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MASTER'S THESIS

POTENTIALS FOR THE GREEN ECONOMY IN BOSNIA AND HERZEGOVINA BASED ON ENERGY COOPERATIVES

Ljubljana, March 2021. VEDAD SULJIĆ

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LIST OF ABBREVIATIONS

BiH – Bosnia and Herzegovina

CAPEX - Capital expenses

DHS - District Heating System

DPP - discounted payback

EE – Energy Efficiency

EU – European Union

GHG – Greenhouse gases

GIS - Geographic Information System

GIZ - German Organization for International Cooperation

GWh - Giga Watt hour

ILO - International Labour Organization

IRENA - International Renewable Energy Agency

IRR - internal rate of return

KM - Konvertibilna Marka

kW - kilowatt

kW_{el} – kilowatt of electrical energy

MW - megawatt

MWh/a – megawatt hours per year

NPV - net present value

OECD - Organisation for Economic Cooperation and Development

OPEX - Operational expenses

PJ - Peta Joule

RES – Renewable energy sources

TJ - Tera Joule

t/a – tonne per year

UN - United Nations

UNDP - United Nations Development Programme

UNEP - United Nations Environmental Programme

USAID - United States Agency for International Development

INTRODUCTION

The current *neoclassical economic model* was constructed upon it in the late nineteenth century and beyond, mainly shaped by Adam Smith and Thomas R. Malthus. In the context of environmental issues, the reduction of pollution is recognized as an opportunity to gain profit or reduce costs. Even more modern economists follow this way of understanding (Dale, 2012). The last financial crisis, back in 2008, showed that the current economic model is not suitable for today's circumstances and that a change has to be made. According to the World Bank's (hereafter: WB) report, there is clear evidence on how the financial crisis affected social well-being worldwide (Otker-Robe & Podpiera, 2013). Namely, the evidence showed that especially countries with weak institutional capacity (which is the case for Bosnia and Herzegovina), faced severe damages during and after the crisis. The report explains the short-run and long-run negative effects the crisis caused, out of which increased poverty, lower investments for healthcare and education, a decline of development indicators and reversal of progress in the attainment of the Millennium Development Goals represent the most dramatic ones. The green economy, in fact, puts those issues in the focus. In addition, the EU Commission in the European Economic Recovery Plan says that transition to the green economy is a challenge for the recovery after the crisis (European Commission, 2009). Ryszawska (2013) made a very good review of different views (United Nations, European Union, and Organisation for Economic Cooperation and Development) towards the green economy but for all of them a common belief is present, namely that „business as usual" is not possible anymore, and that the need for a green economy is greater than ever. This was actually the key topic of discussion of the Rio+20 Conference held in 2012.

The green economy is one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy is low-carbon, resource efficient, and socially inclusive. In a green economy, growth in income and employment are driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. Green economy can be achieved through (i) investing in natural capital (agriculture, fisheries, water, and forests), (ii) investing in energy and resource efficiency (renewable energy, manufacturing, waste, buildings, transport and tourism), and by (iii) supporting the transition to a global green economy" (UNEP, 2011). This model advocates decoupling of resource use and environmental impacts from economic growth. A green economy is typically understood as an economic system that is compatible with the natural environment, is friendly to environment and ecology, and perhaps is socially just (Mishra, 2017).

Both the United Nations Environmental Program (hereafter: UNEP) and the International Labour Organisation (hereafter: ILO) claim how green economy creates green jobs, but also state governments see link green economy to the creation of jobs (Yeyanran & Qiang, 2016). In this thesis, green jobs are recognized as those which lead to less material input (e.g. energy efficiency, eco-design etc.), less material output (e.g. waste management etc.) and reduction of greenhouse gases (e.g. renewable energy sources). Green jobs are increasing in the whole world. There are also different opinions on what a green job means. For the purpose of this thesis the following classification will be used (Ivanova, 2013): (i) activities related to environmental preservation and conservation (water, bio-economy, waste conservation and recycling, biodiversity), (ii) activities leading to energy efficiency and low energy consumption (construction, insulation materials, bio-based materials etc.), (iii) activities which limit the emission of greenhouse gases (renewable energy sources, transportation, green energy).

The issue of low employment represents the key economic issue in undeveloped and developing countries. The concern about the green economy is especially emphasized in developing countries having in mind problems with rising population and poverty while the risk of food insecurity and environmental damage (Olomola & Adesugba, 2014). Small countries exploit the term green economy more due to their vulnerability to climate change and other environmental issues. However, in practice transition towards a green economy is not achieved, especially in small countries, with traditional economies remaining dominant (Dornan, 2014). A survey made by GlobeScan in collaboration with UNEP revealed several barriers towards a green economy (Erisken, 2012): (i) financial short-termism. (ii) inappropriate regulations, (iii) low awareness of business imperative among business leaders, (iv) low consumer demand for green business practices, products, and services, (v) lack of international standards, and (vi) lack of effective management tools.

During a panel discussion held at the Columbia University, Professor Satyajit Bose stated how energy efficiency and deployment of Renewable Energy Sources (hereafter: RES) present one of the tools of a green economy (Bose, 2016). Especially in Bosnia and Herzegovina RES projects are considered as one of the key driving forces of the economy (Gvero, Tica, Papuga, Petrović, Jakšić & Roljić, 2010). However, in practice deployment of RES projects is not a simple game. Ikejemba (2017) presents typical kinds of RES projects failures in Sub-Saharan Africa, but those examples are actually applicable to any corner of the World. Such failures damage the reputation of RES projects and discourage investors, and examples of them are: (i) shelved projects – planned but not implemented, (ii) stalled projects – started but never completed, (iii) appropriated projects – implementation different than planned, (iv) malfunctioning projects – finalized but are not in operation due to technical or non-technical reasons, (v) non-functioning projects – broken down and cease to be of any use. Other aspects of RES failure are explained by Blazquez, Fuentes-Bracamontes, Bollino & Nezamuddin (2018) who claims that "the renewable energy policy paradox results from the interaction between several factors, including (i) the (almost) zero marginal costs of renewables,(ii) the intermittent nature of renewables, and (iii) the interplay between price volatility and renewable technologies."

High penetration of RES capacities, due to nearly zero marginal costs, lead to a sharp decrease in wholesale prices. In the elaborated cases of Germany, Italy, and Spain the same phenomena occurred, namely, after the high penetration of RES capacities, the share of RES was doubled, the wholesale price went down (ranging from 34-50%), but the price of electricity to consumers increased (15-62%). In addition, Blazquez et al. (2018, p.3) conclude that "these stylized facts from some European countries suggest that renewable energy is leading to a divergence between the cost of the system and the price of electricity in wholesale markets, although these are not a proof of statistical causality."

Investment in RES projects are lower as the price of electricity is lower, due to the reduced profit expectation (Gross, Blyth, & Heptonstall, 2010). Therefore timing for investing into RES is very crucial and the business environment has to be created from the top (state level) but initiatives have to come from the bottom (local level). The issue which remains is how to attract private money for investing in RES projects. Friedemann (2017) claims that "policymakers possess a range of options to encourage the redirection of private finance from 'dirty' to clean innovation and hence to achieve the low-carbon transition". The author stresses out key barriers for private finance towards sustainable energy which include (i) technological, (ii) institutional, (iii) economic, (iv) financial, (v) political and (vi) transformation barriers.

As presented in the above paragraphs reasons why RES can fail are different with different roots of the problem. This thesis will focus on local non-acceptance as a problem for RES deployment. According to Botelho, Pinto, Lourenço-Gomes, Valente & Sousa (2016) deployment of RES projects has to ensure social acceptance. Although RES are accepted by the general public the local non-acceptance hinders such projects which cause an effect called *Not In My Backyard* (the NIMBY effect). In order to overcome this issue the authors argue following crucial factors „collaborative decision-making process, employing effective forms of community involvement; effective involvement of the community in the sitting process or in the management/ownership, which allows the community to identify with the project; the perception of how well the new system fits into the identity of the community; the fact that the decision making process is perceived as being fair; and the existence of mutual trust between community members and the investors and owners of the infrastructure". Kapoor, Oksnes & Hogarts (2018, p. 15) says "the bulk of green investments by volume will come from the private sector, public investment is a critical catalyst. Public money is crucial in galvanizing follow-on investment from the private sector, for example in Research&Development, risk sharing or co-investments in projects that provide a marginal return at the current carbon price or seem too risky from a purely financial perspective".

In Bosnia and Herzegovina (hereafter: BiH) citizens hold more than a half of total deposits, out of which almost 45% represent long-term deposits (savings) which present an investment volume of approximately KM 5 billion (Central Bank of BiH, 2018). One of the possibilities to attract private money in the context of RES investment is through energy cooperatives. Even advanced economies such as German and Denmark set strict goals in terms of RES share in total energy, but they have recognized that achieving those goals deeply rely on the involvement of local communities, especially their citizens. Another aspect is that households and municipalities are no longer passive consumers but producers as well, and therefore they have to be strategically involved (Minghui Gui, MacGill, & Iain, 2017). Energy cooperatives, like enterprises, develop RES projects and, belong to the Social Economy (Šahović & Pereira da Silva, 2016). The EU Report "Social Economy in the EU" states five specific targets of the Social economy which include, inter alia, reduction of greenhouse gases, development of renewable energy and increase of energy efficiency (Monzón Campos & Chaves Ávila, 2012). For the case of Bosnia and Herzegovina, they have significant development potential especially in the case with biomass exploitation and production of biofuels (Suljić & Harbaš, 2016).

The ILO elaborated effects of cooperative models onto different UN sustainable development goals. The ILO Report (2014) stated that "energy cooperatives are contributing to the achievement of the sustainable energy goals of energy access, energy efficiency, and reduced emissions. Cooperatives are visible in facilitating access to sustainable energy, where they are playing a significant role in generating electricity and distributing it to consumers. They are also leading the way to the adoption of new and RES like solar and wind power in many parts of the world". In another ILO Report (International Labour Office, 2013) a clear connection between green economy and energy cooperatives was made saying "cooperatives are ideally placed to promote sustainable development and foster a 'green economy' – which was adopted by Rio+20 as a practical concept and vehicle for achieving sustainability" and further it was said "as economic entities, cooperatives provide their members with commercial services, which in the context of the green economy and renewable energy could derive from opportunities in emerging green sectors".

Another reason for the stimulation of energy cooperatives is the issue of climate change. Based on recent research BiH is vulnerable to climate change and especially the northern and central part of the country have very low adaptive capacities (Žurovec, Čadro, & Kumar Situala, 2017). It is assumed that the highest potential for energy cooperatives based on biomass and biogas are exactly in this part of the country, which will be tested within this thesis. So far there was no previous work on the issue of how energy cooperatives could drive the green economy and to which extent in Bosnia and Herzegovina. This thesis will focus on the examination of the potentials for energy cooperatives and stress out key socio-economic benefits they produce.

The purpose of the thesis is to elaborate tools of the green economy and to demonstrate their benefit for the country as a whole from the economic, social and environmental point of view. This thesis will highlight potentials and barriers to implement green economy tool on the example of energy cooperatives in BiH and will research the potential to create green jobs in BiH based on case studies.

The thesis will elaborate principles of the green economy in general and how green jobs can be created. To test the concept, a research about energy cooperatives will be made in order to quantify benefits which they have to BiH's economy, the society and the environment.

The objectives of this thesis are to (1) present a comprehensive analysis of the concept, scope and the character of the green economy; (2) explore key barriers for the implementation of specific tools (such as energy cooperatives) of the green economy concept in BiH; (3) explore opportunities of a specific tool (such as energy cooperatives) within the green economy concept in BiH; (4) quantify social, economic and environmental benefits of specific energy cooperatives and asses those benefits at the state level; and (5) provide recommendations for enhancement of the green economy at the local level in BiH.

For the preparation of the thesis a combination of research methods will be applied starting with literature review on basic concepts of the green economy approach and energy cooperatives. The literature review will provide an overview from the global perspective, not focusing just on Bosnia and Herzegovina. Secondary data will be used while preparing the thesis which will be selected very carefully. Official reports from international organization dealing with sustainable development in general will also be used while preparing the thesis.

The second part of the thesis will be based on a research which will be done in two phases:

Phase I – In order to identify benefits at different levels experts from different domestic and international organizations will be consulted (interviewed). This will enable to get an insight of the same issue from different points of view. Thus the research will consider benefits at the local level, but also at the regional and the state level.

Phase II – The energy cooperatives concept will be the core of the research. The first step within this phase will include mapping of potential for development of energy cooperatives which use biomass and biogas. For the mapping, apart of relevant databases, applicable software such as Geographic Information System (hereinafter as GIS) software will be used for analysing and processing of obtained data. After the mapping process, case studies for biomass and biogas based energy cooperatives will be developed which afterwards will be used as reference points for the purpose of scaling up to quantifiable benefits onto the state level. In this way an assessment of green economy potentials, on the basis of energy cooperatives based on biomass and biogas, of Bosnia and Herzegovina will be made, including the assessment of social, economic and environmental benefits.

1 GREEN ECONOMY

Green economy is a holistic concept that includes economic activity that generates sustainable development, one that does not come at the expense of generations to come. It has economic and environmental component, but is often forgotten and its social component – no green economy without respect for workers' rights, principles of gender equality and social inclusion (Energetski portal, 2018).

1.1 Defining green economy

Given that the neoclassical economy did not succeed to effectively incorporate value of natural resources as well as harmful environmental impacts into cost-effective pricing and other market mechanisms, the concept of a green economy was introduced.

What we encounter today is limited resources for which economic development poses enormous demands. The boundaries of the potential for exploration already reach many resources. It is also important to mention climate change, disagreement and discomfort within the social and socio-political spheres that have a great impact on unequal distribution and so limited resources. Therefore, there is a need for a new direction in terms of development.

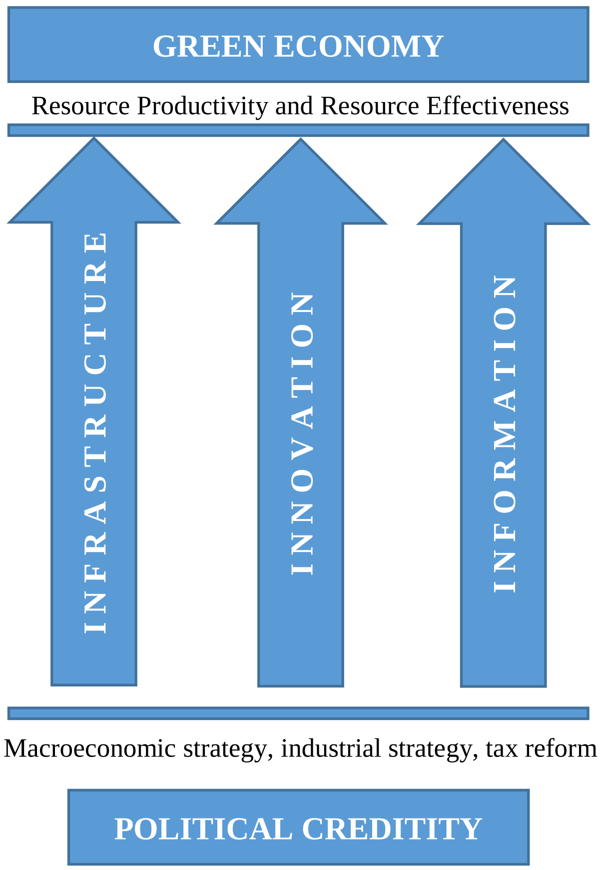
As the world faces multiple crises over the past decades, such as climate change, food and economic crisis, rising poverty and social inequality, the green economy appears to be the focus of the international level.

As an adequate response, the "Global Green New Deal" was proposed by the United Nations Environment Program (hereafter: UNEP). The aim of the agreement was to revive the global economy, stimulate employment, accelerate the fight against climate change, adversely affect the environment and poverty. Following this proposed agreement, a series of intergovernmental green economic initiatives followed, such as UNEP’s green economy Initiative (The Presidency Republic of South Africa, 2009); The International Labour Organisation’s (hereafter: ILO) Green Jobs Initiative (Maia et al., 2011); and the Organisation for Economic Cooperation and Development’s (hereafter: OECD) Green Growth Strategy (National Planning Commision, 2011).

There is no unique definition or model of green economy in the literature, but there is a general belief that green economy should improve people's well-being and restore, sustain, and improve the healthy natural environment that people and other living species should use and enhance. Green economy is a means of achieving sustainable development and should therefore be based on the principle of equality within and between generations. Global sustainable development goals are needed to build a common understanding of the results that the economy needs to achieve in terms of improving human wellbeing and maintaining natural systems (Pokrajac & Josipović, 2015).

Figure 1 gives a simple overview of the essence of the green economy. Some of the key elements of the guidelines for a green economy are sustainable marking, exchange of information on good examples and more education programs (Gašić, 2013).

Figure 1: Green Economy key elements



Source: Ekins (2011).

UNEP defines the green economy as an economy that results in improved human wellbeing and social equity, with a significant reduction of environmental risks and further environmental degradation (United Nations Environment Programme, 2011).

According to OECD (2011) "green economy is fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies", while Green Economy Coalition (2010) defines it as "a fair and resilient economy, which provides a better quality of life for all achieved within the ecological limits of one planet".

