Smarter Stoves
Partnership

Author: UNIQUE

Effects of wood savings on GHG inventory

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This Report was prepared within the project *Smarter Stoves Partnership*, which aims to create a regional knowledge platform to replace inefficient individual heating devices in households across the Western Balkans. The project is being implemented by the RES Foundation, funded by the Austrian Ministry of Climate and European Climate Foundation (ECF). Attitudes and opinions expressed in this report are solely the views of the author and do not necessarily represent the views of RES Foundation or the project donors.

Contents

ABBREVIATIONS

NFI	National Forest Inventory
FAO	Food and Agriculture Organization of United Nations
GHG	Green House Gasses
WISDOM	The Woodfuel Integrated Supply and Demand Overview Mapping
ESTAT	Statistical office of the European union
UNECE	The United Nations Economic Commission for Europe
IEA	International Energy Agency
WB	Western Balkan
CHP	Combined Heat and Power

1 OBJECTIVES OF THE ASSIGNMENT

1.1 About this Assignment/Background

The “Smarter Stoves Partnership” project contributes to the reduction of CO_2 and black carbon emissions from individual devices for residential heating in households across the Western Balkans. This is achieved by establishing the knowledge regional platform for replacement of inefficient stoves and by mobilizing decision makers, international finance institutions (IFIs) and development partners.

One part of the project is the collection and processing of information, performing targeted analysis and assessments to inform and enable a variety of alternatives to the current heating practices with particular focus on A) *technologies*, B) *financial and implementation schemes*, whilst taking into account the needs of the most vulnerable populations, primarily exposed to energy poverty.

Finally, the project is called C) *“partnership”* as it is recognized that the future change-out scheme will not be successful unless it brings together key stakeholders across a number of traditional demarcation lines, such as: i) local, regional, national and international public policy decision-makers, ii) public sector or government, private sector or businesses; civil society sector or NGOs and financial sector or banks and IFIs; iii) economy, public finance, energy, environment, social protection and support services for the poor and marginalized, health, housing, and other sectoral policy-makers and related stakeholders; and iv) the six Western Balkans contracting parties to the energy community.

According to the ToR for this assignment, the main objective of the consultancy is to compose the GHG accounting profile of different mitigation scenarios resulting from implementing stove change-out schemes. The tasks of the consultancy include the preparation of the following scenarios:

- Wood saved as it remains unharvested → Forest carbon
- Wood saved and used in construction wood, furniture or similar types of wood products characterized by long term carbon storage → Product storage
- Wood saved is directed into other biomass-to-energy use → Substitution of fuels

1.2 Scope of the Report

The scope of this report covers six markets of the Western Balkan region:

- Serbia
- Montenegro
- Albania
- North Macedonia
- Bosnia-Herzegovina

- Kosovo*[1]

2 EVALUATION OF AVAILABLE INVENTORY DATA (FOREST AND WOOD PRODUCTION)

For the purpose of this report different data sources were used, both national and international, as presented in Table 1. Due to the methodology of data collection at national level it was difficult to develop joint indicators for different countries. Hence, an advantage was given to the international data sources in certain cases. For this purpose following sources were used:

- FOREST EUROPE[2] (the brand name of the Ministerial Conference on the Protection of Forests in Europe) is the Pan-European voluntary high-level political process for intergovernmental dialogue and cooperation on forest policies in Europe. FOREST EUROPE develops common strategies for its 46 signatories (45 European countries and the European Union) on how to protect and sustainably manage their forests.
- State of Europe's Forests 2020 Report[3] presents recent official figures and information on European forests, their management, policies, institutional and legal frameworks in the FOREST EUROPE signatory countries. This report provides relevant data for forest area, growing stock, volume increment etc., presented through time series from the year 1990.
- In addition to international sources, certain national sources are used as data basis. This was the case for North Macedonia, where data are provided by public enterprise "Makedonski šumi", while for Bosnia-Herzegovina data from National forest inventory were used, as well as for Montenegro, where the national forest inventory was the main source for data used in preparation of WISDOM study.
- UNECE[4] website is a source of information on forests and forestry in Europe, the Russian Federation, North America and the countries of the Caucasus and Central Asia. This website provides the data that is drawn from international sources and collected according to internationally agreed definitions and formats. UNECE website served as a data source for annual production of wood for each country. As base year 2018was used, since the most recent data is provided for this year.

