Mapping Renewable Energy Sources potential, challenges, and opportunities in Bulgaria

RENEWSTART

September 2024

This publication is part of the European Climate Initiative (EUKI). EUKI is a project financing instrument by the German Federal Ministry for Economic Affairs and Climate Action (BMWK). The EUKI competition for project ideas is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It is the overarching goal of the EUKI to foster climate cooperation within the European Union (EU) in order to mitigate greenhouse gas emissions.

Supported by:

Federal Ministry for Economic Affairs and Climate Action

European Climate Initiative EUKI

on the basis of a decision by the German Bundestag

Title: Mapping Renewable Energy Sources potential, challenges, and opportunities in Bulgaria
Subtitle: Analysis
Version: 1.0
Authors: Adriyan Hristov, Donka Todorova
Contact Person: Adriyan Hristov (interreg-med@szeda.eu)
Institution: Stara Zagora Regional Economic Development Agency

September 2024

TABLE OF CONTENTS

INTRODUCTION

Bulgaria's power sector is diverse and well developed, with universal access to the grid and numerous cross-border connections in neighboring countries. A key driver of the Bulgarian economy, the energy sector is strongly affected by geopolitical, economic, and regulatory pressures. The Bulgarian electricity market is in transition, but nuclear power is expected to retain its large share of generation capacities. The government intends to decrease 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 a significant portion of electricity demand.

The operational management of the electricity system of Bulgaria is performed by the National Dispatching Centre at the Electricity System Operator (ESO) which provides for security and continuity of electricity supply to consumers in the country. In 2015 ESO EAD was certified as an independent operator of the electricity network. The Electricity System Operator (Elektroenergien Sistemen Operator, ESO) is the independent transmission system operator of the Republic of Bulgaria, engaged in managing and operation of the country's high-voltage electricity transmission grid. The transmission operator guarantees responsibly and professionally the secure, reliable and uninterrupted electricity supply in the country, and also manages the transit of electricity flows through the territory of Bulgaria and parallel operation with the electricity systems of the countries in Continental Europe synchronous area. The company manages the country's electricity transmission system ensuring its balanced and quality operation 24/7, 365 days a year.

In 2022, the amount of electricity produced increased by 5.7% compared to the previous year. This growth comes from the increase in electricity generated by thermal power plants and renewable energy sources (RES). Among RES, the biggest increase was in photo voltaic (PV), generating 33% more electricity than in 2021. The reasons are an increase in the installed capacities of PV and more sunshine hours in 2022. In the past year, the export of electricity reached record levels of 12.2 TWh, which is an increase of 39% compared to the previous year, ranking Bulgaria third among the largest exporters of electricity in the European Union.

Electricity production capacities meet consumer demand in Bulgaria and enable exports to neighboring markets. In 2022, the Bulgarian energy industry exported more than 12 TWh of electricity totaling to EUR 3 billion, (USD 3.24 billion). Currently, the installed power generation capacity in Bulgaria is 13.247 MW, and the available capacity is 10,771 MW.

The topics of energy security and control of energy systems were discussed at the conference "Energy security - a basis for the development of European industry. The role of Bulgaria"[1], which was held in the European Parliament in Brussels on 20th March 2024, Dries Eyck, director of public policy at Solar Power Europe, explained that solar energy is the cheapest energy known to mankind – under 50 cents per kWh. He disclosed that in just one year energy equal to the energy of 50 large nuclear power plants was produced. He explained the boom in the use of solar energy with the fact that enterprises want energy at lower and predictable prices and informed that an agreement for the purchase of solar energy had also been recently signed in Bulgaria. According to him, RES enable the transition to clean energy. The objectives of RePower.EU. are 30% less emissions reduction than today. The main conclusions were that nobody should rule out technology and turn their backs on the facts. He was of the opinion that energy transmission

[1] Energy Security – a basis for the development of European industry. The role of Bulgaria. Available online.

systems would become a problem, as well as energy storage and cyber security along with the fact that construction of infrastructure was also slow. The bottom line is that there needs to be more energy security and that Bulgaria should consider its plans for the development of the energy system and consider the use of solar energy.

The topic of the role of RES sector and the directions to go forward was also discussed at the conference "Energy security - a basis for the development of European industry. The role of Bulgaria". It is often said how 30-40% of Bulgaria's energy mix should be RES. However, these energy sources are different – water, sun, also nuclear energy. In the next legislation, there should be some mix between the different types of energy, because otherwise Bulgaria risks having a certain type of renewable energy that works only at a certain time, and creates problems the rest of the time. It was emphasized that the need for battery storage would be very important. Batteries are not so easily recycled and pollute. This problem needs to be put on the table and to be solved as quickly as possible. Batteries should be separated into recyclable and polluting ones. The lurch to lithium-ion batteries that last 7 to 10 years must stop. European legislation is extremely important and if Bulgaria fills this gap with batteries that will help the transition a lot.

The distribution of energy in Europe is very important. Huge nuclear facilities are being built on the border with Bulgaria, in Turkey, precisely with the support of non-EU countries. A voice was heard saying that not all nuclear energy can be concentrated in France and it is high time to plan a new distribution in Europe. Bulgaria is one of the main suppliers of non-ferrous metals. Whatever connectivity is done, Bulgaria needs a proper distribution of RES and the basic base energy that is planned for the future.

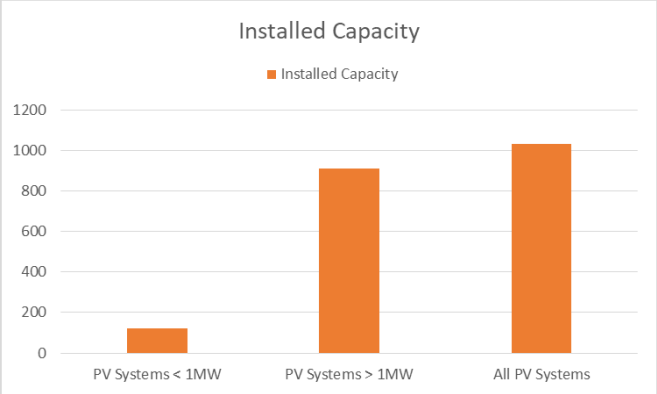
Therefore, from a geopolitical point of view it is very important for Bulgaria to secure its own energy sources and energy security and that is the reason why the “brown” topic is still a political hot potato in the country.

TYPES AND IMPORTANCE OF RENEWABLE ENERGY SOURCES

In terms of renewable energy sources development Bulgaria is slowly but steadily gaining momentum. There is an online information portal[2] classified as a public register of installations for the production of electricity from renewable energy sources (RES). Its main purpose is to provide the public with up-to-date information on the electricity produced by photovoltaic, wind, water and other plants. The main source of data is the register of issued guarantees of origin of electricity, maintained by the Sustainable Energy Development Agency (SEDA). The online platform gives a breakdown of all types of RES capacities. A separate page contains information on the owner of each RES installation. Below is statistical information in the form of a breakdown of the various types of RES currently in use in Bulgaria for the production of electricity. The paragraphs below give a brief overview of the official information on the installed capacity of the four main types of RES – solar, wind, hydro and biomass in line with the data presented in the online RES register.

