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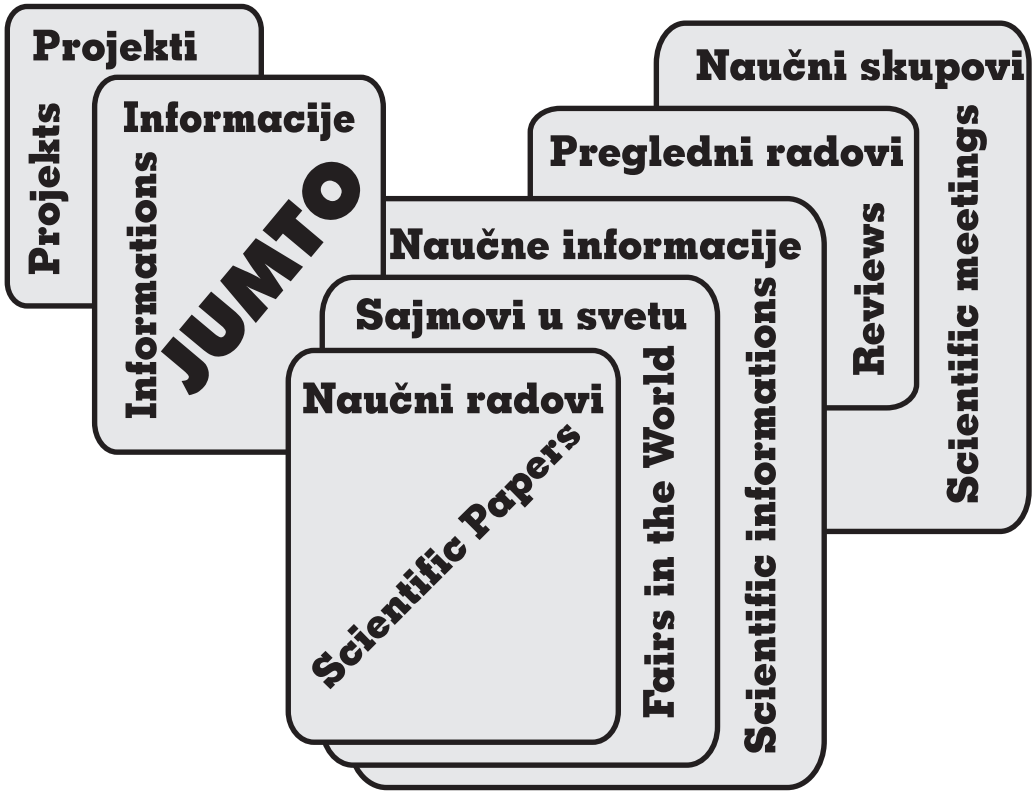

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POSSIBILITIES FOR REDUCING CO_2 EMISSIONS IN PUBLIC BUILDINGS USING BIOMASS

MOGUĆNOSTI ZA SMANJENJE EMISIJE CO_2 U JAVNIM ZGRADAMA PRIMENOM BIOMASE

Radojević, A.,[1] Nikolić, D.,[2] Janjušević, M.[3] Skerlić, J.,[4] Gordić, D.[5]

SUMMARY

EU plans in the area of climate and energy until 2050 are presented in two strategic documents: Energy Roadmap 2050and Roadmap for moving to a competitive low carbon economy in 2050, and they foresee goals for reducing greenhouse gases emissions by 80-95% compared to the 1990. At the moment, Serbia does not have an adopted climate strategy, but the drafting of the Law on Climate Change is underway.

Municipality of Priboj is one of the local governments that has made the most progress in replacing fossil fuels with biomass. This paper presents a drastic reduction of emissions in the example of four facilities (a kindergarten, the Community Center, the City Hall and one primary school), with a total area of 7800 m^2, which have a common boiler room. The boiler room was previously using coal, and now it is running on pellets and wood chips. The power of the new boiler room is 0.9 MW. The reduction of total annual thermal energy consumption in MWh is 36% - from 2,635.57 MWh consumed in 2016 to 1,678.11 MWh in 2018, while CO_2 emissions were reduced from 586.68 t in 2016 to 120.62 t in 2018, or by as much as 79%.

