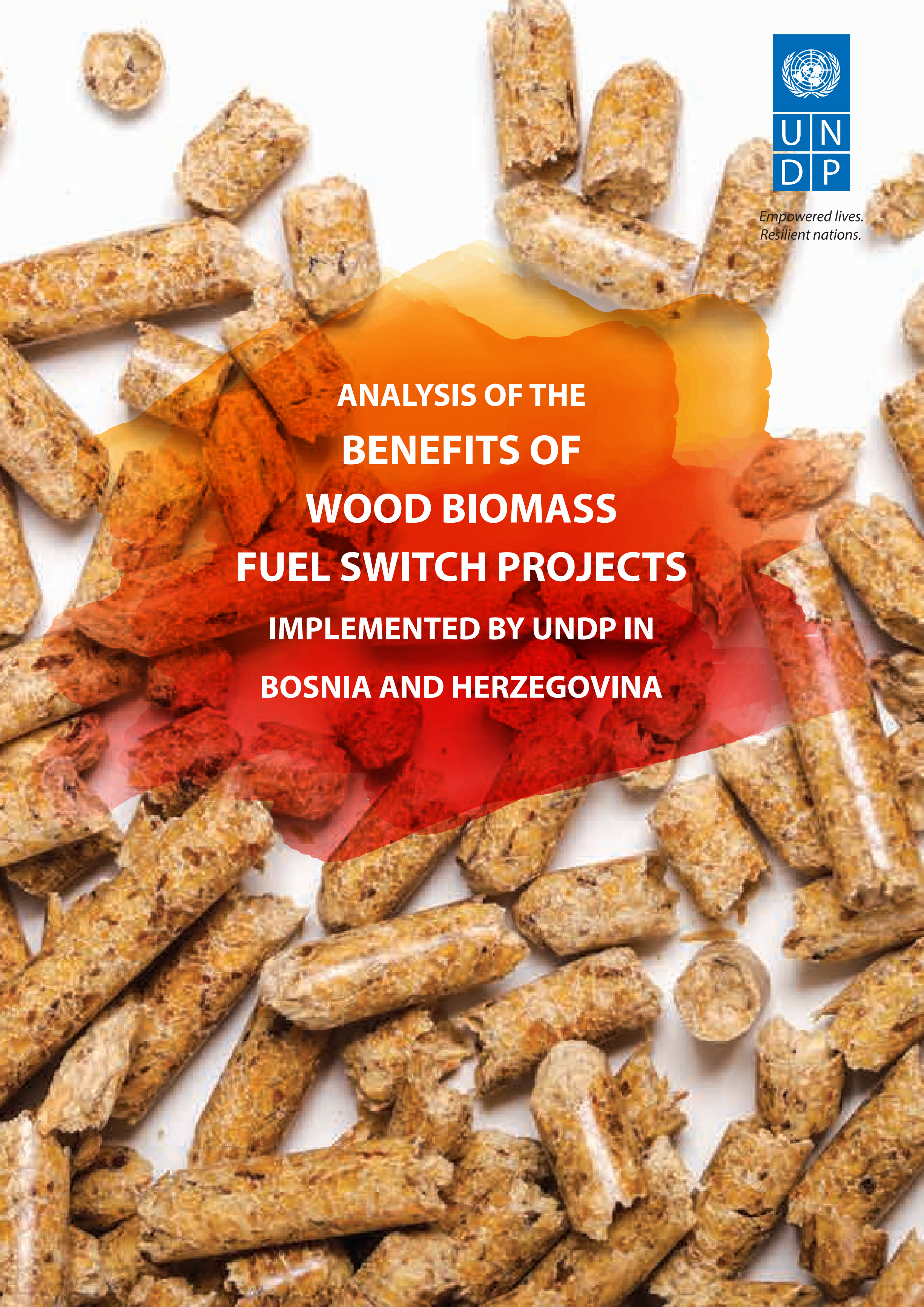

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ANALYSIS OF THE BENEFITS OF WOOD BIOMASS FUEL SWITCH PROJECTS IMPLEMENTED BY UNDP IN BOSNIA AND HERZEGOVINA

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UNDP IN BOSNIA AND HERZEGOVINA
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I CONTENTS

LIST OF ACRONYMS

BAM	Convertible Mark – Currency of Bosnia and Herzegovina (1 BAM = 0.57 USD (October 2015); 1 BAM = 0.51 EUR (fixed exchange rate)
BiH	Bosnia and Herzegovina
CH4	methane
CO2	carbon dioxide
CO2eq	carbon dioxide equivalent
EF	emission factor
EMIS	Energy Management Information System
EU	European Union
EUR	Euro
FAO	Food and Agriculture Organisation of the United Nations
FBiH	Federation of Bosnia and Herzegovina
GED	Green Economic Development Project
GEF	Global Environment Facility
GHG	greenhouse gas
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
kW	kilowatt
kWh	kilowatt hour
MDG-F	Millennium Development Goals Achievement Fund
MJ	megajoule
MOFTER	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
MSŠ	mješovita srednja škola (secondary school)
MW	megawatt
N2O	nitrous oxide
OŠ	osnovna škola (primary school)
RS	Republic of Srpska
SDG	Sustainable Development Goal
t	tonne
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollars

01 INTRODUCTION

Forestry and the wood industry are major economic sectors in BiH

Bosnia and Herzegovina (hereinafter BiH) has rich forest resources, both from the aspect of distribution and biodiversity, with a significant share of its territory covered by forests.[1] BiH has the highest forest share as well as the highest level of diversity in terms of forest types among the countries of the Western Balkans.[2] Forest resources are the basis of the local economy in many rural communities and often form the only source of income. Many businesses are involved directly or indirectly in wood harvesting and processing and wood and wood products (most notably furniture) represent one of the country's main export categories. Wood resources are also widely used by households for heating: 88.3 per cent of room heating and 54.5 per cent of individual central heating.[3] Wood stands as the largest source of renewable energy in BiH, accounting for 57 per cent of renewable energy production in 2013.[4]

Wood biomass can play a key role in meeting BiH's renewable energy targets and the objectives of climate change mitigation

The further development of BiH's enormous renewable energy potential, including wood biomass, combined with heightened investment in energy efficiency has the potential to play an instrumental role in reducing the amount spent annually on energy, which currently accounts for around 20 per cent of BiH's GDP.[5] Wood biomass is also expected to make a major contribution to achieving BiH's targets set under the framework of the Energy Community Treaty to which BiH is a party.[6] This requires BiH to cover a 40 per cent share of its gross final energy consumption through renewable resources by 2020 (up from 34% of renewable energy in 2009). Current estimates show that there is approximately 2.3 million tonnes of wood biomass available for energy production on an annual basis.[7]

[1] Although the figures differ, recent assessments suggest that 63% of the territory of BiH is covered in forests and other wooded land. FAO, The Forest Sector in Bosnia and Herzegovina. Preparation of IPARD Forest and Fisheries Sector Reviews in Bosnia and Herzegovina, FAO Regional Office for Europe and Central Asia, Budapest, January 2015.

[2] Ibid.

[3] Agency for Statistics of Bosnia and Herzegovina, Survey on Household Energy Consumption in BiH, 2015, Sarajevo, 2015.

[4] Energy Community Secretariat, Annual Implementation Report 2014/2015, Vienna, September 2015.

[5] Softić, Admir and Ljubo Glamočić, National background report on energy for Bosnia and Herzegovina, Prepared in the frame of the WBC-INCO.NET project on co-ordination of research policies with the Western Balkan countries, Sarajevo, March 2012.

[6] Decision 2012/03/MC-EnC on the implementation of Directive 2009/28/EC and amending Article 20 of the Energy Community Treaty.

[7] UNDP, Possibility of using biomass from forestry and wood industry in Bosnia and Herzegovina, UNDP Bosnia and Herzegovina, Sarajevo, October 2014.

This increase in the share of renewable energy in Bosnia and Herzegovina's energy mix together with the implementation of energy efficiency measures are also essential for meeting the country's climate change objectives laid out in its Climate Change Adaptation and Low Emission Development Strategy.[8,9] One of the objectives of the strategy for the period 2013-2025 is to phase out the use of fuel oil and coal for home and district heating and to replace them through energy efficiency gains and biomass, thermo solar and geothermal by 2020.

Renewable energy in BiH is managed at the sub-national level and falls within the competence of the entities (the Federation of Bosnia and Herzegovina and Republic of Srpska) and Brčko District. The parliaments of Republic of Srpska (RS) and the Federation of Bosnia and Herzegovina (FBiH) adopted two separate renewable energy laws in May 2013 and August 2013, respectively. Renewable energy action plans were adopted by both entities in 2014.[9] Yet there is still no comprehensive countrywide promotion or development of the renewable energy sector and the adoption of a national renewable energy action plan, as required by the Energy Community Treaty, is still pending.

Legal framework for renewable energy and energy efficiency

BiH is not fully compliant with the EU acquis in relation to energy efficiency. Republic of Srpska has advanced further in the transposition of the core directives and related implementation labelling regulations than the FBiH.[10] A similar trend exists in relation to the Energy Efficiency Action Plans (EEAP), where RS has adopted its EEAP and the FBiH has not. Moreover, there is a lack of transposition of energy efficiency laws in Brčko District and a state level EEAP is yet to be enacted. This all points to problematic coordination of legal measures targeted at energy efficiency between the entities and between the entities and the state level.

UNDP supporting BiH in developing modern biomass energy for heating

The United Nations Development Programme (UNDP) in Bosnia and Herzegovina has assisted BiH for several years in fostering the development of the wood biomass energy sector. Through a UNDP Global Environment Facility (GEF) project focused specifically on the removal of market barriers to the growth of modern biomass energy in the country, UNDP has raised awareness of the potential and advantages of biomass energy

[8] Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina (2013). Available from http://www.unfccc.ba/. See also BiH's Intended Nationally Determined Contribution under the UNFCCC (October 2015). Available from BiH's UNFCCC portal http://www.unfccc.ba/site/pages/dokumenti/dokumenti_izvjestaji.php.

[9] Energy Community Secretariat (2015).

[10] Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products; Directive 2010/31/EU on the energy performance of buildings; Directive 2006/32/EC of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.

among diverse stakeholders and helped to strengthen the sector through the creation of a national biomass association. UNDP has also piloted the switch from heating systems that run on fossil fuels to those that uses wood biomass in schools and public buildings through pilot projects. UNDP has subsequently replicated and mainstreamed this approach through its energy efficiency projects and as part of the reconstruction and rehabilitation of infrastructure in communities affected by the floods of 2014.

Study objective

Biomass energy is seen as having the potential to reduce greenhouse gas (GHG) emissions, contribute to rural development, create local jobs and increase energy security.[11] In light of the growing portfolio of biomass fuel switch projects [12] implemented by UNDP in BiH, this study aims to quantitatively assess the environmental and socioeconomic impact of these projects in terms of changes in GHG emissions, heating costs and thermal comfort as well as their contribution to the local economy.

