



## Bosnia and Herzegovina's Renewable Energy Policy and Perspective

Amir Tokic<sup>1</sup>, Tahir Cetin Akinci<sup>2\*</sup>, Aydin Tarik Zengin<sup>3</sup>

<sup>1</sup>Department of Electrical Engineering, Tuzla University, Tuzla, Bosnia and Herzegovina, <sup>2</sup>Department of Electrical Engineering, Istanbul Technical University, Istanbul, Turkey, <sup>3</sup>Department of Computer Engineering, Istanbul Sabahattin Zaim University, Turkey.  
\*Email: [akincitc@itu.edu.tr](mailto:akincitc@itu.edu.tr)

Received: 12 March 2020

Accepted: 13 June 2020

DOI: <https://doi.org/10.32479/ijeeep.9777>

### ABSTRACT

Bosnia and Herzegovina is one of the richest countries in the Balkans in terms of renewable energy sources. Although Bosnia and Herzegovina has energy sources such as geothermal, solar and wind, the primary sources of electricity supply are from hydroelectric power plants and thermal power plants. The share of these two sources in total consumption is 62%. Drina attracts investors in the sector with nearly 200 hydroelectric power generation projects located on big and other small rivers such as Neretva, Bosnia, Una, Trebisnjica and Vrbas. According to Bosnia and Herzegovina 2019 data, it has an electricity generation capacity of approximately 18,000 GW. It is ranked ninth in the world in terms of hydroelectric power. Also, renewable energy potential in Bosnia and Herzegovina, such as wind, biomass and geothermal energy, is quite high. Especially the southern part of the country has been identified as the corridor of wind energy. In the examinations made, it has been determined that Bosnia and Herzegovina's performance coefficient in wind energy potential is above 30% of the EU average. However, the country's population density includes sensitive situations for new energy investments due to migration and geopolitical reasons. Despite this, the successful progress in the European Union negotiations and the laws enacted in the field of renewable energy also offer very attractive investment areas. In this study, a prospective approach was made regarding the renewable energy policy of Bosnia and Herzegovina, the economic approach of the country to renewable energy and the renewable energy policies of the government were discussed.

**Keywords:** Bosnia and Herzegovina, Renewable Energy, Renewable Energy Policy, Energy Perspective.

**JEL Classifications:** Q2, O2, N74, F13.

### 1. INTRODUCTION

Energy demand all over the world tends to increase constantly due to developing technology, industrialization, population growth. Researches are expected to increase by 56% of energy in the world between 2010 and 2040. Energy markets turned to renewable energy sources due to restrictions on fossil reserves. To increase the interest in renewable energy sources, states provide many facilities to investor companies (NREAP BIH, 2016). In this sense, the renewable energy sector is the center of attention for investors all over the World (Mazzucato, and Semieniuk, 2018). Renewable energy use is also important because of its positive

contribution to the environment and the inexhaustible natural resources of the countries (Ahmedov and van der Borg, 2019). In this study, research has been done on renewable energy policy and renewable energy perspective of Bosnia-Herzegovina.

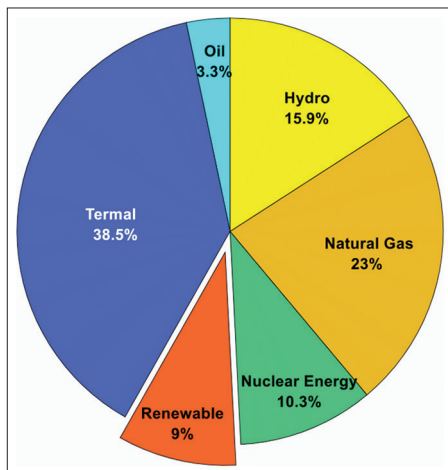
The population of Bosnia and Herzegovina, which was born as a new state in 1992, is 3.5 million according to 2019 data. The surface area of the country is 51.209 km<sup>2</sup>. The country, which is neighboring Serbia, Montenegro and Croatia, has 5 rivers named Drina, Neretva, Sava, Bosnia, Vrbas, Una, Sana. Bosnia and Herzegovina have taken its place as an energy exporter in the region. More than half of its electricity generation capacity

is provided by hydroelectric power plants, and the other part from thermal power plants (MFTERBH, 2019; EFAPBH, 2016; Nikolakakis et al., 2019; NREAP BIH, 2016).

