Final Report

Biomass-Based Heating in the Western Balkans – A Roadmap for Sustainable Development

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A Roadmap for Sustainable Development

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Acronyms and Abbreviations

General

ALB	Albania
BFB	bubbling fluidized bed combustion
BHS	biomass heating systems
BiH	Bosnia and Herzegovina
BL&TC	biomass logistics and trade center
CFB	circulating fluidized bed combustion
CHP	combined heat and power
cm	centimeter
CRO	Croatia
DH	district heating
DHW	domestic hot water
ECS	Energy Community Secretariat
EE	energy efficiency
EERF	Energy Efficiency Revolving Funds
EFFIS	European Forest Fire Information System
EIB	European Investment Bank
EIRR	economic internal rate of return
EN	Euro Norm (standard)
eNPV	expected net present value
ERBD	European Bank for Reconstruction and Development
EU	European Union
FAO	Food and Agricultural Organization
FLEOH	full load equivalent operating hours
FYROM/MAC	the former Yugoslav Republic of Macedonia
GHG	greenhouse gas
GWh	gigawatt-hour
HFO	heavy fuel oil
HOB	heat-only boiler

km	kilometer
KOS	Kosovo
ktoe	kilotons of oil equivalent
kW	kilowatt
kWe	electrical kilowatt
kWh	kilowatt-hour
LCOH	levelized cost of heat
LFO	light fuel oil
LHV	lower heating value
LPG	liquefied petroleum gas
m^3	cubic meter
m/ha	meters per hectare
MC	moisture content
MJ	megajoule
MNE	Montenegro
MWe	electrical megawatt
MWh	megawatt-hour
MWth	thermal megawatt
Mtoe	million tons of oil equivalent
NGO	nongovernmental organization
PIU	project implementation unit
NCV	net calorific value
NEEAP	National Energy Efficiency Action Plan
NREAP	National Renewable Energy Action Plan
O&M	operations and maintenance
ORC	organic Rankine cycle
PM	particulate matter
PPP	public-private partnership
RE	renewable energy
RES	renewable energy sources
SER	Serbia
SRC	short rotation coppice
tCO_2eq	tons of carbon-dioxide equivalent
toe	tons of oil equivalent
ToR	terms of reference
μg/g	microgram per gram
UNECE	United Nations Economic Commission for Europe
BAT	value added tax
W-B	Western Balkans
WACC	weighted average cost of capital
WBIF	Western Balkans Investments Framework

Regional

The Western Balkan (W-B) region comprises the following nations:

ALB	Albania
BiH	Bosnia and Herzegovina
CRO	Croatia
FYROM/MAC	the former Yugoslav Republic of Macedonia
KOS	Kosovo
MNE	Montenegro
SER	Serbia

Acknowledgments

This final report presents a summary of the key findings and results of a technical assessment from the project, Sector Study on Biomass-based Heating in the Western Balkans, conducted by a team from Tractebel Engineering and experts from the Centre for Renewable Energy Sources and Saving (CRES).

The study was funded by the Western Balkans Investment Facility and sponsored by the Energy Community Secretariat, with the World Bank as the implementing agency.

This report was prepared by Dejan Stojadinovic (Team Leader), Elena De Bortoli, and Marco Baldini (Tractebel Engie).

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ESMAP

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Executive Summary

A reliable and sustainable energy supply in the Western Balkan (W-B) region is essential to support the region's economic growth and pave the way toward EU accession for its constituent nations.[1]

For this reason, with the support of Energy Community Secretariat, the World Bank initiated the Sector Study on Biomass-based heating in the Western Balkans project. The project aimed to help the W-B countries—Albania, Bosnia and Herzegovina, Croatia, Kosovo, Montenegro, Serbia, and the former Yugoslav Republic of Macedonia—identify viable investment options and determine policy measures to increase the use of biomass for heating in a sustainable manner. This is intended to (a) enhance energy security in the region and the seven target countries, (b) improve the reliability and sustainability of the energy supply, (c) reduce greenhouse gas emissions and local air pollution, and (d) help the countries cost-efficiently meet their 2020 renewable energy (RE) targets.

The project was financed by the Joint Grant Facility under the Western Balkans Investments Framework (WBIF). This report presents a summary of the key findings.

The project was divided into five main tasks:

1. An analysis of the biomass supply potential.
2. An assessment of heating systems in the target countries.
3. An assessment of economically viable biomass options for heating.
4. An analysis of key barriers to, and measures to increase the share of, sustainable biomass-based heating.
5. A detailed assessment of the use of biomass for heating in selected cities and sub-regions (the case studies are provided in a separate volume).

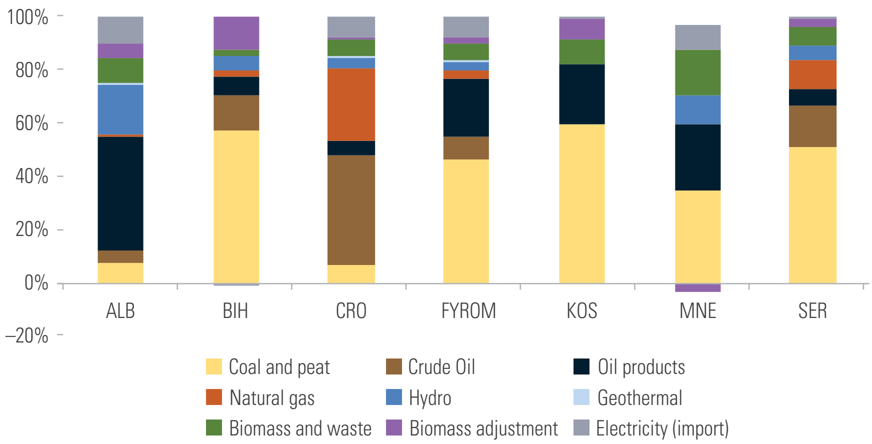
[1] Croatia became an EU member in 2013.

In addition, stakeholder roundtables and workshops at the regional and country levels were held with stakeholders to present the key results and findings of the study.

The high level key findings are presented below, followed by a comprehensive executive summary of the report.

- **Biomass is the most important heating energy source in the W-B region, in both rural and urban areas**, accounting for 42% of the energy required for heating. In rural areas, biomass is the primary source of heating for the majority of the population. Rural households account for 63% of total biomass consumption, and urban households account for 37%.
- **A significant share of biomass is used inefficiently because of outdated equipment and the lack of wood drying before use**. Apart from the loss of 40–50% of the energy content and higher energy costs of heating due to such practice, resulting particulate emissions contribute significantly to poor air quality in W-B cities.
- **To advance changes of existing practices and circumstances, improvements in the policy and regulatory frameworks, increase in the volume of sustainable biomass supply available to the market, and increase in the availability and investments in efficient biomass-based heating technologies are all needed.** To this end, a comprehensive Roadmp is presented in this report. The aim of the Roadmap, structured in three pillars, is to provide guidance for policy and financing in the short term (until 2020), and medium to long term (until 2030). The Roadmap contains a set of recommendations disaggregated into activities that should be implemented to improve the landscape for biomass heat in the Western Balkans.
- **The implementation of the Roadmap will require close cooperation and coordination among all stakeholders in both the public and private sectors.** The overall cost to implement the Roadmap, including the required infrastructure investments, is estimated at EUR 1.4 billion through 2030. Considering limited public finances in W-B countries and fiscal room to allow for adequate investments to biomass-based heating, as well as the limits to the availability of financing from e.g. development finance institutions, there is a clear need for public and private sector to work together to implement the proposed Roadmap for sustainable scale-up of biomass for heating.
- **There are significant economic opportunities for investments in the W-B and the benefits outweigh the costs.** Replacement of inefficient stoves with efficient stoves, and switching from electric heating appliances to efficient biomass stoves in stand-alone buildings, switching from electric heating appliances to wood-chip–fired heating boilers in multistory buildings, and switching boilers from fossil fuels to biomass

Figure 1: Primary Energy Supply Adjusted for Unregistered Biomass Consumption



Source: IEA Energy Balances; biomass adjustment based on consultant estimates, 2012.

in existing district heating system all represent economically attractive options for the W-B countries and their citizens. Furthermore, these investments in efficient biomass heating technologies yield multiple benefits of energy costs savings, wood savings, reduced use of electricity, and reduced dust and greenhouse gas emission. Indeed, the costs of implementing the Roadmap can be more than offset by the economic value of these benefits.

Overview of Biomass Use in the Western Balkans

When accounting for unregistered use, the share of biomass in total energy supply is relatively high. When measured as a share of total primary energy supply, according to official statistics, the use of biomass is relatively limited in the Western Balkans, with its share varying between 2% and 10% per country. However, if one includes the estimated unregistered biomass use, the share is between 7% and 17% (see Figure 1).[2]

The majority of timber is used for energy, agricultural biomass remains unexploited. Of the total annual production of 36.3 million cubic meters of timber, roughly two-thirds, or 23.2 million cubic meters, is used for energy, and 11 million cubic meters is used for industrial purposes. About 3.3 million

[2] The use of biomass is unregistered because of the practice of statistical offices to collect and publish data on official woody biomass trade only, whereas the collection of woody biomass for heating by local communities near forest areas, the use of wood by private forest owners, and the use of agricultural residues are not recorded.

cubic meters of roundwood equivalent is exported. By contrast, agricultural residues and energy crops, with the potential to provide 8.4 million tons of oil equivalent (Mtoe) of bioenergy, remain largely unexploited.[3] However, the development and bringing to market of energy crops in particular would require significant time and effort, and additional analysis on e.g. availability of land for energy crop use would be required.

Wood is the most important heating energy source in the W-B region, in both rural and urban areas. Use of biomass for electricity generation and production of transport fuels is negligible in the Western Balkans. However, when looking at heating, the critical importance of biomass is highlighted. Overall in the W-B region, biomass accounts for 42% of the energy required for heating. In rural areas, biomass is the primary source of heating for the majority of the population. Rural households account for 63% of total biomass consumption, and urban households account for 37%.

The production of pellets and briquettes is increasing, but they are mostly exported. In 2013, more than 60% of the region's total wood chips production, and more than 70% of its output of wood pellets and briquettes, were exported. Bosnia and Herzegovina and Croatia are the leading exporters of wood briquettes, wood pellets, and firewood—mainly to Austria, Hungary, and Italy—while the largest share of firewood is consumed in domestic markets.

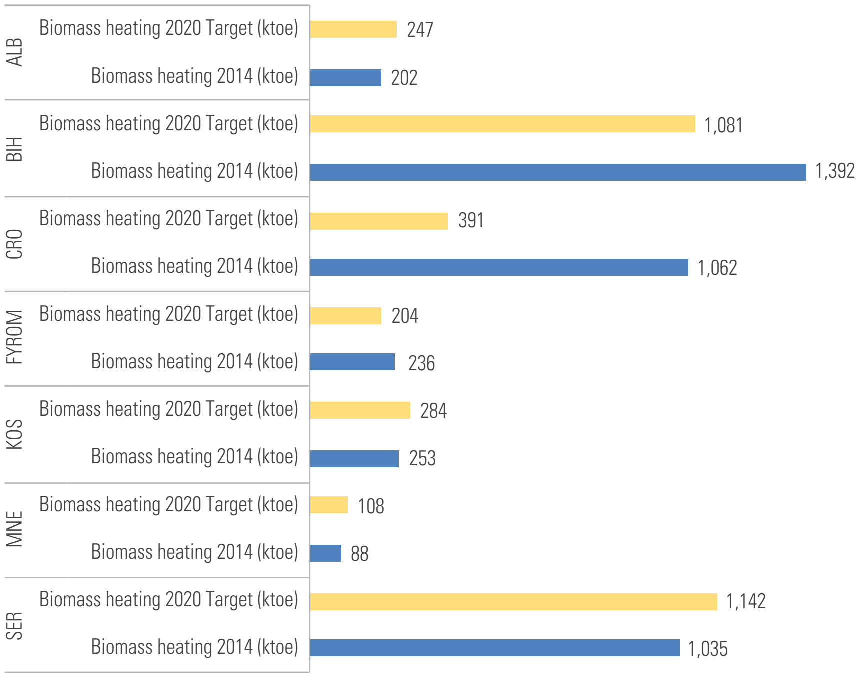
Most W-B countries are on track to meeting their targets for biomass heating. The countries of the Western Balkans have a mandatory obligation to implement the European Union's Renewable Energy Directive, which sets a binding target for final gross energy consumption from renewable sources by 2020. The countries are also each required to have at least 10% of their transport fuels come from renewable sources by 2020. The targets are part of national renewable energy action plans the W-B countries have adopted. The plans include separate targets for biomass use for heating, and progress toward them as of 2014 is shown in Figure 2. Judging by progress made through 2014, Bosnia and Herzegovina, Croatia and Montenegro have already achieved their 2020 targets for biomass heating, while Albania, FYR Macedonia, Kosovo, and Serbia are on track to reach theirs by 2020.[4]

Unfortunately, a significant share of biomass is used inefficiently because of outdated equipment and the lack of drying before use. The resulting particulate emissions contribute significantly to poor air quality in W-B cities,

[3] For comparison, total annual heat demand in the Western Balkans is estimated to be 8 Mtoe.

[4] Assessment is performed by the Energy Community Secretariat. Based on a provision of the Renewable Energy Directive, if country follows an indicative trajectory path toward the achievement of their final mandatory target, it is considered to be on track to reach them.

Figure 2: Biomass Heating Targets for 2020 and Progress as of 2014 (ktoe)



Source: National Renewable Energy Action Plans of the W-B countries; progress is measured based on Progress Reports (2016), and for BIH-IEA Energy Balances (2014).

such as Belgrade, Pristina, Sarajevo, Skopje, and Uzice. Sustainably increasing the use of biomass and making the current use of biomass more efficient would contribute to increasing the share of renewable energy by exploiting local energy resources, and would significantly reduce greenhouse gas (GHG) emissions, with the positive economic and employment impacts.

Heat Demand and Technologies

Almost two-thirds of annual heat demand in the Western Balkans is met using firewood (42%) and electricity (21%). Total annual heat demand in the Western Balkans is estimated to be 8 Mtoe, or 93 thermal terawatt-hours (TWhth). The residential sector accounts for more than 70% of heat demand. The commercial and industrial sectors account for 18% of annual heat demand,[5] and the public sector 10%. In the residential sector, firewood is the most common fuel for heating in all the Western Balkan countries, except in

[5] Within the scope of the study, only space heating is considered, and the use of process heat in industrial applications is therefore not included.

Albania,[6] where electricity is the primary heating method. In the commercial and industrial sectors, electricity is the most common (covers 42% of heat demand), and in the public sector light fuel oil (30%), electricity (24%), and biomass (23%) are the most common fuels.

The vast majority of buildings use decentralized heating systems, with district heating (DH) providing heat to about one tenth of buildings. Approximately 88% of the 7.3 million buildings in the Western Balkan (W-B) region use decentralized heating systems—small heat-only boilers (HOBs), stoves and electric devices—whereas only 12% use district heating. Across all building types, small HOBs are used for heating in 3.3 million buildings (45%), making them the most popular individual heating system in the Western Balkans. Wood stoves are used in about 1.9 million buildings, representing 26% of all buildings. When looking at building segments, in stand-alone buildings, stoves are used in more than a half (51%) and small HOBs and electric appliances in one quarter each (25% and 24%, respectively); many households use both wood stoves and electric appliances for heating. In multistory buildings, two-thirds of buildings use small HOBs (66%), one quarter are connected to DH systems (25%), and about one tenth use electric appliances (9%).

Figure 3 provides an overview of annual heat demand in the Western Balkans by fuel, heating system, and type of building.

Inefficient wood stoves and ovens waste biomass resources and lead to pollution, compounded by the burning of untreated wood. Simple, inefficient, and leaky firewood stoves and ovens that produce high levels of smoke and indoor pollution[7] are a widely used heating and cooking method in both rural areas and cities or towns. Wood is typically harvested in the months preceding each winter heating season and burned as a fresh material with little or no drying—with the consequent loss of 40–50% of the energy content.

The use of biomass in DH systems is negligible. DH systems exist in about 100 cities and towns in the Western Balkans with more than 10,000 MWth of installed capacity. No DH has been developed in Albania and Montenegro.[8] The primary fuels used for district heating are natural gas (50%), coal (40%), and heavy fuel oil (10%). The share of biomass DH in the Western Balkans is negligible (less than 1%) at the regional level.

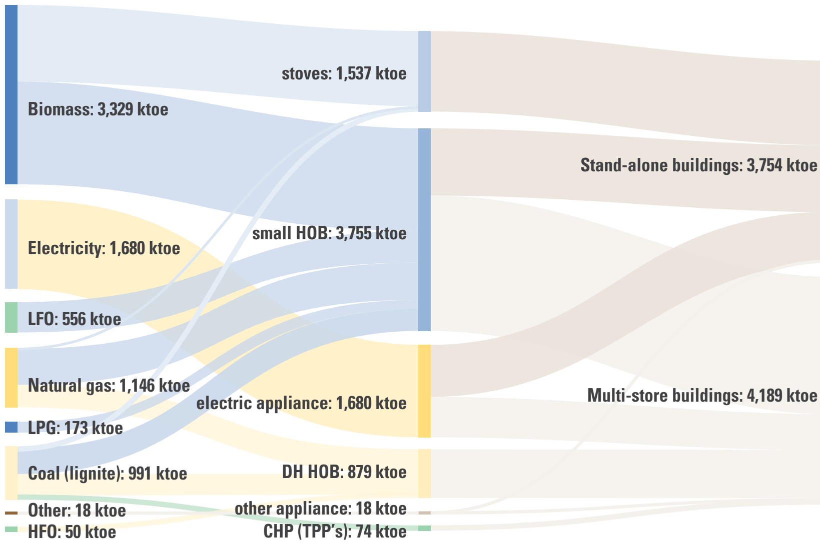
Biomass heating appliances are manufactured in the region, but those available in the domestic markets are poorly tested and certified, more expensive, or not always readily available. The producers of wood-fueled heating

[6] Appendix A provides country-specific figures for heat demand and an overview of heating systems.

[7] http://www.who.int/mediacentre/factsheets/fs292/en/.

[8] In Montenegro, there are two small (6 MW), lignite-fired boiler rooms in the city of Pljevlja that could be perceived as a rudimentary DH system; they are used for heating 284 apartments and public buildings (35 offices) in the city center.

Figure 3: Annual Heat Demand in the Western Balkans, per Fuel, Heating System, and Type of Building



Note: Country-specific annual heat demand is available in Appendix A.

appliances—such as stoves, small boilers, and wood-pellet and wood-chip appliances—are located mainly in Bosnia and Herzegovina, Croatia, Macedonia, and Serbia. The nominal efficiency of the appliances is declared by the producers and usually is higher than the efficiency of the appliances operating in real-life conditions. Typically, the efficiency of the appliances sold on the local market is measured in national or manufacturer laboratories that are not accredited for certification of appliances against Euro Norm (EN) harmonized technical standards. Furthermore, certification of all heating appliance components and parameters is voluntary (other than for electrical systems), and is market-driven. Testing of heating devices, even for their declared efficiency, is also rare.

Biomass Supply

The use of biomass for heating could be sustainably increased by about 20% in the W-B region. The study employed both bottom-up and top-down approaches to collate and analyze biomass supply and demand data in the Western Balkan countries. As Table 1 shows, the sustainable technical potential of biomass for heating in the W-B region is significant at around 13.5 Mtoe annually. However, after (a) deducting the current, already relatively high use of biomass, (b) deducting all non-energy and energy competing uses, (c) excluding the energy crops potential (while the potential is significant, energy crops are not currently available and would take a long time to

Table 1: Assessed Types of Biomass Potential (ktoe)

	Total available (theoretical) potential	Sustainable technical potential	Unconsumed potential	Unconsumed potential (excluding energy crops[a])	Additional heating use potential (excluding energy crops[b])
Albania	865	694	362	5.4	52
Bosnia and Herzegovina	2,599	2,074	933	183.3	104
Croatia	3,488	2,640	1,976	885.5	164
FYR Macedonia	1,243	1,010	740	47.7	60
Kosovo	844	665	224	–157.2	68
Montenegro	931	820	673	200.7	68
Serbia	7,676	5,597	4,046	1,420.5	436
TOTAL W-B region	17,647	13,499	8,953	2,603.9	954

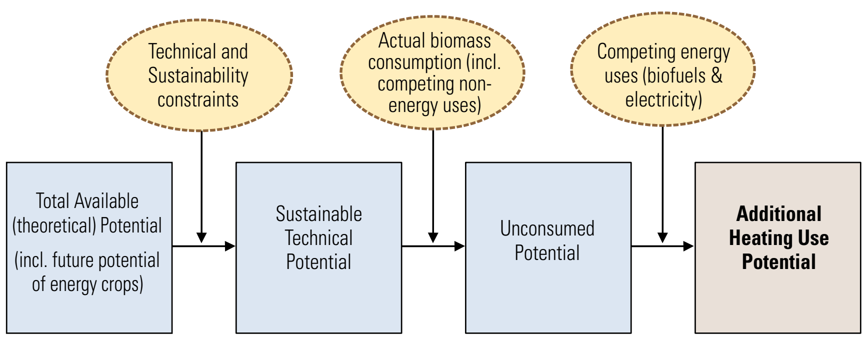
[a] Development of energy crops supply is complex subject that requires separate analysis to formulate recommendations on sustainable development of energy crops in the Western Balkans.
[b] Ibid.

develop), and (d) taking into account only those biomass types that are technically suitable for heating (see Figure 4 for the approach used), the combined woody biomass and agricultural biomass available for additional heating uses is estimated at 954 ktoe. This is equivalent to about 21% of the current biomass heating use of 4.5 Mtoe.

Table 1 summarizes the four categories of biomass potential by country and for the W-B region as a whole.

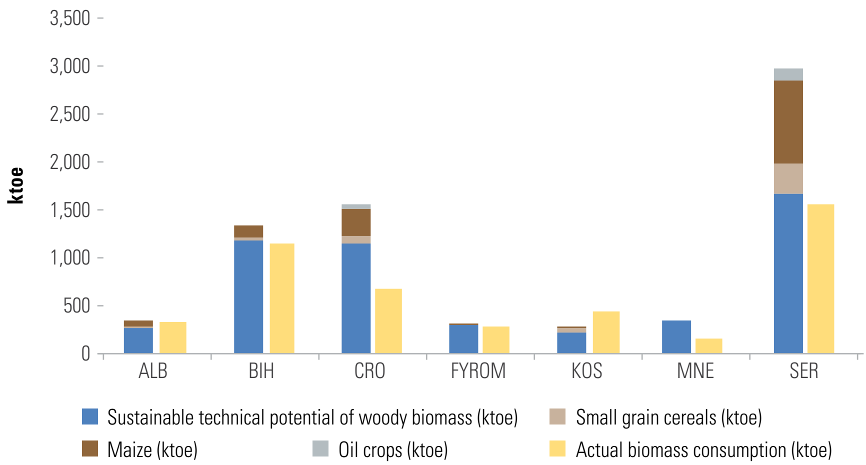
Most of the woody biomass is already used, with significant potential to increase wood use only in Montenegro and Croatia, and sustainability concerns in Kosovo and Albania. The best available data suggest that 75% of

Figure 4: Assessment of Biomass Supply



Note: Country-specific annual heat demand is available in Appendix A.

Figure 5: Sustainable Technical Potential of Biomass, by Type, and Estimated Actual Biomass Consumption, Excluding Energy Crops, 2013



Note: Country-specific annual heat demand is available in Appendix A.
[a] Development of energy crops supply is complex subject that requires separate analysis to formulate recommendations on sustainable development of energy crops in the Western Balkans.
[b] Ibid.

the *woody biomass* sustainable technical potential in W-B countries is already used. Only in Montenegro and Croatia does significant sustainable technical potential exist to increase the use of woody biomass for heating (see Figure 5).

Forest management practices and logistics infrastructure vary, but need development in all countries. On average, 71% of forest area in the W-B countries is state-owned. The annual increment of the woods per hectare of forest area is an indicator of forest management practices, and it is highest in Serbia (4 m^3/ha), followed by Croatia, Bosnia and Herzegovina, Montenegro, and Kosovo (3–4 m^3/ha), with a significantly lower increment found in FYR Macedonia and Albania (1.9 m^3/ha and 0.8 m^3/ha, respectively).[9] Forest logistics and infrastructure to facilitate biomass supply—such as forest roads, railway connections, roadside chipping sites, forest terminals, and biomass supply centers—are not well developed in the W-B countries. Furthermore, the use of available forest management techniques is fragmentary. For example, the thinning of young and middle-aged stands is not a regular forest maintenance measure in the W-B region (it is done only when governmental funds are dedicated to this purpose), and logging residues—mainly treetops, branches, and stumps—are currently unused. Also, significant areas of degraded or scrub forests in the W-B countries are not developed into high forests through reforestation and tree planting.

[9] The *annual increment* refers to the annual growth of a given forest stand.

Additional supplies could be obtained from woody biomass residues, agriculture, and energy crops. While most of the sustainable technical potential of woody biomass in W-B countries is already used, additional supplies of woody biomass can be obtained from currently unused wood biomass residues—logging residues, thinnings, wood found outside the forest, prunings of fruit trees and vineyards, and wood from conversion of coppices. The potential of agricultural residues (most widely available in the Pannonian Basin region, which encompasses the cross-border regions of Bosnia and Herzegovina, Croatia, and Serbia)—which could cover 25% of the current heat demand in the Western Balkans—is largely unexploited. Where a large area of unused agricultural land exists, dedicated energy crops could be grown on the unused land, thus representing significant potential for increased biomass supply.[10] However, the unused agricultural land that could be used for the cultivation of energy crops is not recorded consistently, and the availability and suitability for energy crops of such lands should be further explored.

The additional heating use potential could supply significant new heating capacities. Based on the additional heating use potential of 853 ktoe, a total of 2,148 MW of heating capacity in the Western Balkans could be supplied with the woody biomass, while 1,363 MW of DH/CHP[11] capacity can be provided with agricultural biomass. Adding these new capacities would be important because it would replace 10% of the electricity currently used for heating while significantly increasing the use of biomass in DH/CHP (currently only 50 MW).

Economic and Financial Potential for Biomass-Based Heating

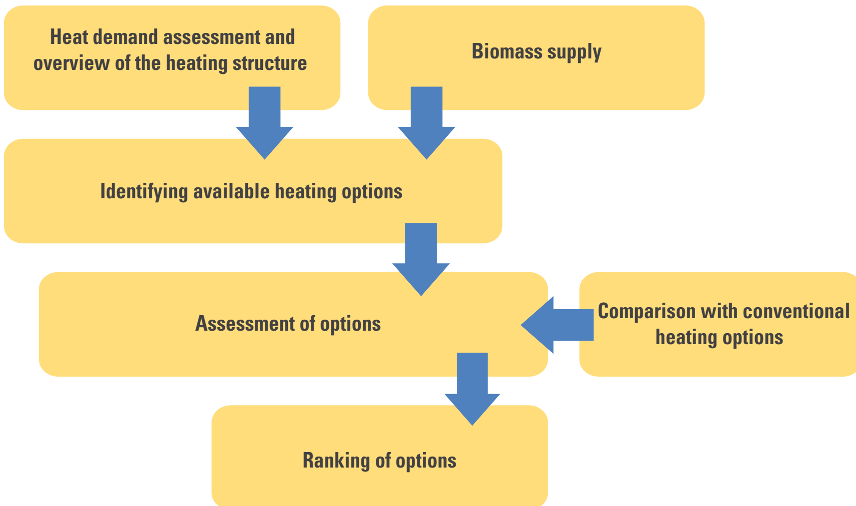
To identify the most cost-effective bio-based heating options in each W-B country, the study compared biomass heating options with conventional heating options using the levelized cost of heat (LCOH) (see Figure 6).

The assessment was done from two perspectives: that of a wider society (the economic analysis), and that of the individual decision maker or consumer (the financial analysis). The following definitions were used:

- **Economic (social) costs** include the costs of externalities (that is, GHG emissions and local air pollution effects) and are evaluated based on the principles of economic analysis, which measures the costs and benefits of heating to the community.

10 Since dedicated energy crops require a long time to develop, they are not considered for the supply of biomass-based heating in the short term in this study.
11 Assuming that agricultural biomass (straw) can be used in DH/CHP plants only.

Figure 6: Approach in Assessing the Cost-Effectiveness of Biomass Heating Options



Note: Country-specific annual heat demand is available in Appendix A.

- **Financial (private) costs** are the costs facing end-users. Based on actual market prices, they are assessed based on principles of financial analysis.

Economic Viability of Biomass Heating Options

Biomass options are economically viable in most scenarios, but not always in comparison to coal and gas in DH, CHP, and HOBs. The economic analysis compared biomass heating options with conventional heating options using the levelized cost of heat (LCOH), including externalities. The economic viability of biomass heating options compared to that of the fossil fuel and electricity options in the W-B region as a whole is summarized in Figure 7 for new and retrofitted DH, HOBs, CHP, new and retrofitted small HOBs, and new individual heating systems. The left side of the figure presents biomass-based heating options that are compared to the heating options listed in the top row. The figure uses a "traffic light" system (see legend) to demonstrate the cost-effectiveness of each heating option.

Significant financial savings can be gained in most scenarios, but switching from coal would require incentives to be provided in certain countries and scenarios. From the perspective of the end-consumer in the Western Balkans (that is, private costs), the financial savings generated by introducing biomass heating is often very significant (see Table 2). In most cases, replacing an existing heating system with a biomass-based heating technology can significantly reduce costs. For example, replacing electric appliances with efficient firewood stoves can generate savings of 40–70%, and replacing LPG and

Figure 7: Economic Viability of Biomass Heating Compared to Conventional Heating Options

Heating option	Coal	HFO/LFO	NG	Electricity	Heat Pumps	Firewood Inefficient Stove
New DH HOBs						
Wood chips	● (blue)	● (brown)	● (brown)			
Straw	● (blue)	● (brown)	● (brown)			
New CHPs*						
Wood chips			● (blue)			
Straw			● (blue)			
Retrofitting DH HOBs (Fuel Conversion)						
Wood Chips	● (blue)	● (brown)	● (brown)			
Straw	● (yellow)	● (brown)	● (brown)			
New Small HOBs						
Wood chips	● (brown)	● (brown)	● (brown)	● (brown)		
Pellets	● (blue)	● (brown)	● (brown)	● (brown)		
Retrofitting Small HOBs						
Wood chips	● (brown)	● (brown)	● (brown)			
Pellets	● (blue)	● (brown)	● (blue)			
New Individual Heating						
Firewood (Efficient Stove)	● (brown)		● (brown)	● (brown)	● (brown)	● (brown)
Pellet stove	● (blue)		● (brown)	● (brown)	● (yellow)	● (brown)

LEGEND: ● (brown) Biomass heating more cost-effective than conventional; ● (blue) Biomass heating less cost-effective than conventional; ● (yellow) Biomass heating similarly cost-effective as conventional

* The analysis of CHP options considered only environmentally superior solutions to currently existing heating options. Thus, only natural gas is taken into consideration, whereas coal and HFO CHP are not.

LFO HOBs with wood chips can save 49–70%. However, conversion of coal-based stoves, small HOBs, and DH to wood chips is financially not viable (or only marginally viable) for the end-consumer (rows highlighted in blue). In these cases, some incentives would need to be provided to make the switch to biomass more financially viable.

By building segment, large economically viable options are found across the whole region in stand-alone and multistory buildings not connected to DH, as well as in many DH heating connected systems. However, in all segments, coal heating options are financially more viable in several W-B countries. In summary, the economic and financial analysis indicates the following as the most attractive biomass heating options in stand-alone buildings and multistory buildings:

Table 2: Savings on Financial Costs Because of Replacement of Current with Biomass Heating

Economically viable heating option	ALB	BIH	CRO	KOS	MK	MNE	SER
Stand-alone buildings							
Individual electric appliance—replacement with efficient firewood stove	74%	54%	65%	45%	55%	62%	40%
Inefficient firewood stove—replacement with efficient firewood stove	51%	53%	53%	53%	53%	53%	53%
LFO small HOB—conversion to wood chips	61%	56%	60%	54%	49%	57%	62%
LPG small HOB—conversion to wood chips	31%	—	47%	58%	—	—	—
Coal stove—replacement with efficient firewood stove	—	–19%	—	—	—	—	15%
Coal small HOB—conversion to wood chips	—	–32%	—	—	—	—	2%
NG small HOB—conversion to wood chips	—	—	21%	—	8%	—	28%
NG stove—replacement with efficient firewood stove	—	—	—	—	—	—	34%
Multistory buildings							
Individual electric appliance—replacement with wood chips small HOB	52%	63%	77%	55%	67%	64%	53%
LPG small HOB—replacement with wood chips	49%	—	58%	66%	—	—	—
LFO small HOB—replacement with wood chips	70%	63%	66%	62%	56%	—	68%
Coal small HOB—conversion to wood chips	—	–7%	—	—	—	–37%	5%
NG small HOB—replacement with wood chips small HOB	—	63%	35%	—	—	—	40%
DH coal HOB—conversion to straw	—	–23%	—	—	—	—	4%
DH NG HOB—conversion to straw	—	—	23%	—	—	—	47%
DH NG HOB—conversion to wood chips	—	—	—	—	19%	—	—
DH HFO HOB—conversion to straw	—	—	27%	23%	—	—	41%

A. For stand-alone buildings

- Efficient solid wood firewood stoves are the most *economically* viable option to introduce biomass heating in all seven countries.
- However, in comparison to coal stoves, efficient solid wood stoves are not *financially* viable in Bosnia and Herzegovina, Kosovo, and Montenegro, and therefore in these countries some incentives would need to be provided in order to introduce biomass heating.

B. For multistory buildings not connected to DH

- New wood chip small HOBs are the most *economically* viable option to introduce°in comparison to coal HOBs, new wood chip small HOBs are not *financially* viable in Albania, Bosnia and Herzegovina, FYROM, Kosovo, and Montenegro, and some incentives would need to be provided.

C. For multistory buildings connected to DH
  - Conversion of existing district heating HOBs to straw or wood chips is the most *economically* viable option to introduce biomass heating in Croatia, FYROM, and Serbia. In Bosnia and Herzegovina and Kosovo, refurbishing existing coal boilers is somewhat more economic; switching to straw or woods chips is the second best option.
  - Conversion of existing district heating HOBs to straw is *financially* viable in Serbia. In all other countries and cases (including wood chips in Serbia), conversion to wood chips or straw is not financially viable, and incentives would have to be provided.[12]

Priority Investment Areas for Increasing Biomass-Based Heating

Based on the identified economic potential for making current biomass use more efficient and to increase its use further, priorities for programmatic regional promotion of biomass-based heating and investment initiatives emerge. Three investment programs are proposed for the Western Balkans (details of the programs and investment requirements per country are presented in Chapter 7):

- Stand-alone buildings.
- Multistory buildings.
- District heating.

Stand-alone buildings: Replacement of inefficient stoves with efficient stoves, and switching from electric heating appliances to efficient biomass stoves. Assuming annual replacement of 10% (770 MW) of the heat demand originating from inefficient stoves with efficient stoves over a 10-year period, and switching from 527 MW of electric heating appliances to efficient biomass stoves, such an initiative would require total investments of EUR 417 million over the 10-year period in the seven W-B countries. Full implementation of the program would result in annually reduced air pollution coming from biomass heating by 2,440 tons of particulate matter (PM), improved resource efficiency and saving of 3.8 million m^3 of wood worth around EUR 140 million, annual

12 For example, in Austria, biomass district heating plants are subsidized at a standard rate of 25% of the environmentally relevant investment costs. If at least 80% of the forest wood chips used in the heating plants are produced in the region, a premium (sustainability premium) of 5% is granted in addition to the standard subsidy rate. By stimulating the use of regional biomass, the opportunity to create added value for local products is increased.

saving of 1,503 GWh of electricity currently used for heating, and a reduction of GHG emissions for more than 1.4 million tons of CO_2 equivalent.

Multistory buildings: Switching from electric heating appliances to wood-chip–fired HOBs. For the implementation of the program, a total of EUR 162 million of investments would be needed to replace 1,622 MW of electric appliances with biomass HOBs. In addition to the benefits of saving 4,052 GWh of electricity annually, full implementation of such a program would result in a reduction of more than 3.4 million tons of CO_2 equivalent. While it is estimated that full implementation of the program would increase annual local air pollution emissions by 57 tons in the Western Balkans, the economic benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

District heating: Switching existing DH boilers from fossil fuels to biomass. Such a program for district heating would facilitate a switch to biomass in 1,200 MW of existing district heating plants that currently use fossil fuels and construction of 100 MW of new biomass DH capacity. The benefits of such a program would be the replacement of mainly imported fossil fuels with locally produced biomass and, once fully implemented, reduction of 1.3 million tons of CO_2 equivalent annually. While it is estimated that full implementation of the program would increase air pollution emissions for 97 tons of PM in the Western Balkans, the economic benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

Financing Sources

Significant financing needs to be mobilized through 2030 to exploit the economic opportunities to increase biomass use and make the existing use more efficient. The estimated total investment amount required through 2030 to sustainably increase the use of biomass for heating in the region is EUR 950 million. Therefore, it is recommended that a financing facility (or program) be created to support the increased use and efficiency of biomass heating, in a sustainable manner, in the consumption sectors of the W-B countries. The facility could be a new dedicated instrument or could be embedded into existing financing instrument available in the region. The facility, which would support both investments and policy measures, should cover all countries of the Western Balkans and should be accessible to residential, commercial, and public sector borrowers, with the support of the Energy Community Secretariat.

The facility's main objectives would be to:

- Increase financing capacity for investments in biomass heating in the W-B countries.
- Develop an enabling environment for sustainable biomass heating by addressing the identified barriers.

- Assist the W-B countries in harmonizing their legislative frameworks with the relevant EU Acquis.

The facility (or program) should integrate financing, technical assistance, and policy dialogue through the following components:

- **IFI credit lines with financial incentives**[13]**—*EUR 950 million (over the 10-year period 2018–28).*** While various implementation models would need to be expored, these credit lines could for example be made available to two types of entities:
  a. *Local financial institutions*—for financing (a) replacement of inefficient wood stoves with efficient stoves in stand-alone buildings and (b) switching from electric heating to wood-chip–fired HOBs in multistory buildings in the residential, commercial-industrial, and public sectors. Financing could be coupled with existing initiatives aiming at improving energy efficiency in buildings, by making biomass heating investments eligible for support[14].
  b. *District heating companies*—for financing (a) the conversion of existing DH boilers from fossil fuels to biomass and (b) the development of new, biomass-based DH.
- **Policy dialogue and project preparation support (technical assistance), along with grant funding.** This component should have two objectives:
  a. Policy support for the governments in the Western Balkans as they remove barriers and propel investments into efficient and sustainable biomass heating. (To facilitate implementation, the Energy Community Secretariat should be involved.)
  b. Technical assistance in project preparation for banks, manufacturers and providers of biomass heating appliance, installers, homeowners' associations, and district heating companies.

The **IFI credit-line financing option** could include credit lines through a network of local financing institutions ("Green" banks in the Western Balkans). The **financing option for switching existing DH boilers from fossil fuels to biomass and developing new biomass-based DH** could be implemented through a budget "capturing" system (see more-detailed explanation of financing options in Chapter 7). Under this option, the finance ministries

[13] Financial incentives can be provided through credit lines and other financing instruments (e.g. guarantees, tax credits, etc.)
[14] For example, the EBRD established the Western Balkans Green Economy Financing Facility in July 2017, which takes the form of credit lines for a total of up to EUR 85 million to financial intermediaries in the W-B countries, to finance residential energy efficiency and/or small-scale renewable energy investments. Efficient biomass boilers/stoves are eligible for this type of financing.

in the W-B countries would use loans from the regional financing facility to fund municipalities and/or district heating companies through existing budgetary mechanisms, with future budgetary provisions reduced until the loan has been fully repaid.

Conclusions and Policy Recommendations

Unlocking the biomass heating potential in the W-B requires multisector coordination and concerted long-term effort to remove barriers and stimulate investments. Biomass heating is a multifaceted issue with a complex supply side, several end-use sectors each with its own specific heat-demand profile, and a wide range of technology and fuels options. As such, the sector has not received enough attention from policy makers, and many barriers remain (see Chapter 6 for a comprehensive barrier analysis). To increase biomass-based heating in the W-B countries, the framework conditions will need to be improved further, the volume of sustainable biomass supply increased, and the availability of, and investments in, efficient bio-based heating technologies improved.

The countries individually, and as a coordinated group, need to implement a comprehensive roadmap through 2030. A comprehensive roadmap, as well as a summary of the key messages per country, for advancing these changes is presented in Chapter 8. It aims to provide guidance for policy and financing in the short term (until 2020), and in the medium to long term (until 2030). Implementation of the roadmap requires cross-sectoral approaches and institutional collaboration coordinated by the government to create added benefits. The countries can also benefit from coordinated implementation of the roadmap, supported, for example, by the Energy Community Secretariat.

The proposed roadmap is aimed at removing identified barriers and increasing investments. The roadmap reflects the factors that hinder the implementation of biomass heat in W-B countries, and includes a set of concrete and interrelated activities that will facilitate the removal of barriers and improvement of the framework conditions in the region, thus allowing biomass-based heating in the W-B region to be more efficient and to be scaled up. The three pillars of the proposed roadmap comprise activities related to framework conditions, biomass supply, and investments in efficient biomass heat technologies. The total budget for the Western Balkans, to implement the roadmap to increase biomass-based heating and make it more efficient and sustainable until 2030, is estimated at EUR 1,404 M.[15]

[15] Note that the cost for Pillar 2 includes construction of the forest logistics infrastructure, and Pillar 3 represents the upper boundary of the investment cost in the most economic biomass heating options in W-B countries. It should also be noted that many proposed actions under Pillars 1 and 2 are important and useful well beyond biomass-based heating and, as such, their costs should be viewed in a broader context.

Pillar 1—Framework Conditions: The aim of Pillar 1 is to improve the framework conditions for the development of biomass heat value chains in the Western Balkans concerning policy and regulatory framework, data collection and monitoring, and awareness and capacity building. The total budget of Pillar 1 is estimated at EUR 37.5 M.

Pillar 2—Biomass Supply: The aim of this pillar is the development of country-level projects and programs for scaling up investments in biomass based heating, and it is divided to two sub-pillars. Pillar 2a includes soft measures, with the aim to demonstrate approaches for sustainable forest and land management, and create enabling environment for use of agricultural biomass and energy crops. Pillar 2b present investment measures focused on the development of forest and biomass supply infrastructure. The total budget for Pillar 2 is estimated at EUR 414.6 M (Pillar 2a EUR 41.4 M and Pillar 2b EUR 373.3 M, respectively).

Pillar 3—Investments in Efficient Biomass Heating Technologies: This pillar is comprises the priority investment programs outlined above. They include the investment initiatives for (a) switching from electric heating appliances to efficient biomass stoves; (b) conversion from inefficient to efficient biomass stoves in stand-alone buildings (EUR 419 M); (c) investment initiatives for switching from electric heating appliances to wood-chip–fired HOBs in multistory buildings (EUR 163 M); and (d) investment initiatives for switching existing DH boilers from fossil fuels to biomass and the development of new biomass-based DH (EUR 371 M). The total budget of Pillar 3 is estimated at EUR 952 M.

An abbreviated overview version of the roadmap is provided in Table 3 below.

The W-B focus in the short term should be on improving framework conditions and biomass supply, and in the longer term on scaling up investments. Given the multitude of activities that should take place to increase biomass-based heating in the Western Balkans, a phased approach in the implementation of the roadmap is needed. It is recommended that implementation of the roadmap should be initiated with the improvement of Framework Conditions (Pillar 1), and implementation of recommended activities to increase sustainable biomass supply (Pillar 2). While demonstration and pilot investment projects should be started in parallel to the short-term focus on Pillar 1, majority of the previously outlined three outlined investment programs, (Pillar 3) should start after the Framework Conditions are enhanced.

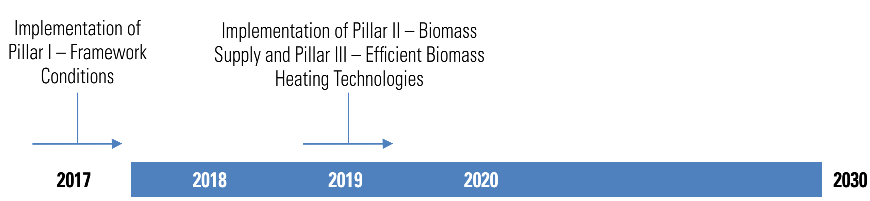


Table 3: Overview of the Roadmap to Increase Biomass-Based Heating

Pillar	Component	Sub-component
1. Framework conditions	1.1 Policy and Regulatory framework	1.1.1 Forestry
		1.1.2 Biomass heat procurement and pricing
		1.1.3 DH
		1.1.4 Buildings
		1.1.5 Adopt & transpose technical standards
		1.1.6 Testing infrastructures
		1.1.7 Biomass fuels certification and labelling
		1.1.8 Air quality
	1.2 Data collection and monitoring	1.2.1 Buildings
	1.3 Awareness	1.3.1 Campaign for promotion of biomass heating
	1.4 Capacity Building	1.4.1 Local stakeholders in the forestry and agricultural sector
		1.4.2 Municipalities
		1.4.3 Professionals
		1.4.4 Stakeholders from government
2a. Biomass Supply—Soft Measures	2.1 Sustainable forest management	2.1.1 Monitoring and collection of data
		2.1.2 Multi-purpose forestry demonstration techniques
		2.1.3 Forest fire management
		2.1.4 Unregistered logging
2a. Biomass Supply—Soft Measures *(continued)*	2.2 Enabling environment for agricultural biomass and energy crops	2.2.1 Knowledge for energy crop or tree species
		2.2.2 Use of marginal land
		2.2.3 Commercial conversion technologies for agricultural biomass
2b. Biomass Supply—Infrastructure Investments	2.3 Development of Forest and Biomass Supply Infrastructure	2.3.1 Forest Logistics infrastructure
		2.3.2 Biomass supply infrastructure
3. Investments in Efficient Biomass Heating Technologies	3.1 Investment Initiatives for (a) switching from electric heating appliances to efficient biomass stoves and (b) conversion from inefficient to efficient biomass stoves in stand-alone buildings	3.1.1 Financing facilities for biomass heating in stand-alone buildings
		3.1.2 Develop customer oriented services for local banks participating in financing Program

(*continued on next page*)

Table 3: Overview of the Roadmap to Increase Biomass-Based Heating (*continued*)

Pillar	Component	Sub-component
3. Investments in Efficient Biomass Heating Technologies (*continued*)	3.2 Investment Initiatives for switching from electric heating appliances to wood-chip–fired HOBs in multi-storey buildings	3.2.1 Financing facilities for biomass heating in multi-storey buildings
		3.2.2 Develop customer oriented services for local banks participating in financing Program
	3.3 Investment Initiatives for switching existing DH boilers from fossil fuels to biomass and the development of new biomass based DH	3.3.1 Financing facilities for biomass DH

While the implementation of the roadmap requires significant resources through 2030, the economic benefits from its implementation can rapidly outweigh the costs. Analysis of the estimated budget and investment needs per pillar of the roadmap and total *annual* economic benefits in 2030[16] in

Table 4: Total Costs and Total Annual Benefits of the Roadmap Implementation

	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Total costs per country and W-B region (EUR M)	105.8	249.9	338.0	111.8	165.1	64.5	369.3	**1,404.4**
Total **annual** benefit in 2030 per country and W-B region (EUR M)	57.5	257.1	146.1	145.4	191.6	77.4	272.8	**1,147.9**
Annual wood savings (m^3)	348,000	972,000	197,000	525,000	880,000	178,000	691,000	**3,791,000**
Annual reduction of electricity consumption (GWh)	413	879	902	591	388	676	1,706	**5,555**
Annual reduction of dust emissions (tons)	191.2	515.9	76.8	287.7	486.5	41.8	189.7	**1,789.6**
Reduction of GHG emissions (tCO_2eq)	297,500	947,250	539,360	661,640	719,600	338,400	2,616,700	**6,120,450**

16 The difference in the total economic energy costs based on LCOH (including externalities) between biomass heating options and other heating options. Economic energy costs, including externalities, for different heating options are presented in Appendix A.

each of the W-B countries is presented in Table 4 and detailed in Chapter 8. The benefits are also presented in physical units, including wood savings, reduction of electricity consumption, and reduction of dust and GHG emissions. As can be seen, the cumulative annual benefits (the benefit amounts below represent the annual benefit in 2030) would rapidly and significantly outweigh the costs, which demonstrates that implementation of the roadmap would make more efficient and would increase the use of biomass for heating in the W-B countries in a cost-efficient and sustainable manner.


ENERGY
ALTERNATIVE
WOOD
POWER
FUEL
BIOMASS
RESOURCEFUL

1

Background of the Study

A reliable and sustainable energy supply in the Western Balkan (W-B) region is essential to support the region's economic growth and pave the way toward EU accession for its constituent nations.[17]

W-B countries, through Energy Community, adopted obligation to implement the European Union's Renewable Energy Directive, and have binding targets for energy consumption from renewable sources by 2020. Further to that, each country approved the National Renewable Energy Action Plan, which includes sectoral targets for electricity, heating and cooling, and transport; planned policy measures; the mix of renewables technologies they expect to employ; and the planned use of cooperation mechanisms.

According to a regional study conducted in 2010 (commissioned by the Energy Community Secretariat),[18] the use of biomass for heating is estimated to be the most cost-efficient solution to meet the 2020 targets, and thus, is expected to account for the bulk of the renewable energy mix in 2020.

Scope of the Study

Given the similar situations, issues, options and the potential for regional solutions, a region-wide approach is used, expected to generate replicable options and synergies for implementation. Country-specific assessments are conducted to identify common regional key, and common regional recommendations and conclusions are highlighted. Moreover, despite the fact that each W-B country is different, they all aspire to become members of the EU in the future. This process requires similar steps in harmonizing national frameworks with EU, including biomass energy use.

[17] Croatia became an EU member in 2013.
[18] Energy Community Secretariat (2010).

For this reason, with the support of Energy Community Secretariat, the World Bank initiated the "Sector Study on Biomass-based heating in the Western Balkans." The study aimed to help the W-B countries—Albania, Bosnia and Herzegovina, Croatia, Kosovo, Montenegro, Serbia, and the former Yugoslav Republic of Macedonia—identify viable investment options and determine policy measures to increase the use of biomass for heating in a sustainable manner. This is intended to (a) enhance energy security[19] in the region and the seven target countries, (b) improve the reliability and sustainability of the energy supply, (c) reduce greenhouse gas emissions and local air pollution, and (d) help the countries cost-efficiently meet their 2020 renewable energy (RE) targets.

The project was financed by the Joint Grant Facility under the Western Balkans Investments Framework (WBIF). This report presents a summary of the key findings.

The project was divided into five tasks:

1. **An analysis of the biomass supply potential (Task 1):** To gain a better understanding of the overall situation in the biomass markets across the countries covered, the potential of available and sustainable biomass resources for heating was assessed, as were the factors influencing resource availability and prospects.
2. **An assessment of heating systems in the target countries (Task 2):** The types of heating systems currently in use were outlined, and the demand potential and implementation options for biomass-based heating were identified.
3. **An assessment of economically viable biomass options for heating (Task 3):** The technical and economic potential to increase the use of biomass energy for heating in W-B countries was evaluated.
4. **An analysis of key barriers to, and measures to increase the share of, sustainable biomass-based heating (Task 4):** The relevant institutional, regulatory, financial, legal and policy frameworks were assessed at the country level. This included a review of international experience, as well as regional issues hampering the implementation of environmentally and economically viable biomass-based heating options.
5. **A detailed assessment of the use of biomass for heating in selected cities and sub-regions (Task 5):** For this task, the results of Tasks 1–4 were applied to practical examples.

In addition, stakeholder roundtables and workshops at the regional and country levels were held with stakeholders to gather inputs and to present the key results and findings of the study.

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[19] Defined by International Energy Agency as "the uninterrupted availability of energy sources at an affordable price."

Tasks 1–4 were carried out using a combination of a region-wide (due to the similar situations and potential for regional solutions at the level of Western Balkans) and country-specific assessments (because of specific issues and options in each country).

For Task 5, **five case studies** were selected in consultation with the local stakeholders, as follows:[20]

1. **FYR Macedonia:** Evaluation of the potential for developing a program to replace old or traditional wood stoves with more-efficient models at the individual household level, with a focus on Skopje.
2. **Bosnia and Herzegovina:** An analysis of opportunities for introducing, or increasing the use of, biomass in existing DH systems in Bosnia and Herzegovina, replacing oil-, gas-, or coal-fired boilers with biomass boilers and evaluating the possibilities for biomass-based combined heat and power (CHP) plants.
3. **Kosovo:** An analysis of options for using forestry and agricultural biomass residues to supply district heating in the city of Gjakova.
4. **Kosovo:** An evaluation of the possible replacement of fossil-fired heat-only boilers (HOBs) with biomass boilers in public buildings in Pristina.
5. **Bosnia and Herzegovina, Croatia, and Serbia:** An analysis of the use of available agricultural wastes and energy crops for sustainable, efficient, renewable heating solutions in the cross-border region of Bosnia and Herzegovina, Croatia, and Serbia.

This report is intended primarily to address policy makers and biomass-heating industry stakeholders (biomass suppliers, manufacturers of heating appliances, installers, and investors and project developers), but also the scientific community, civil society organizations, and end-users in the W-B countries. It is structured along the lines of the tasks enumerated earlier.

It is hoped that the report will be used to support policies to increase use of biomass for heating, to inform investment decisions, and to provide guidelines for sustainable, efficient, and economic biomass heating.

While the study is comprehensive, further research would need to be conducted, inter alia, to identify marginal or degraded agricultural land in the W-B countries and their potential use for growing energy crops, to develop methods to lower emissions from biomass combustion in residential-scale heating appliances and conversion technologies for use of agricultural residues.

20 The five case studies conducted for Task 5 are summarized in Appendix C. The full case studies are provided separately and are not included in this report.

Structure of the Report

Chapter 2 provides an overview of biomass use in W-B countries. **Chapter 3** provides an overview of heat demand in W-B countries. **Chapter 4** reviews the existing use of biomass for heating, and then estimates the potential for increasing biomass use in a sustainable manner. **Chapter 5** evaluates economic and financial impact of biomass-based heating. **Chapter 6** analyzes the barriers preventing greater use of biomass for heating. **Chapter 7** examines where biomass-based heating can best be increased in an economically viable manner, then indicates how this potential may help the region meet its renewable energy targets. And finally, **Chapter 8** sets forth recommendations for policy makers and presents a roadmap, with preliminary cost estimates, for their implementation.

2

Overview of Biomass Use in the Western Balkans

In general, the W-B energy sector is burdened by the high cost of imported fuel. Of all the region's countries, only Bosnia and Herzegovina is a net exporter of electricity. The highest price of electricity for the residential sector is in Croatia (EUR 131.7 per MWh), and the lowest prices are in Serbia and Kosovo (EUR 57.5 per MWh and EUR 62.5 per MWh, respectively). The average price of natural gas is EUR 48.4 per MWh (VAT included) for the residential sector and EUR 39.8 per MWh for the industrial sector. Natural gas is available for heating only in Bosnia and Herzegovina, Croatia, and Serbia.

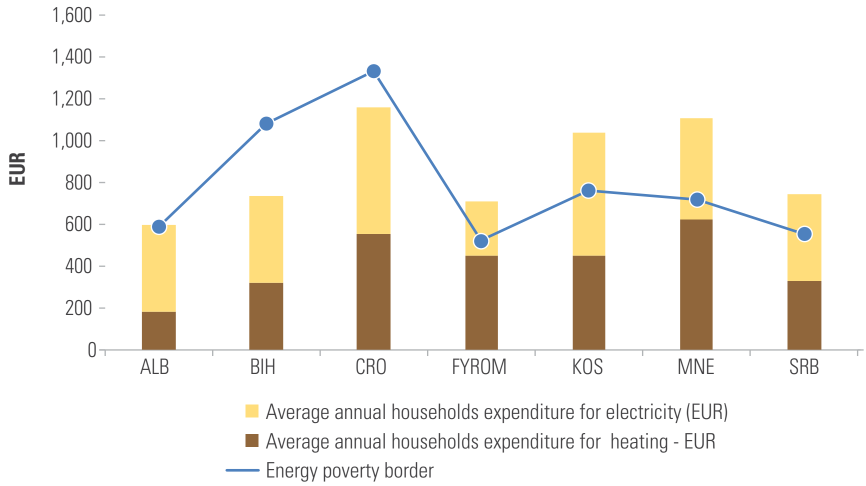
Estimated average annual household expenditures for heating and electricity are at the level of EUR 829, or 10.4% of the average household annual spending in the W-B region. This indicates the presence of energy poverty (defined in this report as "energy expenditure representing at least 10% of household income") in Albania, FYR Macedonia, Kosovo, Montenegro, and Serbia (see Figure 8). Hence, the impact on consumers of any measures affecting total energy costs needs to be carefully considered.

According to official statistics on the overall primary energy supply, the share of biomass as an energy source is relatively small in the Western Balkans, varying between 2% and 10% from country to country. If one includes the estimated unregistered use of biomass for heating, the share of primary energy use increases to between 7 and 17% (see Figure 9). It is higher than the EU average of 5%[21] of energy consumption coming from bio-energy.

However, when looking at heating, the critical importance of biomass is highlighted. Overall in the W-B region, biomass accounts for 42% of the energy required for heating. An estimated 23.22 million cubic meters of

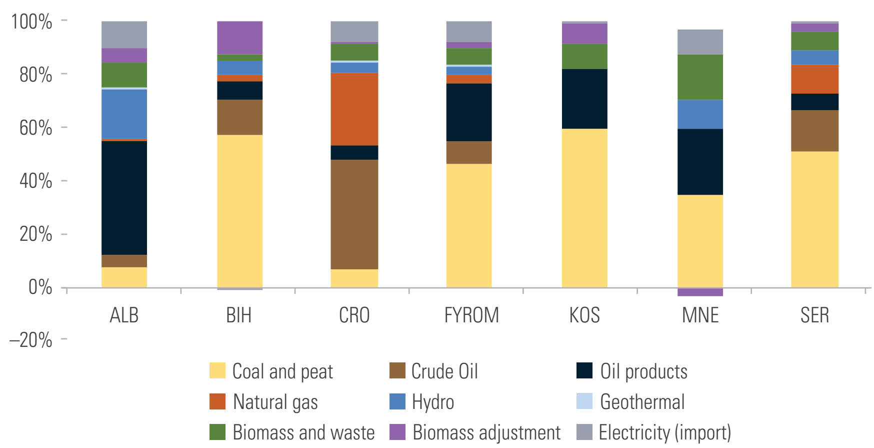
[21] Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling SEC (2010) 65 final SEC (2010) 66 final.

Figure 8: Average Annual Household Expenditures for Heating and Electricity
(EUR)



Sources: Annual household expenditures in the W-B: from the last available Household Budget surveys of W-B countries, adjusted for the inflation rate. Expenditures for heating: ECO, *Assessment of the Residential Energy Efficiency Investment Potential in the Western Balkans*, 2015. Expenditures for electricity: consultant estimates based on electricity consumption in the residential sector in the W-B countries.

Figure 9: Primary Energy Supply of W-B Countries, Adjusted for Unregistered Biomass Consumption

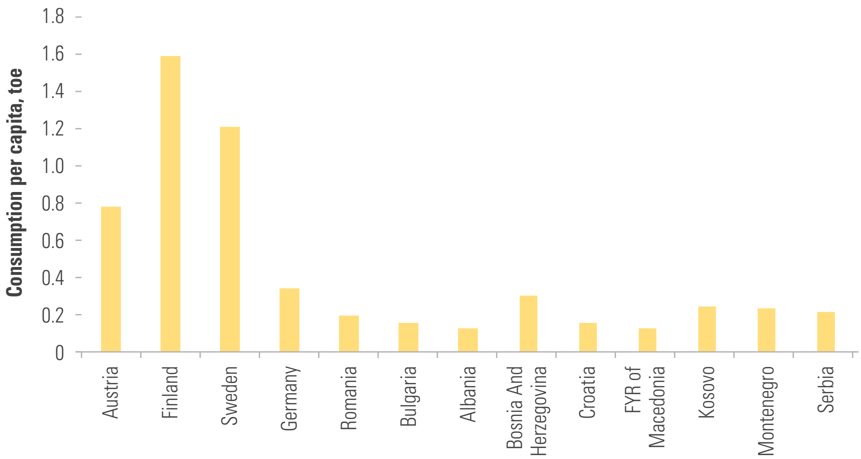


Source: IEA Energy Balances 2012; biomass adjustment based on consultant estimates.

woody biomass is consumed for energy in the Western Balkans, with some variation between the individual countries.

Per capita biomass consumption for energy is significantly lower in W-B countries than in countries with developed bioenergy use (such as Austria,

Figure 10: Biomass Consumption for Energy Purposes in Selected Countries, per Capita



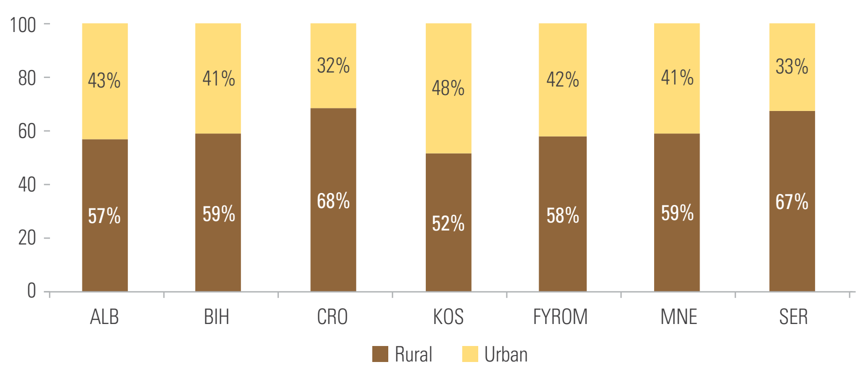
Source: IEA Energy Balances 2012. For W-B countries, adjusted biomass consumption is used. (*Adjusted biomass consumption* includes statistically unrecorded biomass consumption.)

Finland, and Sweden), though it is similar that of other countries in the region, as shown in Figure 10.

In rural areas, biomass is the primary source of heating for the majority of the population. Rural households account for 63%, and urban households for 37%, of total biomass consumption (see Figure 11.

