both 2018 and 2019.
[6] https://www.stat.gov.rs/media/345275/energy-consumption-in-households-in-republic-of-serbia-2020.pdf

understanding of the issue among the decision makers and, more important, to guide the policy response design.

Table 7 *Individual heaters and use of fuel wood in contracting parties- entire population. Source: Project survey, except for Bosnia and Herzegovina where Statistical Office is the source.*

Contracting party	Share of solid fuel[7] individual heater (stove, oven, masonry stove) as main heating device (%)	Estimated number of households using solid fuel individual heater as the main heating device	Share of households using solid fuels for space heating (%)	Share of households using wood for cooking (%)	Share of households using same devices for heating and for cooking[8] (%)
Albania	48.6	351,019	48.8	18.4	22.5
Bosnia and Herzegovina[9]	N/A	743,955	N/A	N/A	N/A
Kosovo*	63.7	189,246	70.5	47.3	64.7
Montenegro	58.8	113038	65.0	38.2	62.2
North Macedonia	46.9	264,655	54.0	23.3	31.5
Serbia	46.0	1,144,428	61.7	21.4	31.5

The results obtained through this survey are compared to the available results of the ad-hoc and regular surveys performed in some of the contracting parties and show a good match. Latest example are the World Bank data[10] published in November 2021 after the conduction of our Survey. Results clearly point to the individual solid fuel heater as the main device for heating in the region. More than 2,800,000 households were using such device as the main source of heat provision. The number of these devices used, however, has not secured almost any policy attention. Largest shares of household energy balances, most widespread devices and largest number of households are out of the policy loops in the WB. Consequences are described in the next chapters. When we take a closer look at the survey findings on the relevance of the biomass use and devices in place for such use among vulnerable population, we find even greater relevance.

[7] Does not include pellet
[8] Out of those who operate individual heater as main heating appliance
[9] Sample survey in Bosnia and Herzegovina was not nation-wide representative
[10] https://www.energy-community.org/dam/jcr:d16f0354-d06a-4bd6-ac73-64a7a3a2c19c/WSEE_WB_112021.pdf

Table 8 *Individual heaters and use of fuel wood in contracting parties- vulnerable population[11]. Source: Project survey*

Contracting party	Share of solid fuel[12] individual heater (stove, oven, masonry stove) as main heating device (%)	Share of households using solid fuels for space heating (%)	Share of households using wood for cooking (%)	Share of households using same devices for heating and for cooking (%)
Albania	54.7	54.6	18.6	22.5
Bosnia and Herzegovina[13]	N/A	N/A	N/A	N/A
Kosovo*	84.4	87.7	58.3	79.6
Montenegro	78.6	79.2	45.1	77.6
North Macedonia	58.6	67.1	34.1	47.8
Serbia	54.7	69.7	22.9	38.5

Segregated analysis of heating practices of vulnerable population is rare among the contracting parties. Republic of Serbia regularly provides decile analysis of households according to the type of heating used providing for the insight on the fuels used rather than on the devices. This analysis will be presented in the report.

EFFICIENCY, EMISSIONS, AIR POLLUTION AND HEALTH

Efficiency

We have seen so far, the numbers of individual heating devices spread across the region of the WB and the fuels used in households. Understanding the efficiency of the devices and fuels used and associated emissions will help us estimate the costs of policy inaction in household heating.

Real life efficiency of biomass use depends on the devise technology. It is also affected by the quality of fuel, chimney, and skills of the user. Current stock of biomass burning devices across the region is inefficient and causes high emission rates. Real life efficiency and emission rates of devices used are difficult to measure with precision. What we know from the research performed, and from the understanding of the biomass burning processes, clearly shows that efficiency of the devices used is very low while emissions are high. Out of all factors that influence real-life efficiency and emissions, lab tests capture only technology factors.

[11] Respondents who have reported to make ends meet with "great difficulty" or with "difficulty"
[12] Does not include pellet
[13] Sample survey in Bosnia and Herzegovina was not nation-wide representative

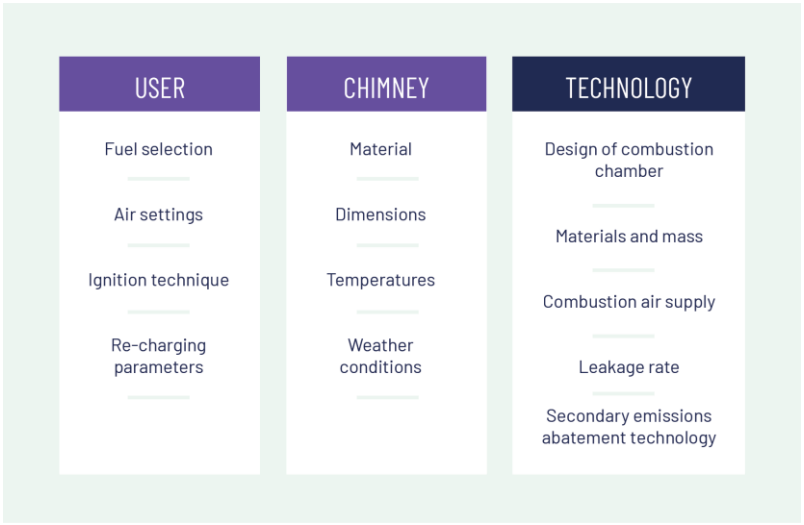


Figure 8 *Main influencing factors on emissions and thermal efficiency in real-life operation. Source: IEA*[14]*.*

Real life efficiency of devices used is estimated to be in the range from 30-40%. 65% seasonal efficiency is minimal type test efficiency required for the eco-design certified appliances while benchmark value set by the regulation is 86%. Even when we take into considerations deviations of real-life efficiency from lab tests, we see significant space for improvement. Real life efficiency may be doubled in some instances.

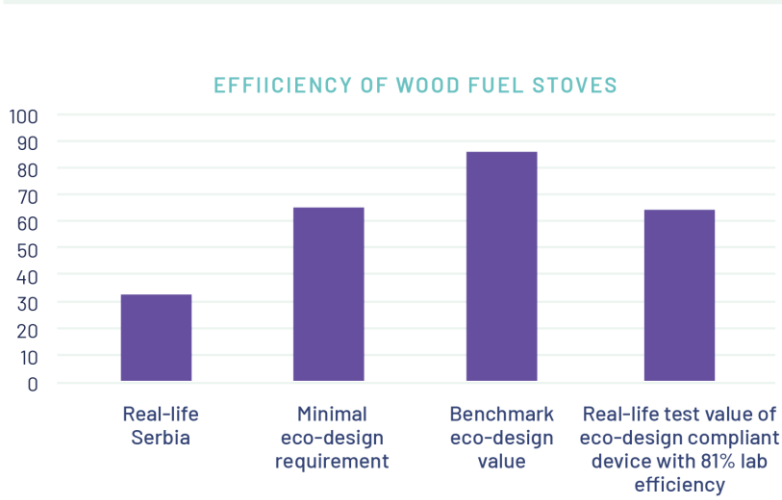


Figure 9 *Different values of efficiency measurements of fuel wood stoves*[15]

[14] https://www.ieabioenergy.com/wp-content/uploads/2021/05/Reichert-Webinar_Task32_Real-life-test-methods-for-log-wood-and-pellet-stoves_210505.pdf

[15] Sources: GiZ for real/life Serbia, European Commission for eco-design values and IEA for real-life test value of the device with lab efficiency of 81%.

Emissions

New technologies have significantly lower level of emissions in laboratory environment when compared to the old technologies. Reductions of PM emissions can be as high as 90%.

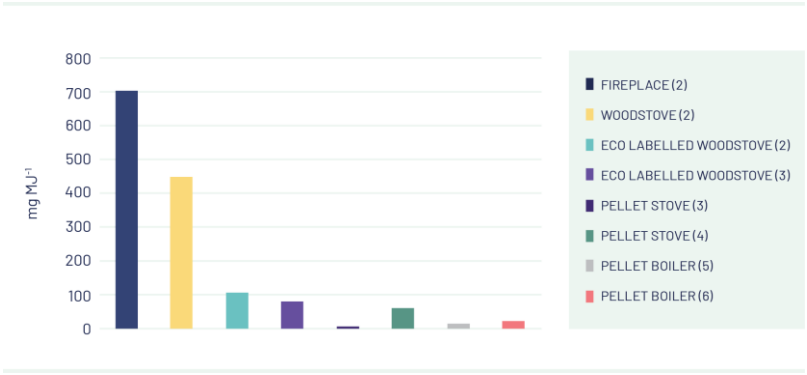


Figure 10 *Particle emission factors for various residential combustion appliances. Source: Life*[16]

Field measurements of emissions are even more rare and less conclusive than measurements of efficiency. Real life emissions of PM, OGC and BaP vary dramatically, due to various reasons. Those reasons include type of testing, operator's skills, moisture of wood used and other factors influencing fuel quality, such as geometry or presence of the bark. Wood moisture can influence the increase of emissions of particulate matter by a factor of 8 in new appliances[17].

Although, the emissions of biomass combustion vary in a wide range, optimization leads to a distinct decrease of most target pollutants and is accompanied by the lower overall toxicity. These results show that user training is of similar importance as changes in technology, because maloperations may counteract technological improvements. The high variations found for biomass combustion show, that emission factors are only representative when a diversity of maloperations and appliances is considered[18].

[16] http://airuse.eu/wp-content/uploads/2013/11/R27_AIRUSE-TechGuide-biomass-burning-emissions-reduction.pdf
[17] Impact of the quality of firewood and the evolution of the wood burning appliances on the quality of air Avis d'expert CERIC – July 2017
[18] Real-life emissions from residential wood combustion in Austria: From TSP emissions to PAH emission profiles, diagnostic ratios and toxic risk assessment

Table 9 *Overview of emissions data from literature review collected from all different types of wood appliances with unit mg/MJ. Source: Flanders Environment Agency*[19]

	PM (mg/MJ)	CO (mg/MJ)	PAH (mg/MJ)	NOx (mg/MJ)
Conventional wood stove	38 - 955	1100-7200	0.0325-220	35 - 66
Masonry stove	16 - 833	703-10611	0.081-14.10	72 - 83
High efficiency stove	15 - 176	100-7829	0.0003-340	99-182
Advanced stove	9.7-68.05	731-824	NO DATA	NO DATA
Modern pellet stove	16 – 139	73-413	0.000077-0.5	32-165
Conventional boiler	98.6-106.1	8969-12 632	3.39-18.85	NO DATA
Advanced boiler	6.0-45.8	7-793.1	0.00012-0.105	50.2-168
Wood/pellet boiler	11-116	12-547	0.00003-0.00015	59-127

Air pollution and health

In the Western Balkans, the residential sector is the largest source of harmful PM2.5 emissions. Current trends indicate that $PM_{2.5}$ emissions are not expected to decline markedly under existing policies due to the burning of solid fuel for heating in stoves and boilers.10 While it would be technically feasible to bring ambient $PM_{2.5}$ concentrations in the residential sector below or slightly above the WHO-recommended $PM_{2.5}$ guideline value, including at the city level, this would require implementation of a range of measures from improving fuel quality to significantly improved stoves and boilers in line with the stringent standards of the Eco-design Directive of the European Union (EU)[20].

[19] https://en.vmm.be/publications/literature-review-of-emissions-of-modern-wood-combustion-devices-and-emissions-reducing-technologies-under-real-life-conditions/@@download/attachment/WoodCombustion_FINAL-REPORT.pdf?

[20] https://openknowledge.worldbank.org/bitstream/handle/10986/33557/Regional-Note-on-Air-Quality-Management-in-the-Western-Balkans-Bosnia-and-Herzegovina-Kosovo-and-North-Macedonia.pdf?sequence=1&isAllowed=y

The quantification of health effects is specific to age groups for which exposure-response functions have been developed based on epidemiological studies. Most recent process in which consequences of air pollution in the WB were quantified was preparation of the Draft Programme of Air Protection of the Republic of Serbia for the period 2022-2030 with Action plan[21] . We believe that due to the similarities with other contracting parties Serbian case study is sufficient to inform the decision-making processes in other parties as well.

Some health effects indicators are calculated specifically for more fragile populations, such as children and the elderly within the framework The health impacts quantified are chronic and acute effects of population exposure to concentrations of fine particles (PM2.5), tropospheric ozone (O3) and nitrogen dioxide (NO2), in terms of morbidity and mortality. Effects are qualified as "acute" when they are due to an increase in ambient exposures of a few days (e.g. hospital admissions), and as "chronic" when they are due to ambient exposures of a longer term, sometimes life-long duration (e.g. mortality). The results of the assessment of the current situation are presented in the table below.

Table 10 *Estimated health impact due to current ambient air quality in Serbia. Source: The Government of Serbia*

Health impacts in Serbia	Unit	Pollutant	REF
			2015
Acute Mortality (All ages)	Premature deaths	O3	461
Respiratory hospital admissions (>64)	Cases		242
Cardiovascular hospital admissions (>64)	Cases		2 061
Minor Restricted Activity Days (MRADs all ages)	Days		1 415 555
Chronic Mortality (All ages)	Life years lost	PM2.5	92 013
Chronic Mortality (30yr +) deaths	Premature deaths		9 773
Infant Mortality (0-1yr)	Premature deaths		9
Chronic Bronchitis (27yr +)	Cases		5 934
Bronchitis in children aged 6 to 12	Added cases		22 762
Respiratory Hospital Admissions (All ages)	Cases		4 261
Cardiac Hospital Admissions (All ages)	Cases		5 144
Restricted Activity Days (all ages)	Days		8 656 749
Asthma symptom days (children 5-19yr)	Days		186 041
Lost working days (15-64 years)	Days		2 132 518
Bronchitis in children aged 5 to 14	Added cases	NO2	2 395
Respiratory Hospital Admissions (All ages)	Cases		2 113
Chronic Mortality (All ages)	Life years lost		6 530
Chronic Mortality (30yr +) deaths mean VSL	Premature deaths		694

By far the highest impact on health are observed due to PM2.5, where for the modelling reference year 2015 the estimated premature deaths amount to 9773 premature deaths and

[21] https://drive.google.com/file/d/1FizqEP5laZLU0dUWGChwId6utKMI84SA/view

more than 92 thousand life years lost. Due to PM2.5 concentrations in ambient air it is estimated that Serbia in 2015 lost over 2.1 million working days. Because ambient air quality has been deteriorating since 2015 the negative effects of air pollution in Serbia are even higher. It also must be noted that the numbers as presented in the above does not contain the transboundary effects of pollutants emitted in Serbia on health in the neighbouring countries.

Decades old coal-fired thermal power plants are responsible for the large majority of the SO_2 and NO_x pollution, as well as PM to some extent as sources for secondary PM. Majority of the PM, however, comes from households in the region which rely on wood or coal stoves and ovens as the main source of heating. So far, this evidence has not resulted in the policy consideration to motivate technology innovation and product development. This represents the most prominent missing opportunity to tackle the single biggest source of $PM_{2.5}$ and PM_{10} in Serbia stemming from individual heating (<50MW) that stands at 67% and 51% respectively. To understand the scale of this impact the share of road traffic in both $PM_{2.5}$ and PM_{10} remained at 5%.[22] Determining which sources of pollution contributed to the concentrations of pollutants is more difficult than to determine sources of emissions due to pollution transport and chemical processes that take place in the atmosphere.

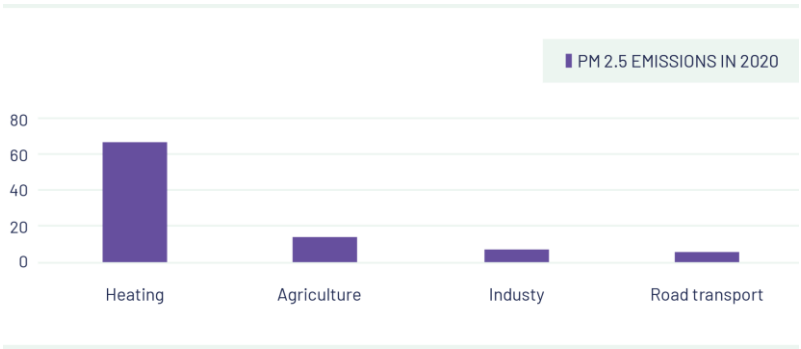


Figure 11 *Inventory of PM 2.5 emissions in 2020 in the Republic of Serbia. Source: SEPA.*

World Bank has also calculated the economic costs of ambient air pollution in three contracting parties. In its reports it also found that heating is the main contributor to dangerous concentrations of PM in the three contracting parties analysed.

Table 11 *Economic cost of mortality from AAP in Western Balkans, 2016. Source: World Bank*[23].

Contracting party	US$, millions	Share of GDP %
Kosovo*	160-310	2.5-4.7
North Macedonia	500-900	5.2-8.5
Bosnia and Herzegovina	1,000-1,800	5.9-10.5

[22] Which is responsible for 67% of emissions according to the latest annual report http://www.sepa.gov.rs/download/izv/Vazduh_2020.pdf

[23] https://www.worldbank.org/en/region/eca/publication/air-quality-management-in-western-balkans

In addition to the ambient air pollution, indoor air pollution also takes significant health toll. WHO takes stock of the health effects of indoor air pollution. Results for Serbia are presented in the table below.

Table 12 *Household air pollution (HAP) attributable deaths in Serbia, GHO 2016. Source: WHO*

Indicator	Household air pollution (HAP) attributable deaths		
Period	2016		
Location: Serbia	Both sexes	Male	Female
Total	4,822 (1,082 - 9,307)	2,573 (601.4-4,971)	2,248 (494.9-4,474)
Lower respiratory infections	299.7 (74.03-547.9)	157.3 (38.45-296.4)	142.4 (36.48-256)
Trachea, Bronchus, lung cancers	1,086 (270.2-2,038)	727 (177-1,411)	359.5 (90.08-656.8)
Ischaemic heart disease	1,694 (352.1-3,494)	854.5 (185.7-1,753)	839.5 (169.5-1,752)
Stroke	992.8 (192.8-2,084)	426.4 (85.04-876.6)	566.4 (109.3-1,231)
Chronic obstructive pulmonary disease	749.7 (147.2-1,553)	408.7 (48.86-1,002)	340 (84.86-639.7)

The technology of new devices that are being sold in the markets of the WB is non complaint with the requirements of the eco design directive which we present in the table below.

Table 13 *Eco-design limits for emissions and efficiency*

Regulation	Condition	CO	DUST	NOx	OGC	Efficiency
Regulation 2015/1185: local space heaters from 1/1/2022	Open fire appliances	2000 mg/m3 (13%02)	50 mg/m3 (13%02)	200 mg/m3 (13%02)	120 mg/m3 (13%02)	30% (seasonal efficiency)
	Closed fire appliances (except pellet)	1500 mg/m3 (13%02)	40 mg/m3 (13%02)			65% (seasonal efficiency)
	Pellet appliances	300 mg/m3 (13%02)	20 mg/m3 (13%02)		60 mg/m3 (13%02)	79% (seasonal efficiency)
	Kitchens	1500 mg/m3 (13%02)	40 mg/m3 (13%02)		120 mg/m3 (13%02)	65% (seasonal efficiency)
Regulation 2015/1189: boilers From 1/1/2020	Hand loaded boilers	700 mg/m3 (10%02) (seasonal)	60 mg/m3 (10%02) (seasonal)	Biomass: 200 mg/m3 Fossil: 300 mg/m3 (10%02) (seasonal)	30 mg/m3 (10%02) (seasonal)	75% (seasonal efficiency; power ≤20kW) 77% (seasonal efficiency; power >20kW)
	Automatic loaded boilers	500 mg/m3 (10%02) (seasonal)	40 mg/m3 (10%02) (seasonal)		20 mg/m3 (10%02) (seasonal)	

Natural replacement: investing in the past

Current annual value of the market for household devices burning fuel wood is estimated at more than 38 million EUR at the size of more than 125 thousand pieces. Average values of items sold clearly indicate that majority of products sold are from the lower end of the existing range of products. As already indicated the entire range of products is not up to eco-design standard[24]. Pellet stoves and boilers market is estimated to be of similar value, but much smaller size given that pellet boilers are represented much more than fuel wood boilers and that the price of fuel wood technologies currently sold is much lower than the price of pellet technology.

Table 14 *Quantities and value of the solid fuel and pellet individual heaters market in WB in 2020. Source: Consultants' reports.*

	Estimated annual sales in 2020 in WB, volume (pcs)	Estimated annual sales in 2020 in WB, value (EUR)
Solid fuel stoves and boilers	125,285	38,451,195
Pellet stoves and boilers	32,130	36,702,000

As devices using solid fuel that are currently sold in the market are devices that are not compliant with the eco-design standard, natural replacement will not lead to energy savings, wood savings and associated GHG emission reductions or local emissions reductions. Without introduction and enforcement of the eco-design standard a lock in the outdated technologies continues and economies resume to invest in the past. Understanding the data on efficiency and emissions of the existing practices presented in this chapter we may estimate the costs of inaction. World Bank assigned annual cost of 5,000 EUR to the use of one inefficient heating device in the Western Balkans[25]. Every year we miss more than 100,000 opportunities to reduce these costs.

Another important segment of the heating technologies market is the heat pump segment. This segment contains different range of products from highly advanced heat pumps to air-conditioners. In such a broad range of products almost every user may found a replacement heating technology depending on several factors that are described in the next chapter and that include the efficiency of the dwelling and the stability and quality of electricity supply. While heat pumps are more advanced technology by default standards are also important in this segment.

[24] Dominant regional market player introduced in the beginning of 2022 several products marketed as eco-design compliant.
[25] https://www.energy-community.org/dam/jcr:d16f0354-d06a-4bd6-ac73-64a7a3a2c19c/WSEE_WB_112021.pdf

As air conditioners or air to air heat pumps could serve in many instances as a viable heating technology it is of utmost importance that EU standards and regulations are immediately introduced to prevent devices with low seasonal efficiency to be sold in the market. From the market data gathered during the *Smarter stoves project* we may conclude that substandard devices are still widely present in the market.

Table 15 *Value of heat pumps market in selected contracting parties in WB in 2020. Source: Consultants' reports.*

		Serbia		Albania		Bosnia		Macedonia	
HP type	Product groups	(MEUR)	Share (%)	(MEUR)	Share (%)	(MEUR)	Share (%)	(MEUR)	Share (%)
A-A	Single Split	41.20 €	56.7%	22.90 €	45.3%	18.60 €	53.7%	18.80 €	64.3%
	Multi Split		14.5%		16.7%		17.9%		14.7%
	VRF		18.2%		15.8%		14.5%		10.5%
	Other (roof top units)		0.6%		0.7%		0.4%		1.6%
A-W	Chillers (all types)		10.0%		21.5%		13.5%		8.9%

Table 16 *Average price of single and multi-split heat pumps market in selected contracting parties in WB in 2020. Source: Consultants' reports.*

System	Albania		Bosnia		Macedonia		Serbia	
	2019	2020	2019	2020	2019	2020	2019	2020
Single split	437.00 €	441.00 €	318.00 €	321.00 €	363.00 €	372.00 €	324.00 €	327.00 €
Multi split	963.00 €	979.00 €	944.00 €	960.00 €	860.00 €	875.00 €	714.00 €	744.00 €

HOUSEHOLDS: INCOME, CAPABILITIES, EXPENDITURES, ATTITUDES

Building condition, type of fuel used, type of device used together with the preferences of household members, occupancy time and socio-demographic characteristics of the household determine the quantity of energy required to provide adequate preconditions for a healthy indoor environment in the household, including adequate thermal comfort. These factors also influence the emissions from heating.

Household income, knowledge and skills, access to one's own forest resource are among the factors that will decide whether a household will be able to achieve required comfort. Sometimes households decide to achieve this comfort at the expense of other basic requirements such as good quality food, transportation, education, recreation or other. They might also revert to the use of non-standard, low-quality fuel.

Analysis of statistical data on energy related expenditures and of perception related to housing conditions helps us understand the positions of the household and helps us complete information required for good quality policy design. Such analysis should also reveal current capabilities of household to improve private and public benefits of resources invested in heating by improving its efficiency.

Energy costs and income: affordability, comfort, and ability to change

Table 17 *Energy related expenditures in contracting parties*

Contracting party	Mean share of housing, water, and energy costs as part of the entire household expenditure[26]	Mean share of energy costs as part of the entire household expenditure	Mean annual household expenditures for housing, water, and energy27 (EUR)
Albania	11.7		470
Bosnia and Herzegovina[28]	14.6	9.4[29]	N/A
Kosovo*	N/A		N/A
Montenegro	15.6	12.0[30]	880
North Macedonia	21.8		760
Serbia	20.5	14[31]	910
EU 27	25.7		

[26] Eurostat, except Kosovo* where source was Kosovo* Agency for Statistics. Data for Albania and North Macedonia are for 2019, for Kosovo* for 2017, and for other contracting parties for 2020
[27] Eurostat.
[28] The survey sample in Bosnia and Herzegovina was not nationally representative
[29] Source: Household budgetary survey 2015.
[30] Household budgetary survey for 2017
[31] Household budgetary survey for 2019

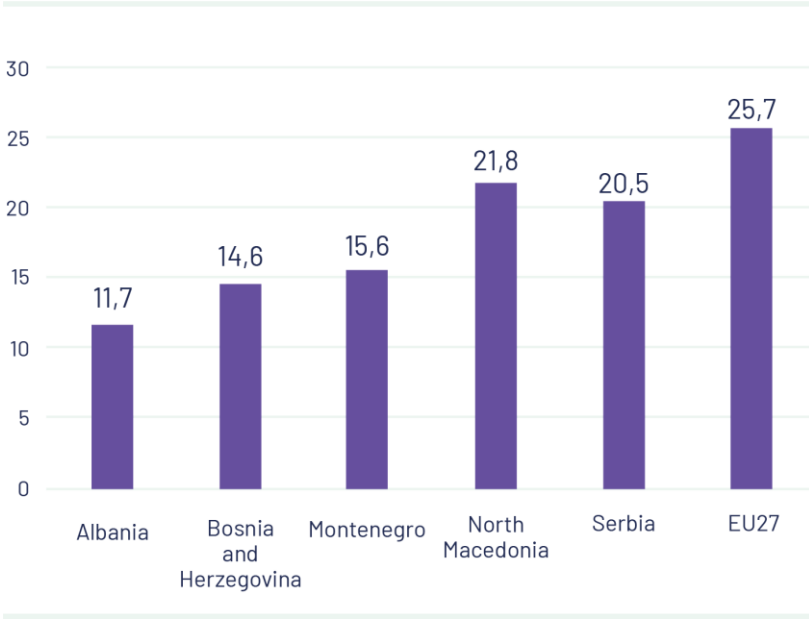


Figure 12 *Share of housing, water, and energy costs as part of the entire household expenditure (%)*

Relative shares of energy costs as part of the entire household expenditures in the Western Balkan are high and are around the 10% threshold. Where median shares are known they are usually somewhat lower than mean shares. However, only when we look at the absolute expenditures for energy and knowing the fuel and energy prices in the region, we can understand the environment in which energy supply to households takes place. We also provide a more detailed analysis of Serbian case due to the better data availability.

