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Photovoltaic Project Development in Montenegro: a case study

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supervised by
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Affidavit

I, **ANNA MARIA STRIGL, BA**, hereby declare

1. that I am the sole author of the present Master's Thesis, "PHOTOVOLTAIC PROJECT DEVELOPMENT IN MONTENEGRO: A CASE STUDY", 129 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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Abstract

Due to climate change and unreliable natural gas supplies, renewable energy has become increasingly important. The current share of electricity generated by solar power in Montenegro is negligible. However, the country has a high solar potential which is suitable for developing PV projects. Consequently, this thesis will elaborate on the following research questions: *(1)"What are the main steps involved in developing a feasible PV project in Montenegro, and what external factors need to be considered during the process?", (2)"What is the outcome of a cost-benefit analysis for developing a PV project in Montenegro?" and (3)"What are the challenges and opportunities for the PV sector in Montenegro?"* The first part of the thesis gives a fundamental background about PV technology and the project development framework. After basic knowledge has been given, a case study was conducted on how a PV project can be developed in Montenegro. An analysis of the most important political, economic, social, technical, environmental, and legal settings has been made. In addition to this, a stakeholder analysis and cost-benefit analysis were carried out. In order to get local insights, insightful interviews with specialists from Montenegro were done. The result is a guideline for a project developer coming to Montenegro with the aim of developing a PV project. Further interpretation shows that the project is financially feasible but the external factors have a crucial impact on the outcome of the project. Political instabilities, missing legislative and supporting incentives, a lack of best-practices, corruption, and informal market structures outweigh the favorable environmental and financial conditions. A first-mover advantage can be seized by experienced developers but should be closely managed with good insurance and risk management. Nevertheless, if the country manages to get back on track with a clear political direction and takes action regarding the promotion of renewable energy systems, it could turn Montenegro into a favorable environment for project developers and transform the country into an innovative renewable energy hub on its path to become an EU member state.

Contents

List of Abbreviations

Abbreviation	Description
AC	Alterning Current
BELEN	Berza električne energije
BIPV	Building Integrated PV Panels
BoP	Balance of Plant Contract
CAPEX	Capital Expenditures
CGES	Crnogorski elektroprenosni sistem
COTEE	Crnogorski operator tržišta električne energije
D.O.O	Društvo s ograničenom odgovornošću
DC	Direct Current
DSCR	Debt service coverage ratio
EBIT	Earnings before interest and taxes
EBITDA	Earnings Before Interests, Taxes, Depreciation and Amortisation
EBT	Earnings before taxes
EBRD	European Bank for Reconstruction and Development
ECG	Elektropivreda Crne Gore
EFTA	European Free Trade Association
EIA	Environmental Impact Assessment
EORI	Economic Operators Registration and Identification
EPA	Environmental Protection Agency of Montenegro
EPC	Engineering, Procurement and Construction contract
EPCG	Elektroprivreda Crne Gore

ESIA	Environmental and Social Impact Assessment
EU	European Union
FIT	Feed-in-Tariff
GDP	Gross Domestic Product
GIS	Geographic Information System
GW	Gigawatt
IEA	International Energy Agency
IFC	International Finance Corporation
IPA	Instrument for Pre-Accession Assistance
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
KPI	Key Performance Indicator
KW	Kilowatt
KWh	Kilowatt-hour
LFS	Labor Force Survey
MEPX	Montenegro Power Exchange
MONSTAT	Statistical Office of Montenegro
MPP	Maximum Power Point
MW	Megawatt
NATO	North Atlantic Treaty Organization
NGO	Net Present Value
NGO	Non-Governmental Organisation
NOPLAT	Net Operating Profit Less Adjusted Taxes
O&M	Operation and Maintenance Costs
OeBD	Österreichische Entwicklungsbank
OPEX	Operational Expenditures
P&L	Profit and loss
PESTEL	Politica, Environmental, Social, Technological, Ecological and Legal
PPA	Power Purchase Agreement

PV	Photovoltaic
REGAGEN	Energy and Water Regulatory Agency of Montenegro
RES	Renewable Energy Systems
SPC	Special Purpose Company
SPV	Special Purpose Vehicle
VAT	Value Added Tax
WACC	Weighted average cost of capital
WBIF	Western Balkan Investment Framework

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First of all, I would like to thank my supervisor Dipl.- Ing. Dr. Mario Ortner for his support during the writing process of my thesis. I would also like to thank him and his team in Podgorica who made it possible for me to conduct personal interviews in Montenegro which have been very valuable for my thesis. Therefore, I am also very grateful that the interviewees have taken so much time for me and have provided me with local insights into the topic. In this sense, I would also like to thank Ao.Univ.-Prof.i.R. Dipl.-Ing. Dr.techn. Puxbaum and the TU Academy for Continuing Education for the opportunity to complete my research trip to Montenegro. A big thank you also goes to my dear study colleagues who have always supported me in the last two years. Moreover, I am very grateful for the continuous support of my parents, family, and friends without which I would certainly not have made it this far.

1. Introduction

1.1. Topic and research question

"*The fulfillment of one of the greatest desires of mankind – the use of the almost limitless energy of the sun*" (New York Times, seen at: Mertens, 2019, p.17).

This is how the New York Times introduced the first silicon solar cell developed in the year 1954 in the Bell Labs by Daryl Chapin, Calvin Fuller, and Gerald Pearson to the public (Mertens, 2019, p.17). Almost 70 years later Photovoltaic Energy is playing an increasingly important role in our society. A key reason for this is the importance of the use of renewable energy sources to combat climate change and its effects. The Sixth Assessment Report of the IPCC shows that the 1.5°C goal will be almost impossible to reach. The development of PV projects contributes positively towards a low-carbon society and is crucial for reducing the effects of climate change (IPCC, 2022). The generation of PV Energy has shot up in the past years and hydropower was the only renewable energy source with a higher absolute generation growth in 2021. But for being able to meet the net-zero goal in 2050, a much higher share of solar energy is needed (IEA, 2022).

The Western Balkans are in this regard an interesting geographical area as they need to import a lot of energy compared to other countries in Europe, and on the other hand, they are not yet very developed in terms of efficiency and renewable energy systems (Lalic, et al., 2011). The state of Montenegro located in South-eastern Europe at the Adriatic Sea signed its declaration of independence in 2006 and has been a candidate country for the European Union since 2010. It is a vibrant country in an interesting location and with an instable political situation. The status as EU member candidate makes the situation even more alluring as certain regulations have to be followed (European Commission, 2022). It is staggering that currently the solar energy sector in Montenegro is not very developed. However, the location and climate in Montenegro are very favorable for the use and implementation of solar energy (Energy Community Secretariat, 2022). Montenegro only uses little of its potential and consumes more energy than it produces. There are ample opportunities to develop solar energy projects in the country. Regarding the trend of solar energy projects developed by investors around the world and considering the potential in Montenegro the question arises why in the country the sector is not yet developed at all. This thesis focuses on this question and discusses the potentials of the PV sector in Montenegro with the help of a case study. Throughout the thesis, the perspective of an investor who has the goal to develop a solar energy project in Montenegro will be followed.

After outlining the relevance of the topic, the research questions which are answered in the course of this thesis will be defined in the subsequent part. The aim is to answer the following main research question and two sub-questions:

Main research question:

What are the main steps involved in developing a feasible PV project in Montenegro, and what external factors need to be considered during the process?

Sub-research questions:

What is the outcome of a cost-benefit analysis for developing a PV project in Montenegro?

What are the challenges and opportunities for the PV sector in Montenegro?

To answer the research questions it is important to discuss not only the technical but also the political dimension in order to assess all the important factors relevant for developing a renewable energy project in Montenegro. The goal of this thesis is to establish a handbook for investors and project developers. As the solar energy sector in Montenegro is not advanced, this will be a challenge and has not been done in other literature sources. This again outlines the importance of the topic of this thesis and is also the reason why Montenegro has been chosen for this research. It should help to fill the respective research gap and contribute to the energy transition of this country.

1.2. Methodology

The thesis is structured in three building blocks. First of all, a literature review will serve as a theoretical framework and provides the basis for the subsequent sections. Basics of PV technology will be explained by the review of fundamental literature and scientific journal articles. The current state of the art will be taken from white papers and reports from for example IRENA, European Commission, and IEA. The explanation of the steps required for developing a renewable energy development project will be reviewed in the second building block by examining scientific journals, best practices, case studies, and reports. The third part will be the a case study which entails on the one hand a political, environmental, social, technological, economic and legal (PESTEL) analysis of the country and on the other hand the discussion of the specific project development steps and a cost-benefit analysis. The PESTEL analysis serves as an excellent tool and will be carried out with information from journals, reports, and articles. Additionally, interviews with local specialists will be taken into account. The transcripts of the interviews are attached in the Appendix (A.1) and used as local insights into the current situation of the country. Throughout the case study PV technology basics, project development and information about Montenegro will be combined to create a handbook for an investor. The outline of the various stages of the project development in Montenegro will be expanded by the cost-benefit analysis. This case study is a combination of information taken from literature and local insights, put into practice. Therefore, the result will be combination of literature and practice. The result of the case study will also expand on the answer to the research questions.

1.3. Literature review

This section of the thesis only serves as a short overview of the most important literature used in the thesis as chapters (2) and (3) serve as a more accurate review. In his publications, Mertens gives a good overview of the most relevant topics relating to photovoltaic energy (Mertens, 2018; Mertens, 2019). However, he is only one author among numerous others dealing with this topic. Renewable energies are also a topic in reports by the United Nations, IRENA or on the website of the Office of Energy Efficiency. Current and future application of technologies are also discussed within the respective sources (IRENA, 2018; United Nations, 2023; Office of Energy Efficiency & Renewable Energy, 2023c). In addition, there are numerous current papers in peer reviewed journals that deal with this topic (Dambhare, Butey and Moharil, 2021). New technologies are also discussed for example in IRENA reports but also by MIT research institutes (IRENA, 2019; Energy Initiative Massachusetts Institute of Technology, 2015). Concerning the topic of solar PV project development, less literature is published. Literature deals mainly with renewable energy project development in general and not specifically with solar PV installations. The basis of this thesis are the elaboration of the International Finance Cooperation and the book by Mohamadi on Project Finance in Renewable Energy Infrastructure (International Finance Cooperation, 2015; Mohamadi, 2021). For this purpose, parts of Ortner's script, reports and various case studies have also been very helpful (Ortner, 2023; Cement Sustainability Initiative, 2016; Nielsen, et al., 2016).

1.4. Structure

The introduction is followed by an explanation of the main topics concerning PV (2). The beginning is an explanation of renewable energy systems (2.1) and the history behind PV (2.2). To understand the subject, the functioning of PV cells (2.3.1) and their materials (2.3.2) are explained. The chapter concludes with the most important performance indicators (2.4), areas of application and an outlook on the future (5.4). The third chapter deals with the most important contents of the project development framework (3.1) and explains on the one hand all stages and on the other hand possible support mechanisms and policies (3.9). After providing a basic understanding of the most important theoretical contents the case study is outlined (4). At the beginning the framework and the methodology (4.1) are explained and the interviews are summarized (4.1.1). The heart of the case study is the PESTEL analysis (4) of Montenegro, the Project Development Framework (4.3) and the Cost Benefit (4.4) analysis. The conclusion of the work provides the answer to the research questions, presents limitations (5.3) of the work and a future outlook (5.4).

2. PV - State of the Art

This chapter will elaborate on the technological, energetic, and economical implications of PV. As this thesis is focusing on the investor perspective, the most important facts for investors regarding the technical functionalities and key indicators of PV will be discussed. Subsequently, the state-of-the-art technology will be indicated. Relevant literature in the field is reviewed and compared.

2.1. Renewable Energy

Over time, extensive literature on PV has developed. Before elaborating more on the technology of PV, a definition of renewable energy is necessary. Mertens defines renewable energy as a source of energy that is indispensable (Mertens, 2019, p.11). Energy can be defined as the possibility of a system yielding external influences like heat and light. Figure (2.1) shows different classifications of renewable energies with their processes and respective power plants. Solar radiation can be used for thermal collectors, thermal power stations, and photovoltaic.

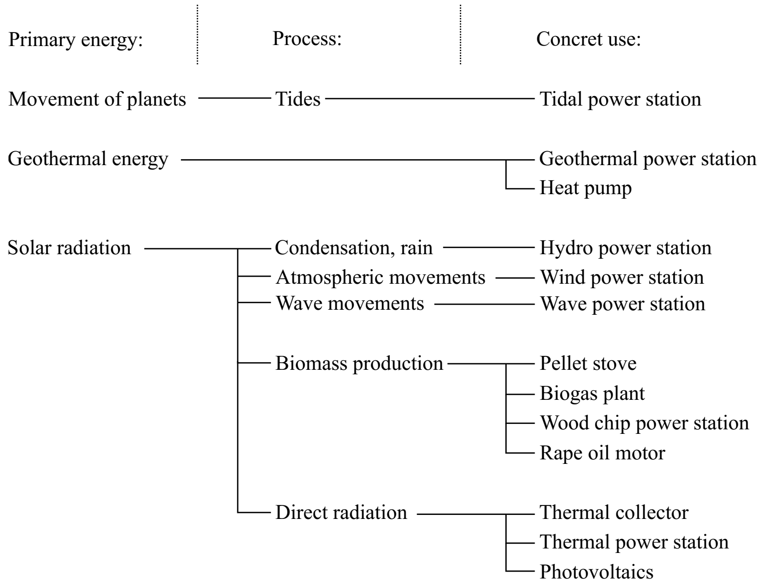

Figure 2.1.: Possibilities of renewable energy forms (derived from Mertens, 2019, p.12)

Another comprehensive definition of renewable energy can also be found on the homepage of the United Nations: "*Renewable energy is energy derived from natural* *sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished. Renewable energy sources are plentiful and all around us.*" The organization classifies solar energy, ocean energy, bioenergy, hydropower, geothermal energy and wind energy as renewable energy sources (United Nations, 2023). Ramalingam and Indulkar point out in their study that when comparing different renewable energy sources, PV systems have the advantage that solar energy is obtainable over a long-time scale on the earth's surface (Ramalingam and Indulkar, 2017, p.1). After elaborating on what renewable energy means, the following section will focus on the historical development of photovoltaics.

2.2. Historical Aspects

'Phós' (light) and 'Volt' (name of the physicist Alessandro Volta) are the components of the term Photovoltaic. The combination means the "*direct conversion of sunlight into electric energy*" (Mertens, 2019, p.14). The History of PV energy goes back to 1839 when Henri Becquerel discovered the photovoltaic effect. Hossain and Jieb outline that these findings were developed by Grylls who showed that electricity can be drawn from solid materials and Fritts who came up with a design for a PV module in 1884. The problem is that the photoelectric effect was not really understood until Einstein could deliver the explanation in 1921. The effect is the basis for today's solar energy production and the next huge step forward was the development of the first semiconductor in 1954 by Daryl Chapin, Calvin Fuller, and Gerald Pearson working for the Bell Labs. The efficiency from the first cell was as little as six percent and due to intensive development, the efficiency level could be increased. Initially, solar cells were mainly used in space and found their broad application in the 1990s. Especially after the first oil crisis in 1970 and the Chernobyl disaster in 1986 the demand for alternative renewable energy sources increased and so did the research in that field. The start of the twenty-first century marked the switch to renewable energy sources. This is also the reason why the annual growth rate of PV climbed. This development goes hand in hand with the recognition of the harmful effects of greenhouse gases resulting in climate change. Therefore the production and instalment of PV modules is rising (Mertens, 2019, p.14-21; Jieb and Hossain, 2022, p. 9-10). Studies from IRENA reveal that even if Asia installed the highest capacity in 2018 followed by Europe and North America, in 2030 North America will catch up with Europe and close the gap. Hossain and Jieb strengthen the upward-moving trend by stating that: "*The installed capacity of the PV system worldwide is expected to increase to 2840 GW by the next decade and is anticipated to reach 8519 GW by 2050*" (Jieb and Hossain, 2022, p.12).

Regarding solar power generation to meet the rising demand, technical development is a top priority. To understand the basics of the technical aspects of PV and the current state of the art of technologies, the most important key facts will be explained in the next chapter.

2.3. Technical Aspects

2.3.1. Functioning of solar cells

This section will focus on the technical background regarding the generation of electric energy from solar radiation, this is also called the photovoltaic effect. Solar cells are used to carry out this effect as they are deployed to convert solar energy into direct current (DC).

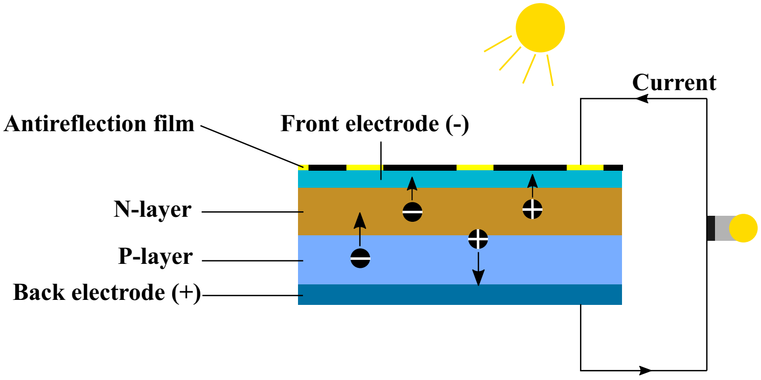

Figure 2.2.: Photovoltaic effect of a solar cell (derived from Richhariya, Kumar and Samsher, 2020, p.28)

Figure (2.2) illustrates the photovoltaic effect. This effect is based on the photoelectric effect but the main difference is that within the photovoltaic effect, the electrons which are knocked off, stay within the material. To simplify the illustration of how a solar cell functions, the process will be divided into three main steps:

1. The start of the process relies on the incoming solar radiation. Relevant to state is that solar rays can occur in varying wavelengths. The wavelength also determines the amount of energy which is transported by the photons. Solar radiation consists of photons which carry energy. But not all of the incoming solar radiation ends up in the solar cell as some of it is reflected or absorbed by clouds or the atmosphere beforehand. This depends heavily on the condition of the atmosphere. The remaining incoming solar radiation is then absorbed by the cell. An anti-reflection film helps to decrease the reflection and consequently increases the performance of the cell. The photons react with the semiconductor material of the solar cell. When solar radiation hits a PV cell, the electrons are knocked off atoms that are located in the semiconductor material.

2. The electrons are starting to move around, which in the end results in an electric current. The cell consists of two different types of semiconductor layer material: p- and n-type. Together, they are forming the p-n junction. The two layers are differently charged, which results in an electric field functioning like a diode. The electrons are flowing within the two layers and generate the current.

3. This generated electric current is captured by the two plates on the top and bottom of the cell. They forward it to be converted into a preferred current (I) and voltage (V) (Richhariya, Kumar and Samsher, 2020, p. 28; Mertens, 2019, p.71-80; Ramalingam and Indulkar, 2017, p.100-101).

The cell can be classified into five different components: inverter, charge controller, solar module and the balancing of the constituents, which includes wiring, cooling and protection (Jieb and Hossain, 2022, p.95). A single solar cell only has an output of 1-2 Watt which can be multiplied by connecting several solar cells to each other. This results in solar panels or modules. When many solar panels are connected, an array is set up. Additionally, solar modules can be installed in strings or parallel to each other. The flexibility of putting as many cells together as required makes it possible to create small and large quantities of electricity (Office of Energy Efficiency & Renewable Energy, 2023a). Literature shows that the amount of electricity generated by the cell is depends on several factors. First of all, as solar cells are powered by solar radiation, the output depends strongly on the availability of solar radiation at the site. Also, the occurrence of shades and orientation of the installation is relevant. There are also modules which have fixed or single and double axis tracking systems to ensure an efficient capturing of solar radiation. Moreover the material, components, and inverters also have a huge impact on the electrical power output (Ramalingam and Indulkar, 2017, p.105).

Nevertheless, PV energy would not work with a solar cell as its only constituent. To be able to put into operation, a whole photovoltaic system is necessary. The components of the system depend on the application of PV, which will be discussed in chapter (2.5).

2.3.2. Material

As explained above, the output and efficiency of a solar cell is dependent on its material. This section will focus on a short review of recent literature on this topic. A wide range of literature on the type of solar cells is availiable. The office of Energy Efficiency and Renewable Energy supports the argument that the material plays a crucial role regarding the efficiency and output of a solar cell. The focus lies on the material of the semiconductor within the cell. Semiconductoral means that, "*it can conduct electricity better than an insulator but not as well as a good conductor like a metal.*" The authors divide the different types of solar photovoltaic cells into silicon, thin film-, perovskite-, organic-, quantum dots-, multifunction- and concentration photovoltaics (Office of Energy Efficiency & Renewable Energy, 2023b). A more comprehensive description can be found in the book published by Richariya et al.. The following figure (2.3) shows the classification of the different solar cell technologies.

Crystalline solar cells can be classified into mono- and poly cristalline solar cells. Even if this group of cells is more expensive than the thin film solar cell, it is the most

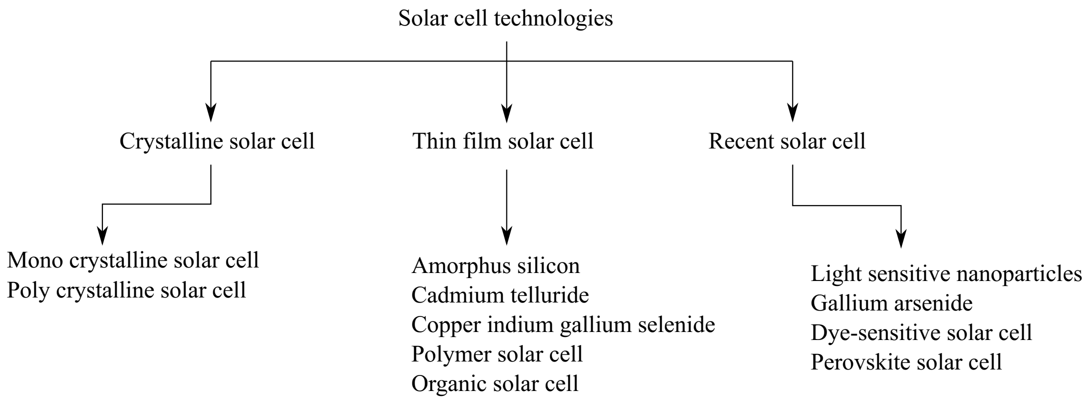

Figure 2.3.: Solar cell technologies (derived from Richhariya, Kumar and Samsher, 2020, p.30)

popular because of their accessibility. Tiwari et al. classify the crystalline solar cells as first generation cells and the technology used is called Si wafer. Their theoretical efficiency accounts for about 33 percent and the energy-conversion efficiency for about 15-20 percent. Even if they are both made from silicon, mono crystalline solar cells are compared to poly crystalline cells, more expensive but also more efficient. One advantage of first generation cells is that their technology and efficiency is proven as they were already installed in the 1970s and are still used today. The second generation is the thin film solar cell. Compared to the first group, they are less expensive but also less efficient. They are called thin-film cells because only a thin layer of semiconductor material is installed onto the foil which consists of plastic, glass or metal. Advantageous is that they are more flexible regarding the possibility to install them compared to other generations. The organic solar cell and polymer solar cell are two examples of thin film cells. The organic solar cell uses organic electrons and is less expensive but lacks efficiency compared to other technologies. Due to the increase in application of solar energy, the technology has developed accordingly. Furthermore a third generation can be presented in this context. Examples of new technologies are the gallium arsenide- and the dye-sensitized solar cell (G. Tiwari, A. Tiwari and Shyam, 2016, p.140-149; Office of Energy Efficiency & Renewable Energy, 2023a; Richhariya, Kumar and Samsher, 2020, p.27-48). Recent research by the IRENA on the future of PV has revealed facts about the future design of solar modules. Especially the search for higher efficiency fuels the search for new materials. A combination of high-efficiency and low-cost technology is necessary as unitl now mostly one of these factors has fallen short. So far, crystalline silicon materials still make up most of the production share worldwide. Even if this technology is highly accepted on the market there is a lot of room for improvement concerning the efficiency, environmental effects and costs. An important factor to be considered is the end of life management of PV modules, which is a research area yet to be developed (IRENA, 2019, p.40-50).

2.4. Economic Performance Indicators

After defining the technical aspects, the economic performance indicators are outlined in this section. This is just a brief outline of essential performance indicators which are alluring when it comes to controlling the performance of a PV plant. Haramaini et al. state that "*for a PV project investment, the economic indicators are usually most concerned to make sure the investment gives a benefit impact*"(Haramaini, et al., 2019, p.123). The focus lies on indicators which are also used during the cost-benefit analysis. First of all, the Internal Rate of Return (IRR) can be used to calculate how profitable an investment is. The economic viability of the capital employed is determined. The net present value at the end of the investment should be higher than at the beginning and the return on investment should also exceed the financing costs. Furthermore, the weighted average costs of capital (WACC) should be considered. The risks of an investment can be assessed and the cost of capital calculated. For this purpose, the debt and equity ratios are used to calculate the interest rate paid to the investor. A low WACC means a good result. The debt coverage ratio (DSCR) measures the amount of money generated by a project compared to its costs. The higher the ratio, the better. A favorable ratio also helps to get a loan. The cash flow calculation is an ongoing comparison of income and expenses. It shows which surpluses the company has generated and how strongly the company can finance itself. This is also particularly important for lenders. Lastly, a profit and loss statement should be made. During this calculation the expenses from land lease, OPEX, reserves and incentives are subtracted from the revenues which results in the earnings before interest, taxes, depreciation and amortization (EBITDA). After deducting the depreciation (EBIT) and the interest (EBT) the corporate tax can be subtracted, which results in the net operating profit less adjusted taxes (NOPLAT). Moreover, the sensitivity analysis shows how a selected variable changes if the factors that make up this variable are changed. This can be done with a wide variety of indicators and also helps to better assess risks and situations. (Berk and DeMarzo, 2020) How the economic performance indicators are put into practice can be seen in section (4.4) when the cost benefit analysis for a fictious project is concluded.

2.5. Application

2.5.1. PV System Design

There are several types of applications for PV Systems. Different installations can be classified into various groups. First of all, they may be divided into grid-connected, stand-alone, and hybrid systems. This is a classification regarding their functioning alongside the grid. When power is directly fed into a grid, the system is called a grid-connected system. It is called a stand-alone system when the power is not fed into the grid but used for a local purpose at the point of generation. The energy not consumed can for example be stored in battery systems. A combination of the two systems is a hybrid system. On the one hand, excess energy can be stored in batteries. On the other hand, it be fed into the grid, which results in high overall system stability. In Figure (2.4), the stand-alone and grid-connected systems are shown with their most important components.

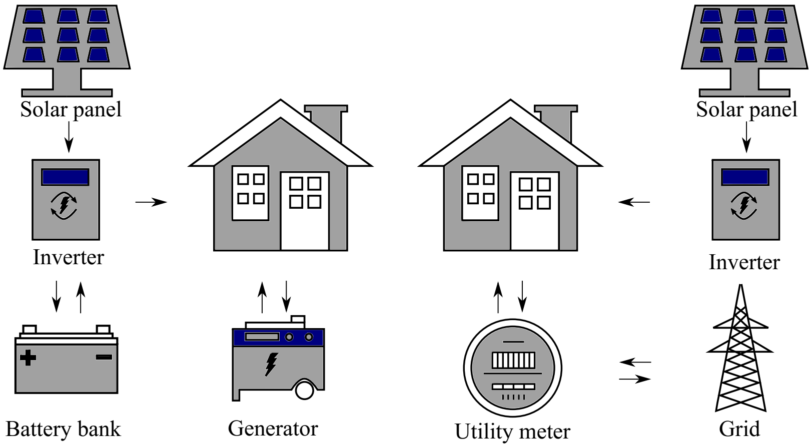

Figure 2.4.: Off-Grid vs. On-Grid system (derived from Ramalingam and Indulkar, 2017, p.122)

Secondly, with regard to the type of PV plants a lot of flexibility exists concerning size and the environment where they can be installed. The following graph shows the most important types of plants. This is a categorization according to the placement of solar modules.

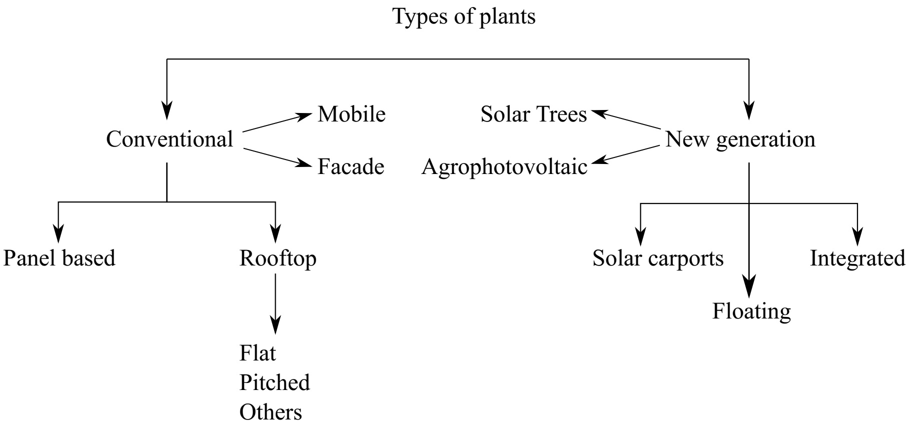

Figure 2.5.: Types of plants (derived from Mertens, 2019, p.158-164; IRENA, 2019, p.40-47)

The different types of PV installations can occur in several sizes and therefore differ in performance. Ground-based installations are mostly built as large-scale PV parks. Those big solar farms are able to produce up to hundreds of MW of solar power. The biggest solar park in the world is located in India (Bhadla Solar Park) with an output of 2.25 GW. Solar panels installed on rooftops have a smaller capacity and are estimated to have an output of 3-20 KW. Rooftop panels can come in different installation types as flat or pitched. Especially interesting are the new generations of Solar PV. In a report published in 2019, the IRENA discussed upcoming new technologies. One example is floating PVs. They are especially demanded on islands in Asia where land is a scarce resource and the cost of installation on the water is cheaper than on land. One example for a floating PV plant is in China with a size of 70 MW. This technology is very promising and will also bring a lot of possibilities for European countries. Furthermore, building integrated PV Panels (BIPV), solar trees, and solar carports all open up new opportunities for solar energy systems to be integrated into the energy sector. Especially the combination of agriculture and photovoltaic is a promising installation that brings advantages for the crops and the energy supply (IRENA, 2019, p-40-47; Mertens, 2019, p.158-164).

2.5.2. Storage systems

As mentioned above, there is the possibility to construct solar systems with storage systems. These systems can help in peak load hours and help to manage the grid efficiently. As solar radiation is varying and is not always available, storage possibilities are crucial to maintaining energy supply security. This section will discuss shortly the most important technologies in this field. Electricity storage technologies can be classified into six different groups: Electrochemical Storage, Thermal Energy Storage, Flywheel Storage, Compressed Air Storage, Solar Fuels, and Virtual Storage. Batteries, which are electrochemical storage technologies, are the most frequently used type in PV systems. Examples of the composition of the batteries are lithium-ion, lead-acid, nickel-based, and sodium (Office of Energy Efficiency & Renewable Energy, 2023c). The functioning of batteries in storage systems depends mainly on the setup of the system. Mertens differentiates between a Direct Current (DC) and Alternate Current (AC) coupling. When an AC coupling is installed energy is transported on the AC side and has to be converted to DC for storage. No conversion has to take place with a DC coupling and the energy can be transferred directly to the battery (Mertens, 2019, p.188-189).

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2.6. Future Outlook

After explaining the most important aspects of PV technology, fundamental knowledge is given, to understand the subsequent parts of the thesis. With the expansion of renewable energies and especially solar power, a lot of research is happening at the moment. In every technical aspect, progress will be made in the near future which will affect the efficiency and the cost of solar power installations. These new innovations are therefore also essential for developing solar PV projects. The MIT has published a study about the future of solar energy and lines out that if we want to meet the demand in the future, cost-competitiveness regarding fossil fuels has to be reached. It will be a long way to reach this goal and a lot of changes in local politics and policies have to be made. Attention should also be drawn to the challenge of introducing large-scale solar plants into grids without the risk of overloading. These challenges must be considered in solar project development (Energy Initiative Massachusetts Institute of Technology, 2015). How these projects are developed and the most important factors will be explained in the next section. The outline above regarding the components of PV systems, also shows that there are different attributes for every technological constituent. Therefore, there is no top technology which fits for all projects. This has also to be assessed during the development of the project.