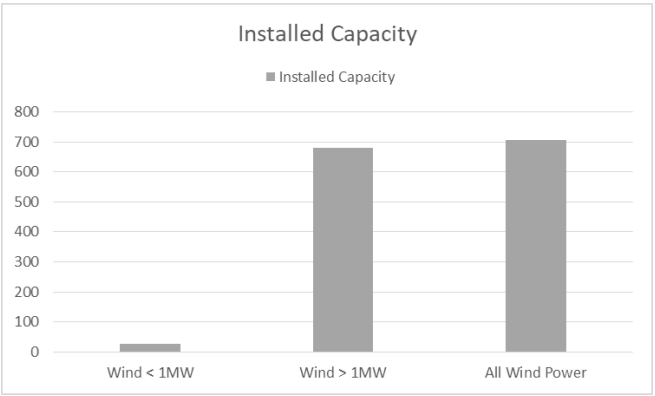
[2] https://www.veiregistar.bg/

SOLAR POWER INDUSTRY



Photovoltaics is the well-known method of producing electricity by converting solar radiation into direct current. For this purpose, manufacturers use solar panels composed of multiple solar cells and achieving the photovoltaic effect. All PV systems currently in operation account for a total of 1,033 MW of installed solar capacity, with PV Systems less than 1 MW accounting for 121 MW of installed solar capacity and PV Systems greater than 1 MW accounting for 911 MW of installed solar capacity. After Eurohold commissioned its Verila solar power plant of 123 MW in nameplate capacity and a 100 MW connection, the biggest in the country in 2023, now the largest solar park is Dalgo Pole (208 MW)[3], owned by Santera Re and its subsidiary Galaxy Re, though it is administratively separated into three units.

WIND POWER INDUSTRY

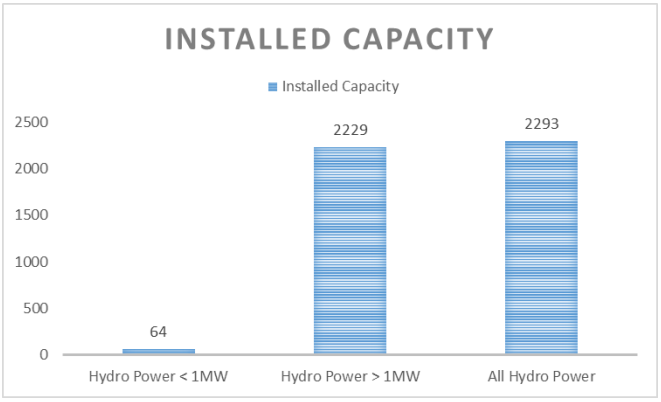


Wind turbines convert mechanical energy from the wind into direct current. They are the basis of wind farms and wind farms that are built on land or in large bodies of water such as oceans, dams or lakes. The installed capacity of all wind farms currently in operation amounts to 707 MW, with wind turbines up to 1 MW accounting for an installed capacity of only 26 MW and wind turbines over 1 MW accounting for an installed capacity of 681 MW. It should be noted that in 2009, AES Geo Energy built the 156 MW Saint Nikola Wind Farm[4] near the town of Kavarna. With its 52 Vestas wind turbines erected, the Kavarna project is the largest wind farm in the country.

[3] https://balkangreenenergynews.com/bulgaria-enjoys-solar-boom-as-biggest-photovoltaic-parks-come-online/

[4] https://www.aesbulgaria.com/en/saint-nikola-wind-farm

WATER POWER INDUSTRY

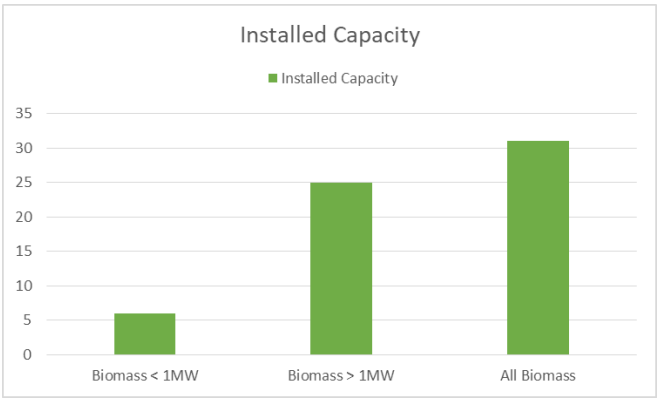


Hydroelectric plants use the energy of the water table to produce electricity. A common practice is to use the water from a dam to turn a water turbine with an attached electric generator driven by falling water. All Hydroelectric power stations currently in operation amount to 2293 MW, with hydro power up to 1 MW accounting for 64 MW of installed capacity and hydro power over 1 MW accounting for 2229 MW of installed capacity. It should be noted that although the largest hydroelectric power station in Bulgaria – Chaira PSHPP – is out of operation, hydropower has the biggest share of installed capacity in the country.

The official website of the International Trade Administration says that 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. Notwithstanding the difference in the figures of total installed capacity of water power, hydropower's importance is paramount; also it is not limited to the production of energy. It plays a key role in greenhouse gas emissions reduction.

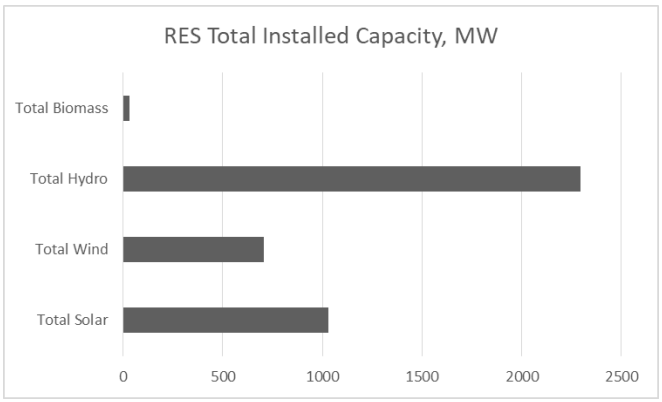
Hydropower contributes to an annual avoidance of 491,690 tons of CO2 emissions, which translates into an annual CO2 cost avoidance of $3,5 million. Another significant benefit of the sector is the opportunity for integrated water resource management to reduce the risk of natural disaster.

BIOMASS POWER PLANTS

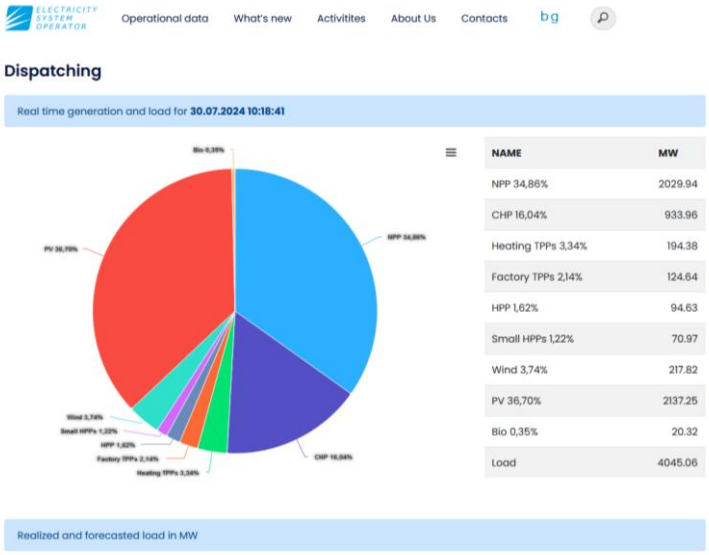


Biomass (plant material and animal waste) is the oldest source of renewable energy, the production of which employs several basic technologies – combustion, pyrolysis, gasification and anaerobic digestion. All biomass power plants currently in operation amount to a total of 31 MW, with biomass power plants up to 1 MW accounting for 6 MW and biomass power plants over 1 MW accounting for 25 MW of installed biomass capacity.

