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ENERGY MIX
ALBANIA, NORTH MACEDONIA AND SERBIA CONCEPT OF BALKANS RENEWABLE POWER COOPERATION

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CONCEPT OF BALKANS RENEWABLE POWER COOPERATION



Belgrade Open School

With the support from Open Society Foundations - Western Balkans

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Nothing is impossible for one who has the will to try.

- Alexander the Great

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EXECUTIVE SUMMARY

The integration of the Western Balkans into the European Union (EU) is a logical step for countries with relatively small economies, aiming to strengthen and stabilize them. This goal can be achieved through timely adaptation to the challenges of EU accession, which includes the flexible application of EU regulations to each country's system. The process requires individual countries to undertake a series of activities to update their regulations. However, changing regulations is not enough. Just as no society can thrive in isolation, countries need to collaborate with their neighbours to build stronger systems together.

Electricity is a critical component of economic development, and the challenges of global warming, along with the aspirations for a cleaner and healthier environment, underscore the need to integrate renewable energy sources into existing power systems. This shift involves adapting traditional energy infrastructure like thermal power plants, hydroelectric plants, and transmission and distribution networks to accommodate renewable energy sources.

An innovative and strategic initiative emerged to contribute to energy transition and sustainability through regional cooperation among three countries: Albania, North Macedonia, and Serbia. The idea is to create a power mix system that combines various electricity sources in this geographic region. The project, known as the Regional Cooperation for Three Countries (RCTC), begins with exploring the feasibility and preconditions for such a complex endeavour, focusing on both legislative and technical aspects. The research results will guide the next stages of the project, leading to the creation of a "master plan" for interconnected investments that leverage local competitive advantages with two renewable technologies.

In this paper, the authors investigate the potential for a joint venture company established among Albania, North Macedonia, and Serbia. The concept involves constructing electricity generation plants, with solar power (SP) in Albania and North Macedonia, and wind power (WP) in Albania and Serbia. The study examines existing regulations and the possibility of joint operations. The paper also considers planned projects financed by each country. At the end of the paper, the authors illustrate the benefits of joint ventures and cooperative operations through a case study.

The paper concludes that Albania, North Macedonia, and Serbia have comparable regulatory frameworks for obtaining construction permits, connecting to the grid, and participating in the electricity market. The potential for electricity exchange among the countries is also promising, both in cases of system malfunctions and under normal operations. A hypothetical scenario exploring a malfunction in one system, with an observed capacity of 316 MW, supports the viability of this joint venture.

The primary goal of this project’s first phase was to explore the concept's feasibility, not to delve into its full implementation. Given the benefits demonstrated with the observed capacity, this paper provides a basis for further development of the concept. Future applications of this concept could lead to broader cooperation in areas like energy security, stability in electricity supply, joint provision of balanced energy, and participation in third-

party energy markets. It could also open the door for larger regional energy projects in other Western Balkans countries.

The success of the energy transition in Albania, North Macedonia, and Serbia depends on broader cooperation in energy, ecology, and society. Harmonizing energy policies, creating common strategies for energy transition, and encouraging citizen participation—especially through prosumers, energy cooperatives, and communities—will drive the process forward at the regional level. This cooperation will bolster the economies of all three countries, advance the region toward EU integration, and contribute to greater safety and security.

ALBANIA

Power System of Albania

Generation and consumption of electrical energy in Albania

Albania has a small energy market, lacks primary energy resources, and has limited generation and interconnection capacities. It has an energy system that is unbalanced and almost fully dependent on the limited and increasingly unstable hydro resources, which are located mainly in the Northern part of the country generating around 98% of the domestic electricity generation. This limitation, as well as the lack of primary energy sources, has led to dependence on imports of electricity, which at certain periods, like the years 2001–2002, 2005– 2007, and 2022 reached over 45-50% of the entire domestic consumption. The lack of interconnection capacities with the neighbouring systems has also been an impediment in the effort to balance the local demand, with electricity imported from other sources in the region.

The main problems and challenges the energy sector has been facing in recent years are the following:

- The generation capacity is insufficient to meet current domestic demand.
- The absence of alternative sources for energy generation (thermal, biomass, wind) and total dependence on hydrological conditions is another factor causing difficulties in the supply of consumers with electrical energy.
- The capacity to import electrical energy is constrained by the inadequate capacity of its existing interconnection lines with neighboring countries and the transmission lines in the region, especially with North Macedonia.
- There is no natural gas commercial sector and the gas market does not function well. The country is connected with gas Trans Adriatic Pipeline (TAP) to secure its supply with hydrocarbons, especially to furnish Vlora TPPs.
- Non-technical losses remain relatively high as a result of several factors, but mainly because of illegal connections and tampering with the electricity meters.
- High technical losses in the distribution are the result of the depreciated and inadequate electric distribution network.
- The level of electricity consumption for heating and cooling is high, as electricity is used for heating and cooling residences, commercial buildings, etc. This is another reason for the inability of the electrical energy system to guarantee regular supply for other services or industrial activities.
- The price of electricity is liberalised, while the use of other materials is not attractive for heating and cooking purposes (gas, woods, pellets, etc.).
- The use of electricity and other energy sources is inefficient as a result of poor building insulation and use of low efficiency equipment.

In the past Albania was faced with the difficulty to supply its consumers with the electricity due to: lack of primary energy resources, no networks and gas resources, limited generation and interconnection transmission capacities, and full dependence of its power generation on hydro resources. The electricity demand was much higher than domestic generation, which means that Albania was one of the net importer countries in the region. In 2007, the Albanian Power Corporation (KESH sha) utility imported more than 50% of its consumption and also made 17% load shedding. The hydrological situation was improved in 2008 and the utility

made only about 5 % load shedding, but it continued to import 40% of the electricity consumption. In 2022, power generation was 7.9 TWh, the losses were 1.7 TWh, domestic consumption was 6.2 TWh and imported electricity was 3.1 TWh. (INSTAT & OST.al).

An overview of the power generation, import and export during the period 2009 – 2019 is presented in Fig. 1

DTU Wind & Energy 2023

Fig. 1 – Energy supply during 2009 - 2019 (GWh)[1]

During the period of 1990 - 2021, the electricity consumption in Albania increased to 25,000 TJ or 7 TWh.

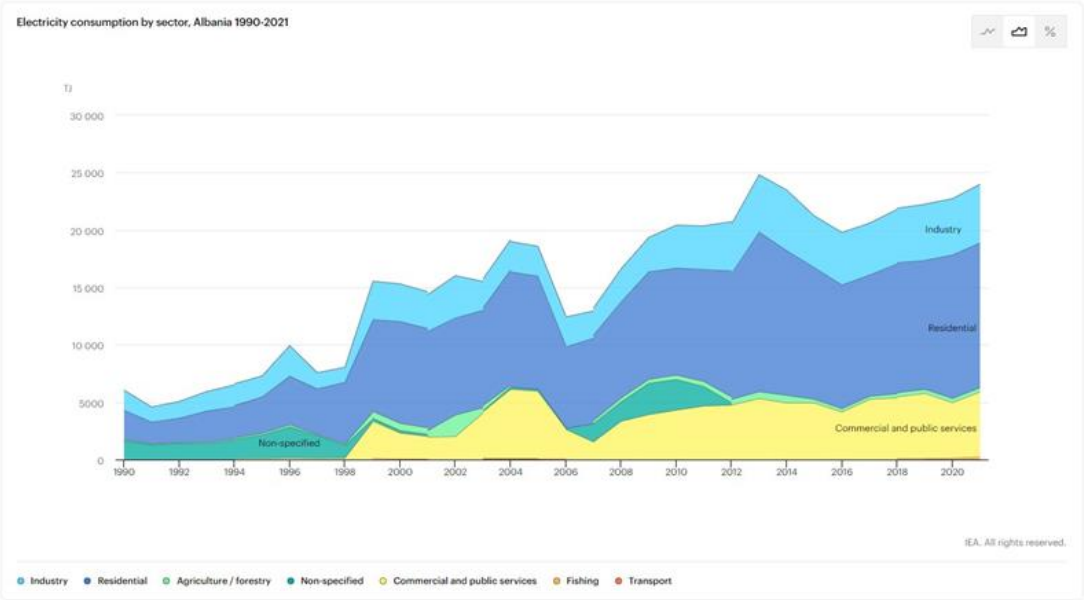


Fig. 2 – Electricity Consumption (TJ)[2]

In Albania, most of electricity generation comes from the hydro energy through the large hydro power plants with an installed capacity of around 2,011 MW and an average annual power generation of 7 – 8 TWh. Currently, only 35-40% of Albania's potential hydro energy capacities have been exploited while the rest is subject to various project studies.

[1] IEA – Electricity Consumption per Sector in Albania
[2] IEA – Electricity Consumtion per Sector in Albania

Albanian Government is working on involving the private sector (both local and foreign) to participate in the development of the remaining capacities through the construction of electricity power plants with the PPP Concession model. While the number of small hydro power plants is considerably increasing, mainly through the participation of the private sector from Albania, great interest from large companies is also present. In this regard, there are plans for constructing large HPPs on different rivers, such as the Devoll, Vjosa and Black Drin, or even lignite thermal plant at Korca region. In addition, there are plans for constructing wind and solar plants in the western part of the country, with the purpose of generating for the local market, balancing and exports.

The generation of electricity from the hydro resources has increased in recent years, mostly due to rainy weather conditions. Nevertheless, the Albanian electrical power system is not sufficient to provide a qualitative and adequate supply to domestic consumers. Regarding this, it should be noted that:

- the present generating capacity is insufficient to meet the increasing demand for electricity in the country even if the hydro conditions are favourable;
- the present generating capacity is insufficient for meeting the electricity demand in various periods (daily, monthly, yearly);
- for better management of the hydro reserves, it is necessary to improve the structure of electrical power generation, i.e. to diversify the resources. Since nearly all domestic generation comes from hydropower plants, the power system is vulnerable towards variations in Albanian territorial rainfalls.

At this point, the construction of the Weather Forecasting Centre is necessary, to predict the water capacity of the watersheds based on the precipitation data received from the remote sensors and the Weather Radar Centre in Albania and/or from the neighbouring centre systems.

OST - Albania Transmission System Operator TSO

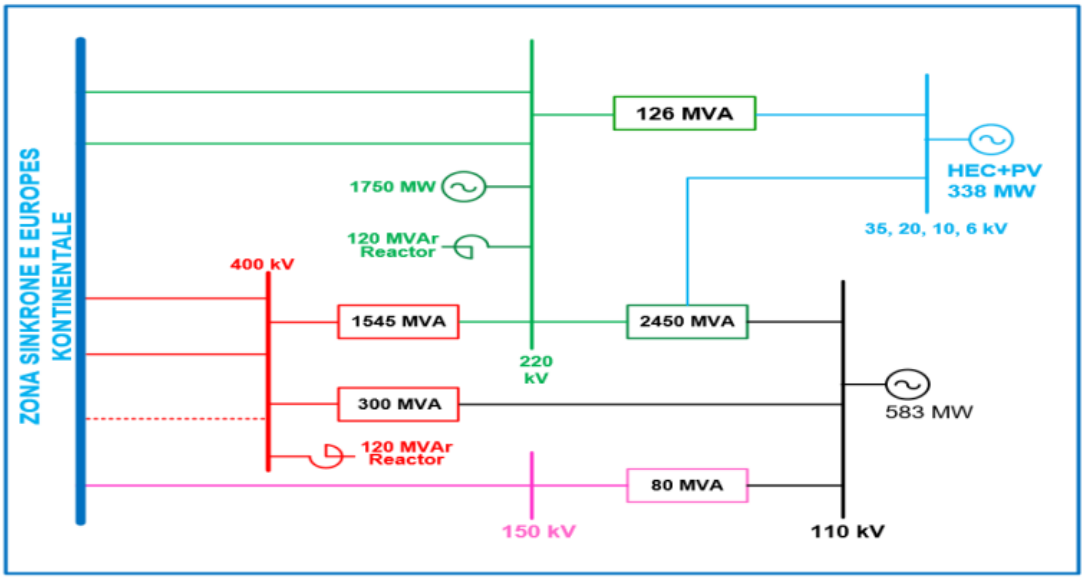
OST - Albania Transmission System Operator TSO - is one of the main stakeholders in the Albanian power system. The OST performs its responsibilities and duties as defined in the Power Sector Law and the Electric Power Market Model, as well as the respective regulatory framework.

OST is organized and structured for smoother running of business in accordance with the international standards, with the scope of its integration in the open international electricity markets being based on signing of the Treaty establishing Energy Community and in compliance with the rules approved by the Albanian institutions.

Albania Transmission System is composed of 400, 220, 154 and 110 kV transmission lines, whereby 110 kV lines are mainly used for the supply of the DSO.

The OST schematic diagram is presented as follows:

Ovaj naziv je bez prejudiciranja statusa i u skladu je sa Rezolucijom Saveta bezbednosti Ujedinjenih nacija 1244 i mišljenjem Međunarodnog suda pravde o deklaraciji o nezavisnosti Kosova.



ERE Report 2022

Fig. 3 – OST Transmission Schematic Diagram

The main Transmission System Network is composed of 220 kV and 400 kV lines.

- Transmission line 400 kV
- Transmission line 220 kV
- Transmission line 154 kV
- Transmission line 110 kV
- Interconnection line 220kV Fierze (Albania) – Prizren (Kosovo)
- Interconnection line 400kV Koman (Albania) – Kosovo B (Kosovo)
- Interconnection line 220 kV Koplik (Albania) – Podgorica (Montenegro)
- Interconnection line 400 kV Zemblak (Albania) – Kardia (Greece)
- Interconnection line 400 kV Tirana 2 (Albania) – Podgorica (Montenegro)
- Interconnection line 154kV Albania - Greece.

The total technical losses of the transmission system network amount to around 2%, while the annual electricity transmission index increased to around 3 - 4 %.

The lack of control and managing system based on advanced digital technology was one of the main causes that threatened the security of the system and the optimal running of the power system. The dispatching is, in a way, defining the way of economical and optimal running of the electrical power system based on the generation and exchange of electric power.

The digital control and dispatching system were implemented in 2014, when the new dispatching centre and the expanding of the OST data communication and information system were put into operation, as planned, within the new National Dispatching Centre (NDC) with supervisory control and data acquisition (SCADA).

A very important issue of maintaining the electric power exchange balance with the neighbouring countries in accordance with the defined program profile remains, which is automatically arranged through the closed circuit secondary regulation (LFC) provided by the new SCADA system.

Considering that the additional power capacity in Fieri and Vlora regions should be around 450 MW, OST is upgrading the 220/110 kV infrastructure and it has planned to construct 400 kV transmission line, enforcing the capacity to 450 MW for the Net Transfer Capacity (NTC) with North Macedonia in both directions. OSHEE (DSO) is connected to the power lines with 110 kV primary transformers within Distribution Substation, where the energy measurement systems are installed.

OSHEE – Albanian Distribution System Operator (DSO)

OSHEE - Albania Distribution System Operator DSO, is the entity that fulfils the Albanian Power System responsibilities and duties as defined in the Power Sector Law and the Electric Power Market Model and the regulatory framework.

OSHEE is a state company and it is restructured in accordance with the standards defined by the Government and international institutions, with the scope of its integration in the open international electricity markets being based on signing of the Treaty establishing Energy Community and in compliance with the rules approved by the Albanian institutions.

OSHEE is responsible for ensuring the safe and sustainable development of the distribution system, as well as the maintenance and safe operation of the electricity distribution system throughout the territory for which it is licensed.

In accordance with the Law no. 43/2015 "On Power sector", it will cover losses in the distribution network through the procurement of the electricity in the open market and from renewable sources, in accordance with the regulation approved by the Licensing & Monitoring Department of Energy regulatory entity (ERE) and through the electronic platform for electricity purchasing procedures.

OSHEE is organized into 11 distribution areas and 42 agencies.

OSHEE owns the assets in the electricity distribution system, for the purpose of delivering electricity to customers. The assets include all 110/35/20/10/6 kV Distribution Substations (with a total capacity of 2576 MVA) which are part of OSHEE (DSO). The schematic diagram of Albania Electrical Power System and the grid interfacing between the system’s operators is shown in Fig. 4.