National Strategy for Sustainable Development, South African Department of Environmental Affairs (2011) highlights that green economy "implies the decoupling of resource use and environmental impacts from economic growth".

The future of development and progress is reflected in the green economy. Green economy ensuring equitable distribution of resources and assets, reduce poverty and inequality in society. It is also better prepared for the effects of climate change and better disposes of natural resources. Furthermore, it is important the energy potential of biomass that is always present, regardless of weather conditions or inconveniences. For example, one hectare of corn silage can provide biogas production of about 10,000 m^3, or 22,000 kWh of electricity and about 25,000 kWh of heat. Another significant example is the manure, where it is possible to produce about 2,200 m^3 of biogas per year from four dairy cows, ie 5,200 kWh of electricity and about 5,800 kWh of heat. Such production, which gives rise to the aim of this work, generates neutral energy and a significant amount of bio fertilizers, which reduces the intensity of use of mineral fertilizers (Gašić, 2013, p. 174).

1.2 Green jobs

Green jobs include jobs that produce goods and services, prevent, limit, minimize or correct damage to the environment, water, air and soil, as well as waste, noise, and eco-systems issues. This includes technology, products and services that reduce the risk to the environment and pollution (OECD, 1999).

According to joint ILO UNEP report green jobs are defined as "...work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity, reduce energy, materials, and water consumption through high efficiency strategies, decarbonize the economy, and minimize or altogether avoid generation of all forms of waste and pollution" (International Labour Office, 2012, p. 18).

Developing sustainable forms of production and consumption makes it possible to create quite new jobs or transforming existing jobs into high-quality green jobs. This is indeed possible in all sectors, along the entire value chain, from research to production, distribution and maintenance. This is particularly evident in the new sectors of high-tech renewable energy technologies, in traditional industries such as the production of goods and construction, agriculture and fisheries. Green jobs are easily accessible in service sectors such as catering, tourism and transportation, and new opportunities are also opening up in the field of education.

It is obvious that green jobs provide decent work that in turn guarantees adequate social protection, adequate income, and healthy working conditions. In such an environment, it is possible to respect the rights of workers and the participation of individuals in decisions affecting their lives.

Unemployment is one of the most prominent problems in Europe, and especially in Bosnia and Herzegovina. No more than 25 million Europeans or more than 10% of the active population are unemployed, while in BiH this number reaches 18.4% (Agency for Statistics of BiH, 2018). Young people are faced with a more troubled situation where almost one out of four young adults is unemployed. In the strongest affected European countries, such as Greece or Spain, more than half of young people are unemployed, and savings are further aggravated by the situation (Statista, 2019; Statista, 2019a).

At the same time, the climate and environment crisis is becoming more and more serious. Scientists today are quite certain that human activity is changing our climate. They warn of the danger of not taking measures that would stop them from happening. Meanwhile, economists warn us that the delay in action increases the cost of mitigating damage and sanctioning the consequences (Stern, 2007).

However, there is a way out of this situation: by greening our economies, we can create high-quality green jobs in order to combat unemployment, climate change and environmental degradation at the same time. From such an action the European Union (hereafter: EU) can only benefit. If the EU retained its role as a 'green leader', by 2050, it would increase annual exports by an additional 25 billion euros, and cut annual energy accounts by 350 billion euros. This reduces dependence on imported energy and resources obtained at volatile prices, and increases security of supply (European Climate Foundation, 2010).

If we are able to establish targeted training and education programs, we will ensure a strong involvement of social partners and facilitate ambitious strategies to encourage innovation and green investment. This will enable the creation of millions of sustainable, high-quality green jobs, many in small and medium-sized businesses across Europe.

The category of 'green jobs' can be seen as one of the new perspectives and opportunities in which Bosnia and Herzegovina could make significant progress. A wide range of areas with significant opportunities for developing a green employment strategy and agriculture and forestry sectors are certainly one of the most interesting.

Green jobs are particularly beneficial to the construction sector, as the usual energy consumption structure is such that the building consumes the most energy, and therefore these are objects of improvements. Improving the energy performance of facilities and carrying out measures has many advantages, and one of the most significant is job creation. Irrational energy consumption for heating, cooling and lighting is characteristic for virtually all types of existing residential and public buildings in Bosnia and Herzegovina.

At the end of 2016, under the Green Economy Development project implemented by UNDP with the support of the Government of Sweden, in cooperation with project partners was presented the 'Green Jobs study' (Center for Development and Support, 2016). The aim of this study and analysis is to illustrate the effects of investment in energy efficiency and renewable energy (EE/RES) measures on direct employment in Bosnia and Herzegovina. Direct employment implies employment as a result of an increase in demand for goods and services directly related to the implementation of EE/RES measures. In Bosnia and Herzegovina, there is a very low employment rate, and in such circumstances, increasing employment rates and reducing unemployment should be the main political and national priorities, especially among hard-to-employ people, and in areas and regions characterized by high unemployment. For the purpose of assessing the effects of direct employment, the research team analysed the data on the implemented EE/RES measures to 34 buildings with a total heated area of 77,147 square meters, distributed throughout Bosnia and Herzegovina. At each of the facilities, all or some of the EE/RES measures were implemented, which included preparatory works, masonry and insulation works, roofing and sheet metal works, carpentry works (PVC windows and portals), facade works, painting works, lightning works and electrical installations, works water and sewage systems and a significant group of mechanical works. The total spent funds for all objects/projects amount to KM 6.6 million, and the average investment per square meter of heated area is around KM 85. Based on the valid building standards for the time consuming by type of work, for all the objects concerned it is necessary to have a working engagement of 727,019 hours. Based on 2,257 operating hours per year, which are typical for the field of construction, according to the full-time equivalent, the number of jobs is 322, or working engagement of 322 people full-time for one year (Center for Development and Support, 2016).

Thus, the key information of this study, through which the comparison of investments and effects in different economic areas is made, is the number of jobs per million euros of investments in EE/RES measures, that is, energy efficiency and renewable energy sources. If the structural measures envisaged in the National Energy Efficiency Action Plan (NEEAP) Bosnia and Herzegovina for the period 2010-2018 are going to be implemented, an annual employment potential of almost 4,000 jobs would be created, primarily in the construction sector (Center for Development and Support, 2016).

By 2016, through works carried out on 46 facilities, CO_2 emissions were reduced by about 4,000 tons per year, annual savings in budgets exceeding KM 1,000,000, and 322 jobs created equivalent to around KM 2,000,000 of wages annually for domestic labor. The Green Economic Development (hereafter: GED) project has been implemented since 2014, and the total value of the project is over KM 23 million (Center for Development and Support, 2016).

As pointed out in the 'Green Jobs study', it is interesting to compare the results obtained by this analysis with similar studies conducted in Europe and the world. What is common to all studies is an estimate of the number of jobs based on workplace as a full-time equivalent per million euros of investment in EE/RES measures. There are significant differences in the obtained results of this analysis and the results of the similar studies. Thus, the number of jobs in Bosnia and Herzegovina is 17% higher than the results of the 'SAVE: UK case study' conducted in the UK, which gives the largest workplace as a full-time equivalent per million euros of investment in EE/RES measures for comparative studies (Center for Development and Support, 2016). The reasons for such deviations may be multilayered. Primarily, as explained in the analysis, all the above studies and projects have been carried out in highly developed countries where the degree of automation and mechanization of the production and construction process in construction is much higher than in the developing countries, such as Bosnia and Herzegovina. This fact significantly reduces the need for labor in the production or construction process, and the number of jobs per million euros of investment is lower than in developing countries.

1.3 Financing the green economy

The European Commission adopted a package of legislative proposals to encourage sustainable financing in the EU. The EU Commission's proposals are upgraded to the recommendations of the High Level Expert Group on Sustainable Financing, made up of civil society, financial sector, scientific community and European and international institutions (EU High-Level Expert Group on Sustainable Finance, 2018).

In general, sustainable financing is reduced to redirecting and increasing investments that contribute to achieving sustainability goals. Green financing is part of sustainable financing, and it relates to investments that contribute to the achievement of environmental policy objectives in terms of sustainability. Encouraging green financing is important because achieving ecological goals largely represents the investment challenge.

Taking into account the environmental, social and managerial dimensions of the entire investment chain will help to redirect capital to long-term sustainable activities. This will also contribute to identifying potential systemic risks for financial stability and managing them.

What is actually green financing? Ryszawska (2013) emphasizes the importance of the role of government during the recovery of the resulting crisis situation and stated fiscal policy, public finance, and private finance as key factors for the start of the transition of any state toward a green economy. Ryszawska (2013, p. 152) states that “public finance can focus on reorienting existing public resources from brown to green economic activities, while private financial institutions can direct greater flows to assets that sustain and enhance financial, environmental and social values in economy”, while Kapoor says that “finding public money for green investment is very hard if not impossible at the time of crisis, when even basic provision of healthcare and education services is also being cut. Green expenditure is often wrongly seen as a ‘luxury’ item to be funded in good times only. While the bulk of green investments by volume will come from the private sector, public investment is a critical catalyst. Public money is crucial in galvanizing follow-on investment from the private sector, for example in R&D, risk-sharing or co-investments in projects that provide marginal return at the current carbon price or seem too risky from a purely financial perspective.” (Kapoor et al., 2018, p. 15).

In short, green financing is crediting or investing in certain measures to achieve a positive effect through reduced use of energy and/or other resources, leading to a reduction in the greenhouse gas emissions. In practice, green financing means investing in energy efficiency, renewable energy sources and possibly other measures that have a positive effect on the environment (for example water, air and soil protection, waste management, etc.) In the world there are so-called green banks that are solely engaged in such crediting. But this is not the rule, so other financial institutions can partly deal with this type of client financing. The term green financing has variations on the topic. Thus, we can often meet concepts such as climate finance, mitigation and adaptation finance, energy efficiency and renewable energy finance and similar.

Green financing is directly related to the theme of global warming or climate change. The goal of green financing is to establish sustainable development of the planet by reducing the negative impact through smart investments through the activities of different entities (companies, the public sector, the population) in the environment. This type of financing is particularly important at the end of 2015, after the famous Paris Agreement, where nearly 200 countries committed themselves to reducing carbon dioxide emissions relative to the base year of 1990. The aim of the Paris Agreement was to reduce the rise in global average temperatures to less than 2 degrees at the beginning of the XXII century (United Nations Climate Change, 2015). Scientists consider this temperature rise in the coming years to be tolerable, while all over this level may have more severe consequences for mankind. Therefore, in order not to have this scenario, large investments are needed in the adaptation and mitigation of climate change. Due to all this, green financing will have a decisive influence over the next 100 years on the further development of planetary events.

According to UNEP (2011, p. 588-589), a global green economy transformation will require following substantial financial resources:

1. Additional investments required will likely be in the range of 1 to 2.5 per cent of global Gross Domestic Product (GDP) per year from 2010 to 2050. A considerable amount of investment will be needed in energy supply and efficiency, particularly in greening the transport and buildings sectors.

2. Financial investment, banking and insurance are the major channels of private financing for a green economy. The financial services and investment sectors control trillions of dollars that could potentially be directed towards a green economy. More importantly, long-term public and private institutional investors, banks and insurance companies are increasingly interested in acquiring portfolios that minimise environmental, social and governance risks, while capitalising on emerging green technologies.
3. The rapid growth and increasingly green orientation of capital markets, the evolution of emerging market instruments such as carbon finance and microfinance, and the green stimulus funds established in response to the economic slowdown of recent years, are opening up space for large-scale financing for a global green economic transformation.
4. The role of the public sector is indispensable in freeing up the flow of private finance towards a green economy. The governments and multilateral financial institutions should use their own resources to leverage financial flows from the private sector and direct them towards green economic opportunities.
5. Public finance is important for triggering a green economic transformation, even if public resources are significantly smaller than those of private markets. Development finance institutions can allocate significant proportions of their new lending towards financing green economy transition projects.

Green credit is a type of loan that is paid to interested customers based on certain qualification criteria. The qualification criteria are of a technical nature and are defined on the basis of calculations by which savings in energy consumption and/or emission of harmful gases have been calculated. In order for the loan to qualify as green, investment is required to have a 20% savings effect. This percentage is used by most banks and international funds dealing with green financing. The percentage of savings represents a reduction in energy consumption compared to the previous state (for example - the company replaces the old machine with new, which consumes 25% less electricity) or in relation to the state of the market (for example - the company introduces a new machine into production, and its energy consumption per product unit is 22% lower in comparison with the same or similar machines that can be found on the given market) (European Commission, 2017; Shishlov et al., 2017).

Regarding renewable energy sources, because of their nature of self-renewal, most of the technologies are generally acceptable for green financing, and in practice we are most likely to meet the funding of solar power plants, hydroelectric power plants, glassworks, biogas plants and other biomass plants.

In addition, green financing can be viewed as well as investing in other measures, such as water, land and air protection measures, and waste management. There are no simple quantitative indicators of savings in such measures, but it is commonly accepted that such measures have a positive effect on the environment. Thus, a good example of this approach is the financing of organic production.

There are several advantages of green financing compared to classical financing. First, green-funded investments in most cases have a quantitatively relevant or tangible impact - energy savings and costs of at least 20%. This client can provide better financial performance and additional space for new investments. This also gives additional value to a bank that deals with such loans. Second, the rate of delays for green loans is, as a rule, smaller (up to three times) relative to the rate of delays in the entire loan portfolios. This is proof that such investments are more than justified and that clients do not have a problem with paying instalments. Third, green loans are used to finance long-term investments (5 years and over), thus securing long-term income. All in all, there is mutual benefit both for the bank and the client (European Commission, 2017; Shishlov et al., 2017).

2 ENERGY COOPERATIVES

Renewable Energy recorded significant growth in the EU and the world. In part this is the result of political will, while the other part of the growth can be attributed to the development of technology and lower prices. Germany's energy transition, known as *Energiewende*, is based on, inter alia, incorporating citizens into ownership over facilities using renewable energy sources (Oko-Institut e.V., n.n.). In addition to reducing emissions of harmful gases and energy dependence on fossil fuel imports, the creation of decentralized energy systems owned by citizens supports the development of local economies.

2.1 The Cooperative model

Under the cooperative we mean independent association of people who are united voluntarily to meet their common economic, social and cultural needs through common ownership and democratic control over the enterprise (International Cooperative Alliance, 1995). Basic features of the cooperative are the possibility of free and voluntary joining and withdrawing from the cooperative, democratic internal structure of the cooperative, which is reflected in the application of the principle of "one member - one vote" decision-making by majority vote and the choice of manager of the cooperative, which correspond to the members and an equal and fair allocation of economic results of cooperative business (Commission of the European Communities, 2001). Cooperatives do not have the emphasis on high profitability in their business at the first place, but on improving the financial and other well-being of their members and the community in which they operate.

Cooperatives differ in many ways from companies that are focused on earning profits. Thus, they differ in the fact that the principle of "one member - one vote" or a limited number of votes of a member is applied in the decision making process, the shares of individual members of the cooperative capital are equal, the return on profit is limited and is proportional to the use of the cooperative service, the value of the cooperative's assets is not reflected in the value of the shares, the business unit of the cooperative can not be included in the stock exchange, the freedom of entry and exit from the cooperative, the change of the cooperative capital of the cooperative and the application of the principle of (or limited division) of the cooperative reserves in the event of its termination. From these characteristics derive the benefits of the cooperative as a flexible legal form for economic activities in the market and removes problems discrepancies interests of members of governing bodies and members of the cooperative, provides the high-quality data exchange and the cooperative focused on its own sources of capital. However, unions have certain drawbacks which are reflected in the limited access to external capital in the capital market, inertia in decision making, attachment governing bodies of the cooperative for the interests of members in decision-making and the like. Particularly significant deficiency is manifested in the limited access to external capital, so the cooperatives are oriented either on their own resources or on loans. Therefore, it is proposed to set up special investment funds that provide the required capital for cooperative work (Jurić, 2006).

There is a set of values and principles that have arisen in accordance with the ideas of the founders of the cooperatives in the XIV century and on the basis of which the cooperatives realize their business, namely (McDonnell, Macknight & Donnelly, 2012; Zimbelman, 2007):

1. Voluntary and open Membership – Cooperatives are voluntary associations open to all persons capable of using their products and services ready to take over membership obligations and to accept the responsibilities of members without any sexual, social, racial, political, religious or any other discrimination.
2. Democratic member control – Cooperatives are democratic organizations under the control of their members who are actively involved in creating their policies and making decisions. The elected members' representatives respond to the membership. Members basically have equal voting rights (one member - one vote), and cooperatives on other levels are also organized in a democratic way. Contrary to cooperatives, owners of more traditional corporations are entitled to one vote per share (so the number of shareholders votes depends on the amount of money they have invested). Accordingly, the cooperatives offer a more democratically based voting system. In most food cooperatives, members are made up of individuals or households. In accordance with the principle of democratic control, each member receives one vote in making decisions as far as the cooperatives are concerned. What is most important, each member gets one vote, regardless of the amount of their investment in the cooperative.