### 1.1. Renewable Energy Investment and Policies in the World

The advancement of technology enables the costs of renewable energy technologies to decrease (Akinci, 2019). Investment costs also stimulate investment and competition in the renewable energy sector. Investments in coal-borne power plants, which constitute the largest part of the thermal power plants, have been reduced by 80%. Despite this, existing power plants continue to exist due to energy requirements or limited regional resources. The interruptions that started in 2010 cause investments to decrease and energy produced to decrease. In Figure 1, the distribution of electricity generation by power plants in the world is given. When these data are analyzed, it can be concluded that 24% of the world's electricity and electricity is provided by renewable energy sources (Wang, 2019).

**Figure 1:** Distribution of energy production in the world by power plant (Wang, 2019)



Since 2010, the cost of electricity generated from PV and wind power plants has decreased by 73% for PV and 22% for wind. It is estimated that the energy produced by fossil in 2025 will be more expensive than energy produced from renewable sources. Besides, many governments around the world support for investments in electric vehicles. While it offers tax discounts for electric vehicle users, it also offers advantageous opportunities for important technology investments for manufacturers. With these supports, the cost of lithium-ion batteries has decreased by 80% in the past decade. It is estimated that these costs will decrease by 59% more in the next ten years (NREAP BIH, 2016).

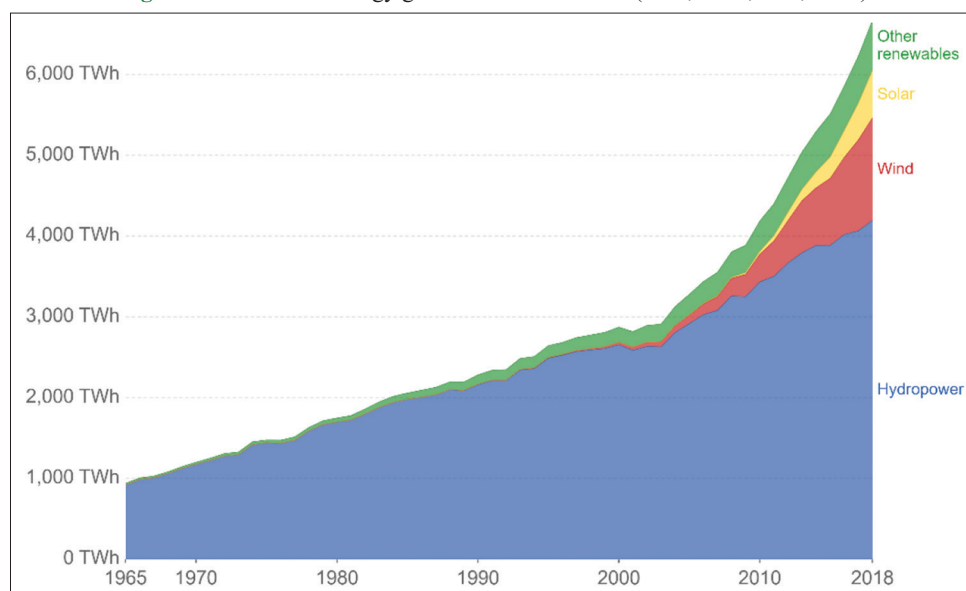
The World Energy Agency (IEA) has published a report on the future of energy production and consumption. In this report, it also shows a outlook from world energy policies. The report presents the projected energy outlook from 2018 to 2040 (IEA, 2019). Figure 2 renewable energy generation in the World is shown.

### 1.2. Renewable Energy Resources Investment and Policies in the Balkans

Conflicts in the region during the breakup of Yugoslavia damaged the energy systems of the entire region. Many countries in the region faced significant energy problems, and although most of the energy transmission and distribution problems have been resolved, the energy infrastructure still needs to be supported by reliable, sustainable policies (Chattopadhyay et al., 2017).