Biomass consumption in the W-B countries is primarily based on domestic wood supply. Of the total annual production of 36.28 million cubic meters of timber, roughly two thirds, or 23.22 million cubic meters, is used for energy and 11 million cubic meters is used for industrial purposes. About

Figure 11: Rural vs. Urban Households: Share of Biomass Consumption



Source: Biomass Consumption Survey, Energy Community Secretariat, 2012.

3.34 million cubic meters of roundwood equivalent is exported. Biomass is used mainly in the sawmill, panel, pulp, and processed-wood fuel industries.[22]

Regarding woody biomass, only part of the stem and branches (up to 7 cm in diameter) are commonly used. Other types of biomass—such as treetops and thin branches, as well as damaged parts—remain in the forest as logging residue. There is potential to increase the use of woody biomass for energy in W-B countries by increasing the collection of logging residues, producing woody biomass on energy plantations, managing forests better, and increasing the thinning of young stands—both to facilitate the growth of high-value wood and to collect the resulting residue for energy use.

In 2013, more than 60% of the region's total wood chips production, and more than 70% of its output of wood pellets and briquettes, was exported. Bosnia and Herzegovina and Croatia are the leading exporters of wood briquettes, wood pellets and firewood—mainly to Austria, Hungary and Italy—while the largest share of firewood is consumed in domestic markets.

By contrast, agricultural residues and energy crops, which have the potential to provide 8.4 million tons of oil equivalent (Mtoe) of bioenergy, remain largely unexploited in W-B. Currently, only a small portion of maize cobs and tree prunings, especially olive tree prunings, are used by households and small farms for heating and drying purposes. However, the development and bringing to market of energy crops in particular would require significant time and effort, and additional analysis on e.g. availability of land for energy crop use would be required.

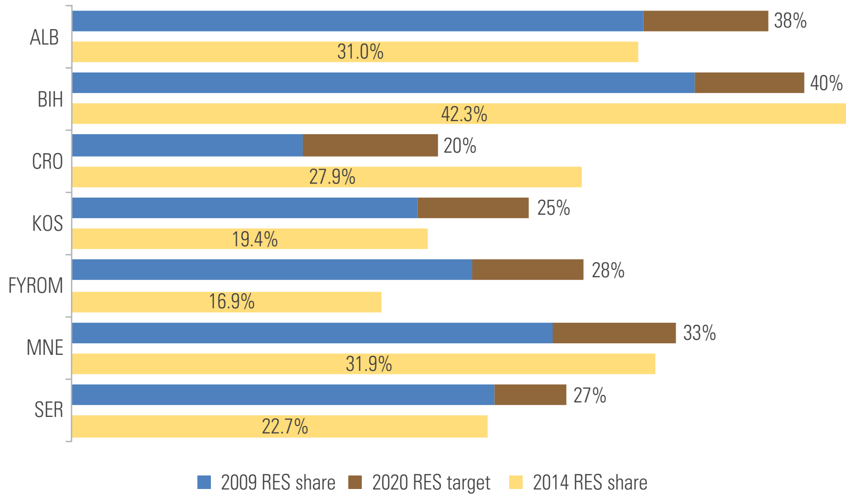
Unfortunately, a significant share of biomass is used inefficiently due to outdated equipment and lack of drying before use. The resulting particulate emissions contribute significantly to poor air quality in W-B cities such as Skopje, Pristina, Sarajevo, Belgrade, and Uzice. Sustainably increasing the use of biomass and making the current use of biomass more efficient would contribute to increasing the share of renewable energy by exploiting local energy resources with the positive economic and employment impacts.

Provided that biomass is grown sustainably and used efficiently, the use of biomass for heating has the potential to significantly reduce greenhouse gas (GHG) emissions in W-B countries (see Chapter 5 for an estimate of this potential).

The countries of the Western Balkans have a mandatory obligation to implement the European Union's Renewable Energy Directive, which sets a binding target for final gross energy consumption from renewable sources by 2020. As a result, each country has established a national renewables target, ranging from 20% in Croatia to 40% in Bosnia and Herzegovina (see Figure

[22] Sawmill industry: 7.46 million cubic meters (Mm3), panel 0,78 Mm3, pulp 0,31 Mm3, processed wood fuel 2.14 Mm3.

Figure 12: Progress toward 2020 Renewable Energy Targets



Source: Energy Community Secretariat.

12). The countries are also each required to have at least 10% of their transport fuels come from renewable sources by 2020.

The targets are part of national renewable-energy action plans the W-B countries have adopted. The plans include sectoral targets for electricity, heating and cooling, and transport; planned policy measures; the mix of renewables technologies they expect to employ; and the planned use of cooperation mechanisms. Sectoral targets for biomass use for heating, and progress toward them as of 2014, are shown in Figure 13.

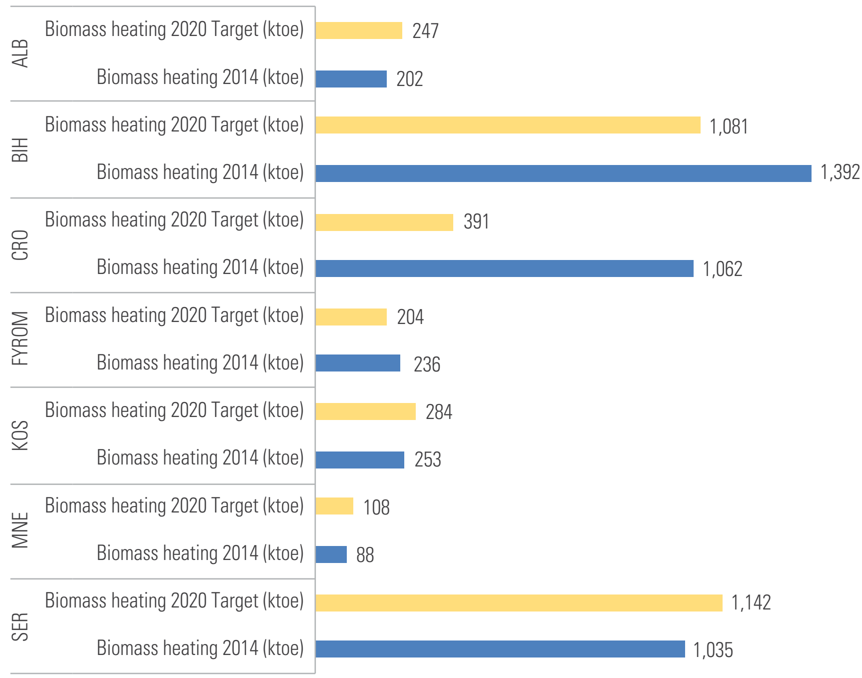
Judging by progress made through 2014, Bosnia and Herzegovina and Croatia have already achieved their 2020 targets for biomass heating, while Albania, FYR Macedonia, Kosovo, Montenegro, and Serbia appear to be on track[23] to reach theirs by 2020.

The Proposal for a Directive on the Promotion of the Use of Energy from Renewable Sources (recast) aims at tackling the existing issues hampering renewable energy deployment during the transition toward 2030, and proposes even more ambitious targets. The recast directive would enter into force on January 1, 2021, and (except for few provisions) would have to be transposed into national law by June 30, 2021.

Key provisions of the proposal, relating to biomass-based heating, include the following:

23 Assessment is performed by the Energy Community Secretariat. Based on a provision of the Renewable Energy Directive, if country follows indicative trajectory path toward the achievement of their final mandatory target, it is considered to be on track to reach them.

Figure 13: Biomass Heating Targets for 2020 and Progress as of 2014 (ktoe)



Source: National Renewable Energy Action Plans of the W-B countries; progress is measured based on Progress Reports (2016), and for BIH-IEA Energy Balances (2014).

- A EU-wide minimum target of 27% share of renewable energy in gross final consumption by 2030. Member States have to reach a minimum national share of renewable energy in gross final consumption of between 10% and 49%. If a Member State fails to reach its targets, payments must be made into a fund used to launch competitive bidding procedures for renewable projects.
- The contribution of biofuels, bio-liquids, and biomass fuels consumed in transport, if produced from food or feed crops, is limited to 7% of the final consumption of energy for road and rail in that country by 2020, further reduced to 3.8% by 2030. To count toward the renewable energy targets, the contribution of biofuels, bioliquids, and biomass fuels will need to meet further sustainability and greenhouse gas emissions saving criteria.
- The share of renewable energy in the heating and cooling sector is supposed to increase by 1% each year. Consumers that are connected to a district heating or cooling system not meeting the efficiency criteria of directive 2012/27/EU will be allowed to produce heating or cooling from renewable energy sources themselves.

- Countries (EU Member States) must enhance predictability for investors by defining and publishing a long-term schedule in relation to the expected allocation of support, covering at least the next 3 years.
- Regarding the streamlined permitting process: by January 1, 2021, single administration contact points must be set up to coordinate the entire permit-granting process and guide applicants through the application process. Permit granting procedures should not last longer than 3 years, or 1 year in the case of an application to repower an existing installation. Demonstration projects, installations smaller than 50 kW, and certain repowering projects will only be subject to a notification.
- DH suppliers have to provide consumers with information of district heating energy performance, and enable them to stop buying heat from a district heating system at building level, if the consumers can achieve a significantly better energy performance by measures taken at the building level. It also opens local heating and cooling distribution networks for producers of renewables heating and cooling and waste heat or cold, as well for third parties acting on behalf of the producers.

3

Heat Demand and Technical Options for Using Biomass for Heating

This chapter first discusses heat demand in the Western Balkans, then sets forth three technical options for increasing the use of biomass for heating:

- Technologies for biomass DH systems,
- Biomass CHP technologies,
- Small-scale biomass heating appliances,

Heat Demand and Heating Systems in Use

Almost two-thirds of annual heat demand in the Western Balkans is met using firewood (42%) and electricity (21%), while other fuels supply the remaining 37%. Total annual heat demand in the Western Balkans is estimated to be 8 Mtoe (93 thermal terawatt-hours, or TWhth). Figure 14 presents a country-by-country breakdown.

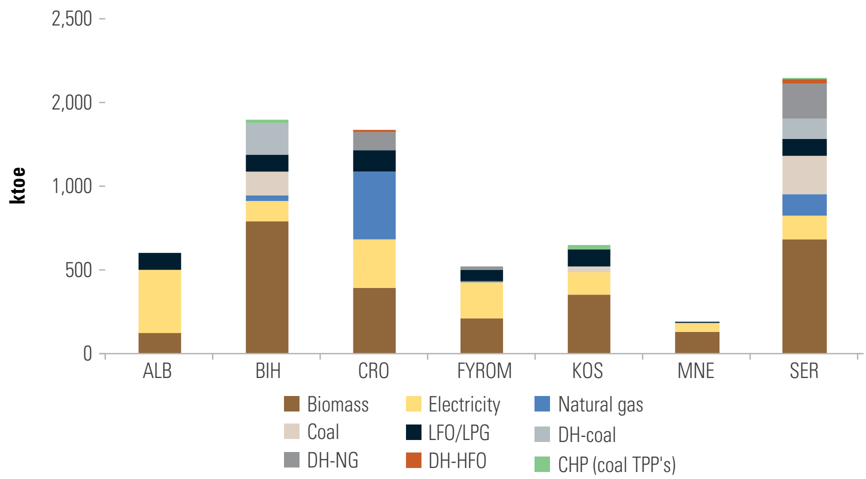
Figure 15 provides an overview of annual heat demand in the Western Balkans, by fuel, heating system, and type of building. The sections below provide additional details on fuel use and demand in in key sectors, on types and shares of heating systems, and on household energy expenditures.

In the residential sector, firewood is the most common fuel in most W-B countries (Bosnia and Herzegovina 76%, Croatia 49%, FYR Macedonia 63%, Kosovo 72%, Montenegro 65%, and Serbia 60%). The exception is Albania, where electricity is the prevailing heating method.[24] In rural areas throughout

[24] Appendix A provides country-specific figures for heat demand and an overview of heating systems.

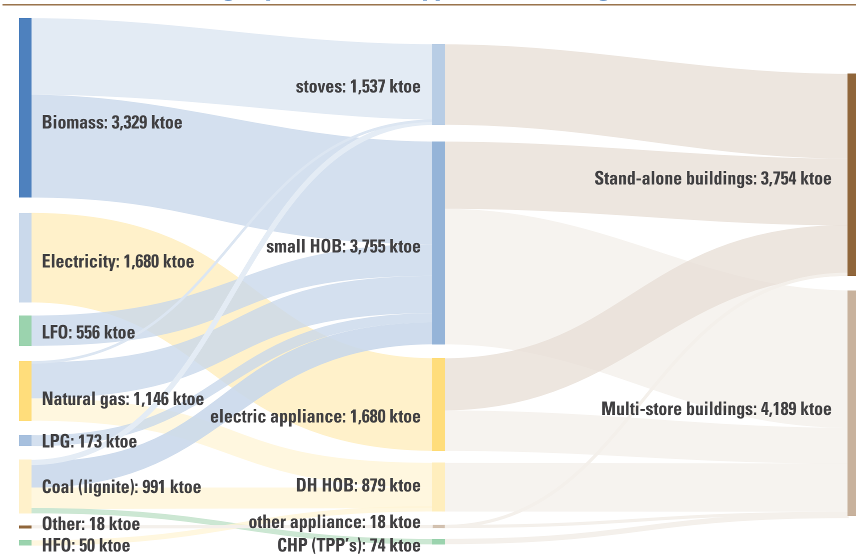
the region, most heating is based on wood fuel, and the use of wood is widespread in urban areas as well.

Figure 14: Annual Heat Demand



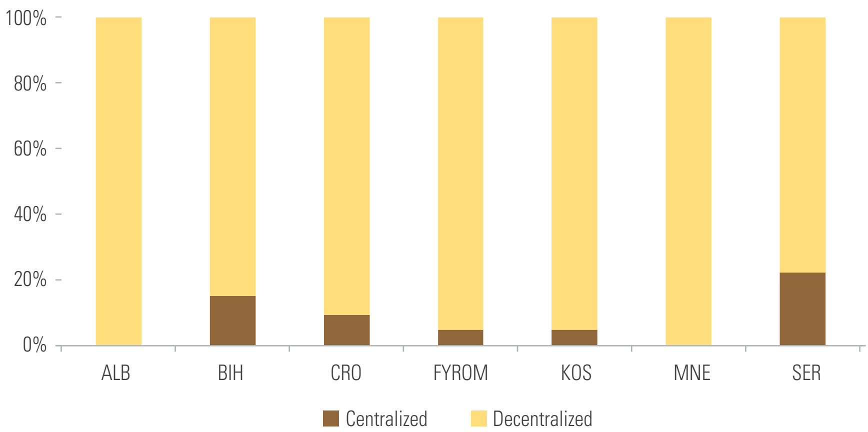
Source: Consultant estimates based on best available data.

Figure 15: Annual Heat Demand in the Western Balkans, by Fuel, Heating System, and Type of Building



Source: Consultant estimates based on best available data.
Note: Country-specific annual heat demand is available in the Appendix A.

Figure 16: Centralized vs. Decentralized Heating Systems



The commercial and industrial sectors account for 18% of annual heat demand.[25] About 18% of commercial and industrial buildings are connected to the centralized DH system, whereas 82% use individual heating systems. For the latter, the main fuels are electricity (42%); liquid fuels, such as light fuel oil (LFO), heavy fuel oil (HFO), and liquefied petroleum gas (LPG) (20%); biomass (17%); and natural gas (16%).

The public sector is responsible for 10% of annual heat demand in the Western Balkans. Heating is based mainly on liquid fuels (LFO, HFO, LPG) (34%), followed by electricity (24%) and biomass (23%). Coal is used for heating in 11% of public buildings, and natural gas in 8%.

Most heating systems in the W-B are decentralized. As shown in Figure 16, approximately 88% of the 7.3 million buildings in the Western Balkans use decentralized heating systems—small HOBs, stoves, and electric devices—whereas only 12% use DH. No DH has been developed in Albania and Montenegro.[26]

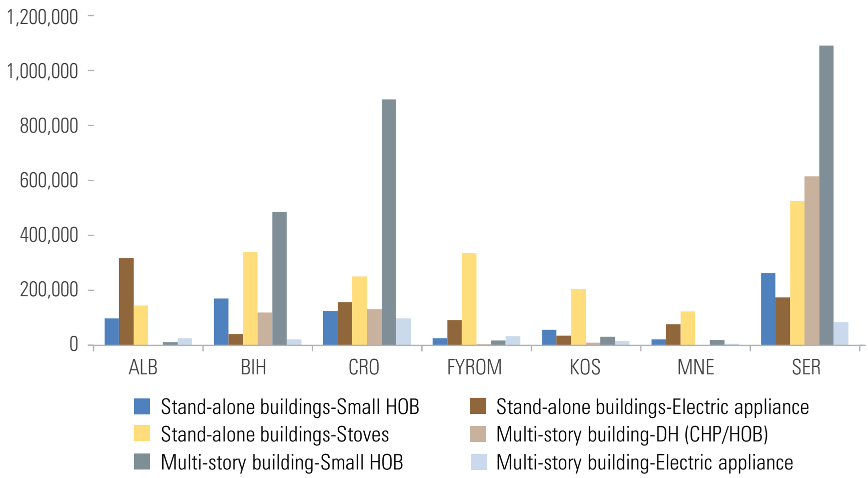
The use of individual heating systems[27] is most common in Albania (94% of buildings), followed by Montenegro (90%) and FYR Macedonia

[25] Process heat in industrial applications is not considered in this study—only space heating.

[26] There are two small (6 MW), lignite-fired boiler rooms in the city of Pljevlja that could be considered a rudimentary DH system; the boilers are used for heating 284 apartments and public buildings (35 offices) in the city center.

[27] *Individual heating systems* are heating systems for stand-alone or multistory buildings; they are independent from the heating systems used in other parts of the building. The heating source can be electric appliances for space heating or stoves and ovens.

Figure 17: Overview of the Heating Systems in the Western Balkans, by Number of Buildings



Source: Consultant estimates based on the available statistical data.

(89%), while less than 1% of buildings have no kind of heating system at all (mainly in Albania). Small HOBs are the most common individual heating system (47%), followed by electric appliances (21%) and stoves (19%). For stand-alone buildings, stoves are used in more than half (51%), small HOBs in 25%, and electric appliances in 24% (see Figure 17). In multistory buildings, two-thirds of buildings use small HOBs (66%), 25% are connected to DH systems, and 9% use electric appliances. It should be noted that division by building heating system is not always straightforward because many households use both wood stoves and electric appliances for heating.

Small HOBs are used for heating in 3.3 million buildings (45%), making them the most popular individual heating system in the Western Balkans. Seventy percent of small HOBs are installed in multistory buildings with existing internal heating networks.

Firewood stoves and ovens are a widely used heating and cooking method (used in more than one-fourth of existing buildings—1.9 million buildings)—in both rural areas and cities and towns. Wood is typically harvested in the months preceding each winter heating season and burned as a fresh material with little or no drying—with the consequent loss of 40–50% of the energy content. It is mainly used in simple, inefficient, and leaky stoves that produce high levels of smoke and indoor pollution.[28]

District heating (DH) systems exist in about 100 cities and towns in the Western Balkans; combined, they represent more than 10,000 MWth of

28 http://www.who.int/mediacentre/factsheets/fs292/en/.

installed capacity. They generally work during the heating season—typically from October 15 to April 15, with differences between cities according to the local climate—and for 16–18 hours per day. The primary fuels used for district heating are natural gas (50%), coal (40%), and heavy fuel oil (10%). Biomass was recently introduced as a fuel in several small towns, including Gradiska (9 MW), Pale (6.5 MW), Nemila (3 MW), and Livno (6 MW) in Bosnia and Herzegovina; Pokupsko (1 MW) in Croatia; and Knjazevac (6 MW) and Sremska Mitrovica (18 MW) in Serbia. However, with an installed capacity of 50 MW, the share of biomass DH in the Western Balkans remains negligible—less than 1%—at the regional level.

In Serbia, out of 5,700 MWth of installed capacity in 57 municipalities, 4 towns (Belgrade, Novi Sad, Nis, and Kragujevac) account for 60% of installed capacity. In Croatia, the DH sector has around 2,400 MWth of installed capacity. Almost 80% of heating facilities belong to state-owned HEP Toplinarstvo, a power company serving six cities (Zagreb, Zaprešić, Samobor, Sisak, Velika Gorica, and Osijek) out of 20 DH systems existing in Croatia. In Bosnia and Herzegovina, 22 cities and towns have DH systems, and their combined capacity is around 1,200 MWth, of which 200 MWth is out of operation. Sarajevo and Banja Luka account for 75% of total installed capacity. In Kosovo, the DH sector consists of three networks with a capacity of around 200 MWth. In Macedonia, which has 660 MWth of installed capacity, DH is available in Skopje and Bitola.

Because most of the pipelines in district heating systems are in poor condition, heat losses and water leakage from the network are high. International financial institutions and bilateral development agencies have in recent years supported the rehabilitation of district heating. Examples include the World Bank in Bosnia and Herzegovina in 1996–97 (US$20 million) and KfW in Serbia (EUR 132 million). However, despite these and other significant investments in DH system recovery over the last decade in many cities, heat and water losses remain high in most systems, making improved system efficiency a priority for most DH distribution systems over the next 10 years.

In most W-B countries, the DH service is the responsibility of municipalities and cantons, and the systems are operated by municipal-level, publicly owned DH companies. The exceptions are Macedonia, where the largest DH company, in Skopje, is privatized, and Croatia, where state-owned national electricity company HEP is responsible for 80% of the district heating market.[29] Although most regulators are independent, and the tariff methodologies in principle allow for cost recovery, in practice social concerns remain a significant factor in the process of proposing and approving DH tariffs.

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29 See http://toplinarstvo.hep.hr/.

The inefficiency of DH systems, coupled with inefficient management of the municipal service companies (overstaffing, lower collection rates, lack of introduction of consumption-based billing in the DH systems), raises heat production costs, which in turn requires an increase in selling prices. The need for increasing heating prices puts pressure on households—particularly low-income families—which has brought municipal DH systems to the brink of losing both commercial and residential customers.

Although the collection rate has been increasing, the district heating companies are still faced with accruing uncollected debts, which is the main obstacle for the development of market-based activities and investments.

Technical Options for Increasing Biomass Use for Heating

Wood-pellet and firewood stoves produced for domestic use in the Western Balkans generally do not comply with EU standards because of the higher cost of compliance with EU certification requirements. Regional demand for certified appliances is hindered by buyers' low awareness of the benefits of certification and efficiency of appliances, coupled with a lack of appropriate legislation and high prices for efficient heating appliances. Many producers have two product lines: uncertified, low-cost, inefficient appliances that are sold in the local markets; and certified, more efficient, and more expensive products for export to the EU. Most of the producers of wood pellet and firewood stoves are located in Croatia, Bosnia and Herzegovina, Macedonia, and Serbia.

A small number of used furnaces are imported—primarily from China, without adequate attestations and certificates. Interest is growing in new and modern wood stoves and ovens that use briquettes and/or pellets, but technical standardization (to align with EU standards for efficiency and emissions of such products) is lacking. The implementation of EU or international standards or the development of national standards would promote consumers' understanding of the impact of efficiency on fuel consumption, thereby reducing the consumption of wood for energy in households and small enterprises. Using dried wood and efficient stoves also reduces emissions caused by burning wood; this is particularly important in urban areas, where wood burning can significant reduce air quality—as is currently the case in Belgrade, Pristina, Sarajevo, Skopje, and Uzice, for example.

In district heating (DH), technically feasible alternatives to increase biomass use include biomass-fueled district heating (DH) systems with heat-only-boilers (HOBs) or combined heat and power plants (CHPs) that can use both agricultural and woody biomass fuels. At the building-level, feasible technologies include stoves and small boilers fueled by wood logs, wood chips, briquettes, or pellets.

Many municipal initiatives to increase the use of biomass in DH are under way in the region. In Bosnia and Herzegovina, these are taking place in Sokolac, Tesanj, Sipovo, Zenica, Prijedor, and Banja Luka; in Croatia, Vukovar, Sisak, and Osijek; in Montenegro, Pljevlja, Kolasin, and Mojkovac; in Kosovo, Gjakova; and in Serbia, Belgrade, Pancevo, Subotica, Krusevac, Zrenjanin, Cacak, Sabac, Kraljevo, Trstenik, Priboj, Kikinda, Jagodina, Nova Varos, Kladovo, Negotin, Novi Pazar, Bajina Basta, Knjazevac, Kosjeric, and Mali Zvornik. However, these initiatives have not yet resulted in actual investments. Successful examples of biomass heating entrepreneurship in Finland (see Box 1) might help municipalities in the Western Balkans to develop new forms of provision of heating service and support local economy.

Technologies for biomass-based heating include the following:

- **Biomass DH systems.** Modern biomass DH systems are equipped with process control systems supporting fully automatic system operation based on the system's head load.
- **Biomass CHP technologies.** Cogeneration—also known as combined heat and power (CHP)—is the simultaneous generation of heat and power, both of which are used for better total efficiency than conventional energy systems, since better exploitation takes place and energy is used to produce heat as well.
- **Small-scale biomass heating appliances.** Wood stoves and wood-log small boilers are widely used in all W-B countries, while wood-pellet and wood-chip appliances are less common. Use of agricultural biomass and dedicated energy crops in domestic appliances may cause technical problems from the formation of molten or partially fused deposits on grates and chimneys exposed to radiant heat.

See Appendix B for more detail on these technologies.

Biomass Combustion and Air Pollution

W-B countries largely rely on biomass fuels for heating (mainly firewood), because of their low cost and widespread availability. Biomass combustion in small-scale heating appliances, however, is frequently marked as one of the main channels through which particles and pollutant gases enter the atmosphere. Selected annual emissions of PM, from different heating appliances and heating fuels are presented in Figure 18. Although the efficiency and other technical specifications of the system are important factors, the level of PM emissions is mainly driven by the fuel combusted. Naturally, it is important to compare the emissions in each use case between the most relevant and realistic alternatives.

As can be concluded from Figure 18, the replacement of inefficient wood stoves with efficient wood stoves or pellet stoves reduces PM emissions considerably. Similarly, in multi-story buildings not connected to DH, the use of

Box 1: Heat Entrepreneurship in Finland

In the beginning of the 1990s some Finnish municipalities started to invest in biomass heating systems for municipal buildings, such as schools and old-age homes (output <1MW). At the same time farmers established new form of rural enterprises, so called "heat entrepreneurs." This means that they were supplying customers with heat produced from forest biomass. The mode of operation is such that the entrepreneur mainly carries the responsibility for looking after heating of municipal buildings, and biomass fuel supply.

Heat entrepreneur or enterprise is a single entrepreneur, a cooperative, a limited liability company, or consortium, which carries out the operation and maintenance work at the heating plant, and sells heat. The heating enterprise typically operates locally and the main fuel is woody biomass. The fuel comes from the entrepreneur's own forest or from local forest owners or wood processing industry. The heat entrepreneur operates the heating plant and earns an income based on the amount of produced heat.

Municipalities have the principal role in establishment of heat enterprises, since they own public buildings, such as schools and old-age homes that need heating. Municipalities can buy these services from local entrepreneurs. That way, the money previously spent on heating now circulates locally, promoting local livelihoods, and increases the amount of locally taxable incomes.

When choosing the form of heat entrepreneurship, the factors that have to be taken into account include the size of the building to be heated and the required investments.

The most common concept is one in which 1–3 entrepreneurs are responsible for heating local premises. In such cases, the size of the heating plants is usually 50–500 kWth. Heat entrepreneurs are usually forest-owning farmers. In small plants managed by heat entrepreneurs, the main fuel is usually wood chips. Most of the plants in Finland are managed by a single entrepreneur, and the typical boiler output is 75–370 kW.

There are also entrepreneur consortia with 2–4 members each. Most of the plants are school buildings and typical boiler output is 60–300 kWth. In these plants, more than 50% of wood fuel was produced from their own forests by own equipment.

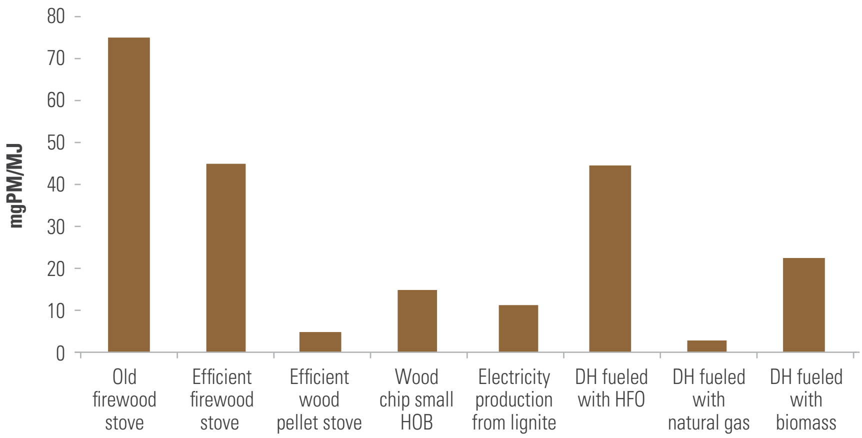
Only in a small number of plants is heating carried out by a limited liability company that has invested in wood procurement equipment or a boiler plant.

In heating co-operative, the mode of operation is such that forest owners collaborate in the procurement and delivery of the fuel to the customer´s premises. The cooperative´s members also earn revenues in the form of interest paid on the invested capital and dividends paid out by the cooperative. The cooperative solution is appropriate when dealing with heating entities larger than single building, for example, district heating plants.

Source: Biomass Heat Entrepreneurship in Finland—E. Alakangas, VTT.

pellet stoves would reduce PM emissions compared to HOBs fueled by fossil fuels (other than gas, which is not readily available in most of the region). However, replacing electric heating devices with efficient wood and pellet stoves or biomass HOBs would in most cases lead to higher PM emissions. In DH systems, biomass DH would typically have higher PM emissions than the most relevant alternatives (coal or lignite and gas), but would reduce PM emissions wherever the use of HFO is displaced. In addition to comparisons to the most relevant alternatives in each use case, it is also important to note that in an economic analysis the impacts of higher PM emissions in certain biomass use cases are offset by the reduced CO_2 emissions.

Figure 18: Specific Emissions of Particulate Matter from Different Heating Appliances and Fuels



Source: Own elaboration. European Environmental Agency http://efdb.apps.eea.europa.eu); emission factor for agricultural residues DH combustion is estimated to 22.5 mg/MJ (50% higher compared to woody biomass.
Note: For the purpose of this study, emission factors for biomass-heating appliances in the Western Balkans are adopted from "Analysis and Action Plan for Education on Optimal Combustion in Residential Heating" Government of Macedonia, 2014, as follows: traditional wood stoves—75 mg/MJ, efficient wood stoves—45 mg/MJ, efficient pellet stoves—5 mg/MJ, modern wood chip boiler—15 mg/MJ; adopted emission factors for fossil fuels DH combustion: lignite—11.1 mg/MJ, HFO—44.5 mg/MJ, natural gas—2.89 mg/MJ.

During biomass combustion, PM emissions are dominated by small particles that can cause severe health effects such as lung cancer, and chronic lung and heart diseases (the damage to human health is mainly linked to exposure to PM 10 and PM 2.5). According to report about Global Disease[30], it is estimated that in 2010 approximately 3.5 million deaths worldwide were attributed to smoke exposure from residential solid fuel combustion. The effect of PM goes beyond risks to human health as they also affect weather and reduce visibility. Also, black smoke that is produced through incomplete combustion contributes to global warming because these particles absorb solar light.

However, different technical, nontechnical and regulatory measures, described in Appendix C could be undertaken to reduce harmful emissions.

[30] A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010, http://dx.doi.org/10.1016/S0140–6736(12)61766–8.

4

Biomass Supply

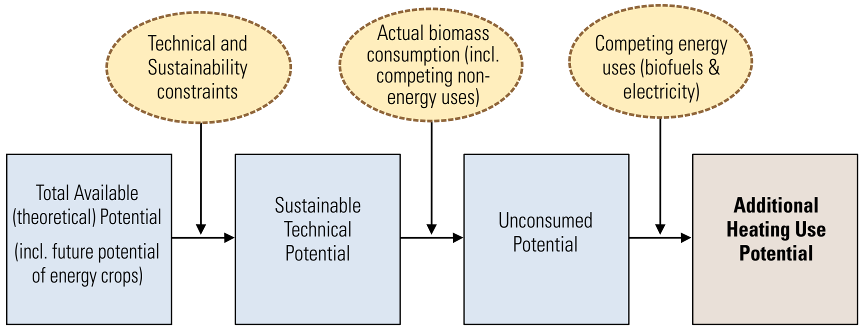
In this chapter, the current and potential future use of woody and agricultural biomass are analyzed.[31]

The study team employed both bottom-up and top-down approaches to collate and analyze biomass supply and demand-consumption data. On the supply side, four types of potential were evaluated:

- **Total available (theoretical) potential** is the overall maximum amount of biomass that can be considered theoretically available within fundamental bio-physical limits. It is the quantity grown or disposed, constrained only by macro-factors such as land availability and growth yield. Theoretical potential also includes estimates of the future potentials of energy crops, based on a set of assumptions regarding *unused* agricultural land.
- **Sustainable technical potential** is the fraction of the theoretical potential that is available given the technical conditions and the current technological possibilities, spatial confinement resulting from competition with other land uses (such as physical infrastructure, protected areas), and accounting for the specific sustainability criteria set forth in the EU Renewable Energy Directive for production of biofuels. In other words, it is the *theoretical potential* minus the *biomass potential* that could be produced on lands that are used (or suitable to be used) for food and feed instead; it is is also discounted, for example, the requirement that land with high soil carbon stocks (like wetlands), high biodiversity

[31] According to the EU, *biomass* is "the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste" (EU RES Directive 2009/EC). However, the industrial and municipal waste fractions were not considered in this study.

Figure 19: Assessment of Biomass Supply Potential



areas, and peatlands, should not be used for growing biomass for biofuels.[32] Sustainability criteria also include the application of strict biomass harvesting guidelines and the need to leave material on the ground to replenish soil nutrients.

- **Unconsumed potential** is the fraction of Sustainable Technical Potential that remains after deducting all *current* consumption of biomass for both heating and all non-energy purposes[33] (including domestic and export uses). It should be noted that in some countries current consumption may already be higher than the Sustainable Technical Potential.
- **Additional heating use potential**, finally, is the fraction of the *unconsumed potential* that could be made available to supply an increase in biomass-based heating (over and above the current use) after deducting the anticipated or expected biomass use for energy purposes other than heating[34] (see Figure 19) and when considering only the types of biomass that are technically suitable for heating (see Table 5). Table 5 summarizes the four categories of biomass potential by country and for the W-B region as a whole. Additional details are provided in the sections below.

The biomass streams considered—all of which are available, or potentially available, in the Western Balkans—are defined in the Glossary on Biomass Supply included at the end of this report.

32 Directive 2009/28/EC of the European Parliament and of the Council of June 5, 2009, on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
33 The competing use of biomass for non-energy purposes is based on the quantities currently used for industrial purposes in W-B countries.
34 Competing uses for energy purposes other than heating assume the use of 30% of biomass to produce biomass fuels for transport, and 10% to generate electricity.

Table 5: Assessed Types of Biomass Potential (ktoe)

Country or region	Total available (theoretical) potential	Sustainable technical potential	Unconsumed potential	Unconsumed potential (excluding energy crops)	Additional heating use potential (excluding energy crops)
Albania	865	694	362	5.4	52
Bosnia and Herzegovina	2,599	2,074	933	183.3	104
Croatia	3,488	2,640	1,976	885.5	164
FYR Macedonia	1,243	1,010	740	47.7	60
Kosovo	844	665	224	–157.2	68*
Montenegro	931	820	673	200.7	68
Serbia	7,676	5,597	4,046	1,420.5	436
Total W-B region	**17,647**	**13,499**	**8,953**	**2,603.9**	**954**

* Unconsumed potential in Kosovo (excluding energy crops) has a negative value, and it is very low in Albania, as a result of unsustainable consumption of woody biomass—primarily stemwood. However, additional heating-use potential still exists in Kosovo because other categories of woody biomass (such as thinnings, logging residues, and prunings) and agricultural biomass are not used for heating, despite their availability.

In all W-B countries, the official statistics on wood use cover only a limited share of the total consumption. The information presented is based on the best available data, including government statistics and data collected by the World Bank consultant team as part of the project. The main sources of information include the Joint Wood Energy Enquiry (UNECE 2013), UNECE/FAO Database, Progress reports under EU Renewable Energy Directive, National Forest Management Plans, National Energy Balances, Biomass Consumption Survey for the Western Balkan Countries (Energy Community Secretariat, 2012), information collected during country visits, scientific papers, and consultant's calculations and estimates.

Current Biomass Supply

Currently, the primary source of biomass for heating in the Western Balkans is woody biomass, while agricultural residues are used only in minor amounts—mostly in Serbia. Only in Croatia and Montenegro is there a significant sustainable potential for increasing the use of woody biomass for heating. In addition, currently unused logging residues, thinnings, prunings of fruit trees and vineyards, and dedicated energy crops could be used to increase the use of woody biomass for heating. Agricultural biomass, which is currently untapped, could be utilized for biomass-based heating.

Bosnia and Herzegovina, Croatia, and Serbia have the largest areas of forest cover, but the greatest share of forest land out of the total land area is

Table 6: Main Indicators of Forest Growth

							Forest ownership			
	Forest area (ha)		Annual increment		State forest		Private forest			
Country	**ha**	**% in total land area**	**m³**	**Per ha (m³/ha)**	**Annual consumption of woody biomass (m³)**	**Share of annual increment used (%)**	**ha**	**%**	**ha**	**%**
Albania	1,502,200	27	1,197,013	0.8	1,750,000	146	815,995	97	60,088	3
Bosnia and Herzegovina	2,823,300	43	10,781,257	3.8	9,545,000	89	2,268,100	80	555,200	20
Croatia	2,688,687	34	10,526,000	3.9	6,772,000	64	2,106,917	78	581,770	22
FYR Macedonia	947,685	39	1,830,000	1.9	1,553,000	85	853,539	90	94,146	10
Kosovo	481,000	44	1,550,000	3.2	2,421,000	156	295,200	62	180,800	38
Montenegro	826,722	39	2,793,703	3.4	1,158,000	41	432,375	52	394,346	48
Serbia	2,252,400	35	9,000,000	4.0	8,877,000	99	1,194,000	53	1,058,400	47
W-B	11,521,994	42	37,677,973	3.3	32,076,000	85	7,078,590	71	2,924,750	29

* Includes estimated unregistered consumption of woody biomass.

Source: Estimated figures for consumption of woody biomass for each country are based on the available data including JWEE UNECE 2013, UNECE/FAO database, National Forest Management Plans, national statistics, Biomass Consumption Survey (Energy Community 2010), and author's calculations based on industrial roundwood data.

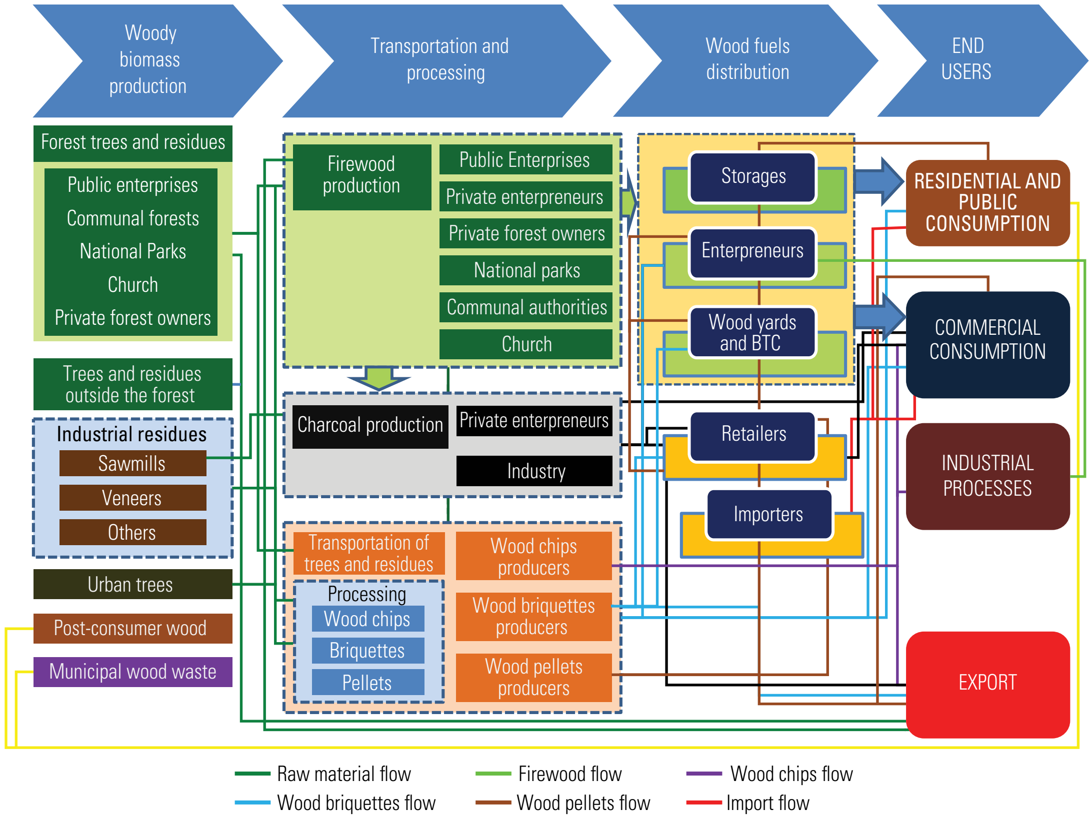
in Kosovo. The annual increment[35] of the woods is highest in Bosnia and Herzegovina, Croatia, and Serbia. In these countries, an estimated 64–99% of the total annual increment is already used. Of all the W-B countries, Montenegro is using the smallest share (41%) of the annual increment, while FYR Macedonia uses 85%. The consumption of woody biomass in Albania and Kosovo is unsustainable, since those countries use 46% and 56% more wood than the annual increment, respectively. (See Table 6 for further details.)

Woody-biomass supply chains in the W-B countries (see Figure 20) are based primarily on domestic raw materials and wood fuels. Forests are the most significant resource of woody biomass used for energy, followed by residues from the wood-processing industry, then by trees and residues outside the forest. Public enterprises and national parks are most important suppliers of woody biomass, particularly firewood from the state-owned forests.

Among the seven countries analyzed, the ownership situation of the forest sector varies, which in turn affects how biomass is retrieves, transported, and sold. On average, 71% of forest area is state-owned. In Montenegro, the share of private sector ownership is the highest at 48%. In Albania, forest

[35] The *annual increment* refers to the annual growth of a given forest stand.

Figure 20: Model of the Supply Chain of Woody Biomass and Wood Fuels



Source: Consultant data.

ownership is in transition from state to local communities, and currently, 47% of forests there are state-owned, 50% are communal forests, and only 3% are private forests.[36]

Larger producers, such as public enterprises and national parks, focus on the wholesale of large quantities of wood, supplying wood-based panel industry and retail wood fuels companies. Households are the largest end-consumers of wood fuels, with 90% of total firewood consumption. The firewood is supplied mainly through warehouses and retail stores (supermarkets), as well as directly from producers.

Transport and processing form a highly complex segment of biomass supply in the W-B region because of the large number of actors. The transport of raw wood materials from forests to industrial plants is usually outsourced to private companies, while major producers of wood fuels use their own transportation fleets.

36 Forest fund by ownership, INSTAT, Albania, 2015.

Wood fuel distribution involves various channels, depending on the wood fuel type. Most households, businesses, and public institutions buy firewood from private companies or entrepreneurs; to a lesser extent, they buy directly from public enterprises. Private companies typically use warehouses as distribution channels for firewood, wood pellets and briquettes, and coal to end consumers (in Croatia the Biomass Trade Center is also used[37]).

In urban areas, the wood is typically sold through the network of warehouses selling the heating fuels. In the countryside close to forests, wood is mainly harvested in the forest, for the basic needs of rural households.

Firewood—the Most Commonly Consumed Wood Fuel

Annual firewood production in the Western Balkans is approximately 20.4 million m^3 (about 8.16 million tons) followed by wood chips (about 600,000 tons), wood pellets (about 580,000 tons), wood briquettes (about 200,000 tons), and charcoal (about 85,000 tons).

The Inadequacy of Forest Logistics for Increasing Biomass Supply

Forest logistics to facilitate biomass supply—such as forest roads, railway connections, roadside chipping sites, and forest terminals—is not developed in the W-B countries.

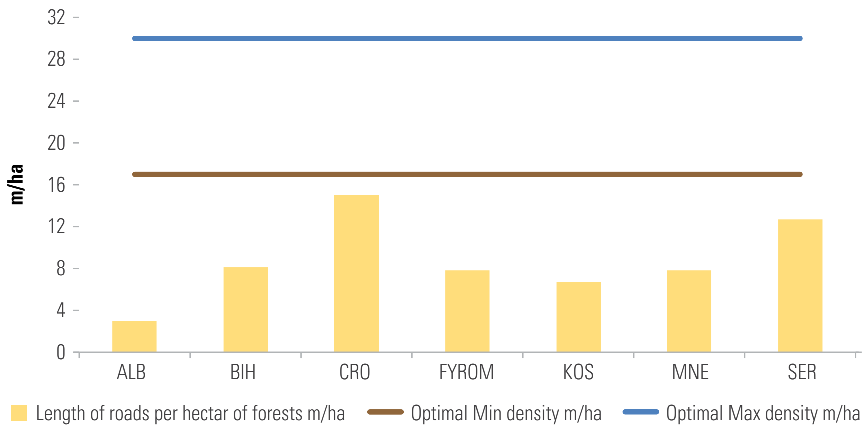
With the exception of Croatia, forest accessibility in the Western Balkans is not optimal from the perspective of production. The paucity of roads in the region's forests currently prevents proper forest management, effective fire management, and realization of the full commercial potential of these resources. Where woody biomass and wood fuels are concerned, the lack of forest infrastructure—especially roads—is the main bottleneck.

The length of forest roads per hectare of forest is below 10 meters per hectare (m/ha) in most countries (see Figure 21). In Serbia, for example, the density of forest roads is 13 m/ha, while in Croatia it is between 10 and 20 m/ha. In general, forest accessibility in the W-B is higher in high forests[39] because such forests are more valuable commercially; it is significantly lower in low forests (for example, coppices). We estimate the optimal density of the

37 Biomass trade centers are a new and innovative way to develop and organize local biomass supply. They are usually regional centers with optimized logistics and trading operations, where various biomass fuels (firewood, chips, pellets, energy crops, and so on) are marketed at guaranteed quality and prices.

38 Unlike a low forest (also known as a *coppice forest*), a *high forest* usually consists of tall mature trees. High forests can occur naturally or they can be created and/or maintained by human management.

Figure 21: Length of Forest Roads, per Hectare of Forest



Source: Consultant data.

primary forest roads at between 17 and 30 m/ha, depending on the field characteristics.

To improve the accessibility of forests in the W-B, apart from forest roads, new logistical solutions, such as forest terminals, are needed to provide biomass storage and processing options for securing the fuel supply in all conditions. The concept of forest terminals (see Table 7), developed in the Nordic countries—despite the fact that it does not create direct cost benefits per se—provides several indirect benefits. Regional biomass procurement can be widened to a national scale, the security of supply increases (easily available storage facilities), large supply volumes can be delivered by an individual operator,

Table 7: Key Characteristics of Different Types of Forest Terminals

Satellite terminal	• Complex and developed sites for large scale biomass handling and processing • Located near the biomass resources—away from the usage sites • Require large areas (typically around 10 hectares of paved area) • Railway connections in addition to road connections are essential—as they serve large, distant customers
Feed-in terminal	• Main function is the balancing of biomass supplies to a heat or power production facility to improve security of supply • Located near a usage site • Optimally, a railway link should be available, as trains are usually unloaded at the terminal and further transport is executed with trucks
Fuel upgrading terminal	• Special case of feed-in or satellite terminal where biomass upgrading process is applied, such as artificial or natural drying, blending, densification (pelletization or briquetting)

Source: Virkkunen and others (2015).

prices remain more stable, and a more even quality of delivered fuel can be achieved.

Unproductive Application of Forest Management Techniques

The main **techniques of forest management** involve the introduction of silvicultural[39] thinning of young stands, the conversion of coppices into high forests, and the increasing use of logging residues to produce woody biomass.

To develop, test, and demonstrate innovative approaches to forest management, including the use of local-level indicators to monitor progress, model forests could be developed. Model forests promote sustainable forest management at the field level, help translate national forest programs into action, and provide continuous feedback to governments for use at the policy level.

The thinning of young and middle-aged stands is not a regular forest maintenance measure in the W-B region. Rather, it is done only when governmental funds are dedicated to this purpose. When young and middle-aged stands are thinned, the forest becomes more productive. Reduced competition among the stems results in an increase in the volumes, while improving the value of the growth in the forest post-thinning.[40] This improvement in silviculture is both sustainable and economically viable.

Significant areas of degraded or scrub forests in the W-B countries could be developed into high forests. Because of changing demographics and living standards, vast areas of the countryside that were traditionally used for pasture have been abandoned. Left alone, these areas undergo natural regeneration toward a forest structure, but require a very long time to develop into natural forests. They could be restored to functional ecosystem services through reforestation—while improving rural livelihoods and food security, increasing climate resilience, and helping mitigate climate change (through the sequestration of carbon and reduction of forest exploitation).

Logging residues—mainly treetops, branches, and stumps—represent the largest, currently unused, potential source of woody biomass that can be used for heating—26% of unconsumed potential for heating in the W-B countries.

To encourage biodiversity and preserve soil nutrients, research is needed to determine the amount of logging residues that can be removed without impact to fertility and biodiversity. For example, in Finland, environmental guidelines and logging rules state that 30% of the logging residues in the harvesting area must be left in the forest.[41] To increase the use of logging residues in the Western Balkans, a "take or pay" method could be introduced that

[39] Silviculture is the practice of controlling the establishment, growth, composition, health, and quality of forests to meet diverse needs and values.
[40] https://www.uaex.edu/publications/PDF/FSA-5001.pdf.
[41] Horstman 2013.

would require payment of stumpage[42] for both removed wood and logging residues left behind upon completion of the primary logging. Also, the Forest Logistics Master Plan should include the development of roadside chipping locations for collected logging residues to improve their utilization rate.

For areas with high biodiversity value, scrub, and unutilized pastures—in both state-owned and private forest and non-forest lands—the intensification of forest management should involve *integrated* management that addresses objectives in other sectors, such as energy, water management, agriculture, and tourism.

Finally, the increase in thinning intensity in young and middle-aged stands and the utilization of the residues that would otherwise be left in the forest will create additional employment opportunities in rural areas. This will contribute to the economic development of the region's poorer rural areas, thereby contributing to shared prosperity.

The Export of Most Processed Wood Fuels

In 2013 the total export of wood fuels from the W-B region was equivalent to 3.34 million m^3 of roundwood. A significant share is exported by Croatia and Bosnia and Herzegovina (see Appendix D), and almost half of the volume is solid firewood (solid logs of wood, cut and chopped) exported mainly outside the W-B region—to Austria, Hungary, and Italy. Of the total amount of wood chips, briquettes, and pellets produced, 62%, 71%, and 71%, respectively, is exported. The large proportion of exports is the result of undeveloped national bioenergy markets, a lack of incentives encouraging the efficient use of biomass for heating, and the relatively high prices available at primary export markets. The import of wood or wood fuel into W-B countries is insignificant.[43]

Total consumption of woody biomass in the Western Balkans was 32.1 million m^3 in 2013. Of this, 8.8 million m^3 was used for industrial purposes, 23.2% (7,458,000 m^3) in the sawmill industry, 2.4% (779,000 m^3) in the panel production industry, 1% (308,000 m^3) in the pulp industry, and 6.7% (2,143,000 m^3) for processed pellets and briquettes.

Using wood for industrial applications occurs primarily in Croatia and Bosnia and Herzegovina, where wood is used mostly in the sawmill industry (3,078,000 and 2,817,000 m^3, respectively), the processed wood fuel industry

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42 *Stumpage* is the price a forestry entity pays for the right to harvest wood from a given land base.

43 Data are based on the following information sources: 1. SNV 2012; 2. Glavonjić 2015; 3. Ministry of Economy, Republic of Croatia 2013; 4. FAO 2009; 5. FAO 2013; 6. FAO 2015; 7. FAO 2015; 8. Čomić and others 2013; 9. Vusić and Đuka 2015; 10. Trade balances of W-B countries; 11. Consultant calculations.

Table 8: Industrial Use of Woody Biomass (1,000 m³)

	Sawmill industry		Panel industry		Pulp industry		Processed wood fuel industry		Other physical utilization	
Country	**% of total woody biomass cons.**	**1,000 m³**	**% of total woody biomass cons.**	**1,000 m³**	**% of total woody biomass cons.**	**1,000 m³**	**% of total woody biomass cons.**	**1,000 m³**	**% of total woody biomass cons.**	**1,000 m³**
Albania	7	122	0.1	2	—	0	13.7	240	0.3	5
Bosnia and Herzegovina	29.5	2817	0.7	62	2	195	8.3	795	1.8	171
Croatia	45.5	3078	4.1	276	1.7	113	7.1	484	0.7	47
FYROM	9.3	145	—	0	—	0	1.2	18	1.6	25
Kosovo	1.7	41	—	0	—	0	2.1	51	0.3	8
Montenegro	29.3	339	0.4	5	—	0	0.9	10	0.3	3
Serbia	10.3	916	4.9	434	—	0	6.1	545	0.6	53
W-B	**23%**	**7,458**	**2%**	**779**	**1%**	**308**	**7%**	**2,143**	**1%**	**312**

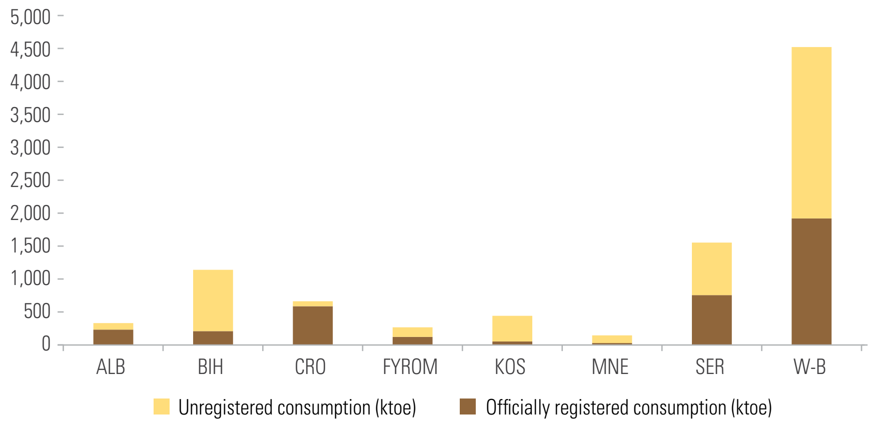
(484,000 and 795,000 m³, respectively), and to a lesser extent in the panel industry and pulp industry. In Serbia, 916,000 m³ of woody biomass is used in the sawmill industry, and 434,000 m³ and 545,000 m³ in the panel industry and processed wood fuel industry, respectively. In Montenegro significant amounts of wood (339,000 m³) is consumed in the sawmill industry. In the remaining W-B countries, industrial wood use is relatively limited.

Increasing competition between producers of wood fuels and manufacturers of wood-based panels, especially in Serbia and Croatia, is a critical factor when considering the supply of wood in the W-B region. The data are shown in Table 8.

The Unregistered Use of Most Woody Biomass

In 2013, 1,922 ktoe of woody biomass was registered for energy use in the W-B region. By contrast, the actual estimated total was 4,525 ktoe in the same year, indicating that more than 58% of the total came from unregistered consumption (see Figure 22). There is insufficient data on the composition of the unregistered use. However, a major component is the unregistered collection of woody biomass for heating by local communities near forest areas and by private forest owners, resulting from the practice of statistical offices to collect and publish data on official woody biomass trade only. Other factors contributing to unregistered use include unfavorable socioeconomic conditions with low income and high unemployment rates, particularly

Figure 22: Estimated Actual Woody Biomass Consumption (ktoe)



Source: Estimates are based on the results of the Study on the Biomass Consumption for Energy Purposes in the Energy Community (Energy Community Secretariat, 2012).

in rural, mountainous areas; institutional weaknesses on the part of the competent authorities; insufficient infrastructure and lack of knowledge; corruption; inefficient judicial authorities; and insufficient interest on the part of police authorities in this type of illegal activity.[44] A precondition of a sustainable and transparent biomass market would be that more of the consumption is registered, along with better data on the unregistered use.

Failure to Exploit Agricultural Residues

Agricultural residues remain largely unexploited in the region. The agro-biomass market is almost nonexistent in W-B countries. The exception is a few examples of agro-pellet production and energy production for industrial purposes, which are taking place mainly in the region of Vojvodina in Serbia. Examples include the following:

- An 18 MW heating plant fired by sunflower husks and connected to district heating in Sremska Mitrovica (developed and owned by Electric Power Industry (EPS), a power company in Serbia).
- 40 MW of heating capacity used in the processing plants of Victoria Group, a large agribusiness company, fired by different agro-biomass fuels.
- An experimental facility, installed in the "Tipo Kotlogradnja" boiler factory in Belgrade, designed to obtain energy through the combustion of large bales of soybean straw.

[44] Markus-Johansson and others 2010; World Bank 2002.

Box 2: Production of agricultural pellets in Serbia

Victoria Group in 2013 invested 1.2 M EUR in production line for straw pellet (capacity 4 tons per hour i.e. 30,000 tons annually), mainly for own consumption. Second largest producer of agricultural pellets MIVA invested 2 M EUR in agripellet plant in Indjija, in 2013, with production capacity of 12,500 tons per year. Besides agricultural pellets for energy use, this company produce pellets for animal bedding.

Agripellet production facilities in Zrenjanin and Indjija

However, production and trade of agricultural pellets is facing challenges, as market is still in early development. For example, in Serbia, the rate of applicable VAT for wood pellets is decreased to 10%, while for agricultural pellets the VAT rate is still 20%. Price of raw materials for pellets production is very volatile because of fragmented, and underdeveloped market.

Trade of agricultural pellets is burdened with administrative issues. For example, customs nomenclature and code for agricultural pellets was introduced in Serbia in 2014, for the first time at request of producers of agripellets. Also, for the import of agricultural pellets to Croatia, veterinary border control is mandatory (240 EUR/truck[3]), which increases the cost of pellets.

[a] For comparison, the price of veterinary border control in Hungary is 48 EUR/truck.

According to local experts, there are currently eight plants making pellets and four plants making briquettes from field crop residues in Vojvodina, Serbia. The largest producers are the Victoria Group, with an installed capacity of 30,000 tons, and Miva company with capacity to produce 12,500 tons of agro-pellet from straw (see Box 2).

Agricultural residues are estimated to account for 2 Mtoe, or 15%, of the sustainable technical total potential for increased biomass energy use in the Western Balkans. This potential includes residues of both field crops (such as maize, wheat, barley, rye, oats and rice) and oil crops (such as soybean and sunflower). The highest potential for increasing the use of agricultural residues is in Serbia (an estimated 1.3 Mtoe), followed by Croatia, Bosnia and Herzegovina, Albania, Kosovo, and FYR Macedonia. Straw, which is suitable for DH use, is most widely available in the Pannonian Basin region, which encompasses the cross-border regions of Bosnia and Herzegovina, Croatia, and Serbia.

Three main factors constrain the use of agricultural residues in the region:

- Patterns of farm ownership, especially the large number of small farms, may hinder the collection of residues for central biomass installations. Collecting biomass from such farms for small-scale or even individual biomass boilers may be more appropriate in many cases.
- Most of the existing domestic stoves or boilers in W-B countries are not adjusted for burning large amounts of straw, miscanthus, or similar unprepared biomass residues. Nevertheless, a domestic, regional market for straw boilers already exists and could be further developed.
- Residues from pruning fruit trees consist of leaves, thin branches, and thick branches (that is, branches greater than 3 cm in diameter). Thick branches are in most cases already used by farmers as fuelwood. However, this is not the case for smaller branches, since special machinery is required for chipping these residues—machinery most farmers cannot afford.

The Potential for Additional Biomass Supply

The study estimated the annual sustainable technical potential by adding together the energy potential of different types of woody and agricultural biomass. The calculation of the energy content of woody biomass was done using the parameters presented in Table 9 and Table 10; for agricultural biomass, the parameters shown in Table 11 were used.

Table 9: Basic Density and Lower Heating Value of Absolute Dry Biomass for Conifers and Non-conifers Adopted in this Study

Parameter	Conifers	Non-conifers
Basic density (kg/m³)	430	645
Lower heating value of absolute dry biomass (GJ/t)	18.9	17.9

Table 10: Moisture Content of the Woody Biomass Categories Examined in This Study
(%)

Category	Moisture (%)
Stemwood for energy, wood outside forest, and wood from conversion of coppices	35
Logging residue	40
Secondary forestry residue	40
Green biomass from wood energy plantations	64

Note: A period of drying is assumed for the stemwood, logging residue, and secondary forestry residue.

Table 11: Moisture Content and Net Calorific Value of Agricultural Residues Examined in This Study

Field crop residues	Moisture Content (%)	Net calorific value (GJ/t)	Fruit tree and vineyard prunings	Moisture Content (%)	Net calorific value (GJ/t)
Wheat	15	14	Citrus	20	14.31
Barley	15	14	Olives	20	14.31
Maize	20	13	Pergola	20	14.31
Rye	15	14	Apples	20	14.31
Sunflower	15	13	Pears	20	14.31
Soybean	15	15	Cherries	20	14.31
Rapeseed	15	15	Sour cherries	20	14.31
Oats	15	14	Apricots	20	14.31
Rice	15	14	Plums	20	14.31
			Figs	20	14.31
			Peaches	20	14.31
			Tangerines	20	13.58
			Walnuts	20	14.31

The Estimated Sustainable Technical Potential of Biomass

The sustainable technical potential of biomass is estimated to be 13.5 Mtoe in the Western Balkans. See Table 12 for further details. While 62% of the sustainable technical potential originates from agricultural residue, 38% comes from wood residue.

Figure 23 shows a breakdown of sustainable technical potential of biomass in the Western Balkans.

How Improving Forest Roads Could Increase Production

The potential exists to increase annual woody biomass production by improving the forest road infrastructure in Bosnia and Herzegovina, Croatia, FYR Macedonia, Montenegro, and Serbia.[45] By intensifying the construction of forest road infrastructure, the available biomass potential can be increased.