3. Economic participation of cooperative members and distribution – the duty of the members of the cooperative is, according to their interests and possibilities, participation in the work and contribution to the development of the cooperative. Members fairly and democratically control the capital of their cooperative. A part of the capital is always in the joint ownership of the cooperative. Members allocate a surplus for any of the following purposes: development of a cooperative, increase of reserves, then for the benefit of members in proportion to their cooperative transactions and support of other activities accepted by the member board. Although this principle has many different aspects, everything is based on the basic idea that a cooperative, as well as co-owned money under the control of its members. To be more precise:

- Members as owners, initially invest the money needed to start the business. However, regardless of the amount of money invested by each member, decisions are made democratically.
- In order to encourage co-investment by members, cooperatives can pay dividends (as well as interest). However, if the cooperatives do that, the dividend rate must be limited. Such a limitation impels people to enter the cooperative only for speculative purposes, i.e. to make a financial return and to keep the cooperative owned by those who really want to use its services.
- The realized surplus, or the profit resulting from the business belongs to the members (owners) of the cooperative, and they determine how it will distribute it.
- The surplus is allocated to members in proportion to the invested business which each member carried out in the cooperative. In this way, each return excess fairly distributed – to avoid the collection of merit at the expense of other members. This distribution has a special name and that's patronage refund.

4. Autonomy and independence – as a separate and independent legal entity cooperatives in legal transactions with other legal entities and national authorities rely on the work of its members and a cooperative resources, under the direct supervision of its members. Cooperatives are autonomous organizations that are supervised and managed by members. If they come to an agreement with other organizations, including financial or state institutions, or they decide to increase capital from external sources, they will do that under conditions that ensure democratic control of their members and maintain the cooperative autonomy. This principle protects the cooperatives so they will not be controlled by government or development agencies as long as they are well-intentioned. Members must maintain control over co-management so that the cooperative is in line with the wishes and needs of the members themselves.
5. Education, vocational training and information of cooperative members – cooperatives provide education and training of members, elected representatives, managers and employees to effectively contribute to the development of the cooperative. They inform the public, predominantly young people about the nature and benefits of cooperatives. The role of cooperative members is quite different from the role of members of

traditional business. The member of the cooperative is at the same time a buyer, owner and decision maker. Education of members and leaders on the principles, practices and cooperative structure is very important. There can be no cooperation without associates, and the right associates need to know how to effectively use and manage the cooperative. Cooperative education programs provide members with insight into cooperative information and how to become a member (about voting, membership rights, management system, etc.) as well as the products and services of the cooperative itself. The training principle is in fact an obligation to achieve membership effectiveness and is also a prerequisite for democratic control, while cooperation between cooperatives is a necessary business strategy without which the cooperatives would be economically vulnerable.

6. Cooperation between cooperatives – Cooperatives effectively benefit the members by strengthening cooperative cooperation at the local, regional, national and inter-national level. In order to complete the theory of joint work, cooperatives recognize the key importance in cooperation with other cooperatives both locally and regionally, nationally and even with international cooperative groups. In this way, cooperatives are trying to help one another in strengthening their economic positions and to enable the development of existing ones and the establishment of new cooperatives. This principle of cooperation between cooperatives expands the idea of joint cooperation at the organizational level. When cooperatives work together, either at the regional or within the industry, they can do much more for the benefit of their members.
7. Care for the community – cooperatives work for the sustainable development of their communities through policies approved by cooperative members. Each cooperative operates in a community that extends beyond its own spheres of activity and in which members live, or cooperative action affects the wider community. While the needs of the members are their primary concern, the cooperatives also work for the sustainable development of their communities and create positive effects. Cooperatives have a commitment to contribute to the development of a strong and economically viable solution that the community needs, not just to provide local group assistance in the form of charitable contributions. With respect to communion, unlike the investor, cooperative members tend to be part of a particular community, which is linked to the need of the cooperative to recognize and meet the needs of the broader community. This does not mean that cooperatives are more "social" than economic, but the fact that community needs can be used as a means of development.

The originators of the cooperative movement in Europe are considered to be cotton mill workers from the town of Rochdale in the south of England, who in 1844 founded the consumer cooperative called the Rochdale Equitable Pioneers Society (ICA, 2016). Rochdale experiment was the first attempt to formalize the system of principles for the conduct of the individual but also collective action in connection with the organization of business practice that reflects cooperation. In fact, it can be said that the principles serve as a guide for the collective formulation of organizational identity as a cooperative model.

The cooperative organization can be seen as part of a broader movement aimed at improving economic and social conditions and facing negative outcomes of the economic system characterized by setting profits above human needs. What makes it special is a cooperative emphasis on fairness and equality within the business practices of the organization. For example, a consumer cooperative may offer a seemingly typical products and services, but it would never do if it is not in accordance with a set of principles which it considers the social, ethical and sustainable. Another example can be seen in housing care that is affordable for individuals of different living incomes. Cooperatives apply their principles by adopting a community-based development practice that is in line with the ideals of the cooperative that the Rochdale pioneers advocated (Sousa, 2015).

Cooperative principles can be divided into traditional and contemporary. Traditional principles include service at cost, financial obligations of members / owners, restricted return on equity and democratic governance. Modern principles imply ownership of members under the control and fees per use (the benefits are distributed according to the use of the cooperative service). These principles that determine the work and success of a cooperative can lead to conflicts within the organization. Conflicts, especially those involved in property rights and fees, may arise among members or between board and management, members and managers and/or board members. In order to prevent or at least minimize conflicts, it is necessary that all parties understand the cooperative principles and the importance of contributing to these principles for sustainable work and the success of the cooperative. Accordingly, education and training of individuals and groups is very important in this process (Adrian, Jr. & Wade Green, 2001).

Cooperatives belong to the oldest and most persistent organizations. They were mostly related to patriarchal life in the countryside. In BiH, cooperatives exist for over a hundred years. The first cooperative in BiH was formed on October 16, 1904, in the village of Tolisa near Orašje, and it was called the Peasant Cooperative (with limited guarantees). The first cooperatives in BiH emerged in rural areas and established by farmers, they still had a purely credit character. After the emergence of credit unions, in 1909, the first agricultural-producing cooperative was established, founded by Italian colonists in the village of Mahovljani near Banja Luka, whose name was "Cooperatives of wine producers in Mahovljani". Cooperatives in that period in BiH based its development mainly on the countryside and agriculture. In parallel with the establishment of agricultural cooperatives, craft-credit and purchasing-consumer cooperatives, and later manufacturing and processing cooperatives, were also established. Over time, three basic types of cooperatives have been developed: i) a specialized agricultural cooperative; ii) general agricultural cooperative; and iii) peasant labour cooperative (Regional Education and Information Centre for sustainable development in SE Europe, 2016).

2.2 Energy Cooperatives

Energy cooperatives are associations of local actors (individuals, companies, public institutions, local communities, etc.) that jointly develop RES projects. Unlike companies, energy cooperatives have been established and operate on different principles and financing models. Through this mode of association, multiple benefits can be divided into three groups: (i) environmental, (ii) social and (iii) economic benefits.

Energy cooperatives are set up with the aim of using the RES for the development of the local community in the first place, not for gaining profit. Then all members of the energy cooperatives participate in decision-making, allowing citizens to be owners, and the benefits generated through the project remain on the local community level. To put it simply, projects of energy cooperatives have more goals that are socially and environmentally motivated.

The energy cooperatives develop projects in the field of renewable energy sources, and cooperative members are wholly or partly owned. The members of the cooperatives are to a large extent a community in the area of implementation of a particular project. In this way, energy potentials such as biomass, wind, solar energy, geothermal energy, etc. are exploited locally and members of local communities (residents) invest in energy cooperative members. Investments of cooperative members can be in financial but also in material terms. The basic characteristic of energy cooperatives is solidarity and transparency, so that one member of the cooperative has one vote regardless of the amount of investment in the project. In this way, they put into the forefront of other values such as the social and environmental benefits of the project, rather than just financial benefits (Suljić, 2015).

In other words, energy cooperatives are associations of individuals, companies, public institutions, local self-governments linked to the key location that jointly develop renewable energy projects. The joint venture reduces the investment risk and divides the profits from the project.

Energy cooperatives are organized in such a way that for all issues of managing the cooperative, a democratic decision-making process is carried out. The goal of such cooperatives is to promote renewable energy in the ownership of local communities. In this way it is allowed easier implementation of energy efficiency measures focused on the local community, because the unions can achieve greater bargaining power, greater trust and knowledge to operate at a higher level than the individual.

The concept of energy cooperatives has experienced a strong expansion in the EU at the beginning of the XXI Century, which has contributed to the greater participation of RES citizens. In some countries, they are part of state energy programs and strategies, and their development is stimulated. For example, in Scotland, 500 MW of total installed power must be owned by citizens. In Denmark, during the construction of wind farms, it must be offer ownership of a plant in the amount of at least 20% to the population living in a radius of 4.5 km from the wind farm (Suljić, 2015). In Germany, 47% of RES ownership is in the hands of citizens and this number has increased several times over the last 15 years due to the decision of the German government to stimulate the development of energy cooperatives.

EWS is one of the first energy cooperatives in Europe that has taken over the ownership of the local electricity distribution network. The city of Schönau, where EWS operates, is located near the city of Freiburg, which is at the same time one of the most indented parts of Germany, and the whole region is known for a number of installed photovoltaic systems (Energy Cities, 2016).

Today's energy transition of this region and all Germany is the result of a nuclear disaster in Chernobyl in 1986, which prompted the inhabitants of Schönau to launch an energy-saving initiative. Their goal was to point out the possibility of interrupting dependence on nuclear power plants through energy efficiency projects. However, the company that manages the city's electrical network has decided to ignore the demands of the inhabitants of Schönau. After all, the main business of the electricity distributor is its sale, not the savings. At that time, the residents of Schönau realized that the only way to achieve their goals was to take control of the local electricity network.

At that time, the electricity grid was controlled by KWR, which had a concession for the period from 1974 to 1994. In the early 1990s, the KWR requested from the City Council a new concession that would last until 2014. Citizens of the city then realized that they had to stop reloading the electricity network. For this reason, 283 Schönau citizens collected DM 125,000, which is equal to the amount offered by the KWR. Nevertheless, the City Council rejected this civic initiative. However, the decision was rejected by a referendum in which 55% of citizens opposed the takeover of the network by the KWR. As a result of this initiative, the Elektrizitatswerke Schönau Energy Cooperative (EWS) was founded (Energy Cities, 2016).

Despite the great support of the local population, there was strong resistance to such developments at the city level. That's why in 1996 a second referendum was held where citizens and EWS again confirmed their first victory. However, the network was still owned by the KWR, which was then sold under the German law to the EWS.

The estimated value of the network was DM 4 million, however KWR decided to offer a price of DM 8.7 million. Due to the lack of capital for network purchasing, EWS launched a donation campaign across Germany, bringing an additional DM 2 million within 6 weeks. Negotiations agreed a new price for the network for which the EWS now had enough capital. Citizens of Schönau, with the support of Germany, have managed to buy out the local electricity network. Today, EWS is the main electricity distributor in Schönau, offering its customers energy from conventional and renewable sources. In addition, the EWS has 4795 members, has an annual turnover of 43 million euros and has 105 employees. In addition to distributing electricity, EWS also manages today with several companies involved in the sale of electricity on the market, the construction and management of renewable energy projects, the distribution of biogas, etc. (REScoop 20-20-20, 2013).

Middelgrunden is one of the most famous wind farms in the world. Its position on 2 km of Copenhagen and makes it one of the main attractions of the capital city of Denmark. The power plant was put into operation in 2001 and has since become an integral part of the local landscape. Due to the great involvement of the public from the very beginning, both in the planning process and in the ownership of the power plant, this project had no problems with NIMBY syndrome. Half of the plant is owned by the Middelgrunden Energy Cooperative, which has over 8,500 members from all over Denmark (Copenhagen Environment and Energy Office, 2003).

The project started in 1996 as an initiative of the Copenhagen Energy and Environment Office, one of the offices, established throughout Denmark for the purpose of providing advice on sustainability. Based on the initiative of the employees of this office, the Middlegrunden Energy Cooperative was founded in 1997. Although it has this title, this initiative actually has a legal form of partnership (Interessentskab), which is specifically regulated by the Danish law (Suljić, 2015).

The whole project was developed in cooperation with Copenhagen Energy, one of the major energy companies in the east of Denmark. Each side owns a half of the project, which has a total of 20 turbines, each power of 2 MW, making the total installed capacity of 40 MW. The plant produces around 40,500 MWh per year, which is enough to supply about 35,000 households with electricity. Collaboration of these two sides has certainly contributed to the sustainability of the project. Copenhagen Energy has expertise in technology and project management while the Middlegrunden Energy Cooperative, thanks to its numerous memberships, has the opportunity to communicate effectively with the public and the media.

Ten wind turbines with a capacity of 2 MW were financed by the sale of 40,500 shares, each of which represents the annual production of electricity of 1,000 kWh. The total investment budget of the cooperative was 23 million euros, while each share was sold for 570 euros. The number of shares offered is based on the estimated 90% of annual energy production. Thus, the cooperative avoided the possibility of offering a large number of shares, and the inability to pay dividends to members (Copenhagen Environment and Energy Office, 2003).

In the early stages of the project, until all licenses were collected before the start of the construction, the cooperative financed its work by selling bookings for shares. Reservation of one share cost 7 euros. In this way, 30,000 reservations for the project's shares were sold, whereby the cooperative financed the initial work, without bringing members into great financial risk. Most plant owners are residents of Copenhagen, although the cooperative include members from all parts of Denmark. The return on total investment is anticipated after 8 years with an internal rate of return of 7.5% or 70 euros per share.

The Energy Cooperative "Island of Krk" was founded at the founding assembly of 19 founders on July 31, 2012 in the premises of the City of Krk. Members of the energy cooperative on the island of Krk who are interested in the realization of the photovoltaic projects jointly through the cooperatives managed to win up to 40% more favorable photovoltaic equipment prices and lower the project documentation price by as much as three times. In addition, numerous projects have been implemented to provide employment for a number of people to maintain a large number of photovoltaic systems. Such a form of interdisciplinary association can be considered as a consumer cooperative where it meets the common interest of the consumers themselves, and it is feasible to realize craftsmanship for joint ventures in the market and for the financing of renewable energy projects (Heinrich Böll Foundation, 2014).

2.3 Development opportunities

Generally it can be said that the energy cooperatives for the local community bring more benefits that can be divided into three basic groups (Heinrich Böll Foundation, 2014):

- Environmental benefits – reduction of greenhouse gas emissions, solving environmental problems of the community - the efficient management of fertilizer and / or waste residues from agriculture and forestry, the reduction of pollutants in the air, etc.
- Social benefits – division of investment risk among cooperative members, investing in projects developing the local community, suppressing and/or eliminating NIMBY effects, reducing local population opposition to projects, creating new opportunities for local businesses, creating new jobs, contributing to sustainable development of the local community, etc.
- Economic benefits – creating managerial and technical knowledge in the local community, creating new jobs, creating a stronger sense of local community, saving on energy costs.

Table 1 shows the comparison of energy cooperatives with business companies.

Table 1: Differences between business companies and energy cooperatives

Business companies	Energy cooperatives
Regulated by the Law on Business Companies	Regulated by the Law on Cooperatives
Basic capital is money	Basic capital is work
Number of votes depends on the structure of capital	One member of the cooperative is one vote
The requirement for membership is the making of money	The requirement of membership is working through cooperatives
The goal of the company is to maximize profit	Promoting the welfare of its members
Profit is divided in proportion to the participation in the capital	Profit is distributed by taking into account the participation in the work
In case of bankruptcy/liquidation, the remaining assets are distributed to members of the company	In case of bankruptcy/liquidation, all remaining property is transferred to the local community where the cooperative is located

Source: Pašičko, Kirac & Jerkić (2014)

The power of the local community and its key players to participate in projects in which citizens invest or participate in the production and/or use of RES is the development lever of each local community.

The guidance for the participation of local communities and citizens in the energy sector lies in the realization of certain types of benefits from the development of energy projects for citizens, as consumers and/or producers of energy from RES. With the usual large investment in the energy sector, the equality of ordinary citizens and small businesses, it can be used to access finance, while simultaneously streamlining profits towards the wider local community increases the social acceptability of sustainable development and renewable energy sources. This way of involving the wider local community is of particular importance for the rural environment, not only financially, through the export of electricity to urban and industrial centers, but also in participating in decision making and profit making, as well as transparency, which are a prerequisite for local acceptance of infrastructure projects of renewable energy sources. In addition, funds directed to communities can be of use in social and cultural life. Incorporating a local community can also strengthen local economic development and create a sustainable investment cycle. RES projects can create temporary or, sometimes, long-term activities and profit of local investors for reinvestment and further local development. This is particularly true if key players in communities take a key role in the project, thus developing important cooperative skills and empowering themselves and the community.

There are many different forms of community involvement in RES projects, in relation to the number and type of benefits, as well as the degree of participation. An example of some of the projects included at the local community level is given in Figure 2.

In order to enable the inclusion of key players in the local community, it is necessary to respect certain criteria and to create models for the development of projects based on local community based RES. These criteria are reflected in (Suljić & Harbaš, 2016):

1. Openness towards non-institutional, external investments – Capital or loan can be a means of improving new forms of financing and enabling individuals to benefit financially from renewable energy projects: this criterion primarily applies to investors who come outside the local community in the absence of local investment.
2. Creating benefits for the wider community – If it is created as much as possible benefits for the wider local community, it will be easier to improve the climate for the acceptance of RES projects in the local community.
3. Openness or active mobilization of non-institutional local investments – It enables all local community stakeholders to participate in RES projects, thus facilitating the climate for the acceptance of RES projects, but also providing a favorable share of the exploitation of local community resources.