In the past two decades, Balkan countries have developed important policies in renewable energy investments, and have made legal progress. The standards brought by the European Union on clean energy to the energy sectors and the necessity to apply these standards for full membership negotiations have led Balkan countries to include renewable energy in their programs. Legal preparations have been completed through the policy assemblies developed on renewable energy. The preparation of these policies offers these countries sustainable good opportunities to use and develop their renewable energy potential. However, population

**Figure 2:** Renewable energy generation in the World (Smil, 2017; IEA, 2019)



decline and migrations in Balkan countries are among the factors that decrease the investment potential in the country (Zaimovic, 2018; Chattopadhyay et al., 2017). Especially the coastal countries, although there is an effort to generate energy by using the sea facilities, finding the investors for the renewable energy potentials of the countries constitute the most important problem. In this sense, since many Balkan countries have similar problems, they have created common policies by acting jointly.

In the countries in the Balkan Region, energy markets have two main features. First, all countries are energy importers. All countries in the region are heavily dependent on imported fossil fuels, energy imports account for 44% of the total energy use, making it an average of over 3 billion euros for countries. The second is Energy subsidies. It characterizes the overall political strategy in the region, which is based on the energy systems of all countries because the sector sees renewable energy as the locomotive sector (Dominkovic et al., 2016; Mocevic, 2020; Energy, 2018).

It is possible to evaluate the renewable energy projects in the Balkan region within the framework of the criteria described below. National strategies: Identify action plans for each renewable energy sector to ensure that national targets are translated into achievable and measurable action items. Regulatory framework: Support programs provide stable, efficient and balanced support to renewable energy sources with limited demands on public spending. Local RES developers: Must create opportunities using local opportunities to bring quality projects to the market. This is important as foreign investors are often looking for joint venture partners to reduce local risks. Allowing and managing equity: Steps should be taken to develop a regular and transparent energy investment permit process and the use of equity, and policies should be developed. Project agreements: Project financing structures require sound project agreements to ensure that risks are transferred to the best manageable parties. In the Western Balkans, it is often difficult to make bank deals with strong,

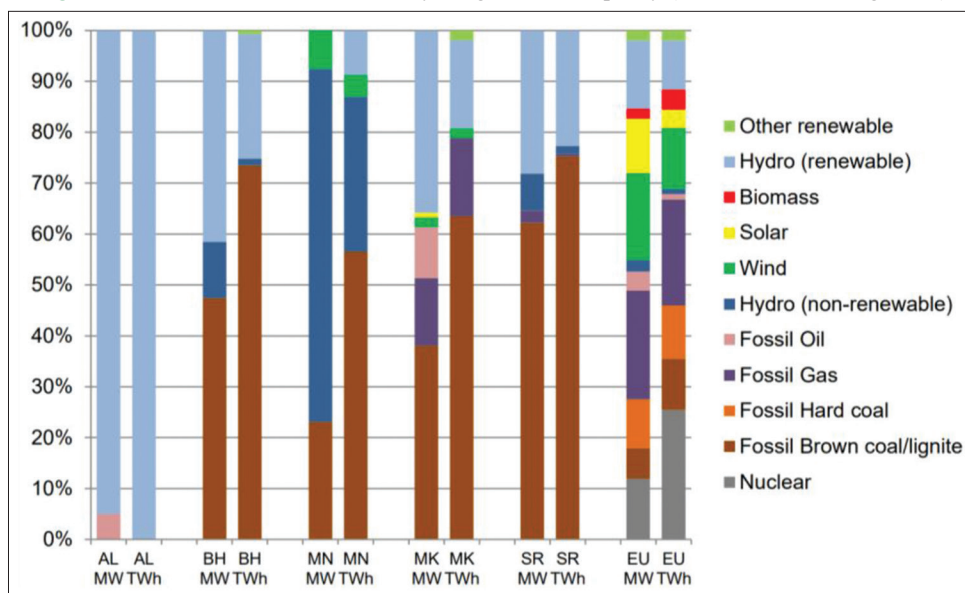
loan-worthy counterparts that can take over and deliver these deals. It is important to regulate the credit system to make long term contracts. However, all countries in the region are developing policies on how renewable energy sources turn into energy-related expenditures. Also, they make legal arrangements for a closer look at the electricity sector and how RES-E support can be passed on to an end-user, so that the work done will yield results (Zuvela, 2018; Mocevic, 2020; Energy, 2018; Politis and Zucker, 2016). In Figure 3, the energy production capacities of Balkan countries are shown comparatively (Milatovic and Chung, 2017).