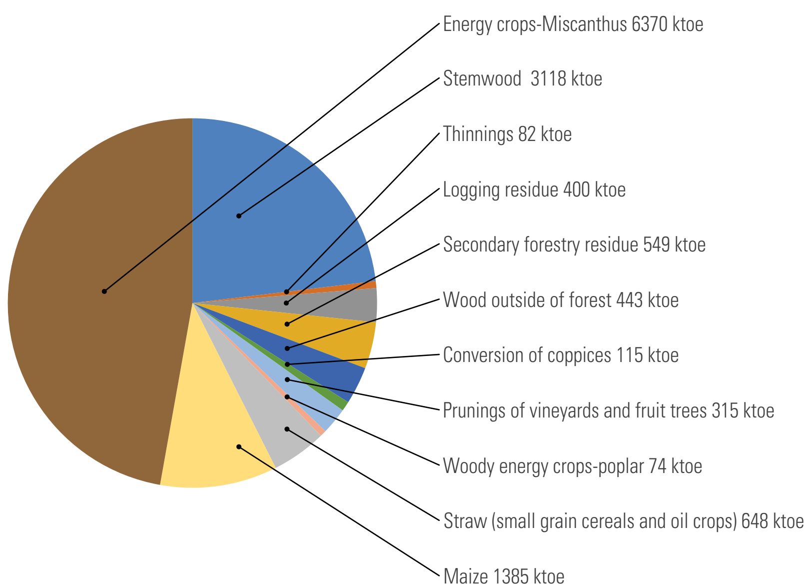
[45] Despite the fact that woody biomass consumption (mainly stemwood) in Kosovo and Albania is unsustainable, additional potential exists if the structure of use can be shifted from stemwood to other categories of woody biomass, such as thinnings, logging residues, and prunings, that are currently unused.

Table 12: Energy Content of the Sustainable Technical Potential of Biomass for Heating, including Energy Crops

Country or region	Sustainable technical potential of woody biomass (ktoe)	Sustainable technical potential of agricultural biomass and energy crops (ktoe)	Sustainable technical potential of biomass (ktoe)
Albania	254.9	439.5	694.4
Bosnia and Herzegovina	1,178.9	895.4	2,074.3
Croatia	1,136.2	1,503.3	2,639.5
FYROM	293.4	716.3	1,009.7
Kosovo	216.0	448.8	664.8
Montenegro	347.7	472.0	819.7
Serbia	1,668.3	3,928.2	5,596.5
Total W-B region	**5,095.4**	**8,403.5**	**13,498.9**

To optimize this investment in the Western Balkans, two government initiatives are necessary: the identification of high-priority forest-road rehabilitation projects, and the development of forest-road master plans. Each master plan should first assess not only the forest infrastructure requirements, but also the technical requirements and the legal, regulatory, and policy environment governing transport operations within W-B forests. It should then

Figure 23: Assessment of Sustainable Technical Potential of Biomass, by Type of Residue



identify (a) key hubs for increased supply of sustainable woody biomass and (b) ways to develop appropriate and efficient infrastructure capacity along the main forest corridors.

Because defining the necessary investment is not a straightforward procedure, the study team considered two scenarios for the upgrade of the forest infrastructure to increase production of woody biomass:

- The first scenario assumes a regional investment of roughly EUR 35 million per year for 15 years and the construction of new forest roads, with a resulting increase in usage of the "sustainable technical potential" (see the introduction to this chapter for a definition of this term). With the aim of reaching the higher level of accessibility of forests over the next 15 years, this scenario envisions the construction of 15,990 km of solid (that is, paved, typically required in mountainous terrains which are common in the region) forest roads and 3,200 km of soft (that is, gravel) forest roads in the W-B countries.
- The second one is based on the information provided in National Forest Management Plans of the W-B countries, and a gradual increase of availability of woody biomass. This scenario includes construction of 56,283 km of forest roads (46,683 km of solid forest road, and 9,600 km of soft forest roads) in the W-B countries, with total investment requirements of EUR 1.6 billion. However, it is unlikely that this amount of investments could be economically justified with the current prices of woody biomass.

The first scenario, believed to be more realistic, is based on an approach that increases the production of woody biomass for energy purposes. The additional quantities of woody biomass that could be provided by implementing the first scenario are in the range of 9–15%. However, the cost-effectiveness of the proposed investment should be analyzed in each country to confirm its economic viability.

Based on a rough estimate, an investment of EUR 35 million per year in these five countries for the next 15 years would provide access to 2.5 million cubic meters[46] (or 540 ktoe[47]) of wood per year. Once in place, the forest roads can be used, with proper maintenance for a very long time. For illustration purposes, if we assume they would be used for 30 years, 75 million cubic meters (16,200 ktoe) of additional wood could be supplied. The investment cost of about EUR 7 per cubic meter of additional supply, relative to current cost of roundwood of approximately EUR 35 per cubic meter is significant

[46] This amount of woody biomass is already included in the assessment of sustainable technical potential, but with improved accessibility, it would increase additional heating use potential.
[47] European beech (moisture content 45%).

(20%). However, it should be kept in mind that, besides energy uses, the wood can be used for high value add industrial uses, and that forest roads have multi-use benefits related to, for example, tourism, various recreational uses, and forest fire prevention.

This amount of woody biomass is already included in the assessment of the sustainable technical potential. However, for it to become available as additional heating use potential, these investments in forest roads would be needed and are assumed in the estimation of the additional heating use potential (seeTable 15).

Any construction of forest roads should take into account the increments in sustainable yield and forest growth of each specific area, the need to carefully manage unregistered logging, and other environmental and social considerations.

Energy Crops and the Potential to Increase Sustainable Biomass Production

On a regional level, 45% of the estimated potential to increase biomass production would be based on energy crops—mainly cultivation of miscanthus, a perennial grass that can be grown on abandoned or degraded agricultural land. The estimated volume assumes that currently unused agriculture land would be used for energy crops. This is a theoretical assumption given that the share of unused agricultural land is high, ranging from 18% to 57% of total agricultural land.[48] The resulting, indicative potential (a total of 6,370 ktoe) for bioenergy production is very high and equals 17% of the total primary energy supply in the region. However, the food balance of most W-B countries is negative (the import of food supply is significant), so there may be pressure to increase local agricultural production.

A key constraint for increasing the cultivation of energy crops is that no incentives (legislative or otherwise) have been implemented in any of the W-B countries to encourage the use of abandoned agricultural land for energy plantations. Nevertheless, there are several initiatives to promote energy crops cultivation (see Box 3).

Estimates for the energy-crops potential of unused agricultural land should be further explored for the following reasons:

- The total area of unused agricultural land is not currently recorded consistently in W-B countries. Although this study has used FAO estimates,[49] they are based on several assumptions, some of which may not apply in the Western Balkans.

48 Volk, Erjavec, and Mortensen 2014.
49 Volk, Erjavec, and Mortensen 2014.

Box 3: Promotion of energy crops cultivation

The growing of energy crops on degraded and set-aside land, contaminated by former industrial or military impacts, is one of the activities recommended in the Danube Region Biomass Action Plan (DRBAP)[a], prepared under the EU Strategy for the Danube Region (EUSDR). Bosnia and Herzegovina, Croatia, and Serbia are among 14 participating countries of the EUSDR.

With the support of EU Strategy for the Danube Region (EUSDR), the project to establish research network for Danube Miscanthus is started, aiming to support increasing cultivation of Miscanthus on marginal land for energy purposes. Local participating institutions include Faculty for Applied Environmental Protection Futura (Serbia), Agricultural Faculties in Banja Luka (BIH) and Osijek (Croatia), Faculty for Agriculture and Food processing technology in Mostar (BIH).

Promotion of energy crops cultivation in RDA Srem

In addition, local organizations for regional development actively promote use of biomass for energy, and growing of energy crops in the cross-border region of BIH/CRO/SER. Regional Development Agency Srem (RDA Srem), established in 2010 by 7 Municipalities of the Srem region (Serbia), with the support of Embassy of Finland, completed mapping of local spatial, infrastructure, resource and logistic support for the production of electricity and/or thermal energy from biomass in Srem. RDA also organized workshop in July 2016, under auspices of the World Bank, to disseminate results of the study on biomass-based heating, and discuss potential for growing energy crops. As an outcome, RDA is currently developing project to demonstrate cultivation of energy crops in the Srem region.

[a] http://www.danubebiomass.eu/.

- In most W-B countries, there is no distinction between fallow, uncultivated and abandoned land. Furthermore, because the reasons for agricultural land abandonment vary, they have to be investigated in each country separately. As an example, has the land been abandoned because land fragmentation has made its exploitation unfavorable in economic terms, or it the mountainous terrain that has made the land unsuitable for mechanized production systems? According to the Institute for European Environmental Policy, "farmland abandonment is widely recognized as "a local specific phenomenon," thus requiring high-resolution data to appropriately assess farmland abandonment."[50]

- Most W-B countries currently have a negative food balance, and there may be a need to increase agricultural food production in future.
- There is no policy in place regarding the development of energy crops in any of the countries that could be used as a guide.

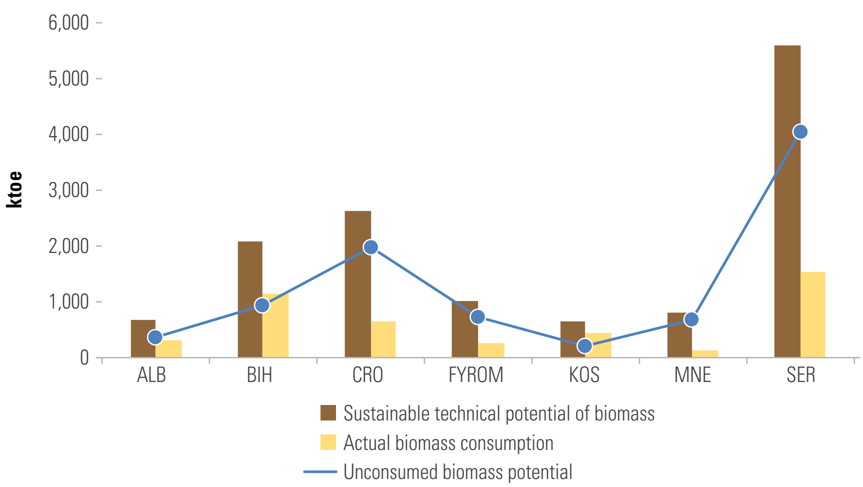
However, the development and bringing to market of energy crops in particular would require significant time and effort, and this complex subject requires separate analysis to enable formulation of recommendations on sustainable development of energy crops in the W-B.

Sustainable Technical Potential of Biomass versus Biomass Consumption

When including energy crops, unconsumed biomass potential, is estimated to be 9 Mtoe. Of this potential, 9% is woody biomass and 91% is agricultural biomass and dedicated energy crops (see Figure 24).

When excluding energy crops, the sustainable technical potential of biomass for heating in the W-B region is around 7 Mtoe annually[51] (see Table 13). The highest value can be found in Serbia (3 Mtoe), followed by

Figure 24: Unconsumed Biomass Potential, including Energy Crops



Note: Scenario assumes the use of 1% of other wooded land and unused agricultural land for growing dedicated energy crops.

50 Allen et al. 2014).

51 Energy crops have been excluded for the assessment of *currently available* biomass because energy crops represent potential that requires time to develop.

Table 13: Sustainable Biomass Supply, excluding Energy Crops, 2013

	Sustainable technical potential of woody biomass (ktoe)	Small grain cereals (ktoe)	Maize (ktoe)	Oil crops (ktoe)	Sustainable technical potential of agri-biomass (ktoe)	Sustainable technical potential of biomass—TOTAL (ktoe)	Actual biomass consumption (ktoe)	Unconsumed potential of biomass (ktoe)
ALB	254.9	15.5	67.0	0	82.5	337.4	332.0	5.4
BIH	1,178.9	24.6	120.8	0	145.4	1,324.3	1,141.0	183.3
CRO	1,136.2	79.0	291.0	43.3	413.3	1,549.5	664.0	885.5
FYROM	293.4	0.0	21.3	0	21.3	314.7	270.0	44.7
KOS	216.0	47.6	20.2	0	67.8	283.8	441.0	–157.2
MNE	347.7	0	0	0	0.0	347.7	147.0	200.7
SER	1,668.3	305.9	864.9	132.4	1,303.2	2,971.5	1,551.0	1,420.5
Total W-B region	**5,095.4**	**472.6**	**1,385.2**	**175.7**	**2,033.5**	**7,128.9**	**4,525.0**	**2,603.9**

Croatia (1.5 Mtoe) and Bosnia and Herzegovina (1.3 Mtoe). The sustainable technical potential of biomass in Albania, FYR Macedonia, Kosovo, and Montenegro is around 0.3 Mtoe.

When energy crops are excluded, 71% (5 Mtoe) of the sustainable technical potential of biomass is attributed to woody biomass and 29% (2 Mtoe) to agricultural biomass. **Unconsumed biomass potential, excluding energy crops**, is estimated at 2.6 Mtoe (see Table 25).

Figure 25: Sustainable Technical Potential of Biomass, by Type, and Estimated Actual Biomass Consumption, excluding Energy Crops, 2013

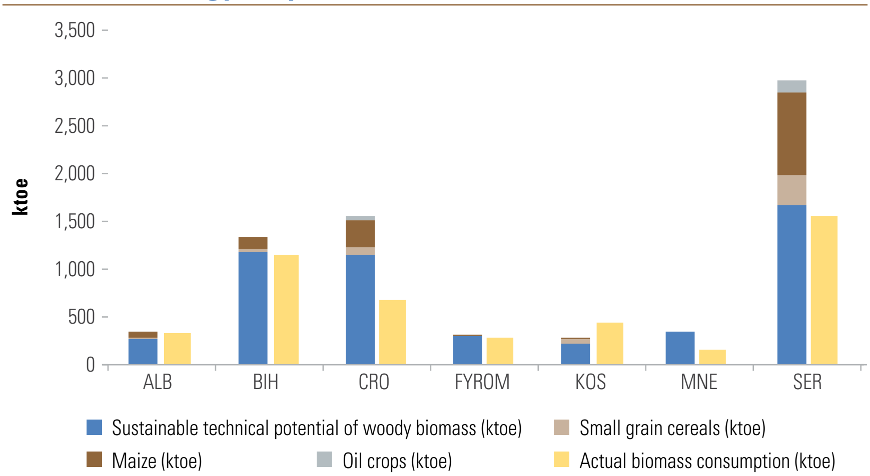
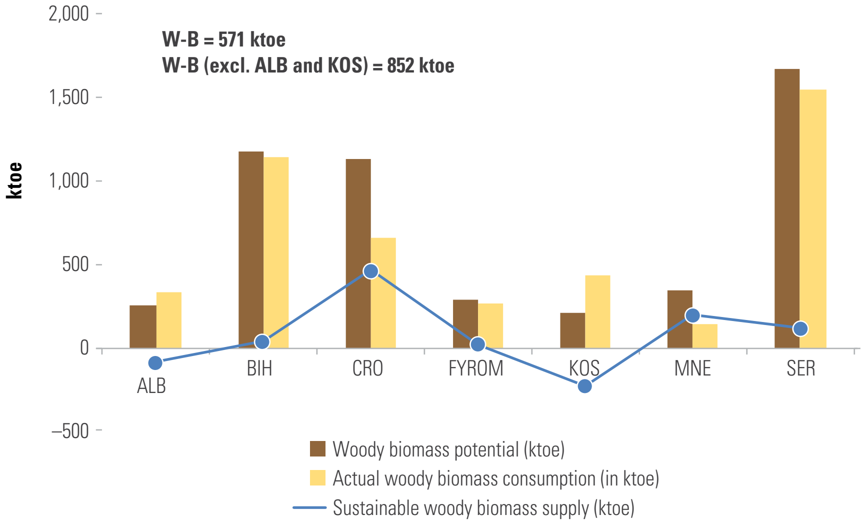


Figure 26: Unconsumed Potential of Woody Biomass

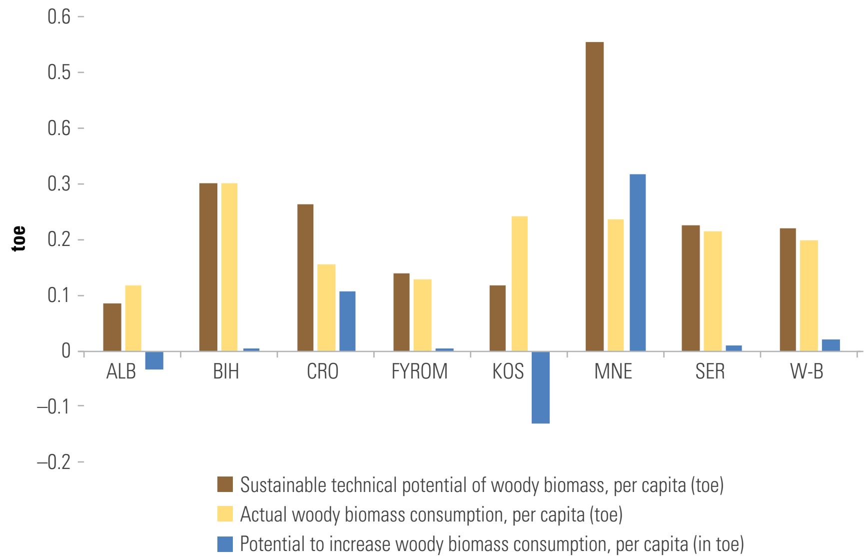


With regard to woody biomass, the balance of—that is, the gap between—the sustainable technical potential of woody biomass and total actual woody biomass consumption in the W-B region in 2013 was 3.71 million m^3, or 571 ktoe of woody biomass. Even though 75% of the sustainable technical potential of woody biomass is already used, it should be highlighted that if one considers only the countries with a positive balance between the annual forest growth increment and current use, the balance—5.1 million m^3 (852 ktoe)—is higher. The countries with positive balances include Croatia (2.74 million m^3), Montenegro (1.12 million m^3), Bosnia and Herzegovina (0.81 million m^3), Serbia (0.38 million m^3), and FYR Macedonia (0.048 million m^3), as shown in Figure 26.

Based on the best available data and on EU sustainability requirements, in 2013 the consumption of woody biomass in Kosovo and Albania was unsustainable and should be decreased to sustainable levels. Consumption would need to be scaled down 36% in Kosovo, and 2% in Albania, to reach a level that allows for sustainable annual production. It should be noted that inappropriate distribution of consumption is the main sustainability challenge in Kosovo and Albania: current consumption is based on the use of stemwood, while logging residues and thinnings remain untapped. Shift of consumption toward larger use of wood residues would help in improving biomass supply in these countries.

The sustainable technical potential of biomass (excluding energy crops), per capita, is highest in Montenegro (0.55 tons of oil equivalent, or toe), where biomass could cover almost 50% of the total final energy consumption. In Serbia, the sustainable technical potential per capita is 0.41 toe and

Figure 27: Potential to Increase Woody Biomass Consumption, per Capita



in Croatia 0.36 toe. In Kosovo, FYROM, and Albania, the per capita potential is significantly lower at 0.16, 0.15, and 0.12 toe, respectively.

On a per capita basis the unconsumed potential, that is, the potential for additional increase in biomass consumption (for any type of use) in the W-B is 54%. The highest potential is in Croatia, Montenegro, and Serbia, which have the opportunity to increase biomass consumption by 134%, 131%, and 90%, respectively. FYR Macedonia has the potential for an increase of 15%, and Bosnia and Herzegovina 14%.

The W-B region could increase the supply of woody biomass by 11% on average (with a wide range, from 134% in MNE to only 2% in BiH), without compromising sustainability levels (see Figure 27. As noted above, in Kosovo and Albania the use of woody biomass would need to be reduced to reach a sustainable level of consumption.

Additional Heating Use Potential of Biomass

This section provides information on the 954 ktoe additional heating use potential, that is, the supply of sustainable biomass in the Western Balkans that is both available (following actual consumption) and suitable for supplying an increase in biomass-based heating. It also takes into account biomass use for energy purposes other than heating—production of biofuels and electricity.

As noted above, most of the sustainable technical potential of woody biomass in W-B countries is already used. However, additional supplies of woody biomass can be obtained from currently unused wood biomass residues—logging residues, thinnings, wood found outside the forest, prunings of fruit trees and vineyards, and wood from conversion of coppices. Agricultural biomass, a currently untapped resource, could also be used for biomass heating.

Where a large area of unused agricultural land exists, dedicated energy crops could be grown on the unused land, thus representing significant potential for increased biomass supply. Since dedicated energy crops require time to develop, and separate analysis is needed to formulate recommendations on sustainability of energy crops in the W-B, they were not considered for the supply of biomass-based heating in the short term.

In the assessment of additional heating use potential of biomass for residential-scale appliances, only woody biomass residues are considered for fuel supply; stemwood is not included because it is higher-quality wood suitable for industrial applications. By contrast, DH/CHP plants can be fueled by both woody and agricultural biomass.

Agricultural biomass and energy crops are excluded from consideration as a fuel for residential heating because of technical problems that can arise from the use in domestic appliances of pellets made from agricultural biomass and dedicated energy crops (poplar, miscanthus, wheat straw), as they show slagging[52] tendencies. Slag formation on grates and in burners is of special relevance for smaller units because it reduces accessibility and combustion performance. Silicon-rich fuels, such as wheat straw, often cause slagging because of the low melting temperature of silicates. In addition, alternative pellet materials may cause higher emissions and toxicity.[53]

The higher particulate emissions generated by burning short-rotation coppices must be considered when promoting their widespread use as a biomass fuel for residential heating, in which filters are not applied for PM emission control. They are better used in large-scale biomass combustion plants, which apply electrostatic precipitators or baghouse filters for particle removal.

The long-term use of alternative fuels (miscanthus, wheat straw) in residential-scale appliances will require technological advances in both burners and filtration. Therefore, available agricultural biomass and potential for dedicated energy crops (miscanthus) in W-B countries are considered for DH/CHP use only.

Combustion of biomass with high chloride concentrations (over 1,000 micrograms per gram, or μg/g) can lead to increased ash fouling. High chloride content leads to the formation of hydrochloric acid in the boiler tubes, resulting in corrosion that can lead to tube failure and water leaks in the boiler. Because this has been observed with corn stover (that is, residue left

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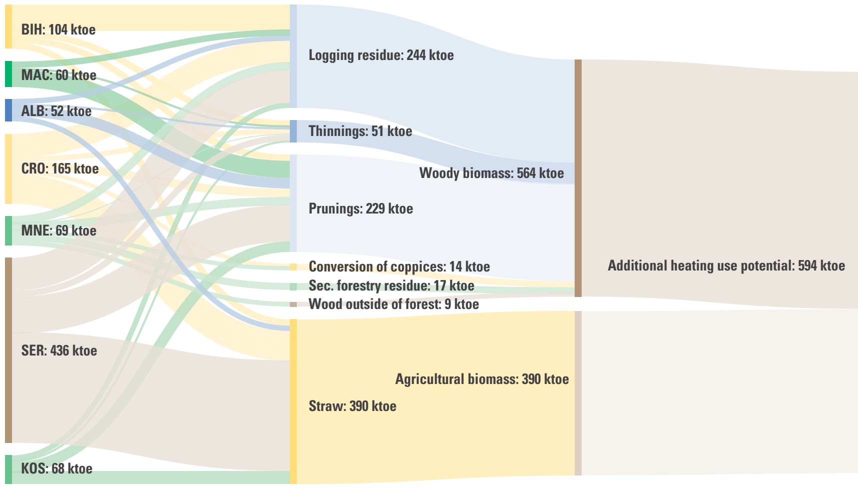
52 *Slagging* is formation of molten or partially fused deposits on the grate or chimney; the slagging may reduce the lifetime of the equipment and decrease its thermal efficiency due to higher pressure drops in the stack.

53 Kasurinen and others 2015.

Figure 28: Additional Heating Use Potential of Biomass



Source: Consultant data.

after harvest),[54] maize residues are not considered to supply increased biomass-based heating in the Western Balkans.

Biomass types considered as suitable for heating are presented in Table 14.

When excluding agricultural biomass and energy crops as a fuel for residential heating, and taking into account that growing energy crops on unused agricultural land requires time to develop and establish supply chains, we arrive at the amounts of additional heating use potential of biomass in the W-B countries, as presented in Figure 28 and Tables 15 and 16.

Table 14: Assessed Biomass Types Suitable for Heating

Included	Excluded
Woody biomass residues	Woody biomass
Thinnings	Stemwood
Logging residue	Energy Crops
Secondary forestry residue	Miscanthus
Wood outside of forest	
Conversion of coppices	
Prunings of vineyards and fruit trees	
Agricultural biomass	
Straw (small grain cereals and oil crops)	

[54] Clarke and Preto 2011. Retrieved from http://www.omafra.gov.on.ca/english/engineer/facts/11–033.htm.

Table 15: Assessment of Additional Heating Use Potential of Biomass (ktoe)

Biomass type	ALB	BIH	CRO	FYROM	KOS	MNE	SER	Total W-B region
Thinnings*	6	12	11	2	1	1	18	50
Logging residue	9	61	54	15	12	17	76	244
Secondary forestry residue	0	0	0	0	0	17	0	17
Wood outside of forest	0	0	0	0	0	9	0	9
Conversion of coppices	0	0	8	0	0	6	0	13
Prunings of vineyards and fruit trees	27	16	19	43	26	19	79	229
Woody biomass residues	**42**	**89**	**91**	**60**	**39**	**68**	**173**	**564**
Straw (small grain cereals and oil crops)	10	15	73	0	29	0	263	389
Agricultural biomass	**10**	**15**	**73**	**0**	**29**	**0**	**263**	**390**
Total	**51**	**104**	**164**	**60**	**68**	**68**	**435**	**954**

* Consultant estimate. However, many forest areas in W-B countries are underthinned and undermanaged, and could provide more woody biomass from thinnings.

Table 16: Overview of New Heating Capacity that Can be Supplied with Additional Heating Use Potential of Biomass

Installed heating capacity (MW) that could be supplied…	ALB	BIH	cro	FYROM	KOS	MNE	SER	W-B
…with woody biomass	224	380	361	240	126	266	551	2,148
…with agricultural biomass	63	64	290	—	107	—	839	1,363

5

Economic and Financial Impact of Biomass-Based Heating

This chapter discusses the barriers preventing greater use of biomass for heating in the Western Balkans. These include the cost of biomass feedstock, the economic and financial viability of biomass heating options, and the economic and financial impact of biomass-based heating. The chapter concludes with a discussion of the economic potential for increasing the use of biomass for heating in the region.

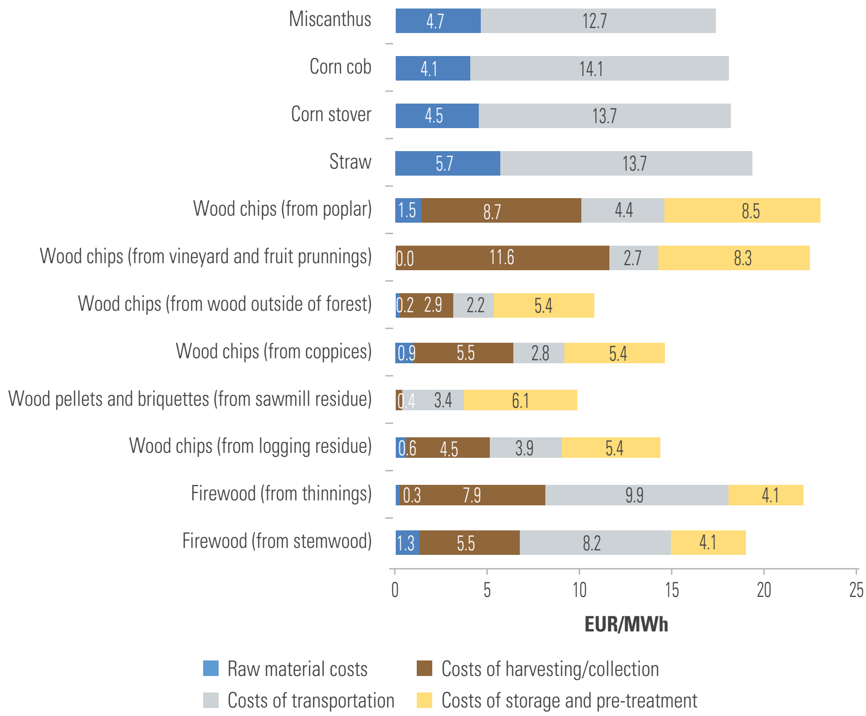
Costs of Biomass Feedstock and Heating Equipment

To evaluate the suitability of various biomass feedstocks for biomass heating in the Western Balkans, the study first calculated the costs of available residue streams from agriculture and forestry. (This was done across value chains, and included production and logistics costs—that is, the cost of harvesting and collection, processing, transport, and storage.) Then, to investigate the economic and financial viability of different biomass heating options, the study team assessed the cost-effectiveness of each.

The production cost of biomass for heating in the Western Balkans is in the range of EUR 9.2–27.4 per MWh, for transport distances up to 50 km. This reveals that biomass is relatively cheaper compared to traditional fuels, whose cost is in the range of EUR 10.4–131.7 per MWh.

Biomass heating systems depend on the simultaneous nearby availability of heat consumers and biomass feedstock. At the same time, transport costs represent a significant proportion of the total delivered cost of the heat. Thus, a short, manageable transportation distance for biomass feedstock is an essential component of a viable biomass heating system as (see Figure 29).

Figure 29: Structure of Production Costs of Biomass for Heating, with Transport <50 km



Source: Own elaboration.
Note: The costs of harvesting and collection of the agricultural residues and energy crops are included in the costs of the raw material.

To identify the most cost-effective bio-based heating options in each W-B country, the team compared biomass heating options with conventional heating options using the levelized cost of heat (LCOH) (see Figure 30).

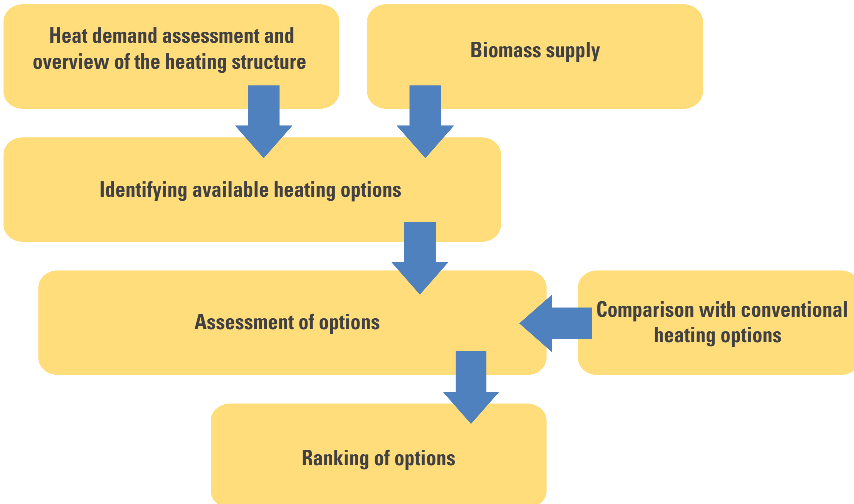
The assessment was done from two perspectives: that of an individual decision maker or consumer (the financial analysis), and that of the wider society (the economic analysis). The following definitions were used:

- **Financial (private) costs** are the costs facing end-users. Based on actual market prices, they are assessed based on principles of financial analysis.[55]
- **Economic (social) costs** include the costs of externalities (that is, GHG emissions and local air pollution effects) and are evaluated based on the principles of economic analysis, which measures the costs and benefits of heating to the community.[56]

55 VAT is included where subject to payment. The cash flows are discounted with a country-specific WACC.

56 VAT is *not* included, and the cash flows are discounted with a 10% discount rate in all W-B countries.

Figure 30: Approach in Assessing the Cost-Effectiveness of Biomass Heating Options



The biomass market in the Western Balkans is developing: certain kinds of biomass are already traded on the market, while others are not yet traded (for example, energy crops, prunings, logging residues, straw, corn stover). Because our economic viability analysis was based on the market prices of biomass fuels, it considered only biomass fuels currently sold on the market: firewood, wood chips (forest residues), straw, and wood pellets.

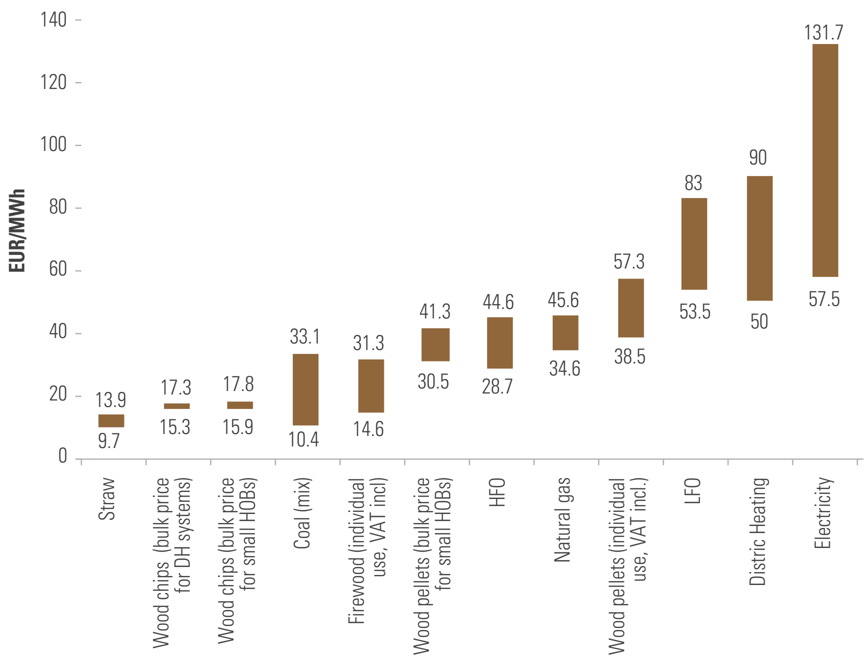
The market prices of the various biomass and conventional fuels, DH, and capital costs of heating equipment in the Western Balkans, presented in Figure 31 and Figure 32, were compiled from various information sources. As Figure 31 below shows, straw and wood chips are the most competitive biomass fuels, while coal is the cheapest conventional fuel for heating. Electricity is by far the most expensive option for heating.

Economic Viability of Biomass Heating Options

The team compared the economic viability of the biomass heating options against that of conventional heating options from the perspective of two types of customer: a customer in a *stand-alone building* in the residential sector, and a customer in the *multistory building* in the residential, commercial-industrial, and public sectors. Viability was evaluated for new systems, for retrofitting of DH, and for systems using small HOBs.

Stand-alone buildings in the W-B typically use small HOBs and individual devices and stoves for heating. Two demand situations were addressed for stand-alone buildings:

Figure 31: Market Prices of Biomass, Conventional Fuels, Electricity and DH, VAT Included



Source: Market prices of biomass fuels are derived from the timber trade database of the Faculty of Forestry in Belgrade. These are the retail prices paid by the end consumers at the producer's place of business (that is, a warehouse). The prices do not include transportation costs from the place of sale (the warehouse) to the place of application. The market price of straw is based on the price of straw achieved in bilateral negotiated deals in Vojvodina (Serbia), where straw is traded for energy purposes. Prices of conventional fuels are derived from statistical sources, and VAT is added. The district heating price includes both fixed and variable costs, while the biomass and conventional prices represent only the energy or fuel costs.

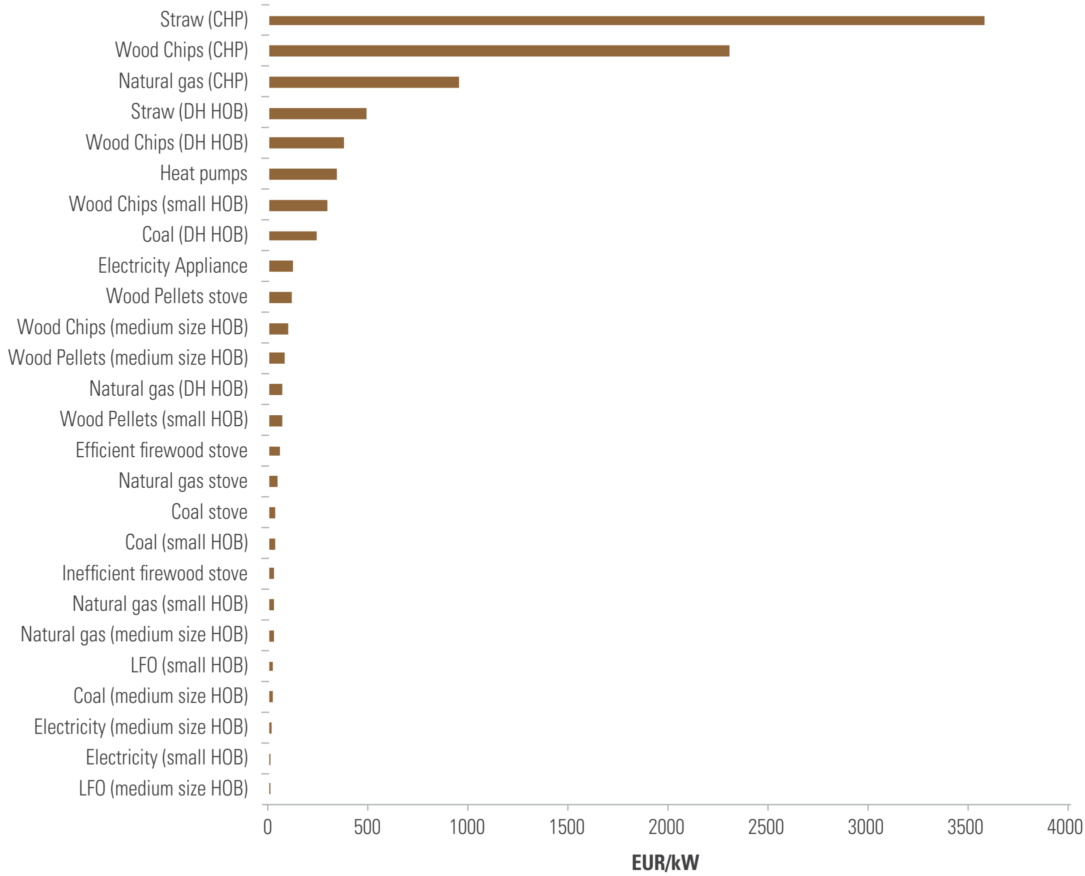
- Buildings with internal network in place.
- Buildings that currently use stoves or electricity appliances for heating and do not have an internal network in place (here, capital costs for building the internal network were added).

Multistory buildings use district heating, small HOBs, and individual electricity devices. Multistory buildings in Bosnia and Herzegovina, Croatia, Kosovo, FYR Macedonia, and Serbia are assumed to have a building-level heating system in place because in these countries internal building networks are typically installed when the buildings are first erected. In Albania and Montenegro, where this is not the case, internal network costs are added to capital costs for construction of new DH systems and new small HOBs.

Figure 33 shows the heating options whose economic viability was assessed.

In general, the most both economically and financially competitive heating options compared to biomass heating options are coal-based technologies, due to their low capital costs and low fuel costs. Electricity and LFO options are generally not economically competitive with biomass options. Natural gas

Figure 32: Capital Cost of Heating Equipment



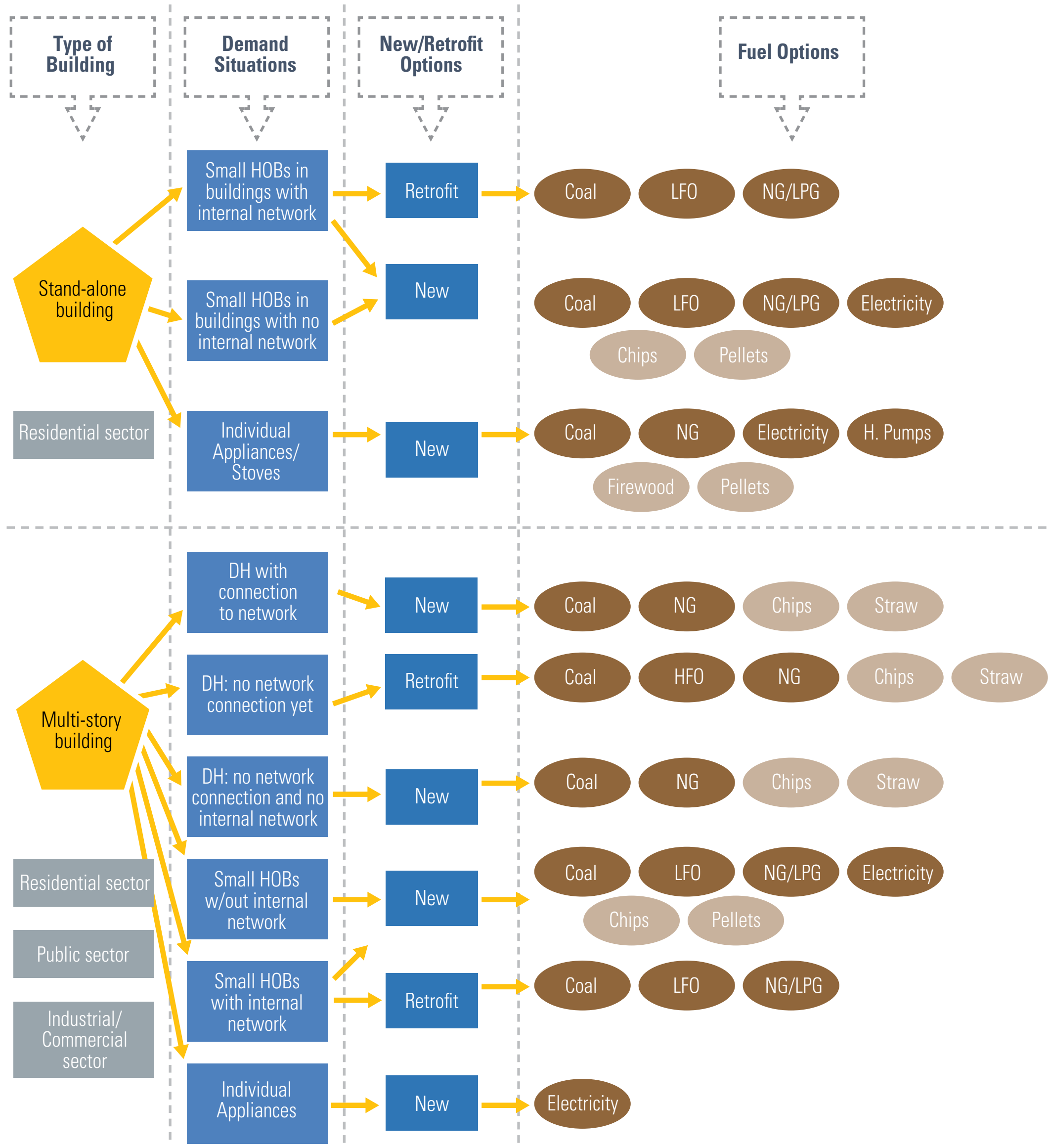
Source: Consultant data based on market survey of the heating equipment. DH HOB and CHP equipment is mainly imported from the EU, and costs are similar across the region (prices vary slightly due to tax regimes and other specific market factors; however, these differences are minor). Presented capital cost includes investments in the equipment and fuel storage, while distribution network costs, costs of connection to the network, and internal heating network costs (radiators) are not included. Costs of medium-size HOBs (<500 kW), small HOBs (<50kW), and individual heating appliances are average values of the capital costs across the W-B, and do not include costs of building internal heating network (radiators).

options are still competitive to wood pellet options, especially in the small HOBs, and individual stove segments.

Coal-based technologies have high economic LCOH because of the high costs of the externalities[57]. It is evident that some coal options (new

[57] Externalities typically include environmental effects, such as air pollution, GHG emissions, noise, soil contamination, water pollution, eco system degradation. Adopted value of CO_2 externalities is 11.29 EUR/tCO_2eq, based on the lower value estimated by the World Bank for 2015. Adopted value of air pollution externalities from electricity generation in EUR/MWh is ALB-1.29, BIH-5.29, CRO-3.24, FYROM-6.93, KOS-8.88, MNE-4.86, SER-5.74. Adopted value of air pollution externalities from heat generation are differentiated based on the fuel use and scale of operation, in EUR/MWh: coal—3.92 (DH), 5.02 (small HOB), 10.75 (ind. appli-

Figure 33: Matrix for Comparing Cost-Effectiveness



Source: Market prices of biomass fuels are derived from the timber trade database of the Faculty of Forestry in Belgrade. These are the retail prices paid by the end consumers at the producer's place of business (that is, a warehouse). The prices do not include transportation costs from the place of sale (the warehouse) to the place of application. The market price of straw is based on the price of straw achieved in bilateral negotiated deals in Vojvodina (Serbia), where straw is traded for energy purposes. Prices of conventional fuels are derived from statistical sources, and VAT is added. The district heating price includes both fixed and variable costs, while the biomass and conventional prices represent only the energy or fuel costs.

ance); HFO/LFO—4.37 (DH), 4.77 (small HOB), 5 (individual); natural gas—1.65 (DH), 1.79 (small HOB), 2.08 (ind. appliance); biomass—3.68 (DH), 4.12 (small HOB), 4.8 (ind. appliance).

coal-burning small HOBs, existing coal-burning small HOBs that have been optimized,[58] and coal stoves) are the most viable from a financial perspective (private costs), whereas other, biomass based, options (such as new wood-chip–fired small HOBs and the fuel conversion of coal-, LFO-, LPG-, and NG-burning small HOBs into wood-chip–fired small HOBs) are the most viable from an economic perspective. It is thus recommended that incentives be introduced in order to motivate households, SMEs, industries, and public sector entities to invest in such biomass technologies.

More-sophisticated biomass DH technologies, such as new CHPs that burn straw and wood chips, have higher specific capital costs and are thus less-viable options.

The results of our analysis are summarized in the following graphs for stand-alone and multistory buildings, respectively. The options are ranked by average economic cost and expressed in euros per MWh. The "Low-High range" refers to the lowest and highest value calculated for the seven countries in the W-B region for the base-case LCOH scenario for each option.

As Figure 34 shows, the most economically viable heating option in the Western Balkans ***for stand-alone buildings in the residential sector*** is the use of efficient firewood stoves, followed by wood-chip–fired small HOBs (this includes coal- and LFO-, LPG-, or NG-fired small HOBs converted into wood-chip–fired small HOBs as well as new, wood-chip–fired small HOBs).

As Figure 35 shows, the most cost-effective options for ***multistory buildings (commercial-industrial, public, and residential)*** are the conversion of coal-LFO- LPG- or NG-fired small HOBs into wood-chip–fired small HOBs or the use of new, wood-chip–fired small HOBs. This is followed by coal-fired small HOB options, namely, the optimization of existing HOBs or the use of new small HOBs.

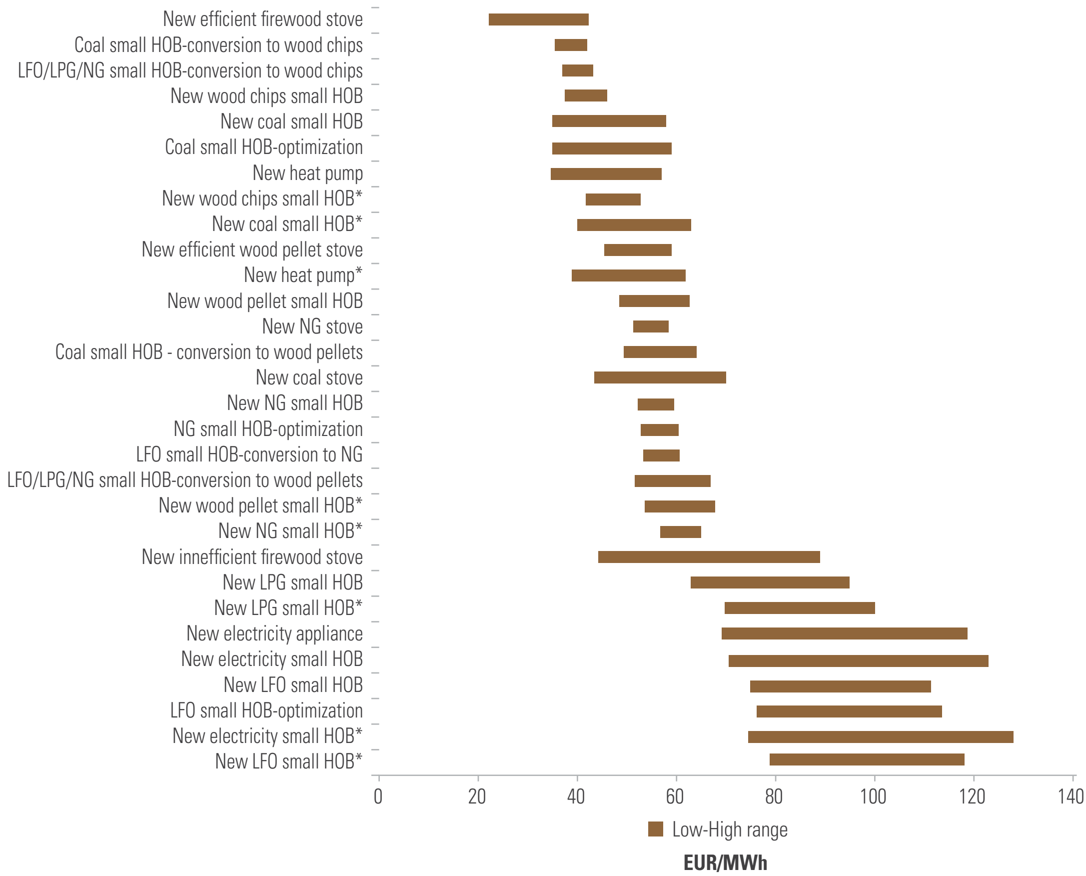
The economic viability of biomass heating options, compared to that of the fossil fuel and electricity options, is presented in Figure 36. The left side presents biomass-based heating options that are compared to the heating options listed in the top row. The figure uses a "traffic light" system (see legend) to demonstrate the cost-effectiveness of each heating option.

The key factors driving the both economic and financial cost-effectiveness of biomass technologies are as follows:

- **Fuel costs:** Biomass heating is made more attractive by the increasing prices and environmental impacts of fossil fuels and electricity, along with the decreasing prices of biomass fuels (in relative terms, because of the

[58] The thermal efficiency of a DH plant declines with use. However, much of this efficiency loss can be recovered through optimization—that is, onsite improvements to the boiler and associated equipment—without fuel conversion (that is, the fuel type does not change).

Figure 34: Ranking of Different Heating Options for Stand-Alone Buildings, by Economic Viability



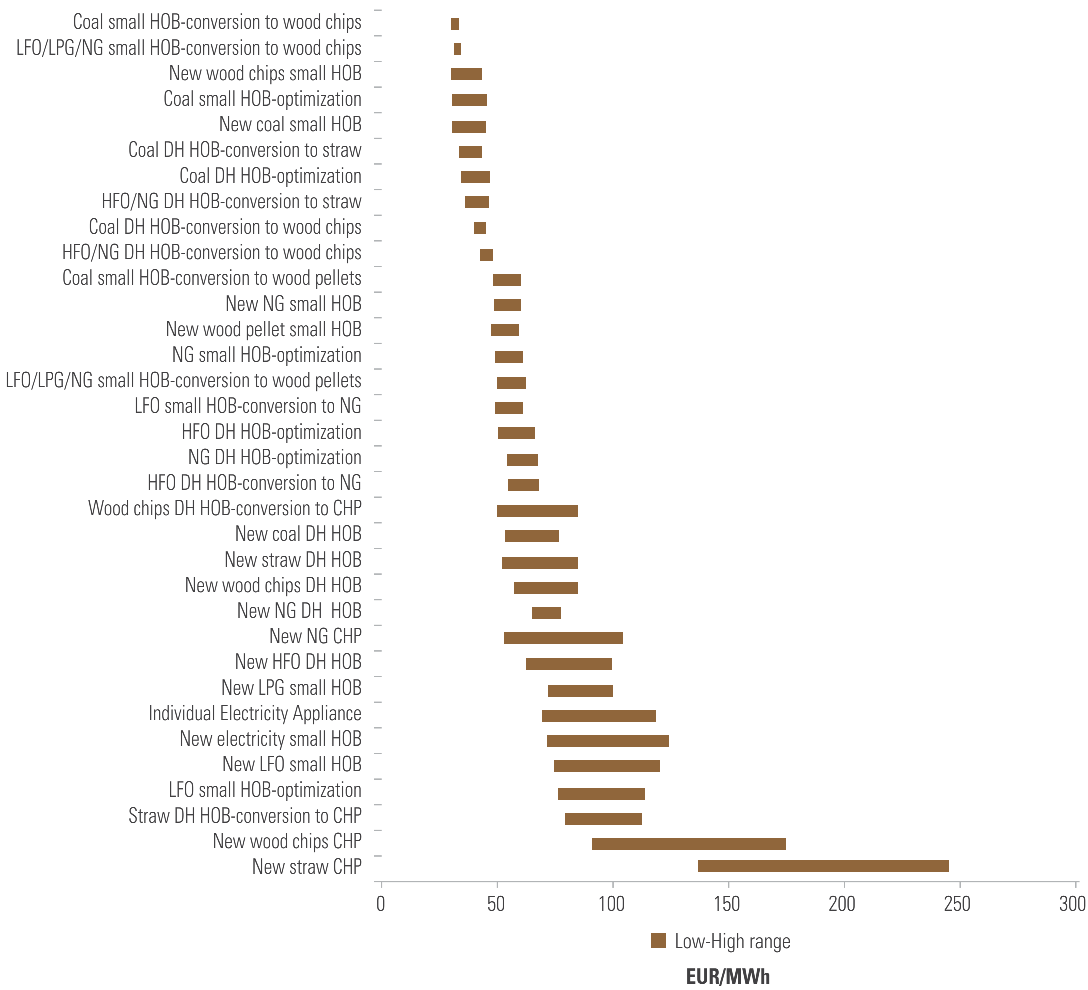
* Includes the cost of building a new internal heating network.

expected increase in productivity of biomass production, combined with market development).

- **Capital costs**: Currently, one of the main disadvantages of biomass heating options is the higher capital cost when compared to conventional heating options. With the increase in productivity and greater involvement of local suppliers, biomass technology capital costs are expected to decrease.
- **Full load equivalent operating hours (FLEOH),**[59] if lower, lead to higher capital and operations and maintenance (O&M) costs per unit of heat produced. Technologies with higher capital and O&M costs—such as the biomass DH, CHP, and small-HOB technologies—are thus at a disad-

59 The equivalent number of hours during which a technology runs at full capacity to generate heat over one year.

Figure 35: Ranking of Different Heating Options for Multistory Buildings, by Economic Viability



* Includes the cost of building a new internal heating network.

vantage when the FLEOH decreases (in areas with a milder climate, for instance). That is also a possible risk inherent in climate change effects. The production and distribution of the domestic hot water[60] could help

[60] In Bosnia and Herzegovina, domestic hot water (DHW) is produced mainly in individual gas-fired or electric heaters. There are only few cases (mainly in Sarajevo) where the hot water is produced and distributed by the DH company. In the major systems in Zagreb, Croatia, DHW is produced in the DH substations. The distribution system operates 365 days per year providing DHW, while the space heating is turned off at the substations outside the heating season. As metering and thermostatic valves are being installed, the space heating can potentially continue year-round as well, improving the quality of supply and leaving it to the consumers to decide when

Figure 36: Economic Viability of Biomass Heating Compared to Conventional Heating Options

Heating option	Coal	HFO/LFO	NG	Electricity	Heat Pumps	Firewood Inefficient Stove
New DH HOBs						
Wood chips	● (blue)	● (brown)	● (brown)			
Straw	● (blue)	● (brown)	● (brown)			
New CHPs*						
Wood chips			● (blue)			
Straw			● (blue)			
Retrofitting DH HOBs (Fuel Conversion)						
Wood Chips	● (blue)	● (brown)	● (brown)			
Straw	● (yellow)	● (brown)	● (brown)			
New Small HOBs						
Wood chips	● (brown)	● (brown)	● (brown)	● (brown)		
Pellets	● (blue)	● (brown)	● (brown)	● (brown)		
Retrofitting Small HOBs						
Wood chips	● (brown)	● (brown)	● (brown)			
Pellets	● (blue)	● (brown)	● (blue)			
New Individual Heating						
Firewood (Efficient Stove)	● (brown)		● (brown)	● (brown)	● (brown)	● (brown)
Pellet stove	● (blue)		● (brown)	● (brown)	● (yellow)	● (brown)

LEGEND ● (brown) Biomass heating more cost-effective than conventional; ● (blue) Biomass heating less cost-effective than conventional; ● (yellow) Biomass heating similarly cost-effective as conventional

* The analysis of CHP options considered only environmentally superior solutions to currently existing heating options. Thus, only natural gas is taken into consideration, whereas coal and HFO CHP are not.

the DH companies by increasing FLEOH; it could also serve as a basis for the future production of combined heat and power by extending district heating into an all-year operation. Also, biomass heating units could be downsized to increase FLEOH, and combined with other forms of renewable energy (such as wind and solar) in hybrid systems.

- **Conversion efficiencies**: Conversion efficiencies in fuel use significantly impact the total costs of heating technologies that are more sensitive to

heating is needed. For other DH systems in Croatia, no DHW is produced in the DH substations currently. In Kosovo, there are no DHW installations in the district heating systems, and the space heating building installations are owned by the owners of the buildings. In Serbia, only small parts of the DH systems in Belgrade and Novi Sad supply DHW to consumers. However, in general, no DHW is produced and distributed in the DH substations in Serbia.

fuel costs, such as small HOBs and individual heating systems. The high conversion efficiency of efficient firewood stoves make them by far the most preferred solution for individual heating.

District Heating

The construction of new DH systems is capital intensive, and the results of the economic analysis are highly sensitive to higher capital costs. The high capital costs of biomass DH HOBs cannot be easily offset by the low costs of biomass fuels and relatively lower costs of externalities. The capital costs of wood-chip–fired DH HOBs are by 50% higher than coal-fired DH HOBs, while the capital costs of straw–fired DH HOBs are two times those of coal-fired DH HOBs. Our sensitivity analysis[61] of the main factors affecting the viability of biomass DH revealed the following:

- A 20% decrease in FLEOH is weakening the economic viability of biomass DH, and coal DH systems are becoming a more favorable option.
- A 10% reduction in capital costs of new biomass DH technologies would make biomass DH technologies preferable to coal-fueled DH systems.
- A 10% reduction in biomass fuel costs, or a 22% increase in coal prices, would make biomass-fueled DH systems preferable to coal-fueled ones.

The retrofitting of DH systems, combined with their conversion from fossil fuels to biomass (using straw or wood chips), is in most cases the preferred option. Only coal-fired DH optimization is more economically viable than a conversion into biomass fuels. Here, the sensitivity to fuel costs is highest. Thus, the heating options with HFO and natural gas are least cost-effective.

[61] The assessment of cost-effectiveness of biomass heating options included analysis of sensitivity to changes in the following key input parameters, based on the expected developments of the markets within next 10-year period (World Bank Commodity Markets Outlook projections are used, except in case for coal, HFO and LFO, where DECC projections specifically refer to these types of fuels): (a) changes in FLEOH: 20% decrease in FLEOH due to global warming effect, resulting in decreased heat demand (b) changes in biomass fuel price: 10% increase and decrease (c) changes in fossil fuel prices: 15% for HFO and LFO (based on the Fossil Fuel Price Projections, September 2014, UK Department for Energy and Climate Change); coal price increase of 22% (Fossil Fuel Price Projections, Sept. 2014, UK Department for Energy and Climate Change); natural gas and LPG prices stay on same levels (Commodity Markets Outlook, April 2016, World Bank Group); electricity price increase by 30% due to assumed introduction of carbon tax; (d) changes in capital costs of heating technologies: 10% decrease for DH HOB; 20% decrease for heat pumps; and 50% increase for small HOBs and individual appliances (except heat pumps).

Combined Heat and Power

Biomass CHPs are not economically viable option compared to natural gas CHPs.[62] This is for two reasons: the significantly higher conversion efficiency of natural gas CHPs, and lower capital costs compared to biomass CHPs.

Heat-Only Boilers

Regarding small HOBs used in stand-alone and multistory buildings, the economic analysis demonstrated that wood chips is the preferred fuel option in all consumption sectors and across the W-B region. Wood pellets, typically used in small HOBs, are more economical than natural gas and less cost-effective than coal. Small HOBs that use wood chips and wood pellet are both preferred options compared to electric appliances and small HOBs that use LFO, and this advantage will grow further with expected increase in fossil fuel costs.

Retrofitting of small HOBs that use fossil fuels, with fuel conversion into wood chips, is the most cost-effective option. The relatively high capital costs of wood-chip–fired small HOBs are offset by the lower costs of fuel. On the other hand, fuel conversion into wood pellets is a less cost-effective option, mainly because of the high prices of wood pellets

For small HOBs, the cost-effectiveness is mainly driven by fuel costs. Small HOBs that use wood pellets become more cost-effective than coal-fueled small HOBs under the scenario of increased fossil fuel prices (that is, a 22% increase in the price of coal).

Individual Heating Systems

When it comes to individual heating systems, efficient firewood stoves are by far the most economical solution for stand-alone buildings. Because of their greater conversion efficiency, their cost-effectiveness is more than twice as high as that of inefficient firewood stoves.

It is also more viable to replace inefficient firewood stoves with wood-chip–fired small HOBs, even if the internal network is not in place and must be developed.

Efficient firewood stoves and wood-chip–fired small HOBs are preferable to coal-burning small HOBs (if an internal network already exists) and coal stoves, while all biomass-fueled individual heating systems (efficient firewood stoves, small HOBs fueled by wood chips and wood pellets, and wood-pellet stoves) are more cost-effective than electric appliances.

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62 Biomass-fired CHPs are compared only to natural gas–fired CHPs because coal- and HFO-fired CHPs are seen as environmentally inferior solutions to the region's current heating challenges.

A detailed list of economically viable options for biomass heating in each W-B country is presented in the Appendix A.

Financial Viability of Biomass Heating Options

From the perspective of the end-consumer in the Western Balkans (that is, private costs), the financial saving generated by introducing biomass heating is very significant. In most cases, replacing an existing heating system with a biomass-based heating technology can significantly reduce costs.

However, in some cases, the financial costs of the technologies currently used for heating (such as coal) are lower than the costs of biomass heating. This difference, when compared to the results of the economic analysis, is mainly the result of the exclusion of externalities from the financial analysis. In such cases—where the results of the financial analysis show that economically viable biomass heating option is not financially viable—incentives could be provided for the utilities and consumers to realize the investment, as the benefits for the society overweigh the costs of the introduction of biomass heating.