What are the consequences of relatively low income that needs to provide for the expenditures in general, and for energy expenditures in particular? Usually, analysts revert to the findings of the Survey of income and living conditions to see whether households can provide warmth to their houses that is perceived as adequate by its members, whether they notice roof leakage, condensation, or dump creation, or whether they manage to pay their utility bills on time. We added here also the perception of the households related to the burden that paying of housing costs represent for them. We would like to start showing that even when people manage to pay for housing costs, and perhaps currently obtain sufficient comfort, they perceive housing cost as financial burden or heavy financial burden. More than 50% of Serbian households estimate housing costs as heavy financial burden with additional 40% stated that housing costs are financial burden for them. Data on improvements in perception regarding the housing comfort can only be properly understood when we understand the burden of housing costs for the households. An ongoing energy crisis is a major threat for those improvements.

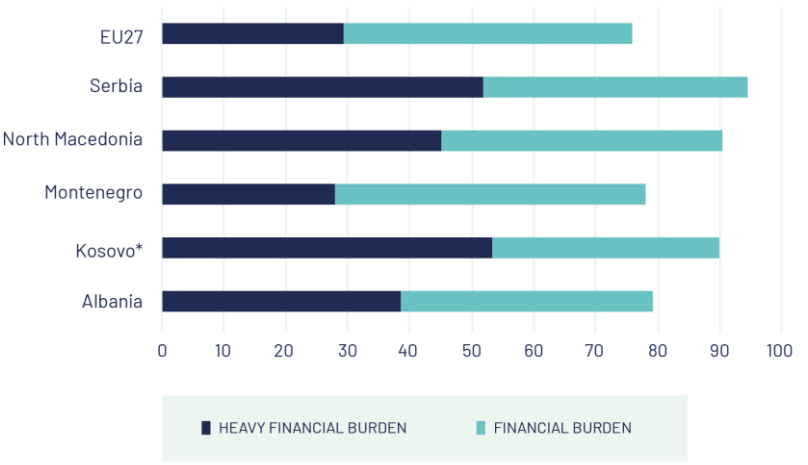


Figure 13 *Share of households experiencing "burden" of housing costs (%)*

Serbian citizens are most satisfied with the warmth they enjoy in their households and less than 10% report inadequate warmth. This share rises to more than 40% in Kosovo*.

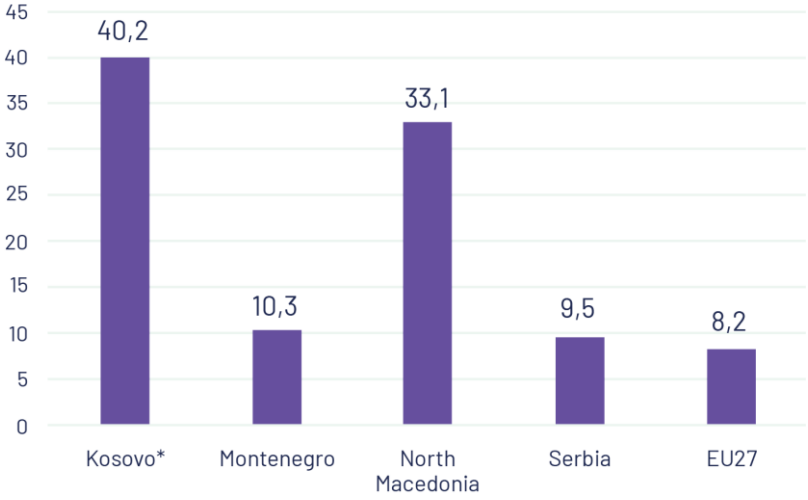


Figure 14 *Share of households unable to keep their home adequately warm (%)*

People are struggling to pay their utility costs and very large share of households is late with payments in all contracting parties. With the rising energy prices the situation is scheduled to deteriorate.

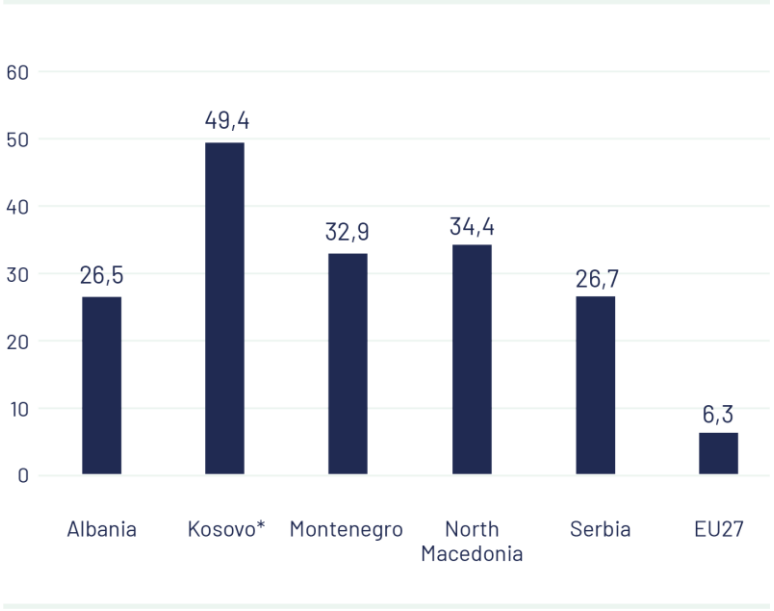


Figure 15 *Share of households, in arrears with utility bills (%)*

More than fifth of households in the three contracting parties live in the dwellings with serious construction issues. In remaining two this share is higher than 10%. These household certainly need distinctive approach form those who are not facing such issues.

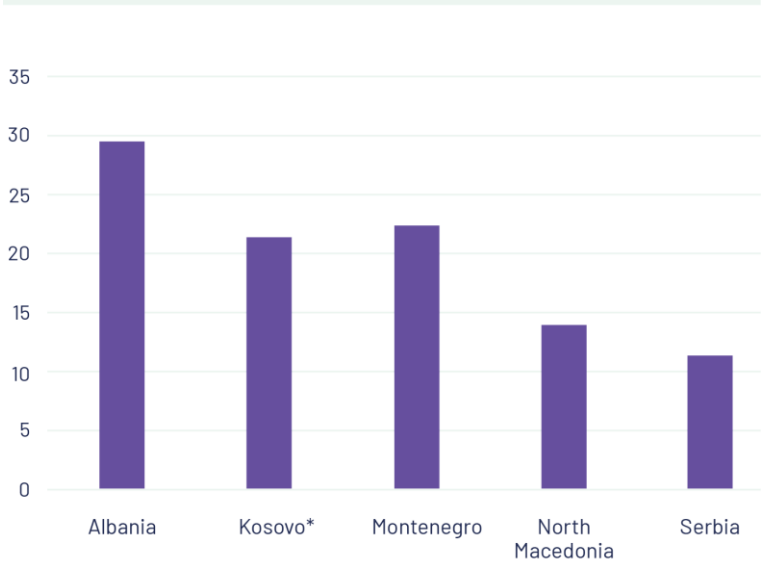


Figure 16 *Share of households living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor (%). Source Eurostat*[32].

[32] Data for Serbia and Montenegro for 2020, For Albania and North Macedonia for 2019, and for Kosovo* for 2018.

For households to embark on a change that will improve benefits of energy consumption they need to have resources including financial resources. While from the analysis of Household Budgetary Survey data (where available) we see that majority of household cannot make any meaningful improvements with the resources that they are currently investing, SILC may help us understand how deep this inability is. The share of households who responded that they are unable to cover minimal unexpected costs from their budgets (including the borrowing capabilities) is strikingly, but not surprisingly, high and ranges from 35.1% in Serbia[33] to 62.2% in Montenegro.

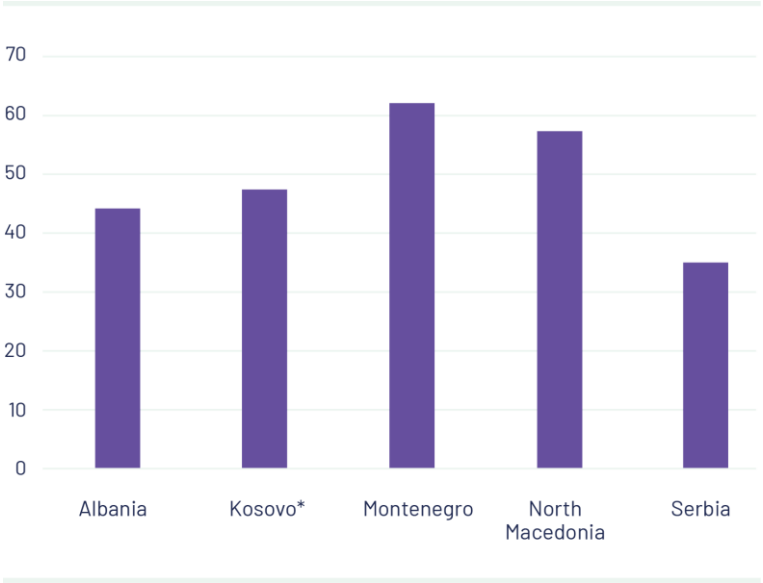
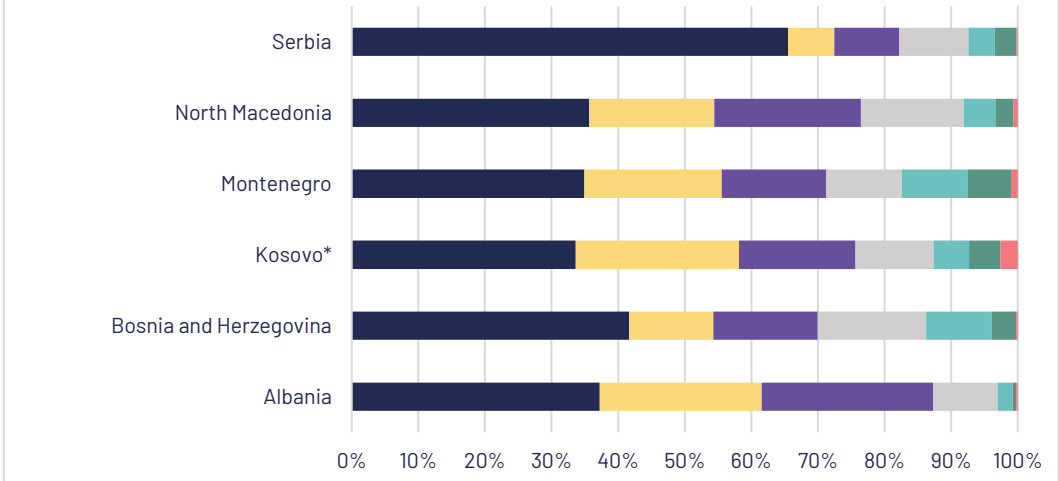


Figure 17 *Inability to face unexpected financial expenses in the contracting parties: Source Eurostat[34].*

Household survey conducted within the framework of the Smart stoves project confirms SILC data on ability to face financial expenses. Respondents were asked, how much would they be able to pay for a new heating device if forced to replace. The answers clearly show low purchasing power and low willingness to pay for heating devices. It is impossible to procure improvement in heating with the amounts preferred by vast majority of respondents in all the contracting parties.

[33] Amount in question for Serbia is approximately 140 EUR.
[34] Data for Serbia and Montenegro for 2020, for Albania and North Macedonia for 2019, and for Kosovo* for 2018.

Table 18 *Respondents' willingness to pay for new appliance. Source: Project survey.*



	Albania	Bosnia and Herzegovina	Kosovo*	Montenegro	North Macedonia	Serbia
Could not afford a new appliance	37,3	41,7	33,6	34,9	35,7	65,5
Up to 300 EUR	24,3	12,6	24,5	20,6	18,8	6,9
301 to 500 EUR	25,8	15,7	17,5	15,7	22,0	9,7
501 to 1.000 EUR	9,6	16,3	11,7	11,3	15,5	10,4
1.001 to 1.500 EUR	2,2	9,8	5,3	9,8	4,8	4,0
1.501 to 3.000 EUR	0,5	3,7	4,7	6,5	2,7	3,3
Over 3.001 EUR	0,3	0,2	2,6	1,0	0,6	0,2

Meaningful(less) means, meaningful(less) medians: case study Serbia

Making sure that public money is effectively used to help those in need improve their living conditions while simultaneously improving public goods such as air quality or forest resource availability requires diligence. Addressing inefficient heating practices through the angle of energy poverty may be helpful if we understand the context. Thanks to the relatively good quality of available statistics in the Republic of Serbia we can illustrate the meaning of median (or mean) expenditures for energy. We believe that this illustration is valid also for other contracting parties of the region.

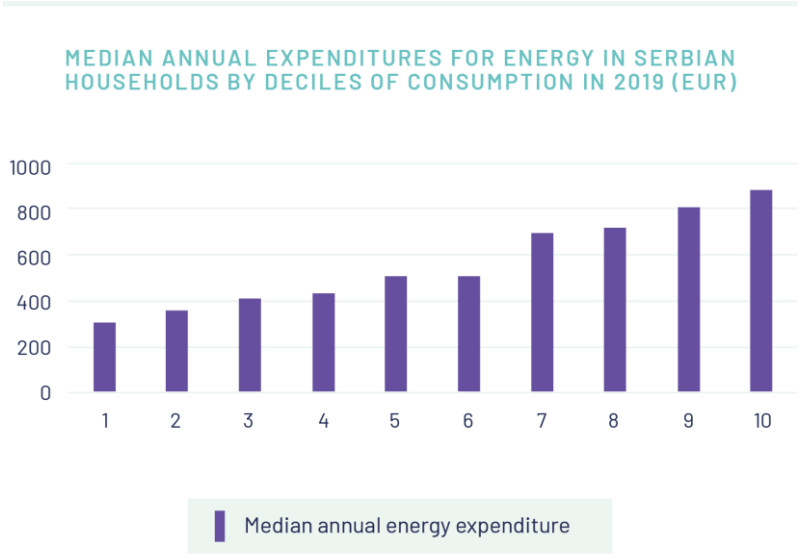


Figure 18 *Median annual expenditures for energy in Serbian households by deciles of consumption in 2019 (EUR). Source: Statistical Office of the Republic of Serbia*

While median and mean shares are very useful to describe phenomena, absolute figures on median energy expenditures combined with the energy prices, and deeper understanding of the context, portray a picture that is more useful for decision making. Annual median expenditure for energy is rising with the deciles of consumption and reaches, in the case of the Republic of Serbia, 510 EUR only in fifth and sixth decile.

Table 19 *Decile analysis of energy expenditures, heating installations and main fuels used for heating*

Share of households using solid fuel or combined heating	83.3	79.6	74.7	69.9	62.3	55.8	48.7	48.3	47.4	40.8
Share of households with central heating installations	14.1	20.3	28	30.4	41.3	43.1	50.1	58.5	58.1	63.6
Median annual energy expenditure	306	357	408	434	510	510	697	714	808	884
Deciles	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10

Decile analysis of heating modes and existence of central heating installations is discovering much more details about the customer of our public policy. It is a household that probably uses fuel wood for heating in individual heaters.

Table 20 *Calculated wood and electricity consumption with decile analysis of dwelling surface and energy expenditures. Source: Statistical office, own calculations*

	Consumption of wood (Stack m3)	Consumption of electricity (kWh)	Useful energy for heating from wood (kWh)	Average surface of the dwelling (m2)	Median energy expenditures (EUR)	Median share of energy expenditures (%)	Number of households below M/2
Decile 1	3.5	1630	2608	64	306	34	76000
Decile 2	4.1	1902	3043	68.1	357	19	48000
Decile 3	4.7	2174	3478	71.3	408	16	42000
Decile 4	5.0	2309	3695	71.6	434	15	42000
Decile 5	5.9	2717	4347	76.9	510	13	24000

If we interpret the data from the energy balance of the residential sector in the Republic of Serbia and assign 80% of energy consumed to fuel wood and 20% of energy used to electricity, we may have a simplified insight into what useful energy at disposal of households in the first five deciles of consumption is. We may, only then, understand how many kWh of useful energy a household may deliver to its rooms spending 500 EUR and less to procure fuel and energy to be used with the technology they currently own in the buildings as they currently are.

This calculation is based on the energy prices from 2021 and on the assumption that individual heaters convert fuel energy into useful heating energy with 40% efficiency which is probably a generous assumption. Understanding that the current energy expenditures, not sufficient for procuring adequate quantities of energy, represent a very high share of total household expenditure, we may conclude that partial subsidies for energy efficiency will not help those households. Looking at numbers of households who, under these conditions, spend less than half of the median expenditures we see the need for immediate targeted support. The fact that a certain share of these households has access to their own wood resources is the key factor that prevents further detrimental consequences of energy inefficient heating.

To use energy poverty as the framework that may be helpful, we must apply the approach that takes into consideration broader context. This approach has been taken by the Republic of Serbia. The definition of energy poverty in the Republic of Serbia includes access to own wood, efficiency of heating devices and fuel used as important drivers of energy poverty. This approach better suits the universe of public policy customers we should serve.

What do users think? No knowledge, no power.

The customer is always right. Any effort to design a publicly funded support scheme must attempt to understand its customers (beneficiaries). We have, so far, analyzed the building stock, heating devices and fuels and households as statistical units in this report. Responses collected though SILC also gathered perceptions of real people. In this chapter we present the social science findings relevant for users' heating choices, but we also present the findings from the focus groups and opinions and perceptions collected in the survey in all contracting parties.

Literature review offers two main theories that aim to describe the behaviour of people regarding fuel and stove use, as well as energy transition from one source to another. According to the dominant approach, the energy ladder model (ELM), people are perfectly rational actors, and have ranked preferences for different fuels based on several factors (cost, ease of use, efficiency, etc.).

This model is derived from the highly influential theory of human rationality Rational choice theory whose main assumption is that people try to maximise their own utility. Another implication of ELM is that they also make a complete transition from one fuel to another, i.e. they switch to a better fuel as their income grows. For example, people will try to obtain the most affordable and most available fuel; they will first use whatever they can obtain (e.g. wood, coal), and as their socio-economic status grows, they will "climb the energy ladder" and make a complete transition to gas and to electricity. So, income is positively correlated to adoption of more efficient and more costly energy sources.

However, there are studies showing that income is not the key explaining variable and, in some countries, socio-economic status is not at all linked to fuel consumption. In other words, some empirical data cannot be explained by the energy ladder model, as there are other factors that may outweigh the importance of income (e.g., fuel availability). Critics of ELM show that in reality people often diversify their fuel use and don't make a complete transition to one fuel source.

For example, people may continue to use wood if it is cheap and easily available even if they have the money to switch to cleaner and more expensive energy sources. In other cases, even the people with low socio-economic status use electricity if they have access to it. People usually don't make a complete transition to one fuel, but rather use multiple fuel sources.

The second approach posits that people diversify their fuel and stove use. Although the new and improved stove types can be added, traditional ones are rarely abandoned. Based on different tasks and needs, people may use different fuel or stove options. According to the multiple fuel use model, income is not a crucial factor, and people are more constrained by different factors (e.g., fuel availability), then they are guided by maximum utility.

People often stack lower-level fuels, e.g., wood, coal, or use whatever they have available (tires, clothes). This model is derived from cognitive-ecological perspective on human rationality, whose main assumption is that people don't act as rational agents according to some norm (e.g. logical norms), but rather use heuristics (i.e., intuitive reasoning) that provide good-enough solutions.

Because people live in an uncertain world where gains and losses cannot be computed, they develop heuristics through interplay between the cognitive processes and structure of the environment. Metaphorically speaking, they use a pair of scissors, where one blade is their cognitive limitations, and the other is the structure of the environment. For example, people may draw samples from their social environment (e.g., neighbourhood) and base their decision on other people's habits regarding fuel and stove use.

Socio-cultural factors also play an important role according to this theory. For example, an improved ceramic stove that was successfully implemented in one country often won't be as effective in other countries with different cultural patterns. People in the Balkans often use their stove for making traditional meals or preserved food (beans, ajvar, sarma, etc), even when they have a cleaner fuel stove they use as their primary device.

Factors that may influence fuel use and energy transition

Income: Studies show that low income can be a crucial determinant of solid fuel use. Cleaner fuel sources require up-front investments, which is not feasible for people with low income. People with low income usually obtain cheap fuel in small quantities to get through the winter, and do this every year.

Family/community: The influence of the family and the community (particularly neighbours) on heating choices can be both positive and negative. Certain activities such as collecting and preparing firewood can play an important role in the community and are part of the local tradition. Therefore, some people may refuse to switch to a more modern way of heating in order not to stand out or be perceived to signal a higher social status. On the other hand, it is possible that people would be more willing to switch to cleaner energy sources if their neighbours do it first, after they get familiar with new technologies and after they have the opportunity to hear other people's testimonies.

Household size: Data on household size as a factor that can influence fuel use is inconclusive.

Fuel availability and security: In some studies, fuel availability and access is observed to be the main determinant of fuel use. In addition, even when people have access to cleaner fuels, they often stack wood and coal just in case, e.g. in the event of an electricity outage. In other words, they are risk averse, and try to be prepared for every eventuality.

Gender roles: Studies show that women's and men's roles are different when it comes to fuel and stove use. Women are mostly engaged in cooking, while men usually decide which fuel and technology is used for heating purposes.

Cooking: The use of solid fuels for cooking is a practice that has been passed down through the generations and has been the standard for a long time. People are often satisfied with the stove their grandmothers used and often do not want to deviate from tradition. In addition, people have often emphasised the economical aspect of the stove, which can handle several pots of food at the same time, which can save time. The food is often perceived as more delicious when prepared on solid fuel stoves. The economical aspect is also reflected in the fact that in winter the stove heats the room and serves for food preparation. In the Balkans,

even people who do not use the stove for cooking and heating in winter, may use it to prepare preserved food in the yard.

Perception of health hazards: Studies show that people generally do not see the connection between their choice of fuel and stove and the health problems they might have. Moreover, in some studies, respondents did not perceive ash and smoke as something bad, but something that could be useful to them, e.g. because it protects them from insects.

These results and correlations are not unambiguous. More often than not, different studies show different results, which is understandable bearing in mind that studies are done in many different contexts and countries. Also, there are only a few experimental studies. Given that the research on fuel and stove use in the Western Balkan markets was, to date, non-existent, the aforesaid literature review was followed by a qualitative study of Serbian citizens' attitudes and behavioural patterns, to be able to provide a better understanding of behavioural patterns of the people in the Balkans and to inform the design of a more detailed survey of representative samples in each of the region's six markets.

Feedback from focus groups: security, practicality and sticking to "what is natural"

To examine the importance of numerous factors (such as psychological, cultural and social), and to answer the question of whether a fuel and stove diversification can be observed in specifically - Serbian context, four focus groups were conducted over the summer of 2021 with participants who use solid fuel for household heating, assigned based on residence (urban, rural) and gender (male, female).

Respondents from rural groups on average heat about 50% of their living space. On the other hand, respondents from urban groups heat about 80% of rooms on average.

When it comes to insulation, citizens from rural areas all have old and worn-down wooden joinery and their houses need new doors, windows and insulation. It seems to them that it is very expensive and represents a huge investment, which they cannot afford. Therefore, replacing the heating source is not their top priority, because even if they had the money to upgrade their heating device, they would invest in joinery first.

Some consider wooden doors and windows superior to, for example, PVC ones. In the rural group, one woman pointed out that, even if she could afford it, she would not be able to install PVC joinery because she would be bothered by artificial material (PVC) due to health problems. Another woman from the rural group pointed out that she would prefer her new doors and windows to be made of wood.

> *"I am against PVC, I am for wood. It seals well, but it's not that permanent. It can't last like wood, which you coat with oil paint...and it breathes, breathes. We install PVC windows, close houses, but where is the ventilation? And then there is condensation, mould and other things...I'm against PVC, that rubber can't last fifty years." Woman, urban*

"If you ask me, woodwork is the king. Firstly, it is healthier. PVC is better because it seals better, it is more modern, it has its advantages, but it is plastic. Wood is wood after all, it's alive, just like you have the parquet floor. Parquet and laminate can never be the same. Laminate is plain cardboard, and parquet is parquet, it is living wood." Man, urban

This is where the first heuristic appears. We will see below that it is also used when thinking about the type of fuel that is used. The **"natural is better"** heuristic allows people to be guided by the fact that if something is natural, in this case made of wood, that it is *a priori* better and healthier than something new, "artificial" and more modern. They often use this heuristic instead of informing, studying and considering various options which the energy ladder model posits. All people who were against PVC have never had or used PVC joinery. This line of thinking is repeated when they talk about how they heat their homes.