[1] *This designation is without prejudice to positions on status, and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo Declaration of Independence
[2] https://foresteurope.org/foresteurope/
[3] https://foresteurope.org/state-europes-forests-2020-report/#1476295991324-493cec85-134b
[4] https://forest-data.unece.org/Countries

Table 1: Overview of data sources for six WB countries

Country	Data sources	Year of data production	Reliability of data
Serbia	WISDOM Study for Serbia	2015	WISDOM methodology relevant and used in several countries for estimation of consumption looking into demand side. Very often, it gives higher figures in consumption than official statistic especially in countries with high percent of private forest.
Montenegro	WISDOM Study for Montenegro (based on NFI 2009)	2013	WISDOM methodology relevant and used in several countries for estimation of consumption looking into demand side. Very often, it gives higher figures in consumption than official statistic especially in countries with high percent of private forest.
Albania	FOREST EUROPE - State of Europe's Forests 2020 Report	2021	Very relevant data based on national reporting systems.
North Macedonia	PE „Makedonski šumi"	2021	Very relevant data based on national stand inventory system.
Bosnia-Herzegovina	NFI	2009	Very relevant data based on national inventory grid system.
Kosovo*	No available data	-	-

Source: 2021

As the baseline data for each country are used the following parameters:

- Area — in 1,000 ha (Forests & Trees outside forest)
- Volume — in 1,000 m^3
- Volume increment — in 1,000 m^3/a
- Percentage of increment — in %
- Utilization — in 1,000 m^3

3 OVERVIEW OF WOOD BIOMASS UTILIZATION AND POTENTIALS IN WESTERN BALKAN REGION

An assessment of biomass availability and quality is an important approach towards understanding its utilization potential in various sectors. Traditionally, forestry supplies forest industries with saw log, wood for wood-based panels as well as pulpwood. In addition to this, forestry supplies bioenergy sector, that includes firewood for district heating and household use, wood for briquettes and wood pellets, etc. Pulp and paper industry in the Western Balkan region is not sufficiently developed, since the only country that uses pulpwood is Bosnia-Herzegovina for the factory “Natron Hayat” in Maglaj. It is producing different paper assortments. In addition to this, wood-based panels are produced in Albania, Bosnia and Herzegovina and Serbia. The biggest production is in Serbia, at Kronospan factory.

As the main source of data for woody biomass utilization are used different international sources such as Reports from Food and Agriculture Organization of the United Nations – FAO:

- WISDOM SERBIA - Spatial wood fuels production and consumption analysis
- WISDOM MONTENEGRO - Woodfuel Integrated Supply/Demand Overview Mapping
- UNECE – the database of UNECE was used as a data source for annual production of firewood for all countries, as well as for source of production of pulpwood and wood-based panels.
- ESTAT - Eurostat is the statistical office of the European Union that provide high quality statistics and data on Europe. This source has been used as the main data source for energy consumption for WB Countries.

Table 2: Production of timber in Western Balkan countries (gross volume)

Country	Data source	Total production (1,000 m^3)	Households’ fuelwood (1,000 m^3)	Pulpwood (1000 m.t.)	Wood based panels (excluding veneer) (1000 m3)
Serbia	UNECE (2018)	7959.0	6533.0	-	292.4
Montenegro	UNECE (2018)	1082.2	1060.0	-	-
Albania	UNECE (2018)	1180.0	1100.0	-	11.0
North Macedonia	UNECE (2018)	802.0	681.0	-	-
Bosnia and Herzegovina	UNECE (2018)	4486.8	1506.77	69	39.8
Kosovo*	No available data	-	-	-	-

Source: 2021

3.1 Basic Assumptions and Calculation Process

As defined within the ToR, three different scenarios are prepared for distribution of saved firewood due to the improvement of stoves performances. As a base for calculation quantities of fuelwood used in households, presented by UNECE (Table 2), and saving rate of 5% of the total household fuelwood use are used.