Table 17 provides an overview of cost reduction from the introduction of biomass heating—that is, how much could be saved during the economic life of the heating system by replacing current heating systems with biomass-based heating. The fields marked in blue indicate that the financial analysis shows that biomass option is not viable for the end-consumer, but is economically viable from a social perspective. In such cases, incentives would need to be provided for the end-consumers in order to realize the investment.

Summary of Viability of Biomass Heating Options

As shown in previous analysis, there is substantial potential for economic and financial savings to accrue from increased use of biomass heating in the Western Balkans, given that expensive technologies and fuels or energy sources (including electricity, LFO, and HFO) are widely used.

The economic benefits of replacing current conventional technologies[63] with efficient biomass technologies are driven primarily by two factors: the relatively high specific consumption of heat energy in the region, especially in the public sector (hospitals and schools); and the high social costs of electricity and fossil fuel technologies.

In summary, the economic and financial analysis indicates the following as the most attractive biomass heating options in stand-alone buildings and

[63] Conventional technologies include both fossil fuel (coal, HFO/LFO, and NG/LPG) and electricity technologies.

Table 17: Savings on Financial Costs Because of Replacement of Current with Biomass Heating

Economically viable heating option	ALB	BIH	CRO	KOS	MK	MNE	SER
Stand-alone buildings							
Individual electric appliance – replacement with efficient firewood stove	74%	54%	65%	45%	55%	62%	40%
Inefficient firewood stove – replacement with efficient firewood stove	51%	53%	53%	53%	53%	53%	53%
LFO small HOB – conversion to wood chips	61%	56%	60%	54%	49%	57%	62%
LPG small HOB – conversion to wood chips	31%	—	47%	58%	—	—	—
Coal stove – replacement with efficient firewood stove		–19%	—	–33%	—	–5%	15%
Coal small HOB – conversion to wood chips	—	–32%	—	—	—	—	2%
Individual electric appliance – replacement with efficient wood pellet stove	43%	40%	51%	29%	32%	51%	12%
NG small HOB – conversion to wood chips	—	—	21%	—	8%	—	28%
NG stove – replacement with efficient firewood stove	—	—	—	—	—	—	34%
Multistory buildings							
Individual electric appliance – replacement with wood chips small HOB	52%	63%	77%	55%	67%	64%	53%
Individual electric appliance – replacement with wood pellet small HOB	36%	42%	59%	34%	40%	50%	22%
LPG small HOB – replacement with wood chips	49%	—	58%	66%	—	—	—
LFO small HOB – replacement with wood chips	70%	63%	66%	62%	56%	—	68%
Coal small HOB – conversion to wood chips	—	–7%	—	—	—	–37%	5%
NG small HOB – replacement with wood chips small HOB	—	63%	35%	—	—	—	40%
DH coal HOB – conversion to straw	—	–23%	—	—	—	—	4%
DH NG HOB – conversion to straw	—	—	23%	—	—	—	47%
DH NG HOB – conversion to wood chips	—	—	—	—	19%	—	—
DH HFO HOB – conversion to straw	—	—	27%	23%	—	—	41%

multistory buildings connected, and not connected, to district heating systems, respectively:

D. For stand-alone buildings

- Efficient solid wood fire wood stoves are the most economically viable option to introduce biomass heating in all seven countries

- However, in comparison to coal stoves, efficient solid wood stoves are not financially viable in Bosnia and Herzegovina, Kosovo, and Montenegro, and therefore in these countries some incentives would need to be provided in order to introduce biomass heating.

E. For multistory buildings not connected to DH
- New wood chip small HOBs are the most economically viable option to introduce biomass heating in all countries, except Kosovo where new coal HOBs are somewhat more attactive even in an economic comparison.
- However, in comparison to coal HOBs, new wood chip small HOBs are not financially viable in Albania, Bosnia and Herzegovina, FYROM, Kosovo, and Montenegro, and some incentives would need to be provived.

F. For multistory buildings connected to DH
- Conversion of existing district heating HOBs to straw or wood chips is the most economically viable option to introduce biomass heating in Croatia, FYROM and Serbia. In Bosnia and Herzegovina and Kosovo refurbishing existing coal boilers is somewhat more economic; switching to straw or woods chips is the 2nd best option.
- Conversion of existing district heating HOBs to straw is financially viable in Serbia. In all other countries and cases (including wood chips in Serbia), conversion to wood chips or straw is not financially viable and provision of incentives would be required.[64]

Based on the identified economic potential for making current biomass use more efficient and to increase its use further, priorities for programmatic regional promotion of biomass-based heating and investment initiatives emerge:

- Conversion to efficient biomass stoves in stand-alone buildings.
- Conversion to wood-chip–fired HOBs in multistory buildings.
- Switching existing DH boilers from fossil fuels to biomass in some countries and circumstances.

However, prior to discussing these priorities and their potentials in more detail, it is useful to analyse the barriers facing such investments. This is done in the next chapter.

64 For example, in Austria, biomass district heating plants are subsidized at a standard rate of 25% of the environmentally relevant investment costs. If at least 80% of the forest wood chips used in the heating plants are produced in the region, a premium (sustainability premium) of 5% is granted in addition to the standard subsidy rate. By stimulating the use of regional biomass, the opportunity to create added value for local products is increased.

6

Barriers to Increasing Biomass Use

Despite the economic, financial, and environmental benefits that could result from increasing biomass use in the Western Balkans, significant barriers remain.

The work on the identification of the common key barriers was performed in two stages:

1. Literature review, based on a desk study, including research articles and project reports.
2. Semi-structured survey (89 respondents) prepared to identify the perceived barriers and opportunities both at country and regional level of the W-B countries.

Perceived barriers at the country level are based on the results of survey, stakeholders' opinions, and interviews. This chapter summarizes the most relevant, common barriers throughout the region, by grouping them into various categories as follows (see Table 18):

- *Technical* barriers are further divided into supply and demand, where the former refers to biomass supply (including feedstock production, harvesting, primary and secondary residue collection, fuel logistics, and processing) and the latter to biomass demand for energy use (including combustion equipment, district heating, and heating solutions for individual buildings).
- *Financial* barriers are linked to the financial sustainability of biomass-based heating options, as well as the availability of capital.
- *Policy and regulatory* barriers refer to the lack or inadequacy of policy and regulations in the area of biomass-based heating, and market-distorting policies (such as subsidized prices) for energy products.

Table 18: Common Barriers for the Development of Biomass-Based Heating

Technical barriers	
Supply	**Demand**
(1.1) Biomass supply infrastructure necessary to support the biomass fuel supply (1.2) Control of fuel quality (1.3) Lack of comprehensive forest strategy and management capacity for sustainable forest management (1.4) Equipment for agricultural biomass (1.5) Prevalence of illegal and unregistered logging (1.6) Lack of knowledge on energy crops	(1.7) The building stock in the region comprises high shares of old buildings which, combined with poor building maintenance and underheating, hinder the uptake of efficient technologies (1.8) Poor metering and control of heating systems (1.9) Use of moist wood by residential consumers (1.10) Lack of production and distribution of DHW in DH systems
Financial barriers	
(2.1) DH sales revenues due to lack of implementation of consumption-based billing and full cost recovery tariffs (2.2) Poor credit rating of municipalities and municipality-owned companies (2.3) Strict rules for public budgets (2.4) Lack of access to, and high cost of, capital (2.5) Low energy tariffs and lack of consumption-based billing for heating and norm-based billing systems (that is, billing by square meter rather than by actual supply) (2.6) Lack of financial investment capability of households and homeowners' associations	
Policy and regulatory barriers	
(3.1) Lack of overall strategy for heat in the region (3.2) Low or no inclusion of biomass heating equipment in public procurement (3.3) Lack of legal provisions for heat pricing (3.4) Lack of incentives (3.5) Lack of certification and standardization of biomass fuels and biomass heating appliances (3.6) Insufficient building code enforcement—lack of secondary legislation	
Institutional barriers	
(4.1) Insufficient and incomplete data on biomass supply and consumption across various feedstock and products (4.2) Poor access to up-to-date monitoring and census data (4.3) Lack of national registries on public and commercial buildings, projects pipeline, and marginal or abandoned land (4.4) Low awareness across stakeholder groups regarding policy on, supply of, and demand for cost-efficient biomass technologies and the related benefits (4.5) Lack of training courses for professionals and lack of skills for residue harvesting (4.6) Lack of knowledge and information tailored for investors (4.7) Insufficient legislation on environmental issues related to production and use of biomass for energy	
Market-related barriers	
(5.1) Limited availability of affordable high-efficiency stoves and equipment in the local market (5.2) Lack of regional market structures and practices (such as BL&TCs)	

- *Institutional* barriers are related to institutional frameworks and include the lack of information availability, education, and environmental legislation.
- *Market-related* barriers refer to inadequate energy-market structures for the introduction or increased use of sustainable biomass-based heating.

Technical Barriers

Some of the most important barriers under each category are discussed below.

Supply-Side Barriers

The primary supply barrier to the use of biomass for heating in the Western Balkans is the inadequate supply of biomass at an economical price. Because there is no organized market for biomass fuel in the region, there is no price consistency for biomass material.

Another significant barrier is the public concern that the production of biomass is unsustainable. In countries such as Kosovo and Albania, where forests are harvested at a rate greater than their rate of annual increment, this view is clearly correct.

It is also true that the region's woody biomass supply is not well developed. This is primarily due to three things: a lack of comprehensive forest strategies, a lack of infrastructure, and insufficient skills and equipment for forestry residue harvesting.

A comprehensive forest strategy is crucial to the development of a sustainable biomass supply chain. Until now, however, institutions in W-B countries have not worked out detailed forestry management plans. This fact, combined with the high level of unregistered logging, is a significant obstacle to the development of a sustainable biomass supply and heating market.

The lack of a logistics infrastructure (and the high cost of transportation) limits the development of markets, resulting in fragmented and localized biomass markets. The seasonal nature of biomass material, the variation in quantity, and the low density of such material further complicate the development of an organized market for biomass.

Biomass fuel-supply logistics are critical, both for large- and small-scale applications. However, the W-B countries still lack biomass trade and logistic centers (except in Croatia, where several biomass trade and logistic centers are operational). Moreover, some of the forest management units in the W-B region are prevented from accessing forests because of the lack of forest roads, rail transport, intermediate storage facilities, and terminals. Hence, it is necessary to intensify the construction of primary and secondary forest infrastructure to allow better utilization of biomass potentials.

For both woody and agricultural biomass, the logistical barriers are most apparent in the area of biomass utilization—that is, the lack of technically mature "pre-treatment" technologies available to compact biomass at low cost, to facilitate transportation. The high cost of local transportation by truck influences the overall energy balance and total costs.

The final barrier to agricultural biomass supply development is a lack of skills and equipment for residue logistics and processing, as well as for energy crop cultivation. The use of energy crops and agricultural residues for energy is almost nonexistent, and there are no skilled professionals—and professional skills are required for energy-crop storage and sales operations. Farmers lack knowledge of agricultural residue collection and processing—including gathering, packaging, transporting and storing agricultural biomass—as well as modern agricultural equipment that allows for the joint collection of grain and residues, and increased collection rates.

The development of energy crop cultivation requires investment in equipment for land cultivation, harvesting, and biomass processing. The equipment used for traditional cereal and forage crops can be used for seeding, spraying, and harvesting dedicated energy crops. However, entirely new types of equipment are being invented specifically for use in the biomass supply chain. For example, the general practice for miscanthus planting is to use a manure spreader or potato planter, followed by cultivation and rolling. Recently, however, special two- and four-row miscanthus planters have been commercially developed that can establish crops at between 10 and 20 hectares per day while controlling planting density—a large step up from potato planters. Similarly, agricultural equipment manufacturers have designed new generations of balers that are compatible with crop residues and dedicated energy crops. They are adapting forage harvesters to meet the more challenging physical properties of woody biomass, miscanthus, and other high-moisture biomass. Specialized equipment allows,[65] for example, one-pass harvesting of grain and biomass. If the cultivation of energy crops is to increase, farmers must be encouraged to take as much interest in energy crops as they do in traditional agricultural products.

Demand-Side Barriers

The main challenges for utilities trying to increase the use of bio-based fuels in the Western Balkans are the poor condition of existing heating infrastructure, low energy tariffs, and the lack of financial investment capability of utilities and homeowners' associations.

District heating infrastructure, where it is available, is often in a bad condition due to poor maintenance. The heat distribution networks are

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65 Dooley 2013. Retrieved from http://biomassmagazine.com/articles/8585/engineering-a-better-biomass-supply-chain.

characterized by high network losses[66] and require significant modernization. In Croatia, the district heating tariff-setting regulation has been reformed and tariffs are currently estimated to be at the cost-recovery rate. In other countries, however, the tariffs are often insufficient (that is, too low) and therefore the financial status of the utilities is poor.

Because most of the utilities are municipally owned, their poor credit rating and limited public funding means they lack both investment capacity and access to financing. The housing stock is generally in poor condition, underheating is common, and the district heating system operates only during part of the day. Underheating and limited time-of-use combine to reduce the heat demand per network length and therefore increase the share of fixed costs in district heating. This impairs the financial viability of a district heating system.

Domestic hot water (DHW) is rarely produced and distributed by the DH companies in the Western Balkans. It represents an important element of the expansion of district heating to all-year operation (most systems currently operate only from October to April) and would create a better basis for future production of combined heat and power based on biomass fuels.

Financial Barriers

Although many bioenergy projects are technically feasible, investments do not proceed because other forms of energy appear to be more cost competitive. Biomass heating competes with fossil fuel heating on the basis of direct production costs (excluding externalities). This represents a significant barrier, as biomass heating cannot compete with coal on purely financial terms. The W-B countries should adopt the concept of providing a level playing field to enable true cost comparisons. This should include all subsidies, externalities, and co-benefits, together with provision of incentives where biomass heating is *economically* viable (from a social perspective), but not *financially* viable (from the perspective of the end consumer).

Limited financial capacity is a serious barrier for many local governments, whose budgets—due to limited territory or a low number of inhabitants—are too low to support serious investment projects. On the other hand, strict rules for public budgets limit the borrowing capacity of the municipalities and local governments.

In individual buildings, the main barriers for increasing bio-based heating or improving the efficiency of heating are related to lack of investment capacity as well as weak incentives to invest due to the common "free" sup-

66 Network losses in W-B DH systems are high—typically 15%–30%—and can reach 60% in the worst cases. Softić and Glamočić 2012; Gjoshevski 2014.

ply of wood (primarily in the rural areas) and/or non-cost reflective energy tariffs.

Because individual households, especially in rural areas, are poor, they are unable to invest in appliances that would improve the energy efficiency of their buildings. By contrast, in rural areas, wood fuel is also often available at no cost. In addition, much of the wood consumed by individual households has a high moisture content because of its low storage or drying time, which leads to greater use of wood to produce the required heat and—together with the use of inefficient stoves—contributes to higher particle emissions. High particulate emission levels have a negative public health impact, especially in urban areas.

Policy and Regulatory Barriers

The existing policy and regulatory framework for biomass-based heating in the W-B countries is presented in Appendix A.

In general, the policy and regulatory framework for heating, and especially biomass heating, in the W-B countries is undeveloped. Moderate legislation related to heating exists only in countries where DH exists. Legislation related to biomass-based, small-scale heating in the end-consumption sectors still needs to be developed. It is important to harmonize national legislation in this field with that of the EU.[67]

Decision-making requirements for homeowner associations in Albania and Bosnia and Herzegovina, where 75% and 100% owner's agreement is required for decision making, present a significant barrier for conversion to biomass heating in multistory buildings (see Table 19). Addressing these issues, and developing secondary legislation on housing, would improve the framework and conditions for introducing biomass heating.

Greater effort must be made to improve the sustainability of biomass feedstock. Creating and implementing[68] a certification system for biomass sustainability would benefit domestic and international trade, help maintain sufficient supply and consistent quality, and support the overall development of markets for these products.

Biomass sustainability has three basic dimensions—environmental, social, and economic. For each of the dimensions, criteria and indicators should be established to evaluate the sustainability of biomass value chains (see

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[67] For example, the proposal for a new Renewable Energy Directive foresees open access to local district heating systems for producers of renewable heating. See European Commission 2016, http://ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v7_1.pdf.

[68] The EU recognizes a number of voluntary schemes that demonstrate compliance with the sustainability criteria—for more details, see https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes.

Table 19: Decision-Making Requirements for Homeowner Associations

Albania	Decision-making requirement for investment requires 75% majority vote agreement among the owners
Bosnia and Herzegovina	Decision-making requirement for investments at the national level is described as requiring 100% agreement among the owners, which is almost impossible in many cases
Croatia	Decision-making requirement for investment requires qualified majority (50%+1) vote agreement among the owners
FYR Macedonia	Decision-making requirement for investment requires qualified majority (50%+1) vote agreement among the owners
Kosovo	Decision-making requirement for investment requires qualified majority (50%+1) vote agreement among the owners. A quorum is deemed present if 50% of the participants are present personally or represented by proxy at the beginning of the meeting
Montenegro	Decision-making requirement is a qualified majority (50%+1)—with one vote to each owner. The Assembly shall decide if more than half of the members of the Assembly are present.
Serbia	Valid decisions are made when more than half of the Assembly members are present at a meeting. Decision-making requirement is 50%+1 owners of the total area of apartments and of other special parts of the building

Table 20). These developments need continued attention to sustainably accommodate the increasing demand for biomass.

Sustainability certification should be used as an "independent stamp" showing that biomass has been produced, processed, and/or used sustainably. Besides biomass sustainability schemes stemming from EU legislation (for example, requirements of the Common Agricultural Policy, Renewable Energy Directive, EU Biodiversity Strategy, EU Waste Directive, Resource Efficiency Scoreboard), there have been a variety international voluntary biomass sustainability schemes aimed at setting standards for sustainable biomass production and use, including sustainable forest management schemes (such as the FSC and PEFC), FAO's framework for the assessment of sustainability along food and agriculture value chains—SAFA, and bio-energy schemes (such as NTA8080, ISCC, and RSB). Unclear and underdeveloped administrative procedures for the development of biomass heating facilities reduce trust with investors and entrepreneurs in this field, and are therefore important barriers to realizing the full potential of biomass heating.

Institutional Barriers

Improving the institutional framework will require improving knowledge sharing, stakeholder capacity at all governance levels, statistics on heating and biomass, and standardization of fuels.

Table 20: Overview of the Criteria and Indicators for Biomass Sustainability

Dimension	Criteria	Indicators
Environmental	Resource use	Land use efficiency, secondary resource efficiency, energy efficiency, and functionality (output service quality)
	Climate Change	Life cycle-based CO_2eq, including direct land use change and other GHG emissions
	Biodiversity	Protected areas and land with significant biodiversity values and biodiversity conservation and management
	Soil	Erosion, soil organic carbon, and soil nutrient balance
	Water	Water availability and regional water stress, water use efficiency, and water quality
	Air	Emissions of SO2 equivalents, and PM10
Social	Participation and transparency	Effective participatory processes, information transparency
	Land tenure	Land tenure assurance
	Employment and labor rights	Full direct job equivalents along the full value chain, full direct jobs equivalent in the biomass consuming country, human and labor rights, and occupational safety and health for workers
	Health risks	Risks to public health
	Food, fuelwood and other products	Food, fuelwood, and other products supply security
Economic	Production costs	Current levelized life-cycle cost, and future levelized life-cycle costs

Lack of Knowledge-Sharing

Knowledge-sharing on best biomass heating practices and successful business models should be improved among W-B countries. Cooperation in this area should be further addressed through enhanced dissemination of the results of successful bioenergy projects. Communication and public consultation about bioenergy projects is essential to build public support.

Changes in Local Government

Another significant barrier is political: changes in local government. Newly appointed government officials often question projects launched by the previous administration, interrupting their implementation and creating setbacks. In such cases, it is important to keep public attention focused on the issues of sustainability, to maintain the flow of public and private investments in biomass heating projects, and to manage any conflicts that arise.

Lack of High-Quality Statistics

A barrier to the efficient development of the heating market is the lack of high-quality statistics on heat demand (that is, type of fuel used and volume of energy consumed) and housing stock (that is, type of heating systems used, heated area of households). The lack of statistics on forestry, as well as the production and consumption of bioenergy, is a challenge for the use of bio-based energy.

The lack of a mature trade-statistics reporting system means that large amounts of potential raw material for biomass fuels are currently traded without the knowledge of the bioenergy sector. Development of comprehensive and detailed statistics for biomass fuels would facilitate a more transparent biomass fuel market, ensuring that traded types and amounts of raw material purchased for bioenergy purposes could be identified. This work should be carried out by national statistics organizations.

Lack of Standardization

The standardization of fuels usually involves parameters, such as chemical composition, heating value, and moisture content. Standards for stoves in Europe, meanwhile, address efficiency and maximum level of emissions. Standards can facilitate trading in biomass by guaranteeing the required fuel characteristics for the buyer, thereby ensuring reliable, efficient, trouble-free operation.

The European Committee for Standardisation (in French, *Comité Européen de Normalisation*, or CEN), under Technical Committee 335 (CEN/TC 335), has defined standards that determine important properties of all forms of solid biofuels in Europe, including wood chips, wood pellets, briquettes, logs, sawdust, and straw bales. The standards include both “normative” information that must be provided about the fuel and optional “informative” information.

Standard EN 14961 deals with classification and specification and standard EN 15234 deals with quality assurance for solid biofuels. Although these two standards have superseded all other European standards for solid biofuels across Europe, the Austrian ÖNORM standard is frequently used as a reference. ÖNORM is the Austrian Standards Institute, and many Austrian boilers specify fuel according[69] to ÖNORM M 7133 for wood chips (Woodchips for energy generation: quality and testing requirements) and ÖNORM M 7135 for pellets. The following standards define the technical requirements and test methods for biomass stoves and boilers:

69 CIBSE 2014.

- EN 13240 Room heaters fired by solid fuel
- EN 13229 Inset appliances, including open fires fired by solid fuels
- EN 15250 Slow heat release appliances fired by solid fuel
- EN 12815 Residential cookers fired by solid fuel
- EN 14785 Residential space heating appliances fired by wood pellets

Market Barriers

Regional demand for highly-efficient biomass appliances is hindered by buyers' low awareness of the benefits of certification and efficiency of appliances, coupled with a lack of appropriate legislation and higher prices for efficient heating appliances—that are mainly imported.

The lack of regional market structures for biomass fuels in the Western Balkans might seriously hamper the promotion of biomass use for heating. Development of network of biomass logistic and trade centers (see Box 4) would support removal of this barrier.

Box 4: Biomass Logistic and Trade Centers

Biomass Logistic and Trade Centers (BL&TCs) are local or regional centers with optimized logistics and trading organization, where different bioenergy products are marketed at standardized quality focusing on the domestic market uptake. It's an innovative business model competitively operating as an intermediator to organize local woody bioenergy value chains between local biomass suppliers and customers of different scale from private households up to deliveries to heat and power plants.

In Slovenia, Austria, Germany, and Finland, BL&TCs of different shapes, with their own production, storage, and logistics facilities, are operating competitively, while in Croatia, establishment of BL&TCs in the Municipality of Pokupsko is in progress. Actors being already involved in forestry, woody energy, or district heating operations are seen as potential BL&TC operators.

For the establishment of BL&TCs, important external stakeholders to be included in BL&TC project are investors, educational and training institutions, development organizations, and biomass association. Public-private partnership is a most favorable solution to run the BL&TC, or as a private company with public control.

Benefits of BL&TC establishment include better quality and prices for consumers, development of local economy, secure supply and prices for local biomass suppliers. Most important objectives and drivers for BL&TC establishment are development of local economy, employment and profit.

Assured quality is at the core of the BL&TC concept, and a competitive advantage over other supply chains. To ensure constant good quality, the BL&TC needs to take care of quality assurance of the products. Quality standards and product certificates play a significant role in ensuring good constant quality wood fuels. Currently, there are two widely used certification systems in Europe regarding solid biofuels, ENplus pellets and DINplus pellets. Both certification schemes exist also for briquettes, but their uptake is limited. The use of EN and ISO standards is increasing; they are mostly used when measuring properties in product descriptions and contracts to ensure a standardized methodology and terminology.

Benefits of quality standards:

- Clear definitions of quality, making competition more transparent
- Clear product descriptions in a standardized manner

(*continued on next page*)

Box 4: Biomass Logistic and Trade Centers (*continued*)

- Comparable standardized measurements between market actors
- Standardized quality assurance system

Awareness campaigns and promotional efforts are needed to increase the consumers' knowledge on the benefits of sustainable wood supply chains. In the medium to long term, increased consumer demand for more sustainable products will make certified products from certified sustainably managed forests more relevant in the domestic markets. Intensive consumer information campaigns are necessary to create awareness for the benefits of bioenergy and promote the concept of biomass logistic and trade centers (BL&TCs), and regional supply chains. Regional campaigns and market development concepts, as well as programs for consumer information days, should be developed to support the establishment of BL&TCs.

The main risks for BL&TC development are in lack of finances, lack of market, poor communication with stakeholders, and costs of biomass mobilization.

Biomass Quality Assurance at BL&TCs

A BL&TC operator needs to know where the raw materials are coming from. The wood needs to be sourced legally from sustainably managed forests.

In the EU, it is a legal requirement, because of EU timber regulation, to know where the wood comes from, and this applies also to imports. The origin of the raw material may also affect quality of the wood fuels; hence it is good practice to know this.

Sustainability standards define good social, economic, and environmental practices. Credible standards have clear and defined objectives agreed upon by stakeholders. There are multiple sustainability standards, that is, FSC (Forest Stewardship Council), PEFC (Program for the Endorsement of Forest Certification), ISO standard for sustainability of solid biomass and national standards. The certifications based on sustainability standards are better known, FSC and PEFC certifications for forest management and Chain of Custody being the most prominent worldwide.

A BL&TC can be Chain of Custody (CoC) certified to ensure the end user that the wood used in the production of wood fuels is coming from certified forests. Chain of Custody standards contain the requirements for sourcing, processing, selling, and tracing certified products and raw materials. Credible CoC supports the truthfulness of sustainability claims and labels made on products. CoC is a suitable way for BL&TCs to ensure their customers that the raw materials are coming from sustainable sources, bringing credibility to the operation.

Chain of Custody (CoC) refers to all steps in the supply chain that take possession of the certified product, hence ensuring that the end product is coming from certified forests. CoC allows the producer of wood fuels to use the product claims on their products, such as the FSC logo. The first step for a BL&TC willing to be CoC certified is to have an idea of the certified forest resources in the area. FSC certified forests exist in the W-B countries, but PEFC forest management certification is now nonexistent in the region. If the BL&TC has a significant area of certified forests in the area, and wishes to be FSC CoC certified, it should contact an accredited certification body active in the region. The certification body will do an initial audit, and if the BL&TC meets the certification requirements it becomes certified. After being certified, the certification body will do audits to the BL&TC to ensure that the BL&TC is still meeting the criteria.

Benefits of Chain of Custody Certification:

- Customer is ensured of the products legality and sustainability
- Helps in complying with EU timber regulation
- Improves management procedures

More information is available at http://www.biomasstradecentre2.eu and http://bioresproject.eu.


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Priority Investment Areas for Increasing Biomass-Based Heating

As concluded in Chapter 5, the priorities for programmatic regional promotion of biomass-based heating and investment initiatives are as follows:

- Conversion to efficient biomass stoves in stand-alone buildings.
- Conversion to wood-chip–fired HOBs in multistory buildings.
- Switching existing DH boilers from fossil fuels to biomass.

Based on these priorities, and the highest impact from an economic-environmental perspective, investment initiatives to increase biomass-based heating have been designed, considering circumstances in each W-B country. The design of the programs considers both the existing biomass use for heating and the additional heating use potential, discussed in Chapter 4. The scope of each program represents the maximum economic investment potential and, as such, assumes that the necessary incentives, policies, and regulations are put in place (see Chapter 8 for recommended actions to address these framework conditions).

Replacement of inefficient firewood stoves with efficient ones is a priority to make current use of biomass for heating in the Western Balkans more sustainable and efficient. Besides being the most economically viable option (it provides around 50% of savings in energy costs), it would significantly reduce air pollution (40% of air pollution coming from inefficient firewood stoves). Furthermore, this action does not require utilizing any of the additional heating use potential (954 ktoe identified in Chapter 4). Instead, as a result of more efficient combustion of biomass, it releases an additional quantity of woody biomass (equivalent to 15% of the current wood consumption for heating) for other uses.

The woody biomass portion of the additional heating use potential is assumed to be first allocated toward replacement of electric heating applies, which are the least economic heating option. Given the relatively widespread use of electric appliances in the W-B countries, all of the available woody biomass would be used for this purpose. Given that agricultural waste is not suitable for use in decentralized heating systems, all the agricultural biomass portion of the additional heating use potential is allocated for use in district heating systems.

Based on this approach, three investment programs are proposed for the Western Balkans:

1. **Stand-alone buildings:** Replacement of inefficient stoves with efficient stoves, and switching from electric heating appliances to efficient biomass stoves.
2. **Multistory buildings:** Switching from electric heating appliances to wood-chip–fired HOBs.
3. **District heating:** Switching existing DH boilers from fossil fuels to biomass.

The approach is illustrated in Figure 37.

Program 1. Conversion of Inefficient Wood Stoves to Efficient Biomass Stoves and Switching from Electric Heating Appliances to Efficient Biomass Stoves in Stand-Alone Buildings

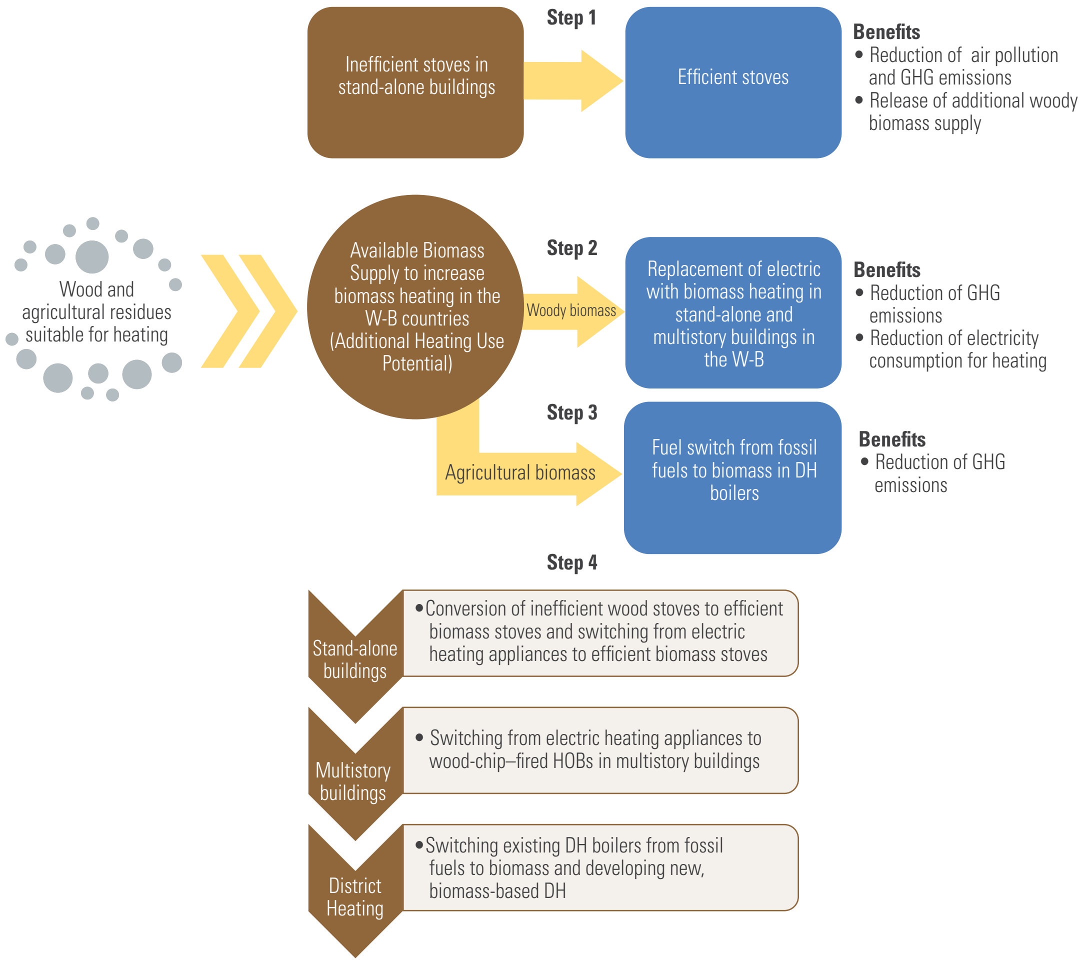
Considering that the replacement of inefficient wood stoves using firewood, with efficient ones is one of the most viable options to make biomass-based heating more efficient in W-B countries, a programmatic approach for conversion to efficient biomass stoves in the residential sector of all seven W-B countries is presented. In addition, replacement of electric heating appliances with efficient biomass stoves in stand-alone buildings in certain countries would have the highest impact in terms of reducing the amounts of both electricity used for heating and GHG emissions.

A program for switching from electric heating appliances to efficient biomass stoves, and conversion of inefficient to efficient biomass stoves in stand-alone buildings in the Western Balkans could be, for example, a 10-year initiative aimed at improving the resource and heating efficiency of biomass heating in the Western Balkans.

Conversion of inefficient to efficient biomass stoves in stand-alone buildings assumes that 10%, or 137 ktoe,[70] of the heat demand from inefficient

70 *Annual replacement* is calculated as the sum of replacements at the national level; a small difference exists due to rounding.

Figure 37: Approach in Identifying Investment Requirements to Increase Biomass-Based Heating



stoves (that is, those with an efficiency of 30–40% using wood with an MC of 35%[71]) would be replaced each year by efficient biomass stoves (efficiency 85% using wood with an MC of 20%[72]), during the next 10 years (see Table 21).

Switching from electric heating appliances to efficient firewood stoves in stand-alone buildings is suggested only in Bosnia and Herzegovina, Montenegro, and Serbia, since the additional heating use potential of woody biomass in Albania, Croatia, FYR Macedonia, and Kosovo will be used for replacement of electric to biomass heating in multistory buildings (see Program 2 for more details).

[71] Typically, wood used for heating in the Western Balkans is not appropriately dried, and is used with higher moisture content.
[72] Moisture content of adequately dried wood.

Table 21: Conversion of Inefficient to Efficient Biomass Stoves in Stand-Alone Buildings

Country	Annual replacement of inefficient stoves (annual consumption in ktoe)	Annually required efficient biomass appliances for replacement (MW)	Annual cost of replacement (€ millions)	Average annual fuel savings (ktoe)	Cumulative fuel savings for heating, 2017–26 (ktoe)
ALB	13	99	5.1	7	67
BIH	35	218	11.3	19	187
CRO	7	42	2.1	4	38
FYROM	19	111	5.7	10	101
KOS	32	147	7.7	17	170
MNE	6	36	1.9	3	34
SER	25	117	6	13	133
W-B	**137**	**770**	**40**	**73**	**731**

Table 22: Replacement of Electric with Biomass Heating in Stand-Alone Buildings

	BIH	MNE	SER	W-B
Efficient firewood stoves (stand-alone buildings) (MW)	39	175	313	527

Replacement of electric heating appliances with 527 MW of efficient firewood stoves in stand-alone buildings in the targeted three countries would replace 6% of electricity currently used for heating in the W-B, and cut down GHG emissions for 1.2 million tons of CO_2 equivalent (Table 22).

Implementation of the program would result in reduced air pollution coming from biomass heating (for 2,440 tons of PM), improved resource efficiency and saving of 3.8 million m^3 of wood worth around EUR 140 million, annual saving of 1,503 GWh of electricity currently used for heating, and a reduction of GHG emissions for more than 1.4 million tons of CO_2 equivalent.

Program 2. Switching from Electric Heating Appliances to Wood-Chip–Fired HOBs in Multistory Buildings

A second program for the Western Balkans would focus on replacement of electric heating appliances with wood-chip–fired HOBs in multistory buildings.

The amount of electricity used for heating in the Western Balkans is currently 1,830 ktoe, or 21% of total heat demand. It is highest in Albania (62%) and FYR Macedonia (41%). In Montenegro (28%), Croatia (22%), and Kosovo (21%), it is slightly above the W-B average. Use of electricity for heating is lowest in Bosnia and Herzegovina (9%) and Serbia (9%).

Table 23: Replacement of Electric with Biomass Heating in Multistory Buildings

	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Wood-chip–fired small HOBs (multistory buildings) (MW)	224	342	361	240	126	91	238	1,622

As emphasized, reduced use of electricity for heating would have the highest impact from an economic or climate change perspective—in terms of reducing the amounts of both GHG emissions and electricity used for heating. Further, the use of wood chip–fired HOBs is more efficient than the use of stoves (which are not suitable for the use in multistory buildings). Considering that small HOBs that use wood chips are the most economically viable option for multistory buildings, it is proposed that the available biomass additional heating use potential should be directed into the use of wood-chip–fired HOBs in multistory buildings, to replace electric heating.

In Albania, Croatia, Macedonia, and Kosovo, all available woody biomass would be used to supply wood-chip-fired HOBs in multistory buildings. In Bosnia and Herzegovina, Montenegro, and Serbia, the surplus of biomass that is left after converting electric heating in multistory buildings to wood-chip-fired small HOBs, is directed to supply replacement of electric heating with efficient firewood stoves in stand-alone buildings (Program 1).

Given the available biomass supply, 1,622 MW of electric heating in multistory buildings could be replaced with small HOBs that use wood chips. This would result in the replacement of a total of 2,149 MW (527 MW in Program 1 according to Table 22, and 1,622 MW in Program 2 according to Table 23) of electric with biomass heating.

In addition to the benefits of annually saving 4,052 GWh of electricity, such a program would result in a reduction of more than 3.4 million tons of CO_2 equivalent. While it is estimated that implementation of the Program fully would increase annual local air pollution emissions by 57 tons in the W-B, the economic benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

Program 3. Switching Existing DH Boilers from Fossil Fuels to Biomass and Developing New, Biomass-Based DH

A third program for the Western Balkans is targeting conversion of existing DH boilers from fossil fuels to biomass and, to a lesser extent, development of new biomass based DH.[73]

[73] An EU Strategy on Heating and Cooling (2016/2058(INI)) adopted in 2016 calls for development of sustainable heating and cooling strategies at national level, with special attention to 'combined heat and power, cogeneration, district heating

In the DH sector, natural gas is the most commonly used fuel in the region (59%), followed by lignite coal (36%) and HFO (5%). Albania and Montenegro[74] have not developed DH systems, while Macedonia and Kosovo have DH systems mainly in capital cities only.

To convert DH boilers from fossil fuels to biomass, in addition to wood chips, available agricultural biomass can also be used in DH, since it is unsuitable for use in residential heating appliances.

In the DH sector, switching fuels to straw and wood chips is the best option for increasing the use of biomass for heating. As mentioned earlier, use of straw for DH is economically viable only when the straw is locally available and the transport distance to the DH plant is short. This means that straw is suitable for DH mostly in the Pannonian Basin region, which encompasses the cross-border regions of Serbia, Bosnia and Herzegovina, and Croatia. In any case, the choice of biomass supply options for DH HOB plants must be based on the results of thorough local feasibility studies and analyses of specific biomass supply conditions.

Details on the suggested fuel switch to biomass in existing DH plants, as well as suggested new biomass based DH capacities, are presented in Table 24.

Fuel switch in DH plants is recommended in Bosnia and Herzegovina (5%), Croatia (17%), Kosovo (100%), and Serbia (50%), based on the available biomass supply. In addition, in Kosovo 101 MW of new DH plants, or conversion of DH plants currently not in operation (such as Mitrovica and Zvecan in Kosovo), could be provided with the available agricultural biomass. Given that the development of new DH plants and revitalization of DH plants currently out of operation is one Kosovo's priorities, they are included in the proposed program, even though they are economically only the second best option at the country level (after coal rehabilitation).

Replacing 1,200 MW of DH plants in the Western Balkans that currently use fossil fuels, and building 101 MW of new DH capacity in Kosovo, would result in the replacement of 29% of fossil-fuel–fired DH with biomass DH, and a 4% increase in the use of biomass for heating in W-B countries. The benefits of such a program would be the replacement of mainly imported fossil fuels with locally produced biomass, and, once fully implemented, reduction of 1.3 million tons of CO_2 equivalent annually. While it is estimated that implementation of the Program would increase air pollution emissions for 97 tons of PM in the W-B, the economic benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

and cooling, preferably based on renewables, as is stated in Article 14 of the Energy Efficiency Directive', and replacement of unsustainable and old individual or district heating and cooling technologies with efficient district heating and cooling systems.

[74] In Montenegro, there are only two small (6 MW), lignite-fired, boiler rooms in the city of Pljevlja.

Table 24: Fuel Switch and New Biomass in District Heating Plants

	BIH	CRO	KOS	SER	W-B
Fuel switch to straw or wood chips in DH HOB coal (MW)	64	0	0	579	643
Fuel switch to straw or wood chips in DH HOB HFO (MW)	0	73	6	123	202
Fuel switch to straw or wood chips in DH HOB NG (MW)	0	217	0	137	354
New DH HOB using straw or wood chips (MW)	0	0	101	0	101

It should be stressed that, in cases where residual wood chips are available, because of the lower penetration rate of replacement of electric heating or other sources, wood chips can be used to supply fuel switch in DH or development of new DH capacity. Also, the supply of available wood chips would increase every year during the implementation of the program for efficient biomass stoves and boilers in W-B countries.

In the longer term, additional biomass to supply biomass-based heating can be provided by growing energy crops on the unused agricultural land and by developing DH systems that use energy crops to replace fossil-fuel heating. However, as noted earlier in this report, significant separate further analysis is needed to formulate recommendations on sustainable development of energy crops in the W-B.

Estimated Investments Needed for Implementation of the Proposed Programs

Table 25 presents the estimated investments for the implementation of proposed programs, based on the capital costs of the required heating appliances and equipment.[75]

Execution of the proposed programs fully would utilize all of the additional heating use biomass potential (identified in Chapter 4) and would thus increase the use of biomass for heating in the W-B countries from 42% to 52% out of the total space heating demand.

As shown in Table 26, the proposed programs, fully implemented, would result in a significant reduction of emissions in the Western Balkans of more than 6.1 million tons of CO_2 equivalent annually.[76]

[75] Assumed capital costs of the required heating appliances and equipment are: efficient firewood stoves—51.8 EUR/kW, wood chip–fired small HOBs—100 EUR/kW, retrofitting of DH HOB coal to straw—245 EUR/kW, retrofitting DH HOB HFO to straw—294 EUR/kW, retrofitting DH HOB NG to straw—294 EUR/kW, construction of new DH HOB fueled by straw—489 EUR/kW.

[76] According to the latest information available from the International Energy Agency (www.iea.org) for 2014, the combined total CO_2 emissions for the seven

Table 25: Overview of the Required Investments

Estimated investment (million €)	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Replacement of inefficient firewood stoves (Program 1)	51	113	21	57	77	19	60	399
Replacement of electric heating in stand-alone buildings with efficient firewood stoves (Program 1)	0	1	0	0	0	6	11	19
Replacement of electric heating in multistory buildings with wood chips small HOBs (Program 2)	22	34	36	24	13	9	24	162
Retrofitting of DH HOB coal to straw and wood chips (Program 3)	0	16	0	0	0	0	142	158
Retrofitting of DH HOB HFO to straw and wood chips (Program 3)	0	0	21	0	2	0	36	59
Retrofitting of DH HOB NG to straw and wood chips (Program 3)	0	0	64	0	0	0	40	104
Construction of new DH HOB straw and wood chips (Program 3)	0	0	0	0	49	0	0	49
Total	**74**	**164**	**143**	**81**	**140**	**34**	**314**	**950**

Financing Sources and Models

Financing of energy efficiency/renewable energy (EE/RE) investments in the Western Balkans is at the very early stage of development and, as such, it is still going through the preliminary phases of increasing awareness about the benefits of EE/RE, regulatory reforms, as well as showcasing successful examples of EE/RE projects. Such projects have been predominantly financed through dedicated credit lines and, in some cases, through regional EE/RE funds that have been established by various IFIs.

Results of this project has confirmed that there are substantial investment needs and opportunities in relation to increase biomass-based heating in the W-B countries and shift to more sustainable and efficient heating. However, W-B countries have limited public finances and fiscal room to allow for adequate investments to biomass-based heating.

In this context, the private sector is expected to play key role in the increase of biomass heating in the Western Balkans. Involvement of private sector could be success factor that provide access to private sector management

Western Balkans countries is 95.83 mtCO_2 per year divided as follows: Albania 4.12 MtCO_2, Bosnia Herzegovina 21.62 MtCO_2, Croatia 15.14 MtCO_2, Kosovo 7.2 MtCO_2, FYROM 7.43 MtCO_2, Montenegro 2.22 MtCO_2, and Serbia 38.11 MtCO_2. A reduction of 6.1 MtCO_2 is therefore equivalent to a reduction of 6.4% compared to 2014 total annual CO_2 emissions.

Table 26: Avoided Emissions

Avoided emissions	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Replacement of inefficient firewood stoves (Program 1)	14,026	39,147	7,955	21,143	35,588	7,118	27,842	152,818
Replacement of electric heating in stand-alone buildings with efficient firewood stoves (Program 1)	0	86,297	0	0	0	218,015	939,093	1,243,404
Replacement of electric heating in multistory buildings with wood chips small HOBs (Program 2)	283,449	762,591	345,741	640,524	554,278	113,367	713,960	3,413,909
Retrofitting of DH HOB coal to straw and wood chips (Program 3)	0	59,172	0	0	0	0	715,417	774,590
Retrofitting of DH HOB HFO to straw and wood chips (Program 3)	0	0	57,339	0	5,847	0	119,856	183,041
Retrofitting of DH HOB NG to straw and wood chips (Program 3)	0	0	128,312	0	0	0	100,519	228,831
Construction of new DH HOB straw and wood chips (Program 3)	0	0	0	0	124,378	0	0	124,378
Total avoided CO_2eq. emissions	297,475	947,206	539,346	661,667	720,091	338,499	2,616,687	6,120,971

practices, capital markets, and more efficient technologies. Key challenge in a small-scale biomass heating schemes is in making such schemes affordable, accessible and appropriate to W-B circumstances and people.

Private sector participation may come in different forms, such as heat entrepreneurship (see Box 1), public-private partnerships for establishment of BL&TC, energy service companies (ESCOs), or through leasing arrangements. Therefore, it is important to strengthen the biomass-heating private sector development via piloting public-private partnerships aimed at ensuring sustainable supply of biomass, or quality assurance of domestically produced heating appliances.

Availability of long-term financing to financial intermediaries is necessary to support the sector. Donors and development institutions were essential in opening the market in the recent years, through the provision of long-term funding, technical assistance, and incentives. They still provide most of the available funding to commercial banks. Some commercial banks fund their own energy efficiency initiatives, albeit in smaller volumes, and often after an initial learning phase using official funding and technical assistance.

The EU plays a key role in supporting the development of EE/RE finance in the Western Balkans, working with IFIs and governments to dismantle regulatory barriers and to provide funding and incentives. The Western Balkans Investment Framework (WBIF) program is financed by the European Union through the European Commission and IFIs that support socioeconomic development and EU accession across the Western Balkans by providing finance and technical assistance for strategic investments, particularly in infrastructure, energy efficiency, and private sector development. It is a joint initiative of the European Union, IFs, bilateral donors, and the governments of the Western Balkans. The WBIF applies the principle of financial "blending"—combining grants and loans—whereby relatively small grants are provided that subsequently attract much larger amounts of loan finance. The grants are predominantly used for technical assistance (TA) in preparing a project's technical documentation and thereby helping investors to make their decision. The Infrastructure Projects Facility (IPF) administrates the TA projects. WBIF distributes its grants into four sectors: energy, environment, social and transport.

The World Bank has had a clear focus on energy efficiency projects in public buildings in the Western Balkans. By spring 2015, recently implemented and planned World Bank projects for energy efficiency in public buildings amounted to a total of USD 163 million. In this context, the World Bank is helping a number of W-B countries (Albania, Bosnia and Herzegovina, Kosovo, and Serbia) to set up Energy Efficiency Revolving Funds (EERF).

The total amount of funding from eight regional programmes offering financial and/or technical assistance to improve EE/RE in the Western Balkan is over EUR 733.6 million[77] (see Figure 38).

Examples of regional EE/RE funds include the Green for Growth Fund (GGF**),**[78] which invests in EE/RE projects in Southeast Europe, including

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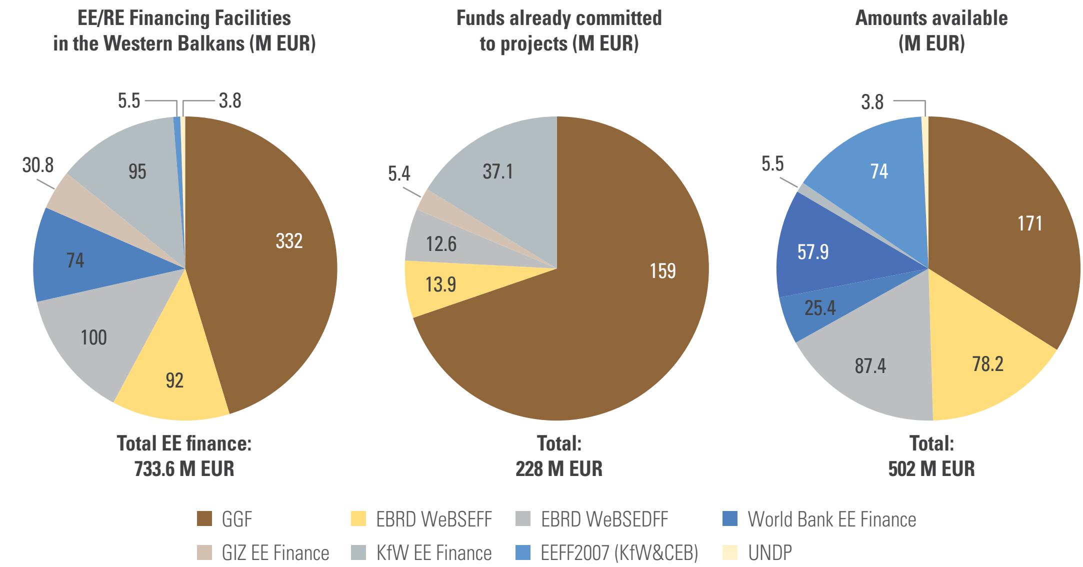
[77] Energy Community Secretariat 2015.

[78] The Green for Growth Fund Southeast Europe (GGF) is the first specialized fund to advance energy efficiency and renewable energy in Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, Kosovo, Montenegro, and Serbia. As of March 2015, the committed fund volume amounts to EUR 355 million. The GGF was initiated as a public-private partnership in December 2009 by the KfW Development Bank (KfW) and the European Investment Bank (EIB) with the financial support of the European Commission, the German Federal Ministry for Economic Cooperation and Development (BMZ) and the European Bank for Reconstruction and Development (EBRD). The European Commission contributed 38.6 million EUR, including 5 million EUR offered to the GGF for technical assistance. It provides refinancing to financial institutions for on-lending to enterprises

Figure 38: EE/RE Financing Facilities



Turkey; and the Regional Energy Efficiency Programme (REEP)[79] for the Western Balkans, initiated by the European Commission with IFIs as partners (CEB, EBRD, EIB) for the purpose financing EE/RE projects, and helping countries reach their sustainable energy objectives. Both funds offer technical assistance grants for establishment of the regulatory framework, as well as removing policy barriers.

Most facilities rely on local implementing agencies or financial intermediaries to identify and implement projects using funds provided by the facilities. Approximately 45 commercial banks or financial institutions offer EE/RE financial products in the W-B region. Also, some successful programs related to biomass heating were already implemented in the W-B region, such as the Energy Wood Program, implemented in Montenegro, that established

and private households seeking to finance energy efficiency projects. The GGF also invests directly in small to medium-scale renewable energy projects. To maximize the impact of the fund's investment activities, the GGF's Technical Assistance Facility offers capacity building support to local financial institutions and partners.

[79] The Regional Energy Efficiency Program (REEP) is one of the flagship programs funded by the European Commission and the WBIF with a EUR 20 million allocation from the European Commission and an additional EUR 3.35 million from bilateral donors through the European Western Balkans Joint Fund. The European Bank for Reconstruction and Development (EBRD) implements the REEP in partnership with the Energy Community Secretariat and the Energy Efficiency Coordination Group (EECG). The countries targeted are Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, Kosovo, Montenegro, and Serbia.

a sustainable financial mechanism allowing local banks to provide attractive loans to consumers wishing to install modern biomass heating systems (see Box 5).

Box 5: The Energy Wood Program in Montenegro

The Ministry of Economy of Montenegro has implemented an "Energy Wood" program (biomass heating program for residential sector). The program was aimed at offering an attractive and sustainable financial mechanism for obtaining a retail loan (for up to 60 months) to install heating systems (stoves and boilers) fired by modern biomass fuels (pellets, briquettes) in households, and was implemented in two phases. The first phase of the program was implemented in cooperation with the Luxembourg Agency for Development Cooperation (Lux-Dev) and the second phase was implemented in cooperation with the Norwegian Government.

The interest accrued for the entire period of repayment of individual loans, as well as the processing fee, are subsidized by the Ministry of Economy of Montenegro, and end-users are obliged to return only principal debt on these loans.

The first phase program, funded by Luxembourg Agency for Development Cooperation (EUR 130,000), started in August 2013 and officially ended in November 2015, and the second phase funded by Norwegian Government (2.2 million NOK) started in April 2015 and should be completed by the end od 2017.

The program's objectives were as follows:

- Providing soft loans, through partners selected by the Ministry of Economy, to citizens for the installation of heating systems on modern biomass fuels (the interest rate is 0%).
- Achieving economic and energy savings through the introduction of high-efficiency technologies.
- Contribution to reducing greenhouse gas emissions using energy sources that have less harmful impact on the environment.
- Creating markets for greater use of heating systems on modern biomass fuels.
- Ensuring the participation of financial institutions with reduced risk when entering a new segment of the market.

Implementation of the Program ENERGY WOOD was very successful, and certain indicators on its implementation and benefits achieved are given bellow:

- In the two phases of the Program, the banks approved a total of 775 interest-free loans (average EUR 2,200) for installation of modern biomass systems, in the total amount of EUR 1.9 million. Ensuring the participation of financial institutions with reduced risk when entering new segment on the market.
- Simplification of all procedures and administrative channels to facilitate quick and efficient approval and disbursement of the loan for heating system, including the reduced loan processing fees.
- Approved loans significantly influenced heating technologies market which was important for distributors/installers of heating equipment.
- Final users (households) installed new biomass heating systems and changed old stoves and heating systems that consume other (more expensive) energy (such as electricity and LFO). Replacement of less efficient heating technologies with state-of-the-art heating systems has created energy saving and has a positive impact on the environment, especially through reduction of CO2 emissions.
- The eligible dealers and installers provide at least one-year warranty period for any complete or partial failure (except in improper working conditions). Dealers and installers are responsible for maintenance services of the installed system during the warranty period.

In general, availability of financing is not considered to be the biggest impediment to increasing energy investments in the region. One of the biggest barriers for EE/RE financing is the regulated, low energy prices, especially in the residential sector, that do not incentivize efficiency measures.

Despite these prices, it is estimated that in all of the W-B countries at least 50% of the population spends more than 10% of their net income on energy—thus falling under the definition of energy poverty used in this study. Hence, the lack of available income for investments in energy retrofitting of households remains a significant barrier.

The region could draw on the experience of Western Europe in adopting already existing and proven traditional models of energy financing. With the gradual establishment of the necessary skills on the local level, combined with the further advancement of energy financing mechanisms at the international level, the W-B countries could transition to adopting the emerging and more advanced models of financing.

The assessment of heating systems and economically viable biomass options for heating in the Western Balkans has demonstrated enough of a common need for financing to justify the creation of regional financing facility. However, the countries' varying stages of economic and political development—and, most importantly, their varying frameworks for sustainable biomass use—require specific levels of technical support tailored to each country.

As Table 25 showed, the estimated total investment amount required to sustainably maximize the use of biomass for heating in the region is EUR 950 million. Therefore, it is recommended that a financing facility (or program) be created to support the increased use and efficiency of biomass heating, in a sustainable manner, in the consumption sectors of the W-B countries. The facility, which would support both investments and policy measures, should cover all seven countries of the Western Balkans and should be accessible to residential, commercial, and public sector borrowers, with the support of, for example, the Energy Community Secretariat.

The financing facility's main objectives would be to:

- Increase financing capacity for investments in biomass heating in the W-B countries.
- Develop an enabling environment for sustainable biomass heating by addressing the identified barriers.
- Assist the W-B countries in harmonizing their legislative frameworks with the relevant EU Acquis.

Eligible investments financed by the facility could include the priority investment areas identified earlier:

- *Stand-alone buildings:* Replacement of inefficient wood- and coal-fired stoves with efficient biomass stoves, and replacement of electric heating appliances with efficient biomass heating appliances.
- *Multi-story buildings*: Replacement of electric heating appliances with wood-chip–fired heat-only boilers.
- *District heating:* Switching of existing DH boilers from fossil fuels to biomass, and development of new biomass based DH.

The facility (or program) should integrate financing, technical assistance and policy dialogue through the following components:

- **IFI credit lines with financial incentives**[80] ***—EUR 950 million (over the 10-year period 2018–28).*** The financing should be made available to two types of entities:
  a. *Local financial institutions*—for financing (a) replacement of inefficient wood stoves with efficient stoves in stand-alone buildings and (b) switching from electric heating to wood-chip–fired HOBs in multistory buildings in the residential, commercial/industrial, and public sectors. Financing could be coupled with existing initiatives aiming at improving energy efficiency in buildings, by making biomass heating investments eligible for support[81].
  b. *District heating companies*—for financing (a) the conversion of existing DH boilers from fossil fuels to biomass and (b) the development of new, biomass-based DH.
- **Policy dialogue and project preparation support (technical assistance), along with grant funding.** This component should have two objectives:
  a. Policy support for the governments in the Western Balkans as they remove barriers and propel investments into efficient and sustainable biomass heating. (To facilitate implementation, the Energy Community Secretariat should be involved.)
  b. Technical assistance in project preparation for banks, manufacturers and providers of biomass heating appliance, installers, homeowners' associations, and district heating companies.

The **IFI financing option** could include credit lines through local financing institutions, and could be structured as shown in Figure 39.

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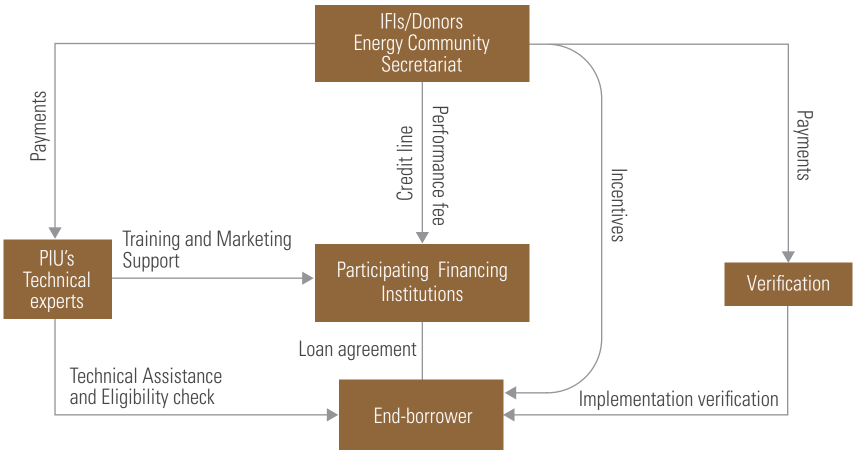
80 Financial incentives can be provided through credit lines and other financing instruments (e.g. guarantees, tax credits, etc.)

81 For example, the EBRD established the Western Balkans Green Economy Financing Facility in July 2017, which takes the form of credit lines for a total of up to EUR 85 million to financial intermediaries in the W-B countries, to finance residential energy efficiency and/or small-scale renewable energy investments. Efficient biomass boilers/stoves are eligible for this type of financing.

Figure 39: Financing Option for Investments in Efficient Biomass Heating in Stand-Alone and Multistory Buildings



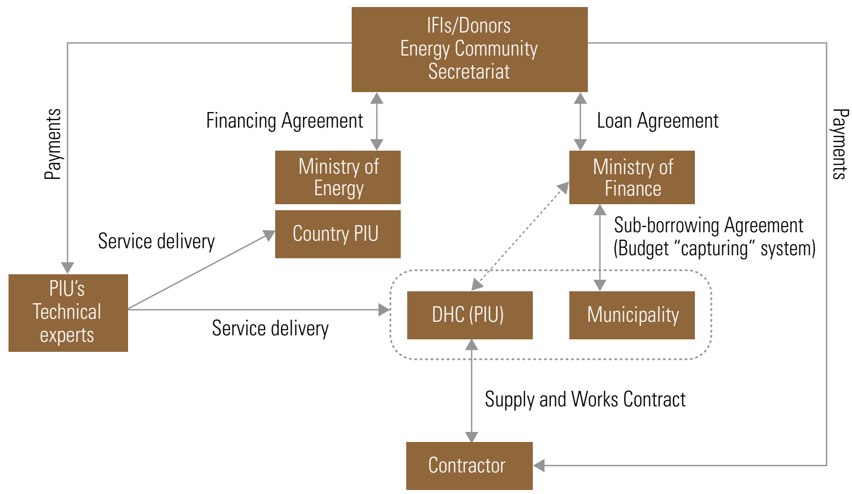
Under this option, the regional financing facility would extend credit lines to participating local financing institutions (local banks or, where operational, energy efficiency funds). The latter would then lend the received funds, in local currency, to households, small and medium-sized businesses, and corporate borrowers wishing to replace or upgrade their heating in order to use biomass, thereby reducing GHG emissions and air pollution.

In addition to financing, technical assistance should be provided to support participating local financial institutions and end-borrowers. The assistance would include a range of activities, such as training staff in promoting investments in biomass heating, checking the technical eligibility of projects, marketing support, provision of technical advice and studies, and supporting the creation of standards for environmental due diligence. The technical assistance should also help borrowers identify biomass heating opportunities, develop financing applications, enhance project designs, and select efficient biomass heating technologies. Finally, the technical assistance should help governments and regulators—through recommendations or drafting of legislative proposals— establish or develop the policy and regulatory framework required for sustainable and efficient biomass heating.

