Karaman Municipality
Solar Power Plant
Project Identification Document

May-2024

REPUBLIC OF TURKEY
MINISTRY OF ENVIRONMENT
AND URBANISATION

iLBANK
CONSTRUCTIVE POWER OF TURKEY

THE WORLD BANK
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LIST OF ABBREVIATIONS

AC	Alternating Current
AFAD	Disaster And Emergency Management Directorate
B/C	Benefit Cost Ratio
CAPEX	Fixed Investment Cost (Capital Expenditures)
DC	Direct Current
DMİ	State Meteorological Affairs
EIA	Environmental Impact Assessment
EİE	Electrical Works Survey Administration
EİGM	General Directorate Of Energy Affairs
ESF	Environmental and Social Framework
ESMS	Environmental and Social Management System
ESMR	Environmental and Social Monitoring Reports
ESS	Environmental and Social Standards
EPDK	Energy Market Regulatory Authority (EMRA)
EMRA	Energy Market Regulatory Authority
ETKB	Ministry Of Energy And Natural Resources
EUR	Euro
EÜAŞ	Electricity Generation Inc.
EV	Electrical Vehicles
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
FNPV	Financail Net Present Value
GDP	Gross Domestic Product
GPN	Good Practice Note
GM	Grievance Mechanism
GW	Giga Watt
İLBANK	İller Bankası A.Ş.
kWe	Kilo Watt Electric
kWh	Kilo Watt Hour
kWp	Kilo Watt Peak
LCOE	Levelized Cost of Energy
LÖSEV	Children with Leukemia Health and Education Foundation
MGM	General Directorate Of Meteorological Affairs
MPPT	Maximum Power Point Tracking
MW	Mega Watt
MWe	Mega Watt Electric
MWh	Mega Watt Hour
MWp	Mega Watt Peak
OHS	Occupational Health and Safety
O&M	Operation and maintenance

OPEX	Operating and Maintanence Costs
UNFCCC	United Nations Framework Convention on Climate Change
ppm	Parts Per Million
PIU	Project Implementation Unit
PMU	Project Management Unit
PUMREP	Public and Municipal Renewable Energy Project
PV	Photovoltaic
RAMEN	Regulation on the Assessment and Management of Environmental Noise
RCIAP	Regulation on Control of Industrial Air Pollution
SCF	Social Conversion Factor
SDG	Sustainable Development Goals
SEA/SH	Sexual Exploitation and Abuse and Sexual Harassment
SEP	Stakeholder Engagemnet Plan
SPP	Solar Power Plant
SuTP	Syrians Under Temporary Protection
TEDAŞ	Türkiye Electricity Distribution Inc.
TEİAŞ	Türkiye Electricity Transmission Inc.
TÜİK	Turkish Statistical Institute
TW	Tera Watt
USD	United States Dollars
WB	World Bank

EXECUTIVE SUMMARY

The solar power plant project in Karaman by Karaman Municipality has been initiated with the collaboration of İlbank and World Bank. The project aims to increase the share of renewable energy sources in the country's energy mix and reduce greenhouse gas emissions. The project site is located in the district of Pirireis, which is a part of Karaman province in Türkiye. The installed capacity of the plant is 4787,2 kWp/4000 kWe, and it is expected to generate 8,577 MWh of electricity annually. The solar power plant project is a part of Türkiye's ambitious plan to increase the share of renewable energy sources in the country's energy mix. The project site is located on a 10-hectare land allocated by Karaman Municipality. The solar panels used in the project are of high quality and have a lifespan of 30 years. The project was designed and constructed by a team of experienced engineers and technicians. The project developer has ensured that the project adheres to international standards of quality and safety. The plant is equipped with state-of-the-art technology, including inverters, transformers, and monitoring systems. The plant is connected to the national grid which will been constructed as a part of the project.

