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USING MINE LANDS AND OTHER BROWNFIELDS FOR SOLAR AND WIND POWER DEPLOYMENT IN NORTH MACEDONIA: STUDY AND METHODOLOGY

Final version

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Prepared by: ICEOR-MANU as a part project Exploring Pathways for Low-Impact Energy Solutions in North Macedonia

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Extended executive summary

Driven by Paris Agreement goals, the transition to clean energy will require a significant global buildout of renewable energy generation. Most of these projects will necessitate large areas for development. Therefore, brownfields, including locations such as abandoned mines, are becoming more attractive, as they already have some infrastructure that could be utilised for renewable energy source (RES) installations.

Over the past few decades, many studies and papers have researched the possibilities for redevelopment or reuse of brownfields.

The Nature Conservancy's recent Study on Clean and Green Pathways for the Global Renewable Energy Buildout[1] identifies six pathways for promoting utility-scale solar and wind energy in places with low-impact on nature and supported by local communities. The study includes several examples from the USA, among which is the Restoration Design Energy Project (RDEP) launched by the Bureau of Land Management (BLM) in 2009 to identify disturbed or previously developed sites within its portfolio of lands, such as brownfields, that could be made available for renewable energy development. Based on an extensive public outreach process, the BLM and other public entities identified 64 previously disturbed sites on federal, state, municipal, and private lands that may potentially be suitable for renewable energy development. Site types include gravel pits, mine sites, landfills, isolated parcels that have been disturbed, marginal or impaired agricultural lands, abandoned unauthorised airstrips, and Central Arizona Project (CAP) land.[2] The sites assessments were performed by giving a weighted score for each of the sites on a scale of 0 (least development potential) to 100 (best development potential), based on general topographic and property size suitability (e.g., the slope of the terrain for solar projects); solar resource availability; wind potential rating; distance to existing transmission and distribution lines, interconnections, and roads; distance to different types of load centres; and the presence of sensitive resources and potentially incompatible land use designations.

A similar assessment of the potential for renewable energy development on brownfields in North Macedonia has not been completed. However, there is likely a high potential given the expected demand for renewable energy systems and the quantity of potentially suitable brownfields.

By 2040, about 1400 MW solar power plants and 750 MW wind power plants should be built in North Macedonia, as defined in the Strategy for Energy Development until 2040. With these installed RES capacities and also investment in hydropower plants, it is expected that the current mix of electricity generation will be modified so that, by 2040, over 80% of electricity will be produced from RES, opposite to the current situation where lignite-fired power plants contribute 80% of domestic production.

To accomplish the 2040 vision, there is an urgency for RES development which is in close proximity to the transmission and distribution network's capacity and the locations where they will

[1] McKenney, Bruce and Jessica Wilkinson, "C*lean and Green Pathways for the Global Renewable Energy Buildout*", The Nature Conservancy, Arlington, VA, 2020.
[2] Arizona Restoration Design Energy Project, "*Solar and Wind Energy Assessment of Nominated Sites"*, 2012.

be built. In addition, numerous limitations need to be taken into consideration, and various stakeholders should take part in planning the future energy system development. In this study, special attention is given to brownfields and mines in particular, as potential locations that can be redeveloped, and can now be used as sites for renewable energy sources. Therefore, this study first gives an analysis of the legal aspect of brownfield investments in renewable energy sources, giving an overview of all the relevant laws and rulebooks that should be considered in this type of investment. Additionally, a financial analysis of the investments in renewable energy on brownfields is also presented, outlining the different types of costs and parameters for assessing the economic efficiency and profitability of the investments, as well as potential parameters and factors that determine the location of photovoltaic (PV) and wind power plants (WPPs).

Legal aspect of brownfield investments

As the main potential for brownfield investments is expected to be located in mining areas – abandoned mines or mines expected to be abandoned, as well as mining sites that allow for additional production facilities to be built therein - the legal analysis primarily focuses on the national legislation related to mineral resources. In that respect, the key laws are:

- **Law on Mineral Resources** that determines that mineral resources are considered as a property of the Republic of North Macedonia, therefore, the only way they can be exploited is by obtaining a concession from the competent state body, and
- **Law on Concessions and Public Private Partnerships** that has to be observed in the procedure for awarding concession for exploiting mineral resources, making the provisions of this law related to contract duration, ownership rights and transfer, of relevance for the brownfield investments.

In addition, the following pieces of legislation have been also analysed due to their relevance in the identification and use of sites for the construction of RE generating facilities:

- **Law on Environment** as an umbrella law that entails certain types of environmental impact assessments to be conducted, even for RES generating facilities,
- **Law on Urban Planning** that elaborates the procedures for urbanising certain pieces of land, thus making the construction of generation facilities on them possible, and
- **Rulebook on Urban Planning** that defines the type of class purpose of each piece of urbanised land, where the mining and energy facilities belong, as well as the flexibility for changing the initially defined purpose class.

For each relevant piece of legislation, its subject matter and a review of the most important provisions are provided, ending with a brief conclusion on their applicability for brownfield investments in RES or if changes might be necessary. In general, the present legal framework is favourable for brownfield investments in RES, while certain modifications may contribute to further improvement and legal certainty.

There seems to be quite a discrepancy between what is written in the **Law on Mineral Resources** and what is happening in practice. First, the Government has not yet adopted its Strategy for Geological Surveys, Sustainable Use and Exploitation of Mineral Resources for a period of 20 years, which, as with any strategic document, should set the guidelines in terms of the type and

quantity of land that could and should be used for geological surveys and exploitation, specific activities that would be taken to make the land and exploitation field sustainable, etc. Second, the Government has not adopted an annual programme for rehabilitation and recultivation that will define more precisely the land/area that will be subject to rehabilitation (*cleaning the land that had been affected by tailings installation, in a way that the land returns to a satisfactory condition, especially in terms of soil quality, wildlife, natural habitats, freshwater systems, landscape and the appropriate usefulness of it*) and recultivation (*returning to a useful condition, the land which was degraded by geological survey or by the exploitation and processing of mineral resources*) as mandatory activities in each concession awarded.

The Law on Mineral Resources allows infrastructure facilities to be built in the concession area and exploitation field if they are of public interest and do not disrupt the exploitation of mineral resources. According to the Energy Law, the construction and operation of an RE generation facility is an activity of public interest, therefore, they can be constructed within a mine site that is still operational. These provisions provide additional possibilities for brownfield investments.

The **Law on Concessions and Public-Private Partnerships** (PPP) regulates the procedural aspects of awarding concessions and PPP. However, the provisions related to contract duration, its transferability and ownership rights on the concession subject are important for brownfield investments. Contracts' duration can be shorter than 35 years, meaning that many actual concessions for exploitation of mineral resources may expire in the near future and be used for other purposes if the exploitation of the site is exhausted. The Public Partner remains the owner or obtains the ownership after the expiration of the concession period and can decide upon the future of that land and facilities built on it. This means that the state as Public Partner can, without any modifications in the law, decide on the land use purpose, whether further concession for exploitation of mineral resources will be awarded or PPP for construction and operation of RES generation facility will be established.

The **Law on Environment** and bylaws deriving from it, provide for different treatment (necessary environmental documents) for different types of RE technologies. Investors in hydropower and wind power plants with an installed capacity of up to 10 MW and other RES power plants with an installed capacity of up to 200 MW must develop environmental 'elaborat'[3] which should be submitted for approval to the Ministry of Environment and Physical Planning. Projects for which an environmental impact assessment procedure must be conducted, which is more complex and time-consuming than the procedure for approval of environmental elaborat' include large hydro power plants with an installed capacity of over 10 MW and installations for use of wind power for electricity generation (so called wind farms).

Strategic assessment is carried out on planning documents if they envisage the implementation of projects for which an environmental impact assessment procedure is implemented or which

[3] According to Macedonian Law on Environment, Legal entities or natural persons whose activities or works do not comprise projects that are subject to an environmental impact assessment procedure, must develop environmental impact assessment 'elaborat' and submit it to the body of the state administration responsible for the project approval and implementation. 'Elaborat' represents rapid and less detailed environmental impact assessment.

affect the protected areas. This includes, among other things, all short-term, medium-term and long-term mining and energy planning documents, as well as individual energy activities to ensure the security of supply of various types of energy.

The **Law on Urban Planning** fails to regulate important issues such as the period for which the national Spatial Plan will be adopted, the procedure for its adoption and modification, as well as its basic content. The present national Spatial Plan was adopted in 2004 for the period up to 2020; there is an obvious need for a new one to be adopted, thus providing legal certainty in the procedure for adopting spatial and urban plans at the hierarchical lower level.

The following types of plans are adequate for the planning of RES generation facilities:

- ***Urban plan for outside settlement boundaries*** adopted for, among other things, larger constructions or infrastructure construction of local importance, located outside a settlement, and
- ***Urban plan for areas and buildings of state importance*** adopted for areas with superstructural and infrastructural complexes, systems, buildings and accompanying buildings of state importance.

Procedures for adoption of an urban plan for outside settlement boundaries can run up to 18 months, while urban plans for areas and buildings of state importance may take up to 36 months. The Law provides a possibility for the land covered by the adopted urban plan to remain agricultural land, which seems quite convenient for those urban plans that envisage construction of an infrastructure line (e.g. connection to the grid) or even PV power plant, where the technology is the least degradable for the land, if it would be degraded at all. In case the RES power plant is to be built on a single cadastral parcel, the procedure for adoption of the urban project can be directly initiated, without prior existence of an urban plan, thus shortening the investment period. In the case of brownfield investments, urban plans already exist, but they will most likely need to be modified to foresee another class purpose (the type of facility to be built), but the procedure for such modification is shorter than the procedure for adoption of a completely new urban plan.

Of particular relevance for brownfield investments is the section system of classes of purposes defined in the **Rulebook on Urban Planning.** Classes of purpose are an instrument used to define the land purpose in urban plans and urban projects. Even if an existing urban plan specifies the purpose class on the level of sub-class, that does not mean that changes are not possible, especially if the change is from a more rigid to a more flexible sub-class (e.g. change from sub-class D1 - Mining that is considered as a heavy and polluting industry into sub-class D3 - energy from renewable sources where non-polluting technologies are applied).

To summarise, though in general, the present legal framework related to brownfield investments in RES generation capacities is favourable, further improvements are necessary:

- To expand the content of the Registry of Awarded Concessions by including data on the number of cadastre parcel and the type of land for which the concession is awarded, and provide these data to the developers of the annual indicative plan for construction of RES generation capacities, which is to be introduced with the amendments to the Energy Law.
- If need be, further to be clarified in the Law on Mineral Resources or with the responsible institution for monitoring the implementation of this Law that:

- constructing RES power plants on the active exploitation field for which concession was awarded is possible on the grounds that construction and operation of RES power plants is an activity of public interest, and
- rehabilitation and recultivation activities on the exploited mine site are not mandatory in the case of a facility of public interest to be constructed on it that does not entail rehabilitation and recultivation of that particular piece of land.

If need be, further to be clarified in the Law on Urban Planning or with the responsible institution for monitoring the implementation of this Law that for construction of certain types of RES power plants (PV technology) that do not degrade the agricultural land, the adoption of an urban plan and above all conversion of agricultural into construction land is not necessary, thus shortening the investment procedures and creating legal certainty.

From a legal point of view, the easiest and fastest way to realise a brownfield investment in a RES power plant, which is to be built on an active or abandoned mine (exploitation) site, would be to change the class purpose from mining to production of energy from renewable sources in the existing urban plan and then, with the project design and other documents, obtain a construction permit. Going beyond brownfield investments would be the building of an RES power plant (PV technology) on agricultural land of lower category that can be barely used for agriculture purposes, and in the procedure, for the adoption of the appropriate urban plan for that construction there will be no need for conversion of the agriculture into construction land.

Financial aspect of brownfield investments

As part of the project, the following financial aspects were elaborated on: the general financial situation in the Republic of North Macedonia; the energy sector in the Republic of North Macedonia; FDI (greenfield and brownfield investments) in North Macedonia and the main economic parameters which determine the location of WPPs and PVPPs.

General financial situation of the Republic of North Macedonia

For an overview of the general financial situation in the country, this report presents the basic characteristics of the public finance system and the banking system of the Republic of North Macedonia.

Public finance system – Prior to 2008, North Macedonia maintained low budget deficits for a relatively long time period (1994 to 2008). In the period 2008-2014, the country doubled its public debt and lost its fiscal space. The situation with the public debt has become more complicated during the crisis caused by the COVID-19 pandemic. The budget deficit in 2020 exceeded 8%. By the end of 2020, the public debt as a share of GDP exceeded 60%. According to this indicator the country is classified in the group of moderately indebted countries – in fact, during the health crisis North Macedonia achieved the 11th lowest increase in the public debt among 32 European countries (European Commission: European Forecast, Institutional Paper No 136/2020).

Compared with the other countries in the region, North Macedonia has a relatively low share of public investments in its total public expenditure. However, North Macedonia has the potential for creating a wider fiscal space to increase public investments, mainly capital infrastructure investments, mostly in the field of energy transformation.

Banking sector – today the banking sector of North Macedonia consists of 14 banks, of which 5 are large, 6 medium and 3 small (classified by the size of assets). The banking system of the Republic of North Macedonia is the dominant segment of the financial system – it accounts for about 90% of the financial potential of the country's total financial system. The general assessment is that the banking system is stable, with a predominant share of foreign capital in the total capital of the banks (almost 70%), with solid capitalisation (the capital adequacy is 18% and is more than twice the legal minimum) and with significant progress in corporate governance. The Macedonian banking system was not hard hit by the current crisis. The credit potential of the banks remains solid – they are able to finance profitable projects from the Macedonian business sector without problem, further, they are increasingly granting eco-loans (to companies and households), including loans for renewable energy sources and the improvement of energy efficiency and are actively participating in the operationalisation of foreign credit lines which are mobilised through the only state bank in the country – Development Bank of North Macedonia.

Regarding the situation in the **balance of payments,** it should be stressed that North Macedonia has a chronic trade deficit, which predominantly results in a deficit in its current account balance (% of GDP), which in the years before the crisis (2010 – 2018) was maintained at an average annual level of -3% (our calculations based on data from the National Bank of the Republic of North Macedonia – www.nbrm.mk) but which is successfully covered by private transfer inflows (transfers – remittances of the Macedonian citizens working abroad), by borrowing at the international financial markets, and with FDI inflows. According to Standard & Poor's, **the credit rating** of North Macedonia remains stable during the crisis, i.e., **BB-/Stable/B**.

Recently, for financing of the green transition, North Macedonia has provided significant funds from foreign sources, under favourable conditions. At the same time the procedure for construction of the Cebren power plant has been accelerated (the largest investment in the energy sector in North Macedonia) and photovoltaic power plants are under construction by TPP Bitola. The Government of the Republic of North Macedonia is participating in the construction of the Alexandropoulos pipeline, with 10% of the total investment.

The role of the energy sector in the national economy

Energy is the bloodstream of the economy because energy is a vital input in economic processes, and thus a constituent element of production costs and the prices of goods and services. Due to the pronounced energy deficit, North Macedonia is implementing an ambitious National Strategy for Energy Development until 2040. The energy transformation is based on several pillars: *firstly*, a significant increase in the share of renewable energy sources in total energy production (from 18% in 2019 to 50% in 2040); *second*, an increase in energy efficiency (reduction of energy consumption by 27% in the period from 2019 to 2040, with simultaneous GDP growth); *third*, reduction of greenhouse gas emission by 55% by 2040, compared with 1990; *fourth*, a change in the government regulation in the field of energy and energy policies and their compliance with EU standards and European Energy Community. Achieving the above-mentioned goals implies the beginning of a strong investment cycle in the energy sector, based on the implementation of innovative energy technologies – green investments. In the Strategy, the plan is to invest EUR 4.7 billion in energy, by 2025. The green investments in energy will have numerous effects: an

increase in energy efficiency; preservation of jobs and creation of new jobs in the energy sector, and, through the employment multiplier, new jobs will be created in other sectors; the decarbonisation process, an increase of the share of renewable energy sources, and moving to the circular economy will contribute to the protection of the environment as one of the sustainable development components. As a result of the largest energy price shock at the global level, caused by the war in Ukraine, the country has started a process of intensified investment in renewable energy sources and energy efficiency. In the meantime, a change has been made in the legislation on renewable energy sources (Official Gazette No. 112.19): households and individuals now receive the status of prosumers and have the opportunity to install renewable energy power sources. The interest in this type of investment in the country is high, much more than expected, and the number of companies and households investing in renewable energy sources is constantly growing.

Foreign direct investments – overview of greenfield and brownfield investments

There are two major types of international capital flows: **foreign direct investments (FDI)** and **portfolio investments (PI).**
Depending on the type of investment, foreign direct investment can be divided into two segments: *greenfield investments* and *brownfield investments.*
The Republic of North Macedonia is in the group of countries in transition and developing countries with a relatively weak performance in the area of attracting FDI. A decade after independence, FDI in the country, de facto, were absent or marginal. After 2006, the Government of the Republic of Macedonia promoted a strong stimulating policy for attracting FDI, especially in Technological Industrial Development Zones (TIDZ) and industrial zones. During the period (2006-2020), in North Macedonia, the average annual net FDI inflows amounted to USD 363.4 million, while the average annual net inflows as a share of GDP amounted to 3.6%. (UNCTAD: World Investment Report, 2019 p. 2016; p. 219).
Depending on the direction of the investment, the NBRNM's Statistical Survey on direct investments covers data for stocks and flows of Direct Investments abroad (Outward Direct Investments) and Direct Investments in the country (Inward Direct Investments). In addition, the direct investment statistics of NBRNM covers the annual FDI inflows and what is known as the stocks balance, (i.e. accumulated inflows for a certain period of time). Depending on the direct investments' structure, the Statistical Survey of the NBRNM for direct investments in the country covers stock data of new, existing, and other investments. Direct investments stocks data are valued at book value. Changes in stocks between two reporting periods may arise from transactions, price changes and/or exchange rate changes and other changes in volume https://www.nbrm.mk/direktni_investicii_sostojbi-en.nspx.
However, the NBRNM's statistics **do not monitor greenfield and brownfield investments separately, but provide converged data in the category of foreign direct investment.** For the needs of this project, the distinction between the two types of FDI is important, because the economic costs that determine the location of green investments in energy are usually lower in the case of brownfield investments, primarily due to the lower costs related to the necessary infrastructure and especially the electricity distribution network, further due to the fact that in a case where the location of the power plant is in an existing company (brownfield investments) there are savings in costs for education and training of employees, etc. But this aspect of the problem will be elaborated upon more widely in the next part on economic factors and parameters that determine the location of energy facilities.

Economic factors and parameters that determine the location of wind and solar power plants

Different types of costs and parameters for assessing the economic efficiency and profitability of the investments

One of the most widely used methods for determining the efficiency and justification of the investments is the **cost-benefit analysis**. On the cost side, the average energy production costs are important, while on the benefit side of primary importance is the quantity of the energy produced. For this particular **cost-benefit analysis** on the cost side, the division of **investment** and **operation and maintenance (O&M) costs** are relevant.
The O&M costs of investments in renewable energy power plants are significantly lower and experience has shown that they represent around ¼ in the total costs, while the O&M of investments in conventional power plants are much higher and represent almost 80% in the total costs. In the later phases of the exploitation of power plants (wind power plants - WPPs and solar power plants - PVPs), of particular importance are the costs related to the **decommissioning of the power plant or its re-powering**. It should be considered that different components of the fixed costs have different useful life and depreciation periods. This has an impact on the costs of replacing the old equipment with new equipment. After the depreciation period, when the old equipment is replaced with new, these types of costs are significantly lower compared with the decommissioning, because some of the already made investments (for example – the road access infrastructure, and energy infrastructure) could be further used for the new investment. In this way, the fixed costs are reduced and thus the total average costs are lower.
On the **benefit side,** the most important indicator is energy production. Besides the energy production, other benefits classified as positive socio-economic benefits are evident: generating new jobs at the local level; being a source of revenues for local companies involved as subcontractors; the construction or improvement of road access infrastructure at the location of the investment.