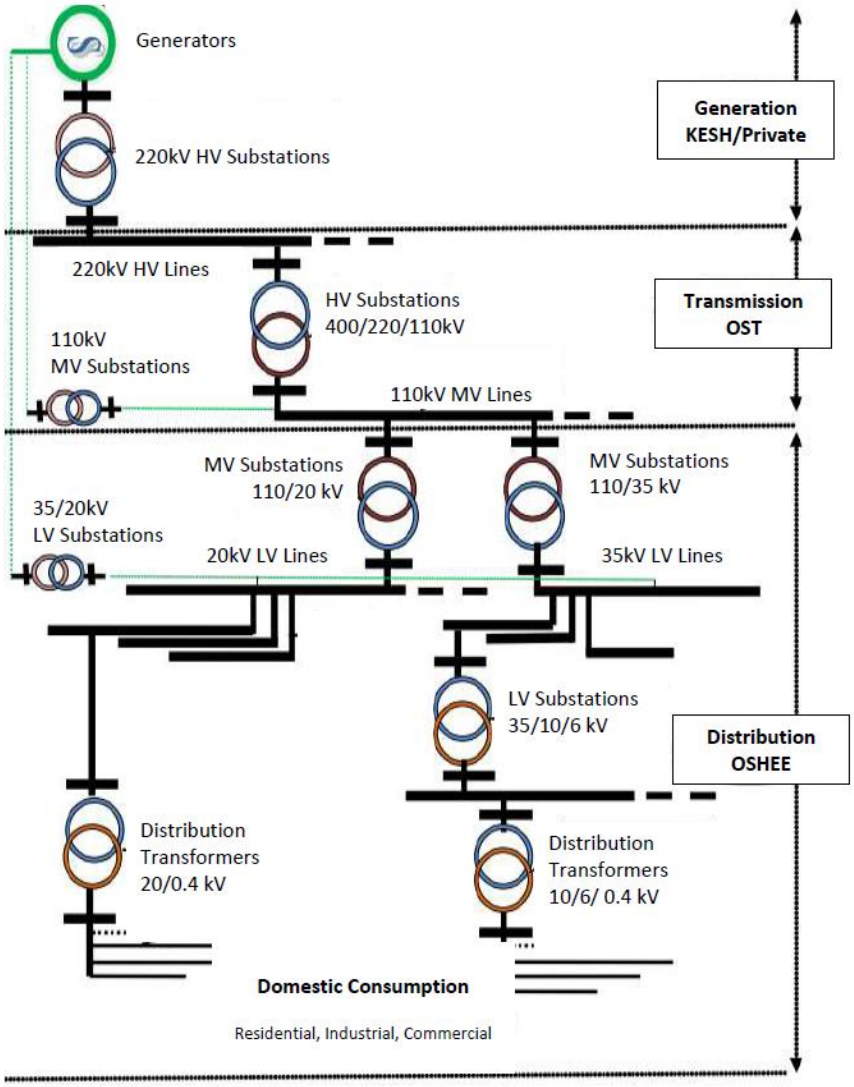


Fig. 4 – Electrical Power System Schematic Diagram[3]

Solar and Wind energy potential in the Republic of Albania

The country has the significant potential for electricity production from various renewable energy sources but currently it relies on hydropower for almost all its electricity, which creates difficulties when water flows are low.

The Government of Albania has recently adopted new electricity market laws and is conducting a process of opening that market for competition. From the view of the investment prospective in Albania, the significant renewable solar energy resources and technologies are described as follows.

Based on the potential, technical and practical (realistic) estimation of the energy and the power capacity for the different resources and technologies, the following Table 1 presents the summary data of the generation and power capacity in Albania.

[3] ERE Report 2022

RES Power	Generation GWeh/y	Equivalent (ktoe/y)	Power MWt	Power MWe
PV Photovoltaic Large scale	1,200	103	-	480
PV Photovoltaic Roof scale	180	15.5	-	72
Concentrating Solar Large scale	335	103	480	134
Solar Water Heat scale	630	180	840	-
Onshore Wind	2,000	172	-	800
Offshore Wind	3,600	310	-	1,440
Lake Offshore Wind	50	4.25	-	20
Tidal Current	1,500	128	-	300
Hydro	12,381	1,061	-	2,817
Geothermal	16	4.8	7	2
Biomass & Biogas	1,280	376	550	160
Total	**23,171**	**2,458**	**1,877**	**6,227**

Table 1. Renewable Energy & Capacity Summary Data[4]

In addition, solar energy generation in Albania may benefit from projected decrease in cloudiness, as it is estimated that output from solar power could increase by 5% by 2050, increasing the interest for the implementation of solar technology in the future (WB Report No. 53331 – Climate Vulnerability Assessment on 2009).

RES Power	Generation GWeh/y	Equivalent (ktoe/y)	Power MWt	Power MWe
PV Photovoltaic Large scale	1,260	108.15	-	504
PV Photovoltaic Roof scale	189	16.275	-	75.6
Concentrating Solar Large scale	352	108.15	504	140.7
Solar Water Heat scale	662	189	882	-
Onshore Wind	1,600	137.6	-	640
Offshore Wind	2,880	248	-	1,152
Lake Offshore Wind	40	3.4	-	16
Tidal Current	1,200	102.4	-	240
Hydro	9,887	848.8	-	2,250
Geothermal	16	4.8	7	2
Biomass & Biogas	1,280	376	550	160
Total	**19,365**	**2,143**	**1,943**	**5,427**

Table 2 - Climate Change Practical Energy & Power Estimation – Scenario 2050[5]

[4] TU Wien Country Module-Albania 2016 CSE
[5] Ibid

Referring to the proposed project terms, the main requirements and conditions shall be:

- The construction of renewable energy power plant (solar and/or wind) with a capacity of 100 – 150 MW to fulfil the frequency control requirements (FRR) during the unbalancing and incident intervals (see below).
- The new power plant shall be placed in the southern part of the country reducing the transmission losses and issue qualitative electrical parameters.
- The new power plant shall be connected to the transmission lines for the energy/capacity exchange 450MW with the neighboring systems.

Solar Power

Albania is located on the western part of the Balkans Peninsula, at the eastern coast of Adriatic and Ionian seas. It is situated between latitudes 39°38' - 42°38' and longitudes 19°16' - 21°04'.

Mediterranean climate is prevalent in Albania, with a hot dry summer, long sunny days and a mild winter with abundant rainfall, possessing in this way a considerable potential for solar energy production.

Most areas in Albania are exposed to more than 1,500 kWh/m^2 per year, varying from 1,185 to 1,690 kWh/m2 per year with maximum 2,200 kWh/m^2 per year.

The main constraints (altitude, site accessibility, infrastructures, nature protected areas, power grid) are applied to provide an estimation of the actual scope of the area exploitable for solar energy production. The following (positive and negative) constraints were considered:

- Elevation above sea level (areas lower than 500 m asl)
- Natural or protected areas
- Transport infrastructure (roads)
- Electric power supply systems (distance from the electric power supply system)

The potential land area for the PV photovoltaic as large-scale PV deployed, excluding areas not suitable for this technology, is calculated in total to 5,000 km^2 (Solar Radiation Map) and the technical area is calculated to 1,000 $km^{2,}$ placed in western parts of Albania (Fieri, Lushnja & Vlora areas) as well as the southern parts (Saranda area) (0 – 500 m asl).

Using the technical calculation for this technology, the technical parameter of the annual solar energy is estimated around 80 kWh/m^2 or 80 GWh/km^2.

The main solar large scale estimation data for the territory of Albania, are presented in Tables 3 and in Solar Irradiation and Power Potential Maps (Fig. 3) as follows:

Solar Power	Generation GWh/y	Power MWt	Power MWe
PV Photovoltaic Large scale	*1,200*		*480*
Fieri PV	375		150
Vlora PV	375	-	150
Berati -Lushnja PV	250		100
Saranda PV	200		80
Concentrating Solar Large scale	*335*	*480*	*134*
Fieri CSP	112.5	150	45
Vlora CSP	112.5	150	45
Berat-Lushnja CSP	75	100	30
Saranda CSP	35	80	14
Total	**1,535**	**480**	**614**

Table 3 – Solar Power Capacity Estimation[6]

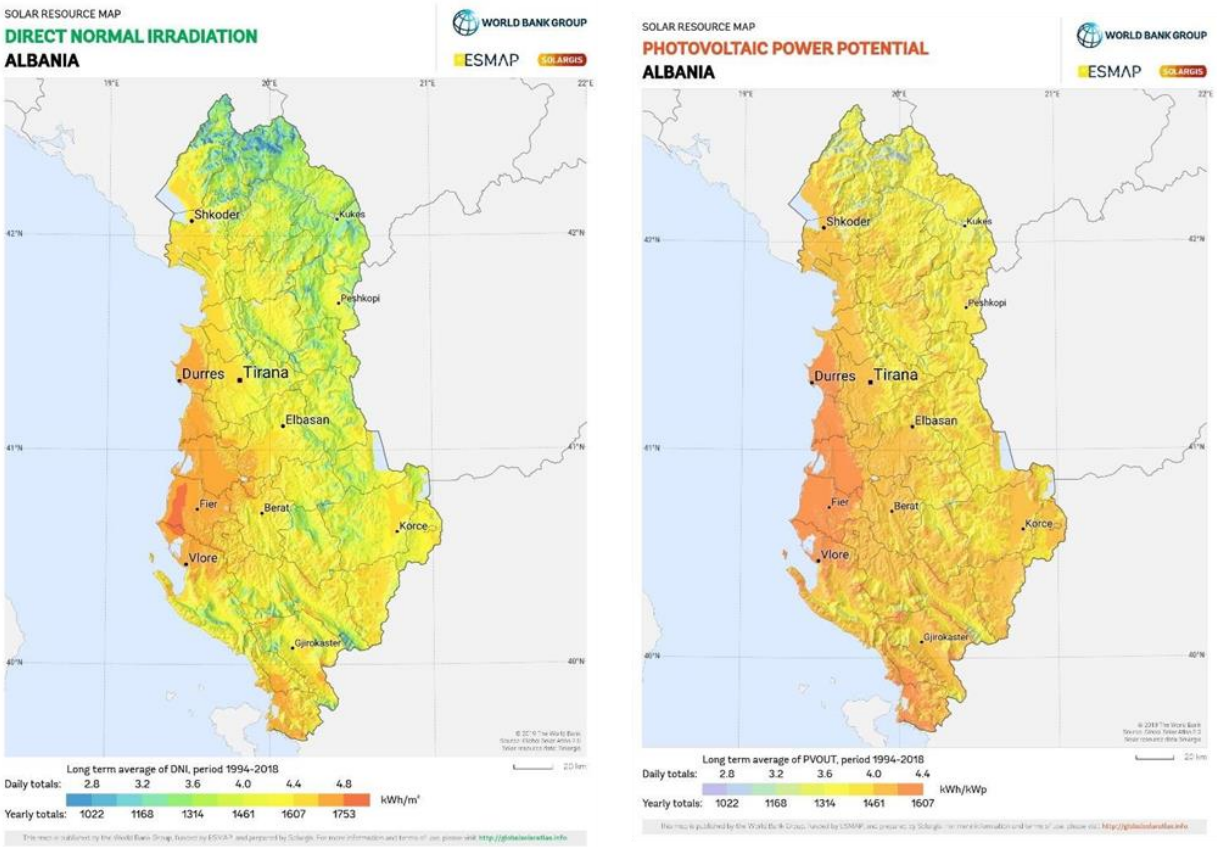


Fig. 5 – Solar Normal Irradiation and Power Potential

Wind Power

The potential onshore wind areas are the coastal and the lowlands of the eastern part, the hills of northern Albania and mountains of Southern and Eastern Albania. There are many areas that are identified, such as Shkodra, Kukes, Lezha, Durres, Kavaja, Fier, Vlore, Saranda, Korça and Tepelena.

[6] Ibid

The potential offshore wind area are practically entire Adriatic and Ionian coastlines (estimated to 362 km), with a distance 1.5 - 2 km from the seaside and at the height of 10-50 m, given as an economical estimation.

According to the study, the average onshore wind speed is around 6 m/s and the average offshore wind speed is 8 m/s at the height of 50 m. The wind maps show the potential area based on the wind speed data. The main directions of the wind are northwest-southeast and southwest-northeast, with dominant direction towards the land. In the mainland, the direction and intensity of wind from area to area varies depending on time.

The figure below shows the map of the simulated average wind speed at 50 m a.s.l. over the Albanian territory, where the potential areas of the western (onshore 5,000 km2) and coast parts (offshore 3,000 km^2) of the country are estimated as the good location for the wind energy generation.

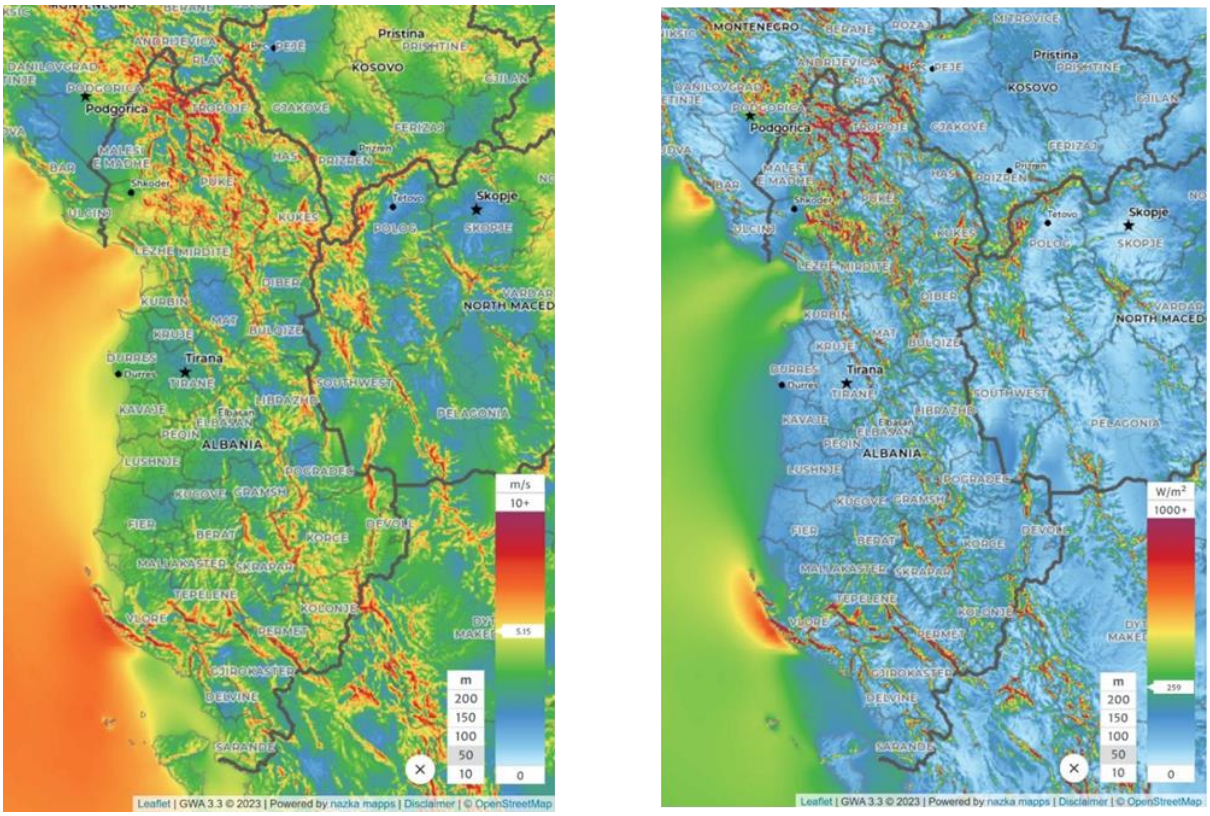


Fig. 6 – Wind Speed and Power Density Maps

Onshore Wind Large Scale

The potential onshore area for the wind farm as large-scale (excluding areas not suitable for this technology) is estimated around 5,000 km^2 (refer to Wind Speed and Hours Maps) and the technical area (with the turbines' distance between 250 m or 5 turbine/km^2) is estimated to 1,000 km^2 (i.e. 5,000 km^2/5 turbines), located in the western and southern parts of Albania (0 – 1,000 m asl).

Using the technical calculation for this technology suggests that the technical parameter of the wind turbine capacity should be 5 turbine/km^2 x 320 kW/km^2 (swept area 1600 m^2 x 200 W/m^2) for the sheltered terrain or 1.6 MW/km^2.

The annual power generation (2,500 hrs/y) is estimated to 4 GWh/km^2.

Offshore Wind Large Scale

The potential offshore area for the wind farm as large-scale (excluding areas not suitable for this technology) is estimated in total to 3,000 km^2 and the technical area (with the turbines' distance between 150 m or 5 turbine/km^2) is evaluated to 600 km^2 (3,000 km^2 / 5 turbines) placed in coast seaside part of Adriatic and Ionian seas (0.5 – 1 km from the seaside line).

The technical calculation used for this technology suggests that the technical parameter of the wind turbine capacity should be 5 turbines x 480 kW/km^2 (swept area 1600 m^2 x 300 W/m^2) for the sheltered terrain or 2.4 MW/km^2.

The annual power generation (2,500 hrs/y) is estimated to 6 GWh/km^2.

In addition to the planned licensed projects and the results from the practical estimation of the renewable energy sources, the economical wind projects would be:

Wind Power	Generation GWeh/y	Power MWe
Onshore Wind Large scale	*2,000*	*800*
Vjosa valley	1,000	400
Drino valley	375	150
Shushica valley	375	150
Bulqiza	250	100
Offshore Wind Large scale	*3,600*	*1,440*
Adriatic coast	3,000	1,200
Ionian coast	600	240
Total	**5,600**	**2,240**

Table 4 – Wind Onshore & Offshore Estimation Power Capacity[7]

Proposed location of the new PV and Wind power plants in Albania

Based on the results, Albania has significant potential for the simultaneous development and implementation of wind power plants and solar power plants. Accordingly, both options will be looked at, but the final selection will take into consideration only the wind power plant.

The two proposing options are as follow:

-New PV Solar with BSS power plant

Based on the calculated data, the new solar power plant of 100 MWp is proposed to be built in the mentioned areas as a new potential renewable capacity in Albania (Fig. 5).

[7] TU Wien Country Module-Albania 2016

New Solar Power Plant

Location	**Fieri/Berat/Lushnje/Saranda Municipalities**
Capacity	**100 MWp**
Generation	**175,000 MWh/a**
Electricity export rate	**55.00 €/MWh**
Total initial costs	**100,000,000 €**

The new offshore wind farm of 100 MW is proposed to be built in Adriatic/Ionian coastline areas (1.5-2 km from the seaside and in front of Fieri County, as a new potential renewable capacity in Albania (Fig. 8).