3.1.1 Scenario 1 – Wood Saved in Forest as it Remains Unharvested

The basic assumption for this scenario is that 50% of firewood saved due to the improved stoves performances stays unharvested into the forest. In addition to the calculation of savings from the felling, are calculated savings from harvesting and transport of assortments, since those operations will not be performed. Table 3 presents basic assumptions for this scenario related to harvesting and transport.

Table 3: Basic assumptions for scenario 1 related to harvesting and transport

Harvesting	
Assumption: Assortment Fuel wood; felling, skidding; transportation of workers	
GHG-factor (CO2-t/m^3)	0.00586
Transport	
Assumption: Lorry with trailer; 180 kW; 30 m^3 load return tour: empty	
Assumption on transportation distance (km):	80
GHG-factor (CO_2-t/m^3)	0.0098
Savings - fuel wood not harvested (CO_2-t/m^3)	0.0157

For the calculation the following factors from scientific literature[5] have been used (***Figure 1***):

Assortment	Unit	Chain saw	Skidding	Loading	Transportation of workers	Total
Saw logs	KWh/m^3	1.85	11.22	4.19	1.30	18.56
	KgCO_2e/m^3	0.47	3.00	1.21	0.35	4.94
Fuel wood	KWh/m^3	2.78	0	17.96	1.30	22.04
	KgCO_2e/m^3	0.71	0	4.80	0.35	5.86
Forest residues	KWh/m^3	0	0	17.96	1.30	19.26
	KgCO_2e/m^3	0	0	4.80	0.35	5.15

Figure 1: Energy consumption an equivalent emission of CO_2 for 1 m^3 of produced assortments

Source: Furtula, M. A., et al, 2007

[5] Furtula, M. A., et al.: Energy consumption and equivalent emission of CO2 at wood pellets production in Serbia, THERMAL SCIENCE, Year 2017, Vol. 21, No. 5, pp. 1905-1915

Figure 2 shows energy consumption an equivalent emission of CO_2 for 1 m^3 of solid wood assortments transported to pellet mill.

Operation	Diesel fuel consumption		
	[L/m^3]	[kWh/m^3]	[$kgCO_2e/m^3$]
Transportation	2.88	28.74	9.82
The calculation is done for the following input data> specific consumption was 0.24L/Kw per 100 km, engine power of lorry is 180 KW, average distance to pellet mill was 80 km, (Lorry mainly returns empty), and average volume carried by a Lorry was 30 m^3			

Figure 2: Energy consumption an equivalent emission of CO_2 for 1 m^3 of solid wood assortments transported to pellet mill

Source: Furtula, M. A., et al, 2007

For the calculation of CO_2-quantity in wood remaining in forest the following factors defined by the IPCC Guidelines[6] have been used (Figure 3).

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[6] IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan

Domain	Ecological zone	Above-ground biomass	R [tonne root d.m. (tonne shoot d.m.)$^{-1}$]	References
Tropical	Tropical rainforest		0.37	Fittkau and Klinge, 1973
	Tropical moist deciduous forest	above-ground biomass <125 tonnes ha^{-1}	0.20 (0.09 - 0.25)	Mokany *et al.*, 2006
		above-ground biomass >125 tonnes ha^{-1}	0.24 (0.22 - 0.33)	Mokany *et al.*, 2006
	Tropical dry forest	above-ground biomass <20 tonnes ha^{-1}	0.56 (0.28 - 0.68)	Mokany *et al.*, 2006
		above-ground biomass >20 tonnes ha^{-1}	0.28 (0.27 - 0.28)	Mokany *et al.*, 2006
	Tropical shrubland		0.40	Poupon, 1980
	Tropical mountain systems		0.27 (0.27 - 0.28)	Singh *et al.*, 1994
Subtropical	Subtropical humid forest	above-ground biomass <125 tonnes ha^{-1}	0.20 (0.09 - 0.25)	Mokany *et al.*, 2006
		above-ground biomass >125 tonnes ha^{-1}	0.24 (0.22 - 0.33)	Mokany *et al.*, 2006
	Subtropical dry forest	above-ground biomass <20 tonnes ha^{-1}	0.56 (0.28 - 0.68)	Mokany *et al.*, 2006
		above-ground biomass >20 tonnes ha^{-1}	0.28 (0.27 - 0.28)	Mokany *et al.*, 2006
	Subtropical steppe		0.32 (0.26 - 0.71)	Mokany *et al.*, 2006
	Subtropical mountain systems		no estimate available	
Temperate	Temperate oceanic forest, Temperate continental forest, Temperate mountain systems	conifers above-ground biomass < 50 tonnes ha^{-1}	0.40 (0.21 - 1.06)	Mokany *et al.*, 2006
		conifers above-ground biomass 50-150 tonnes ha^{-1}	0.29 (0.24 - 0.50)	Mokany *et al.*, 2006
		conifers above-ground biomass > 150 tonnes ha^{-1}	0.20 (0.12 - 0.49)	Mokany *et al.*, 2006
		Quercus spp. above-ground biomass >70 tonnes ha^{-1}	0.30 (0.20 - 1.16)	Mokany *et al.*, 2006
		Eucalyptus spp. above-ground biomass < 50 tonnes ha^{-1}	0.44 (0.29 - 0.81)	Mokany *et al.*, 2006
		Eucalyptus spp. above-ground biomass 50-150 tonnes ha^{-1}	0.28 (0.15 - 0.81)	Mokany *et al.*, 2006
		Eucalyptus spp. above-ground biomass > 150 tonnes ha^{-1}	0.20 (0.10 - 0.33)	Mokany *et al.*, 2006
		other broadleaf above-ground biomass < 75 tonnes ha^{-1}	0.46 (0.12 - 0.93)	Mokany *et al.*, 2006
		other broadleaf above-ground biomass 75-150 tonnes ha^{-1}	0.23 (0.13 - 0.37)	Mokany *et al.*, 2006
		other broadleaf above-ground biomass >150 tonnes ha^{-1}	0.24 (0.17 - 0.44)	Mokany *et al.*, 2006
Boreal	Boreal coniferous forest, Boreal tundra woodland, Boreal mountain systems	above-ground biomass <75 tonnes ha^{-1}	0.39 (0.23 - 0.96)	Li *et al.*, 2003; Mokany *et al.*, 2006
		above-ground biomass >75 tonnes ha^{-1}	0.24 (0.15 - 0.37)	Li *et al.*, 2003; Mokany *et al.*, 2006

Figure 3: Ratio of above-ground biomass to below-ground biomass

Source: IPCC, 2006

TABLE 4.5 (CONTINUED)
DEFAULT BIOMASS CONVERSION AND EXPANSION FACTORS (BCEF), TONNES BIOMASS (M^3 OF WOOD VOLUME)$^{-1}$

BCEF for expansion of merchantable growing stock volume to above-ground biomass ($BCEF_S$), for conversion of net annual increment ($BCEF_I$) and for conversion of wood and fuelwood removal volume to above-ground biomass removal ($BCEF_R$)