3. Project Development

In this chapter, all the important steps of developing a PV project will be outlined. A framework will be given to be later applied in the case study. Several case studies and other relevant literature resources will be reviewed to identify the most crucial steps needed to develop a successful project. The exact execution of the steps also depend on factors like the location and preferences of the developer and can be adapted for every project. Figure (3.1) shows an overview of the project implementation framework.

3.1. Project Development Framework

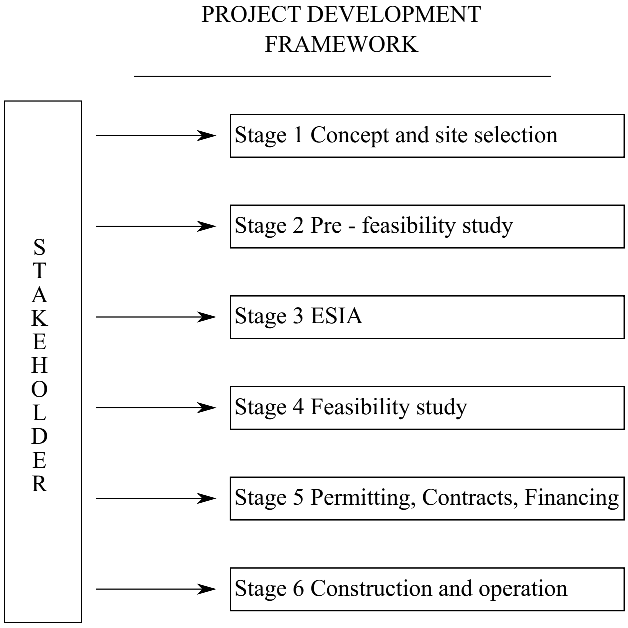


Figure 3.1.: Project Development Framework (derived from International Finance Cooperation, 2015)

3.2. Stakeholder

Before dealing with the details of, planning and execution of a project the stakeholder of the project have to be determined. Stakeholder are "*individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion*" (Project Management Institute, 2023). By identifying the stakeholder, the definition of their role and interests help to minimize and mitigate possible risks that could come up during the process. Moreover, by involving all stakeholder, acceptance for the project can be reached and the local environment will be included. Also, this step is valuable for capital investments and strategic management decisions. A method and the first step to capturing and categorizing all project-relevant stakeholder is called stakeholder mapping. After the mapping process, interaction with the identified groups begins and ends in the evaluation stage (Bremere, Indriksone and Strigune, 2019). There are several frameworks in the literature on how to map stakeholder. This thesis follows the approach of the handbook on innovative modes of stakeholder involvement and communication models. They have set out a framework and predefined seven important groups which can then be customized for every project. The following groups have been defined: "*public authorities (policy and decision makers), energy producers, investors, professional association experts (consultants), environmental NGOs, and citizen/society groups. Depending on the goals of renewable energy projects, stakeholder from national, regional and local level should be involved*" (Bremere, Indriksone and Strigune, 2019, p.14). In the process, for each stakeholder group the respective departments or institutions are selected. Afterwards the role, responsibilities and cooperation is determined (Bremere, Indriksone and Strigune, 2019, p.17). Other methods to visualize stakeholder are the stakeholder circle tool or the organizational tool, but this is only a small selection out of many. The one with the best fit for the project should be selected and applied. Stakeholder engagement should be part of all the upcoming steps (Walker, Bourne and Shelley, 2008, p.2-3).

3.3. Stage 1: Concept and Site Selection

The first stage includes the planning of a first project concept and the selection of a site. The research carried out in the business development process entails an analysis of the market to find out more about the economic factors, electricity demand, regulations and strengths, weaknesses, opportunities and threats of the market. A PESTEL analysis of the selected country provides a good foundation of knowledge for further proceedings. After first assessments, it is easier to estimate how much risk is hidden in this market and what the possibilities of the project are (Mohamadi, 2021, p.11). The project idea and the founding of the special purpose vehicle (SPV) is the starting point of the process. In the first concept the scope of the project, a site selection and first funds should be available to carry out the assessment. At this point the developer should already define clear objectives for the project (International Finance Cooperation, 2015, p.50).

3.3.1. Special Purpose Vehicle

A SPV is set up as a project company and helps with mitigate financial risks. It separates the project from the company which pursues the project and should only be made when a project is set up for financing and pursuing a project. Therefore balance sheets and several projects of a company can be managed separately. This should be considered at the beginning of the project as the SPV requires an initial financial plan and all contracts and permits have to be concluded by the SPV. Later reassembling can result in longer duration and inefficient processes (Mohamadi, 2021, p.10).

3.3.2. Site Selection

In the IFC guideline for utility-scale solar photovoltaic power plants, a site should be selected according to the following criteria: "*accessibility of solar irradiation, good climate conditions in general, grid connection/ accessibility, and land availability. The environmental and social conditions in the area are alluring on top of that*" (International Finance Cooperation, 2015, p.10). What has to be considered regarding the individual factors will now be explained in more detail. When selecting a piece of land, several factors and boundary conditions have to be taken into account. First, solar irradiation has to be sufficient to run the solar PV plant efficiently. There must be enough sunny days per year and peak sun hours per day so that it makes sense to rely on solar power as an energy source. Moreover, the annual radiation and the shading potential have to be determined. According to a study by McKinsey, it is getting harder and harder to find suitable properties for projects. This is due to natural factors but also a lot of regulations reduce the land usable for projects (Christakou, et al., 2022; International Finance Cooperation, 2015, p.10-12).

When suitable land has been found the upcoming question is if it will be leased or bought (International Finance Cooperation, 2015, p.10-12). One example is that a developer leases the land from the owner who is for example a farmer. It also has to be taken into consideration if the land needs to be rededicated to construction land. In such a configuration when electricity is generated, it does not belong to the landowner but to the developer. The owner of the land gets a certain amount of money, specified in the leasing agreement (Ortner, 2023). The social conditions in the region are also relevant. Having good relationships in the area of the chosen country can be very helpful for the development of the project. When it comes to ESIA studies and permits, project opponents can lengthen the process for a very long time. The value the project delivers to the local community should be communicated from the beginning to mitigate public rejection (International Finance Cooperation, 2015, p.10-12).

3.3.3. Information and Grid capacity reservation

The accessibility and availability of a grid from the construction site is one of the most important things when evaluating where to build the power plant. In the beginning, information about the capacity of the local grid from the transmission system operator should be requested. The transmission system operator has control and overview of the transmission grid of a country. The grid is composed of transmission and distribution lines. The transmission covers the high voltage lines and the medium voltage lines are covered by the distribution network, which distributes the power to the consumer. Often a suitable piece of land is not located next to a good grid connection which would for example be next to industrial areas. This would result in the need to construct transmission lines and consequently in higher costs. Precaution has to be taken to avert grid congestion by providing enough storage possibilities in the system. As the security of the grid is very important, the plan of developing new solar power plants and therefore feeding electricity into the grid has to be reported to the local grid operator and determined if there is enough capacity. Keeping this in mind, long waiting times can be reduced (Christakou, et al., 2022; Suleiman and Shan, 2016, p.20).

3.3.4. Conceptual Design

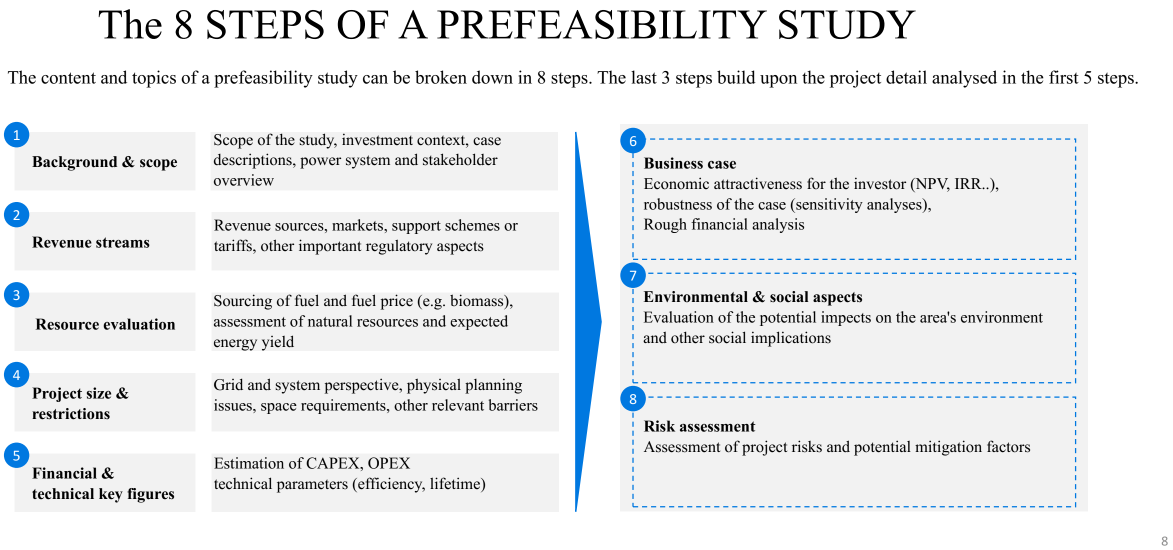
The steps described above result in the conceptual design which summarises all the factors analysed and put into a framework. This means that it entails information about the general structure, information about the selected location and site, grid accessibility and fund availability. It may also include a cost-benefit calculation to estimate the economic viability of the project. This framework forms the basis of further development. Within the design advantages and disadvantages of options are elaborated. The financial and technical aspects are compared and an estimation is made which evaluates the risks that could affect the project. In an initial financial plan the necessary resources and alternatives to finance the project are identified. When the outcome of the conceptual design is positive, the project can be taken to the next stage (International Finance Cooperation, 2015, p.10-12; Ortner, 2023).

3.3.5. Cost-benefit analysis

A cost-benefit analysis can help to make important decisions during the development process. During the analysis all crucial variables regarding the costs and benefits are included, compared and assessed. The results show if the project is feasible or not. The analysis allows to make the project measurable by allocating KPIs to the influencing factors (Gudlaugsson, et al., 2021, p.1-5). Sensibility studies are part of the cost-benefit analysis and help to assess how changes of defined parameters affect the performance of the PV plant (Verma, Mahajan and Garg, 2021). For the project, a cost-benefit analysis framework should be established and the most important parameters identified. Technical, economic and financial information has to be included as well as operation costs and data about the land investment. The cash flow analysis and profit and loss statement represent the various relationships among the parameters which can be interpreted to make sound decisions. The levered and unleveled IRR can be calculated whereas the unleveled IRR is taken into account (Ortner, 2023). An example of a cost-benefit analysis and an interpretation is part of the case study in section (4.4).

3.4. Stage 2: Pre-feasibility Study

The Nordic Energy Research Institute defines the pre-feasibility study as "*a preliminary systematic assessment of all critical elements of the project-from technologies and costs to environmental and social impacts. It is a sanity check on the feasibility of the project*" (Nielsen, et al., 2016, p.10). In the literature, the content of the pre-feasibility study varies in terms of different reports and studies but the following key components could be identified: project description with specification of energy consumption data and energy yield, geographic and demographic data, technical specifications, preliminary design, cost and benefit analysis, preliminary ESIA study, preliminary site evaluation, preliminary evaluation of needed permits and licenses, set up of project implementation time schedule, evaluation of Operational Expenditures (OPEX) and Capital Expenditures (CAPEX), specifications about the electricity tariff (Nielsen, et al., 2016, p.11; International Finance Cooperation, 2015, p.12-13). The Danish Energy Agency classifies the pre-feasibility study in eight steps. The steps of the pre-feasibility study also closely relate to the later described feasibility study. The framework can be withdrawn from the following figure (3.2) which summarizes the most important steps:



The 8 STEPS OF A PREFEASIBILITY STUDY

The content and topics of a prefeasibility study can be broken down in 8 steps. The last 3 steps build upon the project detail analysed in the first 5 steps.

1	**Background & scope**	Scope of the study, investment context, case descriptions, power system and stakeholder overview
2	**Revenue streams**	Revenue sources, markets, support schemes or tariffs, other important regulatory aspects
3	**Resource evaluation**	Sourcing of fuel and fuel price (e.g. biomass), assessment of natural resources and expected energy yield
4	**Project size & restrictions**	Grid and system perspective, physical planning issues, space requirements, other relevant barriers
5	**Financial & technical key figures**	Estimation of CAPEX, OPEX technical parameters (efficiency, lifetime)

6 **Business case**
Economic attractiveness for the investor (NPV, IRR..),
robustness of the case (sensitivity analyses),
Rough financial analysis

7 **Environmental & social aspects**
Evaluation of the potential impacts on the area's environment and other social implications

8 **Risk assessment**
Assessment of project risks and potential mitigation factors

Figure 3.2.: The eight steps of a pre-feasibility study (derived from Danish Energy Agency, 2021, p.8)

3.5. Stage 3: Environmental and Social Impact Assessment

The Environmental and Social Impact Assessment (ESIA) is a very critical component when developing a project. It can be decisive for the outcome of the project. Depending on the location, differences in for example local and European legislation has to be taken into account. The ESIA is accompanying the developer from the beginning until the end of a project. Throughout all the project steps, information is prepared to be included in the final ESIA report. The social and environmental effects, positive and negative, on the environment which result from the execution of the respective project, are summarized and assessed in an ESIA. Therefore, not only the impact of a solar power plant that is in operation but also for example the construction and decommissioning phase have to be considered. The ESIA is implemented in many regulations and legal systems and is mostly required before substantial permits are granted for a project. Even though slight differences apply in countries, the overall framework of the ESIA stays the same around the world (Cement Sustainability Initiative, 2016, p.10-12).

The European Investment Bank published standards for projects within the EU, EFTA and for countries that have an EU membership candidate or potential candidate status. These projects should follow the legislation set out by the respective state and the EU. Therefore, the Environmental Impact Assessment Directive should be considered. For the remaining countries, the EIA Directive can also be taken into account and national legislation should be examined. Other relevant international guidelines are the standards by the International Finance Cooperation and the World Bank. It can be gathered from the respective legal guidelines, which projects need an assessment. There are different regulations to be followed and requirements to be fulfilled (European Investment Bank, 2022, p.1-6; Das, et al., 2017, p.5). Figure (3.3) depicts the steps that make up the framework:

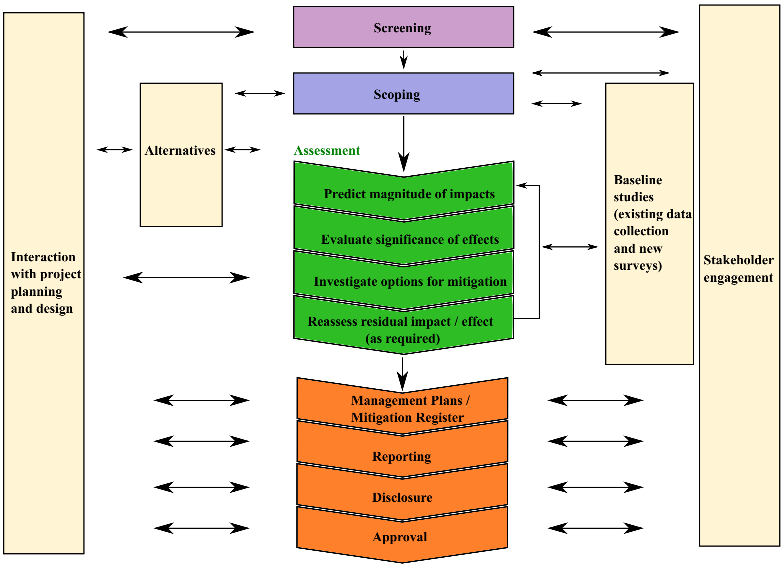


Figure 3.3.: The ESIA process (derived from Das, et al., 2017, p.6)

The first step of screening and the following scoping report help to find out which kind of surveys have to be performed. Examples are biodiversity, geotechnical, social, environmental and topographical surveys. The project developer should be in close contact with relevant stakeholders at any time. The right of access to information and public participation in the decision-making process and access to justice must be taken into account. In this report two settings will be compared: the status-quo before project and after the implementation (Ortner, 2023; Das, et al., 2017; European Investment Bank, 2022).

3.5.1. Environmental Consent

The environmental consent or also called development consent is defined in Article 1.2.c of the EIA directive as "*the decision of the competent authority or authorities which entitles the developer to proceed with the project*" (European Union, 2012). Therefore, the competent authority has to be identified and the project developer needs to apply to it for environmental consent to be able to move on in the process (Ortner, 2023).

3.5.2. Preliminary Design

With the detail design in the end and the conceptual design at the beginning of a project, the preliminary design forms the centerpiece in the design process. The preliminary design makes up 90 percent of the detail design and has to be approved by the authorities. It includes all the important facts analyzed in the pre-feasibility and ESIA study. The most important environmental, social, technical and financial components of the project are defined in more detail. Spatial planning is also considered as crucial in this step.

3.6. Stage 4: Feasibility Study

In the third stage, the feasibility study, the information collected in the pre-feasibility study is specified. Therefore, the developer should start focusing only on one alternative at this point of the project development stage. More specific data are collected for the respective alternative and a comprehensive project scheme is developed. Also, compared to the pre-feasibility stage, more stability regarding financial resources should be given. In other words, the pre-feasibility study is a more detailed feasibility study which focuses on one design option. Moreover, local legislation determines how large and specific the scope of the study has to be. The content of the feasibility study can be summarized in the following main points:

the technical design of the system with specifications for the technology used, information on shading, and solar resource analyses. Regarding the technical parts, the modules, inverting technologies and other components have to be chosen. In addition to this, a detailed design and the needed permits have to be laid out. Also, project relevant stakeholder and the communication framework are included. Another aspect is the grid-specific information. At this stage, the evaluation concerning the connection to the grid should be finalized. Regarding the electricity tariff further examination should happen. This is especially true in markets where it is expected that the tariff will change due to market forces, deliberate design, or government influence. The financial part of the pre-feasibility study should entail a cost-benefit analysis, an investment and funding concept, and a risk analysis. Other components are environmental studies, the selection of counseling services, and agreements regarding the land. A lot of processes run parallel to the other stages (Gevorkian, 2011, p.294-295).

3.6.1. Detail Design

The detailed design is a document that includes the information and outcomes of the feasibility study including the preliminary design. Gevorkian also names it "*engineering design*" (Gevorkian, 2011, p. 295). Sometimes it is only the title that is changed for the detail design. The content however, stays the same as in the preliminary design.

3.7. Stage 5: Permitting, Contracts and Financing

Stage five is one of the most critical ones as it deals with the finalization of permits, contracts, and finances. A lot of external and internal factors have to be harmonized and stakeholder engagement must be continued on a high level. Because of the long duration of some processes in this stage, some of them will probably run parallel to the other earlier project segments.

3.7.1. Permits

The International Finance Cooperation (IFC) classifies the permits needed for solar PV projects in nine different groups: land lease agreements, access agreements, planning/land use consents, construction permits, social impacts, energy permits, grid connection application and operator/generation licenses. The duration for getting permits may vary and has to be contemplated. The relevant stakeholder, as for example authorities, have to be contacted to access information on the requested documents.

Additional documents needed can differ regarding the type and location of the project. Sometimes changes in the plans have to be made to be able to meet the requirements of local authorities. The issuance of permits is subject to conditions for construction and operations. These strictly need to be followed to stay within the legal framework. The costs of the permits should also be considered in the cost-benefit analysis (International Finance Cooperation, 2015, p.16-22).

3.7.2. Contracts

Mohamadi states that different types of contracts may be divided into offtake contract (PPA), license or concessions, land lease and easement agreements, EPC contracts, O&M contract, loan agreement, shareholders agreement, supply or input agreement, direct agreement, investment contract and the government support agreement (Mohamadi, 2021, p.55-57). Forming a SPV for concluding contracts is essential to make sure that all contract closing activities pass through the SPV. This affects permits and licenses as well. Concerning the setup of contracts for the different technical parts of a solar power plant, there are two major paths that can be followed. One approach would be to engage several companies for different parts of the project. This type of contract is called equipment delivery contract and balance of plant contract (BoP). Another option is to set up a single contract for one company, fulfilling all the necessary steps within the project. This is also called an Engineering, Procurement and Construction contract (EPC). Hiring a single company minimizes the risk and management effort but can be more costly. In addition to this, the terms of reference should be reviewed with high caution before signing the contract. Moreover, the O&M contract is another aspect. Depending on the location of the project, the importance, price and extent of this type of contract may vary. Contracts can be classified into full- and regular service contracts. They differ in the extent of maintenance and their scope of special support in unforeseen situations (International Finance Cooperation, 2015, p.16-22; Mohamadi, 2021, p.56-57).

Lastly, the PPA agreement will be defined in more detail. This is an offtake agreement concluded between an off-taker and an independent power producer. The following figure (3.4) depicts the relationship between the parties involved in the PPA:

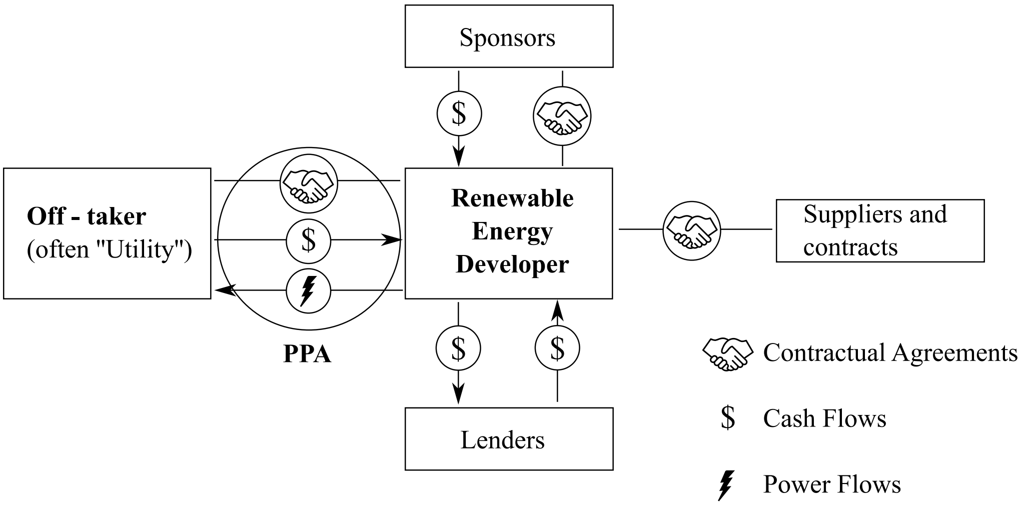


Figure 3.4.: Scheme of the Project Power Agreement (derived from Mohamadi, 2021, p.74)

IRENA classifies the PPA, "*as the most important agreement that governs the sale and purchase of power between the renewable energy producer and the offtaker*"(IRENA, 2018, p. 12). The duration of a PPA is usually about 10-20 years and can be extended when it runs out. Shorter and longer contracts are possible as well. There are several scopes of design for this type of contracts as it is most of the time a bilateral discussion. PPA's can be classified into commercial (private to private) and government agreements (public to private). The former is an agreement between the power producer and a non-governmental institution whereas the latter is concluded between the government and the power producer. Feed-in-tariffs are an example of governmental PPAs. The commercial agreements can take the form of a financial or physical PPA. Moreover, the offtake can happen in a direct or indirect way. Indirect means that there are two agreements involved: first of all directly between the electricity generator and the buyer and secondly between the electricity distributor and the buyer. This means that the electricity is indirectly brought to the consumer through the distribution network, if a direct agreement is concluded between the producer and the consumer. There is an on-site connection between those two and the transmission and distribution network is not used.

The financial part within the PPA also has to be mentioned in this respect. Sometimes the energy regulator is asking for a construction permit and proof of financial capability. Therefore an expression of interest letter and bank guarantee is needed to prove liquidity. The PPA is sometimes included in the requirements by investors and proceedings are only possible with a concluded PPA (Baringa, 2020, p.8-30; Crown Commercial Service, 2020, p.4-7; Ortner, 2023). The most widely used type of contract is designed in such way that the offtaking part is paying a fixed tariff which is independent of retail prices. In addition to this, the political and social situations have a great influence on the conditions of a PPA. Even if the whole project is developed and ready to be implemented, it is worthless without a PPA. This step in the development process is very critical and can put a project on hold for a long time. The PPA is closely connected to the financing and final authorization step as it is a key element for further progress.

Another fact which has to be considered is the conclusion of the permits and contracts by the SPV which has been set up at the beginning of the process.

Before the project is ready to be put into action, an energy license is needed which allows the plant to feed electricity into the system. (Mohamadi, 2021, p.74-80).

3.7.3. Financing and Final Authorization

In order to obtain sufficient funding, the right documents with the required information must be prepared in the process. This is also related to due diligence and risk analysis. There are several ways to finance the project. Which funding is the best suitable one depends on the exact content of the project. The IFC identified two major components of most project financing structures: "*Equity from one or more investors, injected directly or via the project developer into a SPV. Non- or limited-recourse debt from one or more lenders, secured against the assets owned by the SPV*" (International Finance Cooperation, 2015, p.159). As already mentioned, there are several types of financing. First of all, corporate and equity financing is possible. Equity funding is sometimes needed in emerging markets. It is also a good alternative when fast financing is needed to be able to obtain a feed-in-tariff.

In this case additional funding by an infrastructural fund could be considered. For large-scale projects with a longer timeline, project financing represents a frequently chosen option. The IFC distinguishes project financing from the other forms by stating that "*the main distinguishing feature of project financing is that loans are made based on the strength of ring-fenced project revenue, with no or limited recourse to the project sponsor. This approach separates an individual project from other activities of the sponsor*" (International Finance Cooperation, 2015, p.161). Again, all activities pass through the SPV as explained in the beginning of the project development framework. The perspective of all stakeholder is focused on the cash-flow forecast of the project development process when the operation starts and revenue is created. An advantage of project finance is that even if the project is risky, the financing structure is very diversified and the leverage effect promising (Mohamadi, 2021, p.35-36).

Especially for this financing structure, a due diligence process is mostly requested by involved parties like investors. The above identified required documents, permits and contracts are not only necessary for the final goal, which is to generate electricity and revenue but also determine the value of the project. They are considered by stakeholder in the financial process. When looking at the documents it can be quickly assessed if cash-flow will be generated in the future or not. The due-diligence process can help to reveal risks and ensure a successful investment into the project. This is relevant for shareholder and all kinds of funding institutions. Mohamadi distinguishes between technical, legal, tax and financial due diligence. The financial due diligence deals with the potential of the project to generate the desired cash flow during the defined period. In addition, the SPV and the related contracts are examined in more detail. The result is an assessment of the future financial possibilities and revenues of the project with the elaboration of risks and opportunities for improvement. The ESIA and concluded contracts such as the PPA or EPC agreement are examined in the legal due diligence process. Not to forget is the technical part, where all the technical elements in the contracts, agreements, arrangements, ESIAs and plans are reviewed again. Furthermore, the site and lifetime of the plant are examined. The focus here is also on uncovering possible hidden costs (Mohamadi, 2021, p.127-130).

When developing and financing a project, the risk mitigation structure should not be forgotten. Generally it can be said that the risks are decreasing the further the project development progresses. More information is available and the circumstances are better known. This has also to be considered when looking for the perfect timing for seeking financial support as earlier investment means more risk. Due to various risks which could arise, insurance needs to be set up. There are several types of insurances depending on the location and type of the project (International Finance Cooperation, 2015, p.163-169).

The financial closing is one big hurdle and entails a lot of work. It means that all the relevant contracts and documents have been signed by the respective parties. All the conditions are met, contracts concluded, agreements finalized, permits secured and confirmation from the authorities is obtained successfully (Ortner, 2023; The World Bank, 2022). As a last step, the final energy license needs to be obtained. Only then is the solar PV plant ready to be constructed and operated. How to obtain the energy license differs from country to country but what stays the same is that without it generation of electricity is not possible. In most countries a financial liability agreement is needed. Having obtained the energy license means that the project is ready to proceed to the construction and operation phase.

3.8. Stage 6: Construction and Operation

The financial closing is one big hurdle and entails a lot of work. It means that all the relevant contracts and documents have been signed by the respective parties. All the conditions are met, contracts concluded, agreements finalized, permits secured and confirmation from the authorities is obtained successfully. (Ortner, 2023; The World Bank, 2022). Finally, the plant can go into construction and operation. This is a whole new process which will only be outlined briefly as the focus of this thesis is on the project development process and not the operation. After the development process has been concluded, the implementation can be supervised by the developer or a hired site manager. From the developer's perspective an eye should be kept on project controlling, deviation from the original planning, risks, change management and financial analysis. Before the plant can be put in operation after the construction is finalized, tests have to be run. When incidences occur it may be necessary that adaptions on the site have to be made (International Finance Cooperation, 2015, p.125-135).

3.9. Support Mechanisms and Policies

When developing a project, the developer should be familiar with the support mechanisms which are available for the respective project, as projects most of the time need to meet certain requirements for these mechanisms. The developer should soon start researching which suitable forms of support are available and which conditions have to be fulfilled. Then the project content can be agreed in good time. Possible important fund and financing institutions are multilateral development banks, governments, private sector institutions, public-private-partnerships, banks, and pension funds. The International Finance Cooperation classifies six types of support mechanisms: feed-in-tariff (FIT), reverse auction and tenders, market-based instruments, tax incentives and capital grants (International Finance Cooperation, 2015, p.136; Filho, et al., 2021, p.650-652).

Feed-in-Tariff

This type of mechanism is intended to support the closing of the gap between renewable energy sources and non-renewable energy sources. It is a long-term agreement which should support the development of the solar PV sector. FITs can be modified depending on the market characteristics. They can have both, a simple and more advanced design. According to the United Nations Economic and Social Commission for the Asian and the Pacific the most important variables which have to be considered are the following: eligibility, contract duration, grid access, purchase obligations, capacities, comprehensive revision, forecasting obligations and funding of the FIT policy (UNESCAP, 2023). The mechanism works in such a way that the operator of the photovoltaic system is reimbursed a certain amount of money for the electricity he feeds into the grid. The amount is usually fixed for a certain period of time. Normally, FITs are higher than the purchase price of electricity from the grid. This measurement is a good way to promote the solar sector as they are a stable, long-term way of supporting project developers. Attractive FIT conditions can be used to increase the occurrence of project developments in the country. FITs are often processed through a PPA (International Finance Cooperation, 2015, p.136-138).

Reverse Auction and Tenders

This system is based on an auction process. Consequently a project is published by the offtaker or government and qualified electricity producers can place a bid. If the developer is qualified, will mostly be checked through the request of certain technical and financial documents. Social aspects can also play a role. With the highest probability, the bidder with the lowest tariff and the right size will be selected. The process is finalized through a PPA. When a developer is not getting the bid, it will result in losses as the process to prepare all the required documents is very time consuming. This should be considered before participating in the auction. This type of support mechanism has been implemented in for example South Africa and India and is used by many other countries to accelerate the development of the solar sector (International Finance Cooperation, 2015, p.140-143; Sirin and Sevindik, 2021).

Market-based instruments

Examples of market-based instruments are renewable/clean energy certificates and carbon credits. Those can, if required, be traded on the market and hence support the development of the solar sector. Another option are quotas which set an obligation in the production of electricity. A certain percentage has to be sold by suppliers coming from renewable energy sources. In China for example, consumers of electricity as companies working in the grid, electricity retail companies and large-scale consumers who buy power have to prove that a certain amount of their electricity comes from renewable energy sources. This is done by purchasing renewable energy certificates. At the end of the period they need a certain amount of the respective certificates. A separation of the electricity and certificate trading market can lead to more pliability. In the end, this mechanism is more insecure and unstable for developers (IEA, 2021; International Finance Cooperation, 2015, p.143-144). Carbon credits focus more on the reduction of emissions by using renewable energy forms. When the output of greenhouse gases is reduced by the production of clean energy, the producer gets carbon credits. Solar energy was not that successful in this mechanism as often, the cheapest renewable energy form was used to replace fossil fuels. An example for carbon credits is the Kyoto Protocol and several countries developed local trade markets. For the future, if solar energy is getting cheaper, this could be a more effective incentive (International Finance Cooperation, 2015, p.145).