PUMREP is conceptual financial loan instrument to support sustainable development investments. WB classyfied that financial product as VSL(Variable Spread Loan). The disbursement of the credit obtained from the World Bank through the intermediary of the İlbank to the Karaman Municipality will be allocated through the sub-loan agreement. This allocation will be the major financial source of the project. The credit repayment period is 13, loan grace period is 3 years total loan repayment period is 16 years. However, the grace period will be completed and the principal payments will start as of 1 October 2026 as per loan agreement. Interest rate is EURIBOR 6M+ 0.61%[1] (0,61% + 3,06% = 3,67%). Ilbank's interest rate is 0,5%.The final loan repayment will be completed by 1 April 2039.The loan has been provided on favorable terms and framework, with a low-interest rate and a long repayment period. The loan has been used to finance the construction of the solar power plant, including the procurement of equipment and the construction of the power plant. The solar power plant project is expected to have a significant impact on the local economy and the environment. The project will create job opportunities during the construction phase and the operation phase. The project will also contribute to the development of the local infrastructure, including the construction of the substation and the transmission line. The project will also have a positive impact on the environment by reducing greenhouse gas emissions. The solar power plant will generate clean energy, which will replace the energy generated from fossil fuels. The project will also contribute to the country's efforts to address climate change. The solar power plant project in Karaman, Karaman Municipality is a significant step towards the development of renewable energy sources in Türkiye. The project has been initiated by Karaman Municipality with the support of the İlbank and World Bank The project has been designed and constructed to international standards of quality and safety, and it is equipped with state-of-the-art technology. The project is a model for other similar projects in the country.

[1] The 0.61% part is a variable rate and will vary within the scope of World Bank notifications during payment periods.

Table 1 Location and Connection Power Information of the Planned Plant

No	Plant Name	Connection	District/Nbhd	Block/Parcel
1	Karaman Municipality Solar Power Plant	4000 kWe	Pirireis /Pirireis	4883/1

JUSTIFICATION FOR PLANT POWER

According to regulation on unlicensed electricity generation (Article 37-(3)) the generation facility is given right to reduce installed capacity within %10.

Maximum Connection Power (kWe)	Total Allowed Installed Capacity(kWe)
4000	4000

However, the kilowatt-peak value of the power plant can be set up to %30.

Installed Capacity (kWe)	Installed Capacity (kWp)
4000	4787,2

According to regulation on unlicensed electricity generation (Article 30-(6)) the call letter can be applied to the same subscriber group, by the municipalities and irrigation facilities to install SPP up to the double of their contractual power.

Karaman Municipality has applied for the installed capacity of 4.000 kWe, which is higher than the total of contract capacity of its applied subscriber group.

Double of the contractual capacity is possible to be installed according to the recent amendment in regulation on unlicensed electricity generation. However, Karaman Municipality applied for 4000 kWe for below reasons,

1. The total project site is 94.079,03 m2 and the maximum efficient project site is used for locating the power plant which is 4000 kWe /4787,2 kWp installed capacity.
2. Karaman Municipality is aiming to net all energy generation and that is how the municipality is targeting the most financially beneficial investment return rate.
3. The project site is suitable for SPP installations, having no rocky surface or rocky underground characteristic.
4. The transmission system is 550 meters from the project location and project area is next to Organized Industrial Zone area which minimizes adverse impacts of the project to environment.
5. There is road access suitable for material transportation by the project site.
6. The netting benefit and the selling benefit of the solar power plant according to EMRA tariff list published on 01/01/2024 is given below.

Netting Benefit				
Electricity	Electricity Price	Distribution Fee (Consumption)	Distribution Fee (Production)	Total Electricity Trade Benefit
1 kWh	2,7784 ₺	0,3685 ₺	0,7371 ₺	2,4099 ₺
Selling Benefit				
Electricity	Electricity Price	Distrubition Fee (Consumption)	Distrubition Fee (Production)	Total Electricy Trade Benefit
1 kWh	2,7784 ₺	0,0000 ₺	0,7371 ₺	2,0413 ₺

Figure 1:The subscriber energy tariff group is "Government and Private Sector"

1. INTRODUCTION

The project is financed and controlled by the World Bank, in an effort to promote sustainable development and climate action in Türkiye, by reducing the country's reliance on fossil fuels and promoting the use of renewable energy sources.

ILBANK, a subsidiary of the Turkish Ministry Of Environment Urbanization And Climate Change, is responsible for monitoring and supervising the tendering and construction process of the solar plant project. The project is being carried out in accordance with the World Bank's policies and procedures and is expected to be completed by the end of 2025.