The financing option for switching of existing DH boilers from fossil fuels to biomass, and development of new biomass based DH could be implemented through a budget "capturing" system (see Figure 40).

Under this option, the finance ministries in the W-B countries would use loans from the regional financing facility and/or directly from IFIs to fund municipalities and/or district heating companies through existing budgetary mechanisms to pay the upfront costs of investments to switch from fossil fuels to biomass, based on calls for proposals or existing budget request systems. The subsequent repayments could be structured through a budget

Figure 40: Financing Option for Investments in Switching to Biomass and Building New Biomass District Heating Plants



"capturing" system, where future budgetary provisions are reduced until the loan has been fully repaid.

Project implementation would be carried out by a temporary, country-level project implementation unit (PIU) located within the ministry responsible for energy. End users, DH companies and municipalities would also establish PIUs for project implementation.

To facilitate implementation of biomass heating projects and address limited capacity in the public sector, the PIUs should receive technical assistance with regard to project preparation, implementation and monitoring. The budget-capture mechanism is well suited to W-B countries[82], where most of the municipalities are not creditworthy, since there is no repayment risk and it is relatively easy to implement. It can also help build capacity among municipalities to implement such projects while demonstrating the benefits of sustainable and efficient biomass heating. However, in Bosnia and Herzegovina, the financing model might require modifications, as municipalities fall within the competence of entities that have a high degree of autonomy and competences in the state administration functioning.

Implementing the proposed financing facility or program, would result in a 10% increase in biomass heating in the Western Balkans.

[82] The Program between Germany and Serbia—DKTI "Development of a sustainable bioenergy market in Serbia," managed by KfW/GIZ, comprises a loan of up to EUR 100 M aiming at facilitating the development of a market for biomass and supporting the sustainable use of biomass in the generation of heat in Serbia. Within the course of the project, the fuel switch from fossil fuels to biomass in DH plants in the Municipalities of Mali Zvornik, Nova Varos, Novi Pazar, and Prijepolje will be financed through a budget-capture mechanism.

8

Conclusions and Recommendations for Increasing Biomass-Based Heating

In the Western Balkans, biomass is by far the most important renewable energy source used for heating, covering 42% of the heat demand. However, there is a clear need and opportunity to make it more efficient and sustainable through promotion of modern biomass heating technologies and development of supporting policies. Inefficient and leaky stoves that produce high levels of smoke and indoor pollution are used in more than 1.9 million (one-fourth) buildings, while 24% of buildings use mainly uncertified small HOBs fueled with logwood.

Besides improving the efficiency of heating appliances, further development of district heating is an effective option for increasing the efficiency of heating and the use of biomass, since it enables implementation of projects at scale, and as district heating currently covers only 12% of the heat demand in the Western Balkans.

Despite its important role, the biomass heating sector in the Western Balkans does not receive enough attention from policy makers. This is perhaps because of the complexity of the biomass heating sector, which comprises several end-use sectors, each with its own specific heat-demand profile, and includes a range of technology and fuels options. A lack of comprehensive data on biomass heating might be another reason why there is a lack of attention paid to biomass heating.

To increase biomass-based heating in the W-B countries, there is a need to further improve framework conditions, increase the volume of sustainable biomass supply, and improve the availability of, and investments in efficient bio-based heating technologies.

A comprehensive roadmap for advancing these changes is presented below (see Table 27), aiming to provide guidance for policy and financing in the short term (until 2020), and medium to long term (until 2030). The roadmap reflects the factors that hinder the implementation of biomass heat in W-B countries, and includes a set of concrete and interrelated activities that will facilitate the removal of barriers and improvement of the framework conditions in the region, thus enabling making more efficient and scaling up biomass-based heating in the W-B region.

The roadmap is structured in three pillars, with a set of components and subcomponents that aim to disaggregate the recommendations into activities that should be implemented in order to improve the landscape for biomass heat in the Western Balkans. The three pillars comprise of activities related to framework conditions, biomass supply, and efficient biomass heat technologies.

Estimated activity budget is based on consultant estimates, taking into account the costs of recently completed projects in the W-B countries.[83]

Biomass heating issues require cross-sectoral, interdisciplinary approach.[84] For example, actions suggested to improve the supply of biomass should be closely coordinated between Environment, and Agriculture and Rural Development departments. Therefore, implementation of the roadmap requires cross-sectoral approaches and institutional collaboration coordinated by the government, to create added benefits. The overall cost to implement the Roadmap, including the required infrastructure investments, is estimated at EUR 1.4 billion through 2030. The financing will need to come from a combination of public and private sources, and given the limited resources and fiscal space available, the public financing will likely have to be a relatively small part of the total.

Given the multitude of activities that should take place to increase biomass-based heating in the Western Balkans, a phased approach in the implementation of the roadmap is needed. Such a phased approach would also make it easier for countries to move ahead with a pace appropriate to the country's circumstances. It is recommended that implementation of the roadmap should be initiated with the improvement of Framework Conditions

83 Proposed budget is the consultant's best estimate, based on other projects of comparable scope or effort implemented in the Western Balkans.

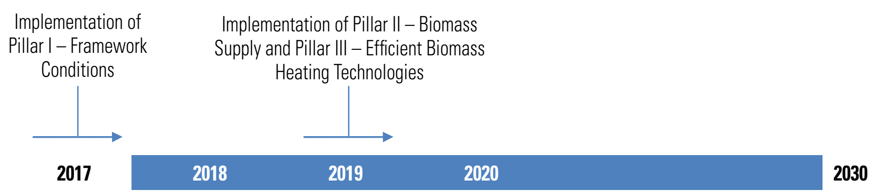
84 Task Force for the preparation of Biomass Action Plan in Serbia included following institutions: Ministry of Agriculture and Environmental Protection, Ministry of Mining and Energy, Ministry of Economy, Ministry of Trade, Tourism and Telecommunications, Ministry for Construction, Transport and Infrastructure, Ministry of Interior, Ministry of Health, Provincial Secretariat for Agriculture, Forestry and Water Resources, Provincial Secretariat for Urban Planning, Construction and Environmental Protection, Provincial Secretariat for Energy and Mineral Resources, Public Enterprises for forest management, National parks, Private forest owners associations, DH associations, Institute for Public Health, Institute for Technical Standardization, Representatives of the biomass equipment and appliance manufacturers, Standing Conference of Cities and Municipalities.

Table 27: Overview of the Roadmap to Increase Biomass-Based Heating (M EUR)

Pillar	Component	Budget until 2020 (M EUR)	Budget until 2030 (M EUR)	Total (M EUR)
1. Framework conditions	**1.1 Policy and Regulatory framework** (Addressed barriers: 1.2, 1.3, 1.5, 2.1, 2.2, 2.5, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 4.1, 4.7 identified in Chapter 6)	7.88	13.30	21.18
	1.2 Data collection and monitoring (Addressed barriers: 1.7, 4.1, 4.2, 4.3)	2.40	2.10	4.50
	1.3 Awareness (Addressed barriers: 1.9, 3.4, 4.4)	0.70	0.70	1.40
	1.4 Capacity Building (Addressed barriers: 2.7, 3.4, 4.6, 5.1, 5.2)	3.40	7.00	10.40
	Total Budget—PILLAR 1	**14.38**	**23.10**	**37.48**
2a. Biomass Supply – soft measures	**2.1 Sustainable forest management** (Addressed barriers: 1.3, 1.5, 4.1)	6.65	25.90	32.55
	2.2 Enabling environment for agricultural biomass and energy crops (Addressed barriers: 1.4, 1.6)	3.30	5.50	8.80
	Total Budget—2a	**9.95**	**31.40**	**41.35**
2a. Biomass Supply – Infrastructure Investments	**2.3 Development of Forest and Biomass Supply Infrastructure** (Addressed barriers: 1.1, 1.2, 5.2)	8.25	365.00	373.25
	Total Budget—2b	**8.25**	**365.00**	**373.25**
	Total Budget—PILLAR 2 (2a+2b)	**18.20**	**396.40**	**414.60**
3. Investments in Efficient Biomass Heating Technologies	**3.1 Investment Initiatives for (a) switching from electric heating appliances to efficient biomass stoves and (b) conversion from inefficient to efficient biomass stoves in stand-alone buildings** (Addressed barriers: 1.7, 2.4, 2.6, 3.4, 4.6)	84.30	334.20	418.50
	3.2 Investment Initiatives for switching from electric heating appliances to wood-chip–fired HOBs in multistory buildings (Addressed barriers: 1.7, 2.4, 2.6, 3.4, 4.6)	33.10	130.00	163.10
	3.3 Investment Initiatives for switching existing DH boilers from fossil fuels to biomass and the development of new biomass based DH (Addressed barriers: 1.8, 1.10, 2.1, 2.2, 2.3, 2.4, 2.5, 3.4)	74.20	296.50	370.70
	Total Budget—PILLAR 3	**191.60**	**760.70**	**952.30**
	TOTAL BUDGET—PILLAR 1 + 2 + 3	**224.18**	**1,180.20**	**1,404.38**

(Pillar 1), and implementation of recommended activities to increase sustainable biomass supply (Pillar 2). While demonstration and pilot investment projects should be started in parallel to the short-term focus on Pillar I, the majority of the previously outlined three outlined investment programs (Pillar 3) should start after the Framework Conditions are enhanced.

It should be noted that many proposed actions under Pillars 1 and 2 are important and useful well beyond biomass based heating, and as such their costs should be viewed in a broader context.



Pillar 1. Framework Conditions

The aim of this pillar is to improve the framework conditions for the development of biomass heat value chains in the Western Balkans in terms of policy and regulatory framework, data collection and monitoring, awareness, and capacity building. Detailed overview and description of the recommended activities are presented in Table 28.

Policy and Regulatory Framework (1.1)

Government policies and regulations have a strong influence on the viability of biomass-based heating, and may take the form of regulations, targets, mandates, incentives, tax rules, and standards. Recommended actions to improve policies and regulations relevant to the biomass-based heating in the Western Balkans are described below.

Forestry (1.1.1)

Legislation to prevent illegal and unregistered use of wood should be improved. Currently, 58% of the total consumption of woody biomass in the Western Balkans comes from unknown sources. To decrease this level, and to promote forest protection and sustainable forest management, the W-B countries should improve forest governance through the simultaneous use of incentives, regulations, sanctions and rewards. In 2013, the volume of officially registered woody biomass production and supply was around 10 million m^3 (1,922 ktoe) while actual consumption was 23.2 million m^3 (4,524 ktoe).[85]

[85] This was elaborated in Chapter 4 in ktoe; here it has been converted to cubic meters.

Table 28: Overview of Roadmap Activities Related to Framework Conditions (*continued*)

Pillar	Component	Sub-component	Until 2020	Budget	Until 2030	Budget (EUR)
1. Framework conditions	1.1 Policy and Regulatory framework	1.1.1 Forestry	Improve legislation to prevent unregistered production and consumption of wood fuels, based on best practices Define levels of allowed annual cut in W-B countries Regulate mandatory performance of National Forest Inventory	1,680,000	Law enforcement	2,100,000
		1.1.2 Biomass heat procurement and pricing	Legal provisions for "green" public procurement that would include biomass heating Legislation related to price regulation of heating Legislation related to biomass pricing based on energy content	910,000	Follow developments in the EU legislation Monitoring of Strategy implementation	2,100,000
		1.1.3 DH	Develop heat pricing policies in W-B countries, with clear provisions and guidelines for third party access to DH networks, construction of new DH networks Include DH in the jurisdiction of Energy Regulatory Agencies in the W-B	600,000	Policy improvements	2,100,000
		1.1.4 Buildings	Ensure appropriate transposition of Eco-design Directive (2009/125/EC) and any actions or regulations relevant to biomass heat Ensure compliance with European Energy Performance of Buildings Directive-EPBD (2010/31/EU)	840,000	Follow up and transpose all relevant directives and EC regulations	2,100,000

(*continued on next page*)

Table 28: Overview of Roadmap Activities Related to Framework Conditions (*continued*)

Pillar	Component	Sub-component	Until 2020	Budget	Until 2030	Budget (EUR)
		1.1.5 Adopt & transpose technical standards	Harmonization in the respective standards and regulations according to the European requirements Legislation for national certification schemes for biomass heating appliances Establish national certification scheme for biomass heating appliances stoves, including Energy labeling	910,000	Continue harmonization and implementation of energy labeling	700,000
		1.1.6 Testing infrastructures	Improve quality of infrastructure (such as technical rule book, laboratories, and testing) for laboratories for testing of biomass stoves, HoBs according to CEN technical standards	1,400,000	Ensure consistent update according to EU and CEN Continue support to the work of the national standardization technical committees	1,400,000
		1.1.7 Biomass fuels certification and labeling	Support establishment and promotion of a certification and quality label for biomass fuels	700,000	Continue promotion of established biomass labels	700,000
		1.1.8 Air quality	Application of provisions of Law on Air Protection to residential sector Align legislation on Air quality with the EU	840,000	Follow EU legislative development on Air quality	2,100,000
	1.2 Data collection and monitoring	1.2.1 Buildings	Develop database or registry of building stock, heating systems in public or institutional sector Establish database or registry of small HOBs in residential buildings	2,400,000	Monitoring and updating	2,100,000

(*continued on next page*)

Table 28: Overview of Roadmap Activities Related to Framework Conditions *(continued)*

Pillar	Component	Sub-component	Until 2020	Budget	Until 2030	Budget (EUR)
	1.3 Awareness	1.3.1 Campaign for promotion of biomass heating	Organize campaigns to increase awareness for the benefits of efficient biomass heating and proper drying of wood fuels	700,000	Follow up campaigns based on market requirements	700,000
	1.4 Capacity Building	1.4.1 Local stakeholders in the forestry and agricultural sector	Training, workshops for cost-effective residual biomass harvesting and/or upgrading technologies	700,000	Further focus, tailor and adjust campaigns considering technology, market and policy developments.	1,400,000
		1.4.2 Municipalities	Training, workshops for efficient biomass technologies that offer higher efficiency, cost-savings and flexibility compared to conventional fossil fuel-based electricity systems	350,000		1,400,000
		1.4.3 Professionals	Training for stoves and boilers producers on the benefits from technical standardization Support local manufacturers on product development toward low emissions combustion systems in the small and medium-scale heating sector	1,750,000		2,800,000
		1.4.4 Stakeholders from government	Develop cross ministerial and institutional collaboration to build the capacity for legislation development, transposition of the relevant European directives, compliance with certification, standardization and sustainability rules.	600,000		1,400,000
Total Budget—Pillar 1				**14,380,000**		**23,100,000**

Because households are the primary consumer of unregistered wood in the W-B countries, measures to decrease the unrecorded production of woody biomass should target the residential-household sector.

Unregistered collection of firewood for self-consumption is typically related to low income and high unemployment rates, particularly prevalent in rural and mountainous areas. This is compounded by weak enforcement of laws that are typical of rural areas close to forests. As a general consideration, implementation of existing forest laws with a focus on law enforcement might have negative impacts on poor people, without first alleviating rural poverty. Forest protection activities should be based on inclusive, multi-stakeholder co-management processes.

(See 2.1.4 for more activities related to prevention of illegal or unregistered logging)

Estimated activity budget: EUR 240,000 per country (until 2020); EUR 300,000 per country (until 2030).

Biomass Heat Procurement and Pricing (1.1.2)

Green Public Procurement or green purchasing is an instrument that could help stimulate a critical mass of demand for sustainable biomass fuels and efficient biomass-based heating. Each W-B country should develop national Green Public Procurement criteria, aiming that Green Public Procurement becomes common practice of public sector bodies.

As outlined in Chapter 5, the fuel conversion of HOBs is one of the most cost-effective ways to produce heat using biomass. Policies aimed at converting heat only boilers in public buildings from conventional fuels to woody biomass fuels should include the establishment of special programs designed to increase the use of renewable energy and seeking to replace old technology with modern, bio-based heating technology.

Mandatory assessment for biomass-based heating should be considered as a policy measure for new public buildings, or public buildings undergoing a major refurbishment[86]. Initially, in a transition to market-based financing models, it could be coupled with subsidized, low-interest loans to support the purchase and installation of equipment for biomass heating.

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[86] For example, in Germany, owners of new buildings and buildings under renovation are obliged to use a particular share or quota of heat and cooling produced from renewable energy. Public buildings are bound by this obligation as well. The quota applies to buildings with a floor space > 50m^2 that is heated or cooled with the exceptions of, for example, buildings for animal breeding, underground buildings, and religious buildings. The quota for heat and cooling produced from renewable energy varies according to renewable energy source and whether it is a new building or a renovation of an existing building. Eligible technologies include biomass, biogas, solar, geothermal.

In the Western Balkans, wood biomass pricing is based largely on volume—that is, the amount (in cubic meters) of solid raw material. The regulation should support a move toward pricing based on the energy content, not volume, of the wood, by making mandatory display of prices in both volumetric (in cubic meters) and ponderal (EUR/MWh) prices. This would encourage a greater focus on the quality of the fuel, thereby increasing efficiency in the use of biomass resources.

(See the next section, DH, for the activities related to price regulation of heating services)

Estimated activity budget: EUR 130,000 per country (until 2020); EUR 300,000 per country (until 2030).

DH (1.1.3)

Price regulation for provision of heating services should be enhanced to enable infrastructure refurbishment, and produce and distribute DHW in district heating systems

Centralized production of heat in DH plants represents an efficient way to produce heat using biomass in densely populated areas. Although DH infrastructure has already been developed in some urban areas in Bosnia and Herzegovina, Croatia, FYR Macedonia, Kosovo, and Serbia, it is generally in poor condition, and investments are needed to improve the efficiency of the infrastructure. However, companies cannot attract financing, in large part because tariffs are generally below the cost-recovery level. A recommendation is, therefore, the adjustment of the tariff regime to be more cost-reflective, while taking into account local living standards and economic conditions.

Domestic hot water (DHW) is rarely produced and distributed by the DH companies in the Western Balkans. Policy should focus on support to DH companies to install equipment for local production of DHW at all substations connected to the distribution network, and installation of internal piping and meters for measuring consumption in buildings, for its distribution. It represents a potentially important element of the expansion of district heating to all-year operation (most systems currently operate only from October to April) and would create a better basis for future production of combined heat and power based on biomass fuels.

Supply of DHW will require investments in installations within the housing sector (heat exchangers and/or piping) because the DHW would be produced in the substations. The DHW could be provided by the DH companies (which are also responsible for installing the heat exchangers or hot-water pipes), ideally in connection with other refurbishment of the building envelope and/or the technical installations (such as heat allocators and thermostatic valves).

The introduction should start in areas close to district-heating boilers, which can be secluded from the rest of the district-heating network during the season when space heating is not supplied. In the short-to-medium term, new construction areas within the footprint of the DH system should be the focus.

Estimated activity budget: EUR 120,000 per country except[87] in Albania and Montenegro (until 2020); EUR 300,000 per country (until 2030).
EUR

Buildings (1.1.4)

With the aim to improve efficiency of biomass heating in the W-B, it is necessary to introduce requirements in building regulations, particularly Eco-design Directive and Energy Performance of Buildings Directive.

Eco-design Directive establishes a framework to set mandatory ecological requirements for energy-using and energy-related products

The intention of the Eco-design Directive is that manufacturers of energy-using products will, at the design stage, be obliged to reduce the energy consumption and other negative environmental impacts of products. Under the current Eco-design Directive, biomass boilers with a rated heat output <500 kW, and local space heaters with a nominal heat output of <50 kW are subject to eco-design requirements—energy efficiency requirements, as well as emission limit values for CO, NOx and PM. Also, more stringent emission limit values for biomass boilers and stoves are currently discussed within EU, and expected to enter into force in 2018.

The Energy Performance of Buildings Directive (Article 8) requires that countries introduce inspection regimes or equivalent provision of advice and information in relation to the energy performance of boilers and heating systems in buildings.

Estimated activity budget: EUR 120,000 per country (until 2020); EUR 300,000 per country (until 2030).

Adopt and Transpose Technical Standards (1.1.5)

To promote the local manufacturing of efficient building-level firewood stoves and biomass boilers, **technical standards** should be introduced—both for biomass fuels and for the local manufacture of biomass boilers and stoves.

Because technical standards help foster customer confidence in the entire supply chain—from the fuel through to the installation of efficient and reliable heating systems and ongoing maintenance—they are key to the

[87] No DH developed.

development of a sustainable biomass heat market. In addition, technical standardization opens the domestic and international biomass market, facilitates trade between consumers and producers, and creates a competitive advantage. Implementation of technical standards delivers quality, efficiency, and best practice for biomass heating.

Legislation for adoption of national certification schemes for biomass stoves, including energy labeling should be harmonized with EU regulations. To introduce efficient equipment for biomass heating to consumers, mandatory labeling should be applied to the manufacture of biomass boilers and stoves sold in the local markets.

Also, work on development of new technical standards and EU legislation should include the following:

- Follow-up on the work of international of technical committee "ISO/TC 238 Solid biofuels," which addresses "standardization in the field of raw and processed materials originating from arboriculture, agriculture, aquaculture, horticulture and forestry to be used as a source for solid biofuels and to translate the technical standards relevant to biomass heating."[88]
- Careful tracking of EU legislative developments related to the Eco-design Directive, as well as any other type of new legislation concerning biomass boilers and space heaters.

Estimated activity budget: EUR 130,000 per country (until 2020); EUR 100,000 per country (until 2030).

Testing Infrastructures (1.1.6)

To improve the quality of infrastructure for **laboratories** testing biomass stoves and HOBs, as well as bio-based fuels, a platform should be developed that brings together the national institutions responsible for testing the performance of equipment. It should work with those institutions to assess current procedures, identify any gaps, and ensure they receive training and appropriate information on current methods, materials, and standards in the field, as well as benefit from existing best practices in other European countries.

Estimated activity budget: EUR 200,000 per country (until 2020); EUR 200,000 per country (until 2030);

Biomass Fuels Certification and Labeling (1.1.7)

A quality label for biomass fuels should be established in the W-B countries to promote the use of biomass for heating. By guaranteeing biomass fuel

[88] http://www.iso.org/iso/iso_technical_committee%3Fcommid%3D554401.

quality, the label would increase consumer confidence. The labeling would make biomass fuels traceable, as well as compliant with production requirements.

The quality assurance system should be simple; it should cause minimal additional bureaucracy and incur minimal added costs. Therefore, it is recommended to provide a simplified labeling procedure for small-scale producers, due to the relatively high cost barrier of laboratory testing and auditing. The labels could be created by various private or public stakeholders, including governments, associations, chambers, organizations and institutes. Good practice examples include the US EPA "Burn Wise" program, and the European Commission's Ecolabel.

Estimated activity budget: EUR 100,000 per country (until 2020); EUR 100,000 per country (until 2030).

Air Quality (1.1.8)

The aim of this sub-component is to improve legislation and regulatory framework of the W-B countries for biomass heat by introducing environmental standards for air emissions from heating appliances used in the residential sector. Currently, air emissions in the residential sector are not regulated. Such measures would lead to the reduction of air pollution coming from biomass heating, and replacement of old and in-efficient boilers or stoves with new high efficient boilers or stoves.

The legislation should be harmonized with the EU legislation, namely with the Air Quality Directive.

Estimated activity budget: EUR 120,000 per country (until 2020); EUR 300,000 per country (until 2030).

Data Collection and Monitoring (1.2)

Buildings (1.2.1)

Develop a database or registry of building stock and heating systems in the public and commercial or industrial sectors in the W-B countries.

Ministries and local authorities responsible for issuance of construction permits should develop a database of building stock and heating systems in the public and commercial-industrial sectors. When issuing construction permit for new buildings and buildings undergoing reconstruction, they should also include information on the heating systems that will be used in new buildings.

For existing buildings, reporting on building stock and heating systems could be added (through the existing regulation on the collection of data) to the preparation of each nation's Energy Balance. The data collected should include building surface or volume, the number of users, heating fuels used (type and quantity), boiler type, insulation, and so on.

A detailed breakdown of the type of buildings and heating systems would allow governmental institutions to introduce targeted measures to promote the development of biomass-based heating systems in the public and commercial-industrial sectors.

Estimated activity budget: EUR 120,000 per country, except in Croatia[89] (until 2020); EUR 300,000 per country (until 2030).

Awareness (1.3)

Campaign for Promotion of Biomass Heating (1.3.1)

The objectives of the campaign for promotion of biomass heating are to raise the awareness of decision makers at local, regional, and national level, spread best-practice, ensure a strong level of public awareness, understanding and support, and stimulate the necessary trends toward an increase in private investment in biomass-based heating technologies.

Campaigns are key in boosting consumer confidence in efficient biomass heating technologies.

Awareness programs that are independent of the sales of a product or service are crucial to market growth. Local biomass information campaigns can be very helpful to kick-start markets, especially for private homes or public buildings.

Estimated activity budget: EUR 100,000 per country (until 2020); EUR 100,000 per country (until 2030).

Capacity Building (1.4)

Local Stakeholders in the Forestry and Agricultural Sector (1.4.1)

Capacity building should be provided for stakeholders at the local level, in order to gain their support for implementation of recommended activities. It should include a provision for training:

- for private companies for wood fuels production, and distributors, in order to extend offer of wood fuels other than firewood—wood chips, pellets, briquettes;
- for state-owned enterprises, forestry experts, NGOs, private forest owners, private wood production companies, logistics experts, about best practice

[89] Database for Croatia already exists.

and guidelines how to increase the biomass supply in a sustainable way, by using residual materials and improved production, collection, processing, transport, and storing practices.

Estimated activity budget: EUR 100,000 per country (until 2020); EUR 200,000 per country (until 2030).

Municipalities (1.4.2)

Capacity building for municipalities on efficient biomass-based heating technologies should be organized. A significant barrier in W-B countries is a lack of awareness of the opportunities available for biomass heating. Local authorities who might implement projects need to gain a better understanding of the specific opportunities and risks involved.

Activities should be aimed at improving the capability of municipalities to identify, prioritize, and develop bankable biomass heating projects. Complementary activities could include the technical identification, energy audits, and elaboration of investment packages for municipal buildings.

Estimated activity budget: EUR 50,000 per country (until 2020); EUR 200,000 per country (until 2030).

Professionals (1.4.3)

Capacity building should aim to improve familiarity of biomass merits among stakeholders like engineers and technicians (Chambers of Engineers in W-B countries), so that they are able to uptake and efficiently implement new biomass projects in the future.

Capacity building should also include training for the utilities or DH companies, based on international best practices for energy efficiency improvements in district heating and proven biomass technologies. Training for installers, chimney sweeps, and planners in the area of small-scale boilers should be organized, based on prepared materials describing state-of-the-art biomass energy technologies.

Support local manufacturers on product development toward low emissions combustion systems in the small and medium-scale heating sector is needed to achieve an increase in biomass utilization for heating without increasing other harmful emissions (such as PM).

Estimated activity budget: EUR 250,000 per country (until 2020); EUR 400,000 per country (until 2030).

Stakeholders from Government (1.4.4)

Capacity building should aim to improve the cross-ministerial and institutional collaboration required to build the capacity for legislation development, transposition of the relevant European directives, compliance with certification, standardization and sustainability rules.

Estimated activity budget: EUR 100,000 per country, except in Croatia[90] (until 2020); EUR 200,000 per country (until 2030).

Pillar 2. Biomass Supply

This pillar is divided to two sub-pillars. Pillar 2a includes soft measures, with the aim to demonstrate approaches for sustainable forest and land management, and create enabling environment for use of agricultural biomass and energy crops. Pillar 2b present investment measures focused on development of forest and biomass supply infrastructure. Detailed overview and description of the recommended activities are presented in Table 29.

Sustainable Forest Management (2.1)

Monitoring and Collection of Data (2.1.1)

Reliable information about forest resources in the Western Balkans is essential for sound policy development, forest resource management, intervention prioritization, valuation of forest resources, productive investments, and integration with overall sustainable development efforts. Therefore, the W-B countries should develop a **monitoring system** that provides the following:

- Better and more timely forest inventories, to enable determining allowable cut.
- Information on forest uses for monitoring changes in the resource base.
- More-accurate information on how changes in resources and their uses are affecting the rural population, and whether the pattern of resource use is sustainable.
- Identification of factors driving forest change.
- Detection of deforestation and degradation.
- Monitoring of illegal logging and land-use change.

Monitoring systems should be designed to be flexible and able to respond to a dynamic context, which can modify the scope and objective of monitoring. The monitoring system design must consider the end user and sustainability of the system.

Two measurement techniques are useful in this regard. Remote sensing is a useful tool for studying forest change across time and space, and should be more used in the W-B countries. The parameters that can be estimated using

90 Relevant EU directives are already transposed in national legislation.

Table 29: Overview of Roadmap Activities Related to Biomass Supply

Pillar	Component	Sub-component	Until 2020	Budget	Until 2030	Budget (EUR)
2a. Biomass Supply—Soft Measures	2.1 Sustainable forest management	2.1.1 Monitoring and collection of data	Preparation of monitoring systems for deforestation, degradation, illegal logging and land use change	1,750,000	Focus on implementation of monitoring systems	7,000,000
		2.1.2 Multi-purpose forestry demonstration techniques	Action plan for sustainable forest management in W-B region Improving silviculture and the sustainability of forest management through demonstration activities	3,500,000	Continue awareness raising on the benefits of efficient use of biomass resources	3,500,000
		2.1.3 Forest fire management	Best practices and new technologies (software) about monitoring and prevention of forest-fires Develop synergy with the European Forest Fire Information System (EFFIS), managed by JRC—http://forest.jrc.ec.europa.eu/effis/	1,400,000	Improvement of monitoring, surveillance and detection of the fires through provision of equipment and vehicles for forest-fires fighting	1,400,000

(*continued on next page*)

Table 29: Overview of Roadmap Activities Related to Biomass Supply (*continued*)

Pillar	Component	Sub-component	Until 2020	Budget	Until 2030	Budget (EUR)
		2.1.4 Unregistered logging	(see 1.1.1)		Development of community-based forest cooperatives	14,000,000
	2.2 Enabling environment for agricultural biomass and energy crops	2.2.1 Knowledge for energy crop or tree species	Action plan for the potential of energy crops, prepared in collaboration with the Ministries in charge for Agriculture	700,000	Establish W-B technology platform for biomass	400,000
		2.2.2 Use of marginal land	Definition and mapping of abandoned or damaged (marginal) land	2,100,000	Demonstration activities on energy cropping	2,100,000
		2.2.3 Commercial conversion technologies for agricultural biomass	Improve market for commercial technologies for agricultural biomass through preparation of the list of recommended technologies for utilization of agricultural residues and dissemination of obtained results from demonstration projects	500,000	Support R&D activities for the combustion of agricultural biomass in order to develop local industry	3,000,000
Total budget—2a				**9,950,000**		**31,400,000**

(*continued on next page*)

Table 29: Overview of Roadmap Activities Related to Biomass Supply *(continued)*

Pillar	Component	Sub-component	Until 2020	Budget	Until 2030	Budget (EUR)
2b. Biomass Supply—Infrastructure Investments	2.3 Development of Forest and Biomass Supply Infrastructure	2.3.1 Forest Logistics infrastructure	Preparation of forest logistics master plans in W-B countries including identification of the forest road rehabilitation projects, development of forest terminals, road-side chipping sites Best practice forest logistics development guidelines	1,250,000	Implementation of forest logistics master plans	351,000,000
		2.3.2 Biomass supply infrastructure	Develop biomass trade centers	7,000,000	Provision of equipment or mechanization to improve logistics Training of local actors	14,000,000
Total budget—2b				**8,250,000**		**365,000,000**
Total Budget—Pillar 2 (2a + 2b)				**18,200,000**		**396,400,000**

remote sensing include the area of forests, other wooded land, and other land types, as well as their changes. In contrast, tree stem volume and biomass, which are critical variables in determining forest status, require more precise field measurements for their estimation.

Estimated activity budget: EUR 250,000 per country (until 2020); EUR 1 M EUR per country (until 2030).

Multi-Purpose Forestry Demonstration Techniques (2.1.2)

The main **techniques of forest management** involve the introduction of silvicultural[91] thinning of young stands, the conversion of coppices into high forests, and the increasing use of logging residues for production of woody biomass.

To develop, test, and demonstrate innovative approaches to forest management, including the use of local-level indicators to monitor progress, model forests could be developed. Model forests promote sustainable forest management at the field level, help translate national forest programs into action and provide continuous feedback to governments for use at the policy level.

The thinning of young and middle-aged stands is not a regular forest maintenance measure in the W-B region; rather, it is done only when governmental funds are dedicated to this purpose. When young and middle-aged stands are thinned, the forest becomes more productive. Reduced competition among the stems results in an increase in the volumes, while improving the value of the growth in the forest post-thinning.[92] This improvement in silviculture is both sustainable and economically viable.

There are significant areas of degraded or scrub forests in the W-B countries that could be developed into high forests. Due to changing demographics and living standards, vast areas of the countryside that were traditionally used for pasture have been abandoned. These areas undergo natural regeneration toward a forest structure but require a very long time to develop into natural forests. They could be restored to functional ecosystem services through reforestation and tree planting—while improving rural livelihoods and food security, increasing climate resilience, and helping mitigate climate change (through sequestration of carbon and reduction of forest exploitation).

Logging residues—mainly treetops, branches and stumps—represent the largest, currently unused, potential source (26% of unconsumed potential for heating in the W-B countries) of woody biomass that can be used for heating.

To encourage biodiversity and preserve soil nutrients, research is needed to determine the amount of logging residues that can be removed without

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[91] Silviculture is the practice of controlling the establishment, growth, composition, health, and quality of forests to meet diverse needs and values.

[92] https://www.uaex.edu/publications/PDF/FSA-5001.pdf.

impact to fertility and biodiversity. For example, in Finland, environmental guidelines and logging rules state that 30% of the logging residues in the harvesting area must be left in the forest.[93] To increase the use of logging residues in the Western Balkans, a "take or pay" method could be introduced that would require payment of stumpage[94] for both removed wood and logging residues left behind upon the completion of primary logging. Also, the Forest Logistics Master Plan should include the development of roadside chipping locations for collected logging residues to improve their utilization rate.

For areas with high biodiversity value, scrub, and unutilized pastures—in both state-owned and private forest and non-forest lands—the intensification of forest management should involve *integrated* management that addresses objectives in other sectors, such as energy, water management, agriculture, and tourism.

Finally, the increase in thinning intensity in young and middle-aged stands and the utilization of the residues that would otherwise be left in the forest will create additional employment opportunities in rural areas. This will contribute to the economic development of the region's poorer rural areas, thereby contributing to shared prosperi*ty*.

Estimated activity budget: EUR 500,000 per country (until 2020); EUR 500,000 per country (until 2030).

Forest Fire Management (2.1.3)

It is necessary to improve the **monitoring, detection, and prevention of forest fires** by disseminating best practices[95] and modern technologies, and developing synergies with the European Forest Fire Information System (EFFIS).

The Western Balkans frequently suffer from forest fires. More than 261,000 hectares of forest burned in 2009–13, representing 2.6 million m^3 of wood.

The W-B countries are part of the European Forest Fire Information System (EFFIS). EFFIS was established in 2000 by the Joint Research Centre (JRC) and the Directorate-General for Environment (DG ENV) of the European Commission (EC) to support the services in charge of the protection of forests against fires, and to disseminate information on forest fires in

93 Horstman 2013. Retrieved from http://bioenergyconnection.org/article/finn-power-why-finland-leads-forest-bioenergy.

94 *Stumpage* is the price a forestry entity pays for the right to harvest wood from a given land base.

95 The Sustainable Forest and Landscape Management Project in Bosnia and Herzegovina is currently (2014–19) being implemented by the government of BIH, supported by GEF and supervised by the World Bank. The resulting best practices should be disseminated in the W-B region.

Europe. EFFIS assessments support fire prevention, preparedness, firefighting, and post-fire evaluations. During the fire season (June to September), EFFIS issues daily maps of forecasted fire danger, monthly newsletters, and quarterly fire statistics. Synergies with EFFIS should be developed in the area of forest regeneration and restoration following forest fires.

Fires that occur on forest land are the responsibility of forestry authorities; on agricultural land, they are the responsibility of the ministries of agriculture; in Protected Areas, they are the responsibility of the ministries of environment; and once fires cross into villages and towns, they are managed by ministries of internal affairs. Coordination between these responsible governmental bodies is, therefore, critical when monitoring and responding to fires.

Recommended actions in this regard include rehabilitation of fire stations, training for local forest fire brigades, and provision of firefighting and communication equipment (such as firefighting machinery, equipment, protective clothing, gear, and hand tools).

Human resource, management, and institutional capacity building should focus on improving fire safety guidelines, fire preparedness planning and wildfire damage assessment. Sustainable systems and institutions for forest fire management should be established, with a clear distribution of functions and responsibilities among fire management units.

To reduce the number of forest fires of human origin, awareness-raising and environmental education programs should be focused on children and youth to encourage long-term behavior change.

Economic benefits would include increased woody biomass supply, income from reduced commercial losses from fire, and faster forest growth resulting from improved generation. Ecological benefits would include better conservation of forest ecosystems. Social benefits would include increased employment and greater awareness among local communities and youth of the benefits of forest fire prevention.

Estimated activity budget: EUR 200,000 per country (until 2020); EUR 200,000 per country (until 2030).

Unregistered Logging (2.1.4)

It is necessary to establish relations with rural communities to allow them to harvest wood for their basic needs, but under the technical guidance and control of the relevant forest service.

To reduce illegal logging and forest degradation while enhancing forest-dependent livelihoods and sustainable forest management, community forestry—that is, community-based forest cooperatives engaged in the protection and/or management of forests—could be part of the solution (see Box 6). However, they should be coupled with legislative and enforcement activities to prevent illegal and unregistered use of wood.

Box 6: Community-Based Forestry in Honduras

Community-based forest management has been recognized over the past two decades as a potential approach for achieving forest sustainability. Community forestry focuses on improving the livelihood and welfare of rural people and conserving natural forest systems through local participation and cooperation. Local community groups negotiate, define, and guarantee among themselves an equitable sharing of the management functions, entitlements, and responsibilities for a given set of natural resources. Success of community-based forest management depends on integration of ecological sustainability, social equity, and economic efficiency in which objectives for long-term use of the resources are well defined so that expectations of users and the society at large remain consistent.

The history of the community-based forestry in Honduras has not been easy. Due to changing socio-political conditions, institutional support waned soon after its creation. Many community-based forestry enterprises collapsed because of market failures, problems with the forest authority, and internal organizational difficulties. Notwithstanding, the community-based forestry has existed for nearly four decades, and its mandate has been reconfirmed by successive legislative reforms, including the Forestry Law approved in 2007. Some of the first cooperatives are still functioning and new communities are constantly becoming involved. Despite its problems, the community-based forestry is one of the most enduring and successful examples of social forestry policy in Latin America. The following table summarizes the key milestones in its history in Honduras.

Year	Event
1974	Creation of the Community-based Forestry System.
1974–1977	Decline in political and institutional support for the Community-based Forestry system.
Early 1980s	Approval of the Agricultural Modernization Law ends forestry nationalization and returns forest ownership to landowners, but also results in a “land rush” in state forest areas (including many CFE areas).
1992	New forestry regulations introduce “‘usufruct contracts” to assign management rights to Community-based Forestry organizations, but at the same time establish limits on the volume of timber an Community-based Forestry system organization can harvest (1,000 m^3 per organization per year in pine forests and 200 m^3 per organization per year in broadleaf forests).
1994–1996	Policy to award long-term (40-year) usufruct contracts to forestry cooperatives.
Latter 1990s	Awarding of usufruct contracts ends because of legal uncertainties and opposition from the private sector.
2007	Approval of a new Forestry Law which reaffirmed the Community-based Forestry system’s legal mandate, eliminated restrictions on harvestable volume, and introduced procedures for granting long-term “community forest management contracts” (of up to 40 years).
2009	Beginning of efforts to award community forest management contracts.
May 2013	234 Community-based Forest Enterprises recognized by Community-based Forestry system, but only 83 have officially awarded use and management rights.

Recent community-based forestry assessments confirm that, albeit not immune, most community-based forestry enterprises have been more successful at preventing runaway timber theft, than establishment of protected areas. An impact evaluation carried out in 2010 found that local forestry cooperatives have contributed to a “cumulative reduction in illegal logging in their assigned areas.”

Community-based forest cooperatives should be given the statutory right, as an incentive, to control a clearly and legally defined area of forest. A designated area of forest would be the common property of the community, with rules governing access and use, in line with the existing legal framework. For example, community members would be allowed to collect firewood from the forest commons. Rules could also mandate that community forest land cannot be sold.

In this way, the local communities would have the long-term security of tenure over the forest and see its future as being tied to the forest, and community-based forest cooperatives would constitute an employment and income-generating force in the rural communities where they operate—thus contributing to the reduction of illegal and unregistered use of wood.

Estimated activity budget: EUR 2 M per country (until 2030).

Development of Enabling Environment for Agricultural Biomass and Energy Crops (2.2)

Knowledge for Energy Crop and Tree Species (2.2.1)

W-B countries should develop an action plan for the potential of energy crops in terms of species, adaptation and yield improvements, cultivation and crop management practices, cost effectiveness, sustainability, and rural development. However, as a first step further analysis should be done to formulate recommendations on sustainable development of energy crops in W-B.

Estimated activity budget: EUR 100,000 per country (until 2030).

Use of Marginal Land (2.2.2)

An enabling environment should be developed in the W-B countries by delivering capacity building for residue harvesting **conversion technologies for agricultural biomass**.

It is necessary to identify marginal land in the W-B countries. Recultivation of abandoned land, and restoration of degraded land, could provide additional land for growing energy crops. The ministries responsible for agriculture in the W-B countries should prepare national databases based on the mapping of abandoned and damaged land; currently, their locations and conditions are not well known. National databases should be established as graphic information systems (GIS) to allow for evaluation of the suitability of using the abandoned and damaged agricultural land. They should include data on the ownership of the land, slope, slope aspect,[96] soil structure, water supply

[96] *Slope aspect* is the compass direction that a slope faces.

conditions, road accessibility, public infrastructure conditions, population density, and the age and skills of the farm holders in the region.

Estimated activity budget: EUR 600,000 per country (until 2030).

Commercial Conversion Technologies for Agricultural Biomass (2.2.3)

It is also necessary to improve the knowledge and market availability of commercially mature conversion technologies for agricultural biomass and learn from Best Practices in other European countries, such as Denmark.

In addition, biomass plants have recently been built in Vojvodina[97] (Serbia), and lessons and best practices from Vojvodina on the use of agricultural residues for heating should be shared with interested parties in the W-B region.

For the period until 2030, establishment of W-B technology platform for biomass is foreseen, to brings together stakeholders from the biomass sectors—including the related industries, such as district heating, and hybrid systems—to define a common strategy for increasing or improving the use of biomass technologies for heating.

Estimated activity budget: EUR 100,000 per country (until 2020), except in FYROM and MNE as use of agricultural residues is not foreseen for bioenergy; EUR 600,000 per country (until 2030).

Development of Forest and Biomass Supply Infrastructure (2.3)

Forest Logistics Infrastructure (2.3.1)

A **Forest Logistics Master Plan** should be prepared in each W-B country by the ministry responsible for the forests. The plan should analyze forest infrastructure requirements, as well as the legal, regulatory, and policy environment governing logistics operations within W-B forests. The objective is to identify production hubs for increased supply of sustainable woody biomass and to develop appropriate and efficient infrastructure capacity (such as forest roads, firebreaks, forest terminals, and road-side chipping sites) along main forest corridors, with minimal environmental impacts on forests. The very low **road density in the forests** of the Western Balkans currently prevents proper

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97 Several modern biomass plants for heating and process heat have been installed in the region of Vojvodina since 2008. For example, in Sremska Mitrovica an 18 MW district heating plant, owned by EPS, is fired with sunflower husks. Victoria Group, a large agribusiness company, has installed a total capacity of 40 MWth (fired by different agro-biomass fuels) to be used in the processing plants of the company. There are currently eight plants for producing pellets, and four plants for producing briquettes, from field crop residues.

forest management, effective fire management, and the realization of the full commercial potential of these resources.

Estimated activity budget[98]: EUR 250,000 per country, except in Bosnia and Herzegovina and Croatia[99] (until 2020 for forest logistics master plans); ALB – EUR 17 M, BIH – EUR 71 M, CRO – EUR 181 M, FYROM – EUR 16 M, MNE – EUR 10 M, SER – EUR 16 M (until 2030 for forest logistics infrastructure investments).

Biomass Supply Infrastructure (2.3.2)

To increase the use of biomass for heating in the Western Balkans, high-quality biomass must be available year-round in sufficient quantities. To accomplish this, it is recommended that a network of **biomass logistics and trade centers (BL&TCs)** be established with the aim of creating a more transparent market for biomass fuels and ensuring the security of biomass supply.

The core of the BL&TC concept is the construction of a collective rural marketing channel for biomass fuels and energy services. Each BL&TC is a regional "service station" for high-quality biomass fuels run by a group of local farmers and/or forest entrepreneurs.[100] The marketing of fuels through the biomass center creates added value for both the farmers and their customers, who benefit from a high-quality local supply of wood fuels. The product range is further enhanced by comprehensive services, such as the delivery of fuel or provision of competent advice on questions relating to proper use of biomass fuels. Through a network of biomass centers, customers can be sure that supplies for their heating systems are guaranteed over the long term.

In addition, the regional biomass centers should also act as energy service providers wherever possible, and become involved in biomass energy contracting projects and biomass heating plants. BL&TCs safeguard the security of supply, promote use of biomass for heating, and provide guarantees for biomass fuel quality.

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98 Budget for this activity is based on rough estimates: investment requirements for development of forest logistics infrastructure would need to be analyzed more specifically within the work on the preparation of Forest Logistics Master Plans in each W-B country. However, it is clear that financing of forest logistics infrastructure investments should come from a combination of public and private sources, where private sources would play a major role in financing the investment needs.

99 There is already ongoing work on the preparation of the Forest Logistics Master Plans.

100 Each BL&TC typically includes a storage building, a storage area for biomass fuels, a paved handling area, and a calibrated weigh-bridge for calculating the available amount of biomass fuels (source: http://www.biomasstradecentreii.eu).

Estimated activity budget: EUR 1 M per country (until 2020); EUR 2 M per country (until 2030).

Pillar 3. Efficient Biomass Heating Technologies

The aim of this pillar is development of country level projects and programs for scaling up investments in biomass based heating. The latter are essentially the investment programs outlined in Chapter 7. Detailed overview and description of the recommended activities are presented in Table 30.

Investment Initiatives for (a) Switching from Electric Heating Appliances to Efficient Biomass Stoves and (b) Conversion from Inefficient to Efficient Biomass Stoves in Stand-Alone Buildings (3.1)

Financing Facilities for Biomass Heating in Stand-Alone Buildings (3.1.1)

A program should be implemented in the Western Balkans to encourage (a) **conversion from inefficient to efficient biomass stoves** and (b) **switching from electric heating appliances to efficient biomass stoves** in stand-alone buildings. With a duration of perhaps 10 years, the initiative could be designed to improve the resource and heating efficiency of biomass heating in the Western Balkans. Assuming annual replacement of 10% (137 ktoe) of the heat demand originating from inefficient stoves with efficient stoves over a 10-year period, and switching from electric heating appliances to efficient biomass stoves, such an initiative would require total investments of EUR 418 million over the 10-year period in the seven W-B countries. Financing could be coupled with the existing initiatives in the W-B aiming to improve energy efficiency of buildings.

In addition to financing, technical assistance should be provided to support participating local financial institutions and end-borrowers.

Replacement of coal stoves with efficient firewood stoves is not financially viable in Bosnia and Herzegovina, Kosovo, and Montenegro, and therefore in these countries some incentives would need to be provided in order to introduce biomass heating.

Estimated Activity Budget: see Chapter 7 for the elaboration of the budget.

Develop Customer-Oriented Services for Local Banks Participating in Financing Program (3.1.2)

W-B countries should **work with local banks** already involved in the financing of renewable energy and energy efficiency projects and develop a set of

Table 30: Overview or Roadmap Activities Related to Investments in Efficient Biomass Heating Technologies

Pillar	Component	Sub-component	Until 2020	Budget	Until 2030	Budget (EUR)
3. Investments in Efficient Biomass Heating Technologies	3.1 Investment Initiatives for (a) switching from electric heating appliances to efficient biomass stoves and (b) conversion from inefficient to efficient biomass stoves in stand-alone buildings	3.1.1 Financing facilities for biomass heating in stand-alone buildings	Establish financing facilities for biomass heating in stand-alone buildings.[a] Initially through pilot projects (including TA), building toward country and region-wide financing facilities and programs Identification and selection of local banks Training for bankers	83,600,000	Continued Program implementation, aiming at scaled up country and region level programs and facilities	333,500,000
		3.1.2 Develop customer oriented services for local banks participating in financing Program	Information on certified equipment suppliers Guidebooks, Best practices, Case studies Online calculators for biomass heat	700,000	Program monitoring and continued support	700,000
	3.2 Investment Initiatives for switching from electric heating appliances to wood-chip–fired HOBs in multistory buildings	3.2.1 Financing facilities for biomass heating in multistory buildings	Establish financing facilities for biomass heating in multistory buildings[b] Initially through pilot projects (including TA), building toward country and region-wide financing facilities and programs Identification and selection of local banks Training for bankers	32,400,000	Continued Program implementation aiming at scaled up country and region level programs and facilities	129,300,000

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Table 30: Overview or Roadmap Activities Related to Investments in Efficient Biomass Heating Technologies (*continued*)

Pillar	Component	Sub-component	Until 2020	Budget	Until 2030	Budget (EUR)
		3.2.2 Develop customer oriented services for local banks participating in financing Program	Information on certified equipment suppliers Guidebooks, Best practices, Case studies Online calculators for biomass heat	700,000	Program monitoring and continued support	700,000
	3.3 Investment Initiatives for switching existing DH boilers from fossil fuels to biomass and the development of new biomass based DH	3.3.1 Financing facilities for biomass DH	Establish financing facilities for conversion of existing DH boilers from fossil fuels to biomass heating and construction of new DH plants	74,200,000	Continued Program implementation aiming at scaled up country and region level programs and facilities	296,500,000
Total Budget—Pillar 3				**191,600,000**		**760,700,000**

[a] Financing could be coupled with the existing initiatives in the W-B aiming to improve energy efficiency of buildings
[b] Idib.

customer services tailored to biomass heat, including guidebooks, best practices, case studies and online calculators for biomass heat.

Estimated activity budget: EUR 100,000 per country (until 2020); EUR 100,000 per country (until 2030).

Investment Initiatives for Switching from Electric Heating Appliances to Wood-Chip–Fired HOBs in Multistory Buildings (3.2)

Financing Facilities for Biomass Heating in Multistory Buildings (3.2.1)

For a program for **switching from electric heating appliances to wood-chip–fired HOBs** in multistory buildings in the Western Balkans, a total of EUR 162 million of investments would be needed to replace 1,622 MW of electric appliances with biomass HOBs. In addition to the benefits of reducing air pollution and annually saving 3,789 GWh of electricity, such a program would result in a reduction of more than 3.4 million tons of CO_2 equivalent. Financing could be coupled with the existing initiatives in the W-B aiming to improve energy efficiency of buildings.

In addition to financing, technical assistance should be provided to support participating local financial institutions and end-borrowers.

Replacement of coal HOBs with new wood chip small HOBs is not financially viable in Albania, Bosnia and Herzegovina, FYROM, Kosovo, and Montenegro, and some incentives would need to be provided.

Estimated activity budget: see Chapter 7 for the elaboration of the budget.

Develop Customer-Oriented Services for Local Banks Participating in Financing Program (3.2.2)

See 3.1.2 for more details.

Investment Initiatives for switching existing DH boilers from fossil fuels to biomass and the development of new biomass based DH (3.3)

Financing Facilities for Biomass DH (3.3.1)[101]

Some EUR 372 million of investments would be required to (a) facilitate a **switch to biomass in 1,200 MW of existing district heating plants** that

101 Prior to investing in conversion of DH plants that currently use fossil fuels—to biomass, it is needed to improve and renovate both DH plants and distribution networks. Estimated budget for these activities is EUR 412 M EUR, is based on the KfW experience and ongoing programs for upgrade of DH plants in several W-B

currently use fossil fuels and (b) build 100 MW of new biomass DH capacity. Such an investment program would benefit the region by replacing mainly imported fossil fuels with locally produced biomass and reducing GHG emissions by 1.3 million tons of CO_2 equivalent.

Conversion of existing district heating HOBs to straw is financially viable in Serbia. In all other countries and cases (including wood chips in Serbia), conversion to wood chips or straw is not financially viable and provision of incentives would be required.

Estimated activity budget: See Chapter 7 for the elaboration of the budget.

Budget Overview

Budget overview for the roadmap implementation is presented in Table 31. Total budget for the Western Balkans to implement the roadmap to increase biomass-based heating and make it more efficient and sustainable until 2030 is estimated to EUR 1,404 M.

Note that the cost for Pillar 2 includes construction of the forest logistics infrastructure, and Pillar 3 represents the upper boundary of the investment cost in the most economic biomass heating options in W-B countries.

Costs and Benefits of the Roadmap Implementation

Analysis of costs and benefits is performed as a basis for decisions required to implement the proposed Roadmap for Biomass-based Heating in the W-B, including investments in efficient biomass-heating technologies (see Table 32).

Input parameters for the analysis of costs are investment requirements for implementation of the three programs presented in Chapter 7, and budget for implementation of the roadmap presented in Chapter 8 (excluding the Programs investment costs) for each W-B country, until 2030.

Benefits of the Roadmap implementation are monetized on annual level (after roadmap implementation), based on the difference in economic energy costs (including externalities) of replacing heating technologies in each country.[102]

countries. Estimated budget per country is: BIH-EUR 80 M, CRO-EUR 130 M, FYROM-EUR 30 M, KOS-EUR 40 M, MNE-EUR 10 M, SER-EUR 122 M. This cost, for renovation of DH plants and distribution network is not included in the roadmap.

102 Economic energy costs (including externalities) per different heating options are presented in Appendix A.

Table 31: Summary of Roadmap Implementation Budget (million EUR)

Country	Period	Pillar 1	Pillar 2	Pillar 3	TOTAL
ALB	Until 2020	2.04	2.70	14.90	19.64
	Until 2030	3.30	23.66	59.20	86.16
BIH	Until 2020	2.16	2.45	33.10	37.71
	Until 2030	3.30	77.66	131.20	212.16
CRO	Until 2020	1.66	2.45	28.70	32.81
	Until 2030	3.30	187.66	114.20	305.16
FYROM	Until 2020	2.16	2.60	16.50	21.26
	Until 2030	3.30	22.06	65.20	90.56
KOS	Until 2020	2.16	2.70	28.10	32.96
	Until 2030	3.30	16.66	112.20	132.16
MNE	Until 2020	2.04	2.60	7.00	11.64
	Until 2030	3.30	22.06	27.50	52.86
SER	Until 2020	2.16	2.70	63.30	68.16
	Until 2030	3.30	46.66	251.20	301.16
TOTAL	Until 2020	14.38	18.20	191.60	224.18
	Until 2030	23.10	396.40	760.70	1,180.20

Table 32: Costs and Benefits of the Roadmap Implementation

		ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B total
Total Costs Of Roadmap	**Investment Program 1** – conversion of inefficient to efficient biomass stoves and switching from electric heating to efficient biomass stoves in stand-alone buildings (M EUR)	51	114.4	21	57	77	25.2	71.6	**417.2**
	Replacement of inefficient with efficient firewood stoves	*51*	*113*	*21*	*57*	*77*	*18.8*	*60.2*	*398*
	Switching from electric appliances to efficient firewood stoves		*1.4*				*6.4*	*11.4*	*19.2*

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Table 32: Costs and Benefits of the Roadmap Implementation

		ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B total
Total Costs Of Roadmap *(continued)*	**Investment Program 2** – switching from electric heating appliances to wood-chip–fired HOBs in multistory buildings (M EUR)	22	34	36	24	13	9	24	**162**
	Investment Program 3 – switching existing DH boilers from fossil fuels to biomass and developing new, biomass-based DH (M EUR)		16	85		51		218	**370**
	Roadmap Implementation – excluding the Investment Programs 1–3 (M EUR)	33	85	196	31	24	30	56	**455.2**
	Total per Country	**105.8**	**249.9**	**338.0**	**111.8**	**165.1**	**64.5**	**369.3**	**1,404.4**
Total Annual Benefits In 2030 After Roadmap Implemeentation	**Investment Program 1** – Annual economic benefits – energy costs + externalities (M EUR)	40	207.7	48.8	107.8	170	63.7	166.5	**804.5**
	Replacement of inefficient with efficient firewood stoves	*40*	*202.8*	*48.8*	*107.8*	*170*	*36.1*	*131.8*	*737.3*
	Switching from electric appliances to efficient firewood stoves		*4.9*				*27.6*	*34.7*	*67.2*
	Investment Program 2 – Annual economic benefits – energy costs + externalities (M EUR)	17.5	46.2	77	37.6	21	13.7	28.4	**241.4**
	Investment Program 3 – Annual economic benefits – energy costs + externalities (M EUR)		3.2	20.3		0.6		77.9	**102**

(*continued on next page*)

Additional benefits in physical units, including wood savings, reduction of electricity consumption, and reduction of dust and GHG emissions, are presented for information purposes only, as these savings are already monetized within economic energy cost of heating.

Table 32: Costs and Benefits of the Roadmap Implementation *(continued)*

		ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B total
Total Annual Benefits In 2030 After Roadmap Implemeentation *(continued)*	**Total per Country**	**57.5**	**257.1**	**146.1**	**145.4**	**191.6**	**77.4**	**272.8**	**1,147.9**
	Annual wood savings (m³)	348,000	972,000	197,000	525,000	880,000	178,000	691,000	**3,791,000**
	Annual reduction of electricity consumption (GWh)	413	879	902	591	388	676	1,706	**5,555**
	Annual reduction of dust emissions (tons)	191.2	515.9	76.8	287.7	486.5	41.8	189.7	**1,789.6**
	Reduction of GHG emissions (tCO2eq)	297,500	947,250	539,360	661,640	719,600	338,400	2,616,700	**6,120,450**

Based on the presented analysis, the total annual benefits after Roadmap implementation would compensate total costs of Roadmap implementation. Hence, it can be concluded that implementation of the roadmap would cost-efficiently increase the use of biomass for heating in the W-B countries in a sustainable manner.

Summary of Key Messages for Each Country

Albania

Biomass supply

- Unregistered logging must be addressed to prevent deforestation in Albania. Current use of woody biomass exceeds annual forest growth increment by 46%.
- Thinning of forests should be promoted to facilitate the growth of high-value wood, and increase biomass supply with the resulting residue.
- Change in structure of use of woody biomass is needed to ensure sustainability. In Albania, current biomass use relies mainly on high-value stemwood—structure of the use should be a move toward more use of forest residues (logging residues, thinnings).
- The potential for energy crops should be further explored and would require concentrated effort for years to bring to markets. In Albania, 18% of agricultural land is not currently used.
- Supply infrastructure and biomass fuel markets need to be developed. In Albania, the density of forest road networks is lowest in the W-B (82% below optimum). An annual investment into forest logistics infrastructure of approximately EUR 1.7 M through next 15 years would be needed. For the markets, development of biomass logistics and trade centers would be key.

Demand, heating technologies, and investment opportunities for biomass heating

- High use of electricity for heating (62%) is the least economically viable option for heating. Moreover, Albania is net importer of electricity and imported 50% of electricity consumption in 2014[103].
- Biomass use for heating is very inefficient (60% of biomass is used in inefficient wood stoves, and not properly dried).
- Limited availability of locally manufactured efficient technologies needs to be addressed through technical standardization and certification of heating appliances, and awareness raising of manufacturers and consumers.
- It is necessary to support local manufacturers on product development toward low emissions combustion systems, especially in the small and medium-scale heating sector, to achieve an increase in biomass utilization for heating without increasing other harmful emissions (such as PM).
- Conversion of all inefficient firewood stoves to efficient ones in Albania with total potential of 990 MW would require total investment of EUR 51 M. Implementation of the program would generate the annual savings in energy cost (economic, including externalities) of EUR 40 M, and the benefits would also include reduction of GHG emissions for 14,000 tCO_2eq, saving of more than 348,000 m^3 of wood worth around 12.8 M EUR, and annual reduction of dust emissions to air of 197 tons.
- Switching of electric heating appliances to efficient wood chip small heating boilers in multistory buildings (224 MW) in Albania, with investing EUR 22.4 M, would generate EUR 17.5 M of annual savings in energy cost (economic, including externalities), and reduce GHG emissions for 283,500 tCO2eq, and electricity consumption for 413 GWh (valued at 24.8 M EUR); the emissions of dust (PM) would be slightly increased (5.8 tons annually), but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

Financing should be coupled with technical assistance related to barrier removals

- Use broad spectrum of financing sources available for Albania, which include WBIF—Western Balkan Investment Framework, WB6—Western Balkan Six, GGF—Green for Growth Fund, REEP—Regional Energy Efficiency Program, WeBSEDFF—Western Balkan Sustainable Energy Direct Financing Facility.

103 IEA 2014.

Many barriers exist, but they can be gradually addressed through implementation of a long-term roadmap of actions at the country level

- Start with improving framework conditions, increased awareness, and gradually build up investment from pilots to country level projects and programs.

  A tentative estimate of the costs of implementing Pillars 1, 2, and 3 of the roadmap through 2030, elaborated in this report (see Section 8) in Albania are, EUR 5.34 M, EUR 26.35 M, and EUR 74.1 M, respectively. Note that the cost for Pillar 3 represents the upper boundary of the investment cost in the most economic biomass heating options in Albania.

Bosnia and Herzegovina

Biomass supply

- Regardless of the vast potential of woody biomass, Bosnia and Herzegovina is already using 89% of annual forest growth increment.
- Thinning of forests should be promoted to facilitate the growth of high-value wood, and increase biomass supply with the resulting residue.
- Change in structure of use of woody biomass is needed to ensure sustainability. In Bosnia and Herzegovina, current biomass use is based on the high-value stemwood—structure of the use should be a move toward more use of forest residues (logging residues, thinnings).
- Use of agricultural residues, concentrated in the north and northeast part of Bosnia and Herzegovina, along the Sava River, should be developed.
- The potential for energy crops should be further explored and would require concentrated effort for years to bring to markets. In Bosnia and Herzegovina, 22% of agricultural land is not currently used.
- Supply infrastructure and biomass fuel markets need to be developed. In Bosnia and Herzegovina, the density of forest road networks is at 52% below optimum. An annual investment into forest logistics infrastructure of approximately EUR 7.1 M through next 15 years would be needed. For the markets, development of a network of biomass logistics and trade centers would be key.