Important conditions for wind and photovoltaic power plant investments

Parameters and factors that determine the location of wind power plants

The construction of wind power plants is determined by the wind speed and wind turbulence at the location (these are technical parameters, which, however, have a strong impact on the economic costs), along with factors such as the already existing energy infrastructure and access road infrastructure. To the extent that the location has a microclimate (a natural factor that also has an impact on the economic costs), and the climate is harsh (cold winters and hot summers) then the maintenance costs increase. To a lesser extent, the costs may be increased due to the preparation of studies for environmental protection generally, and separately for studies for protected areas or studies for the protection of archeological sites. The proximity of the planned location for investment to settlements (<500), may decrease the energy production due to the need to turn off the turbines because of excessive noise and shadow flicker.

The future electricity production, the profitability of the project and the period of return of the investment depend on the measured wind speed at the location. Locations with higher average wind speeds are more favourable for the construction of wind plants. The degree of turbulence of the wind can increase the investment costs due to the need for the installation of resilient types of wind turbines. At the same time, more frequent high turbulence can also increase the maintenance costs for the turbines.

The existing energy infrastructure can increase the construction costs in cases where the power grid is far away from the location for construction, and longer interconnection transmission lines and distribution lines should be constructed for a smaller wind power plant. The construction of a new substation for connection to the electricity network also has a significant impact on the investment and construction costs. The road access infrastructure can increase the investment costs in a case where the location is at a greater distance from the existing infrastructure and construction of longer access roads for the transport of the turbines is needed.

In sum, when building a wind plant at any location, first the essential condition should be met – the measured average wind speed of the micro-location, which directly influences the cost-effectiveness of the project as well as the period of return of the investment. If this essential condition is met, then the crucial economic factors should be considered.

When building wind plants on brownfields the following economic parameters as inputs in the cost-benefit analysis are of crucial importance:

Cost side: energy infrastructure; access to road infrastructure; costs for land acquisition and of the existing facilities; utility costs for construction; building permits; electricity generation licenses; costs for wildlife protection (birds, bats, etc.); cooperation with local subcontractors; an available qualified workforce that can be hired for the new investment; costs related to the proximity to settlements, protected areas, national parks and archaeological locations.

Benefit side: annual electricity production.

Parameters and factors that determine the location of photovoltaic power plants

In the case of photovoltaic power plants, the choice of the location is determined by the larger number of sunny days in the year, as well as the orientation of the location with regard to the Sun. As in the case of wind power plants, the existing energy infrastructure has an impact on the investment costs. The impact of the access road infrastructure is not as significant as in the case of the wind power plants. When building a photovoltaic power plant at some location, first the essential condition should be met, which are the average annual sunny days at the micro-location, which directly impacts the cost-effectiveness of the project as well as the period of return of the investment. If the essential condition is met, then the crucial economic factors should be considered.

When building photovoltaic power plants on brownfields, the following economic parameters as inputs in the cost-benefit analysis are of crucial importance:

Cost side: energy infrastructure; access road infrastructure; costs for land acquisition and of the existing facilities; utility costs for construction; building permits; electricity generation licenses; costs for wildlife protection (birds, bats, etc.); cooperation with local subcontractors; available qualified workforce that can be hired for the new investment; costs related with the proximity to settlements, protected areas, national parks and archeological locations.

Benefit side: annual electricity production.
The above-presented analysis confirms that building wind and photovoltaic power plants on brownfields is determined by numerous economic parameters and factors, but also by other factors, including technical, natural, environmental, etc. The technical, natural and environmental factors have a strong impact on the total investment costs and the average energy production costs, including the price of energy. Hence the choice of the most appropriate location for those types of power plants requires a complex analysis of all relevant factors because they are interdependent and together determine the final result – the optimal location for construction of the power plants.

To summarise:

- The Great Recession 2007-2009 and the COVID-19 recession has led to the significant limitation of the fiscal space in North Macedonia – in 2008, the debt to GDP ratio accounted for 24% and today more than 63%. Adequate fiscal space should be built in order to increase public investment and in particular to increase public investment in the energy sector. The increase in the share of public revenues can be predominantly based on the decrease of the grey economy (which is estimated at a level of 30% - 35% of GDP), through the prevention of tax evasion (this means an increase in the efficiency of tax administration) and through tax increase (progression in personal income tax). On the expenditure side of the budget, there is considerable space for cutting off the typically unproductive government public spending. These measures, together with improvement in the medium-term and long-term budget planning, can contribute to the expansion of the space for capital investments, including investment in energy. Due to the energy crisis, the implementation of the Government's strategy for fiscal consolidation is likely to slow down in the coming period, but it should not be abandoned.
- To improve the general financial situation, increase public and private investment and accelerate the economic growth in the country, the Government of the Republic of North Macedonia and the private sector should maximally use the funds for green investments from EBRD, EIB, KFW, UNDP, USAID, etc., as well as the innovative instruments for financing green growth, part of the Green Agenda for the Western Balkans.
- With the changes in the legislation in North Macedonia, households and individuals receive the status of prosumers and have the opportunity to install power sources for electricity production from renewable sources and to distribute the excess energy to the electricity distribution network. The interest in investing in photovoltaics has increased (in households, individuals and businesses) but the procedures for obtaining permits are still complex. The Government should accelerate the simplification process and harmonise its regulation with EU standards. Although individually they present relatively small funds, in total, they are a large amount, which can contribute to the increase of the solar energy production in North Macedonia (280 sunny days a year and the highest quality peak of solar energy) and for the energy transformation of the country.
- To encourage and support investment in renewable energy on brownfields, to utilise the advantages they offer (existing electricity and road infrastructure; work force etc.)
- In the cost-benefit analysis for energy investments, on the cost side the investment and operation & maintenance costs are relevant, on the benefit side, the most important is the energy production, but also other socio-economic benefits are evident. Generally, it could be concluded that building wind plants and photovoltaic plants on depleted mines could be cost-beneficial but the following conditions should be fulfilled: relevant energy infrastructure; road infrastructure; available workforce etc.
- The technical, natural and environmental factors have a strong impact on the total investment costs and the average energy production costs. Hence, the choice of the most appropriate location requires a complex analysis of all relevant economic, social, environmental, technical and natural factors because they are interdependent and together determine the final result – the optimal brownfield location for construction of the power plants.

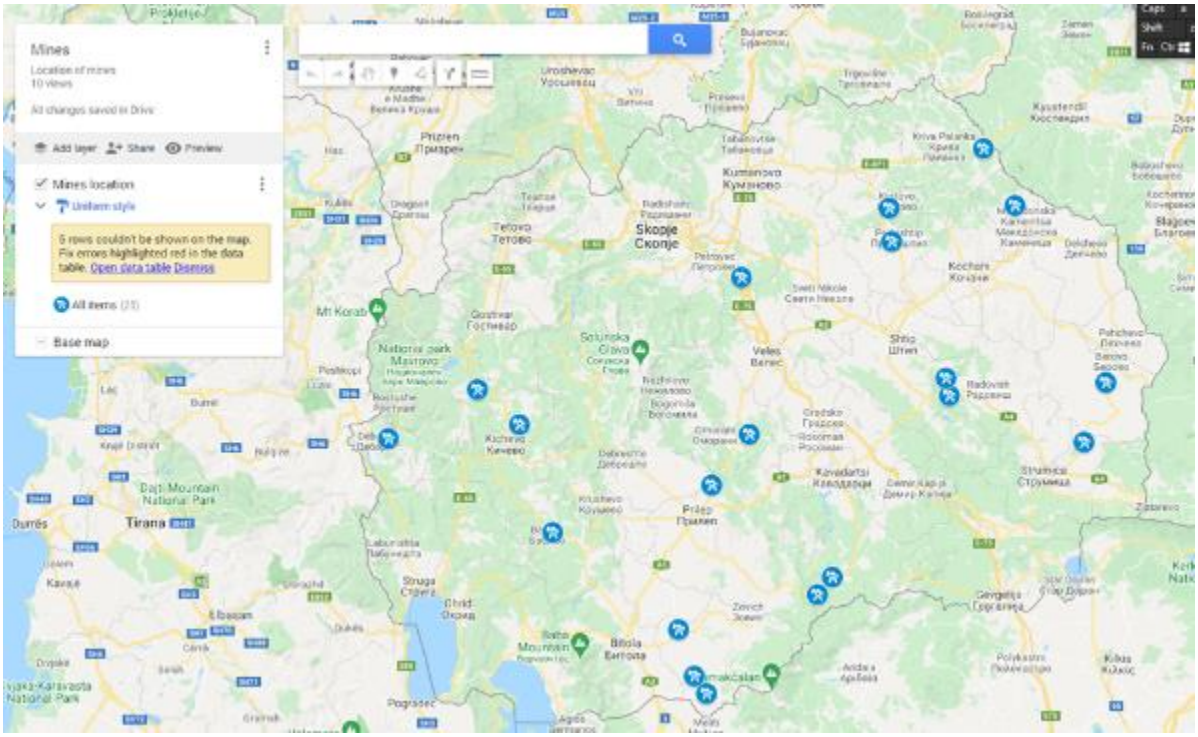
Candidate sites and selection criteria

This study focuses on potential brownfield sites, especially mines - existing, closed, and potential mines. For that purpose, a detailed map of their locations has been developed (Table 1, Figure 1). There are many potential locations of active or non-operational mines, and brownfields that in the future should be successfully transformed into locations for PV or wind plants. Besides the large coal mines "*Oslomej"* near Kichevo, "*Suvodol",* "*Brod Gneotino"* and the potential coal mine "*Zivojn*o" near Bitola, another coal mine in southwest North Macedonia is "*Piskupshtina"* near Struga with a capacity of 80-100 t annually. The same applies to the coal mine *"Berovo".* Additionally, there is a coal mine in the vicinity of Skopje, "*Katlanovo",* with total geological reserves of coal, calculated for the upper productive horizon at the site about 18.5 x 106 tons. Furthermore, in the eastern part of the country, there are several mines mostly for lead zinc ore, namely "Dobrevo (*Zletovo)" near* Probishtip, "*Toranica"* near Kriva Palanka, "*Sasa*" near Makedonska Kamenica. In the vicinity of Radovish, there are two mines, "Buchim" – the only copper mine in North Macedonia – and "*Damjan*" for iron ore. Close to Strumica, there is the feldspar mine "*Hamzali – Drvosh*". In the southern part of the country, near Zovich, there are two mines, "*Ruzhanovo*" for ferronickel and "*Alshar*" known for the thallium mineral Lorandite. Going towards the centre of the country, in the vicinity of Prilep, the marble ore mine named "*Sivec*" can be found. Another iron ore mine, "*Zhvan*", is located in the southwestern part of North Macedonia. Although the majority of the mines are not coal-based, they represent a development area by utilising the equipment, facilities, road and electricity connection that are already in place.

TABLE 1. AN INITIAL LIST OF MINES IN NORTH MACEDONIA

Name of mine	Type of mine	Nearest City	Operational
Oslomej	Lignite	Kicevo	closed
Suvodol	Lignite	Bitola	partially under exploitation
Brod Gneotino	Lignite	Bitola	under exploitation
Zivojno	Lignite	Bitola	potential
Piskupstina	Lignite	Struga	under exploitation
Brik Berovo	Lignite	Berovo	under exploitation
Katlanovo	Lignite	Skopje	under exploitation
Dobrevo	lead zinc	Probistip (Zletovo)	partially under exploitation
Toranica	lead zinc	Kriva Palanka	partially under exploitation
Sasa	lead zinc	Mekedonska Kamenica	partially under exploitation
Buchim	Copper	Radovish	closed
Damjan	Iron ore	Radovish	closed
Borov Dol	Copper	Radovish/Stip	under exploitation
Hamzali - Drvosh	feldspar	Strumica	under exploitation
Ruzhanovo	Ferronickel	Kavadarci	closed
Alshar	Thallium mineral lorandite	Valandovo/Gevgelija	potential
Sivec	Marble ore	Prilep	under exploitation
Zhvan	Iron ore	Demir Hisar	closed
Izvor	Talc	Veles	
Knauf	Gypsum	Debar	under exploitation
Tajmiste	Iron ore	Kicevo	under exploitation

FIGURE 1. INITIAL MAP OF MINE LOCATIONS



Having a list of possible sites for construction of wind or solar power plants means that there should be a methodology for prioritisation of these sites, which will determine which of these sites are suitable for such types of investment, and additionally which are the best sites not only in financial terms, but also legal, environmental, and social. In this regard, this study suggests the multi-criteria assessment methodology, where each location is evaluated through different criteria and the weights for each criterion are determined by using the Analytic Hierarchy Process method. One very important part of this methodology is the selection of criteria upon which the different sites will be graded, including the pre-assessment eligibility criteria. The process of selection of these criteria was complex and included the results of the legal and financial analyses conducted in this study, as well as the opinions of the different stakeholders which were very important in this process. Based on this, the following criteria were selected for the multi-criteria assessment process:

- power grid connection
- distance to road
- slope
- wildlife protection (birds, plants, etc.)
- qualified workforce that can be hired for the new investment
- proximity to settlements
- distance to rivers or lakes
- weather parameters (solar radiation and wind speed)
- type of land
- installed capacity

Additionally, for the project eligibility, the following criteria have been selected:

- Whether the project is consistent with valid EU policies and strategies

- Whether the project is covered by the relevant sector strategy paper (sector action plan or sector master plan)
- Whether the project contributes to valid national development objectives
- Whether the project is within protected areas
- The possibility for land acquisition and existing facilities
- Building permits

Results

The methodology developed in this document is universal and is applicable not only for mines, but also for all other types of land, and especially intended for non barren land. Therefore, in this initial phase of the project five locations (mines) were selected, for which all of the necessary data were available (including pictures of the sites). However, in the next phase of the project this list of locations will be extended, and the same methodology will be applied. The results of applying the proposed methodology to these five locations show that the most suitable mine for PV construction is Suvodol, and the most suitable location for wind power plant construction is Sasa.

Suvodol

This mine is located at a distance of 5 km from the nearest major settlement (Novaci). The location Suvodol is near the 400 kV transmission network. There is also a road next to the location. Using Google Earth it is determined that the average slope of the location is 10% (Figure 2), while using the Global Solar Atlas it is determined that global horizontal radiation is 1538.5 kWh/m^2, and the wind speed is 4.02 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly barren land and pastures, and which are owned by the Power Plants of North Macedonia (ESM). The area of the site is about 6 km^2, on which about 450 MW PV can be installed. In terms of environmental protection, this location is not in a national park or protected area, or in an Important Plant Area (IPA); however, it is located in an Important Bird Area (IBA).

FIGURE 2.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH - SUVODOL

According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, the Suvodolska River is located 500 m from the location, and there is no river at the site where the power plant would be built (Figure 3).

From the Employment Agency, the Survey of Unemployed Persons as of February 28, 2022 is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Bitola (the city closest to the location) is 5 291.

FIGURE 3.RIVER AND LAKES NEAR TO SUVODOL, CADASTER OF NORTH MACEDONIA

Brod Gneotino

This mine is located at a distance of 12 km from the nearest major settlement (Novaci). The location Brod Gneotino is near the 110 kV transmission network. There is also a road next to the location (at about 260 m). Using Google Earth, it is determined that the average slope of the location is 4.5% (Figure 4), while using the Global Solar Atlas it is determined that global horizontal radiation is 1552.9 kWh/m^2, and the wind speed is 4.17 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly barren land, pastures and fields and which are owned by the Power Plants of North Macedonia (ESM) and the Republic of North Macedonia. The area of the site is about 2 km^2, on which about 160 MW PV can be installed. In terms of environmental protection, this location is not in a national park or protected area, or in an IPA; however, it is located in an IBA.

FIGURE 4.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH – BROD GNEOTINO

According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, a small lake is located near the site where the power plant would be built (Figure 5).

From the Employment Agency, the Survey of Unemployed Persons as of February 28, 2022 is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Bitola (the city closest to the location) is 5 291.

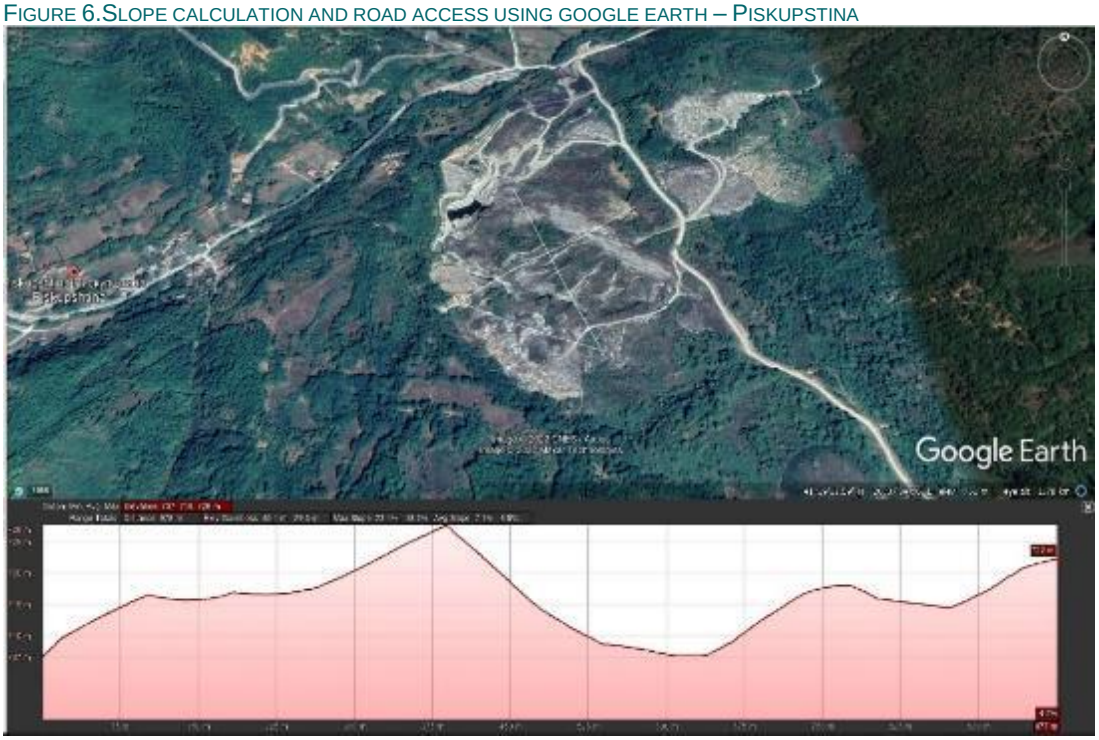
FIGURE 5. RIVER AND LAKES NEAR BROD GNEOTINO, CADASTER OF NORTH MACEDONIA

Piskupstina

This mine is located at a distance of 4 km from the nearest major settlement (Boroec). The location Piskupshtina is in the vicinity of the 110 kV transmission network. There is also a road next to the location. Using Google Earth, it is determined that the average slope of the location is 7.1% (Figure 6), while using the Global Solar Atlas it is determined that global horizontal radiation is

1469.4 kWh/m^2, and the wind speed is 4.1 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly barren land, pastures and fields and which are owned by the Republic of North Macedonia and some private owners. The area of the site is about 0.11 km^2, on which about 9 MW PV can be installed. In terms of environmental protection, this location is not in a national park or protected area, or in an IBA; however, it is located close to an IPA.

FIGURE 6.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH – PISKUPSTINA



According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, the river Volneshki Trapoj, as well as one other river, is located at the place where the power plant would be built (Figure 7).

From the Employment Agency, the Survey of Unemployed Persons as of February 28, 2022 is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Struga (the city closest to the location) is 3 660.