Below is a diagram showing the share of each RES described above has in Bulgaria in terms of total installed capacity. It is clear that the share of biomass power plants is negligible, whereas hydropower confirms its largest share of installed capacity.



Herein below is a visual representation of the real time generation on July 30th 2024 at 10:18:41 taken from the website of the Electricity System Operator[5]



GEOTHERMAL ENERGY IN BULGARIA

Geothermal energy[6] is attracting attention, with legislative proposals to harness Bulgaria's geothermal potential. New assessments are planned with World Bank assistance, studies have indicated Bulgaria has potential of more than 700 megawatts geothermal heating capacity. Increasing the use of geothermal energy in Bulgaria will reduce and could replace the need to burn fossil fuels, when used together with other renewable energy sources. It will accelerate the transition of the country to a modern and sustainable 21st century economy. It will create jobs and provide opportunities to develop new skills that could position Bulgaria as a future European leader in renewable technology applications. And, it will help the country reach the ultimate goal of carbon-neutrality by 2050.

The government of Bulgaria has stated a goal to oversee the development of 400 MW of geothermal energy capacity by 2026. The setting of this ambitious target highlights the important role geothermal energy will play in the transition of Bulgaria to a successful low-carbon economy.

[5] Real time generation on July 30th 2024, Electricity System Operator, available online: https://www.eso.bg/doc/?460

[6] Website of Bulgarian Association Geothermal Energy, https://www.bage.bg/geothermal-bulgaria

Greater development of geothermal energy in Bulgaria is now a cornerstone in the plans of the country for the energy transition. This is because geothermal is the only source of renewable energy that can provide constant, clean and affordable base-load energy without additional needs for battery storage. Its development will reduce dependence on the mix of fossil-fuels and nuclear power that provide more than 80% of base-load energy capacity today. And bring about the eventual replacement of this base-load mix with reliable renewable energy sources. This is why increasing the capacity of geothermal energy use in Bulgaria is so important to the successful transition of the country to a sustainable, low-carbon economy.

Growth in the development and use of geothermal energy can provide Bulgaria with reliable, clean and cheap base-load power and help replace the need to burn fossil fuels. It can also significantly increase the energy efficiency of homes, businesses and towns, by reducing power needs from greater use of direct-heat and geothermal heat pumps.

To become a reality, government, industry, academia and specialists in Bulgaria, Europe and beyond must collaborate to ensure decision-makers have the information needed to take knowledgeable decisions to help the development of geothermal energy in Bulgaria.

The purpose of the Bulgarian Association Geothermal Energy is to support and broaden this collaboration. By bringing together all companies, institutions and specialists with knowledge and experience to share and by creating an open forum for dialogue, proposals and work to encourage greater investment.

LEGAL CONDITIONS

Bulgaria has faced significant challenges in meeting EU targets for reducing greenhouse gas emissions while also addressing its strong energy dependence. The country's energy sector remains heavily reliant on coal and nuclear power, although there have been recent efforts to promote renewable energy sources such as wind and solar power. The government has also introduced policies and initiatives to promote energy efficiency and reduce energy consumption, such as the **National Program for Energy Efficiency** and the **National Program for Energy Development**.

The legal context for the energy transition in Bulgaria is primarily guided by the country's EU membership and the EU's Climate and Energy Package. Here is a brief outline of key legislative instruments:

Bulgaria's legal framework for energy transition is guided by several key legislative instruments. The **Bulgarian Energy Act** and **Renewable Energy Act** are the primary legislative tools directing this transition. The Renewable Energy Act, enacted in 2011, promotes the use of renewable energy sources and set a target of generating 16% of the country’s energy from renewable sources by 2020. This Act provides feed-in tariffs to incentivize the use of renewable energy, establishes guarantees of origin for renewable energy, and mandates energy companies to purchase a certain amount of energy from renewable sources. In September 2023, Bulgaria adopted the Renewable Energy Act 21 (was a bill amending and supplementing the **Act on Energy from Renewable Sources**) in second reading. The draft law defines and regulates “Civil Energy Communities”

In addition to these acts, the **National Energy Strategy 2020**, adopted in 2011, outlined a roadmap for reducing Bulgaria's dependence on imported fossil fuels and increasing energy efficiency. This strategy focused on improving energy infrastructure and promoting renewable energy. More recently, in January 2023, a new 30-year National Energy Strategy was approved,

setting new priorities and raising questions about future energy policies. This updated strategy aims for Bulgaria to remain a leader in electricity production and export, emphasizing national and energy security, sustainable use of local resources, and decarbonization. It includes a fair transition to decarbonization and protection from energy poverty, highlighting hydrogen production to reduce the country's dependency on natural gas.

The **National Recovery and Resilience Plan (NRRP)**, accepted by the European Commission in July 2021, is another significant initiative. This comprehensive strategy addresses post-COVID-19 economic and social challenges, focusing on the green transition and supported by €6.1 billion from the EU. The plan includes a controversial coal phase-out by 2023, which has caused social unrest and led to efforts to renegotiate its terms.

On 26th April 2024 the European Commission published new recommendations on the Bulgarian draft **National Energy and Climate Plan** (NECP)[7]. In December, in a communication assessing the aggregated impact of the draft NECPs from Bulgaria and Poland, the Commission found that the cumulative impact of the drafts is not yet sufficient to reduce net greenhouse gas emissions by at least 55% by 2030, as required under the so-called **'Fit for 55' legislation**. Hence, the Commission recommendations to EU countries on how to update and align their plans to meet our common objectives. The Commission has now closed the infringement procedures which were opened against Bulgaria and Poland in December for their failure to present their plans.

Bulgaria's **Territorial Just Transition Plans (TJTPs)**[8] were finally adopted by the European Commission on 21 Dec 2023. A press release announced that as a result Bulgaria would receive €1.2 billion from the Just Transition Fund (JTF). The JTF will help deliver new jobs and economic activities for a just transition in the Bulgarian regions of Stara Zagora, Kyustendil and Pernik that face the biggest socio-economic challenges in phasing out coal and reducing CO2 emissions. It will also support Bulgaria to reach the EU 2030 climate and energy targets, and a climate-neutral economy by 2050.

The adoption of the TJTPs completes the approval of a total €11 billion Cohesion Policy investments (2021-2027) supporting a more competitive, cohesive and greener Bulgaria, leaving no one behind.

The JTF will help the transition from coal-based energy production and support reskilling and upskilling and the creation of new employment opportunities for over 15,000 workers in the three regions. Moreover, 2,190 hectares of land surface area will be rehabilitated to develop industrial areas and construct renewable energy source capacities. Energy efficiency measures in residential buildings focused on energy-poor households and vulnerable consumers will help tackle energy poverty. In addition, the JTF will support prosumers and help establish renewable energy communities. This will reduce energy consumption, lower electricity bills, and cut greenhouse gas emissions, on top of improving living conditions.

To ensure that the JTF responds to local needs, local sub-committees will be set up with JTF support in each of the three Bulgarian regions, directly involving a wide range of stakeholders for local representation and participation in the governance of the JTF.