But when it comes to gathering information about different energy sources, neighbours have the main role, even though participants won't admit directly they are influenced by their neighbour's choice of heating. This is the case particularly if it is a modern solution; they often learn new information and have the opportunity to witness its effectiveness first-hand, which can influence their decision-making in the future.

"Smederevac", the most widely used device made for decades by a company from the Serbian city of Smederevo, is most often used because of tradition, since they inherited it from their family and are fond of it.

They understand that it is best to buy wood in spring-summer in order to have enough time for it to dry before winter, but they often cannot afford to prepare firewood timely[35].

Participants believe that burning wood is better than anything else *that they can afford*, and they believe that wood pollutes the least, especially compared to coal. In addition, electricity is saved during cooking. Respondents notice well that dry wood is better for burning, that is, that wet wood creates soot and clogs the room. However, they always compare wood to coal.

Participants have very positive associations of using wood. They emphasize the warmth of home, childhood memories, the smell of food that permeates the rooms. This is especially emphasized by women.

> *"There's a charm to it, when it's warm, and then you all get together in the room and you actually get closer because you're all together in that one room there, warming up and still hanging out."*

A stove or furnace in which the flame can be seen has a positive psychological effect on people, who point out that looking at the flame calms them down.

On the other hand, men more often emphasise the practicality and instrumental function of the stove, that is, how well it heats and how it pays off. In general, men appear to know more about different technologies and have more information about different appliances compared to women, while women talk more about the emotional connection with the stove.

[35] This video is also informative https://www.youtube.com/watch?v=KXgqYrmmk_g

Some participants pointed out that owning a stove and purchasing wood enables them to feel secure. Namely, the old stove is not thrown away and is kept just in case even when not in use.

> *"And why is wood the most appealing...because you don't depend on anyone. Buy wood now... put it in the shed and sleep peacefully the whole winter. You don't have to think about whether someone from Russia will turn the gas off...Or whether the power will go out so you can't warm up... [in these situations] you depend on others. You don't depend on anyone [if you use wood]. Get firewood and sleep peacefully until next year... You are your own boss when you use wood."*

Participants especially point out that preparation and use of firewood is a problem, especially if you are older, you need someone to help you, e.g. to cut wood, to bring wood into the house. If you don't have someone who can help, then it all requires additional costs.

In addition, the citizens notice that there is a danger of injuries, since they used to burn themselves on overheated stoves when they were younger. Some people are bothered by the fact that the firebox is small, narrow, so large pieces of solid fuel cannot be inserted.

Respondents are aware that burning harms the environment, but they are convinced that by burning wood, they do so to the least extent. For that reason, the respondents rarely ventilate the rooms when they burn wood (which is not the case when they burn coal). They point out that with use of firewood (as opposed to coal) the house "never stinks", so the rooms are usually ventilated in the morning and sometimes in the evening.

Participants from the rural women's group have no experience with alternative types of heating, so their perception is based on what they heard on television, read on the Internet or saw in the neighbourhood. However, their encounters with gas, air conditioning, pellets and the like are not frequent. They are mostly sceptical of air-conditioning and gas, which they see as something "artificial" - a heuristic we've mentioned before.

Other ways of heating, which are even more abstract in terms of how they work, are somewhat more tempting to them because they see them as "natural" ways of heating, e.g. underfloor heating with pellets or solar energy.

> *"I was attracted to that pellet...It even has a remote control, you adjust the temperature to the needs of the room....Maybe that would be the kind of heating I would want... The pellet makes me think of something natural... Ecologically speaking, it is more suitable. They say it covers a lot of square metres."*

Male respondents from rural areas are significantly more informed about different methods of heating than female respondents. They believe that it is best to heat with gas or electricity, and that would be ideal for them *if they could afford it*. But they can't pay for electricity regularly, they can pay a higher bill once, but they can't do it every month. As for the air-conditioning, they do not know if it pays-off, they do not have air-conditioning, so they cannot estimate how much they would need to pay for electricity. They also "heard about the heat pump", of which they have a very positive impression. However, they think they cannot afford it.

People generally do not perceive that there are authorities in this area, they rely only on themselves and do not believe that anyone wants and can help them. If there was some kind of help, they would expect that help to come from the local, municipal self-government and the state, but they do not have much hope that such a thing is feasible, especially since some families cannot (co)invest anything at all for these purposes.

> *"I'm not asking for money. Come, see, replace. I don't need to see any money; I just need help for this (device change-out) to be done."*

Pellet burners are similar to inserting wood or coal into the stove. For that reason, this option is the closest to focus group participants psychologically, while options such as gas heating or air-conditioning are psychologically distant and "artificial", and for that reason is not that tempting to them. They do not perceive electric heating as a real possibility at all, considering the finances, although they potentially see it as an ideal solution.

They are trying to justify their choice, which is not really a choice in the true sense because they are forced to use a stove and firewood due to a bad financial situation.

In a situation like this when they can't rely on information and experience, people tend to be guided by intuitive thinking, and our results show that the dominant heuristics used by them is the heuristic "natural is better".

These qualitative insights were used to inform the design of an opinion survey conducted in all of the Western Balkans markets with the objective of profiling the markets and informing future change-out strategies.

Public opinion in the Western Balkans: selected quantitative survey results

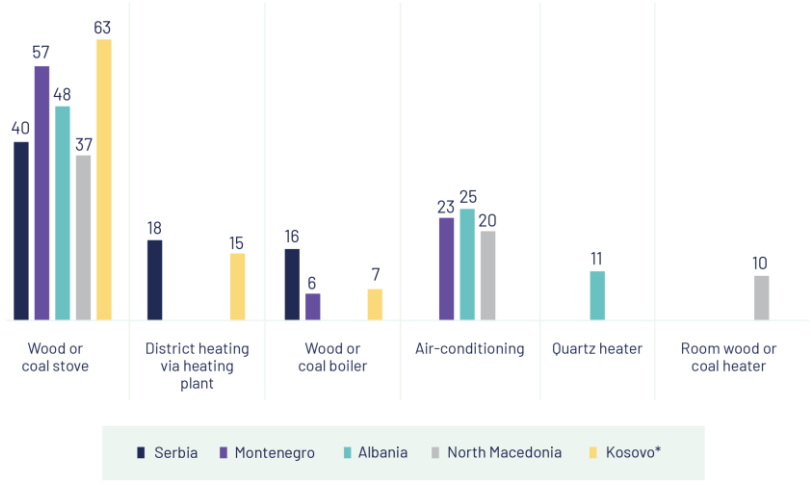


Figure 19 *What is the MAIN APPLIANCE used for heating in your household? (%)*

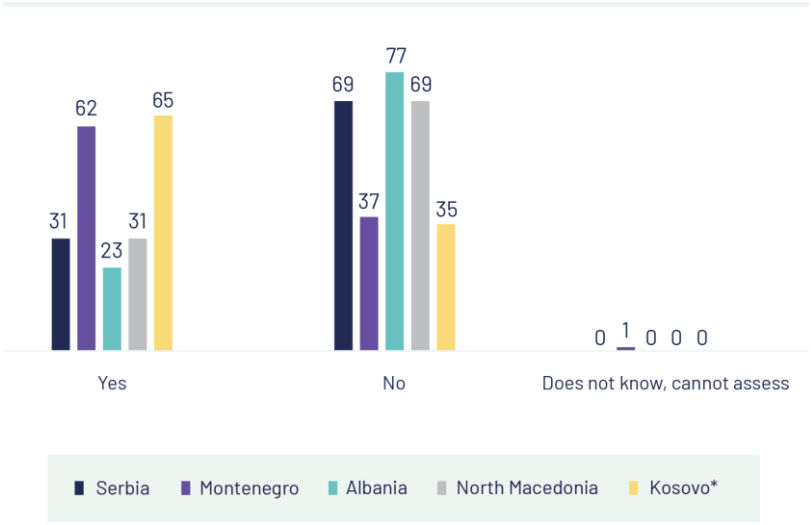


Figure 20 *Do you use the same appliance (stove, for instance) for cooking and heating? (%)*

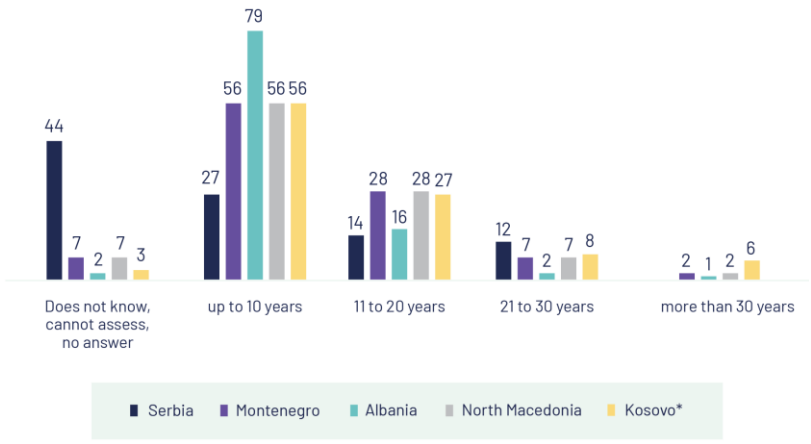


Figure 21 *How old is your main heating appliance? (%)*

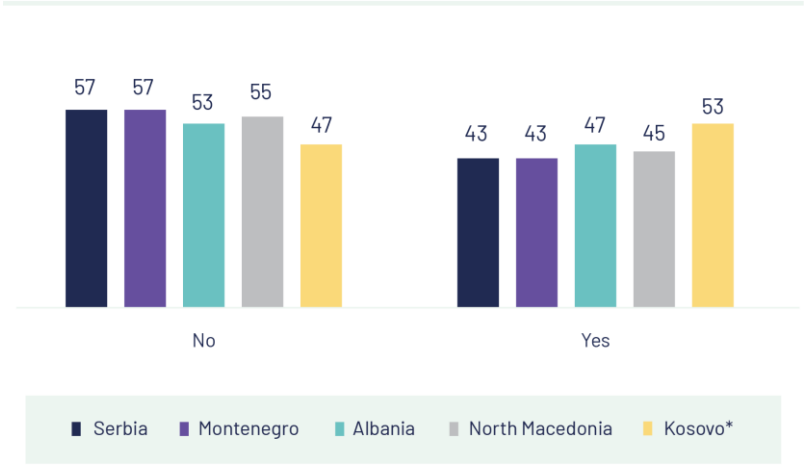


Figure 22 *Do you or any of your family members sleep in a room with a stove or a heater? (%)*

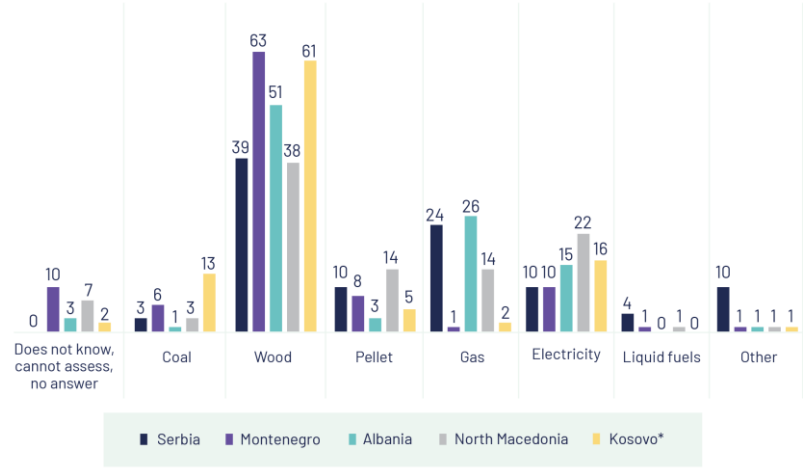


Figure 23 *In your opinion, consumption of which fuel is the most affordable for heating? (%)*

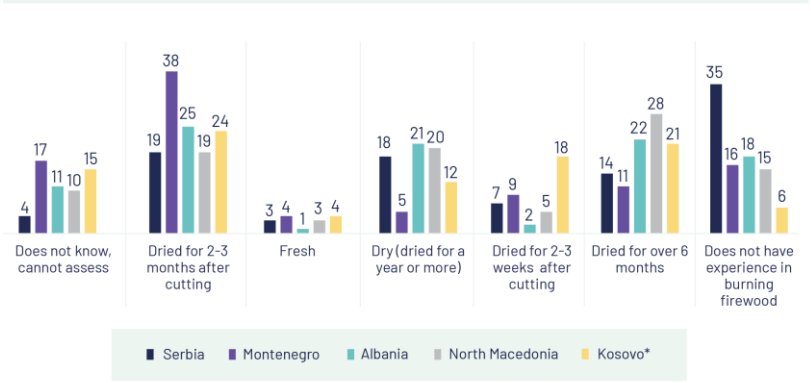


Figure 24 *What type of firewood is, in your opinion, the best for heating? (%)*

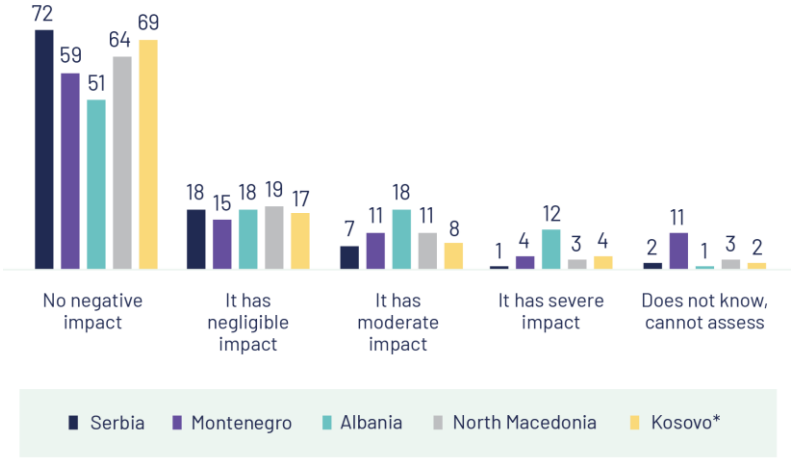


Figure 25 *Do you think that your heating practices have a negative impact on your health and the health of your family members, and what is the extent of those impacts? (%)*

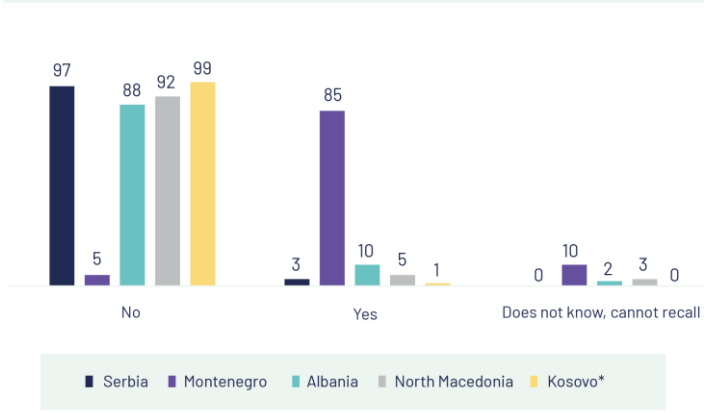


Figure 26 *Has your doctor ever suggested that heating practices can have adverse effects on your health? (%)*

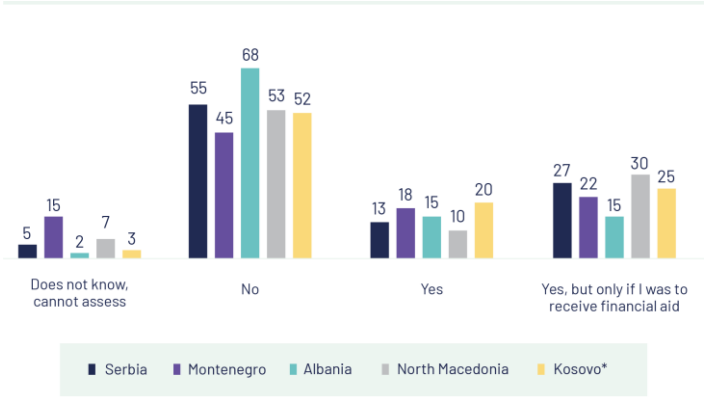


Figure 27 *Would you be willing to replace the heating appliance/system used in your household? (%)*

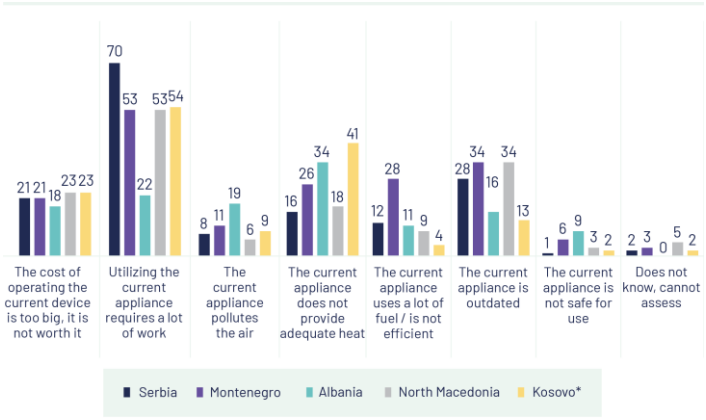


Figure 28 *Why would you replace your current heating appliance? (%)*

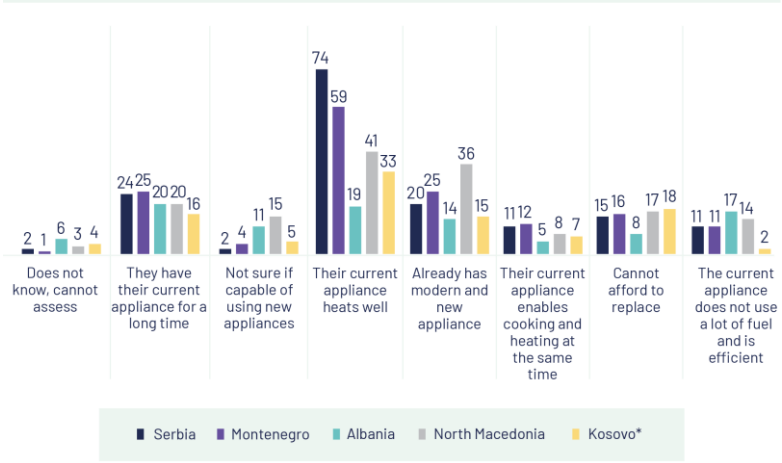


Figure 29 *What is the reason for not wanting to replace your appliance? (%)*

Table 21 *If someone were to convince you that you need to change the heating appliance you are currently using, what would you say, who could have the greatest influence for you to change your mind? (%)*

	Serbia	Montenegro	Albania	North Macedonia	Kosovo*
Appliance manufacturers and vendors	7	28	19	25	18
Politicians from the Government and the Assembly	1	1	5	3	8
Media	1	12	7	8	16
Professors and academia	6	4	1	4	4
Local energy managers	1	5	3	9	4
Non-governmental organisations	1	1	1	2	1
Doctors	4	15	25	15	27
President	1	1	1	1	3
Family and friends	50	60	65	56	66
Local politicians	1	0	1	2	5
Representatives of public institutions	5	6	2	11	7
Neighbours	10	14	3	13	7
Does not know, cannot assess	42	15		20	

Figure 30 *How familiar are you with the following heating technologies? (%)*

HOW IS THE ISSUE ADDRESSED TODAY?

We hope that by now the reader fully understands that the heating of households is a public policy issue that needs to be addressed to unlock numerous benefits for individuals and for the society.

In this chapter we provide an overview of what financing and for whom, is available today. We focus on the financing available for the improvements of the heating systems, but we also provide an overview of financing available for the buildings.

Despite residential sector being the largest energy consumer in WB, and the proven positive effects that investment in the sector provide, a significant share of improvement potential in the residential sector is still not being realized. Financial resources for the replacement of inefficient heating devices seems scares in public sector, not adjusted to the needs of households, in the retail sector, and not in the primary focus of international development support.

Most of the experience with building energy efficiency has been limited to donor-led projects in the public sector, with limited scale. However, these and other projects have suffered from several limitations, primarily limited replication of pilot and demonstration programs and lack of sustainability of project implementation models. Some credit lines have also been initiated for residential sector EE with some success among wealthier households. Public financing options for residential sector have mostly been implemented on the local level.

To identify financing options for replacement of inefficient household heating devices in WB6, following research activities were performed:

- Existing studies and reports on the topics were analysed.
- Websites of international, national and regional institutions were analysed.
- Websites of all municipalities in WB6 region (492) were visited, data was collected and structured.
- Information on public funding options was double checked, to avoid duplicity/repeated actions, and only energy-efficiency and heating-devices related schemes were left to be analysed.
- Websites of all retail banks and leasing companies in the region were visited and analysed.
- Search-engine research was performed, based on 14 fundamental phrases, with adjustment of each phrase to the search focus (national, regional level, or the addition of the municipality name to the search terms).

Public financing schemes at national, regional, and local level

Governments at national and local levels throughout the six Western Balkan markets have made available to their publics over 350 publicly financed support schemes, which can be used to finance heating device replacement. However, only 21 of those are really focused on financing the replacement, while the rest just provide a theoretical possibility to do so, given criteria that limit the beneficiaries in accessing them to acquire a heating device[36]. Upgrading heating devices is rarely the main goal of schemes not specifically designed and dedicated to this purpose.

Two national-level programmes for replacement of the inefficient heating devices in households exist currently in WB (namely North Macedonia and Serbia) and provide for lessons to be learned but also for the practices to be replicated.

[36] Consultants' report. Available at smarterstoves.resfoundation.org

The case of North Macedonia

The Government of North Macedonia has performed thorough analysis before starting its support program, with air pollution being the primary reason behind the initiation of the programme. The first step towards solving the pollution problem was determining the sources of pollution. For that purpose, the Ministry of Environment and Physical Planning, the City of Skopje and other relevant institutions, have made a series of analyses and studies. Although these studies show the concentrations of pollutants and indicate which are the sources that pollute the most, they were not sufficient for proper planning and realization of successful activities at the micro level, because they did not contain data on the causes of pollution. Further surveys were done to identify primary causes of pollution, with one of the most influential being residential heating. These findings paved the road for set-up of the national Program for Reduction of Air Pollution, with 9 priority areas.

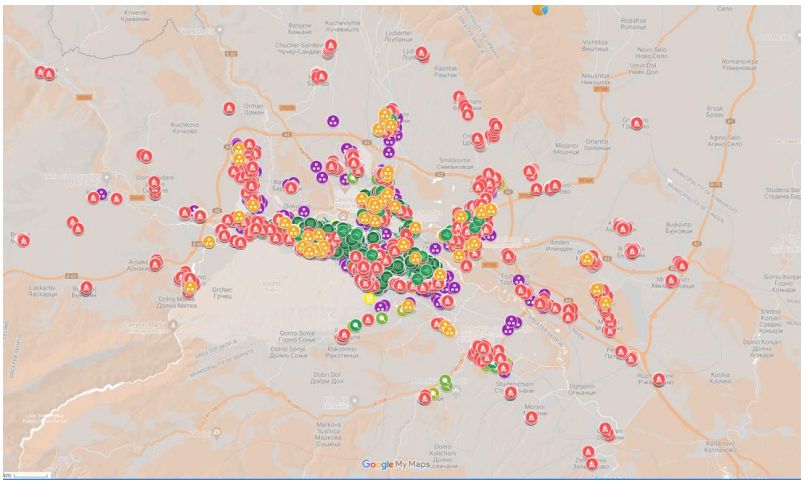


Figure 31 *Heating map of Skopje according to the fuel used. Source: UNDP*[37].

One of the priority areas is **the reduction of emissions of polluting substances from household warming**. As it was identified as the largest source of pollution, most activities are implemented in this sector. A comprehensive set of actions has been envisaged:

- 10,000 households connected to the existing heat exchanger (BEG). The hot water network is expanded;
- VAT of the delivered heat from a heat operator is reduced to 5%; The measure will contribute to an increase in consumption by 11%;
- 20,000 households will change old non-ecological wood stoves with more efficient wood stoves;

[37] https://www.google.com/maps/d/viewer?mid=1qX7RSbgH8IsSozHmCwgFsn6KGps&ll=42.00235771715795%2C21.454014990495786&z=12

- 20,000 households will purchase inverter air conditioners for heating;
- Private companies that sell environmentally friendly devices will receive help to build their capacities and to develop marketing strategies and establish partnerships with banks to offer affordable packages for all categories of citizens;
- 10,000 households will improve the energy efficiency of homes;
- About 3,000 households will join the gas;
- 2,000 households from socially vulnerable categories subsidized to change the way of heating, through a specially designed support mechanism;
- Prohibited sale of coal for heating - Adopted Legislative Amendments in 2019

One priority action was replacement of inefficient heating devices with air-to-air heat pumps (highly efficient air conditioners). The total funds available for the replacement of the heating devices were estimated at 10 million EUR in subsidies and the goal was to replace 10,000 inefficient devices. This programme was later reflected in the funds available at the local level. Subsidies for the procurement of high-efficiency inverter air conditioners were planned for 5,200 households in Skopje, 2,500 households in Bitola, 1,500 households in Tetovo, and 800 households in Kičevo. Resources were set aside from the profit of the company of Elektrane na Severna Makedonija in charge for power production. Total number of subsidies eventually delivered was higher than 10,000 as not all recipients have exhausted the ceiling envisaged for the subsidy in the amount of 62,000 denars (1,000 EUR)[38]. Users' feedback after incomplete first heating season were captured by the RES Foundation[39]. Scheme was implemented using first come, first served principle but with privileged access granted to households with lower income (less than 30 000 denars) and with the obligation on the side of the user to return the old heating device. This subsidy scheme is the most relevant scheme implemented in the Western Balkans. Evaluation that could be conducted after the heating season 2021/2022 may serve as the finest source of lessons learned for future policy making also given the recent developments in the energy markets affecting both affordability of electricity and security of power supply.

