Interreg - IPA CBC
Bulgaria – Serbia

Renewable Energy for Smart Growth and protected Environment

Study

"Recommendations for the introduction of renewable energy in the Vidin - Zaječar region"

The project is co-funded by EU through the Interreg-IPA CBC Bulgaria–Serbia Programme

THE CONTENT

Study on

"Recommendations for the introduction of renewable energy in the Vidin - Zaječar region"

Zaječar 2023

ABREVIATIONS

RES – Renewable Energy Sources

ROI – Return of Investment

Prosumer – Producer/Consumer of RES

PV panel – Photo Voltaic panel for the production of electricity from solar radiation

PVT panel – hybrid solar panel for the production of electricity and hot water simultaneously

ICT – Information and Communication Technologies

PPP – Public Private Partnership

AI – Artificial Intelligence

ML – Machine learning

CO_2 – Carbon dioxide

GHG – Greenhouse gases

HVAC – Air conditioning systems

LSG – Local Self-Governance

ESCO – (Energy Servicing Company), company that generates income for its activities from energy savings on the project.

CAGR - The compound annual growth rate (CAGR) is the rate of return (RoR) that would be required for an investment to grow from its beginning balance to its ending balance, assuming the profits were reinvested at the end of each period of the investment's life span.

This publication was made with the help of European Union funds through Interreg-IPA Cross-border cooperation program Bulgaria-Serbia under number CCI No 2014TC16I5CB007.

1. INTRODUCTION

HOW IMPORTANT IS ENERGY TODAY

Although until not so long ago, energy was considered just one economic branch that, similar to mining, deals with the exploitation of natural resources while ignoring the essential impact of energy on all human activities, in the last fifteen years the issue of sustainable energy management has come to the fore. It has become quite clear hows the mutual connection and dependence of the economy and outside the economy, as well as all other social activities with energy are important. At the same time, the growing population and accelerated exploitation of natural resources forced the need to find new, sustainable solutions.

For example, Connectivity was the key word in 2002, and later in 2003, when the first and second Memorandum of Understanding in the field of energy were signed. It continued in 2006 with the entry into force of the Treaty on Energy Community. The idea to set it up, as a common energy market for the countries of Southeast Europe, emerged from the need to ensure safe supply of energy to the region and to connect the region's power grids with the grids of the European Union.

In the last twenty years, the demand for electricity and thermal energy from renewable energy sources has been growing rapidly due to the attempts of reducing the impact on climate change, i.e. in line with strict measures for introduction of decarbonization and industries that do not emit or have a significantly lower emission of CO_2, being it the mainn source of warming of the atmosphere. The consequences are already clear to everyone, because the increase in average temperatures causes a change in the movement of air masses and water flows, which results in extreme climatic phenomena, large droughts throughout the year, and on the other hand, huge, monsoon like precipitation, even at the time of the year when they are not ussual. Electricity is perceived as the cleanest form that will not pollute the environment, although this is not always the case. Take, for example, the production of electricity from thermal power plants, where large amounts of polluting gases, especially CO_2, are emitted, even when the plants have very complex and very expensive air purification systems. At the same time, the use of hydro or nuclear energy causes controversies since, althought large hydroelectric plants do not emit CO_2, they do have a great impact on the microclimate, on groundwater, on biodiversity and also at the social level when entire settlements and infrastructure are moved from areas where reservoirs are formed. Nuclear power plants are potentially very high risk due to even the minimal possibility of a nuclear accident or breakdown as well as the demanding storage for nuclear waste.

IMPORTANCE OF PROPER ENERGY GOVERNANCE AND TRENDS

For more than 20 years, the European Union has been developing a policy on climate and renewable energy sources, aiming at achieving the decarbonisation of the entire EU economy by 2050. Reaching this goal means transitioning the electricity system with the help of renewable energy technologies, including ocean energy.

To accelerate development, the EU has adopted policies that support the deployment of new industries, research and innovation and the introduction of new low-carbon technologies.

One of the cornerstones of EU policy is the setting of targets for the production of renewable energy throughout Europe. The European Union's Renewable Energy Directive ensures that by 2030, at least 32% of all energy consumed in the EU will come from renewable sources.

The European Green Deal

The European Green Deal is the European Commission's strategy for achieving climate neutrality in the EU by 2050. The package of legislative documents includes all sectors that have an impact to the climate - energy, construction, transport, agriculture, research and industry. The commission also proposed a European climate law that increases the target of reducing greenhouse gases from 40% to 55% by 2030. The law was adopted in June 2021.

The European Commission, European Parliament and EU leaders agreed on a recovery plan that will help repair the economic and social damage caused by the coronavirus pandemic. NextGenerationEU is a temporary €750 billion instrument designed to boost recovery efforts. It establishes a mechanism that provides loans and grants to support reforms and investments undertaken by EU countries. NextGenerationEU will also bring additional funding to other European programs such as Horizon Europe and InvestEU.

Ocean Energy Europe is pushing ambitious targets for both greenhouse gas reduction and renewable energy deployment.

Industrial strategy

As part of the Green Deal, the European Commission adopted an EU industrial strategy that promotes the digitalization and decarbonization of industry, thereby achieving greater global competitiveness of the European economy. The EU industrial strategy emphasizes the need for a more strategic approach to the energy sector, especially in the area of renewable energy sources.

Clean energy package for all Europeans

The package was adopted in 2019 with the aim of helping decarbonise the EU's energy system in line with the European Green Deal. In 2019, the EU improved its energy policy framework to help reduce the use of fossil fuels and the transition to cleaner energy, that is, to fulfill the obligations from the EU's Paris Agreement to reduce greenhouse gas emissions. The agreement on this new energy regulation - called the Clean Energy Package for all Europeans - marked a significant step towards the implementation of the Energy Union strategy, published in 2015.

The new rules will bring significant benefits for consumers, the environment and the economy. By coordinating these changes at EU level, the legislation also underlines the EU's leadership in fighting against global warming and makes an important contribution to the EU's long-term strategy to achieve carbon neutrality (net-zero emissions) by 2050.

Renewable energy

To demonstrate global leadership in the field of renewable energy sources, the EU has set an ambitious, binding target of 32% renewables in the EU's energy mix by 2030. The revised Renewable Energy Directive (2018/2001/EU), which contains this obligation, entered into force in December 2018. The European Commission recently proposed increasing this target to 40%.

Energy efficiency

Putting energy efficiency first is a key goal in the package, as saving energy is the easiest way to reduce greenhouse emissions while saving consumers money. The EU has therefore set binding targets for increasing energy efficiency by at least 32.5% compared to 2018 and until 2030. The Energy Efficiency Directive ((EU) 2018/2002), which has been in force since December 2018, regulates this issue.

Governance regulation

Under this strategy, each EU country is required to establish integrated ten-year National Energy and Climate Plans (NECPs) for the period 2021-30. The NECPs outline how EU countries will achieve their targets, including long-term programs for 2050. The relevant act - Energy Union Governance and Climate Action Regulation (EU) 2018/1999 - has been in force since December 2018.

Energy market design

A further part of the package seeks to establish a modern design for Europe's electricity market, adapted to new commercial realities – more flexible, more market-based and better placed to integrate a greater share of renewables.

Russia's intervention in Ukraine in February 2022 had a profound impact on global energy markets. Price volatility, supply shortages, security concerns and economic uncertainty have contributed to what the International Energy Agency (IEA) is calling "the first truly global energy crisis, with impacts that will be felt for years."

As always, poorer countries — many still recovering from the effects of the global pandemic — will bear the brunt of the negative consequences of the energy crisis.

However, given that so much is changing, it is difficult to predict exactly which way the situation will develop since many benchmarks of this new world are not yet fully defined, but the point of no return has been passed.

From these needs and due to newly created circumstances, the following trends emerged:

Greater focus on renewable energy sources

The RES sector has been thriving for years, but is expected to continue its rapid growth until 2023. Countries around the world are investing heavily in solar, wind and hydropower as an alternative to traditional fossil fuels. This shift towards renewable energy sources is predicted to reduce emissions in the United States alone by up to 40% by 2030, where protectionist policies, especially the Inflation Reduction Act, will attract a massive influx of new investment in this area, both from domestic investors and a large number of companies that will transfer their production from Europe and other parts of the world to the USA. The Inflation Reduction Act is expected to accelerate the decarbonization of the energy sector and this will boost the deployment of clean energy and the introduction of EVs [electric vehicles] while newer technologies such as hydrogen will become cheaper.

Improving storage technology

One of the key issues facing the renewable energy driven field is storage capacity. Without adequate energy storage technology, renewable sources such as solar and wind can be unreliable due to their intermittent nature.

Despite the limitations of earlier periods, improved battery technology makes it much easier to store excess electricity generated from renewable sources. This means that renewables can become much more reliable over time as battery technology continues to improve.

Smart networks

The rise of smart grids is driven by the need to build an adaptable, modern energy grid infrastructure. The smart grid market is estimated to grow at a CAGR of 17.8% between 2021 and 2031.

Smart grids use advanced sensors and automation systems to increase efficiency and reduce losses in electricity distribution. This helps utility companies to better manage their resources and at the same time perform a dynamic adjustment of production and consumption by optimizing the management and distribution of energy in the grid. This avoids interruptions and failure of parts of the system due to sudden overloads or equipment failures.

Autonomous energy systems

Autonomous energy systems are another trend that will become popular in the coming years due to advances in artificial intelligence (AI) and machine learning (ML) technology. These systems allow utilities to autonomously monitor their activities, helping them identify areas of improvement and optimize performance with minimal manual intervention required by operators and on-site technicians.

This reduction in required staff could potentially reduce labour costs while increasing safety as fewer people need to be involved in hazardous situations such as working around high voltage lines or manually checking installations.

Tightening cyber security

The final trend that will shape the future of the energy industry in 2023 is the increased emphasis on robust cybersecurity. As utilities become increasingly digitized through smart grids, autonomous systems and connected devices, they are becoming vulnerable targets for cyber-attacks.

To protect against these threats, businesses will need to invest heavily in cybersecurity measures such as encryption technologies, firewalls, anti-malware software, and other safeguards. By implementing these measures in early stage, companies can protect their data while ensuring compliance with regulatory standards.

How the war in Ukraine led to the energy crisis

1. Higher energy prices

Perhaps the most noticeable change for most people is that energy prices are rising. High fuel costs account for 90% of the increase in the average cost of generating electricity worldwide.

Together with the impact of the global pandemic, the energy crisis means that the 70 million people who recently gained access to electricity can no longer afford it.

One potentially positive aspect of higher fossil fuel prices is that they provide strong reasons to accelerate toward sustainable alternatives. However, the need for energy security may encourage further investment in fossil fuel projects.

2. Changing trade lines and supply shortfalls

Russian gas exports to the EU were drastically reduced, which caused a rapid change in trade lines. Russia cut gas flows to the EU by around 80% between May and October 2022, leaving the European bloc with a significant shortfall in its energy mix and urged the need to find energy alternatives elsewhere.

While many of Russia's former international partners have reduced or severed ties with the country, Russia has largely kept its oil production and exports close to pre-intervention levels, increasing exports elsewhere, including China, India and Turkey.

3. Changes in energy policy

Policy changes have accelerated the push for more intensive use of renewable energy sources, but short-term energy security is also vital.

The change in traditional energy supply chains means that affected countries have had to come together quickly to create new energy policies that not only prioritize long-term energy security, but also allow existing energy demand to be met in the short term. The governments of affected countries are also intensively developing programs aimed at net zero emissions by 2050. In some cases - notably the US Inflation Reduction Act - the crisis has pushed renewable energy projects forward, not stalled them.

4. Economic impacts of the energy crisis

Higher costs due to the energy crisis contribute to rising interest rates, which could threaten the energy transition. Higher energy costs are likely to lead to higher prices for goods and services. Higher interest rates coupled with falling incomes in real terms are pushing the world into recession, and the number of people falling back into extreme poverty is rising. At the same time, as many countries seek to raise the cost of borrowing money to counter inflation, clean energy projects that require financing could be at risk.

5. How CO_2 emissions are affected

Some countries are accelerating their emissions reduction targets, others are increasing their coal use, and some countries are doing both at the same time. The long-term impact of the energy crisis on GHG emissions is unclear and there is real doubt about the possibility of realizing plans to achieve net zero CO_2 emissions by 2050.

However, while CO_2 emissions are projected to continue rising in 2023, growth is less than 1% higher than in 2021, largely due to the rapid increase in the use of renewable energy sources and electric vehicles (EV)

6. Incentive for RES

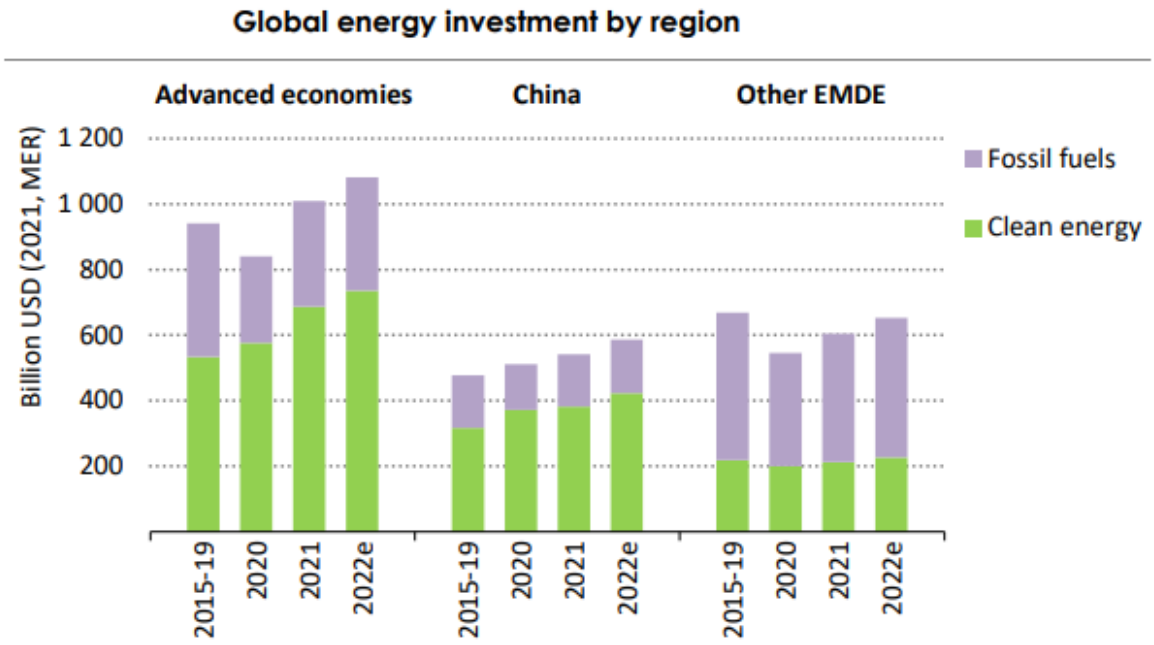


chart showing global energy investment, by region

Severed relations between Russia and its energy customers led to a rapid focus on maintaining energy security. Having a strong and diverse energy mix is at the heart of the policy, and it is possible that the crisis could accelerate the transition to more sustainable fuels.

However, this is not yet certain and cannot be verified at this time, and the negative economic outlook and short-term political moves to secure energy for today's needs could slow down the momentum in the use of renewable energy sources.

Energy problems in the world did not start with Russian intervention in Ukraine, but the energy crisis caused a series of seismic changes in the energy sector. Some changes will be temporary, some permanent, but the decisions made today will forever reshape the energy sector, and that process will not be without difficulties.

2. RENEWABLE ENERGY SOURCES

Renewable energy sources (RES) are sources that are renewed at least the same rate at which they are exploited. Everything in nature what could be renewed is done spontaneously and without side effects, thus RES are considered to be clean energy and the right choice for solving energy needs without polluting the environment with no, or very little, impact on climate. Unlike RES, non-renewable resources are depleted over time and cannot be renewed, at least not on timescales comparable to our understanding of time. Non-renewable energy sources are all fossil fuels (coal, oil, natural gas), for example, because they cannot be renewed even during the time that was sufficient for the creation of human civilization.

Renewable energy sources include:

The energy of water is the energy of rivers, the energy of waves and tides. It has been used to run mills or any other installations that require mechanical energy, threshing machines, saw mills, weaving mills... Since the 19th century, the production of electricity has emerged and since then, water is one of the most common way of using energy sources that are constantly renewed.

The energy of the sun is the energy that our star radiates to the earth's surface and is of both heat and light nature (although they are of the same, electromagnetic origin, but in different spectrums of radiation). This is also a form of energy that has always been available. In the beginning, the sun was only used as a thermal source, for heating homes, for boiling water and in very early stage to dry and preserve the food because, in addition to heat, the sun also

radiates ultraviolet rays, which are excellent disinfectants, thus very good for preserving the food. For this reason, the sun is used to dry meat, plants and plant products. It was only in the 20th century when it was discovered that, when crystallized silicon is exposed to the sun, it causes electric voltage on its ends. This phenomenon is widely used today to make photoelectric panels that generate electricity.

Geothermal energy is the energy of the earth which is a huge heat reservoir. The earth

radiates its own energy and the miners know this best because the temperature in the pits is much higher than on the surface. The earth is a great generator and this feature was used, above all, for balneological and health purposes. Each spa utilizes warm water from depth.

Thermal waters, however, can be used for the production of electricity, for heating swimming pools, residential areas, for heating roads and streets (Iceland, which is all resting on geothermal springs, uses them abundantly for exactly these purposes), greenhouses and fish ponds. However, geothermal energy is not used only for heating, but for also electricity production and can be put to work with the heat pump technology for both heating and cooling.

Biomass - Energy obtained from burning plant residues, using bio gas as a product of decomposition of plant mass and from bio fuel (fuel obtained from processing high oil content plants). Biomass is the oldest form of renewable energy since the humans used wood for heating, to prepare food and as a source of light ever since. Woods grow, so if used carefully, it will always be there. Biomass are both plants and residues from agricultural production and in general, all biological material that can be used as fuel. This is the primary way of using biomass (straw, residues from harvests, residues from vegetable crops, dry branches and plants, etc...). Biomass could be collected from special energy plants that are grown only for this purpose (fast-growing willows, for example). Today, biomass is commonly available in shape of pellets, compressed plant residues that provide uniformity and easy way to use it as a fuel.