Key words: reducing CO_2 emissions, biomass, public buildings

REZIME

Planovi EU u oblasti klime i energije do 2050. su predstavljeni u dva strateška dokumenta: Energetskoj mapi puta do 2050 i Mapi puta za prelazak na konkurentnu, nisko-ugljeničnu ekonomiju do 2050. i predviđaju ciljeve smanjenja gasova sa efektom staklene bašte za 80-95%

[1]*Ana Radojević, EnergyManager of the City of Kragujevac, Kragujevac, Serbia, e-mail: aradojevic@kg.org.rs*

[2]*Danijela Nikolić, PhD, Assistant Professor, Faculty of Engineering, University of Kragujevac, Kragujevac, Serbia, e-mail: (danijelan@kg.ac.rs)*

[3]*Marko Janjušević, EnergyManager of the Municipality of Priboj, Priboj, Serbia, e-mail:markojanjusevic@yahoo.com*

[4]*Jasmina Skerlić, PhD, Assistant Professor,University of Priština temporarily settled in Kosovska Mitrovica, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia, e-mail: j.skerlic@pr.ac.rs*

[5]*Dušan Gordić, PhD, Full Professor, Faculty of Engineering, University of Kragujevac, Kragujevac, Serbia, e-mail: gordic@kg.ac.rs*

u odnosu na baznu 1990. Srbija u ovom trenutku nema usvojenu klimatsku strategiju, u toku je izrada Zakona o klimatskim promenama. Postoji Nacionalni plan za smanjenje emisija glavnih zagađujućih materija koje potiču iz starih velikih postrojenja za sagorevanje.

Priboj je jedna od lokalnih samouprava koja je najdalja odmakla u zameni fosilnih goriva biomasom. U radu je prikazano drastično smanjenje emisije na primeru četiri objekta (vrtić, Dom kulture, opštinska uprava i jedna osnovna škola), ukupne površine 7.800m^2, koji imaju zajedničku kotlarnicu,. Kotlarnica je prethodno bila na ugalj, a sada je na pelet i drvnu sečku. Snaga novog kotla je 0,9 MW. Smanjenje ukupne godišnje potrošnje toplotne energije u MWh iznosi 36% - sa potrošenih 2.635,57 MWh 2016. godine na 1.678,11 MWh 2018. godine, dok je emisija CO_2 smanjena sa 586,68 t 2016. na 120.62 t 2018. godine, ili za čak 79%.

Ključne reči: Smanjenje emisije CO_2, biomasa, javne zgrade

INTRODUCTION

While coal is the most widely used fossil fuel for energy generation in the world, the combustion of coal emits greenhouse gases [1]. Combustion of biomass does not add net CO2 to the atmosphere because biomass consumes the same amount of CO2 during growth [2].

There are a number of plans and strategies in the European Union that address the increased use of renewable energy sources and the reduction of CO2 emissions [3,4].

Some of these plans by 2050 are presented in two strategic documents: Energy Roadmap 2050 and A Roadmap for transition to a competitive low carbon economy by 2050and they foresee targets for reducing greenhouse gases by 80-95% compared to the base year of 1990.

Major EU policies that affect the development of bioenergy are related to renewable energy as a whole. The EU 28 as a political union is currently a party to the Kyoto protocol of the United Nations Framework Convention on Climate Change (UNFCCC), which, after the extension of a second commitment period, is set to expire after 2020through the DOHA agreement [5].

Reformulated Directive on renewable energy sources [6] has increased the EU targeted RES contribution from 27% to 32% by 2030, with a minimum of 14% in the transport, with a strict cap of 7% placed on conventional biofuels. Bioenergy used in end-use sectors of heating and electric energy must comply with a mandatory 70% GHG reduction compared to fossil incumbents starting in 2021, increasing to 80% after 2026, with a stringent list of sustainability constraints [6].

The EU 28 currently use approximately 74% of gross available energy from fossil fuels, with individual member states (MS) deploying various national strategies to achieve energy transition to low carbon fuel mixes, largely based on the geographical resources at their disposal and economic ability, with some countries reliant on a substantial share of fossil power generation. The amount of 59% of renewable gross inland energy consumed in the EU is derived from bioenergy, with some MS almost entirely relying on biomass, >80% of renewables consumed (Czechia, Estonia, Latvia, Lithuania, Hungary, Poland and Finland), only Norway has <25% of renewable consumption from bioenergy. Presently, the largest bioenergy consuming nations are France, Italy, UK, Sweden and Finland [7].