Overview of the Portfolio of Biomass Fuel Switch Projects implemented by UNDP in Bosnia and Herzegovina

The study looks at biomass fuel switch projects implemented at the time of the study by UNDP in twenty-six facilities in twenty municipalities in Bosnia and Herzegovina (see Table 1 and Figure 1). These fuel switch projects were conducted jointly or with co-financing through four projects or programmes implemented by UNDP (as indicated in Table 1).

Biomass Energy for Employment and Energy Security Project (2009-2015)

The project, which cost 1.2 million USD, tackled barriers to the widespread and market based growth of modern biomass energy in BiH. It involved the implementation of biomass fuel switch pilot projects in primary schools and public utility buildings in the Srebrenica region, education and awareness raising activities and the provision of promotional and marketing support for the biomass energy sector in BiH. Project partners included the Ministry of Foreign Trade and Economic Relations of BiH (MOFTER), the Ministry of Education and Culture of Republic of Srpska (RS), the Ministry of Industry, Energy and Mining of RS, and the Ministry of Agriculture, Forestry and Water Management of RS. The Global Environment Facility (GEF) co-financed the project and the Ministry of Foreign Affairs of the Czech Republic worked in synergy with the UNDP-implemented

[11] See, for example, European Commission, Commission Staff Working Document, State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU (SWD(2014) 259 final). European Commission, Brussels, July 2014.

[12] Biomass fuel switch projects here refer to replacing heating systems running on fossil fuels (generally oil or coal) or grid electricity with heating systems that use solid wood fuels (wood pellets, wood briquettes or wood chips). The term biomass in the study refers only to wood biomass and not to other forms of biomass (agricultural residues, municipal waste, biogas, etc.).

Srebrenica Regional Recovery Programme, which is financed by the Government of the Netherlands.[13]

The MDG Achievement Fund and United Nations Joint Programme on Environment and Climate Change titled 'Mainstreaming Environmental Governance - Linking Local and National Action' (2009-2013)

The programme cost 5.5 million USD and was aimed at boosting local management of environmental resources and service delivery by improving environmental governance and developing replicable models for environmental planning. Interventions focused on the provision of capacity for developing Local Environmental Action Plans, seed funding for local service delivery priorities, raising awareness and national level support for environmental action through an environmental innovation fund and the creation of systems for capturing environmental data. The UNDP contribution focused on piloting energy efficiency measures in the public sector through the implementation of replicable energy efficiency projects and the introduction of an Energy Management Information System (EMIS) in public buildings. The Joint Programme thereby laid the foundations for the Green Economic Development Project. The FAO, UNDP, UNEP, UNESCO and UNV implemented the Joint Programme with funding provided by the Government of Spain. National partners included MOFTER, entity ministries, cantons, municipalities and civil society organisations.[14]

Green Economic Development Project (2013-2018)

The project, which costs 11.2 million USD, aims to reduce public expenditure on energy and water consumption. It targets increased energy efficiency, the use of renewable energy resources and the creation of a favourable environment for investment in energy efficiency measures and the generation of 'green' jobs. A key aspect of the project is the institutionalisation of energy management activities within public sector buildings, notably through the preparation of detailed energy audits and by enabling building managers to monitor energy consumption through an Energy Management Information System (EMIS). Another key aspect is the implementation of pilot projects on energy efficiency, including biomass fuel switch projects. The main project partners are the cantonal and entity governments, the sector ministries and the FBiH and RS environmental protection funds. The Swedish International Development Cooperation Agency (SIDA), UNDP and various levels of government in Bosnia and Herzegovina finance the project.[15]

[13] Project webpage: http://www.ba.undp.org/content/bosnia_and_herzegovina/en/home/operations/projects/environment_and_energy/bosnia_and_herzegovina_biomass_energy_for_employment_and_energy_security_project/.

[14] Joint Programme website: http://www.mdgfund.org/program/mainstreamingenvironmentalgovernancelinkinglocalandnationalactionbosniaandherzegovina.

[15] Project webpage: http://www.ba.undp.org/content/bosnia_and_herzegovina/en/home/operations/projects/environment_and_energy/zeleni-ekonomski-razvoj.html.

EU Floods Recovery Programme (2014-2016)

The programme cost 43.52 million euros and is aimed at assisting Bosnia and Herzegovina in recovering from the severe flooding that affected large parts of the country in May 2014. The programme consists of different components all of which aim to assist in the normalisation of peoples' lives in flood affected areas and communities in twenty-four of the most severely affected municipalities. Activities focus on the immediate restoration of the essential public sector infrastructure and the reinstatement of key public services, the emergency reconstruction of private dwellings for the most vulnerable and marginalised people, the revitalisation of the local economy and agricultural production and the rehabilitation of the communal infrastructure in selected municipalities. The programme is reconstructing heating systems in schools, healthcare centres and municipal buildings, including biomass fuel switch projects, as part of the 'build back better' principle. Project partners include the Delegation of the European Union to BiH, UNDP, UNICEF, IOM and the entity governments as well as selected municipalities and cities. The programme is financed by the European Union (42.24 million EUR) and UNDP (1.28 million EUR). [16]

There was insufficient data for this study to include other already implemented or planned UNDP biomass fuel switch projects in BiH. These include fuel switch projects in the building of the former health institute in Bihać (implemented - financed through the MDG-F Environment Programme), the cantonal hospital in Bihać (planned - funding through Czech Development Cooperation) and the municipal building in Posušje and the Zvijezda football club in Gradačac (both implemented – financed through the GED project).

[16] Programme website: http://www.ba.undp.org/content/bosnia_and_herzegovina/en/home/operations/projects/response_to_floods/eu_floods_recovery_programme.html.

NAME OF FACILITY	MUNICIPALITY	DATE OF FUEL SWITCH
BIOMASS ENERGY FOR EMPLOYMENT AND ENERGY SECURITY PROJECT		
"Branko Radičević" Primary School	*Bratunac*	*Sept. 2013.*
"Vuk Karadžić" Primary School	*Bratunac*	*Oct. 2014.*
Public Utility Company	*Milići*	*Oct. 2013.*
First Primary School	*Srebrenica*	*Oct. 2013.*
GREEN ECONOMIC DEVELOPMENT PROJECT		
Kindergarten	*Bosanska Krupa*	*Feb. 2014.*
"Ruđer Bošković" Primary School	*Grude*	*Feb. 2016.*
"Ivana Brlić Mažuranić" Primary School	*Ljubuški*	*Dec. 2015.*
Centre for Children with Special Needs "Los Rosales"	*Mostar*	*Nov. 2014.*
Croatian hospital "Dr. fra Mato Nikolić"	*Nova Bila*	*Jun. 2014.*
"Ante Brune Bušića" Primary School in Rakitno	*Posušje*	*Dec. 2015.*
"Aleksa Šantić" Primary School in Novi Grad	*Sarajevo*	*Feb. 2015.*
First Primary School	*Široki Brijeg*	*Dec. 2015.*
Social and healthcare centre	*Stolac*	*Nov. 2015.*
Kindergarten "Naša radost" in Trebinje	*Trebinje*	*Sept. 2015.*
Healthcare Centre in Velika Kladuša	*Velika Kladuša*	*Nov. 2015.*
BIOMASS ENERGY FOR EMPLOYMENT AND ENERGY SECURITY PROJECT / GREEN ECONOMIC DEVELOPMENT PROJECT		
Cantonal hospital and health centre "Dr. Isak Samokovlija"	*Goražde*	*Oct. 2015.*
EU FLOODS RECOVERY PROGRAMME		
Primary School	*Maglaj*	*Sept. 2014.*
Municipal building	*Maglaj*	*Jan. 2015.*
EU FLOODS RECOVERY PROGRAMME / GREEN ECONOMIC DEVELOPMENT PROJECT (CO-FINANCING)		
First Primary School	*Maglaj*	*Oct. 2014.*
Healthcare centre	*Maglaj*	*Sept. 2014.*
The Mixed Secondary School and the "Edhem Mulabdić" Secondary School	*Maglaj*	*Summer 2014.*
"Borisav Stanković" Primary School [17]	*Banja Luka*	*Jan. 2015.*
The Second Primary School and the General Secondary School [17]	*Bosanska Krupa*	*Dec. 2014.*
MDG ACHIEVEMENT FUND, UN JOINT PROGRAMME ENVIRONMENT AND CLIMATE CHANGE		
Culture Centre Complex (Culture Centre, Una-Sana Canton Museum, Art School, Institute for the Protection of Cultural Heritage and the St. Josip Library)	*Bihać*	*Feb. 2012.*
Municipal building	*Cazin*	*Oct. 2012.*
Kindergarten "Lepa Radić"	*Gradiška*	*Oct. 2011.*

TABLE 1 Facilities in BiH that benefitted from the biomass fuel switch projects implemented by UNDP and considered in this study.

[17] For these facilities, additional energy efficiency measures funded through the Green Economic Development (GED) project were planned but had not been implemented at the time of data collection. Hence, their effects on energy consumption are not reflected in the data.

The facilities that benefited from biomass fuel switch projects were mostly schools and kindergartens (65%), followed by healthcare facilities (19%), municipal buildings and local utilities (12%), and one multi-purpose facility (see Figure 2).

FIGURE 1 Map of fuel switch projects implemented by UNDP in BiH and considered in the study.
Map data (©2016) GeoBasis-DE/BKG (©2009), Google. Interactive map available from https://www.google.com/maps/d/edit?mid=zW5O4fwYzwzs.kJil5f0S7uTo&usp=sharing.

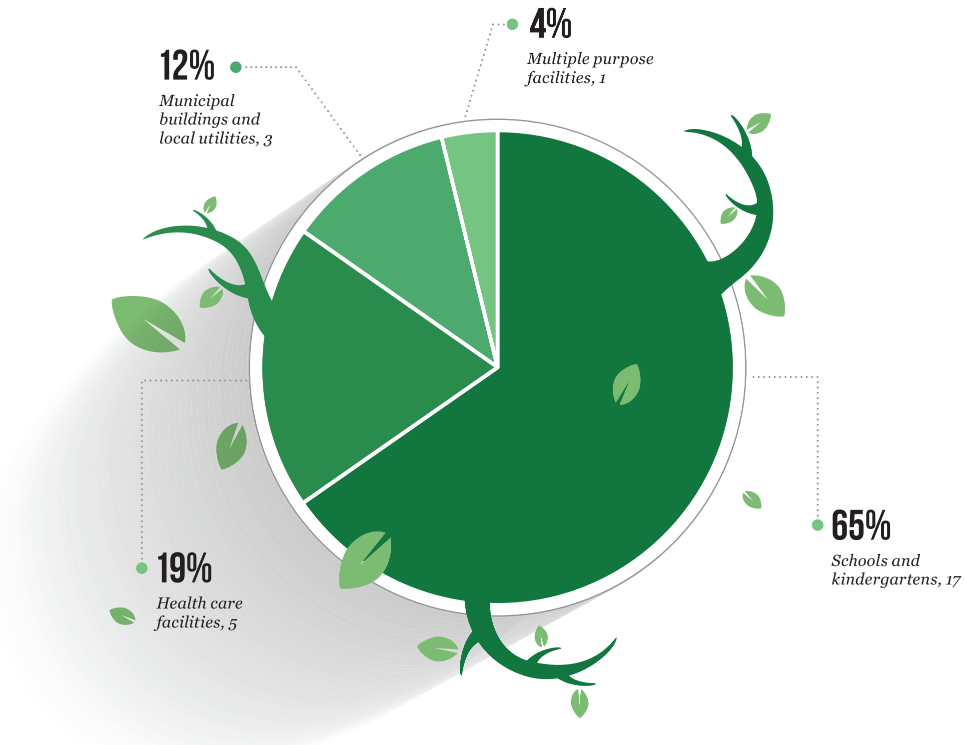

FIGURE 2 Number of facilities benefitting from biomass fuel switch projects according to the type of facility.