Climatic zone	Forest type	BCEF	Growing stock level (m^3)				
			<20	21-40	41-100	100 -200	>200
Temperate	hardwoods	$BCEF_S$	**3.0** (0.8-4.5)	**1.7** (0.8-2.6)	**1.4** (0.7-1.9)	**1.05** (0.6-1.4)	**0.8** (0.55-1.1)
		$BCEF_I$	1.5	1.3	0.9	0.6	0.48
		$BCEF_R$	3.33	1.89	1.55	1.17	0.89
	pines	$BCEF_S$	**1.8** (0.6 -2.4)	**1.0** (0.65 -1.5)	**0.75** (0.6-1.0)	**0.7** (0.4-1.0)	**0.7** (0.4-1.0)
		$BCEF_I$	1.5	0.75	0.6	0.67	0.69
		$BCEF_R$	2.0	1.11	0.83	0.77	0.77
	other conifers	$BCEF_S$	**3.0** (0.7-4.0)	**1.4** (0.5-2.5)	**1.0** (0.5-1.4)	**0.75** (0.4-1.2)	**0.7** (0.35-0.9)
		$BCEF_I$	1.0	0.83	0.57	0.53	0.60
		$BCEF_R$	3.33	1.55	1.11	0.83	0.77
			<20	21-40	41-80	>80	
Mediterranean, dry tropical, subtropical	hardwoods	$BCEF_S$	**5.0** (2.0-8.0)	**1.9** (1.0-2.6)	**0.8** (0.6-1.4)	**0.66** (0.4-0.9)	
		$BCEF_I$	1.5	0.5	0.55	0.66	
		$BCEF_R$	5.55	2.11	0.89	0.73	
	conifers	$BCEF_S$	**6.0** (3.0-8.0)	**1.2** (0.5-2.0)	**0.6** (0.4-0.9)	**0.55** (0.4-0.7)	
		$BCEF_I$	1.5	0.4	0.45	0.54	
		$BCEF_R$	6.67	1.33	0.67	0.61	

Figure 4: Default biomass conversion and expansion factors

Source: IPCC, 2006

For each country, this scenario is presented in the Excel file, in the sheet named "T1-Country Name_Forest".

3.1.2 Scenario 2 – Wood saved and used in construction wood, furniture or similar types of wood products characterized by long term carbon storage

This scenario is implemented for Albania, Serbia and Bosnia and Herzegovina, where paper production and wood-based panels industries (excluding veneer) are located. The basic assumption for this scenario is, that 25% of firewood saved due to improved stove performance, will be used in the processing industry, mainly for wood-based panels (excluding veneer) and paper. For the baseline, UNECE data from 2018 is used, related to production of wood-based panels (excluding veneer) and paper. Calculation formulas are based on IPCC guidelines[7].

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

The scenario results are based on an estimation of annual changes in carbon stocks of wood product pools. The annual inflow of carbon is a result of the available and allocated wood resources to a certain product pool, converted into units of carbon. The annual carbon loss as outflow is calculated based on estimated half-life and associated decay rates of wood products. Conversion factors (product-carbon) and first-order decay rates are based on IPCC (2006) default values (see Table 4: Conversion factors and default values for paper and wood-based panels).

[7] IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan

The final results are presented as annual changes in carbon stock and in CO_2 stock for each country. This scenario is presented in the Excel file, in sheet "T2-Country Name_Ind-Use".

Equation 1: Estimation of carbon stock and its annual change

EQUATION 12.1
ESTIMATION OF CARBON STOCK AND ITS ANNUAL CHANGE IN HWP POOLS OF THE REPORTING COUNTRY

Starting with $i = 1900$ and continuing to present year, compute

$$(A) \qquad C(i+1) = e^{-k} \bullet C(i) + \left[\frac{\left(1-e^{-k}\right)}{k}\right] \bullet Inflow(i) \qquad with \;\; C(1900) = 0.0$$

$$(B) \qquad \Delta C(i) = C(i+1) - C(i)$$

Note: For an explanation of technique used in Equations 12.1A to estimate first-order decay see Pingoud and Wagner (2006).