---

[7] https://energy.ec.europa.eu/news/commission-publishes-new-recommendations-draft-national-energy-and-climate-plans-bulgaria-and-poland-2024-04-26_en

[8] https://ec.europa.eu/regional_policy/whats-new/newsroom/21-12-2023-eu-supports-just-climate-transition-in-bulgaria-with-a-budget-of-eur1-2-billion_en#:~:text=EU%20supports%20just%20climate%20transition%20in%20Bulgaria%20with,Transition%20Plans%20%28TJTPs%29%20by%20the%20European%20Commission%20today

Here is a brief outline of the RES policy in Bulgaria:

- Electricity from RES is promoted mainly through **premium agreements** in Bulgaria. These are signed with the **Electricity System Security Fund (ESSF)**. The scheme includes all power plants using renewables and CHP with installed capacity of 4 MW or higher. The premium offsets the difference between the stock price and the price in the contracts RES producers sign with the National Electricity Company.
- RES producers with a capacity below the 4 MW threshold are supported through FIT schemes. This threshold for new long-term agreements under FIT was reduced to 1 MW and is expected to be further lowered to 0.5 MW. Currently FIT is applied mainly to new rooftop solar panels or façade photovoltaic (solar pv) installations with low capacity.
- Preferential prices under FIT are set and regulated by the Energy and Water Regulatory Commission (EWRC).
- RES producers are not given priority access to the grid. Connecting their systems is subject to the general provisions of the energy legislation.

Economic diversification in Stara Zagora Region

In the region of Stara Zagora, which hosts coal mines and four thermal power plants, EU funding will support the region's citizens in the transition to a green economy with new job opportunities, including across ten satellite municipalities of the Sliven, Yambol and Haskovo regions, where part of the labour force resides.

The JTF, together with the European Social Fund Plus, will develop the mapping of the skills of the employees in power plants and coal mines as well as of the persons indirectly affected, such as family members. This crucial information will feed into the JTF employment measures aimed to reskill and upskill, career counsel and develop entrepreneurial skills.

The Just Transition Fund will also be channelled to degraded sites in line with the ‘polluter pays' principle to prepare them for alternative economic activities and a shift to green energy, such as those related to photovoltaic parks, pilot projects for virtual power plants, industrial parks for clean technologies, and hydrogen-based value chains.

Finally, the fund will support the diversification of the local economy by investing in small and medium-sized enterprises (SMEs) and in research and development (R&D) related to the circular and climate-neutral economy.

Furthermore, Bulgaria has implemented measures to promote energy efficiency through the **Energy Efficiency Act of 2015**. This act sets targets for energy efficiency in buildings, mandates energy audits and management systems, and establishes a system of tradable energy efficiency certificates.

In 2020, Bulgaria adopted the **Climate Change Act**, which outlines the country’s strategy for mitigating and adapting to climate change. This act establishes a national climate council and mandates the development of a national climate plan, setting targets for reducing greenhouse gas emissions and promoting renewable energy.

To promote the use of **electric vehicles (EVs)**, the Bulgarian government launched **several initiatives in 2020**, including financial incentives for purchasing EVs and establishing a network of charging stations. The government has set a target of having 20,000 EVs on the roads by 2025.

Despite these comprehensive legislative frameworks and initiatives, Bulgaria faces significant challenges in meeting EU targets for reducing greenhouse gas emissions while addressing its strong energy dependence. Regulations are often undeveloped or contradictory, hindering the acceleration of renewable energy sources. Numerous ready-to-operate RES projects await connection due to grid limitations, and current legislation imposes double charges for shared electricity among users. There is also a significant disparity between the funds allocated for state and private grid development, and administrative delays risk potential funding loss.

Potential solutions include developing a comprehensive and politically supported national energy strategy, improving synchronization among departments to enforce energy policies, eliminating regulatory misunderstandings and contradictions, and prioritizing grid expansion, digitalization, and efficient use of existing networks.

DETERMINANTS OF DEVELOPMENT

The development of Renewable Energy Sources (RES) is influenced by several components and factors, including technological advancements, government policies, financial incentives, market demand, and public awareness. Over the years, investment costs in RES have significantly decreased due to technological improvements and economies of scale, making renewable energy more competitive with traditional energy sources. Increased awareness among society about climate change and environmental sustainability has led to greater support and adoption of RES. European politics play a crucial role in stimulating the development of RES through ambitious climate targets, subsidies, and regulatory frameworks like the European Green Deal. However, geopolitics also impacts the development of RES, as reliance on imported fossil fuels can drive countries to invest in domestic renewable energy to enhance energy security and reduce geopolitical risks associated with energy supply dependencies.

According to an overview on energy published in January 2024 on the website of the International Trade Administration[9] electricity production capacities meet consumer demand in Bulgaria and enable exports to neighbouring markets. In 2022, the Bulgarian energy industry exported more than 12 TWh of electricity totalling to EUR 3 billion, (USD 3.24 billion). Currently, the installed power generation capacity in Bulgaria is 13.247 MW, and the available capacity is 10,771 MW.

To support its energy needs, Bulgaria imports natural gas, oil and oil products, and solid fuels (anthracite and black coal, coal coke). The main local energy source in Bulgaria is lignite coal. Another local energy source is nuclear energy, which significantly contributes to energy independence. In 2022, the share of nuclear energy production is 32.6% of total electricity production in Bulgaria. The share is expected to remain above 40% until 2030. The reduction of fossil fuel imports into Bulgaria entails an increased need for energy production from renewable sources.

By the end of 2024, Bulgaria's Electricity System Operator (ESO) will finalize its investment program aiming to ensure 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 digitalization of the grid. Modernization and digitalization of the medium-voltage grid is expected to be completed by 2024.

[9] https://www.trade.gov/country-commercial-guides/bulgaria-energy

Power interconnectivity in the region has just made another important step forward with the completion of the second cross-border transmission line between Greece and Bulgaria.

Greece's Independent Power Transmission Operator (IPTO) announced in July 2023 that the new international ultra-high voltage, 400 kV electrical interconnection is operational. The total length of the international interconnection, which starts from Nea Santa EHVC in Rhodopi and ends at Maritsa East Substation in Bulgaria, is 151 km, of which some 30 km is within Greek territory. Its capacity reaches 2 GW.

BARRIERS TO THE DEVELOPMENT OF RES

The latest publication on energy on the website of the International Trade Administration Bulgaria's Recovery and Resilience Plan calls for deployment of a minimum of 1.4 GW of renewable energy with storage in Bulgaria, including an investment in renewable and storage facilities that will be financed by EUR 342 million from the Recovery and Resilience Facility (RRF) (33 per cent) and EUR 684 million from private funding (67 per cent).

The plan includes significant investments to accelerate decarbonization of the energy sector, tripling power generation from renewables by 2026, building large electricity storage capacity, cutting power sector greenhouse emissions 40 per cent by 2025, and setting out a framework for a coal phase-out. However, in January 2023, the Bulgarian Parliament voted to scrap interim coal-reduction commitments from the Recovery Plan and keep its entire coal fleet online until 2038, despite the risk of losing almost EUR 1 billion for energy sector modernization. The RRF is to be renegotiated with the European Commission to keep the coal industry on life support as long as possible.