Wind energy - Wind is a result of the movement of large air masses in the earth's atmosphere, due to climatic, thermodynamic phenomena, differences in temperature and air pressure above the earth's surface. Wind occurs occasionally and we cannot precisely nor predict with certainty when it shall blow, albeit it was also used as a source of energy. In the beginning, it was a driving force for ships with sails which were energy "catchers", and later on, as a driver

for mills and everything that could be powered by external energy (water pumps, saw mills...).

The energy that was initially used to propel vessels is now largely used to generate electricity with the help of wind generators.

WHAT ARE THE ADVANTAGES OF USING RENEWABLE ENERGY SOURCES

Renewable energy sources are available in some form everywhere and can be exploited in any place, immediately and without the need to transport energy fuel. This means that the infrastructure for exploiting energy from renewable sources is simpler and less demanding. Large facilities such as large storage and/or reversible hydropower plants or facilities for the massive use of geothermal water, such as exist in Iceland, for example, are excluded here.

Apart from the aforementioned, in terms of security and strategy, the energy status is much more favorable when there is a dispersion of energy sources into smaller units than when the energy source is large, with the capacity to support significant consumption. Failure of small plants does not threaten the power system, while failure of a large power plant created very serious problems in the production and distribution of energy.

In a technical sense, the generation of energy in small plants means that its distribution is using the electrical network at a lower voltage and not through high voltage transmission lines, which reduces losses in the network and makes it more efficient.

The price of energy production from renewable sources has a downward trend, and on the other hand, the market price of energy has a tendency to increase, which completely justifies investments in this area.

The green economy and therefore the industry of renewable energy sources, is, in addition to ICT, the fastest growing branch of the economy, because the transition to RES requires the development of technologies and significantly greater production of equipment and services,

so the benefit is twofold, on the one hand, clean energy is obtained and on the other hand, the level of energy security has increased and the dependence on other sources and/or energy suppliers has been reduced. Finally, the cost of energy from renewable sources is reduced because the number of operating equipment manufacturers and their quantities are increasing.

Energy production is an important economic activity, by itself while providing the possibility of energy diversification to small and micro producers. This unlashes several advantages. The first is certainly to have individuals or relatively small economic entities being engaged in energy production, what make them part of the electrical energy system, whether they are connected to the electrical distribution network or operate outside of it. The infrastructure requirements of the energy system are very similar to the water distribution system in terms of the degree of interdependence of consumers and producers, as well as in terms of the dynamics of production and consumption in certain time intervals. Namely, especially when it comes to electrical energy, it is consumed to the greatest extent at the same moment when it is produced. Bridging the differences in the time of consumption and production is achieved by involving a larger number of producers and consumers, thus reducing the differences in consumption and production. At the same time, a significantly higher level of energy security is ensured because, in the event of a breakdown or having one of the small-sized producers dropping out of the system, the deficiency is easily compensated by other producers. Unlike this, in conventional energy systems with a limited number of large energy producers, the failure of only one of them can cause a complete break down and major damage. Finally, the production of electricity at a lower voltage reduces the losses in the transmission, which in that case has a shorter range, but is therefore more reliable, that is, the production and transport of energy in a lower voltage network (up to 10KV) enables a significantly more efficient meeting of local needs.

Even more advanced is the producer-customer (prosumer) concept, which enables a high degree of independence for consumers who produce energy for their own needs and only hand over the remaining surplus to the distribution network.

This would be equivalent to the case if each household had its own source of water or a well from which it would meet its needs, and the excess was handed over to the central water supply for use by other consumers, as was decided in Israel, where the central state water supply with a system of canals and reservoirs extends integrally throughout the country, in a length of 130 km, and it fills and empties along its entire route.

As mentioned, the production or transformation of energy into a usable form is an economic activity that creates surplus market values and, as such, is an opportunity for new employments and for generating a profit. It is good for society because it drives the economy and enables community development through the tax system.

In the case of exploitation of renewable energy sources, income can be realized through production, then from land lease, various services, from construction and system maintenance to production of equipment parts.

At the same time, the use of renewable energy sources greatly contributes to the achievement of the UN's sustainable development goals (SDG), especially goals 7, 8, 9, 11 and 13 (available and clean energy, decent work and economic growth, development of industry, innovation and infrastructure, sustainable cities and societies and the fight against climate change).

3. STATE OF THE ART I N ENERGY SECTOR

BULGARIA

Overview

Bulgaria's power sector is diverse and well developed, with universal access to the grid and numerous cross-border connections in neighbouring countries. A key driver of the Bulgarian economy, the energy and climate change sector are currently strongly affected by geopolitical, economic and regulatory pressures. The Bulgarian electricity market is currently in transition, but nuclear power is expected to remain dominant. The government is slowly decreasing its coal power capacity to gradually replace it with renewable power capacity. During this energy shift, the government plans to rely on nuclear power generation to meet the major electricity demand. Nuclear power generation was 15.9TWh in 2020 making its share 44% in total power generation in the country. Nuclear energy will remain a dominant source for power generation until 2030, despite government plans to increase renewable power capacity. Bulgaria has 12,668 MW of installed capacity enabling the country to meet and exceed domestic demand.

Environmentally friendly, efficient and secure energy is critical to Bulgaria's productivity, competitiveness and growth. The two main pillars of the electricity producing sector are coal and nuclear. Bulgaria is a major producer and exporter of electricity in the region and plays an important role in the energy balance on the Balkans. The country's strategic geographical location makes it a major hub for transit and distribution of oil and gas from Russia to Western Europe and other Balkan states.

By the end of 2024, Bulgaria's Electricity System Operator (ESO) will finalize it investment program aiming to ensure secure the grid connection of new power plants with a total installed capacity of 4,500 MW, primarily renewables.

ESO, the country's transmission system operator, has invested more than EUR 25 million in the digitalization of the grid. Modernization and digitalization of the medium-voltage grid is expected to be completed by 2024. The deadline was mid-2026, but the activities were implemented much faster.

ESO has signed preliminary agreements for 4,000 MW, and it must secure the connection for 4,500 MW, according to the target set in the National Recovery and Resilience Plan. The plan also sets a goal to increase the cross-border transmission capacity by 2,000 MW. Bulgaria has already finished its part of the new power line with Greece, where neighbouring Greece needs to build the remaining 29 km of the new interconnector with a total length of 122 km. By the end of 2023 it is expected the power line to become operational.

In general, Bulgaria's electricity system has returned to the levels of 2019, before the coronavirus pandemic hit the economy. According to the data of the pan-European platform ENTSO-E, which receives data from the Bulgaria's Electricity System Operator, the energy produced last year was 43.5 TWh, while in 2020 it was 40 TWh, and in 2019 - 43.8 TWh. The record electricity prices are not related to lack of capacity or shortage of supply, but are entirely dictated by market forces related to natural gas prices and CO2 emissions.

Domestic electricity consumption increased by about 5% on an annual basis to 38.4 TWh and even slightly exceeded the level of 2019, which can be explained by both the colder weather and the economic recovery after the lockdown. Power generation in 2021 has increase by 9% compared to year 2020, mainly due to the coal-based thermal plants based and the hydropower plants in the country.

Lignite coal is mainly behind the growth of electricity production. Data for 2021 show an increase in electricity production from this local coal by 30.8%, reaching 18,888 GWh. Thus, nuclear energy, which in 2020 had the largest share in the electricity mix, has been displaced from the first place. Despite losing its leading position, nuclear power production remains higher than in 2019 and 2020 at 16,487 GWh (+ 0.1% compared to 2020).

The production of electricity from natural gas, like lignite, also marked a significant jump of 27.7% compared to 2020, reaching 2,788 GWh.

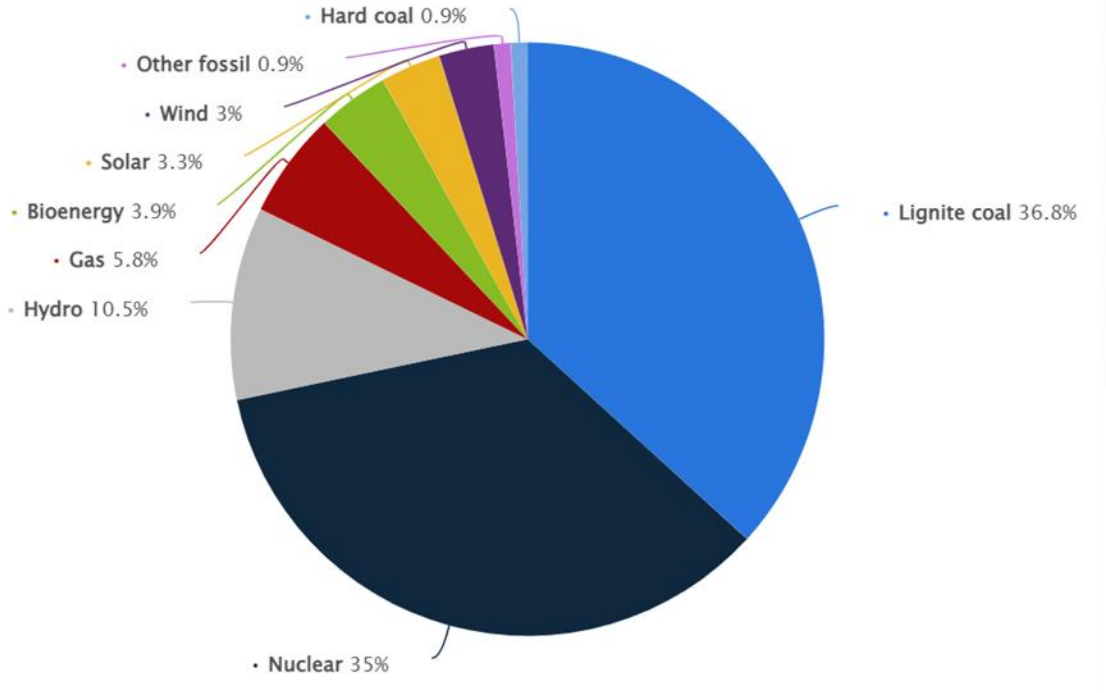
Due to delays in ongoing repair projects and regulatory inconsistencies, Bulgaria uses only one-third of its large, pumped storage HPPs and an even less of smaller run-of-the-river plants. In times of rising prices and shortages of electricity supply, hydropower plants would ease the pressure on the system and offer cheaper electricity during periods of peak consumption.

However, if a more modern solution is sought to support storage technologies, it would be more efficient to invest in the development of battery systems that can be used freely by all participants in the electricity market. Such a solution was proposed in the latest version of the national Recovery Plan, but on a scale that would be difficult to implement in this limited time.

It makes more sense to support storage systems for small and medium-sized businesses, which can reduce their dependence on the grid and hence improve its performance at peak consumption. Support measures aimed at industrial consumers are in place in the Recovery plan. However, the proposed financing scheme for RES installations up to 1 MW would also lead to the non-utilization of a large part of the existing market potential.

The past year turned out to be extremely favourable for the hydropower production, which realized an increase of 52.5% and 5,095 GWh were produced. However, it should be noted that the electricity generated by hydropower pumping capacity has fallen almost twice - from 447 GWh (2020) to 222 GWh (2021) according to ENTSOE data.

The production of electricity from other renewable sources turned out to be more modest compared to 2020. In 2021, the amount of electricity produced by solar power exceeds that of wind. The corresponding values are 1,428 GWh (-0.1% compared to 2020) and 1,388 GWh



Bulgaria: Distribution of Electricity Generation in Bulgaria in 2021, by source[1]

(-2.7% compared to 2020). Biomass electricity decreased by 1.2% to 249 GWh. As a result of higher quantities of electricity produced from lignite, hard coal and natural gas, the share of emission production in the electricity mix has increased from 43% to 47%.

Domestic electricity consumption is 38,411 GWh or 5.2% higher than the previous year.

The export of electricity in 2021 is 10458 GWh or 49% more than the previous year.

Significantly larger amounts of electricity were exported from Bulgaria to Serbia - 3.5 times more and from Bulgaria to Romania - nearly 3 times more. Only a drop of 37% in exported electricity to Turkey.

Last year energy from coal was the main source of electricity production in Bulgaria. In 2021, it accounted for 36.8 percent of total electricity generation. Nuclear energy ranked second, making up 35 percent of total production.

As Russia's invasion of Ukraine is sending shock waves across Europe, Southeast Europe (SEE) is bracing up to bear the brunt of the economic, financial, and security consequences. The countries in the region are heavily reliant on Russian gas and oil, and for their regular supply

[1] *Source:* ***https://www.statista.com/statistics/1234904/bulgaria-distribution-of-electricity-production-by-source/***

Russia is a major trading partner and investor. The sanctions on Russia and the indirect consequences of higher energy and raw material prices and supply chain disruptions are expected to impact businesses across the board, curbing production, further fuelling inflation and slowing down recovery.

Bulgaria's energy market is dominated by state-owned players which include:

- the Bulgarian Energy Holding (BEH) –which manages the most important companies in the energy sector
- the Kozloduy nuclear power plant (NPP) with two operating units
- three thermal power plants
- the National Electric Company (NEK)
- fifteen hydro power plants
- Electric System Operator (ESO), Bulgargaz, Bulgartransgaz.

The highly regulated Bulgarian electricity market is dominated by a few major players that have built a supply monopoly in the country. Despite the legal unbundling of the three distribution system operators from its vertically integrated undertaking, there is no real competition in the distribution market that could enable consumers to choose their supplier as there is only one licensed supplier in each geographical region. Bulgaria's energy intensity is among the highest in the EU. The country is dependent on imported fuels from Russia and, at the same time, the country is attempting to develop itself as an energy hub.

Bulgaria's first nuclear power plant was launched in Kozloduy (KNPP) in 1974. Over the years, six units were completed making KNPP one of the largest in the region with the installed capacity of 2000 MW. In the 1980s, a new nuclear plant at Belene was approved for construction. Meanwhile, two of KNPP's units were closed in the early 2000 as a pre-requisite for EU accession; two other KNPP units were closed as part of the 2007 agreement of Bulgaria's accession into the EU. Over the years there have been countless discussions by the Government and energy companies about a new KNPP unit (Unit 7), as well as debates of completing the controversial, and incomplete, Belene project with the produced and delivered two Russian reactor vessels, two pressure compensators and 24 hydraulic accumulators.

Thermal power plants were encouraged in Bulgaria in the early 2000s as Kozloduy NPP units were being closed as part of Bulgaria's accession into the EU. Today there is a strong thermal power plant complex (TPPs) known as the Maritza Iztok Mining complex which consists of three lignite-fired thermal power plants (TPPs) known as: Martiza East 1 (ME-1), a 686 MW U.S.-built, owned and operated by AES Corporation; Maritza East 2 (ME-2), a 1,610 MW state-owned plant; and, Martiza East (ME-3), a 908 MW plant owned by the U.S. company, Contour Global. Other TPPs exist throughout the country.

Bulgaria's energy generation includes nuclear energy, solid fuels, such as lignite, as well as small quantities of gas. The role of renewable energy sources (wind, solar, biomass, and hydro) has increased dramatically in recent years.

Bulgaria's Electricity Production

Energy prices on the regulated market are fixed, by reference, or formula- based, indicating low levels of competition in the energy sector. The country's regulatory regime is unpredictable and American companies have faced problems with enforcing existing contracts.

Currently, the electricity market in Bulgaria is undergoing certain major changes, including the introduction of new rules for renewable energy producers, the abolition of the electricity export tariff, and market coupling projects, which will also affect the Independent Bulgarian Energy Exchange (IBEX). IBEX has been in operation since early 2016. Bulgaria is among the last countries in Europe that introduced its energy exchange. The purpose was to regulate free trade, to ensure electricity prices are set on a free market basis, and to bring transparency to the trading of energy.

The main issues that the free electricity market in Bulgaria faces are low liquidity, price volatility, and lack of integration with neighbouring markets. The legal framework governing IBEX operations is subject to constant improvements and revisions. Some of the most important regulations implemented in 2018 were the abolition of the "single buyer" role (the Bulgarian National Electricity Company), the inclusion of producers of 4 MW and over on the free market, the switch from preferential prices for electricity to premiums, and the purchase of the electricity distribution companies' technological losses from the market. Centralized trading via IBEX was also introduced.

Main goals of the current leadership of the state and the businesses are the following aspects:

- Decarbonization of the Bulgarian economy
- Recovery and Sustainability Plan of the Republic of Bulgaria
- Energy security and investments (specific proposals for investment projects; the future of public and private TPPs; network development; use of alternative energy sources, etc.)
- Actions undertaken and planned at regional and national level;

Until now, the electricity generated by different plants has been bought by the National Electricity Company (NEK) and sold on the regulated market. Under the new law, producers in the range 1-4 MW switched from preferential prices to a different feed-in tariff structure. They are selling the produced energy at market prices on the IBEX and are compensated for the difference between the market price and the preferential prices granted in 2010, 2011 and 2012 (premium compensation). The premium compensation is paid out by the special

State Energy Security Fund. The changes provide for the granting of a premium on a competitive basis.

It is expected that the IBEX will increase its liquidity, which will inevitably solve one of the main current issues highlighted by the business – high prices. The Government of Bulgaria is considering a stimulus package, aimed at partially compensating businesses hit by surging electricity and gas prices. It is contemplating to keep on paying some 80% of the price of electricity above BGN200.00 ($109.89) per MWh.

Smart Grids

Bulgaria's energy strategy foresees the replacement of ordinary power transmission networks with smart grids by seeking EU funds for the replacement of conventional electricity meters with smart ones. The issue how to deal with overcapacity in the electricity market is critical for the integration of renewables into the electricity grid in Bulgaria. Priority of the Bulgarian Government Are A) increasing the transmission capacity and B) introducing of a smart grid development as solutions handling the overcapacity in the power market.