02 METHODOLOGY

Scope of the Study

The study analysed the information available for twenty-six biomass fuel switch projects implemented by UNDP in Bosnia and Herzegovina (BiH) between 2011 and February 2016.

Data Collection

Data was collected through a user-managed energy management information platform or EMIS (Energy Management Information System).[18] Field visits were conducted at seventeen facilities between August and September 2015 and desk research included detailed energy audits, project documents and telephone and e-mail communications. Location data (coordinates) was obtained via the mobile collection application EpiCollect[19] for those facilities visited or taken from online mapping tools.

[18] EMIS is a web-based platform that allows users to measure and monitor energy and water consumption and costs. Of the facilities considered in the study 22 of the 26 used EMIS at the time of data collection.

[19] EpiCollect. Available from http://www.epicollect.net/.

Baseline Scenario

Based on discussions with building managers, the baseline scenario assumed the continued use of the fossil fuel powered boilers or electric heating in place in the facilities before the fuel switch projects; it also assumed continued under-heating due to the generally high cost of heating and insufficient public funding allocated for that purpose. There was a low probability of the existing boilers being replaced with new more efficient fossil fuel powered boilers in the foreseeable future; it was also very unlikely that the existing boilers would have been replaced with biomass boilers in the absence of the individual projects.

GHG Emissions Calculation Methodology

The study only calculated direct emission reductions resulting from the individual fuel switch projects and not the consequential indirect emission reductions caused by the broader replication of the project outcomes or behavioural changes. Figure 3 shows the causal chain of greenhouse gas (GHG) effects resulting from the fuel switch projects and highlights the effects taken into consideration in the study. The main greenhouse gas effect relates to the change in the type of fuel used for heating (i.e. from fossil fuels or grid electricity to wood biomass). Other effects on greenhouse gas emissions include, for example, those associated with manufacturing and transporting new boilers or with processing and transporting final biomass energy products (e.g. wood pellets). An estimate of how likely it was that these effects would take place (likelihood) and how large these effects could be (magnitude) was used to determine which effects to study.

The Change in GHG Emissions from Fuel Combustion before and after the Fuel Switch

For those facilities where consumption data was available, annual carbon dioxide emissions prior to the fuel switch were calculated based on the average annual quantity of fuel purchased multiplied by an emission factor for the given fuel type (see Box 1).

The average annual quantity of fuel purchased was calculated based on the available historic consumption data where representative of a full year or heating season.

Annual CO2 emissions BFS facility = average annual fuel consumption * emission factor

Where the average annual fuel consumption equates to the annual purchase of fuel

BFS: before the fuel switch

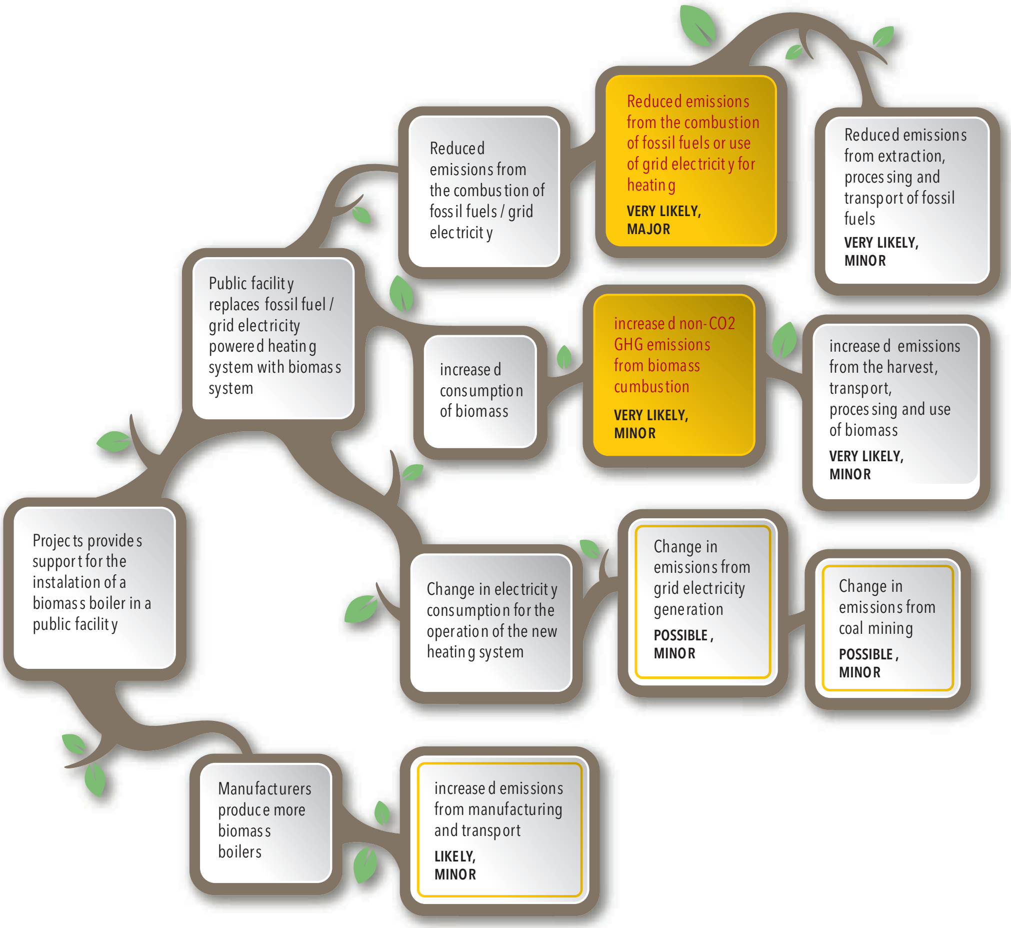

FIGURE 3 Causal chain highlighting greenhouse gas (GHG) effects (orange outline) with (in italics) the estimated likelihood and magnitude of the effect. Boxes with solid orange fill show GHG effects calculated in the study.

The change in annual greenhouse gas emissions before and after the fuel switch was calculated as shown below.

Change in annual GHG emissions = non-CO2 GHG emissions AFS - CO2 emissions BFS

AFS: after the fuel switch; BFS: before the fuel switch

Biogenic carbon dioxide emissions (CO2 emissions from biomass) from heat production were not taken into consideration because the combustion of biomass, assuming that the overall forest carbon stock is maintained, is considered to be carbon neutral, releasing the CO_2 absorbed during plant growth.[20] Non-CO_2 greenhouse gas emissions (CH_4, N_2O) from the direct combustion of biomass were, however, accounted for on the basis of 0,25gCO_2eq/MJ wood pellets.[21,22]

BOX 1 Emission factors.

The CO_2 emission factors retained were those used in the Energy Management Information System (EMIS) programme that is in use in BiH. Despite differences in fuel type categorisation, the values used in the study are within the range of the IPCC default values for CO_2 emission factors. There are large variations in the quality of coal in BiH between different coal basins[1] and between mines within the same coal basin.[1] As specific emission factors for coal from different basins and mines in BiH were not available, average values were used.

EMISSION FACTORS USED IN THE EMIS PROGRAMME		
FUEL TYPE	EMISSION FACTOR PER PURCHASING UNIT	EMISSION FACTOR PER MWH
Extra light fuel oil	*0.002689 tCO2/L*	*0.264 tCO2/MWh*
Light fuel oil	*0.002693 tCO2/L*	*0.280 tCO2/MWh*
Brown coal	*1.695305 tCO2/t*	*0.339 tCO2/MWh*
Coal	*2.906337 tCO2/t*	*0.357 tCO2/MWh*
Grid electricity	*0.000745 tCO2/kWh*	*0.745 tCO2/MWh*

IPCC REFERENCE VALUES[2]	
FUEL TYPE	DEFAULT VALUES FOR CO_2 EMISSION FACTORS
Gas/diesel oil	*0.267 tCO2/MWh*
Residual fuel oil	*0.2786 tCO2/MWh*
Brown coal briquettes	*0.351 tCO2/MWh*
Lignite	*0.364 tCO2/MWh*

[1] Smajevic, Izet, Hodzic Nihad and Kazagic Anes (2014). Lab-scale Investigation of Middle-Bosnia Coals to Achieve High-efficient and Clean Combustion Technology. Thermal Science, 18:3, pages 875-888.

[20] It should be noted that while the study follows the common practice of assuming that all CO_2 emitted as a result of biomass combustion is carbon neutral, there is scientific debate on the validity of the carbon neutrality assumption, because net atmospheric contributions of biogenic CO_2 emissions can vary significantly dependent on the bioenergy pathway and on the timescale considered (see, for example, Matthews, Robert, Laura Sokka, Sampo Soimakallio, Nigel Mortimer, Jeremy Rix, Mart-Jan Schelhaas, Tom Jenkins, Geoff Hogan, Ewan Mackie, Allison Morris and Tim Randle, Review of literature on biogenic carbon and life cycle assessment of forest bioenergy. Final Task 1 report, EU DG ENER project ENER/C1/427, 'Carbon impacts of biomass consumed in the EU'. Forest Research, Farnham, May 2014).

[21] On the basis of 0.003 gCH_4/MJwood pellets and 0.0006 gN_2O/MJwood pellets (Giuntoli, Jacopo, Alessandro Agostini, Robert Edwards and Luisa Marelli (2015). Solid and gaseous bioenergy pathways: input values and GHG emissions. European Commission, Joint Research Centre, Institute for Energy and Transport. Report EUR 27215 EN, table 85).

[22] Due to the unavailability of specific data for wood briquettes, the values for wood pellets was also used for wood briquettes.

In order to reduce the level of uncertainty in the estimates, non-CO_2 greenhouse gas emissions from the combustion of fossil fuels were not taken into account. This is because these emissions depend on several factors, including the technology and maintenance procedures for which specific data was not available.[23]

The values from existing studies were used for those facilities where sufficient data to calculate GHG emissions was not available (three cases).