Tax Incentives

Governments often create tax incentives for PV system operators. Examples are Germany and the United States of America (USA) (Goetzberger and Hoffmann, 2005, p.173). Especially in the USA the tax credit system tries to push the development of renewables forward. Often the tax regulations which could be in favor of the project developer are not very obvious and a deep research should be done to consider all possible benefits (International Finance Cooperation, 2015, p.146). They can be implemented in the investing, producing and consumption phase of a solar PV project. As a result, the liquidity of the developer can be increased, investments become more attractive and it fuels the consumption when fossil fuels are getting more expensive than renewables. Examples of taxes are: "*(1) investment tax incentive, (2) property tax reduction, (3) excise tax reduction, (4) production tax incentive, (5) value-added tax reduction, (6) import duty reduction, (7) accelerated depreciation, (8) tax holiday, (9) research and development and equipment manufacturing tax incentive, (10) tax on fossil fuels*" (Filho, et al., 2021, p.647).

Soft Loans

Soft loans generally have better credit terms and are supported on a small scale by governments. They are characterised by longer repayment periods and lower rates. Development banks, for example, offer this type of loan. Usually, specific conditions have to be fulfilled by the project developer to be able to use this possibility. Often soft loans are offered in combination with other instruments such as FIT. A complicated due diligence process is usually required to qualify as a project developer. Especially in developing markets, this mechanism can lead to success (International Finance Cooperation, 2015, p.146).

Capital Grant Schemes

When a technology is not yet very developed, grant schemes can help to fasten the process. Several grants are distributed to project developers upon application or a tender mechanism. This system has been used for example by the US government and India (International Finance Cooperation, 2015, p.146).

After analyzing all forms of financial incentives for PV projects, it can be said that even if the price for PV has been decreasing, these mechanisms are still necessary to promote the technology. These are particularly important in countries with underdeveloped renewable energy sectors that want to participate in the energy transition and make their country more attractive for investors. The increasing demand for energy, which should be satisfied with renewable energies in the set targets, must be supported by well-developed measures. The focus is on boosting investments in solar energy in developed and developing countries by introducing innovative investment schemes.

4. Case Study

After having outlined the most important theoretical and technical aspects of PV energy and the relevant steps for developing a project in the respective sector, the following chapter will be the case study of the thesis.

The goal of this chapter is to present a framework for project development in Montenegro entailing all the necessary information and steps. With the help of the case study the research questions outlined in Chapter (1.1) will be answered.

4.1. Framework and Methodology

The Framework will be composed of three different sections. At the outset, a country analysis of Montenegro with the help of the PESTEL tool is carried out. After evaluating the results, the project development steps explained in Chapter (3.1) are applied to the PV sector in Montenegro. The case study will be concluded by a cost-benefit analysis taking into account all relevant economical aspects of project development in the respective country. After the three steps a SWOT analysis will give an overview about the results of the case study.

The information for the case study will be taken from literature sources as for example case studies, government documents, news articles, journal articles and books, and on the other hand from three interviews conducted in Montenegro. The interview partners are local specialists in the field of renewable energies, politics, legislation and photovoltaic energy in Montenegro. The transcripts of the interviews are available in Annex (A.1).

4.1.1. Interviews

During the interviews, questions related to the field and the research area were asked. The possibility of having up-to-date information directly from Montenegro is very valuable and needed for the outcome of the thesis.

The interviews of the following local experts will be taken into account:

Table 4.1.: Interview overview

Name	Institution	Role
Sanja Pavićević	Ministry for Capital Investments Montenegro	Acting General Director, Directorate for Energy
Draško Milić	Ministry of Ecology, Spatial Planning and Urbanism	Head of the IPA Unit
Nebojša Jablan	Freelancer	Consultant for Carbon Neutral Transition

Ms. Sanja Pavićević

The Ministry of Capital Investments is responsible for the development of projects in Montenegro and other administrative activities related to renewable and non-renewable energy forms. In the interview it was emphasized that the energy sector is very important for the development of Montenegro. This affects both, the EU accession and the achievement of the Sustainable Development Goals. In addition, it has been discussed that Montenegro is a regional energy hub and is at the forefront regarding the use and production of renewable energy sources. The country is pursuing two strategic frameworks: the Energy Policy adopted in 2011 and valid until 2030 and the Energy Development Strategy also valid until 2030 which have been adopted in 2014. Again, Ms. Pavićević lined out that Montenegro has to follow the energy legislation and goals of the European Union. This is done for example by the development of the National Energy and Climate Plan which should be concluded in June 2023. Among the renewable energy sources that the country wants to develop, hydro power, solar power, wind power and biomass are mentioned in the interview. Likewise, some projects in the field of renewable energies supported by the Ministry were mentioned. Among them is for example the Velje Bodo Solar Project which is being built in the suitable area around Podgorica. The legal framework used is mainly the Energy Law, as the Renewable Energy Law is currently being drafted. A big project currently in development is Solaris 3000+ which aims to install 3000 solar panels on the roofs. Other projects are also in progress as for example in Velje Brdo. Especially around Podgorica the solar potential and the spatial planning conditions are favorable for project developers.

Mr. Draško Milić

First of all, the role of the ministry of ecology was discussed. It was made clear that energy and energy efficiency is not really under their scope of responsibility but that the Ministry of Capital Investments is in charge of this topic. Mr. Milić is working in the Instrument for Pre-accession (IPA) unit and his task is to spend funds on local projects which should help the country to make progress in development. Especially the closing of chapter 27 lies in his field of work. At the moment it is estimated that 1.5 billion Euros are needed for the closing process. This is a huge amount as it is approximately 15 percent of the country's GDP. The distribution of funds based on priorities and which projects will be pursued has to be approved by the government. Also, for all infrastructural projects in Montenegro an EIA is needed. The process follows domestic structures which are almost the same as the EU requirements. It has also been explained that at the moment only the main design of a project needs to be approved by a committee to proceed with the project. In addition to this, the law defines that topographic and geological studies need to be carried out. As a big hurdle, the political instability in the country was discussed. Currently, the division of roles among the various ministries is very unclear. The coordination of projects is not organized and work cannot be done efficiently. More stability is needed and the political system of the country is not working at the moment as there is no constitutional court and the government has been removed by the parliament. Mr. Milić stated that for Montenegro to make progress in the EU accession process clear priorities and goals need to be set by the top-level management. This affects also a lot of funding in the IPA 3 unit. The stability of the country has a strong impact on the efficient use of funding. In the end, it was outlined that energy efficiency also plays an important role in the energy transition.

Mr. Nebojša Jablan

At the beginning, the potential of Montenegro for renewable energy was again emphasized. At the moment EPCG is developing a large project for solar projects on roofs. Furthermore, investors are again starting larger projects. However, recently a large wind project failed due to opposition from NGOs and the population. It is very important in Montenegro to first address the population and educate them about the project in order to eliminate problems that might arise later. In Montenegro there is a lot of land which is not suitable for agriculture but usable for solar projects because it is very stony. Furthermore, land-ownership should be checked so as not to have several negotiating partners. It is also important to have a good connection to the grid and to have bigger voltage levels available. Having a bad location can significantly increase the costs due to necessary licenses and construction measures. The process in Montenegro is also divided into technical recommendation, pre-feasibility study, feasibility study and project design. Unfortunately, in the last two years, due to political instability, not many people in Montenegro have developed projects. But in his opinion, Montenegro should make progress in regards to renewable energies. The Thermal Power Plant in Pljevlja was mentioned as a really big problem. The area around the power plant is very polluted and an outphasing of coal should start immediately. The problem is also that the funds are not sufficient enough for the Western Balkan countries to pursue the transition. Moreover, another issue is the labor sector. For example, if you start to close the coal plant, 1500 people will lose their jobs, which is a lot for Montenegro. Therefore, one should start retraining people for renewable energy. The whole economy and society must be changed to be able to carry out the energy transition. This is also related to the security and stability of the electricity grid. The transmission and distribution network must be prepared for the installation of renewable forms of energy. Furthermore, the government's approach to this problem was discussed again. Examples are the missing renewable energy legislation, a never fulfilled promise of an auction bidding program and the slow progress in the EU accession process. The answer to the question of when the situation would improve was sobering. In his opinion, the elections to be held in April are not promising either. The old government structure had been much better, and at the moment there is a dispute between pro-Serbian and pro-Montenegrian parties. In order to successfully master an energy transition, there must be a clear political direction in the country that is supported by the population.

4.2. Montenegro PESTEL-Analysis

As the focus of this thesis lies on the PV sector in Montenegro, the following chapter will be an analysis of the country. To develop a project in a country, a thorough understanding of the country in political, economic, social, technical, environmental and legal terms is needed. Due to this, a PESTEL analysis will be conducted in the following chapter. Country reports, scientific papers and interviews with local specialists are the main sources for the analysis. The combination of literature and interviews helps to get a deep understanding of the current situation of the respective PESTEL sections in Montenegro.

The PESTEL analysis is a well-known strategic-management tool to analyze important factors of a chosen environment. It has been in use since the 1960s and the classification of all influencing factors helps to understand the complex interlinkages. The process of the analysis entails first of all the identification of the most important factors which could have an influence on the success or failure of the project. After selecting the most relevant ones, the analytical part can start. With the results, a prognosis can be developed and helps the project developer to draft the project development strategy. In the following subsections, the six PESTEL areas will be examined. In every section the crucial factors for developing a PV project in Montenegro will be kept in mind (Reisinger, Gattringer and Strehl, 2013, p.56-57). The factors per section were chosen by consulting several literature sources about the PESTEL analysis in general and with the help of case studies (Mohamadi, 2021, p.12; Northern Periphery and Arctic Programme, 2020). At the end of the analysis, an overview of the most relevant factors and their influence on a PV project is given.

4.2.1. Political

This section will give an overview on the most important political factors of Montenegro. After a brief historical introduction of the political situation, the relationship to Serbia, the EU accession process, political turbulences and the current political system and situation will be discussed. In the end, the focus will lie on the political actions concerning the renewable energy sector and future challenges for the country.

Montenegro is one of six countries in the Western Balkans.

Figure 4.1.: Map of Western Balkans (Mohamadi, 2021, p.74)

As depicted in Figure (4.1) Montenegro with its capital Podgorica is located on the Adriatic coast and is surrounded by Bosnia and Herzegovina, Serbia, Albania, Kosovo[1] and Croatia. Before its declaration of independence in 2006, Montenegro was part of the Socialist Federal Republic of Yugoslavia until its breakdown in 1992. After that Serbia and Montenegro formed as remaining states the Federal Public of Yugoslavia until 2003. This was followed by a political union with Serbia which Montenegro left with its declaration of independence in the course of a referendum held in 2006. The relationship with Serbia continues to shape the political situation in Serbia today and plays an important role in the country's foreign and domestic policy (Lpb, 2023; Duin and Poláčková, 2013). The independence of Montenegro resulted in the growth of the economy. Politically, the socialists with Đukanović as head of the party won the elections of the parliament in 2009. In addition to this, traveling for citizens coming from Montenegro and wanting to travel to the Schengen zone got easier with the lifting of visa regulations. The relationship with Serbia has been disturbed due to several occasions. For example, in 2008 when Montenegro recognized Kosovo as a state and in 2010 when Montenegrin was acknowledged as the language of the country. Montenegro applied for EU membership in 2008 which got accepted in 2010 by granting the country the EU membership candidate status.

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[1] All references to Kosovo, whether the territory, institutions or population, in this text shall be understood in full compliance with United Nations' Security Council Resolution 1244 and without prejudice to the status of Kosovo.

Moreover, Montenegro has joined the North Atlantic Treaty Organisation (NATO) and the Energy Community in 2017. With regard to the EU accession process, the accession negotiations were started in 2012 and accession conferences followed. At the conference in 2021 it was decided that the focus should be more on fundamental reforms. In addition, the 35 chapters in which the negotiating measures were defined were consolidated into 6 groups. To become a member of the EU, the provisions set out in the chapters have to be met and all chapters have to be closed. At the moment three chapters are concluded. Likewise, there is an annual assessment of progress by the EU, which is concluded with a report and proposals for action (European Commission, 2023; Auswärtiges Amt, 2023). Even if Montenegro is integrated in the NATO and an aspiring EU membership candidate, its political situation has been shaped by turbulences in the last years. The BTI summarizes the situation as follows:, "*behind the rather successful international recognition of Montenegrin political commitment to Euro-Atlantic integration, its society has been struggling with slow-paced changes in its political mode, inefficient public institutions, a culture of legal impunity for people politically affiliated with the ruling parties, discriminatory practices in the labor market and public procurement*" (Bertelsmann Stiftung, 2002, p.5). To understand the problems it is important to first of all explain the political system of the country. The economic policy follows the approach of a market economy but a lot of institutions especially regarding energy are controlled by the state. It can still be seen that Montenegro was led under a planned economic regime for a long time. The constitution set up after its independence follows a civic state approach which is also regulated by the law on Montenegrin citizenship. This means that belonging to the state only depends on the statehood and not on the ethical or cultural background. This orientation should help the small state to be protected from non-residents taking over control. With elections happening every five years, the president is elected by the citizen. In this role it is possible to serve for a maximum of two periods. The judicial system is based on a legislative, executive and judicatory separation. The parliament is divided into a unicameral system and consists of 81 deputies. It controls the government and establishes laws. In addition, the government is formed by the parliamentary elections and the candidate proposed by the president for the post of the minister president is elected. Through this process, the division of legislative powers is executed and ensures that Montenegro works as a democratic state. The Democratic Party of Socialists with Đukanović at the top ruled for almost 30 years until 2020. The citizens forced the legacy to come to an end through new parliamentarian elections because of corruption, state capture, few advances regarding the EU integration and rigged elections. In addition to this, the Serbian Orthodoxan Church has been assisting the opponents in the process. Corruption is a big problem in Montenegro and also a reason that the EU process is so slow. A lot of corruption cases are known and in addition to this high-level politicians were accused of money laundering. Moreover, a big scandal regarding real estate and loans given to politicians at better terms does not improve the situation (Bertelsmann Stiftung, 2002, p.13-14). On the yearly published corruption perception index, Montenegro is ranked on the 65th place out of 180 and has a score of 45 points out of 100 (Transparency International, 2022). After the elections in 2020 a period of uncertainty started. The DSP got defeated for the first time by the pro-Serbian Democratic Party. The biggest political parties in the country are the Democratic Party of Socialists, For the Future of Montenegro, Peace is Out Nation, In Black and White, Social Democrats, Bosniak Party and the Social Democratic Party. The new government elected in December 2020 was composed of members of every party but Đukanović's. During that time a mixture of three different governmental configurations have governed the country. Several parties such as Serbian nationalists, left parties and pro-European parties were lead by Zdravko Krivokapić. Even if the new government wanted to reach the goal of EU membership in 2025, the Montenegrin were not satisfied with their actions. After that, the unrest continued to escalate and the divide between the Serbian Orthodox Church, independence supporters and pro-Serbian supporters has been widening. The Identity of Montenegro was undefined. After a bit more than one year the new government was overthrown by a vote of no confidence at the beginning of 2022 (Lpb, 2022). Therefore the legislative of the country was dysfunctional and in a crisis. After the fall of the government under Prime Minister Abzović in August 2022 due to the highly disputed cooperation with the Serbian Orthodox Church the situation got even worse. Due to this, he was only provisionally in office as prime minister. Đukanović who was still the president of the country was supposed to appoint a new prime minister but he refused to act. The parliament wanted to change the law so that it was in charge of forming the government. The whole situation blocked the system and as the constitutional court was not functioning and it was not able to decide on the new law. It was paralyzed due to a lack of judges. The appointment of the new constitutional judges requires a two-thirds majority in parliament, and also the agreement of Đukanović. The candidates proposed did not received this support. The attempt to appoint Lekić with the configuration of the government did not work either and Đukanović dissolved the parliament in March 2023 as a response. These actions show the instability of the system (ORF, 2023; Freedom House, 2023, Król, 2022; Wölfl, 2022; European Commission, 2022). Mr. Milić describes the situation with the following words: "*You have probably heard that last August our government was removed in the parliament. We cannot agree on the next one and we have no constitutional court. We can't have elections. It is a complete mess in the country's organization*" (Milić, 2023).

A shift in the political situation of Montenegro happened in April 2023 due to the presidential elections held in the country. In the runoff election, the people opted for the pro-western Jakov Milatović and against the long-ruling Milo Đukanović. This election was supposed to be a restart of Montenegro's political situation and lead to stabilization. Now it is a matter of deciding the future for a corruption-free and EU-oriented Montenegro in the parliamentary elections that will happen in June. The 'Europe now' party of Milatović has good chances but the pressure is high. Especially because the country needs a big reform to be back on track with the EU accession negotiations, and sectors such as tourism need a boost after COVID and the war in the Ukraine. As Russian tourists had a big influence on Montenegro's economy, after the invasion the sector has shrunken (T. Roser, 2023; Devčić, 2023). According to Mr. Jablan uncertainty haunts the country. He describes the current situation as follows: "*The situation at the moment in the country was never like that before. I find it so very bad and somehow we are in a foggy period. In each sector we don't have the right direction. We don't know where we are going. Especially now in an energy crisis and energy transition when there is no clear direction it is hard*", (Jablan, 2023). Moreover the foreign affairs status of Montenegro is dramatic at the moment as almost half of the ambassador posts are not filled. This and the relationship with Serbia will be one of the biggest challenges for the new president (Devčić, 2023).

After outlining the general political situation in Montenegro, the connection of the importance for a project developer in Montenegro will be drawn. The political situation regarding renewable energies in the country is affected by the political instabilities in the country. Due to its EU membership candidate status the EU has to follow the Green Agenda of the Western Balkans. The country must also follow the decarbonization plan of the EU by 2050 and is committed to the Green Agenda for the Western Balkans issued in 2020. The latest EU report on Montenegro's advances in the accession process states that the country has established a plan for a day-ahead energy market. This plan was completed at the end of April 2023 with the publishing of the day-ahead-market. Regarding strategies for renewable energies and the environment, Montenegro has devised an Energy Development Strategy until 2030 and following the Energy Policy until 2030. Moreover, the goal is to finalize the drafting of the National Energy and Climate Plan in June 2023. The country's renewable energy legislation is still in progress but due to the political instabilities, the progression is rather slow. Therefore the current energy law currently applies to renewable energy systems as well. Even if the country reached its renewable energy target in 2020, more governmental actions have to be taken to make the country ready for the energy transition. Also, one aspect of the problem is that due to the imbalances, the different ministries don't work together efficiently. The tasks are not distributed and a lot of newly appointed members in the ministries don't make the processes more smoothly (Energy Community Secretariat, 2022; Milić, 2023; Pavićević, 2023; European Commission, 2022; Igor, 2023). Even though the process seems to be rather slow, Pavićević describes Montenegro "*as a regional energy hub and a leader in the production and use of energy from renewable resources*", (Pavićević, 2023) Moreover the measures taken by the government to support the citizens should be discussed. Through the energy law, customers with a high vulnerability status are supported through a subsidy program. The permitting process takes a long time at the moment and is complicated (Energy Community Secretariat, 2022). The recently implemented 'Europe Now' package aims to improve the Montenegrin situation. The main points of the program should introduce progress regarding the inequalities of the tax policies, living standards and reduce informal business activities. Compulsory health insurance contributions were reduced, thus lowering non-wage labor costs. In addition, the minimum wage was increased. It is questionable whether this will really bring about major improvements (Aussenwirtschaftscenter Belgrad, 2022).

Concerning funding initiatives and support by the government for renewable energies in the country, a lot has to be done in the future. As already mentioned before, due to missing renewable energy legislation a lack of initiative can be seen. In July 2022 the Ministry of Capital Investments in Montenegro published that together with the EBRD an auction system for renewable energy systems will be introduced. It should help the country to decrease its dependency on hydropower and coal but until now the system has not been set up. This is also due to the political instability in the country. The local specialist argues that the problem lies in the ministry where a lot of people are not experts in their fields and that there is a lack of capacity to deal with big projects. Despite a promising start with meetings discussing the new system and a renewable energy law the progress came to a halt at some point (Ministry of Capital Investments, 2022; Jablan,2023). A first achievement is that value-added tax was lowered for solar panels by the government from 21 percent to 7 percent (Todorovic, 2023). This affects the installation, importing and sales side of the panels. In addition to this, changes in the law for small-scale installations up to 1 MW have been made easier. Due to this, requirements in regard to technical aspects and urban planning have to be obtained. Balkan Green Energy News stated that this is "*an additional impetus for the development of solar projects in Montenegro, which is set to boost solar power production by more than ten times this year, from 3.8 GWh to 41 GWh*" (Vujasin, 2023). In order to increase the use of renewable energy systems in households financial incentives such as the Solarni Katuni and Montesol projects were set up. Their aim was to provide support through favorable loans and decreased installation costs (Melović and Ćirović, 2020, p.3-7). There is also a feed in tariff system from the government which is adjusted every year. It is regulated in the energy law and if you qualify as a privileged producer you receive 12ct/kWh (2022). This always applies for installations up to 1MW and large scale projects have to apply. Another alleviation is that the imbalance costs are cancelled (Austrian Energy Agency, 2022; Energy Community Secretariat, 2022). Moreover, due to the status of Montenegro in the EU enlargement policies, the country receives funding for the energy transition. An energy support package contains 1 billion euros of grants for immediate and short to medium-term measurements in the Western Balkan Countries. Montenegro receives a share of it and together with the Western Balkan Investment Framework the increase of renewable energy projects and more support schemes can be provided. In addition to this, the European Fund for Sustainable Development should assist operators in the private sector dealing with the energy transition (European Union, 2022b).

4.2.2. Economic

In order to be able to describe the economic situation of Montenegro, the following table depicting the most expressive Key Performance Indicators from the past and future is provided.

Table 4.2.: Main Economic Indicators 2020-2025 (derived from The Vienna Institute for International Economic Studies, 2023)

				FORECAST*		
Main Economic Indicators	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Population, 1000 persons	621	619	618	-	-	-
GDP, real change in %	-15.3	13.0	6.1	2.6	3.3	3.0
GDP per capita (EUR at PPP)	13440	15540	16860	-	-	-
Gross industrial production, real change in %	-0.9	4.9	-3.3	-	-	-
Unemployment rate - LFS, in %, average	17.9	16.6	14.7	15.0	13.9	13.0
Average gross monthly wages, EUR	783	793	883	-	-	-
Consumer prices, % p.a.	-0.3	2.4	13.0	7.5	3.5	2.5
Fiscal balance in % of GDP	-11.1	-1.9	-5.2	-7.5	-7.5	-6.0
Public debt in % of GDP	105.3	84.0	70.8	-	-	-
Current account in % of GDP	-26.1	-9.2	-13.3	-12.0	-10.7	-9.5
FDI inflow, EUR m	466	591	833	-	-	-
Gross external debt in % of GDP	221.6	191.7	162.5	-	-	-

The European Bank for Reconstruction and Development (EBRD) summarizes the economic situation in Montenegro with the following statement: "*With a population of 600,000, Montenegro is the smallest country in the Western Balkans and the smallest economy in which the EBRD invests. Even so, it has the highest income per capita of its neighbours and has advanced the most in terms of European Union (EU) approximation. Still, Montenegro's journey toward an advanced market* *economy-one that is competitive, well governed, green, inclusive, resilient and integrated - remains far from complete. While it outperforms other Western Balkans countries on all of these qualities, it lags behind EU Member States in central Europe and the Baltics, especially on the 'green' and 'integrated' qualities.*" (European Bank for Reconstruction and Development, 2022, p.5).

When looking at the economic growth in 2021, it can be seen that the country profited from a good year of tourism in the country. The plan was to continue this upward trend but the war in Ukraine and sanctions against Russia keep tourists from both countries away from Montenegro, affecting its economy badly. Even if Montenegro is not part of the Eurozone, its currency is the Euro. The capital flow rates are highly dependent on foreign investments, export activities, the tourism sector and return flows from foreign countries. Returning capital because of Montenegrin citizens living abroad accounts up to 11 percent of the GDP. The exporting sector in Montenegro is very small and the main target countries are Serbia, Bosnia Herzegovina and Switzerland. In general, the country suffers from a lack of diversification with summer tourism being the biggest economic output of the country. In addition to this, the Kombinat aluminijuma A.D. Podgorica was an exporting aluminium factory which was closed at the end of 2021. This happened due to high prices of electricity and caused an increase in the unemployment rate. The Bar-Boljare highway project financed by the China ExIm Bank is also important to mention. Its finalisation in 2022 led to a decrease in imports of construction materials and machines. The costly project contributed to a high government debt which accounted about 84 percent of the GDP in 2021. Most people in the country have service sector jobs. Greece, China and Serbia are the countries that Montenegro gets most of its imports. Exporting products are for example electricity and the country is especially importing electrical machines. Investments of foreign countries such as Russia, United Arab Emirates, Italy and Turkey, accounted 898.4 million Euros in 2021. A critical issue in the country's economy is the labor market with an unemployment rate of about 16 percent in 2021. The problem is that a structuring of the market is not existent. This results in an informal labor market and a participation rate of only about 54,75 percent. Official companies are especially suffering under this conditions as informal operators harm their businesses. The construction sector has been afflicted heavily because of illegal money transactions and suspicious agreements. Moreover, the tax-system in the country is not fair and the situation got worse during the pandemic. Especially important for the country is the electricity connection between Italy and Montenegro. This makes the country a crucial link in the power supply (Aussenwirtschaftscenter Belgrad, 2022; European Bank for Reconstruction and Development, 2022; The Vienna Institute for International Economic Studies, 2023; European Commission, 2023; International Trade Administration, 2022).

Half of the electricity generated in the country is produced in the coal power plant in Pljevlja and the mine located in the same town. Other than that, most of the electricity is produced from hydropower plants. The plants are for example operated by the Eletropivedra Crne Gore (EPCG). In recent years wind power was added to the electricity mix of the country. The problem is that the country relies on a large amount of hydropower. Moreover, the coal power plant in Plevjla was regulated in its industrial emissions by a law. The set limitation of not exceeding 20,000 in operation until the end of 2023 has already been reached in 2020. By changing the law, the plant is now able to operate until discussions with the European Commission are completed (Bankwatch Network, 2023, Spasić, 2023b). The country report by the Friedrich Ebert Stiftung emphasizes that for the green transition to happen, the plant has to be closed and alternative energy forms developed. Consequently more electricity needs to be imported until the gap can be closed by local resources. Also, more open and transparent communication by the government needs to happen in that manner (Gallop, et al., 2021, p.100-114). At the moment some development regarding solar energy is happening in the country. Most information about current projects is taken from the Balkan Green Energy News homepage and the interviews. This is a step in the right direction as in the past two years not a lot of projects have been developed in the country (Jablan, 2023). The detailed description of the projects can be found in the Appendix (A.2).

The electricity market of the country has recently been updated with a day ahead trading system. This means that the country has made progress regarding the development of renewable energy systems. It is configurated by Berza električne energije (BELEN) and should accelerate the country's integration into international energy markets. Therefore, it is especially important for Montenegro to be a part of the EU (Igor, 2023). Concluding, it can be said that the political instability of the country is affecting the economic stability. A harmed tourist sector, inflation, rising energy prices and fiscal problems lead to the current state of the country. This will also affect foreign investors' investment decisions. Moreover, the countries trading relationships also suffer from recent crisis developments.

4.2.3. Social

The section dealing with the social aspects of the PESTEL analysis will start with a demographic overview of the country. Moreover, a focus will lie on cultural aspects, energy consumption and the perception of the energy transition regarding solar energy in the country. As already mentioned above, the population accounts approximately 600,000 inhabitants and a bit more than half of the people between the ages of 15 to 64 are employed. Also, around 44 percent are Montenegrin and almost 30 percent Serbian. The rest are of Bosnian, Albanian, Muslim and Croatian background (European Commission, 2023). At present 232.461 people are employed in the country whereas 3.247 work in the electricity, gas stream and air conditioning supply and 16.707 in the construction sector (MONSTAT, 2023). In a study conducted by a consultancy, citizens of the country were asked about their perception of the current situation in Montenegro. The citizen stated that most of the problems in the country stem from the economic situation, corruption and unemployment. On the other hand, the attitude towards the EU is positive with 74 percent supporting the accession to the EU. Again corruption, the economic situation, organized crime and the political instability are seen as the biggest obstacles to joining (DeFacto Consultancy, 2022). To understand the social situation concerning renewable energy systems and the energy transition in the country, the energy consumption patterns will be elaborated in the following part. In 2020 all Montenegrin citizens had access to electricity and 60 percent to clean cooking. With only 39 percent accounting for the total final consumption of renewable energies. When looking at data from 2019 published by the IRENA about the renewable energy consumption, solar energy represents zero percent (IRENA, 2022). According to the data published by the national statistic institution in Montenegro, 1336.4 GWh of electricity was consumed by households in 2021 and the price of electricity for household consumers in 2022 in Montenegro accounted for 0.0427 Euro per kWh (Eurostat, 2023; MONSTAT, 2021). The following table depicts the consumption data and prices for households in the country with more recent data from 2022:

Table 4.3.: Annual consumption and electricity prices (derived from MONSTAT, 2022)

Annual consumption kWh	Electricity prices - 1st half 2022 kWh	Percent of households %
< 1000	16.1	2.2
$\geq 1000 < 2500$	10.4	6.9
$\geq 2500 < 5000$	9.6	23.5
$\geq 5000 < 15000$	9.7	56.6
≥ 15000	10.1	10.8

Especially because households are mostly heated by coal, electricity and wood, renewable energy systems in combination with energy efficiency measurements could help to reduce energy poverty in society (Gallop, et al., 2021, p.99-106). According to a study, inefficient use of energy is a big issue in the country which is also caused by a large amount of imported electricity. As Montenegro would be able to fully supply their country with renewable energy sources, development has to be made. This would also relieve the energy burden on the society (Melović and Ćirović, 2020, p.3-4). Even if the current use of solar energy in the country is small, a study conducted by Djurisic et al. shows that renewable energy systems are positively accepted by the Montenegrin population: "*over 86 percent believe that in Montenegro, more RES should be used for generating electricity in the future. Namely, 88 percent of the respondents believe that wind and sun are the most suitable sources of energy in terms of environmental protection, with 53 percent of respondents preferring solar energy over 35 percent who are in favor of the electricity generated from wind power*" (Djurisic, et al., 2020). Therefore, the basic social setting should be suitable for developing renewable energy projects. The study conducted by the Friedrich Ebert Stiftung presents a contradictory picture. People's attitude to the power plant in Pljevlja will pose a big problem for the energy transition. As already explained, a huge part of the electricity is generated by this power plant. People think that the system of energy generation will not function without this plant. This is the result of lacking governmental leadership competencies combined with a lack of experts for the energy transition who can convince the public to speed up the expansion of solar energy. The inclusion of citizens in the decision-making process could help on this pathway (Gallop, et al., 2021, p.105-111).

Non-governmental organizations (NGO) can have a positive and negative impact in the development process of a solar energy project. It depends if their actions are in favor of or against the project. In Montenegro NGOs are under the control of the Ministry of Public Administration, Digital Society and Media. There are several laws regarding NGOs and how they can be established in the country. In general, the government states that the organizations are crucial to achieve public participation and preserve the democracy in the country. Moreover international NGOs are also allowed to act in the country. The whole NGO sector has been strengthened in the last years. (Ministry of Public Administration, 2023; Jablan, 2023). Examples of NGOs in favor of sustainable development also promoting renewable energy systems are Green Home and REC Montenegro (Green Home, 2023; REC Montenegro, 2023). NGOs can have a huge impact on the ESIA study as they reflect public opinion and can consequently lengthen the process. In Montenegro NGOs have criticized projects in the past and therefore this risk should be taken into account. A good example is a hydropower plant projected in 2020 and was hardly criticized by several NGOs (Igor, 2020). The factors described above are very important in the whole development of the solar energy plant as the public is a huge stakeholder. If the project is not accepted by the public it will be very hard to realize it. Therefore the public acceptance of renewable energy systems in Montenegro should be closely monitored. In the beginning the project developer has to approach the local community and watch out for locations which are not too populated (Cement Sustainability Initiative, 2016; Jablan, 2023).