In mid-2021 an innovative mobile power flow control system was installed in the Bulgarian transmission grid which will increase renewable energy penetration and improving cross-border flows between Bulgaria and Romania. In Bulgaria, the installation of a novel mobile power flow control system is made it possible to greatly increase the amount of renewable energy that the country's power grid can handle. It also unlocked cross-border electricity flows. The technology was installed in Bulgaria's transmission system as part of the EU-funded FLEXITRANSTORE project, with collaboration between the Bulgarian transmission system operator, electricity system operator (ESO) and global power technology company Smart Wires. Power flow control technology made the power grid infrastructure more efficient and resilient. Grid congestion was reduced, and quicker connections were made possible between new renewables and demand. The pioneering mobile power flow control solution developed by Smart Wires was installed in north-east Bulgaria, where 750 MW of wind energy is generated.

Renewables

With Moscow's snap decision to halt all gas exports to Bulgaria and the military invasion in Ukraine the crisis created an opportunity for Bulgaria to expand renewable energies and invest in energy efficiency solutions – rather than merely replace one gas supplier with another.

Currently, Bulgaria has the goal of using 27% of renewable energy sources (RES) by 2030. The planned investments in the renewable energy sector are insufficient for the transformation of the energy mix. Some analysts argue that Bulgaria should shift its focus away from large-scale energy projects and towards the decentralization of electricity production with a leading role and thought for households and small and medium enterprises.

Currently, the focus is on financing a large-scale project for RES investment tenders, under which a minimum quota of 25% is set for the installation of battery storage systems. This project to connect 1.7 GW of RES capacity puts excessive focus on the use of batteries. In the framework of well-interconnected power markets in the SEE region, the excess power storage capacity does not make economic sense.

The transformation of the electricity mix on the part of RES and Kozloduy nuclear power plant should put an end to rising electricity prices, and volatility may occur at limited times of the year, when a combination of imports, demand management systems and energy efficiency, would smooth out the peaks and ensure security of supply.

Bulgaria started renewable energy promotion, including the establishment and implementation of the institutional and legal framework only in 2007. The state experienced the strong RES development in two periods (2007-2012 and 2012-2016) and increased its share dramatically. Bulgaria will increase the installed capacity for renewable energy from 1.8 GW to 4.3 GW by 2024. By the end of 2030, Bulgaria is targeting a further 2,645MW (2,174MW solar plants, 249 MW wind parks, 222 biomass powered plants) of electricity generation installed capacity from RES, mostly photovoltaic plants, in line with the EU goals for green energy transition. In accordance with the ESO's plan, by 2030 the share of the energy produced by RES in Bulgaria's gross final consumption should reach 27.1% where the EU target is 32%.

In Bulgaria, there are 242 hydropower plants in operation. In total, the National Electric Company (NEK) owns 30 conventional hydro and pumped storage plants with a total installed capacity of 2,713 MW in generating mode and 937 MW in pumping mode. Hydropower's importance is not limited to the production of energy because it plays a key role in greenhouse gas emissions reduction.

Hydropower contributes to an annual avoidance of 491,690 tons of CO2 emissions, which translates into an annual CO2 cost savings of $3.5 million. Another significant benefit of the sector is the opportunity for integrated water resource management to reduce the risk of natural disaster. Bulgaria must take urgent control measures on small hydropower to avoid EU sanctions: the local authorities need to take urgent measures to effectively control small hydroelectric power plants.

Energy Efficiency

Bulgaria remains the most energy-intensive economy in the EU by a wide margin. The structure of Bulgaria's final energy consumption is quite like that of the EU. The economy in Bulgaria consumes 3.5 times more energy resources per unit of its GDP than the EU average. That may not sound so alarming, but Bulgaria is highly dependent on coal and nuclear power. The energy sector is the biggest greenhouse gas emissions polluter in the country. It is responsible for 70 percent of the total greenhouse gasses nationwide. The low levels of the wages and pension benefits also contribute to many people being unable to afford more sustainable means of heating during winter. The National Energy and Climate Plan stresses

Bulgaria's commitment to decarbonize its economy by 2050 in the context of the European Green Deal, but also states the intention to keep Bulgaria's reliance on domestic lignite sources for 2050 and beyond.

The Bulgarian Government expects to allocate EUR 230 million of EU funding to local companies in the next months to improve energy efficiency, reduce energy costs and launch reforms under the country's recovery and resilience plan. In July 2022, the government will kick off the first procedure under the EUR6.3-billion plan for Bulgaria's economic recovery from the pandemic approved by the European Commission. The first portion of the grant financing, which aims to stimulate companies' technological modernization, will amount to some EUR 260 million. Separately, under the EU's Recovery Assistance for Cohesion and the Territories of Europe instrument, or React-EU, Bulgarian authorities will start providing energy efficiency grants to companies which will enable businesses to bring down their electricity overheads in the face of record-high power prices.

In 2020 Bulgaria requested a derogation from Europe for the implementation of the National Energy Savings Plan, under the energy efficiency obligation scheme. The reason was that this proposal was put in place about three years earlier than the relevant European directive. In Bulgaria, the energy efficiency obligation scheme is implemented through a combination of individual energy savings targets for energy traders and alternative measures. To date, Bulgaria is experiencing difficulties in implementing properly the energy efficiency obligation scheme. For the 2014-2018 period, the country met 48.4% (935 Ktoe) of the total target of 1942.7 Ktoe for energy savings.

SERBIA

Overview of the situation in Serbia

Serbia annually consumes about 190,000 GWh (about 16.5 Mton) of energy, of which 40,000 GWh is electricity. Most of primary energy, about 50%, is obtained from coal. Serbia meets its needs with 1/3 of energy from imports. Households in Serbia consume almost 50% of electricity, in contrast to developed countries where the ratio is 70/30 in favour of industry.

About 38.5 TWh of electricity is produced annually in Serbia, of which:

71% from coal, gas and oil

29% from renewable sources namely:

25% from hydroelectric power plants

4% from wind (3.5%), sun, biomass and biogas

Serbia consumes about 23 MWh of energy per capita, but due to this structure of energy production, it also produces large amounts of CO_2, that is, about 6t of CO_2 is generated per capita. When these data are compared with the national GDP, it comes out that for every EUR

generated, Serbian industry generates 0.65 Kg of CO_2, which is a value that indicates that the economy and population are largely dependent on fossil fuels and that the industry is energy intensive. The world average is half as much, 350 gr/EUR, while, for example, Germany generates only 220 gr/EUR. That is why it is not surprising that air, land and water pollutions are intense in Serbia.

Presentation of the distribution of electricity production by sources

In its strategy, Serbia has outlined that by 2030, it will have 50% of electricity from renewable sources.

The total installed generating capacity is now 8.2 GW.

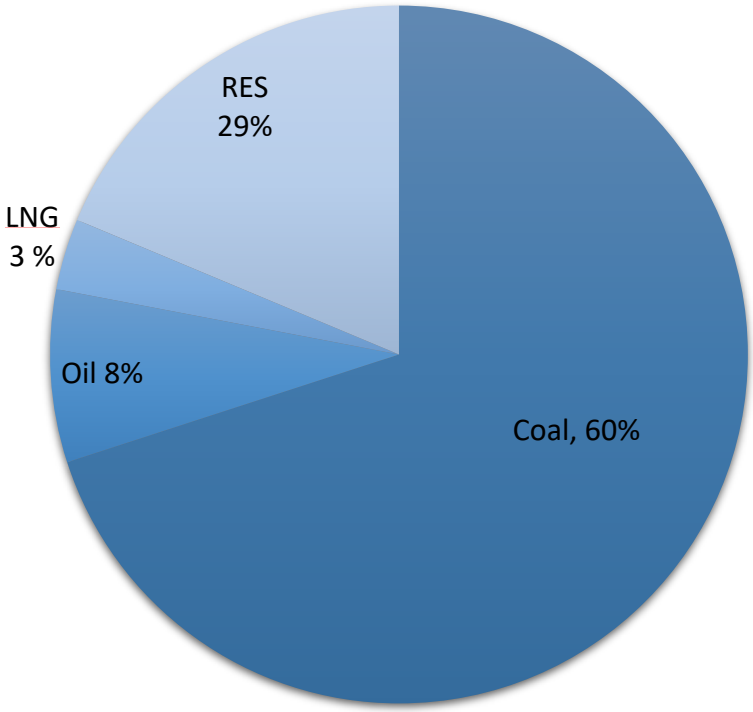
The total potential of RES is 65 TWh, and development projects are underway that should provide:

7 GW of wind

5.5 GW of sun, there are 60,000 ha on roofs alone

711 MW of hydropower plants

70MW bio gas



Presentation of the distribution of electricity production by sources

Energy intensity, as the ratio of consumed energy to gross domestic product, is significantly higher in Serbia than in the countries of the European Union. The reason is low productivity, insufficient economic activity, an environment that is not attractive enough for investors because of administrative obstacles and grid limitation, but also for the low price of electricity. Research by Elektroprivreda Srbije shows that citizens consume up to 60 percent more electricity than those in the EU, even though the standard of living in Serbia is significantly lower. It should be taken into account that the network for the distribution of natural gas to small and medium-sized consumers is underdeveloped, so the economy and citizens in Serbia do not have enough available gas that largely meets the energy needs of consumers in Europe with prices that are lower than other energy sources. This situation is recently beginning to change due to the conflict in Ukraine. This greatly affects the insufficiently developed awareness of the economy and citizens about the benefits of investing in energy saving programs and does not justify the investments. In addition, financial instruments for supporting energy saving projects are poorly developed, either through direct credit lines or support of the so-called ESCO model (Energy Servicing Company) that finances energy efficiency from the savings. There is a need and it is necessary to improve the legal framework and the effective way of implementing measures for the improvement of energy savings and energy share with more intense use of renewable sources.

It is true that the Law on Efficient Use of Energy, adopted on March 15, 2013, created the legal framework for the introduction of a series of measures to increase energy efficiency and create the basis for financing energy saving projects, on the basis of which the Budget Fund began operating in 2014. for the improvement of energy efficiency, as a budget line within the Ministry of Mining and Energy. The funds of the Fund are intended for the public sector, i.e. local self-government units for financing or co-financing programs for energy efficiency, most often in buildings or in reducing energy consumption for public use (i.e. public lighting). However, the funds at the Fund's disposal are limited and in 2018 amounted to around 1.2 million Euros, of which only 39 projects in local self-government units were financed at that time. 230 million dinars from the budget and 500,000 dollars of the UNDP donation were spent on the implementation of those projects. The average savings achieved through these projects amounted to about 40 percent, which indicates the justification of the Fund's work, but at the same time indicates insufficient amounts of money for growing needs.

Thanking to the projects for increasing energy efficiency in public sector facilities, energy savings of one kilowatt-hour are achieved for every ½ EUR of investment. At the same time, the revitalization of all buildings in the public sector would require around 1.2 billion euros, keeping in mind that in these buildings, around 270 million euros per year are currently spent on energy consumption.

Serbia currently generates 18.7% of its needs from renewable energy sources, which is less than the 27% it has committed to have by 2020.

The potential of RES is 5.6 Mtoe (65 GWh), which means that they are currently used at almost 55% of their potential, but at the same time it indicates that Serbia could very easily meet all

its needs for electricity from renewable sources. However, to meet these goals in energy mix, it is necessary to build an infrastructure for an undisturbed two-way flow of energy (a smart electric grid) and to provide the balance with energy also from renewable sources.

An additional difficulty is the incomplete compliance with the EU regulation regarding the use of energy and energy efficiency of the industry as well as high participation of the industry in the consumption of final energy, in relation to neighbouring countries and the insufficient use of energy from renewable sources by industrial entities.

Serbia is largely dependent on energy from coal and oil, which results in significant emissions of greenhouse gases (GHG). In addition, 70% of the total waste generated comes from energy production (fly ash) and this waste is not used, although there have been initiatives to apply it in construction, primarily in road construction. The share of renewable, autochthonous energy sources has not been utilized to a sufficient extent, and that is why Serbia still imports about 1/3 of its energy needs. In addition, the pollution of air, water and land that comes from conventional energy exploitation threatens the quality of life of citizens and the state of the environment in general. In response to that, the Air Protection Program until 2030 was adopted in January 2023, but it remains to be seen what effects it will achieve. The existing quotas for intermittent energy (wind energy and solar energy) of 500 MW and 10 MW of installed power were subject to subsidies through the FIT system, which was suspended by the new regulation and, as said, the transition to a system of incentives through electricity auctions was foreseen. Serbia passed the Law on RES, which foresees the transition from feed-in tariffs to an auction incentive system, but no auction has yet taken place, despite multiple announcements. This lack of predictability has a direct impact on the reduction of investments in the sector of renewable energy sources, which makes it impossible to achieve binding goals for the share of RES in the energy mix. The rising energy price trend has been present for some time what might support new investments.

The average annual specific energy consumption in Serbia for residential buildings heated from a district heating system is 170 kWh/m^2(„D“ energy class), which is almost 3 times more than the maximum allowed according to the new Rulebook, which prescribes the minimum requirement of class "C" in a building with several apartments where energy consumption for heating is limited to a maximum of 60 kWh/m^2 per year, but only for buildings built after the adoption of this regulation.

The cost of delivered thermal energy for citizens is still generally not done according to the consumption, but by the surface area of heated space, which does not contribute to the awareness or motivation for citizens regarding energy consumption and savings.

Legal regulations do not encourage individual production and use of RES, and procedures for obtaining respective permits still take too long. That is why Serbia is only ranked 94th in terms of access to energy on the World Bank's "Doing business" list.

4. GOUVERNANCE AND PUBLIC POLICIES

At the global level in 2015, aiming at further encouraging sustainable development and mitigating climate change, two very important documents were adopted. The United Nations presented the 2030 Agenda for Sustainable Development with 17 goals, which envisages that signatory countries shall mobilize all resources to eradicate poverty, fight inequality and find answers to climate change by 2030. Another important document is the Paris Agreement, which seeks to strengthen the global response to the threats posed by climate change, including limiting the increase in the average global temperature to well below 2°C, compared to pre-industrial levels and at continuing efforts to limit temperature increase to 1.5°C, compared to the pre-industrial level.

The Republics of Serbia and Bulgaria, as members of the UN, have embraced obligations from the 2030 Agenda, and also, as signatories of the Kyoto Protocol, obligations from the Paris Agreement.

The seventh action program of the European Union for the environment until 2020 (Decision 1386/2013/EU), adopted in 2013, contains nine priority goals, one of which is the transition to a raw material-efficient, green and competitive low-carbon economy. This goal is a corner stone of the further development of policies in the area of circular economy and renewable energy sources.

With the European Green Deal (COM/2019/640), the European Union committed itself at meeting the goals of the 2030 Agenda and the Paris Agreement. The Green Deal was promoted as the most ambitious package of measures to make Europe the first climate-neutral continent by 2050. Achieving the goals of this agreement implies a new industrial policy based on the circular economy and the use of renewable energy sources. It has been foreseen that the industry will be modernized and new markets for climate neutral and circular products will be developed. The framework plan of the Green Deal anticipates the adoption of several important strategic documents in 2020.

By signing the Declarations on the Green Agenda for the Western Balkans at the Summit in Sofia, on November 10, 2020, the Republic of Serbia undertook to implement the recommended measures in five areas, at least three of which contain issues that are essential for the proliferation of the use of energy from renewable sources:

In October 2021, the Action Plan for the implementation of the Green Agenda for the Western Balkans was adopted, which includes activities in the area of the circular economy and the use of RES.

Moreover, the Energy Community planned to reduce energy use by 32.5% until 2030.

National frameworks of public policies

The Republic of Serbia is in the accession process to European Union, therefore, it is mandatory to harmonize national strategic documents and legislation with European regulatory framework.

The strategy of the industrial policy of the Republic of Serbia for the period from 2021 to 2030 aims at increasing the competitiveness of industries. Due to the overall utilization of the linear economic model in the Republic of Serbia, there are significant losses in the flow of raw materials, materials and products, which resulted irrational use of resources. One of the special goals (goal 5) refers to the transformation of the industry from a linear to a circular model. Manufacturing industry (especially food), construction, and primary agriculture have been identified as the sectors that have the greatest potential for applying the circular economy concept in the Republic of Serbia. In the Action Plan for the implementation of the strategy within the special objective 5, three measures (seven activities) are defined that will be implemented in the next three years: 1. Promotion of the circular economy and education of businesses; 2. Encouraging investments in circular and low-carbon economy solutions as growth generators; 3. Supporting efficient use of material resources and energy efficiency in industrial processes.

The principles of the circular economy are also recognized in the Strategy of Sustainable Urban Development until 2030. As measures to achieve the goals of urban development, mitigate climate change by improving the quality of all environmental parameters, waste management systems and measures to improve energy efficiency are included in the task list. Package of measures related to the improvement of conditions for local sustainable economic and urban development, this strategy encourages innovation and the development of a low-carbon, resource-efficient, green economy that is an essence of the circular economy.

The strategy for the development of education in the Republic of Serbia until 2030 laid the foundations for the development of education related to increasing the quality, scope, relevance and efficiency of education, in order to create conditions for the individual and professional development for everybody, as well as for the development of the knowledge-based society and the state.

Strategy of agriculture and rural development of the Republic of Serbia for the period 2014-2024. defines goals for: achieving technological development and modernization of agricultural production and processing through the improvement of technology and a more efficient system of transferring experience and innovation; increasing productivity and efficiency in production at all levels in the food production chain; strengthening the ability of the food industry to create more value-added products with the use of domestic raw materials. In addition, the area of environmental protection and preservation of natural resources defines operational goals: raising awareness of the importance of using renewable energy sources and the production of energy biomass; controlled waste management from

primary agricultural production; development and improvement of the management system of secondary products in the food industry.

The Energy Development Strategy of the Republic of Serbia until 2025 with projections until 2030 and the Regulation on Establishing the Program for the Implementation of the Energy Development Strategy for the period from 2017 to 2023, provide basic guidelines and instructions to apply the principles for energy savings and energy efficiency.

When it comes to recognizing the idea of a circular economy in energy, the concept is based on the energy management, increasing energy efficiency and using renewable energy sources for final energy and non-energy purposes.