New Wind Offshore Power Plant

Location	**Adriatic/Ionian Coastline**
Capacity	**100 MW**
Generation	**306,600 MWh/a**
Electricity export rate	**55.00 €/MWh**
Total initial costs	**150,000,000 €**

Fig. 7 – Solar Power Plant Location Areas

CSE Source 2016

Fig. 8 – Wind Onshore & Offshore Power Plant Location Areas

Wind and PV power plants grid connection should be at 220 kV level at Babica 2 substation (Wind plant) and Hoxhara 220/110kV substation (PV plant).

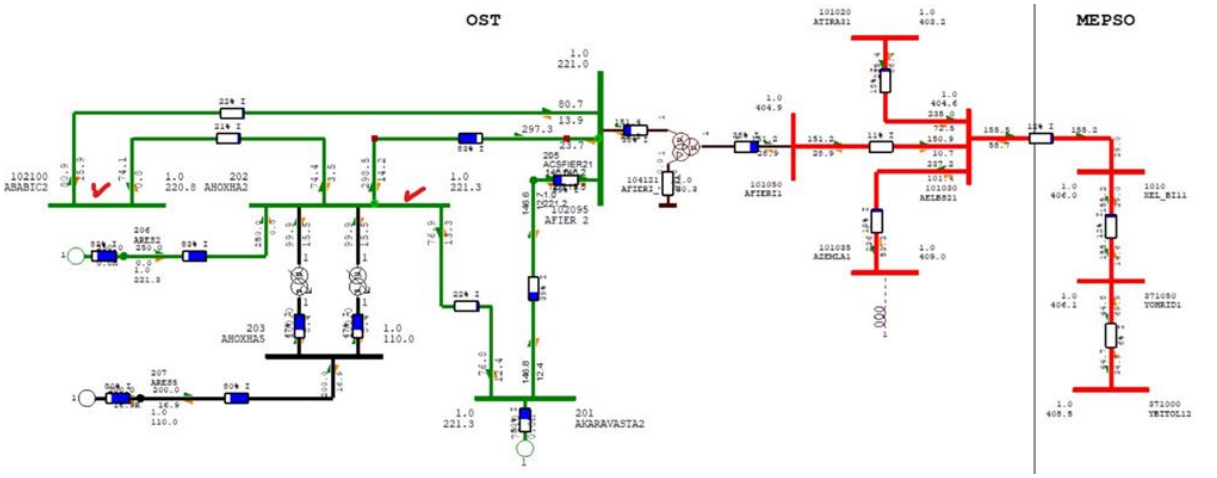


Fig. 9 – Albania – North Macedonia Grid Interconnection[8]

Procedure for Development and Construction of PVs and Wind Power Plants

Permitting Procedures

Environment

The environmental permit is required for any type of power generation installation. The competent authority for the approval of the environmental permit is the Ministry of Environment (MoE), and the National Environmental Agency (NEA). The activities requiring a permit fall into two categories, depending on whether there is an in-depth evaluation or a short-form evaluation to be performed under the guidelines set by the Law on Environmental Impact Assessment in Albania.

Territorial Planning

The mandatory process for construction approval begins with an application for approval of a development permit, which must be obtained before commencing any new development project. Under the Law on Territorial Planning, each and every natural or legal person, domestic or foreign, that intends to carry out a new project development in Albania, on private or public property for which they enjoy legal rights in accordance with Albanian law, must apply for a development permit for any land development, or development of the structures on it, or carrying out of works with regards to such structures.

[8] CIGRE – OST 2023

Building Permit

A building permit is required for new constructions, repair and restoration works, erection of temporary structures, or demolition of existing structures, except where the applicable legislation referenced above may otherwise provide. The building permit is only given upon completion of review and certification of compliance with the applicable building regulations and/or the stipulations contained in the development permit.

Use Permit

The use permit is issued if the records of control confirm the performance of works is in conformity with the permit conditions and safety requirements, according to the stages set forth in the development control regulations regarding, but not limited to, the foundation, framing, mechanical, plumbing and insulation works, finishing and outside systems.

The application for the construction of a new power plant consists of three phases:

a. initial evaluation of the documentation submitted with the application for the CoM - Council of Minister Approval;
b. issuance of the preliminary authorisation, which allows the applicant time for the preparation of key project development documentation;
c. issuance of the CoM Approval.

The foreign entities that have established an Albanian subsidiary or a representative office in accordance with the Albanian law are eligible to apply for the CoM Approval. The decision provides that at least two percent (2%) of the annual electricity generation (fee) generated by the power plant shall constitute a royalty under the licence. In addition to the above, CoM Approval may provide an obligation for the project developer to sell a certain amount of electricity to KESH Gen (WPS), which is the wholesale public supplier of electricity in Albania.

Concession Right

In order to obtain a concession right to exploit natural resources that are publicly owned (such as hydro, wind or solar power), a tender procedure must be organised to ensure the selection of concessionaire with the best proposal. The procedure is initiated either by a public authority or through a proposal submitted to the public authority by a private entity. The proposal may be granted “bonus” points, which are considered during the selection of the best proposal for the award of the concession. The tender is evaluated by comparing the technical, financial and commercial proposals, taking into account the:

1. technical soundness of the bid;
2. compliance with environmental standards;
3. operational efficiency;
4. quality of services and the existence of measures ensuring their continuity;
5. social and economic development potential offered by the proposals;
6. present value of the proposed tolls, unit prices and other charges over the concession period;
7. present value of the proposed direct payments by the contracting authority;

8. costs for design and construction activities, annual operation and maintenance costs;
9. present value of investments and operation and maintenance costs;
10. extent of financial support, if any, expected from a public authority of the Republic of Albania;
11. soundness and viability of the proposed financial arrangements.

The Council of Ministers may also determine any additional criteria, depending on the importance of the specific sector for the development of the economy investment volume and employment level, priorities for the development of particular areas of the country, and other sector-specific indicators, as well as the proposed price or fee.

Licensing

The Law on Energy 43/2015 provides that the exercise of the following exhaustive list of activities in the electricity sector requires a licence for:

1. electricity generation;
2. electricity transmission over electricity networks;
3. electricity supply at retail and wholesale;
4. electricity trade within Albania or abroad.

Energy licence is mandatory for the activities of electricity generation. However, no licence is required for the operation of a self-supporting facility not connected to the power system. For such purposes, stakeholders must establish and maintain a company in Albania for the entire period of validity of the applicable licence. The validity of the Energy Licence may not exceed thirty (30) years. The application for obtaining the licence is submitted to the Licensing & Monitoring Department of Energy regulatory entity (ERE).

Guarantee of Origin

The guarantees of origin are issued by ERE for:

1. all the electricity generated from hydro power sources, on an annual basis (less energy used for the pumping reserves);

2. annual electricity generation from biomass, wind power, solar power, and geothermal sources;

3. the amount of energy produced in cogeneration systems if the amount of energy from non-renewable sources does not exceed five percent (5%) of the total energy generated.

The issuance of the guarantees of origin requires that the power plant generating renewable energy is previously qualified as such by ERE. The qualification procedure lasts up to ninety (90) days.

Power Purchase Agreement

Two types of Power Purchase Agreements (PPA) are stipulated:

1. regulated PPAs, where mandatory content is set forth by ERE;

2. non-regulated PPAs, where the parties enjoy a high degree of flexibility in negotiating the terms and conditions of the agreement, being bound, however, to observe the mandatory provisions of the Market Model and of the Market Rules passed by ERE.

The purpose of the regulated agreements is to protect the tariff consumers against the risk of market price variations. Therefore, there are some legal limitations applicable to regulated PPAs, such as the price for the sale of electricity from the producer to the wholesale public supplier.

Carbon Credits

In order to facilitate the Clean Development Mechanism (CDM) scheme, Albania has passed the necessary legal framework consisting of:

1. Council of Ministers Decision No.1553/2008 "On establishment of the Designated National Authority Clean Development Mechanism, within the framework of implementation of commitments under the Kyoto Protocol"

2. Regulation of the Ministry of Environment No.1/2009 "On the evaluation procedures and approval of Clean Development Mechanism projects."

Albanian Electricity Market

The Albanian Electricity Market (AEM) aims to provide the possibility of development in the electricity market. It is fully compliant with the EU directives and it is expected that it will provide a more enduring structure than was previously in place.

The Albanian Electricity Market is monitored by the ERE as an independent institution. It has the authority to approve all necessary secondary legislations on these matters, as well as to establish the rules for transparent and non-discriminatory conduct by all involved parties. It is also responsible for developing a tariff system that protects the consumer and for increasing the efficiency of the market in general, as well as over-seeing the integration of the Albanian Electricity Market, first into the regional market and then into the European Electricity Market.

Under the Power Sector Law, ERE has the responsibility and authority for defining and reviewing the rights and obligations of market participants and providing regulatory oversight to the Albanian Electricity Market. The Market Rules are to be read in conjunction with Generation, Transmission and Distribution Codes as well as the Metering Code.

The following participants are compliant with the Market Rules:

Transmission System Operator (TSO) – is the market operator and it is responsible for the organization and administration of electricity payment settlements among the market

participants, for balancing the market; maintaining a process for all parties to comply with the Market Rules; maintaining accounts on behalf of trading parties for balancing energy and the services provided; managing the imbalance settlements statement process.

Distribution System Operator (DSO) – is the only distribution system operator on the market and it owns, maintains, expands and operates the distribution system throughout Albania.

Renewable Energy Operator (REO) – is the market operator and it owns, maintains, expands and operates the renewable energy applied to the end users.

Wholesale Public Supplier (WPS) - a Wholesale Supplier purchases the electricity supply required by tariff customers and sells this supply to the Retail Public Supplier.

Retail Public Supplier (RPS) – a supplier that purchases wholesale power from Wholesale Public Supplier and sells this power to tariff customers.

KESH Gen – is compliant with the Market Rules in the capacity of market participant and operates in accordance with Transmission Code, it nominates output levels in accordance with the Transmission Code and Market Rules; sells ancillary services to OST, including energy to cover the transmission losses; sells electricity to Wholesale Public Supplier to the extent required to meet the load of Tariff Customers (subject to ERE approval); sells excess of electricity on the regional market according to rules and procedures approved by ERE; submits meter reading information for all energy delivered into the Transmission System and/or DSO; undertakes all other obligations as set out in the Market Rules.

This market has the following protagonists:

Albanian Power Exchange (ALPEX) - the organized platform for the sale and purchase of electric power, based on the day-ahead and / or within the same day;

Electric Power Market – a system where sales or purchases are carried out effectively, including the electric power derivatives, through bids and offers, submitted in long term and short term periods;

SEE CAO – the Coordinated Auction Office in the South East Europe, established in Podgorica, Montenegro, and that has the authority of conducting the auctions of transmission capacities of the TSOs participating in this office;

Contract for difference (CFD) - a standard agreement, approved by the Council of Ministers, through the renewable energy operator and the producer of electric power from renewable sources, which has been declared as the successful bidder in the auction to get operational assistance and investments;

Balancing Responsible Parties (OST/BSP) - all legal entities that, in accordance with this model and legislation in force, are responsible for their forecast of generation and consumption;

Balancing Service Parties - any legal entity that, in accordance with this model and the legislation in force, provides balancing services to the TSO;

Financial Contracts OTC (Over-The-Counter) - financial transactions for the sale/purchase of electric power, not carried out through the electric power exchange.

All market participants shall be licensed or otherwise authorized by the ERE to participate in the electricity market.

Albanian Balancing Market

The purpose of the Albanian Balancing Market (ABM) is to:

- establish the market management in balancing the power system operated by OST,
- define the relations between the market participants on the balancing market,
- enable balance responsibilities for market participants (BSP),
- define the rights and responsibilities of balance service providers,
- create the mechanism for determining the price of balancing services, calculating imbalance settlement price and financial settlement of imbalances of Balance Responsible Parties.

The objective is to establish an efficient, transparent and non-discriminatory balancing mechanism that allocates balance responsibilities and incentivize market participants to perform balancing, as well as to offer balancing services.

OST - Albanian Transmission System Operator is responsible to maintain the system security and its balance. For this purpose, it will procure the balancing services from the Balancing Service Providers (BSP) in order to ensure operational security. It is responsible to minimize the procurement cost of the balancing service by contracting and activating the most cost-efficient reserves. It defines the size of the balancing reserves needed and it applies a self-dispatching model for determining generation schedules and consumption schedules. OST is obliged to maintain in balance the power system by not causing discrepancies on the network to guarantee the regulated financing regarding the balancing services in conformity with the definitions of the Methodology for Calculating the Electricity Transmission Tariffs. The complete needed balancing reserve volume is procured on the market, in transparent, and non-discriminatory manner.

KESH Gen – Albanian Power Corporation is a state company that is responsible for the electricity supply to the Distribution System Operator (OSHEE). The company has the right to purchase the electricity for the consumption, and together with OST, they both represent the main players at the electricity market, having the right to organize auctions to purchase the electricity for consumption, imbalance, balance and auxiliary services.

Referring to the companies' last year data, the results as follows:

KESH Gen Purchasing price (Dec 2023):
- min 98 EUR/MWh
- max 128 EUR/MWh

OST Imbalance Volume/Average Price (Jan 2023):
- Negative 25,220 MWh / 119.06 EUR/MWh
- Positive 37,600 MWh / 18.77 EUR/MWh

OST Balance Average Price:
- min 96.64 EUR/MWh (Jan 2023)
- max 46.35 EUR/MWh (Dec 2023)

The new proposed power plants shall cover and compensate the system balance in capacity and prices.

The **BSP** is the market participant with its reserved generation or capacity able to provide balancing services to OST. After BSP approval within eight weeks, an agreement shall be signed with OST, containing a list of the technical units to be used to provide the balancing service. All the technical units must pass the technical unit prequalification that proves their capability to meet the technical and organizational requirements defined by the OST.

Based on the real-time data exchange between the BSP's SCADA systems and OST, the OST defines a list of exchange information. This list is specified in the Specification of Operational Rules. The commitment to maintain the grid frequency at an acceptable level has four balancing products.

Based on 99% threshold, the BSP shall provide any one of these frequency control services as follows:

- FCR is set to +/-5 MW,
- aFRR is set to +/-45 MW,
- FRR (aFRR + mFRR) capacity is 150 MW as largest unit capacity (Komani HPP).

For the dimensioning incident the following capacities are calculated:

- 150 MW of positive FRR
- 100 MW of negative FRR

The regional balance system will play an important role as a last resort reserve with low cost in the proper time requested.

Area Control Error - ACE should be inside the range of +/-20 MW, and it amounted to 89.4% in 2018.

Average ACE was almost zero: 0.77 MW, while total range was generally very narrow, with few short extreme periods between –225 MW and +555 MW (Fig. 10).

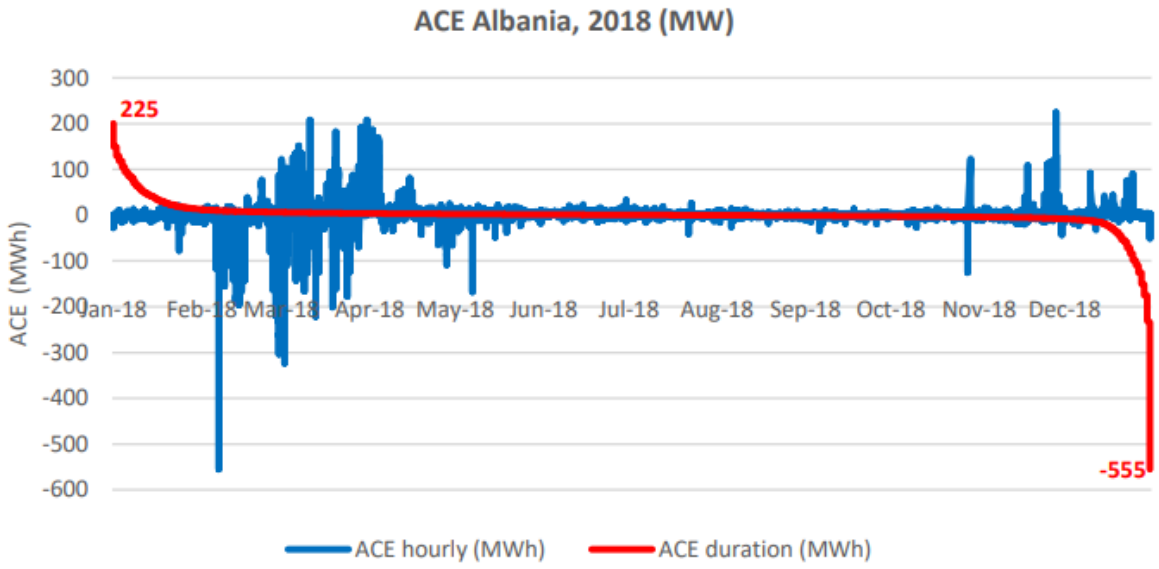


Fig. 10 – Area Control Error 2018 (MW)[9]

[9] USAID 2019 – Metthode for Cross Border exchange of Power System Reserve between Albania & Kosovo

NORTH MACEDONIA

Power system of North Macedonia

The electric power system of North Macedonia consists of generation, transmission, and distribution capacities (see Fig. 1). The largest electricity producer is AD ESM (100% state ownership). There are other independent producers of electricity, the largest of which is TE-TO AD Skopje, a combined power plant that generates electricity and thermal energy. AD MEPSO (100% state ownership) is the transmission system operator in the Republic of North Macedonia. There are two distribution systems in the Republic of North Macedonia. One distribution system, which is very small and in the Energetika industrial complex near Skopje, is operated by AD ESM, while the other distribution system (99% of the total distribution network in the country) is operated by AD EVN (part of the EVN Group from Austria).