FIGURE 7.RIVER AND LAKES NEAR TO PISKUPSTINA, CADASTER OF NORTH MACEDONIA

Sasa

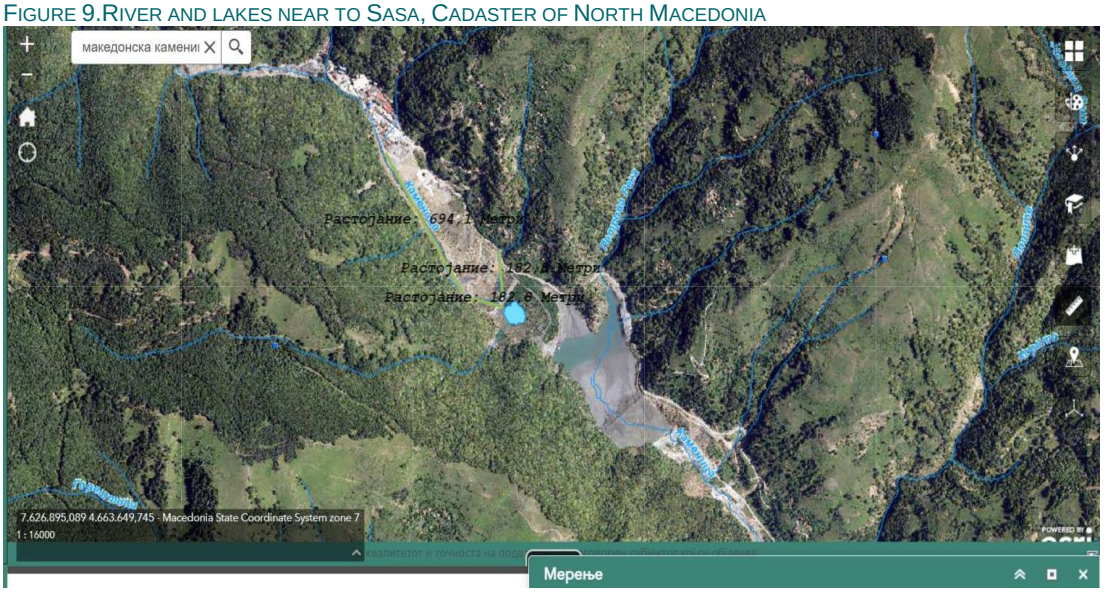
This mine is located at a distance of 10 km from the nearest major settlement (Makedonska Kamenica). The location Sasa is in the vicinity of the 110 kV transmission network. There is also a road next to the location. Using Google Earth, it is determined that the average slope of the location is 11% (Figure 8), while using the Global Solar Atlas, it is determined that global horizontal radiation is 1270.2 kWh/m^2, and the wind speed is 6.9 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly artificially barren land, owned by the Republic of North Macedonia and Sasa. The area of the site is about 0.10 km^2, on which about 8 MW PV can be installed. In terms of environmental protection, this location is not in a national park or protected area, or in an IBA or IPA.

FIGURE 8.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH – SASA

According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, the river Kamenica as well as one other small lake is located at the place where the power plant would be built (Figure 9).

From the Employment Agency, the Survey of Unemployed Persons as of February 28, 2022 is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Kocani (the city closest to the location) is 2 785.

FIGURE 9.RIVER AND LAKES NEAR TO SASA, CADASTER OF NORTH MACEDONIA



Damjan

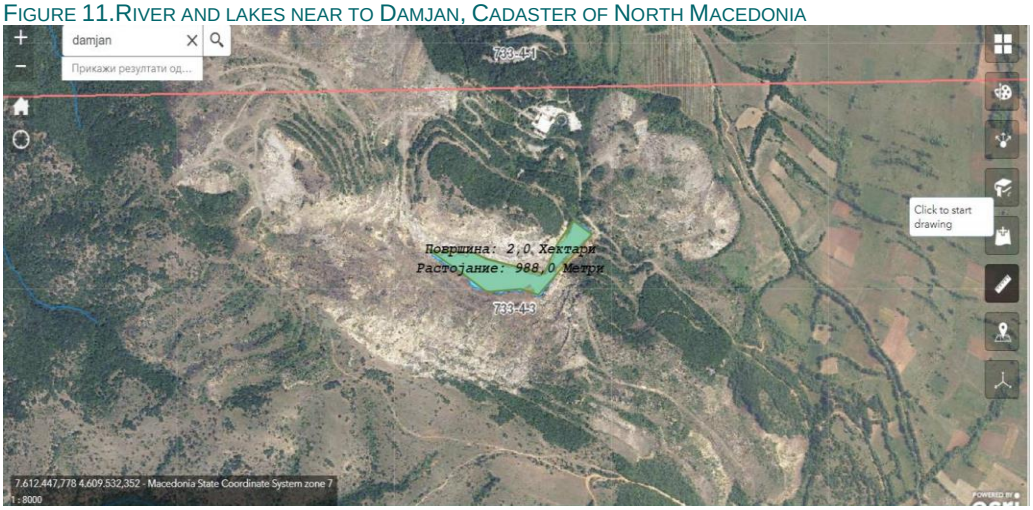
This mine is located at a distance of 10 km from the nearest major settlement (Radovish). Damjan is around 3 km from the 110 kV transmission network. There is a road next to the location. Using Google Earth, it is determined that the average slope of the location is 7.6% (Figure 10), while using the Global Solar Atlas, it is determined that global horizontal radiation is 1513.4 kWh/m^2, and the wind speed is 5.76 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly owned by the Republic of North Macedonia. The area of the site is about 0.09 km^2, on which about 7 MW of PV can be installed. In terms of environmental protection, this location is not in a national park or protected area, or in an IBA or IPA.

FIGURE 10.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH – DAMJAN

According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, one lake is located at the place where the power plant would be built (Figure 11).

From the Employment Agency, the Survey of Unemployed Persons as of February 28, 2022 is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Radovish (the city closest to the location) is 2 491.

FIGURE 11.RIVER AND LAKES NEAR TO DAMJAN, CADASTER OF NORTH MACEDONIA



Results from prioritisation of candidate sites

The results from the prioritisation are based on the calculated and evaluated data for each of the analysed locations, given in Table 1.

TABLE 1. INPUT DATA FOR THE PRIORITISATION

	Suvodol	Brod Gneotino	Piskupstina	Sasa	Damjan
Power grid connection (kV)	400, almost on the site	110, almost on the site	110	110, almost on the site	110, on 3 km
Distance to road (m)	130	260	1	1	110
Slope (Average)	10	4.4	7.1	11	7.6
Wildlife protection	birds	birds	No, birds	No, birds	No, birds
Workforce	5291	5291	3660	2785	2491
Proximity to settelements (km) vozdusno	5	12	4	10	10
Distance to rivers or lakes	500	0	0	0	0
Solar radiation (kWh/m2) (GHI)	1538.5	1552.9	1469.4	1270.2	1513.4
Wind speed (m/s)	4.02	4.17	4.1	6.9	5.76
Type of land, owner	Barren, ESM	Barren, ESM and Republic of North Macedonia	Barren, Republic of North Macedonia, private	Barren, Republic of North Macedonia, SASA	Barren (stonecutter)Каменьари, Republic of North Macedonia
Installed capacity (km2)	6	2	0.11	0.10	0.09
Solar installed capacity (MW)	480	160	9	8	7

The wind speed at the locations of the mines Suvodol, Brod Gneotino and Piskupshtina is around 4 m/s which is lower than the minimum needed for construction of wind power plants, so these locations were not considered. The results of the other two locations are shown in Table 2. It can be noticed that the location of Sasa is more suitable for wind power plant construction since, according to the measured wind speed, it has a higher value, and therefore a higher score. The results of the weights for each criterion, based on the experts' opinions, are also presented in Table 2.

TABLE 2. RESULTS OF THE PRIORITISATION OF LOCATIONS FOR WIND POWER PLANTS

	Sasa	Damjan		Weight of criteria
Power grid connection (kV)	5	5		15%
Distance to road (m)	5	5		6%
Slope (Average)	3	3		8%
Important bird area	5	5		10%
Workforce	1	1		7%
Proximity to settlements (km)	1	1		7%
Distance to rivers or lakes	1	1		7%
Wind speed (m/s)	5	4		16%
Type of land	5	5		16%
Installed capacity (km2)	1	1		8%
Final score	**3.68**	**3.52**		

The results for the prioritisation of the solar power plants are shown in Table 3. It can be noticed that the most suitable location is Suvodol, because of the great solar radiation at the location, the large area on which the solar panels can be installed, as well as the advantage related to the hydrology in the location (since there is no river or lake at the location, as is the case for the other locations).

TABLE 3. RESULTS OF THE PRIORITISATION OF LOCATIONS FOR SOLAR POWER PLANTS

	Suvodol	Brod Gneotino	Piskupstina	Sasa	Damjan		Weight of criteria
Power grid connection (kV)	5	5	5	5	5		15%
Distance to road (m)	5	5	5	5	5		6%
Slope (Average)	3	5	3	3	3		8%
Important plant area	5	5	5	5	5		10%
Workforce	5	5	3	1	1		7%
Proximity to settlements (km)	3	3	3	1	1		7%
Distance to rivers or lakes	5	1	1	1	1		7%
Solar radiation (kWh/m2) (GHI)	5	5	4	1	5		16%
Wind speed							
Type of land	5	5	5	5	5		16%
Installed capacity (km2)	5	2	1	1	1		8%
Final score	**4.70**	**4.34**	**3.80**	**3.04**	**3.68**		

From the obtained results it can be concluded that the tested sites have a great potential for the construction of solar power plants. On the other hand, in terms of capacity for construction of wind farms, only one location stands out, but that location is with minimum wind potential because the wind speed is just over 6 m / s.

1 Introduction

By 2040 about 1400 MW solar power plants and 750 MW wind power plants should be built in North Macedonia as defined in the Strategy for Energy Development until 2040. With these installed RES capacities, and also investment in hydropower plants, it is expected that the current mix of electricity generation will be modified so that by 2040 over 80% of electricity will be produced from RES, opposite to the current situation where lignite-fired power plants (PP) contribute with 80% of domestic production.

To accomplish the 2040 vision, there is an urgency for RES development which is near the transmission and distribution network's capacity and the locations where they will be built. In addition, numerous limitations need to be taken into consideration and various stakeholders should take part in planning the future energy system development. In this study special attention is given to brownfields and mines in particular, as potential locations that can be redeveloped, and can now be used as sites for renewable energy sources. Therefore, this study first gives an analysis of the legal aspect of brownfield investments in renewable energy sources, giving an overview of all the relevant laws and rulebooks that should be considered in this type of investment. Additionally, a financial analysis of the investments in renewable energy on brownfields is also presented, outlining the different types of costs and parameters for assessing the economic efficiency and profitability of the investments, as well as potential parameters and factors that determine the location of photovoltaic (PV) and wind power plants (WPPs).

Having a list of possible sites for construction of wind or solar power plants means that there should be a methodology for prioritization of these sites, which will determine which of these sites are suitable for such type of investment, and additionally which are the best sites not only in financial terms, but also legal, environmental, and social. In this regard, this study suggests the multi-criteria assessment methodology, where each location is evaluated through different criteria and the weights for each criterion are determined by using the Analytic Hierarchy Process method. One very important part of this methodology is the selection of criteria upon which the different sites will be graded, including the pre-assessment eligibility criteria. The process of selection of these criteria was complex and included the results of the legal and financial analyses conducted in this study, as well as the opinion of the different stakeholders which were very important in this process. Based on this, the following criteria were selected for the multi-criteria assessment process:

- power grid connection
- distance to road
- slope
- wildlife protection (birds, plants, etc.)
- qualified workforce that can be hired for the new investment
- proximity to settlements
- distance to rivers or lakes
- weather parameters
- type of land

- installed capacity

Additionally, for the project eligibility, the following criteria have been selected:

- Whether the project is consistent with valid EU policies and strategies
- Whether the project is covered by a relevant sector strategy paper (sector action plan or sector master plan)
- Whether the project contributes to valid national development objective
- Whether the project is within protected areas
- Possibility for land acquisition and existing facilities
- Building permits
- Soil Stability & Engineering Potential
- Reclamation Status and Containment of Environmental Risk

As previously mentioned, the focus of this study were the brownfields, and especially mines - existing, closed, and potential mines. For that purpose, a detailed map of their locations was developed (Figure 15). In this phase of the project, five locations were analysed in details and scored according to all ten proposed criteria and evaluated based on the pre-assessment eligibility criteria. The results of applying the proposed methodology to these five locations show that the most suitable mine for PV construction is Suvodol, and the most suitable location for wind power plant construction is Sasa.

2 Overview of the national energy sector

North Macedonia as an Energy Community Contracting Party, a full member of NATO and EU candidate country is willing to follow the European energy policy and is obliged to transpose and implement the EU energy directives and regulations. As such the country has an opportunity to benefit from increasing access to green energy funds. With the growing development of small-scale renewable energy sources (RES) and energy efficiency (EE) measures, national financial support will play a paramount role in stimulating households and small and medium enterprises (SMEs). Funding programs of international financial institutions and donors (e.g., EBRD, WB-IFC, USAID, GIZ, UNDP and EIB) have been used previously for development and construction of energy projects in the country. Full engagement is expected by all relevant stakeholders, the government, ministries, and public enterprises for proper usage of the financial instruments (Green bonds, Instrument for Pre-Accession IPA (3), Western Balkans Investment Framework (WBIF), Western Balkans Guarantee Facility etc.). Moreover, the commercial banks got acquainted with the importance of targeting RES and EE businesses, and strongly support such projects. In the last years, the country enhanced the most important segments of business climate to create opportunities for SMEs in RES and EE, in particular in the fields of protecting minority investors, dealing with construction permits and getting loan.

The main generating capacities in North Macedonia are coal-fired thermal power plants and hydropower plants. The total installed capacity for electricity production is 2.08 GW with ~50% being thermal power plants, ~34% large and small hydropower plants, ~13% combined natural gas-fired plants and ~3% other renewables. Over the last years, electricity generation from coal has been decreasing, reaching nearly 60% of the domestic generation in 2017. Suvodol and Brod Gneotino are the largest mines with almost 98% of the total coal produced for energy transformation. In terms of produced volume, Suvodol mine is responsible for 68% - 88% of total coal produced for energy transformation depending on the year. Located in the vicinity of the Suvodol mine, Brod Gneotino accounts for 10% - 30% of the total coal produced for energy transformation. Suvodol and Brod Gneotino mines are used to supply TPP Bitola which coal resources are nearing depletion in mid-term. Considering the projected average annual consumption of coal of TPP Bitola of approximately 5 Mt, the reserves in the area are estimated to be sufficient for around 15 years of production. The coal supply to TPP Bitola could be extended for another 10 years with the commissioning of new Zivojno mine according to ESM's 5-year investment plan 2018-2022. TPP Oslomej is supplied solely from the Oslomej mine which is nearly depleted and produces less than 2% of the total coal produced for energy transformation. According to the ESM 5-year investment plan 2018-2022, commissioning of new reserves in the vicinity of TPP Oslomej is not expected due to the socio-environmental reasons, meaning that other sources of fuel supply such as import of higher calorific coal, use of domestic resources from other mines or switching to other forms of fuel are possible alternatives. In the period 2010-

2016 the electricity consumption has been decreased primarily due to the industry sector, but the average share of imports in the observed period made up ~30% of total electricity consumption.

Fortunately, the overall RES is increasing over the years in terms of capacity reaching 37% in 2019, which led to RES generation up to 23% in total generation. In parallel with the introduction of new technologies for electricity production, there is a notable reduction in the total electricity production from thermal power plants in 2019. In addition, the reduction of the price of natural gas contributed to the domestic production of electricity being maintained at a level of about 5600 GWh. A significant increase in installed capacity is made possible by the feed-in tariff as a support mechanism for RES for electricity generation. In 2019, with the help of this mechanism, a total of 141 MW were installed, of which 80 MW were small hydropower plants, 17 MW PV, 37 MW wind, 7 MW biogas and 0.6 MW biomass power plants. Electricity production from these power plants in 2019 is 350 GWh which is 5% of the total domestic electricity production.

The 2040 vision of the Strategy is set on secure, efficient, environmentally friendly and competitive energy system that is capable to support the sustainable economic growth of the country. In order to meet the 2040 goals, the Strategy depicts three scenarios (Reference, Moderate Transition and Green) with different dynamics of energy transition and enables flexibility into Macedonian response to relevant EU policies for a climate-neutral economy by 2050.

The Green Scenario foresees a radical transition from conventional energy based on new policy and lignite phase-out. The assumption in regard to the demand drivers is that Macedonian GDP growth will reach neighbouring countries' GDP per capita of today by 2040. Furthermore, there will be more incentives and advanced technologies for energy efficiency based on the enhanced policies that are in line with EU Directive and EnC guidelines. Nonetheless, an important driver on the demand side is the highest penetration of EVs that the Green Scenario predicts. With regards to generation investments, there will be an extreme emphasis on the RES investments and focus on lignite PP revitalization choice based on least cost principles. The goal for a carbon price at the ETS level is set for 2023 according to the Green Scenario. Additionally, the commodity prices are based on the Sustainable development scenario (World energy outlook 2017), as the assumptions highlight. Last, but not least in the overview for the development of the Macedonian energy system until 2040 is the fuel supply, namely fuel availability. The lignite production will be capped at a maximum level of annual supply expected, and the hydro, wind and solar will be in line with the historical trends and the power system will be adjusted for new entering power plants. Therefore, it is vital to enhance the cross-border electricity and gas capacities by aligning them with the ENTSO-E, ENTSO-G and EnC by 2040. Sustainable consumption of biomass that does not exceed the annual growth of biomass, thus including utilization of residual biomass should be secured in the future.

According to the final draft version of the Program for the realization of the strategy for energy development in the period 2021-2025 for implementation of proposed policies and measures it is necessary to invest 4.7 billion EUR. Most investments are in Energy efficiency (2.9 billion EUR), then investments in Decarbonization (1.2 billion EUR) and Integration and security of the energy market (0.6 billion EUR). A vast part (41%) of the funds needed for the implementation of the proposed policies and measures foresee an investment by the energy consumers, primarily households. It is presumed that private companies will participate with 20% of total investments

and with 18% of total investments the PPP has a significant role. It is predicted that 7% of total investments will be secured from the central budget, and an additional 2% of total investments will be allocated from local government budgets. Different donors and creditors will provide the remaining 12% of the funds, of which the EBRD has the largest share with 5% of total investments.

3 Relevant studies/publications on brownfields as locations for Renewable Energy Plants

Driven by Paris Agreement goals, the transition to clean energy will require a significant global buildout of renewable energy generation. Most of these projects will necessitate large areas for development. Therefore, brownfields, including locations such as abandoned mines, are becoming more attractive, as they already have some infrastructure that could be utilised for the RES installations.

Over the past few decades, many studies and papers have researched the possibilities for redevelopment or reuse of brownfields.

The Nature Conservancy's recent Study on Clean and Green Pathways for the Global Renewable Energy Buildout[4] identifies six pathways for promoting utility-scale solar and wind energy in places with low-impact on nature and supported by local communities. The study includes several examples from the USA, among which is the Restoration Design Energy Project (RDEP) launched by the Bureau of Land Management (BLM) in 2009 to identify disturbed or previously developed sites within its portfolio of lands, such as brownfields, that could be made available for renewable energy development. Based on an extensive public outreach process, the BLM and other public entities identified 64 previously disturbed sites on federal, state, municipal, and private lands that may potentially be suitable for renewable energy development. Site types include gravel pits, mine sites, landfills, isolated parcels that have been disturbed, marginal or impaired agricultural lands, abandoned unauthorised airstrips, and Central Arizona Project (CAP) land.[5] The sites assessments were performed by giving a weighted score for each of the sites on a scale of 0 (least development potential) to 100 (best development potential), based on general topographic and property size suitability (e.g., the slope of the terrain for solar projects); solar resource availability; wind potential rating; distance to existing transmission and distribution lines, interconnections, and roads; distance to different types of load centres; and the presence of sensitive resources and potentially incompatible land use designations.

Also, in the RE-Powering America's Lands Initiative[6] framework, the U.S. Environmental Protection Agency (EPA) pre-screened more than 80,000 brownfields and municipal solid waste landfills for suitability as renewable energy generation facilities, using screening criteria developed in collaboration with the National Renewable Energy Laboratory (NREL). This Initiative aims to encourage renewable energy development on current and formerly contaminated lands, landfills, and mine sites when such development is aligned with the community's vision for the site. The

[4] McKenney, Bruce and Jessica Wilkinson, "C*lean and Green Pathways for the Global Renewable Energy Buildout*", The Nature Conservancy, Arlington, VA, 2020.
[5] Arizona Restoration Design Energy Project, "*Solar and Wind Energy Assessment of Nominated Sites"*, 2012.
[6] https://www.epa.gov/re-powering

Initiative identifies the renewable energy potential of these sites and provides other valuable resources for communities, developers, industry, state and local governments or anyone interested in reusing these sites for renewable energy development.

In addition, another research paper[7] quantitatively examines what factors drive a complete brownfield redevelopment by investigating 200 brownfields properties listed with the United States Environmental Protection Agency (EPA) and redeveloped between 2000 and 2015. The correlation between brownfield redevelopment and a combination of six predictor variables was analysed using multiple regression. The predictor variables include stakeholder involvement (public-private partnership), socio-economic (income level), tax incentives, type of contamination, political climate, and sustainable building practice (green development). The findings from this paper indicate a significant relationship between brownfield redevelopment and two variables: socio-economic factor (income levels) and green development, i.e., the higher factor values, the higher value of brownfield redevelopment.