Figure 2: An example of the involvement of the wider local community in renewable energy projects

Source: Federal Ministry for Economic Affairs and Energy (BMWi) & GIZ (2016)

4. Decision-making at the local level – Provides equitable benefit to the local community through a variety of benefits of RES projects for the strengthening of the local unit, which takes the lead role in the development of projects in their area. Profit remains within the community and provides added value to the local community.

The development of RES projects can be based on several models (Suljić & Harbaš, 2016):

- Self-investing model – individuals or businesses develop or fund RES projects.
- Compensation model – a wider social community gets a certain form of benefit from RES projects.
- Partner model – partnership between institutional investors such as commercial investors, public utility companies.
- The model with a focus on the local community – local community has at least 50% in the decision-making process.

Through the involvement of citizens and all the relevant players in the development and implementation of the project of the RES, the wider community gets some form of benefits that are, among other things, relate to (Suljić & Harbaš, 2016):

- promotion of the local labor market through the creation of new jobs (e.g. for the construction of facilities, for deliveries or services of goods, etc.),
- improving local infrastructure,
- opportunities for formal and informal training,
- investments in future energy projects (e.g. through a local foundation),
- lower prices for energy (electricity and heat),
- measures of household energy efficiency,
- improvement of the state of the environment (greening of areas, parks, etc.), and
- fundraising funds to local institutions for developing new environmental projects, etc.

3 ENERGY COOPERATIVES POTENTIALS IN BOSNIA AND HERZEGOVINA

The energy issue is a very well-known topic in Bosnia and Herzegovina. This is driven by several factors. In the country there are several large energy plants which are key economic drivers for certain local communities but represent also a vital part of the national economy, whereas most of them are fossil fuel fired power plants. Moreover, air quality is often related to local energy production (mostly while using coal and/or wood), since many populated cities face severe problems with this issue during winter. Energy cooperatives can contribute to both of the aspects, employment and reducing environmental damage, thus such a concept needs to be more used in the country. Bearing in mind that energy cooperatives rely on the usage of renewable energy sources, in BiH this concept can mostly be used for the deployment of biomass and biogas potential.

3.1 Energy Cooperatives in Bosnia and Herzegovina

The relevant laws related to cooperatives in BiH do not enable the establishment of an energy cooperative itself, but as a subsidy of other cooperative's forms (agriculture, housing, veteran etc.). The project ENZA 2 (in Bosnian "Energetske Zadruge u BiH 2") had the aim to identify potential sites for the establishment of Energy Cooperatives. The interest and motives vary from community to community but in general stakeholders look very positive to the concept. However, several barriers hinder the breakthrough of the concept in BiH. Based on experience gained during the project implementation in this field several barriers were identified (Regional Education and Information Centre for sustainable development in SE Europe, 2016):

- Lack of trust in the cooperative model – in general cooperatives are familiar for most of the population but in most of the cases with negative connotation. This is due to the fact that many cooperatives (especially agricultural) led to bankruptcy of many farmers in the past due to single interests and corruption.
- Lack of funds – purchasing power of BiH citizens is very low, among the lowest in Europe (International Monetary Fund, 2018), and investing in energy projects is rarely a priority or a desired opportunity for ordinary citizens.
- Lack of free time for volunteering – development of an energy cooperative asks for many volunteering hours, especially in the early stage of its development. Moreover, in this phase benefits are very low or do not even exist which lowers motivation of its members.
- Lack of technical knowledge – basic technical knowledge on energy efficiency and renewable energy sources is a great asset for any cooperative member. This is due to the fact that the EC has to communicate and work with different kind of stakeholders within the energy sector.
- Low price of energy – current prices of energy (of any kind) are low which sometimes make unfeasible any kind of initiative regarding the introduction of renewable energy.

As of January 2019 only one energy cooperative was co-founded in BiH, namely in June 2018 the existing Veteran Cooperative of Nemila was re-registered for the purpose of doing energy related business (Regional Education and Information Centre for sustainable development in SE Europe, 2016).

In general, the awareness regards to the involvement of citizens in energy projects is very low. This is once due to the fact that energy planning and doing business in the former socialist regime was state driven making stakeholder engagement very weak.

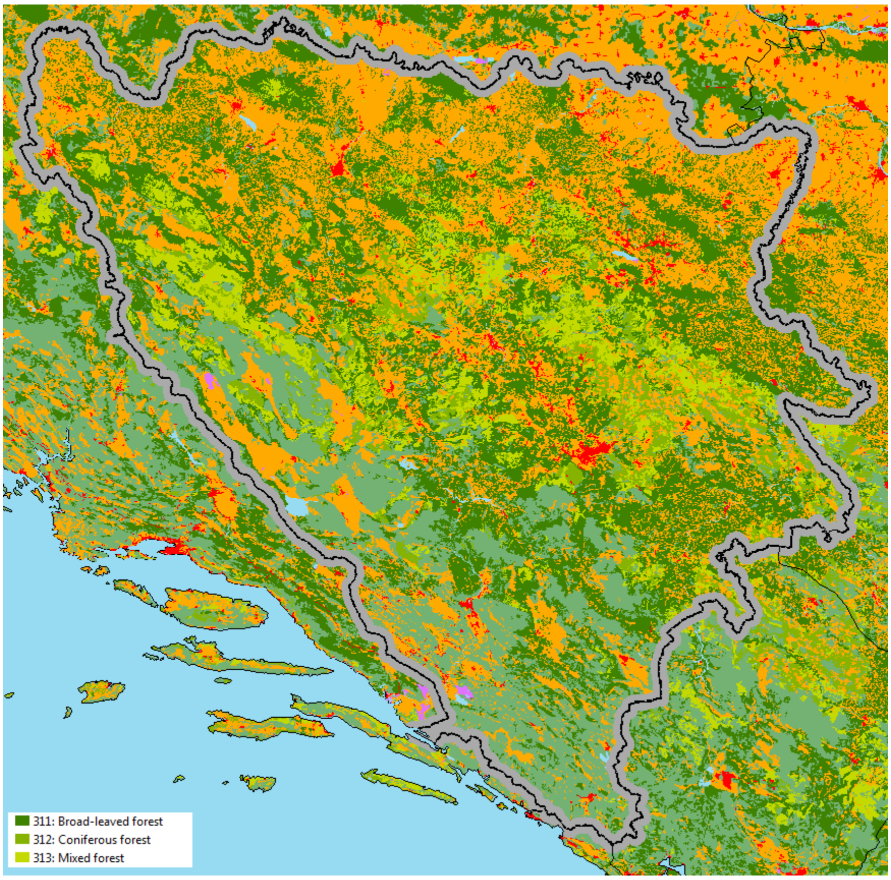
3.2 Development opportunities in Bosnia and Herzegovina

Bosnia and Herzegovina has more advanced renewable energy targets than the EU itself (40% vs. 20%) and the country ranks 13th worldwide in this regard (Eurostat, 2019). This is driven by two facts. A great portion of the final energy is already being covered by hydro energy, while the country has huge potential in other renewable energy sources. Although this target share will be achieved mainly through the usage of hydro, wind and solar energy, the usage of biomass is very important due to its impact onto the local economy. Therefore, this master thesis will elaborate the potential of wood biomass and biogas (as another form of biomass).

3.2.1 Development opportunities based on biomass

Forests in BiH cover more than 2.2 million ha of the total territory or about 43%. This indicates that BiH has huge forest resources, and thus high potential of wood biomass. Out of the total area under forests, 81% is owned by the state, and 19% is privately owned (Jovanović et al., 2005). The largest share of all types of forests is deciduous forests, about 68%, while forests of coniferous and mixed forests account for 12% and 20%. Figure 3 shows the share of some types of forests in the total forest area in BiH and generally about forest cover.

Figure 3: Map of the distribution of forest area of Bosnia and Herzegovina



Source: Copernicus Land Monitoring System (2012).

Sources of wood biomass potential are:

- wood from forests ("natural" forests and energy plantations),
- biomass from agricultural areas (remains of agricultural crops), and
- wood residues from primary and secondary wood processing.

For the purpose of this master thesis biomass which is elaborated includes only wood processing and forest waste. Bosnia and Herzegovina belongs to a group of European countries which are extremely rich in forest resources from the aspect of their distribution and biological diversity. Forests cover more than 50% of the land, but there is no unique strategic orientation toward sustainable exploitation of such a vital resource. The total technical potential of biomass is 7.44 PJ which equals 17.22% of the total energy consumption in BiH in 2014 (UNDP, 2014).

Table 2. Wood Biomass Technical Potential in BiH (2014)

Woody Biomass Sources	Conifer trees		Deciduous trees		Degree of availability (%)	Technical Potential (PJ)
	m^3	PJ	m^3	PJ		
Firewood	1,711	0.01	1,228,441	11.20	0%	-
Forest residues	342,181	2.22	261,154	2.38	33%	1.53
Small branches	314,848	2.04	401,432	3.66	33%	1.22
Stumps	354,857	2.30	200,843	1.83	33%	0.61
Residues from wood processing industry	314,848	2.04	334,527	3.05	80%	4.07
TOTAL	**1,328,446**	**8.61**	**2,426,396**	**22.13**		**7.44 PJ or 2,067 GWh**

Source: USAID (2016).

As it can be seen from Table 2 the largest potential for biomass exploitation is using residues from the wood processing industry. However, this potential is in most of the cases used directly by the company running the business, thus leaving limited options for other players (e.g. energy cooperative). Therefore, energy cooperatives should focus on forest residues and small branches which amount 37% of the biomass potential.

3.2.2 Development opportunities based on biogas

According to last official Census 2013 more than 10% of total working population is employed in the agriculture, forestry and fishing sector (104,946 employees). Total number of legal entities in the same year was almost 2,000 or 2.5 % of total number of legal entities (Agency for Statistics of BiH, 2018). On average an agricultural company employs about 50 workers which is for BiH circumstances very significant. Therefore it is utmost importance to provide additional benefits for those companies and production of biogas could be one of benefit generators. Especially larger farms of cows, swine and poultry can achieve a cost effective biogas production. Since great land, which is greatly unused in BiH, represents a potential for the increase of farms. Apart of poultry the number of farms of cows and swine is not changing rapidly (USAID, 2016).

In order to estimate biogas potential following data are needed: number of living stock (per animal type), daily manure yield, biogas yield per manure type, calorific value of biogas, and availability factor. The last factor is the most essential which is determined by the way farms are organised. If farms are more concentrated (means more farms per ha) the availability factor will be greater and vice versa. In literature this factor varies greatly and for purpose of this master thesis the factor published by USAID Bosnia and Herzegovina will be used which is 20% (USAID, 2016) for all animal types. However, a comparison is provided when using other availability factors based on different literature. Other input data were obtained from official statistic authorities (for the year 2016) and other relevant literature. Total technical potential for plant capacities was estimated taking into account average work rate of 8,000 h/a per plant.

Table *3* shows that total technical potential of biogas is 449 GWh.

Table 3. Energy potential of animal waste in Bosnia and Herzegovina (2016)

	Cattle	Sheep	Swine	Horse	Poultry	Goats	TOTAL
Animal heads (in 000)	445	1,006	527	16	20,118	73	**22,185**
Total manure (t/head year)	10.80	0.64	1.89	8.82	0.03	0.64	**-**
Dry solids (t/head year)	1.54	0.22	0.22	2.60	0.01	0.22	**-**
Total manure (000 t)	4,808	644	996	137	684	47	**7,316**
Biogas yield factor (m^3/dry per t)	281	120	649	160	359	120	
Theoretical biogas potential (10^6 m^3)	193	27	74	6	72	2	**374**
Availability factor	0.2	0.2	0.2	0.2	0.2	0.2	**-**
Technical potential of biogas (10^6 m^3)	39	5	15	1	14	<1	**75**
Technical energy potential in TJ	**832**	**116**	**319**	**28**	**312**	**8**	**1,616**
Technical energy potential in GWh	231	32	89	8	87	2	**449**
Installation capacity in MW (8,000 h)	29	4	11	1	11	0	**56**

Sources: Federal Office of Statistic (2016); Republika Srpska Institute for statistics (2016.), USAID (2016), Batzias et al. (2005).

As mentioned earlier biogas potential may strongly differ when taking into account different availability factors. For the sake of comparison

Table 4 gives an overview of different biogas estimations using different sourced availability factors.

Table 4. Comparison of biogas potential estimation based on different availability factors

	Cattle	Sheep	Swine	Horse	Poultry	Goats	TOTAL
Animal heads (in 000)	445	1,006	527	16	20,118	73	**22,185**
Theoretical biogas potential (10^6 m^3)	193	27	74	6	72	2	**374**
Availability factor							
USAID, 2016	0.20	0.20	0.20	0.20	0.20	0.20	**-**
Batzias et al, 2005	0.45	0.35	0.80	0.10	0.70	0.35	**-**
Chávez-Fuentes et al, 2016	0.43	0.43	0.56	0.37	0.50	0.31	**-**
Technical potential of biogas (10^6 m^3)							
USAID, 2016	39	5	15	1	14	<1	**75**
Batzias et al., 2005	87	9	59	1	51	<1	**207**
Chávez-Fuentes et al., 2016	82	12	42	2	36	<1	**175**
Technical energy potential in TJ							
USAID, 2016	832	116	319	28	312	8	**1,616**
Batzias et al., 2005	1,873	203	1,277	14	1,092	15	**4,473**
Chávez-Fuentes et al., 2016	1,776	250	897	52	780	13	**3,769**
Technical energy potential in GWh							
USAID, 2016	231	32	89	8	87	2	**449**
Batzias et al., 2005	520	56	355	4	303	4	**1,242**
Chávez-Fuentes et al., 2016	493	70	249	14	217	4	**1,047**
Installation capacity in MW (8,000 h)							
USAID, 2016	29	4	11	1	11	<1	**56**
Batzias et al., 2005	65	7	44	<1	38	1	**155**
Chávez-Fuentes et al., 2016	62	9	31	2	27	<1	**131**

Sources: Federal Office of Statistic (2016); Republika Srpska Institute for statistics (2016), USAID (2016), Batzias et al. (2005).

As shown in
Table 4 the estimated technical potential differs strongly when considering different quoted availability factors. As mentioned earlier, for the purpose of this master thesis USAID's availability factor of 20% will be used taking into account that the Report was made solely for BiH and local circumstances have been taken into account. In fact in the Report it was quoted the "in the statistical documents there is no data given regarding the size of animal farms so that it could be determined how many of them are large enough for biogas production to be technically feasible. Based on the fact that most animal farms are small, it was estimated that only 20% of farms are large enough and therefore, the technical potential of livestock residues is 20% of its theoretical value" (USAID, 2016).

Some of the barriers for a stronger deployment of biogas potential are common for developing countries (Batzias et al., 2005) which are lacks of:

- sensitisation of stakeholders,
- know-how,
- proper infrastructure,
- state interest, and
- financial incentives.

As of January 2019 only two biogas plants were operating in BiH, both in the entity Republika Srpska. The older one is located in Aleksandrovac and is part of the agricultural cooperative Livač with an installed capacity of 37 kW. The newer one was put into operation in Donji Žabar in 2016 and has a capacity of 1 MW_{el} for which feed-in tariffs have been obtained (USAID, 2016).

However biogas represents a good potential for further development of rural areas in BiH and to increase the sustainability of existing and new farms. In order to assess the level of applicability the following chapter provides an analysis based on Geographic Information Systems (hereafter: GIS) methods.

4 CASE STUDY: MAPPING OF POTENTIAL BIOMASS AND BIOGAS BASED ENERGY COOPERATIVES USING GEOGRAPHIC INFORMATION SYSTEMS (GIS)

For the purpose of the assessment energy cooperatives have on the economy, society and environment two case studies have been analysed, which are used as reference points to extrapolate results on the state level.

4.1 Biomass oriented energy cooperative

Since the beginning of civilization, biomass has been the main source of energy for mankind. Today, biomass is the primary source of energy for almost half of the world's population, and wood biomass is the main source of energy in many developing countries. Particularly significant is the participation of biomass in total energy consumption in rural areas. The possibilities of using biomass are large, from the production of heat and electricity, the replacement of fossil fuels with biogas and biodiesel, to the possibility of combustion with coal. Therefore, all secondary forms of energy can be obtained from biomass. This means that, with sufficient biomass potentials and sustainable exploitation, a country can cover all its energy needs from biomass and thus be energy-independent. The use of biomass energy has been further stimulated by activities to reduce greenhouse gas emissions. This directs the technological development of the country, increases employment and exports, reduces dependence on fossil fuels, increases the security of energy supply, and so on.

These are also typical goals of the energy policies of these countries. Fighting climate change, hence the use of biomass energy is difficult, i.e. only those measures are adopted and the extent to which development goals such as employment (especially in rural areas), restructuring of forestry, development of innovative technologies and services, etc. are achieved. As a rule, incentives are needed to promote the use of modern technologies to use biomass for energy production. The greatest added value of the wood biomass system is local benefits that help reduce poverty (as opposed to fossil fuels and some renewable energy sources).

Of all the socio-economic benefits of using biomass for energy production, employment is most often emphasized as the most important. The issues of energy security are becoming an increasingly important component of the development policy of the countries. Increasing politicization of oil and gas and the great dependence of most countries on imported energy increases the significance of the issue of security of energy supply. The use of biomass contributes to increasing supply security as biomass is in most cases used locally, i.e. near its origin.