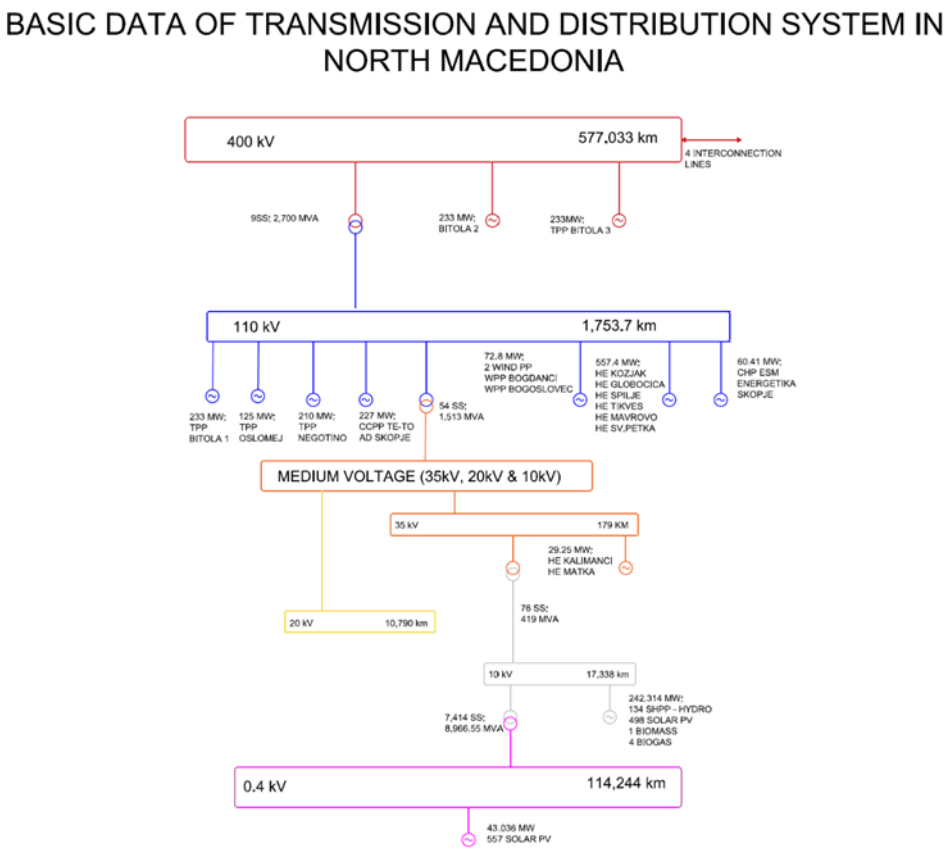


Fig. 11 - Basic data of transmission and distribution system in North Macedonia

Generation and consumption of electrical energy in the Republic of North Macedonia

Electricity in the Republic of North Macedonia is generated from thermal power plants, which as primary energy sources use: lignite, fuel oil and natural gas, as well as power plants that use renewable energy sources: water, wind, solar energy, biomass and biogas. The total installed capacity of power plants in 2022 was 2,266 MW.

In the total installed capacity, thermal power plants have the largest share with 45.63%, followed by hydro power plants with 31.73%, CHP for the generation of electrical and thermal energy with 12.68% and all the rest with 9.99%. The following table shows the installed capacity and electricity generation in 2022:

Producer	Number of units	Installed capacity (MW)	(%)	Generation of electrical energy (GWh)	(%)
AD ESM	**15**	**1,478.61**	**65.25%**	**3,754.99**	**66.64%**
TPP	4	824.00	36.36%	2,621.64	46.53%
HPP	8	557.40	24.60%	985.18	17.48%
WPP	1	36.80	1.62%	107.66	1.91%
CHP	2	60.41	2.67%	40.51	0.72%
TPP Negotino	**1**	**210.00**	**9.27%**	**412.62**	**7.32%**
TPP	1	210.00	9,27%	412.62	7.32%
CCPP TE-TO AD Skopje	**1**	**227.00**	**10.02%**	**926.81**	**16.45%**
CCPP	1	227.00	10.02%	926.81	16.45%
EVN Power Plants	**15**	**62.56**	**2.76%**	**147.67**	**2.62%**
SHPP	11	58.56	2.58%	142.87	2.54%
PV	4	4.00	0.18%	4.80	0.09%
Other	**591**	**288.04**	**12.71%**	**392.77**	**6.97%**
SHPP	113	103.04	4.55%	269.35	4.78%
PV	472	139.40	6.15%	72.04	1.28%
Biogas	4	9.00	0.40%	51.38	0.91%
WPP	1	36.00	1.59%	-	0.00%
Biomass	1	0.60	0.03%	-	0.00%
TOTAL	**624**	**2,266.21**	**100%**	**5,634.86**	**100%**

Table 5 – Generation capacities in North Macedonia[10]

The net consumption of electrical energy, i.e. the consumption of electrical energy by end consumers in 2022 was 6,133 GWh. The total losses of electrical energy in the power transmission system and power distribution systems in 2022 amount to 972 GWh. Gross electrical energy consumption, which included net electrical energy consumption and electrical energy losses for 2022, was 7,105 GWh. In 2022, 79.37% of gross electrical energy consumption was provided by domestic electrical energy generation, while 20.63% was provided by imports. The balance of electrical energy needs (in GWh) in 2022 are given in the following table:

[10] Annual Report of the Energy, water services and municipal waste management services Regulator Commission of the republic of North Macedonia for the year 2022 https://www.erc.org.mk/odluki/2023.04.26_RKE%20GI%202022-FINAL.pdf

Electrical energy consumption in 2022	GWh
Gross consumption	**7,105**
Net consumption	**6,133**
Direct consumers connected to the transmission network	643
Regulated supplier	3,754
Other distribution consumers	1736
Losses	**972**
Transmission	114
Distribution	858
Net import	**1,471**
Import dependence	**20.70%**

Table 6 - Electrical energy consumption in 2022[11]

The structure of net electricity consumption in 2022 is given in the following table:

Consumers connected to 110 kV	643.38
MV 1	315.70
MV 2	885.89
LV.1.1 – Public lighting	69.42
LV 1.2	423.04
LV 2 Households	3,083.24
LV 2 - Others	712.35
TOTAL	**6,133.02**

Table 7 – Number of consumers per category[12]

Transmission network

The transmission system of the Republic of North Macedonia is connected to the transmission systems of the neighbouring countries, except Albania, through five 400 kV interconnections, namely with:

- Kosovo through the 400 kV transmission line TS Skopje 5 - TS Ferizaj 2 (Uroševac);
- Serbia through the 400 kV transmission line TS Shtip - TS Vranje 4;
- Bulgaria through the 400 kV transmission line TS Shtip - TS Mogila;
- Greece through two 400 kV transmission lines TS Bitola 2: TS Meliti and TS Dubrovo – TS Thessaloniki.

This connection increases the reliability and stability of the transmission network, but also of the power system. In the future, the construction of a new 400/110 kV substation near Ohrid

[11] Ibid
[12] Ibid

is planned, as well as the construction of a new 400 kV line to Albania, which will connect the electric power system of the Republic of North Macedonia with all neighbouring systems and enable more reliable and stable operation.

Distribution network

The distribution network in the Republic of North Macedonia consists of lines at 110 kV, 35 kV, 20 kV, 10 kV and 0.4 kV voltage levels, as well as transformer stations TS 110/(20)10 kV/kV, TS 110 /35/(20)10 kV/kV/kV, TS 35/10 kV/kV and TS 10(20)/0.4 kV/kV. The total length of the distribution network is 29,650 km, of which 99.42% or 29,480 km are managed by EVN Elektrodistribucija, while AD ESM Skopje owns and manages 170 km of the electricity distribution network. Out of the total number of consumers, which is 899,155, the number of household consumers is 795,284.5, while 103,871 are remaining consumers.

By the end of 2022, the distribution network had a total of 217 prosumers connected with a total installed power of 3.036 kW. The largest number of them, or 149, with an installed power of 2.681 kW are legal entities, and the remaining 68 with an installed power of 355 kW are households.

Solar energy potential in the Republic of North Macedonia

The average solar radiation in North Macedonia is 3.8 kWh/m^2. The average daily solar radiation varies between 3.4 kWh/m^2 in the northern part (Skopje) and 4.2 kWh/m^2 in the south-western part (Bitola). Depending on the geographical zone conditions where the meteorological stations are placed, total annual solar radiation varies from 1,250 kWh/m^2 minimum in the northern part, to 1,530 kWh/m^2 maximum in the south-western part, which leads to 1,385 kWh/m^2 average annual solar radiation. In terms of seasonal performance, the average energy generation per day for each kilowatt of installed solar capacity varies between 7 to 7.5 kWh during summer months and 5.1 to 5.8 kWh in spring, reflecting a higher level of sunlight exposure, while autumn and winter months yield lower outputs (3.3 - 3.5 kWh and 2 - 2.3 kWh respectively) due to shorter daylight hours. The optimal tilt angle for fixed panel installations is aligned at a southward inclination of 35 - 36 degrees to maximize Sun exposure throughout the year. Seasonal optimal till angle is 26° south in summer, 46° south in autumn, 56° south in winter and 34° south in spring.

The climatic characteristics of this region, including high intensity and duration of solar radiation, temperature, and humidity, provide favourable conditions for the successful development of solar energy. Its continental climate with hot and dry summers makes North Macedonia a country with a higher potential for utilization of solar energy than average European countries.

Fig. 12 and Fig. 13 represent Global Horizontal Irradiation and Photovoltaic Power Potential in North Macedonia.

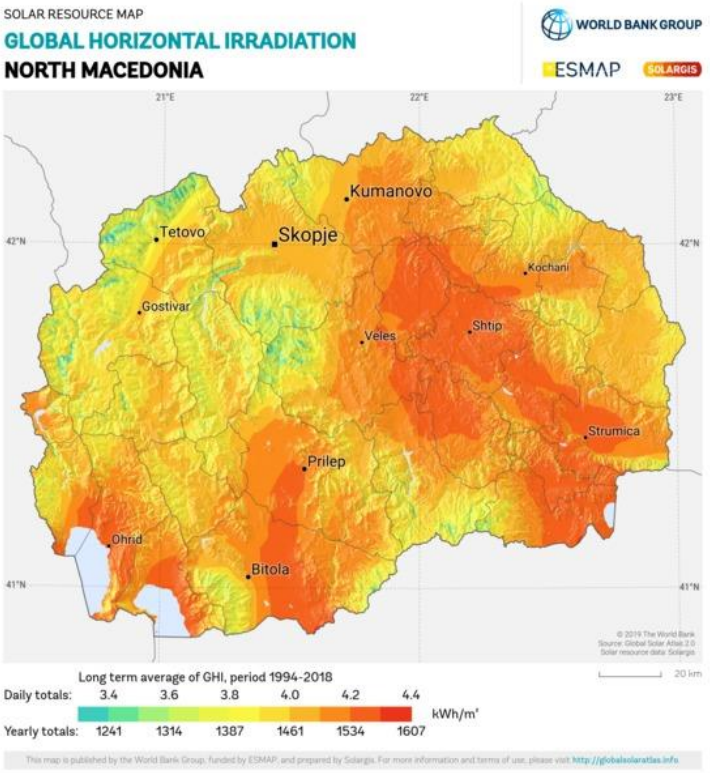


Fig. 12 - Global Horizontal Irradiation in North Macedonia

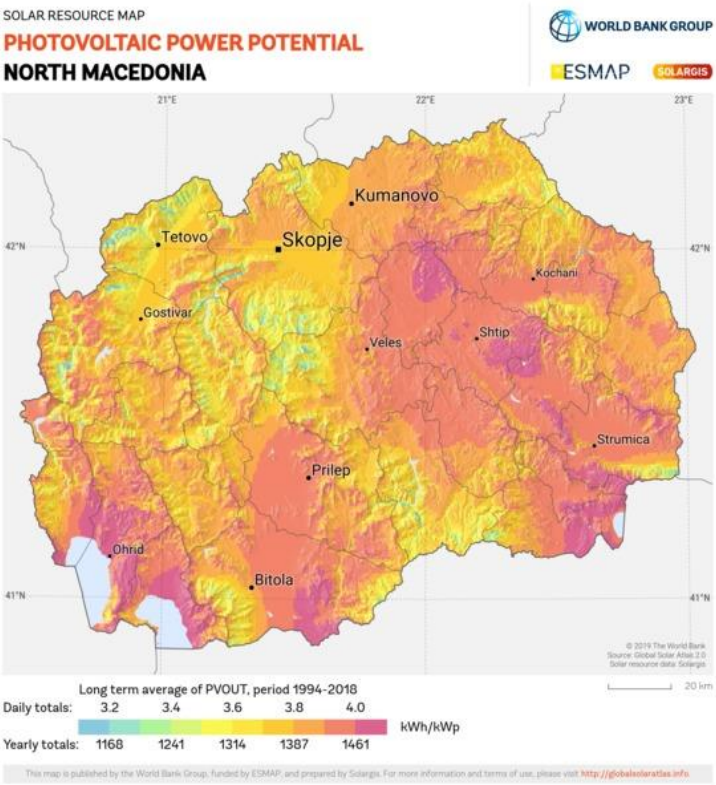


Fig. 13 - Photovoltaic power potential in North Macedonia

Proposed location of the new PV power plant in North Macedonia

The construction of RES capacities in North Macedonia has advanced quickly over the past two years. In 2022, the total installed capacity of RES was calculated at 944.5 megawatts (MW), representing an increase of 16 per cent compared to 2021 and 17 per cent compared to 2020. This trend is expected to continue, since both the transmission system operator (TSO) and the distribution system operator (DSO) have received requests for installation of new capacities, exceeding 12 gigawatts (GW). The evaluation of RES development must consider its environmental implications. Selecting suitable locations for RES development can avoid disruptions to local wildlife and preserve arable land for its primarily intended purpose, agricultural cultivation. According to the study "Using barren lands and brownfields for solar and wind power developments in North Macedonia: Study and methodology" prepared by MANU (Macedonian Academy of Science and Arts) and "Accelerating a renewable future: using brownfields and barren lands for wind and solar energy siting in North Macedonia" prepared by Eko svest, the surface area of the best rated locations in North Macedonia for installation of PV power plants (those which have minimal impact on the environment, near the roads and power transmission network) equals to 14,347 ha, indicating approximately 11 GW of PVPP (Fig. 14 - the areas marked in dark red).

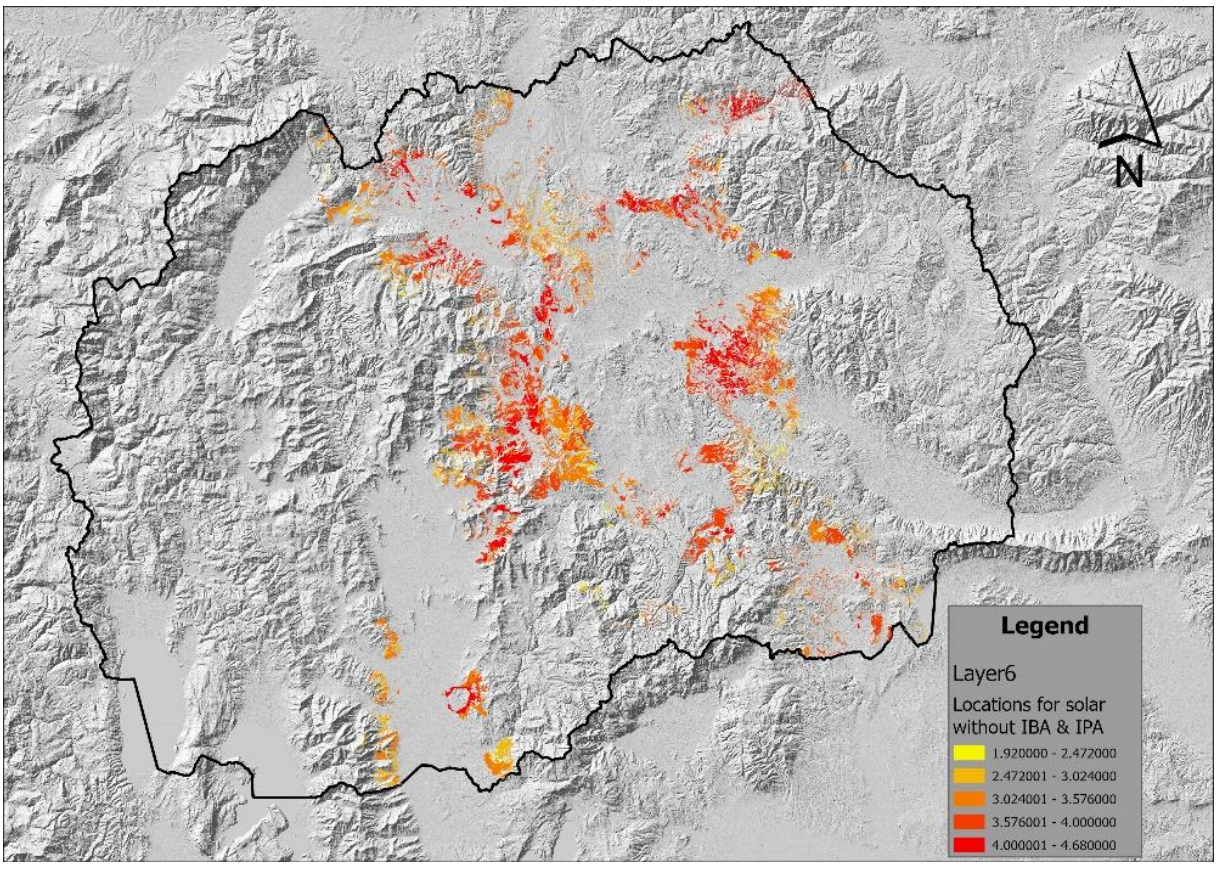


Fig. 14 – Evaluated best rated locations in North Macedonia for installation of PV power plants with minimal impact on the environment, near the roads and power transmission network

According to this, the proposed location for the new Photovoltaic power plant, from the point of view of the expert team, is in Bitola region in the southern part of North Macedonia, near the existing thermal power plant Bitola. This location is chosen by the experts since this region will be mostly affected by the energy transition process (according to the National Energy and Climate Plan (NECP) and Energy Development Strategy 2020-2040 coal phase-out, and since the decommissioning of the existing coal power plants was planned in the period 2021 (TPP Oslomej) and 2027-2029 (TPP Bitola)).