Due to delays in ongoing repair projects and regulatory inconsistencies, Bulgaria uses only one-third of its large, pumped-storage hydro power plants (HPPs) and even less of smaller run-of-the-river plants. In times of rising prices and shortages of electricity supply, HPPs could ease 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 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 a short timeframe.

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 performance at peak consumption. Support measures aimed at industrial consumers are included 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 existing market potential.

The original Integrated National Energy and Climate Plan (NECP), analysed by Bankwatch[10] in 2019 when it was submitted, scored poorly as it was based on only one, business-as-usual energy development scenario. It was updated by the Ministries of Energy and Environment and Water to reflect the higher targets set by the European Green Deal and the European Climate Act, the Fit for 55 Package, the REPowerEU Plan, as well as the latest European Semester report on Bulgaria. By 2030, Bulgaria should achieve a 34.48% share of energy from renewable sources in gross final energy consumption, the updated NECP envisages. For the electricity sector, this share is 55.51%.

[10] https://bankwatch.org/beyond-fossil-fuels/the-energy-sector-in-bulgaria

According to Bankwatch again, Bulgaria's Recovery and Resilience Plan (RRF), approved by the European Commission in spring 2022, seemed slightly more considerate of the climate crisis and the need to reduce the contribution of fossil fuels in the country's mix. The Commission approved the country's EUR 6.3 billion plan, noting that it devotes 59 per cent of its total allocation to measures that support climate objectives. The plan was assessed to include significant investments to accelerate the decarbonisation of the energy sector, tripling power generation from renewables by 2026, building large electricity storage capacity, cutting greenhouse gas emissions of the power sector by 40 per cent by 2025, and setting out a framework for a coal phase-out. However, in January 2023 the Bulgarian Parliament voted to scrap the interim coal reduction commitments from the Recovery Plan and thus keep its entire coal fleet online until 2038, despite the risk of losing EU funds for modernising the energy sector.

The largest-scale mining activities are situated in the Maritsa East Mining and Energy Complex situated in South Central Bulgaria in the region of Stara Zagora. The mining complex itself stretches over 240 km^2 and produces nearly 97 per cent of the lignite in the country, directly employing some 12,500 people.

After years of political turmoil, frequent changes of governments and protests by miners in October 2023, in December 2023 the European Commission approved EUR 1.2 billion in just transition funding for the three coal regions in Bulgaria – Stara Zagora, Pernik and Kyustendil.

INVESTMENT FUNDING - SUPPORT INSTRUMENTS

Given upcoming legislative and market changes, international investors must commit to swift action in Bulgaria due to evolving regulations. It is very likely that the current investment 'window of opportunity' in Bulgaria will be short, following which there will be tenders for allocation of new capacities.

CMS Law Bulgaria[11] has advised on more than a half of the operational PV projects in Bulgaria. In addition, CMS successfully advised on the sale of the biggest greenfield PV project in Bulgaria (229 MW) and is highly active in numerous greenfield PV and wind projects.

Tenders worth around EUR 1 billion (of which EUR 342 million from the Recovery and Resilience Facility) are envisaged in the NRRP to develop in Bulgaria 1,4 GW total capacity renewable energy production and storage installations. The tender shall be divided into 5 tender procedures each for at least 258 megawatts. To meet the requirement, at least 30% of storage capacity installations must last a minimum of 4 hours. These power production sites with integrated storage facilities are designed to promote energy system decentralisation – a crucial factor in achieving sustainability and energy system independence.

Additionally, the NRRP envisages national storage infrastructure with 6,000 megawatts hours storage capacity worth EUR 800 million wholly financed from the Recovery and Resilience Facility.

Bulgaria plans electricity storage projects to enhance system balance, strengthen its export position, and ensure cross-border flexibility. Bulgaria has a unique asset in its energy portfolio being Chaira Pumped Storage Hydropower Plant ('PSHPP'), with a production capacity of 864 megawatts and a pumping capacity of 788 megawatts. Currently it is out of operation and the couple of governments have been trying to restart it. The PSHPP could play important balancing role by securing flexibility in the power system since (1) it can exploit its pumping capacity to

[11] https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/bulgaria

balance the excess production and (2) produce power in the event of shortages. According to the Integrated Plant future investments of EUR 200 million are envisaged to enable the restart of its generation capacity.

Bulgaria is considering introducing a tender system for connecting greenfield renewable energy projects, a reform not yet implemented in the country.

Depending on the various sources of information (official or commercial), Bulgaria is envisaging at least 2 645 megawatts peak renewable capacity increase by 2030 (2,174 megawatts solar and 249 megawatts wind). The National Recovery and Resilience Plan of Bulgaria envisages 3,500 megawatts new capacity from renewable source of energy are envisaged to be put into operation, while ESO envisages new RES capacities of total capacity over 4,8 GW to be connected until 2031, of which over 4,4 GW solar and around 340 megawatts wind. These 'green energy' capacities would allow Bulgaria to retain its net electricity export position in the region.

RES DEVELOPMENT SCENARIOS

The Association of Traders of Energy in Bulgaria have outlined feasible scenarios of RES development in line with the Bulgarian draft energy strategy[12].

The Ministry of Energy (ME) published a draft energy strategy entitled Strategic vision for sustainable development of the electricity sector of the Republic of Bulgaria with a horizon till 2053. In it, the ME based its scenarios for the country's energy development on two simulation models "Pathway Explorer" of CLIMACT and Compass Lexecon's European wholesale electricity market model.

A. Energy scenarios developed and implemented by the Energy Transition Commission (ETC) of the European Green Deal Advisory Board

According to ETC models, Bulgaria can decarbonize the energy sector through continued development of renewable capacities combined with new flexible low-carbon capacities. In all scenarios, in line with the increased European ambition by 2030 and 2050 for the decarbonisation of the European and Bulgarian energy system, CO2 emissions are expected to fall by at least 75% (compared to 1990) by 2030 before reaching zero by 2050.

However, the conclusions of the Ministry of Energy (ME) based on the models presented by the ETC are that the implementation of Reform 10 of the RRP by the end of 2025 will lead to disruption of the security of supply electricity in the country and will threaten the national security. It will be impossible to export electricity, as it will be necessary to import electricity from neighboring countries in order to ensure the security of the Electricity System of Bulgaria, this would lead to an increase in electricity prices in the country. The ME claims that the implementation of the commitments for the Reform on RRP will lead to such an energy mix, in which there will be a shortage of electricity in the peak months of consumption, which will increase Bulgaria's energy dependence, as well as create prerequisites for an increase in the final price of electricity for households and businesses, there will be a need for additional investment in generation capacities. According to the Ministry, since these results do not meet the strategic goals of reliable, secure and affordable energy and national security, a new model has been developed – the Ministry of Energy's model.

[12] The Draft Energy Strategy relies on new NPP, RES and HPPs. Available online

B. Energy model of the Ministry of Energy

The strategic vision for sustainable development of the electricity sector is published on the website of the Ministry of Energy.

The model prepared by the Ministry of Energy explores several options for achieving full decarbonization. The model envisages a strong deployment of low-carbon and RES technologies, hydro and nuclear power by 2050 to maintain security of supply while phasing out lignite over the period 2030-2038. Key assumptions in the national power capacity development model include:

Coal

- use of existing capacities until 2030 to guarantee energy security
- introduction of technical solutions to reduce emissions

Nuclear

- construction of new 2000 MW capacities at the Belene site by 2035/2040 (a decision is required Q1 2023)
- construction of 2000 MW capacities by 2045 at the Kozloduy site, replacing the existing capacities in Kozloduy

RES

- building 7 GW of solar and 2 GW of wind capacity by 2030.
- building 12 GW of solar and 4 GW of wind capacity by 2050.