A significant part will be played by the restructuring of the coal-fired power plant. This will require not only the replacement of technologies but also the restructuring of society. A large part of the population works in the coal sector and will have to be retrained for renewable energy in the near future. Especially in Pljevlja measures have to be taken, says the specialist: “*You should refurbish the whole area to change* *the activities, to change the daily life, to change the economy. Transition studies have to be developed to find a way out of this situation*" (Jablan, 2023).

4.2.4. Technological

This section will focus on the technological status of Montenegro. Also access to the resources and the grid with its technological specifications will be outlined. A first indicator is to compare Montenegro's overall performance in the European Innovation Scoreboard (EIS). The country is classified as an emerging innovator scoring 47.5 out of 160 total points. The general progress of the country in technological innovation is slower than the average of the EU. Compared to the EU the progress in environment technologies accounted for 64 percent. Moreover, the country performs very poorly in the area of environmental sustainability with 55.4 percent compared to the EU. Regarding Research and Development the country has experienced a strong decrease since 2015. When looking at the analysis about the simplicity to launching a business the country is below the EU average. Unfortunately, climate change indicators are not available. The finance and support sector has stayed the same over the last years. Overall Montenegro's innovation performance ranks 32nd out of 39 countries. The lack of research and development in the country is noticeable when it comes to the development of new technologies (European Union, 2022a). Although Montenegro has increased the budget for research and development, local activity in this area is very low. Companies engage in very few research activities and implement few new products and technologies. In 2021 a so-called Innovation Fund was launched, which is intended to promote development in this area. Related to this is the development of the Science and Technology Park in Podgorica. The Eco Fund, launched in 2020, was also established to help develop renewable energies with the help of green finance technologies (European Commission, 2022, p.69-71). When it comes to renewable energy technologies with a special focus on solar energy, hardly any information is available at the moment. This relates to the small solar sector in the country. An example of an implementation of the new generation of solar PV cell is the project planned at the border to Serbia which includes an agrophotovoltaic PV power plant. The quantity of local entities with knowledge in manufacturing, construction and engineering is also rather small (Todorović, 2023). Regarding other innovations, e-mobility and hybrid technologies are also very rare in the country. There are for example some plans to implement liquified natural gas technologies into the country but this sector also needs more development (Jablan, 2023).

The following figure depicts the grid of Montenegro with all the important components:

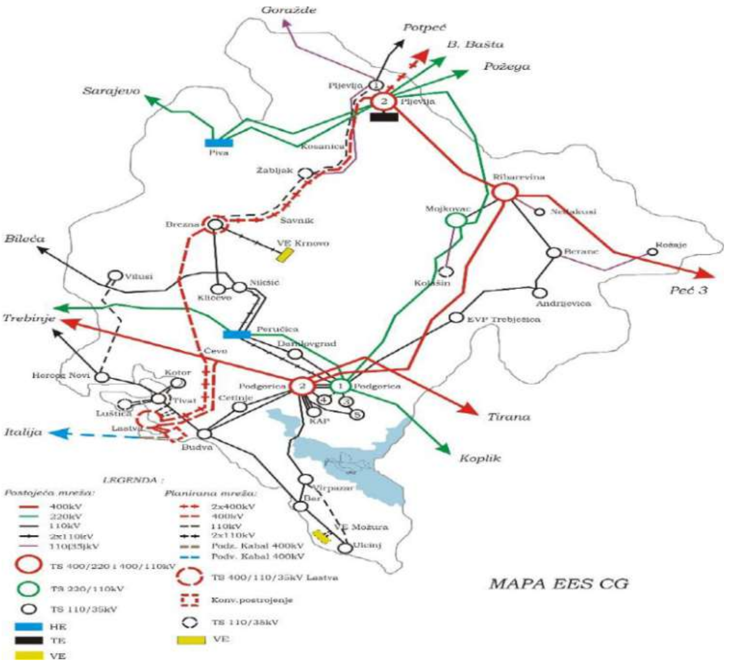


Figure 4.2.: Map of the grid and its interconnections (CIGRE, 2018, p.3)

The electricity grid of Montenegro is categorized into electricity and distribution grids. CGES operates the transmission grid above 110kV and EPCG is in charge of distributing, generating, and supplying. The electricity market is made up of various main participants. These were defined by Krenn et al.: "*generation companies, privileged producers, suppliers, traders and qualified buyers with balancing responsibility*" (Krenn, et al., 2016, p.54). COTEE is the transition system operator of the system. The transmission system operator is in charge of planning, operating and balancing the system. By contrast, the distribution system operator is distributing the electricity and grants access to qualified stakeholders. If there are losses in the system the distribution system operator has to purchase electricity to keep up the system. The whole electricity grid has a peak load of approximately 654 MW. At the moment Montenegro has interconnections with several countries for example Italy, Serbia, Bosnia and Herzegovina, and Albania. Especially the 500 kV connection to Italy, which was established in 2019, was a huge step forward in connecting the energy system with another country. This process is continously progressing and needs further improvement (Balkan Green Energy News, 2019; Krenn, et al., 2016). The transmission network is 1416 km long and covers lines from 110 kV to 400 kV. 44.21 percent of the network are 110 kV lines followed by 400 kV (25.08 percent), 220 kV (23.86 percent), and 110 (35) kV (6.85 percent) (CGES, 2023b). Moreover 29 substations and 56 lines are included in the network (Šćekić, Kontić and Srdanović, 2021, p.2). EPCG is operating three different plants in Montenegro: HPP Perucica, HPP Pica, and TPP Plevlja with a capacity of up to 874 MW. The total production in 2018 accounted for 3539.7 GWh (EPCG, 2018). In 2020 the highest load in the system was 547 MW (Šćekić, Kontić and Srdanović, 2021, p.2). In general, EPCG is supplying most of the citizens of Montenegro with energy. The electricity market in Montenegro can be classified into two markets: retail and wholesale (EPCG, 2018; CIGRE, 2018).

Another upcoming project is the Ionian Adriatic Pipeline running through Montenegro. It is also funded by the Western Balkans Investment Framework and will be connected to the Trans Adriatic Pipeline. This connection should ensure the security of supply for the participating countries (Energy Community, 2023).

Feeding solar energy into grids can lead to risks and inconsistencies in the electricity system. Before a large-scale implementation of solar energy can be carried out, the grid must be more stable and prepared. An example of possible problems is congestion. The local specialist stresses that it makes a difference if renewable or non-renewable energies are fed into a system. This one more reason why Montenegro needs to build momentum in the energy transition to be able to meet the EU regulations. The results of a case study conducted on the sitting and sizing of renewable energy sources show maximum capacities for different zones in the country. Figure (4.3) below shows the maximum capacity which can be installed at the different substations (Šćekić, Kontić and Srdanović, 2021, p. 2-7; Jablan, 2023).

Figure 4.3.: Maximal zonal capacities (Šćekić, Kontić and Srdanović, 2021, p.5)

The information about the network is very important because you need to pay attention to it when choosing a PV location. For example, if you already have a 400 KW line in the vicinity, you save costs and licenses. In the east of the country, for example, there are plans install a project, but it is very far from the transmission grid and the cost of the project will almost double (Jablan, 2023). A valuable addition to the renewable energy sector will be the projects Solari 3000+ and Solari 500+. They include solar systems on the roof and the electricity is exchanged at the point of "*connection to the customer-producer's facility and the distribution system whereby the user supplies the surplus of produced electricity to the distribution system and takes energy from the distribution system in accordance with the facility.*" (Pavićević, 2023).

4.2.5. Environmental

This section will cover all the relevant environmental factors which influence a solar PV project in Montenegro. First a general overview of the environmental situation in the country is given followed by an analysis of the climate and weather. Subsequently, a closer description of the solar energy potential and related spatial data is made.

The status of Montenegro as an EU accession country has a huge influence on the environmental challenges in the country as it has to make progress in the environmental administration and reduce the Greenhouse Gas emissions. This is covered by Chapter 27, which entails all the requirements regarding the topic of environment and climate change (United Nations Montenegro, 2021). The closing of this Chapter is also one of the priorities of the IPA 3 unit in Montenegro. Closing the chapter will be done through structural projects from a singular project pipeline and around 1.5 billion Euros of funding will be needed (Draško, 2023). The EU report states that Montenegro is making slow progress in this chapter. So far, no action has been taken in the direction of air quality management. A big problem is the coal power plant in Plejvlja. Especially SO2, NOx, PM2.5, PM10 and ashes are reported in high quantities around the power plant. The people living next to the power plant are taken on day trips to the mountains to be able to catch a breath of fresh air (United Nations Montenegro, 2021, p.35; Jablan, 2023). In order to achieve the EU 2030 goals, measures have to be made. According to Jablan, refurbishment measurements are taken are projected for 2024 but this will not be enough to be on track with the European guidelines. In general, the use of resources in the country is not sustainable because they are rather used for political purposes (Jablan, 2023; European Commission, 2022, p.111-113). Moreover most of the fossil fuels needed are imported (Jablan, 2023).

In 2021, Montenegro emitted 1.75 million tons of CO2. About 800,000 tons come from coal and the rest from oil. As already stated above, the coal-fired power plant in the country causes heavy pollution. The electricity and heating sectors are the main contributors to greenhouse gas emissions, followed by transportation and agriculture (Ritchie and M. Roser, 2021).

As already stated, Montenegro is one of the countries with the highest solar potential in Europe. To be able to assess the exact potential in the country, the spatial and temporal availability of solar irradiation must be examined. In order to determine the potential of the country and the availability of solar resources, data are necessary. These are available both as satellite and ground-based data. For example, the Meteorological Institute of Montenegro and other platforms such as the World Bank and the PV-GIS can be used. Furthermore, there are some case studies and research projects on this topic. A recent project was conducted in 2020 by Baja et al. Another one was conducted by the Italian Ministry of Environment in 2007, but it is already somewhat outdated at this point (Krenn, et al., 2016, p.27). Montenegro falls under the classification of two different climates. First of all the Mediterranean climate, which means that the summers are very dry and hot and the winters are gentle and are characterized by a lot of rain. This occurs especially in the area around the coast. By contrast, the central region has a continental climate, which means that especially in the mountain region cold winters occur and the temperatures rise sharply in summer (Bajat, et al., 2020, p.47). The annual mean temperature is around 10.2 C° and the annual mean precipitation is 1389 mm (Climate Change Knowledge Portal, 2023). Bajat et al. state that the sunshine hours in Montenegro are more than 2000 hours per year. Moreover, the coastal areas receive more solar radiation than the central part of the country. In the coastal region, the sunshine hours amount to 2500 per year. Mountainous regions get the least sunshine with 600 hours and less. Due to the high number of sunshine hours, the country's solar radiation can be compared with countries located in the Mediterranean area of Europe (Global Solar Atlas, 2023). The following figures show the solar PV potential of the country. The differences in the coastal and central region can be observed by looking at the color code variations The most photovoltaic output occurs in June, July and August.

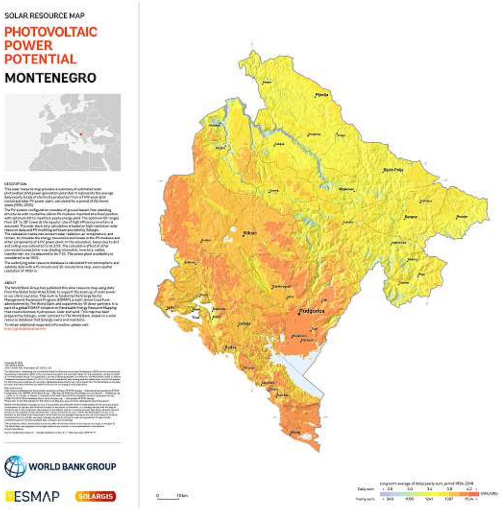


Figure 4.4.: Photovoltaic Power Potential Montenegro (World Bank, 2023)

The solar potential explained above suggests that Montenegro is well suited for solar PV installations. Nevertheless, Šćekić et al. identify other environmental factors which should be taken into account for the environmental analysis. They explain that for a site to be suitable the solar power plant should not be installed higher than 2000m and the solar radiation should be more than 1,300 kWh/m2. As Montenegro is a mountainous region, attention should be paid to the geographical conditions. In addition to this, the project cannot be developed in national parks and other protected areas. Also, urban areas are not suitable for large scale PV plants. There is a complete list of conservation areas in Montenegro available on the CGIS/prirodainfo homepage (CGIS Bioportal Crne Gore, 2023). Moreover, the forest area in the country was 827.618 ha in 2020, which is 62 percent of the country (MONSTAT, 2020). By contrast, 19 percent of the country is used for agriculture (World Bank, 2020a). According to the local specialist, the areas in the country that are not suitable for agriculture because they are too stony but still meet all the other criteria are particularly suitable for the development of solar projects (Jablan, 2023).

4.2.6. Legal

In the political analysis of the PESTEL Framework some important legal points have already been discussed. Therefore, this section will focus on the special legislative requirements and circumstances regarding the development of renewable energy projects in the country. The legislative actions concerning a renewable energy legislation have already been explained in the section regarding the political setting. There are several laws covering the scope of a renewable energy project. Examples are the law on Environment, Foreign Investments, Agricultural Land, rules on contents of the Environmental Impact Assessment study, contents of the study on preparatory works, market rules and State Property. Depending on the specific project the relevant rules and laws have to be considered (Krenn, et al., 2016). Property rights are also relevant in the legal context. The regulatory framework exists but the enforcement could be improved to meet European standards. This affects the safeguarding of the rights. As already mentioned in the environmental analysis, a large part of Montenegrin land is in agricultural use or forested. The Law on Expropriation determines whether land can be expropriated for a PV solar plant. This also includes regulations for compensation payments. As a large share of the country's land is privately owned, developers usually have to negotiate with private owners in the development process. Some companies focus on land owned by the government and some only on privately owned land. Therefore it is important to know beforehand with whom you have to negotiate in further processes. The relevant permits for solar PV project are issued by the different ministries in Montenegro. The OeEB lines out that the duration for getting all the permits is about 6-12 months. In the law of Environment the Environmental Impact Assessment is regulated but the Environmental Protection Agency is in charge of deciding if an Assessment is necessary. Also, the analysis of the organisation shows that the permitting and legal processes are sometimes unclear and take long. This is also influenced by the political instability in the country (Krenn, et al., 2016; Jablan, 2023). According to the Ministry of Ecology, the EIA process is almost identical with the European Guidelines (Milić, 2023). Legal implementation processes of, for example, EU laws are often neglected. Often, the external image is that Montenegro complies with directives, although in the internal system, there is a lot of cover-up and delay. This also has an effect on the information available on legal requirements that are important for the development of projects (Gallop, et al., 2021).

There are various types of companies in Montenegro such as joint stock company (a.d), limited liability company (d.o.o), general partnership (o.d), limited partnership (k.d), and representative office (dsd). The limited liability company is the most widely used type of enterprise used in the country and can also be established from abroad by natural or legal persons. The capital stock is only one Euro (WKO, 2023). The 'Doing Business study' conducted by the World Bank analyzed several factors which are important when investing and starting a business in countries around the world. In total Montenegro got a score of 73.8 out of 100. For the legal analysis, the registration process of the company is important. According to the study, Montenegro lags behind the Regional Average of Europe and Central Asia. This is due to the facts that the procedures are time-consuming and complicated when it comes to registering a company, opening up a bank account and obtaining approvals (World Bank, 2020b, p. 4-7). The corporate tax in the country is progressive and accounts for 9-15 percent (PWC, 2023).

4.2.7. Results

After six different areas have been examined in more detail in the course of the PESTEL analysis, table (4.4) provides a summary of the most important results. The table shows the key-factors per sector and their influence on project development. This may help an investor to assess the situation in the country and the risks involved. The table shows seven factors for every sector and if they have negative (red), medium (yellow) or positive (green) influence on a PV project in the country. From this, one can then conclude what needs to be considered or whether it makes sense for the investor to develop a project in the country. Of course, many factors can change due to constant change and need to be reviewed on an ongoing basis. In total, 16 negative factors, are followed by 13 medium factors and 12 positive factors. It can be seen that especially the political, economic and technological factors have a negative influence on the project. Moreover the legal situation is also not favorable. A lot of negative factors are connected to the current political instability in the country. By contrast, the social and environmental factors have a positive impact. The status as an EU candidate and the attitude of the population are particularly salient.

Table 4.4.: PESTEL Analysis results

Section	Factor	Impact
Political	EU membership candidate	🟩
	President and parliament elections	🟩
	Environmental policy	🟨
	Government policies and support	🟥
	Renewable energy legislation process	🟥
	Political instabilities	🟥
	Consumption	🟥
Economical	Economic growth	🟩
	Russia/Ukraine war	🟥
	Informal market	🟥
	Economic growth	🟨
	PV project development	🟨
	Fiscal situation	🟥
Social	Employment	🟨
	Perception of renewables	🟩
	Perception of EU accession	🟩
	Energy policy	🟨
	Consumption data	🟨
	Pljevlja power plant	🟩
	NGO sector	🟨
Technological	Innovation score	🟥
	Research and development	🟥
	PV technology state of the art	🟨
	Other energy technologies	🟥
	Grid stability	🟥
	Electricity market	🟨
	Adriatic pipeline	🟨
Environmental	EU accession	🟩

	Outphasing of coal	🟩
	Solar potential	🟩
	Land use	🟩
	Resource consumption	🟨
	Availability of spatial, geological and solar data	🟨
	Climate and weather	🟩
Legal	Laws and bylaws	🟨
	Law enforcement	🟥
	Property rights	🟥
	Permitting process	🟨
	ESIA	🟨
	Company registration process	🟩
	Accessibility of laws and guidelines	🟥

4.3. Project Development Framework

The following section will present the Project Development Framework in Montenegro. The steps have been explained in chapter (3.1). The aim of this chapter is to present a framework tailored to the country.

Table 4.5.: Project Information

Information	Specifications
Name	Tuzi 50 MW PV Project 2025
Size of the plant	50MW peak load
Location	Tuzi, Montenegro
Financing	Credit Development Bank
Start of Project Development	June 2023
Start of Operation	June 2025

4.3.1. Stakeholder Mapping

As outlined in section (3.2), categorizing and identifying the stakeholders should be done in the beginning of the development. In order to classify all necessary stakeholders, the following question has been asked: Who may benefit, contribute and impact the project? The stakeholders have been categorized in different groups and Figure 4.5 represents a stakeholder map to get a better overview:

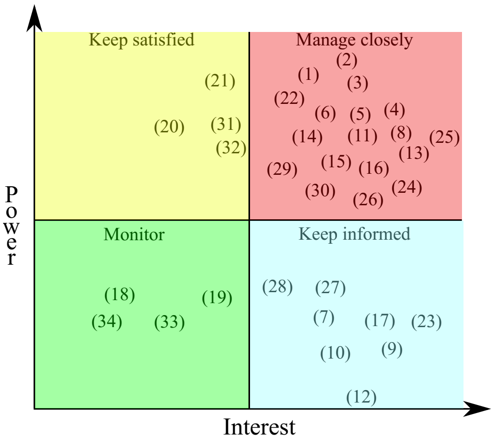


Figure 4.5.: Stakeholder Mapping

Ministries, Governments, Organizations, Institutions:

(1) Ministry of Capital Investments, (2) Ministry of Ecology, Spatial Planning and

Urbanism, (3) Ministry of Economic Development and Tourism, (4) Environmental Protection Agency, (5) Energy Regulatory Agency Montenegro, (6) Central Bank of Montenegro, (7) Energy Community, (8) Local municipalities, (9) MONSTAT, (10) Institute of Hydrometeorology and Seismology of Montenegro, (11) Government, (12) EU, (13) Ministry of Agriculture Forestry and Water Management

Grid participants:
(14) EPCG, (15) COTEE, (16) CGES, (17) MEPX/BELEN, (18) Electricity traders, (19) other grid participants such as suppliers, producers, traders and consumers

Construction and Development of PV plant:
(20) Insurance companies, (21) Funding institutions, (22) Development Banks, (23) WBIF, (24) construction companies, (25) operation and maintenance companies, (26) lawyer, (27) translator, (28) consultant firms for development of studies and reports, (29) real estate agent, (30) owner of selected site

Public:
(31) Local community and citizen, (32) NGO's, (33) other investors and project developer, (34) Newspaper such as Balkan Green Energy News

4.3.2. Project Development Stages

Special Purpose Vehicle

The company law regulates the establishment of a SPV. The entity of a SPV will be a private limited liability company (d.o.o). Therefore, an address in Montenegro, a legal entity, company name and purpose, company structure, proof of payment of registration fee, articles of association, list of founders, a manager and a bank account with a local bank are needed to register with the Central Register of the Commercial Court of Montenegro. A small fee has to be paid and the registration form submitted. After successful registration the company will be made public in the Law Gazette of the country. By submitting the articles of the association with the trade register all the mandatory licenses for the PV project have to be identified. They have to be concluded through the SPV. Regarding taxation, the D.O.O falls under the scope of the corporate income tax. The company can be registered and has an Economic Operators Registration and Identification number with the EU customs authority. For the EORI a VAT certificate, company information and applicant information are needed. The EORI number enables it for the entity to do trading activities with EU countries and the process takes 3-10 days. In total the timescale for the registration process is about two weeks (Radonjic Associates, 2022; eRegulations Montenegro, 2023).

Site Selection

The PV should be located near a 220kV overhead line on agricultural land. As the land in Montenegro is classified into different classes, a site which falls under a class with low quality agricultural land should be chosen. Therefore, a suitable location would be close to Podgorica on a stony agricultural land next to a grid. For this project, the municipality of Tuzi would be appropriate. The solar output is sufficient for the project. More specific Solar GIS data and a map of the municipality can be found in the Appendix (A.3). Also, there are no national parks in close proximity and forest areas are limited. Due to its proximity to Podgorica and the border to Albania, a large infrastructure is available, which is valuable for developing the project. In addition to this, the plan for the development of the grid in Montenegro until 2029 states that in Tuzi a 110/10kv transmission system will be built, which extends the infrastructure in the respective location (CGES, 2020).

Buying or Leasing land process

For buying the selected land, which is in this case agricultural land, a legal entity through which the land is bought is necessary as foreign investors are not allowed to buy agricultural land exceeding 500 sqm in Montenegro. This is regulated in Article 415 of the law on ownership rights. After conducting a few surveys and inspections of the land and concluding all the paperwork with the real estate agent, the reservation agreement can be signed and a deposit paid. It is important to secure the land while probably necessary due diligence processes are running in the background. It is important that all the necessary documents are provided by the seller to avoid problems regarding the construction permit. The following documents are needed: urban and technical conditions, land certificate with land use, urban plan with location, title deed. Another option would be to conclude a long-term leasing agreement with the owner of the land. This can be concluded by a leasing contract including all the necessary information. For the 'Tuzi 50 MW PV 2025 Project' the selected site will be leased from the owner. Agricultural land in Montenegro enjoys special legislation as it is a good of general interest. To be able to construct a PV plant the land has to be rededicated to construction land. According to the law on agricultural land, the rededication must be compensated. In addition to this, there was an option in the law to make a local study of the location and turn the agricultural land into commercial land if the authorities agree. However, the new regulations don't allow this possibility anymore and the decision depends on the planning department, which is very slow in making plans and zoning areas. This can take up to years and also then there is no guarantee that it is possible to do it. It is also important to reconsider are the different land classifications. Dependent on the class the process can be done swiftly. Also, if the project is in the interest of the government and the municipality it can be that the rededication goes faster (Službeni list Crne Gore, 2019; Zirojevic, 2023). When the land is purchased and the planning process has already started it is also mandatory to inform the community of the planned project. This can be done by installing an information board containing information about the employer, design engineer, supervisor, chartered engineers, reviewer, 3D visualisation and other necessary elements (Ministry of Ecology Spatial Planning and Urbanism, 2021).

Concession Agreement

As the PV plant has a higher capacity than 1MW, a concession act has to be concluded as well. It is regulated by the law of concessions are granted according to the Action Plan by the government. This can result in a bidding process and competition between competent entities. It includes a public hearing and debate and most concessions are granted for 30 years. Also a self-initiated concession agreement is possible. The requirements for obtaining a concession and general conditions are all explained in detail in the respective law. Exact procedures always depend on the project scope (Službeni list Crne Gore, 2009; Ministry of Economic Development and Tourism, 2021).

Information and grid capacity reservation

After purchasing or concluding the leasing agreement for the land the next step is to inform the transmission and distribution network about the project and reserve the grid capacity. The energy law also regulates access to the grid. Articles 133 and 134 of the law state that the distribution and transmission operator has to grant access to the new supplier but they can deny it if there is not enough capacity. More specifications regarding the transmission and distribution systems are also defined in the respective bylaws. The necessary files to request participation in the electricity market can be found on the COTEE website. Moreover, ECGS as the distribution system operator needs to be informed about the upcoming project and information needs to be obtained if there will be sufficient capacity (COTEE, 2023, Ministry of Economic Development and Tourism, 2021. Article 18 of the market rules lines out the general procedure for admission of participants to the electricity market (Službeni list Crne Gore, 2012).

Urban and technical specifications

Before starting with the design and planning process, the project developer has to apply for urban planning and technical requirements according to Article 73 of the law of Spatial Planning and Construction. The form has to be filed at the authority which is in charge of the construction of solar PV plants. This is the authority of Ecology, Spatial planning and Urbanism.

After application the ministry has to issue the document within 20 days. The rulebook on detailed criteria for assessing requests for the issuance of urban planning and technical conditions for the construction of facilities for the production of electricity from renewable solar sources and other renewable sources specifies the conditions which have to be met (Ministry of Sustainable Development and Tourism, 2021; Službeni list Crne Gore, 2017a; Ministry of Ecology Spatial Planning and Urbanism, 2021).

Conceptual design

The law on spatial planning and construction establishes a plan for engineering documents. In this case the PV power plant falls under the scope of a complex engineering structure. This means that additional requirements have to be fulfilled. In general, a conceptual design, preliminary design, final design and as-built design is needed and explained in Article 75. The conceptual design entails an architectural design, construction design, electrotechnical design and mechanical design. It includes possible variations of design types regarding technical and spatial aspects. Moreover, technical and economic factors have to be explained. Also it has to be lined out how the power plant will be connected to the grid and the estimated power generated. The conceptual design has to be reviewed by the authority about the following things: compliance with general regulations and technical and zoning legislation. The chief state architect also has to give his consent regarding the proposed conceptual design and he has to approve it within 15 days (Ministry of Ecology Spatial Planning and Urbanism, 2021).

Cost-Benefit Analysis

During the conceptual design and the end of the first stage a cost-benefit analysis should be conducted to get an overview of the financial aspects of the project. The cost-benefit for this project can be found in section (4.4).

Pre-feasibility study

The pre-feasibility study can be conducted by a consultant. The necessary steps for the study are explained in (3.4). The facts evaluated in the conceptual design and cost-benefit analysis are also necessary. Moreover, parallel study the process of the ESIA study and ESIA scoping report are initiated.

Environmental and Social Impact Assessment Study

The Environmental Protection Agency of Montenegro is in charge of the Environmental and Social Impact Assessment. In the local law on the ESIA the basic principles are laid out. The ESIA in Montenegro has three stages. First the need of an ESIA is defined. If a study is needed, the content and scope are specified and laid out in a scoping report and in the end the final ESIA is approved by the government or denied. For the first step the location, project description, possible influences on the environment and sources are submitted on the e-government portal or via mail. The requests are also published within three days on the website of the EPA and a decision has to be made four days after publication. If the ESIA is necessary, the agency has to justify the decision and subsequently the project developer makes a request to determine the content of the study. This also has to include several points defined in Article 15 of the respective legislation. The EPA has to publish the request and therefore the public can suggest additional points and a commission has reviewed the report which will take around three weeks, it will be made public. Five days after the deadline for submitting applications, the authority decides on the scope and content of the application. The project developer has to submit the study within two years after the determination of the content. During that time the necessary studies have to be done. After submission, a public hearing period of 30 days is mandatory followed by the submission of the ESIA to a commission. This can result in amendments to be made by the project manager and after recommendations of the commission, the authority has to decide within five days if they reject or accept the ESIA. The ESIA is valid for two years after acceptance and permits have to be obtained during that time. The study is required to obtain development/environmental consent from the Ministry, which is necessary to develop the project. This document is called the environmental permit, which is specified in the law on environmental protection. The ESIA is also relevant for financing institutions to receive requested financial resources for the project (Cmiljanović, 2010; Službeni list Crne Gore, 2018; EPA, 2023).

Preliminary Design

The Preliminary design contains information about the technical, structural, safety, organizational and design characteristics of the plant. In addition to this, it elaborates on the specific equipment and stability of the site. In general, it defines the conceptual design in more detail. The reviewing process includes the zoning and technical specifications, and correctness of technical, architectural and technological structures. Moreover, the compliance with the law and the bill of quantities are checked during the due diligence process (Ministry of Ecology Spatial Planning and Urbanism, 2021).

Feasibility study

The feasibility study elaborates on one project option only and follows the specification outlined in section (3.6). It is important to create a good feasibility analysis in order to be able to identify and execute possible hurdles in the project. Furthermore, it helps to obtain the necessary documents for permits.

Final design

The elaboration of the preliminary design is the final design. In other project development wordings, this is also called the detail design. The concept should include additional information to architectural-construction, technological, technical and operational characteristics. Also a 3D visualization is mandatory. In addition to this, it is necessary to add information about testing and installation of the equipment concerning its functionality. The review of the final design is obligatory and finalized with a report. The reviewer can, for example, come from a licensed entity. This review follows stricter conditions than the review processes above. Also, all the costs for reviewing have to be paid by the project developer. In case something is changed after the review process, it has to be filed for review again (Ministry of Ecology Spatial Planning and Urbanism, 2021).

As-Built-Design

The As-Built Design is the design laid out in Article 79 and entails changes which were made during the construction of the PV plant. This is useful for maintenance activities during the operation of the plant (Ministry of Ecology Spatial Planning and Urbanism, 2021).

Permits and Contracts

During the development, a lot of permits have to be obtained and contracts concluded. The required documents for the permits have to be prepared in good time.

General Contracts

For the construction, operation and maintenance of the plant all the necessary agreements have to be concluded in time. Depending on the situation, a decision between a BoP and EPC should be made early enough. Moreover, the O&M agreement is a key element. The hired companies all need to have obtained the necessary licenses beforehand as they are required for the construction permit. This is especially not self-evident as Montenegro has a large informal market. The modules and inverters need to be delivered to the site in time so that no delays occur, which result in higher project costs.

Environmental Permit

When the ESIA study is concluded, the environmental permit can be obtained by submitting all relevant documents to the Ministry. It is necessary to move on to the construction process. The permit is specified in the law on environmental protection (Službeni list Crne Gore, 2016).

Energy Licence

For obtaining the energy license a few conditions have to be fulfilled. One precondition is the registration in the central register of commercial entities and another one is the possession of the necessary equipment for the operation. Moreover, the statue, organizational scheme, bank data of the applicants and payment proof of the license application fee. Also the staff needs the necessary certificates for the operation of the solar PV plant. Moreover sufficient financial resources proven by the central bank of Montenegro that the license has not been revoked in the last years and no conviction within the management board is necessary. The license can be obtained for a maximum of 10 years or shorter. Every year a user fee for the license has to be paid which will be set by REGAGEN (Ministry of Economic Development and Tourism, 2021; REGAGEN, 2022b). The form for requesting the energy license and the current fees can be found online on the REGAGEN homepage (REGAGEN, 2022c; REGAGEN, 2023). Article 94 of the energy law lays out the principles for an electricity generator and lines out that agreements have to be concluded with the transmission and distribution system operators as well as the market operator.