As previously stated, the investment in the construction of a new Photovoltaic power plant is planned to be in the region of Bitola, within the largest thermal power plant in Macedonia (picture below) and a region that will be most affected by the energy transition, so therefore, no costs are planned for the purchase of land.

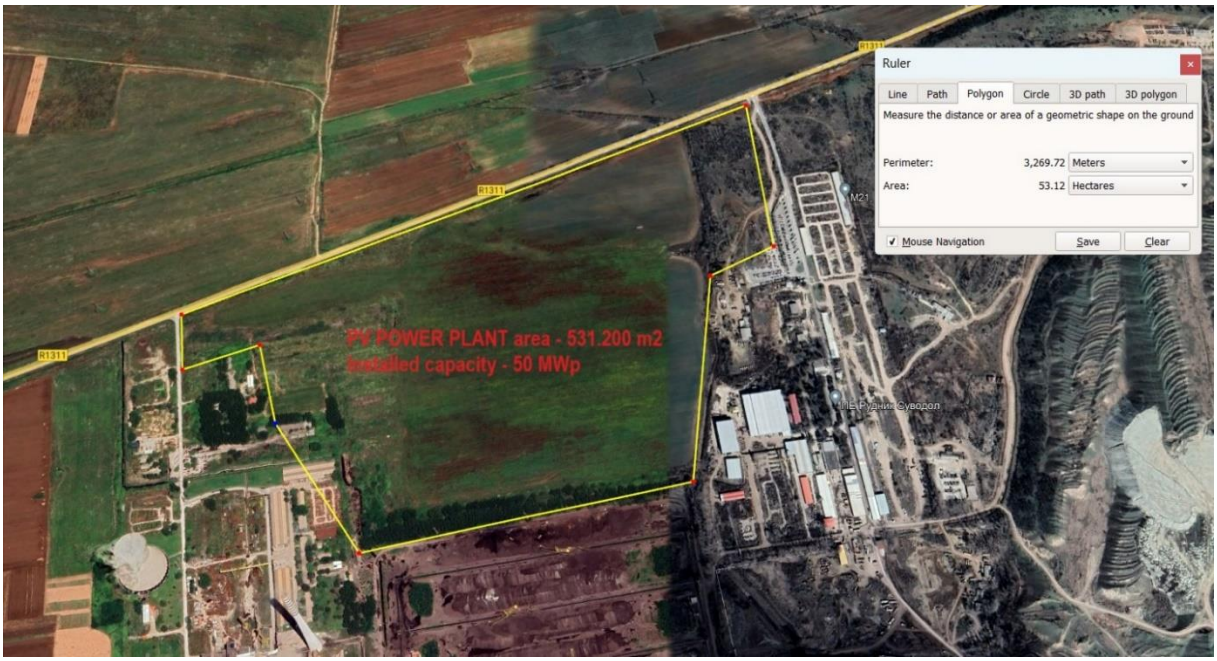


Fig. 15 - Place of PV capacity in North Macedonia

The only costs foreseen in relation to the land are the costs of land preparation for the construction of a photovoltaic power plant. These costs are expected to be around EUR 0.5 million.

The total installed capacity of the photovoltaic power plant would be 50 MWp, with an expected annual electricity generation of about 76,780 MWh, in the first years. Since photovoltaic panels also have a corresponding degradation coefficient, their generation for a period of 25 years (the lifetime of the power plant) is expected to decrease by 15%, that is, after 25 years, the expected generation of electricity would be about 65,260 MWh. For the entire period of 25 years, the planned photovoltaic power plant is expected to produce a total of about 1,763,497 MWh. The annual reduced emissions of CO2 would be at the level of about 33,150 tons.

According to the current market prices, the investment costs for the construction of the photovoltaic plant would be at the level of about EUR 500,000 per installed MWp, that is, the total costs would be about EUR 25 million. Since there is a large switching plant near the proposed location (just 1 kilometer away), where the proposed power plant could be connected, the costs for connection to the power grid are expected to be around EUR 1.5 million.

The total costs for installing the photovoltaic power plant with an installed power of 50 MWp, according to the previously stated approximations, would amount to about EUR 27 million.
If the planned investment is realized with 85% from loan funds (EUR 23 million), and the remaining 15% from own funds (EUR 4 million), with an interest rate of about 4.5%, for a period of 10 years, and the expected annual inflation level is at about 3.5%, the annual annuity would be about EUR 2,930,400. The maintenance and operating costs, according to current experiences, are planned to amount to about EUR 786,700, with an annual growth rate of about 2% for the entire life period. These costs include the annual salary costs of 15 locally employed persons, as well as the costs of replacing the inverters, as key components of the entire photovoltaic power plant after 15 years, i.e. their lifetime.

According to the analysed investment costs, loan annuities, maintenance and operating costs, as well as according to the expected generation of electricity from the photovoltaic power plant for a period of 25 years, the estimated levelized cost of electricity is 30.34 €/MWh.

In short format, previous numbers are as follows:

New Solar Power Plant

Location	**Bitola**
Capacity	**50 MWp**
Generation	**70,540 MWh/a**
Electricity export rate	**57.00€/MWh**
Total initial costs	**27,000,000 €**

Procedure for development and construction of PV power plant

Basic prerequisites: establishment of the company, authorization for construction and license to perform activity

According to the legal and by-law regulations in the Republic of North Macedonia, the construction of photovoltaic power plants and the generation of electricity can be carried out by domestic and foreign legal entities. The legal entity should be registered as a trading company in the Trade Register and the register of other legal entities maintained by the Central Register of the Republic of North Macedonia. If a photovoltaic power plant has a total installed power of less than or equal to 10 MW, it can be built without an "authorization for the construction of new facilities for the generation of electricity" issued by the Government

at the proposal of the Ministry of Economy (Law on Energy, Article 52). If, on the other hand, the installed power is greater than 10 MW, in that case "authorization for the construction of new facilities for the generation of electricity" is required.

The generation of electricity cannot begin before obtaining a license for performing an appropriate energy activity issued by the Regulatory Commission for Energy and Water Services of the Republic of North Macedonia (ERC). The license for performing energy activities is issued for a period of three to 35 years, depending on the type of energy activity, the type and extent of the obligation to provide public service in the performance of the energy activity, the amount of funds needed to perform the energy activity, the duration of the right to use/concession of the corresponding energy resource, as well as the specific request of the performer of the energy activity. The usual duration of the license for electricity generation is 35 years. The same person may be issued several licenses for performing one or more energy activities (Law on Energy, Article 38). The license is issued in the procedure described below.

If the land plot(s) on which the investor intends to build a photovoltaic power plant is classified as agricultural land (arable land, forests, pastures or similar), it must be converted from agricultural to construction land. For this purpose, the competent authority that, at the request of the investor, prepares the appropriate urban-planning documentation (the Ministry of Transport and Communications or the municipality in whose area the land is located) must request the Ministry of Agriculture, Forestry and Water Management to carry out a permanent conversion of the appropriate agricultural land into construction land (Law on Agricultural Land, Article 49). The duration of this procedure, which is carried out through the e-urbanism information system, depends on the complexity of the preparation and review of the project documentation. The Government, based on the proposal of the Ministry of Agriculture, Forestry and Water Management, decides to give consent for the permanent conversion of agricultural land into construction land. The costs of providing project documentation and conversion of the land are borne by the investor.

Unless the land plot(s) on which the Investor intends to build a PV power plant is privately owned, the Investor should establish a long-term lease right on government-owned construction land. This right is acquired through an electronic public auction or by direct agreement. The procedures are led by the municipalities, the municipalities in the City of Skopje and the City of Skopje, each in its area determined by Law or the Ministry of Transport and Communications as the competent state authority for performing the works related to the management of construction land owned by the Republic of North Macedonia. (Law on Construction Land, articles 46 – 73). If the land plot is privately owned, the investor and the land owner can jointly agree on the alienation, long-term lease or right to use the land.

Elaborate for environmental protection

Photovoltaic power plants are subject to the requirements for the preparation and submission of an Environmental Protection Elaborate to evaluate the impact of the activities on the environment. Hence, photovoltaic power plants cannot be built before obtaining the approval of the report in accordance with the Environmental Law.

The Report on Environmental Protection for activities and activities that are carried out on a larger scale should contain and be structured in the following way: General data, Type of report, Authority responsible for approving the report, Description of the project in which the activity or activity is performed, Description of the environment around the project location, Impact of the project on the environment; Environmental protection program; Conclusion; List of attachments; Statement.

The investor of the photovoltaic power plant submits the report to the Environmental Administration for approval, a body within the Ministry of Environment and Spatial Planning.

Construction/Building permit

A building permit is required for the construction of a photovoltaic power plant. The municipality on whose territory the photovoltaic power plant is planned to be built is responsible for issuing a building permit if the power plant has an installed power of up to 1 MW, while the Ministry of Transport and Communications is responsible for issuing a building permit for photovoltaic power plants with an installed power of over 1 MW (Building Law, Articles 57, 58).

With the building permit application, the following documents should be submitted:

- architectural-urban project certified by a competent authority,
- basic project (revised and approved),
- proof of right to build (ownership, right of use, long-term lease, concession),
- geodetic report for numerical data for construction land,
- authorization for the construction of buildings for the generation of electricity, if the photovoltaic power plant has an installed capacity higher than 10 MW.

The municipality or the Ministry of Transport and Communications, depending on the case, is obliged to review it and decide on granting a building permit within 15 days from the day of submission of complete and correct documentation. When considering the request, the competent authority submits the request for inspection of the basic project to the entities responsible for electricity, water, and sewage infrastructure. The entity responsible for electric power infrastructure is obliged within five days from the day of receipt of the inspection request to inspect the basic project and submit an opinion on whether the object can be connected to the appropriate electric power system.

Before receiving the building permit, the applicant must pay the construction land development fee; the building permit is issued within five working days from the submission of proof of payment for the arrangement of construction land. The request for obtaining a building permit is submitted and the building permit is issued in electronic form, through the e-permit for building information system. The building permit ceases to be valid if the applicant does not start the construction within 2 (two) years or does not build the object within 10 (ten) years, in both cases counted from the day the approval became valid. (Building Law, Articles 66 and 68).

Consent for connection to the electric power system

Depending on the installed power and the location of the generation capacity, the photovoltaic power plants are connected to the transmission or distribution network. The request for connection is submitted after obtaining the building permit.
The following documents should be submitted in addition to the request:

- Document for registration in the Central Register,
- Basic project for the generation facility that is to be connected to the network,
- Extract from a cadastral plan with existing buildings drawn,
- Building permit,
- Coordinates of the location where the generation plant will be installed, and
- Technical characteristics of the generation facility.

The transmission and distribution system operator has the obligation to pass a Decision on consent for connection to the electricity system. The issuance of the Decision on consent for connection to the electricity system is accompanied by signing the Agreement for connection and use of the network. The connection costs are borne by the investor, and the transmission or distribution system operator is obliged to install a metering device at its own expense.

License for generation of electricity

The conditions for issuing a license for the generation of electricity from renewable sources are found in the Law on Energy and the Rulebook for Licenses adopted by the ERC.

In accordance with the Rulebook on Licenses, in addition to the request, the Investor shall also submit other requirements to the ERC.

If the request and the attached documentation are incomplete, the ERC will oblige the requester within 20 days to remove the identified deficiencies.

After publishing the announcement about the submitted request, the ERC will schedule a preparatory session that should be held within 30 days from the day of receipt of the complete request. If the ERC determines from the conclusions of the preparatory session, as well as from the documentation, that the conditions for issuing the license are met, it will schedule a regular session within 10 days to decide on issuing the license. The ERC publishes the decision in the "Official Gazette of the Republic of North Macedonia" and on its website.

Registration of the facility in the register of power plants producing electrical energy from renewable energy sources

The investor must register the photovoltaic power plant in the Register of power plants that produce electricity from renewable energy sources, maintained by the Energy Agency. For this purpose, the investor should submit a request to the Energy Agency for registration in the Register.

If the Energy Agency, based on the request and accompanying documentation, determines that there are no obstacles to registration in the Register, it will issue a decision on the registration of the power plant in the Register within 30 days from the date of submission of the request. The Energy Agency performs an on-site inspection of the power plant for which registration is requested before issuing the decision. The Energy Agency delivers to the investor the decision for registration in the Register within three days from the date of adoption of the decision. The investor is assigned a registration serial number that cannot be changed or transferred (Regulation on renewable energy sources, article 20).

Participation on the electricity market

The producer that does not use a preferential tariff is obliged to:

- sell the produced energy on the electricity market,
- register as a participant in the wholesale electricity market in accordance with the Electricity Market Rules and
- assume balancing responsibility in accordance with the Rules for balancing the electricity system.

North Macedonia electricity market – MEMO national operator of the electricity market

The national operator of the electricity market - MEMO DOOEL, Skopje was founded in August 2018 as a result of the adoption of a new Law on Energy that came into force the same year. MEMO is a company fully owned by the Operator of the electric transmission system in the Republic of North Macedonia - A.D. MEPSO. In October 2019, MEMO was licensed to organize and manage the electricity market by the Regulatory Commission for Energy and Water Services and thus began to function independently as an operator of the electricity market on the territory of the Republic of North Macedonia. According to the Decision of the Government adopted in September 2020, MEMO is appointed as the Operator of the organized electricity market.

Currently, trading on the organized electricity market managed by MEMO can be conducted on the day-ahead segment, while the intraday market is planned to be delivered in the next period. The trading on the organized electricity market is conducted in accordance with the Rules for Operation of the Organized Electricity Market. These rules consist of the General Rules for Operation of the Organized Electricity Market, Operational Rules, Clearing and Financial Settlement Rules for the Organized Electricity Market, and the Code of Conduct. The day-ahead market allows for trading products for physical delivery in the Macedonian electricity market, as defined in the Operational Rules. These products can be traded by registered participants of the market, which involves a registration procedure outlined in the Operational Rules. MEMO member list consists of a wide range of companies (more than 30 companies) involved in the wholesale electricity market, no matter if they are domestic companies or foreign branches that operate in the Macedonian electricity Market. They can be Producers, Traders, Suppliers, or even Operators like Transmission System operator or Distribution System operators. Apart from them, end users who are part of the Register of

Electricity Market Participants could participate as well, where they will purchase electricity for their own needs.

Clearing of the organized electricity market – day ahead segment in Macedonian market area is governed according to the rules for operation of the organized electricity market – Clearing & Financial settlement rules for the organized electricity market. MEMO Ltd uses a multilateral clearing mechanism to act as CCP and to provide clearing services and ensure the financial security of transactions concluded on our market.

Base load prices of electrical energy on the power exchanges in our three countries in the period May 2023 - Feb. 2024 are:

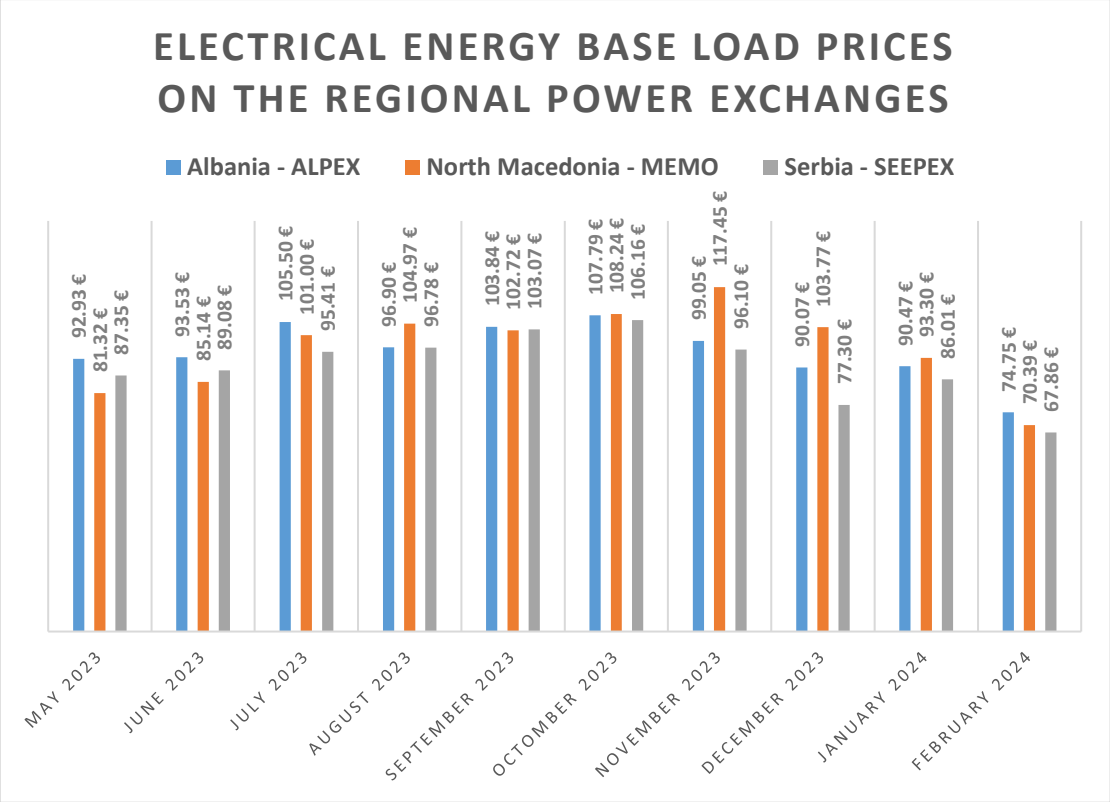


Fig. 16 – Electrical energy base load prices on the regional power exchange

SERBIA

Power system of Serbia

The electric power system of Serbia consists of generation, transmission, and distribution capacities (see Fig. 17) managed by companies that are 100% state-owned. These companies include Joint Stock Company Elektroprivreda Srbije (**JSC EPS**), Joint Stock Company Elektromreža Srbije (**JSC EMS**), and Elektrodistribucija Srbije (**EDS**).