Hydroelectric power

- construction of 870 MW of new hydropower plants by 2030.
- construction of 1270 MW by 2050.

Geothermal energy

- focus on local heating systems

Hydrogen

- construction of 1 GW electrolysers by 2030, production of 90,000 t/y.
- construction of 5 GW electrolysers and production of 520,000 t/y. hydrogen by 2050 for local consumption and export.

Energy storage systems

- completion of the extension of Pump storage plant Chaira by 2030,
- construction of new storage (underground, compressed air) and construction of 1 GW by 2035.
- introduction of 600 MWh batteries by 2030.
- introduction of 1.5 GW of seasonal storage systems by 2050.
- providing system services to neighboring countries as well

High and medium voltage networks

- 1900 km. modernization and construction of new power lines in the transmission network

- digitalization and development of the distribution network

Electro mobility

- 1000 charging stations for the development of technical and charging infrastructure by 2030.

Energy poverty

- introduction of measures to support and increase energy efficiency in households

Energy efficiency

- application of good practices and technologies from around the world

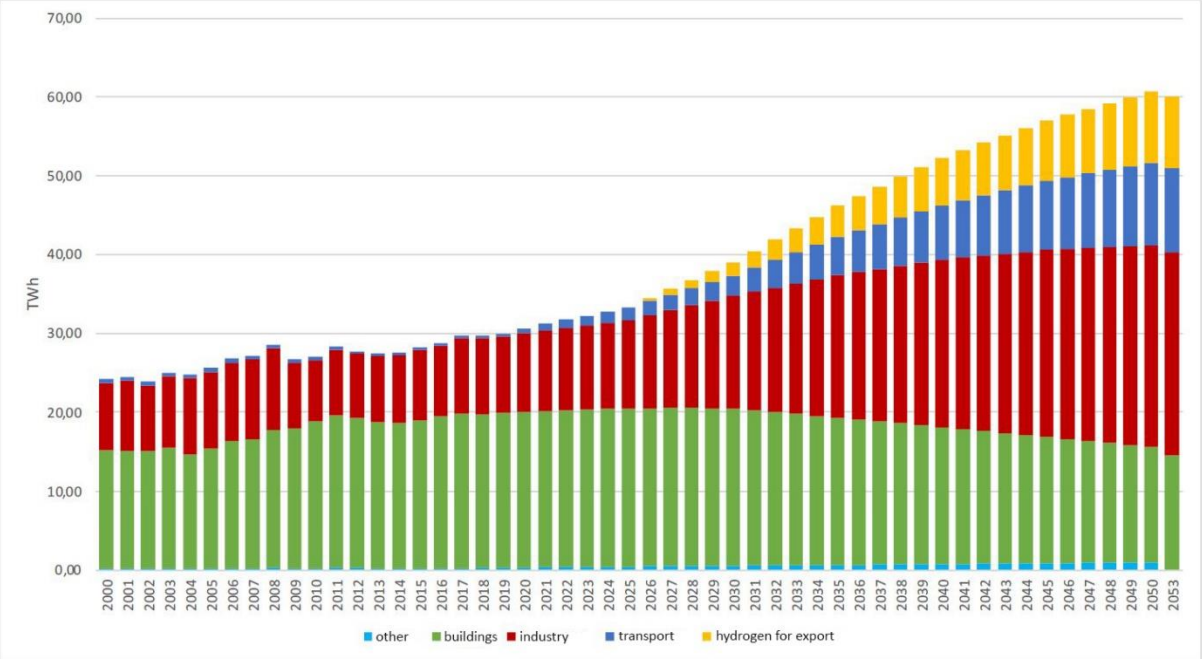


Figure 1. Electricity consumption forecast by sector

According to the scenario of the Ministry of Energy, the final demand for electricity in Bulgaria is expected to reach 61 TWh by 2050, and the increase in demand will be provoked by the electrification of transport and the production of green hydrogen through electrolysis. An increase in energy efficiency is also accounted for in ME projections.

The necessary investments of ME model for the main low-carbon capacities are shown in the table below.

Technology	Project	Investment projection [in mln euros]	Source of financing
Nuclear	New 2000 MW on Belene site	10 000	Financial institutions and strategic investors
	2000 MW replacing capacities till 2045 on Kozloduy site	12 000	Financial institutions and strategic investors
RES	New PV capacities - 7 GW till 2030 and 5GW more till 2053	12 000	Private investors
	New wind capacities - 2 GW till 2030 and 2 GW till 2053	6 400	Private investors
Hydro	Pump storage Chaira - expansion of lower dam (Yadenitsa project)	200	Recovery and resilience plan(RRP), National electric company (NEK)
	HPP Gorna Arda 170 MW	255	Financial institutions, NEK
	HPP Mesta 300 MW	450	Financial institutions, NEK
	HPP on Danube 800 MW	5 000	Financial institutions and strategic investors
Total		46 305	

Table 1. New capacities and necessary investments for their construction.

Regarding the dynamics of the installed capacities, ME considers:

- Lignite plants gradually being replaced in the period 2030 – 2035 with a combination of variable RES, hydropower and NPP.
- Installed capacity increases by 20 GW by 2050 compared to today. This increase is mainly due to the growth of renewable energy sources, with combined wind and solar reaching 17 GW of installed capacity by 2050.
- Growth in variable renewables is also accompanied by increases in hydropower (+2.3 GW from 2040 onwards), nuclear capacity (+2 GW from 2035 onwards) and an increase in storage capacity with 2.4 GW installed by 2050.)