Moreover, an information pipeline needs to be set up in order to ensure a secure and functioning grid.

Guarantee of origin

The guarantee of origin also needs to be requested by submitting the technical conditions set out in Article 99 to REGAGEN (Ministry of Economic Development and Tourism, 2021).

Consent of Connection

The consent of connection gets issued by the Distribution/Transmission System Operator and ensures the connection to the grid. The form for the consent of connection can be found in the Annex of the transmission grid rules. This also includes a study on the connection with detailed simulation models. Article 176 of the energy law is defined that a decision for connection has to be made four months after the request. For this agreement, financial guarantees are obligatory as well. The consent of connection is followed by the contract of connection with the contents presented in Article 178 (Ministry of Economic Development and Tourism, 2021; Službeni list Crne Gore, 2017b).

Connection permit

Before a permanent connection permit is issued, a trial period with a trial connection permit is carried out. The final connection agreement with the transmission system operator regulates the technical, legal and economic financial conditions of connection to the transmission system and details of future ownership relations. It includes all the technical specifications, methodical parts, risks of operation and the connection point measuring (Službeni list Crne Gore, 2017b).

Privileged Producer

After connection to the distribution grid, the next step is the obtainment of the status of a privileged producer, which can be requested by filing to the Agency (REGAGEN) (Službeni list Crne Gore, 2017c).

Wholesale market registration

The registration with REGAGEN for wholesale market has to be made in order to participate in the electricity market. This is possible via the registration form, which can be sent via email or directly to the headquarter (REGAGEN, 2022a). The EIC code can be obtained via CGES by filling out the mandatory form posted on the website and is completed by submitting via mail (CGES, 2023a).

Power Purchase Agreement

The Power Purchase Agreement goes hand in hand with the obtainment of the status of the privileged producer by COTEE. The contract with all its specifications can be found on the COTEE homepage and is concluded for a time of 12 years and is accompanied by a bank guarantee. Mandatory contents of the contract are, for example, the method of delivering and using, measurement method, pricing method, guarantees of origin, payment calculation method and method of resolving disputes (Službeni list Crne Gore, 2012; COTEE, 2023).

Montenegrin Power Exchange registration

To be able to participate in the MEPX day-ahead market of the country, a balance of responsibility with ECGS and COTEE and a registration certificate with COTEE are necessary (MEPX, 2023).

Building and Use permit

The building permit can be requested at the ministry for spatial planning and development and environmental protection after the successful review of the final design. The following documents have to be submitted: positive and stamped designs, ownership evidence, separate approvals, ESIA study, liability insurance evidence. The request has to be processed within 60 days. The building of the structure also has to be registered with the central registry of construction 15 days after the finalization of the last supervision report. 60 days after the last report the structure has to be handed over from the building contractor to the developer. For the plant to be able to be used and put in operation a use permit is necessary, which can be obtained by a technical inspection in the timeframe of the trial operation (Ministry of Ecology

Spatial Planning and Urbanism, 2021).

Financial Closure

The moment of truth in the process is the financial closure. All documents, permits and licences have to be obtained and ready for the project. In addition to this, the necessary O&M contracts need to be concluded. All the relevant stakeholder work together to achieve this milestone and kick off the construction of the plant. Due to this, the stakeholder engagement has to be carried out on a high level.

4.3.3. Project Development Framework Montenegro

To get an overview on the process Figure (4.6) represents all the necessary steps that have to be concluded in Montenegro to develop a solar PV project.

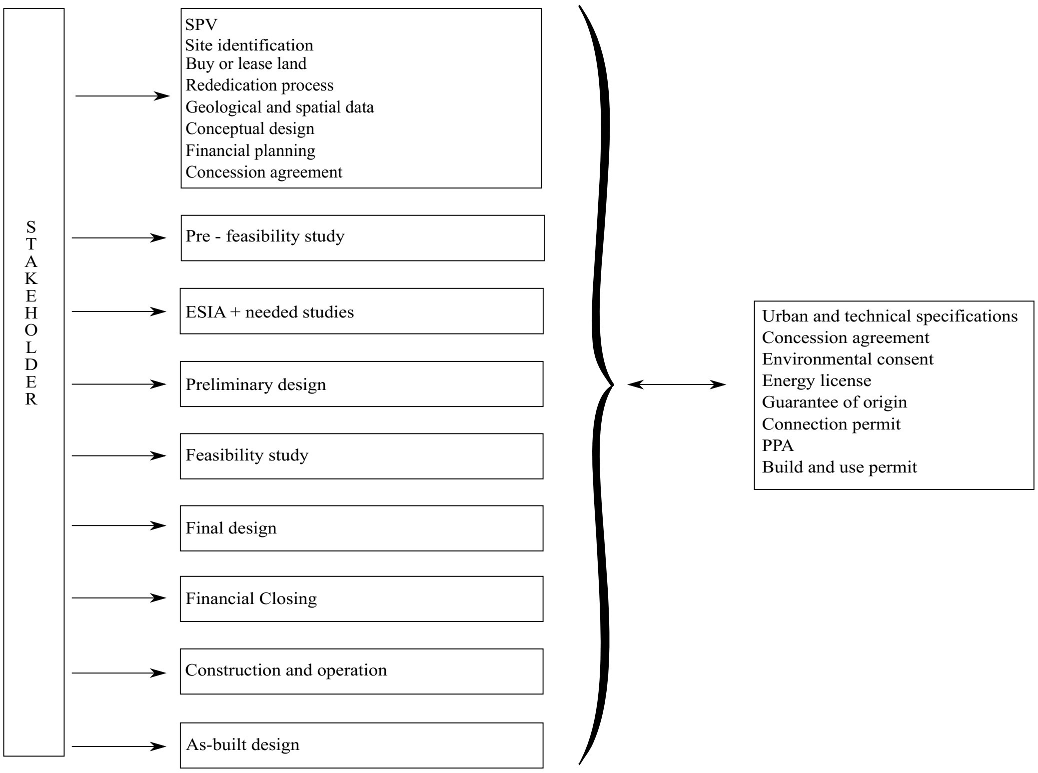
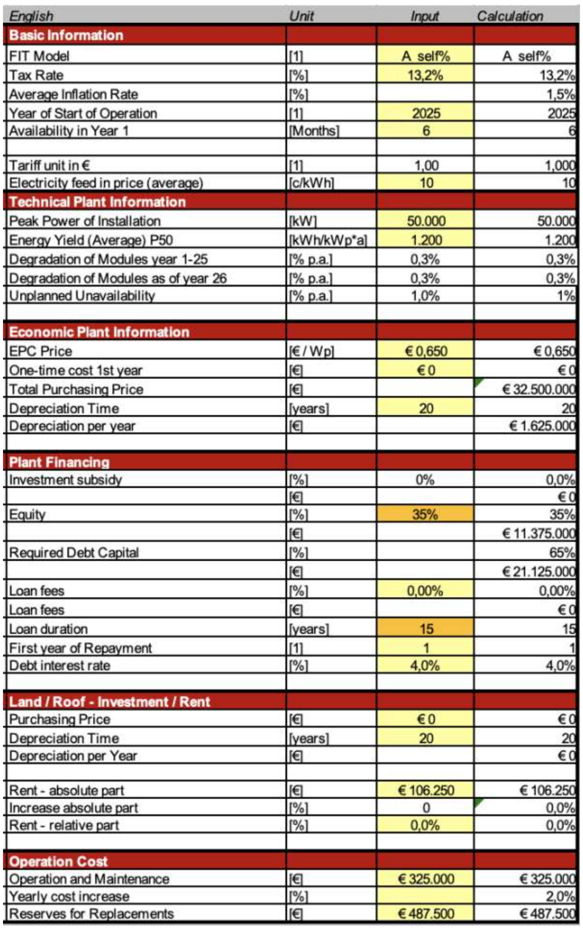


Figure 4.6.: Project Development Framework Montenegro

4.4. Cost-Benefit Analysis

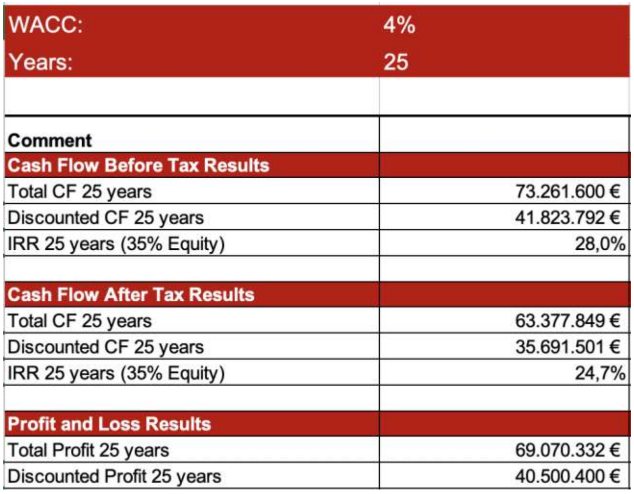
The following section presents a cost-benefit analysis for the respective project. In addition to this, a sensibility analysis will be included. This helps to evaluate the feasibility of the project and the impact of it. Figure (4.7) presents the input data and the summary of the results is given in figure (4.8). The first five years of the cash flow analysis can be seen in figure (4.9) and the first five years of the profit and loss statement in (4.10). Additional data until year 40 and the cumulative operative cash flow can be found in the Annex (A.4).



English	*Unit*	*Input*	*Calculation*
Basic Information			
FIT Model	[1]	A self%	A self%
Tax Rate	[%]	13,2%	13,2%
Average Inflation Rate	[%]		1,5%
Year of Start of Operation	[1]	2025	2025
Availability in Year 1	[Months]	6	6
Tariff unit in €	[1]	1,00	1,000
Electricity feed in price (average)	[c/kWh]	10	10
Technical Plant Information			
Peak Power of Installation	[kW]	50.000	50.000
Energy Yield (Average) P50	[kWh/kWp*a]	1.200	1.200
Degradation of Modules year 1-25	[% p.a.]	0,3%	0,3%
Degradation of Modules as of year 26	[% p.a.]	0,3%	0,3%
Unplanned Unavailability	[% p.a.]	1,0%	1%
Economic Plant Information			
EPC Price	[€ / Wp]	€ 0,650	€ 0,650
One-time cost 1st year	[€]	€ 0	€ 0
Total Purchasing Price	[€]		€ 32.500.000
Depreciation Time	[years]	20	20
Depreciation per year	[€]		€ 1.625.000
Plant Financing			
Investment subsidy	[%]	0%	0,0%
	[€]		€ 0
Equity	[%]	35%	35%
	[€]		€ 11.375.000
Required Debt Capital	[%]		65%
	[€]		€ 21.125.000
Loan fees	[%]	0,00%	0,00%
Loan fees	[€]		€ 0
Loan duration	[years]	15	15
First year of Repayment	[1]	1	1
Debt interest rate	[%]	4,0%	4,0%
Land / Roof - Investment / Rent			
Purchasing Price	[€]	€ 0	€ 0
Depreciation Time	[years]	20	20
Depreciation per Year	[€]		€ 0
Rent - absolute part	[€]	€ 106.250	€ 106.250
Increase absolute part	[%]	0	0,0%
Rent - relative part	[%]	0,0%	0,0%
Operation Cost			
Operation and Maintenance	[€]	€ 325.000	€ 325.000
Yearly cost increase	[%]		2,0%
Reserves for Replacements	[€]	€ 487.500	€ 487.500

Figure 4.7.: Input Information

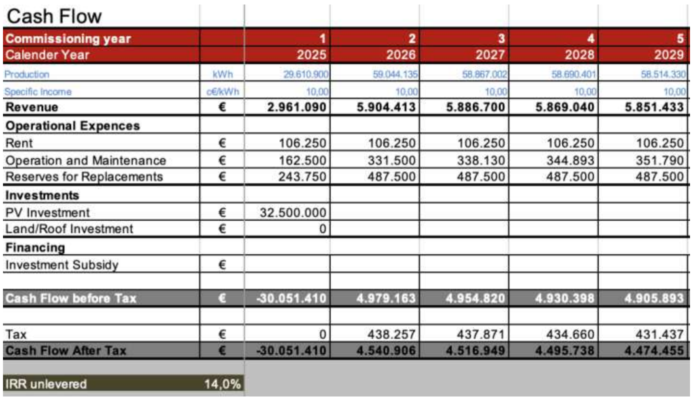
In figure (4.7) can be seen that the investment costs for the analysis account for 32.5 million Euro for a 50 MW installation and an energy yield of 1200 kWh/kWp with an Euro per Watt peak price of 0,65 Euro. The financing structure is 35 percent equity and 65 percent are financed by a debt coming from a development bank with an interest rate of 4 percent/year. As the corporate tax in Montenegro is progressive with 9-15 percent, a mixed tax rate of 13,15 percent has been taken into account. The rent for the land is 106.250 Euro/year. The annual operation and maintenance costs are calculated with 325.000 Euro/year and reserves for replacement account for 487.500 Euro/year.



WACC:	4%
Years:	25
Comment	
Cash Flow Before Tax Results	
Total CF 25 years	73.261.600 €
Discounted CF 25 years	41.823.792 €
IRR 25 years (35% Equity)	28,0%
Cash Flow After Tax Results	
Total CF 25 years	63.377.849 €
Discounted CF 25 years	35.691.501 €
IRR 25 years (35% Equity)	24,7%
Profit and Loss Results	
Total Profit 25 years	69.070.332 €
Discounted Profit 25 years	40.500.400 €

Figure 4.8.: Summary of Results

Figure (4.8) shows the results for a period of 25 years. With an IRR 25 years before tax of 28 percent and after tax of 24,7 percent. Total P&L account for around 69 Mio Euro and discounted profit for around 40 Mio Euro.



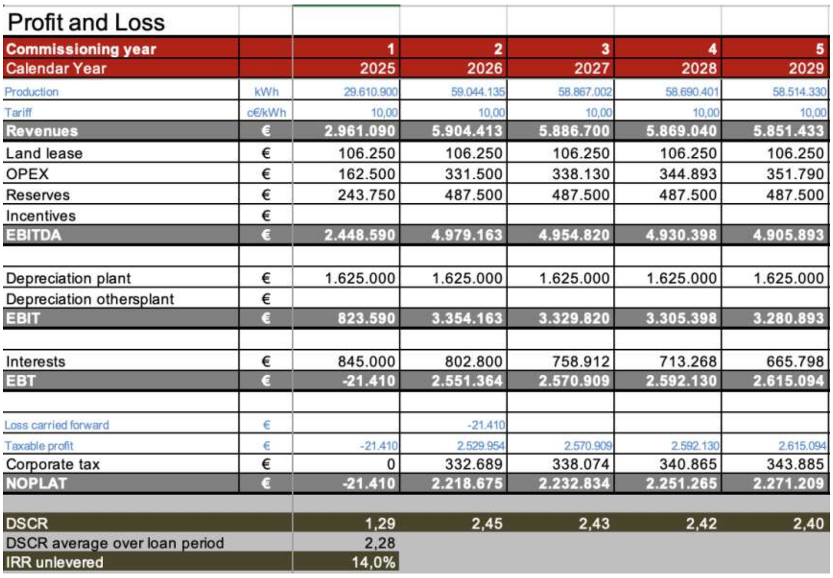
Cash Flow

Commissioning year		**1**	**2**	**3**	**4**	**5**
Calender Year		**2025**	**2026**	**2027**	**2028**	**2029**
Production	kWh	29.610.900	59.044.135	58.867.002	58.690.401	58.514.330
Specific Income	c€/kWh	10,00	10,00	10,00	10,00	10,00
Revenue	**€**	**2.961.090**	**5.904.413**	**5.886.700**	**5.869.040**	**5.851.433**
Operational Expences						
Rent	€	106.250	106.250	106.250	106.250	106.250
Operation and Maintenance	€	162.500	331.500	338.130	344.893	351.790
Reserves for Replacements	€	243.750	487.500	487.500	487.500	487.500
Investments						
PV Investment	€	32.500.000				
Land/Roof Investment	€	0				
Financing						
Investment Subsidy	€					
Cash Flow before Tax	**€**	**-30.051.410**	**4.979.163**	**4.954.820**	**4.930.398**	**4.905.893**
Tax	€	0	438.257	437.871	434.660	431.437
Cash Flow After Tax	**€**	**-30.051.410**	**4.540.906**	**4.516.949**	**4.495.738**	**4.474.455**
IRR unlevered	14,0%					

Figure 4.9.: Cash Flow Analysis

As depicted in figure (4.9), with a production of around 50 Mwh/h and calculated income of 10 c per Euro/kwh the revenue for a full year results in around 5.9 Mio

Euro/year. After deduction of the operational expenses and taxes a cash flow of 4.5 Mio Euro/year remains.

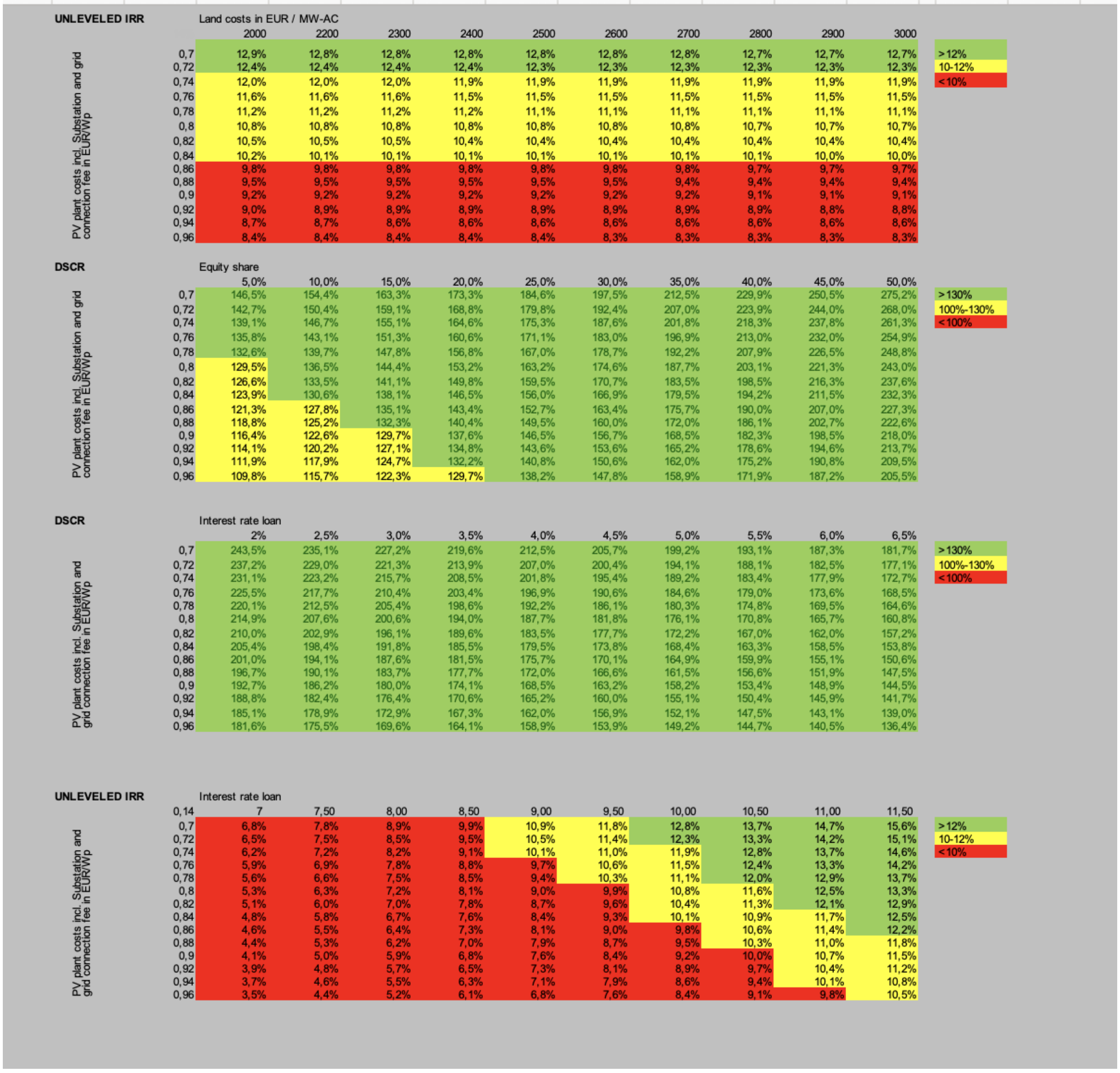


Profit and Loss

Commissioning year		1	2	3	4	5
Calendar Year		2025	2026	2027	2028	2029
Production	kWh	29.610.900	59.044.135	58.867.002	58.690.401	58.514.330
Tariff	c€/kWh	10,00	10,00	10,00	10,00	10,00
Revenues	€	2.961.090	5.904.413	5.886.700	5.869.040	5.851.433
Land lease	€	106.250	106.250	106.250	106.250	106.250
OPEX	€	162.500	331.500	338.130	344.893	351.790
Reserves	€	243.750	487.500	487.500	487.500	487.500
Incentives	€					
EBITDA	€	2.448.590	4.979.163	4.954.820	4.930.398	4.905.893
Depreciation plant	€	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000
Depreciation othersplant	€					
EBIT	€	823.590	3.354.163	3.329.820	3.305.398	3.280.893
Interests	€	845.000	802.800	758.912	713.268	665.798
EBT	€	-21.410	2.551.364	2.570.909	2.592.130	2.615.094
Loss carried forward	€		-21.410			
Taxable profit	€	-21.410	2.529.954	2.570.909	2.592.130	2.615.094
Corporate tax	€	0	332.689	338.074	340.865	343.885
NOPLAT	€	-21.410	2.218.675	2.232.834	2.251.265	2.271.209
DSCR		1,29	2,45	2,43	2,42	2,40
DSCR average over loan period		2,28				
IRR unlevered		14,0%				

Figure 4.10.: Profit and Loss Statement

The unleveled IRR of 14 percent and a DSC over the average loan period of 2,27 percent, which is a very good value, can be derived from figure (4.10). The NOPLAT is around very reasonable 2,2 Mio Euro/year. When looking at figure (4.11), four different sensibility analyses are presented and allow several interpretations. First of all, it shows how the value of the unleveled IRR changes with different variations of the two variables, land costs in EUR/MW-AC and PV plant costs. The variation analysis shows that the land costs do not play a major role for the unleveled IRR but the PV plant costs are a key factor for the profitability of the project. In addition, two different variants of the DSCR are investigated. On the one hand, the relationship between equity share and PV costs show that an equity share of 15 percent stays above the level of 130 percent. On the other hand, the interest loan and PV costs sensitivity analysis shows that in the range of 2-6 percent interest rates the DSCR is always above 130 percent. This is especially in an macro economic situation of rising interest rates a good position. Lastly, it is shown how the unleveled IRR is affected when the interest loan and PV costs are changed.



UNLEVELED IRR Land costs in EUR / MW-AC

PV plant costs incl. Substation and grid connection fee in EUR/Wp	2000	2200	2300	2400	2500	2600	2700	2800	2900	3000
0,7	12,9%	12,8%	12,8%	12,8%	12,8%	12,8%	12,8%	12,7%	12,7%	12,7%
0,72	12,4%	12,4%	12,4%	12,4%	12,3%	12,3%	12,3%	12,3%	12,3%	12,3%
0,74	12,0%	12,0%	12,0%	11,9%	11,9%	11,9%	11,9%	11,9%	11,9%	11,9%
0,76	11,6%	11,6%	11,6%	11,5%	11,5%	11,5%	11,5%	11,5%	11,5%	11,5%
0,78	11,2%	11,2%	11,2%	11,2%	11,1%	11,1%	11,1%	11,1%	11,1%	11,1%
0,8	10,8%	10,8%	10,8%	10,8%	10,8%	10,8%	10,8%	10,7%	10,7%	10,7%
0,82	10,5%	10,5%	10,5%	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%
0,84	10,2%	10,1%	10,1%	10,1%	10,1%	10,1%	10,1%	10,1%	10,0%	10,0%
0,86	9,8%	9,8%	9,8%	9,8%	9,8%	9,8%	9,8%	9,7%	9,7%	9,7%
0,88	9,5%	9,5%	9,5%	9,5%	9,5%	9,5%	9,4%	9,4%	9,4%	9,4%
0,9	9,2%	9,2%	9,2%	9,2%	9,2%	9,2%	9,2%	9,1%	9,1%	9,1%
0,92	9,0%	8,9%	8,9%	8,9%	8,9%	8,9%	8,9%	8,9%	8,8%	8,8%
0,94	8,7%	8,7%	8,6%	8,6%	8,6%	8,6%	8,6%	8,6%	8,6%	8,6%
0,96	8,4%	8,4%	8,4%	8,4%	8,4%	8,3%	8,3%	8,3%	8,3%	8,3%

🟩 >12%
🟨 10-12%
🟥 <10%

DSCR Equity share

PV plant costs incl. Substation and grid connection fee in EUR/Wp	5,0%	10,0%	15,0%	20,0%	25,0%	30,0%	35,0%	40,0%	45,0%	50,0%
0,7	146,5%	154,4%	163,3%	173,3%	184,6%	197,5%	212,5%	229,9%	250,5%	275,2%
0,72	142,7%	150,4%	159,1%	168,8%	179,8%	192,4%	207,0%	223,9%	244,0%	268,0%
0,74	139,1%	146,7%	155,1%	164,6%	175,3%	187,6%	201,8%	218,3%	237,8%	261,3%
0,76	135,8%	143,1%	151,3%	160,6%	171,1%	183,0%	196,9%	213,0%	232,0%	254,9%
0,78	132,6%	139,7%	147,8%	156,8%	167,0%	178,7%	192,2%	207,9%	226,5%	248,8%
0,8	129,5%	136,5%	144,4%	153,2%	163,2%	174,6%	187,7%	203,1%	221,3%	243,0%
0,82	126,6%	133,5%	141,1%	149,8%	159,5%	170,7%	183,5%	198,5%	216,3%	237,6%
0,84	123,9%	130,6%	138,1%	146,5%	156,0%	166,9%	179,5%	194,2%	211,5%	232,3%
0,86	121,3%	127,8%	135,1%	143,4%	152,7%	163,4%	175,7%	190,0%	207,0%	227,3%
0,88	118,8%	125,2%	132,3%	140,4%	149,5%	160,0%	172,0%	186,1%	202,7%	222,6%
0,9	116,4%	122,6%	129,7%	137,6%	146,5%	156,7%	168,5%	182,3%	198,5%	218,0%
0,92	114,1%	120,2%	127,1%	134,8%	143,6%	153,6%	165,2%	178,6%	194,6%	213,7%
0,94	111,9%	117,9%	124,7%	132,2%	140,8%	150,6%	162,0%	175,2%	190,8%	209,5%
0,96	109,8%	115,7%	122,3%	129,7%	138,2%	147,8%	158,9%	171,9%	187,2%	205,5%

🟩 >130%
🟨 100%-130%
🟥 <100%

DSCR Interest rate loan

PV plant costs incl. Substation and grid connection fee in EUR/Wp	2%	2,5%	3,0%	3,5%	4,0%	4,5%	5,0%	5,5%	6,0%	6,5%
0,7	243,5%	235,1%	227,2%	219,6%	212,5%	205,7%	199,2%	193,1%	187,3%	181,7%
0,72	237,2%	229,0%	221,3%	213,9%	207,0%	200,4%	194,1%	188,1%	182,5%	177,1%
0,74	231,1%	223,2%	215,7%	208,5%	201,8%	195,4%	189,2%	183,4%	177,9%	172,7%
0,76	225,5%	217,7%	210,4%	203,4%	196,9%	190,6%	184,6%	179,0%	173,6%	168,5%
0,78	220,1%	212,5%	205,4%	198,6%	192,2%	186,1%	180,3%	174,8%	169,5%	164,6%
0,8	214,9%	207,6%	200,6%	194,0%	187,7%	181,8%	176,1%	170,8%	165,7%	160,8%
0,82	210,0%	202,9%	196,1%	189,6%	183,5%	177,7%	172,2%	167,0%	162,0%	157,2%
0,84	205,4%	198,4%	191,8%	185,5%	179,5%	173,8%	168,4%	163,3%	158,5%	153,8%
0,86	201,0%	194,1%	187,6%	181,5%	175,7%	170,1%	164,9%	159,9%	155,1%	150,6%
0,88	196,7%	190,1%	183,7%	177,7%	172,0%	166,6%	161,5%	156,6%	151,9%	147,5%
0,9	192,7%	186,2%	180,0%	174,1%	168,5%	163,2%	158,2%	153,4%	148,9%	144,5%
0,92	188,8%	182,4%	176,4%	170,6%	165,2%	160,0%	155,1%	150,4%	145,9%	141,7%
0,94	185,1%	178,9%	172,9%	167,3%	162,0%	156,9%	152,1%	147,5%	143,1%	139,0%
0,96	181,6%	175,5%	169,6%	164,1%	158,9%	153,9%	149,2%	144,7%	140,5%	136,4%

🟩 >130%
🟨 100%-130%
🟥 <100%

UNLEVELED IRR Interest rate loan

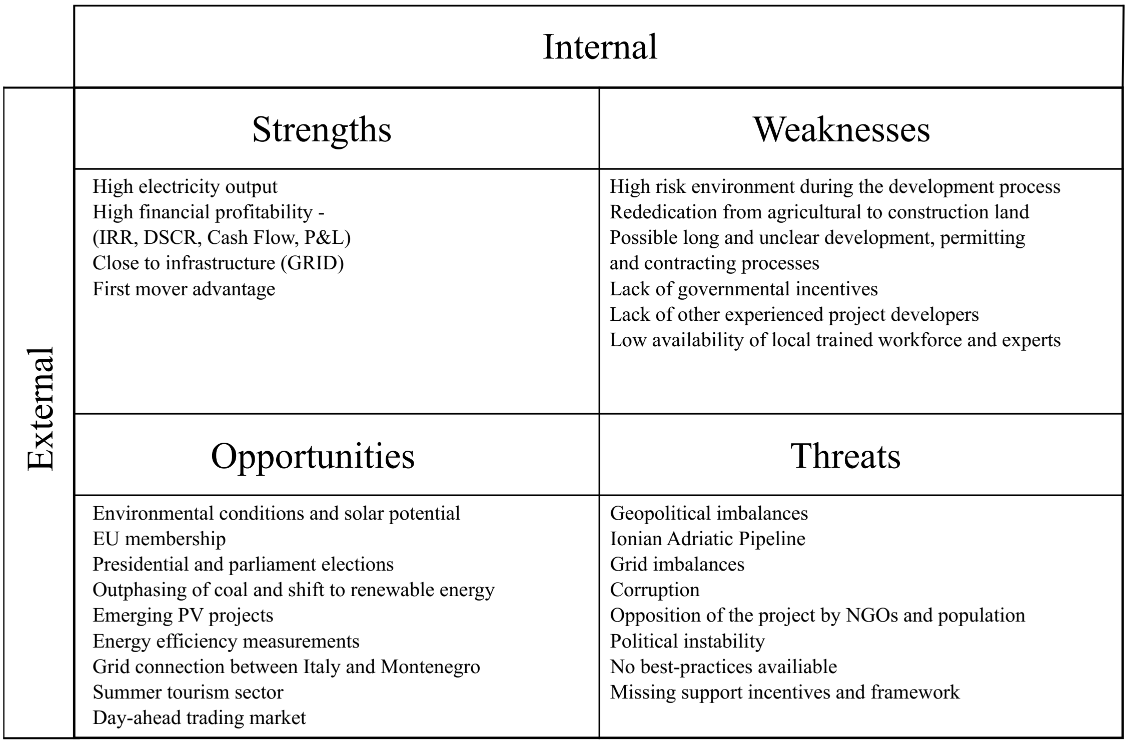
PV plant costs incl. Substation and grid connection fee in EUR/Wp										
0,14	7	7,50	8,00	8,50	9,00	9,50	10,00	10,50	11,00	11,50
0,7	6,8%	7,8%	8,9%	9,9%	10,9%	11,8%	12,8%	13,7%	14,7%	15,6%
0,72	6,5%	7,5%	8,5%	9,5%	10,5%	11,4%	12,3%	13,3%	14,2%	15,1%
0,74	6,2%	7,2%	8,2%	9,1%	10,1%	11,0%	11,9%	12,8%	13,7%	14,6%
0,76	5,9%	6,9%	7,8%	8,8%	9,7%	10,6%	11,5%	12,4%	13,3%	14,2%
0,78	5,6%	6,6%	7,5%	8,5%	9,4%	10,3%	11,1%	12,0%	12,9%	13,7%
0,8	5,3%	6,3%	7,2%	8,1%	9,0%	9,9%	10,8%	11,6%	12,5%	13,3%
0,82	5,1%	6,0%	7,0%	7,8%	8,7%	9,6%	10,4%	11,3%	12,1%	12,9%
0,84	4,8%	5,8%	6,7%	7,6%	8,4%	9,3%	10,1%	10,9%	11,7%	12,5%
0,86	4,6%	5,5%	6,4%	7,3%	8,1%	9,0%	9,8%	10,6%	11,4%	12,2%
0,88	4,4%	5,3%	6,2%	7,0%	7,9%	8,7%	9,5%	10,3%	11,0%	11,8%
0,9	4,1%	5,0%	5,9%	6,8%	7,6%	8,4%	9,2%	10,0%	10,7%	11,5%
0,92	3,9%	4,8%	5,7%	6,5%	7,3%	8,1%	8,9%	9,7%	10,4%	11,2%
0,94	3,7%	4,6%	5,5%	6,3%	7,1%	7,9%	8,6%	9,4%	10,1%	10,8%
0,96	3,5%	4,4%	5,2%	6,1%	6,8%	7,6%	8,4%	9,1%	9,8%	10,5%

🟩 >12%
🟨 10-12%
🟥 <10%

Figure 4.11.: Sensibility analysis

4.5. Discussion of Results

After having examined all the necessary steps for developing the 'Tuzi 50MW PV project 2025', the results allow to draw a picture of how the process is working and which factors have to be considered. To get an overview on the strengths, weaknesses, threats and opportunities, a SWOT analysis has been concluded and the results are shown in figure (4.12). This helps an investor to quickly assess the key results from the project. The internal strengths and weaknesses of the project are combined with the external opportunities and threats in the country. The strategic planning process can be optimized by considering the listed factors.