The Law on Energy establishes long-term goals, as well as providing the conditions for improving energy efficiency and increasing the use of renewable energy sources in the energy mix. This law recognizes the main actors in the field of energy, as well as establishes principles that define their responsibilities, which are presented in details in the respective regulations. This law enables the creation of conditions for reliable and safe operation and sustainable development of energy systems.

The law on the use of renewable energy sources regulates the use of energy from renewable sources and defines goals: the method to determine the share of renewable energy sources in the gross final energy consumption of the Republic of Serbia (energy mix), the integration of energy from renewable sources into the market, incentives for the production of electricity from renewable sources, etc. Some of the most important goals of this law are fully in line with the principles of reducing the use of fossil fuels and increasing the use of RES in order to protect the environment and encourage research, innovation and competitiveness in the renewable energy sector. The possibility of simultaneous production and consumption with small consumers, the so-called prosumers (buyer/consumer), is also introduced as a novelty, which enables individuals and small businesses to produce energy for their own needs, using the electrical distribution network as a temporary storage of excess energy.

The Law on Energy Efficiency and Rational Use of Energy regulates the conditions and manner for efficient use of energy and energy sources, the policy framework to boost energy efficiency; energy management system; energy efficiency policy measures; energy labelling and eco-design requirements; financing, incentives and other measures, as well as other important issues related to the efficient use of energy.

The Law on Climate Change provides the basis for an efficient and transparent Monitoring, Reporting and Verification System (MRV system), which will provide detailed information on progress in meeting domestic and international goals and ensure monitoring of the achievement of the Nationally Determined Contribution (NDC). The aim of this law is to establish a system to reduce emissions of greenhouse gases (GHG gases) in a cost-effective and economically efficient way and thereby, to avoid dangerous climate changes at the global level and adverse their impacts. Also, the goal of this law is to reduce GHG emissions and to

foster accommodation to changed climate conditions by adopting and implementing public policy documents.

The Law on Public-Private Partnership and Concessions regulates, among other things: the conditions and manner of drafting, proposing and approving public-private partnership projects; rights and responsibilities of public and private partners; conditions and method of granting the concession. Through the corresponding articles of the law, the elements that are relevant for principles of environmental protection, requirements in the field of environmental protection in respect with public-private partnerships and concession activities. This is important for municipal heating and public lighting projects using RES, as well as for energy efficiency in public buildings.

The Law on Innovation Activities regulates the basic principles, goals and organization of the application of scientific researches, technical and technological knowledge and inventions in line with R&D in new technologies, new and improved products, processes and services, being them a driver of the development of the Republic of Serbia. The implementation of this law enables support to development of innovations. Therefore, it represents the basis for incentive measures in utilization of RES.

Natural resources

The most important natural resources of the Republic of Serbia are water, forests and agricultural land. However, the Republic of Serbia has also metallic and non-metallic mineral raw materials as well as energy mineral raw materials (coal, oil, natural gas).

Looking at the greater picture of water resources, the Republic of Serbia still has a sufficient amount of water. The average value of the water exploitation index (WEI) at the national level for the period 2008-2017, is low and amounts to 2.69%, what means that Serbia is still far from the water stress (20%) and extreme water stress (40%). However, the territory of the Republic of Serbia has extreme differences in water regime where the actual availability of water and the state of water stress at the local level can be significantly different from the situation at the national level. Furthermore, the amount of surface water formed at the national territory is small (about 1,500 m^3 per dweller per year) and decreases over time, which is why the availability of water in the country partly depends on transit waters. It is estimated that due to climate changes, this trend will prevailed which is why the availability of water in the Republic of Serbia will depend more and more on the waters that come from nearby area. Moreover, the available capacities of underground water are limited, unevenly distributed and that they decrease with time. Hence, all activities related to the preservation of water resources are of great importance, especially at the local level.

In terms of water use, the most significant consumer is the economy, where industries accounts for about 79%, the agriculture, forestry and fishing sector about 13%, as well as the service sector with around 2%, while about 6% of the water is used annually for the sanitary needs of households.

According to available data from the Forestry Administration, state forests occupy an area of 1,194,000 ha or 53.0% of total territory, while private forests occupy an area of 1,058,400 ha or 47%. The preparation of the Second National Forest Inventory is underway, which should be completed in the last quarter of 2022 or the first quarter of 2023 and which will provide new data on forest coverage and the shares of state and private forests. In relation to the total covered area in the Serbian forest fund, coppice forests dominate with 64.7%, natural stands of high origin cover 27.5%, and artificial stands (with crops) cover 7.8%. Overall, the state of public forests can be characterized as satisfactory, while privately owned forests are quantitatively poor. Bearing in mind that wood represents the largest natural renewable resource, but also a resource that takes a long time to renew, adequate forest management and rational consumption of wood are necessary prerequisites for the sustainable development of the economy.

Local reserves of crude oil and natural gas are limited, which indicates the significant dependence of the Republic of Serbia on import. The domestic production of primary energy is based on the exploitation of limited domestic resources (coal, crude oil, natural gas) and renewable energy sources and the largest share in its structure is coal. The total energy consumption at the level of the Republic of Serbia is significantly higher than the available capacities (15.4 Mton), thus about a third (35.9%) of the required energy is provided by importing energy sources. Crude oil and oil derivatives (60%) and natural gas (25%) have the largest share in the net import of primary energy.

In terms of final energy consumption, the most demanding sectors are households (34%), transport (27%) and industry with (26%), while other sectors together (agriculture and public and commercial activities) participate with 13%. In final energy consumption, the most used energy sources are oil derivatives (32.0%) and electricity (29%), and bearing in mind that around 70% of electricity is obtained from coal, it is clear that the Republic of Serbia is largely dependent from fossil fuels. Such a structure of energy consumption results in higher emissions of gases with the greenhouse effect and serious air pollution.

The Republic of Serbia has great investment potential in renewable energy sources, especially in the domain of solar and wind energy, while it is estimated that, in addition to wind and solar energy, the biggest reserves are in biomass and hydropower.

The foundations for the systematic development of energy production from renewable sources in the Republic of Serbia were laid in 2009. Although estimated to have great investment potential, this area is still in development, and traditional fuels, such as non-commercial biomass currently have a large share in meeting the daily energy needs of rural and urban households with low incomes. The production of energy from renewable energy sources in the Republic of Serbia depends on large and small water streams, wind and solar energy, biogas, as well as the production and consumption of thermal energy from geothermal energy and biomass (firewood, pellets and briquettes). The estimated technically usable potential of the available RES amounts to about 5.64 Mtoe per year, of which 35% is

currently used. Of the available RES, the greatest potential for further development is biomass with around 3.4 Mtoe and hydro potential with 1.7 Mtoe per year.

Although one of the largest sources of greenhouse gas emissions, the agricultural sector is also a significant source of renewable energy (biomass, biogas), particularly from arable farming, most of which remains unused.

In the structure of gross final energy consumption (hereinafter: BFPE), RES participate with about 2,063 Mtoe, i.e. with about 20%, of which the most is spent for the production of electricity (about 30%) and for heating and cooling needs (about 25 %). The most used sources are solid biomass (56%) and hydro potential (37%), while other sources are much less represented. Of the total energy produced from RES, only 14%10 is consumed in industry.

From 2009, when the legal framework with incentive measures ("feed-in" tariffs) was established, constant increase in the construction of new capacities for the production of electricity from RES was achieved in the Republic of Serbia. By December 2020, 278 power plants using RES with a total installed capacity of 540.54 MW were built within the system of incentive measures. However, regardless of the built capacities, the share of RES in BFPE in 2019 was 21.44% of the planned 25.6%. The slower than expected development can be explained to some extent by the time needed for the incentive system to work and stabilize, to build investor confidence in the functioning of the system, as well as to prepare appropriate projects, especially for the construction of large power plants.

The natural resources of the Republic of Serbia, as renewable or non-renewable geological, hydrological and biological values, have real or potential economic value, but above all they must be sustained in accordance with the principles of sustainable development.

The goals set in the Action Plans for Energy Efficiency (APEE) have not been achieved in the industry. Outdated technology, high specific energy consumption and lack of energy consumption monitoring in production processes are just some of the problems that pictures it. Efficient use of energy is one of the prerequisites for the development of a circular economy. The transition to renewable energy sources makes sense only if the existing systems are optimized and if the resources are used efficiently, regardless of whether they are renewable or not. Therefore, the further development of the energy management system and the reduction of losses are part of the mainstream for improving the current situation in the industries and for households. Also, greater economic use of energy can be gained by increasing the degree of product processing, i.e. finalization, in which "ecological" design can play a major role.

Further development and wider use of RES are very important for the Republic of Serbia, both in terms of increasing the competitiveness of the economy and energy security, as well as in terms of reducing greenhouse gas emissions, lowering air pollution and fulfilling international liabilities for mitigating climate change. Moreover, for part of the economy, the use of RES may soon become a way to reduce taxes for exporting products to the European Union

market, in respect to the introduction of the mechanism for cross-border carbon adjustment (CBAM).

In the previous period, the business climate for the development of RES projects in the country was significantly improved, with the adoption of a series of by-laws, which for the first time regulate the area of biofuel use and create the conditions for biofuels to be placed on the market of the Republic of Serbia. Also, the Law on the Use of Renewable Energy Sources was drafted, which potentially opens the possibility for an even more dynamic growth of production capacities based on renewable energy sources in the Republic of Serbia. It is expected that this law will primarily be the driver of large investments in the construction of solar power plants and wind parks.

Among other things, Law introduced the buyer-producer category, i.e. the right to produce electricity from RES for own consumption, which will contribute to a more massive application of RES in the area of electricity production, especially small and micro systems. As far as thermal energy utilization is concerned, significant support for the use of renewable energy sources was given by opening the possibility of providing incentive measures for energy consumers that use highly efficient co-generation, waste to heat or renewable energy sources, i.e. their connection to the thermal energy distribution system.

For the further development, it would be necessary to ensure investments safety and the conditions run commercially viable business. For that, further liberalization of the electricity market, the adoption of a mechanism for achieving a low-carbon economy in the Republic of Serbia, as well as investments in the development of innovative technologies for the use of RES, increasing the efficiency of existing solutions, the development of energy storage systems, as well as the development and adoption new business models are needed.

It is necessary to create and provide an environment in which the industries and individuals have an interest and motivation to contribute to the transformation process. The role of local self-government in this regard is to provide appropriate incentives for all the stakeholders, as well as to encourage greater public engagement in implementation and promotion of intensified use of RES. These incentives can be of a financial nature as appropriate subsidies (improvement of energy efficiency, use of renewable energy sources, green roofs, urban mobility), administrative relief, fiscal release or reduction of certain dues when rational use of resources and implementation of RES projects.

Only a small number of the local self-governments in the Republic of Serbia have incorporated the principles of circular economy in their planning documents, mostly in the area of waste management, energy efficiency or the use of renewable energy sources. In the coming period, it will be necessary to systematically work on the development of local energy plans, both on new ones as well as in revising local and regional waste management and development plans.

The focus in generating environment that will support the green energy transition should be on waste management, energy management (especially energy efficiency and renewable energy sources), water management and mobility.

Improvements in district heating systems have priority, above all, upgrade or modernization of installations, distribution network and improvement of control systems. In order to achieve greater circularity in this domain, the inclusion of RES in district heating systems will be of great importance, as well as the connection of such systems with industries, for the better use of their RES capacities, but also the use of waste heat from production processes.

Households are using mostly electricity, coal and wood to meet their needs for energy, while RES are still underrated. Connection to gas is relatively small, which is why households have a significant share in the final consumption of electricity (48%). The share of the household in the total final energy consumption in Serbia (34%) is higher than in the European Union (27%), which, in the case of EU can be explained by a higher degree of industrialization, but also by a more rational consumption of energy, in general.

As much as 83% of the total energy produced from RES in the Republic of Serbia is consumed in households. Unfortunately, for the most, it is a matter of simple burning the solid biomass in individual fireplaces, for heating purposes. More complex and technically advanced systems, such as solar collectors, are used much less, although a sharp increase in interest and finished projects has been obvious in the last few years. A major incentive for the mass use of renewable energy sources and the realization of greater circularity in households in the coming period was given by the Law on the Use of Renewable Energy Sources, which introduced the "buyer-producer" (Prosjumer) category. Based on this, a part of the population will be able to produce electricity from RES for their own consumption and deliver excess electricity to the power system, thus reducing the bill for consumed energy. The system is meant to use the grid as a temporary storage where Prosjumer keeps the surpluses of energy until needed.

Bulgaria will increase the use of renewable energy sources during 2023

In December 2022, the Bulgarian Ministry of Energy completed public consultations on legislation amending the Law on Renewable Energy Sources and the Law on Energy, the Law on Energy Efficiency and the Law on Agricultural Land Protection, in accordance with EU Directive (EC) 2018/2011 of December 11, 2018 on the promotion of the use of energy from renewable sources.

This draft law increases the deployment of renewable energy in Bulgaria in 2023 and beyond as follows:

• Simplifies the grid connection procedure and enables new projects to obtain grid connection contracts

• The draft Law simplifies grid connection procedures by introducing a universal grid connection contract for greenfield projects, which replaces the existing system of preliminary and final grid connection contracts for one and the same project. In case of unavailability or only partial availability of connections to the network, the draft Law foresees temporary connection, whereby the OPS/ODS (transmission system operator/distribution system

operator) is obliged to invest in its network in parallel with the investment of the producer. (According to the current rules, the bidder cannot get a network connection.)

• According to the draft Law, the network connection contract is signed when the investor pays the connection reservation or bank guarantee in favour of the TSO/ODS. This will allow an earlier phase of grid connection reservation and a more transparent procedure that is likely to be implemented vis-à-vis the TSO/DSO.

• Furthermore, the draft Law foresees a deadline of six months for the completion of all necessary preparatory tests and the realization of new renewable energy projects, which avoids delays in the procedure of OPS and DSO that could be harmful to the interests of investors.

• The Draft Law authorizes the Energy and Water Regulatory Commission (EVRC) to carry out checks with OPS/ODS and to impose administrative fines in case of violation of the conditions for connection to the network of renewable energy projects.

• The draft law provides for the simplification of procedures for connection to the network of renewable energy projects with an installed capacity of up to 1 MW, as well as the shortening of the deadlines for assessment and approval of connection to the network.

• Any final consumer of electricity could become a producer of electricity from renewable energy sources if the consumer produces and stores electricity from renewable energy sources, installs and maintains electricity storage devices and sells surpluses at market prices.

• OPS/DSO will maintain IT systems on the Internet in order to provide up-to-date information on signed network access contracts and available electricity capacities for grid connection of renewable energy projects.

• Implementation of Directive (EC) 2018/2011

The Draft Law implements the following measures to improve the use of energy from renewable sources:

• As EU member states jointly ensure that the share of energy from renewable sources in the gross final energy consumption of the EU in 2030 is at least 32%, Bulgaria is focused on its national goal of at least 27.09%. This is a significant increase compared to Bulgaria's 2005 level (9.4%) and its 2020 target (16%).

• Within the provisions of Directive (EC) 2018/2011 related to the organization and duration of the permitting process (Article 16), the draft Law foresees that local municipalities will be the contact points for smaller-scale projects, thus ensuring that municipal administrative support centres be a "one stop shop" for the administration of these projects. Mayors of Bulgarian municipalities will therefore no longer be obliged to adopt short-term municipal plans approved by the local assembly.

• The draft law regulates the status of producers of renewable energy for own consumption and the possibility of using, storing and selling excess energy produced.

Institutional support

The draft Law strengthens the capacities of the Bulgarian authorities in the process of implementing renewable energy projects. In this sense, the Minister of Environment and Water, together with the Minister of Energy, is preparing a plan for determining one or more investment zones on land and at sea, corresponding to each RES technology. The plan will give special priority to artificial or built-up sites, as well as poor-quality land that is not suitable for agricultural production, including sites where a lower environmental impact of wind farms can be ensured. The plan for determining investment zones on land and sea will be the subject of a feasibility study or Environmental Impact Assessment (EIA), so renewable energy projects developed in these planned zones will not be subject to individual studies or assessments.

Through the administrative support centres, the mayors of the municipalities will provide assistance and instructions to investors regarding the procedures for planning and building projects for the exploitation of renewable energy sources, including projects for self-consumption. The Minister of Agriculture will develop shorter procedures for the conversion of agricultural land for investment in projects for renewable energy sources.

EVRC will have the right to intervene and change the reference price for projects of renewable energy sources, which have started operating under the Feed-In Tariff (FiT), if there is a significant change (over 5%) of the reference price for the duration of the subsidies in relation to market prices on the electricity exchange. The purpose of this measure is to ensure that investors are not paid above the FiT level.

5. GOALS OF THE STUDY

The overall goals of this study are:

• To provide clear guidelines for the inclusion of regional actors in public policies for the purpose of stimulating sustainable development and improving local support for the exploitation of energy from renewable sources.

• To emphasize the strategic role of renewable energy sources and to be the driver for the introduction of green energy in the region.

• To serve as a technical basis for capacity building activities;

• To present examples of good practice in the introduction of renewable energy sources in other EU regions;

• To support the sustainability of the project and the possibility of its further repetition.

National level

The overall goal means the determination that at the national level there is a need to:

- Find the most efficient and reliable way to direct their natural resources towards the most significant participation of RES in the energy mix and to reach the decarbonization goals by 2050, in accordance with their international obligations

- Adapt the education system to processes that support the development of the green economy and energy efficiency

- Ensure that the energy mix (in which the green energy transition is integrated) is realized in such a way that citizens and the economy continuously meet the criteria of energy security, sustainability and availability.

- Refocus (including funding models) scientific research activities towards full support for the development of RES technologies and programs of participation in international cooperation

- Ensure financing of pilot and initial projects from the dedicated state budget

- Additionally adjust the legal basis to modernize and adapt the process of planning and development of electric power to the changes that are an integral part of the green energy transition

- Develops and innovates standards, procedures and regulatory policies that are in accordance with relevant international practice

- Support economic policy measures stimulate the development of the energy market, simultaneously affecting the production and consumption of RES

- Carry out a reform of the decision making and legislation process in order to encourage the use of RES as efficiently and reliably as possible. A significant part of this goal relates to interdepartmental cooperation within the government

- Achieve the specific goals of becoming an active participant in the green transition process through development and economic activities in the international environment by 2030.