Biomass is considered a carbon neutral source of energy. This means that the net carbon dioxide emissions in the life of biomass are zero. This is only fulfilled if the utilization of biomass is equal to or less than the increment.

The use of biomass for energy production is generally uncompetitive with respect to fossil fuels. This is a consequence of a number of market and non-market factors. The goal of introducing incentives to use biomass as a source of energy is to achieve biomass competitiveness in the energy market. When determining the amount of incentives, all benefits of using biomass should be considered and quantified in some way. The value of the benefits of using biomass should include benefits such as employment (especially in rural areas), economic development of rural areas, diversification of sources and reduction of external costs of energy production, etc. The central problem of quantification of benefits is the reduction of economic, social and environmental benefits to one unit, preferably monetary. The justified amounts of incentives are all amounts up to the amount of benefits, but they are the optimal ones for achieving the competitiveness of biomass as a source of energy.

Husika (2012) proved in his doctoral dissertation that biomass, as a source of energy, is competitive in the market if its use is stimulated in the amount of economic, social and environmental benefits of its use. The author developed a model for the quantification of the three most important benefits that include economic, social and environmental benefits. After that, using the model are the quantified benefits of using biomass in BiH. With the use of REAM software, the impact of incentives in the amount of quantified benefits on the competitiveness of biomass in the selected area within BiH, in the Central Bosnia Canton, was modelled. The model was developed for the use of wood biomass for the production of heat and electricity in polygeneration plants. The model quantifies, according to the author, the three most significant benefits: employment, local security, energy efficiency (country/ national benefit), benefit of fulfilling obligations and the use of greenhouse gas emission reduction rights using biomass as a source of energy. These are the three most important benefits, as they summarize local, country and global driving forces for the use of biomass. Benefit value is considered at the level of the government of a country. The goal of the model was to increase the economic potential of biomass in one country by providing deserved financial incentives for its use.

Such a model can serve those who create a policy of incentive mechanisms for using biomass to determine the amount of incentives. The amount of financial incentives for the use of biomass for energy production should maintain the amount of benefits that such use of biomass has. In a market where fossil fuel consumption is not encouraging, the amount of biomass incentives should not be higher than the amount of benefits that the use of biomass brings to the field of the observed market, i.e., countries. In case the incentive in the amount of benefits is not sufficient for the competitiveness of biomass as a source of energy, the use of biomass should not be encouraged because the costs are higher than the benefits. The incentive amount may be lower than the amount of benefits if that amount makes the use of biomass competitive. Since this is about, from the perspective of investors in the projects of using biomass, external benefits, through incentive mechanisms, countries should internalize these benefits. By basing the amount of incentives on the amount of benefits, on the one hand, biomass use projects become more attractive to investors, and on the other hand, the country has cover for spending public funds for incentives.

By using the technical potential of wood residues in BiH for energy production, it could open about 2,300 sustainable jobs and reduce the consumption of fuel oil by about 54,000 tons per year. In addition, carbon dioxide emissions would be reduced by about one million tonnes a year. The total benefits of using the technical potential of wood biomass in BiH amount to about 120 million KM/a, which is about 0.5% of GDP in 2011, or about 100 KM/MWh of electricity generated from biogas-based biogas plants. That is about 62.5% of the current feed and tariffs in BiH. The greatest benefit has been shown to increase the security of energy supply, which accounts for about 42% of the total benefits analysed by the model (Husika, 2012).

The impact assessment of the use of biomass incentives on biomass competitiveness, to the amount of benefits quantified using the model developed was carried out using the REAM software for the Central Bosnia Canton. Three scenarios for the incentive to use biomass have been analysed (Husika, 2012):

- Scenario I – there are no incentives,
- Scenario II – there are incentives for fulfilling obligations and the use of the rights to reduce GHG emissions, and
- Scenario III – there are incentives for the use of biomass in the amount of employment benefits and increased security of energy supply.

Modelling has shown that incentives to meet commitments and the use of the right to reduce GHG emissions are sufficient to achieve biomass competitiveness, but at the same time these incentives encourage the use of natural gas at the expense of reducing the use of other fossil fuels (especially coal). In this way, BiH would become increasingly energy-intensive. Introducing biomass incentives that match the benefits of employment and increase security of supply, achieves biomass competitiveness, without compromising the competitiveness of domestic coal in relation to imported natural gas.

Husika (2012) estimated total biomass potential (forest residues and wood processing waste wood) at a level of 12.5 TJ/a. Biomass from forest (forest residues) is estimated at 4,820 TJ/a of which 20% are subject of the energy cooperatives (marketable), i.e. 964 TJ/a or 267,778 MWh/a. Based on average operation hours of biomass fired power plants suitable for energy cooperatives business model of 6,000 hours a year, total installed capacity would amount 45 MW.

4.1.1 Case study for biomass oriented energy cooperative in Nemila

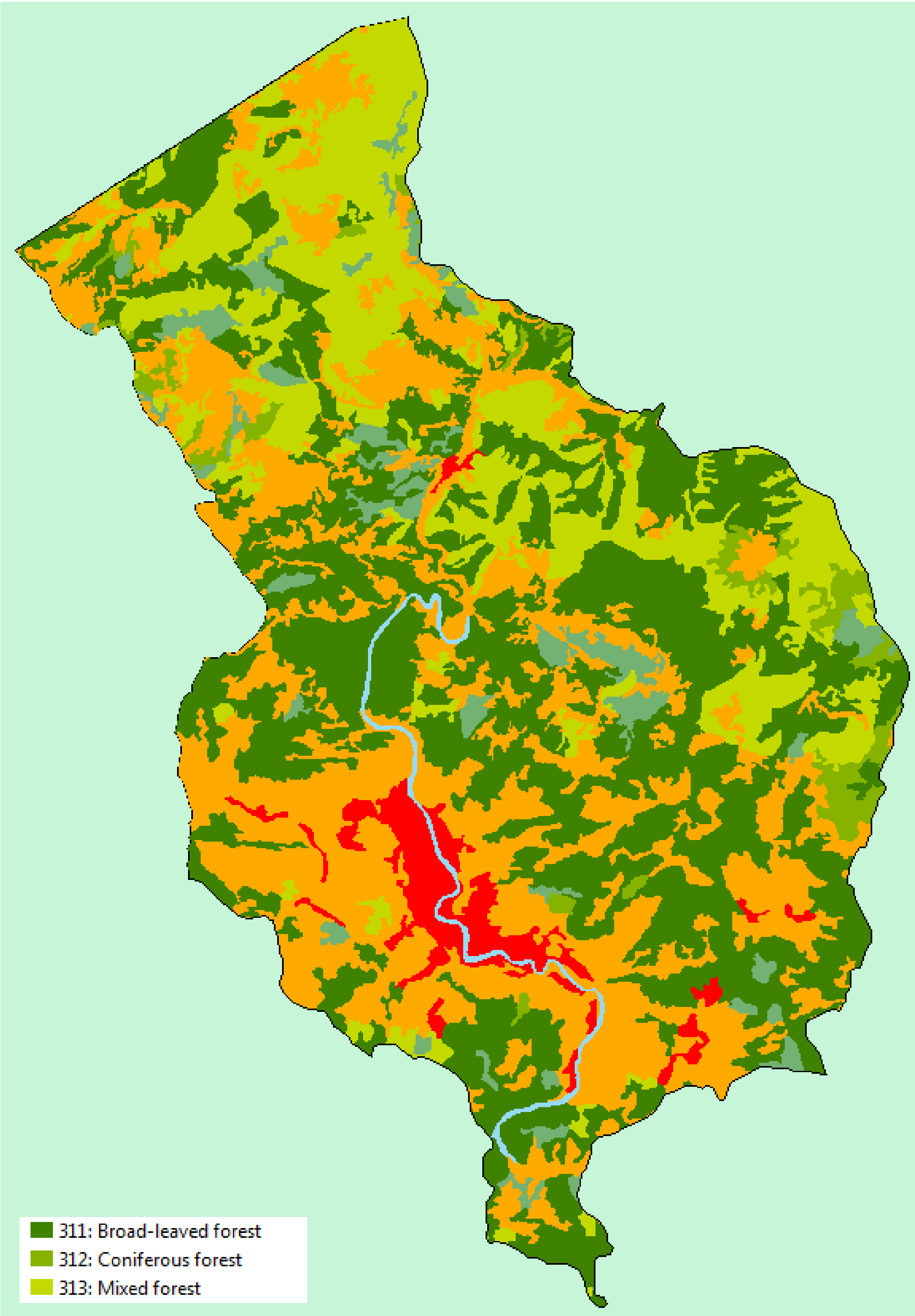
The biomass oriented energy cooperative is based on a real case example of an initiative in Nemila, a town close to Zenica. Nemila is part of Zenica-Doboj Canton and City of Zenica and represents a very small local community with a population of 2,508 inhabitants (Statisika, 2018). The area is rich in forest, with beech, oak, pine, larch, hornbeam and spruce being the most dominant trees (see
Figure 4). The community is located in a valley with a maximum width of 2 km. River Bosna is flowing through the entire community.

The key motive to establish an energy cooperative in Nemila is improving living standard of local population, increase resource efficiency and quality of the environment. Additional benefits include possibilities of employment of locals, preventing illegal logging which presents a permanent problem and causes fires. The aim of the energy cooperative is to establish a collection & logistic centre (hereafter: CL Centre) for biomass. This CL Centre will serve as a collection point for biomass not only from Nemila but also from neighbouring local communities. The CL Centre will also serve for the production and sales of woodchips made of collected wood waste.

The region is rich in forests which represent a great unused potential with a large quantity of wood waste. Forest amount to more than 65% of total are within the City of Zenica, whereas 90% of forests are state owned. Wood stock/wood mass amounts 4.891.000 m^3 or 159 m^3/ha (Federal Institute for Development Programming, 2016). Consumption of wood for energy purposes is especially important in rural areas and biomass represents the forth energy source after coal, oil and gas worldwide, thus representing the key renewable energy source.

From all types of wood biomass, wood chips is most dominant in terms of use for electrical and heat energy production. Wood chips represent a fuel which is obtained by shredding wood into small pieces, as well as from wood residues from wood processing. It can be used in automatic boilers for heating of small and large residential buildings but also public buildings.

Figure 4. Land use in City of Zenica



Source: Copernicus Land Monitoring System (2012).

4.1.2. Project idea

The main activity of the energy cooperative will be production of wood chips from forest waste and wood processing residues. The capacity of the production is 1,500 t/a in the first phase, which is sufficient for the current district heating system (hereafter: DHS), and 5,000 t/a in the second phase. Main sources for production of wood chips are:

- forest residues – low quality trees and residues from forest production,
- residues from agriculture production,
- other clean wood – wood from gardens and parks, wood residues after road maintenance, orchards and wood waste from rivers,
- by-products and wood processing residues – chemical non-treated wood residues (with or without crust, or only crust) from primary wood processing (mainly from sawmills),
- used wood – recycled wood/wood waste, only mechanically treated.

The resources needed for the energy cooperative includes a storage area for forest residues and produced wood chips. The investment in the storage area is estimated at EUR 25,000.

Figure 5. Example of a Collection & Logistic Centre

Source: Google Images (n.d.)

Furthermore, it is necessary to invest in equipment needed for the production of woodchips which include a sifter (to determine dimension of wood chip), moisture meter and a scale. This equipment is estimated at value of EUR 3,500. Other equipment for the energy cooperative amounts to EUR 42,500 and includes a chainsaw, tractor, trailer and low power wood chipper.

Table 5. Overview of capital expenses needed for mechanization

Type of cost	Capital expenses (€)	Share
Chainsaw	500	1%
Tractor	22,500	26%
Trailer	4,500	5%
Wood chipper	15,000	17%
Chipping size equipment	3,500	4%
Storage area	25,000	29%
Land	15,000	17%
TOTAL	**86,000**	**100%**

Source: Regional Education and Information Centre for sustainable development in SE Europe (2016).

Prior to the establishment of the CL Centre for the purpose of the energy cooperative in Nemila it is necessary to identify its location and way of financing. The expenses for the needed area of 3,000 m^2 amount EUR 15,000. Moreover, a storage area is needed which, for this production size, amounts EUR 25,000. As it can be seen from Table 5 total capital expenses (hereinafter: CAPEX) amount to EUR 86,000 out of which storage are represents almost 1/3 of the investment. Another significant cost item is the land needed for the storage area and jointly those two cost items amount almost 50% of the investment. In reality those costs can be avoided or reduced, since members' land and existing unused storage areas can be used almost cost free. In this way the total investment would be significantly reduced.

For an estimated number of 35 cooperative members this would require an investment of approx. EUR 2,500 per member.

In the operational stage the energy cooperative will employ four workers; three guards and one operational manager of the CL Centre. The annual cost is estimated at EUR 25,000 for wages. Operational and maintenance costs are estimated at EUR 15,000. Annual cost for biomass in the second stage of the energy cooperative will amount EUR 150,000 (at a price of 30.00 €/t). In this way total operational expenses (hereinafter: OPEX) are estimated at 190,000 €/a.

The production of wood chips at annual level at full capacity will amount to 5,000 t/a. At current market prices of 40.00 €/t total revenues of the energy cooperative would be

200,000 €/a. Without any additional revenues and with OPEX remaining the same, total profit would amount to 10,000 €/a.

Using biomass for energy purposes has various social and economic benefits which include new workplaces, development of an industry oriented towards domestic consumption, possibilities for export etc. Considering the growing demand for woodchips in BiH a greater number of producers can be expected. Another reason is that wood chips represent the economically most favourable type of biomass. There are numerous examples of wood chips usage in DHSs such as in Gračanica, Banja Luka, Prijedor, Gradiška or Nemila.

Within the project "Usage of renewable energy sources in the district heating system in Nemila" public buildings (primary school, health centre, police station etc.) and 91 private buildings, which are close to the hot water pipeline, were connected to the DHS. This was actually the first stage of the DHS establishment with a 3 MW capacity.

The energy cooperative in Nemila would have a competitive advantage due to the vicinity, which leads to almost zero transportation costs. Apart of the existing heating plant other potential clients are present in the surrounding (business enterprise etc.).

Figure 6. *The existing biomass heating plant in Nemila*

Source: Google Images (n.d.)

The financial analysis was done using following general assumptions:

- Current prices at the domestic market are used, thus increase/decrease of price is not included.
- All prices are given in Euro (€) and do not include Value Added Tax, as well as for project inflows and outflows.

- The period of the analysis is 15 years. This is relation to the duration of the feed in tarrif and peak performance of the facility. For small scale energy projects 15 years is the most used reference period.
- Project benefits (or incomes) represent all net effects of the project (i.e. when all expected inflows are reduced by outflows).
- The biomass produced by the energy cooperative would be utilized in the existing heating plant in Nemila.
- A discounted rate of 5.5 % p.a. is used which is equal to interest rates in entities' development banks. Moreover, investing through model such as cooperatives is a novelty in BiH and thus a little bit riskier in comparison to other form of entities.
- Capacity of the heating plant in the first year is 5,000 t/a.
- Income tax (10%) is not applicable in legal entities such as cooperatives, a thus is not included in the analysis.
- The residual value is calculated in the analysis and represents the value of the plant at the end the project life. The residual value is calculated using the annual depreciation into account. Annual depreciation rate for plants and equipment is 3%.

For the purpose of the feasibility assessment following criteria was used:

- discounted payback period (DPP),
- net present value (NPV), and
- internal rate of return (IRR).

Total CAPEX for the project amount EUR 86,000 (cost for land included), while OPEX amount EUR 190,000 on yearly basis. The envisaged capacity of the centre is 5,000 t/a and at a market price of 40 KM/t total revenues will amount EUR 200,000. Table 6 shows key feasibility indicators for the project.

Table 6. Overview of the project's feasibility

Indicators	Amount
Net present value (NPV)	36,317 €
Internal rate of return (IRR)	10.39%
Discounted payback period (DPP)	11 years 9 months

Source: Own work.

The feasibility indicators show that the project is relatively attractive taking into account all CAPEX needed for such a project. In reality CAPEX could be lower due to the fact that potential energy cooperative member own some or many of the equipment needed which could be used for the purpose of the energy cooperative which again would lead to lower costs.