[38] https://www.slobodenpecat.mk/en/dodeleni-povekje-inverteri-od-planiranite-vo-akcijata-10-milioni-evra-za-10-iljadi-inverteri/
[39] https://www.youtube.com/watch?v=9r8CTc6JXnE

Figure 32 *Subsidies for highly efficient air conditioners in North Macedonia- distinctive characteristics.*

This subsidy scheme is not the only scheme initiated and run by the government of North Macedonia.

The case of the Republic of Serbia

In 2021 the Government of Serbia launched to support schemes that may be used to improve energy efficiency of residential buildings and heating system in households.

Ten local self-governments have received the subsidies from the Ministry of environmental protection for their citizens to replace old and inefficient heating devices in their households as winners of the call launched in February 2021. The Ministry and local self-governments will provide 80% of the investment, while the rest is expected to be provided by the beneficiaries. Around 850,000 euros was allocated for this purpose. [40]

Ministry of Mining and energy, following the adoption of the Law on energy efficiency and rational use of energy rolled-out subsidy scheme for citizens to replace windows and doors, install wall and roof insulation, as well as to replace heating systems (stoves and boilers) with devices that are more efficient and use fewer polluting fuels. A bit over 4 million euros has been allocated through this scheme for sixty-seven (67) local self- governments in Serbia (out of that around 1.9 million euros came from the Ministry of Mining and Energy)[41].

Both schemes are implemented through the local self-governments. Scheme management requires significant man days and exhausts limited local capacities as it demands large number of steps and verifications before the actual energy efficiency intervention is implemented.

The scheme launched by the Ministry of energy prescribed most of the procedures and left little or no space for the decision makers at the local level to influence the implementation modality. As level of co-financing by the citizens was set at no less than 50% the scheme

[40] https://www.ekologija.gov.rs/sites/default/files/inline-files/Preliminarna%20rang%20lista.pdfs
[41] https://www.mre.gov.rs/sites/default/files/2021/06/odluka_o_dodeli_sredstava_jp_2-21.pdf

entirely leaves out vulnerable population. Scheme launched by the Ministry of environmental protection was more flexible. Municipality of Priboj, one of the winners of the scheme, decided to allocate some funds to subsidise 100% of costs for purchasing of the new wood burning stove that are eco-design compliant. Two private companies joined with their donations and 15 beneficiaries of the local social care centre received new devices. They had to give up their old devices. Social care centre selected beneficiaries and estimated that additional 50 beneficiaries would benefit from the same type of assistance.

Figure 33 *Subsidies for eco-design compliant wood stoves/cookers in Priboj, Serbia- distinctive characteristics*

In addition to the mentioned aspects, local self-governments with limited or no capacities fail to win the funds. Frequently these local self-governments without capacities to win the funds are at the same time those with the highest number of vulnerable populations including the energy poor.

Ministry of energy and mining launched the scheme again in 2022 with the increased government funding in the amount of more than 8 million EUR. Total investments in energy efficiency measures will be at least 30 million EUR. Requirement for 50% co-financing from the citizens is mandatory in this call as it was in the previous call[42].

Ministry of environment also re-launched the scheme in 2022 with the budget of 1.2 million EUR. Minimal co-financing from the local self-governments is set at 20% while those who offer larger co-financing will score more points in evaluation[43]. Ministry does not prescribe to local self-governments the amount of co-financing to be required from the end users. More local-self-governments examine the options to offer 100% subsidies to vulnerable population[44].

Numerous local self-governments across the region implement different schemes with or without the support from the national budget. Details for some of the schemes are provided

[42] https://www.mre.gov.rs/sites/default/files/2022/02/tekst_javnog_poziva_-jp1-22_17022022_final1.pdf
[43] https://www.ekologija.gov.rs/sites/default/files/inline-files/Јавни%20конкурс%20за%20реализацију%20пројеката%20смањења%20загађења%20ваздуха%20у%20Србији%20из%20индивидуалних%20извора%20у%202022.%20години.pdf
[44] RES Foundation is in constant communication with many local self-governments on the subject issue.

in the table below together with hyperlinks that lead to pages with more details on the schemes.

Table 22 *Details of selected municipal schemes with hyperlinks to more information. Source: Consultant's compilation.*

Country	Municipality/Town	Type	Minimum own contribution	Total Available funds	Individual Funds
BIH Federacija	Tuzla	Subsidy	50.00%	250,000.00 €	2,500.00 €
North Macedonia	Bitola	Subsidy	70.00%	41,500.00 €	330.00 €
North Macedonia	Gostivar	Subsidy	50.00%	n/a	250.00 €
North Macedonia	Kavadarci	Subsidy	50.00%	n/a	250.00 €
North Macedonia	Kičevo	Subsidy	0.00%	826,000.00 €	1,000.00 €
North Macedonia	Kočani	Subsidy	0.00%	10,000.00 €	166.67 €
North Macedonia	Ohrid	Subsidy	50.00%	n/a	250.00 €
North Macedonia	Prilep	Subsidy	50.00%	n/a	250.00 €
North Macedonia	Probištip	Subsidy	50.00%	n/a	250.00 €
North Macedonia	Skopje - Aerodrom	Subsidy	50.00%	n/a	250.00 €
North Macedonia	Skopje - Butel	Subsidy	0.00%	1,800,000.00 €	1,000.00 €
North Macedonia	Skopje - Gazi Baba	Subsidy	30.00%	25,000.00 €	500.00 €
North Macedonia	Skopje - Šuto Orizari	Subsidy	70.00%	n/a	416.67 €
North Macedonia	Skopje - Šuto Orizari	Subsidy	0.00%	n/a	1,000.00 €
North Macedonia	Tetovo	Subsidy	0.00%	1,500,000.00 €	1,000.00 €
North Macedonia	Veles	Subsidy	70.00%	n/a	250.00 €
North Macedonia	Veles	Subsidy	30.00%	n/a	250.00 €
Serbia	Niš	Subsidy	50.00%	145,000.00 €	1,666.67 €
Serbia	Novi Pazar	Subsidy	50.00%	51,500.00 €	700.00 €
Serbia	Priboj	Subsidy	40.00%	41,500.00 €	600.00 €
Serbia	Trgovište	Subsidy	0.00%	1,500.00 €	300.00 €

Support to vulnerable energy customers, and other monetary subsidies for vulnerable population

All contracting parties manage subsidy schemes for vulnerable customers to support such customers pay their bills. These schemes provide needed relief to targeted vulnerable families but are not instrumental in improving their position in terms of capability to procure better comfort at lower specific costs. In all the contracting parties a portion of local self/governments also provide support for payment of utility bills, procurement of fuel or directly donate fuel to vulnerable households. Again, these schemes are leaving targeted beneficiaries with the same capabilities to sustainably improve their energy services provision, primarily heating.

Amounts spent for this time of subsidies are much higher than amounts spent for support to energy efficiency improvements and exceed 50 million EUR in national support scheme. City of Belgrade alone spends 7 million EUR annually for subsidies to district heating bills of selected beneficiary categories. North Macedonia is the only contracting party which spends more money to support energy efficiency then to pay the bills of vulnerable customers.

Table 23 *Support for payment of energy bills in the contracting parties. Source: Energy, Community, RES Foundation.*

	Coverage	Amount	Year
Albania	213,000	22.2	2020
Bosnia and Herzegovina	69,268	12.3	average over longer period
Kosovo*	36,648	4.5	2019
Montenegro	14,700-21,700	2.7	2018
North Macedonia	N/A	0.1	2021
Serbia	71,993	10.3	2020
WB		52.1	
Subsidies for district heating in the city of Belgrade	N/A	7.0	

Retail financing, development assistance and blended financing

Limited number of banks provide financing for household energy efficiency investments without a publicly funded incentive. In total, 14 banks in WB are providing finance schemes for energy efficiency and heating devices: two in Albania (BKT, OTP Bank Albania), four in Bosnia and Herzegovina (Raiffeisen Bank, Sparkasse Bank, UniCredit Bank Banja Luka, UniCredit Bank FBiH), two in Kosovo* (NLB Banka, TEB SH.A.), two in Montenegro (Crnogorska komercijalna banka AD – OTP Bank group, NLB Banka), four in Northern Macedonia (Silk Road Bank AD Skopje, Komercijalna Banka AD Skopje, NLB Tutunska banka AD Skopje, Procredit Bank AD Skopje), and two in Serbia (Erste Bank, Halkbank).

The only blended financing mechanisms on the market, those which blend development finance with private capital, are supported by the European Bank for Reconstruction and Development (EBRD) and the Kreditanstalt Für Wiederaufbau (KfW), reimbursing up to 20% of the individual household investment project. Neither of the mechanisms, however, enable purchase of solid fuel individual heaters apart from limited number of pellet technologies.

Retail financing, blended or not, does not target vulnerable groups, nor does it make access to finance easier for these groups. Apart from blended schemes by EBRD and Kfw, development assistance institutions do not provide funding for the replacement of inefficient household heating devices, with the single exception being the Millennium Kosovo Foundation, providing 100% subsidies to vulnerable groups.

More details on retail financing may be found on the web page of the project. Herewith we present in more details schemes dedicated to purchase of energy efficient equipment and materials.

Table 24 *Financing schemes for energy efficiency equipment and materials. Source: Consultant's compilation.*

Contracting party	Bank	Type	Grant	N. Interest % Low	N. Interest % High	Amount Max EUR	Duration Max Months	Partner
Albania	BKT	Loan	0%	3.30%	N/A	50,000	84	-
Albania	OTB Bank Albania	Blended (grant&loan)	20%	3.50%	9.00%	50,000	120	EBRD GEFF
Bosnia and Herzegovina	Raiffeisen Bank	Blended (grant&loan)	20%	4.49%	4.49%	20,000	120	KfW
Bosnia and Herzegovina	Sparkasse Bank	Blended (grant&loan)	20%	4.99%	4.99%	49,000	120	EBRD GEFF
Bosnia and Herzegovina	UniCredit Bank Banja Luka	Blended (grant&loan)	20%	4.99%	4.99%	25,000	120	EBRD GEFF
Bosnia and Herzegovina	UniCredit Bank FBiH	Blended (grant&loan)	20%	4.99%	4.99%	25,000	120	EBRD GEFF
Kosovo*	NLB Banka	Loan	n/a	n/a	n/a	n/a	n/a	n/a
Kosovo*	TEB SH.A.	Blended (grant&loan)	20%	n/a	n/a	n/a	120	EBRD GEFF
Montenegro	Crnogorska komercijalna banka AD - OTP Bank group	Blended (grant&loan)	20%	4.40%	4.90%	50,000.00	120	EBRD GEFF
Montenegro	NLB Banka	Blended (grant&loan)*	20%	4.40%	4.90%	50,000	120	EBRD GEFF
Northern Macedonia	Silk Road Bank AD Skopje	Loan	0%	4.40%	4.90%	10,000	84	-
Northern Macedonia	Komercijalna Banka AD Skopje	Blended (grant&loan)	20%	4.40%	4.90%	50,000	240	EBRD GEFF
Northern Macedonia	NLB Tutunska banka AD Skopje	Blended (grant&loan)	20%	4.50%	5.00%	50,000	240	EBRD GEFF
Northern Macedonia	Procredit Bank AD Skopje	Blended (grant&loan)	20%	6.00%	n/a	n/a	60	EBRD GEFF
Serbia	Erste Bank	Blended (grant&loan)	20%	6.87%	13.95%	29,166	95	EBRD GEFF
Serbia	Halkbank	Loan	0%	3.70%	5.70%	Credit rating	71	-

Green Economy Financing Facility and its Technology selector

Green Economy Financing Facility (GEFF) supports businesses and homeowners wishing to invest in green technologies. The GEFF programme operates through a network of more than 140 local financial institutions across 26 countries supported by more than EUR 4 billion of EBRD finance. This has enabled more than 130,000 clients to collectively avoid almost 7 million tonnes of CO2 emissions per year.

GEFF goes beyond providing simple lines of finance. An experienced EBRD team of bankers and technical programme managers ensures consistent quality and innovation in the GEFF product and service delivery. In addition, advisory services are available to help participating financial institutions and their clients enhance their market practices.

GEFF is supported by the following donors: Austria, Bohunice International Decommissioning Support Fund, BP, Canada, Climate Investment Funds, Czech Republic, Eastern Europe Energy Efficiency and Environment Partnership Fund, EBRD Early Transition Countries Fund, EBRD Southern and Eastern Mediterranean Multi-Donor Account, European Union, European Western Balkans Joint Fund, Germany, Global Environment Facility, Green Climate Fund, Japan, Kozloduy International Decommissioning Support Fund, Norway, Slovak Republic, Spain, Sweden, Turkey, Taipei China, United Kingdom[45].

The Green Technology Selector is a list of high-performing technologies and materials that have been assessed and pre-approved as eligible for GEFF financial support.

The pre-approved equipment and materials exceed minimum performance requirements and perform beyond current market practices resulting in clear benefits and environmental improvements.

The list is regularly updated to include the latest technologies, materials and new suppliers.

The reference baseline may be adjusted periodically to reflect technology market development, maturity of market supply, market penetration rates and technology costs.

At present the tool does not recognize individual solid fuel heating devices even though these devices are, as described, energy devices that are sold in the largest quantities across the region.

Evaluation of GEFF scheme implemented by EBRD through commercial schemes may provide for ample of lessons learned on what worked and what not worked. Involvement of financial regulators could be beneficial in designing future schemes.

[45] https://ebrdgeff.com/about-seff/

ENVISIONING THE FUTURE OF BUILDINGS, HEATING DEVICES, CLIMATE IMPACT AND AIR QUALITY

BUILDINGS

Numerous scenarios for energy efficiency improvements in the buildings are being developed by myriad of actors. They seek to quantify investments that are needed to bring the level of buildings' energy needs to a desired level from the current levels. Many uncertainties surround these attempts, including very basic uncertainties related to current energy use in buildings and precision of methodologies developed to calculate savings, investments, and payback periods. In both analyses presented in this chapter energy assumed to be currently used in buildings in contracting parties is (much) higher than entire residential energy sector consumption captured by the official statistics.

However, what we may see from the scenarios is that even with ambitious renovation rates a housing stock will remain largely unrenovated for the foreseeable future, surpassing 50% of all occupied area only in 2038. The other common thing is that investments required are quite large, but in many instances pay back for themselves according to the calculations. While we can draw many messages looking at the scenarios developed, we choose, for the purpose of this report to select the three main messages:

1. We will not be able to use low temperature heating in large number of households in the WB even in 20 years. The only affordable, decarbonized, high temperature energy source we have now is biomass.

2. Most of the investments pay for themselves without grants. We choose to believe that improvements in energy efficiency should be therefore commercially financed with possible provision of incentives to leverage such financing.

3. Marginal benefit of replacement of heating systems, when efficiency improvements and emission reductions are concerned, is larger than marginal benefit of energy efficiency improvement of buildings, and the capital cost is much lower. While we certainly need energy efficiency improvements of buildings, policy makers need to take care of this fact given constrained resources and long time periods needed to renovate the building stock.

Smarter stoves project scenarios

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 analyse the results after entire building stock in the WB6 is retrofitted till 2050.

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 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'.

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 target's 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.

Implementation of different renovation scenarios require different investments and yield different benefits in energy, climate, and monetary terms. However, assumptions on renovation rates are uniform across scenarios. Under the assumed renovation rates which are in line with the EU renovation wave ambitions, and which are much higher than current rates, WB will surpass the 50% share of renovated floor area only in 2038. In such scenario

there will be 200,000,000 m^2 of pre-2015, non-renovated dwellings in 2038. Access to finance will be more difficult for poorer strata of population. Knowing that they currently rely predominantly on biomass for heating, we may conclude that vast majority of dwellings in which biomass is currently used will not be ready for low temperature heating in the next 20 years. Therefore, improving the efficiency of biomass burning devices and reducing its environmental and climate footprint remains an important tool to advance sustainability and achieve SDGs in the WB in the decades to come.

Table 25 *Summary of investments per scenario per contracting party. Source: Consultant's calculation*

Contracting party	**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
Albania	2,656	12,850	2,711	13,080	3,059	14,514
Bosnia and Herzegovina	4,269	20,735	4,357	21,100	4,915	23,400
Kosovo*	1,315	6,383	1,671	10,508	1,516	7,211
Montenegro	500	2,412	510	2,456	576	2,727
North Macedonia	2,192	10,639	2,238	10,827	2,527	12,019
Serbia	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

Table 26 *Summary of energy savings per scenario per contracting party. Source: Consultant's calculations*

Contracting party	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
Albania	12,199	1,634	6,742	1,775	7,320	1,801	7,431
Bosnia and Herzegovina	22,420	5,389	22,231	5,666	23,371	5,859	24,167
Kosovo*	8,313	1,531	6,315	1,606	6,624	1,666	6,872
Montenegro	2,405	292	1,204	316	1,303	321	1,324
North Macedonia	13,529	2,554	10,536	2,679	11,052	2,779	11,465
Serbia	60,534	10,379	42,813	10,900	44,961	11,288	46,563
Totals	119,399	21,780	89,843	22,941	94,632	23,714	97,821

Consultants hired by the RES Foundation were also asked to develop scenarios that are less ambitious than renovation wave but that still reflect the accelerated replacement of existing heating devices followed by renovation of 25% of buildings where heating system has been replaced in LOW scenario and 35% of buildings where heating system has been replaced in HIGH scenario.

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. Consultant envisaged conservative flat annual replacement rate of heating devices of 4.3% for all contracting parties.

Specific CAPEX investments only for retrofit of the envelope were set at 105 EUR/m^2 where 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 are introduced.

Table 27 *Annual renovation rate of building envelope in Low scenario. Source: Consultant's projections*

Contracting party	Heated floor area	Annual replacement rate of h. systems	Annual renovation rate of building envelope (out of those who replaced heating systems)	Annual renovated area	Renovated vs heated floor area	Specific CAPEX	CAPEX
Unit	m2	%	%	m2	%	€/m2 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

Additionally, the total investments together with the envelope renovation have been calculated and are presented in the following table.

Table 28 *Cumulative investments in Low scenario (€, million) Source: Consultant's projections*

Scenario LOW	Horizon 2022	Horizon 2030	Horizon 2040	Horizon 2050
Contracting party	€, 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

Within the Low scenario, the total cumulative investments in the heating systems till 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.

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.

Table 29 *Annual renovation rate of building envelope in High scenario Source: Consultant's projections*

Contracting party	Heated floor area	Annual reduction rate of h. systems	Annual renovation rate of building envelope (out of those who replaced the heating system)	Annual renovated area	Renovated vs heated floor area	Specific CAPEX	CAPEX
Unit	m2	%	%	m2	%	€/m2 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

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

Table 30 *Cumulative investments in High scenario (€, million). Source: Consultant's projections*

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

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.

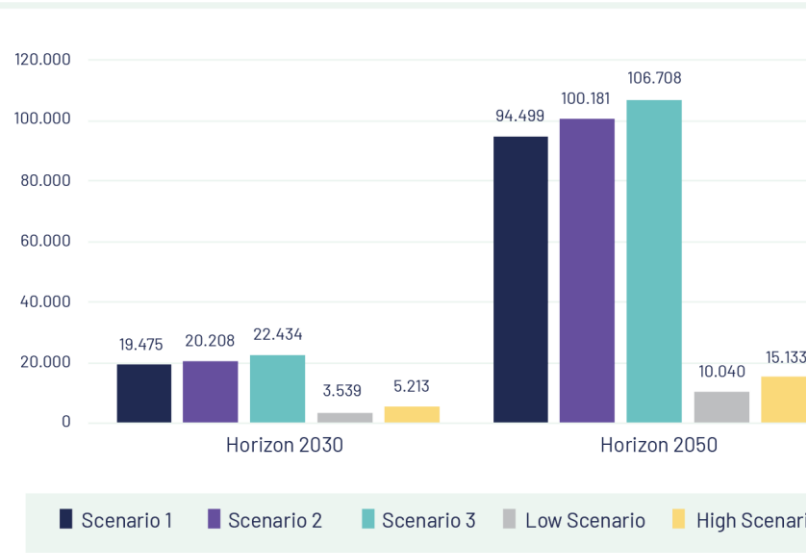


Figure 34 *Investment comparison-all scenarios*

World Bank scenarios

World Bank is preparing residential energy efficiency market assessment for the WB[46]. The assessment methodology. Here we will briefly describe the methodology used and first results of the assessment that were publicly shared.

The assessment covers three groups of buildings: single family houses, small/medium multi-apartment buildings and large buildings. Sources of data were mainly national typology documents; experts experience mainly based on energy audits. Costing and technical parameters were based on market conditions, energy audits and national documentation. When geographical data are concerned model used by the World Bank offers variety of locations, capitals as points of buildings concentration were used as benchmarks.

Technical analysis was based on two scenarios – standard, deep renovation using bottom-up approach for every type of buildings. It was conducted per type of relevant heating energy source. Three different energy utilization areas were examined separately in the model: heating – as the main type of energy consumption; domestic hot water (DHW) consumption and cooling.

[46] https://www.energy-community.org/dam/jcr:d16f0354-d06a-4bd6-ac73-64a7a3a2c19c/WSEE_WB_112021.pdf

Financial analysis consisted of two cost-benefit analysis: leveraged and non-leveraged. In leveraged analysis it was assumed that loan will be accompanied with a 20% investment grant and without participation of the owner. In non-leveraged analysis grant financing has not been considered.

Economic analysis included the following monetized co-benefits of the interventions: GHG emissions avoided, property value increase and air pollution reduction benefits.

Energy efficiency interventions in both scenarios include replacement of the existing firewood device with more efficient boiler or stove. At this point in time more details were not available.

In its analysis World Bank assigned health costs attributed to use of inefficient solid fuel heaters in the amount of 5,000 EUR annually. World Bank estimation of number of devices in use is very close to the results of the survey performed during the implementation of the Smart stoves project.

Input data and main results of the analysis are presented in the table below.

Table 31 *Baseline assumptions for residential energy efficiency market assessment. Source: World Bank*

Contracting party	Current energy consumption-heating	Current energy consumption-cooling	Energy saving potential
Albania	10,012	2,421	8,084
Bosnia and Herzegovina	26,505	2,954	18,055
Kosovo*	6,551	879	4,349
Montenegro	2,482	538	1,889
North Macedonia	10,936	1,590	7,902
Serbia	52,139	7,150	37,454

Table 32 *Investments, direct and indirect monetary savings of standard energy efficiency interventions in all buildings. Source: World Bank*

Contracting party	Investment costs needed (M EUR)	Cost Savings (M EUR)/y)	CO2 emission reduction potential from the sector (Mt CO2/y)	Health cost savings due to PM reduction (M EUR/y)
Albania	4,570	625	6	N/A
Bosnia and Herzegovina	16,488	1,679	16	64
Kosovo*	2,790	363	4	38
Montenegro	1,925	161	2	4
North Macedonia	4,781	496	7	31
Serbia	25,191	4,186	28	183

Table 33 *Investments, direct and indirect monetary savings of deep renovations in all buildings. Source: World Bank*

Contracting party	Investment costs needed (M EUR)	Cost Savings (M EUR)/y)	CO2 emission reduction potential from the sector (Mt CO2/y)	Health cost savings due to PM reduction (M EUR/y)
Albania	7,199	652	7	N/A
Bosnia and Herzegovina	19,381	1,732	17	64
Kosovo*	4,410	362	5	38
Montenegro	2,529	167	2	4
North Macedonia	6,851	539	7	31
Serbia	34,256	4,294	31	183

Table 34 *Technical and financial potential of energy efficiency interventions in single family households using firewood. Source: World Bank*

	Technical potential		Financial Potential	
Contracting party	Standard intervention	Deep renovation	Standard intervention	Deep renovation
Albania	HIGH	HIGH	MODERATE/ grant required	MODERATE/ grant required
Bosnia and Herzegovina	HIGH	HIGH	HIGH	HIGH
Kosovo*	HIGH	HIGH	HIGH	HIGH
Montenegro	HIGH	HIGH	MODERATE/ grant required	MODERATE/ grant required
North Macedonia	HIGH	HIGH	MODERATE/ grant required	MODERATE/ grant required
Serbia	HIGH	HIGH	HIGH	HIGH

HEATING DEVICES- REPLACEMENT TECHNOLOGIES

Reduction of GHG and local emissions from domestic heating requires replacement of the existing heating technologies and reduced building energy demand. Natural replacement of existing heating technologies even when accompanied with the highly ambitious renovation rates will likely not bring about significant emission reduction in the coming two decades. Policy intervention that guides both the market and subsidy schemes is required. While natural gas could perhaps be part of the solution, we discuss here only decarbonized or potentially decarbonized replacement options: eco-design compliant wood stoves and boilers, eco-design compliant pellet stoves and boilers, direct electrical heating and heat pumps including air-to-air heat pumps like inverter ACs.

Draft Programme of Air Protection of the Republic of Serbia for the period 2022- 2030 with Action plan envisages reductions of PM necessary to ensure the compliance with air quality limit compared to 2015 emissions in the range from 46% to 81% in different zones of the country by 2030. Authors agree that such reductions cannot be achieved with natural substitution of appliances using coal and firewood and propose introduction of incentives to achieve the substitution of solid fuel burning devices. Model showed that substitutions in the five most polluted cities should be in the range from 58% to 80%of the existing stock and propose a mix of eco-design compliant biomass devices and heat pumps as replacement technology[47].