## 2. BOSNIA HERZEGOVINA'S ELECTRICAL ENERGY INFRASTRUCTURE

Existing laws in Bosnia and Herzegovina do not envisage the separation of the transmission system operator according to the third energy package. In these areas, the transmission and distribution system is managed by the same operator. The Elektroprenos Electricity Distribution system, the separation of its operators, was partially transposed in the Federation of Bosnia and Herzegovina, but this proposal was not ratified by the government at sessions in 2019. Legal work on Energy Transmission-Distribution continues in Bosnia and Herzegovina. The energy sector in the country has gained speed with the European Union harmonization processes and is constantly developing. There are 8 hydroelectric power plants and 4 thermal power plants in Bosnia and Herzegovina. In Table 1, power plants and power plants in Bosnia-Herzegovina are given. In addition, there are more than 160 small power plants in the country. The main energy transmission line of Bosnia Herzegovina is given in Figure 4 (EFAPBH, 2016; Nikolakakis et al., 2019; Zaimovic, 2018).

Electricity energy data of Bosnia and Herzegovina between 2015 and 2018 are given in Table 2. According to the data in Bosnia Herzegovina; The details about the produced, consumed, energy powers and lengths of energy transmission lines are sorted by years, and the sudden increase of Consumption of energy sector

Figure 3: Balkan Countries of Electricity net generation capacity (Milatovic and Chung, 2017)





### 3. POLITICAL AND TECHNICAL INFRASTRUCTURE PLAN IN RENEWABLE ENERGY

values in 2017 draws attention (EC,2018; Nikolakakis et al., 2019; FIPA, 2014).

Bosnia and Herzegovina, according to September 2019 data; Electricity price is \$0.097/kWh for households. For businesses, it is \$0.110, which includes all components of the electricity bill, such as power, distribution and taxes.

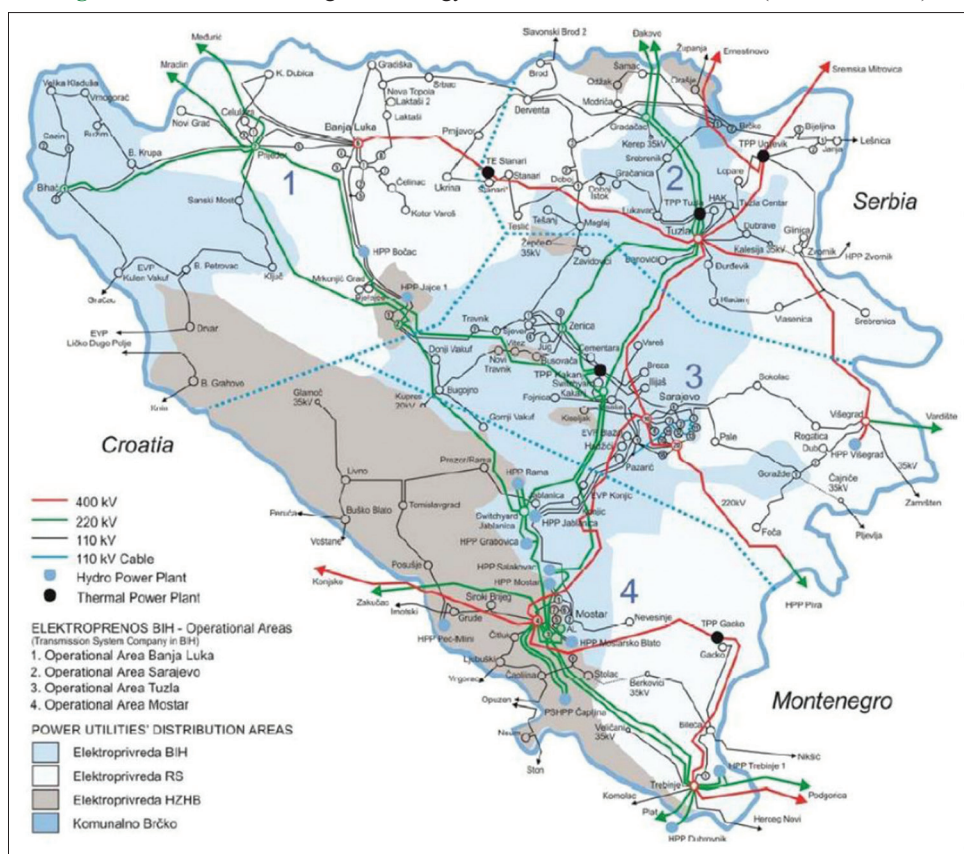
**Table 1: Electrical capacities of power plants in Bosnia-Herzegovina (FIPA, 2014)**