Change from conventional fuel to biofuel is stringent necessity, both to meet energy demand and to limit the production of carbon dioxide, carbon monoxide and particulate matter in urban contexts [8].

Bioenergy provides good opportunities for agricultural markets and has the capacity to promote sustainable development in rural communities. The benefits and the impacts of biofuels or

bioenergy production depend strongly on the specific context [9].

Biomass is a great option because it is widely recognized as a clean and renewable energy source with the potential to replace conventional fossil fuels in the energy market. It is ranked as the third energy resource used after oil and coal [10], and it can make a significant contribution to the reduction of GHG emissions when produced sustainably and used efficiently [11].

LEGISLATION IN SERBIA FOR THE USE OF BIOMASS

At the moment, Serbia does not have an adopted climate strategy. There is a National Plan to reduce emissions of major pollutants from old large combustion plants.

At the local level, some cities in Serbia have joined the Covenant of Mayors and are in the process of developing their local CO2 reduction plans - Sustainable Energy and Climate Action Plan (SECAP). When acceding to the Mayor's Charter, local authorities are committed to drafting a SECAP, which shows how they plan to reach the target of reducing CO2 by 2020 by at least 20% compared to 1990.

Priboj is one of the local self-governments in Serbia that joined the Mayor's Charter and at the same time it is one of the cities that have done the most in replacing fossil fuels with biomass - pellets and wood chips.

Indeed, according to the Covenant of Mayors Initiative, the energy consumption of public and institutional buildings could be significantly reduced by implementing environmental sustainable (ES) practices and promoting the use of renewable energies [12].

According to the Lawon Energy [13], biomass is a biodegradable part of products, waste and residues of biological origin from agriculture (including plant and animal materials), forestry and related industries, as well as a biodegradable part of industrial and municipal waste and is one of the renewable energy sources.

Biomass potential in the Republic of Serbia and the municipality of Priboj

Biomass potential in the Republic of Serbia

According to the Energy Development Strategy of the Republic of Serbia until 2025 with projections until 2030 [14], the total technically available potential of renewable energy sources in the Republic of Serbia is estimated at 5.65 million tons of oil equivalent (toe) per year. Of this potential, 1.054 million toe of biomass (mostly as firewood) and 909000 toe of hydropower are already used. Biomass represents a significant energy potential of the Republic of Serbia. The biomass potential is estimated at 3.448 million toe and participates in the total potential of RES with 61%. Of this potential, the largest part is the potential of wood biomass - 1.53 million tons and the potential of agricultural biomass - 1.67 million tons (residues of land farming, livestock breeding, fruit growing, vine growingand primary fruit processing). According to earlier data, from the National Action Plan for the Use of Renewable Energy Sources of the Republic of Serbia, the available biomass potential is 41%, and the potential used is 19%, which makes a total of 60%. One ton of oil equivalent is 41,868 GJ or 11,630 MWh of electricity or two tons of hard coal, or 5,586 t of crude lignite.

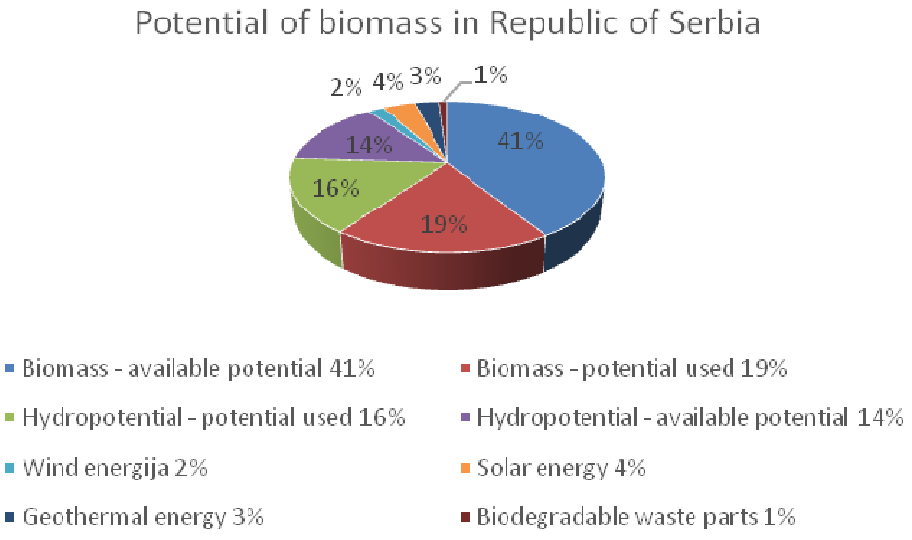

Fig. 1:Potential of renewable energy sources in Republic of Serbia[15]

Potential of biomass in the municipality of Priboj

The municipality of Priboj is located in the southwestern part of Serbia, on the border with Montenegro and Bosnia and Herzegovina. The area of the municipality is 552 km^2.