PUMREP aims to reduce energy use in central government buildings and inform the development of sustainable financing mechanisms to support a scaled-up, national program for energy efficiency in public buildings such as universities and/or administrative ones by using renewable sources. The project will support the Government of Türkiye to scale up renewable energy use in the public sector by focusing on central government buildings. The Project will contribute to expanding the RE market in public facilities to use sustainable energy solutions to deliver on the country's climate mitigation commitment and enhance energy security. There are three components of PUMREP and this project is under component 2 which will support introducing RE technologies in municipalities and will be implemented by Iller Bankası A.S. (İLBANK). In Component 2, that the RE installations will be primarily used to offset the overall energy consumption from public facilities (e.g., administrative buildings, water supply, water treatment, public lighting, etc.) and thus reduce the municipalities' energy bills, is also stated.

Karaman Municipality is responsible for stakeholder engagement activities and grievance resolution, ensuring that the project is carried out in an inclusive and participatory manner. The contractor, selected through a competitive bidding process, is responsible for the construction, logistics, design, test and commissioning, and provisional acceptance of the solar plant. The supervision consultant, appointed by the World Bank, is responsible for guiding all parties involved in the project, including the municipality, the contractor, and ILBANK.

The feasibility report evaluates the technical, economic, financial, and legal feasibility of the proposed non-licensed solar plant project, taking into account the available resources, the environmental and social impact, and the regulatory and legal requirements for establishing and operating a solar plant in Türkiye. The report also assesses the financial returns of the project, including the expected revenue from electricity sales, the financing terms, and the potential return on investment for the municipality.

The report provides recommendations and guidance for the successful implementation of the project, including the need to ensure compliance with all relevant regulations and standards, to engage with stakeholders in a transparent and inclusive manner, and to monitor and evaluate the impact of the project on the local community and environment. The proposed non-licensed solar plant project represents a significant opportunity for Karaman Municipality to contribute to sustainable development and climate action in Türkiye, while providing a reliable source of renewable energy and promoting economic growth in the region.

1.1. PROJECT SUMMARY

Within the scope of this feasibility report, the SPP project planned by Karaman Municipality was examined. Karaman Municipality will install SPP according to the connection power given in theTable 1. It is planned to produce around 8.577 MWh /year of electricity with this installed power.

This feasibility study is prepared within the scope of 30th clause and Article 1 of the "Regulation on Unlicensed Electricity Generation in the Electricity Market" the electricity consumption of the relevant institutions netting with the electricity generation of the power plants to be made over the electricity unit price determined according to the subscription type of the institutions in the Electricity Tariff published by EMRA.

Planned Solar Power Plant has **4787,2 kWp DC Capacity, 4000 kWe AC Capacity**. Equipped with 550 Wp MonoPerc Half-Cut modules with **30° tilt, 25° azimuth angle**.

When the economic life of the plant expires after 30 years, it will be decommissioned, and the cost of **decommissioning** is calculated for **EUR 32.000,00/MWp**. So, the overall power plant decommissioning cost will be, **EUR 153.190,00**.

Table 2: Planned SPP Land Information

Land Information	
Type	**Main Property**
Province, District, Nbhd.	Karaman, Pirireis, Pirireis
Block, Parcel	4883/1
Total Area	94.079,03 m2
Right to property use	Karaman Municipality (National Real Estate Agency – Allocation)
EIA status	EIA process is completed. "EIA Not Required" decision is granted.

Table 3: Planned SPP Technical Details

TECHNICAL INFORMATION	
FV Panel Type	Monocrystalline Monoperc
FV Panel Power Output	550 WP

FV Panel Count	8704
Annual Degradation	%0,5
Inverter Power Output	100 kW
Inverter Count	40
Total Dc Power	4787,2 kWp
Total Ac Power	4000 kWe
Estimated Annual Energy Production	8.577 MWh
Annual Energy Consumption	8.577 MWh
Production/Consumption	%100
Decommissioning Cost	EUR 153.190,00

1.2. PROJECT OBJECTIVES

The subject of this study is to create the feasibility report of the unlicensed solar power plant project with an installed capacity of 4787,2 kWp /4000 kWe belonging to Karaman Municipality located in the Pirireis district of Karaman province. The plant will meet the energy of more than 7.147 households with 8.577 MWh of electrical energy production, save the municipality more than 17.7 million EUR in energy costs within 30 years and prevent the release of more than 1.820 tons of CO_2 per year into the atmosphere.