	Station/City	Capacity (MW)	
Hydroelectric power plant	Bočac Hydroelectric Power Station (Surjan)	110	
	Čapljina Hydroelectric Power Station (Čapljina)	430	
	Grabovica Hydroelectric Power Station (Grabovica)	117	
	Jablanica Hydroelectric Power Station (Jablanica)	151	
	Rama Hydroelectric Power Station (Ravnica)	161	
	Salakovac Hydroelectric Power Station (Potoci)	210	
	Trebinje Hydroelectric Power Station (Gorica)	176	
	Višegrad Hydroelectric Power Station (Višegrad)	315	
	Termal (Coal) Power Plant	Ugljevik Power Plant (Ugljevik)	300
		Gacko Power Plant (Gacko)	300
Kakanj Power Plant (Čatići)		450	
Tuzla Power Plant (Tuzla)		715	

Even though the Action Plan for the Use of Renewable Energy Resources in Bosnia and Herzegovina, which was prepared and put into practice in 2006, was taken with the decision of the establishment of the Energy Community, these decisions were also implemented by regulations before 2006. With the Bosnia and Herzegovina Asset Action Plan, the use of Renewable Energy Resources and the Efficient Cogeneration Law came into force. Policies, measures and binding targets for electricity efficiency, heating, cooling energy, energy used in transportation, the share of RES energy in total final consumption is determined by the legalized action plans. In addition, this law also addresses regulatory measures for energy efficiency improvements and energy savings for end customers. In 2012, in accordance with the Energy Community Treaty, the Council of Ministers of Bosnia and Herzegovina has set binding targets for Bosnia and Herzegovina's energy share to be 40% renewable energy. According to these targets, the share of energy sources and RES energy in transportation has been 10% in final energy consumption until 2020. In line with the decisions taken, supportive and decisions were taken regarding the promotion of electricity production from renewable sources. In line with these decisions, the following renewable energy policies have been determined.

- Safe, high quality and reliable electricity supply,
- Environmental Protection,
- Reducing dependence on energy imports and fossil fuel use.

**Figure 4: Bosnia and Herzegovina Energy Main Transmission Networks (Zaimovic, 2018)**



**Table 2: Electric Energy Data (EC, 2018)**

	2015	2016	2017	2018
Electricity production (GWh)	14.408	16.509	15.151	17.873
Imports (net) (GWh)	3.965	3.145	3.428	3.119
Exports (net) (GWh)	5.768	6.788	5.213	7698
Gross electricity consumption (GWh)	12.606	12.865	13.366	13.294
Losses in transmission line	2,0%	1.7 %	1.9 %	1.96 %
Losses in distribution of networks	10,5%	10.3 %	9,9 %	9,37 %
Consumption of energy sector [GWh]	27.86	75.13	283.96	152.69
Consum. of electricity (Final) [GWh]	11.183	11.432	11.735	11.792
Horizontal transmission line [km]/number of interconnectors	37	37	37	37
Electricity customers/total	1.517.161	1.531,501	1.541.968	1.553.439
Electricity customers/non-households	124.327	126.303	127.553	126.508

These policies are; It is in line with the strategic and planning documents of the Federation of Bosnia and Herzegovina, Republika Srpska and the Brcko Region of Bosnia and Herzegovina. In this sense, they have taken decisions to develop policies to act jointly by ministries and institutions and to promote the use of renewable energy. In Figure 5, the renewable energy scenario of Bosnia and Herzegovina is given until 2035. According to the analysis, it is estimated that the renewable energy sector will produce above average by 2035 with the support of technological progress and investments. Hydroelectric power plants make a great contribution to the total RES share here. Wind energy investments are expected to develop by 9%. Solar biomass investments, other than wind energy, are expected to improve by 4% (EFAPBH, 2016; Nikolakakis et al., 2019).