Another study on Clean energy transition in the coal regions in the EU[8] performed by the Joint Research Center (JRC) of the European Commission explores the coal mines in these regions as attractive locations for renewable energy systems for electricity (RES-E) conversion. The study identified the existing wind and solar projects on closed open-pit mines sites that already demonstrate the energy transition in the EU. From the identified 16 wind projects at eight coal mines sites, five are located at the coal mine Klettwitz in Germany[9], on 61.9 km2 area and a total installed capacity of 145.5 MW (including the last project from 2017). In addition, at the same mine site, four solar projects are located with a total installed capacity of 22.6 MW. Out of 26 identified solar projects in the JRC study, the most significant projects are situated at the former open-pit coal mine Meuro[10] in Germany on a 32.2 km2 area and a total installed capacity of 176 MW.

Nevertheless, in the JRC study, an optimization model was developed to estimate the optimum wind power and solar PV share for each coal mine based on the site-specific resources, technical variables, and land availability. The model objective function is to maximize the total RES-E technical potential on an hourly basis on each of the coal mines for 30 years, and the constraints of the maximization are that the wind and solar PV shares need to sum up to 100% in the available mine area. The calculations were made for the 75 open-pit coal mines operating in 2017 in the coal regions in transition considered in this study.

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[7] L. Green, "*Evaluating predictors for brownfield redevelopment*", Land Use Policy, Volume 73, 2018, Pages 299-319, ISSN 0264-8377, https://doi.org/10.1016/j.landusepol.2018.01.008.
[8] Kapetaki, Z., Ruiz, P. et al., "*Clean energy technologies in coal regions: Opportunities for jobs and growth - Deployment potential and impacts"*, Kapetaki, Z. (editor), EUR 29895 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-12330-9, doi:10.2760/063496, JRC117938.
[9] Horizon 2020 Project TRACER (Transition in Coal Intensive Regions) – Best Practices, *Fact Sheet: Wind park "Klettwitz"& Vestas blade factory Lauchhammer*
[10] Horizon 2020 Project TRACER (Transition in Coal Intensive Regions) – Best Practices, *Fact Sheet: Solar park complex "Senftenberg"*

Another case study for China (Xi'an)[11] describes a multiple criteria decision analysis (MCDA) technique designed and applied for comparing and ranking brownfield redevelopment projects. The technique, called the Modified multilevel grey evaluation method, is developed using concepts from grey systems theory, entropy, and the analytical hierarchical process (AHP). The applied combined weighting method, reflecting both the decision makers' subjective intentions and objective reality, makes the evaluation results better correspond to the actual situation. The study uses an evaluation index system for brownfield redevelopment obtained from six dimensions: environmental and health, financial and accounting, characteristics of the brownfield, social stability, policy and technology criteria, and performance criteria. According to the study, such an approach can provide a valuable tool to obtain scientific and reasonable results for complicated multi-objective decision-making.

Some of the approaches described before, like the multi-criteria assessment in combination with the analytical hierarchical process, will be applied here in this study to identify and prioritise the potential brownfields in North Macedonia that can be used to install PV and wind power plants.

A similar assessment of the potential for renewable energy development on brownfields in North Macedonia has not been completed. However, there is likely a high potential given the expected demand for renewable energy systems and the quantity of potentially suitable brownfields.

[11] Liang Y, Wei J, Lu H, Zhang L., "*Evaluating Brownfield Redevelopment using an Modified Multilevel Grey Method - A Case Study of Xi'an*". *EURASIA J Math Sci Tech Ed*. 2017;13(12), 8383-8392. https://doi.org/10.12973/ejmste/77914

4 Legal analysis on brown-field investments in renewable energy plants

This legal analysis covers the laws and bylaws of the Republic of North Macedonia that are relevant and important for brownfield investments in RES. More precisely, as the main potential for brownfield investments is expected to be located in mining areas – abandoned mines or mines expected to be abandoned as well as mining sites that allow for additional production facilities to be built therein - the legal analysis primarily focuses on the national legislation related to mineral resources.

The mineral resources are considered as a property of the Republic of North Macedonia, therefore, the only way they can be exploited is by obtaining a concession from the competent state body. In that respect, the Law on Concessions and Public-Private Partnerships is also analysed but only those provisions that have relevance for the brownfield investments (contract duration, ownership rights and transfer). Despite in general the RE generating facilities are considered as non-polluting and environment-friendly compared to the fossil fuel power plants, still certain environmental impact assessments have to be conducted, regardless of the location to be used for facility construction and operation, and therefore provisions related to these assessments from the Law on Environment as umbrella law in this area are also analysed. Eventually, the Rulebook on Urban Planning, which elaborates on the Law on Urban Panning in more details, is analysed in terms of the type of class purpose where the mining and energy facilities belong, as well as the flexibility for changing the initially defined purpose class.

For each piece of legislation provided in this analysis, its subject matter and review of the relevant provisions are provided, ending with brief conclusion on its applicability for brown-field investments in RES or if changes might be necessary.

4.1 LAW ON MINERAL RESOURCES („Official Gazette of the Republic of Macedonia" no. 136/12, 25/13, 93/13, 44/14, 160/14, 129/15, 192/15, 39/16, 53/16, 120/16, 189/16 and 7/19)

4.1.1 General provisions

The Law regulates:

- conditions and the manner of conducting a geological survey, the encouragement and improvement of geological survey in order to ensure their optimal use in accordance with the principles of sustainable development and environmental protection,

- encouragement and improvement of the exploitation of mineral resources, as well as strengthening the safety measures, environmental protection and human health,

- encouragement and improvement of the processing of mineral resources, as well as strengthening the safety measures, environmental protection and human health,

- supervision and conditions for performance of geological survey, exploitation and processing of mineral resources, and

- measures and manner in which the harmful impact on the environment and human health that may occur as a consequence of the management of the generated waste and the already generated waste from the exploration, exploitation and processing of the mineral resources is prevented or reduced to the minimum possible extent.

In addition to the provisions of this law, the following laws also apply to the procedures for awarding concessions and exploitation and processing of mineral resources:

1. Law on Concessions and Public-Private Partnership
2. Law on General Administrative Procedure
3. Law on Safety and Health at Work
4. Law on Environment

4.1.2 Definitions of key terms

- ***Mineral resources*** are all organic and inorganic mineral substances that are in solid, liquid or gaseous state.
- ***Ore reserves*** are determined quantities of a specific mineral substance from the site determined by the study for performed detailed geological survey.

- ***Geological survey*** is a set of methods and techniques aimed at obtaining information that defines the geological structure of a particular area of the Earth.
- ***Exploitation of mineral resources*** is an activity of extraction, i.e. release of mineral resources from their natural state, including the preparatory, associated and subsequent activities related to the extraction of mineral resources;
- ***Processing of mineral resources*** is the separation of the useful from useless minerals or mineral types contained in the mineral resource (ore) in the form of concentrate, granulate (classified product) or technogenic solid form of a compound or element (salt, metal, etc.), i.e. to represent a market product with a certain quality for future use;
- ***Recultivation*** is a process of returning the land to a useful condition, which was degraded by geological survey or by the exploitation and processing of mineral resources;
- ***Mine*** is a limited area of land, on the surface or under it, where the mineral resource is exploited with the use of machines, equipment, mining infrastructure necessary for performing the mining works and landfills (landfills and hydro-tailings);
- ***Mining facility*** is a facility on the surface or underground of the area for exploration, i.e. exploitation, which is intended for exploration, exploitation and processing of the mineral resources and for performing other mining works;
- ***Mining infrastructure*** are mining facilities that are necessary for exploration and works related to the exploitation of mineral resources (access roads, electrical installations and devices, facilities, buildings for persons and equipment, etc.);
- ***Landfill*** is a designated place within the mine where the mine cover is transported and deposited;
- ***Exploitation field*** is a part of the area on which the mineral resources are determined, the area necessary for the exploitation of mineral resources and organization of the mining works, construction of mining facilities and the area where the waste from exploitation is located and managed, and which on the surface of the earth is bounded by coordinate points interconnected by straight lines with unlimited depth;
- ***Operator*** is a concessionaire that exploits the mineral resources for the period for which the concession has been granted and that manages the waste from the exploitation of the minerals;
- ***Rehabilitation*** is a process of cleaning the land that had been affected by tailings installation, in a way that the land returns to a satisfactory condition, especially in terms of soil quality, wildlife, natural habitats, freshwater systems, landscape and the appropriate usefulness of it.

4.1.3 Key policy principles and documents

Mineral resources are goods of general interest, property of the Republic of North Macedonia, regardless of the ownership of the land on which they are located.

The Government of the Republic of North Macedonia at the proposal of the Minister of Economy adopts a **strategy for Geological Surveys, Sustainable Use and Exploitation of Mineral Resources** for a period of 20 years.

Such a Strategy has not been adopted so far.

Each concessionaire has obligations in regards to the rehabilitation and recultivation of the land that has been degraded by the mining activities. 4% of the Budget funds collected from the fees

for issuing permits, concessions for detailed geological surveys and concessions for exploitation of mineral resources, will be used for recultivation and return to useful condition of the degraded areas where geological survey and/or exploitation of mineral resources were performed.

4.1.4 Provisions related to recultivation and rehabilitation

Article 83 of the Law lays down the obligations related to the rehabilitation of the environment and elimination of the consequences, as well as the key strategic documents related to it.

The concessionaire who performs a detailed geological survey or exploitation or processing of mineral resources, during these processes and/or during the performance of mining works and works from mineral processing, as well as after their completion must carry out rehabilitation of the area, in accordance with: 1) the project for conducting a detailed geological survey, 2) the rehabilitation project, which is an integral part of the main or additional mining project, as well as in accordance with 3) the waste management plan.

For the purpose of recultivation and return to useful condition of abandoned degraded areas where geological survey and/or exploitation of mineral resources has been performed, the Government shall adopt an annual program for recultivation of degraded areas upon a proposal of the Minister of Economy. The annual program shall determine the abandoned degraded areas for which recultivation measures should be taken, the manner of recultivation, the amount of the necessary means for recultivation, as well as the manner of management of the waste installations which is a consequence of the exploitation of mineral resources on deposits from which the mineral resource is depleted. The funds for financing the annual program shall be provided from the Budget of the Republic of Macedonia from the fees collected from granted concessions for detailed geological exploration and exploitation of mineral resources.

So far, the Government has never adopted an annual program.

Article 84 of the Law allows interventions in the concession area and exploitation field to be made, i.e. infrastructure facilities to be built, if they are of public interest and without disturbing the exploitation of mineral resources.

4.1.5 Conclusions

It seems there is a discrepancy between what is written on paper and what is happening in practice when it comes to mineral resources. First, the Government has not adopted a Strategy for geological surveys, sustainable use and exploitation of mineral resources for a period of 20 years, which as any strategic document should set the guidelines in terms of the type and quantity of land that could and should be used for geological surveys and exploitation, if there would be land for geological surveys and exploitation of particular state interest, specific activities that would be taken to make the land and exploitation field sustainable, including sustainability criteria, etc.

Second, according to the law, rehabilitation and recultivation are activities that are mandatory for implementation in each concession awarded. Furthermore, financial means for implementation of these funds-demanding activities are foreseen. However, in all these years since the law entered into force, the Government has never adopted an annual program for rehabilitation and

recultivation that will define closer the land/area that will be subject to rehabilitation and recultivation.

The fact that the Law allows infrastructure facilities to be built in the concession area and exploitation field if they are of public interest and without disturbing the exploitation of mineral resources provides additional possibilities for brown-field investments. Namely, according to the Lon on Energy, the construction and operation of RE generation facility is an activity of public interest by default (without a need public interest to be declared by a formal act), which means that it can be constructed within the mine site that is still operational, as long as the construction process and the operations of the constricted power plant are not disturbing the exploitation of mineral resources.

Therefore, from a legal point of view, the fastest way to realize a brown-field investment in RE generation facility is to identify active mining (exploitation) sites that have sufficient and adequate areas for construction of RES power plants. The investment process will be further accelerated if the degree of degradability of these areas provides for construction of RES power plants without prior rehabilitation or recultivation.

4.2 LAW ON CONCESSIONS AND PUBLIC PRIVATE PARTNERSHIPS ("Official Gazette of the Republic of Macedonia " no. 6/12, 144/14, 33/15, 104/15 and 215/15 and "Official Gazette of the Republic of North Macedonia" no.153/19 and 261/19)

4.2.1 General provisions

The Law regulates:

- awarding of concession of goods of general interest and contract for the establishment of a public and private partnership (PPP),
- legal protection for each entity that would have or has an interest in obtaining such contract and risked or risks to be damaged in the procedure for awarding such contract, and
- other issues regarding the concessions of general interest and the contracts for establishing a PPP.

Concession of goods of general interest shall mean a contract other than a public work concession and public service concession, the subject of which is to grant the right to use goods of general interest;

The provisions of this Law that regulate the procedures for granting concessions of goods of general interest shall not apply where a concession is granted to the public enterprises, public institutions, as well as companies established by the Republic of North Macedonia, the municipalities and the City of Skopje and companies on which the state or municipal bodies or the City of Skopje have a direct or indirect impact through their ownership, i.e. own the majority portion of the company's capital, have the majority votes of the shareholders/partners and appoint more than a half of the members of the management or supervisory board.

In terms of payment of concession fee, the provisions determined by a special law shall apply.

4.2.2 Right to Ownership

The facilities constructed under a PPP, including accessories and improvements, shall be the property of the public partner, unless otherwise provided in the contract for the establishment of the PPP.

The public partner must stipulate in the tender documentation the conditions under which the property rights may be transferred.

When the PPP contract terminates, the Private partner shall be obliged to return, i.e. transfer to the Public partner's ownership the facilities constructed under the PPP, regardless of whether or not they were either fully or partially constructed, reconstructed, conserved, furnished or improved by the Private partner, under conditions and in a manner stipulated in the contract for the establishment of the PPP, if not otherwise provided.

4.2.3 Contract Period

The contracts provided by this Law shall be concluded for a period of up to 35 years as of the day of the conclusion of the contract, i.e. from the date of enforcement of the contract, if this date differs from the previous one unless otherwise provided by a special law.

When determining the contract period, the financial and economic indicators and technical and/or technological specifics of the subject of the contract are considered, based on the feasibility study on the justification of the granting of the concession of goods of general interest or the contract of establishing the PPP.

The concession grantor or public partner shall, six months before the expiry of the current concession or PPP initiate the procedure for awarding a new concession of goods of general interest, i.e. a new contract for establishing PPP.

4.2.4 Transfer

The contract for a concession of goods of general interest or the contract for establishing PPP can be transferred, with the written consent of the concession grantor, i.e. the public partner, under the conditions laid down in the contract and without breach of the contract duration, unless otherwise provided by a special law.

The contract for a concession of goods of general interest or the contract for establishing PPP may provide for the transfer of the rights and obligations of the contract, from the concessionaire or the private partner in favour of lenders as a means of securing their claims from the concessionaire or private partner, provided that it does not endanger the continuous operation and/or service provision, quality performance of the activity, and also the price.

In the case of transfer of the contract for a concession to goods of general interest or the contract for establishing PPP, the concession grantor or the public partner concludes a contract for transfer with the entity to which the contract for a concession of goods of general interest or the contract for the establishing PPP is transferred under the conditions and in the manner set forth in the existing contract for a concession of goods of general interest or the contract for establishing PPP.

The transfer of shares or portions from the concessionaire or private partner in special purpose vehicle for the purpose of executing the concession or the PPP, cannot be executed without the written consent of the concession grantor i.e. the public partner.

4.2.5 Registry of Awarded Concessions and PPP established

According to Article 56, the Ministry of Economy is responsible to keep the Registry of all contracts for concessions and PPPs established. Each entity that awards the concession or is a Public

partner is obliged to submit data on a prescribed template to the Ministry in order the data to be entered in the Registry, The Registry shall be published on the Ministry of Economy website. This Registry does include data on the duration of the concession (end date of the concession contract), but does not specify the number of cadaster parcel and the type of land for which the concession is awarded.

4.2.6 Conclusions

In general, this law regulates the procedural aspects of awarding concessions and PPP. However, the provisions elaborated above related to contract duration, its transferability and ownership right on the concession subject are important for brownfield investments. Namely, the contracts' duration can be shorter than 35 years, meaning that many actual concessions for exploitation of mineral resources may expire in the near future and be used for other purposes if the exploitation of the site is exhausted.

The general ownership rule is that the Public partner remains the owner or obtains the ownership after the expiration of the concession and can decide upon the future of that land and facilities built on it. This means that the state as a public partner can easily from a legal point of view (without any modifications in the law) decide on the land use purpose, whether further concession for exploitation of mineral resources will be awarded or PPP for construction and operation of RES generation facility will be established or the land to be used for construction and operation of RES generation facility by the state-owned companies or by a private entity to which the land will be sold/leased.

Construction of PV power plant through PPP on the landfill of the Oslomej mines

The following is the first investment in North Macedonia in the construction of RE generation facility on old mines and is based on PPP model.

The location (landfill) where the two PV power plants (50 MW each) will be built is within the mining and energy facility Oslomej owned and operated by the state-owned ESM - the biggest power producer in North Macedonia. Based on the conducted feasibility study, the ESM Management Board decided to conduct a tender for establishing PPP for the construction and operation of the PV power plants. Since ESM is owned by the Government of North Macedonia, the decisions for launching the procedure and selection of the Private partners had to be endorsed by the Government.

The PPP model foresees the following:

1) ESM remains the owner of the land (cadaster parcels) but transfers to the Private Partner the right to use the construction land on which the PV power plant is to be built and land on which the transmission line for connection to the electricity transmission network is to be built (if owned by ESM), without compensation and free from all burdens,
2) ESM, at its own expense, will initiate and complete the procedure for preparation and approval of urban planning documentation for PV power plant and infrastructure project for the access road and hydraulic accumulator network, including procedures for expropriation, change of cadaster culture and/or permanent conversion into construction land of the land on which the construction plot, environmental elaborate, justification study, preliminary

design and techno-economic analysis, as well as to provide a geodetic elaborate for special purposes with numerical data and hydrological study,

3) The private partner will design, build and operate the PV power plant, for the purpose of which it will clean, level and prepare the construction plot, initiate and complete the procedure for issuing construction permits (for the PV power plant and connection to the network), connect the PV power plant to the electricity transmission network, and initiate and complete administrative procedures for obtaining other approvals, permits and licenses required for the operation of the PV power plant, and
4) The private partner will pay a monthly fee in the amount and in a manner determined by the PPP Agreement (portion of the generated electricity).

4.3 LAW ON ENVIRONMENT (*„Official Gazette of the Republic of Macedonia" no.* 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13, 42/14, 44/15, 129/15, 192/15, 39/16 и 99/18))

4.3.1 Subject matter of the law

This Law regulates the rights and the responsibilities of the Republic of North Macedonia, the municipalities and the City of Skopje as well as the rights and the responsibilities of legal entities and natural persons, in the provision of conditions required to ensure protection and improvement of the environment, to exercise the right of citizens to a healthy environment.

The measures and the activities for the protection and improvement of the environment are of public interest. The Government shall provide from the Budget financial resources for the protection and the improvement of the environment. Municipalities and the City of Skopje shall provide, from their respective budgets, financial resources for the protection and the improvement of the environment.

4.3.2 Environmental impact assessment elaborate

According to article 24 of the Law, legal entities or natural persons whose activities or works do not comprise projects that are subject to an environmental impact assessment procedure (elaborated below), shall develop an environmental impact assessment elaborate (hereinafter: elaborate). The elaborate shall be submitted to the body of the state administration responsible for the project approval and implementation, which will then submit it to the body competent for the elaborate approval.
The Government with decrees has determined:

- the activities for which an elaborate is mandatory, and the approval of which is within the competence of the MoEPP, and
- the activities for which an elaborate is mandatory, for the approval of which the mayors of the municipalities and the Mayor of the City of Skopje shall be held competent.

The body competent for approval of the elaborate (MoEPP or mayors) shall issue a Decision approving or disapproving the elaborate, as well as the time limit for each existing capacity that needs to be aligned with the prescribed environment quality standards and the prescribed emission limit values. The body competent for approval of the implementation of the elaborate shall refuse approval of a project, i.e. shall refuse the performance of the activities if there is no decision provided for the approval of the elaborate by the competent body (MoEPP or mayors).