Other Greenhouse Gas effects

Upstream supply emissions[24] for both fossil fuels and biomass were not taken into consideration due to time and resource constraints. For biomass, these upstream supply emissions are likely to be quite limited due to the local sourcing of biomass, short transport distances and partial use of biomass waste as raw material for the production of pellets and briquettes.

Changes in demand for electricity between the old and the new heating systems (whether higher[25] or lower[26] than the baseline) were estimated to result in small changes in overall GHG emissions relative to the effects of fuel combustion and were hence not taken into consideration.

GHG emissions resulting from the manufacture and transport of the biomass boilers were deemed minor over the lifetime of the equipment and were therefore excluded from the study.

Change in Heating Costs

The change in heating costs was calculated for each facility on an annual basis. Where possible, this was based on real multi-year average costs for fuel prior to the fuel switch and on real biomass costs since the fuel switch.

Change in average annual cost of heating facility = average annual cost of heating AFS – average annual cost of heating BFS

Where average annual cost of heating = average annual quantity of fuel consumed * average annual cost of fuel per unit

AFS: after the fuel switch; **BFS**: before the fuel switch.

[23] In line with IPCC guidance on this point. See IPCC, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2, Chap. 1, pp 1-6.

[24] Emissions from the full lifecycle of the fuels from the extraction of fossil fuels or growth of biomass to the final use of the energy carrier at the point of stationary combustion.

[25] For example, in the case where more electricity is required to run the biomass boiler relative to the previous boiler.

[26] For example, in the case where more efficient circulator pumps were replaced during the fuel switch.

Data on the average annual heating costs before the fuel switch were drawn from field visits or information provided by the managers of the facilities, from EMIS or from energy audits. Three facilities did not have data on real heating costs before the fuel switch and therefore figures from existing studies were used (energy audits and/or project final evaluations).

For those facilities that did not have biomass consumption and cost data for a full heating season, the average annual heating costs after the fuel switch were taken either from the estimates of building managers, from the projections contained in energy audits or calculated using data on the average annual heating energy needs provided in the audits.[27]

Maintenance Costs

The absence of data on the maintenance costs of the heating systems before and after the fuel switch meant that they were not taken into consideration.

Gain in Thermal Comfort

The gain in thermal comfort was calculated as the change in indoor temperature before and after the fuel switch, as reported by the managers of the facilities.

Contribution to the Local Economy and Support to the Domestic Biomass Energy Sector

Local Sourcing of Biomass Boilers and Wood Biomass for Energy

Field visits or project documentation and communication with the managers of the facilities provided data on the sourcing of biomass energy carriers and biomass boilers.

Support to Local Employment

The direct impact that the fuel switch projects had on employment generation was estimated on the basis of employment generated through the manufacture of biomass boilers, the installation of biomass heating systems and pellet and briquette production. There were no estimates on upstream employment generation in the forestry sector because of time and data availability constraints. The biomass boiler manufacturers, boiler installers and wood biomass producers in BiH who provided goods and services to the facilities visited supplied data through telephone or e-mail.

Employment generation was calculated based on the average work effort required in the production of goods and services per unit. In order to obtain a comparable metric, the raw data provided by the biomass sector businesses contacted was harmonised into person-hours.

[27] To convert heating needs to the required amount of the biomass energy carrier, a lower heating value (LHV) with 10 per cent moisture content for pellets of 16,9MJ/kgpellets was used (Giuntoli et al. 2015, table A.3.).

The impact that boiler manufacture and installation had on employment generation was calculated on a one-off basis, as shown below:

Employment from boiler manufacturing = number of domestic boilers purchased * average person-hours per boiler produced

Employment from boiler installation = number of boilers purchased * average person-hours per boiler installation

The impact that the biomass energy fuel switch projects had on employment generation was calculated on an annual basis for pellet and briquette production in the manner shown below.

Where specific data on working hours was unavailable, an average working day of eight hours[28] and a forty hour working week formed the basis for any assumptions.[29]

Annual employment from pellet and briquette production = amount of pellets/briquettes purchased per year (in tonnes) * average person-hours per tonne of pellets/briquettes produced

03 RESULTS AND DISCUSSION

3.1 TYPE OF FUEL SWITCH PROJECTS

Over three-quarters of the considered facilities switched from heating oil to wood biomass

Of the facilities considered, the majority of fuel switch projects consisted of a change from heating systems run on heating oil to systems run on wood pellets (see Figure 4). Over three-quarters of projects involved a switch from heating oil to wood biomass in general (pellets, briquettes or firewood). The remaining fuel switch projects involved the replacement of heating based on electricity, coal and firewood, or coal and electricity with heating from biomass.

[28] In line with the data provided by other businesses that were contacted.

[29] In line with the labour laws of the FBiH (Zakon o radu FBiH No. 01-02-639-02/15, Sarajevo 6 August 2015) and of Republic of Srpska (Zakon o radu RS No. 02/3- 951/07, Banja Luka, 30 May 2007).

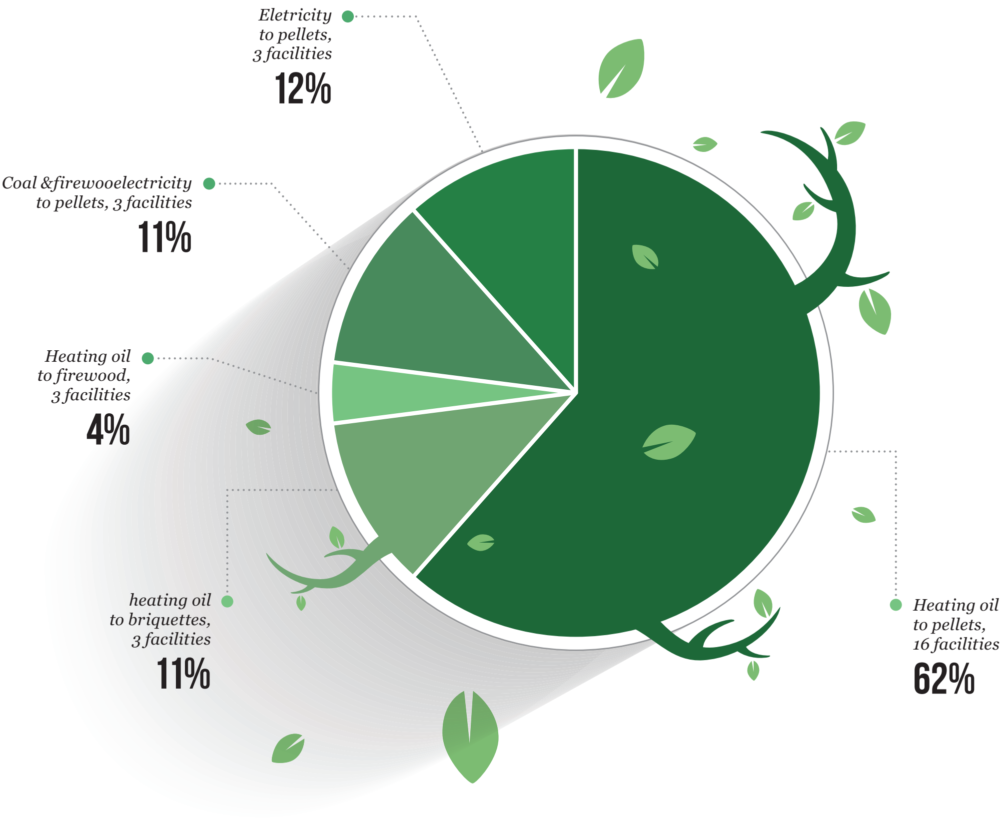

FIGURE 4 Type of fuel switch projects.

3.2 INSTALLED BIOMASS ENERGY CAPACITY

The new biomass heating systems represent an aggregate installed capacity of 11.2 MW

The total installed capacity of the biomass heating systems across the twenty-six facilities was of 11.2 MW. The average installed capacity of the heating systems was 431 kW, with a range of 35 kW to 1000 kW (see Table 2). While the installed capacity generally increases with the heated area of the facility, depending on the energy efficiency characteristics of the facilities, a given installed capacity can be sufficient for a range of areas.

INSTALLED CAPACITY IN KW RANGE OF VALUES (AVERAGE)	HEATED AREA OF FACILITY IN m^2 RANGE OF VALUES (AVERAGE)	NUMBER OF FACILITIES IN THE RANGE
35-200 (131)	*315-2.408 (1.227)*	*8*
300-698 (475)	*1.643-4.085 (2.815)*	*14*
800-1.000 (875)	*5.040-9.300 (6.506)*	*4*
Full range: 35-1.000 (431)	*315-9.300 (2.894)*	*26*

TABLE 2 Installed capacity and the heated area of the facilities.

3.3 CHANGE IN DIRECT HEATING RELATED GREENHOUSE GAS EMISSIONS

Direct heating related greenhouse gas emissions were reduced by approximately 2,173 tCO2eq per year.

The average annual fuel consumption for heating and associated greenhouse gas emissions before and after the fuel switch are presented in Table 3 (per facility) and in Figure 5 (per project). The figures are based on real or estimated consumption data for all but three of the facilities, those for which consumption data prior to the fuel switch was not available.[30] The fuel switch projects directly reduced greenhouse gas (GHG) emissions from heating by around 2,173 tCO2eq per year. This is equivalent to the annual emissions of approximately 395 cars.[31]

[30] Annual GHG emissions for the Culture Centre Complex in Bihać were taken from the final evaluation of the project under which the fuel switch was conducted (Aigner, Dietmar 2013). Final evaluation of the Millennium Development Goal Achievement Fund. Programme title: Mainstreaming Environmental Governance – Linking local and national action. Bosnia and Herzegovina, Thematic window: Environment and Climate Change. Final evaluation report, May 2013. For the First Primary School in Široki Brijeg and the Kindergarten 'Naša radost' in Trebinje values were taken from detailed energy audits.

[31] Based on annual emissions for a typical passenger vehicle of 5.5 tCO2eq (United States Environmental Protection Agency, Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle. EPA420-F-05-004, February 2005).

TABLE 3 >

BFS *before fuel switch*
AFS *after fuel switch*
GHG *greenhouse gas*
NA *not available*
ELFO *extra light fuel oil*
LFO *light fuel oil* * *unspecified density*
ELEC. *electricity*
B.COAL *brown coal*

** Facilities using electricity for heating. Emissions relate to the emissions generated through the production of electricity, calculated on the basis of an emission factor for grid electricity.

[1] Value taken from project final evaluation

[2] Value taken from energy audit

TABLE 3 Fuel consumption for heating and associated GHG emissions before and after the fuel switch, per facility.