### 3.1. Treaty Establishing the Energy Community

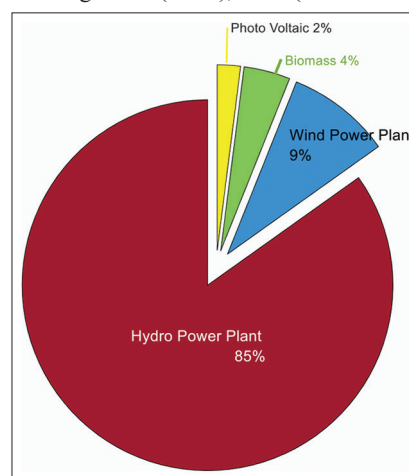
The Energy Community Treaty, which came into force in 2006, enables the creation of an internal market for electricity and natural gas, with eight contracting parties covering the European Union, as well as Albania, Bosnia and Herzegovina, Montenegro, Kosovo, Macedonia, Moldova, Serbia and Ukraine. Here, the work of these energy bodies is monitored by 19 European Union countries. In addition, 4 observer countries are involved in these studies. The main objectives of the Energy Community are listed below.

- Providing reliable energy supply
- Being able to attract investments in the electricity and natural gas sectors
- Creating a stable and unified regulatory framework
- Creating a market area,
- Application of energy efficiency
- Development of alternative ways to gas supply through the use of renewable resources
- It is the improvement of the environment.

With the conclusion of this Treaty, the Contracting Parties in the region undertake to establish a common electricity and gas market amongst themselves, which will operate according to the standards of the EU energy market to which it will be integrated (NREAP BIH, 2016).

The legal framework of the Energy Community has the basic directives and regulations of the EU's Third Energy Package, which provides common rules for the internal markets for Energy and Natural Gas and regulates cross-border trade. The first set of regulations in 2005 was repeatedly updated with new directives

**Figure 5:** Vision for the contribution of RES in the electricity sector as scenario average in % (GWh), 2035 (NREAP BIH, 2016)

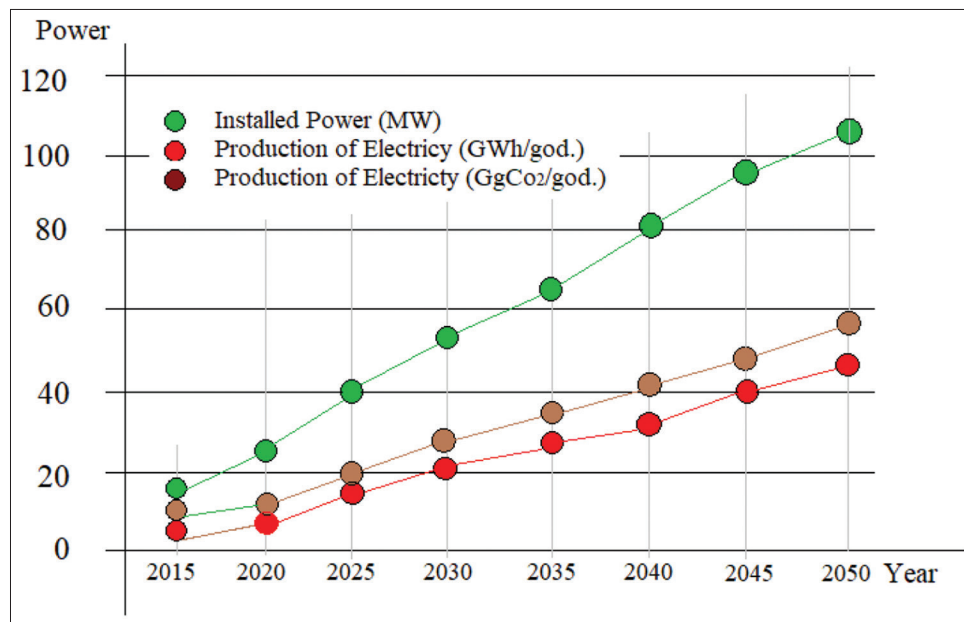


and regulations and supported by regulations in the fields of environmental protection, competition and renewable energy. In 2007, the acquis was extended to EU procurement safety directives, and the term “network energy,” which initially refers to electricity and gas since 2008, was also extended to include the oil industry. In 2015, the acquis was expanded by the rules on energy efficiency, environmental protection, statistics and infrastructure, and is still in force. In addition, frameworks related to energy saving have been determined within the framework of the regulations (NREAP BIH, 2016). The table below shows the gross final energy consumption achieved and expected in heating and cooling, electricity and transport in Bosnia and Herzegovina by 2020.