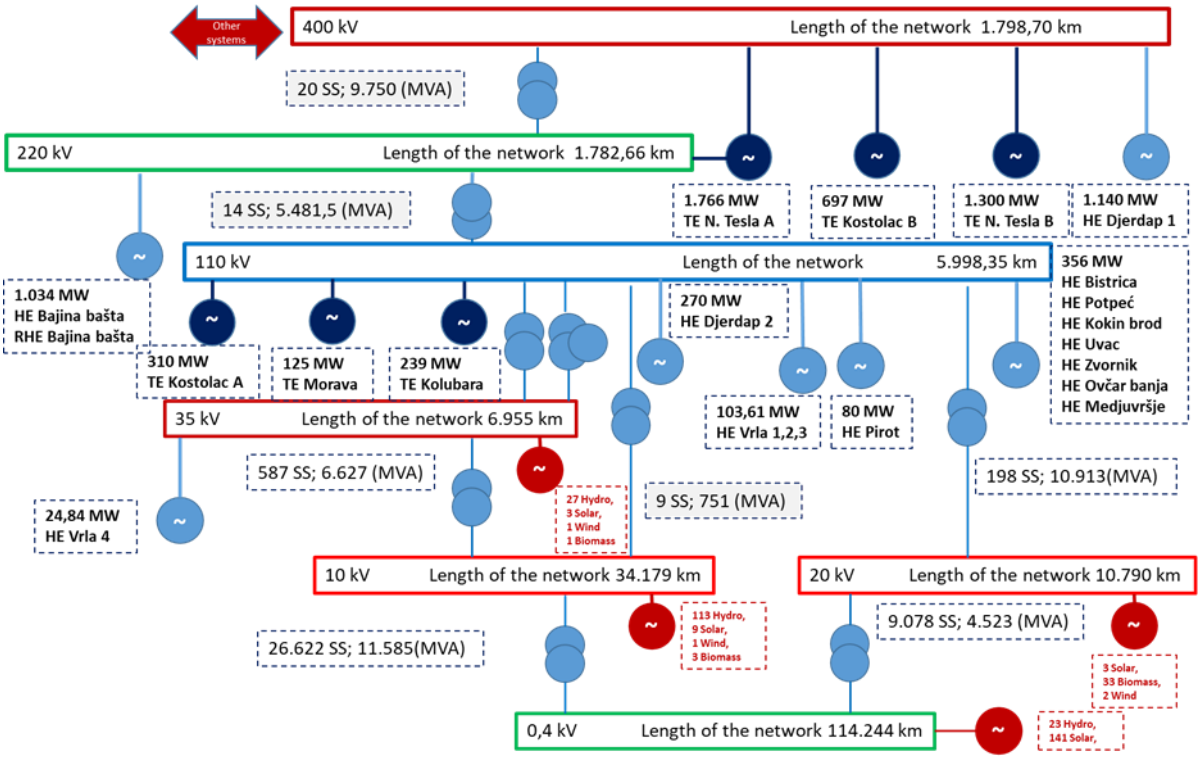


Fig. 17 - Serbian power system

Generation and consumption of electrical energy in Serbia

JSC EPS comprises 22 thermal blocks, 49 hydro units, 1 reversible hydroelectric power plant with 2 units, and 1 pumping station with 2 pumps. The average annual generation in the period from 2010 to 2020 was 34,896 GWh of electricity. **The electricity generation capacities managed by EPS have a total power of 7,855 MW. The generation mix consists of thermal power plants, which generate around 70% of the electrical energy, while approximately 30% comes from 16 hydroelectric plants.** The maximum annual generation of plants managed by EPS, observed since 1990, was achieved in 2013 - 37,433 GWh of electrical energy. For slightly more than 30 years, Elektroprivreda Srbije has not built any new generation capacity. Currently, there is an ongoing construction of a 350 MW capacity at Kostolac B and a 66 MW wind park at the ash and slag landfill in Kostolac. EPS is also responsible for supply and trade of electricity.

In the course of 2022, JSC EPS sold a total of 32,876,875 GWh of electricity to its end customers, namely:

- on guaranteed supply 14,639,069 GWh,
- on commercial supply 18,173,884 GWh,
- on reserve supply 63,922 GWh.[13]

On the free market - commercial supply, with JSC EPS, end customers can freely choose to conclude a supply contract under which JSC EPS, as a supplier, in addition to supplying electricity, undertakes to provide them at a specific price a certain share of renewable energy within the electricity sold, based on the Declaration on the use of the guarantee of origin.

All used guarantees of origin for the consumption of end customers refer to 100% of hydropower.

Transmission system operator

The function of the transmission system operator is assigned to JSC EMS, which conducts it through the 400 kV, 220 kV, and 110 kV networks. The boundary between the transmission and distribution systems is established at the 110 kV switchgear in the substation 110/x kV/kV. In addition to the generation capacities of EPS connected to the transmission system, there are also generation capacities of private investors. Currently, four wind farms with a total installed capacity of 391.8 MW are connected, while 79 investors have submitted connection requests.[14] Among them, 28 are for solar power plants with a total installed capacity of 3,675.5 MW, 45 are for wind farms with a total installed capacity of 7,433.3 MW and 5 are for hydro power plants with a total installed capacity of 154.6 MW. The remaining request concerns 1 mixed character (solar/wind) with a total installed capacity of 150 MW.

Distribution system operator

The distribution system operator is assigned to EDS, which distributes energy to consumers through 110 kV transformers, 35 kV, and 10 kV networks to 0.4 kV voltage. The total annual delivered energy is 30,130,229 MWh, with losses amounting to 3,379,699 MWh, approximately 11.22%.[15] The distribution network is diverse and characterized by long lines in the west, south, and east of the country, with relatively low consumption. In contrast, there is an exceptional concentration of both consumption and power lines in the Belgrade area. The northern part of the country features a well-planned and developed network with the lowest losses in electricity delivery.
Although the separation took place in accordance with EU directives, the state of Serbia is the owner of all three legal entities. Their functioning is coordinated in accordance with market principles and the price of electricity, as well as the technical rules defined by the Rules of

[13] https://www.eps.rs/lat/snabdevanje/Stranice/izvestaji.aspx
[14] https://ems.rs/wp-content/uploads/2024/03/20240329-proizvodjaci-Spisak-prikljucenja.pdf
[15] https://elektrodistribucija.rs/o-nama/informacije/dokumenta/GI_2022.pdf

operation of the distribution and transmission system. They are approved by the Energy Agency of the Republic of Serbia.

What is important to emphasize is that electricity generation surpluses occur during the summer period, while electricity shortages occur during the winter period, when there is a need for additional imports. The amount of imported energy varies depending on various factors (number of days with low temperature, emergency conditions of certain parts of the system, etc.), but in the last 5 years it averaged to about 4.6 % of the total generation.[16]

Wind energy potential in the Republic of Serbia

The wind atlas serves to identify a wider area where there is a possibility of using wind energy. To determine a specific location for the construction of a wind park or farm (wind farm), specialized measurements of wind characteristics at several heights above the ground are necessary, as well as measurements of other meteorological variables: temperature, pressure and air humidity. There are certain rules for setting up the wind measuring station and for the orientation of the sensor on the measuring pole, as well as for the method of data collection and recording. Depending on the used sensors and data processing system, the measurement of wind speed and direction is performed within one or several seconds. Based on these measurements, the mean values of the measured values for each 10-minute period are determined and recorded. These ten-minute values are stored in digital form, and their subsequent statistical processing provides important data for evaluating the energy.

If we look at the wind map that defines the potential of this resource for the generation of electricity, we can conclude that at heights above 150 m there is an acceptable wind potential that can, depending on the selection of turbines as well as the micro locations where their installation is planned, be used for the generation of electricity.

The figures show the quantities used as indicators of wind potential, namely:

- The mean wind speed index – a base index representing the average values of wind speed at 10-m height over relatively long timescales (e.g. seasonally or annually).
- Wind Power Density (WPD) is a quantitative measure of wind energy available at any location. It is the mean annual power available per square meter of swept area of a turbine and is calculated for different heights above ground.

[16]Due to the failure of the generation system in 2021, the year 2022 was not taken into consideration (https://www.eps.rs/cir/Pages/tehnicki-izvestaji.aspx).

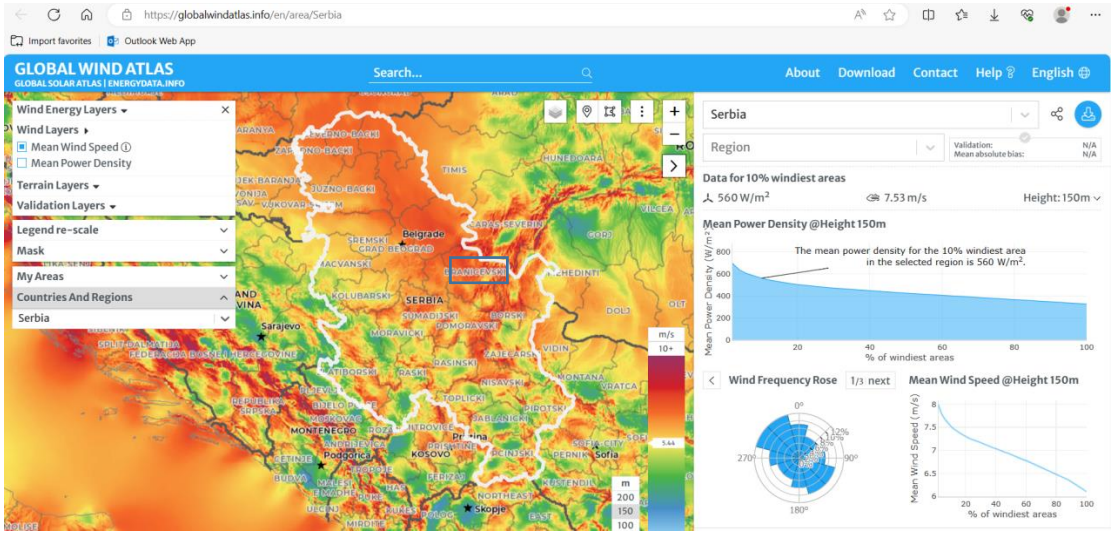


Fig. 18 - Mean wind speed index

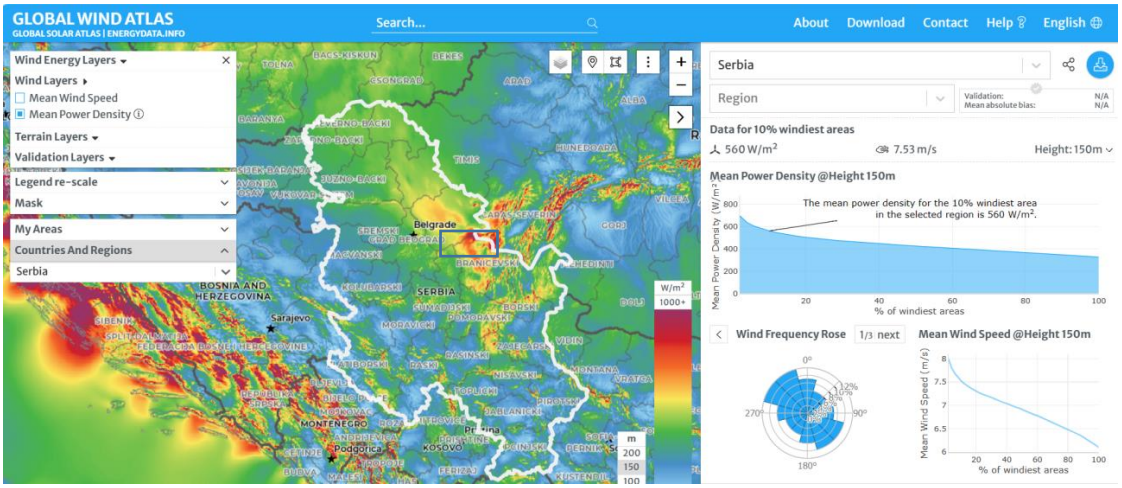


Fig. 19 - Wind Power Density

As the windiest area in Serbia, the so-called Košava area, which covers the Danube, from Slankamen to Golubac, and from Smederevska Palanka to Zrenjanin. Wind power in the Danube area in the winter months (heating season: October - March) exceeds 500 W/m2. Apart from Košava, certain mountain areas also have good potential.[17]

The best locations for the construction of wind farms in Serbia are (Marković, 2010):

1. Eastern parts of Serbia - Stara Planina, Vlasina, Ozren, Rtanj, Crni Vrh, etc. In these regions, there are locations with an average wind speed of over 6 m/s.
2. Zlatibor, Kopaonik and Divčibare are mountain areas where suitable micro locations for the construction of wind generators could be determined by measurement.
3. The Pannonian plain, north of the Danube, is also rich in wind. This area covers about 20000 km² and is suitable for the construction of wind generators because the road infrastructure has been built, there is an electrical network, the proximity of large centers of electricity consumption, and the like.

[17] Energy Potential Study, 2004

Proposed location of the new wind power plant in Serbia

Wind potential of the micro location

The Kostolac basin is located in the eastern Danube region of Serbia, north of the town of Požarevac and south of the Danube river, and it occupies an approximate area of 200 km^2. It is characterized by thermal power plant complexes and coal deposits, as well as the important archaeological site of Viminacium, as well as human settlements in local communities (villages).

The suitability of the Kostolac basin for the development of a wind farm park is reflected in the following characteristics: the locality has a solid wind potential with a dominant south-east wind direction, the road network preliminarily meets the possibilities of delivering equipment (optionally, it is also possible to deliver equipment by water), the existing power network offers opportunities for connection to the park, nature protection zones are located only in the smaller north-eastern part, while the rest of the dominant part of the basin is industrialized, and there are positive circumstances for installing new electric power capacities.

The limitations of the basin location for the development of wind farms are manifested through: the presence of populated areas (the noise of wind generators is one of the main reasons why wind farms are not installed near populated areas), the debatable quality of the soil's bearing capacity (large parts of the area are ash dumps from the last decade's thermal power plant activities), large areas which are marked by the spatial plan of special purpose areas as zones of coal exploration and exploitation (and it will not be desirable to install wind generators on them), possible archaeological sites and the fragmented structure of property-ownership relations of the largest percentage of land.

In order to perform a more precise analysis of the resources at the given location, a measurement was carried out on 80 m poles over a period of three years, which gave the results shown in the following picture:

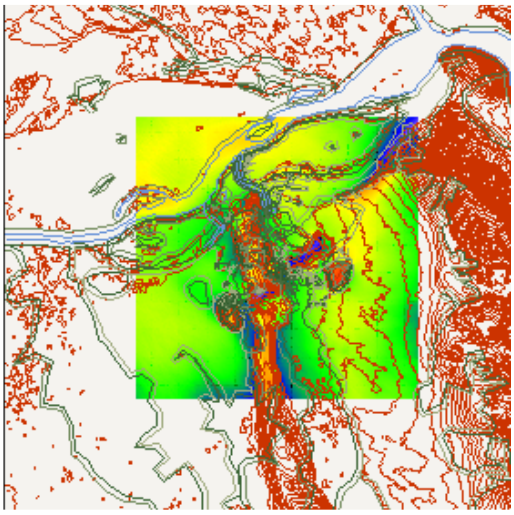


Fig. 20 – Graphic representation of wind resources in the Kostolac Basin

Technical and technological description of the wind power plant

The wind farm complex consists of the following functional sub-units:

- wind turbines representing generator units (consisting of rotor, nacelle, tower and foundation, voltage level 690V/35kV),
- internal cable networks (underground cable lines with a voltage level of 35 kV),
- transformer station 35/110kV with command and control building (through which the wind farm is connected to the transmission system for the purpose of placing the produced electricity and from where the operation of the power plant is managed), and
- access roads (physical access for equipment transportation, construction and installation of wind turbine and substation equipment; it may coincide with the route of the internal cable network partially or completely).

In the context of the above, it can be stated that the wind farm complex consists of infrastructural facilities for the generation of electricity (wind turbines), electricity transmission facilities (internal cable network and TS with administrative and command building) and traffic facilities (access roads) (Fig. 21).