Where:

i = year

C(i) = the carbon stock of the HWP pool in the beginning of year i, Gg C

k = decay constant of first-order decay given in units, yr^{-1} ($k = \ln(2)$ / HL, where HL is half-life of the HWP pool in years. A half-life is the number of years it takes to lose one-half of the material currently in the pool.)

Inflow(i) = the inflow to the HWP pool during year i, Gg C yr^{-1}

ΔC(i) = carbon stock change of the HWP pool during year i, Gg C yr^{-1}

Table 4: Conversion factors and default values for paper and wood-based panels

	Half-life	*ln(2)*	*k*	*e^-k*	*Density*	*Carbon fraction*	*C conversion factor*[1]
Paper	2	0.69	0.35	0.71	0.9 Mg/Mg	-	0.39
Wood based-panels	25	0.69	0.03	0.97	0.595 Mg/m^3	0.454	0.27

Source: IPCC, 2006, values rounded for better visibility ([1]per air dry volume [Mg C/ m^3] or per air dry mass - paper)

3.1.3 Scenario 3 – Wood saved and directed into other biomass-to-energy use

This scenario has been prepared for all countries, with the assumption that saving rate is 25 %, and that firewood saved due to the improved stoves performances will be used for replacing of other energy sources - fossil fuels. The main data source for energy consumption per sector was the statistical office of the European Union (ESTAT)[8]. Energy consumption is shown for three sectors and six different fuels, as shown in Table 4.

[8] https://ec.europa.eu/eurostat

Table 5: Sectors and fuels for energy use defined in the scenario T3

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

Source: ESTAT

The following assumptions for fuelwood characteristics are used:

- Water content: 45%
- Density 0.66 t/m³
- Heating value 2.5727 MWh/t dry

The emissions balance of renewable energy sources from Germany, published by German Environment Agency, was used as source of data for different factors for calculations of energy supply from various energy sources (Figures: 5, 6, 7, 8).[9]

[g/kWh]	THP CO2-Äq.	CO_2	CH_4	N_2O	VP SO2-Äq.	SO_2	NOx	Staub	CO	NMVOC
Einzelfeuerung	16,1	3,9	0,480	0,007	0,211	0,037	0,251	0,437	11,413	0,751
Scheitholz-zentral	12,3	10,4	0,075	0,001	0,295	0,028	0,384	0,250	8,735	0,121
Pellets-zentral	32,0	30,5	0,057	0,001	0,382	0,116	0,383	0,118	0,711	0,029

Figure 5: Emission factors for heat supply from solid biomass in private households

Source: Emissions balance of renewable energy sources[10], 2013

[9] http://www.umweltbundesamt.de

[10] Emissionsbilanz erneuerbarer, Energieträger, Bestimmung der vermiedenen Emissionen im Jahr 2012; 2013. Umweltbundesamt, Deutschland

[g/kWh]	THP CO2-Äq.	CO_2	CH_4	N_2O	VP SO2-Äq.	SO_2	NOx	Staub	CO	NMVOC
Haushalte)	314,4	311,7	0,084	0,003	0,505	0,330	0,252	0,019	0,144	0,049
Erdgas (Haushalte)	248,1	225,8	1,033	0,002	0,134	0,011	0,176	0,006	0,136	0,052
Steinkohlen (Haushalte)	419,1	354,9	2,419	0,043	1,794	1,482	0,448	0,075	12,49 9	0,235
Braunkohle-Brikett (Haushalte)	428,7	414,8	0,229	0,029	0,641	0,381	0,373	0,428	8,554	0,596
Fernwärme (inkl. Netzverluste)	325,4	309,4	0,607	0,010	0,496	0,260	0,338	0,029	0,143	0,019
Stromheizung (inkl. Netzverluste)	626,1	600,4	0,856	0,025	0,686	0,306	0,545	0,041	0,326	0,027

Figure 6: Emission factors for heat supply from fossil fuels in private households