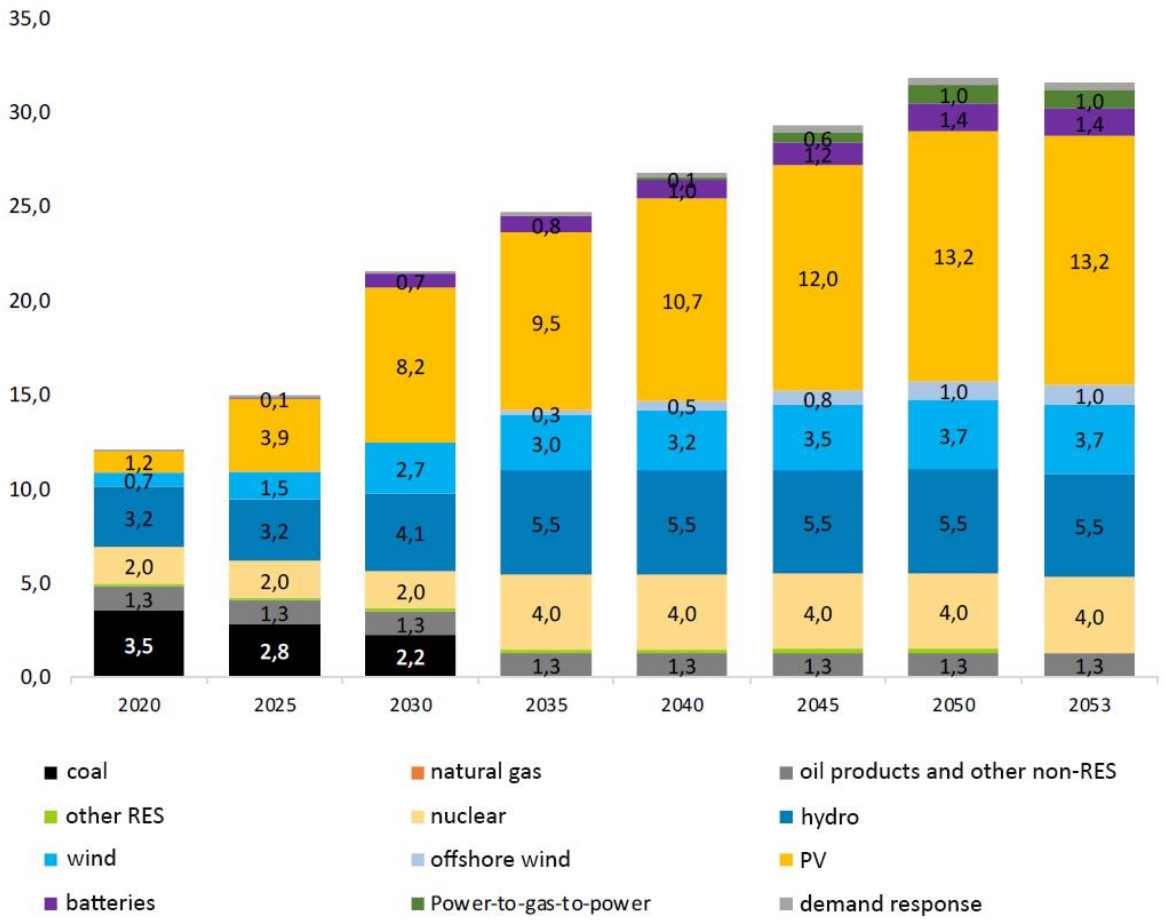


Figure 2. Installed power generation capacities in GW by 2053

In the scenario of ME, Bulgaria is expected to be heavily reliant on lignite production until 2025/30, before it is phased out by the mid-2030s. According to the ME, the scenario shows an energy mix in which Bulgaria achieves the decarbonization goals: -55% CO2 in 2030 compared to 1990 and emission-free energy generation in 2050.

SOCIAL ACCEPTANCE

Awareness and acceptance of RES is increasing in Bulgaria although the level of acceptance varies throughout the country with the coal regions in transition having the lowest level of acceptance for fear of job losses and economic decline of the regions. There are energy efficiency programs going strong in coal regions in transition. The energy efficiency retrofitting program in the three coal regions in Bulgaria, namely Stara Zagora, Kyustendil and Pernik, has finally been launched. The total budget of the energy efficiency retrofitting measure is BGN 196.4 million **from European and national funding**. Most of that amount – BGN 129 million – is intended for Stara Zagora region. This means that all three municipalities have the opportunity to continue completely free of charge the energy efficiency retrofitting of residential buildings which failed to qualify for the program "Support for sustainable energy renovation of the residential building stock - Stage I", **financed within the framework of the National Recovery and Resilience Plan**.

The main objective is to support measures for energy efficiency (EE) of multi-family residential buildings to reduce energy poverty in the areas most affected by the climate transition – Pernik, Kyustendil and Stara Zagora regions. The program will support various energy efficiency activities

as well as the implementation of renewable energy sources (RES), heating and air conditioning installations. Approved residential buildings will receive up to **100% grant funding**. Application under the procedure is carried out on the basis of project proposals, which are submitted to the relevant municipality in partnership with the owners' association, registered under the Bulgarian Condominium Ownership Management Act. Following implementation of energy saving measures (ESM), residential buildings should rank as "B" or higher energy efficiency class buildings.

Bulgaria is lagging behind in establishing and introducing energy communities. The Energy Community Gabrovo - RDNO[13] is the first, and so far the only, energy community in Bulgaria. It came into existence as an innovative initiative from the municipality of Gabrovo that aims to address challenges in the energy market, its characteristics as detailed herein below:

Community memebers	**73**	Clients	**5**
Employees	**1**	Money invested	**EUR 80,000**
Annual heat production	**0 GJ**	Electric cars	**0**
RES capacity installed	**0 GW**	Energy saved	**0 GW**
Active since	**2022**	Renovations completed	**0**

The municipality of Gabrovo and members of the energy community have pooled resources, funds, land, knowledge and time to harvest their own energy together. Their pilot project involved the construction of a 100kWh solar farm. The energy community has 73 members, including Gabrovo residents, citizens from other parts of Bulgaria, and six legal entities. Members are a diverse group of profiles united by the desire of developing an innovative approach to providing clean energy, learning more about the cooperative model and investing in solar production.

Below is a brief overview of the legal conditions behind establishing energy communities in the country[14]. By means of the new additions to the legislation energy communities have been regulated for the first time in Bulgaria, wherein natural and legal persons may associate with the state and the municipalities for the implementation of energy projects.

These communities may carry out production, including of renewable energy, distribution and other activities described more precisely in § 1, item 76 of the Additional Provisions of the Energy Act ("EA").

The changes implement the basic requirements of the European legislation, providing maximal legal and organisational freedom for associating in favour of the consumers. This could be carried out in the form of a trade company, cooperation, non-profit entity, under the Condominium Ownership Management Act, or a civil company under the Obligations and Contracts Act. The relations between the members of the communities shall be regulated by Articles of Association or a contract (depending on the legal-organisational form chosen). Given the lack of such regulation at present, it could be envisaged on legislative level in the future better specification of the mandatory content of the Articles of Association/contract, for instance – the obligation any profit generated to be spent for the development of the activity and not to be distributed in favour of the community members.

One of the key advantages of these energy communities is the absence of an obligation to have a license under Art. 39, para. 4, item 5 of the EA, the existence of which is a requirement for

[13] https://energycommunityplatform.eu/communities/energy-community-gabrovo-rdno/

[14] https://penkov-markov.eu/de/legal-digest/siezdavane-na-energiini-obshhnosti-v-bielgariia

electricity production. Thus, the establishment of such energy communities is facilitated and stimulated.

Despite the undoubtedly positive aspects highlighted above, the new piece of legislation also has some disadvantages, mainly concerning the measures to promote the civil energy communities. For instance, the measure according to which cooperation as regards the transmission of community energy shall be provided to the relevant distribution network operator and/or thermal transmission company is rather wishful. Similar is also the situation with the required regulatory support, ensuring fair, proportionate and transparent administrative procedures, as well as the applying of non-discriminatory treatment to

Gabrovo Municipality is the first one that has benefited from the opportunity to create an energy community. Through cooperation with individuals and legal entities, the municipality has built a photovoltaic farm with a nominal capacity of 100 kWp, with an initial investment of 180 000 BGN (approx. EUR 90 000). The initiative is a partnership between the municipality, natural and legal persons, and small and medium-sized enterprises. During the first stage participants registered on the territory of the Gabrovo Municipality were accepted, whereas the second stage was open for participants from other regions of the country. The good European practices show that for the promotion of the measure, a detailed guideline with instructions to customers (including on the manners of financing) should be drafted. An awareness campaign on the benefits of the energy communities shall be carried out. This will stimulate interest in such cooperation, which will undoubtedly contribute to the realization of the Green Deal as a key EU priority.