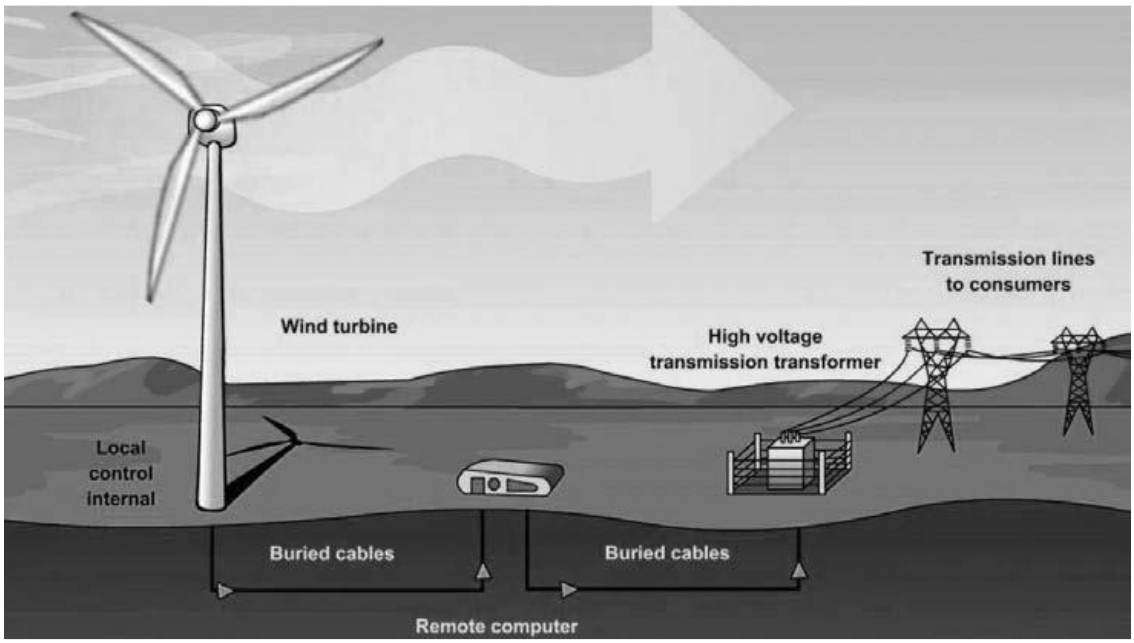


Fig. 21 – The principle of operation of the wind power plant

Spatial characteristics of the wind farm

The wind power plant complex is going to be located predominantly in the areas of external landfills and tailings in Kostolac, which were created as a result of mining activities. All functional units of the wind power plant are located on the territory of the municipality of Požarevac, within the cadastral municipalities (locality Drmno), Klenovnik (part of the locality Petka and part of the locality Klenovnik), Ćirikovac (part of the locality Petka and the entire locality Ćirikovac) and Kostolac selo (part of the locality Klenovnik). The mutual arrangement of wind turbines is determined by wind resources in order to maximize the use of primary

energy, and it varies in the range of about 300 to 1000 meters. The wind farm is located in the zone of the Spatial Plan of the special purpose area of the Kostolac coal bearing basin, which foresees the use of renewable energy sources with a previous evaluation of the justification of the construction of the wind farm based on the measurement of wind parameters.[18]

Fig. 22 – Spatial disposition of wind turbines within the wind farm in Kostolac

As previously mentioned, planned capacity of the new wind onshore power plant is going to be 66 MW at the following 4 locations:

- Drmno outside dump (7 wind turbines, substation SS 35/110 kV)
- Petka outside dump (3 wind turbines)
- Mined out open cast mine Klenovnik (6 wind turbines)
- Mlava – Mogila outside dump (4 wind turbines)

leading to the following results:

New Wind Offshore Power Plant

Location	**Kostolac**
Capacity	**66 MW**
Generation	**150,900 MWh/a**
Electricity export rate	**92.00 €/MWh[19]**
Total initial costs	**96,410,000 €**

[18] The previous justification study with the general project of the "Kostolac" wind farm park, May 2015

[19] Guaranteed for the period of 12 years by the Regulation on the conditions and procedure for acquiring the status of privileged electricity producer, privileged producer with temporary status and producer of electricity from renewable sources (Official Gazette of RS No. 56/2016). After this period, the electricity export rate will depend on the market conditions.

Procedures for development and construction of wind power plants

The planning of the wind farm park is defined, first of all, by the Law on Planning and Construction because it regulates the procedure for issuing construction and use permits for all types of construction facilities. The **Energy Law** and the **Law on the Use of Renewable Energy Sources** regulate specific issues related to power plants and are intertwined with the Law on Planning and Construction. In order to successfully prepare documentation, it is necessary to comply with both laws, as well as the related laws and accompanying decrees and regulations. In particular, it should be emphasized that the Transmission System Operator defines the method and procedure for connecting the wind farm to the transmission system.[20]

Law on Planning and Construction

This law regulates: the conditions and manner of spatial arrangement, the arrangement and use of construction land and the construction of buildings; supervising the implementation of the provisions of this law and inspection supervision; other issues of importance for spatial arrangement, arrangement and use of construction land and for the construction of buildings.

The Ministry of Construction, Transport and Infrastructure is responsible for issuing construction permits for wind farms. In accordance with Art. 131 of the same law, the general and conceptual design are subject to revision (expert control) by the commission appointed by the minister and, based on Art. 132. paragraph 2, the main project must be prepared in accordance with the report of the revision commission (a set of measures that must be applied during the preparation of the main project). Therefore, it is necessary to create project documentation that includes the general project with a preliminary feasibility study and submit it to the review committee, then create a conceptual project with a feasibility study, based on the report of the review committee, and submit it again to the review committee, and then prepare the main project in which the notes of the revision commission report should be implemented. The main project is subject to technical control, after which it is possible to submit documentation along with the request for the issuance of a building permit. The content and scope of the project documentation is defined by the rulebook that governs the preparation of the previous justification study and the justification study, the rulebook on the method of preparation of documentation for high-rise buildings, as well as related technical norms and professional practice. The general project is an integral part of the preliminary feasibility study, while the conceptual design is an integral part of the feasibility study.

Before obtaining a building permit, it is necessary to obtain a location permit issued by the same authority that issues a building permit (Art. 54, paragraph 3 of the Law on Planning and Construction). The location permit is issued on the basis of a planning document that foresees the possibility of building the facility for which such a permit is requested - in this case, wind farm parks, that is, facilities for the generation of electricity from renewable sources with a capacity of over 10 MW. For wind power plants, it is not necessary to form a building plot in the classic sense, but rather the benefits defined in Art. 69 of the Law on Planning and

[20] https://ems.rs/prikljucenje-na-prenosni-sistem/

Construction can be used, where it is necessary to take into account the conditions that, in certain cases, it is necessary to obtain special consents and resolve property-legal relations in terms of land purchase, land lease and, in certain cases, the establishment of easement rights, complete and incomplete expropriation.

Since the considered energy facility is a wind power plant (that is, a set of individual wind generator facilities with accompanying facilities) with an installed capacity of 66 MW, it is necessary to obtain an energy permit before obtaining a building permit (Article 27, paragraph 2 and paragraph 3, point 1 of the Energy Law). The energy permit is issued based on the data defined in Art. 31 of the Energy Law and they are contained in the documentation of the previous justification study with the general project. In addition to the energy permit, after obtaining the use permit for the facility, it is necessary to obtain an energy license for the generation of electricity for the wind farm because its installed capacity is more than 1 MW (Article 20, paragraph 4, point 1 of the Energy Law).

A simplified sequence of steps for obtaining the necessary permits is shown through the following points:

1. Development of a general project with a preliminary feasibility study
2. Obtaining an energy permit
3. Development of an urban plan based on a general project and a higher order plan
4. Adoption and entry into force of the urban plan
5. Obtaining a location permit
6. Development of a conceptual project with a feasibility study
7. Development of the main project with technical control
8. Obtaining a building permit
9. Construction of the facility
10. Development of the project of the derived state
11. Obtaining a use permit
12. Obtaining an energy licence

It should be emphasized that each of the previously mentioned points represents a separate process that can last from a month to a year or more and that it is recommended to perform several actions in parallel (if possible), in order to implement the investment in a realistic and reasonable time frame and so that the obtained permits do not expire.

Zones and conditions of protection

Due to their characteristics, wind farms must undergo an environmental impact analysis, primarily due to the aspect of noise and the possible adverse impact on birds and bats.

Depending on the selected wind generator equipment, their dimensions and amount of noise vary, as does the impact on the environment. As a rule, before the development of wind farm projects, it is necessary to request the opinion of the competent institutions in order to avoid their installation in zones where this is prohibited. After that, investigation works and almost always one-year monitoring of birds and bats are carried out, based on which further optimization of the project is conducted, from the aspect of environmental impact.

The noise problem that can occur in populated areas near wind power plants is assessed with software simulations that provide illustrative projections of whether the noise level in residential areas exceeds the permitted level. In practice, with typical wind turbine equipment, it can be expected that the distance between the object where people reside and the wind turbine noise source will be about 500 meters.

Process of connection to the transmission system[21]

The basic steps in the process of connecting the facility to the transmission system and part of the distribution system managed by Transmission system operator are:

1. Preparation of the Study of connection of the facility;
2. Preparation of planning and technical documentation and obtaining the necessary permits for the construction of the connection and the missing infrastructure;
3. Construction of the connection and missing infrastructure;
4. Approval for connecting the facility;
5. Checking the fulfilment of the conditions for connecting the facility;
6. Temporary connection of the facility;
7. Permanent connection of the facility

The procedure for making the study of the connection of the distribution system object to the transmission system is initiated by submitting a Request for the conclusion of the Contract on the preparation of the Study of the connection of the distribution system object to the transmission system, after which the transmission system operator will consider the Request and send the applicant a proposal for the Contract on the preparation of the Study of the connection of the distribution system object to the transmission system, in accordance with the conditions and deadlines prescribed by the Regulation. The studies are made in two annual intervals, from March 1 to June 30 and from September 1 to December 31, and accordingly, requests for the first mentioned interval are submitted no later than December 31, or July 31 for the second interval. The studies are delivered on the first day following the expiration of each of these intervals (unless otherwise defined by the act defining the terms of delivery of electric power supply). By creating the Study, all technical conditions defined by the rules on the operation of the transmission system are checked, which allow the generation facility of the defined installed power to be connected to the transmission system.

In accordance with the output results of the Study, the next step can be taken - Preparation of planning and technical documentation and obtaining the necessary permits for the construction of the connection and the missing infrastructure. This procedure is conducted entirely according to the Law on Planning and Construction, based on which two procedures are conducted - one for the generation facility and the other for the facility connected to the transmission system, the so-called Connection facilities. Hence, it is necessary to prepare complete documentation for the two facilities, which entails obtaining two building permits.

[21] A detailed explanation of the procedure for connecting to the transmission system can be found at https://ems.rs/wp-content/uploads/2023/11/Procedura-za-prikljucenje.07.11.2023-compressed.pdf

After obtaining the construction permits, the construction of the connection and the missing infrastructure begins. The process of building wind farms has its own specifics in relation to other projects. Special emphasis should be placed on the transport of equipment, which, with its dimensions, defines special transport conditions as well as accompanying logistics.

When the facilities are completed, the fulfilment of the conditions for the connection of the facility, which were previously defined by the Study, and the issuance of the Approval for the connection of the facility are approached. The output document is the Decision on approval for the connection of the Facility, as well as the Agreement on exploitation of the facility, which is signed between the owner and the operator of the transmission system.

The operator of the transmission system issues an act on the permanent connection of the distribution system object to the transmission system upon fulfilment of the conditions from Article 123 of the Energy Law.

Serbian electricity market (SEEPEX)

SEEPEX basic information

The SEEPEX a.d. Beograd (SEEPEX) is a licensed Market operator for an organized electricity market/power exchange established in the form of partnership between JSC EMS and SEPEX SPOT as a joint stock company. The roles and functions of SEEPEX entail organizing markets that are optional, anonymous and accessible to all companies satisfying admission requirements. The SEEPEX objective is to ensure a transparent and reliable wholesale price formation mechanism on the power market by matching supply and demand at a fair and transparent price and ensure that all transactions concluded at SEEPEX are finally delivered and paid.

SEEPEX provides a market place where exchange members send their orders to buy or sell electricity in determined delivery areas. Its role consists in matching these orders in a transparent manner, according to the public market rules which, among others, describe the priorities and algorithms used for the matching of the orders, with a mission that energy belongs to everyone.

According to the abovementioned, SEEPEX operates an organized electricity market, with the standardized electricity products and delivery within a time frame **day-ahead** and **intra-day** with the aim to offer these electricity products for trading in Serbia and in the South East European (SSEE) region.

Trading on SEEPEX is governed by the **Market Rules**. The Market Rules is composed of the **Exchange Rules**, the **Operational Rules** and the **Code of Conduct**.

The Exchange Rules, the Operational Rules and the Code of Conduct of the SEEPEX are of contractual nature. They form a contract between the exchange member and SEEPEX AD. They become applicable to the exchange member once the Exchange Member has signed the Trading Agreement.

The Exchange Rules govern the main decisions with respect to the exchange organisation and operation. The Operational Rules contain more detailed provisions regarding trading systems and trading organisation. The Code of Conduct contains behaviour rules to be followed by Exchange Members in order to ensure fair and transparent market conditions.

The products that can be traded on SEEPEX are standard contracts for the physical delivery of electricity within the Serbian transmission system. The products are characterised auction trading.

Day ahead auction with delivery on the Serbian control area

Day ahead auction with delivery on the Serbian control area is represented by following rules:

Size	The minimum volume increment is 0.1 MW.
Tick	The minimum price increment is EUR 0.1 per MWh.
Underlying	Electricity traded for delivery the following day in 24-hour intervals. Special case: A full 25-hour Excel template is needed when the clocks are set to winter time. Hour 3 and 3X can contain different values. When the time is switched to summer time the system automatically deletes the exceeding quantities for hour 3 (i.e. 2.00 a.m. to 3.00 a.m.).
Place of Delivery	Deliveries are made within the Serbian transmission system managed by EMS.
Auction hours	24 hrs per day starting forty-five days before Delivery Day, 7 days a week, year-round, including statutory holidays.
Order Book closes	Daily at 11:00 a.m.
Publication time	The auction results are published as soon as they are available from 11:10.
Type of orders	Individual hours: Orders contain up to 256 price/quantity combinations for each hour of the following day. Prices must be between 0.0 €/MWh and 4000 €/MWh. The 254 prices are not necessarily the same for each hour. A volume – whether positive, negative or nil – must be entered at the price limits. A price-inelastic order is sent by putting the same quantity at the price limits. Blocks: Block orders are used to link several hours on an all-or-none basis, which means that either the bid is matched on all hours or it is entirely rejected. Block orders have a lower priority compared with single

	hourly orders. The quantity may be different for every hour of the block. A block order is executed for its full quantity only. A block order is executed or not by comparing its price with the volume-weighted average of the hourly market clearing

Table 8 – Properties of Day ahead auction

Intraday continuous market

Intraday auction with delivery on the Serbian control area is represented by following rules:

SEEPEX Intraday Continuous	
Trading Procedure	Continuous
Trading days	Year-round
Tradable Contracts (Expiries)	1 hour of the day (60min) 00-01: the period between midnight and 1:00 01-02: the period between 1:00 and 2:00, and so on and so forth 23-00 the period between 23:00 and midnight
Opening of the trading session	24 hours a day (60 min) 60 min Contracts for Delivery on the next day D open at 18:00 on the day D-1
Closure of the trading session	60 minutes before Delivery in Serbia
Clearing and Settlement	Trade information transmitted by SEEPEX to the central counterparty for Settlement of the Contracts
Delivery procedure	Nomination by central counterparty and by the relevant Balance Responsible Parties to the TSO
Admissible Orders	On the day of the switch from summertime to wintertime, hour 03 is divided in two hours that can be traded separately. On the day of the switch from wintertime to summertime, hour 03 cannot be traded
Minimum increment price	0.01 €/MWh
Minimum increment volume	0.1 MW
Minimum and maximum price	0 € / 9,999.99 €
Minimum quantity	0.1 MWh
Maximum quantity	999 MWh
Single-Contract Orders and Block Orders	
Definition	Single Contract Orders combine a price and a quantity for an Expiry. Block Orders combine several Expiries with a minimum of two contiguous Expiries on the same

	Delivery Day which depend on each other in their execution. The Exchange Member is not restricted in the determination of the Block Orders.
Execution conditions	Single-Contract Orders can be partially executed by default. The following execution restrictions can be used: “IOC” (immediate or cancel) or “FOK” (fill or kill). User-defined Block Orders cannot be partially executed. Therefore, the execution restriction “AON” (all or none) applies by default. By adding the execution restriction “IOC” (immediate or cancel), user-defined Block Orders become “market sweep” Orders and will be executed immediately, as far as possible against respective Single-Contract Orders. The minimum peak quantity for iceberg Orders is 1 MW.

Table 9 – Properties of Intraday auction

Dispatching and market operation centre of the new energy company

The new regional energy company, which in its portfolio would operate **a photovoltaic power plant in the Republic of North Macedonia with an installed power of 50 MWp, a wind power plant with an installed of wind power of 66 MW in the Republic of Serbia and a wind power plant with an installed power of 100 MW in the Republic of Albania, is planned to have one dispatch centre, that is, a centre for technical and market operation of all generation facilities, located in Belgrade - SANMAC (**Serbia**,** Albania**,** North Mac**edonia**).**

From that dispatch centre, it is planned to remotely monitor the operation of the generation facilities, but also to nominate and market (sell) the electricity on the local electricity exchanges to the state energy companies in the region at fixed prices, which sell electricity to suppliers that supply households or to regional state-owned energy companies in case of an emergency need for electricity.

In this analysis, two variants are made: one variant is when the electricity would be sold to the state companies at prices at which they sell the electricity to the suppliers that supply the households, and the second variant is when the electricity is sold to the local electricity exchanges, at prices determined by the exchanges themselves on an hourly basis.

The concept would entail the implementation of the following functions:

Forecasting and Optimisation: software which will be used during operation will be based on smart algorithms to predict energy generation and based on factors like weather, past data, and current market prices. This helps the operator fine-tune its operation and decide the best trading strategy.