Source: Emissions balance of renewable energy sources, 2013

[g/kWh]	THP CO2-Äq.	CO_2	CH_4	N_2O	VP SO2-Äq.	SO_2	NOx	Staub	CO	NMVOC
Altholz-DT-HKW	41,1	16,049	0,240	0,065	1,714	0,302	2,028	0,171	0,846	0,023
Papier-DT-HKW (Schwarzlauge)	12,2	5,277	0,062	0,018	2,363	0,647	2,466	0,070	0,707	1,410
Industrierest-holz-DT-HKW	74,8	50,911	0,266	0,059	1,998	0,193	2,593	0,177	0,906	0,659
Industrierest-holz-ORC-HKW	169,7	141,763	0,270	0,072	1,302	0,243	1,521	0,270	1,250	0,809

Figure 7: Emission factors for heat supply from solid biomass

Source: Emissions balance of renewable energy sources, 2013

[g/kWh]	THP CO2-Äq.	CO_2	CH_4	N_2O	VP SO2-Äq.	SO_2	NOx	Staub	CO	NMVOC
Heizöl-Mix EL+S (Industrie)	341,4	338,0	0,079	0,006	0,578	0,349	0,328	0,022	0,070	0,067
Erdgas (Industrie)	276,8	264,6	0,543	0,003	0,164	0,008	0,223	0,004	0,067	0,017
Steinkohle-Mix (Industrie)	393,4	368,7	0,841	0,022	1,879	1,478	0,575	0,049	0,146	0,034
Braunkohle-Mix (Industrie)	456,5	443,7	0,022	0,040	1,740	1,395	0,496	0,179	0,140	0,019
Fernwärme m. Netzverluste	325,4	309,4	0,607	0,010	0,496	0,260	0,338	0,029	0,143	0,019

Figure 8: Emission factors for heat supply from fossil fuels

Source: Emissions balance of renewable energy sources, 2013

Using these factors and baseline data, as well as data from ESTAT, for each year within the 5-year period the savings in MWh, emissions, and the difference of emissions between baseline and future are calculated. This scenario is presented in the excel file, in the sheet named “T3-Country Name_Energy_use”.

4 LATEST DISCUSSION: CARBON NEUTRALITY OF WOOD BIOENERGY

The latest discussion and publications of the International Energy Agency[11] states that energy from woody biomass can be very positive for the climate, particularly when applying sustainable forest management practices, and when the biomass is used efficiently. On the other hand, certain media headlines state that “biomass is worse than coal”. In the following the argumentation of International Energy Agency related to this issue, with addition of the Western Balkan aspect for each argument will be presented.

Argument 1. Sustainable forestry is vital

IEA: Sustainable forest management plays an important role in storing carbon for extended periods of time, since forest have the potential to absorb significant volumes of carbon in biomass and products, as well as in soil. According to the IEA, valuable forests need to be protected and managed on a sustainable way. In reality, a forest usually comprises stands of different ages, managed such that different stands are harvested each year. Thus, considered across the whole forest estate, stand level fluctuations in carbon stock are evened out. If the annual cut is equal to the annual growth, at estate level, the carbon stock of the whole forest will remain constant. If the annual cut is less than the annual growth, the forest will have a net sequestration of carbon, while also providing wood for products and biomass for energy.

Forest management and forest policy in the Western Balkan (WB) region follow principals of sustainability and in some countries have explicit orientation towards close to nature forest management approach. Harvesting rates in all WB countries are lower than annual increment (Albania has banned harvesting operations) while valuable wood products which have long term storage capacity (wood products used on domestic market) are produced. All state forests in the WB region have forest management plans where all strategic objectives are implemented on the ground using sustainability as basic principle in forest management. Planning and implementation of the plans are under control of forest inspectorate (subordinate to the responsible ministry) in all WB countries.

Argument 2. Biomass combustion emits carbon that was absorbed as the plants grew

IEA: Burning fossil fuels releases carbon that has been locked up in the ground for millions of years, while burning biomass emits carbon that is part of the biogenic carbon cycle. In other words, fossil fuel use increases the total amount of carbon in the biosphere-atmosphere system while bioenergy systems operate within this system; biomass combustion simply returns to the atmosphere the carbon that was absorbed as the plants grew.