The Electricity Market Unlicensed Electricity Generation Regulation published in the Official Gazette No. 30772 dated May 12, 2019, changed tariffs on unlicensed electricity generation facilities and implemented monthly netting provisions for public institutions and organizations.

1.3. PROJECT SCOPE

This study includes technical and financial analyses of the solar power plant project in Karaman province with a capacity of 4787,2 kWp /4000 kWe within the municipality of Karaman. In this study, the capital expenditure cost of the project is focused, the leveled cost of electricity generation is s reviewed, and the financial statements of the investment areshared.

Financial balance sheet, cash flow, return of investment, financial and economical analysis and risks of the project are prepared as the output of the study.

Figure 2:Karaman Solar Power Plant General Layout

1.4. COMPLIANCE OF THE PROJECT WITH POLICY DOCUMENTS

The Paris Agreement, which aims to develop the United Nation's Sustainable Development Goals, particularly SDG 13, strengthens green financial mechanisms such as Green Climate Fund and adopts to keep the global temperature rise below 2°C compared to the pre-industrial period and limits it to 1.5°C[2].

Türkiye signed the Paris Agreement, which entered into force on November 4, 2016, after at least 55 parties constituting 55% of global greenhouse gas emissions, together with the representatives of 175 countries, at the High-Level Signature Ceremony held in New York on April 22, 2016. The Agreement officially entered into force in Türkiye with the publication of the "Law on the Approval of The Paris Agreement Approval" by the Turkish Grand National Assembly in the Official Gazette dated 7 October 2021 and numbered 31621.

By adopting the principle of "Common but Differentiated Responsibilities and Relative Capabilities", the parties to the agreement were given the opportunity to contribute as much as possible within their own National Climate Change Strategies.

Türkiye submitted its statement of intended National Contribution to the UNFCCC convention secretariat on 30 September 2015. According to Türkiye's national contribution statement, it is foreseen that greenhouse gas emissions will be reduced by 21% in 2030 compared to the reference scenario.

However, Türkiye's Minister of Environment, Urbanization and Climate Change announced in Cop 27,2022 the Türkiye's emission reduction goal is increased from %21 to %41.

[2] https://iklim.csb.gov.tr/paris-anlasmasi-i-98587

Under these international policy-driven climate change actions, the renewable energy investments in Türkiye's energy sector especially solar power became significant.

This Project is one of the many projects that Türkiye aims to implement not just only to accomplish its international responsibilities but also to alleviate the internal energy demand which is one of the main economic problems of the country.

1.5. LEGAL FRAMEWORK

The project is the subject of the 30th clause of the "Regulation on Unlicensed Electricity Generation in the Electricity Market", published by the Energy Market Regulatory Authority no. 30772 on May 12, 2019 and amendment published on Official Gazette No: 31479 dated May 09, 2021, updated on Official Gazette No: 31920 dated August 11,2022, final update on Official Gazette No: 32120 dated March 02,2023. Article 1st Paragraph: “In order to meet the electricity needs of the consumption facilities, not exceeding the double of contractual power of the relevant consumption facilities in the connection agreement; Within the scope of subparagraph (h) of the first paragraph of Article 5, a production facility based on renewable energy sources may be established. Within the scope of this article, a production facility based on renewable energy sources may be established by public institutions and organizations within the scope of subparagraph (c) of the first paragraph of Article 5.”

Section 26 of the same regulation. In paragraph 30-(3) under the heading "Applications for consumption needs", referring to the article, it reads: "In the production facilities established within the scope of this article, transactions are established within the scope of the fourth paragraph of Article 26 for surplus energy supplied to the grid during each billing period.

Offsetting involves a comparison between the monthly energy consumption and the energy generated by the power plant. Any surplus production is channeled into selling excess energy back to the grid. The surplus energy supplied to the network is sold at the unit price similar to what the subscriber receives for their electricity, excluding the distribution cost. However, this sale is subject to taxation. The municipality remains committed to continually investing in this endeavor, facilitating the sale of excess energy and contributing to the broader energy infrastructure.

Since the power plant to be established meets the Karaman’s applied subscribers’ energy consumption, the energy produced will be netted and exceed energy will be sold to the grid.