FACILITY	TYPE OF FUE BFS	AVERAGE ANNUAL FUEL CONSUMPTION BFS	ANNUAL GHG EMISSION FROM COMBUSTION BFS (tCO_2)**	TYPE OF FUEL AFS	AVERAGE ANNUAL FUEL CONSUMPTION AFS (t)	ANNUAL NON-CO_2 GHG EMISSIONS FROM COMBUSTION AFS (tCO_2EQ)	ANNUAL REDUCTION IN GHG EMISSIONS FROM COMBUSTION (tCO_2EQ)
Cantonal hospital, Goražde	*b.coal elec.*	*185,8 t 10228 kWh*	*322,6*	*pellet*	*53,6*	*0,2*	*322,4*
Centre 'Los Rosales', Mostar	*ELFO*	*4650 L*	*12,5*	*pellet*	*23,3*	*0,1*	*12,4*
Culture Centre Complex, Bihać	*elec.*	*NA*	*114,0*	*pellet*	*49,0*	*0,2*	*113,8*[1]
First Primary School, Maglaj	*LFO*	*22000 L*	*59,1*	*pellet*	*65,0*	*0,3*	*58,9*
First Primary School, Široki Brijeg	*ELFO*	*NA*	*NA*	*pellet*	*59,8*	*0,3*	*97,0*[2]
First Primary School, Srebrenica	*ELFO*	*20433 L*	*55,0*	*briquette*	*70,0*	*0,3*	*54,7*
Healthcare centre, Maglaj	*LFO*	*25333 L*	*68,1*	*pellet*	*88,4*	*0,4*	*67,7*
Healthcare centre, Velika Kladuša	*LFO*	*30515 L*	*82,0*	*pellet*	*97,0*	*0,4*	*81,6*
Hospital 'Dr. F. Mato Nikolić', Nova Bila	*LFO*	*115857 L*	*311,5*	*pellet*	*360,0*	*1,5*	*310,0*
Kindergarten 'Lepa Radić', Gradiška	*b.coal*	*15 t*	*34,5*	*pellet*	*26,3*	*0,1*	*34,4*
Kindergarten 'Naša radost', Trebinje	*elec.*	*NA*	*NA*	*pellet*	*5,0*	*0,0*	*15,0*[2]
Kindergarten, Bosanska Krupa	*LFO*	*7513 L*	*20,2*	*pellet*	*17,0*	*0,1*	*20,1*
Municipal building, Cazin	*ELFO*	*31284 L*	*84,3*	*pellet*	*52,5*	*0,2*	*84,0*
Municipal building, Maglaj	*LFO*	*15768 L*	*42,4*	*pellet*	*58,5*	*0,2*	*42,1*
'A. B. Bušića' Primary School, Rakitno, Posušje	*ELFO*	*19500 L*	*52,5*	*firewood*	*48,8 m^3*	*0,2*	*52,3*
'A. Šantić' Primary School, Sarajevo	*EFO*	*29051 L*	*78,2*	*pellet*	*75,6*	*0,3*	*77,9*
'B. Stanković' Primary School, Banja Luka	*oil**	*24500 L*	*65,9*	*pellet*	*70,0*	*0,3*	*65,6*
'I. B. Mažuranić' Primary School, Ljubuški	*ELFO*	*12410 L*	*33,4*	*pellet*	*27,2*	*0,1*	*33,3*
'R. Bošković' Primary School, Grude	*ELFO*	*15597 L*	*42,0*	*pellet*	*20,7*	*0,1*	*41,9*
'B. Radičević' Primary School, Bratunac	*ELFO*	*25000 L*	*67,3*	*briquette*	*70,0*	*0,3*	*67,0*
'V. Karadžić' Primary School, Bratunac	*ELFO*	*14942 L*	*40,2*	*briquette*	*41,6*	*0,2*	*40,1*
Primary School, Maglaj	*b.coal*	*83.5 t*	*141,6*	*pellet*	*100,0*	*0,4*	*141,1*
Public Utility Company, Milići	*elec.*	*120140 kWh*	*89,5*	*pellet*	*9,0*	*0,0*	*89,4*
Sec. Prim. School & General Sec. School, Bosanska Krupa	*LFO*	*23474 L*	*63,1*	*pellet*	*82,5*	*0,3*	*62,8*
Secondary School Centre, Maglaj	*LFO*	*50000 L*	*134,4*	*pellet*	*140,0*	*0,6*	*133,8*
Social and Healthcare Centre, Stolac	*LFO*	*20000 L*	*53,8*	*pellet*	*65,4*	*0,3*	*53,5*
Total							***2.172,9***

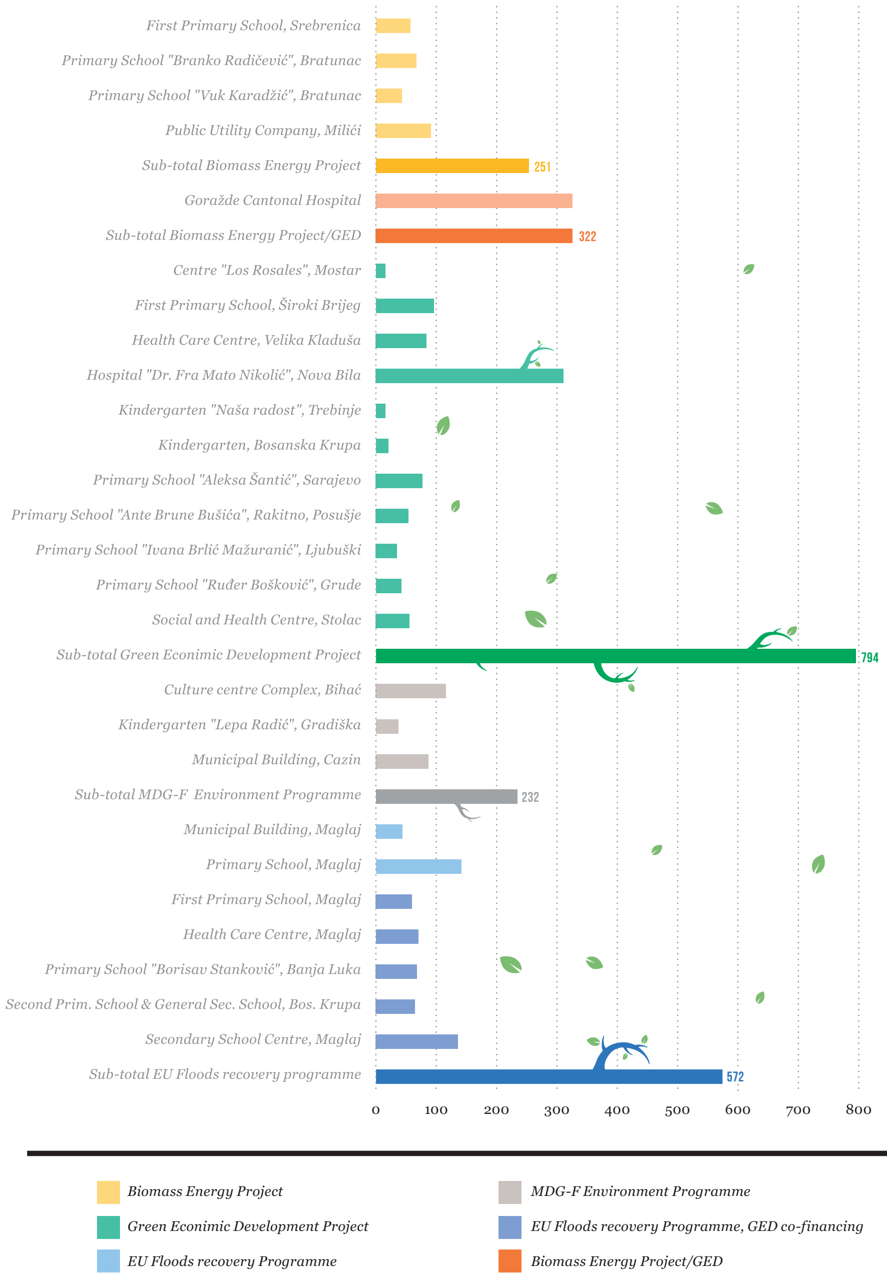

FIGURE 5 Annual reduction in GHG emissions per project (tCO2eq).

SUCCESS STORY

NEW BRIQUETTE BOILERS FOR THE FIRST PRIMARY SCHOOL IN SREBRENICA

Project: Biomass Energy for Employment and Energy Security

Project partners: Global Environment Facility, the Embassy of the Netherlands in BiH, Czech Development Cooperation and UNDP

The facilities of the First Primary School in Srebrenica, built in 1975, were severely under-heated, making the winter months difficult for pupils and teachers in Srebrenica's cold winter climate. The Biomass Energy for Employment and Energy Security project enabled the school to benefit from a full energy efficiency retrofit in 2013 with the fitting of new windows and doors, the insulation of the façade and the renovation of the roof. The old oil fired boiler used for heating was replaced by two modern biomass boilers that run on locally produced wood briquettes. The school and the Municipality of Srebrenica also renovated the heating pipes.
The fuel switch and energy efficiency measures reduced heating costs by 36 per cent while increasing the indoor temperature in winter from 12-13 degrees Celsius to 18-20 degrees Celsius. The savings of 12,000 BAM per year are now used by the school to purchase more biomass briquettes and other school supplies and to pay bills.

3.4 CHANGE IN HEATING COSTS

Heating costs are reduced by 54 per cent on average, while aggregate savings on heating costs amount to close to 850,000 BAM per year.