Demand, heating technologies, and investment opportunities for biomass heating

- High use of biomass for heating already (56% of current heat demand), but mostly inefficient (36% of biomass is used in old wood stoves, and not properly dried).
- Limited availability of locally manufactured efficient technologies needs to be addressed through technical standardization and certification of heating appliances, and awareness raising of manufacturers and consumers.

- It is necessary to support local manufacturers on product development toward low emissions combustion systems, especially in the small and medium-scale heating sector, to achieve an increase in biomass utilization for heating without increasing other harmful emissions (such as PM).
- Conversion of all inefficient to efficient firewood stoves (2,180 MW) in Bosnia and Herzegovina requires investment of EUR 113 M; program implementation would generate the annual savings in energy cost (economic, including externalities) of EUR 202.8 M, and the benefits would also include reduction of GHG emissions for 39,150 tCO_2eq, saving of more than 972,000 m^3 of wood worth around EUR 35.8 M, and annual reduction of dust emissions to air of 544 tons, that is, reduction of 40% of air pollution coming from inefficient stoves.
- Switching electric heating appliances to efficient firewood stoves (39 MW) in stand-alone buildings, with investing EUR 1.4 M would generate the annual savings in energy cost (economic, including externalities) of EUR 4.9 M, and the benefits would also include reduction of GHG emissions for 86,300 tCO_2eq, saving of 89 GWh of electricity (valued at EUR 5.4 M). However, this would increase dust emissions to air for 11 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.
- Switching of electric heating appliances to efficient wood chip small heating boilers (342 MW) in multistory buildings in Bosnia and Herzegovina with investing EUR 34.2 M, would generate EUR 46.2 M of annual savings in energy cost (economic, including externalities), and reduce GHG emissions for 762,600 tCO_2eq, and electricity consumption for 790 GWh (valued at 47.4 M EUR); the emissions of dust (PM) would be increased for additional 11.1 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.
- Fuel switching in existing DH systems that use coal (64 MW)—to straw, with investing EUR 15.7 M, would generate savings in energy cost (economic, including externalities) of EUR 3.2 M annually, and reduce GHG emissions for 59,200 tCO_2eq; this would increase emissions of dust (PM) for 6.1 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

Financing should be coupled with technical assistance related to barrier removals

- Use broad spectrum of financing sources available in Bosnia and Herzegovina including WBIF—Western Balkan Investment Framework, WB6—Western Balkan Six, GGF—Green for Growth Fund, REEP—Regional Energy Efficiency Program, WeBSEFF—Western Balkan Sustainable Energy Financing Facility, USAID REELIH—Residential Energy Efficiency for Low Income Households.

Many barriers exist, but can be gradually addressed through implementation of a long-term roadmap of actions at the country level

- Start with improving framework conditions, increased awareness, and gradually build up investment from pilots to country level projects and programs

  A tentative estimate of the costs of implementing Pillars 1, 2, and 3 of the roadmap through 2030, elaborated in this report (see Section 8) in Bosnia and Herzegovina are, EUR 5.46 M, EUR 80.1 M, and EUR 164.3 M, respectively. Note that the cost for Pillar 3 represents the upper boundary of the investment cost in the most economic biomass heating options in Bosnia and Herzegovina.

Croatia

Biomass supply

- Current use of woody biomass is at 64% of annual forest growth increment.
- Thinning of forests should be promoted to facilitate the growth of high-value wood, and increase biomass supply with the resulting residue.
- Change in structure of use of woody biomass is needed to ensure sustainability. In Croatia, current biomass use is based on the high-value stemwood—structure of the use should be shifted toward more use of forest residues (logging residues, thinnings).
- Use of agricultural residues, concentrated in the eastern part of Croatia (Slavonia and Baranya regions)—part of the fertile Pannonian Basin, should be developed.
- The potential for energy crops should be further explored and would require concentrated effort for years to bring to markets. In Croatia, 51% of agricultural land is not currently used.
- Supply infrastructure and biomass fuel markets need to be developed. In Croatia, the density of forest road networks is highest in the Western Balkans, but still 12% below optimum. An annual investment into forest logistics infrastructure of approximately EUR 18 M through the next 15 years would be needed. For the markets, further development of a network of biomass logistics and trade centers (currently existing in Croatia) would be critical.

Demand, heating technologies, and investment opportunities for biomass heating

- Use of biomass for heating is lower compared to other W-B countries (29% of current heat demand), but inefficient (34% of biomass is used in old wood stoves, and not properly dried).

- Limited availability of locally manufactured efficient technologies needs to be addressed through technical standardization and certification of heating appliances, and awareness raising of manufacturers and consumers.
- Support to local manufacturers on product development toward low emissions combustion systems is needed, especially in the small and medium-scale heating sector, to achieve increase in biomass utilization for heating without increasing other harmful emissions (such as PM).
- Conversion of all inefficient firewood stoves to efficient ones (420 MW) in Croatia, requires investment of EUR 21.5 M; conversion would generate the annual savings in energy cost (economic, including externalities) of EUR 48.8 M, and the benefits would also include reduction of GHG emissions for 7,960 tCO_2eq, saving of more than 197,000 m^3 of wood worth around EUR 7.3 M, and annual reduction of dust emissions to air of 113 tons, that is, reduction of 40% of air pollution coming from inefficient stoves.
- Switching of electric heating appliances to efficient wood chip small heating boilers in multistory buildings in Croatia (361 MW) by investing EUR 36.1 M, would generate EUR 77 M of annual savings in energy cost (economic, including externalities), and reduce GHG emissions for 345,700 tCO_2eq, and electricity consumption for 902 GWh (valued at EUR 54.1 M); the emissions of dust (PM) would be increased for additional 12.7 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase of PM emissions.
- Fuel switching in existing DH systems that use HFO (73 MW) and natural gas (217 MW)—to straw, with investing EUR 85.2 M would generate savings in energy cost (economic, including externalities) of EUR 20.3 M annually, and reduce GHG emissions for 185,700 tCO_2eq. This would increase emissions of dust (PM) for 23.5 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase of PM emissions.

Financing should be coupled with technical assistance related to barrier removals

- Use broad spectrum of financing sources available in Croatia, including Croatian Fund for Environmental Protection and Energy Efficiency, GGF—Green for Growth Fund, GEF—Global Environmental Facility, EU Cohesion funds.

Many barriers exist, but can be gradually addressed through implementation of a long-term roadmap of actions at the country level.

- Start with improving framework conditions, increased awareness, and gradually build up investment from pilots to country level projects and programs.

A tentative estimate of the costs of implementing Pillars 1, 2, and 3 of the roadmap through 2030, elaborated in this report (see Section 8) in Croatia are, EUR 4.96 M, EUR 190.1 M, and EUR 142.9 M, respectively. Note that the cost for Pillars 2 and 3 represents the upper boundary of the investment costs in the forest roads and most economic biomass heating options in Croatia.

FYR Macedonia

Biomass supply

- FYR Macedonia is already using 85% of annual forest growth increment.
- Thinning of forests should be promoted to facilitate the growth of high-value wood, and increase biomass supply with the resulting residue.
- Change in structure of use of woody biomass is needed to ensure sustainability. In FYR Macedonia, current biomass use is based on the high-value stemwood—structure of the use should move toward more use of forest residues (logging residues, thinnings).
- The potential for energy crops should be further explored and would require concentrated effort for years to bring to markets. In FYR Macedonia 38% of agricultural land is not currently used.
- According to strategic documents, use of agricultural residues is intended for fodder and cellulose production, and not for bioenergy.
- Supply infrastructure and biomass fuel markets need to be developed. In FYR Macedonia, the density of forest road networks is 54% below optimum. An annual investment into forest logistics infrastructure of approximately EUR 1.6 M through next 15 years would be needed. For the markets, development of a network of biomass logistics and trade centers would be key.

Demand, heating technologies, and investment opportunities for biomass heating

- Biomass use for heating is already high (39% of current heat demand), but mainly inefficient (74% of biomass is used in traditional, inefficient stoves, and not properly dried).
- Limited availability of locally manufactured efficient technologies needs to be addressed through technical standardization and certification of heating appliances, and awareness raising of manufacturers and consumers.
- Support to local manufacturers on product development toward low emissions combustion systems is needed, especially in the small and medium-scale heating sector, to achieve increase in biomass utilization for heating without increasing other harmful emissions (such as PM).
- Conversion of all inefficient to efficient firewood stoves (1,110 MW) in FYR Macedonia requires investment of EUR 57.3 M; it would generate

the annual savings in energy cost (economic, including externalities) of EUR 107.8 M, and the benefits would also include reduction of GHG emissions for 21,140 tCO_2eq, saving of more than 525,000 m^3 of wood worth around EUR 19.3 M, and annual reduction of dust emissions to air of 296 tons, that is, reduction of 40% of air pollution coming from inefficient stoves.

- Switching of electric heating appliances to efficient wood chip small heating boilers in multistory buildings (240 MW) with investing EUR 24 M, would generate EUR 37.6 M of annual savings in energy cost (economic, including externalities), and reduce GHG emissions for 640,500 tCO_2eq, and electricity consumption for 591 GWh (valued at EUR 35.4 M); the emissions of dust (PM) would be increased for 8.3 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

Financing should be coupled with technical assistance related to barrier removals

- Use broad spectrum of financing sources available in FYR Macedonia—WBIF—Western Balkan Investment Framework, WB6—Western Balkan Six, GGF—Green for Growth Fund, REEP—Regional Energy Efficiency Program, WeBSEFF—Western Balkan Sustainable Energy Financing Facility, GEF—Global Environmental Facility, USAID Municipal and Household Energy Efficiency Development Credit Authority.

Many barriers exist, but can be gradually addressed through implementation of a long-term roadmap of actions at the country level

- Start with improving framework conditions, increased awareness, and gradually build up investment from pilots to country level projects and programs.

  A tentative estimate of the costs of implementing Pillars 1, 2, and 3 of the roadmap through 2030, elaborated in this report (see Section 8) in Macedonia are, EUR 5.46 M, EUR 24.6 M, and EUR 81.7 M, respectively. Note that the cost for Pillar 3 represents the upper boundary of the investment cost in the most economic biomass heating options in FYR Macedonia.

Kosovo

Biomass supply

- Unregistered logging must be addressed to prevent deforestation. Current use of woody biomass exceeds annual forest growth increment by 56%.

- Thinning of forests should be promoted to facilitate the growth of high-value wood, and increase biomass supply with the resulting residue.
- Change in structure of use of woody biomass is needed to ensure sustainability. In Kosovo, current biomass use is mainly based on high-value stemwood—structure of the use should be moved toward more use of forest residues.
- The potential for energy crops should be further explored and would require concentrated effort for years to bring to markets. In Kosovo, 41% of agricultural land is not currently used.
- Supply infrastructure and biomass fuel markets need to be developed. In Albania density of forest road networks is 60% below optimum. An annual investment into forest logistics infrastructure of approximately EUR 1 M during next 15 years would be needed. For the markets, development of a network of biomass logistics and trade centers would be key.

Demand, heating technologies, and investment opportunities for biomass heating

- High use of biomass for heating already (54% of fuels used for heating).
- Biomass use for heating is very inefficient (38% of heat demand is covered with wood stoves of very low efficiency, and not properly dried).
- Limited availability of locally manufactured efficient technologies needs to be addressed through technical standardization and certification of heating appliances, and awareness raising of manufacturers and consumers.
- Support to local manufacturers on product development toward low emissions combustion systems is needed, especially in the small and medium-scale heating sector, to achieve increase in biomass utilization for heating without increasing other harmful emissions (such as PM).
- Conversion of all inefficient stoves in Kosovo to efficient ones (1,470 MW), with investing EUR 77 M, would generate the annual savings in energy cost (economic, including externalities) of EUR 170 M, and the benefits would also include reduction of GHG emissions for 35,600 tCO_2eq, saving of more than 880,000 m^3 of wood worth around EUR 13 M, and annual reduction of dust emissions to air of 492 tons.
- Switching of electric heating appliances to efficient wood chip small heating boilers in multistory buildings (126 MW) with investing EUR 12.5 M, would generate EUR 21 M of annual savings in energy cost (economic, including externalities), and reduce GHG emissions for 554,000 tCO_2eq, and electricity consumption for 388 GWh (valued at EUR 23 M); the emissions of dust (PM) would be increased for 5.5 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

- Fuel switching in existing DH systems that use HFO (6 MW) and construction of 100 MW of new DH plants using straw with investing EUR 51 M would generate savings in energy cost (economic, including externalities) of EUR 0.6 M annually, and reduce GHG emissions for 130,000 tCO_2eq.

Financing should be coupled with technical assistance related to barrier removals

- Use broad spectrum of financing sources available in Kosovo—KoSEP—Kosovo Sustainable Energy Projects, REEP—Regional Energy Efficiency Program, Green for Growth Fund.

Many barriers exist, but can be gradually addressed through implementation of a long-term roadmap of actions at the country level

- Start with improving framework conditions, increased awareness, and gradually build up investment from pilots to country level projects and programs.

  A tentative estimate of the costs of implementing Pillars 1, 2, and 3 of the roadmap through 2030, elaborated in this report (see Section 8) in Kosovo are, EUR 5.46 M, EUR 19.4 M, and EUR 140 M, respectively. Note that the cost for Pillar 3 represents the upper boundary of the investment cost in the most economic biomass heating options in Kosovo.

Montenegro

Biomass supply

- Use of annual forest growth increment is lowest in the Western Balkans (41%), thus creating a solid base for increase of bioenergy use.
- Thinning of forests should be promoted to facilitate the growth of high-value wood, and increase biomass supply with the resulting residue.
- Change in structure of use of woody biomass is needed to ensure sustainability. In Montenegro, current biomass use is based on the high-value stemwood—structure of the use should move toward more use of forest residues (logging residues, thinnings).
- The potential for energy crops should be further explored and would require concentrated effort for years to bring to markets. In Montenegro, 57% of agricultural land is not currently used.
- Supply infrastructure and biomass fuel markets need to be developed. In Montenegro, the density of forest road networks is at 54% below optimum. An annual investment into forest logistics infrastructure of approximately EUR 1.6 M through next 15 years would be needed. For the markets, development of a network of biomass logistics and trade centers would be key.

Demand, heating technologies, and investment opportunities for biomass heating

- Use of biomass for heating is already high—the highest in the Western Balkans (68% of current heat demand), but very inefficient (41% of biomass is used in traditional, inefficient stoves, and not properly dried)
- Limited availability of locally manufactured efficient technologies needs to be addressed through technical standardization and certification of heating appliances, and awareness raising of manufacturers and consumers.
- Support to local manufacturers on product development toward low emissions combustion systems is needed, especially in the small and medium-scale heating sector, to achieve an increase in biomass utilization for heating without increasing other harmful emissions (such as PM).
- Conversion of all inefficient to efficient firewood stoves (360 MW) in Montenegro, with investing EUR 18.8 M would create multiple benefits; it would generate the annual savings in energy cost (economic, including externalities) of EUR 36.1 M ER, and the benefits would also include reduction of GHG emissions for 7,100 tCO_2eq, saving of more than 178,000 m^3 of wood worth around EUR 6.5 M, and annual reduction of dust emissions to air of 99 tons, that is, reduction of 40% of air pollution coming from inefficient stoves.
- Switching electric heating appliances to efficient firewood stoves (175 MW) in stand-alone buildings, with investing EUR 6.4 M would generate the annual savings in energy cost (economic, including externalities) of EUR 27.6 M, and the benefits would also include reduction of GHG emissions for 218,000 tCO_2eq, saving of 445 GWh of electricity (valued at EUR 13.8 M); however, this would increase dust emissions to air for 54 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.
- Switching of electric heating appliances to efficient wood chip small heating boilers in multistory buildings (91 MW) with investing EUR 9.1 M, would generate EUR 13.7 M of annual savings in energy cost (economic, including externalities), and reduce GHG emissions for 113,300 tCO_2eq, and electricity consumption for 231 GWh (valued at EUR 40.5 M); the emissions of dust (PM) would be increased for additional 3.2 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

Financing should be coupled with technical assistance related to barrier removals

- Use broad spectrum of financing sources available in Montenegro, including WBIF—Western Balkan Investment Framework, WB6—Western Balkan Six, GGF—Green for Growth Fund, REEP—Regional Energy Efficiency Program, and the World Bank Montenegro Energy Efficiency Project.

Many barriers exist, but can be gradually addressed through implementation of a long-term roadmap of actions at the country level

- Start with improving framework conditions, increased awareness, and gradually build up investment from pilots to country level projects and programs.

  A tentative estimate of the costs of implementing Pillars 1, 2, and 3 of the roadmap through 2030, elaborated in this report (see Section 8) in Montenegro are, EUR 5.34 M, EUR 24.6 M, and EUR 34.5 M, respectively. Note that the cost for Pillar 3 represents the upper boundary of the investment cost in the most economic biomass heating options in Montenegro.

Serbia

Biomass supply

- Serbia is already using 99% of annual forest growth increment, characterized with a large share of unregistered logging—more than 51%.
- Thinning of forests should be promoted to facilitate the growth of high-value wood, and increase biomass supply with the resulting residue.
- Change in structure of use of woody biomass is needed to ensure sustainability. In Serbia, current biomass use is based on the high-value stemwood—structure of the use should shift toward more use of forest residues (logging residues, thinnings).
- The potential for energy crops should be further explored and would require concentrated effort for years to bring to markets. In Serbia, 32% of agricultural land is not currently used.
- Use of agricultural residues, concentrated in the north part of Serbia (Vojvodina and Mačva regions), part of the fertile Pannonian Basin, should be further developed.
- Supply infrastructure and biomass fuel markets need to be developed. In Serbia, the density of forest road networks is 25% below optimum. An annual investment into forest logistics infrastructure of approximately EUR 4 M through next 15 years would be needed. For the markets, development of a network of biomass logistics and trade centers would be key.

Demand, heating technologies, and investment opportunities for biomass heating

- Already high use of biomass for heating (41% of current heat demand), but very inefficient (28% of biomass is used in old wood stoves, and not properly dried)
- Limited availability of locally manufactured efficient technologies needs to be addressed through technical standardization and certification of heating appliances, and awareness raising of manufacturers and consumers.

- It is necessary to support local manufacturers on product development toward low emissions combustion systems, especially in the small- and medium-scale heating sector, to achieve an increase in biomass utilization for heating without increasing other harmful emissions (such as PM).
- Conversion of all inefficient firewood stoves in Serbia to efficient ones (1,170 MW) with investing EUR 60.2 M would generate multiple benefits, including the annual savings in energy cost (economic, including externalities) of EUR 131.8 M, reduction of GHG emissions for 27,800 tCO_2eq, saving of more than 691,000 m^3 of wood worth around EUR 25.4 M, and annual reduction of dust emissions to air of 391 tons, that is, reduction of 40% of air pollution coming from inefficient stoves.
- Switching electric heating appliances to efficient firewood stoves (313 MW) in stand-alone buildings, with investing EUR 11.4 M would generate the annual savings in energy cost (economic, including externalities) of EUR 34.7 M, and the benefits would also include reduction of GHG emissions for 939,100 tCO_2eq, saving of 969 GWh of electricity (valued at EUR 58.1 M); however, this would increase dust emissions to air by 118 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.
- Switching of electric heating appliances to efficient wood chip small heating boilers in multistory buildings (238 MW) with investing EUR 23.8 M, would generate EUR 28.4 M of annual savings in energy cost (economic, including externalities), and reduce GHG emissions for 714,000 tCO_2eq, and electricity consumption for 737 GWh (valued at EUR 44.2 M); the emissions of dust (PM) would be increased for additional 10 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.
- Fuel switching in existing DH systems that use HFO (123 MW), coal (579 MW), and natural gas (137 MW)—to straw with investing EUR 218.3 M would generate savings in energy cost (economic, including externalities) of EUR 77.9 M annually, and reduce GHG emissions for 935,800 tCO_2eq; this would increase emissions of dust (PM) for 73.3 tons annually, but the benefits of the GHG emissions reduction outweigh the marginal increase in PM emissions.

Financing should be coupled with technical assistance related to barrier removals

- Use broad spectrum of financing sources available in Serbia, including WBIF—Western Balkan Investment Framework, WB6—Western Balkan Six, GGF—Green for Growth Fund, REEP—Regional Energy Efficiency Program, WeBSEFF—Western Balkan Sustainable Energy Financing Facility, KfW/GIZ DKTI Program.

Many barriers exist, but can be gradually addressed through implementation of a long-term roadmap of actions at the country level

- Start with improving framework conditions, increased awareness, and gradually build up investment from pilots to country level projects and programs.

  A tentative estimate of the costs of implementing Pillars 1, 2, and 3 of the roadmap through 2030, elaborated in this report (see Section 8) in Serbia are, EUR 5.46 M, EUR 49.4 M, and EUR 314.5 M, respectively. Note that the cost for Pillar 3 represents the upper boundary of the investment cost in the most economic biomass heating options in Serbia.

Appendixes

Appendix A. Country Profiles

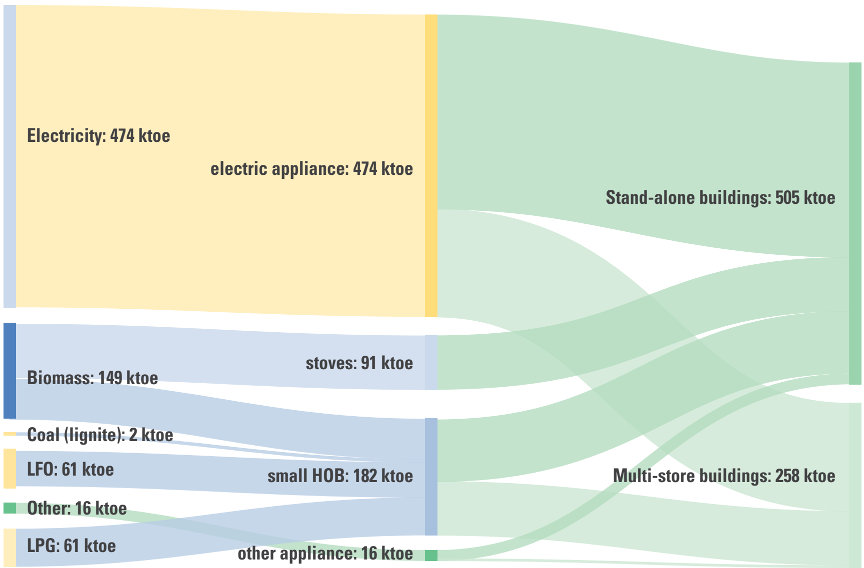
In this appendix, you will find general country information, as well as information on the existing policy and regulatory framework for biomass-based heating in the W-B countries, a detailed list of economically viable options for biomass heating in each W-B country, and country-specific figures for heat demand and an overview of heating systems.

Table A.1: Albania

General Country Information		
Population	2,803,093	
Land area, km² (FAOstat)	28,748	
Agricultural land, % of land area (FAOstat)	42%	
Forest land, % of land area (FAOstat)	27%	
Gross national income 2015, billion current US$ (WDI World Bank)	12.4	
Gross national income per capita 2015, current US$ (WDI World Bank)	4,280	
Population below national poverty line, % of total (WDI World Bank, 2012)	14.3%	
2020 target for renewables (% of gross final energy consumption)	38%	
2014 share of biomass heating in total renewable energy	28%	
Heat Energy Supply And Production		
Total Primary Energy Supply (TPES) – ktoe, Energy Balance (IEA, 2012)	2,073	
Total Primary Energy Supply (TPES) – ktoe, Energy Balance adjusted for unregistered biomass consumption	2,200	
Heat Demand, 2012 (ktoe, % of TPES)	764 (35% of adjusted TPES)	
Heat produced in residential sector (ktoe, % of total)	452	59%
Heat produced in commercial-industrial sector (ktoe, % of total)	203	27%
Heat produced in public sector (ktoe, % of total)	109	14%
Heat supplied to stand-alone buildings (ktoe, % of total)	506	66%
Heat supplied to multistory buildings (ktoe, % of total)	257	34%
Heat produced by DH systems (ktoe, % of total)	–	–
Main Fuels For Heat Production		
Biomass (ktoe, % of total)	150	20%
Coal (ktoe, % of total)	2	0%
Natural Gas (ktoe, % of total)	0	0%
Electricity (ktoe, % of total)	474	62%
LPG (ktoe, % of total)	61	8%
LFO/HFO (ktoe, % of total)	61	8%
Other (ktoe, % of total)	16	2%
Biomass Potential And Supply		
Sustainable technical potential excluding energy crops (ktoe)		337
Biomass consumption (ktoe, % of sustainable technical potential)	332	98%
Biomass available to supply an increase in biomass-based heating over and above the current consumption (ktoe, in MW of heating capacity that could be supplied)	52*	287 MW

* Regardless of currently unsustainable woody biomass consumption, potential to increase biomass-based heating still exists in Albania taking into account that certain categories of woody biomass (such as thinnings, logging residues, and prunings) and agricultural biomass are not used, despite their availability.

Figure A.1: Annual Heat Demand and Overview of Heating Systems in Albania



Note: Country-specific annual heat demand is available in Appendix A.

Economic and Financial Viability of Different Heating Options in Albania

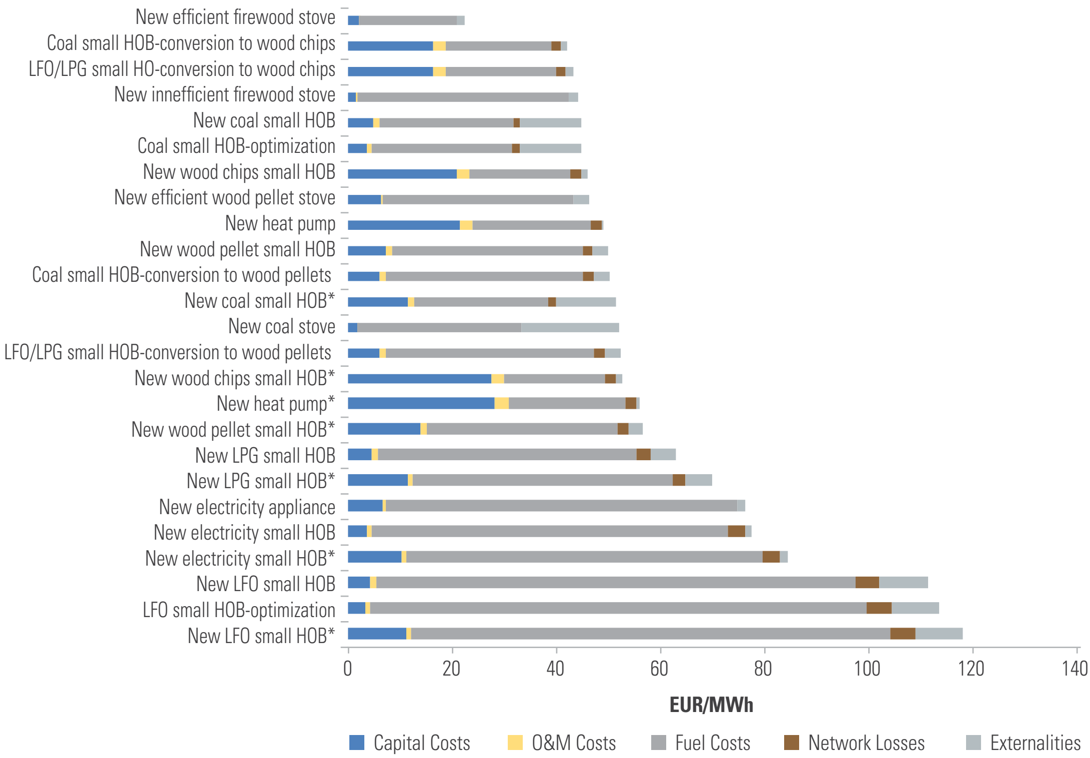
Most stand-alone buildings in Albania are heated by appliances using electricity, inefficient firewood stoves, and small HOBs using LFO and LPG. Most dwellings in multistory buildings use individual electrical appliances and small HOBs fueled by LPG and LFO/HFO. Economically viable biomass heating options in Albania are presented in Table A.2.

Table A.2: Economically Viable Biomass Heating Options in Albania

Albania	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
Stand-Alone Buildings	Individual electric appliance	**New, efficient firewood stove**	New efficient wood pellet stove New wood chips small HOB* New wood pellets small HOB*
	Inefficient wood stoves		None
	Small HOB-LFO	**LFO small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB – conversion to wood pellets
	Small HOB-LPG	**LPG small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LPG small HOB – conversion to wood pellets
Multistory Buildings	Individual electric appliance	**New wood chips small HOB***	New wood pellets small HOB*
	Small HOB-LPG	**New wood chips small HOB**	LPG small HOB – conversion to wood chips New wood pellets small HOB LPG small HOB – conversion to wood pellets
	Small HOB-LFO		LFO small HOB – conversion to wood chips New wood pellets small HOB LFO small HOB – conversion to wood pellets New wood chips DH HOB

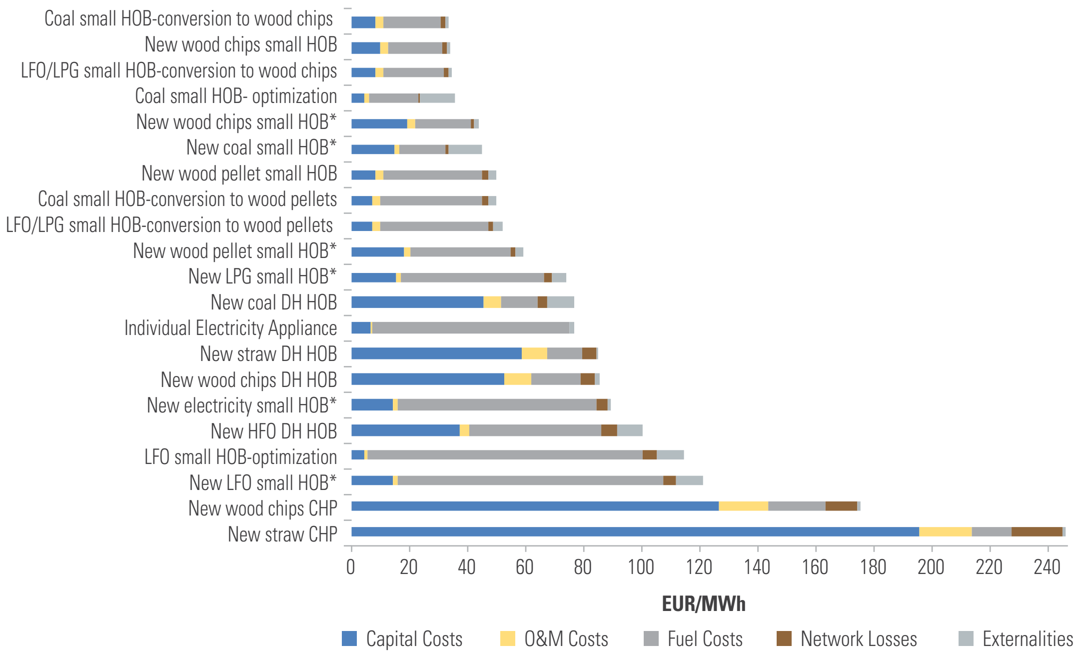
*Includes construction of new internal heating network.

Figure A.2: Economic Viability of Heating Options for Stand-Alone Buildings in Albania



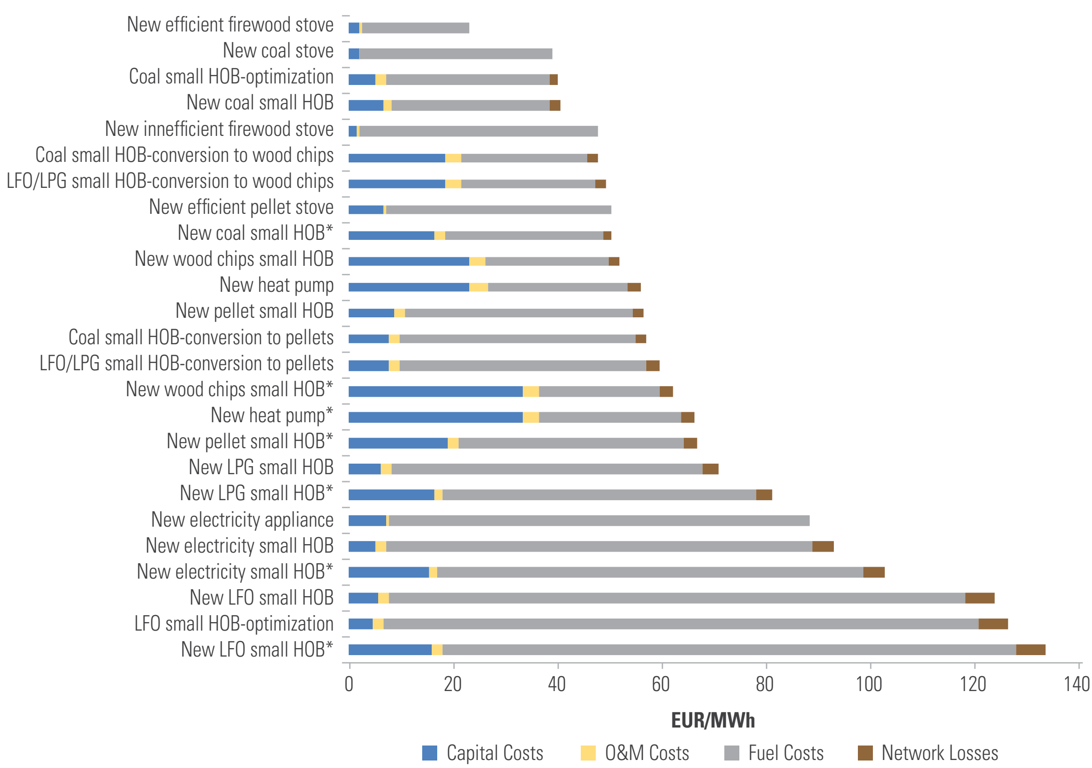
* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.3: Economic Viability of Heating Options for Multistory Buildings in Albania



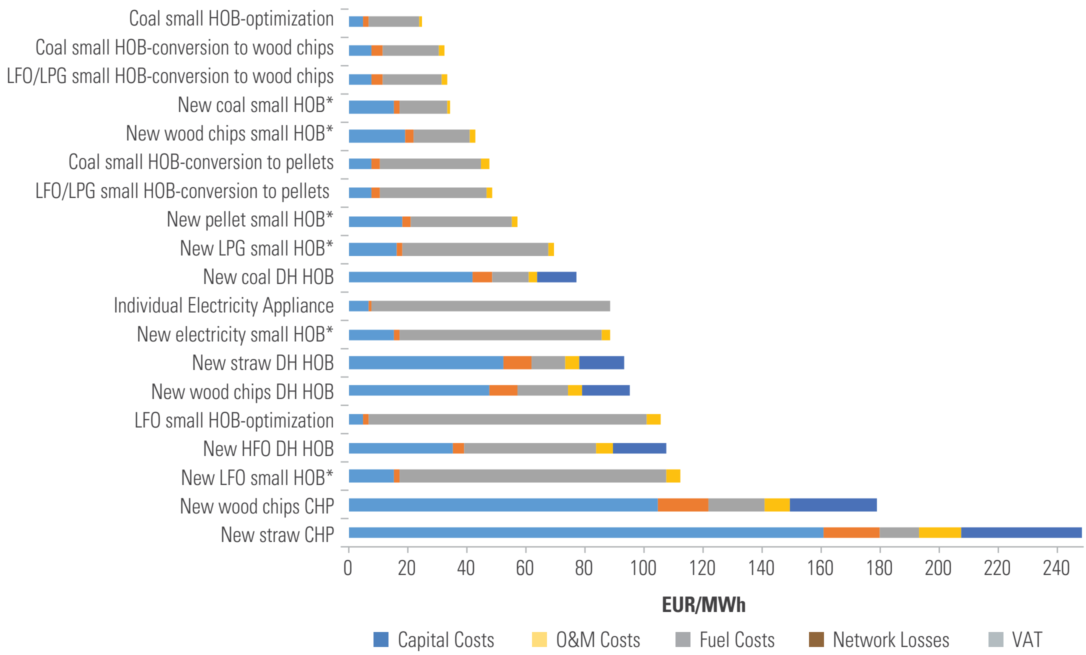
* Multistory buildings that do not have internal network (costs of internal network added to capital costs)

Figure A.4: Financial Viability of Heating Options for Stand-Alone Buildings in Albania



* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs)

Figure A.5: Financial Viability of Heating Options for Multistory Buildings in Albania



* Multistory buildings that do not have internal network (costs of internal network added to capital costs)
Note: VAT expressed for provision of heating services only

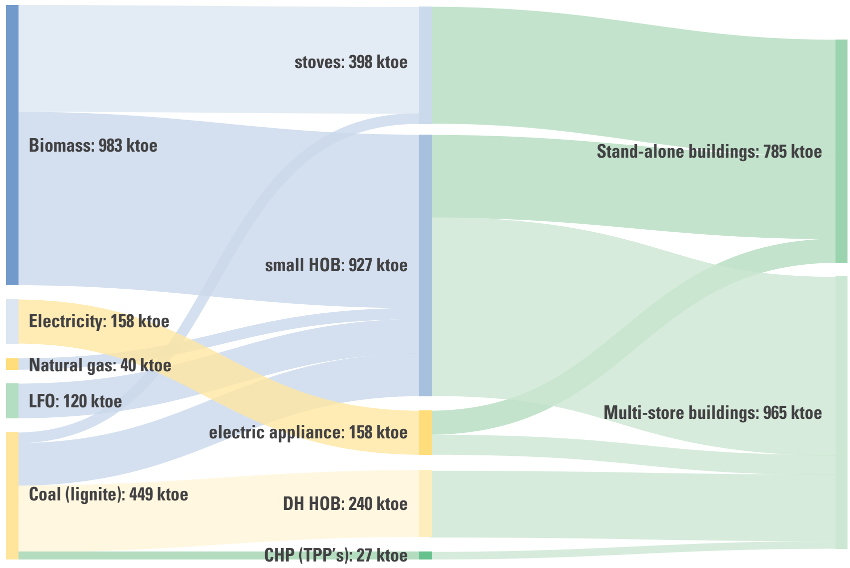
Table A.3: Current Policy with Relevant Measures for Biomass Heat in Albania

Policy type		Albania
Regulations **Legal** **Policy**	**Targets and qualifying criteria for incentives**	• National Renewable Energy Action Plan (2016) • Law on Energy Efficiency was prepared in 2011 but not adopted as of the time of writing this report (December 2014). In April 2014, the new draft EE Law was divided into an EE and EPBD laws. This and other changes to the draft EE Law were initiated in order to transpose Directive 2006/32/EC and certain provisions of the new Directive 2012/27/EU, such as energy management. • NEEAP 2010–2018 primarily aims to align the Albanian legal system to the EU Acquis, and in particular with the Directive 2006/32/EC of April, 5, 2006 (ESD), the Directive 2002/91/EC (EPBD), and with the Directive 92/75/EC (Labelling). The NEEAP contains a description of measures to improve the energy efficiency in the country.
Financial	**Tax relief**	None
	Subsidy	• FiT for biomass
	Low-interest loan	• Financing with incentives from EBRD and EIB
	Energy-based payment	• EE credit lines by KfW (ProCredit Bank) and GGF (to Banka Kombetare Tregtare – a EUR 10 million credit line).
	District heat support	None
Soft measures	**Best practice info**	None
	Promotion	• Priority grid connection for RES-E
	Awareness raising	None

Table A.4: Bosnia and Herzegovina

General Country Information		
Population	3,531,159	
Land area, km² (FAOstat)	51,209	
Agricultural land, % of land area (FAOstat)	42%	
Forest land, % of land area (FAOstat)	43%	
Gross national income 2015, billion current US$ (WDI World Bank)	17.8	
Gross national income per capita 2015, current US$ (WDI World Bank)	4,670	
Population below national poverty line, % of total (WDI World Bank, 2011)	17.9%	
2020 target for renewables (% of gross final energy consumption)	40%	
2014 share of biomass heating in total renewable energy	75%	
Heat Energy Supply And Production		
Total Primary Energy Supply (TPES) – ktoe, Energy Balance (IEA, 2012)	6,670	
Total Primary Energy Supply (TPES) – ktoe, Energy Balance adjusted for unregistered biomass consumption	7,630	
Heat Demand, 2012 (ktoe, % of TPES)	1,750 (23% of adjusted TPES)	
Heat produced in residential sector (ktoe, % of total)	1,326	76%
Heat produced in commercial-industrial sector (ktoe, % of total)	129	7%
Heat produced in public sector (ktoe, % of total)	295	17%
Heat supplied to stand-alone buildings (ktoe, % of total)	786	45%
Heat supplied to multistory buildings (ktoe, % of total)	964	55%
Heat produced by DH systems (ktoe, % of total)	267	15%
Main Fuels For Heat Production		
Biomass (ktoe, % of total)	983	56%
Coal (ktoe, % of total)	449	26%
Natural Gas (ktoe, % of total)	40	2%
Electricity (ktoe, % of total)	158	9%
LPG (ktoe, % of total)	0	0%
LFO/HFO (ktoe, % of total)	120	7%
Other (ktoe, % of total)	0	0%
Biomass Potential And Supply		
Sustainable technical potential excluding energy crops (ktoe)		1,324
Biomass consumption (ktoe, % of sustainable technical potential)	1,141	86%
Biomass available to supply an increase in biomass-based heating over and above the current consumption (ktoe, in MW of heating capacity that could be supplied)	104	444 MW

Figure A.6: Annual Heat Demand and Overview of Heating Systems in Bosnia and Herzegovina



Economic and Financial Viability of Different Heating Options in Bosnia and Herzegovina

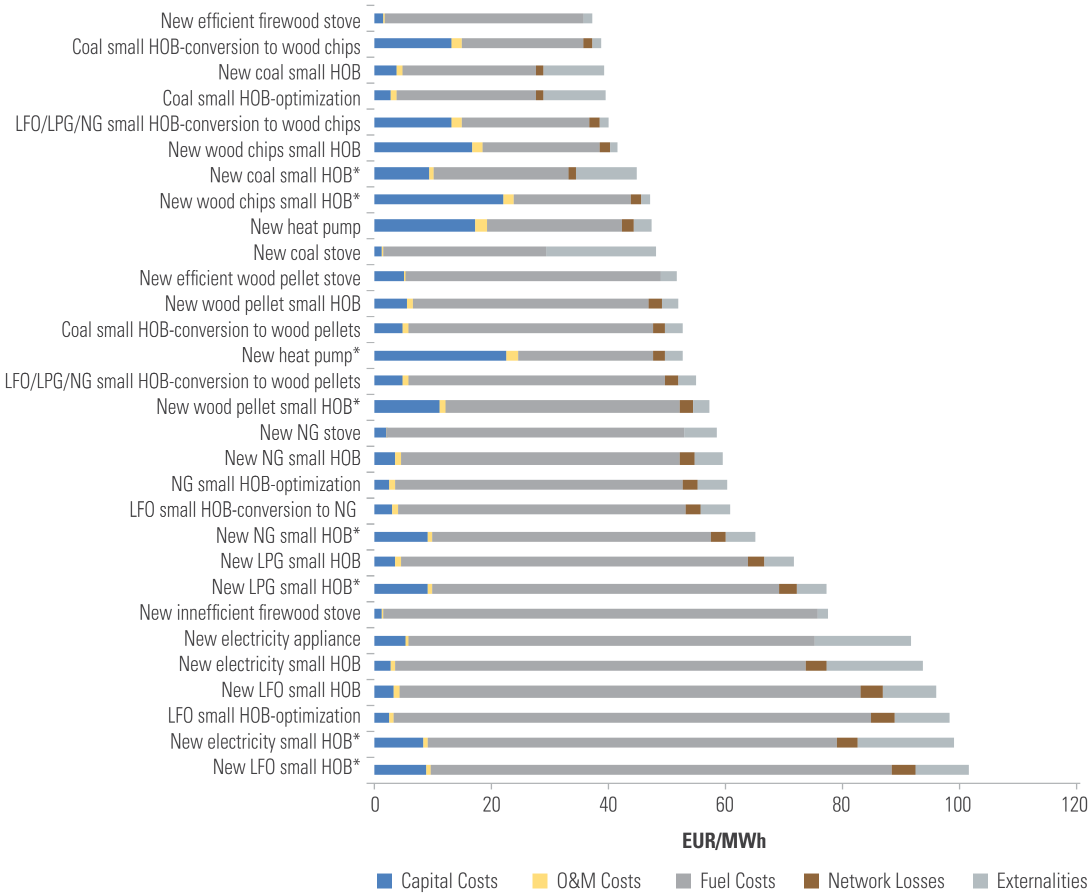
The largest share of stand-alone buildings in Bosnia and Herzegovina is heated by inefficient firewood stoves, appliances using electricity, small HOBs that use LFO, and coal stoves and small HOBs. The majority of multistory buildings use coal small HOBs for heating, followed by the electric appliance, and small HOBs using LFO and NG. In DH sector, HOBs are predominantly fueled by coal. Economically viable biomass heating options in Bosnia and Herzegovina are presented in Table A.5.

Table A.5: Economically Viable Biomass Heating Options in Bosnia and Herzegovina

Bosnia and Herzegovina	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
Stand-Alone Buildings	Inefficient wood stoves	New efficient firewood stove	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LFO	LFO small HOB – conversion to wood chips	New wood chips small HOB LFO small HOB – conversion to wood pellets New wood pellets small HOB
	Coal stoves	New efficient firewood stove	New wood chips small HOB*
	Small HOB-coal	Coal small HOB – conversion to wood chips	None
Multistory Buildings	Small HOB-coal	Coal small HOB – conversion to wood chips	New wood chips small HOB
	Individual electric appliance	New wood chips small HOB	New wood pellets small HOB New straw DH HOB New wood chips DH HOB
	Small HOB-LFO		LFO small HOB – conversion to wood chips New wood pellets small HOB LFO small HOB – conversion to wood pellets New straw DH HOB New wood chips DH HOB
	Small HOB-NG		NG small HOB – conversion to wood chips New wood pellets small HOB NG small HOB – conversion to wood pellets
DH/CHP	DH HOB-coal	Coal DH HOB – conversion to straw	Coal DH HOB – conversion to wood chips

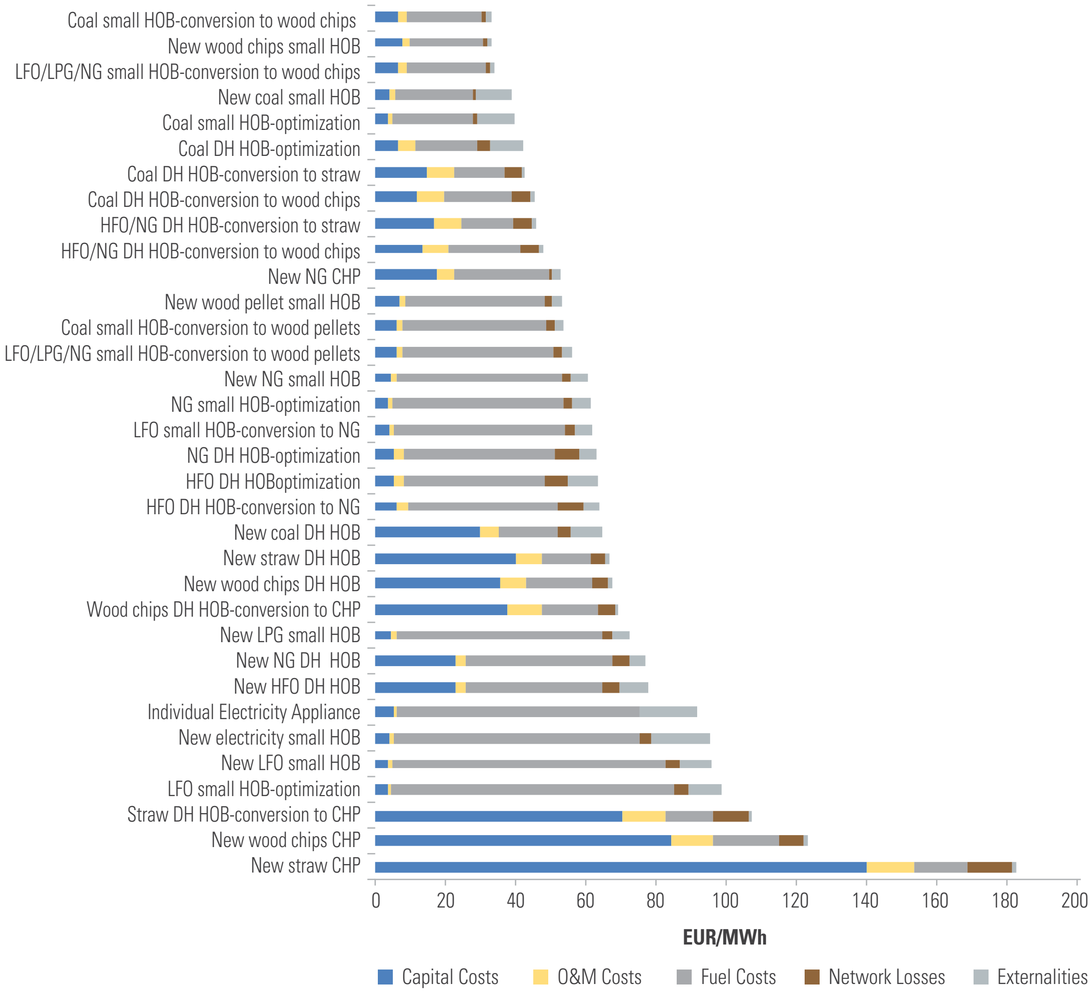
*Includes construction of new internal heating network.

Figure A.7: Economic Viability of Heating Options for Stand-Alone Buildings in Bosnia and Herzegovina



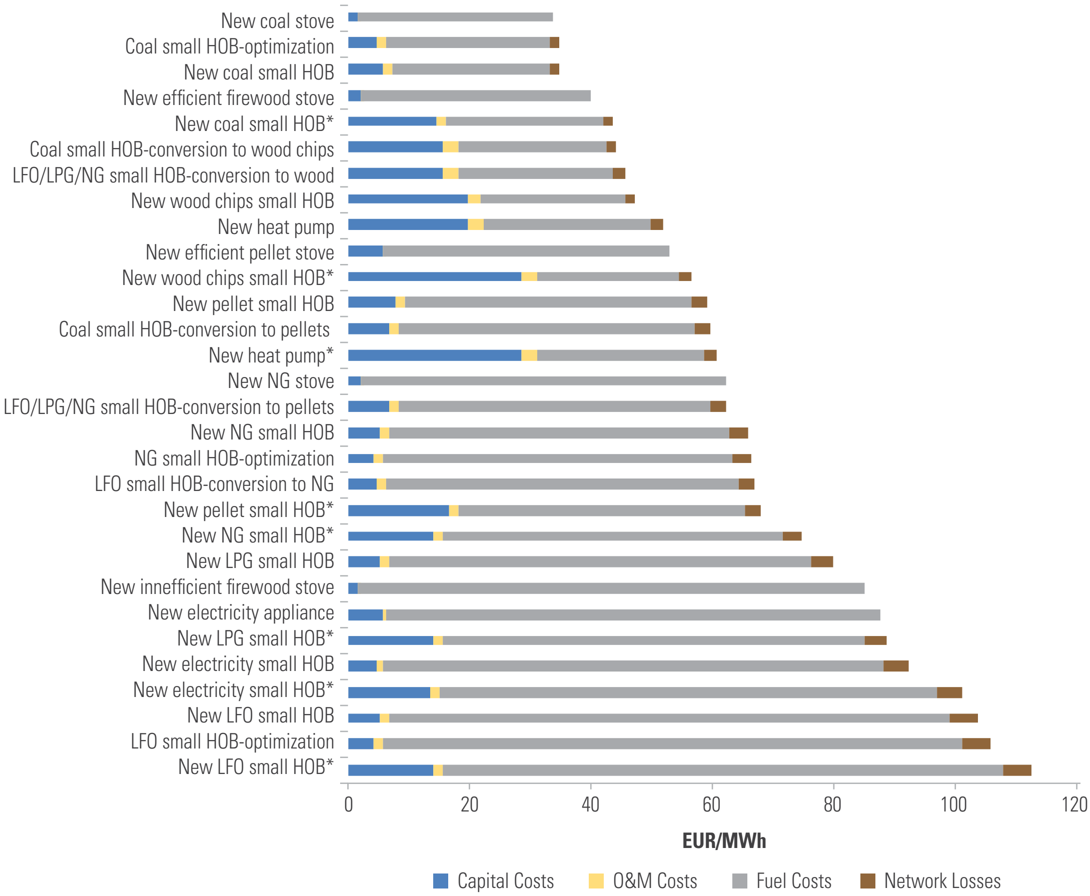
* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs)

Figure A.8: Economic Viability of Heating Options for Multistory Buildings in Bosnia and Herzegovina



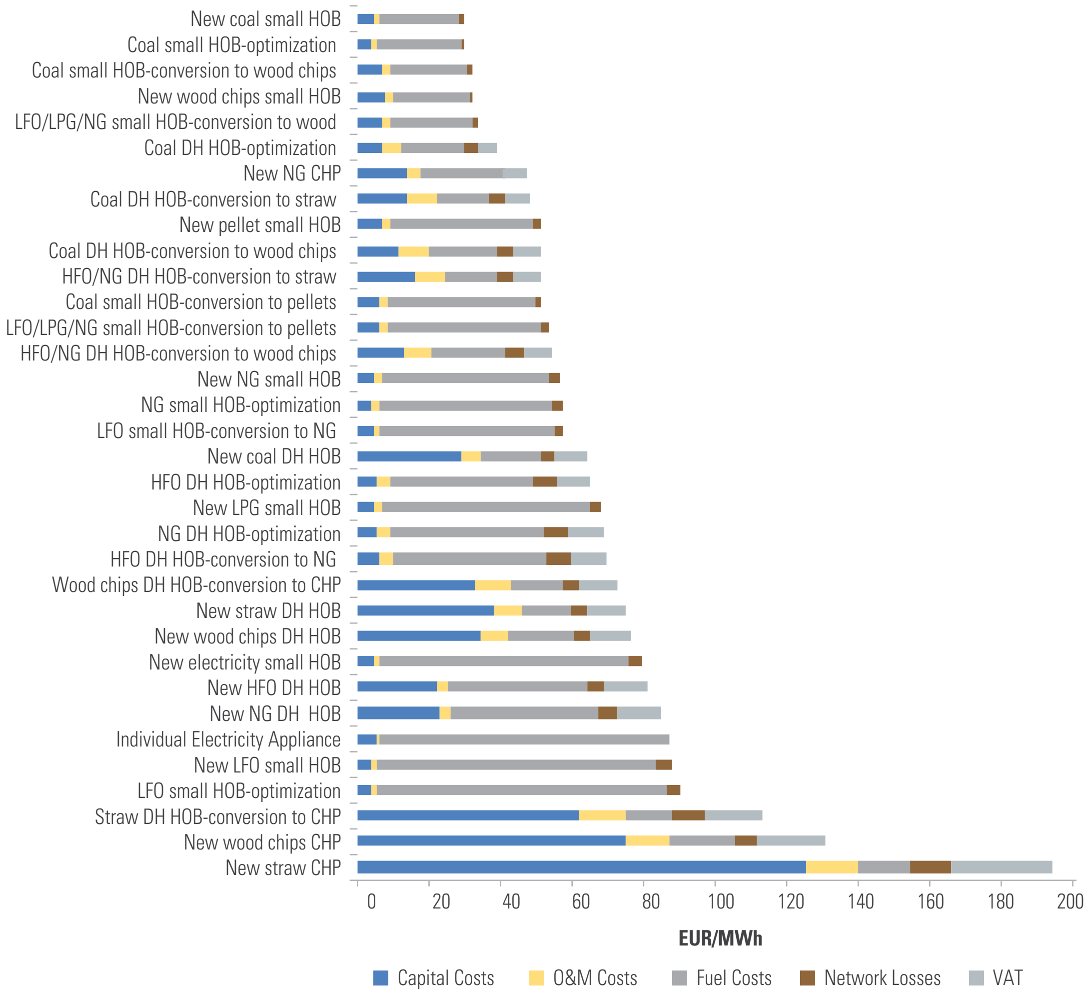
* Multistory buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.9: Financial Viability of Heating Options for Stand-Alone Buildings in Bosnia and Herzegovina



* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.10: Financial Viability of Heating Options for Multistory Buildings in Bosnia and Herzegovina



* Multistory buildings that do not have internal network (costs of internal network added to capital costs).
Note: VAT expressed for provision of heating services only.

Table A.6: Current Policy with Relevant Measures for Biomass Heat in Bosnia and Herzegovina

Policy type		Bosnia and Herzegovina
Regulations **Legal** **Policy**	**Targets and qualifying criteria for incentives**	• National Renewable Energy Action Plan (2016) • Law on Energy – Official Gazette RS No.49/09; Law on RES and efficient cogeneration – Official Gazette RS No.39/13 and 108/13 • First EEAP was adopted by the Government of Republika Srpska in December 2013 • The Energy Efficiency Law in FBiH was submitted to Parliament for adoption in June 2014 and was finally adopted in September 2014. Law on Electric Energy – Official Gazette FBIH No.66/13 • Law on RES and efficient cogeneration – Official Gazette FBIH No.70/13; Law on RES and efficient cogeneration – Official Gazette FBIH No.70/13 • The RS Forestry Development Strategy covers the period 2011–2021.
	Quotas	None
	Product standards	• Federal Ministry of Physical Planning adopted in 2010 the Law on Spatial Planning (OG FBiH 4/10), which was the basis for adoption of a set of regulations and guidelines dealing with building certification, inspection of heating, and air-conditioning systems • Republika Srpska has defined Energy Efficiency in Buildings as a priority direction through the Law on Physical Planning and Construction. • In FBiH, the EPBD Directive's requirements related to the calculation methodology for minimum energy performance of buildings, energy audits and energy certification of buildings are already partly transposed through the existing Law on Physical Planning and Land Utilization, as well as several by-laws. • In Republika Srpska, the key requirements of Directive 2010/31/ EU were transposed through the new Law on Physical Planning and Construction of May 2013. No secondary legislation is included. • Rulebook on Guarantee of Origin – Official Gazette RS No.1/2014

	Obligations in buildings	• In FBiH, a specific Law on Construction does not exist. Instead there are adopted amendments to the Law on Spatial Planning and Land Use:
		  ◦ Preparation of Ordinance on Energy Certification of Buildings, which was adopted (Official Gazette No. 50/10)
		  ◦ Regulation on technical requirements for ventilation, partial ventilation and air-conditioning systems (OG FBiH 49/09)
		  ◦ Regulation on technical requirements for heating and cooling systems (OG FBiH 49/09) Regulation on technical requirements for thermal protection of buildings and rational energy use (OG 49/09)
		  ◦ Regulation on conditions for the legal entities that carry out energy audits and energy certification (OG 28/10) · Guidelines for Energy Audits of Buildings (September 2010)

(*continued on next page*)

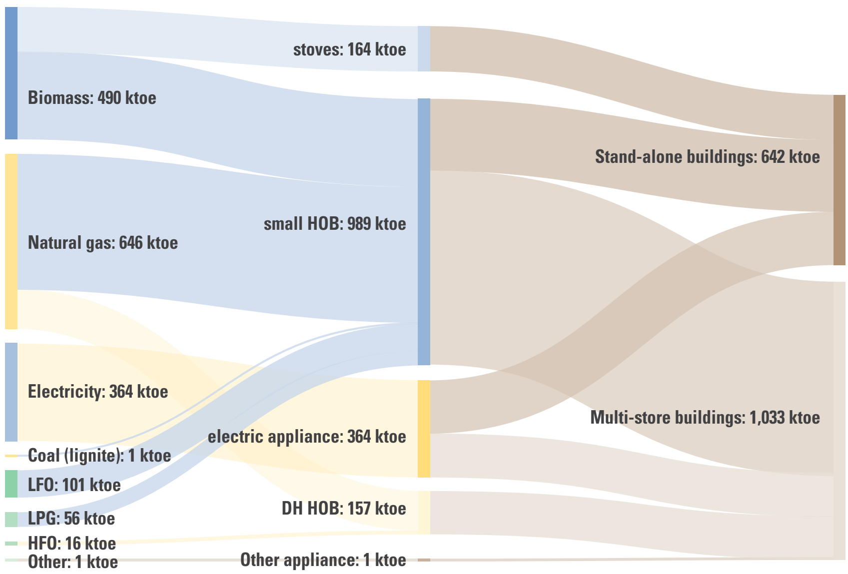
Table A.6: Current Policy with Relevant Measures for Biomass Heat in Bosnia and Herzegovina (*continued*)

Policy type		Bosnia and Herzegovina
Financial	**Tax relief**	None
	Subsidy	• Decree on FITs and Premiums – Official Gazette RS No.113/2013; Decree on FITs – Official Gazette FBIH No./2014; • Each entity has established an Energy Efficiency and Environmental Fund, which is supplied mostly by fines imposed on environmental polluters and may be used to finance energy efficiency projects. The funds however do not offer any programmes yet for EE renovation of the residential sector – including multi-apartment buildings.
	Low-interest loan	• Habitat for Humanity offers loans for EE improvements with interest rate of 3%, either to HOAs or to vendors. • Green for Growth Fund also has credit lines for EE in the residential sector.
	Energy-based payment	None
	District heat support	None
Soft measures	**Best practice info**	None
	Promotion	• UNDP is supporting some municipalities in preparing their public building stock register and some awareness events on EE. · GIZ was supporting 6 municipalities across BiH for preparation of Local Energy Action Plans (LEAP) and preparation of related awareness events. • Additionally, individual cities (more than 20) have joined EU Covenant of Mayor Initiative, and these cities are carrying out occasional promotional activities.
	Awareness raising	None

Table A.7: Croatia

General Country Information		
Population	4,236,400	
Land area, km² (FAOstat)	56,620	
Agricultural land, % of land area (FAOstat)	23%	
Forest land, % of land area (FAOstat)	34%	
Gross national income 2015, billion current US$ (WDI World Bank)	53.7	
Gross national income per capita 2015, current US$ (WDI World Bank)	12,700	
Population below national poverty line, % of total (WDI World Bank, 2013)	19.4%	
2020 target for renewables (% of gross final energy consumption)	20%	
2014 share of biomass heating in total renewable energy	59%	
Heat Energy Supply And Production		
Total Primary Energy Supply (TPES) – ktoe, Energy Balance (IEA, 2012)	8,852	
Total Primary Energy Supply (TPES) – ktoe, Energy Balance adjusted for unregistered biomass consumption	8,965	
Heat Demand, 2012 (ktoe, % of TPES)	1,674 (19% of adjusted TPES)	
Heat produced in residential sector (ktoe, % of total)	1,007	60%
Heat produced in commercial-industrial sector (ktoe, % of total)	508	31%
Heat produced in public sector (ktoe, % of total)	159	9%
Heat supplied to stand-alone buildings (ktoe, % of total)	642	38%
Heat supplied to multistory buildings (ktoe, % of total)	1,032	62%
Heat produced by DH systems (ktoe, % of total)	157	9%
Main Fuels For Heat Production		
Biomass (ktoe, % of total)	489	29%
Coal (ktoe, % of total)	1	0%
Natural Gas (ktoe, % of total)	646	39%
Electricity (ktoe, % of total)	364	22%
LPG (ktoe, % of total)	56	3%
LFO/HFO (ktoe, % of total)	117	7%
Other (ktoe, % of total)	1	0%
Biomass Potential And Supply		
Sustainable technical potential excluding energy crops (ktoe)		1,550
Biomass consumption (ktoe, % of sustainable technical potential)	664	43%
Biomass available to supply an increase in biomass-based heating over and above the current consumption (ktoe, in MW of heating capacity that could be supplied)	164	651 MW

Figure A.11: Annual Heat Demand and Overview of Heating Systems in Croatia



Economic and Financial Viability of Different Heating Options in Croatia

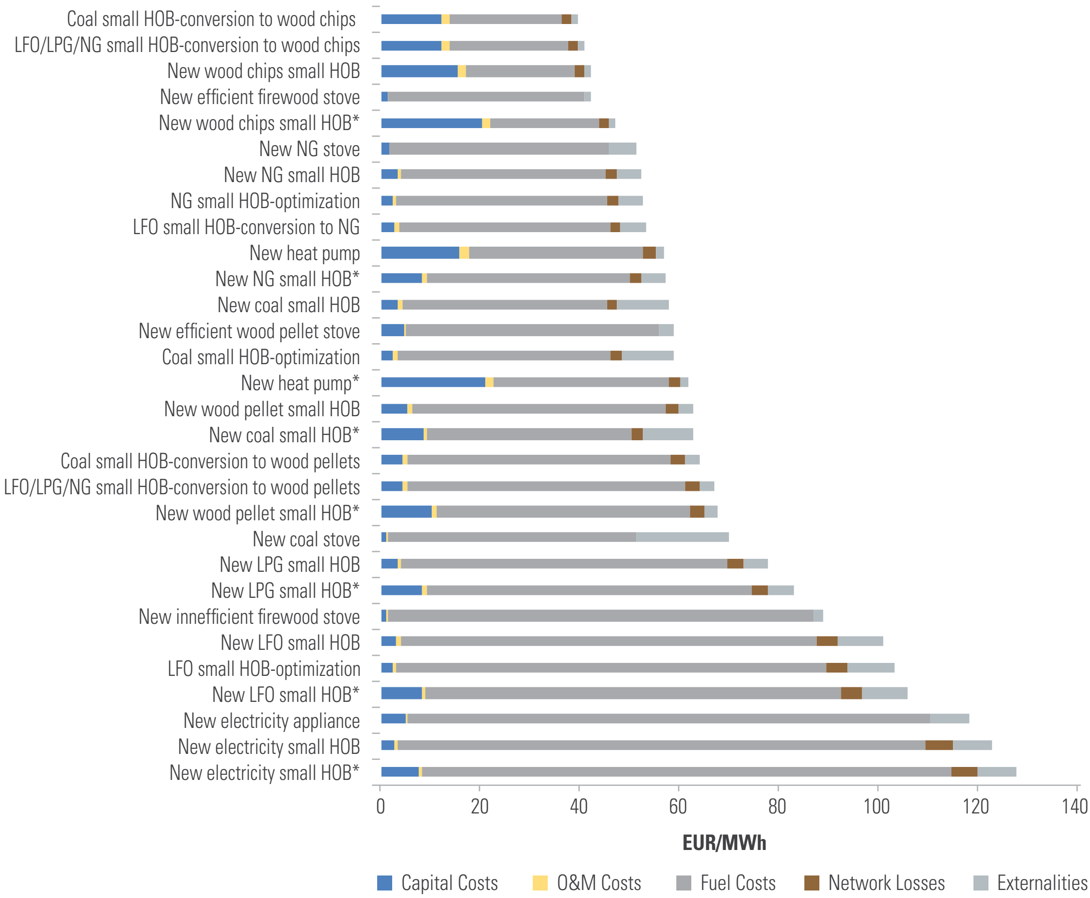
The main heating options currently deployed in stand-alone buildings in Croatia are electric appliances, small HOBs using natural gas, inefficient firewood stoves, and small HOBs using LFO and LPG. Most dwellings in multistory buildings are heated with small HOB that uses natural gas, individual electric appliance, and small HOBs that use LFO and LPG. DH HOBs are mainly fueled by natural gas and HFO. Economically viable biomass heating options in Croatia are presented in Table A.8.