As per the regulation implemented on 11.08.2022, new power plants established from 2019 onwards are subject to specific guidelines regarding surplus energy production. If such a plant generates an excess of energy beyond the total amount it consumed in the previous year, this surplus production will be transmitted to the grid at no cost. To illustrate, consider a scenario where a consumer utilized 1 MWh of electricity in the prior year. In the event that a solar power plant produces more than 1 MWh of surplus energy (which accounts for energy in excess of the consumer's usage), the initial 1 MWh surplus—equal to the consumer's consumption—can be sold to the grid. However, if the plant generates over 2 MWh (1 MWh for the consumer's consumption and 1 MWh for sale), the surplus exceeding the 1 MWh sold will be transmitted to the grid without charge. This regulation essentially encourages the efficient use of energy and incentivizes the contribution of surplus renewable energy to the

wider grid network.

Article 26 relates to monthly netting and the difference between what is given and withdrawn to the grid can be recorded as income.

Indirect and direct government incentives for solar power plants include:

- Article 24 of the Regulation on Unlicensed Electricity Generation in the Electricity Market (official newspaper no. 30772 dated May 12, 2019). It is stated that the surplus productions of Solar Power Plant will be purchased for 10 years at the price determined by the supply company by applying within the scope of 5c of the same regulation with the regulation in the article. The regulation's linking this purchase to a certain period is also considered an indirect incentive of the state.
- In addition, the fact that SPP applications based on self-consumption can be obtained in the same regulation is considered as an indirect incentive.

Laws, decrees and related legislations on which SPP installation and feasibility are based;

Law:

- Electricity Market Law no. 6446 dated 14/3/2013
- Environmental Law, No 2872

Decree:

- President's Decision, Number of Decision 1044 (10.05.2019/30770)

Regulation:

- Regulation on Unlicensed Electricity Generation in the Electricity Market dated 12/5/2019 and numbered 30772 amendment published on Official Gazette No: 31479 dated May 09, 2021, updated on Official Gazette No: 31920 dated August 11,2022, final update on Official Gazette No: 32120 dated March 02,2023

Compliance with the Legal Framework

- Legal Framework Compliance: The project operates under the legal framework established by the Electricity Market Law no. 6446 and the Regulation on Unlicensed Electricity Generation in the Electricity Market. These laws provide the necessary legal basis for the establishment and operation of renewable energy projects.
- Net Metering: The project utilizes a net metering system as stipulated in Section 30-(3) of the Regulation, where surplus energy generated by the solar power plant is supplied to the grid during each billing period. The excess energy supplied to the grid is offset against the energy consumed, resulting in no energy sales by the municipality.
- Regulatory Updates: The project takes into account the regulatory updates mentioned in the Regulation, including the amendments published in the Official Gazette. By adhering to the latest regulatory requirements, the project ensures compliance with the evolving legal framework governing unlicensed electricity generation.
- Legal Basis: The project's installation and feasibility are based on relevant laws, decrees, and regulations, including the

Electricity Market Law no. 6446 and the Environmental Law, No 2872.

- Regulation Adherence: The project falls under the purview of the 30th clause of the "Regulation on Unlicensed Electricity Generation in the Electricity Market," as detailed in the publications by the Energy Market Regulatory Authority. This regulation permits the establishment of production facilities based on renewable energy sources, in line with the project's objectives.
- Surplus Energy Transmission: The project adheres to the guidelines outlined in Section 26 of the regulation, particularly in paragraph 30-(3), which allows transactions for surplus energy supplied to the grid during each billing period. The surplus energy produced by the power plant is channeled back to the grid, contributing to the broader energy infrastructure.
- Offsetting Mechanism: The project employs an offsetting mechanism wherein surplus energy generated by the power plant is compared against monthly energy consumption. Any excess production beyond consumption is sold back to the grid, subject to taxation, as per the regulatory requirements. This mechanism encourages efficient energy use and incentivizes surplus renewable energy contribution.
- Incentives and Purchasing: The project benefits from indirect and direct government incentives outlined in Article 24 of the Regulation on Unlicensed Electricity Generation. This includes the purchase of surplus productions of Solar Power Plants for ten years at a price determined by the supply company. Additionally, SPP applications based on self-consumption further incentivize renewable energy adoption.
- Monthly Netting: Article 26 of the regulation relates to monthly netting, where the difference between energy supplied and withdrawn from the grid can be recorded as income. This mechanism ensures transparency and accountability in energy transactions.