The municipality of Priboj has the population of 27,133. The municipality of Priboj belongs to the group of the most forested municipalities in Serbia, with an area of 30,781.8 haunter forests. In relation to the total area of the municipality, forests occupy 56.2%. With such a high degreeof forest cover, Priboj is significantly above the average for the Republic of Serbia (29.2%) [16].

The analysis of data from the balance shows that the municipality of Priboj has a positive balance of wood biomass for energy needs in the amount of 39,379 m^3, which means that there are potentials in that amount that can be used for future energy needs of this municipality. There are no recorded plantations under "energy" crops in the municipality of Priboj, although there are satisfactory conditions for their cultivation. According to the current level of available and used energy from biomass residues from agricultural production in the municipality of Priboj, 1,447 t (4.2%) of biomass residues of lower humidity is available in the municipality at the annual level that can be directly burned and 32,899 t (95.8%) biomass residues of increased humidity that can be used for biogas production and as livestock feed [17].

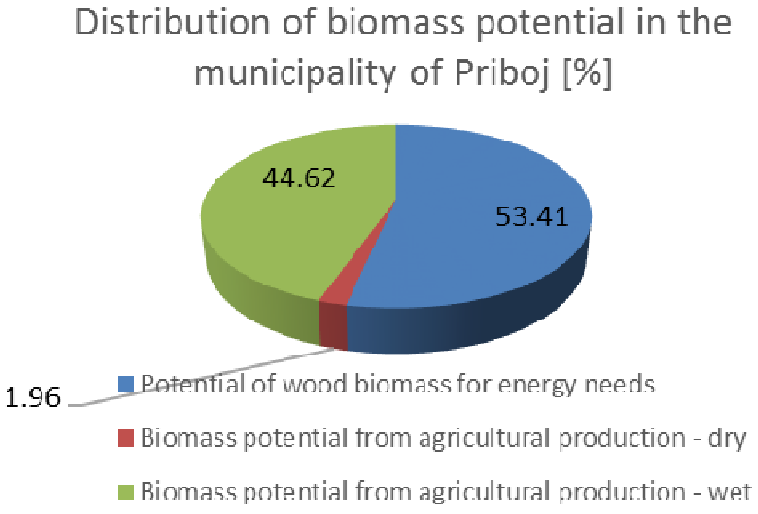

Fig. 2: Distribution of biomass potential in the municipality of Priboj [%][17]

METHODOLOGY

The methodology of work includes the creation of the municipality of Priboj's energy balance for the public sector, which includes public buildings and public lighting, for which energy consumption is paid from the local budget.Energy consumption for the period of three years (2016-2018) was analyzed. The base year was 2016, before fossil fuel (coal) was replaced by biomass. After that, the share of renewable energy sources in the total consumption was calculatedfor all three years. Finally, the reduction of CO_2 emissions using biomass in relation to the entire public sector as well as at specific facilities were calculated.

Energy balance of the municipality

The energy balance of the municipality includes the consumption of primary energy in public buildings and public lighting.

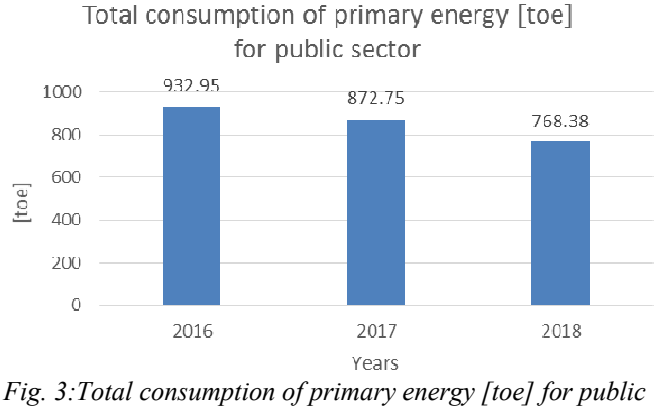

Fig. 3:Total consumption of primary energy [toe] for public sector – public buildings and public lighting

The municipality of Priboj finances fuel costsfor 65 public buildings that are heated by coal, firewood and district heating,where total gross area of those buildings is 48,513.9m², and total usable area of those buildings is 39,250.6m².