4.3.3 Environmental impact assessment of certain projects

Section IX. (articles 76-94) of the Law is fully dedicated to the environmental impact assessment. The subject of environmental impact assessment shall be projects which due to their character, scope or location of their implementation, may have a significant impact on the environment. The assessment shall be carried out by determining, describing and assessing the impacts made or that may be made by the given project during its execution, operation and termination of operation on:
- human beings and biological diversity;
- soil, water, air and other natural resources, and climate;
- historical and cultural heritage, as well as on the
- inter-action between the elements indicated above.

The Government with a Decree has:

- specified the projects which are subject to a mandatory requirement for an environmental impact assessment procedure,
- defined the criteria based on which a need is identified for an environmental impact assessment of other projects specified in general terms which may have a significant impact on the environment, and
- defined the criteria based on which a need is identified for an environmental impact assessment in case of changes appearing on existing projects.

The Government may in exceptional cases decide based on case-by-case examination not to carry out an environmental impact assessment, either in whole or in part, of projects, in case of war or state of emergency, defines needs of the Republic of North Macedonia, if it is found that the implementation of the procedures for environmental impact assessment would have adverse effect on the defines, or need for urgent prevention of events that could have not been predicted and are likely to have a serious impact on health, security or property of people, or on the environment.
The Investor shall prepare the study on the project environmental impact assessment required for the carrying out of the project environmental impact assessment procedure and submit it to the MoEPP. To develop the study the Investor must engage at least one person from the List of Experts referred to in the law.
The report on the adequacy of the study on the project environmental impact assessment shall be prepared by the MoEPP or by persons appointed thereby from the List of Experts. MoEPP shall, based on the study on the project environmental impact assessment, the report on the adequacy of the study on the project environmental impact assessment, the mandatory public debate and the opinions obtained, issue a decision on whether to grant consent to or reject the application for the project implementation.

4.3.4 Conclusions on the legal status of RES generation facilities from the aspect of environmental protection

Investors in hydropower and wind power plants with an installed capacity of up to 10 MW and other RES power plants with an installed capacity of up to 200 MW must develop environmental elaborate which approval is issued by the MoEPP. In other words, local self-government units (municipalities and the City of Skopje) have no authority to issue an approval for the environmental elaborate.

Projects for which an environmental impact assessment procedure must be conducted (generally defined projects), which is more complex and time-consuming than the procedure for approval of

environmental elaborate, include large hydro power plants with an installed capacity of over 10 MW and installations for use of wind power for electricity generation (so-called wind farms). Neither the Law on Environment nor the Decree provides for definition or distinction between wind power plants and wind farms.

Strategic assessment is carried out on planning documents if they envisage implementation of projects for which an environmental impact assessment procedure is implemented or which affect the protected areas declared in accordance with the law. This includes, among other, all short-term, medium-term and long-term planning documents in the field of mining and energy, which define long-term goals for the development of RES (hydropower, wind energy, solar energy, geothermal energy, biomass, natural gas, biogas, biofuels, etc.) as well as individual energy activities to ensure the security of supply of various types of energy.

4.4 LAW ON URBAN PLANNING ("Official Gazette of the Republic of North Macedonia" no.32/20)

4.4.1 Subject matter of the law

In general, for any construction/facility to be constructed there must be an appropriate urban plan in place that will foresee such construction on the specific land area. The construction of RES power plants is no different from the construction of any other type of facility, therefore, they must be foreseen in the urban plans. Even mining sites must be foreseen in an urban plan. As of that, urban planning rules contained in the Law on Urban Planning are relevant and need to be elaborated.

This law regulates the systemic and hierarchical regulation of urban planning in the system of spatial and urban planning, goals and principles of spatial and urban planning, types and content of urban plans, conditions for performing activities in the field of urban planning, procedures for preparation, adoption and implementation of urban plans, supervision over the implementation of the provisions of this Law, as well as other matters in the field of urban planning.

Urban planning is part of the system of spatial and urban planning, which consists of the Spatial Plan of the Republic of North Macedonia and spatial plans for its implementation, as well as urban plans and acts for their implementation. The plans within the spatial and urban planning system are hierarchically and horizontally harmonized.

In the space covered by the urban plans, the public interest is the arrangement and humanization of the space, the protection and promotion of the environment and nature, as well as the preservation of the natural and cultural values of the space.

With the adoption of this law, the previous Law on Spatial and Urban Planning is repealed, which was in force since 2014.

4.4.2 Spatial planning provisions

Unlike the previous Law on Spatial and Urban Planning, the present law has very little provisions on the spatial plan(s). Extracts from the Law that define the place of spatial plans in the system and responsible authorities for their preparation and adoption are given below.

The spatial Plan of the Republic of North Macedonia, together with the spatial plans of the regions, the spatial plans of areas of special interest and the spatial plans of the municipalities and the city of Skopje are plans of a higher level of planning than the urban plans, which are plans of a lower level of planning and should be in accordance with them. The Spatial Plan of the Republic of North Macedonia is implemented by adopting spatial plans of regions, spatial plans of areas of special interest and spatial plans of the municipalities and the city of Skopje, while these spatial plans are implemented by adopting urban plans.

For harmonization of the urban plans with the plans from a higher level of planning (spatial plans), the Agency for Spatial Planning issues a document called Conditions for space planning. This document contains guidelines and solutions from the planning documentation of a higher level, i.e. from the Spatial Plan of the Republic of North Macedonia and the spatial plans for its elaboration and implementation, as well as a graphic (visual presentation) which is an excerpt from the plan. It also contains guidelines on the need to implement a Strategic Environmental Assessment in accordance with the Law on Environment.

The Agency is also responsible for developing the Spatial Plan of the Republic of North Macedonia and the spatial plans for its elaboration and implementation, as well as for monitoring the implementation of the Spatial Plan. According to the Constitution, the Parliament, based on Government's proposal, adopts the Spatial Plan of the Republic of North Macedonia.

4.4.3 Types of urban plans and procedure for their adoption

Depending on the scope of urban planning, as well as whether the subject of planning is of state or local importance, the following urban plans are foreseen:

TABLE 3. URBAN PLANS

Title of the plan	Importance	Responsible authority for adoption	Planning period	Procedural phases	Deadline for adoption
General urban plan	Local - city	Council of the City of Skopje and Council of municipality	10 years	2 phases	48 months
Detailed urban plan	Local – city	Council of municipality within the City of Skopje and with a seat in a city	5 years	2 phases	18 months
Urban plan for the village	Local - village	Council of municipality within the City of Skopje, with a seat in a city and with a seat in a village	10 years	1 phase	36 months
Urban plan for outside settlement boundaries	Local -	Council of municipality within the City of Skopje, with a seat in a city and with a seat in a village	5 years	1 phase	18 months
Urban plan for areas and buildings of state importance	State	Government	10 years	1 phase	36 months

The procedure for development and adoption of Urban plan for outside of settlement boundaries and Urban plan for areas and buildings of state importance is the following:

1. Adoption of the planning programme by the City Mayor / Minister of Transport and Communication
2. Preparing documentary basis of the plan
3. Developing the initial version of the plan
4. Based on the opinions obtained, developing plan proposal
5. Expert's revision of the plan proposal
6. Organizing public survey and public presentation of the plan proposal

7. Municipality / Ministry of Transport and Communication commission prepares a report with an explanation of the accepted and unaccepted remarks on the plan proposal
8. Obtaining consent on the plan proposed by the Ministry of Transport and Communication – only for the Urban plan for outside settlement boundaries
9. Adoption of the plan by the Municipality Council / Government

For efficient implementation of spatial and urban planning policy and the needs of preparation, adoption, implementation and monitoring of the implementation of urban plans, the Agency for Spatial Planning establishes an information system for urban and spatial planning, which provides conditions for professional and analytical monitoring of the implementation of the plans and continuous observation and analysis of the degree and manner of realisation of the plans.

4.4.4 Conversion of agriculture land into construction land with urban plans

Mining sites are already within the planning scope of certain urban plans. Therefore, the procedure for conversion of agricultural land into construction land does not apply to the existing or abandoned mining sites that might be used for the construction of RES power plants. However, the possibility of using agricultural land, especially those classified in the lowest categories, which can be barely used for agriculture purposes, should be further explored. Due to this possibility, the land conversion procedure is elaborated in the following paragraphs.

The land in the planning scope of the urban plan receives the status of construction land with the adoption of the plan, if it is so regulated in the plan. As an exception, in the planning scope of the general urban plan, the land may retain the status of agricultural, forest or other lands, if in the plan that is regulated by a special provision. In the planning scope of the other urban plans, the land can also retain the status of agricultural, forest or other lands, if there is an archeological site on it or if the plan envisages construction of an infrastructure line along the route of which a real load on the land is established and its further use as agricultural, forest and other lands, or if for other reasons it is regulated in the plan by a special provision. Eventually, the land covered by the project scope of urban projects for construction of individual buildings and infrastructures of state and local importance outside settlements and the scope of urban plans on agricultural, forest and other lands, coastal belts and other areas retains the status of agricultural, forest or other lands that existed before the approval of the urban project.

In any case, the Ministry of Agriculture, Forestry and Water Economy must give an opinion on the quality of agricultural land, existing facilities, established real loads of land or other relevant facts within their competence right after the adoption of the planning programme. Eventually, this Ministry must be informed for the adoption of the urban plan, if with the urban plan the agricultural land has been converted into construction land.

4.4.5 Urban project and urban project with a parcel plan

Acts with which the urban plans are implemented in accordance with this Law are:

1. **Urban project** as planning-project documentation that is prepared based on the urban plans and serves for their elaboration and implementation, i.e. detailed elaboration of construction plots and construction land for general use, for which the urban plans do not provide detailed provisions

for construction and arrangement of land. Among the different types of urban projects, the following ones are relevant for construction of RES generation facilities:

- Urban project for construction land intended for construction of commercial, industrial, energy and other technical-technological and special purposes;
- Urban project for infrastructure, and
- Urban project for construction of individual buildings and infrastructures of state and local importance outside settlements and outside the scope of urban plans on agricultural, forest and other land, coastal belts and other areas, which, among other, can include infrastructure lines for the individual buildings and wind farms, photovoltaic plants and small hydropower plants.

2. **Urban project with a parcel plan** implements the urban plans, in the planning scope of which there is a need for two or more adjacent construction plots by the same owner to form one construction plot or where from one larger construction or cadastral plot in the planning scope where construction plots are not formed, two or more construction plots should be formed.

4.4.6 Conclusions

- The Law fails to regulate important issues such as the period for which the Spatial Plan will be adopted, procedure for its adoption and modification, as well as its basic content. The transitional provisions in the law also have no mention of the status of the present Spatial Plan of the Republic of North Macedonia. Taking into account that the present Spatial Plan was adopted in 2004 for the period of up to 2020, there is an obvious need a new Spatial Plan to be adopted or at least the implementation period of the present one to be extended, thus providing legal certainty in the procedure for adopting spatial and urban plans at hierarchical lower level.

- The following two types of plans are adequate for planning of RES generation facilities:
    - ***Urban plan for outside settlement boundaries*** is an urban plan that is adopted for groups of constructions and complexes, larger constructions or infrastructure construction of local importance, which are located outside the settlement, i.e. which are not covered by either the general urban plan or the urban plan for a village.
    - ***Urban plan for areas and buildings of state importance*** to be adopted for areas for superstructural and infrastructural complexes, systems, buildings and accompanying buildings of state importance or in function of buildings of state importance. Hydroenergy systems are among the constructions indicated in the illustrative list given in the Law.
- The procedure for adoption of these two types of urban plans is 1-phase procedure that can run up to 18 months for Urban plan for outside settlement boundaries and 36 months for Urban plan for areas and buildings of state importance.
- This Law provides a possibility for the land covered by the adopted urban plan to remain agricultural land, which was not the case with the previous law. This solution seems quite convenient for those urban plans that envisage construction of an infrastructure line (e.g. connection to the grid) or even PV power plant which technology is the least degradable for the land, if it would be degraded at all.

- Urban projects are relevant for RES generation facilities and the procedure for their development and adoption must be initiated in case the adopted urban plans do not provide detailed provisions for construction and arrangement of land. In case the RES power plant is to be built on a single cadaster parcel, the procedure for adoption of urban project can be directly initiated, without prior existence of urban plan, thus shortening the investment period.
- In case of brown-field investments, urban plans already exist, but they will most likely need to be modified to foresee another class purpose (type of facility to be built), but the procedure for such modification is shorter than the procedure for adoption of completely new urban plan.

4.5 RULEBOOK ON URBAN PLANNING ("Official Gazette of the Republic of North Macedonia" no. 225/2020)

4.5.1 Subject matter of the Rulebook

This Rulebook in adopted by the Minister of Transport and Communication on the basis of Article 24 paragraph (4) of the present Law on Urban Planning ("Official Gazette of the Republic of North Macedonia" no. 32/2020). The subject matter of this Rulebook is the following:

- standards and norms for urban planning
- principles and methods for rational planning of sustainable settlements and constructions for arranging and use of space,
- methods and techniques of urban planning,
- legal effect of planning provisions,
- class system of purposes, as well as
- all protective or generative standards that ensure the fulfilment of the goals and principles of urban planning.

4.5.2 System of classes of purposes

Of particular relevance for brown-field investments is the section system of classes of purposes**.** According to Article 75**,** the purpose of the land in the urban plans and urban projects is implemented with the system of classes of purposes, as an instrument of urban planning which classifies the activities within the planning scope of the urban plans and urban projects and their mutually harmonized and balanced spatial arrangement. Another important objective of the system of classes of purposes is to provide flexibility and feasibility in the implementation of urban plans and urban projects.

The system of classes of purposes is comprised of individual purposes, purpose classes and groups of purpose classes, whereby related purposes with common functional and spatial characteristics are grouped into purpose classes, and related purpose classes are grouped into group of purpose classes.

The following are the six groups of purpose classes:

- A - housing and residence

- B - business and commercial purposes

- C - public activities and institutions

- D - production, mining, energy and industry

- E - greenery, recreation and memorial spaces

- F – infrastructures.

As it can be noticed, mining and energy belong to the same group of purpose classes. More precisely, according to Article 77, within and among this group of classes are the following sub-classes:

- D1 - Energy production and heavy and polluting industry, which includes: D1.1 - Mining and extraction of oil and gas: constructions and plants for surface and underground mining, quarries and D1.9 - Large power plants: hydroelectric power plants, thermal power plants for coal, fuel oil, natural gas, tailings and ash dumps, nuclear power plants; and
- D3 - Industry for assembly of final products, services and production of energy from renewable sources, which includes: D3.7 - Wind power plants, concentrated solar power plants, small hydropower plants, and biofuel power plants.

The Rulebook defines the flexibility of the urban plan as capacity of the plan to provide a wider selection of alternative and compatible uses of land and constructions by applying the system of purpose classes, which increases the degree of realisation of the plan and the dynamics of the spatial development of the city. The greatest flexibility is provided by the determination of the purpose at the level of a group of classes of purposes. Medium flexibility of the urban plan is provided by the use of purpose classes, and the least flexibility is achieved by specifying concrete individual uses for each construction plot individually.

The purpose classes can be: complementary, compatible and alternative. Complementary purpose is a purpose that complements one construction plot and one building and serves exclusively for the functioning of the basic purpose determined by the urban plan. Compatible purposes, classes of purposes or groups of classes of purposes, are two or more purposes that can exist in the spatial unit, i.e. in the same purpose zone or in the same construction plot without disturbing their normal functioning. Due to the flexibility of the plan, when determining the purpose of the land in the urban plans, two or more mutually compatible purposes can be used as alternative purposes, but only within the construction plot.

The purposes with the highest incompatibility are the purposes of the purpose class D1 - energy production and heavy and polluting industry, which are the most polluting class of purposes and are incompatible with the groups of purpose classes A, B and C. Less incompatibility of the purpose class D1 has, among others, D3 - industry for assembly of final products, services and energy from renewable sources, whose greater compatibility can be achieved by applying new non-polluting technologies and protection that qualify these purposes into compatible with some purpose classes from the purpose class groups B and C, and even the purpose class A2.

4.5.3 Conclusions

It can be concluded that even if the existing urban plan specifies the purpose class on the level of sub-class, that does not mean that changes are not possible, especially if the change is from more rigid into more flexible sub-class, such as the change from sub-class D1 - Mining that is considered as heavy and polluting industry into sub-class D3 - energy from renewable sources where non-polluting technologies are applied.

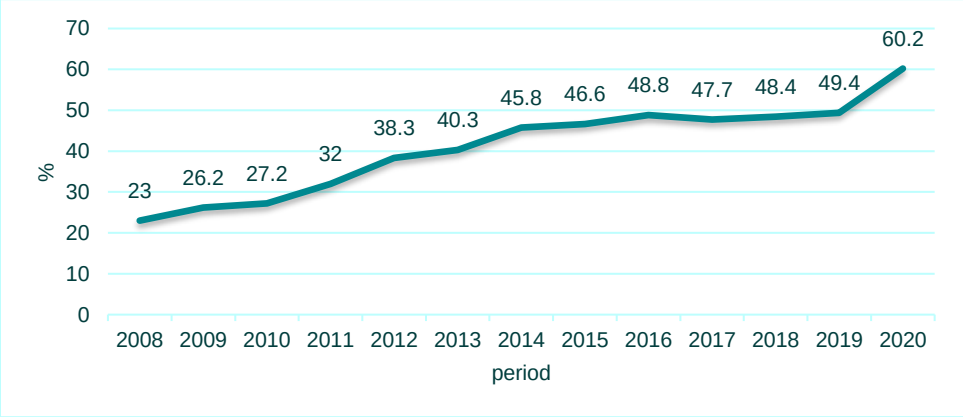
5 Financial analysis

5.1 General financial situation of the Republic of North Macedonia

For an overview of the general financial situation in the country, this report presents the basic characteristics of the public finance system and the banking system of the Republic of North Macedonia.

Public finance system – North Macedonia is a "small state", measured by the share of public revenues and public expenditures in GDP – they are maintained at a level of 30% on the public revenues side, and about 32% on the public expenditures side, and remain significantly bellow the average of the post-transition economies (they are only slightly higher than those in Albania and Kosovo). Prior to 2008, North Macedonia maintained relatively low budget deficits for a relatively long time period (1994 to 2008). In the period 2008-2014 the country doubled its public debt (Figure 12) and has lost its fiscal space, unfortunately, to unproductive public investments, which do not generate revenues to service debt and are also negatively correlated with the economic growth. The situation with the public debt has become more complicated during the crisis caused by the COVID-19 pandemic. In 2020 the government package of anti-crisis measures amounted to about EUR 1 billion, or something over 9% of GDP. The government has mobilized significant funds from foreign sources (IMF, EU and with the issuance of a new Eurobond) and domestic sources (borrowing on the domestic capital market – partly through the issuance of government bonds and partly from the commercial banks). The budget deficit in 2020 exceeded 8%. By the end of 2020, the public debt as a share of GDP exceeded 60%.

FIGURE 12. PUBLIC DEBT, % OF GDP



Source: Ministry of finance of the Republic of North Macedonia, link: http://budget.finance.gov.mk/

According to this indicator the country is classified in the group of moderately indebted countries – in fact, during the health crisis North Macedonia achieved the 11th lowest increase of the public debt among 32 European countries (European Commission: European Forecast, Institutional Paper No 136/2020). Some Macedonian experts expect that the public debt will remain

sustainable, even in the situation of its moderate increase in future, if in the next period North Macedonia achieve growth rates near to its potential (4% to 4.5% annual growth rates of GDP) (Bishev, Stojkov, Besimi 2021). However, in our opinion, the Government in future should be cautious in the field of public debt creating, in terms of directing pubic investments for productive purposes and increasing their efficiency. This is because the gross public debt of the country (it is included the debt of the corporate sector) in 2020 has exceeded over 76%. The Ministry of Finance has prepared Programme for financial consolidation which envisages continuously decrease in the public deficits in the period 2021-2025 and according to which the public debt of the country will continue to grow in 2021, 2022, 2023 (63,4%, 64%, 64.1% respectively) and after that will start to decrease – to 62% in 2024 and 58.8% in 2025.