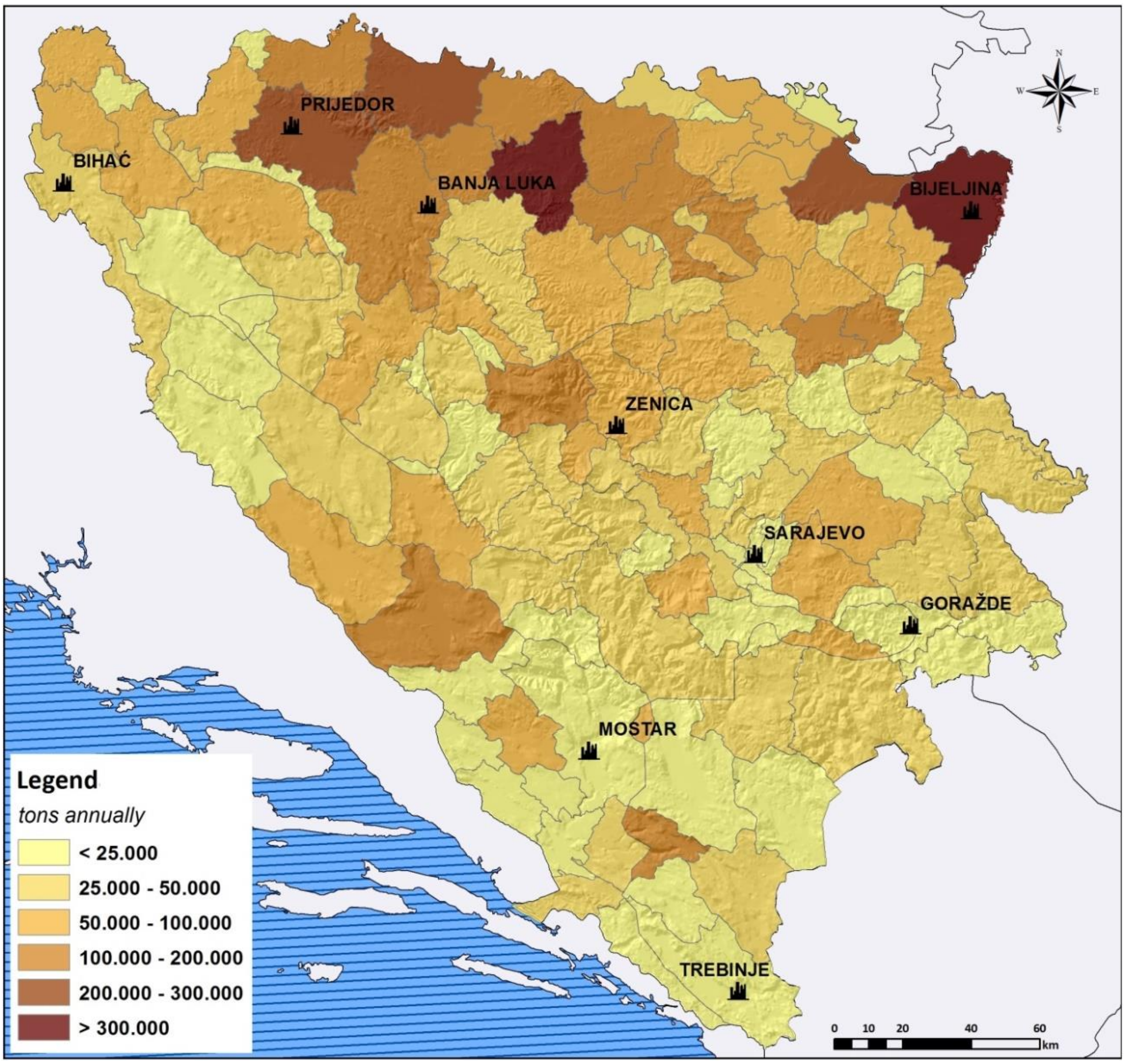
Based on available technical potential defined in chapter 4.1.1.1 for biomass exploitation in energy cooperatives under such business model a total of 8 cases could be developed in the entire country.

4.2 Biogas oriented energy cooperative

As presented in the previous chapter total technical potential of biogas in BiH is estimated at a level of 1,616 TJ/a. However, real (i.e. market) potential depends on many factors. A very important factor is the geographical distribution of biogas potential. As biogas sources (e.g. livestock and poultry manure) are concentrated closer to each other the market potential is greater and vice versa. For this purpose a GIS based method was applied to determine which areas of BiH have the greatest potential for biogas exploitation and which could be utilized through energy cooperatives.

The first step was to calculate total manure production on municipal level and out of this data to calculate energy potential per municipality.

Figure 7. Total manure in BiH by municipality (2016)



Source: Regional Education and Information Centre for sustainable development in SE Europe (2018).

As it can be seen from Figure 7 municipalities located in the northern part of the country have a greater contribution in overall manure production. This due to the fact that in general northern part of the country has more advanced level of agriculture production than other parts.

For the purpose of this master thesis official data on number of livestock was obtained from the Federal Office of Statistic and the Republika Srpska Institute for statistics for the year 2016. Applying earlier mentioned coefficient factors it was possible to estimate biogas potential on municipal level. In order to make the estimation more precise land use was taken into account. For this purpose official Corine (2012)[1] Land Cover (hereinafter as CLC) was used. In fact only land classified as “242 – Complex cultivation patterns” and

[1] Corine means 'coordination of information on the environment' and it was a prototype project working on many different environmental issues. The Corine databases and several of its programmes have been taken over by the EEA. One of these is an inventory of land cover in 44 classes.

“243 – Land principally occupied by agriculture, with significant areas of natural vegetation” was taken into account since such a land is used for farms.

In this step information on energy technical potential (expressed in MWh/a) per municipality was determined and Table 7 shows top 10 municipalities in terms of manure production and biogas potential.

Table 7. Biogas potential of top 10 municipalities in BiH

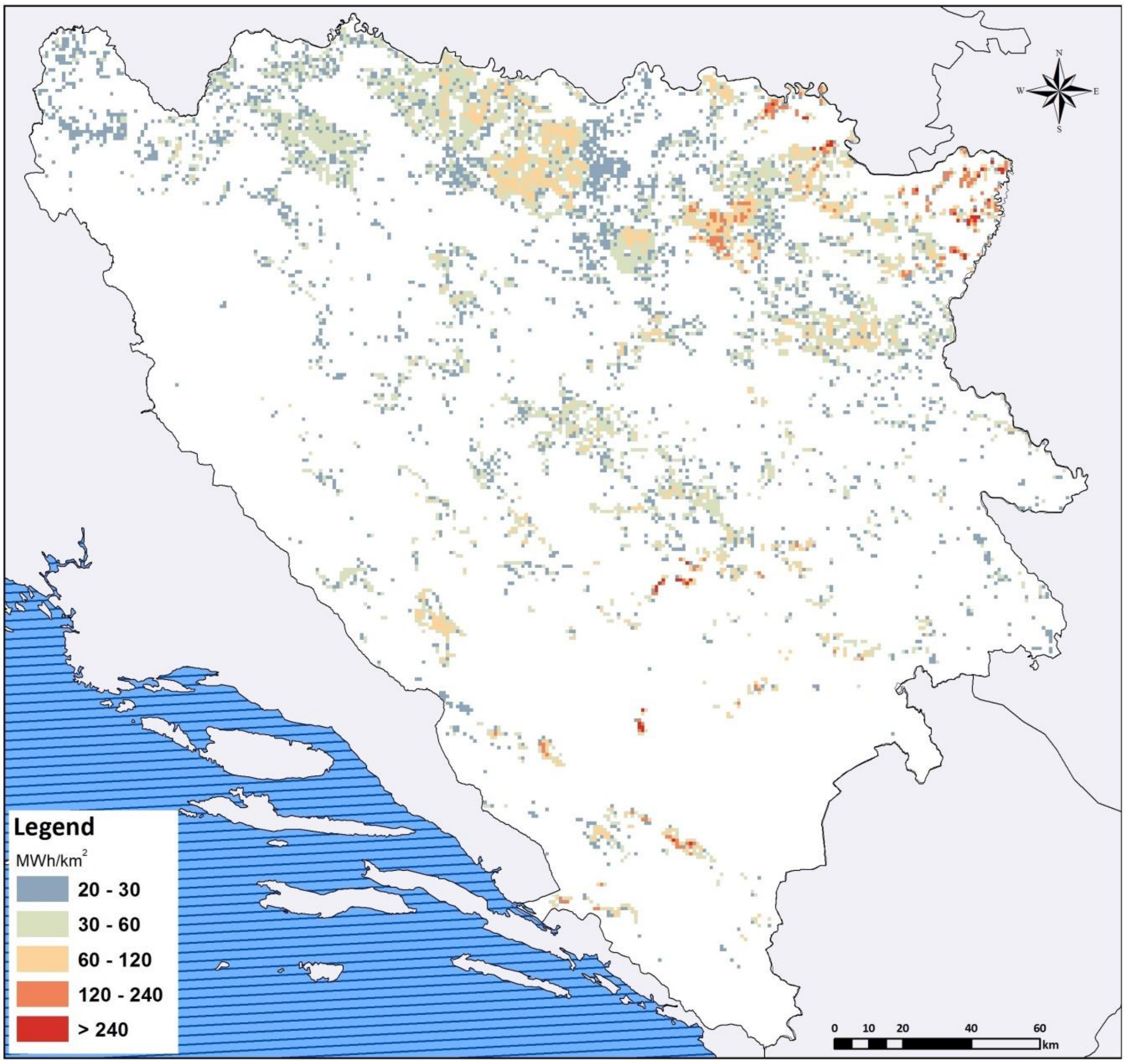
No.	Municipality	Location	Total area (km^2)	Total manure (t/a)	Total technical biogas (m^3/a)	Total technical energy potential (MWh/a)
1	Bijeljina	N	734	376,652	4,100,061	24,600
2	Prnjavor	N	630	348,588	4,687,778	28,127
3	Gradiška	N	762	283,186	3,257,346	19,544
4	Prijedor	N	834	262,840	2,559,324	15,356
5	Doboj	N	772	163,593	1,604,924	9,630
6	Gračanica	N	216	159,573	2,369,920	14,220
7	Banja Luka	N	1,239	152,268	1,472,135	8,833
8	Tomislavgrad	S	967	132,883	1,114,644	6,688
9	Živinice	N	291	122,051	1,330,371	7,982
10	Laktaši	N	388	112,486	1,209,262	7,256
		Total	**6,833**	**2,114,120**	**23,705,765**	**142,236**
		Share in BiH	*13%*	*29%*	*32%*	*32%*

Source: Own work (2020).

As shown in Table 7 the top 10 municipalities, although covering 1/8 of the country’s territory amount together to almost 1/3 of total biogas potential. Nine out of ten municipalities presented in Table 7 are located in the northern part of the country (except Municipality of Tomislavgrad).

As shown in Figure 8 most biogas potential (per km^2) of area have municipalities located in the northern part of the country, which is again due to the developed agricultural activities in this region.

Figure 8: Biogas technical potential density from manure – per sq km (2016)

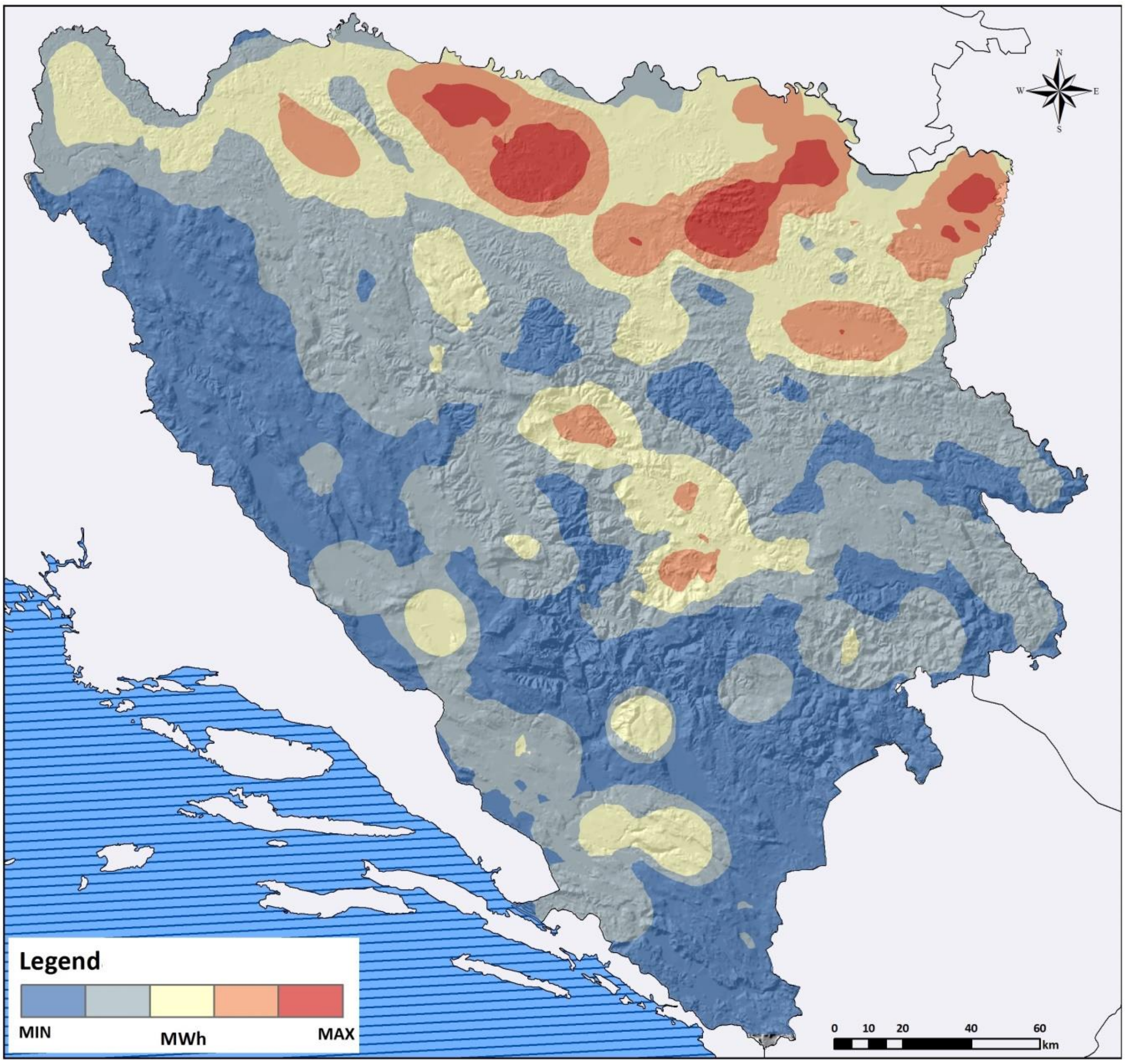


Source: Regional Education and Information Centre for sustainable development in SE Europe (2018).

A better overview of biogas potential is illustrated on Figure 9 which is based on Kernel Densitiy Analysis[2].

Figure 9: Biogas potential densitiy from manure – based on Kernel Density calculation (2016)

[2] The Kernel Density calculates the density of features in a neighborhood around those features. Calculates a magnitude-per-unit area from point or polyline features using a kernel function to fit a smoothly tapered surface to each point.



Source:Regional Education and Information Centre for sustainable development in SE Europe (2018).

The data obtained after the kernal density calculation enables identification of hot spots, or regions with the highest technical potential for development of biogas projects, e.g. energy cooperative.

The total technical biogas potential, after the kernel density calculation (red coloured polygons showed at Figure 9), is 167,573 MWh/a. Since expected operation hours for the power plants are 8,000 hours, total installation capacity is estimated at 21 MW.

4.2.1 Case study for biogas oriented energy cooperative in Prijedor

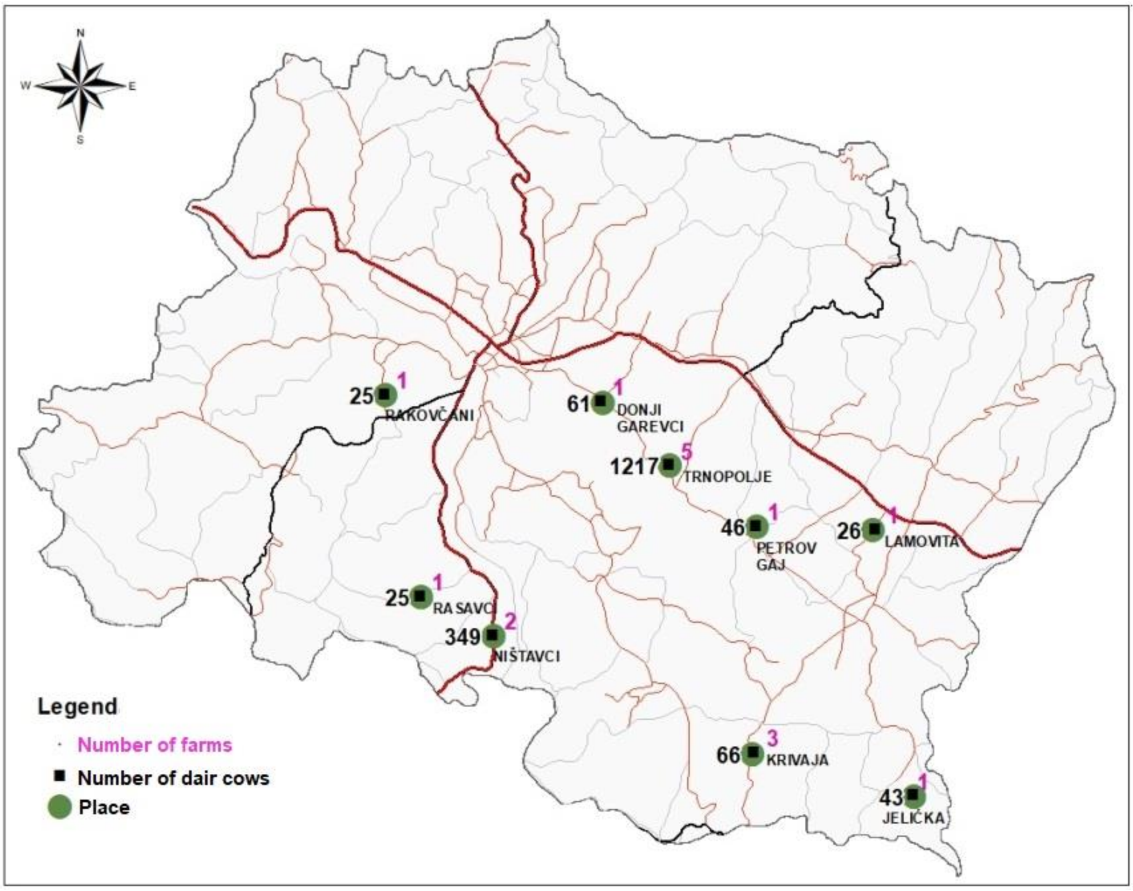
The area of Prijedor is rich in agricultural production and in narrow area more than 15 farms exist which count for almost 2,000 cows combined. Daily production of manure is immense and current model of management includes disposing of manure onto soil. Such a behaviour dangers underground water and harms the soil. Therefore rational use of manure can lead to environmental benefits, but also economic and social benefits. This is one of the reasons why manure is often used for biogas production which can be used for energy purposes (heat and/or electrical energy). Bosnia and Herzegovina has introduced feed in tariffs in both entities which guarantee sales prices of electricity for a specific period of time (different by entities). The case study refers to a biogas plant with a capacity of 100 kW_{el}. Having in mind that several different farms at different location form the EC the location was chosen based on lest mileage (to reduce transportation costs). Table 8 shows an overview of farms in the narrow area of Prijedor which have been analysed for the project.