The change in heating costs, based on average annual fuel purchases before and after the fuel switch projects, showed an average reduction of 54 per cent, while aggregate savings on heating costs across the twenty-six facilities amounts to 849,522 BAM annually (see Table 4 and Figure 6), while achieving significantly greater thermal comfort (see section 3.5). The calculated cost savings can be attributed to the projects

TABLE 4 Annual heating costs before and after the implemented fuel switch projects

FACILITY	AVERAGE ANNUAL HEATING COSTS BFS (IN BAM)	AVERAGE ANNUAL HEATING COSTS AFS (IN BAM)	ANNUAL SAVING (IN BAM)	PERCENTAGE DECREASE IN HEATING COSTS
'Los Rosales' Centre, Mostar	*9803*	*6531*	*3272*	*33%*
Culture Centre Complex, Bihać [1]	*NA*	*18620*	*164963*	*70%*
First Primary School, Maglaj	*54054*	*19175*	*34879*	*65%*
First Primary School, Srebrenica	*33000*	*21000*	*12000*	*36%*
Healthcare centre, Maglaj	*49767*	*30000*	*19767*	*40%*
Hospital 'Dr. Fra Mato Nikolić', Nova Bila	*254908*	*123327*	*131581*	*52%*
Kindergarten 'Lepa Radić', Gradiška	*18342*	*11894*	*6448*	*35%*
Kindergarten, Bosanska Krupa	*15963*	*6456*	*9507*	*60%*
Municipal building, Cazin	*66574*	*19357*	*47217*	*71%*
Municipal building, Maglaj	*37701*	*17535*	*20166*	*53%*
'B. Stanković' Primary School, Banja Luka	*49000*	*24500*	*24500*	*50%*
'B. Radičević' Primary School, Bratunac	*50000*	*16800*	*33200*	*66%*
'V. Karadžić' Primary School, Bratunac	*26000*	*9529*	*16471*	*63%*
Primary School, Maglaj	*22664*	*30000*	*-7336*	*-32%*
Public Utility Company, Milići	*9731*	*2843*	*6888*	*71%*
Sec. Primary School & General Sec. School, Bosanska Krupa	*46565*	*25598*	*20967*	*45%*
Secondary School Centre, Maglaj	*137475*	*43196*	*94279*	*69%*
Cantonal hospital, Goražde	*36718*	*16340*	*20378*	*55%*
First Primary School, Široki Brijeg [2]	*NA*	*19131*	*15477*	*NA*
Healthcare centre, Velika Kladuša	*60604*	*26190*	*34414*	*57%*
'A. B. Bušića' Primary School, Rakitno, Posušje	*40950*	*4878*	*36072*	*88%*
'A. Šantić' Primary School, Sarajevo	*60270*	*23079*	*37191*	*62%*
'I. Brlić Mažuranić' Primary School, Ljubuški	*25887*	*9553*	*16334*	*63%*
'R. Bošković' Primary School, Grude	*33118*	*7252*	*25865*	*78%*
Social and Healthcare Centre, Stolac	*42000*	*19620*	*22380*	*53%*
Kindergarten 'Naša radost', Trebinje2	*NA*	*1375*	*2643*	*NA*
Total savings (aggregate)			***849 522***	
Average decrease in heating costs				***54%***

BFS *before fuel switch*
AFS *after fuel switch*
KM *Bosnia and Herzegovina Convertible Mark*
NA *not available*

[1] Annual savings are taken from the final evaluation of the project under which the fuel switch was conducted (see Aigner 2013).

[2] Annual savings are taken from the projections in the detailed energy audits.

as a whole. In addition to changing the heating system, energy efficiency measures, such as replacing windows and doors or fitting façade and roof insulation, were implemented in more than 70 per cent of the facilities. The effects of energy efficiency measures implemented since the field visits in two facilities (the Second Primary School and the General Secondary School in Bosanska Krupa and the 'B. Stanković' Primary School in Banja Luka) are not reflected in the data, but will further reduce heating costs in the future.

The high variation in the change in heating costs as a result of the fuel switch projects, ranging from a 32 per cent increase to a 88 per cent reduction in heating costs, can be explained by several factors. These include the extent of the change in indoor temperature before and after the fuel switch, the type of fuel that was replaced and the extent of the energy efficiency measures implemented at the same time as the fuel switch project.

The facilities varied considerably in terms of the degree of under-heating prior to the fuel switch and the level of thermal comfort attained after the fuel switch. The cost of wood biomass energy relative to the type of fuel or fuels used before the switch was frequently lower and the greater efficiency of the new heating systems installed enabled facilities to attain greater thermal comfort. The type of fuel used for heating prior to the fuel switch is also a key factor, given the high level of variability in the average cost per kilowatt-hour observed in the cost data for the twenty-six facilities (see Figure 7) for heating with different types of fuel.

The cost comparison on a per kilowatt-hour basis shows that fuel oil is three times more expensive and electricity almost twice as expensive as wood pellets. Brown coal and firewood stand as the cheapest energy sources when considered on a per kilowatt-hour basis for primary energy, with wood pellets being 75 per cent more expensive than brown coal. Energy efficiency measures implemented at the time of the fuel switch are also an important factor in determining the magnitude of the cost savings as they considerably reduce primary energy needs and hence reduce the cost of heating. The cost profile of coal underscores the importance of the simultaneous implementation of wide ranging energy efficiency measures in order to gain net savings in heating costs.

The cost of wood biomass also varied considerably across the facilities for which real cost data was available. Data for fourteen facilities showed prices ranging from 280 BAM to 422 BAM per tonne with an average price of 337 BAM and a median price of 328 BAM, including 17 per cent value added tax (see Figure 8).
The unit price of briquettes paid by the three facilities in our

sample using briquettes ranged from 229 BAM to 300 BAM per tonne, with an average price of 256 BAM per tonne.

The main factor put forward by building managers during the field visits to explain the variation in prices was the time of year at which biomass was purchased, with wood biomass prices tending to rise in the winter when demand is higher and fall in the summer when demand is lower. Some facilities with greater budgetary flexibility are able to use the price variation to purchase biomass when prices are lower, whereas others have supply contracts with a fixed price. Differences in the quality of the energy carrier and the size of the biomass production facilities can also partly explain the variation in prices, yet an analysis of these factors was beyond the scope of this study.

Durable changes that occur in the price of grid electricity, coal and in particular oil (oil being subject to the greatest price volatility) in BiH as well as price changes of the biomass energy carriers can alter the magnitude of savings achieved by switching fuel. Future environmental policy instruments, such as carbon taxes applied to carbon-based fuels, could increase the cost attractiveness of biomass energy by increasing the cost of its fossil fuel alternatives. The results of this study can be updated in the future with the incorporation of additional data covering several heating seasons after the fuel switch in order to better account for inter-annual climatic variability (e.g. unusually cold or mild winters) that affect heating needs and hence heating costs.

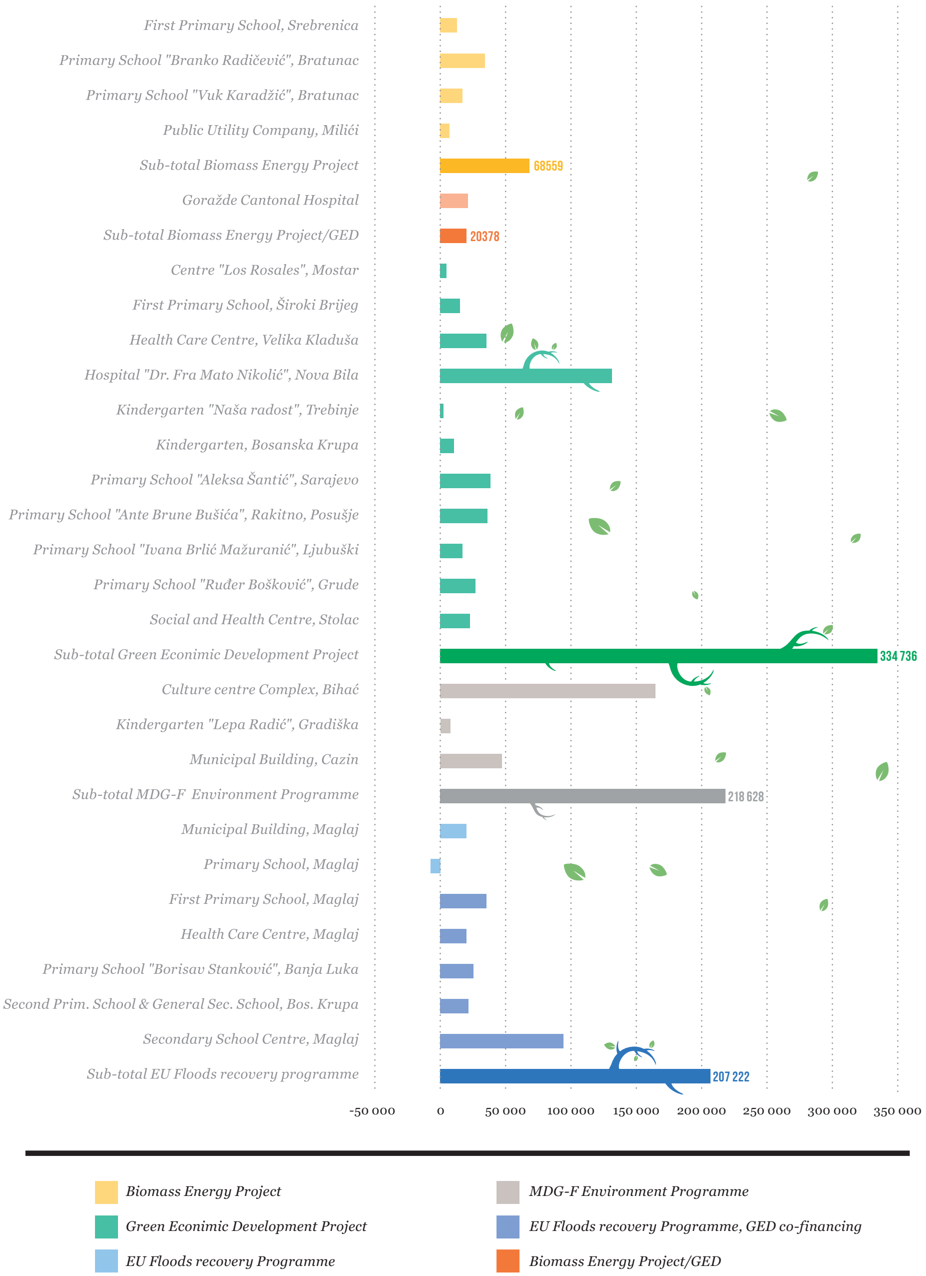

FIGURE 6 Annual savings from reduced heating costs, per project (in BAM).

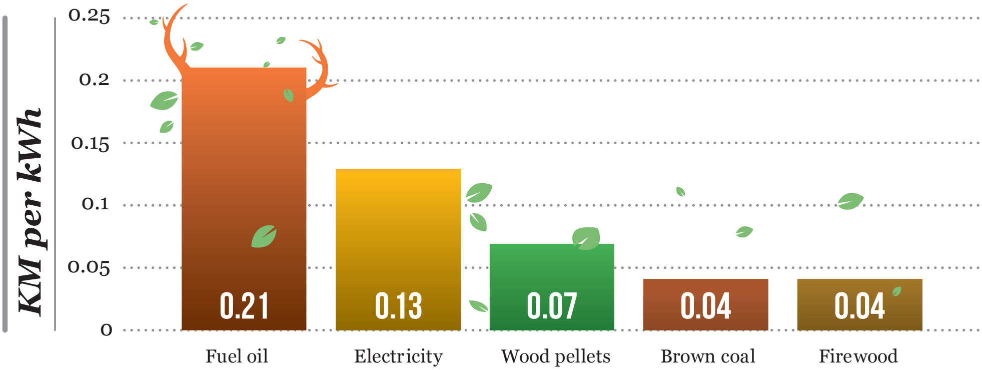

FIGURE 7 Cost of primary energy per kWh for different fuel types (in BAM).