Realization of national goals requires:

• Alignment with the EU Climate Change Act with the vision of achieving climate neutrality by 2050;

• Setting goals in the field of energy and climate change until 2030 in accordance with the framework of the Energy Community and the EU acquis and to develop and implement integrated National Energy and Climate Plans with clear measures designed to reduce greenhouse gas emissions in the economies of the Western Balkans, by integrating climate action into all relevant sectoral policies;

• Review and revise, as necessary, all relevant legislation to support the progressive decarbonization of the energy sector and ensure full implementation, especially within the Energy Community;

• Collaborate on the preparation of an assessment of the socio-economic impact of decarbonization at the level of an individual economy and at the level of the region with the aim of fair transformation;

• Prioritize energy efficiency and improve it in all sectors;

• Actively participate in the Initiative for the Western Balkans regarding the transition of the region from coal to clean and renewable energy sources;

• Create programs for dealing with the problem of energy poverty and financial schemes for the reconstruction of households and ensuring an appropriate level of living standards;

• Support the development of smart infrastructure, promote the cultivation of innovative technologies and strengthen cooperation in the region as shown by the Green Belt/Corridors Initiative;

• Define and implement sustainable mobility solutions at the local and regional level, including the development of urban mobility and plans for the use of alternative fuels and the construction of filling stations for EV and green fuels (green hydrogen). Increase regional cooperation in the field of alternative fuel infrastructure development.

• Integration of Serbia and Bulgaria into EU industrial supply chains through decisive action to improve the sustainability of primary production of raw materials, together with the application of an industrial ecosystem approach to achieve an environmentally sustainable

and balanced economic recovery across the region. This is particularly referring to future-proof key industrial ecosystems such as renewable energy sources;

• Support investments in the production of renewable energy and technologies, as well as the reduction of emissions and measures to adapt to climate change in agriculture.

Furthermore, the guidelines for the implementation of the Green Agenda for the Western Balkans (SWD/2020/223) should encourage the transition from the traditional model to a sustainable economy in the countries of the Western Balkans, while the implementation of the measures itself will be supported by the European Union in accordance with the Economic and Investment Plan for Western Balkans (COM/2020/641).

Local level

The aim of the recommendations is to:

- It helps to introduce the wide use of energy from renewable sources in the most efficient way, but in a way that would stimulate the local economy

- Establish effective and pragmatic cross-border cooperation on issues of mutual interest in the field of exploitation and application of energy from renewable sources

- To strengthen the capacities of the local self-government in order to be able to successfully support RES use programs.

- It will help the local population achieve a higher level of energy independence and thus indirectly help the energy security of both citizens and the economy

- Enable the creation of financial products and mechanisms to support the RES industry, production and consumption and energy storage systems.

- Ensure financing of pilot and initial projects from the local budget and donor funds;

- Additionally encourage energy efficiency programs in the building industry and the economy

- Full application of green public procurement

- Provide additional education and training for recognizing the need and ways of using RES at the local level.

6. RECOMMENDATIONS

The aim of these recommendations is to help the process of including the districts of Vidin and Zaječar, as well as Serbia and Bulgaria, with their human, economic, scientific, educational and resource potentials into the modern trends of the green energy transition, promoting them to be recognized as active participants in the decarbonization process and in fight against climate change.

Recommendations for national levels

Recommendation: Supporting economy in the transformation towards greater use of renewable energy sources

The economy has a very important role in the transition to green energy and is one of the key stakeholders of that process. This specifically refers to providing support to industries by laying the foundations for the green transformation, in order to help supply from renewable energy sources (RES) - the development of additional mechanisms of financial and fiscal incentives for the industries and the provision of direct technical assistance to companies for development of business action plans to introduce RES, as well as encouraging cooperation between scientific, research organizations and businesses in the innovation and optimization of production.

Innovations are integral part of the green transition. Switching industries to new sources of energy requires development and application of innovative solutions in all stages of production process, with a special emphasis on RES, as well as access to specialized research equipment. Innovative solutions represent a significant challenge for businesses, which are mostly micro, small and medium enterprises with limited capacities for R&D. The lack of capacity in industries can be overcome by encouraging cooperation between industries and scientific research organizations. At the same time, existing research capacities in scientific organizations will be efficiently and fully utilized.

Indicative overview of possible measures:

Measure 1: Education of specific groups of industries for the use of energy from renewable sources

a) Adequate technical capacities are necessary for the transition of business entities to use RES, thus the measure foresees the education and training of experts and/or employees who can carry out this transition. It is expected that the acquired knowledge will initiate the quest for ideas and utilization of technical-technological, organizational and business innovations and other changes in production processes,

all in order to reduce resource consumption and increase overall and particularly energy efficiency.

b) Effective education of specific groups of businesses accounts on a detailed analysis and identification of their needs for new knowledge and a well-designed plan to strengthen their capacity, including a training program and implementation plans. In addition, it is necessary to produce specialized manuals and other informative and educational material on issues that are particularly important for the understanding the nature, generation and use of RES.

Measure 2: Support for businesses in finding incentives and other financial instruments

a) The transition to full utilization of energy from renewable sources entails certain costs, which is the main obstacle for industries to modernize their production and to invest in innovations. Increasing investments in RES can be achieved through appropriate programs for the allocation of grants or use of favourable loans, followed by timely and accountable information about the programs/sources of financing that are available.

b) Existing levels of investment are still insufficient to develop the transition to green energy in a comprehensive way. In the previous period, logistic, financial and fiscal incentives in both countries of the region were predominantly aimed at overcoming the negative consequences of the crisis caused by the COVID-19 virus pandemia. Such incentives actually represented support for a linear economic system, rather than investing in the transformation of the economy towards a sustainable development that uses RES. Therefore, it is necessary to conduct an analysis of fiscal policies and administrative procedures in order to define proposals for incentive mechanisms for companies for faster and simpler introduction of renewable energy sources in business operation.

c) Furthermore, it is necessary to adjust the criteria for the allocation of funds through public calls (grants) from available programs/funds in a way to enable effective support for the use of RES to those that need help the most. At the same time, in order to easy utilization of the available financial resources, it is necessary to provide experts' support to companies in the preparation and submission of applications for public calls, in accordance with the defined procedures and Terms of References (ToRs).

d) Connecting governmental institutions and commercial banks through consultative activities in order to find softer access to funds for financing projects in the field of RES (loans, subsidies, etc.) is very important. To obtain stimulating investment environment, it is necessary for banks to develop and incorporate into their operations a general understanding of the importance of RES, both from the production and from the consumer side. Although there are some bank products that

provide required support, banks should create and issue guides for financing the production and use of RES projects. It is also necessary for banks to adjust current financial models or develop completely new products for the field of RES. It is necessary to include social benefits and costs related to the environment, i.e. a positive relationship to the reduction of CO2 emissions.

e) Currently, in the Republic of Serbia, but also in Bulgaria, there are banks that offer "green loans" and finance, to the greatest extent projects in the field of energy efficiency and, to some extent, energy production from renewable sources. That is why it is important to create additional and favourable credit lines to small, medium and large companies that would follow RES projects. Commercial banks should also work on improving capacity of their personnel to effectively assess the risks and vulnerability of projects for the exploitation and use of RES.

f) Providing assistance to businesses to secure favourable financial sources for the introduction of RES will have an impact to their competitiveness on the domestic and foreign markets, as well as to the quality of the environment, the reduction of an impact to climate changes and, consequently, to the health and general well-being of citizens.

Measure 3: Analysis of the potential for the application of RES in certain areas of industry and support to selected MSMEs

a) The measure implies the selection and detailed analysis of at least two different industries in order to asses the potential and necessary investments for the transition to RES supply.

b) The analysis of individual areas should indicate potentials in the introduction of RES and serve as a basis for the intensified and extensive cooperation between businessmen of different sectors of the industry, as well as between scientific research organizations and educational institutions with the economy.

c) In addition to increasing the competitiveness of businesses on the domestic and foreign markets, increased use of RES will contribute to more efficient use of resources, reduction of pollution, improvement of working conditions in selected companies, as well as new jobs. Successfully implemented projects can serve as case studies and examples of good practice for other companies in the selected areas of the industry.

Measure 4: Encouraging cooperation between scientific research organizations and businesses in the field of innovation and optimization of production

a) Bearing in mind that the transition to a circular economy model is closely related to the development and application of innovative solutions in industries, in general and requires significant research and development activities, it is necessary to encourage cooperation between businesses and scientific research organizations in achieving this goal.

b) Consequently, a program should be established for the allocation of financial resources to introduce innovative and other technical solutions in companies, primarily for the use of RES. Funding programs should be implemented through specialized public calls that will support the cooperation of industries and scientific research organizations on priority issues, such as the use and control of RES for the purpose of optimizing production processes, supported by digitization of business operations and technological processes.

c) Improved cooperation between scientific, research organizations and industries and increased innovative performance, would affects all sectors of the economy and represents the engine of economic growth, the basis of sustainable economic development and support to international and cross-border cooperation.

Given that this document is primarily focused on the Vidin and Zaječar districts, these recommendations will not be further evaluated in this document.

Local level

The general recommendations refer to all three sectors at the local level (public, private and to civil society), respecting their specificities.

In order to make the process of introducing RES effective, it is necessary to ensure the cooperation of all three sectors, since these are issues of importance for the entire community.

General recommendations for the local level are aiming at:

1. Raising awareness at the importance of RES
2. Strengthening capacity for the use of RES
3. Planning the introduction of RES
4. Creation of support mechanisms for the promotion of RES
5. Implementation of projects and increased utilization of RES

Recommendation 1: Raising awareness at the importance of RES

In order to make the process of transition to green energy being successful, it is necessary to foster certain knowledge and raise public, businesses and academia awareness in order to

change their habits, help them to adapt to new reality and requirements, and to obtain support. Therefore, raising awareness, providing accountable information and educating the population of all ages on the benefits of renewable energy sources is a mandatory goal. To achieve it, it is necessary to carry out systematic promotion and education using promotional materials, media and educational institutions.

Increased awareness of the concerned public about the importance of the introduction of RES for modern society, as well as the preservation of resources, the protection of human health and the environment, can be achieved through the application of information and educational measures and activities. Also, considering that the use of RES contributes to the achievement of the SDGs (Sustainable Development Goals), special attention should be paid tom cross-sectoral activities, both in the production and consumption of energy, in order to achieve decarbonization and the reduction of the impact on climate changes, through the simultaneous and synchronized of industrial activities related to economic development, environmental protection environment and social responsibility.

The transition to green energy requires certain changes in the entire society, therefore it is necessary to involve concerned public (population, media, representatives of civil society, consumer associations, entrepreneurs as well as experts in business entities and state institutions).

Indicative list of measures

a) **Implementation of a campaign to raise awareness** of the interested public on the advantages of using RES and sustainable development, which includes information and education that should encourage a change in habits, value systems, ways of public rationale and comprehension which is necessary for sparing energy consumption and use of RES. The role of the media and representatives of civil society in the campaign is particularly important, bearing in mind their influence to public opinion, primarily consumers. A campaign can have one general and several specific approaches. The motivation of the industries does not always have to coincide with the motivation of citizens, however there are certain common interests and goal. In order to encourage the industry to use renewable energy sources to a greater extent, there must be a commercial incentive. It is unrealistic to expect any changes to be accepted unless they bring some clear financial/economic gain or an improvement in the market position through additional benefits and/or increased competitiveness. On the other hand, citizens see the improvement of standards through a healthier life, better air, a preserved environment and achieving a greater degree of energy independence, which seems to be at the top of the list of priorities. Bearing this in mind, it is necessary to create a promotional program adjusted to the interests of all target groups.

b) **Creation and distribution of practical manuals** for the utilization of renewable energy sources that contain methods of exploitation, assessment of possibilities, types

of RES and types of plants for the conversion of RES into electrical or thermal energy, with the selection of optimal systems and an overview of investment costs, with an indication of the savings and advantages of using RES , but also with all the challenges that such an approach has. Practical manuals for the use of renewable energy sources should be available online, as well as in Info points for RES. The distribution of practical manuals for the use of renewable energy sources should be accompanied by an appropriate promotional campaign, which includes the organization of workshops and seminars for local governments, public and utility companies and other interested parties (business representatives, associations, etc.). These promotional gatherings are an opportunity to present the participants the previous activities, possible plans for green energy of LGs (Local Gouvernment), as well as for networking and exchange experiences, supporting further communication. This is of particular importance in the case of cross-border programs where such gatherings are important for strengthening mutual understanding and cooperation.

c) **Preparation of information on supporting measures** to promote the use of RES. It is necessary to systematize and update all public calls and tenders with information on subsidies, grants and professional support for the introduction of RES. The informant should be available at the Info Point for RES as well as on the digital platform for RES. An important segment of the campaign should certainly be the share of information about available funds and financing programs that can be used to implement the measures and projects from local plans and initiatives.

d) **Civil society projects and business associations**. Civil society and business associations have a big role to play in raising awareness. It is necessary that both civil society and business associations make their contribution through various activities in order to strengthen awareness of RES.

e) **Public promotions of good practice examples** with rewarding exceptional solutions. In this way, the attention of the public is attracted and at the same time all interested parties are encouraged to join the program of using of RES, either in the industries or for public and individuals.

Note: this list is not exhaustive, it represents an overview of possible measures

Recommendation 2: Strengthening capacity for utilization of RES

Strengthening local capacity is a necessary step for greater use of RES, in which in addition to local self-government, citizens and industries participate directly, as consumers and producers of energy.

The gap between the current situation in local self-governments in Serbia and Bulgaria and the situation in societies that operates in accordance with the principles of sustainable communities, in terms of energy use, reveals a huge potential for improvement, but also

represents a great challenge for local self-governments. Specific knowledge and skills are needed to fully utilize that potential, and additional challenge is the fact that each local community is characterized by a specific social, economic and territorial context. One should respect considerable autonomy and specific needs of local communities in creating programmes for cross-border cooperation between neighbouring municipalities and cities.

Priority areas at the local level, in addition to waste management and mobility, should be energy independence (access to energy sources) and energy efficiency, thus higher level of energy security.

To get there, it is necessary to transfer knowledge and skills for the preparation and implementation of projects using RES at the local level, thus to provide capacities to carry out the green transition. In a broader context, support is to be provided to local governments in order to ensure a better quality of life for their citizens in a healthier environment and paves the way for the formation of a network of sustainable communities that use resources and energy in a sustainable manner, thereby reducing their carbon footprint.

Indicative list of measures

a) **Education and trainings**. Through various trainings, capacities for all activities of importance for the introduction of RES can be improved, such as, for example: need assement, planning, design, feasibility studies, preparation of project proposals for external financing, monitoring, evaluation, etc.

b) **Technical assistance.** For some very specific issues, expertise and technical assistance can be very useful. This primarily refers to the preparation of strategies and plans as well as to design.

c) **Study trips**. Study trips for representatives of LGs and interested parties to European Union countries and cities that have already reached a high level of use of renewable energy sources is an excellent way to improve their knowledge on use of RES through examples of good practice.

d) **Information share**. Joining the existing networks for the promotion and use of RES at the national and international level can help to better understanding and perception of new trends, which will enable timely response and better cooperation with other local governments that have the same or similar problems.

Note: this list is not exhaustive, it represents an overview of possible measures.

Recommendation 3. Planning the introduction of RES

This recommendation implies the need for systemic and long-term planning for the introduction of RES, primarily for LGs and industries. Introducing RES is not just a short-term activity, but a long-term investment in a sustainable future.

For example, municipalities need help, among other things, for the development of local plans for green energy, inclusion of RES in other general and sectoral strategies and development plans, preparation of pilot projects, etc.

Indicative list of measures

a) As part of the support, representatives from the local level, in cooperation with a group of engaged experts in the field of RES, would work on the analysis of the current situation in their LG (review of institutional capacities and local regulations, determination of energy flows), as well as on the definition of the necessary measures and the creation of a local energy plan based on the performed analysis. Plans and their implementation would have to be realized through cooperation with local authorities, public and utility companies and interested business entities at the territory of local self-government, as well as with the concerned public. During cooperation with experts, LG representatives will simultaneously acquire the necessary knowledge to present the measures foreseen in the green energy plan, and such prepared documents will serve as case studies and examples of good practice for other local governments. Local green energy plans need to be linked and harmonized with existing LG documents, such as low-carbon production strategies or waste management plans.

b) The use of RES is only one part of the concept of sustainable settlements, which, at the same time have other characteristics, primarily in relation to safety measures against climate disasters and with programs to help the poorest, but at the same time with the goal of comprehensive development with a minimal environmental footprint. In practice, this means supporting development programs based on the circular economy, i.e. waste reduction and its reuse as a resource, even for energy purposes, as well as the intensive utilization of RES. In this sense, the promotion of the use of renewable energy sources should be seen as part of complex and interdependent measures that together aim at sustainable development in the context of economic and social betterment while preserving the natural environment and people's health.

c) As a rule, the planned increase in the use of RES goes hand-in-hand with higher energy efficiency because it is senseless to introduce new technologies for energy supply and at the same time to consume that energy irrationally. However, the transition to a different or more advanced energy supply system requires the creation, or at least the innovation of both the infrastructure and the supporting grid system for the new supply method. In the technological sense, it is necessary to ensure the balancing of the supply in the grid or in suppling independent consumers, off the grid. That is why making an energy plan is a good step forward because it introduces concrete and pragmatic measures in respect with the current situation, set goals and available capacities.

d) The preparation of pilot projects that are important for the public sector and for the local community, assumes support to the realization of exceptional examples solutions, at the same time will justify efforts to promote the use of RES and show pragmatic reasons for the introduction of alternative green energy resources, while enabling the creation of project models that can be replicated. For this reason, pilot projects are important and it is necessary that the local self-government and the financial sector recognize them as an opportunity to open new market niches and even new jobs.