In WB markets use of coal is still significant source of energy while in same time these countries are rich in wood biomass as potential source for energy production. WB markets have

[11] https://www.ieabioenergy.com/iea-publications/faq/woodybiomass/

substantial area under poor quality forests. By their improvement wood material can be used as substitution source for fossil fuel heating plants. In the in rural areas of WB region fuelwood for heating and cooking is the most common in everyday life of local inhabitants. Improvement of stove characteristic and house isolation could be one of the most important saving of fuel wood. It then could be use as substitution source in fossil fuel depending on district heating systems.

Argument 3. Bioenergy is carbon neutral

IEA: The use of forest biomass is carbon-neutral because the carbon contained in wood originates from the atmosphere and it is released to the atmosphere by wood decay or by combustion. However, the full supply chain must be considered, and all emissions associated with the production, processing, transport and use of bioenergy need to be included. Particularly harvesting, transport and processing generally involves fossil energy use. Nevertheless, analysis shows that the fossil energy used in the supply chain is generally a small fraction of the energy content of the bioenergy product, even for woody biomass transported over long distance.

In WB region wood biomass transport have short distance while wood resources are distributed all-round the area.

Argument 4. Asynchrony between the timing of emissions and sequestration exists

IEA: The asynchrony between the timing of emissions and sequestration, exists particularly when biomass is obtained from long rotation forests, where a stand takes decades to regrow. Considering the long residence time of CO2 in the atmosphere, it is less important whether carbon in forest residues is emitted to the atmosphere soon after the forestry operations take place (such as when used for energy) or is emitted in the course of the next few decades (such as when the residues are left in the forest to decay). This asynchrony exist in WB countries. Wood residue in WB countries are not used as energy source due to lack of supply chain for such material.

Argument 5. Unharvested forests have declining carbon uptake over time

IEA: In a sustainably managed forest, silvicultural operations and harvest activities are coordinated across the forest landscape to maintain a healthy forest and to obtain a continuous flow of wood for society, while maintaining or increasing wood volume in the forest. Unharvested forests have declining carbon uptake over time because growth rates diminish as forests get older and approach maturity, or high tree density constrains further growth. Thinning promotes the production of high-quality stem wood and can stimulate increased growth rate of the forest stand. Utilization of thinned trees for bioenergy is beneficial both to the carbon balance of the forest-product system and also to future production of high-value timber.

In the WB region introduction of close to nature forest management was indirectly present over a long period of time. Production of valuable timber taking in consideration of sustainability as leading principle don’t follow with clear operational close to nature silvicultural systems. In recent periods, WB markets start introducing target-oriented forest management and silvicultural interventions which follow natural processes and do the same as nature will do but on slower rate.

Argument 6. Emerging bioenergy markets influence the decisions of forest managers

IEA: Forest management is linked to economic incentives and market expectations of forest owners for different forest products. Emerging bioenergy markets, along with the outlook for other forest product markets, influence the decisions of forest managers. A market for bioenergy can support investment in forest improvement – to enhance health and productivity of the forest, which in turn positively influences forest carbon stocks. Bioenergy demand is a driver for such activities the carbon sequestration can be considered an additional contribution to climate mitigation provided by the bioenergy system.

In the WB region bioenergy market is emerging but still not developed as it is in Western Europe. Biomass in district heating system is in developing stage, CHP plants are not existing or very rare present in the region. Promotion use of wood as construction and substitution material for concrete and metal is not visible. Creating a demand side could have positive effects on biomass market and could become a significant substitution source which will contribute to positive synergy on local employment potential, ecological, health and local economy. In network of such intervention at local or regional level, WB markets could reduce dependence on imported fossil fuels and thus secure independent energy policy in the future.