For the project needs it is important to be pointed out that the public investments, especially those oriented to modernization and construction of energy, road and railway infrastructure, as well as public investments in health, education, research and protection of the environment, are positively correlated with economic growth and development, for a number of reasons: they represent an important segment of the business climate, have a multiplicative effect on the GDP growth and employment and raise the level and quality of public services. Despite the positive effects of capital investments, two characteristics of this component of government spending in North Macedonia are evident continuously, almost throughout the period of the country's independence: small amount of capital investments, accompanied by a low level of their realization compared with the initially envisaged budget amounts and low efficiency of the capital investments.

However, North Macedonia has the potential for creating a wider fiscal space to increase public, investments, mainly the capital infrastructure investments in the total budget expenditures and to increase their effectiveness. We can argue this statement as follows:

(1) In North Macedonia the increase of the share of public revenues and public expenditures can be predominantly based on the decrease of grey economy (which is estimated at a level of 30% - 35% of GDP), through prevention of tax evasion (this means the increase of the efficiency of tax administration), through cutting off the typically unproductive public government spending and only partly through tax increase (slight progression in personal income tax and increase of property taxes). These measures together with the improvement of the medium-term and long-term budget planning can contribute to the expansion of the space for the capital investments;

(2) Despite the value of capital investments, of crucial importance is the improvement of their efficiency. Therefore, it is necessary continuously to build and increase the capacity of state institutions responsible for the realization of the capital investments (mainly of the general government, of the ministries whose budgets receive funds from foreign sources for financing and realization of public investments, of the units of local self-government and of the State Enterprise for Public Roads) for their efficient management. This approach should result in improving the reality of capital investment planning, the stability and certainty of the funds for their financing, by improving the quality of feasibility studies. In this context some improvement has been made with the introduction of new measures and mechanisms by the Ministry of Finance that are directly related to the public finance – CAPEF mechanism ("rewards" or "penalties" for budget users with a high or low level of

realization of public investments), Methodology for Assessing the Effectiveness of Public Finance (PIMA), Methodology for Assessing the Realization of Public Investments, National Investment Committee at the Government level, etc.;

(3) the structure of the capital investments is extremely important because it is one of the key determinants of the level of fiscal multiplies – synthetically viewed, the productive public investments are accompanied by higher fiscal multipliers compared with those from the other types of government spending;

(4) in order to improve the general financial situation, increase the public and private investments and to accelerate the economic growth in the country, the Government of the Republic of North Macedonia in cooperation with the World Bank and the other foreign partners (EBRD, EIB, KFW, UNDP, USAID and SDC) is in the process of preparation and adoption of an extremely important project, entitled as Recovery and Growth Financing Plan. The main goal of the plan is "…to finance the recovery of the economy affected by COVID-19 and to support accelerated and sustainable growth while maintaining fiscal stability by mobilizing capital from the private sector in addition to the funds allocated from the budget and borrowings."(see: Recovery and Growth Financing Plan, Ministry of finance and Prime Minister's Office, Government of the Republic of North Macedonia, September 2021). More precisely, the Project goal is in the period 2022 – 2026 to ensure average annual growth rates of GDP of 5%, to ensure efficient use of the public investments envisaged in the medium-term Budget in the amount of EUR 4 billion and to mobilize additional EUR 8 billion from the public sector. At the same time, the Budget envisages fiscal consolidation in the medium term, i.e., the share of public debt in GDP to be stabilized at 60%, and the budget deficit above 3%. Numerous innovative financial instruments are envisaged for the realization of the plan (Green bond, Guarantee fund, Energy efficiency fund, Fund for research and development, Hybrid SMEs investment fund, Venture capital etc.). The Funds will be established within the existing institutions, and the initial capital will be provided from budget funds and from borrowing from abroad.

In the table below the expected movements of the main macroeconomic indicators of the country, estimated in the Recovery and Growth Financing Plan are presented.

TABLE 4. MAIN MACROECONOMIC INDICATORS FOR THE ECONOMY - FORECAST

	2020	2021	2022	2023	2024	2025	2026
Real GDP growth	-4.5	4.1	4.6	5.2	5.6	5.9	5.7
Annual inflation rate	1.2	2.1	1.8	2.0	2.0	2.0	2.0
Gross investment (% of GDP)	29.6	30.8	31.8	32.9	34.0	35.1	36.2
Trade balance (% of GDP)	-16.9	-17.9	-17.7	-17.3	-16.8	-16.2	-15.6
Current account balance (% of GDP)	-3.5	-3.0	-2.4	-2.0	-1.6	-1.2	-0.7
Nominal net wage growth (in %)	7.8	3.0	3.5	3.8	4.1	4.2	4.2
Unemployment rate (annual average)	16.4	15.8	14.4	12.9	11.4	9.9	8.6
Employment rate (annual average)	47.2	47.5	48.6	49.8	51.3	52.8	54.3

Source: Recovery and Growth Financing Plan, Ministry of finance and Prime Minister's Office, Government of the Republic of North Macedonia, September 2021, p. 6

Banking sector – today the banking sector of North Macedonia consists of 14 banks, of which 5 are large, 6 medium and 3 small (classified by the size of assets). The banking system of the Republic of North Macedonia is the dominant segment of the financial system – it accounts for

about 90% of the financial potential of the county's total financial system. The general assessment is that the banking system is stable, with a predominant share of foreign capital in the total capital and in the banks reserves (almost 70%), with solid capitalisation (the capital adequacy is 18% and is more than twice the legal minimum) and with significant progress in corporate governance. Otherwise, the Macedonian banking system is traditional, mainly based on deposits, as a main financial source, insufficiency integrated in the world financial flows, which explains why the Macedonian banks during the Great Recession 2007 – 2009 had no exposure to "toxic" banking products and government bonds of European countries which were the hardest hit by the Great Recession. As a result of that, the Macedonian banking system benefited from what is called blessing of underdevelopment (Fiti, 2021 Macroeconomics of Big Crises – The Great Depression, The Great Recession and The Great Lockdown). The Macedonian banking system was not hard hit even by the current crisis. Macedonian commercial banks through the reprogramming of the business and households' loans and the strengthening of the credit activity had made a significant contribution to dealing with the crisis determined by the COVID-19 pandemic. What should be especially stressed is the increased credit activity of the banks, in terms of supporting the corporative sector and the households. Namely, at the height of the crisis, in the second quarter of 2020, the total value of new loans amount to about 9 billion denars, which indicates an annual credit growth rate of 6.6%. Now, the average interest rate of loans to the business sector is 3.9% (NBRNM, August 2021). The growth of the credit activity of the banks has sound foundations, i.e., it is based on the growth of the deposit base of the commercial banks, as the cheapest source of funds for performing the credit function of the banks. The credit potential of the banks remains solid – they are able to finance profitable projects from the Macedonian business sector without problem, further, they are increasingly granting eco-loans (to companies and households), including loans for renewable energy sources and for the improvement of energy efficiency and are actively participating in the operationalisation of foreign credit lines which are mobilised through the only state bank in the country – Development Bank of North Macedonia.

Regarding the situation in the balance of payments, it should be stressed that North Macedonia has a chronic trade deficit, which predominantly results in a deficit in its current account balance (% of GDP), which in the years before the crisis (2010 – 2018) was maintained at an average annual level of -3% (our calculations based on data from the National Bank of the Republic of North Macedonia – www.nbrm.mk) but which is successfully converted by private transfers inflows (transfers – remittances of the Macedonian citizens working abroad), by borrowing at the international financial markets and with FDI inflows.

According to Standard & Poor's **the credit rating** of North Macedonia remains stable during the crisis, i.e., **BB-/Stable/B**.

In 2016, based on a previously signed agreement between the Development Bank of North Macedonia (DBNM) and the International Bank for Reconstruction and Development - IBRD (IBRD - International Bank for Reconstruction and Development) and by signing a new agreement between the Development Bank and The Ministry of Finance in 2016 was established a credit line for EE and RES (energy efficiency and renewable energy sources) with the following conditions:

Energy Efficiency projects

Source:	Assets of the Bank, the Ministry of Finance and the International Bank for Reconstruction and Development (IBRD)
Aim:	Financing of projects in the field of sustainable energy or energy efficiency (energy saving)
Amount of project:	Up to EUR 500.000 The bank will lend up to 90% of the amount of the individual project
Repayment period:	up to 8 years, with up to 1 year grace period.

Renewable Energy Projects

Source:	Assets of the Bank, the Ministry of Finance and the International Bank for Reconstruction and Development (IBRD)
Amount of project:	Up to EUR 500.000 The bank will lend up to 90% of the amount of the individual project
Aim:	Financing of projects in the field of sustainable energy, ie production of energy from renewable energy sources (hydropower, geothermal energy, biomass energy, wind energy, solar energy, etc.)
Repayment period:	up to 12 years, with up to 2 year grace period.

For the both credit lines, deviations from these amounts and criteria are possible with the permission of the IBRD or the Ministry of Finance. It is possible to be included a grant component.

According to the Law on Borrowing of the Republic of North Macedonia, under the Loan Agreement for financing the Energy Efficiency Project in the public sector[12], the Republic of North Macedonia borrowed a loan in the amount of EUR 25.000.000 from the International Bank for Reconstruction and Development - World Bank, intended for the realization of the project.

According to the Law, the beneficiaries of the loan funds are the municipalities, the City of Skopje, PHI, the Ministry of Economy, the Ministry of Finance and the Development Bank of North Macedonia, in which organization an Energy Efficiency Fund will be established. The Coordinator of the Energy Efficiency Project in the public sector is the project unit of the World Bank within the Ministry of Finance.

The project has three components, as follows:

Component 1: Energy Efficiency Investments in the public sector (EUR 18 million). Within this component, the realization of energy-efficient projects and some investments in renewable energy in public buildings (municipal buildings, central government buildings and public lighting) are envisaged.
Component 2: Technical assistance and support for the Project implementation (EUR 2 million).

Component 3: Start-up capital for the Energy Efficiency Fund (EUR 5 million)[13].

[12] https://finance.gov.mk/wp-content/uploads/2021/05/2-Zakon-Proekt-za-energetska-efikasnost-Sl.vesnik-br.77-06.04.2021.pdf
[13] Based on the information received from DBNM.

5.2 The role of the energy sector for the national economy

Energy is the bloodstream of the economy because energy is a vital input in economic processes, and thus a constituent element of production expenditures and the prices of goods and services. This is mainly evident in the energy-intensive sectors of the economy. Certain energy sources such as oil are not direct inputs in the production processes, but through the transport sector, they affect the final prices of a large number of goods and services. Hence the energy transformation and especially the increase in the energy efficiency (the decrease of the energy consumption per unit of product) have a significant impact on the economic-finance performance of the enterprises and the whole economy. As is projected by the National Strategy for Energy Development until 2040, the starting of a strong investment cycle in the Macedonian energy sector will have a significant impact on the investment cycle of the whole economy, as a result of the fact that investments in fixed assets in the energy sector will participate with almost ¼ in the total investments in the economy. Having in mind the energy transformation and investments in the energy sector, it should be taken into account the induced and multiplier effects of the investments on the economic growth in the country. Approximately, if in the next 5 years in the energy sector will be invested EUR 5 billion, on the assumption that the multiplier is 0.8, this amount of investments will create an additional value of around EUR 4 billion to GDP by 2025 (or some years later). Investments in the energy sector will also have significant positive effects on the labour market in North Macedonia. In fact, the investments will generate new jobs, i.e. will directly increase the employment in the new energy facilities, and also will have indirect, induced i.e. multiplier effects on the employment, which are difficult to be estimated. But according to some economic roles, every new employee creates additional employment through the effect of the multiplier. Namely, the new employed will receive a salary. The new employed one part of the salary will save and one part will spend. The part of the salary that will be spent will increase the demand for consumable goods and as a result of this, the enterprises that are producing these types of goods, as a response to the increased demand will have to hire new employees i.e. this process will create so-called secondary employment. By similar logic, tertiary employment is created, etc. Further, the multiplier effect on the employment (saving of exciting jobs and creating of new ones) besides it is evident in the sectors which are producing consumable goods, it is also evident in the other sectors of the economy – for the example in the construction sector, in the enterprises which will deliver inputs for the construction of new energy facilities, etc. The green investments through the increase of the share of renewable energy sources, decarbonization, an increase in energy efficiency, moving towards a circular economy, etc., will have a positive impact on the protection of the environment, as an important component of sustainable development. The reduction of the pollution as a typical negative externality will have a significant feedback effect on the life quality and well-being of the population, on the health sector expenditures and so on. The green investments in the energy sector are increasing the innovativeness, not only in the business-sector, but also in the society as a whole. Those positive effects confirm that energy transformation delivers benefits not only to the economy, but also to the society.

The presented findings above can be further explained by the significant share of energy in overall economic activity in the country. Namely, according to the SSO data in the Electricity, gas, steam and air conditioning supply sector, there is a tendency of increasing the number of enterprises (in 2019, a total of 222 enterprises were registered in this sector, compared to 212 enterprises in 2018); in 2019, in this sector, the total realized turnover is 92.262 million denars, and the share of the realized turnover from this sector in the total realized turnover in the economy is 6.7%; value added at factor cost in the Electricity, gas, steam and air conditioning supply sector in 2019 is 16.236 million denars; in 2020, in the sector have been employed 9.395 persons, ie 1.2% of the total number of employees in the country. The average net wage paid per employee in Energy is constantly growing and is maintained significantly above the average net wage paid per employee in the country - in June 2021, the country average was 28.774 denars, and in the Electricity, gas, steam and air conditioning supply sector the average was 40.860 denars etc.

5.3 Foreign direct investments – overview of greenfield and brownfield investments

Exports and imports of goods and services and the international capital movements are the two most important forms of international economic relations manifestation. In the world economy, in the long run, the importance of international capital movements (exports and imports of capital) is growing.

The two most important forms of capital exports are ***foreign direct investment*** and ***portfolio investment.***

The main drivers of foreign direct investment (FDI) are transnational companies (TNCs). Most synthetically viewed, TNCs realize foreign direct investment by opening their own, primarily, manufacturing companies - affiliations, in foreign countries, by purchasing the controlling stake of an existing company or by establishing a completely new company, usually 100 % owned by the foreign investor.

If a foreign investor invests in corporate shares in a domestic company of another country, where the investor's share is less than 10% of the total number of voting shares, it is *portfolio investment*. The portfolio investment category, regarding the corporate sector, also includes investments in corporate bonds - bonds issued by companies to raise additional capital. Different from shares which are equity securities and which bring to the investor two basic rights (the right to vote on the principle of one share one vote and the right to participate in the distribution of profits as dividends), the bonds are debt securities and those to the investor bear interest, but not the right to acquire ownership and to participate in the management of the company.

Depending on the type of investment, foreign direct investment can be divided into two segments: *greenfield* and *brownfield investments.*

Greenfield investment is a process of investing in a new business, a new manufacturing process, or a new facility and is therefore extremely important to the economy. This type of

investment "starts from 0", i.e. with this type of investment the investor begins a new venture from the ground up, especially in areas where there are no facilities that already exist, the investor procures new equipment, and often employees the management staff from the parent company, develops new technology, trains the employees and so on. The main advantages of greenfield investments for the host countries are that the investor transfers knowledge (know-how), positively affects the country's balance of payments, especially if the whole production or a significant part of the production is intended for export, as well as due to the fact that FDI in its classic form does not affect the country's debt, hires local labour and local firms as subcontractors (suppliers), increases competition, etc.

There are several reasons why a company may decide to build a new facility rather than purchase or lease an existing one. The primary reason is that a new facility offers design flexibility along with the efficiency to meet the project's needs. An existing facility forces the company to make adjustments based on the present design. All capital equipment needs to be maintained. New facilities are typically much less costly to maintain than used facilities. If the company wants to advertise its new operation or attract employees, new facilities also tend to be more favourable.

There are also downsides to constructing new facilities. Building from scratch can bring more risk as well as higher costs. For example, a company may have to invest more initially when it decides to build from scratch to fulfil feasibility studies. There may also be problems with local labour, local regulation, and other hurdles that come with brand new construction projects[14].

Brownfield investments mean investing in an existing company, on an already built facility. The investor, in this type of investment, invests in an existing facility or company, in order to expand its capacity or to launch an entirely new business process. The tendency of this investor is from the previous investment to create more value, manage better, introduce new standards, and implement new strategies that should bring greater and visible results.

Among the main advantages of brownfield investments is that the investor does not have to invest from the beginning, but is able to use existing infrastructure, which brings significant savings[15]. Hence, the clear advantage of a brownfield investment strategy is that the building is already constructed, therefore reducing the start-up costs. The time devoted to construction can be avoided as well.

Brownfield investments run the risk of leading to buyer's remorse. Even if the premises had been previously used for a similar operation, it is rare that a company finds a facility with the type of capital equipment and technology to suit its purposes completely. If the property is leased, there may be limitations on what kinds of improvements can be made[16].

As has been noted before, it can be concluded that foreign direct investments are cross-border investments made to obtain a lasting interest in a company resident in an economy other than the investor’s, as well as to gain influence on the business strategy of that company.

[14] www.investopedia.com.
[15] www.businessinfo.mk.
[16] www.investopedia.com.

In accordance with the international recommendations and standards, the criterion for defining direct investments is a minimum 10% capital share (direct or indirect) in the entity in which the capital is invested.

Whether it is **greenfield** or **brownfield** investments, FDI is one of the most favourable forms of international capital movements. The advantages of FDI for developing countries, and in this context for the Republic of North Macedonia, are numerous: FDI contributes to increasing the gross investment of the host country, i.e. to close the gap between domestic savings and the desired volume of gross investment; to finance (cover) the current account deficit in the balance of payments; to increase employment and valorisation of other development resources in the country; to transfer technology and new knowledge (managerial, marketing, etc.); to increase productivity, competitiveness and exports, etc. It should be particularly noted that FDI in its classical form does not increase the public debt of the domestic economy. Of course, FDI also has "weaknesses", which are summarized as follows: this type of investment can significantly increase the import of the host country; crowd out part of the domestic enterprises from the economic activity; to enable foreign investors to make high economic profits (extra profits), if they are located in sectors with a monopolistic position; to increase the outflow of capital from the host country through the known channels - repatriation of profits in the domestic economy, import of goods and services and intercompany lending between the domestic and parent company, and thus to worsen the current account position on the balance of payments, etc. Hence, assessment the net effects of FDI on the domestic economy is neither an easy nor a simple task. However, the prevailing view in economic theory is that FDI, in the long run, has a significant positive impact on the domestic economy because, as the UNCTAD World Investment Report 2021 states, international investment flows are one of the key factors in sustainable and inclusive development of the developing countries.

FDI is the fastest growing form of international capital movement and the dynamics of its growth, on a global scale, are far greater than the growth of exports and imports of goods. This is evidenced by the fact that the so-called FDI stocks (cumulative amount of FDI in a certain country in a given period), especially in the period after the 1990s, show extremely fast dynamics.

TABLE 5. GLOBAL FOREIGN DIRECT INVESTMENT STOCKS

Year	Amounts in billion USD
1990	2.078
2000	7.511
2007	14.278
2012	22.813
2014	25.875
2018	30.974

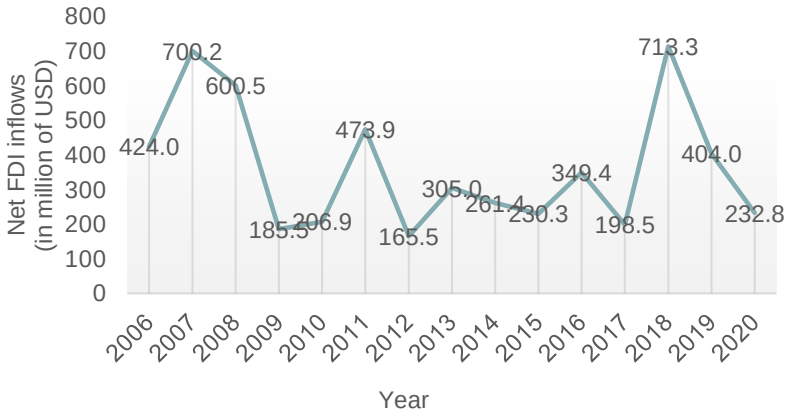
Source: UNCTAD World Investment Report, for the respective years.

The Republic of North Macedonia is in the group of countries in transition and developing countries with a relatively weak performance in the area of attracting FDI. A decade after independence, FDI in the country, de facto, were absent or marginal. This, synthetically viewed, is due to the action of two factors: the presence of numerous non-commercial risks (embargo in the early transition years, the Kosovo crisis and the 2001 conflict) and the insider model of privatization.