	Internal	
External	Strengths	Weaknesses
	High electricity output High financial profitability - (IRR, DSCR, Cash Flow, P&L) Close to infrastructure (GRID) First mover advantage	High risk environment during the development process Rededication from agricultural to construction land Possible long and unclear development, permitting and contracting processes Lack of governmental incentives Lack of other experienced project developers Low availability of local trained workforce and experts
	Opportunities	Threats
	Environmental conditions and solar potential EU membership Presidential and parliament elections Outphasing of coal and shift to renewable energy Emerging PV projects Energy efficiency measurements Grid connection between Italy and Montenegro Summer tourism sector Day-ahead trading market	Geopolitical imbalances Ionian Adriatic Pipeline Grid imbalances Corruption Opposition of the project by NGOs and population Political instability No best-practices availiable Missing support incentives and framework

Figure 4.12.: SWOT Analysis

5. Conclusion

The final chapter of this thesis brings the discussed content to a close and answers the research questions presented in section (1.1). This will be followed by a brief outline of the limitations of the thesis and a future outlook.

5.1. Summary

As stated in the introduction, the main purpose of this thesis is to study the development of a PV project in Montenegro. Therefore, the internal and external factors, costs and benefits, hurdles and opportunities are discussed. The aim is to present the current situation of the country and to develop a handbook with the most important information for a project developer. From this study it should be possible to deduce whether it pays off to invest in the country and what must be taken into account during the process. For this purpose, the background information regarding PV was discussed at the beginning to get a fundamental understanding. After giving an outlook on future technological developments, the key steps of a PV project development were presented within a framework. The third part is the case study in which first a PESTEL country analysis was conducted to get an overview of Montenegro. The analysis was completed by an evaluation of the key factors and their influence on the project development. Subsequently, the Project Development Framework was applied to Montenegro and the steps that need to be taken in order to successfully develop a PV project in the country were explained. For this, the fictitious 'Tuzi 50MW PV Project 2025' project has been developed and all project development steps including a stakeholder mapping have been discussed. Moreover, a cost-benefit analysis was carried out, which provides an overview of the most important financial factors and makes the process measurable. In addition to this, a sensitivity analysis has been included. The results of the thesis are presented in the next section by answering the research questions.

5.2. Answers to the Research Questions

The aim of this chapter is to answer the research questions by interpreting the content presented in the thesis.

What are the main steps involved in developing a feasible PV project in Montenegro, and what external factors need to be considered during the process?

Through analyzing regulations, legal frameworks, laws, documents, interviews and other sources a guideline presented in chapter (4.3) has been developed that at first glance offers a clear answer on the posed research question. The steps to be followed are similar to the classical procedure of a renewable energy project. Starting with a project idea, creating a SPV, identifying key stakeholders, purchasing or leasing land, development of pre-feasibility and feasibility studies, ESIA process, reviewing processes from the preliminary to final design and a cost-benefit analysis. On top of that permits have to be obtained and contracts concluded. Successfully concluded is the development process by the financial closing where the developer has to deliver all necessary documents. Figure (4.6) presents an overview on the necessary steps. It is important to mention that depending on the project, some steps and processes may be varying. What can be observed from the stakeholder analysis is that a constant engagement with the relevant stakeholder is obligatory for the success of the project. A large fraction of stakeholders is classified in the category 'manage closely', which signalizes that they have great influence on the project and can lead to extensions and difficulties in the process. However, when looking more closely at the result of the case study a lot of further influencing factors have to be taken into account and the answer to the question whether it pays off for an investor to develop a project in the country no longer seems that simple. This is also proven by the results of the PESTEL analysis shown in table (4.4) which rates the degree of influence various external factors have. Montenegro with its high solar potential, geological and spatial attractiveness and general suitable climate and weather conditions seems at first glance as the ideal location for developing a project. Nevertheless, the political instabilities and missing support incentives in the country unfortunately could be detrimental for a smooth project development and make the project infeasible. In addition to this, the informal business sector and corruption are a high risk for investors coming to Montenegro. Some administrative processes are still quite complicated and not clear. At the moment it could be an advantage to enter the market as one of the first movers but when taking into account all the different factors it is recommended to be an experienced project developer in the Balkans with a strong financial background. Therefore, an existing network can be used to engage with key stakeholders. With the help of a strong and focused project management team and a good risk management system, the risks should be spread and good insurance is of utmost importance. If experience and management capabilities are available, Montenegro is definitely a very attractive location to develop profitable projects. Strong support from local advisory, lawyers, and relationships to politics are necessary to manage current uncertainties and to be successful within the project implementation objectives. All in all, the correlation between instabilities and the success of the project development is it significant and should not be underestimated. It is likely that a lot of unexpected hurdles and risks could emerge during the process. Another option could be to wait until the first projects have successfully been developed in order to learn from their experience and minimize the risks in the own project.

What is the outcome of a cost-benefit analysis for developing a PV project in Montenegro?

The analysis presented in chapter (4.4) represents the cost and benefits of a PV project in Montenegro. By putting all relevant financial indicators of the project into relation to each other, a financial prognosis has been made. It is again an indicator for an investor to see how feasible and profitable the development of a project in the country is. When looking at the results of the cost-benefit analysis it can be seen that a 50MW plant with the conditions assumed for the analysis presented in (4.7) would present a financially attractive project. This is for example proven by an unleveled IRR of around 14 percent and DSCR in the second year of 2,45. Both indicators prove that the cost-benefit analysis turns out very well in this case. The cash flow break-even point can be reached after around eight to nine years, which is also an indicator for a feasible project. Moreover, the sensibility analysis shows how fluctuations in variables have a damaging impact on the financial output of the project. This is especially important in an uncertain environment and should not be underestimated. The financial analysis makes the project profitable but the already discussed external factors have to be considered on top of it. It is obvious that an investor has to generate a risk premium for his investment to get a compensation for the higher risks linked to this investment compared to investing in a country with a more stable business and political environment. This is also shown by the SWOT analysis where the financial aspects are mostly classified under the strengths of the project but the risks and threats could swiftly shift the calculated profitable project into an infeasible one. Therefore, a well-balanced project management plan has to be set up.

What are the challenges and opportunities of the PV sector in Montenegro?

After a detailed analysis of the country the challenges and opportunities can be are going to be presented. As a result of the recent political imbalances, the EU integration process slowed down which leaves the country in a state of uncertainty. The current situation is unclear and a clear strategic direction is missing. This also makes the country very vulnerable to geopolitical imbalances. The focus lies on the improvement of the general political situation and renewable energies are neglected. This results in a lack of renewable energy legislation and no clear project development frameworks provided by the government. Due to structural problems, the roles of the ministries are not clear, which also slows down the overall process and generates an unattractive environment for project developers. Also, preparing the grid for a larger share of photovoltaic systems with the ensuing expansion steps to ensure security and availability poses a challenge. Moreover, more research and development in the area is needed to make it possible for Montenegro to become part of the innovative movement towards the energy transition with the help of solar power. This also effects the energy efficiency measurements in the country. Another important factor is the coal plant in Pljevlja, which is an opportunity and challenge at the same time. The need to shut down the plant sooner than later is a possibility for the PV sector to expand and fill the gap in the course of an energy transition in the country. To be able to go this path Montenegro has to create a more attractive business framework for project developers supporting national investors and attracting international ones. For this to happen the right governmental decisions have to be made. Moreover, the workforce bound in the coal sector has to be trained to be employable in other sectors. If nothing is done in this respect, the country will risk plunging into a social crisis and the turnaround to renewable energy systems will not succeed. Therefore, the positive attitude of the population towards renewable energies and EU accession should be used and expanded through awareness raising measures. A huge opportunity is definitely the currently ongoing change of the political structure in the country. The new presidential elections in April 2023 and the upcoming parliamentarian elections in June could bring stability to the country and put the country back on track. This change could be used to listen to the needs of the population and pave the way for Montenegro to become a member of the EU. Through cooperation and integration, a clear direction must be presented by the government and ministries in charge to get the country ready for the transition and create a more favorable environment for investors. The challenges in the country currently outweigh the opportunities but balances could shift in the near future.

5.3. Limitations

The result of this thesis paper provides a manual with all the important information for a project developer who has the goal to develop a PV project in Montenegro. Through analyzing several sources and by conducting interviews with local specialists a good overview about the process has been made. However, the limitations of the work should not be disregarded. One important factor is the language barrier and the unavailability of official and legal documents in English. Only a small fraction of the legal documents, decisions, protocols and information published by the government is translated. Moreover, websites such as from the EPA, Law Gazette, COTEE and other relevant stakeholders are not translated into English which restricts the accessibility to information. This has also to be considered for the representativity of the presented framework as due to the partly difficult research conditions relevant information might have been neglected. This also accounts for data used in the thesis as often the most recent accessible data were published in 2021. Due to the effect of the COVID crisis and Russian-Ukrainian war more recent data would allow a more accurate assessment. Furthermore, although the interviews conducted provide a good overview of the current situation, more interviews with different stakeholders would draw a more precise picture and reveal additional necessary processes. This was not possible in the course of the work because of several unanswered interview requests. Also, the limited availability of already developed projects in the country made it hard to learn from best practices. For additional research, the projects announced online and referred to in the interviews definitely have to be monitored to stay up to date. In addition to this, it has to be stated that the project development framework which has been presented has to be seen as a guideline and not as a 'one-size-fits-all' model. Therefore, depending on the project the necessary steps, contracts and permits can change. The parameters inserted in the cost-benefit analysis are also assumptions and vary depending on the project. This accounts also for laws and regulations as unexpected legal barriers could emerge. As the project taken into account in the case study is just fictitious additional processes probably have to be considered. Moreover, due to sudden changes and unexpected crises the situation in the country might deteriorate. Therefore the analysis and interpretation of the country's PESTEL factors and the derived impacts on project development have to be repeated and revised. It also has to be mentioned that the included and interpreted interviews were conducted in early February 2023, before the country's presidential elections held in April 2023.

5.4. Future Outlook

By presenting the limitation of this thesis a new opportunity for further research has been opened. With the availability of more resources the framework presented in this thesis can be further developed. Moreover, with more projects successfully being developed in the country best-practices can be included in the future. This also helps project developers to learn from failures and successes of others.

For Montenegro it should be taken as a task for the future to turn the country into an energy hub with an attractive environment for investors. The country has to seize the moment of change and uncertainty to get back stronger with clear directions. The interview with a representative of the Ministry of Capital Investments shows that the motivation is strong but should now also put into practice. The solar and environmental preconditions are good, but the political, technical, social and economic states have to be transformed. This can happen on the one hand by a strong governmental direction and on the other hand by a transformation of the society and economy. The whole infrastructure needs to be prepared for the upcoming increase in solar energy. This means that the grid needs to be developed, energy efficiency measurements increased, citizens need to be involved, legislation developed, guidelines published and research on renewable technologies in the country expanded. New technologies as floating solar PV and agriphotovoltaics could also be an opportunity for the country and research should be carried out on possible implementation and support schemes. This is crucial for Montenegro to be able to return to the leading position in the Balkans in the EU accession process. The transformation of the economy and energy sector will help the country in all sectors: new jobs are created, the economic situation improved and, independence increased. All in all, Montenegro can be a role model for other West Balkan states on how to proceed with the energy transition but a lot of work has to be done to make it possible. This development is mandatory to be an attractive destination for investors in the near future and to reach the goals set out in the Energy Policy and Energy Development Strategy until 2030.

Bibliography

Aussenwirtschaftscenter Belgrad, Jan. 2022. *Wirtschaftsbericht Montenegro.* Tech. rep. Belgrade: WKO. Available at: `https://www.wko.at/service/aussenwirtschaft/montenegro-wirtschaftsbericht.pdf`.

Austrian Energy Agency, 2022. *Support schemes.* Available at: `https://www.enercee.net/countries/montenegro/support-schemes` [Accessed 30th Apr. 2023].

Auswärtiges Amt, 2023. *Montenegro: Politisches Porträt.* Available at: `https://www.auswaertiges-amt.de/de/service/laender/montenegro-node/politisches-portraet/216348?openAccordionId=item-216326-0-panel&view=` [Accessed 17th Apr. 2023].

Bajat, B., Antonijević, O., Kilibarda, M., Sekulić, A., Luković, J., Doljak, D. and Burić, D., 2020. Space-Time High-Resolution Data of The Potential Insolation and Solar Duration for Montenegro. *Spatium*, 243(44), pp. 45–52. ISSN: 1450569X. `https://doi.org/10.2298/SPAT2044045B`.

Balkan Green Energy News, 2019. *Italy-Montenegro undersea power interconnector put in operation.* Available at: `https://balkangreenenergynews.com/italy-montenegro-undersea-power-interconnector-put-in-operation/` [Accessed 25th Apr. 2023].

Bankwatch Network, 2023. *The energy sector in Montenegro.* Available at: `https://bankwatch.org/beyond-fossil-fuels/the-energy-sector-in-montenegro` [Accessed 18th Apr. 2023].

Baringa, 2020. *Commercial Power Purchase Agreements A Market Study including an assessment of potential financial instruments to support renewable energy Commercial Power Purchase Agreements.* Tech. rep. European Investment Bank. Available at: `https://advisory.eib.org/publications/attachments/commercial-power-purchase-agreements.pdf`.

Berk, J. and DeMarzo, P., 2020. *Grundlagen der Finanzwirtschaft.* 5th ed. Pearson Deutschland. ISBN: 978-3-86894-394-8.

Bertelsmann Stiftung, 2002. *BTI 2022 Country Report-Montenegro.* Tech. rep. Gütersloh. Available at: `https://bti-project.org/fileadmin/api/content/en/downloads/reports/country_report_2022_MNE.pdf`.

Bremere, I., Indriksone, D. and Strigune, D., 2019. *Handbook on innovative modes of stakeholder involvement and communication models: planning sustainable energy projects Editorial team.* Tech. rep. Riga: Interreg Baltic Sea Region.

Cement Sustainability Initiative, 2016. Guidelines for Environmental Social Impact Assessment. Available at: `http://docs.wbcsd.org/2016/08/Guidelines_for_Environmental_Social_Impact_Assessment.pdf`.

CGES, 2020. *Razvoj Sistema.* Available at: `https://www.cges.me/regulativa/razvoj-sistema` [Accessed 3rd May 2023].

– 2023a. *EIC / PARTICIPANTS REGISTRATION.* Available at: `https://www.cges.me/en/regulation/eic-participants-registration` [Accessed 4th May 2023].

– 2023b. *Overhead Line Network.* Available at: `https://www.cges.me/en/about/electrical-transmission-system/overhead-line-network` [Accessed 25th Apr. 2023].

CGIS Bioportal Crne Gore, 2023. *Prikaz zaštićenih područja na mapi.* Available at: `http://www.prirodainfo.me/Mapa` [Accessed 27th Apr. 2023].

Christakou, N., Heinke, F., Janecke, N., Klären, H., Kühn, F., Tai, H. and Winter, R., 2022. *Renewable-energy development in a net-zero world.* Available at: `https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/renewable-energy-development-in-a-net-zero-world-land-permits-and-grids#/` [Accessed 10th Apr. 2023].

CIGRE, 2018. The Electric Power System Montenegro. Available at: `https://www.cigre.org/userfiles/files/Community/National%20Power%20System/`

Pr%C3%A9sentation%20PowerPoint%20-%202020_National_power_system%20Montenegro.pdf.

Climate Change Knowledge Portal, 2023. *Montenegro Climatology*. Available at: https://climateknowledgeportal.worldbank.org/country/montenegro/climate-data-historical [Accessed 27th Apr. 2023].

Cmiljanović, B., 2010. *Report of Montenegro on the Implementation of the Convention on Environmental Impact Assessment in a Transboundary Context*. Tech. rep. UNECE. Available at: https://unece.org/DAM/env/eia/documents/Review_2006_2009/Questionnaire2006_09_Montenegro_en.pdf.

COTEE, 2023. *Dokumenta Interna*. Available at: https://cotee.me/pages/interna/ [Accessed 3rd May 2023].

Crown Commercial Service, 2020. *Introduction to Power Purchase Agreements*. Tech. rep. Crown Commercial Service. Available at: https://assets.crowncommercial.gov.uk/wp-content/uploads/Power-Purchase-Agreements-PPA-An-Introduction-to-PPAs.pdf.

Dambhare, M. V., Butey, B. and Moharil, S. V., 2021. Solar photovoltaic technology: A review of different types of solar cells and its future trends. *Journal of Physics: Conference Series*, 1913(1). ISSN: 17426596. https://doi.org/10.1088/1742-6596/1913/1/012053.

Danish Energy Agency, 2021. Prefeasability Studies Guidelines, Methodology overview on how to conduct a prefeasability assessment of renewable power generation technologies. Available at: https://ens.dk/sites/ens.dk/files/Globalcooperation/prefeasibility_study_guidelines_final.pdf.

Das, S., Goswami, A. R. G., Basu, S. and Mishra, A., 2017. *Environmental and Social Impact Assessment (ESIA) of proposed 100 MW Solar PV Power Project: Veltoor Telangana, INIDIA*. Tech. rep. ERM India Private Limited. Available at: https://www.eib.org/attachments/registers/77758459.pdf.

DeFacto Consultancy, May 2022. *Stavovi građana o evropskim integracijama i procesu pristupanja Evropskoj uniji*. Tech. rep. Available at: http://www.euic.me/wp-content/uploads/2022/06/Istrazivanje-javnog-mnjenja-o-evropskim-integracijama-i-procesu-pristupanja-Evropskoj-uniji.pdf.

Devčić, J., 2023. *Montenegros neuer Staatspräsident*. Available at: https://www.kas.de/de/laenderberichte/detail/-/content/montenegros-neuer-staatspraesident [Accessed 18th Apr. 2023].

Djunisic, S., 2023. *Green light for 150-MW solar PV project in Montenegro*. Available at: https://renewablesnow.com/news/green-light-for-150-mw-solar-pv-project-in-montenegro-818053/ [Accessed 19th Apr. 2023].

Djurisic, V., Smolovic, J. C., Misnic, N. and Rogic, S., 2020. Analysis of public attitudes and perceptions towards renewable energy sources in Montenegro. *Energy Reports*, 6(April), pp. 395–403. ISSN: 23524847. https://doi.org/10.1016/j.egyr.2020.08.059. Available at: https://doi.org/10.1016/j.egyr.2020.08.059.

Duin, P. and Poláčková, Z., 2013. Montenegro Old and New: History, Politics, Culture, and the People. *Studia Politica Slovaca*, VI(1), pp. 60–82. ISSN: 1337-8163.

Energy Community, 2023. *Gas_16 / Ionian Adriatic Pipeline (Fier, AL - Split, HR)*. Available at: https://www.energy-community.org/regionalinitiatives/infrastructure/PLIMA/Gas16.html [Accessed 26th Apr. 2023].

Energy Community Secretariat, 2022. *Montenegro Annual Implementation Report*. Tech. rep. Energy Community. Available at: https://www.energy-community.org/dam/jcr:77a9cb08-a6bd-4479-9c05-0cbb8b10b015/IR2022_Montenegro.pdf.

Energy Initiative Massachusetts Institute of Technology, 2015. *The Future of Solar Energy*. Tech. rep. Available at: https://energy.mit.edu/wp-content/uploads/2015/05/MITEI-The-Future-of-Solar-Energy.pdf.

EPA, 2023. *Agencija za zaštitu životne sredine*. Available at: https://epa.org.me/ [Accessed 4th May 2023].

EPCG, 2018. *Electricity production and electro energetic balance*. Available at: https://www.epcg.com/en/about-us/electricity-production-and-electro-energetic-balance [Accessed 26th Apr. 2023].

eRegulations Montenegro, 2023. *Register a business*. Available at: `https://montenegro.eregulations.org/procedure/23/23/step/5?l=en` [Accessed 4th May 2023].

European Bank for Reconstruction and Development, 2022. *Montenegro country diagnostic : Private investment challenges and opportunities 2022*. Tech. rep.

European Commission, 2022. Montenegro 2022 Report.

– 2023. *Montenegro*. Available at: `https://eurydice.eacea.ec.europa.eu/national-education-systems/montenegro/historical-development` [Accessed 17th Apr. 2023].

European Investment Bank, 2022. Environmental and Social Standards - Overview. Luxembourg. Available at: `http://www.eib.org/infocentre/publications/all/environmental-and-social-standards-overview.htm`.

European Union, 2012. Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification) Text with EEA relevance. *Official Journal of the European Union*, L26(1). Available at: `https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32011L0092`.

– Jan. 2022a. *European Innovation Scoreboard*. Available at: `https://ec.europa.eu/assets/rtd/eis/2022/ec_rtd_eis-country-profile-me.pdf` [Accessed 25th Apr. 2023].

– 2022b. *Western Balkans, Focus on Energy*. Available at: `https://neighbourhood-enlargement.ec.europa.eu/system/files/2022-12/Factsheet%20focus%20on%20energy.pdf` [Accessed 27th Mar. 2023].

Eurostat, 2023. *Electricity prices components for household consumers - annual data (from 2007 onwards)*. Available at: `https://ec.europa.eu/eurostat/databrowser/view/NRG_PC_204_C__custom_5891138/default/table?lang=en` [Accessed 20th Apr. 2023].

Filho, W. L., Azul, A. M., Brandli, L., Salvia, A. L. and Wall, T., 2021. *Affordable and Clean Energy*. Springer Reference. ISBN: 9783319958637.

Freedom House, 2023. *Montenegro: Freedom in the World 2023 Country Report*. Available at: `https://freedomhouse.org/country/montenegro/freedom-world/2023` [Accessed 17th Apr. 2023].

Gallop, P., Gray, E., Nikolovska, E., Mustață, A. and Petcu, R., 2021. *The Political Economy of Energy Transition in Southeast Europe - Barriers and Obstacles*. Tech. rep. Sarajevo: Friedrich Ebert Stiftung, pp. 529–538.

Gevorkian, P., 2011. *Large-Scale Solar Power System Design*. McGraw-Hill. ISBN: 978-0-07-176327-1.

Global Solar Atlas, 2023. *Global Solar Atlas Montenegro*. Available at: `https://globalsolaratlas.info/global-pv-potential-study` [Accessed 27th Apr. 2023].

Goetzberger, A. and Hoffmann, V. U., 2005. *Photovoltaic Solar Energy Generation*. Berlin Heidelberg: Springer. ISBN: 3-540-23676-7.

Green Home, 2023. *Green Home*. Available at: `https://www.greenhome.co.me/en/` [Accessed 25th Apr. 2023].

Gudlaugsson, B., Ahmed, T., Dawood, H., Ogwumike, C. and Dawood, N., Dec. 2021. Application of Cost Benefits Analysis for the Implementation of Renewable Energy and Smart Solution Technologies: A Case Study of InteGRIDy Project. *Environmental Sciences Proceedings 2021, Vol. 11, Page 15*, 11(1), p. 15. ISSN: 2673-4931. `https://doi.org/10.3390/ENVIRONSCIPROC2021011015`. Available at: `https://www.mdpi.com/2673-4931/11/1/15/htm%20https://www.mdpi.com/2673-4931/11/1/15`.

Haramaini, Q., Setiawan, A., Damar, A., Ali, C. and Adhi, E., 2019. Economic Analysis of PV Distributed Generation Investment Based on Optimum Capacity for Power Losses Reducing. *Energy Procedia*, 156(September 2018), pp. 122–127. ISSN: 1876-6102. Available at: `https://doi.org/10.1016/j.egypro.2018.11.115`.

IEA, 2021. *Renewable Electricity Quota and Assessment Method (Draft for Opinions)*. Available at: `https://www.iea.org/policies/6483-renewable-`

electricity-quota-and-assessment-method-draft-for-opinions [Accessed 15th Apr. 2023].

IEA, 2022. *Solar PV*. Available at: https://www.iea.org/reports/solar-pv [Accessed 3rd Apr. 2023].

Igor, T., 2020. *Activists in Montenegro say small hydropower plants' study is illegal.* Available at: https://balkangreenenergynews.com/activists-in-montenegro-say-small-hydropower-plants-study-is-illegal/ [Accessed 25th Apr. 2023].

– 2023. *Montenegro launches day-ahead electricity market at MEPX*. Available at: https://balkangreenenergynews.com/montenegro-launches-day-ahead-electricity-market-at-mepx/ [Accessed 28th Apr. 2023].

International Finance Cooperation, 2015. *Utility Scale Solar Power Plants. A guide for Developers and Investors*. Tech. rep.

International Trade Administration, 2022. *Montenegro - Country Commercial Guide.* Available at: https://www.trade.gov/country-commercial-guides/montenegro-market-overview [Accessed 18th Apr. 2023].

IPCC, 2022. *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Tech. rep. Cambridge University Press. https://doi.org/10.1017/9781009325844.

IRENA, Jan. 2018. *Power Purchase Agreements for Variable Renewable Energy.* Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Events/2018/Aug/Renewable-Energy-PPAs.pdf?la=en&hash=C365D5D08EBFF26A1F7A29A13D721C5B3C4390D9 [Accessed 13th Apr. 2023].

– 2019. *Future of Solar Photovoltaic: Deployment, investment, grid integration and socio-economic aspects*, pp. 18–19. ISBN: 978-92-9260-155-3.

– Jan. 2022. *Energy Profile Montenegro*. Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Europe/Montenegro_Europe_RE_SP.pdf [Accessed 27th Mar. 2023].

Jieb, Y. A. and Hossain, E., 2022. *Photovoltaic systems:Photovoltaic systems: fundamentals and applications*. Springer. ISBN: 9789814289078.

Krenn, A., Miljanic, Z., Oberbichler, S., Petronijevic, D., Schwaiger, F. and Steinmaurer, D., 2016. *Status quo of the Renewable Energy Sector in Montenegro. Final Report*. Tech. rep. July. OeEB.

Król, M., 2022. *Political Crisis In Montenegro Is Accelerating*. Available at: https://visegradinsight.eu/political-crisis-in-montenegro-is-accelerating/ [Accessed 17th Apr. 2023].

Lalic, D., Popovski, K., Gecevska, V., Vasilevska, S. P. and Tesic, Z., Aug. 2011. Analysis of the opportunities and challenges for renewable energy market in the Western Balkan countries. *Renewable and Sustainable Energy Reviews*, 15(6), pp. 3187–3195. ISSN: 1364-0321. https://doi.org/10.1016/J.RSER.2011.04.011.

Lpb, 2022. *Politisches System Montenegro*. Available at: https://osteuropa.lpb-bw.de/montenegro-politisches-system [Accessed 17th Apr. 2023].

– 2023. *Montenegro Geschichte - Übersicht - Zusammenfassung - kurz gefasst*. Available at: https://osteuropa.lpb-bw.de/montenegro-geschichte [Accessed 16th Apr. 2023].

Melović, B. and Ćirović, D., 2020. Analysis of financial incentives as an instrument of renewable energy sources management in Montenegro. *E3S Web of Conferences*, 157. ISSN: 22671242. https://doi.org/10.1051/e3sconf/202015704001.

MEPX, 2023. *Kako postati učesnik?* Available at: https://belen-spot.me/en/kako-postati-ucesnik/ [Accessed 4th May 2023].

Mertens, K., 2018. *Photovoltaik*. 4th ed. München: Carl Hanser Verlag GmbH & Co. KG. ISBN: 978-3-446-44863-6. https://doi.org/10.3139/9783446456174. Available at: https://www.hanser-elibrary.com/doi/book/10.3139/9783446456174.

– 2019. *Photovoltaics. Fundamentals, Technology, and Practice*. 2nd ed. München: Carl Hanser Verlag GmbH & Co. KG. ISBN: 9781119401049.

Ministry of Capital Investments, 2022. *EBRD helps Montenegro to increase investments in renewable energy sources*. Available at: https://www.gov.me/

en/article/ebrd-helps-montenegro-to-increase-investments-in-renewable-energy-sources [Accessed 19th Apr. 2023].

Ministry of Ecology Spatial Planning and Urbanism, 2021. *Law on Spatial Planning and Construction of Structures*. Available at: https://www.gov.me/en/article/law-on-spatial-planning-and-construction-of-structures [Accessed 4th May 2023].

Ministry of Economic Development and Tourism, 2021. *Zakon o energetici*. Available at: https://www.gov.me/en/documents/d17f9f62-ea19-4dd2-a73f-cbf6bfffab5c [Accessed 4th May 2023].

Ministry of Public Administration, 2023. *NGO*. Available at: https://www.gov.me/en/article/cooperation-between-the-government-of-montenegro-and-ngos [Accessed 25th Apr. 2023].

Ministry of Sustainable Development and Tourism, 2021. *What steps should be taken to construct a building*. Available at: https://www.gov.me/en/article/196602-what-steps-should-be-taken-to-construct-a-building [Accessed 4th May 2023].

Mohamadi, F., 2021. *Introduction to Project Finance in Renewable Energy Infrastructure*. Springer Nature. ISBN: 978-3-030-68739-7.

MONSTAT, 2020. *Forestry-Data*. Available at: https://monstat.org/eng/page.php?id=203&pageid=65 [Accessed 27th Apr. 2023].

– 2021. *Energy statistics. EUROSTAT Balance*. Available at: https://www.monstat.org/eng/page.php?id=1314&pageid=39 [Accessed 20th Apr. 2023].

– 2022. *Electricity Prices for Consumers in Montenegro*. Available at: https://www.monstat.org/uploads/files/infografici/Infografik%20cijena%20el.energije_ENG.pdf [Accessed 25th Apr. 2023].

– Jan. 2023. *Employments and Earnings*. Available at: https://monstat.org/uploads/files/Bilten/2023/3/3.pdf [Accessed 20th Apr. 2023].

Nielsen, P. B., Hormann, M., Rud, J. N. and Lauge, F. M., 2016. *Guide report 4: The project development process*. Tech. rep. Nordic Council of Ministers, p. 14. Available at: https://www.nordicenergy.org/wp-content/uploads/2017/03/Guide-report-4-The-project-development-process.pdf.