This study aims at facilitating the use of RES and pilot projects, especially those that have a cross-border dimension and are, therefore, of great importance.

e) The prime goal of any business, regardless of its size or activity, is the profit. It is a legitimate goal because it supports the overall growth and development of the society in which businesses operate. Channelling businesses to operate under certain requirements and under desired standards that have also social and environmental dimension, is made by regulations and respective, either punitive or supportive measures, while monitoring implementation alongside. This is the responsibility of public and state administration. Admittedly, local self-government has limited powers, but even so, tools can be developed to create a favourable climate for the development of new technologies and new industries, either through facilitating measures for start-ups or with direct support for the construction of facilities, opening new jobs for the local population, etc. It is up to industries to develop profitable projects of green energy that would respect the necessary standards in the social and environmental area. That is why the businesses should also invest in the awareness raising on RES projects.

f) Setting up special economic zones (industrial zones, duty-free zones, technological parks...) can be extremely stimulating for investments. If special economic zones have a program framework, significant economic development of a certain area can be achieved. This is especially important in border areas because by setting up two special economic zones that would lean on each other on both sides of the border, a very favourable environment for cross-border projects and investments could be created.

Note: this list is not exhaustive, it represents an overview of possible measures

Recommendation 4. Creation of supporting mechanisms for the use of RES

The mechanisms to support use of RES, by their nature, can be systematic, i.e. institutional, then operational, which presumes the capacity of public administration and the businesses to implement programs, public support, i.e. the support of citizens, the academia and experts, which facilitates the application and identification of public interest and, finally, financial tools that enable the actual application of programs. In

addition to this, it is necessary to create support mechanisms at a level that are lower than the national one and are tailored against specific needs, so that help can reach all those who require them.

Indicative measures:

a) Subsidization and other financial support for the introduction of RES. Various measures can be created to support the introduction of different RES. Subsidies can be given through direct grants through public calls or vouchers, through cooperation with banks and subsidizing interest rates and in other ways.
b) Create recommendations at the local level for the approval of building permits in which investors would be required to apply some of the types of using of RES when building new or reconstructing old buildings.
c) Create special incentive measures for rural and underdeveloped parts of municipalities in order to make it as easy as possible for the residents of those areas to apply some of the ways of using RES, bearing in mind the poor economic status and underdevelopment of the remote areas. For example, a subsidy program for appliances or for consumption. These measures should have an emphasis on savings in energy consumption from conventional sources or from the central distribution network, if these users have access to it at all. The method of financing such, but not only these, projects can be implemented through different models, of which financing from savings (ESCO) is the most acceptable. It is necessary to encourage ESCO companies to finance projects from which savings in consumption will be able to pay for their work, and the user can pay the costs of the project in instalments. After some time, which is usually between 5 and 10 years, all savings remain with the user providing him a high degree of energy independence.
d) Establishment of an Info Point for RES (as a kind of One-Stop-Shop) where all interested parties will be able to acquire information relevant to the use of RES. The info point for RES should provide citizens and the businesses with all information on available support measures, including financial ones for the use of RES. Information points for RES can be established at the district/regional level and later on, at the local level, depending on needs and available capacities.
e) Setting up a digital platform to support the utilization of RES. The digital platform should contain all relevant information for potential users as well as all information on available support measures, including financial ones for the use of RES. The digital platform should be available on the web and on social networks.
f) Formation of teams for design and for installation of RES equipment. Those teams should be subsidized by local governments or banks that intend to invest in exploitation RES projects.

Note: this list is not exhaustive, it represents an overview of possible measures

Recommendation 5. Implementation of pilot projects and increased use of RES

The practical implementation of RES projects will give a full contribution to the utilization of RES.

Indicative projects for municipalities:

- Replacing the district heating system and switching from non-renewable energy sources to RES.
- Use of PPP - Public-Private Partnership in RES utilization projects
- Replacement of heating and cooling systems using RES;
- Production of electricity for own needs from RES;
- Preparation of locations that enable the construction of installations to use RES;
- Establishment of local infrastructure with support for the use of RES in traffic (traffic lights, emergency communication systems, solar powering of bus stops, information panels...);
- Construction of infrastructure and grid for transmission and distribution of energy from renewable sources;
- Development of public mobility and services that use RES – public transport, water purification, garbage collection;
- Support to networking and association on RES issues, with special emphasis on the formation of energy cooperatives;
- Support to MSME for the utilization of RES in their activities, especially in the food industry (greenhouses, dryers, irrigation systems);
- Support the production of electricity from micro solar and hydro plants;
- Construction of public lighting powered by solar panels;
- Energy efficiency programs in public buildings, schools, hospitals... as well as in individual homes.

Indicative projects for the businesses:

- Replacement of heating and cooling systems using RES;
- Production of electricity for own needs from RES;
- Production of parts and installations and RES storage systems;
- Construction of infrastructure for transmission and distribution of energy from renewable sources - electric grids;
- Production of equipment and parts of equipment for plants for the exploitation the energy from renewable sources;

• Development of supporting activities, assembly, maintenance, repairs of RES systems;
• Production of equipment for measurement and energy management for RES;
• Development of new technological solutions in the area of RES;
• Education and training services for business wit activities related to the production, distribution and use of RES;
• Professional consulting services and services of design, construction and supervision;
• Networking on issues related to RES;
• Integrating RES into supply chains in local economies, such as agriculture, forestry, traditional production, food processing, tourism, etc.;
• Production of equipment and materials for energy efficiency projects and for the exploitation and consumption of RES (highly insulating windows and doors, materials for increased thermal insulation, mechanical supports and installations for devices that exploit RES, production of cable sets and other electrical equipment for power plants and devices that use RES, construction of charging stations for electric vehicles);
• Production of equipment for industries that use RES (greenhouses, dryers, biomass furnaces, biogas collection systems, biogas burners, construction of RES exploitation facilities - warehouses, production halls...);1

Note: this list is not exhaustive, it represents an overview of possible measures

Recommendations for the cross-border cooperation

Cross-border cooperation provides great opportunities for the promotion of RES. Although it is not possible to physically connect projects for the use of energy from renewable sources, this does not mean that there are not many other ways to achieve cross-border cooperation.

The exchange of experiences and examples from practice are of valuable importance for the development of RES exploitation because the configuration of the terrain and the potentials in the border area are similar, which means that the ways of using RES are also similar. The difference may emerge in different legal environments in these areas as well as in the level of development of the infrastructure. However, by promoting good practice, most of these limitations can be outbalanced. The scope of opportunities for cooperation between RES companies is also very large.

Indicative measures:

• Formation of a joint body to monitor project implementation and to evaluate the success. Body should care of project's further development and its replication on the wider territory of the region, fostering cooperation on RES issues. The body aims to propose future steps as well as to gather all interested groups around the activities and the project.

• Organization of joint meetings, forums and other events in order to facilitate share of knowledge and experiences, where the best and most effective solutions would be promoted.

• Creation of joint teams for training program users.

• Preparation and implementation of joint projects that would be used on both sides of the border, which would be an excellent information data base for a comparative analysis of success in similar conditions and a good guide for overcoming potential problems. This includes recommendations for the local businesses and for projects that can be implemented mutually.

• Establishment of joint energy cooperatives, that is, a pool of small investors who could invest in projects within cross-border cooperation.

• The development of tourism with an emphasis on "green tourism" and the use of renewable energy sources for the purpose of sustainability and added value in the offer, for air conditioning, for supplying electricity, for balneological purposes, for heating sanitary water, for swimming pools...

• Elaborating the model for using the plant residues in farming and agriculture and in the sustainable exploitation of forests, being them a source of RES.

• Networking and cooperation in the field of RES. Companies operating in the RES sector (production of equipment or parts of equipment, installation and servicing of systems, design and construction services, sales, etc.) can cooperate and jointly cover a larger market. The formation of a cross-border RES cluster could be a good step forwards to that direction.

• Networking and working together in providing support for the promotion of RES. All those who support the utilization of RES can cooperate better in the field of providing support for the use of RES. This primarily applies to business support organizations and municipalities. This also applies to Info points or cross-border RES info centres, as well as to digital platforms that can be developed for this purpose.

• Joint investments in RES. Given the great similarities on both sides of the border, joint investments in renewable energy production are possible. These investments can also be extended to the areas of trade, service, maintenance and similar.

• Organization of competitions of local communities in the success of RES utilization.

• Joint capacity building projects, which include trainings, lectures, expert meetings, as well as the organization of joint visits to best practice examples, both in the region and in other countries.

Note: this list is not exhaustive, it represents an overview of possible measures

7. INSTEAD OF CONCLUSION

Energy is crucial for both global development and for every individual, and to secure a stable energy supply is of paramount significance.

The use of renewable energy sources provides an exceptional opportunity to gain the energy security of the state and its citizens with relatively small investments.

The 10 most important advantages of RES are:

1) It is available everywhere

2) It is easy to use and suitable for both small and large consumers

3) Stimulates the local economy

4) Reduces dependence on energy imports and geopolitical influences

5) Low exploitation costs

6) Plants can be easily expanded.

7) They do not pollute the environment.

8) They are safe

9) They are not so expensive anymore

10) They enable an increase in the standard of living.

The 5 most important challenges in using RES are:

1) It is not there all the time

2) Higher initial investments

3) Lack of sufficient infrastructure

4) Insufficient knowledge and practice

5) How to store the energy surpluses

Implementation of the recommendations should lead to:

- Extended use of RES in the areas covered by the project activities. The expected level of increase should follow national targets in this area. Performance evaluation to be carried out after three years.

- Increased volume of investments in RES. Checking the achievement of these goals based on data in official statistics are foreseen at least 2 or 3 years after the end of the project.

- Increased the number of employees in areas that are directly or indirectly related to RES. The verification of the achievement of these goals should be carried out on the basis of data in the official annual statistics of employment, starting from the first year after the end of the project.

- Increased the number of registered legal entities with activities related to RES. Verification of the achievement of these goals should be carried out on the basis of data in official statistics, starting from the first year after the end of the project

- Increased awareness of the need to use RES. It is difficult to determine the evaluation parameter unless a survey is done before and after, so the assessment can be made based on the number and type of events aimed at increasing the level of awareness, as well as on the actions of local civil society organizations and the reactions of the public administration.

- Reduction of greenhouse gas emissions. Using RES instead of conventional energy sources reduces greenhouse gases' (GHG) emissions. This effect might increase if RES are used independently from national plans. The statistical and actual benefits of reducing greenhouse gas emissions resulting from projects implemented within the framework of cross-border cooperation are not transferred to the contributing country, which is a direct benefit to the host country and region. Verification of success can only be determined at the national level on the basis of statistical data, and that goes back two to three years.

- Increased cross-border cooperation between the industries, municipalities and the non-governmental sector on circular economy projects and on the use of RES. Check the achievement of these goals on the basis of data in official local statistics, if they exist for this type of data. If not, an indirect assessment can be made by measuring the success of other areas.

- Increased number of educational and training programs for jobs and activities related to RES. Cross-border cooperation can be a stimulus for innovative solutions. The assessment should be made on the basis of local statistical data

- Clean air and public health. The use of coal in the electricity production is a source of local air pollution and health problems. Increasing the share of RES, decarbonizes the power system and provides additional capacity for green energy supply in the household. The assessment of success can be determined indirectly through the statistics of people suffering from diseases that are directly related to air pollution. The decrease in the annual number of patients and/or the downward trend in the number of patients clearly indicates the effects of RES use on health. It is necessary to use short-term and long-term data. From the short-term data (annual) trend can be seen, and from the long-term statistic, the factual situation.

- Increasing the number of events aimed at increasing the level of awareness on the need to use RES, especially for children and youngsters. The success of these activities can be in correlation with the number and type of events that took place during the calendar year.

- Increased number of registered vehicles that use electricity. This information can be obtained from official statistics.

Next steps

Based on the assessment of the success of the implementation of the recommendations, the project can be improved in order to get expected effects and to strengthen the measures provided for the activities and apply them to other areas with similar needs.

Promote successful results as good practice examples and offer them as an incentive to all participants of this or a project that follows this one. The project should serve as a pilot and/or model for further replication.

8. GOOD PRACTICE EXAMPLES

1. Energy communities

Energy communities are business formations in which citizens join together in order to benefit from their own produced renewable energy, minus business costs. Considering all the business activities that are expected during the lifetime of an energy community whose framework is determined by the Law on the Electricity Market, the most likely legal form will be a cooperative, i.e. the energy community will be established and operate according to the regulations governing the establishment and operation of cooperatives and such a legal form is also possible under Directive (EU) 2019/944.

Despite the fact that the meaning and purpose of the association of citizens, public bodies, entrepreneurs is sharing of self-produced energy, in real life it is possible to expect business activities ranging from the exclusive sharing of produced energy (which implies that the members of the cooperative have already implemented the activities of setting up a system for production and/or energy storage), to association due to invest in plants for the production of renewable energy, sharing in consumption management (members of the energy community invest in plants through a legal entity and then share the produced energy and manage consumption). Therefore, the structure and scope of business activities can be quite complex and future members of the energy community are faced with the question of the optimal way of management, economy, efficiency and financing.

By transposing the aforementioned European Union directive into domestic legislation, the countries should accepted the idea of energy communities as a socially justified and desirable instrument of energy transition. If this is true, then public policies should be articulated in a way which shall facilitate the management of available resources and encourage the establishment and operation of such legal entities. Moreover, energy communities could be an effective instrument and measure within the framework of accelerating the use of energy from renewable sources as foreseen by the recently adopted Regulation (EU) 2022/25773. One of the resources could be the Multiannual Financial Framework 2021-2027, especially in the part related to financial instruments of the European Union, combined financial instruments with a non-refundable component to encourage the preparation and establishment of energy communities and a refundable debt component for partial settlement of the capital project values.

Energy communities in the European Union

In recent years, the EU has increased its climate and energy ambitions and recently committed to a 55% reduction in net greenhouse gas emissions by 2030. The key mechanism for implementing those goals is the energy transition towards renewable energy sources. By adopting the Renewable Energy Directive (RED I) in 2009, the EU set a general goal of a 20%

share of energy from renewable sources in final energy consumption by 2020. It was significantly revised in 2018 (RED II), setting a new EU target of at least a 32% share of renewable energy sources in final energy consumption by 2030. RED III aims to create a fully integrated energy market, which also creates space for innovation both in the power grid and in the market. In order to achieve this goal, significant investments are needed in decentralized energy sources, such as photovoltaic plants or wind farms, energy storage, electric vehicles or heat pumps and all kinds of smart energy solutions that are intended to monitor and manage energy consumption in households, aiming at efficient use of the European power infrastructure. However, apart from investing in physical infrastructure, it is important to find new organizational, production and economically viable forms in the context of wider decentralization and democratization of energy consumption and production processes.

Energy communities are one of such new innovative organizational forms that are not primarily directed towards businesses. Although they are part of commercial activities, their primary purpose is to provide social, economic and environmental benefits to the community and not to generate profit, whereas that dimension is not excluded. The EU legislative framework recognizes two types of such structures: Citizen Energy Communities (CECs) and Renewable Energy Communities (RECs). Both communities can bring together citizens, local authorities or small businesses, but only RECs can bring together small and medium-sized enterprises (SMEs). While CEC can produce and use a combination of renewable and non-renewable energy sources, REC is dedicated exclusively to renewable sources. Furthermore, RECs often also have a local context: communities should be established in close proximity to the renewable energy projects they own or develop. As a type of community-driven initiative, CECs and RECs play a key role in social innovation because they reflect a fundamental change in consumer behaviour. A traditionally passive consumer becomes a co-owner of renewable energy facilities and implements a socially just model of the so-called prosumer (energy production and consumption). Through the context of local energy sharing, for example, owners of photovoltaic plants share their generated energy with community members who cannot afford such plants or do not have adequate areas for installation. Energy communities enable wider and democratic access to renewable technologies even for community members who do not have their own funds to invest in renewable energy sources (vulnerable social groups, pensioners, etc.). By 2050, approximately 264 million European citizens are expected to join the energy market as producers of their own energy (prosumers), producing up to 45% of renewable electricity. However, there are also numerous problems related to the transposition of EU regulations for CEC and REC, which creates big differences in the possibilities of implementing civil energy projects and creating energy communities.

The EU proposes to ensure the establishment of at least one community of renewable energy sources in every municipality with a population of more than 10,000 people by 2025. It will also support member states in implementing the framework of shared consumption for their own needs and the energy community.

The Just Transition Fund (JTF), which is the EU's tool for financing fossil fuel-dependent regions and industries with high greenhouse gas emissions, should act complementary to the 2021 revision of the RED, financially supporting energy communities across Europe. This is not only a financial challenge, but also an organizational one that requires the active participation of end users and citizens. Energy communities can make a huge contribution in this regard. As stated in the recent EU State of the Energy Union report, at least 2 million people in the Union are already involved in more than 7,700 energy communities, and the trend is growing. Energy communities in the EU contributed to the total capacity with 7% of nationally installed renewable energy plants - estimated at 6.3 GW.

Figure: Success rate of EU regulation transposition

The number of communities varies a lot, however, the number of communities is not so important, but the number of active members. The differences are significant, for example the largest Belgian community Ecopower has more than 65,000 active members, with huge production, management and financial power, actively participating in the energy markets, while the German communities are typically smaller and number around a hundred members and are connected to brokers who participate in virtual commerce. A good example is Next Kraftwerke7 from Germany, which brings together fifteen thousand producers and small communities, currently has a capacity of over 11,000 MW and actively trades more than 15 TWh of energy.

Number of active Energy Communities in EU

County	Number of active Energy Communities (2020)
Germany	1750
Denmark	700
Holland	500
UK	431
Sweden	200

France	70
Belgium	34
Poland	34
Spain	33
Italiy	12

Source: https://energy-communities-repository.ec.europa.eu/support/ toolbox/energy-communities-overview-energy-and-social-innovation_en (17.1.2023.)

For a better understanding of the problems of energy communities in the EU, it is convenient to introduce a matrix overview that recognizes 4 organizational archetypes that participate in the processes of energy production and trade and 4 dimensions that influence the realization of each of those archetypes. Table 2 shows their relationship and mutual influences are now clearly visible. Each dimension has an impact on the archetypes, but some participants are more significant, for example, the social dimension is the most preeminent in the cooperatives and the least present with the brokers because they operate on different bases.