Bidding and Market Participation: Biding capacities to various energy markets, including day ahead, intraday, and real-time imbalance markets. Bids to sell electricity according to their strategy. Market operators either accept or reject bids based on factors like market price, grid conditions, and other participants' bids.

Dispatch and control: Once the bids are accepted, the electricity generation is dispatched following the individual power plant profile, market schedules and the strategy. The software constantly oversees and controls power plants operation, ensuring they stick to the accepted bids and schedules while adjusting for unexpected changes in generation or consumption.

Settlement and reporting: After trading, handling of the financial settlements with market operators takes place. This includes checking actual energy generation and consumption, reconciling differences between accepted bids and real performance, and sending regular reports to market operators about their market involvement and performance.

In conclusion, energy trading with considered power plants includes forecasting, optimisation, bidding, dispatch, control, settlements, and reporting. This process allows efficient

participation in different energy markets, making the renewable resources and contributing to a greener and more efficient energy system.

Variant 1 Dispatching and selling electricity to state owned national companies

In the event that the electricity would be sold to the local state companies, the sale would be with fixed monthly, quarterly or annual electricity prices and with a guaranteed purchase, but also without balancing costs, given that the balancing responsibility, for small generation deviations, would be borne by the state generation company.

This means that each generation facility would have different revenue, different costs, as well as different profit.

In case of the Photovoltaic power plant in Macedonia, according to the current market conditions, the price at which the state company would sell electricity to the supplier that supplies households and at which the electricity company would buy energy from the photovoltaic power plant in 2024 would be **€ 57/MWh,** and the expected net profit on an annual level would be around EUR 1.88 million. These results are without balancing costs.

The 66 MW capacity building project in Serbia is planned with a subsidized price (Feed-in tariff) of **€ 92/MWh**. Considering the fact that the prices on the market at the moment are much lower than the ones mentioned, it is expected that the export of electricity will be carried out only in those conditions when the price on the market is higher than the ones mentioned. Expected net profit on an annual level for wind power plant in Serbia would be around EUR 7.5 million.

In accordance with the abovementioned, for generation from wind power plant in Albania with installed capacity of 100 MW and the planned price of selling electricity of around **€ 55/MWh,** the expected net profit on an annual level would be around EUR 2,4 million**.**

Variant 2 Dispatching and selling electricity on an open market - national power exchanges

In the second variant, it is envisaged that the electricity will be sold on the local electricity exchanges.

With the first variant, the reliability of the supply of electricity to the state generation companies is increased, and with the second variant, the reliability and safety of the supply of electricity at the local and regional level is increased, but so is the liquidity of the regional electricity exchange markets. Electricity exchanges make their income from buying and selling electricity. As this concept envisages that all electricity will be sold on the local exchanges, the amount of traded electricity will also increase, and thus the liquidity of the exchanges themselves. This is also significant, considering that regional and local electricity markets in these three countries are not as liquid as on other European electricity markets.

With this variant, it is foreseen that the dispatching of the generation capacities will be done by the dispatching center, the nomination of the generated electricity will also be carried out from the same dispatching center to the local electricity exchanges, where it would be sold and from where the income for the regional company would be generated.

In the example of the Republic of North Macedonia and the planned photovoltaic power plant with an installed capacity of 50 MWp, as well as the prices of electricity on the Macedonian electricity exchange MEMO, the expected net profit on an annual level would be around EUR 2.2 million. These results are without balancing costs.

If the balancing costs are added, since in this case each producer is balancing responsible for itself during operation, which for photovoltaic power plants are at the level of about 3% annually, the net profit at the annual level would decrease to the level of about EUR 2,14 million.

This shows that operating on a market basis will contribute to greater profit, better profitability of the project and liquidity of the company itself. It must also be noted that these are the results without periods when this company would sell electricity for the needs of households in emergency situations, when a certain country would face shortage of electricity in certain periods and when the company would have to produce and sell electricity at generation prices, without making a profit from it.

In case of Serbia, the entire generation would most likely be placed at the local (national) level. Actually, the fact that the subsidized price is far higher than the price valid on the market predetermines this type of placement. In this case there is a guaranteed profit, but after the feed-in tariff period has expired, it would be necessary to comply with the market conditions. **E**xpected net profit on an annual level for wind power plant in Serbia would be around EUR 7.5 million, the same as it is in variant 1.

Referring to the generation prices from the new Wind power plants in Albania with a total capacity of 100 MW, energy generation of 306,6 GWh/year would have an average energy generation cost of € 47,2/MWh. In accordance with the average electricity price on Albanian Energy Exchange ALPEX, for the period May 2023 – April 2024, of € 90,61/MWh, the expected annual profit would be up to EUR 13,35 million EUR, without balancing costs.

This result proves a good profitability of the project in the market basis operation, in addition to the last resort mission of supporting during the emergency and crisis situation.

Operation in emergency situations (as assistance to the three countries energy system)

The idea of this regional company, which would generate electricity at the regional level, is not based only on economic logic but also, in case of periods when there is a lack of electricity in a certain country, or in emergency situations, the entire generation of electricity from all three generation capacities, through the dispatch centre, would be transferred to the specific country where there is a problem in order to help the given situation. Moreover, in such cases, which would be defined in advance (the period, the quantities, as well as the conditions under which the assistance would be provided), the price at which the electricity will be delivered would be equal to the generation price of all three generation capacities, plus the costs of cross-border facilities, in cases where electricity would go from one country to another.

Case study

Let's assume that on January 23, 2024 at 9:00 a.m. an outage occurs in one of the blocks in the thermal power plant Bitola, which until that moment was operating with a power of 170 MW. Due to this outage AD ESM, which is the largest producer of electricity, immediately requests electricity for the same day (January 23, 2024) and provided it on the electricity market in the region, i.e. on an intraday basis, it provided electricity from the HUPX electricity exchange. But after considering all the parameters, it is concluded that AD ESM would also have a shortage of electricity of 170 MW for January 24, 2024. In accordance with the emergency assistance agreement with the joint company, JSC ESM immediately requests the redirection of all generation capacity for January 24, 2024 from the joint company, activating the emergency service.

For January 24, 2024, the possibilities for electricity generation from the joint company would be as follows:

ESTIMATED GENERATION OF ELECTRICAL ENERGY from NEW COMPANY					TOTAL NEEDs of Electrical energy from AD ESM
h	PV North Macedonia (MWh)	WPPP Serbia (MWh)	WPP Albania (MWh)	TOTAL (MWh)	
H1	-	61	100	161	170
H2	-	62	100	162	170
H3	-	61	100	161	170
H4	-	61	100	161	170
H5	-	61	100	161	170
H6	-	59	100	159	170
H7	-	61	100	161	170
H8	-	62	100	162	170
H9	1	57	100	158	170
H10	5	36	100	140	170
H11	9	38	100	147	170
H12	9	31	100	140	170
H13	9	24	100	133	170
H14	7	24	100	131	170
H15	4	20	100	124	170
H16	1	22	100	122	170
H17	-	40	100	140	170
H18	-	45	100	145	170
H19	-	43	99	142	170
H20	-	43	100	143	170
H21	-	59	99	158	170
H22	-	66	97	162	170
H23	-	66	96	162	170
H24	-	66	82	148	170
TOTAL	44	1.169	2.369	3.582	4.080

Table 10 – Case - electricity generation from the joint company for the day January 24, 2024

Since additional energy is needed, AD ESM takes energy from the joint company, but also procures additional energy from the Hungarian HUPX exchange. According to the above, and additionally from the Hungarian power exchange HUPX, the purchase of 498 MWh is planned.

The prices at which procurement of energy is planned from the joint company would be equal to the generation prices of electricity from the generation facilities, that is:

	MW	€/MWh
PV N. Macedonia	50	30,34 €
WPP Serbia	66	42,32 €
WPP Albania	100	47,20 €

Table 11 – Case – planned procurement prices

Since the prices of electricity on the Hungarian HUPX stock exchange are expected to be much higher, AD ESM procures the necessary energy for January 24, 2024, on an hourly basis, in the following way:

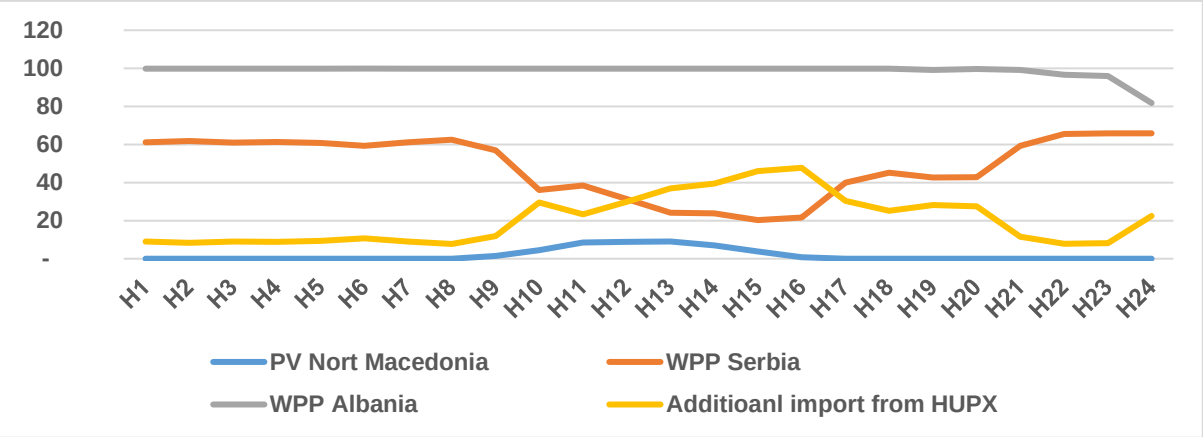


Fig. 23 – Procured energy on hourly basis

In order to bring energy to North Macedonia, it is necessary to provide cross-border capacities. The price of the cross-border capacities for January 24, 2024 at individual borders, which are the subject of interest for the specific case, are as follows:

	ATC AL-KOS	ATC KOS - MKD	ATC RS - MKD	ATC HU - RS
H1	- €	- €	24,11 €	0,44 €
H2	- €	- €	24,11 €	0,33 €
H3	- €	- €	24,11 €	0,33 €
H4	- €	- €	15,00 €	0,35 €
H5	- €	- €	15,00 €	0,35 €
H6	- €	- €	8,00 €	0,40 €
H7	- €	- €	15,00 €	0,17 €
H8	- €	0,07 €	15,00 €	0,22 €
H9	- €	0,15 €	2,55 €	0,22 €
H10	0,03 €	0,15 €	0,95 €	0,23 €
H11	0,09 €	0,09 €	0,63 €	0,23 €
H12	0,12 €	0,09 €	0,63 €	0,22 €
H13	0,09 €	0,09 €	0,63 €	0,22 €
H14	0,03 €	0,09 €	0,63 €	0,22 €
H15	- €	0,09 €	2,49 €	0,22 €
H16	- €	0,15 €	5,77 €	0,22 €
H17	0,03 €	0,30 €	5,55 €	0,22 €
H18	0,08 €	0,30 €	5,55 €	0,38 €
H19	0,03 €	0,25 €	5,55 €	0,40 €
H20	- €	0,21 €	5,55 €	0,40 €
H21	- €	0,15 €	15,00 €	0,40 €
H22	0,03 €	0,09 €	24,11 €	0,44 €
H23	0,12 €	0,09 €	24,11 €	1,00 €
H24	0,11 €	0,09 €	24,11 €	1,57 €

Table 12 – Case – price of the cross-border capacities for the day January 24, 2024

According to the previous data, for the specific day, the total value that AD ESM would pay to the joint company would be € 233,948.00, and if the energy is purchased from the Hungarian HUPX exchange, the value it would have to pay would be € 445,616.00. On hourly bases, it is:

	Total Costs for EE from new company	Total Costs for EE from HUPX	*Diff.*
H1	9.789 €	19.033 €	- *9.245 €*
H2	9.662 €	17.094 €	- *7.431 €*
H3	9.619 €	15.878 €	- *6.259 €*
H4	8.849 €	11.968 €	- *3.119 €*
H5	8.856 €	11.944 €	- *3.088 €*
H6	8.692 €	15.672 €	- *6.980 €*
H7	9.306 €	20.582 €	- *11.276 €*
H8	9.493 €	26.211 €	- *16.717 €*
H9	8.978 €	23.776 €	- *14.798 €*
H10	9.874 €	19.836 €	- *9.961 €*
H11	8.933 €	16.772 €	- *7.839 €*
H12	9.247 €	16.471 €	- *7.224 €*
H13	9.551 €	16.133 €	- *6.582 €*
H14	9.804 €	16.594 €	- *6.790 €*
H15	10.644 €	18.073 €	- *7.428 €*
H16	11.164 €	19.122 €	- *7.957 €*
H17	10.614 €	22.217 €	- *11.603 €*
H18	10.539 €	24.574 €	- *14.035 €*
H19	10.871 €	24.825 €	- *13.954 €*
H20	10.749 €	24.587 €	- *13.838 €*
H21	9.477 €	20.322 €	- *10.845 €*
H22	9.717 €	17.187 €	- *7.470 €*
H23	9.603 €	14.110 €	- *4.507 €*
H24	9.914 €	12.636 €	- *2.722 €*
TOTAL	**233.948 €**	**445.616 €**	**- 211.668 €**

Table 13 – Case –Total Costs for EE new company/ HUPX on hourly bases

With this specific example, using real values for both electricity prices and cross-border capacities, we have shown that only for one day of assistance in emergency situations state energy company, in the case of AD ESM, can make quite significant savings, in this case, over **211.000,00 €.**

If the electrical energy needed for January 24, 2024 is purchased from the joint company, the total costs would be **233.948 €.**

Fig. 24 – Support by the regional energy company

If the electrical energy needed for January 24, 2024 is purchased from HUPX power exchange, the total costs would be 445.616 €:

Fig. 25 – Total import electricity from Hungarian HUPEX power exchange

Further development

This paper researched the individual power capacities that use wind and sun power for electricity generation, the regulatory requirements of individual countries regarding their connection to the transmission system, an overview of market conditions, and explored the possibility of joint operation within one legal entity. Conceptually, there is no doubt that the prerequisites for establishing such a legal and technical entity exist, as well as that it could successfully operate within the market conditions and satisfy the technical requirements of power systems in all three countries.

The authors believe that the next step in this research would be the preparation of a Prefeasibility Study that would examine the aspects of this concept in greater detail.

The proposed chapters of such a study would be:

1. Background (regional energy overview, investment context, case descriptions, power system and stakeholder overview).
2. Scope (scope of the study).
3. Resource evaluation (assessment of natural resources and expected energy yield).
4. Project size & restrictions (grid and system perspective, physical planning issues, space requirements, other relevant barriers).
5. Financial & technical key figures (estimation of CAPEX, OPEX, technical parameters (efficiency, lifetime).
6. Business case (economic attractiveness (NPV, IRR, etc.), robustness of the case (sensitivity analyses). Preliminary financial analysis.
7. Revenue streams (revenue sources, markets, support schemes or tariffs, other important regulatory aspects)
8. Environmental & social aspects (evaluation of the potential impacts on the environment and other social implications)
9. SWOT & Risk assessment (assessment of project risks and potential mitigation measures)
10. Conclusions
11. Annexes

List of Acronyms and Abbreviations

ABM	Albanian Balancing Market
ACE	Area Control Error
AD MEPSO	Transmission system operator in the Republic of North Macedonia.
AD EVN	Power distribution network operator in North Macedonia
AEM	Albanian Electricity Market
ALPEX	Albanian Power Exchange
BSP	Balancing System Provider
CCPP TE-TO	Combined Cycle Cogeneration Power Plant
CDM	Clean Development Mechanism
CFD	Contract for difference
CHP	Combine heat and power
CoM	Council of Minister Approval (Albania)
DSO	Distribution System Operator
EDS	Elektrodistribucija Srbije
ER	Emergency Reserve
ERC	Regulatory Commission for Energy and Water Services of the Republic of North Macedonia
ERE	Licensing & Monitoring Department of Energy regulatory entity
FCR	Frequency Containment Reserve (or Primary Control Reserve)
FRR	Frequency Restoration Reserve
aFRR	Automatic Frequency Restoration Reserve
mFRR	Manual Frequency Restoration Reserve
JSC EMS	Joint Stock Company Elektromreža Srbije
JSC EPS	Joint Stock Company Elektroprivreda Srbije
KESH Gen	Albanian Power Corporation
LV 1.2	Consumers with direct and indirect measurements
LV 2	Households
LV 2	Others (Legal entities in North Macedonia)
MANU	Macedonian Academy of Science and Arts
MEMO DOOEL	National operator of the electricity market, Skopje
MV 1	Consumers on 35 kV voltage level
MV 2	Consumers on 10 kV voltage level
NEA	National Environmental Agency NEA
NECP	National Energy and Climate Plan Republic North Macedonia
OSHEE	Power supplier and distribution system operator (DSO).
OST	Albanian Transmission System Operator (TSO)
OST/BSP	Balancing Responsible Parties
PPA	Power Purchase Agreements
PVPP	Photovoltaic power plant
RCTC	Regional cooperation for three countries
REO	Renewable Energy Operator
RES	Renewable energy sources
RPS	Retail Public Supplier
RR	Replacement Reserve
SANMAC	Dispatching and market operation centre of the new energy company
SEE CAO	Coordinated Auction Office in the South East Europe

SEEPEX	Serbian electricity market
SHPP	Small hydro power plant
SSEE	Serbia and the South East European Region
TPP	Thermal power plant
TSO	Transmission System Operator
WPD	Wind Power Density
WPP	Wind power plant
WPS	Wholesale Public Supplier

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