After 2006, the Government of the Republic of Macedonia promoted a strong stimulating policy for attracting FDI, especially in Technological Industrial Development Zones (TIDZ) and industrial zones. Incentives for foreign investments are numerous: exemption from payment of corporate tax for a period of 10 years, exemption from payment of personal income tax up to 100%, exemption from payment of value-added tax, customs duties on inputs, ie. raw materials, goods, machinery and equipment, free connection to water, electricity, gas, exemption from payment of utility taxes to the municipalities in which the zones are located, cash grants for buildings that are constructed in the zones, etc. This policy has resulted in a significant increase in the foreign capital inflows into the Macedonian economy.

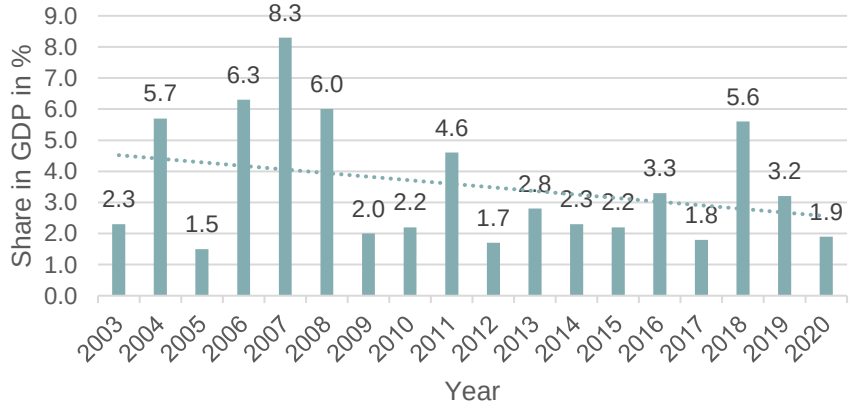
During the period (2006-2020), in North Macedonia, the average annual net FDI inflows amounted to USD 363.4 million, while the average annual net inflows as a share of GDP amounted to 3.6%.

FIGURE 13. AVERAGE ANNUAL NET FDI INFLOWS IN NORTH MACEDONIA



Source: National Bank of the Republic of North Macedonia

FIGURE 14. AVERAGE ANNUAL NET FDI INFLOWS AS % OF GDP



Source: National Bank of the Republic of North Macedonia

The above-presented figures confirm that, although the country lags far behind the average FDI inflows in the transition countries, especially behind the average of the advanced transition countries, in the last 15 years, the growth of the FDI inflows volume and their share in GDP is significant. This in the first place, is due to the foreign direct investors who located their facilities in the technological industrial development zones (TIDZ) and in the industrial zones. Hence, the

importance of FDI in closing the gap between the domestic accumulation and the desired rate of gross investment is growing, as well as in dynamizing the export of goods and services (increased share of export products with higher finalization, i.e. higher value-added in the whole Macedonian export), in the creation of new productive jobs and in the increasement of the integration level of the Macedonian economy in the world economic and financial flows. FDI stocks in North Macedonia in 2000 amounted to only USD 540 million, in 2010 to USD 4.3 billion, and in 2018 exceeded USD 5.9 billion. (UNCTAD: World Investment Report, 2019 p. 2016; p. 219).

On 31.12.2019, the foreign direct investment stock in the Republic of North Macedonia amounted to EUR 5.7 billion (or 50.9% of GDP), of which EUR 4.4 billion are investments in equity, while EUR 1.3 billion are investments in debt instruments. A reduction of around 200 million euros in FDI stock is due to the COVID-19 crisis and this tendency, again due to health crisis is a typical feature present worldwide.

Analysed by countries, a larger amount of direct investments of EUR 772 million are registered from Austria followed by the United Kingdom, with a direct investment of EUR 660 million. In the group of the five largest foreign direct investors in the country are also Greece (EUR 518 million), the Netherlands (EUR 398 million) and Slovenia (EUR 397 million). These five countries account for 48.1% of the total foreign direct investments in the analysed period.

The analysis of foreign direct investment by activity shows that EUR 2.1 billion, or 38% of the total foreign direct investment in the country are invested in "Manufacturing", while EUR 1.1 billion, or 19,7% are located in "Financial and insurance activities"[17].

Depending on the direction of the investment, the NBRNM's Statistical Survey on direct investments covers data for stocks and flows of Direct Investments abroad (Outward Direct Investments) and Direct Investments in the country (Inward Direct Investments). In addition, the direct investments statistics of NBRNM covers the annual FDI inflows and so-called stocks (balance, i.e. accumulated inflows for a certain period of time). Depending on the direct investments' structure, the Statistical Survey of the NBRNM for direct investments in the country covers stock data of new, existing and other investments. The new investments present the amount of equity (including reinvestment of earnings) which arises from investment in new entities (greenfield investments). The existing investments present the amount of equity (including reinvestment of earnings) which arises from investment in existing entities by mergers or acquisitions. The other investments present the amount of equity (including reinvestment of earnings) which arises from the establishment of branches, foundations etc.

Direct investments stock data are valued at book value. Changes in stocks between two reporting periods may arise from transactions, price changes and/or exchange rate changes and other changes in volume https://www.nbrm.mk/direktni_investicii_sostojbi-en.nspx.

However, the NBRNM's statistic **do not monitor greenfield and brownfield investments separately, but provide converged data in the category of foreign direct investment.** For the needs of this project, the distinction between the two types of FDI is important, because the

[17] www.nbrm.mk.

economic costs that determine the location of green investments in energy are usually lower in the case of brownfield investments, primarily due to the lower costs related to the necessary infrastructure and especially the electricity distribution network, further due to the fact that in a case where the location of the power plant is in an existing company (brownfield investments) there are savings in costs for education and training of employees, etc. But this aspect of the problem will be elaborated upon more widely in the next part pertaining to economic factors and parameters that determine the location of energy facilities.

5.4 Economic factors and parameters that determine the location of WPPs and PVPPs

5.4.1 Different types of costs and parameters for assessing the economic efficiency and profitability of the investments

One of the most widely used methods for determining the efficiency and justification of the investments is the **cost-benefit analysis** i.e., the analysis of the costs and the effects of the investment. On the cost side, the average energy production costs are important, while on the benefit side of primary importance is the quantity of the energy produced.

For this particular **cost-benefit analysis** on the cost side, the division of **investment** and **operation and maintenance (O&M) costs** are relevant.

The **investment cost** should be considered the following parameters:

- costs for procurement of the equipment (wind turbines and photovoltaic panels)
- costs for the access road infrastructure
- cost for the energy infrastructure
- cost for the transport of the equipment
- costs for the installation of the equipment
- costs for planning and engineering

In **O&M costs** should be considered the following parameters:

- staff costs
- fuel costs (if needed)
- administrative costs

The O&M costs of investments in renewable energy power plants and significantly lower and experience have shown that they represent around ¼ in the total costs, while the O&M of investments in conventional power plants are much higher and represent almost 80% in the total costs.

In the later phases of the exploitation of power plants (WPPs and PVPs), of particular importance are the costs related to the **decommissioning of the power plant or its re-powering**. It should be considered that different components of the fixed costs have different useful life and

depreciation periods. For example, buildings, energy and road infrastructure have a longer useful life compared with the equipment (turbines, photovoltaic panels). This has an impact on the costs of replacing the old equipment with new equipment. After the depreciation period, when the old equipment is replaced with new, these types of costs are significantly lower compared with the decommissioning, because some of the already made investments (for example – the road access infrastructure, and energy infrastructure) could be further used for the new investment. In this way, the fixed costs are reduced and thus the total average costs are lower.

On the **benefit side,** the most important indicator is energy production. Besides the energy production, other benefits classified as positive socio-economic benefits are evident:

- generating new jobs at the local level
- being a source of revenues for local companies involved as a subcontractors
- the construction or improvement of the road access infrastructure at the location of the investment

5.4.2 Parameters and factors that determine the location of wind power plants

The construction of wind power plants is determined by the wind speed and wind turbulence at the location (these are technical parameters, which, however, have a strong impact on the economic costs), along with factors such as the already existing energy infrastructure and access road infrastructure. To the extent that the location has a microclimate (a natural factor that also has an impact on the economic costs), and the climate is harsh (cold winters and hot summers) then the maintenance costs increase. To a lesser extent, the costs may be increased due to the preparation of studies for environmental protection generally, and separately for studies for protected areas or studies for the protection of archeological locations. The proximity of the planned location for investment to settlements (<500), may decrease the energy production due to the need to turn off the turbines because of excessive noise and shadow flicker.

The future electricity production, the profitability of the project and the period of return of the investment depend on the measured wind speed at the location. Locations with higher average wind speeds are more favourable for the construction of wind plants. The degree of turbulence of the wind can increase the investment costs due to the need for the installation of resilient types of wind turbines. At the same time, more frequent high turbulence can also increase the maintenance costs for the turbines.

The existing energy infrastructure can increase the construction costs in a cases where the power grid is far away from the location for construction and longer interconnection transmission lines and distribution lines should be constructed for smaller wind power plants. The construction of a new substation for connection on the electricity network also has a significant impact on the investment and construction costs. The road access infrastructure can increase the investment costs in a case where the location is at a greater distance from the existing infrastructure and construction of longer access roads for the transport of the turbines is needed.

In sum building a wind plant at any location, first, the essential condition should be met – the measured average wind speed of the micro-location, which directly influences the cost-effectiveness of the project as well as the period of return of the investment. If this essential condition is met, then the crucial economic factors should be considered.

When building wind plants on brownfields the following economic parameters as inputs in the cost-benefit analysis are of crucial importance:

- for the **cost side**
  - energy infrastructure
  - access road infrastructure
  - costs for land acquisition and of the existing facilities
  - utility costs for construction
  - building permits
  - electricity generation licenses
  - costs for wildlife protection (birds, bats, etc.)
  - cooperation with the local subcontractors
  - available qualified workforce that can be hired at the new investment
  - costs related to the proximity to the settlements, protected areas, national parks and archaeological locations
- for the **benefit side**
  - Annual electricity production

5.4.3 Parameters and factors that determine the location of photovoltaic power plants

In the case of photovoltaic power plants, the choice of the location is determined by the larger number of sunny days in the year, as well as the orientation of the location with regard to the Sun. As in the case of wind power plants, the existing energy infrastructure has an impact on the investment costs. The impact of the access road infrastructure is not as significant as in the case of the wind power plants.

When building a photovoltaic power plant at some location, firstly the essential condition should be met, which are the average annual sunny days at the micro-location, which directly impacts the cost-effectiveness of the project as well as the period of return of the investment. If the essential condition is met, then the crucial economic factors should be considered.

When building photovoltaic power plants on brownfields the following economic parameters as inputs in the cost-benefit analysis are of crucial importance:

- For the **cost side**
  - energy infrastructure
  - access road infrastructure
  - costs for land acquisition and of the existing facilities
  - utility costs for construction
  - building permits
  - electricity generation licenses
  - costs for wildlife protection (birds, bats, etc.)
  - cooperation with the local subcontractors

    - available qualified workforce that can be hired at the new investment
    - costs related with the proximity to settlements, protected areas, national parks and archeological locations
- for the **benefit side**
    - annual electricity production

The above-presented analysis confirms that building wind and photovoltaic power plants on brownfields is determined by numerous economic parameters and factors, but also by other factors, including – technical, natural, environmental, etc. The technical, natural and environmental factors have a strong impact on the total investment costs and the average energy production costs, including the price of energy. Hence the choice of the most appropriate location for those types of power plants requires a complex analysis of all relevant factors because they are interdependent and together determine the final result – the optimal location for construction of the power plants.

6 Methodology for prioritization of candidate sites

6.1 Pre-assessment

During the prioritisation process of the projects, the first step is the pre-assessment phase of the projects. This pre-assessment phase includes:

- Project eligibility
- Validation on project data

6.1.1 Eligibility criteria

At the beginning, each project is checked whether it fulfills the eligibility criteria. Each of the eligibility criteria has to be met by each project. If at least one of the eligibility criteria is not met, then the project is not eligible and is not considered for further processing.

For project eligibility, the following criteria have been selected:

- Whether the project is consistent with valid EU policies and strategies
- Whether the project is covered by a relevant sector strategy paper (sector action plan or sector master plan)
- Whether the project contributes to the valid national development objective
- Whether the project is within protected areas (because of their high risk of vulnerability and their ecological values, protected areas are considered entirely unsuitable for building power plants)
- Possibility for land acquisition and existing facilities
- Building permits
- Soil Stability & Engineering Potential
- Reclamation Status and Containment of Environmental Risk

6.1.2 Validation of project data

The final step of the pre-assessment process is data validation. The aim of this step is to initially check the correctness of the provided data and to identify possible data errors and inconsistencies. Additionally, information for the missing or inconsistent data may be requested from the project promoters in order for the project to fulfill this step and continue with the multi-criteria assessment process.

6.2 Multi-criteria assessment

All the projects that have fulfilled the pre-assessment criteria are then evaluated according to the multi-criteria assessment methodology. Using this methodology, each of the projects is scored and ranked according to the criteria given in this section.

6.2.1 Power grid connection

Power grid connection is one of the key points when selecting a location for construction of a power plant since the produced electricity should be fed into the system and delivered to the final consumers. The cost of connection to the power grid could be divided into two parts: first the cost of construction of the line from the power plant location to the connection point, which is a cost per km (and depends on the distance); and cost of the work that should be done at the connection point (such as transformers), which is a cost per MW of installed capacity and depends on whether the connection is done to an existing line or connecting to the substation.

In this case, the best option for estimation of the cost of connection to the power grid for each location is to obtain the calculations from the electricity distribution company EVN or the transmission network operator MEPSO, since they are the ones that finally determine this cost. If these calculations are not available for each location, then an approximate cost can be determined based on the first part of the cost, i.e. the distance of the power plant to the connection point. Based on this, the location with the lowest cost of power grid connection will have a grade 5, and the one with the highest cost will have a grade 1. For the grading of the other locations, linear interpolation should be used.

6.2.2 Distance to road

The potential location for construction of a wind or solar power plant should be close enough to transport infrastructure, which should be used for transportation of the equipment and personnel transport. On the other hand, locations with difficult access should be avoided. Therefore, road distance is considered as one of the most important criteria. The lands that have access to road with a distance lower than 500 m are considered most suitable, with a grade 5. The distance higher than 5 km is considered as most unsuitable (since construction of a road is needed) and it is graded with 1 (Table 6).

TABLE 6. DISTANCE TO ROAD GRADES

Distance to road	Grade
x<500m	5
500m<x<5km	3
x>5km	1

6.2.3 Slope

The slope of the land is another important criterion that should be considered when selecting the most suitable locations for PV and wind power plants construction. This is because very high slope of the area means increased investment and operational costs. Therefore, the land slope is classified into three groups, and based on that the corresponding grade of the area is evaluated (Table 7).

TABLE 7. SLOPE

Slope	Grade
x<5%	5
5%<x<15%	3
x>15%	1

6.2.4 Wildlife protection (birds, bats, etc.)

Based on the Important bird areas (IBA), as well as other important areas related to wildlife protection, each of the locations should be classified as high, medium or low risk. Based on that, the corresponding grades will be determined, so that the low-risk areas will have grade 5 and high-risk areas will have grade 1.

6.2.5 Qualified workforce that can be hired for the new investment

Another important aspect that should be considered is the social aspect. In this regard, the amount of qualified workforce that can be hired for the new investment in the given location will be estimated. This quantity will mainly be based on the number of unemployed people in the nearest municipality. The location that has the largest number of qualified workforces gets a grade of 5, on the other hand, the project with the fewest qualified workforce gets a grade of 1. Linear interpolation between the minimum and maximum qualified workforce is used to score other locations.

6.2.6 Proximity to settlements

Proximity to urban and rural areas of the location for construction of wind or solar power plants is another factor that should be taken into account.

On the one hand, if the location is very close to the settlement and may have a negative impact on the future development of the urban or rural area, or increases the noise level in the settlement, or disturbs the visual appearance of the settlement, then the project is not acceptable.

On the other hand, the very long distance between the location and residential areas is also unfavorable because of the need to supply the residents with electricity as well as transportation cost of the staff. Therefore, depending on the type of area (urban or rural) different grades are given to the locations based also on their proximity to the corresponding area, as presented on Table 5.

TABLE 5. PROXIMITY TO SETTLEMENT

Type of area		Grade
Urban	**Rural**	
x < 2 km	x < 500 m	5
2 km < x < 20 km	500 m < x < 7 km	3
x > 20 km	x > 7 km	1

6.2.7 Distance to rivers or lakes

According to the Law on waters, a power plant should be at least 50m away from a river or a lake without development of a hydrology study. So, this factor is also used for evaluation of the locations which will ensure environmentally safe while economically favorable power generation. If the distance is closer than 50 m, then a hydrology study should be developed. Therefore, the

locations that are closer than 50 m from a lake or river are graded with 1, and the locations with a higher distance than 50 m are graded with 5.

6.2.8 Weather parameters

6.2.8.1 Solar radiation

For a selection of the best location for construction of solar power plants, solar radiation is of course one of the most important parameters. The number of sunny hours is directly related to the amount of energy received from the sun, therefore for each location, the average solar radiation in kWh/m2/year is calculated. The location that has the highest value for solar radiation gets a grade of 5, on the other hand, the project with the lowest value gets a grade of 1. Linear interpolation between the minimum and maximum solar radiation is used to score the other locations

6.2.8.2 Wind speed

Accordingly, for selection of the most suitable location for construction of wind power plants is the wind speed. This is because the wind speed is directly related to the electricity production from the wind power plant. Therefore, for each location, the average yearly wind speed should be evaluated. Based on this value, the location with the heist value for the wind speed will get a grade 5, and the one that has the lowest value for wind speed will get a grade 1. In order to score the other locations, linear interpolation between the minimum and the maximum wind speed is used.

6.2.9 Type of land

The type of land is also very important because it takes into account the environmental aspect. For example, a location with very good weather conditions for electricity generation should have a smaller priority if it is on agricultural land. Therefore, a land categorization according to the national cadaster is used, and for each land type, a corresponding grade is given, as presented in Table 6.

TABLE 6. LAND TYPE

Type of land	Grade
Barren	5
Agricultural	3
Forest land	1

6.2.10 Installed capacity

The potential for the installed capacity of the power plant in the given location is also a valuable parameter. The installed capacity is mostly affected by the area of the location. The locations on which power plants with larger installed capacity can be built are more cost-effective, so they are more favorable. The fixed cost during installation, such as the eventual road construction, access

to the network etc, will be more cost-effective if more electricity is generated at the given location, i.e. the installed capacity of the power plant is higher. Therefore, the location on which a power plant with the highest installed capacity can be built is graded with 5, and the one with the lowest installed capacity is graded with 1. Linear interpolation is used for grading the other locations.

6.3 Analytic Hierarchy Process method

The weights for each criterion are determined by using the Analytic Hierarchy Process (AHP) method. Analytic Hierarchy Process is a multi-criteria decision-making method that is used to derive ratio scales from paired comparisons. These ratio scales are derived from the principal Eigen vectors and the consistency index is derived from the principal Eigen value.

In order to compute the weights for the different criteria, at the beginning a pairwise comparison matrix A is created. The matrix A is a m×m real matrix, where m is the number of evaluation criteria considered. Each entry a_{jk} of the matrix A represents the importance of the j-th criterion relative to the k-th criterion. If $a_{jk}>1$ then the j-th criterion is more important than the k-th criterion. To evaluate the importance between two criteria a numerical scale from1 to 9 is used. If the j-th criterion is equally or more important than the k-th criterion, the following scoring may be used:

- $a_{jk}=1$ – j and k are equally important
- $a_{jk}=3$ – j is slightly more important than k
- $a_{jk}=5$ – j is more important than k
- $a_{jk}=7$ – j is strongly more important than k
- $a_{jk}=9$ – j is absolutely more important than k

If the k-th criterion is equally or more important than the j-th criterion, the corresponding reciprocal values are used.

After the comparison matrix, a priority vector is calculated. In this report an approximation of Eigen vector (and Eigen value) of a reciprocal matrix is used. At first the normalized pairwise comparison matrix A_{norm} is calculated according to the following equation:

$$\underline{a_{jk}} = \frac{a_{jk}}{\sum_{l=1}^{m} a_{lk}}$$

Finally, the criteria weight vector w, or the normalized principal Eigen vector can be obtained by averaging across the rows, using the following equation:

$$w_j = \frac{\sum_{l=1}^{m} \underline{a_{jl}}}{m}$$

The vector w_j which is also called priority vector, show the relative weights among the criteria that we compare.