Table 2: Dimensions and archetypes of energy communities

Type / Dimension	Community investnment	Energy platform	Broker	Micro grid
Technical			+	++
Social	++	+		+
Regulatory		++	+	
Business	+	++	+	

During 2019, the European Commission conducted a survey among EU member states to see what are the main benefits of energy communities. The most important values identified by the member states refer to the following aspects of the energy community project:

- Stimulating the local economy and investing in renewable energy sources;
- Reduction of bills for end consumers;
- Guaranteed production and consumption of green energy in local communities;
- Simple access to renewable energy for all groups of consumers, not only for the privileged;
- Use of local resources for plant construction and energy production;

• Access to new sources of capital through individual investments;

• Management and optimization of local energy;

• Peer-to-peer trading;

• Own production and consumption for a wider range of users;

• Change of existing paradigm, adoption of new principles such as, for example, response to demand - Demand/Response;

• Development of new services, for example charging electric vehicles;

• Ownership and democratization of natural and productive resources;

• A different approach to the development of the electricity distribution network.

There are still significant technical, social, regulatory and economic differences among EU countries and in many member states the processes of change are too slow. But the energy transition and expansion of energy communities is unstoppable.

Setting up and operation of energy cooperatives

Although it is possible to establish an energy community based on the existing regulations, according to the regulations governing the establishment and operation of cooperatives, their work, i.e. business will not be everywhere possible to full extent. For example in Croatia the reason is, most likely, banal, and concerns the working ability of the operator of the Croatian energy system to recognize and process the sharing of energy produced in the energy cooperative. At the same time, the current limitation of the number of members of the energy cooperative to those connected to the same transformer station reduces such business to the level of pointless futility. This ineffectiveness stems from the disproportion between the costs of sharing current surpluses of produced energy and its availability and the effects of shared energy. Related to this is the limitation of the energy cooperative's operations in accordance with the rules of the work of non-profit organizations. This restriction introduces significant uncertainties into the operation of an energy cooperative due to the fact that the regulations governing the operation of cooperatives allow the realization of an excess of income over expenses. The energy community can achieve this surplus of income over expenses, for example, based on the sale of energy on the market. Such possibility is allowed by the provision of Article 26.11. According to the Law on the Electricity Market, it is therefore legal when an energy cooperative sells, through an authorized intermediary, the produced energy on the market. On that basis, they will generate income. Also, the sharing of energy for charging electric vehicles owned by members of the cooperative will most likely be calculated at a certain price, so that part of the energy will also be recorded as income of the energy cooperative. The same effect on income will be produced energy shared with members of the energy cooperative who do not participate in production or storage, i.e. passive members of the cooperative. Sharing energy with such members will most likely not be without an

assigned value, that is, without a price. The value of that energy will be recorded as income. In addition to all that, an energy cooperative that invests in the assets of its members by settling capital costs from other debt sources of financing will most likely, during the repayment of debts from financing, charge certain fees from its members for the purpose of settling due obligations based on long-term debt loans. The question to be answered is related to the accounting and tax treatment of such transactions.

On the other hand, the business of an energy cooperative is not a business without expenses. These are capital investment costs, plant maintenance costs and replacement of worn parts, management costs, interest and the like. Therefore, it is a relatively complex business system that will not be sustainable in the circumstances of non-profit operation.

What does it mean to establish and manage an energy cooperative?

These are processes that can be structured according to the following steps:

• Preparation of the energy cooperative

• Establishment of an energy cooperative

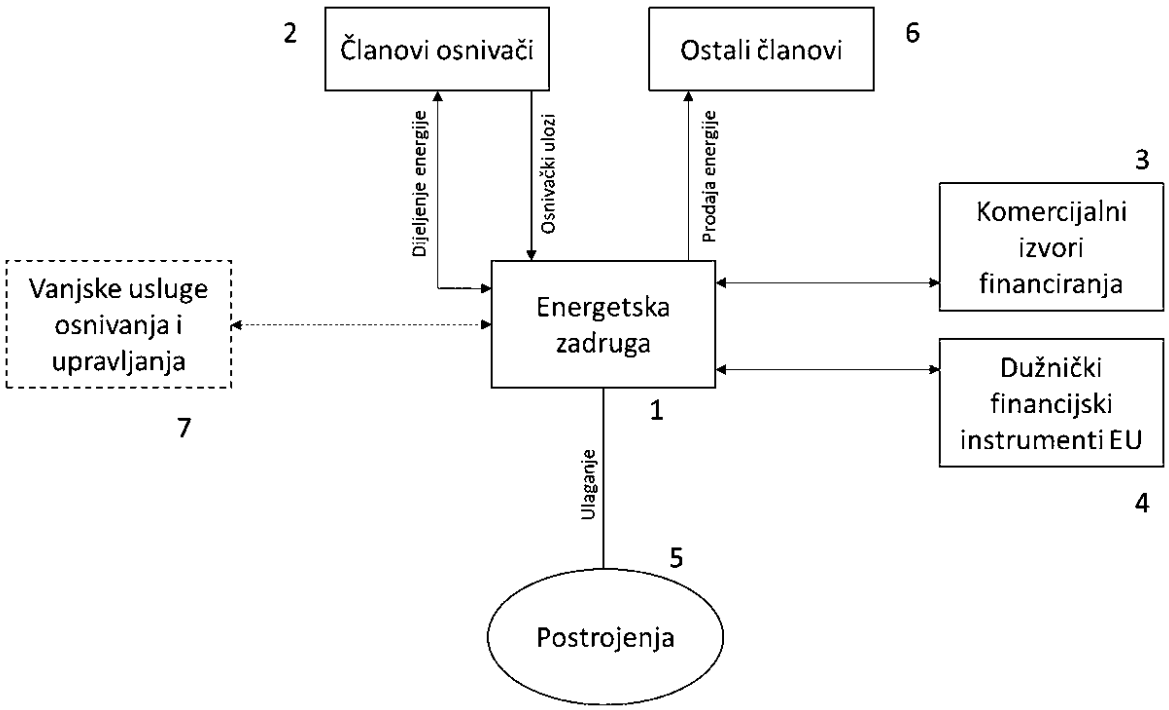
Operational business can also include processes such as: organization of design, drafting of contracts between investors and contractors, collection of offers from contractors, organization of financing, organization of equipment purchase and installation, supervision of works/installation of plants, testing of plants, organization of obtaining permits and approvals for work facilities, managing the accounting of the energy cooperative, managing membership, reporting, designing an IoT sensor network for energy consumption monitoring, managing an IoT sensor network for energy consumption monitoring, organizing and conducting assembly the supervisory board meetings, organization of mediation for the purpose of selling surplus energy, managing plant maintenance, merger of energy cooperatives and many other activities that are part of regular operation.

Without specifically entering into the organization and operation of energy communities to which entities with already installed facilities for the production and/or storage of produced energy have joined, energy communities whose operational business is preceded by investment activities could be organized and financed in the manner shown in scheme below.
.

An energy cooperative (1) is founded by at least seven founders (2). The purpose of establishing a cooperative is the individual production of energy from renewable sources (5), its sharing among members of the cooperative, possibly the storing of excess energy and charging of electric cars, for example. Regardless of the founder, the energy cooperative can be composed from members (6) who will not invest in the plants, but will buy/take over the excess energy produced at a lower price than that from the grid and higher than the production price from photo voltage/battery plants. Investment in energy plants, energy cooperatives can be financed from commercial sources (3) or from EU financial instruments (4). Considering the complex structure of the establishment and management of an energy

cooperative, the cooperative can use the services of specialized experts for the establishment and business management of energy cooperatives (7).

Establishment, financing and operation of an energy cooperative



EU financial instruments for energy communities

In addition to grants, financial instruments in the form of debt, guarantees and equity sources will be available from the Multiannual Financial Framework (MFF) 2021 - 2027. The most important feature of financial instruments in the VFO 21.-27. is the possibility to combine non-reimbursable funds (grants) with repayable (debt, guarantee and equity) instruments. In general, the procedure for securing financial instruments is significantly simpler than the procedure for securing grants.

Financial instruments are deliverables of European funds with terms more favorable than commercial products. The purpose of financial instruments is to support effective development of cohesion policy. In case of economically justified projects, financial instruments help the implementation and are always returned to the fund. What is particularly important is that financial products are used only for income generating or savings' projects, where the production of energy from renewable sources certainly belong to. Given that RES energy production enable savings as the difference between the unit price of electricity from the grid and the production price as well as the reduction of greenhouse gas emissions, financing of projects based on energy communities with a price lower than the market prices of financing sources could be economically rational and socially acceptable.

Although the purpose of financial instruments are to enable projects to be developed with long-term economic sustainability, but also have the goal to achieve social benefits due to lower energy costs, greater affordability, reduced risk of adverse consequences of climate change, offloading electricity transmission and distribution system, increase in GDP and contribution to the greater well-being of citizens.

Basic characteristics of financial instruments from VFO 21.-27. are as follows:

– They cannot be used to refinance existing contracts, but to support all kinds of new investments in accordance with the basic policy objectives;

- Support to end users of investments in assets and intellectual property as well as for working capital that are expected to be financially viable and for which sufficient financing from market sources is not available;

- Only for investments that are not completed or fully realized at the time of the financing decision;

- They can be combined with grants within the one single contract. In that case, the rules for FI (financial instruments) apply;

- Grants are not used to compensate support received from financial instruments;

– VAT is an eligible cost for FI, and in combination with grants, the rules for grants apply;

- Financial instruments are awarded by the national governing body or may be entrusted to the EIB;

- The value of the grant in the same operation must not be greater than the value of the financial instrument.

Unlike the previous, so-called of non-combined financial instruments, the current combined ones can be:

• a grant in combination with a debt instrument,

• a grant in combination with a guarantee instrument,

• rebate debt financial instrument (performance-based grant),

• a grant for technical assistance in combination with a financial instrument and similar combinations.

In order to make financial instruments available to users, the ministry responsible for the economy must identify the need and the ministry responsible for EU funds must program them. If social justification and the need for financial instruments for the faster establishment and development of energy communities are accepted, basic assumptions for programming will be created.

Conclusion and recommendations

The current legislative framework in Croatia is certainly not supportive to establishment and operation of energy communities, regardless of their legal form. Limitation to one transformer station is an outstanding obstacle for the development of energy communities. If this restriction were to be removed, the prerequisites to boost the energy cooperatives' development throughout the country would be created. Taking into account significant needs for investment in the operation of energy cooperatives, the introduction of combined EU financial instruments in the financing mix would considerably speed up the development of this new market where such opportunities exist in the VFO 21.-27.

ENERGY COOPERATIVES IN SERBIA

Elektropionir is one of the first energy cooperatives that connects households and individuals in order to produce their own energy, "at home". Elektropionir was launched in December 2019 by a group of enthusiasts who were involved in various ways in issues related to renewable energy sources and now there are more and more people who would like to join the cooperative in some way.

Citizens are an outstanding motivating factor and catalyst for the transition to clean energy. The energy cooperative Elektropionir was created with the idea of being one of the key actors in empowering plain people to participate more actively in the green transition of the Serbian energy sector to renewable energy sources. The goal is to demonstrate an ecologically and economically sustainable way of producing electricity, based on the principles of democratic, cooperative management. In a cooperative, each member has one vote in decision-making. The cooperative's operation is aiming at establishing a network of decentralized rooftop solar power plants and solar parks, collectively owned by small investors throughout Serbia.

Solar panels on your own roof are a great start. Elektropionir plans to connect people who want to invest together in larger solar power plants, much larger than those that fit on rooftops. There are many "empty" roofs on residential and industrial buildings. Moreover, clean energy can be produced outside the city, in fields combined with agricultural production, on abandoned plots and other locations. According to the latest estimates, Serbia

has 60,000 ha of roofs and about 200,000 ha of uncultivated and neglected land that can be used for installing solar panels. Together, these power plants will form one large "virtual power plant" that will supply the members of the cooperative with energy.

Through this type of joint investment, cooperative members will become owners of shares in the power plant. The return of the investment will be materialized through produced electricity.

The first cooperative solar power plants on Stara planina.

Project description

In cooperation with the dwellers of the old mountain villages of Dojkinci and Temska and the town of Pirot, the Energy Cooperative Elektropionir launched the Solarna Stara project, in order to build the first cooperative solar power plant in Serbia. Half of the necessary funds were collected by the founder of the Cooperative, and for the other half hey turned to the citizens and through a donor campaign. The collected funds exceeded the target amount. Construction of the first cooperative rooftop solar power plants in Serbia is under preparation!

The plan is that all funds from the sales of electricity produced by the old mountain solar power plants will be handed over to the local community for the next 25 years.

The Solarna Stara project shows that all citizens can be initiators of change towards sustainable energy and that this is not a position reserved exclusively for large investors. Energy must be clean and can be jointly owned. The cooperative tradition exists in Serbia and now is also applied to the production of energy from sustainable sources.

Phases of the Solarna Stara project

1. Design and planning of the Solarna Stara project

Energy cooperative Elektropionir, together with the local community in the villages of Temska and Dojkinci, started designing the Solarna Stara project from January 2022. The signing of the Memorandum of Understanding and Cooperation with the City of Pirot on the use of the roofs of the Temska Local Community and the Dojkinci Cultural Center for the purpose of installing solar power plants, was done at the beginning of the project.

January - June 2022.

2. Drafting of the budget

The basic budget for the construction of two solar power plants was drafted in cooperation with independent experts and companies engaged in the design and construction of solar power plants.

May-June 2022.

Budget (for one solar power plant):

a) Construction of a solar power plant of 5.25 kWp (5,850 EUR), which includes:

a. 1 inverter of 5 kW

b. 14 solar panels of 375 Wp (total 5.25 kWp)

c. supporting structure for a pitched roof with tiles

d. cables, cable accessories and protection equipment

e. installation and commissioning of the system

b) Drafting of project-technical documentation and implementation of the procedure to obtain the status of "producer from RES" (820 EUR).

c) Construction of connection and supply of meters for power plant operation (520 EUR)

Total: 7,190 EUR

3. Acquiring the first part of funding

Elektropionir collected half of the required sum for the construction of two solar power plants from donations, from partner organizations and from its own funds.

January-June 2022.

4. Donation campaign on the Donacije.rs platform

The crowdfunding campaign on the Donacije.rs platform "Solarna Stara" got noted from the local and wider public, due to several aspects:

The initiative to set up the first cooperative solar power plants in Serbia met with understanding, but also with many ambiguities about the use of clean energy. This prooves that, in addition to social and environmental dimension, the campaign also has an educational role for all citizens who are interested in the increasingly popular issue of micro-energy.

This project is a first of the kind Serbia - designed by the energy cooperative Elektropionir. It advocated for the thesis that energy must be owned by all citizens, where it is particularly important that it should be green&clean and obtained from renewable sources that contribute to environmental protection.

The whole initiative started in June 2022 when the idea of the first cooperative solar power plants in Serbia draw attention and support of the community - in less than a month, Elektropionir, with the help of 229 donors, collected funds to install solar panels on the roofs of the Temska Municipality and Cultural center "Dojkinci" on Stara planina.

Their successful idea is not only useful, but also sustainable where all the annual income from the production and sales of electricity from these power plants will go to local associations and organizations for activities that improve the welfare of the community.

The donor campaign to collect the second half of the required amount for the construction of two solar power plants was prepared during the months of May and June and started on June 21 (the day of equinacium). In cooperation with the Donacije.rs platform, in one month, 229 donors donated a total of EUR 8,310, which is 116% of the targeted amount! Thanks to the fact that the target sum was exceeded, the solar power plants will have a power of 6 kWp (16 panels) instead of the previously planned installed power of 5.25 kWp (14 panels).

May-July month 2022.

5. Preparation of technical documentation

Project documentation has been prepared for the implementation of the procedure for acquiring the status of "producer from renewable energy sources" (OIE) for both power plants. This was done in cooperation with United Green Energy from Niš.

September-October 2022

6. Procurement of equipment

Equipment for solar power plants was purchased: 32 Ulica Solar panels of 375 Wp with a 12-year warranty, supporting structure for a pitched roof with tiles, 2 inverters, cables, cable accessories and protection equipment.

June 2022-February 2023.

7. Signing the Agreement on the implementation of the solar power plant construction project

Based on the Decision of the Pirot City Council (November 28, 2022), the City of Pirot and the Elektropionir Energy Cooperative drafted an Agreement on the use of parts of public roofs in Dojkinci and Temska for the realization of two cooperative solar power plants and on the method of using the income from these power plants for the benefit of local communities. This is a pioneering contract, the first of this kind in Serbia! Representatives of the city of Pirot, Elektropionir and the local communities of Dojkinci and Temsko signed the Agreement on February 6, 2023.

November 2022-February 2023.

PROGRESS TIMELINE

8. Implementation of the procedure

In cooperation with the company United Green Energy from Niš, the legal and technical procedure for acquiring the status of "producer from renewable energy sources" (OIE) is being carried out for both power plants.

February – May 2023.

9. Construction of solar power plants

After the delivery of the equipment to the location, the construction of solar power plants on the roof of the Temsko Local Community and the Dojkinci Cultural Center is a week away. The power plants will be built in cooperation with the company Conseko from Belgrade.

March - April 2023.

10. Construction of the connection

Procurement of materials and infrastructural works, along with the procurement and installation of power meters for the power plant.

May - Jun 2023.

11. Selection of suppliers

Selection and signing of a PPA with a company that will purchase electricity from solar power plants.

June-July 2023.

12. Commissioning of the first cooperative solar power plants

Connecting power plants to the grid and putting them into operation.

July-August 2023.

13. Collection and distribution of first income

In the next 25 years, the power plants will generate income from the production and sales of electricity. On an annual basis, Elektropionir will hand over the collected money for the purposes defined in the program of distribution of funds, that is to be adopted by the Councils of Local Communities of Temska and Dojkinci, for activities which improve the welfare of local communities.

January 2024

GREEN TRANSPORT

Amts Catania, 11 electric buses in use.