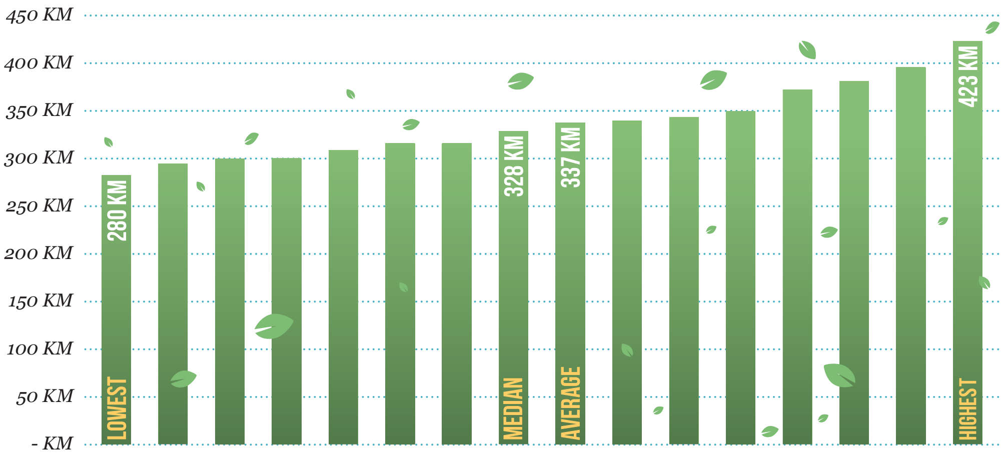

FIGURE 8 Price of pellets per tonne, recorded by 14 facilities (in BAM, 17% VAT inclusive).

Simple Payback Period

Through the above data on savings on heating costs and costs related to the fuel switch and energy efficiency measures for eighteen facilities[32] the basis for the average simple payback period is 8.6 years, with a range of 1.3 to 19.3 years. However, this data does not reflect the gains in thermal comfort (i.e. savings on heating costs do not account for the change in the level of heating before and after the fuel switch). The different types of fuel used before the change in heating systems as well as higher civil engineering investment costs incurred by some of the facilities (e.g. the construction of a storage room for wood biomass) partly explains the variability in the simple payback period.

[32] The specific energy related investment costs were unavailable for eight facilities where the fuel switch and energy efficiency measures were part of broader reconstruction or renovation projects for which the detailed cost breakdown of works was not available at the time of the study.

SUCCESS STORY

A WARM, WELCOMING AND ENERGY EFFICIENT KINDERGARTEN IN BOSANSKA KRUPA

Project: Green Economic Development (GED)

Project partners: Fund for Environmental Protection of the FBiH, the Ministry for Construction, Spatial Planning and Environmental Protection of the Una-Sana Canton, the Municipality of Bosanska Krupa, PLOD Centre Bihać and EKUS Bihać UNDP

Before the change of heating system only half of the facility's surface was heated, as the required heating oil was expensive and the doors, windows and facade were in poor condition. Although some of the rooms were heated, the kindergarten was still uncomfortable and cold and many parents did not want to send their children there. Through the Green Economic Development project, run in close cooperation with the European Union financed Strengthening Local Democracy project (LOD), and implemented by UNDP the heating system was changed. It now runs on wood pellets, the façade and part of the roof have been reconstructed and the windows and doors changed. The kindergarten has become a warm and welcoming place for children: attendance increased from 70 to 120 after the renovations and the energy efficiency retrofit.

The subsequent savings of over 8,000 BAM per year have enabled the kindergarten to invest in a changing room for the teachers and guests, a kitchen, terraces, walking trails, new flooring and carpets and new didactic equipment. The current focus is on adapting the kindergarten infrastructure to meet the needs of children with disabilities and to enable inclusive teaching. The kindergarten is also fully engaged in achieving even greater energy efficiency by installing solar panels and more efficient light bulbs.

3.5 GAIN IN THERMAL COMFORT

Thermal comfort increased on average by 6.1 degrees Celsius

For the eight facilities for which data were available, the quality of heating increased markedly because of the change in heating systems and implementation of other energy efficiency measures. The thermal comfort in winter increased on average by 6.1 degrees Celsius, from an average indoor temperature before the fuel switch of 15.2 degrees Celsius to an average temperature after the fuel switch of 21.3 degrees Celsius (Figure 9).

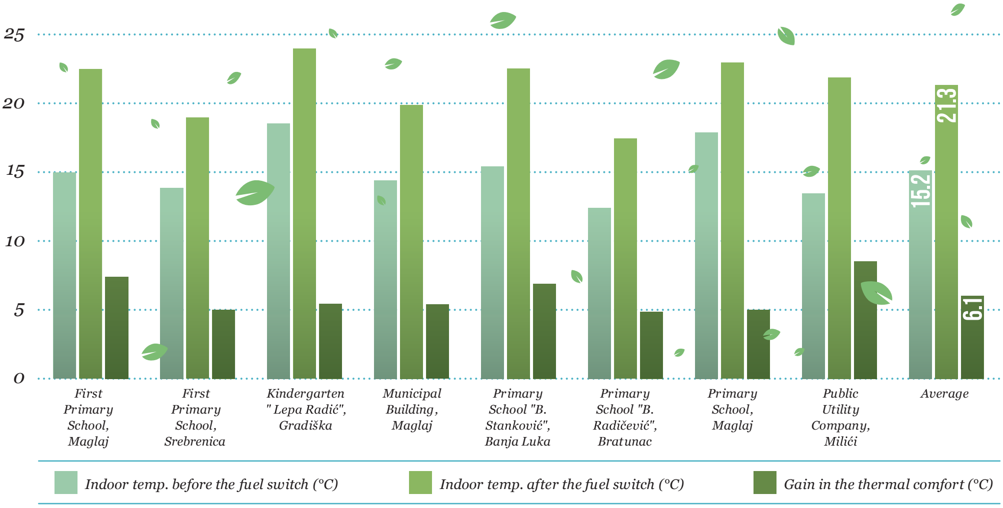

FIGURE 9 Thermal comfort before and after the fuel switch project.

3.6 NUMBER OF BENEFICIARIES

Over 14,350 people benefit every day from the improved heating quality in the winter months

In total, 14,354 people benefit daily from the improved heating quality achieved through the fuel switch projects (Figure 10). This represents the average number of people using the facilities on a typical working day. The beneficiaries are mostly children, teachers and staff of schools and kindergartens, which account for 80 per cent of all beneficiaries. Patients, visitors and staff of healthcare facilities account for 15 per cent of beneficiaries with users and staff of municipal buildings and cultural facilities making up the remaining 5 per cent. The number of daily beneficiaries per project or programme is shown in Figure 11.

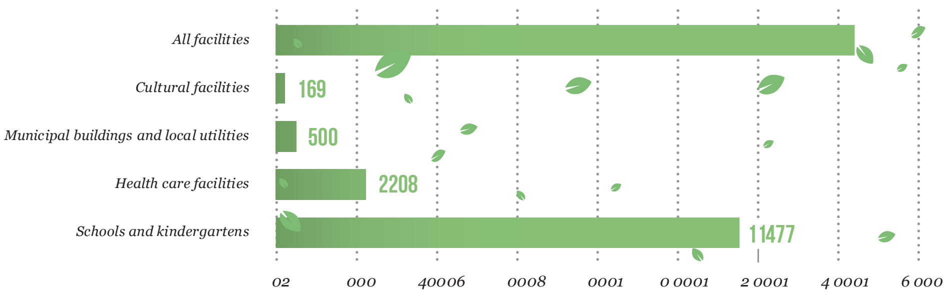

FIGURE 10 The number of people that benefit from the improved heating quality on a daily basis, by facility type.

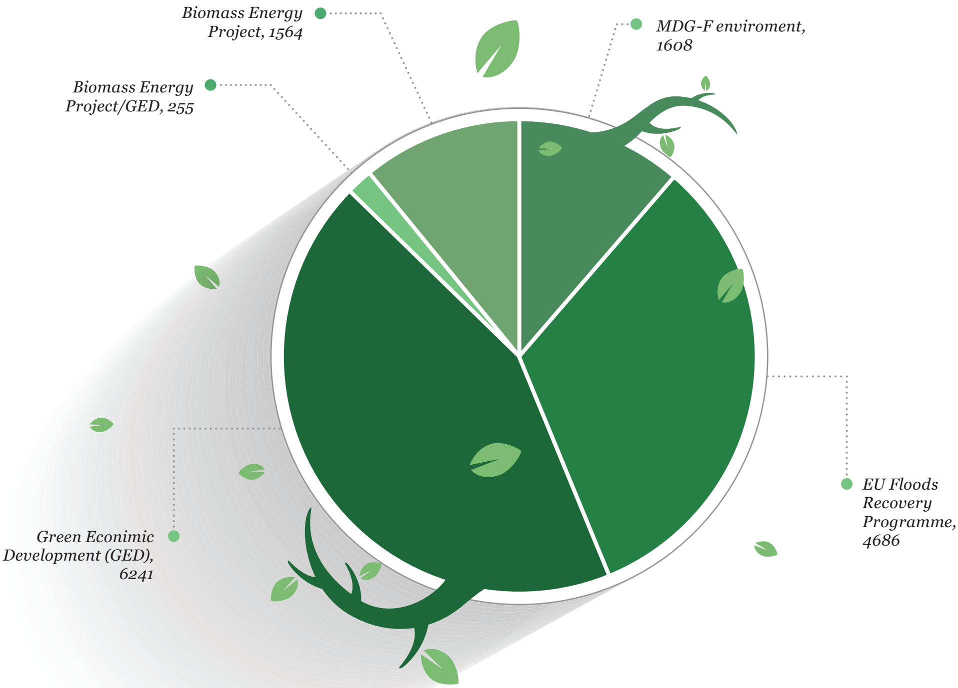

FIGURE 11 The number of people benefitting from improved heating quality on a daily basis, by programme/project.

3.7 CONTRIBUTION TO THE LOCAL ECONOMY AND SUPPORT TO THE DOMESTIC BIOMASS ENERGY SECTOR

It is estimated that the 26 facilities inject more than 550,000 BAM into the local economy each year through the purchase of wood biomass

Over seventy per cent of the biomass boilers installed in the facilities for which data was available were manufactured in Bosnia and Herzegovina (22 of 30 boilers for 18 facilities[33]). All of these facilities also source biomass from Bosnia and Herzegovina. The annual purchase of wood biomass from these facilities injects 442,701 BAM into the local economy each year. For the remaining eight facilities for which specific information was not available, it is estimated that these follow the same trend in sourcing local biomass and therefore add an additional 111,079 BAM per year to the local wood biomass energy economy.

Support to Local Employment

The average work effort needed for the production of biomass boilers, their installation and for the production of wood biomass for energy is summarised below in Table 5, which is based on information collected from the companies who supplied goods and services to the different biomass fuel switch projects. These figures should be considered only as indicative as more detailed information from a broader range of producers and service providers (in particular for boiler production) would increase the reliability of the data.

[33] One facility may have more than one boiler.