Table 8. Greater farms in the area of Prijedor

No.	Farmer	Place	Number of dairy cows
1	Miodrag Granatić	Jelićka	43
2	Miodrag Darda	Ništavci	54
3	Milan Škundrić	Ništavci	295
4	Biljana Pađan	Petrov Gaj	46
5	Nijaz Hrnić	Trnopolje	50
6	Rajko Grbić	Rasavci	25
7	Dragan Baltić	Trnopolje	98
8	Ljuban Baltić	Trnopolje	46
9	Radivoj Piljić	Krivaja	20
10	Dragoslav Radanović	Krivaja	23
11	Merima Crljenković	Rakovčani	25
12	Zoran Miletić	Lamovita	26
13	Dušan Berić	Krivaja	23
14	Mladneko Aleksić	Trnopolje	23
15	Zoran Karajica	Garevci	61
16	Jusuf Arifagić	Trnopolje	1,000
		TOTAL	**1,859**

Source: Municipality of Prijedor (n.n.)

Figure 10. *Location of farms and number of cows*



Source: Regional Education and Information Centre for sustainable development in SE Europe (2017).

Total population of the Municipality of Prijedor is less than 100,000 inhabitants with more than 50% living in rural areas. Majority of the population is active in agriculture (fruit growing and farming, especially breeding of dairy cows). The number of livestock in Prijedor is given in Table 9.

Table 9. Number of livestock in Prijedor in 2016

Type of Livestock	Amount
Cattle	16,874
Sheep	37,600
Swine	23,950
Poultry	305,500

Source: Institute of Statistics of Republika Srpska (2016).

4.2.2. Project idea

The basic idea for the energy cooperative in Prijedor is production of energy (heat and/or electric) out of biogas which is again produced from manure as daily residue in the farming industry. A biogas plant are typical decentralised energy sources which enable farmers to satisfy energy needs from own resources. Advantages of biogas plant refer to autonomous operation with very low operational costs. Based on the local circumstances (number of cows, willingness to join the energy cooperative) a 100 kW sized plant is envisaged. A biogas plant may vary in dependence of substrate type and characteristics.

The proposed solution for this energy cooperative is the installation of several individual biogas plants ranging from 50 to 250 kW. The amount of resources needed depends on the resource used. If resources with higher energy potential (e.g. corn) are used for a 100 kW plant 5 tonnes/day of manure are needed. If only manure is used than the biogas plant requires 10 tonnes of manure each day. A farm with 500 cows can generate enough resources for a 50 kW biogas plant. This amount could be reduced, or capacity increased, if additional resources would be used such as corn, silage etc.

Capital expenses for this project are estimated at a level of EUR 5,000 per kW_{el} of installed capacity (Regional Education and Information Centre for sustainable development in SE Europe, 2016). Table 10 shows CAPEX and OPEX for different sized biogas plants.

Table 10. Capital and operational expenses for a biogas plant depending on installed capacity

Biogas plant size	50 kW	100 kW	150 kW	200 kW	250 kW
CAPEX (000 €)	273	497	704	893	1,046
OPEX (000 €/a)	12	22	28	35	41

Source: Regional Education and Information Centre for sustainable development in SE Europe (2016).

As of February 2018 only one biogas plant in entity Republika Srpska got a feed in tariff for a 242 kW installed power plant and 5.5 MW are still free for new entries (Power Utility Company of Republika Srpska, 2018). For this reason for the purpose of the case study it was envisaged that 100% of electrical energy is sold using feed in tariff which amount 122.81 €/MWh for a period of 15 years. Table 11 provides an overview of feed-in tariffs by different countries.

Table 11. Comparison of feed-in tariffs in the region depending on installed capacity

Installed capacity (kW)	Bosnia and Herzegovina Federation BIH (EUR/MWh)	Bosnia and Herzegovina Republika Srpska (EUR/MWh)	Serbia (EUR/MWh)	Croatia (EUR/MWh)
up to 23	363.84	122.81	156.60	178.67
23 - 150	340.71	122.81	156.60	178.67
150 - 200	142.60	122.81	156.60	178.67
200 - 300	142.60	122.81	152.40	178.67
300 - 700	142.60	122.81	135.70	168.00
700 – 1,000	142.60	122.81	123.10	168.00

Source: RES LEGAL Europe (2018).

It is also envisaged that the plant operates 8,000 hours on yearly basis. Additional revenue could be obtained if heat energy could be utilized and sold, which amount EUR 10,000 for a 100 kW plant.

The financial analysis was done using same general assumptions as in the biomass case study. Table 12 shows key feasibility indicators for the project.

Table 12. Overview of the project's feasibility

Biogas plant size	50 kW	100 kW	150 kW	200 kW	250 kW
CAPEX (000 €)	274	499	706	895	1,048
OPEX (000 €/a)	12	22	28	35	41
Revenue (000 €/a)	49	102	147	196	245
Residual value (in year 15)	150	274	388	492	576
Internal rate of return (IRR)	**12%**	**15%**	**16%**	**17%**	**19%**
Net present value (NPV) in 000 €	**163**	**430**	**664**	**942**	**1,263**
Discounted payback period (DPP)	**9y 10m**	**7y 3m**	**7y 5m**	**6y 10m**	**6y 2m**

Source: Own work (2020).

The project is highly attractive since IRR exceeds discount rate for each of the variations. Since the CAPEX would be borne by each energy cooperative member the respective investment per EC member would be achievable. Other indicators such as NPV and payback show great level of feasibility.

In both of the cases the IRR indicates that it is more cost effective to invest in any of the proposed projects rather to earn interest on savings in banks since the interest rates for savings are far lower.

4.3 Impact of energy cooperatives on the green economy in BiH

As it has been presented in the previous chapters BiH has significant resources in regards to the use of RES which can lead to economic, social and environmental benefits. In order to estimate these benefits the case studies developed in the previous chapter will be used as reference point.

The overall estimate is based on extrapolation of benefits which are achieved at 1 MWh/a of RES potential exploited for biogas and biomass in line with findings from previous chapters. As it has been defined in the previous chapters, total technical and marketable potential for biogas was estimated at 167,573 MWh/a and 267,778 MWh/a for biomass or 435,351 MWh/a combined. In terms of installed capacity, based on average operation hours the installed capacity would equal 66 MW in total, or 21 MW for biogas and 45 MW for biomass.

For the purpose of this master's thesis three groups of benefits were defined:

- economic benefits,
- social benefits, and
- environmental benefits

The quantification of the benefits identified during RES deployment within energy cooperatives is given in the following chapters.

4.3.1 Economic benefits

"An economic benefit is any benefit that we can quantify in terms of the money that it generates. Net income and revenues, for example, are forms of economic benefit. Profit and net cash flow are also economic benefits" (MBN, n.n.).

One of the key indicators of success for any project is the net present value which measures financial and economic performance of a certain project. The key requirement for this criterion is to be greater than zero for a defined period of time (e.g. during the life time of the equipment). The greater the net present value the better.

In the case of the biomass based energy cooperative (reference case) two types of revenues will occur. The first type represents collection and sales of biomass (i.e. wood chips) and a NPV of 15,736 EUR applies.

The second type of revenue represents sales of heat energy where a NPV of EUR 12,765 applies. Altogether NPV (for a period of 15 years) in the case of biomass based energy cooperatives for entire BiH amounts EUR 69.1 mil.

In the case of biogas based energy cooperative one type of revenue will occur, i.e. sales of electricity. Based on the case study developed in chapter 4.2 a NPV of EUR 3.1 mil per MW of installed capacity was retrieved. This figure was later multiplied with total potential of installed capacity (20 MW for biogas). After this calculation a benefit of EUR 61.5 mil was estimated for biogas. The total NPV for both types of energy cooperatives thus amount EUR 130.6 mil.

4.3.2 Social benefits

In countries such as Bosnia and Herzegovina, one of the most important benefits any project can generate is new jobs. Although, the unemployment rate in BiH has fallen from 25.4% in 2016 to 18.4% in 2018 BiH is still among the highest in Europe (Agency for Statistics of BiH (2018a).

Number of total jobs created per MW of renewable energy sources were 9.87 for biomass and 20.00 for biogas (IRENA, 2018). As it can be seen employment in biogas is more than two times higher than in biomass, but total installed capacities shall be taken into consideration to drive conclusions. Those two benchmarks will be used for the calculation of this benefit.

The value of one new job equals the amount of contributions and taxes payed for an average salary in Bosnia and Herzegovina. According to the Agency for statistics of Bosnia and Herzegovina average net salary was KM 894 or EUR 458 (as of October 2018) (Agency for Statistics of BiH, 2018) while contribution and taxes are KM 652 or EUR 334 per month, or EUR 4,008 a year (Agency for Statistics of BiH, 2018). This amount actually represents the benefit for one job.

The benefit of creating new jobs through the deployment of RES within energy cooperatives can easily be computed by multiplying number of jobs created per MW of installed capacity per RES type and amount of contribution and taxes payed annually.
The equation for job creation is

$$JCB_{RES} = \left(IC_{biomass} \times sjc_{biomass} + IC_{biogas} \times sjc_{biogas}\right) \times SC \qquad (1)$$

JCB_{RES} – Job creation benefit (EUR/a)
IC_n – Installed capacity of renewable energy soruce (MW)
sjc_n – Jobs created using deploying renewable energy source (jobs/MW)

SCT – Salary contribution and taxes payed (EUR)

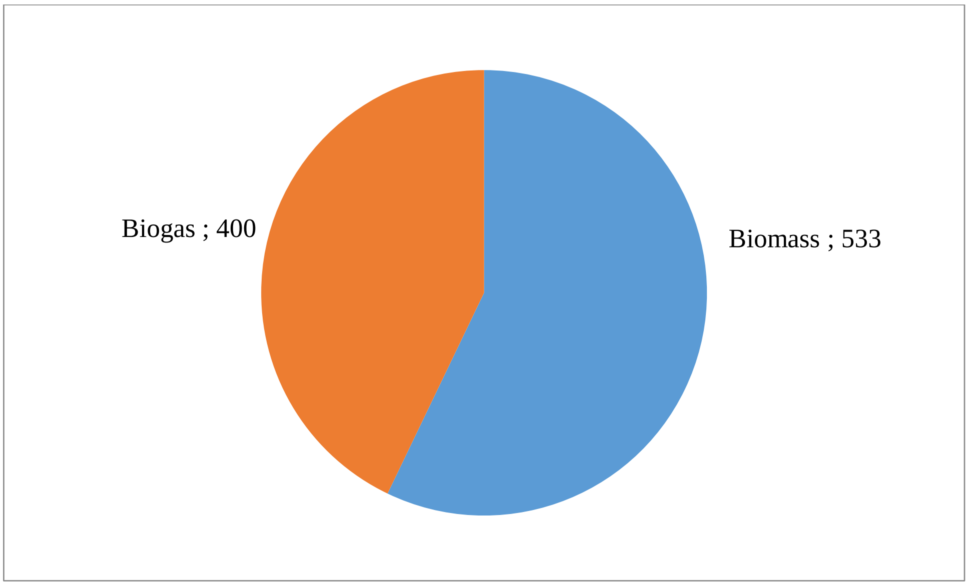
In the case of biogas and biomass exploitation in BiH JCB_{RES} equals

$$JCB_{RES} = \left(45\ MW \times 9.87\ \frac{job}{MW} + 21\ MW\ \times 20.00\ \frac{job}{MW}\right) \times 4{,}008\ \frac{EUR}{job} \approx 3.7\ mil.EUR/a \qquad (2)$$

The input data was retrieved from previous chapters where installed capacity was determined (45 MW for biomass and 21 MW for biogas) while other determinants were taken from literature described previously in this chapter.

The total employment capacity is estimated at 933 jobs annually, which represents a significant number, especially taking into consideration that those jobs are more likely to occur in rural rather than in urban areas. The split of job created per RES type is shown in *Figure* .

Figure 11. *Number of jobs created per RES type*



Source: Own work (2020).

4.3.3 Environmental benefits

Greenhouse gases represent the key climate change trigger and major global challenges are fighting this challenge. According to the Third National Communication and Second Biennial Update Report on greenhouse gas emissions of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change energy contributes to almost 60% of all greenhouse gases in Bosnia and Herzegovina. According to the Report six different greenhouse gases are identified which have the greatest impact onto climate change (carbon dioxide – CO2, methane – CH4, Nitro oxide – N2O, Tetrafluoromethane – CF4, Hexafluoroethane – C2F6 and Sulfur hexafluoride – SF6). A common approach is to use carbon dioxide equivalent (CO2eq) which represents a weighted average of the six different gases (UNDP, 2016).

The benefit of the reduction of greenhouse gas emission equals the amount of avoided emissions in comparison to the business as usual scenario. The business as usual scenario in the case studies described in this master's thesis foresees the use of coal instead of biomass in terms of heat energy and coal instead of biogas in terms of electricity. Thus, emission factors for coal for heat energy was used, which equals 0.357 t/MWh (UNDP, 2016a), and for biogas 0.802 t/MWh.

The equation for greenhouse gas emission reduction is

$$ER_{CO_2} = EP_{RES} \times ef \tag{3}$$

$ER_{CO2\text{-}eq}$ – Emission reduction of carbon dioxide equivalent (t/a)
EP_{RES} – Energy production from biomass and biogas (MWh/a)
ef – emission factor for energy production (t/MWh)

In the case of biogas and biomass exploitation in BiH ER_{CO2} equals

$$ER_{CO_2} = 267{,}778\ \frac{MWh}{a} \times 0.357\ \frac{t}{MWh} + 167{,}573\ \frac{MWh}{a} \times 0.802\ \frac{t}{MWh} = 229{,}983\ t/a \tag{4}$$

The input data was retrieved from previous chapters where installed capacity was determined (267,778 MWh/a for biomass and 167,573 MW/a for biogas) while other determinants were taken from literature (UNDP, 2016).

This amount actually represents the emission avoided due to the exploitation of biogas and biomass. In order to estimate the overall benefit of greenhouse gas reduction the following equation is used

$$B_{GHG} = ER_{CO_2} \times P \tag{5}$$

B_{GHG} – overall benefit of greenhouse gas reduction (t/a)
P – Price of CO_2 (EUR/t)

For the purpose of this master's thesis price of carbon dioxide is referred to the actual price traded at the European Energy Exchange (EEX) which averaged 24.32 EUR/t in May 2019 (EEX group, n.n.).

$$B_{GHG} = 229{,}983 \frac{t}{a} \times 24.32 \frac{EUR}{t} \approx 5.6\, mil. \frac{EUR}{a} \quad (6)$$

Production of energy implies also certain environmental damage, whereas one of the most significant is emission into the air. In the previously chapter benefits of the reduction of greenhouse gases were assessed, while here reduction of main polluters into the air are assessed. In terms of energy generation three main polluters are under consideration:

- Sulphur dioxide (SO_2)
- Nitrogen oxide (NO_2) and
- Particulate matter (PM)

The energy produced as described in the case studies will for sure contribute to emission into the air, but far less than business as usual (i.e. coal fired technologies). For the purpose of this master's thesis published emission coefficients were used for coal (as business as usual case), biomass and biogas.

Table 13. shows emission factors which were used for the assessment and price for pollution based on Fees applicable in Federation BiH (EUR/t) (Official Gazette of Federatione BiH, 2011).

Table 13. Emission factors (kg/TJ)

	SO_2	NO_2	PM
Coal (kg/TJ)	1,800	180	80
Biomass (kg/TJ)	11	210	40
Biogas (kg/TJ)	0	60	6
Price (EUR/t)	19	18	87

Source: EMEP, 2019; Službene novine Federacije Bosne i Hercegovine (2011).

Table 14 shows total emission *for* three polluters for different energy sources.