The new vehicles, with zero emission of harmful gases and very low noise impact, are equipped with a "fully electric" engine that guarantees a range of about 300 km and are

equipped with air conditioning. The first 11 eight-meter "fully electric" buses used in local public transport in the city of Catania are already in circulation to carry out the necessary operational tests and adjustments. It is only the first tranche of the latest generation vehicles purchased by AMTS, as the implementing body and beneficiary of the Municipality of Catania in the context of the PON Metro 2014-2020 funding program (Axis 6 REACT-EU), launched by the Administrative Community at the end of 2021 with the coordination of the Directorate for community policies.

Vehicle characteristics:

The first 11 buses with zero emissions and very low acoustic impact are equipped with an electric motor that guarantees an autonomy of about 300 km, as well as with air conditioning. The vehicles have 49 places for passengers, 18 of which are seated. All of them have platforms for access by people with disabilities, and a special space for wheelchairs is provided in the buses. During next period, 7 more buses, 12 meters long and with a capacity of 85 seats, will join the fleet of electric buses that ply the streets of the city. These longer vehicles are instead produced by Solaris, the Urbino 12 electric model, which have a higher power (300 kV) and a mileage of around 400 kilometers and can be used on the busiest lines.

In the second half of 2023, 18 more fully electric buses will be added, which will be purchased by Amts in cooperation with the Municipal Administration, in this case the Directorate for Community Policy, with a plan to engage EU funds for this purpose. This new, "green" public transport is part of an wider plan to completely renew the fleet of the municipal public transport thanks to EU funds for sustainable mobility. The funds (78 million euros) were specifically requested by the Municipality of Catania in the first months of 2022, in order to guarantee the purchase of another hundred electric and ten hydrogen vehicles, the procurement of which would begin in 2024 and be completed by 2026.

Comment:

This is a project could be interesting for setting up of a cross-border "green" bus line, with RES chargers on both sides of the border. Although this is an example from an environment that has well-developed instruments of support and the use of EU funds, it can be, fully justified, implemented in the cross-border traffic.

Moreover, a chargers for "green transport" should be connected to OIE, solar panels or to a small hydroelectric power plant or to a plant for the production of electricity from biomass/biogas...

PUBLIC PRIVATE PARTNERSHIP

Public-private partnership (hereinafter: PPP) represents long-term cooperation between a public and private partner for the purpose of providing financing, construction, reconstruction, management or maintenance of infrastructural and other facilities of public importance and provision of services of public importance, which can be contractual or institutional .

Public-private partnership implies financing of the project by the private partner and in this way the budget of the local self-government is not in debt. PPP essentially represents a framework for joint actions of the public sector and private capital, in order to ensure the functioning of activities of general interest and efficient and economically sustainable development of infrastructure.

FINANCIAL ACCEPTABILITY OF PUBLIC-PRIVATE PARTNERSHIP FOR THE PUBLIC PARTNER

Energy efficiency projects are very profitable, especially in the area of replacing public lighting. The replacement of obsolete lamps is inevitable because of the responsibility imposed ba the Energy Community of Southeast Europe. The problem is the fact that, at the moment neither cities nor municipalities have sufficient additional funds available to finance energy efficiency projects. That is why the public-private partnership model is the most adequate since it does not require new borrowings and the growth of public debt. The basic elements of the public-private partnership concept are a clear allocation of responsibilities, risk sharing and the duration of the partnership. The division of risk allows each of the partners to take on the risk that they can manage in the most adequate way, thus achieving greater efficiency of such projects. The concept of public-private partnership, in the example of replacing existing public lighting lamps with energy-saving LED lamps, enables municipalities, as a public partner, to reduce costs, and at the same time allows it to use the management, technical, financial and innovative capabilities of a private partner.

PROJECT BASED ON THE "ESCO MODEL"

The "ESCO model", i.e. the model of financing from savings is a solution according to which the total investment costs of replacing outdated lamps with energy-efficient LED lamps are covered from the savings achieved during the contract period. The essence of the "ESCO model" is to provide cities and municipalities, which are struggling with a lack of money, a financial and technical solution that achieves greater energy efficiency and a reduction in energy consumption. Through long-term and mutually beneficial business cooperation, the local self-government does not take loan and the financing is provided by a private partner who makes a profit by, *de facto*, leasing the facility where new technological solution is applied in order to save the energy consumption and to earn from share of savings.

The largest number of energy efficiency projects were realized exactly in the public sector, where the PPP model (public-private partnership) is one of the most acceptable models for both partners. Public lighting is one of the most common and most successful forms of planning that have been implemented so far through PPP. The "ESCO model" project consists of:

• Preparatory period,

• Period of implementation of energy saving measures,

• Period of guaranteed savings based on applied measures (MUE), which in this case has two parts:

1. The period in which the private partner provides warranty and maintenance and charges a fee for MUE application and maintenance. During the preparatory period, activities such as time planning, obtaining permits, opinions and technical conditions, elaboration of technical documentation and technical control of technical documentation are carried out.

2. During the implementation period, reconstruction activities are carried out, which includes installation and commissioning and maintenance of the lamps. During the warranty period in which the private partner provides guarantee and maintenance, while fee for MUE application and maintenance, investment and maintenance are paid and energy and cost savings are monitored, verified and reported on. During that period, the private partner performs the maintenance of the lamps.

The realization of such a model can be implemented through a public-private partnership with a company that would be selected after the public procurement procedure has been carried out and includes the replacement of existing conventional public lighting lamps with energy-saving LED ones on the streets, parks, promenades, on public areas and the introduction of a public lighting management system. Private partner is to provide financial and technical

means for the implementation of the reconstruction of public lighting through the following activities:

Procurement, installation of equipment for managing the public lighting system, replacement of existing public lamps with energy-saving LED lamps and the preparation of technical documentation for new public lighting, financing and insurance, ongoing maintenance of the system during the contract period, monitoring of achieved contracted savings, which is the basis for payment of fees according to the "ESCO model".

The city of Kruševac and the GGE company, a regional group for energy services, signed a public-private partnership (PPP) contract for the complete renovation of the public lighting system in that municipality. It is the largest PPP public lighting project in the Balkans in terms of number of replaced lamps, and the largest PPP for energy efficiency in Serbia so far.

Kruševac is a city in Serbia and the seat of a municipality that includes 101 villages and has a total of 128,000 inhabitants. The public lighting system was outdated and the city issued a tender for a public private partnership that would modernize it the sity centre but also in the neighbouring villages.

The contract was signed for a period of 13 years, while GGE provides warranty for the installed equipment for an additional period of 2 years.

Results of the project:

- 80% savings at the end of the contract

- Reduction of the total installed electric power of consumers by 1,308 kW
- 12,545 old lamps were replaced with 12,545 energy-efficient Phillips and Schreder LED lamps.

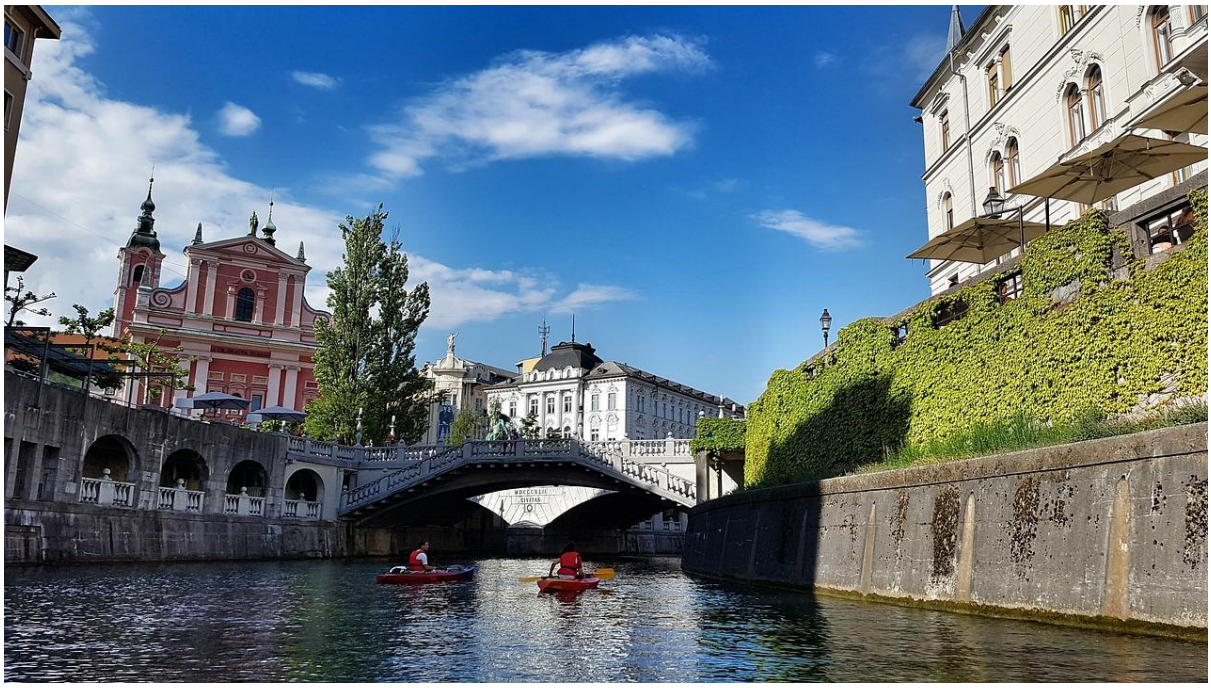
In case of Kruševac, the lamps were carefully selected after photometric calculations in order to meet all the lightning requirements of the city and surrounding settlements.

Outdated systems for turning on and off public lighting in all 330 transformer stations in the municipality were replaced with an automated system regulated by an astronomical clock that was set according to the conditions in Kruševac. The system will provide energy savings as well as the required 4,000 operating hours per year (all lights will turn on and off at the same time).

The PPP contract lasts 12 years, and the warranty on the lighting equipment is an additional 3 years.

Resalta carried out a PPP project with the City of Ljubljana for the energy reconstruction of 49 buildings

In accordance with its energy efficiency policy, the City of Ljubljana has begun implementing its largest energy reconstruction project to date, thanks to the public-private partnership model. The private consortium Resalta and Petrol invested in the renovation of 49 buildings with the aim of making them more energy efficient. Of these, 26 buildings will undergo comprehensive reconstruction and 23 partial reconstruction, including individual measures to improve efficiency. Public facilities include kindergartens, elementary schools, health centers, cultural and sports facilities, and administrative buildings. The total value of the investment is EUR 14.9 million.



Among the measures that resulted in higher energy efficiency, lower energy consumption and a positive impact on the environment, were

• renovation of the HVAC system,

• replacement of internal lighting with more energy-efficient equipment,

• replacement of existing heating systems with systems that will use renewable energy sources,

• replacement of windows and doors,

• renovation of facades,

• roof insulation.

All these measures have brought savings of 8,245,534 kWh of energy per year, in addition to 2,956 tons of CO_2 emissions that will be reduced every year.

The city will take the savings and use them to pay off the private partners over the 15-year contract period. After the contract expires, the City of Ljubljana will enjoy all the benefits of the energy savings achieved. The private partner provided management and maintenance of the equipment and systems installed as part of the energy reconstruction for the duration of the contract. With the consortium providing 50.1 percent of the funds, the EU Cohesion Fund and the City of Ljubljana provided the rest of the investment.

The first public-private partnership for the supply of thermal energy for public buildings in Serbia was contracted in Pirot.

The city and the GGE ESCO company signed a contract to replace fuel oil boilers with biomass boilers for heating 4 schools in that town.

The value of the work is EUR 684,000. Pirot is for heating the school "Dr. Obren Pejić" and elementary schools "Sveti Sava", "Dušan Radović" and "8. September" until now allocated 274,000 EUR per year, while switching to biomass and improving the efficiency of the system would amount to 171,000 EUR.

According to the terms of the contract, GGE ESCO will deliver thermal energy for the next 15 years. That company first completely overhauled the existing heating system, and then installed new ecological and efficient biomass boilers that replaced the old ones, oil fueled. Each school now has two boilers, which will ensure an uninterrupted supply of thermal energy, even in the event if one of them is out of order.

The private investor is responsible for the maintenance and repairs of the heating system. It is estimated that with this modernization, the annual emission of carbon dioxide will be reduced by 420,000 tons, which means that Pirot is well on its way to reaching all the environmental standards of the European Union, as soon as possible.

The responsibility of the public partner is, in addition to the regular payment for the thermal energy, to enable this support realization of investment and to deliver heating to schools in the following period at prices that are lower than the prices that they would pay to Toplana.

All four schools had outdated and unreliable oil boilers, an unecological solution, and the project was to install two biomass boilers in each facility:

Secondary school 360 kW + 120 kW

Elementary school September 8 450 kW - 120 kW

Elementary school Duško Radović 550 kW + 120 kW

Elementary school Sveti Sava 240 kW + 120 kW.

Biomass is an environmentally friendly fuel that is procured from local suppliers.

The duration of the contract is 7 years.

1. Satellite images and artificial intelligence in the function of energy efficiency and the use of RES

Using satellite images, scientists are developing a model to quantify energy consumption in buildings. The model could help policymakers redesign settlements for a lower-carbon world, but also help local governments draw up their energy plans. Scientists have also noted that paved roads can affect the temperature of a wider area and microclimate changes. In the face of climate change, reducing energy consumption in buildings is at the top of the priority list. By some estimates, buildings consume 40% of the energy used in the United States. Significantly reducing that use will require a comprehensive, holistic approach. According to current methods, designers model the energy profiles of individual buildings without taking into account their surroundings. But that building-by-building approach is not credible. Buildings use energy in a way that involves the interactions not only of the systems and people inside the building, but also interactions with external systems such as streets and trees. For a true picture of the energy status of a wider area, a system of unifying individual assessments, the so-called building-by-building approach is not good enough. Instead, manage the energy consumption of buildings remotely - using analytics computer satellite imagery is significantly more efficient. The developed model, called SCHMEAR (Scalable Construction of Holistic Models for Energy Analysis from Rooftops), represents, for the first time, a modelling approach that shows how much the context around a building contributes to its energy profile. SCHMEAR provides a new tool to help city planners and designers understand the range of solutions they might look for when they start designing low-carbon environments. This approach will be useful for the development of large urban conglomerates and will help urban planners to decide what the foundations of cities should look like in 50 years, but the tool is also applicable to less populated areas to identify needed interventions

in local energy. Because satellite imagery is readily available, SCHMEAR enables this type of analysis for settlements around the world, without limitation.

Source: https://worldview.earthdata.nasa.gov/

Why SCHMEAR?

Until now, researchers modelling energy consumption in urban buildings used one of two approaches: either they simulated building characteristics using detailed information about the structure and its systems, or they developed a data-driven model that relied only on basic information about the building, such as the age and material from which the building was built. Although the simulation approach can provide useful information, it is not practical for objective modelling of larger urbanistic entities. On the other hand, building reliable models using a data-driven approach is often a problem because different cities collect different types of data about their buildings. If every city sees things a little differently, it becomes quite difficult to create a consistent model. Cities often contain "heat islands" that absorb heat and reflect it back to surrounding buildings and pedestrians, and large buildings can cause urban canyon effects and other physical phenomena that affect air flow and thus building energy use. The fact that a building is located in a dynamic environment can significantly change its energy consumption.

SCHMEAR relies directly on high-quality satellite imagery, which is routinely available for buildings around the world. This should enable analysis for any urban entity in the world while respecting the influence of the environments in which the buildings are located, which can be interesting for detailed mapping of areas for which sufficient data does not otherwise exist.

A new tool for urban decarbonization.

The SCHMEAR project team created several models of energy use in buildings in New York, for example, to see what would be the best way to create consumption profiles. One was a model created using computer analysis of satellite photos, and the other, by comparison, was a data-driven model that relied on a set of available data about each building, such as the number of floors, the building's age and its floor area.

A SCHMEAR model based on a single close-up satellite image provided as much useful information for predicting building energy use as a data-driven model built from basic building data.

SCHMEAR's footage analysis relies on a neural network – a type of artificial intelligence that is often considered an unknown. This means that it can be difficult to determine which building characteristics contribute to the model's predictions. However, if models of this type are to help cities develop decarbonisation plans, they will need to be interpreted correctly. In particular, it is necessary to compare the importance of the immediate environment around the building with the part that is further away from the building. The analyses showed that the environment of buildings in a dense urban settlement has a greater influence on the energy of the building than in settlements with larger distances between buildings. While the SCHMEAR project used only high-resolution images, the next iteration could use satellite images made with different light frequencies or building outlines and surfaces. With data separated by type, it's easier to see how a particular feature contributes or doesn't contribute to predicting energy consumption.

The possibility of influencing climate change

The need to decarbonize buildings and cities is becoming more urgent as climate change threats grow. Decision-makers and policy-makers could consider a range of interventions – some relating to individual buildings and others relating to the city as a whole. For example, they could offer building owners free trees to reduce the urban heat island effect, or they could consider adding a neighbourhood park, changing street layouts, or changing the types of roofing materials allowed on new construction. Even a temporary or permanent reduction of traffic in certain areas can help reduce energy consumption in buildings. Some cities are already starting to take steps in that direction. For example, in 2019, the New York City Council passed Local Law 97, which set limits on emissions from large buildings. In the future, different spaces, especially urban conglomerates, will involve the use of programs such as SCHMEAR for planning and urban development.

8. ABOUT THE PROJECT

Project name	Renewable energy for smart growth and protected environment
Leading partner	Vidin Chamber of Commerce, Bulgaria
Partner	RARIS, Regional Agency for the Development of Eastern Serbia, Serbia
Priority axis	Environment
Project objectives	The main objective of the project is to increase capacity and improve awareness of environmental issues such as renewable energy sources and energy efficiency among the target groups: SMEs, local authorities, environmental organizations and institutions, the general public

Trg oslobođenja bb

19000 Zaječar, Serbia

Tel. +381 (0)19 426 376

Fax: +381 (0)19 426 377

office@raris.org

www.raris.org

3 a

19 -21 "Tsar Alexander II" street

office@vdcci.bg

www.vdcci.bg/bg/