Impact of biomass use on CO_2 emission reduction

Four objects were observed in the paper: a kindergarten, Community Center, Municipal Administration building and one primary school, with a total area of 7,800 m^2. These four facilities have a common boiler room, which used brown coal until 2016. Since 2017, the boiler room has been using pellets and wood chips. The power of the new boiler room is 0.9MW.

The share of primary energy consumption from renewable energy sources in 2016 was 82.72 toe, in 2017 - 124.87 toeand in 2018 - 121.66 toe (Fig. 4).As a percentage, in total energy consumption, it is 8.9 %, 14.3 % and 15.8 %, respectively (Fig. 5).

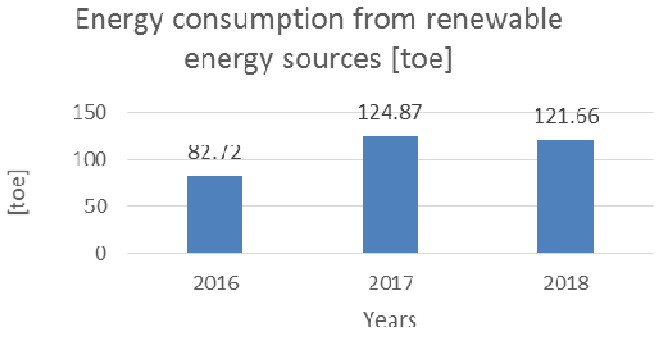

Fig. 4:Primary energy consumption from renewable energy sources [toe]

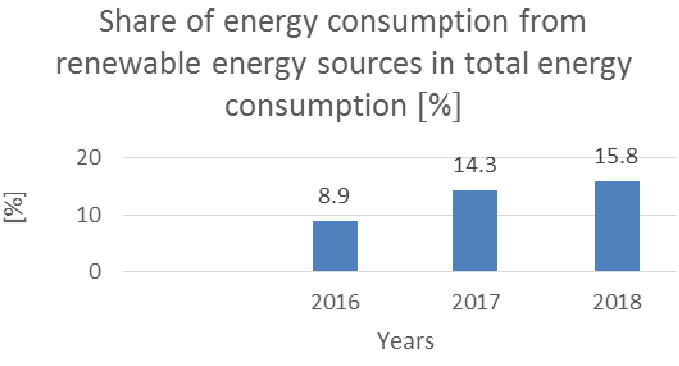

Fig.5:Increasing the share of primary energy consumption from renewable energy sources in total energy consumption[%]

Reduction of CO_2 emission

CO_2 emission in the entire public sector, which includes public buildings and public lighting, in 2016 amounted to 3,587.66 tCO_2, in 2017 - 3,192.31 tCO_2 and in 2018 - 2,765.55 tCO_2(Fig. 6).

The CO_2 emission from heating for all public buildings by yearsare: 586,68 tCO_2 – 2016; 174,81tCO_2- 2017 and 120,62tCO_2 – 2018 (Fig. 7).

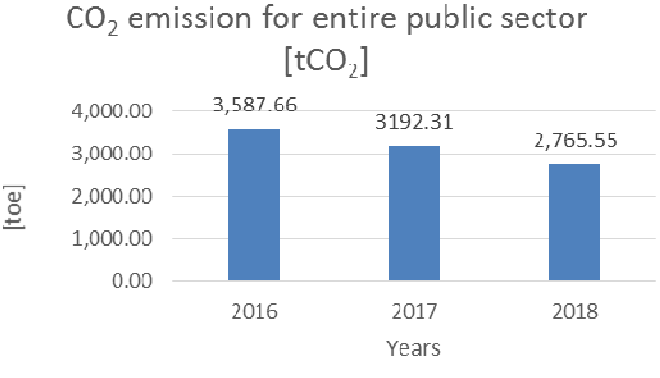

Fig. 6: Reduction of CO2 emissions originating from the entire public sector [tCO2]

CO_2 emissions for heating for the boiler room itself have been reduced over the years in the following way: 346.59 tCO_2 – 2016, 29.32 tCO_2 –2017 and 29.04 tCO_2 – 2018

(Fig. 8).