Northern Periphery and Arctic Programme, 2020. *PESTLE Analysis of Barriers to Community Energy Development*. Tech. rep. European Union. Available at: https://leco.interreg-npa.eu/subsites/leco/PESTLE_Analysis_LECO_A4_180830.pdf.

Office of Energy Efficiency & Renewable Energy, 2023a. *Solar Integration: Solar Energy and Storage Basics*. Available at: https://www.energy.gov/eere/solar/solar-integration-solar-energy-and-storage-basics [Accessed 6th Apr. 2023].

– 2023b. *Solar Photovoltaic Cell Basics*. Available at: https://www.energy.gov/eere/solar/solar-photovoltaic-cell-basics [Accessed 5th Apr. 2023].

– 2023c. *Solar Photovoltaic Technology Basics*. Available at: https://www.energy.gov/eere/solar/solar-photovoltaic-technology-basics [Accessed 5th Apr. 2023].

ORF, 2023. *Montenegros Verfassungsgericht wieder funktionsfähig*. Available at: https://orf.at/stories/3306924/ [Accessed 17th Apr. 2023].

Ortner, M., 2023. Renewable Energy Systems Scriptum.

Project Management Institute, 2023. *Stakeholder Definition*. Available at: https://www.pmi.org/learning/library/stakeholder-analysis-pivotal-practice-projects-8905 [Accessed 7th Apr. 2023].

PWC, 2023. *Montenegro - Corporate - Taxes on corporate income*. Available at: https://taxsummaries.pwc.com/montenegro/corporate/taxes-on-corporate-income [Accessed 10th May 2023].

Radonjic Associates, 2022. *Company Register in Montenegro*. Available at: https://www.companyformationmontenegro.com/ [Accessed 4th May 2023].

Ramalingam, K. and Indulkar, C., 2017. *Solar Energy and Photovoltaic Technology*. Elsevier Inc., pp. 69–147. ISBN: 9780128042632. https://doi.org/10.1016/

B978-0-12-804208-3.00003-0. Available at: `http://dx.doi.org/10.1016/B978-0-12-804208-3.00003-0`.

REC Montenegro, 2023. *REC Montenegro – Resource Environmental Community*. Available at: `http://recmontenegro.org/` [Accessed 25th Apr. 2023].

REGAGEN, 2022a. *How to apply for entry in the REGAGEN's register of wholesale market participants?* Available at: `https://regagen.co.me/en/registration-of-market-participants/how-to-apply-for-entry-in-the-regagens-register-of-wholesale-market-participants/` [Accessed 4th May 2023].

– 2022b. *Pravila o licencama za obavljanje energetskih djelatnosti*. Available at: `https://regagen.co.me/publikacije/pravila-o-licencama-za-obavljanje-energetskih-djelatnosti/` [Accessed 4th May 2023].

– 2022c. *Proizvodnja električne energije*. Available at: `https://regagen.co.me/publikacije/proizvodnja-elektricne-energije/` [Accessed 4th May 2023].

– 2023. *Odluka o utvrđivanju naknada za licence i za zatvoreni distributivni sistem za 2023. godinu*. Available at: `https://regagen.co.me/elektricna-energija/licence/naknade-za-izdavanje-licence/odluka-o-utvrdjivanju-naknad-aza-licence-i-za-zatvoreni-distributivni-sistem-za-2023-godinu/` [Accessed 4th May 2023].

Reisinger, S., Gattringer, R. and Strehl, F., 2013. *Strategisches Management. Grundlagen für Studium und Praxis*. Pearson. ISBN: 978-3-86894-200-2.

Richhariya, G., Kumar, A. and Samsher, 2020. *Photovoltaic Solar Energy Conversion: Technologies, Applications and Environmental Impacts*. Elsevier. ISBN: 9780128196106. `https://doi.org/10.1016/B978-0-12-819610-6.00002-8`.

Ritchie, H. and Roser, M., 2021. *Montenegro: CO2 Country Profile - Our World in Data*. Available at: `https://ourworldindata.org/co2/country/montenegro#what-are-the-country-s-annual-co2-emissions` [Accessed 26th Apr. 2023].

Roser, T., 2023. *Wahlsieger Milatović will Montenegro in den nächsten fünf Jahren in die EU führen*. Available at: `https://www.diepresse.com/6271252/wahlsieger-milatovic-will-montenegro-in-den-naechsten-fuenf-jahren-in-die-eu-fuehren` [Accessed 17th Apr. 2023].

Šćekić, L., Kontić, M. and Srdanović, N., 2021. Siting and Sizing of Renewable Energy Sources: A Case Study on Montenegro; Siting and Sizing of Renewable Energy Sources: A Case Study on Montenegro. `https://doi.org/10.1109/Ee53374.2021.9628246`.

Sirin, S. M. and Sevindik, I., 2021. An analysis of Turkey's solar PV auction scheme: What can Turkey learn from Brazil and South Africa? *Energy Policy*, 148. ISSN: 03014215. `https://doi.org/10.1016/j.enpol.2020.111933`. Available at: `https://doi.org/10.1016/j.enpol.2020.111933`.

Službeni list Crne Gore, 2009. *Zakon o koncesijama*. Available at: `http://sluzbenilist.me/pregled-dokumenta-2/?id=%7BA1DB39A1-BB75-42CD-B4F5-504CAC6CE041%7D#` [Accessed 6th May 2023].

– 2012. *Market rules*. Available at: `http://sluzbenilist.me/pregled-dokumenta/?id=%7BBDC98E1F-943A-4F79-B68D-3814BECC1792%7D`.

– 2016. *Zakon o zaštiti prirode*. Available at: `https://www.ilo.org/dyn/natlex/natlex4.detail?p_lang=en&p_isn=104645&p_classification=14` [Accessed 6th May 2023].

– 2017a. *O obrascima zaht jeva za obavljanje djelatnosti u oblasti izgradnje objektata*. Available at: `https://wapi.gov.me/download-preview/61d7fe4f-c1fe-4f6e-90d3-d53bf8f74e97?version=1.0` [Accessed 4th May 2023].

– 2017b. *Pravila za funkcionisanje prenosnog sistema električne energije*. Available at: `https://regagen.co.me/wp-content/uploads/2021/12/Pravila_za_funkcionisanje_prenosnog_sistema_elektricne_energije_Precisceni_tekst_sa_prilozima.pdf` [Accessed 4th May 2023].

– 2017c. *Tržišna pravila*. Available at: `https://cotee.me/wp-content/uploads/2021/09/Trzisna-pravila.pdf` [Accessed 3rd May 2023].

– 2018. *Ukaz o proglašenju zakona o projeni uticaja na životnu sredinu*. Available at: `https://epa.org.me/wp-content/uploads/2019/05/Zakon-o-procjeni-uticaja-na-zivotnu-sredinu.pdf` [Accessed 4th May 2023].

Službeni list Crne Gore, Mar. 2019. *Zakon O Svojinsko-Pravnim Odnosima*. Available at: `http://sluzbenilist.me/pregled-dokumenta/?id=%7B2BD5CC87-0B7C-488C-82E0-A8285FBECB19%7D` [Accessed 3rd May 2023].

Spasić, V., 2023a. *CWP enters Montenegrin renewables market with 400 MW solar project*. Available at: `https://balkangreenenergynews.com/cwp-enters-montenegrin-renewables-market-with-400-mw-solar-project/` [Accessed 19th Apr. 2023].

– 2023b. *Montenegro changes law for coal power plant Pljevlja to continue operating*. Available at: `https://balkangreenenergynews.com/montenegro-changes-law-for-coal-power-plant-pljevlja-to-continue-operating/` [Accessed 18th Apr. 2023].

– 2023c. *Montenegro's EPCG to start production of racking for solar power plants*. Available at: `https://balkangreenenergynews.com/montenegros-epcg-to-start-production-of-racking-for-solar-power-plants/` [Accessed 19th Apr. 2023].

Suleiman, I. S. and Shan, K., 2016. *Renewable Energy Guideline on Solar Photovoltaic (Large) Project Development in Malaysia*. Tech. rep. September. Juala Lumpur: GIZ. Available at: `http://re-guidelines.info/uploads/tech_files/RE%20Guidelines%20on%20Solar%20PV%20Large%20Malaysia_Sept%202016.pdf`.

The Vienna Institute for International Economic Studies, 2023. *Montenegro*. Available at: `https://wiiw.ac.at/montenegro-overview-ce-36.html` [Accessed 18th Apr. 2023].

The World Bank, 2022. *Achieving Contract Effectiveness and Financial Close Public Private Partnership*. Available at: `https://ppp.worldbank.org/public-private%20partnership/achieving-contract-effectiveness-and-financial-close` [Accessed 14th Apr. 2023].

Tiwari, G., Tiwari, A. and Shyam, 2016. *Handbook of Solar Energy*. Singapore: Springer.

Todorovic, I., 2023. *Montenegro gives initial clearance for major solar power projects*. Available at: `https://balkangreenenergynews.com/montenegro-gives-initial-clearance-for-major-solar-power-projects/` [Accessed 27th Mar. 2023].

Todorović, I., 2023. *Agrisolar project of 148 MW underway on Montenegro-Serbia border*. Available at: `https://balkangreenenergynews.com/agrisolar-project-of-148-mw-underway-on-montenegro-serbia-border/` [Accessed 19th Apr. 2023].

Transparency International, 2022. *2012 Corruptions Perceptions Index*. Available at: `https://www.transparency.org/en/cpi/2012/index/mne` [Accessed 28th Apr. 2023].

UNESCAP, 2023. *Feed-in tariff*. Available at: `https://www.unescap.org/sites/default/files/26.%20FS-Feed-In-Tariff.pdf` [Accessed 14th Apr. 2023].

United Nations, 2023. *What is renewable energy?* Available at: `https://www.un.org/en/climatechange/what-is-renewable-energy` [Accessed 4th Apr. 2023].

United Nations Montenegro, 2021. *United Nations Common Country Analysis Montenegro*. Tech. rep. United Nations. Available at: `https://montenegro.un.org/sites/default/files/2021-06/Common%20Country%20Assessment%20Montenegro%202021%20-%20ENG.pdf`.

Verma, P., Mahajan, P. and Garg, R., 2021. Sensitivity Analysis of Solar PV System for Different PV Array Configurations. *Communications in Computer and Information Science*, 1483, pp. 393–403. ISSN: 18650937. `https://doi.org/10.1007/978-3-030-91244-4{\_}31/TABLES/4`. Available at: `https://link.springer.com/chapter/10.1007/978-3-030-91244-4_31`.

Vujasin, M., 2023. *Three investments in solar power announced in Montenegro*. Available at: `https://balkangreenenergynews.com/three-investments-in-solar-power-announced-in-montenegro/` [Accessed 19th Apr. 2023].

Walker, D. H., Bourne, L. M. and Shelley, A., 2008. Influence, stakeholder mapping and visualization. *Construction Management and Economics*, 26(6), pp. 645–658. ISSN: 01446193. `https://doi.org/10.1080/01446190701882390`. Available at: `www.stakeholder-management.comhttp://journalsonline.tandf.co.uk/`.

WKO, 2023. *Ein Unternehmen in Montenegro gründen*. Available at: `https://www.wko.at/service/aussenwirtschaft/ein-unternehmen-in-montenegro-gruenden.html` [Accessed 28th Apr. 2023].

Wölfl, A., 2022. *Montenegros Politik wegen fehlender Verfassungsrichter gelähmt*. Available at: `https://www.derstandard.de/story/2000140700057/montenegros-politik-wegen-fehlender-verfassungsrichter-gelaehmt` [Accessed 17th Apr. 2023].

World Bank, 2020a. *Agricultural land (% of land area) - Montenegro | Data*. Available at: `https://data.worldbank.org/indicator/AG.LND.AGRI.ZS?end=2020&locations=ME&start=1961&view=chart` [Accessed 27th Apr. 2023].

– 2020b. *Economy Profile of Montenegro Doing Business 2020*. Tech. rep. Available at: `https://www.doingbusiness.org/content/dam/doingBusiness/country/m/montenegro/MNE.pdf`.

– 2023. *Photovoltaic Power Potential Montenegro*. Available at: `https://worldbank-atlas.s3.amazonaws.com/download/Montenegro/Montenegro_PVOUT_mid-size-map_156x178mm-300dpi_v20191015.png?AWSAccessKeyId=ASIAS2HACIWTK5FTA4OJ&Expires=1682582301&Signature=YAt5fDyupjuynnx8FKjJq0wBQDc%3D&x-amz-security-token=IQoJb3JpZ2luX2Vj` [Accessed 27th Apr. 2023].

Zirojevic, N., 2023. *How to buy land in Montenegro?* Available at: `https://www.dreammontenegro.com/en/how-to-buy-land-in-montenegro/` [Accessed 3rd May 2023].

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A. Appendix

A.1. Interviews

A.1.1. Mr. Draško Milić

Information:

Role: Head of the IPA unit in the Ministry of Ecology, Spatial Planning and Urbanism Montenegro

Method: Personal Interview

Date: 02.02.2023

Key: Interviewer- Anna Strigl (A.S) / Respondent - Draško Milić (D.M)

(A.S): Yeah, so I have a few questions and you can check which one's you can answer. I am aware that you are not a specialist in PV, so I have prepared some general questions as well. First of all, a general question how the ministry is organized.

(D.M): The best is if I send you the organigramm. The structure and those things. Because talking about it is useless. I will note it down and send it to you afterwards. So first question solved.

(A.S): Ministry of Ecology, what is the role of the ministry in the energy transition at the moment.

(D.M): In the energy transition. Those parts are in charge of different ministries. Ministry of capital investment. About energy is in their consideration.

(A.S): So, I know that you are in the IPA unit. So there is the IPA 3 from your ministry?

(D.M): Yes. One sector is the Environment and Climate Action.

(A.S): What is the role and what is your part of it? How can the IPA contribute to the environment and climate action. What are the actions of Montenegro in this process? And the ministry?

(D.M): For our unit we are conducting our duties regarding spending IPA money by domestic institution. We are doing the process with beneficiaries and contracting authorities. So like last three days we went to Belgrade to a workshop. European Commission is telling us for period x you have amount of money. We are deciding about priorities and then we are working on project description with beneficiaries. Tender documentation, Procurement and Project implementation follows. That is shortly how it is going. We were in Belgrade for IPA 3 workshops. In IPA 3 we have two things running at the same time and we are preparing an operational program and some other documents for about 50 Million Euros of IPA funds. The priorities of chapter 7 are the environment and most of them will be structural projects from singular project pipeline. The priority projects for every sector are updated every year and approved by government. Do you want coffee or tea?

(A.S): No I am good thank you!

(A.S): Then I wanted to ask because I am especially interested in the scenario when an investor is coming to Montenegro and wants to develop a PV and how the whole sector is improving. I wanted to ask if you know more about the EIA in Montenegro. How is that working?

(D.M): I know that for all infrastructural projects we have EIA Process which is pretty long. We have domestic procedures which are almost completely in line with EU requirements. It is 99 percent that it is line with the EU. When it comes to practical terms, requirements are not same for EIA Montenegro and EU. EU is a bit wider so we prepare some additional documents so we have support from the Commission which covers structural funds in the EU. So they are supporting our IPA countries and try to help us with the job as we are in the EU.

(A.S): Ok. So the goal is to get the Environmental Consent for the projects. Can you elaborate more on that?

(D.M): that‘s, today those people knowing about that are on a break at the moment. This is a bad time for meeting the others because I don’t care about a break. The procedure, I am thinking. We had a huge problem archiving this year. We had an ESIA in English somewhere but I don’t know. Maybe you want to see it as a document. How the process is. Ok I can see with colleagues and send you later on.

(A.S): So, maybe you can talk more about the preliminary design of a project. How the approval process works?

(D.M): Preliminary design used to be until the last two years the design was prepared by some license engineers and then revision committee needed to approve it. But now, not anymore. Just for man design needs to be controlled by committee. Now the design is prepared and agreed with beneficiary. When you go into works, after preparing the main design, so revision committee needs to approve all the parts so you can go forward with the execution of works.

(A.S): Also important are topographic and geological studies.

(D.M): yes it is some part of all of those designs. Defined by a law that all studies need to be done before project can start.

(A.S): Do you know more about the permits needed for renewable energy projects?

(D.M): I have some experience with waste water projects so all I am talking is regarding that experience.

(A.S): Yeah, but this is still very interesting for me.

(D.M): But maybe did you have any connection with ministry of capital investments?

(A.S): Yes I was there yesterday.

(D.M): Energy and Energy Efficiency is in their hand, so not too complicate.

(A.S): Ok. Ahm, more general question about renewable energy development. What is your opinion about the development at the moment and the role of the IPA?

(D.M): Here in the ministry we have a climate change directorate. There are some projects from IPA and some from other sources. But I think that in the future, what is the main challenge is that we need to make all those projects and coordinate them. At the moment the ministry of capital investment is doing something without our connection and without others so an integrated approach needs to be done in the future. Also had discussion with the European Commission that for the future those things need to be done more together and integrated but we will see because now everybody is doing their part and that is it. I am doing something and you are doing the same thing in your own ministry but we are not connected almost at all.

(A.S): And do you know more about the new energy legislation?

(D.M): I don't know.

(A.S): Also, more on the EU level, what do you think Montenegro has to do to meet the goals set within the EU legislation?

(D.M): For chapter 27 we have closing benchmarks so we are defining our priorities regarding this document. So in environment is not a complicated situation. We have our main document and are now going on with priorities from that document. Legislation, Implementation, Infrastructure and everything there. Needs for the closing of chapter 27 is about 1.5 billion. It is huge amount for our country. It is 15 percent of GDP.

(A.S): You said that the ministries have to work together but when do you think that will happen?

(D.M): We need more stabilized political situation because here we have political changes. The system is stopped. Political instability, EU process is not going so fast as expected. There are a lot of complications in that process. I hope that the set of priorities in the top level management will be followed by the others. Now it is complicated to do things on the lower level. You have probably heard that last August our government was removed in the parliament. We cannot agree on the next one and we have no constitutional court. We can't have elections. It is complete mess in all country organization.

(A.S): So before moving on with the energy transition the political situation should be better.

(D.M): Now I probably heard that because of the energy problem in the Region the European Commission put all IPA3 Program in the Energy Transition so Montenegro got about 30 Mio Euro for those purposes.

(A.S): Do you think all these funds will be used efficiently?

(D.M): I don't know it is in the other ministry.

(A.S): Ok Thank you, I guess we are coming to an end. Do you have some final words to say?

(D.M): A lot of things can be done for all these energy efficiency issues.In Montenegro all the buildings are old and I am now living in a new apartment and it is easy to see that I am using, that my bill for electricity is much lower than it used to be because it is better isolation and air condition device. Bottom level energy efficiency needs to be improved. Savings can be increased a lot.

(A.S): Thank you very much, I think I got a good overview now.

(D.M): Perfect!

A.1.2. Mr. Nebojša Jablan

Information:

Role: Freelance Consultant for Carbon Neutral Transition

Method: Personal Interview

Date: 02.02.2023

Key: Interviewer- Anna Strigl (A.S) / Respondent - Nebojša Jablan (N.J)

(N.J): So I can tell you more about the Energy but also Electricity sector but I can also tell you some words industry, other sector that are targeting climate you know. Since I have some more overview of the situation here, since I am doing this strategies. It is working? The recording?

(A.S): Yes!

(A.S): Maybe again, the topic I am focusing on in my work is, when you come as an investor to Montenegro and how the situation looks like.

(N.J): So there are many interests from investors here. Actually since we are, we have very good locations for both wind and solar, so far EPCG, started to develop such ambitious project. Solar roofing, so they want to cover the roofs of households. A global, American company has received funding. They are building 400 MW. In a territory between mountains and sea and it is very close to the sea. It is about solar PV. Montenegro is small country and, I mean it is about 20.000 square km and for our circumstances 400 MW are a very big installation. Some german investor wanted to install 500 MW of wind also close to the sea coast but this project is somehow controversial since the citizen in that area are due to the visual impact, somehow banned this project. You know in your country you have developed a lot of such project and in the beginning you have to approach to the people. People are always opposing such a project since it controversial. Especially this is typical for hydropower. Based on small on streams and they use the water for drinking and farmer and for this agriculture reasons and when someone comes to stop the river and wants to stop it, they always protest. Also they have support from the various NGOs now. NGO sector is even more stronger and stronger and this is how this projects are somehow always not welcomed by the local people.

(A.S): So this is also connected with the Environmental Impact Assessment?

(N.J): According to law we have an impact assessment but first step is to approach the local community and the people and to talk to them and I think it is clever to find locations that are somehow not populated you know and especially in our some part of the country we have some mountains and areas that are covered by stone and not used for agriculture. Somehow useless and this last project I share with you later on, you have to check Balkan Green Energy News.

(A.S): Ah yes I have checked that out, this is a really good Homepage.

(N.J): Very good source of information and you can use it for your master so this is , it covers all the Balkan countries and they told me that you will cover all the countries?

(A.S): No I am just looking at Montenegro!

(N.J): Ah ok, so you should find very good information about this project. Energy sector and everything what is dealing with climate and energy. Separate areas are covered by this Balkan Green Energy news. This American company is approaching to this area and they have already got confirmation of the government to start the project and before I think they have already find area and groundings where they put it and some companies are mostly going to the land owned by the country so its easier when you have only one partner. But some companies are exclusively going to the private owned land.

(A.S):Agricultural land for example?

(N.J): Yeah lets say somehow but I have already explained you that this area is not good, it is good for farming but not for PV but the rocky areas are not good for farming but for PV. They approach to private owners and make an idea in order to buy the land and to install the solar power. Also there is a good connection since there is a new line 400 KW lines because it is important to approach to the bigger voltage levels so this is the transmission network. Übertragungsnetzwerk auf Deutsch. Do you understand this?

(A.S): Yes

(N.J): What are you studying? Energy or Economics?

(A.S): I am studying Environmental Technologies and International Affairs.

(N.J): So once they have a good location and connection point. It is very important to have, since it is not easy to approach if you are far away from the network. It will double the cost of the whole the project because 400 kW is extremely expensive to build. That is the problem of another project in the south of the country because there we do not have the transmission network. I think like 40km and now once they collect all this licenses they could start to build and of course first in the technical recommendation, pre-feasibility study, feasibility study, technical recommendation, project design. Everything should be approved by the administration and after that they can start to build and of course the Environmental and Social Impact Assessment study should be approved by the governmental agency. So that is the procedure how the people come to invest. So I think in the last 2 years we unfortunately we did not have projects, we did have a lot of interest by investors but since due to the political instability, not so many investors coming. Its the plan to have as many as possible installed renewables prior to 2020. Since in 2030 we should, sorry, after that now I think will go much faster than in previous since I told you in our electricity system we only have one thermal power plant and it is very outdated and very old technology already more than 40 years old and it destroys the environment, energies and all this area around it is very polluted by this. Especially winter season. The thermal power plaint operator has this January paid people busses to go on mountains on daily bases. Because the area is totally destroyed and you cannot see anyone on a mid-distance due to these gasses and they started last year refurbishment in order to reduce air pollutants SOx, NOx and they I think complete it on the end of 2024. After that they will be much better in that but this refurbishment has not dealing with changes, so SO2 remains the same you know it is quite different technology to catch storage CO2 than other gases. Also nitric oxides are covered by this projects also they have covered some land pollutants but Greenhouse Gases remain the same. That is why the development of a strategy should start. Especially the way how to deal with this power plant. How we will start the out phase of coal. You know the term phase out?

(A.S): Yes.

(N.J): And also this transition in this coal region so the European Union brought us some finance that are unfortunately not enough for this Western Balkan Countries.

They have very good funds for European Countries and little bit rest for Western Balkan countries. Western Balkan Countries ask to increase these funds because in real in reality especially Montenegro does not have enough funds to pass through this transition. It is extremely expensive we should start developing the studies. Social, Environment studies, find a proper way how to switch from coal to green technology. You should train the people and let no one behind. There are too many people depending on this coal sector. Not just coal mine but also power plant. All the companies that are relying on this sector, that are supplying and living on this sector. 1500 people work in the coal sector. 1200 in coal mine and the rest in coal power plant and this connected business and it is important in this region. For a short period of time they should switch to technologies they are not dealing with so far. New development of the coal plant and that is why, lets say from your perspective 1500 people is not too much you know. Especially for a powerful country like your country but for our country it is a lot. 10-20 percent of these people could be retired in this period but still you should start to retrain coal workers to build solar equipment or something like that. You should refurbish the whole area to change the activities, to change the daily life, to change the economy. Transition studies have to be developed to find a way out of this situation. On the other side you should replace this capacity, electricity generating bodies thermal power plant. Should switch to renewable and also develop the market, the system balancing this is very important because it is quite different if you power the system on renewable than on stable sources and we as a system operator we must provide security or supply, energy security so the whole system should be transformed. We only have six years and that is why I should, I would like to have this plan for energy and environment future planning in order to start developing this project as far as possible and as early as possible to catch this 2030 in line with goals have already signed as our international commitments. So in December 2022, few months ago our government signed the minus 55 percent goal that is in line with the European goal. You know the European Environment Policy?

(A.S): Yes

(N.J): So it is very important to start doing this processes in order to be in line with this goals. This is shortly how the situation looks like right now and what are we expecting in the future. According to this development of the various electricity generators our networks both distribution and transmission should be developed that way in order to catch all this energy and what I really find is very good project is this electricity generators on our roofs so it is very good for unloading the distribution network and it is very good positive signal in currently how we should start the very beginning of this transformation.

(A.S): I have also read about something on Balkan Green Energy news, it was posted in July 2022. It was about a bidding/auction program by the EBRD with the government together. Have you heard about that?

(N.J): Yeah, actually, I believe they told you yesterday in the Ministry of Capital Investments? It is auction of renewables.

(A.S): Yes, they were not able to tell me more about it.

(N.J):Yes it is still nothing because the government is not a serious partner for building such things. Most people sitting there are not from that area. They are all new people and are not included in those issues. International donors starting projects and are trying to move forward but already almost all the projects have stopped since they have do not have enough capacity to deal with this project. It has started already last year to develop new laws for renewables and auction mechanism and they had several meetings but it stopped somehow. This is the same situation with NECP somehow. It goes very very slowly unfortunately. Prior to that we had a very rapid development and approaching to the European Union and we had the best results In this process and few years ago Montenegro was the first country to enter the European Union. We have continued this progress but now the situation is bad and everything stopped and we should see what happens.

(A.S): When do you think the situation will get better again?

(N.J): Now it is very big struggling between political parties and I don't expect spectacular things even in this elections so I would like to somehow get back to this government structure from the past since they are already experienced in this processes and this parties that are Montenegrian than toward Serbia. So we have two strikes among the parties. Montenegrian parties and Serbian parties. Serbian Parties are somehow not progressive, and they are going direction Russia. They are supporting Russia. Very stupid politics and primitive in this 21 first century but

still there will be hard battle among this parties. This option wins I believe will be better in a short period. There are also some new political parties which are somewhere inbetween. They are not left or right but it is a party of young people. They look progressive somewhow. I personally, I am not quite sure about their EU agenda so we will see. Situation as I remember it is it was never like that. I find it so very very bad and somehow we are in a foggy period. In each sector we don't have the right direction developing we don't know where we are going.
(A.S): Especially now in an Energy crisis and Energy transition when there is no clear direction it is hard. I have learned a lot now about the current situation and got an overview
(N.J): Also, I don't whether to talk a bit about the other sources. We just have coal from this fossil fuels but liquid and gaseous fossil fuel we are importing. We do not have a refinery so we don't have any oil or gas sources and there is one stupid project in the Adriatic sea. It is like exploitation. All fossil fuels and gases are imported in our country. We don't have any gas or oil infrastructure. In transport sector there were some studies about e mobility. At the moment we have less than one percent of e mobility. The same is also for hybrid cars. There are some plans for building some liquid natural gas infrastructure and also some gas power plant. This is the situation with other fossil fuels and we have some reserves with coal and they will probably will be exhausted in this period of further work of this thermal power plant. Not so many measures are made for this energy efficiency. The government has subsidized some measures in households. That is how we reduce our carbon footprint. On the other side the industry, it was , there were two very important industry facility. One of them was about steel works and it collapsed and therefore decreased production and carbon footprint. In our inventory we have 60 and Greenhouse Gases coming from the thermal power plant. Traffic 10-15 percent. This are two sectors we should act in order to reduce this carbon footprint and these emissions.

(A.S): Thank you so much!
(N.J): Do you have any other questions?
(A.S): I think I got a good overlook but do you have any more final remarks? I mean you talked about the most important steps for the future also regarding the

legislation.

(N.J): What is your thesis topic exactly?

(A.S): PV in Montenegro. I am doing a case study and I am researching how an investor can make an entrance into the market.

(N.J): I also already told you about this homepage with a lot of information. Unfortunately, you were not able to approach the EPCG solar company but it will be interesting how they are developing their projects. A few months ago they got into the third phase and they have funds. 20 percent of installation is subsidized by the government and Ecofund. But I guess that is what I can tell you at the moment.

(A.S): Thank you so much!

(N.J): You are welcome.

A.1.3. Ms. Sanja Pavićević

Information:

Role: Acting General Director in the Ministry of Capital Investments Montenegro

Method: Personal Interview with Summary communicated via Email

Date: Interview: 01.02.2023 ; Email: 06.03.2023

The Ministry of Capital Investments performs administrative tasks related to the preparation and evaluation of development investment projects of interest to Montenegro which are under the competence of this ministry, as well as administrative tasks in the field of energy, mining, transport and maritime affairs, as well as conducting development policy, monitoring the situation and taking measures in these areas. The Ministry of Capital Investment has nine directorates and several administrations under its competence The energy sector is one of the strategic branches of the Montenegrin economy, so special attention is given to its development, reform activities and inclusion in the regional and European energy market. It is a sector that greatly influences the development of the green economy in Montenegro and the achievement of national sustainable development goals. Montenegro is determined to follow the global and European trend that recognizes clean energy as a product of special importance, and the environment as one of the most important resources.

Also, as an ecological country, Montenegro strongly supports climate change mitigation activities through efforts to achieve economic development with maximum environmental protection. Montenegro is recognized as a regional energy hub and a leader in the production and use of energy from renewable sources. Montenegro has significant sources of energy, but it is important that they are used wisely and rationally, in accordance with the goals of sustainable development and the principles of green economy. In addition, the energy sector is a significant source of greenhouse gas emissions. At the same time, this sector greatly affects sustainable development, which is confirmed by the fact that one of the goals of sustainable development is related to the provision of energy for all people. The strategic framework in Montenegro in the field of energy is defined by the Energy Policy of Montenegro until 2030 and the Energy Development Strategy of Montenegro until 2030. The energy policy of Montenegro until 2030, adopted by the Government in March 2011, sets the goals of our energy development. This document stipulates that the Montenegrin energy sector develops in accordance with the goals of the European Union and the Energy Community, namely: increasing the security of energy supply, developing a competitive energy market, improving energy efficiency and greater use of renewable energy sources, while preserving the environment. The Energy Development Strategy of Montenegro, which was adopted by the Government in July 2014, defines the strategic commitments and development paths of the Montenegrin energy sector until 2030. As a member of the Energy Community and a candidate for membership in the European Union, Montenegro harmonizes its energy policy and legislation with the policy and legislation of the European Union in the field of energy and energy efficiency. In accordance with the policy and legislation of the European Union, work is being done on the preparation of the first National Energy and Climate Plan, which will represent the main strategic document of Montenegro in the field of energy and energy efficiency until 2030. This document will, among other things, contain a plan for the construction of facilities for the production of energy from various energy resources. The deadline for submitting the First Draft of the National Energy and Climate Plan to the European Commission is June 30, 2023, and the deadline for submitting the final version of the document to the European Commission is June 30, 2024.