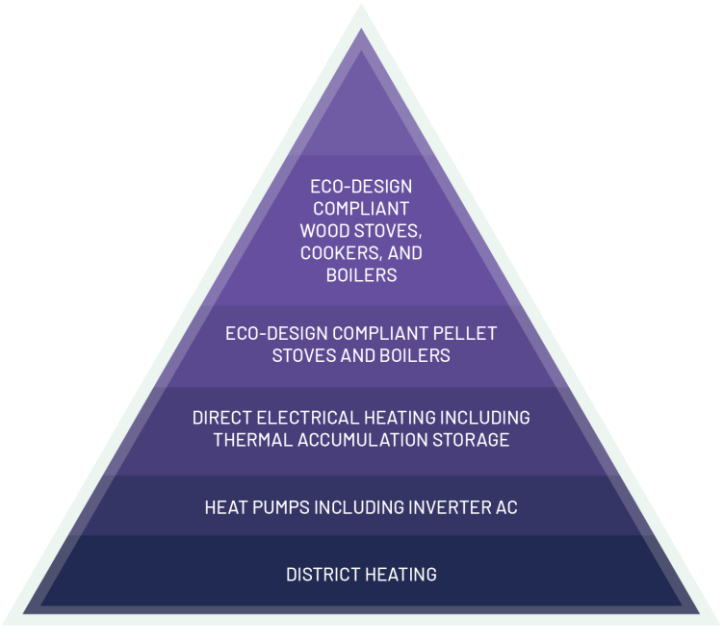


Figure 35
Replacement options with potential for provision of decarbonized heat

[47] https://drive.google.com/file/d/1FizqEP5IaZLU0dUWGChwId6utKMI84SA/view

Deciding on technology to be used for heating among available alternatives is not an easy task for the user. Still user can be guided also by own preferences and, as explained frequently does not make choices that seem perfectly "rational" for an outsider. The task for energy planners and policy makers might be more difficult as they are required to make as rational decisions as possible. Availability of information is crucial for the decision-making processes. Authors of the globally recognized publication "Technology Data for heating installations" put a subtitle to their publication: Technology descriptions and projections for long term energy system planning. Authors state that the catalogue is intended to work as a tool for energy planners including municipalities in their assessment, comparison, and identification of future energy solutions for heat production in households etc. They stress that the specific technical and economic data for each technology presented in the catalogue are not in all cases directly comparable, as data/figures cover different aspects of the energy supply of a buildingand the needed investment costs, respectively. Therefore, decision making cannot be automatized and performed out of contexts. The catalogue offers useful classification on groups of information that are valuable for any decision maker who is engaged in energy planning. Those who will lead on heating replacement schemes in the Western Balkans will certainly need to look for such information[48].

Table 35 *Groups of information on heating technologies and its content required for policy making. Source: Danish energy agency.*

Brief technology description	**Brief description for non-engineers of how the technology works and for which purpose**
Input	The main raw materials and/or energy carriers, e.g. fuels, used by the technology
Output	The forms of generated energy i.e. heat.
Typical capacities	Relevant product range(s) in capacity (kW).
Regulation ability	Description of how the unit can regulate, e.g. a gas boiler is very flexible whereas a solar heating system depends on the solar radiation.
Advantages/disadvantages	A description of specific advantages and disadvantages relative to equivalent technologies.
Environment	Particular environmental characteristics are mentioned, for example special emissions or the main ecological footprints.
Research and development perspectives	Most important challenges to further development of the technology.

[48] https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_individual_heating_installations.pdf

Examples of market standard technology	Presentations of recent commercially available units, which can be considered market standard.
Prediction of performance and costs	Cost reductions and improvements of performance can be expected for most technologies in the future. This section accounts for the assumptions underlying the cost and performance in 2020 as well as the improvements assumed for the years, 2025, 2030, 2040 and 2050. The specific technology is identified and classified in one of four categories of technological maturity, indicating the commercial and technological progress, and the assumptions for the projections are described in detail. In some cases, new technological developments might substantially change the function and/or efficiency of a technology, for example by a radically new design or by using a new material with better properties.
Uncertainty	Price and performance of some technologies may be estimated with a relatively high level of certainty whereas in the case of others, both cost and performance today as well as in the future are associated with high levels of uncertainty.
Economy of scale effects	The per unit cost of larger units are usually less than that of smaller plants.
Energy efficiencies	Efficiencies are calculated under the assumption of a correct installation. For some technologies this matters less, whereas for other technologies, such as heat pumps, the quality of the installation can have a substantial effect on the efficiency and should be discussed where relevant. The evaluations of the energy efficiencies of the technologies may be inspired from the methodologies from the energy-related products directive s developed by the EU Commission.
Auxiliary electricity consumption	A specification of the annual auxiliary electricity demand for the heat installation is given in kWh/year. It accounts for the consumption of electricity from auxiliary systems such as circulation pumps, other pumps, ventilation systems, controls etc.
Lifetime	The lifetime is defined as the technical-economic lifetime, which refers to the expected time for which an energy plant can be operated within, or acceptably close to, its original performance specifications, provided that normal operation and maintenance takes place. As such, the technical-economic lifetime of the technology is found by comparing the on-going costs of repairing and maintaining against the expected costs of re-investing in a similar technology.

Environment	All plants should be designed to comply with the regulation that is currently in place or is expected to be introduced soon.
Electric regulation ability	Relevant for power consuming technologies. Three parameters describe the electricity regulation capability of the technologies: Primary regulation (% per 30 seconds): frequency control Tertiary regulation (% per minute): balancing power Minimum load (percent of full load).
Investment costs	The investment cost includes the total costs of establishing the technology for the consumer. Where possible, the investment cost is divided on equipment cost and installation cost. Equipment cost covers the heat generation facility and other major component like water tank and environmental facilities if relevant, whereas installation cost covers counselling on unit design by the installer, grid connection, fittings and commissioning of equipment.
Possible additional investment costs	Possible additional specific investment should be considered when evaluating different technologies.

Capital, operational expenditures and levelized costs of heat of replacement technologies

In this section we provide a wealth of information that may be of assistance to the decision-makers in the WB when evaluating possible replacement heating technologies. This include estimation of levelized cost of heat, i.e. all costs related to the heat provision by certain technology over its lifetime.

Table 36 *Overview of investment costs included in technology data sheets and possible accompanying investment costs. Source: Danish energy agency49*

	Abolition/removal of prior heat production system/unit	Improvements of building envelope	Accompanying heat supply installations	Installation of primary heat production technology – elements included in the technology data sheets	Installation of secondary heat production technology
Biomass boiler	Often necessary in existing buildings removal of oil tank, etc.	Existing buildings: not directly needed but in many cases recommendable	Water based supply system Fuel storage facility Chimney/flue	Investment/installation cost of boiler incl. pumps, hot tap water production and hot water tank. Dismantling of existing heat installation.	
District heating unit	Often necessary in existing buildings removal of oil tank, etc.	Existing buildings: not directly needed but in many cases recommendable	Water based supply system Branch pipe	Investment/installation cost of DH unit incl. pumps, hot tap water production, hot water tank. Dismantling of existing heat installation.	
Electric heat pumps – air/fluid to water	Often necessary in existing buildings removal of oil tank, etc.	Existing buildings: energy saving measures often needed in order to optimise heat pump installation	Water based supply system Existing buildings: measures to reduce radiator temperatures often needed	Investment/installation cost of heat pump incl. pipes, pumps, back-up electric heater, hot tap water production and hot water tank. Dismantling of existing heat installation.	
Electrical heating		Existing buildings: not directly needed but in many cases recommendable		Investment/installation cost of electrical radiators, hot tap water production and hot water tank	

[49] ibid

Heat pumps – air to air/ventilation	Often necessary in existing buildings (ventilation heat pump only) dismantling of existing boiler, removal of oil tank, etc.	Existing buildings: energy saving measures often needed in order to optimise heat pump installation	Existing buildings: measures to reduce radiator temperatures often needed (ventilation heat pump only)	Investment/installation cost of heat pump incl. hot water storage tank.	Back-up heat e.g. electrical radiators Hot tap water supply needed
Wood stove			Fuel storage facility Chimney/flue	Investment/installation cost of stove (and water tank). Dismantling of existing stove.	Supplementary heat supply system Water heater and possibly storage
Solar heating		In some cases, improvement of roof construction		Investment/installation cost of panel incl. pipes, pumps and hot tap water tank	Supplementary heat supply system and water heater and possibly storage

IEA compared levelized costs of heat between the combustion technologies (natural gas and pellet) with three different heat pumps technologies and two solar technologies. This calculation is relevant for buildings with relatively low energy consumption equipped with central heating installations.

This comparison has been performed in six developed economies. Variations between economies were present, but as a rule we may say that heat pump-based technologies have lower LCOH than pellet. There is another message we may derive by looking into this analysis: LCOH of the ground source heat pump installations in all economies in the entire range of costs is competitive with the price of the district heating paid by the consumers in Serbian capital city of Belgrade.

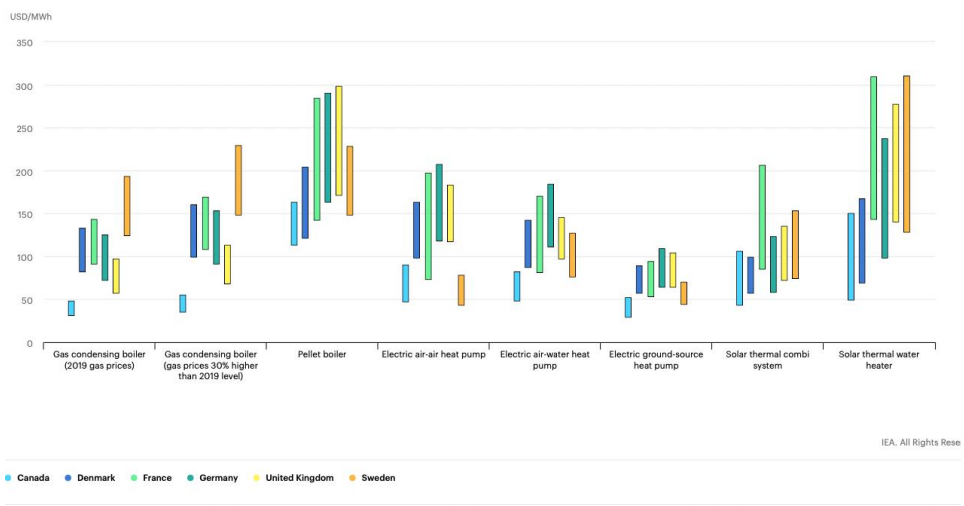


Figure 36 *Levelized costs of heating for selected technologies in six developed economies. Source: IEA*[50].

It is difficult to calculate levelized costs of heat when we discuss technologies whose heat output is hard to measure as is the case with individual space heaters and air-to-air heat pumps. However, such LCOH calculation is far more relevant for the decision makers in the WB. In the tables below we provide one such calculation accompanied with the short explanation of assumptions made and inputs taken.

Table 37 *LCOH for individual heating replacement technologies over 20 years*[51] *and DH benchmark. Source: own calculations based on publicly available data.*

	Investment cost-equipment, and installation (EUR)	Fixed operation and maintenance costs (EUR/a)	Lifetime estimation (years)	Fuel/energy carrier price assumption[52] (EUR/MWh)	Levelized cost of heat (EUR/MWh)
Eco-design compliant wood cooker	670	25	20	27	51.81

[50] https://www.iea.org/data-and-statistics/charts/levelized-cost-of-heating-lcoh-for-consumers-for-selected-space-and-water-heating-technologies-and-countries
[51] Assuming 7kW peak load capacity and 9,000 kWh annual heating energy, and declared efficiencies
[52] Price increase of 1% calculated except for electricity where 5% price increase annually has been assumed

Eco-design compliant pellet stoves	1,200	30	20	40	63.41
Direct electrical heating	750	0	20	120	192.34
Thermal accumulation heater	1,000	0	20	50	87.01
Air-to-air heat pump	1,700	40	12	90	56.53
District heating annual costs Belgrade					83.30

Table 38 *LCOH for individual heating replacement technologies over 20 years- assumptions explanations*

	Investment cost-equipment, and installation (EUR)	Fixed operation and maintenance costs (EUR/a)	Lifetime estimation (years)	Fuel/energy carrier price assumption[53] (EUR/MWh)	Levelized cost of heat -20 years, 3% discount rate (EUR/MWh)
Eco-design compliant wood stoves	Consultants' input online market survey realised purchases in gvt sponsored schemes. Single device, , currently the only eco-design labelled.	Chimney sweeping costs	Technology Data for heating installations, Danish energy agency	Assumed price of 50 EUR per stacked meter of fuel wood, assumed calorific value of 1840 kWh pe unit. Assumed annual price increase of 1%.	Own calculation, 20 years, 3% discount rate
Eco-design compliant pellet stoves	Consultants' input online market survey realised purchases in gvt. sponsored schemes. Single device.	Chimney sweeping costs, electricity costs required for operation included at annual level	Technology Data for heating installations, Danish energy agency	Assumed price of 200 EUR per t of pellet, assumed calorific value of 5000 kWh per unit. Assumed annual price increase of 1%.	Own calculation, 20 years, 3% discount rate
Direct electrical heating	Consultants' input online market survey. More devices depending on their nominal power.	N/A	Technology Data for heating installations, Danish energy agency	Assumed existence of block tariff which penalizes excess consumption. Assumed annual price increase of 5%.	Own calculation, 20 years, 3% discount rate
Thermal accumulation heater	Consultants' input online market survey. Two devices.	N/A	N/A	Assumed mix of night and daily tariff. Assumed annual price increase of 5%.	Own calculation, 20 years, 3% discount rate
Air-to-air heat pump	Consultants' input online market survey (conservative estimation allows for investment cost of supplemental direct	Market survey, Consultants' input	Technology Data for heating installations, Danish energy agency	Current household electricity price in the region. Assumed annual price increase of 5%.	Own calculation, 20 years, 3% discount rate

[53] Price increase of 1% calculated except for electricity where 5% price increase annually has been assumed

	electric heater). Two devices, upper end.				
District heating annual costs Belgrade					Calculated using online calculator of Belgrade DH utility for 9000 kWh annual heat consumption 60 m2 apartment

Results of the analysis are sensitive to a variety of factors that include investment costs, operation and maintenance costs, fuel/energy prices, demand side management measures, and assumptions on lifetime of technologies, to name just a few. One can argue that electricity prices in the region are relatively low which tends to favour heat pump and other electricity-based technologies. While this is true, we need to understand that fuel wood prices are effectively hooked to electricity prices in the region of WB as these two are the closest substitutes. With pellet, situation is similar with some differences. Pellet production is export oriented which has different implications, but certainly also involves sensitivity to global energy prices. In addition, and as explained, pellet production, in particular pellet production in the WB, is very energy intensive which provides for another angle of sensitivity of pellet price to prices of other energy carriers. To allow for corrections of possible disparities between the prices we have assumed price increase of electricity at 5% annual rate while price increase of other fuels has been assumed at 1% annual rate.

We see that four replacement technologies have LCOH in ranges from 50 EUR/MWh to close to 90 EUR/MWh. We need to underline the two solutions that offer additional service: wood fuel cookers provide for cooking service, while air to air heat pumps provide for cooling services.

In the following sections we provide a long list of factors that need to be considered when deciding on the design of policy aimed to accelerate replacement of existing heating devices. We assess feasibility of the replacement technologies with a view to users, public good and vendor perspective.

User, public and vendor perspectives relevant for accelerated replacements

Eco-design compliant wood stoves, cookers, and boilers

USER PERSPECTIVE- BENEFITS, RISKS, AND ATTITUDES

Table 39 *Eco-design compliant fuel wood stoves, cookers and boilers, user perspective SWOT analysis*

Strengths	Weaknesses
Users are familiar with the technology	Time consuming to operate
Relatively low capital investment required	Requires physical work to operate
Relatively low maintenance costs	Manual operation required
Fuel is widely available	Difficult to regulate
Significant share of users has access to own fuel source	Produces comparatively large indoor and outdoor pollution during operation even when standardized
Possibility to provide both heating and cooking service	Pulls relatively large quantities of external air to operate
Simple design with small number of parts prone to failure	Performance dependant of the quality of the chimney
Does not require auxiliary energy to operate	User knowledge largely affects performance

Comparatively competitive, stable, and predictable price Provides high-temperature heating required in low efficient buildings	Fuel quality largely affects performance of the device Price affected by the price of the closest substitute (usually electricity) Necessity to have a large, proper space for disposal of wood Small area of the house is heated (stoves & cookers) CO threat Other safety issues in fuel preparation and device operation
Opportunities	**Threats**
Further development of technology to improve efficiency and reduce emissions Further development of technology to enable smaller scale woodchips-based boilers Enforcement of fuel quality control Organized provision of wood drying service Financial support for purchasing of new devices for vulnerable population Tax exemption for standardized devices	Standard of available fuel not properly controlled Low capacities of chimney sweeping services Increased air pollution standards Local supply of technology endangered due to vendor's capacities Users might use other flammable materials for burning instead of wood – even dangerous and toxic ones

PUBLIC GOOD PERSPECTIVE- RISKS AND BENEFITS

Table 40 *Eco-design compliant fuel wood stoves and cookers, public perspective SWOT analysis*

Strengths	**Weaknesses**
Locally available fuel supports the security of supply Carbon neutral operation at present Small energy footprint of fuel (low energy usage required for fuel preparation)- very low EROI Local/regional vendors of technology Share of public ownership in local vendors Provides a heating resource for significant part of local population keeping the most vulnerable from freezing	Comparably high indoor and outdoor pollution and related health consequences Pressure on forests resources Ash disposal management Sidewalks and streets are crowded during firewood preparation season Huge amounts of firewood are acquired through semi-legal financial transactions
Opportunities	**Threats**
Large untapped opportunities for knowledge increase among users	Capacities of local vendors insufficient to cope with the technology development Chimney service capacities weak

Provision of external business to business support for technology development facilitated with the development partners Development of public provision (or public support to provision) of fuel management service (wood drying) Switch to legal financial transactions of firewood market would increase tax incomes Accelerated introduction and implementation of eco-design standard Phase out date setting for existing non-compliant devices facilitated by scrap scheme	Human resource availability across the supply chain (forestry, vendors, chimney sweeping service, operation and maintenance, installations) Homeowners do not see the replacement of old stoves and cookers with new ones as a solution Poor forest resource management Unclear and weak regulatory framework

VENDOR PERSPECTIVE

Table 41 *Eco-design compliant fuel wood stoves and cookers, vendor perspective SWOT analysis*

Strengths	**Weaknesses**
Large, established market for firewood stoves, cookers, and boilers Large market for firewood Easy post-sales services Less sensitive to external shocks	Market undeveloped as homeowners tend to use old equipment and there is no regulatory pressure Capacity to develop eco-design compliant product
Opportunities	**Threats**
Market has a large potential to develop National and local program of replacement of old stoves and cookers with new with eco-design could trigger development of the market	Competing technologies (pellet and non-combustion) Regulatory and policy uncertainty

Eco-design compliant pellet stoves and boilers

USER PERSPECTIVE- BENEFITS, RISKS, AND ATTITUDES

Table 42 *Pellet stoves and boilers, user perspective SWOT analysis*

Strengths	**Weaknesses**
Comfortable way of operating the system Easy for maintenance Relatively high efficiency	Higher capital investment required Fluctuation of pellet prices

Wood pellet burned in complete combustion process Low emission levels Larger area of the household is heated Provides high-temperature heating required in low efficient buildings	Physical work needed when pellet bags are moved for storing and filling dozer Ash needs to be cleared regularly Pellet quality is not standardized and often insufficient High temperature levels of heated water in the system Requires stable electricity supply Larger number of parts prone to failure Burning of bad quality pellet causes local pollution Requires storage space
Opportunities	**Threats**
Quality standards of pellet might be improved and by doing that market relations and trust would be improved Most likely the subject of future subsidy programs	High pellet prices might cause rejecting to use it as a fuel by homeowners Fuel quality Security of supply on local markets Regional pellet industry export dependant (export markets subsidy-driven) Pellet exports to richer markets

PUBLIC GOOD PERSPECTIVE- RISKS AND BENEFITS

Table 43 *Pellet stoves and boilers, public perspective SWOT analysis*

Strengths	**Weaknesses**
Pellet could be produced locally Considered to be carbon neutral fuel Could utilise wood residues and waste wood	Ash disposal management Pellet market unstable because of the change of prices and inconsistent quality Weak governance framework enables threat to resource and misallocation of forest resources Burning of bad quality pellet causes local pollution
Opportunities	**Threats**
Local production of pellet might be developed supporting economic development and employment opportunities Subsidy schemes	Prospects for mid to long term competitiveness of pellet industry High demand of pellet could cause additional pressure to the forests Regulatory capacities for fuel quality and standard enforcements

VENDOR PERSPECTIVE

Table 44 *Pellet stoves and boilers, vendor perspective SWOT analysis*

Strengths	**Weaknesses**
The interest for using pellet boilers is rising Established retail network	Pellet market is unstable Capital intensive technologies for device manufacturing
Opportunities	**Threats**
The implementation of quality standards for pellet would increase homeowners trust in pellet boilers Most likely the subject of future subsidy programs	Change of pellet prices might hurt development of the boiler market as buyers are losing trust in technology Global supply chains risks Poor pellet quality undermines trust in technology vendors

Direct electrical heating

USER PERSPECTIVE- BENEFITS, RISKS, AND ATTITUDES

Table 45 *Direct electrical heating, user perspective SWOT analysis*

Strengths	**Weaknesses**
Currently one of the cheapest heating options (if thermal storage heaters are used) Easy to install, operate and regulate Relatively low capital cost Electricity widely available Light weighted and easy to manipulate (move to other locations – if one room heaters are used) No indoor air pollution The equipment can easily be automatized and optimized to respond to the needs and tariff system Provides high-temperature heating required in low efficient buildings	Small area of the household is heated (if electric heaters or similar is used) Often heaters have a large open surface with extremely high temperature Heavy weighted and difficult to manipulate (if thermal storage heaters are used) Might cause fire if not operated properly Users might easily get burned at open surfaces Requires stable electricity supply and robust in-house installations Aesthetics Fire and electric shock risks
Opportunities	**Threats**
Flexibility management of power systems in the future may provide incentives for direct electric heating Can be powered by PV local electricity source	Electricity prices rise (market and regulatory driven) which would increase heating costs

PUBLIC GOOD PERSPECTIVE- RISKS AND BENEFITS

Table 46 *Direct electrical heating, public perspective SWOT analysis*

Strengths	**Weaknesses**
No local air pollution May facilitate flexibility management of the power system Easy to implement at wider scale	Large energy conversion losses (from the fuel in the power plant) to get heating energy at the apartment Fossil fuels are used for the electricity production today Direct electrical heating and supplemental heating in poorly insulated buildings coincides in time with system peak load
Opportunities	**Threats**
Support accumulation heaters production	Today, increased usage of electrical heaters might increase electricity production and carbon emission as consequence Low network capacity Affordability

VENDOR PERSPECTIVE

Table 47 *Direct electrical heating, vendor perspective SWOT analysis*

Strengths	**Weaknesses**
Interest for using this kind of equipment is large Customers familiar with the product	Equipment does not require any maintenance which would need vendor to offer service
Opportunities	**Threats**
If electrical heaters are used as a part of a Program to fight local air pollution, the market could expand	Increase of heating costs might lower the interest on the side of consumers More efficient solutions (as Heat pumps) that use electricity are threatening market position

Heat pumps

USER PERSPECTIVE- BENEFITS, RISKS, AND ATTITUDES

Table 48 *Heat pumps, user perspective SWOT analysis*

Strengths	**Weaknesses**
Low energy costs during operations High comfort System totally automated and optimized May be used for cooling and preparation of the sanitary hot water Could easily be paired with other heating resources Pre-requisites for installation not demanding Solutions with integrated heat storage available	High capital costs High costs of installation and maintenance Requires larger physical space for some types of installations Low understanding among the users Difficult to operate efficiently for uninformed user Does not provide high temperature heating Requires stability and quality of electricity supply Some operational limitations in extreme weather conditions Type of installations feasible for use dependant of the local conditions Requires that minimal energy efficiency standards of the buildings are met. Heating system adaptation required in certain instances
Opportunities	**Threats**
Decreasing technology costs Subsidies Increased knowledge of technology Compatible with power system flexibility management Any earth works around the buildings provide the opportunity to deploy heat pump solution Possibility of combining with solar produced electricity (increases cost-effectiveness of investing in solar panels	Stability of electricity supply Electricity price Shortage of precise and useful information on technology constraints

PUBLIC GOOD PERSPECTIVE- RISKS AND BENEFITS

Table 49 *Heat pumps, public perspective SWOT analysis*

Strengths	**Weaknesses**
Highest EROI No local pollution	Working fluid could be hurtful to environment Systems that use underground water could be harmful to the natural water flows

Possible use of CO_2	Capacities for proper installation and maintenance
Opportunities	**Threats**
Creation of stable policy and regulatory framework Combining or supplementing other heating sources like DH	Capacity of electricity network

VENDOR PERSPECTIVE

Table 50 *Heat pumps, vendor perspective SWOT analysis*

Strengths	**Weaknesses**
Increased interest and stable growth perspective Low operation costs	Long, global supply chains
Opportunities	**Threats**
Better marketing and awareness raising Creation of stable policy and regulatory framework Overall increase in energy prices Increased building efficiency Eco-labelling Technology suitable for incentives It can be part of the offer of energy services	Certification scheme for servicemen Workforce size and capacities Deployment of technology in dwellings where it cannot deliver sufficient heat undermines reputation of technology

District heating

USER PERSPECTIVE- BENEFITS, RISKS, AND ATTITUDES

Table 51 *District heating, user perspective SWOT analysis*

Strengths	**Weaknesses**
Easy to operate Easy to maintain Difficult disconnection in case of non-payment Radiant heating High temperature heating possible Sanitary hot water preparation possible Safety	Low level of heat control, optimization, and automatization Maintenance interventions create discomfort in the apartment Intermittent heating (if such regime is applied) Requires auxiliary energy for system operation Difficult disconnection Quality and affordability of service affected by capacities and quality of governance also at local level

No indoor air pollution Payment in monthly instalments	High connection costs
Opportunities	**Threats**
Development of RES based heat and power production Provision of sanitary hot water	Price fluctuation Poor local governance Dependence on heat supplier and poor risk mitigation options

PUBLIC GOOD PERSPECTIVE- RISKS AND BENEFITS

Table 52 *District heating, public perspective SWOT analysis*

Strengths	**Weaknesses**
Existing network infrastructure Existing relationships with customers	Endangered trust in service providers and regulators Difficult network expansion in built areas
Opportunities	**Threats**
Utilisation of low grade and low temperature waste heat Use of locally available renewable energy Deployment of heat pumps Possibility to develop public ESCOs to improve energy efficiency of multi-apartment buildings Improved planning and regulation Flexibility management of power systems Local economy value creation	Low capacities for implementation of innovative and sustainable solutions on owners and regulator side Natural gas lock-in that may lead to collapse of district heating systems

VENDOR PERSPECTIVE

Table 53 *District heating, vendor perspective SWOT analysis*

Strengths	**Weaknesses**
Remaining technical capacities Established relationship with customers Network is a natural monopoly	Deteriorating capacities Low storage capacities
Opportunities	**Threats**

Possibility to develop public ESCOs to improve energy efficiency of multi-apartment buildings Continued dispatch and delivery of heat Can be part of PPP projects	Network infrastructure condition Decreasing heat requirements Competing technologies As a communal service needs permission from local governments Political influences in management and operation of DH companies

A note: Energy return on investment for different biomass usage options

Biomass is the fuel that mankind may grow. Biomass is the only fuel whose usage may bring about negative carbon balances. Biomass is renewable fuel that may produce dispatchable electricity. Biomass supply chains may provide for the employment of large number of people directly and indirectly. On the other hand, poor management of the resource can cause significant damage to the society. For all these reasons biomass management requires more diligence and more information. One of the aspects of biomass to energy supply chains which is frequently overlooked is the energy return on investment.