BOILER PRODUCTION			
Person-hours for the production of one boiler	***114,4***	COMMENTS	*Based on information provided by one company manufacturing boilers in BiH*
BOILER INSTALLATION			
Average person-hours for the installation of one boiler	***16*** *(small boilers, ≤ 50 kW)* ***340*** *(large boilers, ≥ 150 kW)*	COMMENTS	*Based on information provided by one company that installs biomass boilers in BiH*
WOOD BIOMASS PRODUCTION			
Average person-hours per tonne of final energy carrier produced (pellets or briquettes)	***5,5***	COMMENTS	*Based on information provided by five companies that produce wood biomass energy carriers in BiH*

Full dataset available in the database on the wood biomass fuel switch projects implemented by UNDP in BiH.

TABLE 5 Average work effort.

Over 15,900 hours of local employment are estimated to have been generated through the manufacture and installation of biomass boilers. A further 9,508 person-hours are generated each year in meeting the 26 facilities' demand for biomass energy.

Based on the data on the average work effort above, estimates place the number of hours of local employment generated in the manufacture and installation of the biomass boilers for the twenty-six facilities at 15,911 or the equivalent of 7.6 full-time jobs[34] over one year (Table 6).[35] The annual biomass consumption of the twenty-six facilities generates approximately 9,508 hours of local employment each year through the production of wood pellets and briquettes, equivalent to approximately 4.6 full-time jobs year after year.

	ONE-OFF EMPLOYMENT GENERATION (PERSON-HOURS)	ANNUAL EMPLOYMENT GENERATION (PERSON-HOURS)	BASIS FOR CALCULATION
Boiler manufacture	*3.318*	--	*29 biomass boilers produced in BiH*
Boiler installation	*12.594*	--	*39 biomass boilers installed (2 ≤ 50kW; 37 ≥ 150kW)*
Biomass production	--	*9.508*	*1,727 tonnes of biomass purchased annually*
Sub-total	***15.911***	***9.508***	

TABLE 6 Employment generation.

These results do not account for employment generated upstream in the forestry sector nor for employment generated by the implementation of energy efficiency measures.

[34] On the basis of 2,080 working hours per year.

[35] Using the same proportion of domestic sourcing of boilers (73%) and biomass (100%) found for the 18 facilities for which real data was available for the 8 facilities for which specific data was not available .

3.8 CHANGE IN AIR POLLUTANT EMISSIONS

The combustion of wood biomass can emit important amounts of air pollutants that can have an adverse impact on health. This ranges from particulate matter to volatile organic compounds, especially in the case of incomplete combustion.[36] The combustion of coal and fuel oil for heating is also associated with the emission of air pollutants. For all fuel types, pollutant emissions are affected by the quality of the fuel as well as by the efficiency of the heating systems.

No specific data on air pollutant emissions was available to enable a quantification of changes in emissions levels as no measurement of air pollutant emissions was conducted either before or after the fuel switch projects. As the fuel switch projects replaced generally old boilers (often around 30 to 40 years old) with modern, more efficient heating systems, pollutant emissions can, however, generally be estimated to be significantly lower in the case of switching from coal to biomass, in particular due to the low quality and high-sulphur content of Bosnian coal.[37] In the case of switching from heating oil to biomass, the change in air pollution may vary depending on the pollutant (e.g. lower sulphur emissions but higher particulate matter emissions), while the switch from electricity to biomass is associated with higher direct air pollutant emissions.

[36] World Health Organization, Residential heating with wood and coal: health impacts and policy options in Europe and North America, WHO Regional Office for Europe, 2015.

[37] Smajevic et al. (2014).

SUCCESS STORY

NEW PELLET BOILERS FOR THE 'DR. FRA MATO NIKOLIĆ' HOSPITAL IN NOVA BILA

Project: Green Economic Development (GED)

Project partners: Environmental Fund of the Federation of Bosnia and Herzegovina, Government of the Central Bosnia Canton and UNDP

Switching from heating with fuel oil to heating with wood pellets has enabled the 'Dr. Fra Mato Nikolić' hospital in Nova Bila to realise considerable savings, reducing heating costs by 52 per cent. This saving of over 130,000 BAM per year is used to purchase medicine, ensure round-the-clock security services for the hospital and to fit the existing radiators with thermostats. As heating with pellets is cheaper than heating with fuel oil, the hospital has also been able to increase the level of heating and considerably improve the working and caring environment for the 700 patients, visitors and staff who use its facilities each day.

As the hospital building was not originally built with energy efficiency in mind, much remains to be done. The hospital is fully engaged in continuously improving energy efficiency by implementing new measures: Two-thirds of the roof has been renovated, LED lights will be installed in the basement, one of the five wings will be fitted with new windows, radiators have been fitted with temperature regulators and the hospital plans to install solar water heaters. These measures should further decrease the cost of heating, increase the hospitals environmental performance and improve comfort.

04 CONCLUSION

The study has shown that modern wood biomass energy for heating in public buildings is an attractive alternative to heating with fossil fuels or grid electricity in Bosnia and Herzegovina, with numerous benefits.

The savings on heating costs can be substantial for individual facilities that switch from using heating oil or grid electricity to modern wood biomass for heating, while thermal comfort is significantly improved. This helps to foster better learning, working and caring environments, reduces operational expenditure and frees up funds for investment in other areas. The best results are achievable when a fuel switch is combined with energy efficiency measures, such as the installation of thermal insulation on facades and/or energy efficient windows and doors. Energy efficient retrofits of buildings reduce heating needs and thereby reduce energy consumption and costs; it may also enable the purchase of boilers of smaller capacity, thus reducing the initial investment. In the context of Bosnia and Herzegovina, this is especially important in the case of switching from coal to biomass. Wood biomass energy carriers, such as pellets and briquettes, are generally more expensive than coal on a per unit of energy basis. Therefore, without simultaneous energy efficiency measures, the switch from heating with coal to heating with biomass can increase heating costs. This means that despite the clear environmental benefits, making the economic case for the fuel switch is more tenuous. Data from the twenty-six public facilities that benefitted from the UNDP-implemented fuel switch projects across Bosnia and Herzegovina show an average reduction in heating costs of 54 per cent and annual aggregate savings on heating costs of close to 850,000 BAM.

At the local level, wood biomass energy can have a powerful effect on local development; this is particularly the case in rural areas. Green jobs are created all along the wood biomass energy value chain: from forestry to biomass energy carrier production and transport to the production, installation and maintenance of biomass boilers. The greatest impact on local development and job creation is achievable through a high degree of local sourcing of biomass energy carriers, boilers and heating system components. The data for eighteen of the facilities shows that these facilities sourced biomass exclusively from within BiH and that over 70 per cent of the biomass boilers were manufactured domestically, thereby supporting the development of the biomass energy sector in BiH and the transition to a green economy. It is estimated that the fuel switch projects directly generated over 15,900 hours of local employment through the manufacture and installation of biomass boilers and more than 9,500 hours of local employment through the annual production of wood biomass energy carriers (pellets and briquettes). The development of local renewable energy resources than can reduce the import of fossil fuels will help to increase the security of local energy.

Fuel switch projects that enable a transition from fossil fuel based heating to wood biomass energy contribute to achieving broader environmental goals, especially in relation to climate change mitigation. The portfolio of projects considered in the study is estimated to reduce the emission of greenhouse gases by around 2,173 tCO2eq annually. The sustainable management of forest resources and prioritisation of the cascading use of wood, for example, by maximising the use of wood waste (that would otherwise be discarded) as the primary source for biomass energy, are important for ensuring the sustainability of biomass energy throughout its lifecycle.[38] Local sourcing of biomass can reduce transport distances and the related greenhouse gas and air pollutant emissions, while the use of the most efficient heating systems with the lowest emissions can also ensure air pollutant emissions are minimised.[39]

By demonstrating the potential and viability of heating with modern wood biomass in public facilities used by large numbers of people (benefiting over 14,350 daily users) the biomass fuel switch projects implemented by UNDP in BiH give impetus to the achievement of the objectives laid out in Bosnia and Herzegovina's Climate Change Adaptation and Low Emission Development Strategy.[40] This includes the phasing out of fuel oil and coal for home and district heating and their replacement by, inter alia, energy efficiency gains and biomass by 2020. These projects also contribute to the attainment of Bosnia and Herzegovina's objective of achieving a forty per cent share of renewable energy in the country's final energy consumption by 2020.[41] They are also consistent with the commitments on climate change that BiH expressed in its Intended Nationally

[38] See, for example, Matthews, Robert, Laura Sokka, Sampo Soimakallio, Nigel Mortimer, Jeremy Rix, Mart-Jan Schelhaas, Tom Jenkins, Geoff Hogan, Ewan Mackie, Allison Morris and Tim Randle (2014). Review of literature on biogenic carbon and life cycle assessment of forest bioenergy. Final Task 1 report, EU DG ENER project ENER/C1/427, 'Carbon impacts of biomass consumed in the EU'. Forest Research, Farnham, May 2014

[39] World Health Organization, Residential heating with wood and coal: health impacts and policy options in Europe and North America, WHO Regional Office for Europe, 2015.

[40] Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina (2013). Available from http://www.unfccc.ba/.

[41] As part of Bosnia and Herzegovina's obligations as a party to the Energy Community Treaty, Decision 2012/03/MC-EnC on the implementation of Directive 2009/28/EC and amending Article 20 of the Energy Community Treaty.

Determined Contribution (INDC)[42] presented to the UNFCCC in 2015. These projects are in line with broader international goals in this field and international efforts to mitigate climate change and with Sustainable Development Goals 7 and 13[43] in particular.

The potential for the development of modern wood biomass energy for heating in Bosnia and Herzegovina is considerable given its rich forest resources and dynamic domestic biomass energy sector. In many cases, modern wood bioenergy can provide a cost-effective alternative to heating with fossil fuels or grid electricity and has important co-benefits for local development and climate change mitigation.

KEY RESULTS ACROSS THE 26 FACILITIES THAT BENEFITTED FROM THE UNDP IMPLEMENTED BIOMASS FUEL SWITCH PROJECTS

- Greenhouse gas emissions directly reduced by 2,173 tCO2eq annually.
- Heating costs reduced by 54% on average, saving close to 850,000 BAM annually.
- Over 15,900 hours of local employment generated through the manufacture and installation of biomass boilers and over 9,500 hours of green jobs generated annually through the production of wood pellets and briquettes.
- Over 14,350 daily users of the facilities benefit from better heating quality, with an average increase in thermal comfort of 6.1°C.

[42] Intended Nationally Determined Contribution of Bosnia and Herzegovina under the UNFCCC (October 2015). Available from BiH's UNFCCC portal http://www.unfccc.ba/site/pages/dokumenti/dokumenti_izvjestaji.php.

[43] SDG 7 aims to ensure access to affordable, reliable, sustainable and modern energy for all. SDG 13 calls for urgent action to be taken to combat climate change and its impact. See http://www.un.org/sustainabledevelopment/.