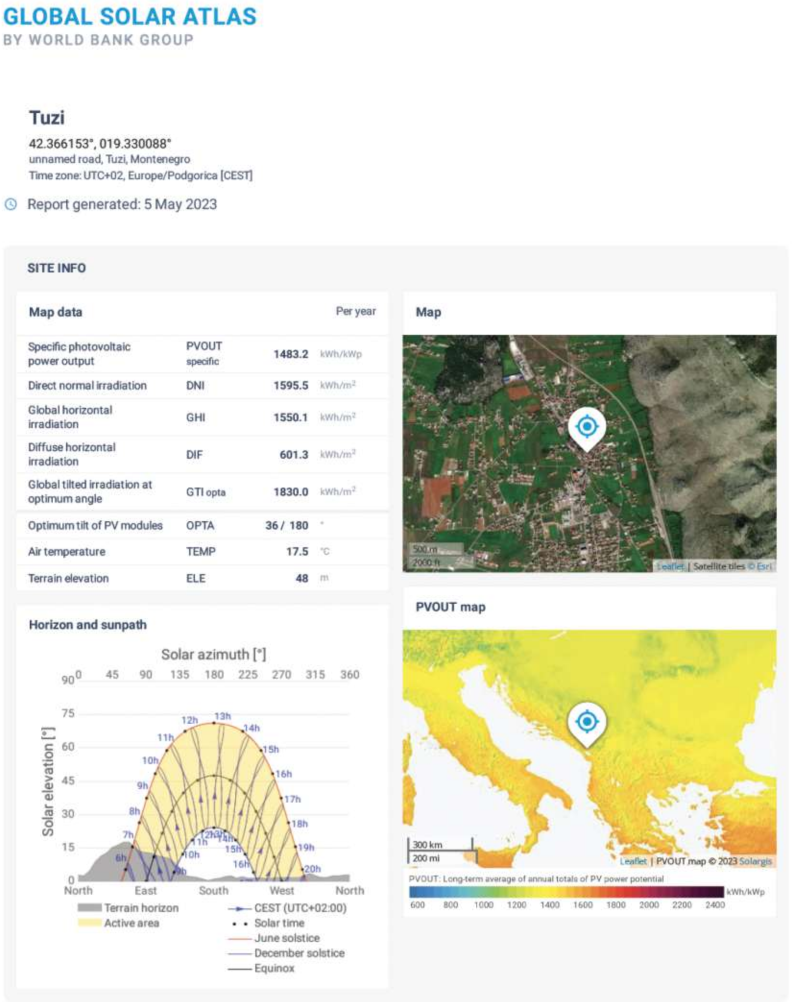
In accordance with the European Green Deal and EU energy policy, we plan further development of the energy sector through green energy transition and decarbonization, increasing the use of energy from renewable sources and improving energy efficiency, as well as building infrastructure for connecting with neighboring energy systems, which is of great importance for the development of the energy sector and the overall economic development of Montenegro. We want to turn climate and environmental challenges into our opportunities and competitive advantages by ensuring a fair and inclusive transition to climate neutrality. When considering the possibility of implementing a low-carbon energy transition, it should be taken into account that Montenegro has significant potential in the field of renewable energy sources. The most important are: hydro potential, solar radiation potential, wind potential, as well as biomass potential. Also, in Montenegro there is a great potential for saving energy through the application of various energy efficiency measures. In order to ensure sufficient amounts of electricity and use the available potential of renewable energy sources, as well as to implement the transition of green energy, we are working on projects for the construction of facilities for the production of electricity from renewable sources, such as hydropower, wind and solar energy. Activities are currently underway on the following projects: Komarnica Hydroelectric Power Plant (installed capacity 171.9 MW), Gvozd Wind Power Plant (54.6 MW), Brajići Wind Power Plant (100.8 MW), Briska Gora Solar Power Plant (250 MW), of which in the first phase, the construction of a power plant (50 MW) is planned. We are also working on creating the conditions for the implementation of the Velje Brdo Solar Power Plant project (50 MW) near Podgorica. The legislative framework in the field of renewable energy sources is defined by the Law on Energy and by-laws. In order to comply with the new EU directive in this area, with the help of the EBRD consulting team, the process of drafting the Law on the use of energy from renewable sources was initiated in 2022. With the entry into force of this law, the provisions of the Law on Energy related to renewable energy sources will cease to be valid. Projects in the field of renewable energy sources:¬ Through the implementation of the contract monitored by the ministry responsible for energy (Ministry of Capital Investments), 34 new facilities for the production of electricity were built, namely: 32 small hydroelectric power plants (MHP) and two wind power plants, Krnovo and Možura. Based on the energy permits issued for the construction of solar power plants on roof structures, the construction of five solar power plants with a total installed capacity of 2.2 MW was completed. The Ministry of Capital Investments is monitoring the implementation of the lease agreement, which provides for the construction of the wind power plant "Brajici" (100,8 MW) and the solar power plant "Briska gora" (250 MW), for which activities related to the preparation of planning documents are underway. SPP Velje Brdo construction project:¬ The Ministry of Capital Investments is working to create the conditions for the implementation of the Velje Brdo solar power plant project in Podgorica. Having in mind the great potential of solar radiation in the area of Podgorica, as well as the created spatial and planning preconditions, it is planned to conduct a tender for the leasing of state-owned land in the location of Velje Brdo, Municipality of Podgorica, for the construction of a solar power plant with an installed power of at least 50 MW. In accordance with the Conclusion of the Government of Montenegro, the Ministry of Capital Investments formed the Commission for the preparation of tender documents for the selection of investors for the construction of a solar power plant at the Velje Brdo site. Project "Solari 3000+ and Solari 500+":¬ Montenegrin Electric Enterprise (EPCG) launched the "Solar 3000+" and Solari 500+" project in August 2021 by publishing a public call to domestic and international financial institutions to provide financial resources for financing the project. Aim of projects is to install 3000 solar systems on the roofs of buildings for individual housing and 500 solar systems on the roofs of buildings owned by legal entities, which will apply the prosumer concept in Montenegro. This concept implies the exchange of electricity at the point of connection of the customer-producer's facility and the distribution system, whereby the user supplies the surplus of produced electricity to the distribution system and takes energy from the distribution system in accordance with the requirements of his facility. The estimated maximum value of this project is around €30 million. The maximum installed power provided by the project is 28.6 MW, and the expected annual production is 44 GWh.

A.2. Project Descriptions

Table A.1.: Project Descriptions (derived from Todorovic, 2023; Vujasin, 2023;Todorović, 2023; Spasić, 2023a; Todorovic, 2023; Djunisic, 2023; Spasić, 2023c; Milić, 2023; Pavićević, 2023; Jablan, 2023)

Project	Information	Location
RES Montenegro Group	up to 506 MW; annual output 750 GWh	Cetinje (Lastva and Ubi)
Montenegro Investments and Holdings	12.5 MW Facility	Draževina
CWP Europe, Montevecho	400 MW	
Sunrise Europe	225 MW	Savnik
Obnoviji izvori energije	225 MW; 306,2 GWh per year	Cetinje (Lastva and Ubi)
EPCG-Zeljezara	47 MW combined capacity	
Briska gora	50 MW	
Velje brdo	50 MW - 300 MW	
Solari Project EPCG	Roof installations	
BSD Invest Europe	148.3 MW	Rožare
EPCG-solar-grdnja		Čevo
Solar Power	214 GWh annual output	
Unipan Green	100 MW	Botun
TM Invest	15 MW	Povija

A.3. Solar GIS Data Tuzi



GLOBAL SOLAR ATLAS
BY WORLD BANK GROUP

Tuzi

42.366153°, 019.330088°
unnamed road, Tuzi, Montenegro
Time zone: UTC+02, Europe/Podgorica [CEST]

Report generated: 5 May 2023

SITE INFO

Map data			Per year
Specific photovoltaic power output	PVOUT specific	1483.2	kWh/kWp
Direct normal irradiation	DNI	1595.5	kWh/m²
Global horizontal irradiation	GHI	1550.1	kWh/m²
Diffuse horizontal irradiation	DIF	601.3	kWh/m²
Global tilted irradiation at optimum angle	GTI opta	1830.0	kWh/m²
Optimum tilt of PV modules	OPTA	36 / 180	°
Air temperature	TEMP	17.5	°C
Terrain elevation	ELE	48	m

Horizon and sunpath

Map

PVOUT map

PVOUT: Long-term average of annual totals of PV power potential

Figure A.1.: Global Solar Atlas Tuzi (Global Solar Atlas, 2023)

GLOBAL SOLAR ATLAS
BY WORLD BANK GROUP

PV ELECTRICITY AND SOLAR RADIATION

Annual averages

Direct normal irradiation

1610.5

kWh/m² per year

Monthly averages

Direct normal irradiation

Average hourly profiles

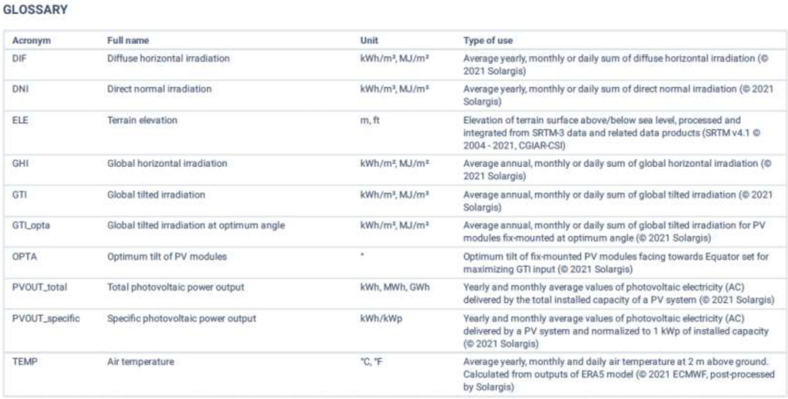
Direct normal irradiation [Wh/m²]

Average hourly profiles

Direct normal irradiation [Wh/m²]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0 - 1												
1 - 2												
2 - 3												
3 - 4												
4 - 5												
5 - 6					55	71						
6 - 7				170	284	355	375	255	139			
7 - 8		70	299	311	370	459	493	447	364	315	120	
8 - 9	314	345	397	387	443	535	583	544	451	407	319	297
9 - 10	395	404	459	438	499	594	649	608	510	464	372	367
10 - 11	423	438	486	463	521	621	685	649	536	495	392	397
11 - 12	439	463	503	465	515	622	684	655	545	504	410	406
12 - 13	441	462	500	465	506	621	674	652	533	499	405	403
13 - 14	425	447	481	436	474	578	635	613	494	461	371	376
14 - 15	373	398	429	385	428	517	571	550	431	399	304	319
15 - 16	222	327	368	324	367	458	505	467	359	292	139	114
16 - 17	17	118	255	264	303	378	419	381	239	58		
17 - 18			26	118	207	284	314	203	22			
18 - 19					29	94	79	8				
19 - 20												
20 - 21												
21 - 22												
22 - 23												
23 - 24												
Sum	3050	3472	4203	4227	4999	6189	6666	6032	4623	3894	2831	2679

Figure A.2.: Electricity and Solar Radiation (Global Solar Atlas, 2023)

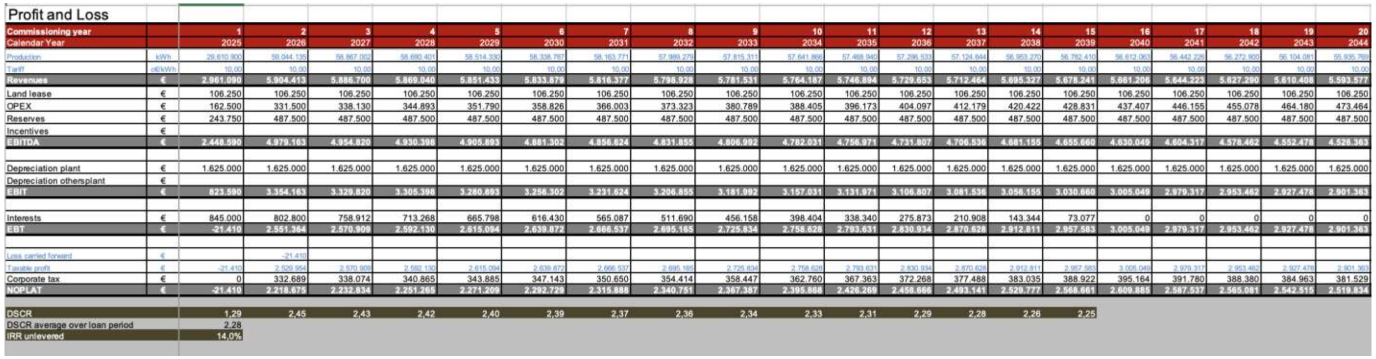


GLOSSARY

Acronym	Full name	Unit	Type of use
DIF	Diffuse horizontal irradiation	kWh/m², MJ/m²	Average yearly, monthly or daily sum of diffuse horizontal irradiation (© 2021 Solargis)
DNI	Direct normal irradiation	kWh/m², MJ/m²	Average yearly, monthly or daily sum of direct normal irradiation (© 2021 Solargis)
ELE	Terrain elevation	m, ft	Elevation of terrain surface above/below sea level, processed and integrated from SRTM-3 data and related data products (SRTM v4.1 © 2004 - 2021, CGIAR-CSI)
GHI	Global horizontal irradiation	kWh/m², MJ/m²	Average annual, monthly or daily sum of global horizontal irradiation (© 2021 Solargis)
GTI	Global tilted irradiation	kWh/m², MJ/m²	Average annual, monthly or daily sum of global tilted irradiation (© 2021 Solargis)
GTI_opta	Global tilted irradiation at optimum angle	kWh/m², MJ/m²	Average annual, monthly or daily sum of global tilted irradiation for PV modules fix-mounted at optimum angle (© 2021 Solargis)
OPTA	Optimum tilt of PV modules	°	Optimum tilt of fix-mounted PV modules facing towards Equator set for maximizing GTI input (© 2021 Solargis)
PVOUT_total	Total photovoltaic power output	kWh, MWh, GWh	Yearly and monthly average values of photovoltaic electricity (AC) delivered by the total installed capacity of a PV system (© 2021 Solargis)
PVOUT_specific	Specific photovoltaic power output	kWh/kWp	Yearly and monthly average values of photovoltaic electricity (AC) delivered by a PV system and normalized to 1 kWp of installed capacity (© 2021 Solargis)
TEMP	Air temperature	°C, °F	Average yearly, monthly and daily air temperature at 2 m above ground. Calculated from outputs of ERA5 model (© 2021 ECMWF, post-processed by Solargis)

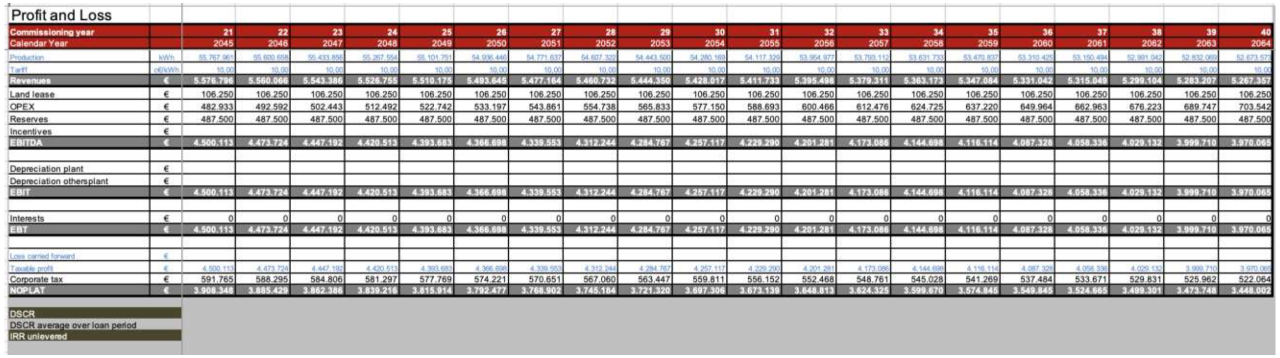
Figure A.3.: Glossary (Global Solar Atlas, 2023)

A.4. Cost-Benefit Analysis



Profit and Loss																					
Commissioning year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Calendar Year		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
Production	kWh	29.610.900	59.044.135	58.867.002	58.690.401	58.514.330	58.338.787	58.163.771	57.989.279	57.815.311	57.641.866	57.468.940	57.296.533	57.124.644	56.953.270	56.782.410	56.612.063	56.442.226	56.272.900	56.104.081	55.935.769
Tariff	c€/kWh	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Revenues	€	2.961.090	5.904.413	5.886.700	5.869.040	5.851.433	5.833.879	5.816.377	5.798.928	5.781.531	5.764.187	5.746.894	5.729.653	5.712.464	5.695.327	5.678.241	5.661.206	5.644.223	5.627.290	5.610.408	5.593.577
Land lease	€	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250
OPEX	€	162.500	331.500	338.130	344.893	351.790	358.826	366.003	373.323	380.789	388.405	396.173	404.097	412.179	420.422	428.831	437.407	446.155	455.078	464.180	473.464
Reserves	€	243.750	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500
Incentives	€																				
EBITDA	€	2.448.590	4.979.163	4.954.820	4.930.398	4.905.893	4.881.302	4.856.624	4.831.855	4.806.992	4.782.031	4.756.971	4.731.807	4.706.536	4.681.155	4.655.660	4.630.049	4.604.317	4.578.462	4.552.478	4.526.363
Depreciation plant	€	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000	1.625.000
Depreciation othersplant	€																				
EBIT	€	823.590	3.354.163	3.329.820	3.305.398	3.280.893	3.256.302	3.231.624	3.206.855	3.181.992	3.157.031	3.131.971	3.106.807	3.081.536	3.056.155	3.030.660	3.005.049	2.979.317	2.953.462	2.927.478	2.901.363
Interests	€	845.000	802.800	758.912	713.268	665.798	616.430	565.087	511.690	456.158	398.404	338.340	275.873	210.908	143.344	73.077	0	0	0	0	0
EBT	€	-21.410	2.551.364	2.570.909	2.592.130	2.615.094	2.639.872	2.666.537	2.695.165	2.725.834	2.758.628	2.793.631	2.830.934	2.870.628	2.912.811	2.957.583	3.005.049	2.979.317	2.953.462	2.927.478	2.901.363
Loss carried forward	€		-21.410																		
Taxable profit	€	-21.410	2.529.954	2.570.909	2.592.130	2.615.094	2.639.872	2.666.537	2.695.165	2.725.834	2.758.628	2.793.631	2.830.934	2.870.628	2.912.811	2.957.583	3.005.049	2.979.317	2.953.462	2.927.478	2.901.363
Corporate tax	€	0	332.689	338.074	340.865	343.885	347.143	350.650	354.414	358.447	362.760	367.363	372.268	377.488	383.035	388.922	395.164	391.780	388.380	384.963	381.529
NOPLAT	€	-21.410	2.218.675	2.232.834	2.251.265	2.271.209	2.292.729	2.315.888	2.340.751	2.367.387	2.395.868	2.426.269	2.458.666	2.493.141	2.529.777	2.568.661	2.609.885	2.587.537	2.565.081	2.542.515	2.519.834
DSCR		1,29	2,45	2,43	2,42	2,40	2,39	2,37	2,36	2,34	2,33	2,31	2,29	2,28	2,26	2,25					
DSCR average over loan period		2,28																			
IRR unlevered		14,0%																			

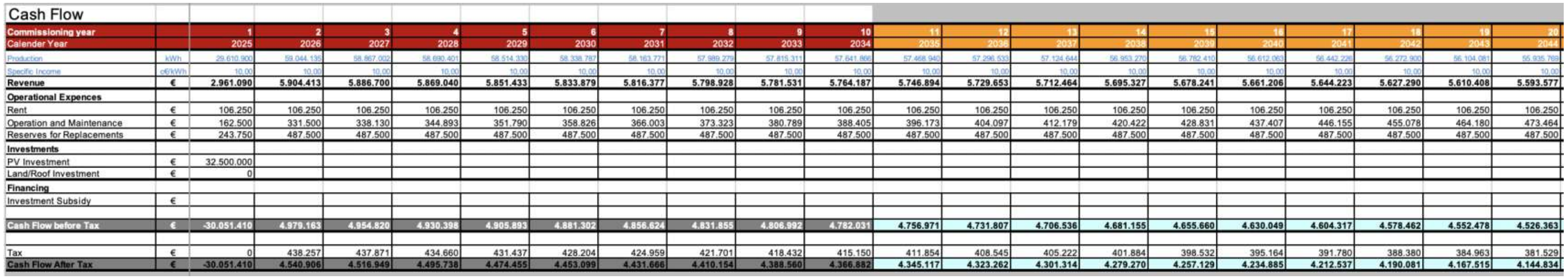
Figure A.4.: Profit and Loss Year 1-20



Profit and Loss

Commissioning year		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Calendar Year		2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064
Production	kWh	55.767.961	55.600.658	55.433.856	55.267.554	55.101.751	54.936.446	54.771.637	54.607.322	54.443.500	54.280.169	54.117.329	53.954.977	53.793.112	53.631.733	53.470.837	53.310.425	53.150.494	52.991.042	52.832.069	52.673.573
Tariff	c€/kWh	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Revenues	€	5.576.796	5.560.066	5.543.386	5.526.755	5.510.175	5.493.645	5.477.164	5.460.732	5.444.350	5.428.017	5.411.733	5.395.498	5.379.311	5.363.173	5.347.084	5.331.042	5.315.049	5.299.104	5.283.207	5.267.357
Land lease	€	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250
OPEX	€	482.933	492.592	502.443	512.492	522.742	533.197	543.861	554.738	565.833	577.150	588.693	600.466	612.476	624.725	637.220	649.964	662.963	676.223	689.747	703.542
Reserves	€	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500
Incentives	€																				
EBITDA	€	4.500.113	4.473.724	4.447.192	4.420.513	4.393.683	4.366.698	4.339.553	4.312.244	4.284.767	4.257.117	4.229.290	4.201.281	4.173.086	4.144.698	4.116.114	4.087.328	4.058.336	4.029.132	3.999.710	3.970.065
Depreciation plant	€																				
Depreciation othersplant	€																				
EBIT	€	4.500.113	4.473.724	4.447.192	4.420.513	4.393.683	4.366.698	4.339.553	4.312.244	4.284.767	4.257.117	4.229.290	4.201.281	4.173.086	4.144.698	4.116.114	4.087.328	4.058.336	4.029.132	3.999.710	3.970.065
Interests	€	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EBT	€	4.500.113	4.473.724	4.447.192	4.420.513	4.393.683	4.366.698	4.339.553	4.312.244	4.284.767	4.257.117	4.229.290	4.201.281	4.173.086	4.144.698	4.116.114	4.087.328	4.058.336	4.029.132	3.999.710	3.970.065
Loss carried forward	€																				
Taxable profit	€	4.500.113	4.473.724	4.447.192	4.420.513	4.393.683	4.366.698	4.339.553	4.312.244	4.284.767	4.257.117	4.229.290	4.201.281	4.173.086	4.144.698	4.116.114	4.087.328	4.058.336	4.029.132	3.999.710	3.970.065
Corporate tax	€	591.765	588.295	584.806	581.297	577.769	574.221	570.651	567.060	563.447	559.811	556.152	552.468	548.761	545.028	541.269	537.484	533.671	529.831	525.962	522.064
NOPLAT	€	3.908.348	3.885.429	3.862.386	3.839.216	3.815.914	3.792.477	3.768.902	3.745.184	3.721.320	3.697.306	3.673.139	3.648.813	3.624.325	3.599.670	3.574.845	3.549.845	3.524.665	3.499.301	3.473.748	3.448.002
DSCR																					
DSCR average over loan period																					
IRR unlevered																					

Figure A.5.: Profit and Loss Year 21-40

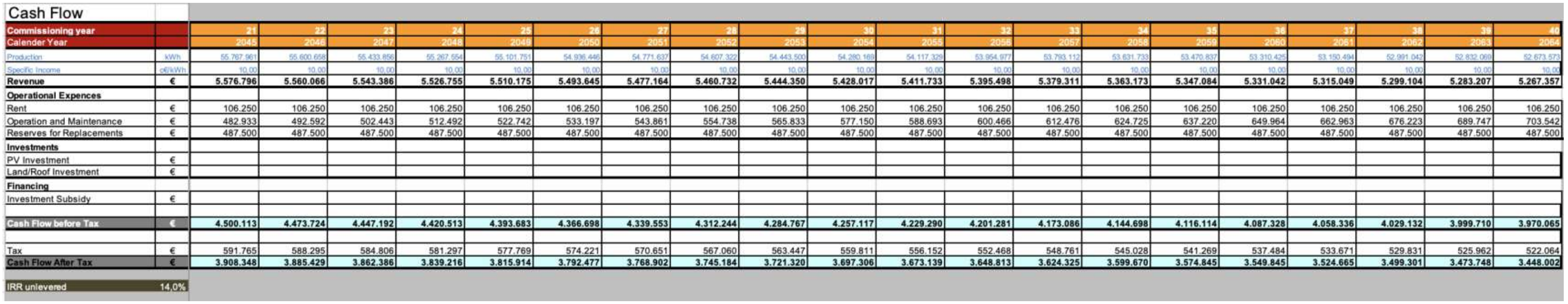


Cash Flow

Commissioning year		1	2	3	4	5	6	7	8	9	10
Calender Year		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Production	kWh	29.610.900	59.044.135	58.867.002	58.690.401	58.514.330	58.338.787	58.163.771	57.989.279	57.815.311	57.641.866
Specific Income	c€/kWh	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Revenue	€	**2.961.090**	**5.904.413**	**5.886.700**	**5.869.040**	**5.851.433**	**5.833.879**	**5.816.377**	**5.798.928**	**5.781.531**	**5.764.187**
Operational Expences											
Rent	€	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250
Operation and Maintenance	€	162.500	331.500	338.130	344.893	351.790	358.826	366.003	373.323	380.789	388.405
Reserves for Replacements	€	243.750	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500
Investments											
PV Investment	€	32.500.000									
Land/Roof Investment	€	0									
Financing											
Investment Subsidy	€										
Cash Flow before Tax	€	**-30.051.410**	**4.979.163**	**4.954.820**	**4.930.398**	**4.905.893**	**4.881.302**	**4.856.624**	**4.831.855**	**4.806.992**	**4.782.031**
Tax	€	0	438.257	437.871	434.660	431.437	428.204	424.959	421.701	418.432	415.150
Cash Flow After Tax	€	**-30.051.410**	**4.540.906**	**4.516.949**	**4.495.738**	**4.474.455**	**4.453.099**	**4.431.666**	**4.410.154**	**4.388.560**	**4.366.882**

Commissioning year		11	12	13	14	15	16	17	18	19	20
Calender Year		2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
Production	kWh	57.468.940	57.296.533	57.124.644	56.953.270	56.782.410	56.612.063	56.442.226	56.272.900	56.104.081	55.935.769
Specific Income	c€/kWh	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Revenue	€	**5.746.894**	**5.729.653**	**5.712.464**	**5.695.327**	**5.678.241**	**5.661.206**	**5.644.223**	**5.627.290**	**5.610.408**	**5.593.577**
Operational Expences											
Rent	€	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250
Operation and Maintenance	€	396.173	404.097	412.179	420.422	428.831	437.407	446.155	455.078	464.180	473.464
Reserves for Replacements	€	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500
Investments											
PV Investment	€										
Land/Roof Investment	€										
Financing											
Investment Subsidy	€										
Cash Flow before Tax	€	**4.756.971**	**4.731.807**	**4.706.536**	**4.681.155**	**4.655.660**	**4.630.049**	**4.604.317**	**4.578.462**	**4.552.478**	**4.526.363**
Tax	€	411.854	408.545	405.222	401.884	398.532	395.164	391.780	388.380	384.963	381.529
Cash Flow After Tax	€	**4.345.117**	**4.323.262**	**4.301.314**	**4.279.270**	**4.257.129**	**4.234.885**	**4.212.537**	**4.190.081**	**4.167.515**	**4.144.834**

Figure A.6.: Cash Flow Year 1-20



Cash Flow											
Commissioning year		21	22	23	24	25	26	27	28	29	30
Calender Year		2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Production	kWh	55.767.961	55.600.658	55.433.856	55.267.554	55.101.751	54.936.446	54.771.637	54.607.322	54.443.500	54.280.169
Specific Income	c€/kWh	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Revenue	**€**	**5.576.796**	**5.560.066**	**5.543.386**	**5.526.755**	**5.510.175**	**5.493.645**	**5.477.164**	**5.460.732**	**5.444.350**	**5.428.017**
Operational Expences											
Rent	€	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250
Operation and Maintenance	€	482.933	492.592	502.443	512.492	522.742	533.197	543.861	554.738	565.833	577.150
Reserves for Replacements	€	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500
Investments											
PV Investment	€										
Land/Roof Investment	€										
Financing											
Investment Subsidy	€										
Cash Flow before Tax	**€**	**4.500.113**	**4.473.724**	**4.447.192**	**4.420.513**	**4.393.683**	**4.366.698**	**4.339.553**	**4.312.244**	**4.284.767**	**4.257.117**
Tax	€	591.765	588.295	584.806	581.297	577.769	574.221	570.651	567.060	563.447	559.811
Cash Flow After Tax	**€**	**3.908.348**	**3.885.429**	**3.862.386**	**3.839.216**	**3.815.914**	**3.792.477**	**3.768.902**	**3.745.184**	**3.721.320**	**3.697.306**
IRR unlevered	14,0%										

Cash Flow											
Commissioning year		31	32	33	34	35	36	37	38	39	40
Calender Year		2055	2056	2057	2058	2059	2060	2061	2062	2063	2064
Production	kWh	54.117.329	53.954.977	53.793.112	53.631.733	53.470.837	53.310.425	53.150.494	52.991.042	52.832.069	52.673.573
Specific Income	c€/kWh	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Revenue	**€**	**5.411.733**	**5.395.498**	**5.379.311**	**5.363.173**	**5.347.084**	**5.331.042**	**5.315.049**	**5.299.104**	**5.283.207**	**5.267.357**
Operational Expences											
Rent	€	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250	106.250
Operation and Maintenance	€	588.693	600.466	612.476	624.725	637.220	649.964	662.963	676.223	689.747	703.542
Reserves for Replacements	€	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500	487.500
Investments											
PV Investment	€										
Land/Roof Investment	€										
Financing											
Investment Subsidy	€										
Cash Flow before Tax	**€**	**4.229.290**	**4.201.281**	**4.173.086**	**4.144.698**	**4.116.114**	**4.087.328**	**4.058.336**	**4.029.132**	**3.999.710**	**3.970.065**
Tax	€	556.152	552.468	548.761	545.028	541.269	537.484	533.671	529.831	525.962	522.064
Cash Flow After Tax	**€**	**3.673.139**	**3.648.813**	**3.624.325**	**3.599.670**	**3.574.845**	**3.549.845**	**3.524.665**	**3.499.301**	**3.473.748**	**3.448.002**

Figure A.7.: Cash Flow Year 21-40

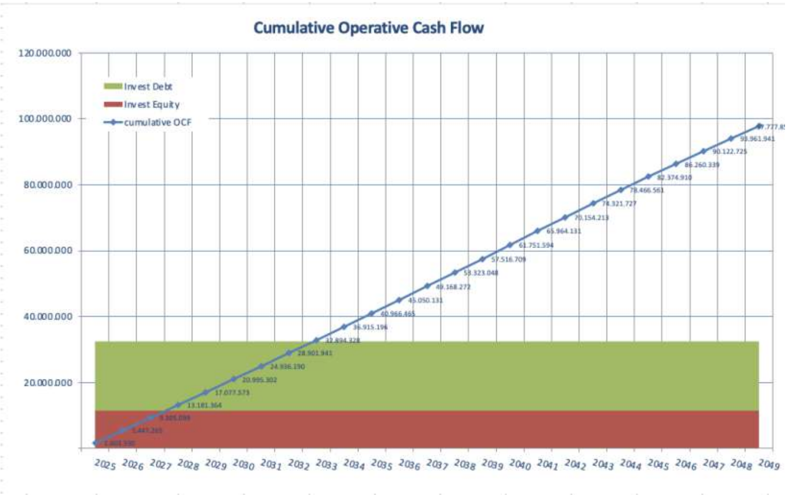


Figure A.8.: Cumulative Operative Cash Flow