Energy systems follow the same rule as organic systems: to be viable, they need to produce at least as much useful energy as they consume. The Energy Return on Investment (EROI) calculates the ratio of energy output of a system or resource to all the energy inputs required by this system, or to exploit this resource. It is thus a measure of the energy cost of energy: how much energy is required to provide energy in a specific form with a given technology[54]?

Though conceptually simple, there are, however, many caveats associated with the calculation of this metric. The first lies in the definition of the boundaries of the system for which EROI is calculated: what should be considered as the "energy output" of the system, and similarly, what should be considered as "energy inputs". Some authors categorised fourteen EROI methodologies, defining three levels of energy output boundaries from extraction (or "mine-mouth") to end-use or point of use, and five levels of energy inputs from direct energy and material inputs to auxiliary services consumption and environmental impacts. As pointed out by the authors, the diversity in methodologies result in a great divergence in EROI values in the literature. [55]

For all these reasons instead of providing conclusions we want to inspire thinking and to underline one fact: pellet is the fuel with the lowest EROI before it reaches the mouth of the combustion chamber. Depending on the efficiency of technology and exact EROI pellet use for heat from the energy balance perspective may be lower than that of the fuel wood in forest rich areas. If consider EROI of heat supply chain in which biomass in the form of wood chips is used to generate electricity which is used to drive heat pump differences can be up to 4 times setting the EROI of infrastructure aside. As low EROI is inherent to the nature of this technology it is not sensitive to any of the outside developments. On the other hand, research and development may reduce the advantages that pellet currently has over other biomass technologies such as automated feeding of smaller scale units for example. EROI is the factor that decision makers need not to forget when planning sustainable heating replacement schemes.

[54] https://pubs.rsc.org/en/content/articlelanding/2018/ee/c7ee03610h
[55] https://www.mdpi.com/2071-1050/3/10/1888

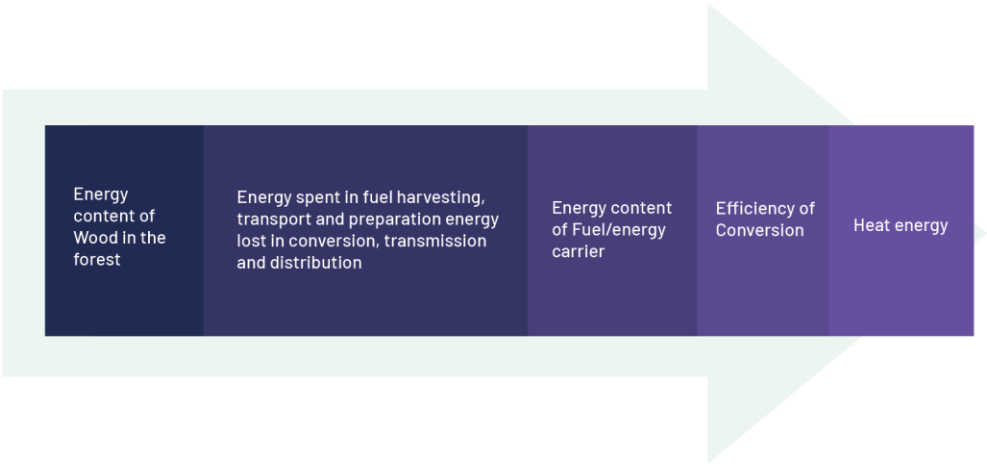


Figure 37 *From the woods to the warm home*

Table 54 *Wood biomass fuels and typical EROI values*

Fuel	EROI literature range
Pellet	2-16
Wood Chips	18-25
Fuel Wood	50-60

GHG REDUCTIONS

Biomass is seen as carbon neutral since emissions released while burning biomass are emissions of carbon that plants captured during lifetime. Still, avoiding biomass burning results in real emissions reductions or increase in sinks, depending on the destination of biomass that has not been burned in inefficient stoves. Within the framework of the project, we have examined the GHG accounting profile of different mitigation scenarios resulting from implementing stove change-out schemes. Any savings in wood that may arise from the implementation of the change-out scheme will result in increased carbon stock which we will present in the forms of annual removals. We have prepared three scenarios that reflect possible future destinations of saved wood:

- Wood saved as it remains unharvested yielding increase in forest carbon stock
- Wood saved and used in construction wood, furniture or similar types of wood products characterized by long term carbon storage resulting in increased carbon stock
- Wood saved is directed into other biomass-to-energy use replacing emissions from other energy activities.

For calculation of savings, we have assumed relatively rate of 5% annual savings of wood used in the baseline year. The assumptions and wood saving calculations for the first 5 years of implementation are given in the table.

Table 55 *Wood saving due to heating improvements: assumptions and calculations. Source: Consultant's calculations*[56]

Contracting party	Assortment	Baseline	Annual savings		Year 1	Year 2	Year 3	Year 4	Year 5
		in 1000 m^3	in 1000 m^3	in %	in 1000 m^3	in 1000 m^3	in 1000 m^3	in 1000 m^3	in 1000 m^3
Serbia	Households Fuelwood	6,533	327	5%	326.7	653.3	980.0	1,306.6	1,633.3
Albania	Households Fuelwood	1100	55	5%	55.0	110.0	165.0	220.0	275.0
Bosnia-Herzegovina	Households Fuelwood	1506.77	75	5%	75.3	150.7	226.0	301.4	376.7
Montenegro	Households Fuelwood	1060	53	5%	53.0	106.0	159.0	212.0	265.0
North Macedonia	Households Fuelwood	681	34	5%	34.1	68.1	102.2	136.2	170.3

Three possible options of alternative use of saved wood with calculation of consequences on GHG inventory are examined in this report.

Saved wood remains unharvested

The basic assumption for this scenario is that firewood saved due to the improved stoves performances stays unharvested in the forest. In addition to the calculation of savings since wood stays in the forests and continues to grow, we have also calculated the savings from avoided harvesting and transport of assortments since those operations will not be performed. In this scenario wood that remained in the forest continues to capture carbon but also continues to grow and creates cumulative savings of CO_2. If 50% of the saved wood will remain unharvested, we have calculated the annual changes in CO2 savings per contracting party.

Table 56 *Annual changes in CO2 saving effects due to saved wood that remains unharvested. Source: Consultants' calculations.*

	Annual changes in CO2 saving effects (CO2-t)				
Contracting party	Year 1 - 0	Year 2 - 1	Year 3 – 2	Year 4 -3	Year 5 - 4
Serbia	246,327	991,538	1,509,274	2,040,108	2,584,370
Albania	41,475	166,081	249,747	333,774	418,163
Bosnia-Herzegovina	56,813	229,243	350,908	476,838	607,185
Montenegro	39,967	160,819	244,577	330,325	418,111
North Macedonia	25,677	103,255	156,808	211,500	267,357

Saved wood used in construction wood, furniture or similar product characterized by long term carbon storage

This scenario is implemented for Albania, Serbia, Montenegro, and Bosnia-Herzegovina, where paper production and wood-based panels industries (excluding veneer) are located. The basic assumption for this scenario is, that 25% of firewood saved due to improved stove performance, will be used in the processing industry, mainly for wood-based panels (excluding veneer) and paper. For the baseline, UNECE data from 2018

[56] No projections for Kosovo* due to lack of reliable data

is used, related to production of wood-based panels (excluding veneer) and paper. Calculation formulas are based on IPCC guidelines[57].

The methodological background is described in IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Chapter 12.2.1.1 Tier 1, equation 12.1.

The scenario results are based on an estimation of annual changes in carbon stocks of wood product pools. The annual inflow of carbon is a result of the available and allocated wood resources to a certain product pool, converted into units of carbon. The annual carbon loss as outflow is calculated based on estimated half-life and associated decay rates of wood products. Conversion factors (product-carbon) and first-order decay rates are based on IPCC (2006) default values.

Table 57 *Annual changes in CO2 saving effects due to saved wood that was used in construction wood. Source: Consultants' calculations.*

	Annual changes in CO2 saving effects (CO2-t)				
Contracting party	*Year 1 - 0*	*Year 2 - 1*	*Year 3 - 2*	*Year 4 -3*	*Year 5 - 4*
Serbia	201,380	226,788	251,501	275,538	298,918
Albania	6,413	6,238	6,067	5,901	5,740
Bosnia-Herzegovina	119,900	95,448	78,910	67,948	60,909
Montenegro	2,508	4,947	7,320	9,628	11,873

Saved wood directed into other biomass-to-energy use

This scenario has been prepared for all countries, with the assumption that saving rate is 25 %, and that firewood saved due to the improved stoves performances will be used to replace other energy sources - fossil fuels. The main data source for energy consumption per sector was the statistical office of the European Union (ESTAT)[58]. Energy consumption is shown for three sectors and six different fuels, as shown.

Table 58 *Sectors and fuels for energy use defined in the scenario.*

Sector	Type of fuel
Households	Natural gas
Industry	Primary solid biofuels
Services - commercial and public	Gas oil and diesel oil (excluding biofuel portion)
	Solid fossil fuels
	Liquefied petroleum gases
	Other kerosene

The following assumptions for fuelwood characteristics were used:

Water content:	45%
Density	0.66 t/m^3
Heating value	2.5727 MWh/t

[57] IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan
[58] https://ec.europa.eu/eurostat

Table 59 *Annual CO2 emission changes due to other energy use of saved wood. Source: Consultants' calculations.*

	Annual changes in CO2 emissions (CO2-t)				
Contracting party	Year 1	Year 2	Year 3	Year 4	Year 5
Serbia	-51,191	-102,382	-153,573	-204,765	-255,956
Albania	-8,619	-17,239	-25,858	-34,477	-43,097
Bosnia-Herzegovina	-11,807	-23,613	-35,420	-47,227	-59,034
Montenegro	-8,306	-16,612	-24,918	-33,224	-41,530
North Macedonia	-10,672	-21,345	-32,017	-42,689	-53,362

Total annual changes in CO2 saving effects due to saved fuel wood

5% annual savings in comparison to the baseline consumption in wood for heated if distributed as described in the scenarios can help the region save almost 5 million tonnes of CO_2 in one year, after five years of continuous achievements. If those emission reductions are monetized, their value would be measured in hundreds of millions of EUR and could be a significant revenue stream for financing of the accelerated replacement schemes.

Table 60 *Total annual changes in CO2 saving effects due to saved fuel wood. Source: Consultants' calculations.*

	Annual changes in CO2 saving effects (CO2-t)				
Contracting party	Year 1 - 0	Year 2 - 1	Year 3 - 2	Year 4 -3	Year 5 - 4
Serbia	501,459	1,078,445	1,600,870	2,136,546	2,685,810
Albania	65,626	185,141	269,818	354,860	440,268
Bosnia-Herzegovina	95,950	246,267	369,119	496,283	627,912
Montenegro	51,197	173,236	257,798	344,373	433,009
North Macedonia	36,616	115,001	169,110	224,371	280,809
Total Western Balkan	750,848	1,798,091	2,666,715	3,556,434	4,467,808

AIR POLLUTION REDUCTION AND HEALTH BENEFITS

A study that has been conducted by the WHO, Ministry of Health, Ministry of Environmental Protection and National Institute for Public Health of Serbia was based on simulation of progressive reductions in current $PM_{2.5}$ concentrations. In base case that covered the then existing situation nearly 3,600 premature deaths every year were attributable to exposure to $PM_{2.5}$ in 11 studied cities in Serbia. Only in Belgrade, the number of premature deaths per year was estimated at 1,796. The overall health impact of air pollution for the whole of the urban areas in Serbia (not just the 11 cities studied in detail) was estimated at 6 394 attributable deaths. Over the next 10 years, 150 865 YLL due to air pollution were expected if current levels of air pollution persist. Of these, 75 261 YLL were projected to occur in Belgrade.[59]

[59] Joint publication by WHO, Ministry of Health, Ministry of Environmental Protection and National Institute for Public Health publication Health Impact of Ambient Air Pollution in Serbia – a call to action https://www.euro.who.int/en/countries/serbia/publications/health-impact-of-ambient-air-pollution-in-serbia-a-call-to-action-2019

The simulations of progressive reductions in current $PM_{2.5}$ concentrations show significant health benefits from improved air quality in the country. For example, annual number of premature deaths in 11 cities in Serbia could be halved if the concentrations of $PM_{2.5}$ are reduced by 10 µg/m3 and 10 times lower if the concentrations are reduced by 20 µg/m3).

World Bank identified heating as the main cause of PM $_{2.5}$ concentrations also in other contracting parties in the WB.

Table 61 *Modelled mortality attributable to different levels of PM2.5 concentrations in 11 Serbian cities. Source: WHO*

11 Cities	Current situation		Reduction by 5 µg/m3		Reduction by 10 µg/m3		Reduction by 20 µg/m3	
	Estimated deaths	YLL	Estimated deaths	YLL	Estimated deaths	YLL	Estimated deaths	YLL
	3 585	150 865	2 737	114 539	1 862	77 515	301	12 508

Note. Concentrations are rounded to one decimal point; $PM_{2.5}$ values were converted from PM_{10} with a coefficient of 0.65.

As already stated, in the Draft Programme of Air Protection of the Republic of Serbia for the period 2022- 2030 with Action plan reductions of PM necessary to ensure the compliance with air quality limit compared to 2015 emissions in the range from 46% to 81% in different zones of the country by 2030 are envisaged. Model showed that substitution of the heating devices in the five most polluted cities should be in the range from 58% to 80%of the existing stock and propose a mix of eco-design compliant biomass devices and heat pumps as replacement technology[60].

We have also already seen that the analysis of the World Bank also clearly identifies household heating as the main cause of PM $_{2.5}$ concentrations also in the other contracting parties in the WB. Relevant measures would require (a) early compliance of all new household stoves and boilers burning fuelwood with the stringent standards of the Eco-design Directive of the European Union; (b) replacement of the oldest existing installations; and (c) assurance of adequate quality of fuelwood, through burning of only dry fuelwood and proper storage of fuelwood. Such changes would require strong financial and governance mechanisms for their realization[61].

[60] https://drive.google.com/file/d/1FizqEP5laZLU0dUWGChwld6utKMI84SA/view
[61] https://thedocs.worldbank.org/en/doc/571891579547481576-0080022020/original/AirQualityManagementinBosniaandHerzegovinaExecutiveSummaryeng.pdf

MANAGING THE CHANGE

OPTIONS FOR FINANCING UPGRADES

The current financial schemes in the region are not sufficient. Existing public financial schemes need to be improved, their scope widened, their target customers more focused, and their (increased) funds more accessible.

The same applies to retail financing schemes, but these will most likely be market-driven in response to growing user education and market demand. Even if that is the case, **retail market institutions should be incentivized by the public sector, in order to speed up the replacement process.**

The development assistance institutions need to assist local authorities in providing those incentives or need to provide them directly (as it is currently the case).

New financing schemes need to be introduced, with more focus on citizen engagement, transparency and participation in investment decision making. This could be accomplished through

- improved grants,
- blended finance schemes,
- on-tax incentives and fiscal solutions,
- introduction of revolving funds,
- third-party investments,
- crowdfunding,
- utilisation of energy communities, or
- using all of these solutions combined.

Grant Programs

Grant programs offering investment subsidies are one of the most common financing tools for energy efficiency (EE). However, in WB6 they need to focus on specific target groups, including vulnerable populations.

This tool needs to provide funds for the population which is unable to provide it for itself. Current grant schemes do not provide that.

Suggestions for improving current grant schemes are:

- Introduce vulnerable consumers into grant schemes – target primarily households with low-income and poor living conditions; Partner with those branches of government and public service providers engaged in delivery of social services, support to poverty alleviation and similar, as they will be the ones intimately familiar with the number and type of potential beneficiaries and their needs;
- Limit grants to certain technologies; Give more emphasis on modern technologies and/or renewables;
- However, offer multiple heating solutions, apart from electricity-based ones (with most of electricity production in the region being coal-based);
- Provide additional benefits for projects with better EE and environmental impact;

- Expand existing grant schemes to include replacement of heating devices as an eligible cost;
- Increase the total amount of funds available, on all administrative levels (national, regional, local).

Blended Finance Mechanisms

There are currently just two blended finance mechanisms for the replacement of heating devices on the market, supported by EBRD and Kfw, and implemented by the local banks. The foundation of the blended mechanism is in line with best practises. Current schemes are focused on the consumers that are already close to making the decision to replace the heating device, and the reimbursement provided in the scheme serves as a turning point for the consumer, making it (from personal perspective) cost-effective to apply for funding.

In that sense, the current schemes serve their purpose – they motivate consumers to make the decision and replace the inefficient heating device. However, the schemes are also lacking in many areas. Firstly, they are not accessible to the population that needs funds the most – vulnerable groups and poor households. Secondly, banks are not inclined to provide loans to high-risk groups. And lastly, there is no segmentation among the consumer groups.

To avoid these obstacles, several blended schemes could be introduced (or upgraded) in the market:

- Introduce state-funded blended schemes, where national authorities provide the grant-part of the finance as incentive for retail banks to include the product in the portfolio, and additional guarantees or incentives for providing the funds to vulnerable groups;
- The role of retail banks could be taken over by some of the national financing institutions (revolving funds, energy efficiency funds, development funds, etc);
- "Staging" could be introduced in blended mechanisms, with the grant amount varying among different (income, social, vulnerable) groups. The purpose of such a scheme would be to provide a needs-based approach and solution, tailor made for the financial and social status of beneficiaries:
- As a first stage in the staging process, a soft loans scheme could be introduced, with only interest rate being subsidised below the market value. It represents an incentive to carry out energy efficient renovation works.
- In some cases, public administration would need to provide a guarantee fund and cover operational costs of banks, in addition to the subsidised interest rate.
- A soft loan financing scheme should be part of a global energy retrofit programme, ideally offered in a one-stop-shop for energy efficiency;
- A clear division of roles is needed – private partners (banks) should provide financial services and advice, while public partners should provide technical support, education and awareness raising.

Energy Communities

Vulnerable groups in the region, more often than not, live in the neighbourhoods or settlements with people in the same social group as themselves. This allows for territorial solutions, which would target multiple vulnerable households at the same time.

Central heating production could be established for the entire settlement or neighbourhood, with heat sources based on renewables. Investment and management models need to be developed for these groups, as the knowledge level to manage energy communities is almost certainly not existent.

Solutions such as small solar plants, providing free energy to vulnerable populations, would not only solve the issue of air pollution and energy efficiency, but would showcase examples for commercial off-the-grid projects, leading to more independent and self-sufficient local energy markets.

The most important barriers to the introduction of the model are:

- Legal preconditions and recognition of energy communities in the legal framework (some WB6 countries have already achieved it);
- Securing the funds for the investment;
- Securing (sustainable) management model.

Local administration will have a key role in this process, as it is connected the most to local communities, and it responds the fastest to their needs. If in place, local Energy Efficiency Agencies, or other expert bodies, could play the management role in the process; at least until capacities of the beneficiaries are built up enough to make their own informed decisions in managing the plants.

Crowdfunding

In addition to the above, crowdfunding from the private sector to finance renewable energies is an interesting possibility. Crowdfunding approach is an alternative method, completely different to the common typical business process, used to raise capital through small collective efforts (amounts of money) of a large number of people, friends, family members, customers and individual investors, to finance a project.

This alternative financing scheme takes place through internet channels and social-media platforms that allow sharing project ideas and keeping in touch with project developments.

The scheme seems perfect for tackling societal challenges that impact large populations, and air pollution from heating devices in individual households impacts all WB6 countries, and beyond. This fact alone could motivate enough people to participate in the heating devices replacement campaign.

If we use the small-solar-plant example above, aiming at a vulnerable group in the local community, various social groups might be inclined to support that kind of a project, achieving several personal goals along the way:

- Reducing the impact of air pollution for the whole population, themselves included;
- Improve living conditions of families in need; Give them a kick-start in moving away from poverty, by removing one of the most significant costs they have (heating);
- Personal satisfaction, issue-based motivated investing.

An example of available supporting tools to find the necessary funding is the CrowdFundRES European project[62], which contributes to the acceleration of renewable energy growth in Europe by promoting crowdfunding for financing renewable energy projects.

[62] http://www.crowdfundres.eu/

On-Tax Financing

On-Tax Financing, or the tax equity investment, describes transactions that pair the tax credits or other tax benefits generated by a qualifying physical investment, with the capital financing associated with that investment.

In terms of replacement of heating devices or energy efficiency in general, local taxes can be used to recover payments from citizens and companies for energy efficiency measures financed by private investors. These investors lend the money for retrofits up-front and then get repaid over a timescale of up to 20 years through an additional charge on a property-related tax bill.

In the US, the 'PACE scheme'[63] can pay for energy efficiency, renewable energy, and water conservation upgrades to homes and buildings, covering up to 100% of the project's costs. In Europe an equivalent scheme, EuroPACE, is currently under development and will be launched in a few leading cities.

However, further analysis is needed, as the scheme is not viable everywhere. Through the research in preparation for the EuroPACE project, it became clear that the fiscal differences between European countries will not allow this scheme to be developed equally. Also, investors need to be sure that the local authority will have the capacity to regularly collect the taxes in question. This is not always the case in WB6, where local tax collection is often irregular or not effectively enforced.

A variation of this scheme is the Pay-as-you-Save scheme[64] of the UK government. It is a financial mechanism that allows a utility to pay for the upfront cost of a distributed energy solution and to recover its cost on the monthly bill with a charge that is less than the estimated savings. Householders would be able to get finance at term such that householders will be able to cover the cost of the installation out of bill savings, and usually with a further monthly surplus as well. The finance itself would come from the private sector, as banks and others provide funding for the eco-upgrade, secured against future savings on bills.

Third-party Investment

Third-party investment is a scheme where the investment on the renovation of a building is not paid by the homeowner but by a third-party investor. Thus, the homeowner does not take on a debt but pays a service fee to the investor instead. The investment can be done via an Energy Performance Contract. In this case the costs are repaid through the guaranteed energy savings.

The city of Stuttgart developed a 'carefree energy renovation package'[65] for homeowners. The package includes: planning, building and construction, operation and maintenance, financing, guarantee and risk assumption. Homeowners do not need to secure upfront financing for the replacement of the heating system. This is financed by a municipal ESCO to whom the homeowners pay a monthly service fee through energy supply contracting.

Revolving Funds

A revolving fund is a reserve of money used to finance a particular set of activities by lending to one or more borrowers. Over a given period of time, the borrower is expected to repay the original sum that restocks the fund. Usually, an interest is charged to the borrower as a fee for administrative costs but also to protect the fund from being depleted.

[63] https://www.energy.gov/eere/slsc/property-assessed-clean-energy-programs
[64] https://www.theguardian.com/environment/2010/mar/02/pay-as-you-save-loans-decc-answers
[65] https://energy-cities.eu/in-stuttgart-private-home-owners-can-enjoy-care-free-energy-renovation-package/

Revolving fund should not be the main actor on the market, it should act as an additionality, satisfying the needs of consumer groups that are considered too risky or too small to be targeted by retail financing.

Funding alone is not enough, but should be accompanied with technical support and capacity building. EU instruments support (co-fund) such financial schemes.

One-stop shop for EE

Establishing a single point where beneficiaries could get all the needed information and assess their options, would be of utmost importance. Limited information and information bias can be detrimental to all the efforts invested by stakeholders in the process. One-stop shop could be an entire institution, or just an office in the local municipality – it is the purpose that matters, not the organisational form.

WORLD BANK ASSESSMENT OF OPTIONS

The World Bank recently presented some insights into their ongoing work on residential energy efficiency market assessment in the WB. This work is primarily focused on financing of the energy efficiency of buildings but touches upon the heating systems and the issues related to access to financing of the poorer households. In its work World Bank presented 8 possible options for financing together with a brief assessment of readiness for its implementation and applicability for all the contracting parties. Those options overlap with the ones presented above and assessed by the RES Foundation consultant.

As numerous clients will be looking into the propositions of the World Bank, we provide the list of identified options with brief explanation and our views on its applicability for financing of the individual solid fuel burning heating system replacement.