The sector in Bosnia Herzegovina should be supported by sustainable development and sustainable energy systems. Thermal and hydroelectric power plants provide a large share in energy production in Bosnia-Herzegovina (Tica, 2019; Chattopadhyay et al., 2017). Bosnia and Herzegovina's total GgCO<sub>2</sub> emission by 2050 and the total capacity perspective in agriculture for biogas are given in Figure 6.

The country needs to generate significant initiatives to use its large non-hydro renewable energy potential, estimated at 6.9 GW. Necessary legal procedures must be arranged for investments. Policy and decision-makers, project developers, investors, technology providers and NGOs as well as international donors and financial institutions are in agreement for actions on renewable energy.

**Figure 6:** Total installed capacity in Agriculture of cogeneration plant on biogas in Bosnia and Herzegovina and Total emission of GgCO<sub>2</sub>/year, and assessment of events until 2050 (Tica, 2019)



#### 4. CONCLUSION

In this study, technical, economic and political perspectives of renewable energy sources of Bosnia Herzegovina were examined. In terms of employment in Bosnia Herzegovina, those working in the energy sector make up 3.4% of wage employment. The gross salary level of the energy sector is 42% above the average gross salary. Foreign trade performance of the energy sector in the country is of great importance for the country's economy. The country is in a position to export electrical energy. In this sense, the government of Bosnia and Herzegovina cares about the energy sector as the locomotive sector. Although the country's electricity prices tend to increase, household and industrial sector electricity prices have increased in favor of households over the years.

The country electricity prices are at the lowest level in every consumer group compared to the European Union, the Euro Area and some European countries. The low sales prices of electricity make energy prices an attractive factor for the investments to be made in the country, but it provides a tendency towards foreign markets rather than the domestic market for the companies that will sell to the domestic market. At the same time, many opportunities are offered to investors in the field of renewable energy in the country. Considering the social status of the country, geographical location, foreign trade performance, appropriate laws regarding foreign capital, targeting integration into the EU, it offers an important investment environment in terms of renewable energy investments.

#### REFERENCES

Ahmedov, A.K., van der Borg, C. (2019), Do natural resources impede renewable energy production in the EU? A mixed-methods analysis. *Energy Policy*, 126, 361-369.  
Akinci, T.C. (2019), Intelligent systems in renewable energy sources. In:

Bostancı, SH., Yıldırım, D.Ç., Nişancı, E., editors. *İktisadi Teknik ve Strateji Boyutları ile Türkiye'de Enerji Sorunsalı*. Turkish: Ekin Pub. p229-262.  
Chattopadhyay, D., Nikolakakis, T., Malovic, D., Vayrynen, J. (2017), Bosnia and Herzegovina Power Sector Note: Least-cost Power Development Plan. United States: Energy Sector Management Assistance Program. p1-52.  
Dominkovic, D.F., Bacekovic, I., Cosic, B., Krajacic, G., Puksec, T., Duic, N., Markovska, N. (2016), Zero carbon energy system of South East Europe in 2050. *Applied Energy*, 184, 1517-1528.  
EC. (2018), Bosnia and Herzegovina's energy sector benchmark data. Available from: [http://www.enc-public-prd.batmen.at/implementation/Bosnia\\_Herzegovina.html](http://www.enc-public-prd.batmen.at/implementation/Bosnia_Herzegovina.html). [Last accessed on 2020 Feb 20].  
EFAPBH. (2017), Energy Efficiency Action Plan of Bosnia and Herzegovina for the Period 2016-2018. Available from: [https://www.energy-community.org/dam/jcr:d5da6e89-291c-4e97-b978-85804d98d040/BIH\\_NEEAP\\_2016\\_2018\\_042017.pdf](https://www.energy-community.org/dam/jcr:d5da6e89-291c-4e97-b978-85804d98d040/BIH_NEEAP_2016_2018_042017.pdf). [Last accessed on 2020 Feb 20].  
Energy. (2018), Guide on for Central and South Eastern Europe. Brussels, Belgium: Publications of the European Union. Available from: <https://www.s3platform.jrc.ec.europa.eu/documents/20182/238542/Guide+on+good+practice+in+energy+efficiency+for+Central+and+South+Eastern+Europe/3f8a1d96-e259-4ab7-8da0-723e389f4abf>. [Last accessed on 2020 Feb 23].  
Entsoe, Statistics and Data. (2020), Available from: <https://www.entsoe.eu/publications/statistics-and-data>. [Last accessed on 2020 Feb 15].  
IEA. (2019), World Energy Outlook 2019. Available from: <https://www.iea.org/reports/world-energy-outlook-2019/electricity>. [Last accessed on 2020 Feb 22].  
Mazzucato, M., Semieniuk, G. (2018), Financing renewable energy: Who is financing what and why it matters. *Technological Forecasting and Social Change*, 127, 8-22.  
MFTERBH. (2019), Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina. Framework Energy Strategy of Bosnia and Herzegovina Until 2035. Available from: [http://www.mvteo.gov.ba/data/Home/Dokumenti/Energetika/Framework\\_Energy\\_Strategy\\_of\\_Bosnia\\_and\\_Herzegovina\\_until\\_2035\\_ENG\\_FINAL...](http://www.mvteo.gov.ba/data/Home/Dokumenti/Energetika/Framework_Energy_Strategy_of_Bosnia_and_Herzegovina_until_2035_ENG_FINAL...)