6.3.1 Consistency check

When many pairwise comparisons are performed, some inconsistencies may arise. There is a method that can be applied to check the consistency of each experts answer. For that purpose a

Principal Eigen value is used. Principal Eigen value is obtained from the summation of products between each element of Eigen vector and the sum of columns of the reciprocal matrix.

$$\lambda_{max} = \sum_{j,k=1}^{m} (w_j * \sum_{l=1}^{m} a_{lk})$$

A Consistency Index (CI) is obtained by using the following equation:

$$CI = \frac{\lambda_{max} - m}{m - 1}$$

where *m* is the number of the criteria.

A perfectly consistent decision-maker should always obtain CI=0, but small values of inconsistency may be tolerated. So, this consistency index is compared with a Random Consistency Index (RI). The values for RI for small problems, where m is less than 10, are given in Table 7.

TABLE 7. VALUES FOR RANDOM CONSISTENCY INDEX

m	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.51

According to this, a Consistency Ratio is calculated as follows:

$$CR = \frac{CI}{RI}$$

If the value of Consistency Ratio is smaller or equal to 10% (CR<=0.1), the inconsistency is acceptable.

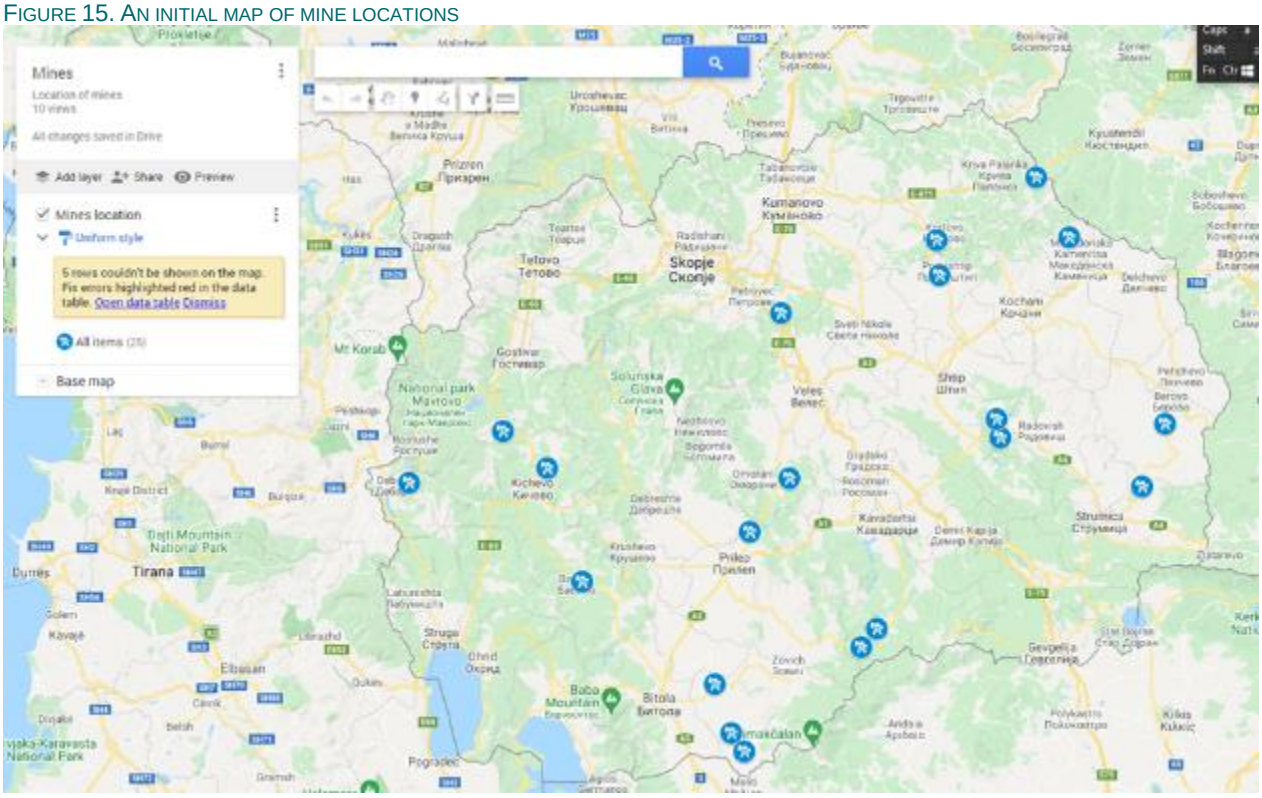
6.3.2 Calculation of the final weights for each criterion

The pairwise comparison has been carried out separately by experts from different institutions in Macedonia in the energy field. Also, a consistency check of the results of each expert is applied and a single weight for each criterion has been calculated by weighting the assessments of each expert according to the consistency check results, again by using the AHP method.

7 Description of candidate sites and their RES potential

As shown on the map (Figure 15) there are many potential locations of active or not-operational mines, brownfields that in the future should be successfully transformed into locations for PV or wind plants. Besides the large coal mines "*Oslomej"* near Kichevo, "*Suvodol",* "*Brod Gneotino"* and the potential coal mine "*Zivojno*" near Bitola, another coal mine in southwest North Macedonia is "*Piskupshtina"* near Debar with a capacity of 80-100 t annually. The same applies for the coal mine *"Berovo".* Additionally, there is a coal mine in the vicinity of Skopje, "*Katlanovo"* with total geological reserves of coal, calculated for the upper productive horizon at the site about 18.5 x 106 tons. Furthermore, in the eastern part of the country, there are several mines mostly for lead zinc ore, namely "*Zletovo" near* Probishtip, "*Dobrevo*" near Kratovo, "*Toranica"* near Kriva Palanka, "*Sasa*" near Makedonska Kamenica. In the vicinity of Radovish there are two mines, "Buchim" – the only copper mine in North Macedonia and the latter "*Damjan*" is for iron ore. Close to Strumica, there is the feldspar mine "*Hamzali – Drvosh*". In the southern part of the country, near Zovich there are two mines, "*Ruzhanovo*" for ferronickel and "*Alshar*" known for the thallium mineral Lorandite. Going toward the centre of the country in the vicinity of Prilep, the marble ore mine named "*Sivec*" can be found. Another iron ore mine "*Zhvan*", is located in the southwestern part of North Macedonia. Although the majority of the mines are not coal-based, they represent a development area by utilising the equipment, facilities, road and electricity connection that are already in place.

FIGURE 15. AN INITIAL MAP OF MINE LOCATIONS



In this phase of the project, the criteria defined in Chapter 6 are determined for the following above-mentioned locations:

1) Suvodol
2) Brod Gneotino
3) Piskupstina
4) Sasa
5) Damian

All these locations meet the eligibility criteria. Soil stability and engineering potential in this phase are evaluated visually for each analyzed location. More in-depth analysis will be made immediately before the construction phase, which will reveal whether additional investments will be needed in this regard. Regarding reclamation status and containment of environmental risk, in this phase, we do not have data that any of the locations does not fulfil this criterion.

7.1Suvodol

This mine is located at a distance of 5 km to the nearest major settlement (Novaci). The location Suvodol is in the immediate vicinity of the 400 kV transmission network. There is also a road next to the location. Using Google Earth it is determined that the average slope of the location is 10% (Figure 16), while using the Global Solar Atlas it is determined that global horizontal radiation is 1538.5 kWh/m^2, and the wind speed is 4.02 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly barren land and pastures, and which are owned by the Power Plants of North Macedonia (ESM). The area of the site is about 6 km^2, on which about 450 MW PV can be installed. In terms of environmental protection, this location is not in a national park or protected area, or in an Important Plant Area; however, it is located in an Important Bird Area (IBA).

FIGURE 16.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH - SUVODOL

According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, the Suvodolska River is located 500 m from the location, and there is no river at the site where the power plant would be built (Figure 17).

From the Employment Agency the Survey of Unemployed Persons as of February 28, 2022, is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Bitola (the city closest to the location) is 5 291.

FIGURE 17.RIVER AND LAKES NEAR TO SUVODOL, CADASTER OF NORTH MACEDONIA

7.2 Brod Gneotino

This mine is located at a distance of 12 km from the nearest major settlement (Novaci). The location Brod Gneotino is near the 110 kV transmission network. There is also a road next to the location (at about 260 m). Using Google Earth, it is determined that the average slope of the location is 4.5% (Figure 18), while using the Global Solar Atlas it is determined that global horizontal radiation is 1552.9 kWh/m^2, and the wind speed is 4.17 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly barren land, pastures and fields and which are owned by the Power Plants of North Macedonia (ESM) and the Republic of North Macedonia. The area of the site is about 2 km^2, on which about 160 MW PV can be installed. In terms of environmental protection, this location is not in a national park or protected area, or an IPA; however, it is located in an IBA.

According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, a small lake is located near the site where the power plant would be built (Figure 19).

From the Employment Agency the Survey of Unemployed Persons as of February 28, 2022 is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Bitola (the city closest to the location) is 5 291.

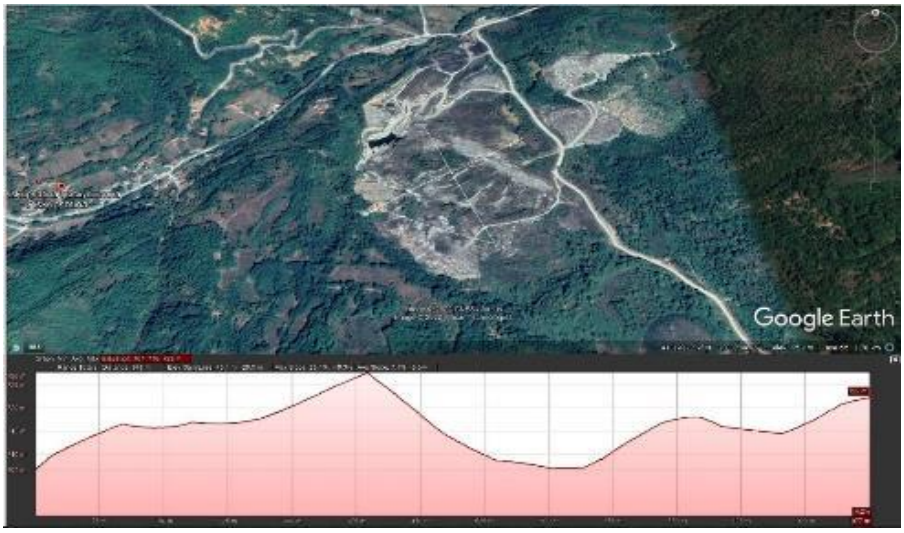
FIGURE 18.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH – BROD GNEOTINO

FIGURE 19.RIVER AND LAKES NEAR TO BROD GNEOTINO, CADASTER OF NORTH MACEDONIA

7.3 Piskupstina

This mine is located at a distance of 4 km from the nearest major settlement (Boroec). The location Piskupshtina is near to 110 kV transmission network. There is also a road next to the location. Using Google Earth it is determined that the average slope of the location is 7.1% (Figure 20), while using the Global Solar Atlas, it is determined that global horizontal radiation is 1469.4 kWh/m^2, and the wind speed is 4.1 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly barren land, pastures and fields and which are owned by the Republic of North Macedonia and some private owners. The area of the site is about 0.11 km^2, on which about 9 MW PV can be installed. In terms of environmental protection, this location is not in a national park or protected area, or in the IBA; however, it is located close to an IPA.

FIGURE 20.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH – PISKUPSTINA



According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, the river Volneshki Trapoj, as well as one other river, is located at the place where the power plant would be built (Figure 21).

From the Employment Agency, the Survey of Unemployed Persons as of February 28, 2022, is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Struga (the city closest to the location) is 3 660.

FIGURE 21.RIVER AND LAKES NEAR TO PISKUPSTINA, CADASTER OF NORTH MACEDONIA

7.4 Sasa

This mine is located at a distance of 10 km from the nearest major settlement (Makedonska Kamenica). The location Sasa is near to 110 kV transmission network. There is also a road next to the location. Using Google Earth, it is determined that the average slope of the location is 11% (Figure 22), while using the Global Solar Atlas, it is determined that global horizontal radiation is 1270.2 kWh/m^2, and the wind speed is 6.9 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly artificially barren land, owned by the Republic of North Macedonia and Sasa. The area of the site is about 0.10 km^2, on which about 8 MW PV can be installed. In terms of environmental protection, this location is not in a national park or protected area or in an IBA or IPA.

FIGURE 22. SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH – SASA

According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, the river Kamenica as well as one other small lake is located at the place where the power plant would be built (Figure 21).

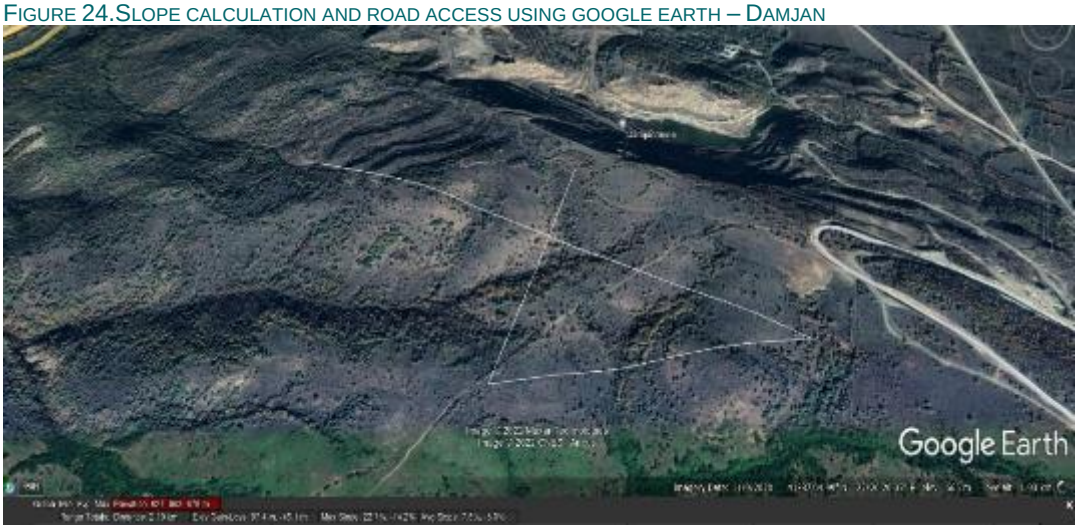
From the Employment Agency, the Survey of Unemployed Persons as of February 28, 2022, is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Kocani (the city closest to the location) is 2 785.

FIGURE 23.RIVER AND LAKES NEAR TO SASA, CADASTER OF NORTH MACEDONIA

7.5 Damjan

This mine is located at a distance of 10 km from the nearest major settlement (Radovish). The location Damjan is at a distance of around 3 km from the 110 kV transmission network. There is a road next to the location. Using Google Earth it is determined that the average slope of the location is 7.6% (Figure 24), while using the Global Solar Atlas it is determined that global horizontal radiation is 1513.4 kWh/m^2, and the wind speed is 5.76 m/s. According to the Cadastre of the Republic of North Macedonia, this location is composed of cadastral parcels which are mostly scree owned by the Republic of North Macedonia. The area of the site is about 0.09 km^2, on which about 7 MW can be installed. In terms of environmental protection, this location is not in a national park or protected area, or in an IBA or IPA.

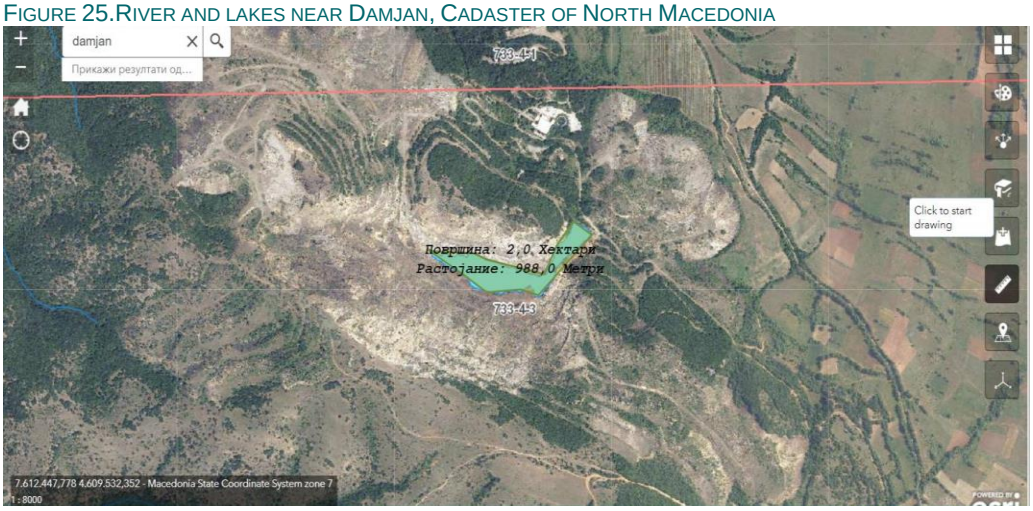
FIGURE 24.SLOPE CALCULATION AND ROAD ACCESS USING GOOGLE EARTH – DAMJAN



According to the National Geoportal (http://nipp.katastar.gov.mk/), taking into account the hydrography, one lake is located at the place where the power plant would be built (Figure 25).

From the Employment Agency the Survey of Unemployed Persons as of February 28, 2022, is used (https://av.gov.mk/content/Statisticki%20podatoci/%D0%A4%D0%B5%D0%B2%D1% 80% D1% 83% D0% B0% D1% 80% D0% B8% 202022 / p1_gradselo022022.xls.pdf), according to which the number of unemployed in Radovish (the city closest to the location) is 2 491.

FIGURE 25.RIVER AND LAKES NEAR DAMJAN, CADASTER OF NORTH MACEDONIA



8 Results from prioritisation of candidate sites

The wind speed on the locations of the mines Suvodol, Brod Gneotino and Piskupshtina is around 4 m/s which is lower than the minimum needed for construction of wind power plants, so these locations were not considered. The results of the other two locations are shown in Table 8. It can be noticed that the location of Sasa is more suitable for wind power plant construction since according to the measured wind speed, it has a higher value, and therefore a higher score. The results of the weights of the criteria based on the experts opinion is also presented in Table 8.

TABLE 8. RESULTS OF THE PRIORITISATION OF LOCATIONS FOR WIND POWER PLANTS

	Sasa	Damjan		Weight of criteria
Power grid connection (kV)	5	5		15%
Distance to road (m)	5	5		6%
Slope (Average)	3	3		8%
Important bird area	5	5		10%
Workforce	1	1		7%
Proximity to settlements (km)	1	1		7%
Distance to rivers or lakes	1	1		7%
Wind speed (m/s)	5	4		16%
Type of land	5	5		16%
Installed capacity (km2)	1	1		8%
Final score	**3.68**	**3.52**		

The results for the prioritisation of the solar power plants are shown in Table 9. It can be noticed that the most suitable location is Suvodol, because of the great solar radiation on the location, the large area on which the solar panels can be installed, as well as the advantage related to the hydrology on the location (since there is no river nor lake on the location, as it is the case for the other locations).

TABLE 9. RESULTS OF THE PRIORITISATION OF LOCATIONS FOR SOLAR POWER PLANTS

	Suvodol	Brod Gneotino	Piskupstina	Sasa	Damjan		Weight of criteria
Power grid connection (kV)	5	5	5	5	5		15%
Distance to road (m)	5	5	5	5	5		6%
Slope (Average)	3	5	3	3	3		8%
Important plant area	5	5	5	5	5		10%
Workforce	5	5	3	1	1		7%
Proximity to settlements (km)	3	3	3	1	1		7%

Distance to rivers or lakes	5	1	1	1	1		7%
Solar radiation (kWh/m2) (GHI)	5	5	4	1	5		16%
Wind speed							
Type of land	5	5	5	5	5		16%
Installed capacity (km2)	5	2	1	1	1		8%
Final score	**4.70**	**4.34**	**3.80**	**3.04**	**3.68**		

From the obtained results it can be concluded that the tested sites have a great potential for construction of solar power plants. On the other hand, in terms of capacity for construction of wind farms, only one location stands out, but that location is with minimum wind potential because the wind speed is just over 6 m / s.