Table 62 *Menu of options for financing of residential energy efficiency. Source: World Bank*

Option	Brief description	Applicability for the replacement of individual solid fuel burning heating system
Public grant programs	Non-reimbursable subsidy towards purchase cost of energy efficiency measure Financed through government / municipal budget – in some instances this draws on a levy on energy bills with the receipts either explicitly or implicitly hypothecated	Applicable for replacement.
Private sector mandates (including introduction of energy efficiency obligation scheme)	Placing an obligation of private entities (typically utilities) to support uptake of energy efficiency measures and deliver energy savings among end consumers. Support will usually be in the form of grants but can also include technical assistance, loans, and financial assistance to ESCOs	Applicable for replacement with air-to-air heat pumps alone or coupled with PV installation. Could target poor customers.
Provision of direct loans by the fund for energy efficiency	Provision of loans to consumers usually on preferential terms to commercial market offering Seed financing may come from government budget, donors/IFIs, energy bill levies, and in some cases private entities	Applicable but given the low value of investments it is not the optimal choice.
Commercial financing (loan and credit enhancement tools)	Credit lines extended to commercial banks for on-lending for energy efficiency May be supported by credit enhancement tools including guarantees and hierarchical debt (and sometimes interest rate subsidies) Financed as per direct loans but with leverage from capital by commercial banks (minimum co-financing levels may be stipulated)	Applicable. With the provision of guarantees possible perfect tool for reaching customers with lower purchasing power and weak borrowing capabilities.

Public-private partnership through ESCOs and Super ESCOs / aggregators	ESCOs undertake and aggregate energy efficiency interventions across multiple consumers based by an Energy Performance Contract (EPC) that transfer technical and financial risk Financing may be made through the ESCO which can be supported by financial institutions, including an EE Fund, or undertaken in parallel directly to the consumer	Difficult to apply for switch from non-metered heating.
Enhancing green mortgages	Mortgage provider offers improved terms for an energy efficient home or renovation Mortgage providers may be supported through credit enhancement tools, capital provision, facilitating regulations, and common standards	Difficult to apply.
On- bill financing	Consumer pays for energy efficiency measure through energy bills This can be treated as a loan or as a service whereby it is considered part of services offered by the utility and integrated into tariffs Funds may come from utility (which may be offered access to low-cost public funds) or third- party financing bodies Loan may be attached to meter/property rather than individual	Applicable for replacement with air-to-air heat pumps alone or coupled with PV installation. Could target poor customers.
Property Assessed Clean Energy (PACE) loans	Lending to houses over long-term repaid through property tax or linked to land value / real- estate value ▪ Funding source may be municipal bonds (or other direct debt) although private lending mechanisms also used	Possible but difficult to apply.

WHO'S GOING TO WORK ON DELIVERING THE CHANGE?

Capacity gaps and how to overcome them

Producers of stoves and heating devices feel that the capacity gaps based on the mismatch between demand and supply in the labour market can be overcome by the existing vocational training to the most extent, but they also expressed some concerns over the structural challenges and more overarching approach by different stakeholders involved.

So far, they have done and financed from their own funds most of the workers' training, research and development activities and launching of new projects and products. Thus, any support or state subsidy for producers and investors who employ new workers would certainly make a difference.

What is even more important than funds in bridging the gaps is the link with education. The support from the technical faculties, the institutes for standardisation, or the chambers of commerce for development of individual or joint projects regarding new technologies for stoves that should meet the new standards can lead to better and more efficient solutions.

Also, cooperation with secondary technical schools would be beneficial in organisation of various training by professional staff, or even, if supported by local self-governments, the formation of specialised vocational training providers /schools, e.g. for welding.

The power of the education-industry partnership can be fostered through local employment partnerships, as a platform for networking, the exchange of ideas and good practises by bringing together not only education institutions and companies, but also business associations, public authorities, and policymakers, as well as civil society organisations.

Also, Public Employment Services in all the Western Balkans region organise various vocational education and training measures such as professional practice, acquisition of practical knowledge, trainings for labour market, trainings on employer's demand or programmes for young interns with secondary and high education, albeit more targeted approach for specific companies and sectors might be needed.

In many of these measures, the employer is entitled to reimbursement of wage costs for the involved person for a certain period of time or it can be paid for financing the costs of training. Particularly interesting can be the training on employer's demand, which is implemented for the needs of the employer and conducted by a publicly recognized organiser of adult education activities or a training provider licensed by the competent institution.

Also, there is a need to improve education systems, which are sometimes stuck with outdated technologies in case education institutions have little contact with and understanding of private sector needs, and the lack of on-the-job training fails to impart students with both the technical and the socioemotional skills required for success in the job market.

Workers must also be given the opportunity to continue developing their skills throughout their working life. With changing technologies and ageing populations lifelong learning is essential. Those already out of school, whether employed or unemployed, must be given the opportunity to continually equip themselves with new skills. Skill upgrading must be a joint effort of both the public and private sectors. Incentives should be provided to firms to develop the firm-specific or sector-specific technical skills of their workforce more effectively and on a larger scale.

Employment and net job creation

Three different forms of employment are recognized, resulting from implementing technology upgrades and different strategies for the implementation of change-out schemes. Total employment therefore consists of those three different forms:

- Direct employment, which results from construction and replacement of stoves. This refers to total labour necessary for construction, operation, and maintenance of new devices, as well as managing waste of replacing stoves.
- Indirect employment, which is a result of expenditures related to new technologies, and includes secondary activities such as transport and other services.
- Induced employment, which is caused by spending additional wages and profits from new technologies.

Excluding all other externalities, it is difficult to make an assessment about net job creation that would be created out of the process of replacement of obsolete stoves. This is especially the case as it would not only have an impact on the jobs along its formal value chain, but potentially also in its downstream linkages among retailers, distributors and selling points. Thus, the following estimate is an approximation, and it is based on the limited information provided by producers of heating devices.

Regarding direct employment, including maintenance, the marginal gain in terms of job creation according to the current ratio of workers per device can be estimated at a maximum of 0.015 workers per additional device. In other words, if 3 million households change the stoves and heating devices, this might create 45,000 additional jobs. However, this is without considering the economy of scale, learning and increased productivity, as well as fast-paced technological advances in automation, engineering, and machine-learning converge, which can seriously undermine this number. Also, these effects on creating jobs in the short run may disappear in the longer term when infrastructure expansion has reached its saturation point.

According to the common productivity rules - which might be different in this sector - the ratio of direct labour to indirect labour is about 3 to 1. This means that 45,000 direct jobs might be eventually multiplied by 15,000 additional indirect jobs. A shift toward low-carbon, green technologies may also create additional employment opportunities in research and development but may also crowd out investment-induced employment in non-green sectors.

Finally, the multiplier effect regarding induced employment may greatly vary depending on many factors such as taxation, how much of a worker's earnings are spent on consumption goods, etc, which go beyond this research.

As a reference point, it is worth mentioning that in general the renewable energy sector has a significant contribution to the EU economy. According to the European Commission, a rough estimate indicates that nearly half of the jobs created in the renewable energy sector are within the heating and cooling industry.

In exploring employment potential in the Western Balkans and proposed areas of new skills development in line with the market needs and future activities at local and regional level, it is necessary to keep continuous dialogue with different technology providers.

In any case, massive change-out schemes will deliver different externalities – including on employment – depending on the technology that will be used in the future.

WHAT TO DO WITH THE OLD DEVICES?

Publicly funded change-out schemes for wood-fired stoves must be conditional on the safe and efficient turnover of old devices: Here's why.

"Smederevac?" scrap metal dealers were almost puzzled when we interviewed them for the quantities of scrap metal coming from disused solid fuel stoves, "Oh yes, we do get one, every now and then!"

Scarce findings of this type of stove on the scrap metal collection sites, bring us to the conclusion that once the change-out starts, there should either be a very strong financial incentive subsidy for the stove replacement, or a strong "old for new" rule with no exceptions, or, better still – both.

To deal with the waste arising from the replacement of disused household heating stoves with new more efficient ones in a responsible manner, we must ensure that disused household heating devices do not have a prolonged use after their substitution. Moreover, they should not appear on the second-hand market after collection and must be replaced swiftly with no room left for the end-users to dump them into the natural environment.

According to the analysis, there are currently over 3 million solid fuels stoves that await replacement throughout the region, and with over 130.000 newly sold devices annually, just over 84% come from two main Serbian manufacturers (see Table below).

This fact puts the largest opportunity but also pressure on Serbian producers, urging them to find solutions for responsible collection, replacement and recycling of their devices. With no dedicated or regulated waste-management fee levied on producers for the devices placed onto the market, this responsibility lies solely on the awareness and enlightenment of producers and end-users.

Table 63 *Market share per manufacturer country of origin*

Market share per manufacturers' country of origin	Percent
Serbia	84.07
Croatia	3.89
Bulgaria	3.43
Turkey	4.28

If one assumes the number of newly sold devices as the potential number of replaced stoves with the average weight of two market leading stoves of around 78kg, and the purchase price paid out by scrap metal collectors of around €24 for the average weighted clean old stove, we see that potential generated waste in the region of the Western Balkans is over 10,000 tons per annum, with an estimated July 2021 scrap metal purchase value of €3.2 million.

Further, our analysis was aided by the calculation of average collection and transport costs by colleagues from "Komdel", the business association of more than 100 local public waste management companies and related businesses operating in Serbia. According to these calculations, up to a minimum of EUR 155.400 is estimated to be needed for the collection and transport to the recycler, regardless of who the collector shall be: i) a waste collection company, ii) a local recycler or iii) project-based one-time collection scheme.

There is clearly a considerable potential for return on investment into design and implementation of a suitably informed collection scheme for old disused devices. Given i) the dangers of old devices being disposed of irresponsibly, ii) the growing price differential between old and environmentally more acceptable, eco-design devices and iii) the obvious need to invest into market education and development with suitably designed communications and marketing campaigns, none of this value should be allowed by future publicly-funded change-out schemes to go to waste.

The leading producers of these devices already recognise the concept of Extended Producer Responsibility through the obligations they already have for the recovery and recycling of packaging waste that remains in the market after the purchase of their products. Their environmental responsibility is thereby extended beyond

factory gates. They should now be approached as partners in building a collection and recovery scheme for their disused products, the stoves - as well.

- Financial instruments such as fees for stove producers when placing the new stove on the market are not imposed in any WB market. However, this fee could become the incentive for producers to start treating their products in a more responsible manner after their end-of-life, they can help set up a scheme for managing the waste from disused household heating stoves in the first phase and they can also be time limited, as the change-out process has its limitations in stoves replacement numbers and years to implement the potential replacement.

- Having in mind there is no separate collection of waste and packaging waste at source developed in rural areas (in some countries such as Albania, even the urban separation at source is under big question), it may be considered to propose setting the obligation and/or education for stoves producers to take-back the packaging after the installation of new stoves and manage it accordingly in a responsible manner.

- The aim is to have 0 waste in the process of the stoves replacement and closing the loop.

- Obligation and/or education for stoves producers to manage such taken-back packaging in a lawful manner – to be recycled/recovered with licensed operators. The process should bear the proof of recycled material from licensed recyclers whether in the country or abroad if exported.

- Create a list of pre-approved partners per region (collection centres / public utility companies / scrap metal collectors / metal recyclers) and inform the potential/targeted users.

- Introduce a certificate (a kind of an abbreviated bill of lading certifying the movement of waste materials or disused stoves) from the user to the designated facility as the precondition for subsidy pay-out.

- Make the potential subsidy for purchasing new stove subject to proper disposal of their disused household heating stove by bringing disused household heating stoves to a collection centre/ public utility company centre/ local scrap metal dealer / local recycler.

- When applying for the subsidy, the condition is that installation personnel of the new stove take back the old one to their own facility or transport it to the closest pre-approved partner (reverse distribution).

- Covering the costs through user transport charges alone in many contexts result in user charges or transport requests that are not affordable for most of the population. Therefore, the full range of economic instruments should be considered, including user charges / incentives, landfill fees or taxes for this product, product taxes and similar, as well as economic incentives for improved solid waste management like subsidies and tax exemptions.

- Some of these measures must be imposed on national level, for example product taxes, while some may be established locally.

Table 64 *Total annual scrap metal purchase value for possibly replaced old stoves excluding chamotte in July 2021 in EUR*

	SERBIA		KOSOVO*		BIH		NORTH MACEDONIA		MONTENEGRO		ALBANIA		Total EUR per manufacturer	
Manufacturer	Minimum prices EUR	Current stock value EUR	Minimum prices EUR	Current stock value EUR	Minimum prices EUR	Current stock value EUR	Minimum prices EUR	Current stock value EUR	Minimum prices EUR	Current stock value EUR	Minimum prices EUR	Current stock value EUR	Minimum retail value EUR	Current stock value EUR
1.	262,500	675,000	70,312	180,803	506,250	506,250	46,875	120,536	28,125	72,321	23,438	60,268	937,500	1,615,179
2.	234,375	602,679	56,250	144,642	144,643	144,643	8,438	21,696	12,188	31,339	7,988	20,539	463,880	965,539
3.	1,406	3,616	-	-	-	-	-	-	-	-	-	-	1,406	3,616
4.	6,093	15,670	-	-	-	-	3,750	9,643	-	-	-	-	9,844	25,313
5.	3,750	9,643	4,687	12,053	40,982	40,982	9,375	24,107	7,500	19,286	6,225	16,007	72,520	122,079
6.	2,343.75	6,027	-	-	-	-	-	-	-	-	-	-	2,344	6,027
7.	4,687.50	12,054	-	-	-	-	-	-	2,813	7,232	-	-	7,500	19,286
8.	-	-	-	-	-	-	9,375	24,107	-	-	-	-	9,375	24,107
9.	-	-	5,625	14,464	-	-	-	-	2,813	7,232	7,922	20,371	16,359	42,067
10.	-	-	3,750	9,642	-	-	9,375	24,107	-	-	15,000	38,571	28,125	72,321
11.	-	-	-	-	-	-	-	-	-	-	4,688	12,054	4,688	12,054
12.	-	-	3,281	8,437	-	-	-	-	-	-	28,481	73,238	31,763	81,675
13.	-	-	-	-	-	-	-	-	-	-	7,641	19,647	7,641	19,647
14.	-	-	-	-	-	-	-	-	2,813	7,232	-	-	2,813	7,232
15.	-	-	-	-	-	-	6,563	16,875	-	-	-	-	6,563	16,875
16.	-	-	-	-	-	-	469	1,205	-	-	-	-	469	1,205
17.	-	-	-	-	-	-	5,625	14,464	-	-	-	-	5,625	14,464
18.	14,062.50	36,161	-	-	-	24,107	11,250	28,929	-	-	13,041	33,533	38,353	122,729
TOTAL	529,219	1,360,848	143,906	370,045	691,875	715,982	111,094	109,688	56,250	144,643	114,422	294,228	1,646,766	3,171,415

CONCLUSIONS AND POLICY RECOMMENDATIONS: SMARTER HEAT VALUE-CHAIN

CONCLUSIONS

The existing use of inefficient and air-polluting wood-fired stoves for heating of households across the Western Balkans continues to stifle economic growth by keeping people stuck in energy poverty and by eroding public health. It continues to excessively pressure the region's natural resources, the environment, and the climate. Such are the negative effects of current heating devices and practices that they fully justify the investment of all our citizen's resources, regardless of their current individual choice of heating technology or fuel.

Few public issues have such wide repercussions. As complicated a policy challenge as it may be, the present situation cannot be allowed to persist. To support people to upgrade the quality of their heating (device or technology) policy makers need a Swiss-army-knife policy device providing them with tools for improving:

- environmental sustainability and forestry,
- air quality,
- carbon capture and storage,
- prevention of soil erosion, resilience to- and flash flooding risk reduction,
- support biodiversity,
- directing resources (wood) to higher value-adding uses thereby supporting economic growth and competitiveness, etc.
- citizens purchasing power and ensuring growth in domestic consumer demand,
- reducing strain on social welfare services through poverty alleviation,
- energy efficiency,
- public health, to name just a few.

Policy makers may choose between three broad avenues that are illustrated in a table below: continue with the business as usual, implement simplified models bound to have restricted effects, and engage in smart upgrade having in mind all factors described in this report as well as options outlined, but also many others not captured here.

Table 65 *Policy options*

Business-as-usual	"Radical" one-size-fits-all solutions	SMART upgrade (SMARTer heat value-chain)
Decide not to decide; pretend nothing is happening and refuse to risk being the "bearer of bad news";	Heat-pump or nothing (Tuzla, Bosnia and Herzegovina) 50/50 co-investment	Specific, Measurable, Actionable, Resourced and Timebound!
This cannot be fixed before the next election; pass the buck to someone else.	Pellet or nothing (Pljevlja, Montenegro) subsidise 100% of the fuel / pellet only	Match diversity of needs, with diversity of measures, schemes, implementation mechanisms, implementing partners
It's already too late for this; votes will be lost over this; the erosion of your electorate has already began; you will first notice it in local/municipal elections;	All subsidies (100% of support schemes) implemented / administered by municipalities / local government only	Accelerating the upgrade of household heating is a team sport; list "positions" you need filled on you team; sign existing players with required competencies;
Business as usual means YOU and your children will live shorter and less productive lives.	Any one-size-fits-all approach is like using only one knife: it's not going to cut it (the problem)	Every team needs leadership and a shared understanding of the goal and their role in achieving it; Set the goal post(s)! e.g. everyone keeps warm, none buys substandard devices (Eco-design) after 2027.

Policy makers should remember that business as usual as well as implementation of simplified models leads to large opportunity costs. We repeat here the two of them:

1. More than 125 000 new substandard devices being purchased every year across the Western Balkans at the cumulative value of almost EUR 40 million, which could and should have served as down-payment for a soft loan to purchase at the minimum, an eco-design compliant wood-fired stove, that would signal and advertise change to friends and family, neighbors and whoever else is considering a new device whilst trusting only or primarily the testimonies of fellow users. At present, these sales of substandard devices are not just a lost opportunity. They take us in the opposite direction as their owners will be off the market for a new device for the foreseeable future (e.g. minimum 5-7 years) as they look to maximize the utility value from the device they just acquired, however old fashioned and inefficient. World Bank estimated annual external cost of substandard device in the WB at 5,000 EUR. Possible carbon savings in year 5 if we save 5% of wood burned annually amount to more than 4 million tons of CO_2. Missed opportunity costs due to lack of standards and delayed modernization of heating are high.

2. If all the public funding being invested and administered through direct subsidies from a variety of government levels and departments (national/local, energy, environment, social protection, etc.) is used as seed capital for kick-starting a larger campaign to attract both more of the available funding and more of the available competencies for a maximization of return in the form of coverage and speed of replacement benefits would be certainly much greater.

Those who are best positioned to inform future decision making and innovate existing schemes are those employees of local municipal authorities who have carried the load of support scheme implementation to date. Their feedback must be prioritized as input into design of smartly structured value-propositions, this time not directly to users but to banks, vendors, social protection agencies, etc. and other value-adding partners equipped with existing competencies to build such improvements and fine tuning into their products and services.

This input must be provided into the process. The process is however not yet in place. The key question seems to be **policy leadership.** There is confusion out there about who should be the policy leader on this. Because of less-than-ideal horizontal coordination, there is a lack of inter-sectoral cooperation and coordination. For a variety of reasons, some obvious, some less so - the burden of responsibility to date has most of the time landed either on i) ministries of energy in national government or ii) local government / municipal authorities in locally driven demand for solutions to the escalating air pollution crisis. This last point has sometimes led to iii) ministry

of environment / climate policy occupying the high 3rd place in the ranking of policy initiators. This reactive, rather than proactive approach has somewhat skewed the perception of the issue being addressed. Namely, rarely in the Western Balkans can one see the engagement of policy making entities with far more experience and competence at such issues as:

- Quality standards for consumer products (e.g. ministries of trade or economy, consumer protection, institutes/agencies for standardization, etc.) or
- Social protection services delivery to those most in need, in poverty alleviation programmes (e.g. ministry of social services, local social protection centers, who know the energy poor by name and surname and are engaged in providing support to them as their core competence).

Whilst it is appropriate for the policy process to be driven by ministries of energy, by itself - it does not have the required competencies for fully informed and inclusive policy making which leaves no one behind and effectively drives forward what is essentially a market development programme for consumer goods. The priority in the policy development process is for the policy leader (ministry of energy) to engage from the onset into an open and close collaboration and partnership with at least the aforesaid government relatives - policy leaders.

The task at hand is a difficult one. It may deter some decision makers from engaging in efforts to solve an issue which has so many different dimensions. It is, therefore, helpful - to first map these dimensions on what we chose to call "the smarter heat value chain". The term value chain is borrowed from economics and business management terminology and denotes the addition of value at every stage on a product's path to its end consumer. This report has followed the structure of the smarter heat value chain. Using this approach enables division of one large complex issue into individual, ordered value-adding steps where each one requires the policymakers' attention.

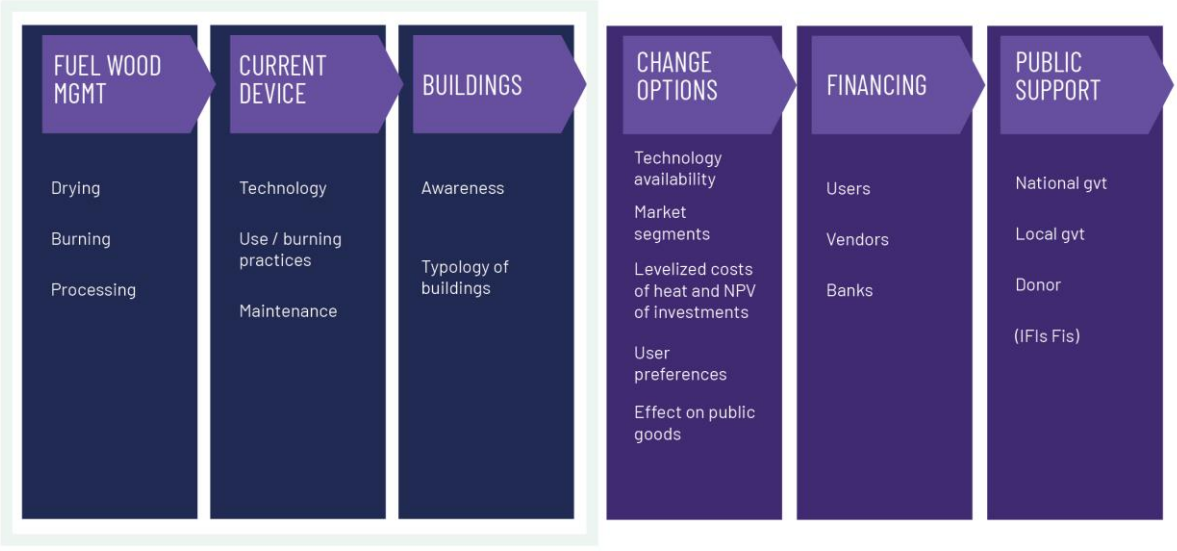


Figure 38 *The "smarter heat" value chain: first things first!*

It is also useful to stick to several basic principles when designing policy that will enable reaching the private and public benefits through improvement of heating efficiency in residential sector in the WB.

Figure 39
Principles of policy making

RECOMMENDATIONS

In this section we add main process related recommendation and repeat or re-phrase some of the recommendations that could be identified in previous chapters of the report to provide summarized list of main directions that decision makers could consider in implementing smoky phase-out.

Managing the process

The process may be steered by the "Smarter heating commission", similar to commissions on just transition from coal to renewables formed around the continent. This commission should serve the purpose of continuous ownership, knowledge management, implementation, M&E of the rolling 5–7-year smokies phase-out plan. The commission would be best initiated by the national government / ministry of energy inviting interested representatives of the remaining sectors (local govt. device vendors, banks, CSOs) to participate according to the interest, capacity, and competence.

In recognition of the growing pressure onto local authorities (and other implementing agents, e.g. banks, as the case may be) to both supply and administer change-out schemes, regardless of the source of funding, and - at the same time - their finite capacities for a more massive change out scheme (which is likely to be implemented in parallel to related initiatives such as energy efficiency measures / building renovation subsidies etc.), the "commission" should seek and find every opportunity to design, develop and implement shared, non-financial implementation resources, including know-how mgt., communications, awareness campaigns, etc. so as to allow local authorities (and all other, more diversified implementing agents) to focus solely on seamless, efficient administration of support mechanism(s); The commission should have in its terms of reference to the extent possible the role of the supportive :back-office" to local authorities, and other implementing agents - the retirement scheme's "front office".

Fuelwood management and use of existing devices

Users don't have the required knowledge or are unable to harvest, process, prepare and use their firewood in an efficient manner. Given the fact that firewood will continue to be used by millions of households, and their apparent lack of knowledge and skills, as evidenced by our survey findings, any policy maker can begin improving

the situation by looking to improve the behavior of existing firewood users. Most have never even been offered or supplied qualified and practical advice on:

When, how and why to ventilate their homes?

When, how and why to clean their chimneys?

When, how and why to use their device so as to get most utility out of it?

When, how and why to stack their firewood?

When, how and why to purchase, harvest, process their firewood for stacking?

There are examples from numerous countries of attempts to develop user education materials.

A range of these have been presented for inspiration on our project website https://smarterstoves.resfoundation.org/user-education/

Figure 40 *A poster of a promotional campaign for proper fuel wood management in one region of the Republic of Serbia*

The survey of user attitudes and knowledge (see above, chapter: What do users think? No knowledge, no power.) shows much work, however, needs to be done. These skills and knowledge will serve the users and our policy objectives even when a switch is made to more efficient wood-fired devices.

Municipal authorities may be well placed to provide to their residents who use wood-fired devices as their primary household heating device a kind of quality and quantity assurance service by procuring fuel wood timely and at scale, ensuring sufficient storage and drying capacity and making high quality dry wood available to residents when it is needed - regardless of individual household's knowledge, capacity or responsibility for doing this by themselves. Indeed, such procurement at scale would drive down prices, increase the quality, improve the management of forests and their resources, make an immediate impact on existing burners by improving efficiency and reducing emissions and air pollution. Finally, such a public service / utility could and should benefit equally the users of obsolete, inefficient devices to be phased out as well as those users who already have and will continue to use eco-design certified wood-burning devices. This service does not need to be provided directly but could be done in partnership or via better regulation of existing traders.