- pdf. [Last accessed on 2020 Feb 20].
- Milatovic, J., Chung, D. (2017), How Can the Western Balkans Electricity Mix be Made Sustainable? Available from: <https://www.ebrd.com/documents/admin/how-can-the-western-balkans-electricity-mix-be-made-sustainable.pdf?blobnocache=true>. [Last accessed 2020 Feb 15].
- Mocevic, A. (2020), Bosnia and Herzegovina, Wolf Thesis. Available from: <http://www.brochures.wolftheiss.com/en/TRITBdKW/bosnia-herzegovina>. [Last accessed on 2020 Feb 23].
- Nikolakakis, T., Chattopadhyay, D., Malovic, D., Väyrynen, J., Baziliana, M. (2019), Analysis of electricity investment strategy for Bosnia and Herzegovina. *Energy Strategy Reviews*, 23, 47-56.
- NREAP BIH. (2016), National Renewable Energy Action Plan of Bosnia Herzegovina, 2016. Available from: [https://www.energy-community.org/dam/jcr:ef59bc5d-a6c3-48a8-9653-2a40e5721d58/NREAP\\_2016\\_BH.pdf](https://www.energy-community.org/dam/jcr:ef59bc5d-a6c3-48a8-9653-2a40e5721d58/NREAP_2016_BH.pdf). [Last accessed on 2020 Feb 15].
- Politis, S., Zucker, A. (2016), Energy Scenarios for SE Europe: A close look into the Western Balkans. Vienna: JRC Conference and Workshop Reports, Proceedings of the Enlargement and Integration Action Workshop.
- Smil, V. (2017), Energy Transitions: Global and National Perspectives. And BP Statistical Review of World Energy. Available from: <https://www.ourworldindata.org/renewable-energy>. [Last accessed on 2020 Feb 20].
- FIPA. (2014), Foreign Investment Promotion Agency, Bosnia and Herzegovina Energy Sector. Available from: [https://www.ticaret.gov.tr/data/5b8a43355c7495406a2276af/Enerji\\_Sektoru.pdf](https://www.ticaret.gov.tr/data/5b8a43355c7495406a2276af/Enerji_Sektoru.pdf). [Last accessed on 2020 Feb 15].
- Tica, G. (2019), Mitigation of climate change in terms of the use of renewable energy sources in Bosnia and Herzegovina and mitigation scenarios defined. *IOP Conference Series: Materials Science and Engineering*, 477, 1-11.
- Wang, T. (2019), Distribution of Electricity Generation Worldwide in 2017. Available from: <https://www.statista.com/statistics/269811/world-electricity-production-by-energy-source>. [Last accessed on 2020 Feb 20].
- Zaimovic, T. (2018), Energy Roadmap 2050 Outlook. Whitepaper. p1-18. Available from: <http://www.efsa.unsa.ba/~tarik.zaimovic/wp-content/uploads/2019/02/BiH-Energy-Roadmap-Outlook-2050.pdf>. [Last accessed on 2020 Feb 15].
- Zuvela, M. (2018), First Wind Farm Operational in Coal-reliant Bosnia, Reuters. Available from: <https://www.reuters.com/article/us-bosnia-energy-windfarm/first-wind-farm-operational-in-coal-reliant-bosnia-idUSKCN1GQ1OB>. [Last accessed on 2020 Feb 22].