Table A.8: Economically Viable Biomass Heating Options in Croatia

Croatia	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
Stand-Alone Buildings	Individual electric appliance	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-NG	**NG small HOB – conversion to wood chips**	New wood chips small HOB
	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LFO	**LFO small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB
	Small HOB-LPG	**LPG small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB
Multistory Buildings	Small HOB-NG	**New wood chips small HOB**	NG small HOB – conversion to wood chips
	Individual electric appliance		New wood pellets small HOB New wood chips DH HOB New straw DH HOB New wood chips CHP
	Small HOB-LFO		LFO small HOB – conversion to wood chips New wood pellets small HOB New wood chips DH HOB New straw DH HOB
	Small HOB-LPG		LFO small HOB – conversion to wood chips New wood pellets small HOB New wood chips DH HOB New straw DH HOB
DH/CHP	DH HOB-NG	**NG DH HOB – conversion to straw**	NG DH HOB – conversion to wood chips New wood chips DH HOB New straw DH HOB
	DH HOB-HFO	**HFO DH HOB – conversion to straw**	HFO DH HOB – conversion to wood chips New wood chips DH HOB New straw DH HOB

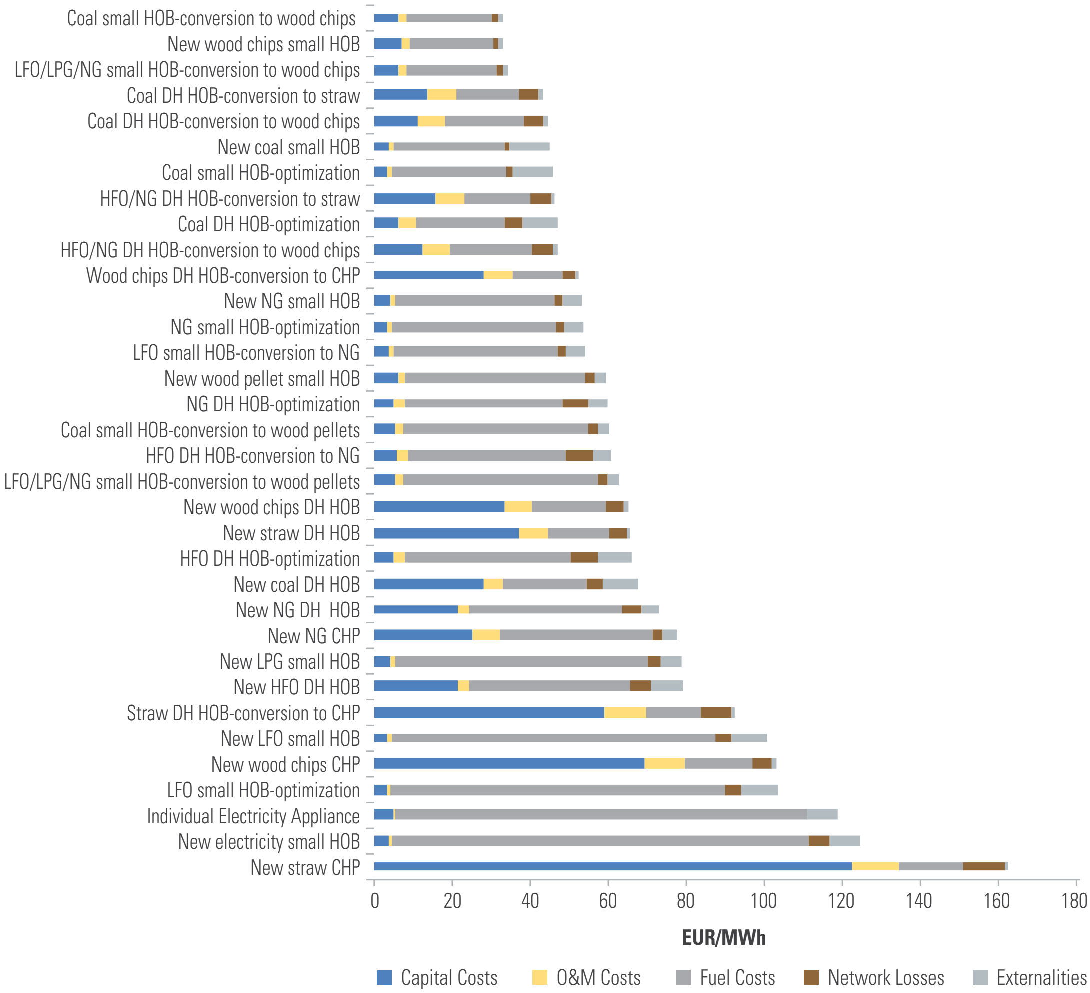
* Includes construction of new internal heating network.

Figure A.12: Economic Viability of Heating Options for Stand-Alone Buildings in Croatia



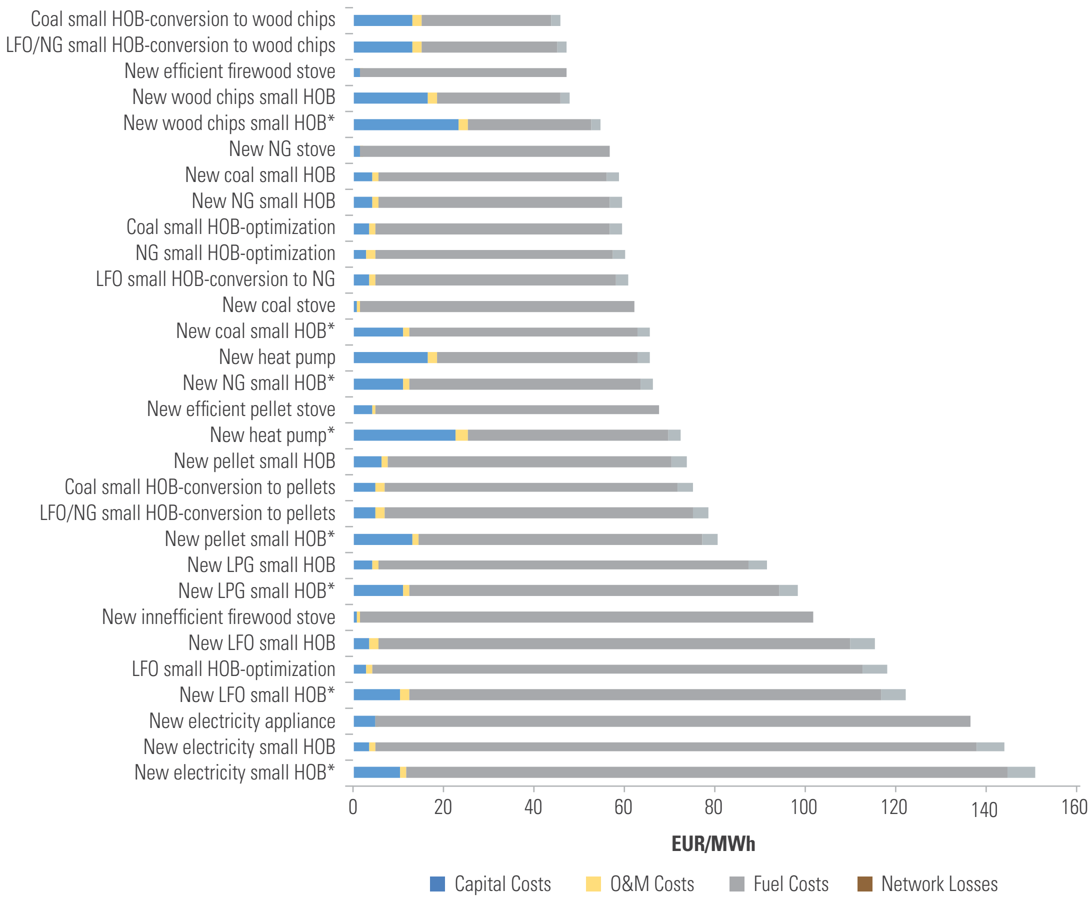
* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.13: Economic Viability of Heating Options for Multistory Buildings in Croatia



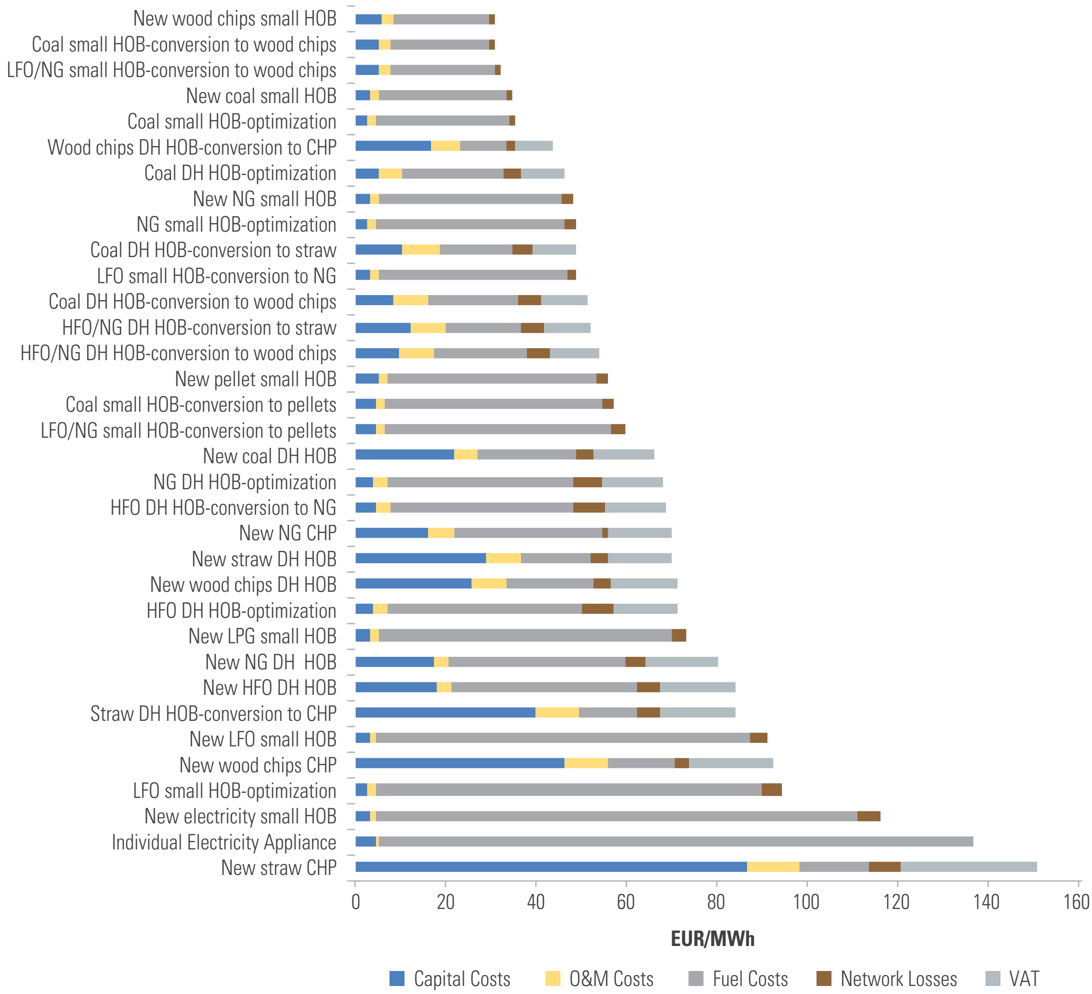
* Multistory buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.14: Financial Viability of Heating Options for Stand-Alone Buildings in Croatia



* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.15: Financial Viability of Heating Options for Multistory Buildings in Croatia



*Multistory buildings that do not have internal network (costs of internal network added to capital costs).
Note: VAT expressed for provision of heating services only.

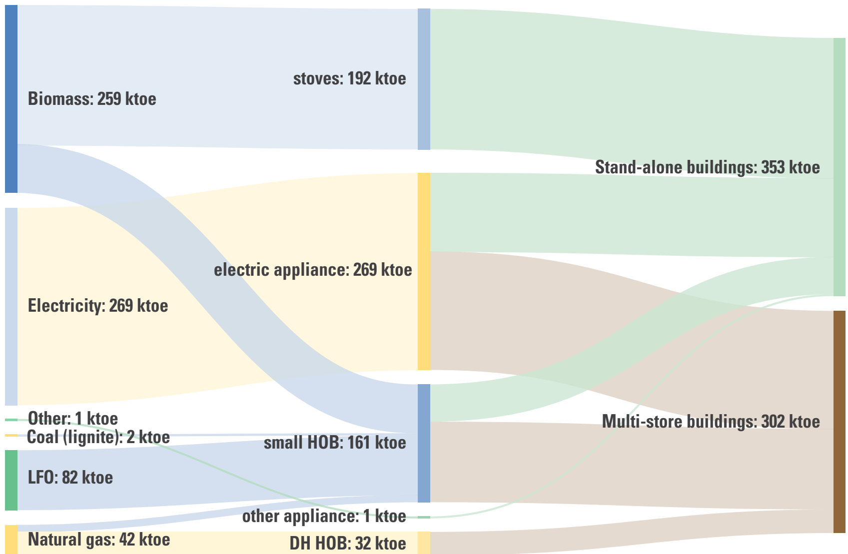
Table A.9: Current Policy with Relevant Measures for Biomass Heat in Croatia

Policy type		Croatia
Regulations Legal Policy	Targets and qualifying criteria for incentives	• National Renewable Energy Action Plan (2010) • Regulation on the procedure and criteria for servitude of forest and forest land owned by the Republic of Croatia aimed for perennial plantation (OG 121/08) • Energy Act (2012); Energy Activities Regulation Act (2012); Electricity Market Act (2013) • Act on implementation of EU Regulation related to trade of illegally cut wood and products made of that wood (OG 54/13) • Forest Act (OG 140/05, 82/06, 129/08, 80/10, 124/10, 25/12) • Ordinance on forest management (OG 111/06, 141/08) • Decision on determination of vulnerable areas in the Republic of Croatia (OG 130/12) • Regulation on air emission limit values of pollutants from stationary sources (OG 117/12) in line with European Industrial Emissions Directive (2010/75/EC)
	Quotas	None
	Product standards	None
	Obligations in buildings	None
Financial	Tax relief	None
	Subsidy	None
	Low-interest loan	• Fund for Environmental Protection and Energy Efficiency Act (OG 107/03, 144/12) • HBOR Loan Programme for Environmental Protection, Energy Efficiency and Renewable Energy Sources
	Energy-based payment	• Tariff System for Electricity Production from Renewable Energy Sources and CHP (OG 133/13, 151/13, 20/14) • Regulation on the Fee to Encourage the Production of Electricity from Renewable Energy Sources and CHP (OG 144/11, 128/13)
	District heat support	None
Soft measures	Best practice info	None
	Promotion	None
	Awareness raising	None

Table A.10: FYR Macedonia

General Country Information		
Population	2,065,769	
Land area, km² (FAOstat)	25,713	
Agricultural land, % of land area (FAOstat)	43%	
Forest land, % of land area (FAOstat)	39%	
Gross national income 2015, billion current US$ (WDI World Bank)	10.7	
Gross national income per capita 2015, current US$ (WDI World Bank)	5,140	
Population below national poverty line, % of total (WDI World Bank, 2014)	22.1%	
2020 target for renewables (% of gross final energy consumption)	28%	
2014 share of biomass heating in total renewable energy	62%	
Heat Energy Supply And Production		
Total Primary Energy Supply (TPES) – ktoe, Energy Balance (IEA, 2012)	2,968	
Total Primary Energy Supply (TPES) – ktoe, Energy Balance adjusted for unregistered biomass consumption	3,048	
Heat Demand, 2012 (ktoe, % of TPES)	654 (21% of adjusted TPES)	
Heat produced in residential sector (ktoe, % of total)	418	64%
Heat produced in commercial-industrial sector (ktoe, % of total)	201	31%
Heat produced in public sector (ktoe, % of total)	35	5%
Heat supplied to stand-alone buildings (ktoe, % of total)	351	54%
Heat supplied to multistory buildings (ktoe, % of total)	304	46%
Heat produced by DH systems (ktoe, % of total)	32	5%
Main Fuels For Heat Production		
Biomass (ktoe, % of total)	258	39%
Coal (ktoe, % of total)	2	0%
Natural Gas (ktoe, % of total)	42	6%
Electricity (ktoe, % of total)	269	41%
LPG (ktoe, % of total)	0	0%
LFO/HFO (ktoe, % of total)	82	13%
Other (ktoe, % of total)	1	0%
Biomass Potential And Supply		
Sustainable technical potential excluding energy crops (ktoe)		315
Biomass consumption (ktoe, % of sustainable technical potential)	270	86%
Biomass available to supply an increase in biomass-based heating over and above the current consumption (ktoe, in MW of heating capacity that could be supplied)	60	240 MW

Figure A.16: Annual Heat Demand and Overview of Heating Systems in FYR Macedonia



Economic and Financial Viability of Different Heating Options in FYR Macedonia

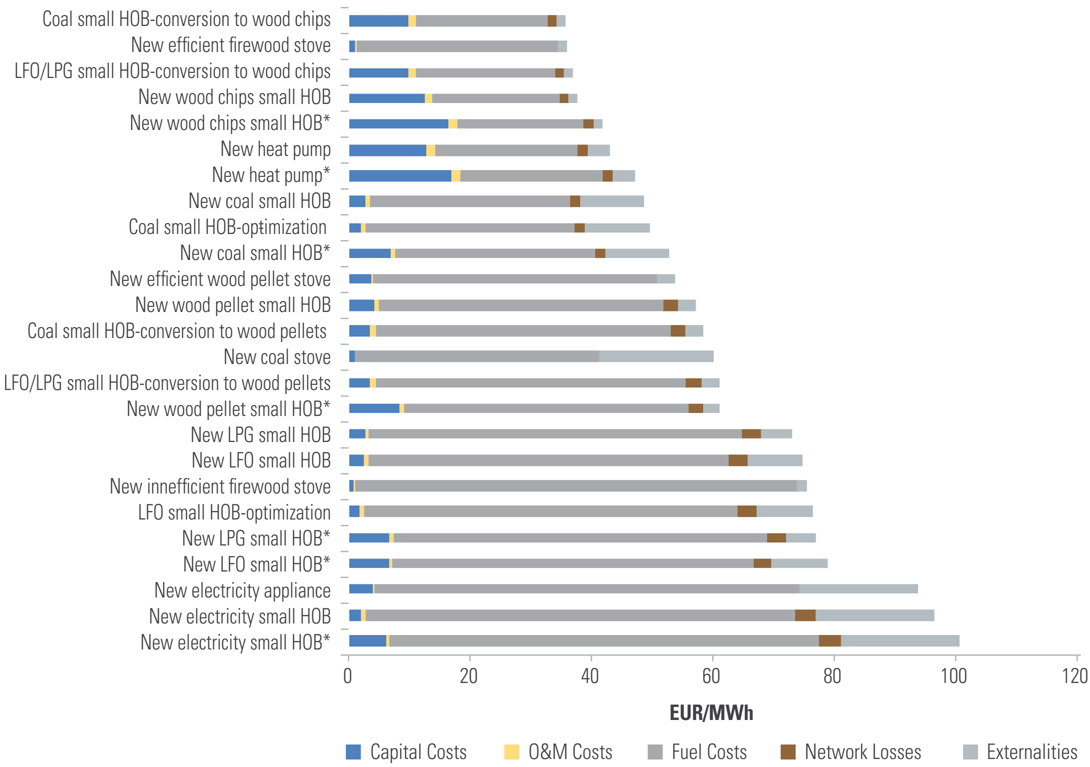
The main heating options currently used in stand-alone buildings in FYR Macedonia include inefficient firewood stoves, electric appliances and small HOBs using LFO and NG. Most dwellings in multistory buildings are heated by individual electric appliances and small HOB that uses LFO. DH is based on the use of natural gas. Economically viable biomass heating options in FYR Macedonia are presented in Table A.11.

Table A.11: Economically Viable Biomass Heating Options in FYR Macedonia

Fyr Macedonia	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
Stand-Alone Buildings	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LFO	**LFO small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB – conversion to wood pellets
	Small HOB-NG	**NG small HOB – conversion to wood chips**	New wood chips small HOB
Multistory Buildings	Individual electric appliance	**New wood chips small HOB**	New wood pellets small HOB New wood chips DH HOB New wood chips CHP
	Small HOB-LFO		LFO small HOB – conversion to wood chips New wood pellets small HOB New wood chips DH HOB LFO small HOB – conversion to wood pellets
DH/CHP	DH HOB-NG	**NG DH HOB – conversion to wood chips**	New wood chips DH HOB

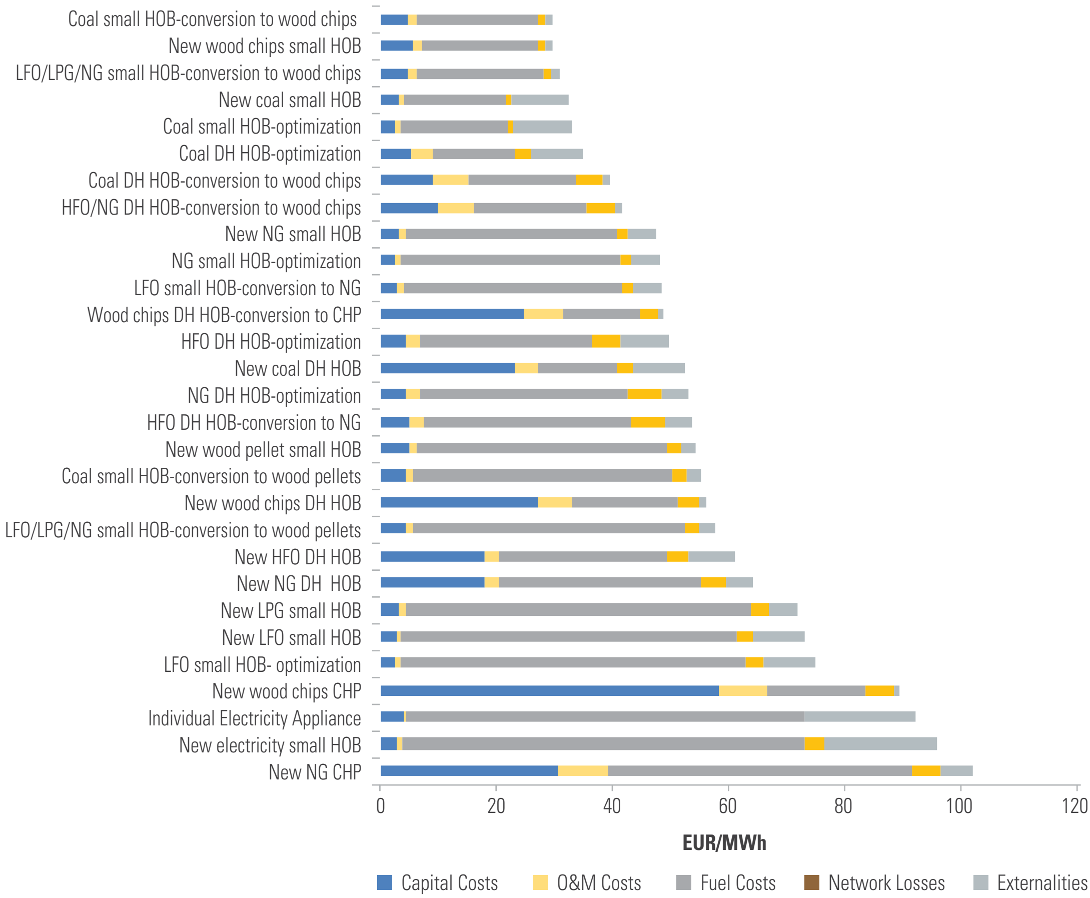
* Includes construction of new internal heating network.

Figure A.17: Economic Viability of Heating Options for Stand-Alone Buildings in FYR Macedonia



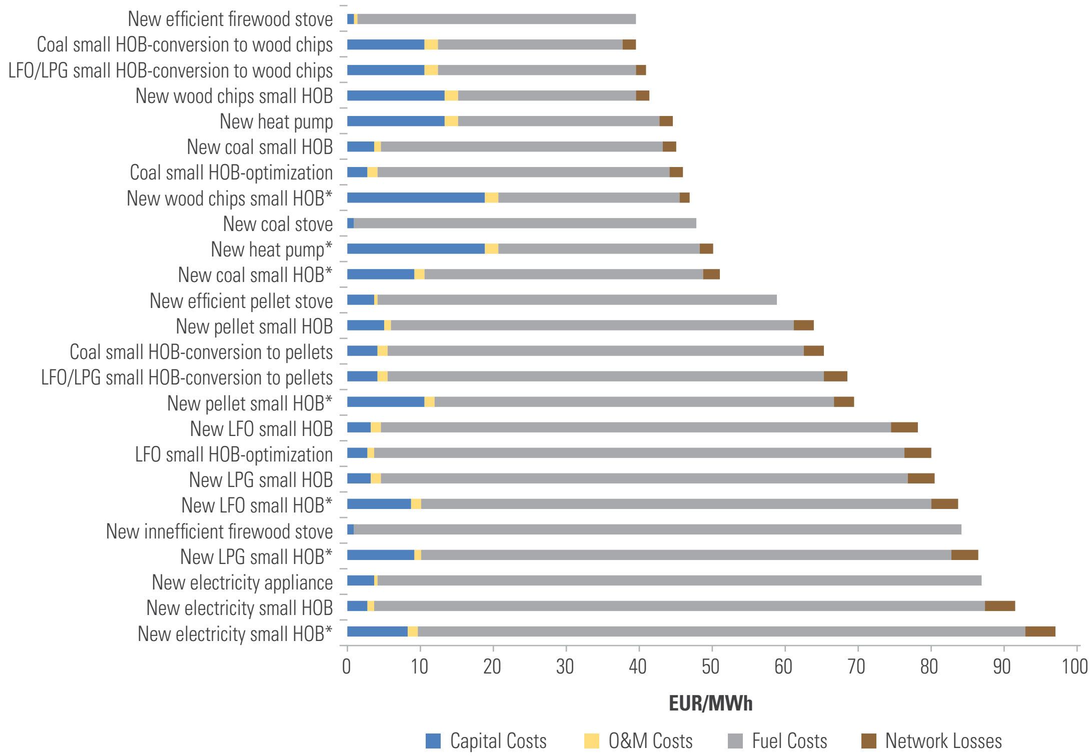
* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.18: Economic Viability of Heating Options for Multistory Buildings in FYR Macedonia



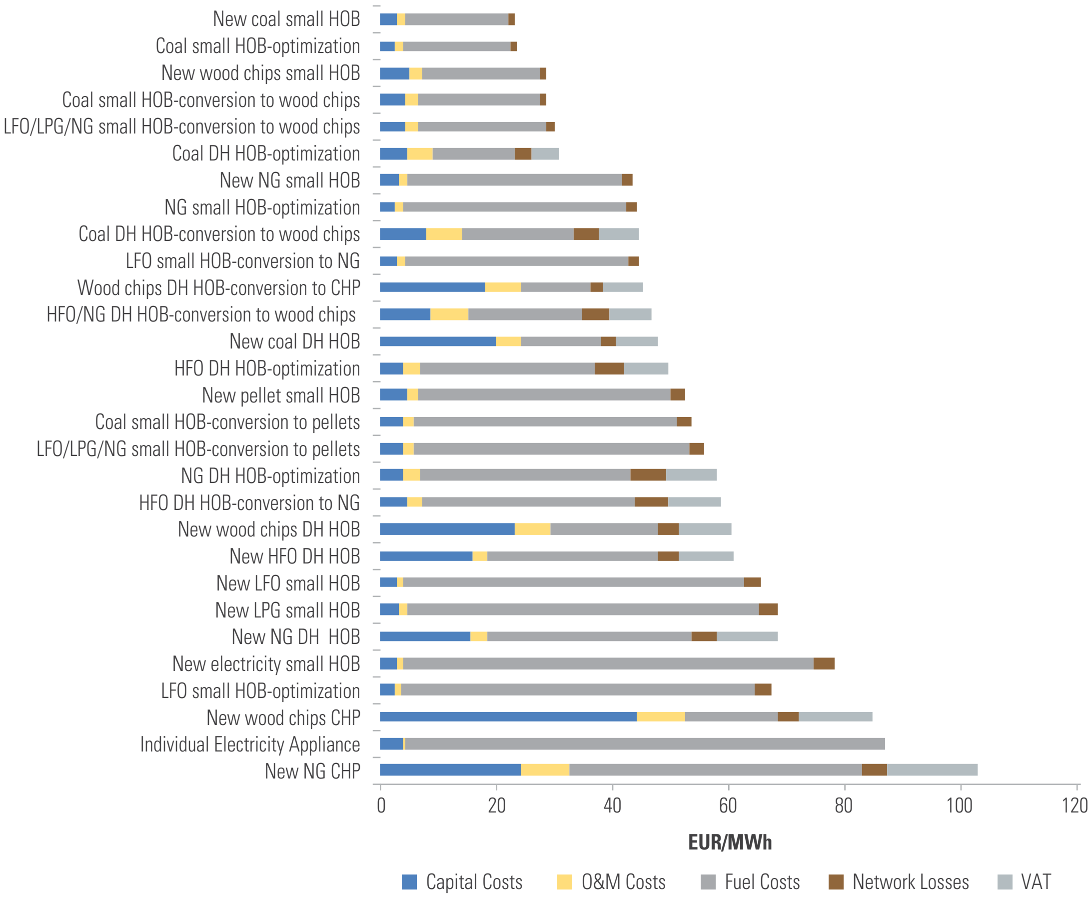
*Multistory buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.19: Financial Viability of Heating Options for Stand-Alone Buildings in FYR Macedonia



* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.20: Financial Viability of Heating Options for Multistory Buildings in FYR Macedonia



*Multistory buildings that do not have internal network (costs of internal network added to capital costs).
Note: VAT expressed for provision of heating services only.

Table A.12: Current Policy with Relevant Measures for Biomass Heat in FYR Macedonia

Policy type		FYR Macedonia
Regulations **Legal** **Policy**	**Targets and qualifying criteria for incentives**	• National Renewable Energy Action Plan (2016). • Energy Development Strategy of the Republic of Macedonia until 2030. • Energy Law of 2011 (with amendments adopted in May and November 2013, as well as October 2014) includes an extensive chapter on energy efficiency and establishes a good legal basis for the development of secondary legislation and implementation of Directives 2006/32/EC, 2010/30/EU and 2010/31/EU. • Second NEEAP.
	Quotas	None.
	Product standards	None.
	Obligations in buildings	• For the newly built residential buildings the Housing Law (Official Gazette No. 70/2013) only declaratively stipulates that they should provide efficient energy use and thermal insulation. There is no legal procedure to ensure this is implemented during construction of residential buildings. The Energy Law (Official Gazette No. 16/2011), Article 136, states that the investor is obligated to provide a statement from an energy auditor for compliance of the basic design with the minimal requirements from the Rulebook of Energy Performance of Buildings. This is, however, still not applicable in practice.
Financial	**Tax relief**	None.
	Subsidy	Energy Efficiency Fund (under development?). FiT for biomass.
	Low-interest loan	• Habitat for Humanity runs a program offering several credit lines for reconstruction and renovation of the substandard homes in Macedonia with distinctive terms and conditions. • Credit products for EE in the residential sector with Procredit, Alpha Banks. • Halkbank Macedonia – EUR 5 million from Green for Growth Fund starting in 2010 (seems geared toward businesses).
	Energy-based payment	None.
	District heat support	None.
Soft measures	**Best practice info**	None.
	Promotion	• Platform for Energy Efficiency.
	Awareness raising	None.

Table A.13: Kosovo

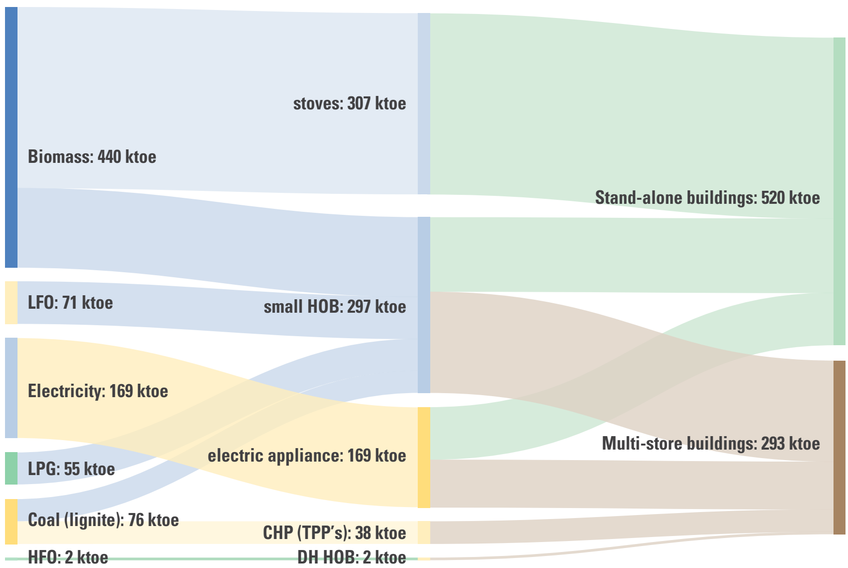
General Country Information		
Population	1,804,944	
Land area, km² [a]	10,887	
Agricultural land, % of land area	52%	
Forest land, % of land area	44%	
Gross national income 2015, billion current US$ (WDI World Bank)	7.1	
Gross national income per capita 2015, current US$ (WDI World Bank)	3,970	
Population below national poverty line, % of total (WDI World Bank, 2011)	29.7%	
2020 target for renewables (% of gross final energy consumption)	25%	
2014 share of biomass heating in total renewable energy	95%	
Heat Energy Supply And Production		
Total Primary Energy Supply (TPES) – ktoe, Energy Balance (IEA, 2012)	2,369	
Total Primary Energy Supply (TPES) – ktoe, Energy Balance adjusted for unregistered biomass consumption	2,563	
Heat Demand, 2012 (ktoe, % of TPES)	813 (32% of adjusted TPES)	
Heat produced in residential sector (ktoe, % of total)	567	69%
Heat produced in commercial-industrial sector (ktoe, % of total)	217	27%
Heat produced in public sector (ktoe, % of total)	29	3%
Heat supplied to stand-alone buildings (ktoe, % of total)	520	64%
Heat supplied to multistory buildings (ktoe, % of total)	293	36%
Heat produced by DH systems (ktoe, % of total)	40	5%
Main Fuels For Heat Production		
Biomass (ktoe, % of total)	440	54%
Coal (ktoe, % of total)	77	9%
Natural Gas (ktoe, % of total)	0	0%
Electricity (ktoe, % of total)	169	21%
LPG (ktoe, % of total)	55	7%
LFO/HFO (ktoe, % of total)	72	9%
Other (ktoe, % of total)	0	0%
Biomass Potential And Supply		
Sustainable technical potential excluding energy crops (ktoe)		284
Biomass consumption (ktoe, % of sustainable technical potential)	441	155%
Biomass available to supply an increase in biomass-based heating over and above the current consumption (ktoe, MW of heating capacity that could be supplied)	68[b]	233 MW

Regardless of currently unsustainable woody biomass consumption, potential to increase biomass-based heating still exists in Kosovo taking into account that certain categories of woody biomass (such as thinnings, logging residues, and prunings) and agricultural biomass are not used, despite their availability.

[a] http://en.worldstat.info/Europe/Kosovo/Land.

[b] Regardless of currently unsustainable woody biomass consumption, potential to increase biomass-based heating still exists in Kosovo taking into account that certain categories of woody biomass (such as thinnings, logging residues, and prunings) and agricultural biomass are not used, despite their availability.

Figure A.21: Annual Heat Demand and Overview of Heating Systems in Kosovo



Economic and Financial Viability of Different Heating Options in Kosovo

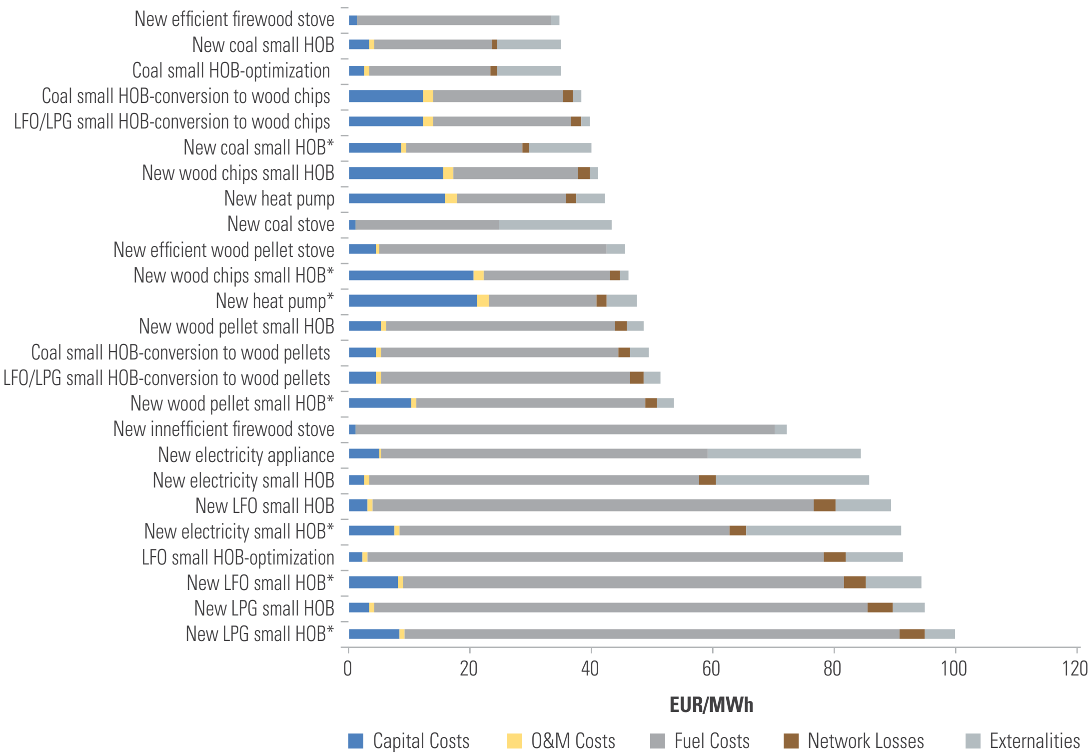
The largest share of stand-alone buildings in Kosovo is heated by inefficient firewood stoves, individual electrical appliances, and small HOBs fueled by LPG, coal and LFO. Most dwellings in multistory buildings are heated by individual electric appliances, followed by small HOBs that use LFO, coal, and LPG. Most DH in Pristina is based on the supply of waste heat from the lignite-fueled "Kosovo B" thermal power plant (TPP). The rest of the DH plants (Gjakova, Mitrovica) are based on HFO. Economically viable biomass heating options in Kosovo are presented in Table A.14.

Table A.14: Economically Viable Biomass Heating Options in Kosovo

Kosovo	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
Stand-Alone Buildings	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LPG	**LPG small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LPG small HOB – conversion to wood pellets
	Small HOB-coal	**None**	None
	Small HOB-LFO	**LFO small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB – conversion to wood pellets
Multistory Buildings	Individual electric appliance	**New wood chips small HOB**	New wood pellets small HOB New straw DH HOB New wood chips DH HOB
	Small HOB-LFO		LFO small HOB – conversion to wood chips New wood pellets small HOB LFO small HOB – conversion to wood pellets New straw DH HOB New wood chips DH HOB
	Small HOB-coal	**None**	None
	Small HOB-LPG	**New wood chips small HOB**	LPG small HOB – conversion to wood chips New wood pellets small HOB LPG small HOB – conversion to wood pellets New straw DH HOB New wood chips DH HOB
DH/CHP	DH HOB-HFO	**HFO DH HOB – conversion to straw**	HFO DH HOB – conversion to wood chips New straw DH HOB New wood chips DH HOB

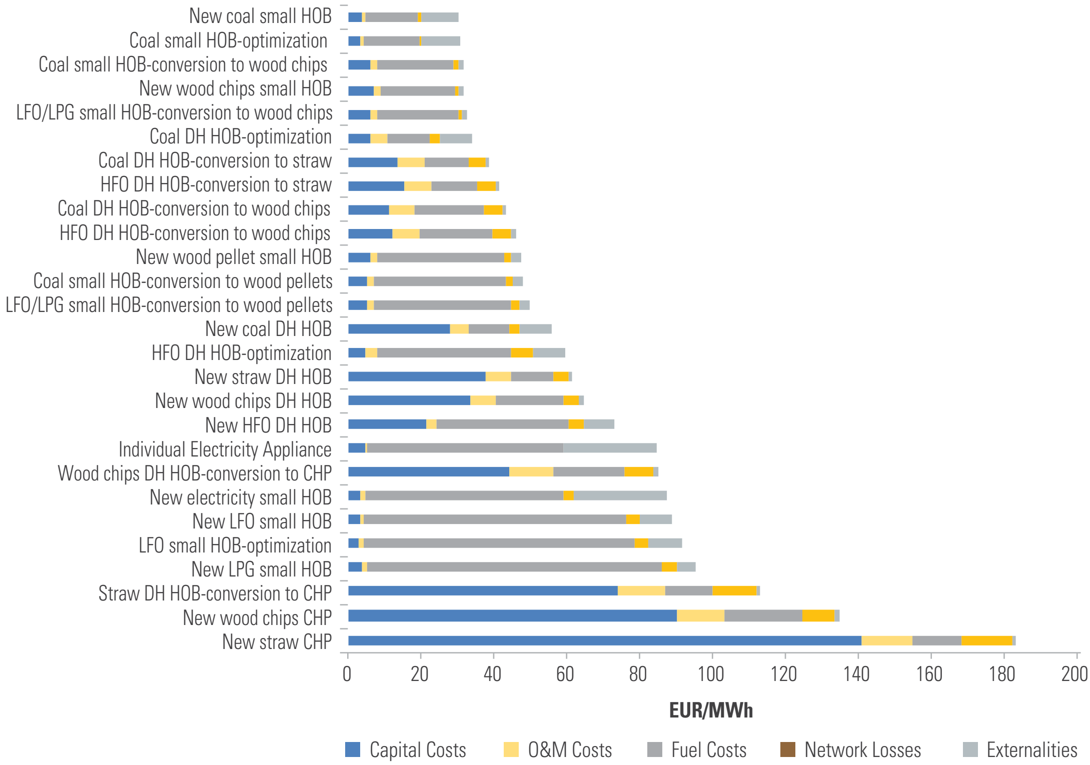
* Includes construction of new internal heating network.

Figure A.22: Economic Viability of Heating Options for Stand-Alone Buildings in Kosovo



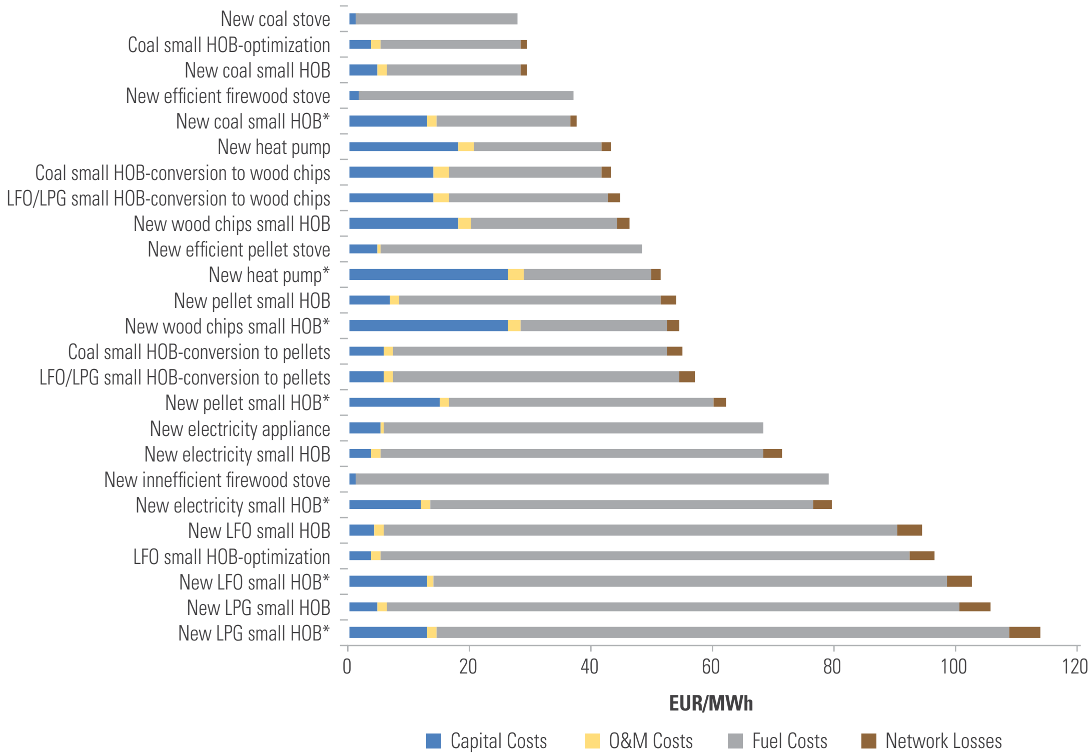
* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.23: Economic Viability of Heating Options for Multistory Buildings in Kosovo



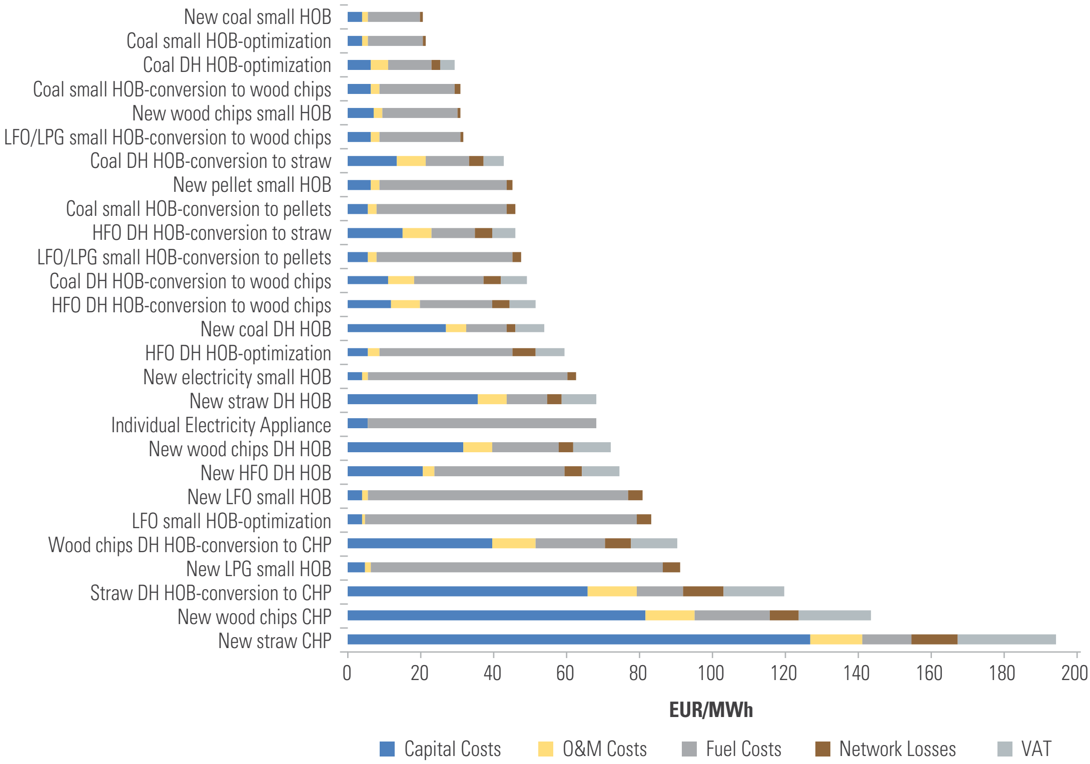
* Multistory buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.24: Financial Viability of Heating Options for Stand-Alone Buildings in Kosovo



* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.25: Financial Viability of Heating Options for Multistory Buildings in Kosovo



*Multistory buildings that do not have internal network (costs of internal network added to capital costs).
Note: VAT expressed for provision of heating services only.

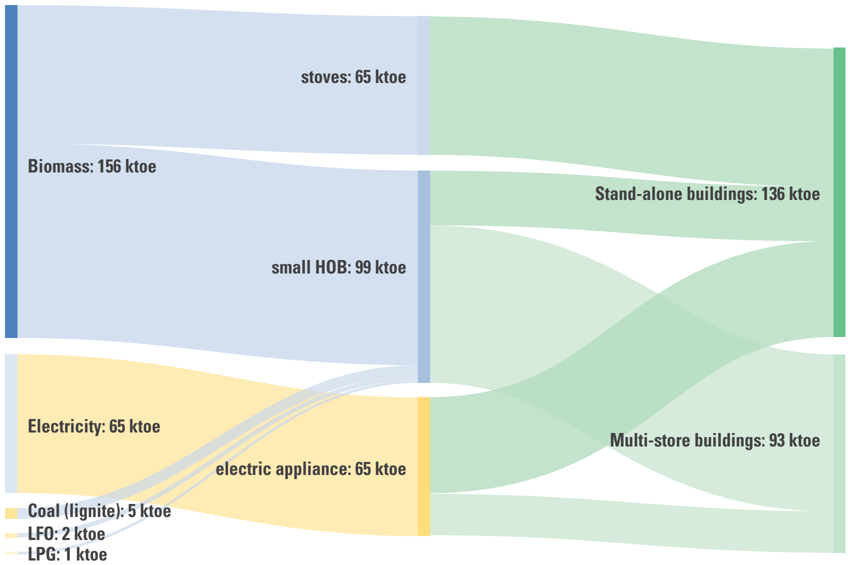
Table A.15: Current Policy with Relevant Measures for Biomass Heat in Kosovo

Policy type		Kosovo
Regulations Legal Policy	**Targets and qualifying criteria for incentives**	• National Renewable Energy Action Plan (2013). • Law on Energy Efficiency, stipulating the establishment of the EE Agency, pending amendments stipulating the establishment of the EE Fund. • Law on Energy. • Law on the Energy Regulator. • 1st NEEAP until 2018 and 2nd NEEAP. • Energy Strategy for 2009–2018. • Draft EPBD Law was produced under the REEP/EBRD assistance.
	Quotas	None.
	Product standards	• Law on Construction (Law No.04/L-110) sets the general legislative framework for construction processes. • Technical Regulation on Thermal energy saving and thermal protection in buildings. • Administrative Instruction 01–2012 for Energy Audits.
	Obligations in buildings	None.
Financial	**Tax relief**	None.
	Subsidy	• Decree on FITs (OGM No.52/2011). • EBRD is implementing KoSEP which involves investment for the implementation of EE and RES measures in residential buildings and SMEs (thermal insulation of the outside walls, new high quality windows, new heating systems on biomass) with 20% grant cofinancing.
	Low-interest loan	• Two credit lines that have been active in Kosovo for EE in the residential sector—EBRD's KoSEP and a KfW line.
	Energy-based payment	None.
	District heat support	None.
Soft measures	**Best practice info**	None.
	Promotion	None.
	Awareness raising	• Public Awareness Campaign for Energy Efficiency and Renewable Energy Resources (Sept. 2009–Dec. 2010). • State financing for the household EE through outreach and technical assistance: the annual public budget is for EE&RE awareness and energy audits for public buildings (EUR 50,000 annual budget).

Table A.16: Montenegro

General Country Information		
Population	620,029	
Land area, km² (FAOstat)	13,812	
Agricultural land, % of land area (FAOstat)	37%	
Forest land, % of land area (FAOstat)	39%	
Gross national income 2015, billion current US$ (WDI World Bank)	4.5	
Gross national income per capita 2015, current US$ (WDI World Bank)	7,220	
Population below national poverty line, % of total (WDI World Bank, 2013)	8.6%	
2020 target for renewables (% of gross final energy consumption)	33%	
2014 share of biomass heating in total renewable energy	37%	
Heat Energy Supply And Production		
Total Primary Energy Supply (TPES) – ktoe, Energy Balance (IEA 2012)	1,062	
Total Primary Energy Supply (TPES) – ktoe, Energy Balance adjusted for unregistered biomass consumption	1,028	
Heat Demand, 2012 (ktoe, % of TPES)	229 (22% of adjusted TPES)	
Heat produced in residential sector (ktoe, % of total)	145	63%
Heat produced in commercial-industrial sector (ktoe, % of total)	40	18%
Heat produced in public sector (ktoe, % of total)	43	19%
Heat supplied to stand-alone buildings (ktoe, % of total)	136	60%
Heat supplied to multistory buildings (ktoe, % of total)	93	40%
Heat produced by DH systems (ktoe, % of total)	—	—
Main Fuels For Heat Production		
Biomass (ktoe, % of total)	157	68%
Coal (ktoe, % of total)	5	2%
Natural Gas (ktoe, % of total)	0	0%
Electricity (ktoe, % of total)	65	28%
LPG (ktoe, % of total)	1	0%
LFO/HFO (ktoe, % of total)	2	1%
Other (ktoe, % of total)	0	0%
Biomass Potential And Supply		
Sustainable technical potential excluding energy crops (ktoe)		348
Biomass consumption (ktoe, % of sustainable technical potential)	147	42%
Biomass available to supply an increase in biomass-based heating over and above the current consumption (ktoe, in MW of heating capacity that could be supplied)	68	266 MW

Figure A.26: Annual Heat Demand and Overview of Heating Systems in Montenegro



Economic and Financial Viability of Different Heating Options in Montenegro

Most stand-alone buildings in Montenegro are heated by inefficient firewood stoves, individual electrical appliances, and small HOBs that use LFO. Most dwellings in multistory buildings are heated by individual electrical appliances and coal-fired small HOBs.[104] Economically viable biomass heating options in Montenegro are presented in Table A.17.

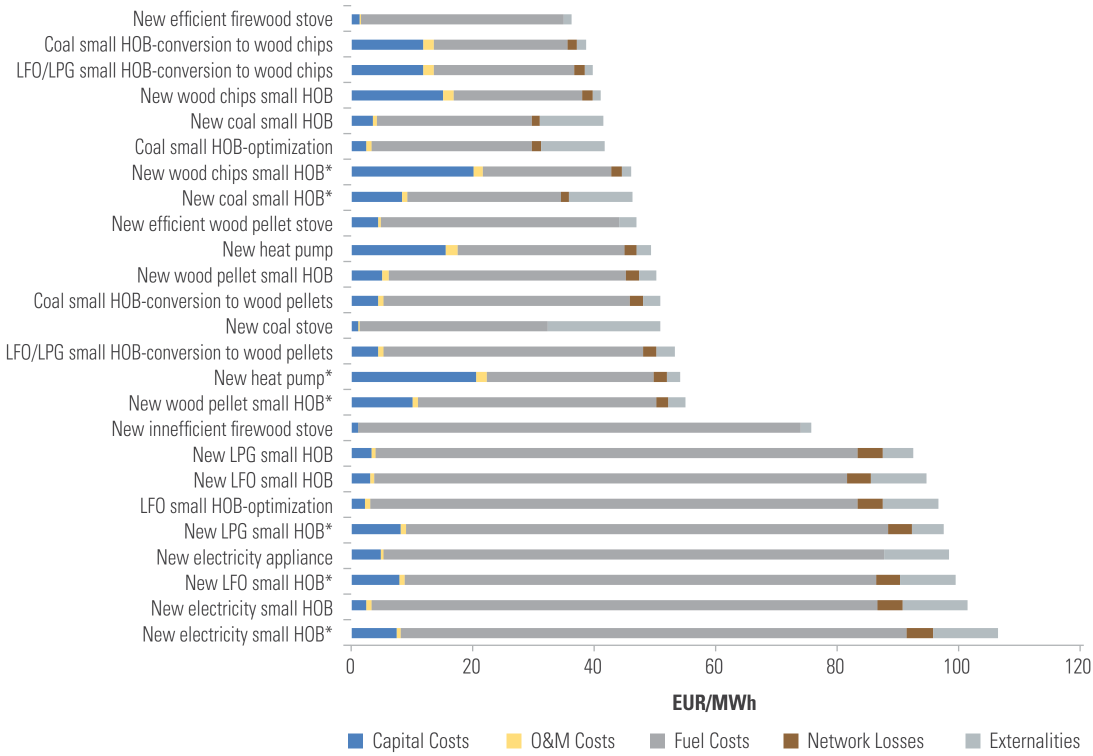
[104] DH in Montenegro is not developed. There are two small (6 MW), lignite-fired boiler rooms in the city of Pljevlja that could be perceived as a rudimentary DH system; it is used for heating 284 apartments and public buildings (35 offices) in the city center.