Buildings

Prepare local building typology. Preparation of local building typology may inform the development of local subsidy scheme and preparation of the menu of replacement options. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Enable diversification of local policy by evidence-based air-pollution zoning. Building typology accompanied with the heat map combined with the data on air pollution concentrations from formal and informal networks

and ad hoc measurements may lay grounds for air pollution zoning enabling geographically differentiated heating replacement policy[66]. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Gather information on (prepare typology of) buildings of vulnerable consumers. As vulnerable consumers who receive monetary support to pay their energy bills are in relatively frequent communication with the public authorities their building typology could be prepared with lower costs. Information gathered may provide for informed decision on best heating replacement options for vulnerable consumers.

Options for change, financing and filling the gaps with public sector intervention(s)

Transpose the eco-design directive into domestic legislation to set the minimum bar for sales of new devices with delayed and/or rolling implementation. Based on the capacity assessment of leading producers prepare and implement capacity building program. Building capacities of national institutions for transposition of EU Eco-Design Directive (target group: relevant ministries and conformity assessment bodies). Design and implement national campaigns focused on benefits of implementation of Eco-design Directive: new market development opportunities, energy efficiency, better air quality, better health, fuel efficiency. *Stakeholders to be involved: National government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Decide and regulate on a 5 to 7 years-long phase-out or transition period for sales of heating devices below the minimum bar set by eco-design directive. Introduction and enforcement of minimal efficiency and emissions standards is pre-requisite for the achievement of private and public benefits of more efficient heating. Announcing duration of transition period send strong signals to all stakeholders. *Stakeholders to be involved: National government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Business-plan the number of devices pulled off the market per annum for every year of phase-out period, including separate numbers for prevented sales of new smokies and for change-out of old ones without user-initiated purchase. Governments need to put targets for annual replacement of existing old devices with newer technologies. A separate target for accelerated replacement and for incentivised natural replacement (customers who were in the market to buy new devise and were incentivised to alter the decision to more environmentally friendly technology). *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Budget amounts / allocations per every year of phase out. National and local governments need to set budgets for every year of the phase out programmes. *Stakeholders to be involved: National government, Local government, Banks, Civil society organizations, Development partners.*

Allocate more and more funding for publicly funded support schemes or subsidies to accelerate the change-out including through new development loans and borrowing; as well as assurance across the local heat value-chain. The funding available need to be increased in comparison to the existing funds. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Seek co-financing from i) local government ii) customers iii) banks iv) international development and financial institutions to cover any gap between plan and available budget. *Stakeholders to be involved: National government, Civil society organizations, Development partners.*

Building on EBRD GEFF experience develop blended schemes with inclusion of guarantees. EBRD GEFF scheme could be amended to include guarantees to enable participation of customers with lower ability to secure loan financing. The scheme needs to include option to purchase eco-design compliant wood stoves.

[66] https://skopjesezagreva.mk

Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.

Examine introduction of energy efficiency obligation. As introduction of energy efficiency obligation may spur the replacement with electricity heating (including heat pumps) the government in the region may wish to re-assess the decisions on implementing modalities of the energy efficiency directive and re-consider introduction of energy efficiency obligation. *Stakeholders to be involved: National government, Technology / devices vendors, Banks, Civil society organizations, Development partners, Utilities*

Discuss with utilities and regulators options of on bill payments. On bill payments may be introduced without prejudice to the energy efficiency obligations and may be suitable for replacement with air-to-air heat pumps. The funding may come from different sources. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners, Utilities.*

Build into the regulatory framework a more specific / tight mechanism of extended producer responsibility (EPR). EPR could be introduced to ensure comprehensive coverage and collection / management of scrapped / replaced devices to maximize efficiency and reinvest on a not-for-profit basis the growing scrap value into the phase our scheme, best through a collective manufacturers'/dealers' compliance scheme which could generate resources for targeted market development initiatives, such as awareness campaigns, pilot crowdfunding schemes and other ways of further de-risking the phase out. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners, Waste management utilities, Recyclers.*

Plan the phasing down in quantities of eco-design non-compliant devices and the replacement growth in production/sales of upgraded, eco-design devices. Producers of old technology devices need to accommodate their business plans and production plans and capacities with the phase-out timeline agreed with the governments. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Prioritize heating devices in retail banking department / consumer credit lines. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Development partners.*

Decide on immediate VAT reduction or VAT-free sales of eco-design compliant devices before the date of introduction of eco-designed standard. *Stakeholders to be involved: National government, Technology / devices vendors, Development partners.*

Define a variety of user categories / market segments (e.g. urban centers can "retire" such devices, or their sale, sooner, rural can go all the way to end of phase-out period). *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Develop standardized menu(s) of replacement options of heating devices without the building efficiency improvement and without introduction of central heating systems. Based on the building typologies or other available information on buildings design national and local menus of replacement options for instances in which renovation of building is not envisaged in the short to mid-term nor introduction of central heating. Based on the socio-demographic characteristics of the households, building type and user preferences define guidelines to decide between air-to-air heat pumps, wood stoves, thermal accumulation heaters and pellet technologies. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Immediately prioritize replacement of heating devices among vulnerable population. Every scheme run by the national or local governments, retail financing institutions or utilities needs to have a separate track for vulnerable population including a 100% subsidy for most vulnerable. Contracting parties with established databases of vulnerable customers may start by addressing the needs of vulnerable customers. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

Develop guidelines for social care workers for identification of beneficiaries for replacement schemes. Social care workers are best positioned to identify possible beneficiaries of 100% replacement schemes. If properly guided and trained, they could also be able to help identify most suitable intervention. Such involvement of social care workers can greatly reduce implementation costs of replacement schemes. Energy managers at the local level could help in building capacities of local social care workers. *Stakeholders to be involved: National government, Local government, Technology / devices vendors, Banks, Civil society organizations, Development partners.*

SMOKY PHASE-OUT RECOMMENDATIONS

Table 66 *Smoky phase-out recommendations*

	National government	Local government	Technology / devices vendors	Banks	Civil society organizations	Development partners
Shared	Form the "Smarter heating commission", similar to commissions on just transition from coal to renewables formed around the continent for the purpose of continuous ownership, knowledge management, implementation, M&E of the rolling 5-7 year smokies phase-out plan; Best initiated by national government / ministry of energy inviting interested representatives of the remaining sectors (local govt. device vendors, banks, CSOs) to participate according to interest, capacity and competence. In recognition of the growing pressure onto local authorities (and other implementing agents, eg. banks, as the case may be) to both supply and administer change-out schemes, regardless of the source of funding, and - at the same time - their finite capacities for a more massive change out scheme (which is likely to be implemented in parallel to related initiatives such as energy efficiency measures / building renovation subsidies etc.), the "commission" should seek and find every opportunity to design, develop and implement shared, non-financial implementation resources, including know-how mgt., communications, awareness campaigns, etc. so as to allow local authorities (and all other, more diversified implementing agents) to focus solely on seamless, efficient administration of support mechanism(s); The commission should have in its terms of reference to the extent possible the role of the supportive :back-office" to local authorities, and other implementing agents - the retirement scheme's "front office".					
Fuelwood management and use of existing devices		Establish local wood procurement, drying and quality assurance service				
Buildings		Enable diversification of local policy by evidence-based air-pollution zoning. Prepare local building typology				

Replacement technologies	Transpose the eco-design directive into domestic legislation to set the minimum bar for sales of new devices with delayed and/or rolling implementation. Decide on immediate tax reduction or tax-free sales of eco-design compliant devices before the date of introduction of eco-designed standard Decide and regulate on a min. 5 and max. 7 years-long phase-out or transition period for sales of heating devices below the minimum bar set by eco-design directive	Develop standardized menu(s) of replacement options of heating devices without the building efficiency improvement and without introduction of central heating systems.	Business plan the phasing down in quantities of eco-design non-compliant devices and the replacement growth in production/sales of upgraded, eco-design devices	Prioritize heating devices in retail banking department / consumer credit lines.	Develop standardized menu(s) of replacement options of heating devices without the building efficiency improvement and without introduction of central heating systems.	Develop standardized menu(s) of replacement options of heating devices without the building efficiency improvement and without introduction of central heating systems.
Financing	Seek co-financing from i) local government ii) customers iii) banks iv) international development and financial institutions to cover any gap between plan and available budget			Prioritize heating devices in retail banking department / consumer credit lines.		

Public sector support	Budget amounts / allocations per every year of phase out Business-plan the number of devices pulled off the market per annum for every year of phase-out period, including separate numbers for prevented sales of new smokies and for change-out of old ones without user-initiated purchase Define a variety of user categories / market segments (e.g. urban centres can "retire" such devices, or their sale, sooner, rural can go all the way to end of phase-out period). Immediately prioritize replacement of heating devices among vulnerable population Develop guidelines for social care workers for identification of beneficiaries for replacement schemes	Allocate more and more funding for publicly funded support schemes or subsidies to accelerate the change-out including through new development loans and borrowing; as well as assurance across the local heat value-chain; Immediately prioritize replacement of heating devices among vulnerable population Develop guidelines for social care workers for identification of beneficiaries for replacement schemes				

Key notes:	Ensure policy coherence & coordination heating devices are not left behind in the energy transition: Integrate this plan into and with The National energy and climate plan (NECP), The National energy strategy, The national action plan for alleviating energy poverty, The national air quality protection plan, Other plans and strategies, as appropriate.

WHAT DO STAKEHOLDERS IN THE REGION THINK OF SUCH A PLAN?

By way of a final reality check related to aforesaid recommendations, we designed a short questionnaire to validate key findings and policy directions. The respondents are a representative sample of the variety of stakeholders who have participated in any one of the 12 workshops on the subject conducted in spring and late autumn of 2021 (two workshops per market). We present here some selected responses.

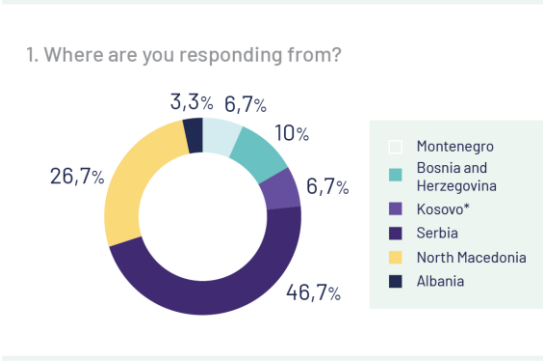


Figure 41 *Where are you responding from?*

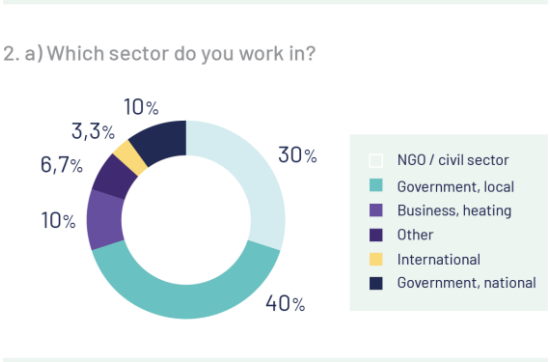


Figure 42 *Which sector do you work in?*

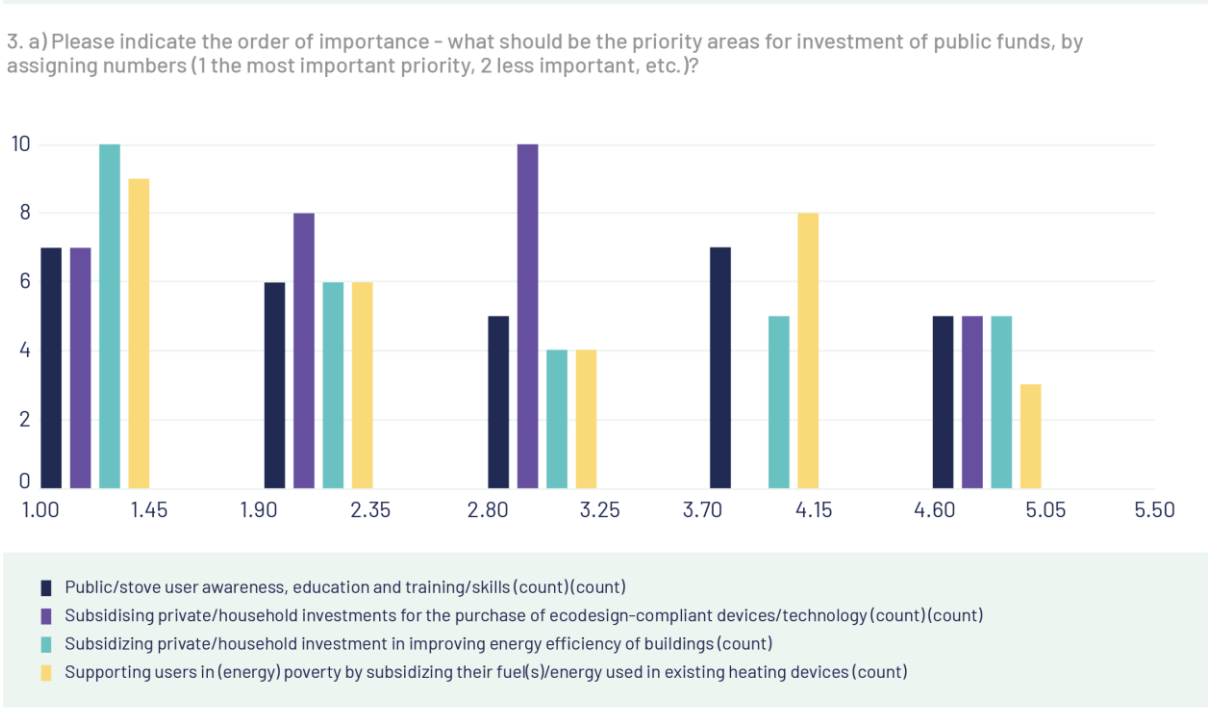


Figure 43 *What should be the priority areas for investment of public funds?*

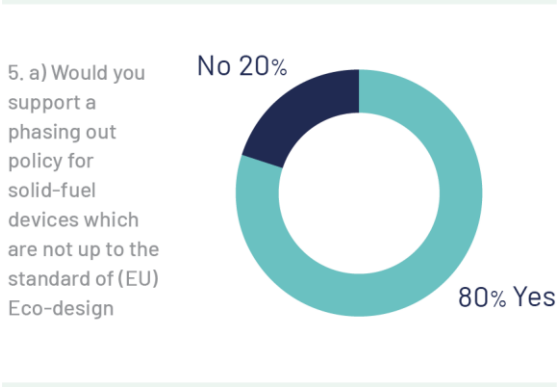


Figure 44 *Would you support a phasing out policy for non Eco-design solid fuel devices*

Why not?

- Price and poverty; most people are forced to use these inefficient devices, forcing them to pay for expensive, efficient devices is politically unacceptable and difficult to achieve; it should be a gradual process;

- I think it's not justified to spend public funds on the transition in two steps;

Why yes?

- EE, alleviate energy poverty, reduce emissions and air pollution, protect health;

- "Otherwise it's not going to happen."

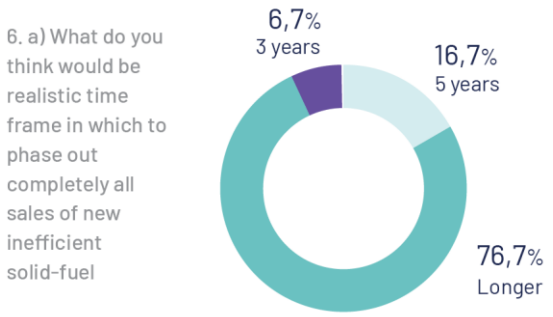


Figure 45 *Realistic timeframe*

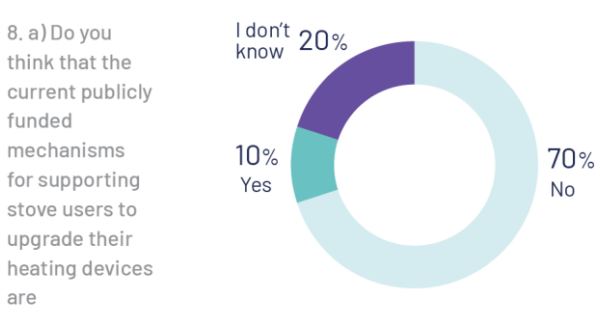


Figure 46 *Current publicly funded mechanisms*

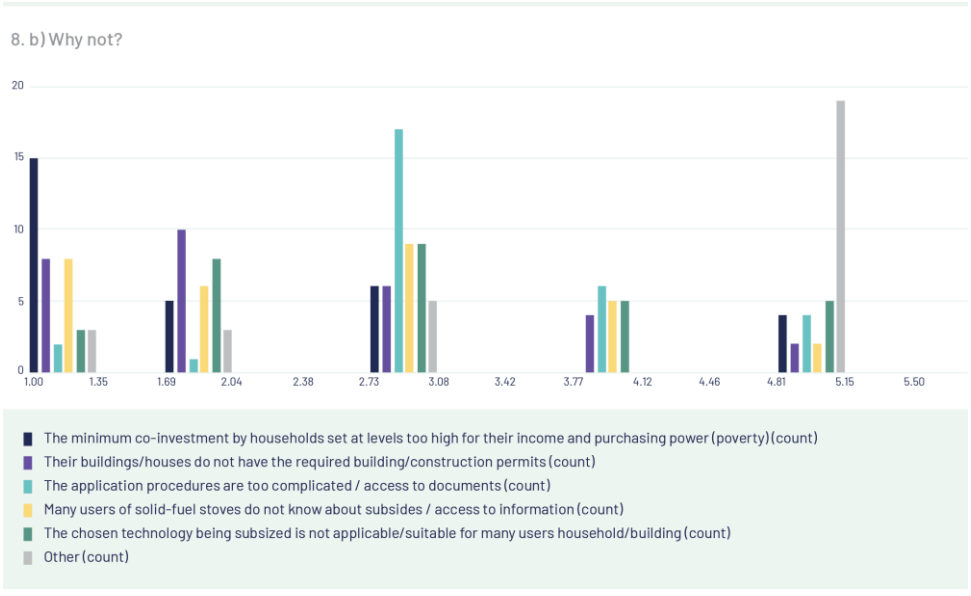


Figure 47 *Why not?*

Other:

"If citizens want to be beneficiaries of subsidies, taxes for houses and apartments must be paid. This kind of process already exists in some municipalities.

"There should be special contracts with banks to invest credits for households (citizens and housing communities / stambene zajednice)".

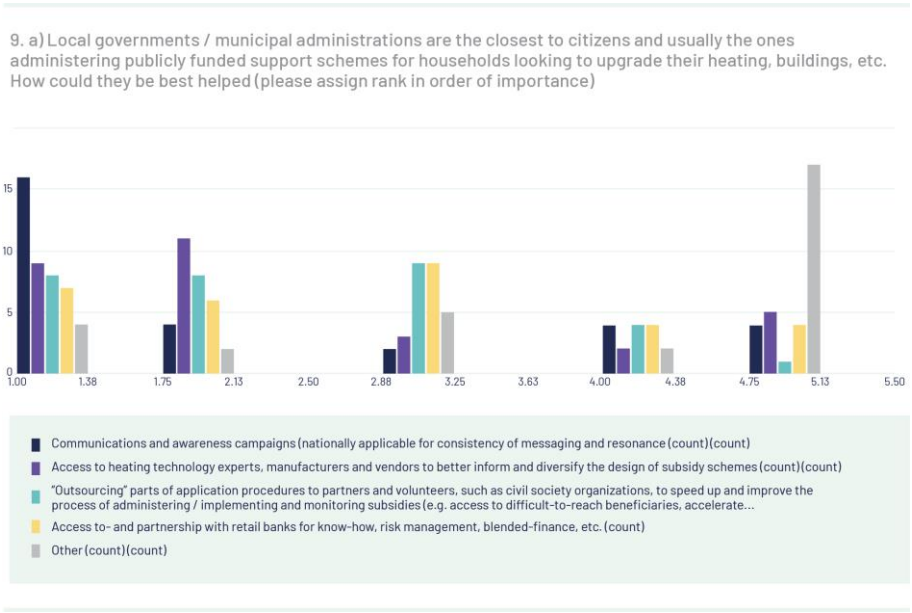


Figure 48 *Helping local governments/municipal administrations*

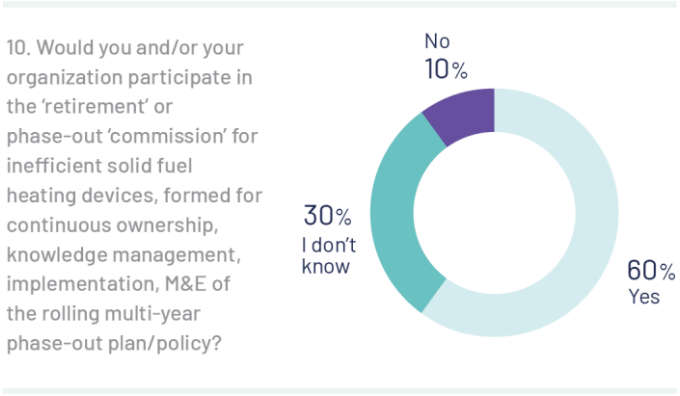


Figure 49 *Participation in the "retirement" or phase-out "commission" for inefficient solid fuel heating devices*

COMMUNICATIONS BLUEPRINTS

There will be different communications approaches required from different angles at which stakeholders arrive at this issue; Nevertheless, some key navigational tools can be identified already as initiation of future communications and advocacy plans; The ones listed here present our impression of basic premises and narrative structures which we find will hold water for any campaigner looking to contribute towards increased knowledge of-, demand for- and effectiveness of schemes designed for an acceleration of change out schemes for upgrading household heating in the Western Balkans;

⇒ **Targeting: All avalanches start with the small first snowball: connect with and support the champions of change!**

Surveys have shown that roughly 20% of wood-fired stoves know they need a better solution and are ready for change - now.

Surveys also tell us that most people will look to see or hear testimonies of other users, preferably neighbours, friends and/or family, before beginning to really trust the message and develop an interest in changing their heating device and practices. In marketing terms, it will take seeing and hearing from other people how they get on with a new device before "customer volatility" is achieved, a state in which they are either looking for- or are open to changing the way they "buy heating".

Targeting everyone is a waste of resources. Target the 20% only, to support them, to nudge them towards their decision and to make them into the snowballs that will develop an avalanche of interest and demand for upgrades across their communities.

⇒ **Message: Must turn from negative communication/narratives to positive!**

Given the feedback from users it is important to frame the narratives of change around the positives of improved user experience, safer and more sustainable practice, etc. Advocates should be especially aware of

1. the variety of traditional utilities provided by these devices, real or perceived
2. of the fact that many users rationalise the benefits of old heating practises as a form of coping strategy for dealing with lack of choice induced by (energy) poverty
3. the fact that for users, the key determinant of change is not climate change, environmental sustainability, public health nor air pollution, but convenience of use and cost-effectiveness of the combined ratio of expenditures for a) acquiring device and b) acquiring the energy for that device.

With this in mind, a focus group meeting of communications and energy transition advocates concluded that future change out schemes should not be perceived, framed or promoted as anything focused on the negative aspects of old devices. Illustrative examples include: phase out of smokies, retirement of smokies, ban on sale of inefficient devices, substandard devices etc. Rather, future change-out programmes should attempt to preserve the sense of utility and promote the change for the better, the improvements in user experience and value for money. Examples include referring to change out schemes as device upgrades, stove modernisation programme, heating improvement programme, etc.

⇒ **Channels: What one stakeholder cannot do alone, form partnerships to fill the gaps**

It should not at all be difficult to reach the target customers, given the leads provided by the SMARTer heat value chain model. We can reach our target audiences at points of sale of firewood already, regardless of device they use and of the attention they are giving to potential upgrades.

We can reach them at points of sale of new devices.

We can reach them at their banks and or social security centres.

We know where they are and where we can approach them.

That said, there are a variety of different components to such future communication (e.g. on financial vs. non-financial programmes, on different market segments, rural vs, urban, etc.). Wherever division of communications labour cannot be made according to clearly delineated, existing communications channels, stakeholders across traditional sectoral divides (public sector, private/business sector, civil society organisations) should look for partnership opportunities to bridge such gaps for the benefit of users/customers.

⇒ **Dissemination: Divide the different communications tasks among different stakeholders**

Remember, few messages are ever properly received and acted upon without being delivered over and over again in a consistent and reinforcing manner. Their dissemination will be just as important as their tactful design and will call for smarter heat partners to commit to continued cooperation and coordination.

⇒ **Innovation: The old ways got us where we are. Encourage partnerships so new ways can emerge to accelerate the change out.**

For so many users, the difficulty in making informed choices lies in having no experience or access to new and constantly improving technologies being rolled out year-in year-out. Some research shows that offering a choice between free trials or payments in instalments can increase adoption of new technologies, especially if there is an option to return it and stop payments at any point. The "free trial" enables people to try the new technology and witness first-hand the benefits of using a cleaner and more efficient heating appliance. Vendors should be encouraged to set up demonstration shops/venues in addition to existing sales and market development methods.

Other examples include targeting not heads of households, but remembering that households are or often consist of many members. Communications can target youth through social media and call upon them to develop an interest and share information and knowledge with other, older members of the households.

Crowdfunding campaigns can attract "crowds" with family members in any given rural setting to raise finance for projects which would otherwise stay out of reach, etc.

This is not an exhaustive list, of course. It is an invitation to build future communications, engagement and awareness efforts around some basic building blocks arising out of the research conducted within the framework of this project.

If there is one message that the RES Foundation Smarter Stoves Partnership team can send to you, a stakeholder in the mass change-out scheme for inefficient overtly emitting wood-fired heating devices, and ask you to remember and act on it, than it is this:

We all continue to be affected together. Together is, also, how we will succeed in solving this challenge.


Smarter Stoves
Partnership