Naturally, a more detailed regulation of the status of these communities as participants in the electricity market is required, in connection, for instance, to their relationships with the relevant network operator – connection, measuring, payment of network services, the conditions under which the end customer exercises rights as a separate end customer of the network and the status of the energy community as a participant, as well as the sustainable financing mechanisms.

By introducing these regulations for the establishment and operation of energy communities, a further step has been taken in stimulating the production of renewable energy, which is in line with the European directives.

RECOMMENDATIONS

System flexibility and energy safety are part and parcel of RES development and cannot be omitted from the equation. Enhancing system flexibility and energy safety involves several strategic measures, including grid modernization with smart grids and demand response programs, and investing in energy storage solutions like battery and pumped hydro storage. Distributed energy resources, such as microgrids and virtual power plants, flexible generation through hybrid power plants and hydrogen production, and advanced forecasting using AI and improved weather prediction models are crucial. Ensuring energy safety requires robust cybersecurity measures, continuous monitoring, grid resilience through redundancy and hardened infrastructure, and compliance with safety standards and regular audits. Emergency response planning, decentralization with local energy systems and storage, public awareness campaigns, and international cooperation through cross-border interconnections and knowledge sharing are also essential to create a flexible and secure energy system capable of integrating increasing renewable energy sources while maintaining stability and safety.

Globally, hydrogen has emerged as a new energy vector and the Bulgarian Ministry of Transport fully supports investments in hydrogen to help foster new technological and industrial

development in Bulgaria. A total of BGN 92 mln is expected by the end of 2024 from EU's Transport Connectivity Program 2021 – 2027 to be disbursed for building alternative fuels infrastructure along TEN-T roads, hydrogen refuelling, and supply of electricity to ships at the quayside in ports. The Bulgarian Ministry of Transport sees enormous potential in both urban public transport and rail transport. On May 10, 2024, Bulgaria celebrated a significant step towards green mobility with the inauguration of its first hydrogen refuelling station. Led by HITMOBIL Competence Center[15], this new facility could revolutionize the country's green transportation landscape. It is situated within the "Integrated Energy Systems" field laboratory of the Competence Centre in Sofia, and signifies the inception of hydrogen electric mobility in the country. The project is the result of the joint efforts of HITMOBIL Competence Center, BAS and the Institute of Electrochemistry and Energy Systems "Academician Evgeny Budevski" with the Bulgarian Academy of Sciences. It is an on-site station wherein hydrogen is produced directly inside the station, stored, and then ready to be dispensed inside the vehicle at the required pressure. The hydrogen is dispensed via two nozzles controlled by smart valves which regulate the flow rate of the gas to fill the vehicles to the required pressure in accordance with the fuelling protocol.

The Institute for Sustainable Transition and Development at Trakia University is involved in numerous projects focused on hydrogen production, storage, and transmission systems. Their work also includes hydrogen fuel systems, industrial technologies using hydrogen as a raw material, hydrogen electromobility, and supply infrastructure, as well as hydrogen technologies for energy storage, energy production, and power system management. Academic institutions like the Institute for Sustainable Transition and Development at Trakia University play a crucial role in advancing hydrogen technology through research and development projects. These initiatives contribute to the broader adoption of hydrogen as a clean energy source. ZAHYR Project (Zagora Sustainable Hydrogen Region (aka Stara Zagora Hydrogen Valley))[16] is intended to decarbonize the entire Stara Zagora Region by means of hydrogen. This is a significant initiative in Bulgaria's hydrogen landscape part of the Clean Hydrogen Partnership, a public-private collaboration, and with a grant of EUR 8 million from Horizon Europe it had received in early 2023 it aims to produce green hydrogen in the Maritsa Iztok Complex, replacing part of the electricity generation from conventional coal-fired power plants. The plan includes the construction of a solar farm to supply the electricity needed for electrolysis to produce hydrogen. In turn the produced green hydrogen will power a gas turbine for electricity generation and be used in the streetlight power supply system of Stara Zagora, as well as for refueling 10 fuel cell electric buses. It should be noted that Projects like ZAHYR have a significant impact on regional economic development by creating jobs and promoting sustainable industrial practices. The integration of green hydrogen production and usage helps in reducing carbon emissions and reliance on coal-fired power plants. The involvement of academia in public-private partnerships, such as the Clean Hydrogen Partnership, highlights the collaborative efforts needed to drive the transition to sustainable energy. These partnerships leverage the strengths of academic research, industry expertise, and governmental support.

The acceleration of the development of RES needs active work in more than one area. Please find below a breakdown in tabular form of the various areas and sub-areas that need to be addressed:

[15] Visit the project webpage by clicking this link: https://hitmobil.iees.bas.bg/en

[16] ZAHYR Project: https://cordis.europa.eu/project/id/101111903

Main area	Sub-area	Description
Policy and regulatory support	Incentives and Subsidies	Governments should provide financial incentives such as tax credits, grants, and subsidies to reduce the cost burden on renewable energy projects
	Renewable Energy Standards	Implementing renewable portfolio standards (RPS) that require a certain percentage of energy to come from renewable sources can drive demand
	Simplifying Permitting Processes	Streamlining and standardizing the permitting processes for renewable energy projects can reduce delays and lower costs
Financial Mechanisms	Green Financing	Encouraging investments through green bonds, venture capital, and other financial instruments can provide the necessary capital for RES projects
	Public-Private Partnerships	Collaboration between governments and private entities can leverage resources and expertise
Technological Innovation	Research and Development (R&D)	Investing in R&D for new technologies and improving existing ones can enhance the efficiency and reduce the cost of renewable energy systems
	Energy Storage Solutions	Developing advanced energy storage technologies is crucial for managing the intermittent nature of renewable energy sources like solar and wind
Infrastructure Development	Grid Modernization	Upgrading the existing grid infrastructure to accommodate renewable energy sources is essential for reliable distribution and transmission
	Microgrids and Smart Grids	Implementing microgrids and smart grid technologies can improve energy management and integration of distributed energy resources
Education and Awareness	Public Awareness Campaigns	Educating the public about the benefits of renewable energy can increase acceptance and support for RES projects
	Workforce Training	Developing training programs for the workforce can ensure that there are enough skilled workers to support the growth of the renewable energy sector
International Cooperation	Global Partnerships	Engaging in international cooperation and knowledge exchange can help accelerate technology transfer and adoption of best practices
	Climate Agreements	Adhering to and promoting international climate agreements can drive global efforts towards increased renewable energy deployment
Market Mechanisms	Carbon Pricing	Carbon pricing mechanisms such as carbon taxes or cap-and-trade systems already make fossil fuels less economically attractive compared to renewables
	Feed-in Tariffs	Providing long-term contracts to renewable energy producers at fixed prices can guarantee returns on investments and encourage more projects
Community Involvement	Community Energy Projects	Supporting local, community-based renewable energy projects can increase local engagement and investment
	Decentralized Energy Systems	Promoting decentralized energy systems can enhance energy security and resilience while supporting renewable energy deployment
Legal and Institutional Frameworks	Clear Legal Frameworks	Establishing clear legal frameworks for property rights, land use, and environmental regulations can reduce uncertainties and barriers for renewable energy projects
	Institutional Support	Strengthening institutions that support renewable energy development, including regulatory bodies and industry associations, can provide necessary guidance and oversight

By addressing these areas, stakeholders can create a conducive environment for the rapid development and adoption of renewable energy sources.