Table 13. Annual emission

Type of polluters	Coal	Biomass	Biogas
NO_2 (t/a)	174	202	36
SO_2 (t/a)	1,735	11	0
PM (t/a)	77	39	4

Source: Own work (2020).

Table 15 shows total benefits for all polluters.

Table 14. Net emission

Type of polluters	Emission reduction (t/a)	Price (EUR/t)	Benefit (EUR/t)
NO_2	-64	18	-1,152
SO_2	1,724	19	32,756
PM	34	87	2,958
		TOTAL (EUR/a)	**34,562**

Source: Own work (2020).

The total reduction amount almost 1,700 tonnes a year of different polluters, which represents a benefit of approx. 35,000 EUR/a. The greatest emission reduction can be achieved in terms of SO_2 reduction. This is due to the fact that greatest reduction is in terms of coal use which has the greatest SO2 content. The reduction of NO2 is in fact negative which means that the net emissions are greater than in the case of the business as usual scenario. However, they represent a very small increase and do not affect severely total reduction.

5 RECOMMENDATIONS

The year 2008 is the first in history when the urban population exceeded the rural population. According to many scientific and professional literature, this problem is one of the key in the fight against climate change. Therefore, a major focus is placed on strengthening the capacity of the population living in rural areas. Traditional activities (mainly agriculture) can hardly provide adequate living conditions in rural areas. Especially due to climate change, the risks associated with agricultural production are increasing (floods, droughts, etc.). The standard of living in rural areas can be improved by a combination of traditional agricultural production and the production of energy or renewable energy.

Bosnia and Herzegovina is at a crossroads when it comes to energy planning. The power plants that were built in the former Yugoslavia are still in operation, but in the coming period for their further work investment in their revitalization and/or upgrade are necessary in order to significantly reduce environmental impacts associated to their work. Another option is to invest in innovative techniques and technologies to meet energy needs, most notably energy efficiency and renewable energy. In whatever direction the energy development of BiH goes, the price of that development will fall on the end customers, and that are mostly citizens. Considering that citizens are the category of the society that have the most money available (on deposit and savings accounts, this is over 70% of the total money in BiH, or over KM 16 billion), this is not such a "problem". The problem is the allocation of funds. Investment must be economically justified, not necessarily financially, in order to be acceptable to society as a whole.

Renewable energy potentials are very significant in BiH, and this is primarily related to biomass. Other RES sources also have great potential, but in the whole chain of RES, biomass employs most of the people, since BiH has both biomass and equipment manufacturers. Although there are more and more projects in the field of RES lately, the potentials are far from being optimally utilized and one of the reasons is the unsystematic planning of the deployment of these resources. RES investors are mostly domestic or foreign investors, without significant citizen involvement in the investment. The reason given is that these investments are often contested by the local population, as they are not involved in any of the project phases (from design and planning to development and investment). The result is that no one wants such drives near them (the so-called NIMBY effect - Not In My Back Yard; not in my backyard). This approach rejects and will reject stronger development of RES projects.

Experience in EU countries, mostly Germany, Denmark, Austria, the United Kingdom and the Netherlands, indicates that many RES projects are locally owned. In Germany, locals own almost a half of new RES projects. This was mainly due to the movements of establishing energy cooperatives, while in Denmark over 75% of wind farms are owned by energy cooperatives.

Citizens as payers and beneficiaries should be involved in the development process. A major drawback is the lack of information on the consequences for ordinary citizens of conventional energy planning. For this reason, continuous information and awareness raising is of the utmost importance. Also, it is necessary to provide citizens with tools to act from the local level. There are numerous examples from other countries where citizens have been shown to be able to launch initiatives of general interest, and energy cooperatives play a very important component in this process.

Thus, to further affirm the concept of energy cooperatives, it is necessary to continuously work on expanding the critical mass and to promote this topic to a wider audience. Energy cooperatives can be a tool for rural development, because they enable synergy among rural activities and energy. However, target groups (farmers, existing cooperatives, etc.) do not have sufficient information about the concept of energy cooperatives, and it is necessary to work on their education and education of local authorities as well. This is extremely important for lobbying and financing of energy cooperative initiatives in the future.

Until now, renewable energy plants in Bosnia and Herzegovina have been developed almost entirely by individual companies, with minimal involvement of citizens and the local community in those projects. There is currently no example of an active energy cooperative in BiH. Citizens participate in the development of renewable energy only through the installation of solar collectors and photovoltaic panels. The concept of energy cooperatives is a way of stimulating investments in RES that contribute to national goals. In Bosnia and Herzegovina, political decision-makers still do not recognize the importance of ownership of RES by citizens and how energy cooperatives can have multiple impacts. On the one hand, public resistance to RES projects is reduced or completely eliminated, citizens become (co)owners of the plant, employment at local level increases and contributes to local development, environmental impact is being reduced, etc. Other modalities undoubtedly add to some of the aforementioned benefits, however, Western practice has shown the importance of involving the local community in decision-making as well as ownership.

Although RES investment is of great importance for the economic development of the country, it is equally important for the local community to benefit from these projects. The practice to date has individualized the benefits of investing in RES, and the local community has very little or no benefit. This way of developing the potential of RES in BiH will increasingly question the energy democracy that threatens to become a serious problem for BiH’s society. The pressure that local communities could put on future investors could significantly slow down investment in RES projects, thereby jeopardizing the fulfillment of targets related to RES participation in the country's overall energy mix.

Furthermore, the loss of trust in RES due to the "privatization" of existing subsidies could shake up any future initiatives in favour of the development of RES projects, which would mean political stagnation in this segment. Such stagnation could lead to the exclusion of the state of BiH from numerous funds that finance sustainable energy projects. BiH is already, on other grounds, subject to sanctions and restrictions on certain funds (primarily EU IPA funds for environment and energy), and further stagnation would only further exacerbate this problem.

Examples from developed EU countries show that the state can make an energy transition by placing smaller players at the centre instead of the big players. This approach, on the one hand, allows for differentiation of production and contributes to security of energy supply, and more importantly encourages innovation and entrepreneurship, leading to the creation of new values, which means employment and economic growth. The money available to individuals in BiH (deposited savings, etc.) represents a serious potential for investing in the energy transition. The role of government (at local and higher levels) is to create the enabling conditions for investment. The three key conditions for private equity investment in utilities are the rule of law, transparency in public sector operations, and the ability to assess risks. These are the elements on which the BiH authorities need to work significantly in the future to attract investments by individuals in the energy sector. According to estimates by 2050, every second EU citizen will be an energy producer, fundamentally changing the current model of business in the energy sector. BiH’s citizens rarely have the opportunity to be asked, much less the opportunity to invest in sustainable energy projects, because they are, first of all, insufficiently informed about the possibilities and, on the other hand, the information is not made transparent.

Climate change will be mostly reflected at the local level and therefore timely action at the national level is needed to create the conditions for action at lower levels of government. BiH, as a country, generally supports all global efforts to be involved in the fight against climate change (including the country's low-emission development strategy, the signing of the Paris Agreement, etc.), but very little has been done in practice. This is partly due to the fact that the state in front of the Ministry of Foreign Trade and Economic Relations of BiH communicates all international obligations of the state in this context, while decision making and implementation of activities is the responsibility of lower levels of government. For this reason, it is imperative that decisions are made at the local level that are tailor-made for a particular community.

As rural areas in BiH are losing more and more to self-sustainability, the problem of illegal construction in the peripheral settlements of major cities as a result of uncontrolled urbanization can still be expected in the future. The loss of rural areas directly affects the production of numerous agricultural crops, reduces employment, increases trade deficits and causes permanent damage to rural development. Therefore, energy cooperatives should be in the function of rural development as well as their sustainability.

It has to be noted that deployment of RES potential through the energy cooperative model can also have some adverse effects which could be subject of further research. Those effects may include land use issue and degradation of landscape values. Deployment of both biomass and biogas potentials requires significant land resources which can face land use issues or even land unavailability for those purpose. In the case of biogas production often odour is associated as an adverse effect for the local community. Moreover, biomass and biogas based plants and belonging facilities may impact land scape values due to their size and appearance.

CONCLUSION

The green economy gain publicity after UNEP published the repot of the same name and set a so called “Green new deal agreement” with the aim to revive the global economy, stimulate employment, accelerate the fight against climate change, adversely affect the environment and poverty.

Bosnia and Herzegovina is at a crossroads when it comes to energy planning. The power plants that were built in the former Yugoslavia are still in operation, but in the coming period for their further work investment in their revitalization and/or upgrade are necessary in order to significantly reduce environmental impacts associated to their work. Another option is to invest in innovative techniques and technologies to meet energy needs, most notably energy efficiency and renewable energy. In whatever direction the energy development of BiH goes, the price of that development will fall on the end customers, and that are mostly citizens. Considering that citizens are the category of the society that have the most money available (on deposit and savings accounts, this is over 70% of the total money in BiH, or over KM 16 billion), this is not such a "problem". The problem is the allocation of funds. Investment must be economically justified, not necessarily financially, in order to be acceptable to society as a whole. This money represents a serious potential for any investment, and also for the energy transition.

This master's thesis examined the potential for deployment of RES through a very specific model, the energy cooperative model. In this model citizens play the pivotal role in the energy sector and they are both decision makers and investors. In Bosnia and Herzegovina the cooperative model is been already introduced more than a century but the energy cooperative is a novel and it's unknown to most of the folk. The role of governments (at each level) is to promote and facilitate the establishment and operation of energy cooperatives since they provide significant benefits to the community.

This master's thesis analysed two types of RES, i.e. biomass and biogas. For both RES types two different case studies (based on real life examples) have been analysed, which were used as reference points to extrapolate results onto state level. The overall estimate is based on extrapolation of benefits which are achieved at 1 MWh/a of RES potential exploited for biogas and biomass in line with findings during the research. Total **marketable potential** for biogas was estimated at 167,573 MWh/a and 267,778 MWh/a for biomass or **435,351 MWh/a combined**, under the energy cooperative business model. In terms of installed capacity, based on average operation hours the installed capacity would equal **66 MW in total**, or 21 MW for biogas and 45 MW for biomass.

The master's thesis focuses onto three types of benefits (i) economic, (ii) social and (iii) environmental. Economic benefits calculated in this master's thesis represent net present value for two types of energy projects (biomass and biogas) in the entire BiH. Social benefits are retrieved while calculating social contribution payed for new jobs created. Environmental benefits represent reduction of environmental damage such as GHG reduction and reduction of pollution into air.

All benefits together are estimated in the amount larger than **18 million EUR a year**, whereas economic benefits account for almost 50% of total benefits. Energy cooperatives can produce significant benefits and this master's thesis analysed only biomass and biogas based technologies, while energy cooperatives can play an even more important role in solar and wind technologies.

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APPENDICES

APPENDIX 1: Povzetek v slovenščini

Zeleno gospodarstvo je pridobilo na glasu, potem ko je UNEP objavil istoimenski sko poročilo in postavil tako imenovani "zeleni sporazum o novem dogovoru", katerega cilj je oživiti svetovno gospodarstvo, spodbuditi zaposlovanje, pospešiti boj proti podnebnim spremembam, škodljivo vplivati na okolje in revščino .

Kar zadeva energetsko načrtovanje, je Bosna in Hercegovina na križišču. Elektrarne, zgrajene v nekdanji Jugoslaviji, še vedno obratujejo, vendar so v prihodnjem obdobju za nadaljnje delo potrebne naložbe v njihovo revitalizacijo in / ali nadgradnjo, da se znatno zmanjšajo vplivi na okolje, povezani z njihovim delom. Druga možnost je vlaganje v inovativne tehnike in tehnologije za zadovoljevanje energetskih potreb, predvsem energetske učinkovitosti in obnovljive energije. V katero koli smer gre energetski razvoj BiH, bo cena tega razvoja padla na končne odjemalce, to pa so večinoma državljani. Glede na to, da so državljani tista kategorija družbe, ki ima na voljo največ denarja (na depozitnih in varčevalnih računih je to več kot 70% celotnega denarja v BiH ali več kot KM 16 milijard), to ni takšen "problem". Težava je v dodeljevanju sredstev. Naložbe morajo biti ekonomsko upravičene, ne nujno finančno, da bodo sprejemljive za celotno družbo. Ta denar predstavlja resen potencial za vsako naložbo in tudi za energetski prehod.

To magistrsko delo je preučilo možnosti za uporabo OVE prek zelo specifičnega modela, energetskega zadružnega modela. V tem modelu imajo državljani osrednjo vlogo v energetskem sektorju in so tako nosilci odločitev kot vlagatelji. V Bosni in Hercegovini je zadružni model uveden že več kot stoletje, vendar je energetska zadruga nov in za večino ljudi ni znan. Vloga vlad (na vseh ravneh) je spodbujati in olajšati ustanavljanje in delovanje energetskih zadrug, saj zagotavljajo pomembne koristi za skupnost.

V magistrskom delu smo analizirali dve vrsti OVE, tj. biomaso in bioplin. Za obe vrsti OVE sta bili analizirani dve različni študiji primerov (na podlagi primerov iz resničnega življenja), ki sta bili uporabljeni kot referenčne točke za ekstrapolacijo rezultatov na državno raven. Celotna ocena temelji na ekstrapolaciji koristi, ki se dosežejo z 1 MWh / leto potenciala OVE, ki se izkorišča za bioplin in biomaso v skladu z ugotovitvami med raziskavo. Skupni tržni potencial za bioplin je bil po poslovnem modelu energetske zadruge ocenjen na 167.573 MWh / a in 267.778 MWh / a za biomaso ali 435.351 MWh / a skupaj. Kar zadeva inštalirano zmogljivost, bi bila glede na povprečne obratovalne ure nameščena moč skupaj 66 MW ali 21 MW za bioplin in 45 MW za biomaso.

Magistarsko delo se osredotoča na tri vrste koristi (i) ekonomske, (ii) socialne in (iii) okoljske. Ekonomske koristi, izračunane v tem prispevku, predstavljajo neto sedanjo vrednost za dve vrsti energetskih projektov (biomasa in bioplin) v celotni BiH. Socialni prejemki se pridobijo med izračunom plačanega socialnega prispevka za nova delovna mesta. Okoljske koristi predstavljajo zmanjšanje okoljske škode, kot sta zmanjšanje toplogrednih plinov in zmanjšanje onesnaževanja v zrak.

Vse ugodnosti so skupaj ocenjene na več kot 18 milijonov EUR letno, medtem ko gospodarske koristi predstavljajo skoraj 50 % vseh koristi. Energetske zadruge prinesejo pomembne koristi, in v tem magistrskom delu so bile analizirane samo tehnologije, ki temeljijo na biomasi in bioplinu, medtem ko imajo lahko energetske zadruge še pomembnejšo vlogo pri sončnih in vetrnih tehnologijah.

APPENDIX 2: Overview of the project's feasibility – biomass project

Item (in 000 €)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
CAPEX	-85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX		-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190	-190
REVENUE		200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
RESIDUAL VALUE																47
NET CASH FLOW	-85	10	10	10	10	10	10	10	10	10	10	10	10	10	10	57
DISCOUNTED NET CASH FLOW	-85	9	9	9	8	8	7	7	7	6	6	6	5	5	5	25
Net present value (NPV)	**36,317 €**															
Internal rate of return (IRR)	**10.39%**															
Discounted payback period (DPP)	**11 years 9 months**															

APPENDIX 3: Overview of the project's feasibility – biogas project

Item (in 000 €)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CAPEX (50 kW)	-274															
OPEX		-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12
REVENUE		49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
RESIDUAL VALUE																150
DISCOUNTED NET CASH FLOW	-274	35	33	31	30	28	27	25	24	23	22	20	19	18	17	84
CAPEX (100 kW)	-499															
OPEX		-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22
REVENUE		102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
RESIDUAL VALUE																274
DISCOUNTED NET CASH FLOW	-499	76	72	68	65	61	58	55	52	50	47	45	42	40	38	159
CAPEX (150 kW)	-706															
OPEX		-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28
REVENUE		147	147	147	147	147	147	147	147	147	147	147	147	147	147	147
RESIDUAL VALUE																388
DISCOUNTED NET CASH FLOW	-706	113	107	101	96	91	86	82	78	74	70	66	63	59	56	227
CAPEX (200 kW)	-895															
OPEX		-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35
REVENUE		196	196	196	196	196	196	196	196	196	196	196	196	196	196	196
RESIDUAL VALUE																492
DISCOUNTED NET CASH FLOW	-895	153	145	137	130	123	117	111	105	99	94	89	85	80	76	293
CAPEX (250 kW)	-1,048															
OPEX		-41	-41	-41	-41	-41	-41	-41	-41	-41	-41	-41	-41	-41	-41	-41
REVENUE		245	245	245	245	245	245	245	245	245	245	245	245	245	245	245
RESIDUAL VALUE																576
DISCOUNTED NET CASH FLOW	-1,048	194	184	174	165	156	148	141	133	126	120	113	108	102	97	350
Net present value (NPV)	**50 kW**	163	**100 kW**	430	**150 kW**	664	**200 kW**	942	**250 kW**	1.263						
Internal rate of return (IRR)	**50 kW**	12%	**100 kW**	15%	**150 kW**	16%	**200 kW**	17%	**250 kW**	19%						
Discounted payback period (DPP)	**50 kW**	9y10m	**100 kW**	7y3m	**150 kW**	7y5m	**200 kW**	6y10m	**250 kW**	6y2m						