The share of CO_2 emissions from this boiler room was almost 10% before the change of heating method, and after the transition to biomass, this share was about 1%. The use of biomass has so far reduced CO_2 emissions and significantly reduced CO_2 emissions for the entire public sector, by about 8.5% (Fig. 9).

CONCLUSION

Biomass for heating public buildings, despite its great potential, is used very little in Serbia.

This paper presents a drastic reduction of emissions on the example of four buildings (a kindergarten, the Community Center, the Municipal Administration building and one primary school) that have a common boiler room, with a total area of 7,800 m2. The boiler room was previously on coal, and now it is on pellets and wood chips. The power of the new boiler room is 0.9 MW. In relation to the total consumption for thermal energy in the period from 2016 to 2018, the decrease in MWh was from 2,635.57 MWh to 1,678.11 MWh or by 36%, while CO2 emissions were reduced from 586.68t to 120.62 t or by 79%.The use of biomass has so far significantly reduced CO2 emissions for the entire public sector, by about 8.5%. The share of CO2 emissions from this boiler room was almost 10% before the change of heating method, and after the

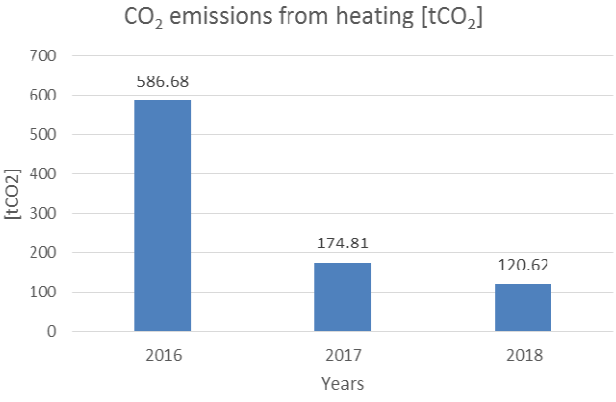

Fig. 7: Reduction of CO2 emissions from heating for all public buildings [tCO2]

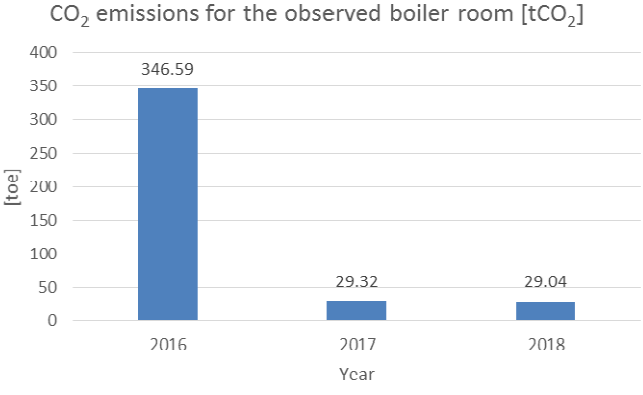

Fig. 8:Reduction of CO2 emissions for heating for the observed boiler room [tCO2]

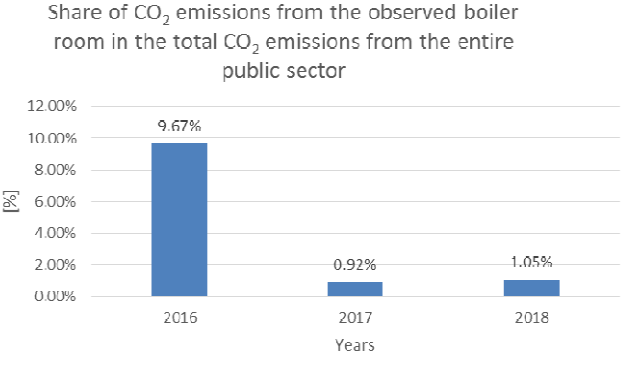

Fig. 9:Share of CO2 emissions from the observed boiler room in the total CO2 emissions from the entire public sector

transition to biomass, this share was about 1%.

Throughout the region, in which the municipality of Priboj is located, there is equal availability of biomass, so this example can be applied in other municipalities in this region.

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