Table A.17: Economically Viable Biomass Heating Options in Montenegro

Montenegro	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
Stand-Alone Buildings	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LFO	**LFO small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB – conversion to wood pellets
Multistory Buildings	Individual electric appliance	**New wood chips small HOB***	New wood pellets small HOB* New wood chips DH HOB
	Small HOB-coal	**Coal small HOB – conversion to wood chips**	New wood chips small HOB

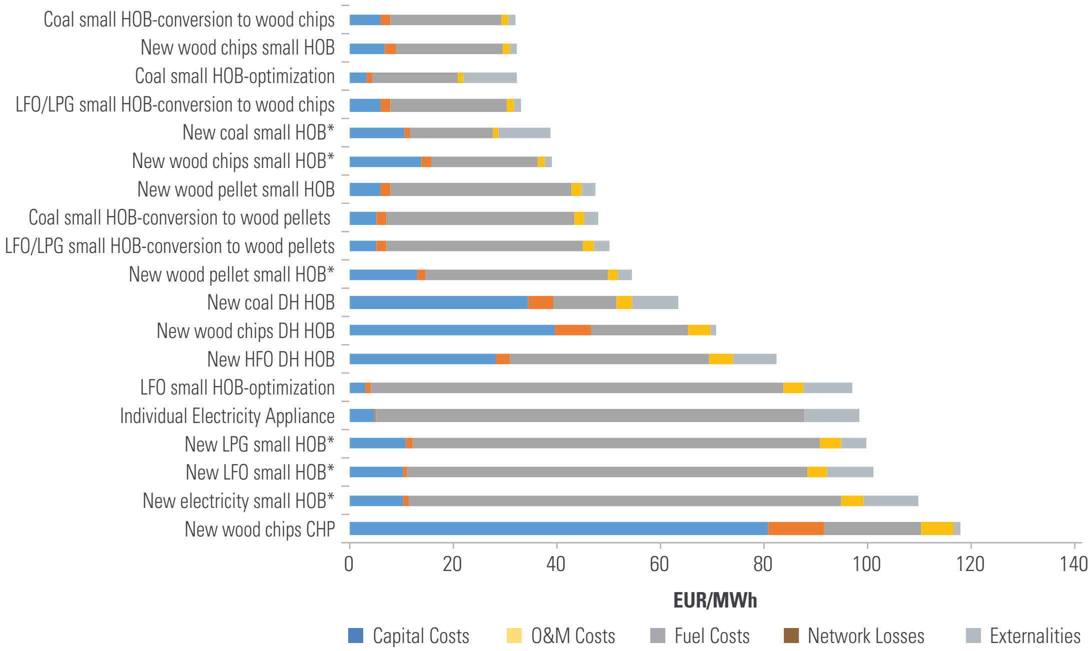
*Includes construction of new internal heating network.

Figure A.27: Economic Viability of Heating Options for Stand-Alone Buildings in Montenegro



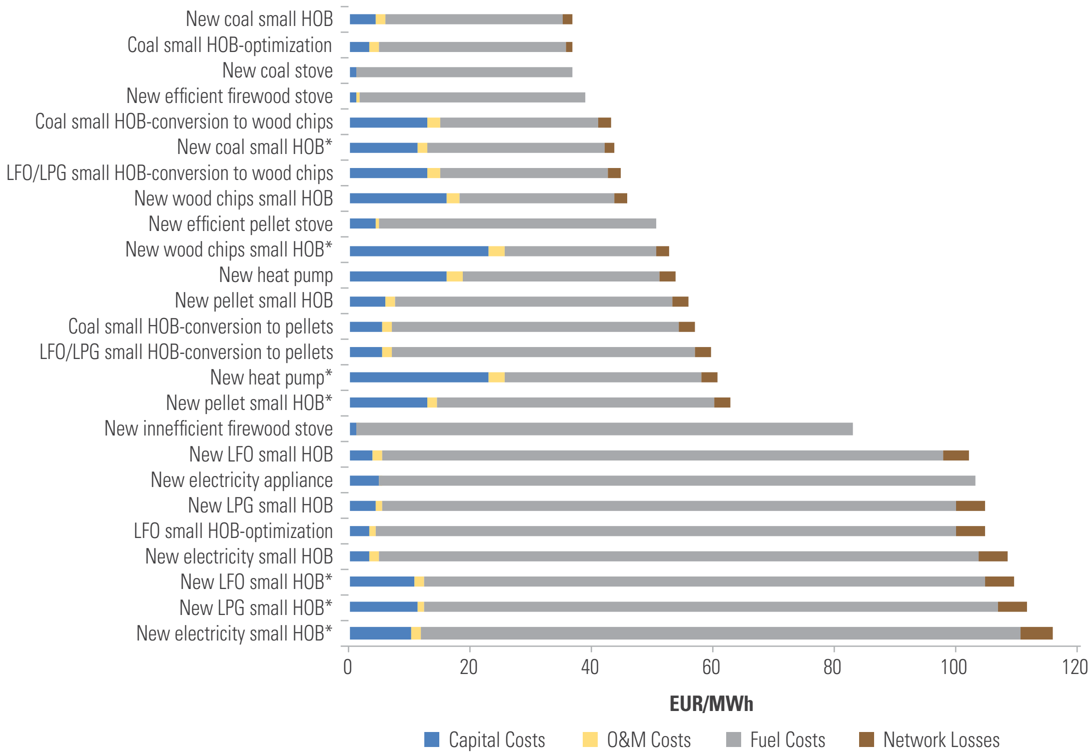
* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.28: Economic Viability of Heating Options for Multistory Buildings in Montenegro



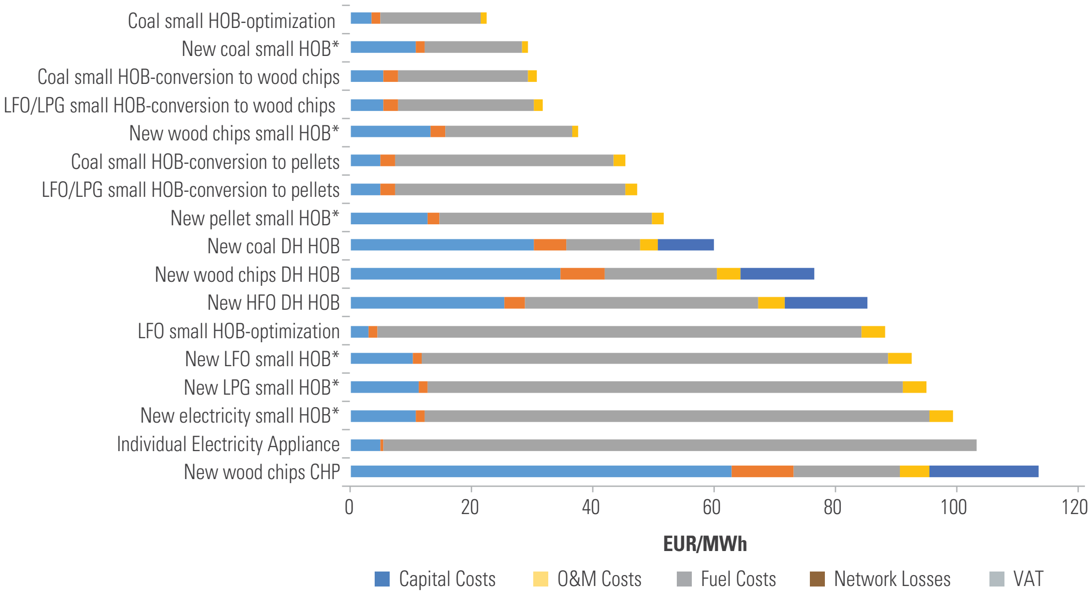
* Multistory buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.29: Financial Viability of Heating Options for Stand-Alone Buildings in Montenegro



* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.30: Financial Viability of Heating Options for Multistory Buildings in Montenegro



* Multistory buildings that do not have internal network (costs of internal network added to capital costs).
Note: VAT expressed for provision of heating services only.

Table A.18: Current Policy with Relevant Measures for Biomass Heat in Montenegro

Policy type		Montenegro

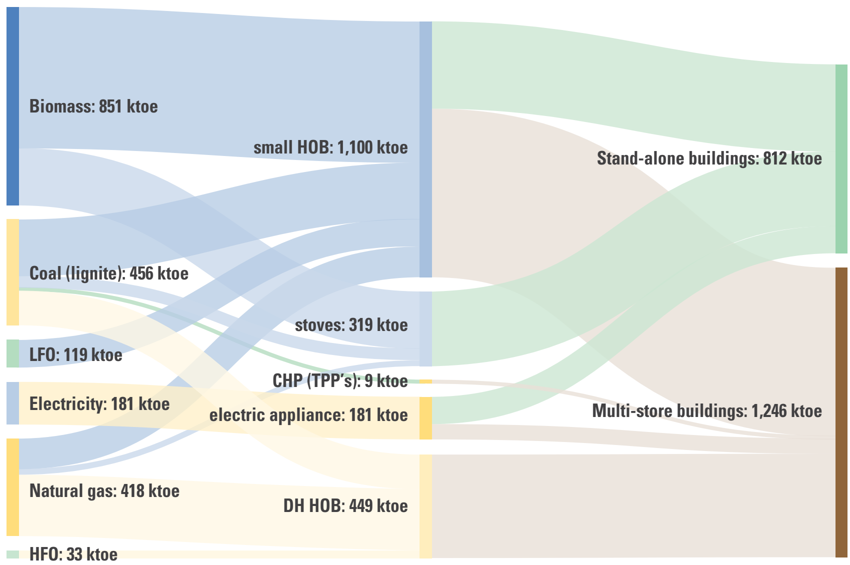
Regulations
Legal
Policy
	Targets and qualifying criteria for incentives	• National Renewable Energy Action Plan (2014).
		• Law on Energy (Official Gazette of Montenegro 28/2010 and 6/13).
		• Law on Energy Efficiency (Official Gazette of Montenegro 29/2010) is compliant with main EU directives in the field of energy efficiency, as follows:
		  ◦ Directive 2006/32/EC on energy end-use efficiency and energy services.
		  ◦ Directive 2002/91/EC on the energy performance of buildings.
		  ◦ Directive 2005/32/EC on establishing a framework for the setting of eco-design requirements for energy-using products.
		  ◦ Directive 92/75/EEC on the indication by labeling and standard product information of the consumption of energy and other resources by household appliances.
		• Montenegro has submitted two NEEAPs—the first in December 2010 (covering 2010—2012) and the second in November 2013 (covering 2013–2015).
		• Energy Strategy of Republic of Montenegro to 2030.

	Product standards	• The Rulebook on Regular Energy Audits of Air Conditioning Systems and Heating Systems (Official Gazette of Montenegro 24/2013) determines the manner and deadlines for performing regular energy audits of air conditioning systems of nominal power of 12 kW and larger and gas, liquid or solid fuels heating systems of nominal power of 20 kW and larger.
	Obligations in buildings	None.
Financial	**Tax relief**	None.
	Subsidy	Decree on FITs (OGM No.52/2011).
	Low-interest loan	• "Energy Wood," which was carried out starting in August 2013 and which set out to establish an attractive and sustainable financial mechanism for obtaining a retail loan to install modern biomass heating systems in Montenegrin households (presented in Box 5).
	Energy-based payment	None.
	District heat support	None.
Soft measures	**Best practice info**	None.
	Promotion	None.
	Awareness raising	• Regional Initiative "Public Dialogue on the Sustainable Use of Energy in South East Europe," funded by German International Cooperation (GIZ).

Table A.19: Serbia

General Country Information		
Population	7,186,862	
Land area, km² (FAOstat)	77,592	
Agricultural land, % of land area (FAOstat)	58%	
Forest land, % of land area (FAOstat)	36%	
Gross national income 2015, billion current US$ (WDI World Bank)	39.3	
Gross national income per capita 2015, current US$ (WDI World Bank)	5,540	
Population below national poverty line, % of total (WDI World Bank, 2014)	25.4%	
2020 target for renewables (% of gross final energy consumption)	27%	
2014 share of biomass heating in total renewable energy	53%	
Heat Energy Supply And Production		
Total Primary Energy Supply (TPES) – ktoe, Energy Balance (IEA, 2012)	14,460	
Total Primary Energy Supply (TPES) – ktoe, Energy Balance adjusted for unregistered biomass consumption	14,989	
Heat Demand, 2012 (ktoe, % of TPES)	2,058 (14% of adjusted TPES)	
Heat produced in residential sector (ktoe, % of total)	1,480	72%
Heat produced in commercial-industrial sector (ktoe, % of total)	292	14%
Heat produced in public sector (ktoe, % of total)	286	14%
Heat supplied to stand-alone buildings (ktoe, % of total)	813	39%
Heat supplied to multistory buildings (ktoe, % of total)	1,245	61%
Heat produced by DH systems (ktoe, % of total)	457	22%
Main Fuels For Heat Production		
Biomass (ktoe, % of total)	851	41%
Coal (ktoe, % of total)	456	22%
Natural Gas (ktoe, % of total)	418	20%
Electricity (ktoe, % of total)	181	9%
LPG (ktoe, % of total)	0	0%
LFO/HFO (ktoe, % of total)	152	7%
Other (ktoe, % of total)	0	0%
Biomass Potential And Supply		
Sustainable technical potential excluding energy crops (ktoe)		2,972
Biomass consumption (ktoe, % of sustainable technical potential)	1,551	52%
Biomass available to supply an increase in biomass-based heating over and above the current consumption (ktoe, in MW of heating capacity that could be supplied)	436	1,390 MW

Figure A.31: Annual Heat Demand and Overview of Heating Systems in Serbia



Economic and Financial Viability of Different Heating Options in Serbia

Most stand-alone buildings in Serbia are heated by inefficient firewood stoves; individual electrical appliances; small HOBs that use coal, LFO, and NG; and coal and NG stoves. Most multistory buildings use small HOBs fueled with coal and NG, individual electric appliances, and small HOBs that use LFO for heating. DH HOBs are based on the use of NG, coal and HFO. Economically viable biomass heating options in Serbia are presented in Table A.20.

Table A.20: Economically Viable Biomass Heating Options in Serbia

Serbia	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
Stand-Alone Buildings	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-coal	**Coal small HOB – conversion to wood chips**	New wood chips small HOB
	Small HOB-LFO	**LFO small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB – conversion to wood pellets
	Small HOB-NG	**NG small HOB – conversion to wood chips**	New wood chips small HOB New wood pellets small HOB
	Coal stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove
	NG stoves		New wood chips small HOB* New efficient wood pellet stove
Multistory Buildings	Small HOB-coal	**Coal small HOB – conversion to wood chips**	New wood chips small HOB
	Small HOB-NG	**New wood chips small HOB**	NG small HOB – conversion to wood chips New wood pellets small HOB New straw DH HOB
	Individual electric appliance		New wood pellets small HOB New straw DH HOB New wood chips DH HOB
	Small HOB-LFO		LFO small HOB – conversion to wood chips New wood pellets small HOB New straw DH HOB LFO small HOB – conversion to wood pellets New wood chips DH HOB New wood chips CHP

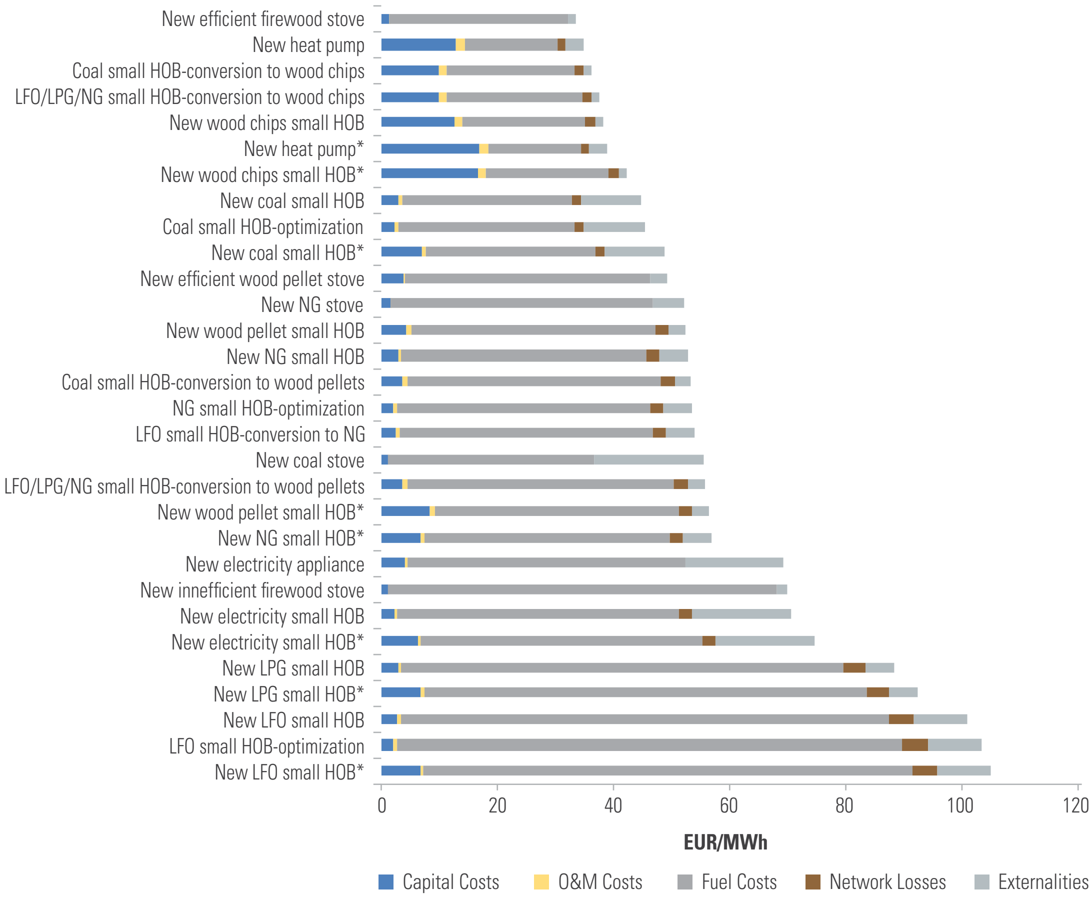
(*continued on next page*)

Table A.20: Economically Viable Biomass Heating Options in Serbia (*continued*)

Serbia	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
DH/CHP	DH HOB-NG	**NG DH HOB – conversion to straw**	NG DH HOB – conversion to wood chips New straw DH HOB New wood chips DH HOB
	DH HOB-coal	**Coal DH HOB – conversion to straw**	Coal DH HOB – conversion to wood chips New straw DH HOB New wood chips DH HOB
	DH HOB-HFO	**HFO DH HOB – conversion to straw**	HFO DH HOB – conversion to wood chips New straw DH HOB New wood chips DH HOB

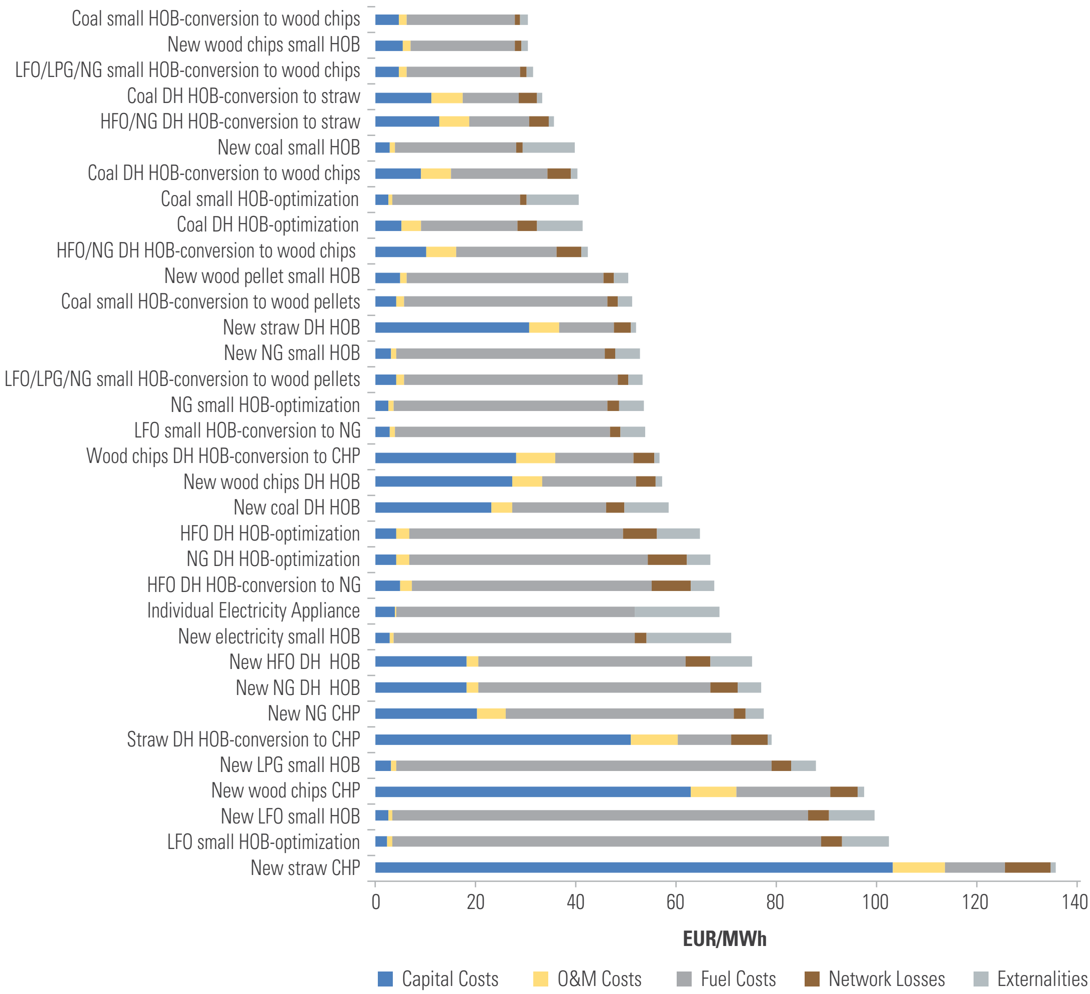
* Includes construction of new internal heating network.

Figure A.32: Economic Viability of Heating Options for Stand-Alone Buildings in Serbia



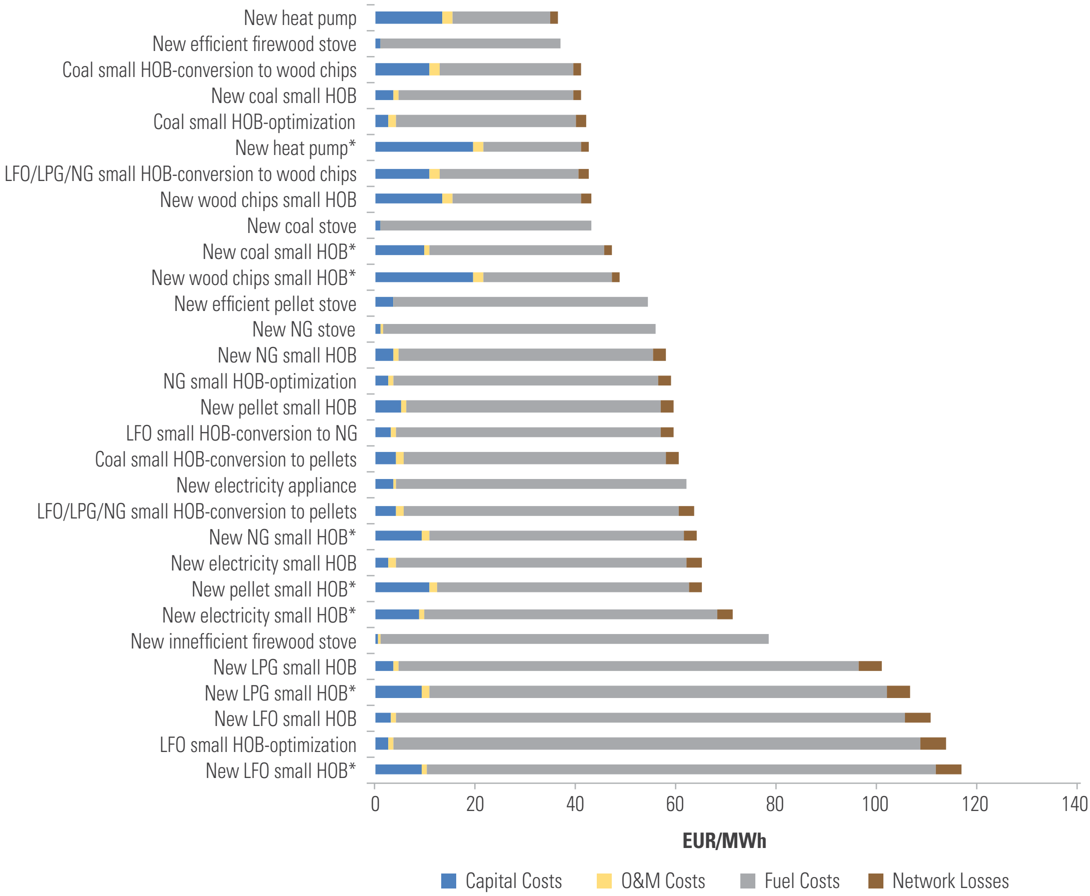
* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.33: Economic Viability of Heating Options for Multistory Buildings in Serbia



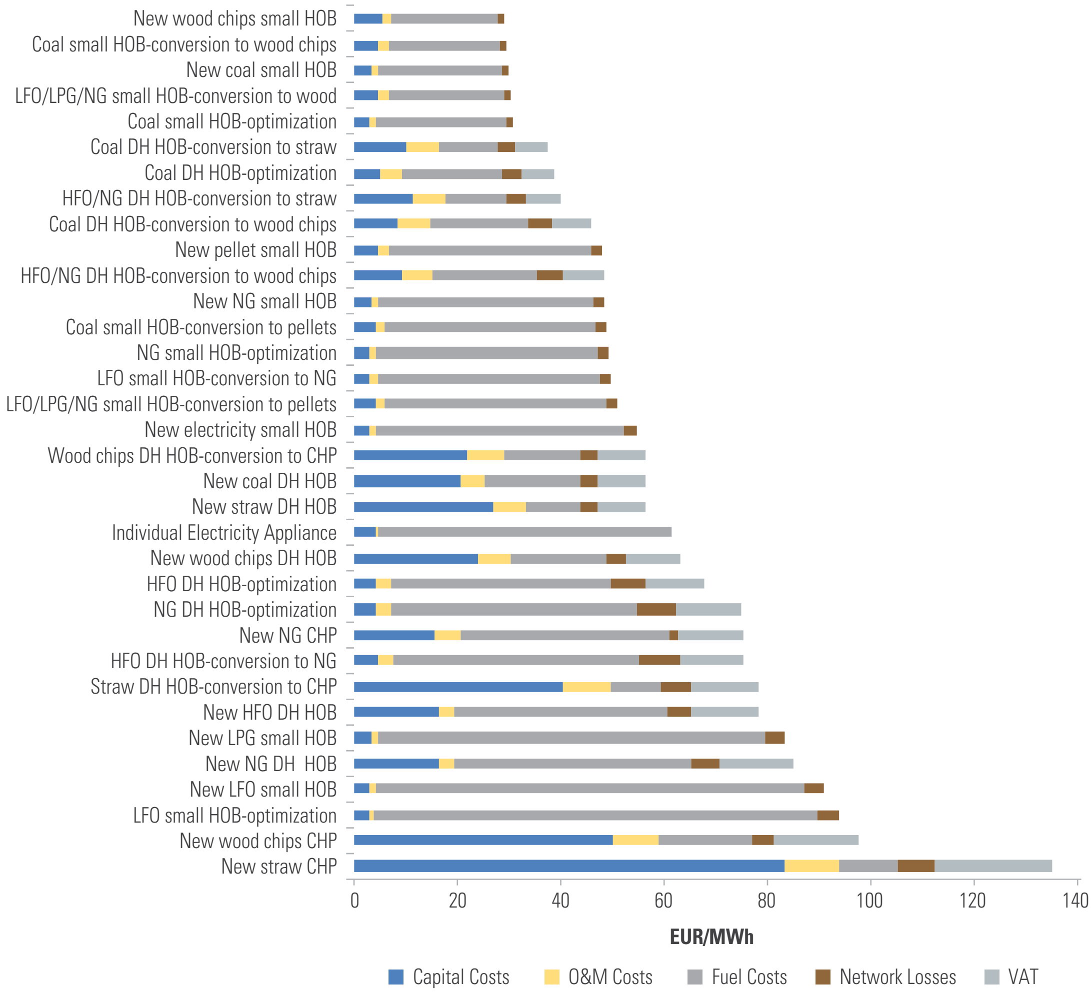
* Multistory buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.34: Financial Viability of Heating Options for Stand-Alone Buildings in Serbia



* Stand-alone buildings that do not have internal network (costs of internal network added to capital costs).

Figure A.35: Financial Viability of Heating Options for Multistory Buildings in Serbia



* Multistory buildings that do not have internal network (costs of internal network added to capital costs).
Note: VAT expressed for provision of heating services only.

Table A.21: Current Policy with Relevant Measures for Biomass Heat in Serbia

Policy type		Serbia
Regulations **Legal** **Policy**	**Targets and qualifying criteria for incentives**	• National Renewable Energy Action Plan (2013). • Energy Law (2012); Law on Planning and Construction (2011); Law on the Efficient Use of Energy ("Službeni glasnik RS," No. 25/2013); Regulation on energy efficiency of buildings (2011). • Regulation on conditions, content and manner of publication certificates on the energy performance of buildings (2012). • Energy Sector Development Strategy Implementation Programme of the Republic of Serbia until 2015 for the period 2007–2012.(OGRoS, No.99/2009). • Serbia has submitted two NEEAPs – the first in June 2010 (covering 2010 until 2012) and the second15 in October 2013 (covering 2013 until 2015).
	Product standards	• Rulebook on conditions and manner of collection, transport,storing and treatment of waste used as secondary raw material or for producing energy (OGRoS,No. 98/2010).
	Obligations in buildings	• The transposition of the EPBD has for the most part been achieved in Serbia including secondary legislation on certification. Certification of buildings via energy passports began in 2012. The two major regulations for this issue are: a) Regulations on the conditions, content and manner of issuance of certificates of energy performance of buildings; and b) Regulations on energy efficiency in buildings, which sets out standards for construction and renovation (including U-values of materials).
Financial	**Tax relief**	None.
	Subsidy	• Decree on FITs (OGRoS No.8/2013). • Budgetary Energy Efficiency Fund which has been established that could channel government funds and donations to the implementation of EE measures.
	Low-interest loan	• Green for Growth credit lines with Komercijalna Banka, Banca Intesa Beograd and Čačanska banka.
	Energy-based payment	None.
	District heat support	None.
Soft measures	**Best practice info**	None.
	Promotion	None.
	Awareness raising	**None.**

Appendix B. Technologies for Biomass-Based Heating

Technologies for Biomass DH Systems

Modern biomass DH systems are equipped with process control systems supporting fully automatic system operation. The design of a DH system is always based on the system's heat load, and the choice of heat production technology is based on the required capacity and planned fuel mixture. For biomass-based DH boilers, several different furnace technologies are available, with varying technical characteristics and applications, depending on boiler capacity and biomass type and properties (for example, ash and moisture content).

For DH systems, the following technologies can be used (see also Table A.9):[105]

- **Grate furnaces** are typically used for systems whose capacity is less than 20 MWth where the primary fuel is woody biomass. The efficiency is usually in the range of 65–98%. Because combustion conditions (that is, the distribution of the fuel over the grate surface) are not as homogenous as for other technologies, low emission levels can only be achieved with sophisticated process control, and by installing flue gas cleaning systems (such as baghouse filters, electric precipitators, and multi-cyclones).
- **Underfeed stokers** are used for small capacities (below 6 MWth) and they use woody biomass (efficiency 80–85%). They guarantee low emissions at partial load due to good fuel dosing; however, since they are controlled mechanically, they are relatively inflexible with regard to particle size, and can be used only with fuels with a high ash melting point.

105 Van Loo and Koppejan 2008.

- **Bubbling fluidized bed combustion (BFB) furnaces** are used only for high capacities (over 20 MWth) due to the high investment cost. Their average efficiency is 90–98%.[106] They offer the significant benefits of low oxides of nitrogen emissions, high thermal efficiency, and great flexibility with regared to biomass (except for particle size, which must be kept to less than 80 millimeters). However, they have the drawback of high amounts of dust in the flue gas flow.
- **Circulating fluidized bed combustion (CFB) furnaces** offer the same benefits of high efficiency (97.5–99.5%)[107] and low emissions that BFB furnaces do, but with improvements due to the high level of turbulence. They have the drawback of high investment costs (they are economical only over 30 MWth), and they must be fed with smaller particles (40 millimeters or less).
- **Pulverized fuel combustion**, which is the standard technology in coal-fired power plants, presents high performance regarding load control and flexibility. However, it needs very small particles (less than 10–20 millimeters) and requires an extra start-up burner (pulverized boilers operate at 95% efficiency).

Technologies for Biomass CHP

Cogeneration, also known as combined heat and power (CHP), is the simultaneous generation of heat and power, both of which are used. CHP units have better total efficiency than conventional energy systems, since better exploitation takes place and energy is used to produce heat as well. Key benefits that CHP provides compared to conventional (HOB) thermal energy production include less fuel to produce a given energy output, and reduction of emissions of greenhouse gases and other air pollutants (because less fuel is burned).

Typical fields of application for CHP technologies are wood-processing industries, district heating systems, and industries with a high process-heat demand.

Considering the typical size of the district heating plants, the most suitable technology for application in the district heating systems of the Western Balkans, for small-scale biomass CHP production, is the organic Rankine cycle (ORC). It is by far the most used technology for biomass CHP in Europe. The nominal electric capacities of ORC modules for biomass CHP plants range from 200 electrical kilowatts (kWe) to 15 electrical megawatts (MWe).

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106 Basu 2006.
107 Basu 2006.

Table B.1: Characteristics of Biomass Combustion Technologies

Type	Typical size range	Fuels	Ash	Biomass moisture content (MC)
Moving grate	150 kW–15 MW	All wood fuels; most biomass	<50%	5%–60%
Understoker with rotating grate	2–5 MW	Wood chips, high MC	<50%	40%–65%
BFB	5–15 MW	Various biomass, d<10 mm	<50%	5%–60%
CFB	15–100 MW	Various biomass, d<10 mm	<50%	5%–60%
Pulverized combustion	5–10 MW	Various biomass, d<5 mm	<5%	<20%

Technology	Advantages	Disadvantages
Grate furnaces	• Lower investment costs for plants < 20 MWth • Lower operating costs • Lower dust loads in the flue gas • Less sensitive to slagging than fluidized bed furnaces	• Usually no mixing of wood fuels and agricultural biomass possible (only special constructions can cope with such fuel mixtures) • Efficient NOx reduction requires special technologies • High excess oxygen decreases efficiency • Combustion conditions not as homogeneous as in fluidized bed furnaces • Low emission levels at partial load operation require a sophisticated process control
Underfeed stokers	• Lower investment costs for plants < 6 MWth • Simple and good load control due to continuous fuel feeding and low fuel mass in the furnace • Low emissions at partial load operation due to good fuel dosing • Low flexibility regarding particle size	• Suitable only for biomass fuels with low ash content and high ash-melting point (wood fuels) (< 50 mm)
Bubbling fluidized bed combustion (BFB) furnaces	• No moving parts in the hot combustion chamber • NOx reduction by air staging works well • High flexibility concerning moisture content and kind of biomass fuels used • Low excess oxygen raises efficiency and decreases flue gas flow • Low CO and NOx emissions due to a homogeneous combustion	• High investment costs, interesting only for plants > 20 MWth • High operating costs • Reduced flexibility regarding particle size (< 80mm) • Utilization of high alkali biomass fuels (such as straw) is critical due to possible bed agglomeration without special measures • High dust loads in the flue gas • Loss of bed material with the ash without special measures

(*continued on next page*)

Table B.1: Characteristics of Biomass Combustion Technologies (*continued*)

Technology	Advantages	Disadvantages
Circulating fluidized bed combustion (CFB) furnaces	• No moving parts in the hot combustion chamber • NOx reduction by air staging works well • High flexibility concerning moisture content and kind of biomass fuels used • Homogeneous combustion conditions in the furnace if several fuel injectors are used • High specific-heat transfer capacity due to high turbulence • Use of additives easy • Very low excess oxygen raises efficiency and decreases flue gas flow • Low CO and NOx emissions due to a homogeneous combustion	• High investment costs, interesting only for plants > 30 MWth • High operating costs • Low flexibility regarding particle size (< 40 mm) • Utilization of high alkali biomass fuels (such as straw) is critical due to possible bed agglomeration • High dust loads in the flue gas • Loss of bed material with the ash without special measures • High sensitivity concerning ash slagging
Pulverized fuel combustion	• Low excess oxygen increases efficiency • High NOx reduction by efficient air staging and mixing possible if cyclone or vortex burners are used • Very good load control and fast alteration of load possible	• The particle size of biomass fuel is limited (< 10–20mm) • High wear rate of the insulation brickwork if cyclone or vortex burners are used • An extra start-up burner is necessary

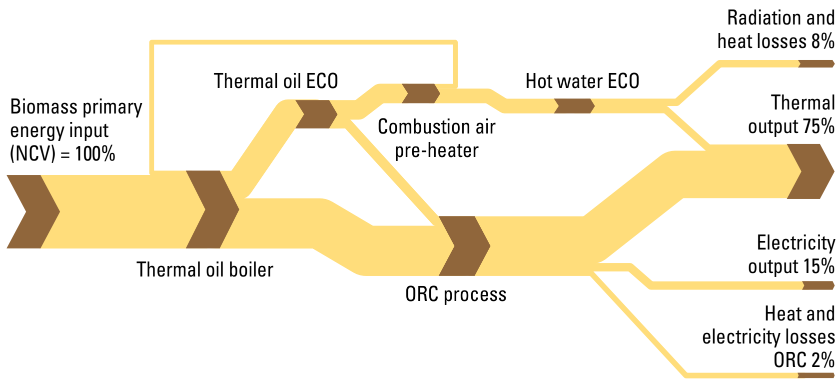
Source: Sjaak and Koppejan 2008.

The main advantages of ORC biomass CHP plants are as follows:

- High efficiency
- Simple start-up procedures
- Automatic and continuous operation
- Simple maintenance procedure
- No operator attendance required
- Long life of the plant (longer than 20 years)
- No need to demineralize water

ORC plants are relatively silent. The operating costs are low, since the ORC process is closed and thus no losses of the working medium occur. Moreover, only moderate consumption-based costs (lubricants) and maintenance costs are incurred. The lifetime of ORC units usually exceeds 20 years, which has been proven by geothermal applications. The silicone oil used as the working medium has the same lifetime as the ORC since it does not undergo any significant ageing.

Figure B.1: Energy Balance of a Biomass CHP Plant Based on ORC Technology



Source: Obernberger and others 2004.

The ORC process can be designed a manner that allows for both (a) hot water feed temperatures between 80 and 120°C and (b) a temperature differential between feed and return in the range of 15–50°C. Therefore, the return temperatures vary between 50 and 100°C. On this basis, the exact level of the hot water feed temperature required can be perfectly adjusted to the design requirements for the heating purpose. The lower the hot water feed temperature at the condenser outlet, the higher the electric efficiency.

Based on the requirements from the heat consumers and the plant design chosen, the resulting hot water temperatures at the ORC condenser are determined for the nominal design point (for example: feed temperature 80°C; return temperature 60°C) and allow a net electric efficiency of about 15%. In Figure B.1, the energy flow chart of the ORC unit of the biomass CHP at nominal load conditions is given.

Since biomass CHP plants are usually operated in a heat-controlled mode—for both economic and energetic reasons—the partial load behavior and the partial load efficiency of the ORC process is very important. At 40% of the net electric power of the ORC unit, the net electric efficiency still amounts to 85% of the nominal value. This circumstance is a substantial advantage of the ORC process in comparison to steam turbines, which show a stronger efficiency decrease at partial load.

Operating experiences have shown that the ORC technology is a technologically feasible application for medium-scale biomass CHP plants. More than 200 CHP plants based on ORC technology are in operation in Austria, the Czech Republic, Finland, Germany, Italy, the Netherlands, Poland and Switzerland.

Small-Scale Biomass Heating Appliances

In the Western Balkans, the producers of wood-fueled heating appliances—such as stoves, small boilers, and wood-pellet and wood-chip appliances—are located mainly in Bosnia and Herzegovina, Croatia, Macedonia, and Serbia. Usage of wood stoves and wood-log small boilers is widespread in all the countries of the region, while wood-pellet and wood-chip appliances are less common.

The nominal efficiency of the appliances is declared by the producers and usually is higher than the efficiency of the appliances operating in real-life conditions. Typically, the efficiency of the appliances sold on the local market is measured in national or manufacturer laboratories that are not accredited for certification of appliances against Euro Norm (EN) harmonized technical standards.

Existing legislation for residential heating appliances in W-B countries requires mandatory attestation of electronic components only. Certification of all other components and parameters is voluntary, not mandatory, and is market-driven.

Considering the lack of legislation related to the efficiency of the heating appliances, only market supervision inspectorates (generally parts of the ministry responsible for trade) are authorized to perform testing of the heating devices—although the testing determines only whether the efficiency of the appliance is in line with the declared and displayed efficiency. Because of budgetary restrictions and lack of funds for these purposes, this kind of testing is rare.

The availability of highly efficient, EN-certified biomass heating appliances is limited for two reasons: higher prices (50–100%) compared to the (mainly uncertified) appliances currently available on the market, and lack of consumer awareness of the benefits of efficient appliances. As a result, efficient appliances are significantly less available in the distribution chains, compared to inefficient appliances. Should demand for them increase, however, local manufacturers of small-scale biomass heating appliances in the Western Balkans would be in a position to supply the market with the efficient appliances.

Wood Stoves

Efficient wood stoves are produced in W-B countries only for export to the EU and are equipped with a catalytic combustor to reduce emissions caused by incomplete combustion. The catalytic combustor is usually placed in the flue gas channel beyond the combustion chamber. Leading biomass fuels suitable for the use in the wood stoves include wood logs and wood briquettes.

The conversion efficiency of the efficient wood stoves can be as high as 80%. However, although wood stoves are widely used in all the countries of the region, their efficiency is generally low, as previously depicted. Investment costs are in the range of EUR 50–100 per kilowatt of installed capacity.

A wood stove is a free-standing appliance designed to heat the space in which it is located, without the use of ducts to distribute the heat. Stoves release useful heat energy by radiation and convection to their surroundings.

Wood-Log Small Boilers

Wood is fed through the upper door and ashes are removed from the lower door. Unlike a stove, the heat produced is not directly transferred to space where it is located; rather, it is used to heat water that is then sent to heat exchangers (such as radiators or the equivalent) to warm the heated ambient.

The water is not usually sent to these exchangers directly: the over-fire boilers are usually connected to heat storage tanks so as to uncouple heat production and utilization. This fact enables optimal combustion at nominal load; the supply of heating and hot water then comes from the tank. It is very important that the heat storage tank be large enough to accumulate the total heat released from a wood batch. Also, a well-insulated tank is a prerequisite for the high overall efficiency of the system.

Over-fire boilers with no storage tank may have high emissions of unburned hydrocarbons, since they need to be operated at low burning rates in spring and autumn. An environmentally optimal combustion can only be obtained if the boiler is operated at nominal heat output.

Wood-Pellet Appliances

Pellet-fired systems allow continuous automatic combustion of a well-defined fuel. Some burners are equipped with a small pellet-storage area (enough for one or a few days of operation) that can be refilled either manually or automatically.

Wood-pellet–fired appliances have a significant share of the domestic heating market in countries with developed bioenergy use. Pellet stoves combust only pelletized material and depend on electricity for their operation: an electric fan controls the combustion process by varying the supply of combustion air.

Pellet fuels have the potential to burn with very low emissions. Moreover, pellet burners can replace oil burners in existing boilers, thus reducing payback time. Well-designed pellet-fired systems can achieve efficiencies of over 85%, although at part load and varying load, or with a very high excess air level, their efficiency falls to 50–60%. Investment costs of the wood-pellet appliances (stoves and small HOBs) are in the range of EUR 150–300 per kilowatt of installed capacity.

Wood-Chip Appliances

Wood chips haven't been used for home heating furnaces as wood chip is not usually available as ready-to-use fuel for small-scale devices due to their irregular size and high moisture content. Modern wood chip furnaces generally require an industrial size burn chamber (eg. a blown or "fluidized bed" combustor) and large-scale fuel feed designs, with chip storage buildings and automated augers and conveyors. This complex and expensive equipment is considered necessary because of the uneven size of chipped wood—often mixed with twigs and sawdust. This mixture tends to jam in small feed mechanisms. Thus, the wood chips heating systems (boilers) can be used mainly for heating larger houses and farms, schools, or for commercial and municipal scale operations. Advantages of using woodchips instead of firewood are automatic operation and much lower emissions because of the use of feed rate rather than air supply to control heat release rate. Wood chips boilers are often sited in basements, in free-standing heating containers (that combine boiler and storage) or in their own separate buildings. The wood chips are transported to the boiler, often using a screw feed system. The size of the storage depends on the specific situation and should be correctly sized on the basis of energy demand.

Appliances for Agricultural Biomass and Dedicated Energy Crops

Agricultural biomass and dedicated energy crops have high ash, chlorine, nitrogen and sulphur content and major element contents, and are recommended to be used in appliances which are specially designed or adjusted for this kind of pellet.

For example, during the combustion of straw, maize, energy crops and rape straw, the potassium and the chlorine content combines and turns into a salt that appears to be a white-brownish dust. This dust deposits in the pipes of the heat exchanger and in the dust-extractor, that has to be cleaned frequently. If the salt gets damp, it becomes extremely corrosive. In case of using sunflower husks as a heating fuel, boiler must be constructed with stainless steel parts in order to avoid corrosion of the boiler tank.

The long-term use of agricultural biomass and dedicated energy crops in residential-scale appliances require technological developments in both burners and filtration. Thus, the agricultural biomass and dedicated energy crops preferably should be used in larger-scale biomass combustion plants (DH/CHP), which apply electrostatic precipitators or bag house filters for particle removal.

Appendix C. Measures to Reduce Emissions from Biomass Combustion

The negative aspects related to biomass combustion emissions may prevent its use as a sustainable fuel. In order to overcome this disadvantage, detailed information is necessary regarding emissions of PM from burning of different types of biomass. This information would help to identify the types of biomass that emit more particles during combustion and may lead to measures for reducing this pollutant.

Increased use of biomass for heating must be achieved without increasing other harmful emissions such as PM, nitric oxides, carbon monoxide, and organic compounds. Therefore, increase in biomass-based heating, especially in the segment of the small and medium-scale heating sector, must be accompanied by further technology development toward low emission combustion systems.

At the same time the performance of stoves and knowledge about proper stove technology are progressing and there are various technical, nontechnical, and regulatory measures which can be undertaken to avoid the problems described above; the end users today can choose between much better stove products than in the past. They could also optimize the integration of a wood stove into their heating infrastructure. Above all, however, it is the end user's heating behavior (that is, fuel selection, stove operation and maintenance), which is most decisive for achieving high efficiency and low emissions.

The following measures presents the main findings and conclusions of the "FutureBioTec" project,[108] aimed to provide a contribution concerning the

108 More details available at http://futurebiotec.bioenergy2020.eu.

development of future low emission stoves and automated small and medium-scale biomass combustion systems.

Technical Measures to Lower Emissions from Biomass Combustion

The objective to improve efficiency and lower emissions could be also achieved through different measures implemented by heating appliances manufacturers, including air staging, implementation of automated process control systems, or by fuel suppliers—as utilization of additives and biomass fuel blending.

There are two possible measures that can be applied on their own or together in order to eliminate the formation of slag, as well as to reduce the release of fine ash PM:

1. Reduce the temperature on the grate by, for example, applying air staging concepts.
2. Alter the composition of the ash forming content, either by adding a fuel additive or by changing the ash composition via fuel blending.

Air staging (staged combustion) is a method for reducing nitrogen oxides (NOx) from combustion, based on spatial separation of primary (control of combustion) and secondary (for burnout) air. It is an efficient primary measure to reduce NOx and PM emissions at different fixed bed combustion systems. NOx emissions increase with decreasing residence time in the primary combustion chamber. PM emissions decrease with increasing volume flow through the fuel bed because of lower fuel bed temperatures at higher air flows.

In order to reduce both NOx and PM emissions:

- The air ratio in the primary combustion chamber should be kept slightly below 1.0 (the optimum value of the air ratio in the primary combustion chamber is technology specific but not fuel specific and has to be determined within the scope of measurements).
- The mean residence time in the primary combustion chamber should be reasonably high (above ~0.5 s).
- Flue gas recirculation should be mainly applied below the grate to avoid slagging when fuels with low ash melting temperatures are used. Moreover, flue gas recirculation below the grate provides the possibility to cool the fuel bed in order to reduce the release of ash forming vapors and thus to reduce PM emissions.
- Flue gas recirculation into the primary combustion chamber should also be applied to improve the mixing of the flue gases (reduce streak formation) and to control the temperature in the primary combustion chamber.

- The flue gas temperature in the primary combustion chamber should be kept moderate (900–1,000°C).
- Small-scale biomass appliances are often operated uncontrolled or with a very simple control mechanism, mostly mechanical controller. The environmental contribution of such uncontrolled or poorly controlled boilers in comparison with fossils fuels ones can be very small if any. A typical issue is an improperly controlled air-to-fuel ratio during transition states. Such poor control method moves combustion process out of optimal combustion interval and causes significant heat losses and high emissions. By using advanced control techniques together with inexpensive sensor technology emissions could be further reduced.

Therefore, **automatic control** can be also regarded as a primary measure for preventing biomass combustion emissions. In this view, the control technology covers broadly the control methods, sensors and actuators for monitoring and controlling combustion. Modern control technology also covers combustion condition monitoring, process diagnostics, and the higher-level optimization of the energy consumption with system integration.

Combustion control is usually applied to achieve targets like steady heat output and constant oxygen level in flue gas. This means that disturbances, changes in fuel quality and heat load, are smoothed by the control actions reducing process variations. The control of the process behavior is directly related to clean combustion since steady-state conditions in general are favorable for achieving lower emissions.

The use of additives is seen as a fuel-related primary measure for combating both operational problems and emissions of fine ash PM. In smaller (residential and medium sized) grate-fired appliances fuel additives (such as calcium or clay kaolin dominated by the aluminium-silicate) may be used both for combating slagging problems and as a measure for reduction of fine particle formation.

The use of kaolin (and other clay minerals) as fuel additive in combustion of ash rich woody biomass (such as bark and logging residues) and wheat straw in small-scale, grate-fired appliances can reduce the fine PM emissions considerably. Also in phosphorus rich agricultural fuels, such as oat grains, a reduction effect on fine ash PM has been shown by adding kaolin to the fuel.

Nontechnical Measures to Lower Emissions from Biomass Combustion

As highlighted earlier, the end user's heating behavior is critical for reducing emissions from biomass combustion. For that reason, recommendations and advice related to nontechnical aspects of low-emission stove operation are developed (see Box C.1 for more detailed advice):

1. Only fuel with a moisture content between 8 and 20 wt% should be applied for stove combustion, and the utilization of technically dried wood (below 8 %) and wet wood shall both be avoided. It is pointed out that preferably hardwood (such as beech) should be used. Wood briquettes are also well suitable for combustion in chimney stoves. However, briquettes made of pure bark should be avoided due to smoldering conditions causing high emissions.
2. A major advise is that stove ignition should be performed from the top (that is, the ignition block is placed on top of a single layer of wood logs, then the ignition block is covered with the kindling and ignited). This ignition method has the potential to decrease the CO emissions already during the start-up batch by about 60% in comparison to traditional methods and is therefore an important issue to be communicated not only to users, but also to manufacturers. The traditional bottom-up ignition method is no longer recommended.
3. The correct recharging should preferably be done at the extinction of bright yellow flames and that the fuel load per batch should be adjusted to the instructions of the manufacturer (using single logs, as well as overloading the stove lead to a drastic increase of emissions and should therefore be avoided).

Regulatory Measures to Lower Emissions from Biomass Combustion

1. **Regulation under the EU Ecodesign Directive plays important role for the development of better stoves and boilers.** Current technical regulations in the Western Balkans do not give incentives for manufacturers to reduce emissions nor do they cover black smoke. The forthcoming regulation on emission limits for stoves and boilers under the EU Eco-design directive will be an important tool to reduce emissions from stoves and boilers.
2. **The W-B countries do not have the regulatory tools necessary to intervene in individual cases where wood burning results in poor air quality.** Therefore, it is important to adopt environment legislation that allows local authorities to intervene against local impacts of wood burning.
3. **Labeling of heating appliances can be a powerful driver in W-B countries to product development and consumer recognition related to black smoke.** With the ability to push requirements and to reward best practices, the regional W-B label should be established to serve as a leading edge in the development of requirements for black smoke, design of new stoves and future legal requirements. Development of joint protocols for testing emissions is a prerequisite to the development of such standards.
4. **There are significant uncertainties in emission factors for both PM and black smoke.** The way emissions are measured and reported varies

between countries, as do emission factors used to estimate the amount of emissions of PM. It is important to recognize that testing protocols should be compatible across the residential sector in order to assess their relative contributions to the overall emissions. The W-B countries should develop testing protocols for measuring emissions of black smoke and PM harmonized with EU, regarding the application of the Eco-design Directive to domestic heating appliances.

5. **Policy interventions and further cooperation is needed to develop a long-term strategy.** Technology development should be further promoted. It should not rely entirely on research and development, but other forms of stimulus are needed to bring new products to market. Industry and market actors have a key role in developing and putting new technology on the market. Additional measures should be considered if the natural change out of older equipment is not expected to be sufficient to achieve the desired goal. This could for example be done by setting deadlines for using particular kinds or models of stoves. Other ways of promoting the introduction of new and better products would be by using differentiated taxes and other economic instruments.

Box C.1: Recommendations for Optimal Operation of Wood Stoves

Permissible fuels for use

- Natural untreated wood, which is either round wood or wood split into logs, with or without adherent bark.
- Sawn wood (scantlings, boards), with or without adherent bark.
- Wood briquettes made from natural untreated wood.
- Ignition fuels (in small quantity): coarse wood chips, brushwood, sticks, kindling.
- Ignition aids (only in small quantity!) made of wood shavings, wood-wool, wood fiber, wax or mineral oil.
- It is not recommended that fuels of herbaceous crop materials are used in a chimney stove, even if such fuel is legally permitted in the respective country.

Fuel that should be avoided in chimney stoves

- Pure bark briquettes.
- Straw, paper, carton and similar products.
- Painted, coated, glued wood or wood which is treated with wood protecting chemicals, for example, used wood from outdoor applications, construction, or demolition wood.
- One-way pallets or fruit boxes and similar, if any impregnation or impurities cannot reliably be excluded.
- Other wastes.

Suitable log wood quality

- For chimney stoves the following log wood fuel recommendations are given:
- Avoid wet wood. Moisture content should be below 20% (wet basis).

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Box C.1: Recommendations for Optimal Operation of Wood Stoves (*continued*)

- When mould is visible on the surface, the log may be too wet.
- Avoid overdried wood logs. Moisture content should not be below 8%. Wood from long storage in a heated room can be overdried. Wood which comes directly from fuel producers using hot ventilation for drying can also be overdried. After intermediate storage in ambient air such wood is again suitable for stoves.
- The logs should have a length which allows for several centimeters clearance to the firebox walls when horizontally placed onto the ember. Logs should never be so long as to make it necessary to lean them against the walls of the firebox.
- Logs with a uniform medium thickness (that is, 20 to 30 cm circumference) should be used.
- Split logs should be used in preference of round wood (should be split at diameters greater than 8 cm).
- Select thin wood sticks or small logs for the ignition phase. Clean and coarse wood chips can also be selected for ignition.
- Small logs are useful for the ignition batch but not recommended for the recharging of the stove.
- The optimal log size is usually specified by the stove manufacturer (check the manual).
- Use hardwood (such as beech) rather than softwood.
- Use logs with low dust or dirt content.

Suitable briquette quality

- Compacted biomass tends to emit different levels of pollutants in relation to natural form of biomass. Check whether the fuel supplier declares compliance with any of the quality classes in the European briquette standard EN 14961–3, but note that the supplier is usually not obliged to refer to the European briquette standard. Standard briquettes usually have a low ash content and the concentration of disturbing or polluting components is usually also low (for example, chlorine, nitrogen, sulphur, or heavy metals). If standard quality is certified (for example, EN plus or DIN certification scheme) the quality is also monitored.
- Avoid the use of briquettes that are made from 100% bark. Such briquettes can lead to smoldering combustion with high gaseous emissions.
- The briquette length should be significantly shorter than the width of the firebox (due to swelling during combustion of wood briquettes). If volume increase is not allowed for, the briquette may get stuck between the sides of the firebox without any contact to the ember. Long briquettes therefore need to be broken into shorter lengths before use.

Suitable ignition materials

- For the first fuel batch select several normal or rather small wood logs combined with thinly sliced ignition wood sticks or brushwood or coarse wood chips. Such kindling is preferably produced from coniferous wood.
- Use professional ignition aids as available on the market, for example, wax-soaked wood wool blocks or wood fiber blocks with paraffin.
- Do not use the paper, cardboard, or liquid fuels as ignition aids. The use of paper for ignition has several disadvantages. Due to its leafy ash structure, the combustion air flow to the bed of ember is disturbed. Also, the burning time of paper is too short (and unstable) to guarantee a reliable ignition. In addition, ignition happens too slowly.

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Box C.1: Recommendations for Optimal Operation of Wood Stoves (*continued*)

Proper log wood drying, storage and quality control

- For proper storage and natural drying of the logs choose windy storage places, protect the wood against rain (by coverage of the top), protect against surface water (by stacking on wooden beams), and ensure sufficient distance to walls or neighboring stacks (> 0.1 m).

Ash handling and maintenance

- Clean and de-ash the stove frequently and follow the manufacturer's instructions.
- When de-ashing and cleaning the stove and pipe, do not inhale any released ash particles and avoid any direct contact of your skin with soot; use protective equipment such as masks or gloves. Carbon and soot containing ashes are known to be poisonous due to high concentrations of polycyclic aromatic hydrocarbons (PAH).
- The ash should be deposited to the residential waste.
- Check the connecting pipe to the chimney once or twice per year and clean the pipe using a round pipe brush (can also be done by chimney sweep).
- Check if a firm shutting mechanism of the door is still given and if any door sealing is damaged. Adjust the lock or replace the sealing if necessary.
- Check if any refractory lining is broken and if the grate is torn, and replace if necessary.
- The chimney must also be regularly cleaned by a chimney sweeper to avoid soot fire, according to the regulations.

Appendix D. Import, Export, Production, and Consumption of Biomass

Table D.1: Foreign Trade Balance of Firewood and Wood Chips, 2013

Country	Firewood				Wood chips			
	Production (m^3)	Import (m^3)	Export (m^3)	Consumption (m^3)	Production (tons)	Import (tons)	Export (tons)	Consumption (tons)
Albania	1,422,063	6,542	76,556	1,352,049	18,248	492	16,248	2,492
Bosnia and Herzegovina	5,556,286	599	706,885	4,850,000	134,600	182	14,020	120,762
Croatia	2,289,700	25,887	707,151	1,608,436	346,000	43,271	324,675	64,596
FYROM	1,319,500	1,944	8,444	1,313,000	300	48	0	348
Kosovo	2,271,562	n.a.	n.a.	2,271,562	300	n.a.	n.a.	300
Montenegro	768,616	33	22,019	746,630	26,876	795	25,914	1,757
Serbia	6,741,000	12,123	32,207	6,720,916	96,248	1,411	2,249	95,410
Total W-B	**20,368,727**	**47,128**	**1,553,262**	**18,862,593**	**622,572**	**46,199**	**383,106**	**285,665**

Table D.2: Foreign Trade Balance of Wood Briquettes and Wood Pellets, 2013

Country	Wood briquettes				Wood pellets			
	Production (tons)	Import (tons)	Export (tons)	Consumption (tons)	Production (tons)	Import (tons)	Export (tons)	Consumption (tons)
Albania	8,000	85	5,988	2,097	4,900	46	709	4,237
Bosnia and Herzegovina	120,000	2,464	90,296	32,168	194,568	235	168,641	26,162
Croatia	45,600	2,185	38,354	9,431	181,568	975	136,108	46,435
FYROM	5,500	201	18	5,683	3,850	9,182	1,019	12,013
Kosovo	5,100	—	—	5,100	20,500	0	0	20,500
Montenegro	575	87	0	662	2,635	3,225	2,220	3,640
Serbia	21,000	154	11,501	9,653	169,612	2,646	100,765	71,493
Total W-B	**205,775**	**5,176**	**146,157**	**64,794**	**577,633**	**16,309**	**409,462**	**184,480**

Glossary on Biomass Supply

Woody Biomass

Stemwood is the main product derived from forests. It is harvested for material and energy use.

Thinnings are a woody biomass product created during the "thinning" of a forest, when slower-growing or defective trees are removed to provide more space for the remaining trees to grow.

Logging residues are woody biomass byproducts (branches, treetops and leaves or needles) created during the harvesting of commercial timber. They are usually left at the logging site, both because of the high cost of collection and because they help to maintain the soil.

Secondary forestry residues include various types of biomass originating during the industrial processing of timber. These include sawdust and cutter chips, bark, slabs, lump wood residues, and black liquor. Secondary forestry residues are a spatially concentrated resource, meaning that large amounts of residues can be available from a single factory. In contrast to other types of forest woody biomass, all secondary forestry residues are technically accessible. Moreover, secondary solid forestry residues usually have lower moisture content than primary forestry residues and, thus, a higher net calorific value.

Wood outside of forest includes trees outside of forests, such as trees on other wooded land, including settlement areas, along the roads, and in other infrastructural areas, farms, and hedgerows.

Woody biomass for energy from conversion of coppices includes wood obtained from the process of restoring neglected and damaged forests into high stands. This wood is usually available in the initial phases of the restoration, and gathering it often necessitates the improvement of road networks in forests where coppices have been neglected.

Biomass energy crops (poplar) are in this study defined as crops specifically bred and cultivated for energy production by direct conversion to heat and electricity. For the purposes of this study, the energy crops included in woody biomass potential refer only to poplar grown on land classified as "other wooded land."

Agricultural Biomass

Field crop residues are derived from field crops, such as small-grain cereals (wheat, barley, oat, rye, and rice), maize and oil crops (sunflower and rapeseed). These residues are incorporated into the soil, burned in the field, or collected and used for various purposes (such as animal feed, bedding, and mushroom cultivation).

Arboricultural residues are the prunings of trees (such as apple, olive, and pear trees) and grapevines in vineyards.

For this study, part of **biomass (energy) crops that are grown on abandoned or degraded agricultural land** is included in the **agricultural biomass** category. This category refers mainly to miscanthus.

Miscanthus (commonly known as "elephant grass") is a high-yielding energy crop that grows over 3 meters tall, resembles bamboo, and produces a crop every year without the need for replanting. Miscanthus is used for both energy and non-energy end uses.

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