1.6. STAKEHOLDER ANALYSIS

This sub-project will be financed by World Bank within the scope of the PUMREP which is subject to ILBANK ESMS, 2023 and World Bank Environmental and Social Framework (ESF), 2018. In addition, this sub-project is subject to Annex-I of the EIA regulation and has an EIA not required, which was received in 2020, Jan.

In this feasibility study, a stakeholder analysis has not been conducted. Stakeholder analysis will be undertaken in subsequent steps. Moreover Türkiye Public and Municipal Renewable Energy Project-Stakeholder Engagement Plan (SEP) framework document (ILBANK, 2023) published on ILBANK's website has to be taken into consideration while shaping stakeholder analysis.

1.6.1. POLICY AND LEGISLATION FRAMEWORK

This section outlines the national and international legislation applicable to the management of environmental, social, health, and

safety aspects of the proposed project.

Institutional and Legal Framework in Türkiye

In Turkiye, institutional framework consists of central and local administrations. Turkiye is structured by provinces according to economical and geographical conditions. Each province is managed by local administrations consisting of municipalities, villages/neighborhoods. Representatives of the administrative structure of municipalities and villages/neighborhoods are mayors and mukhtar, respectively. Ministries, which are central administrative units, provide services to local areas through their local branches including provincial organizations affiliated to governor and district organizations affiliated to district governors.

Environmental impacts, permits, management and inspection of the project is under the scope of authority of MoEUCC, Ministry of Agriculture and Forestry, Ministry of Culture and Tourism, Ministry of Labor and Social Security and Ministry of Health. MoEUCC is the key authority regulating policies and procedures related to conservation and protection of natural environment, management of natural resources and settlements by its general directorates. Those principally related to the Project are given as follows:

- General Directorate of Environmental Impact Assessment, Permit, and Inspection
- General Directorate of Environmental Management
- General Directorate of Protection of Natural Assets
- General Directorate of Infrastructure and Urban Transformation Services
- General Directorate of Land Registry and Cadastral

Provincial, regional and district level administrations are the provincial organizations of ministries and related institutions. The Project is within the scope of Karaman Municipality, Karaman Provincial Directorate of Environment, Urbanization and Climate Change, Karaman Provincial Directorate of Agriculture and Forestry, Karaman Regional Directorate for the Protection of Cultural Assets, State Hydraulic Works (DSİ) Regional Directorate, Regional Directorate of Highways. Relevant neighborhood administrations have been associated as local administrations for the Project.

National Legislation on Environmental, Social, Labor and Health and Safety:

The National Legislation applicable to the management of environmental, social, health and safety aspects of the proposed Project has been identified under this section.

The Environmental Law No: 2872 published in the Official Gazette No. 18132 dated 11.08.1983 and later revised in the Official Gazette No. 28661 and dated 29.05.2013 (Law No. 6486) constitutes the basic legal framework of the environmental legislation in Türkiye and is largely in line with the EU Directive on EIA.

This law is supported by numerous regulations. Article 10 of Environmental Law forms the main framework of the Environmental Impact Assessment (EIA Regulation) published in the Official Gazette No. 31907 dated 29.07.2022. As per the EIA Regulation, the projects that are listed in its Annex-I are subject to a full EIA process and those projects have to receive an “EIA Not Required” certificate to proceed with investments. The projects that are listed in Annex-II of the Regulation are subject to a shorter process where the project proponents are required to submit a Project Information File (PIF) to the MoEUCC. MoEUCC gives its “EIA is

Necessary" or "EIA is not necessary" decision regarding the project.

Unless the decision that "EIA is Positive" or "EIA is not Required" is made in accordance with the EIA Regulation for the project's activities, incentive, approval, permit, building license and use permit for such projects cannot be granted, and no investment can be started or tendered for the project. However, this does not preclude applying for the processing of such incentives, approvals, permits, and licenses. As part of the European Union membership process, Türkiye has carried out a variety of organizational and legislative reforms. With these reforms, environmental legislation and environmental protection instruments have been harmonized with international standards. The activities and liabilities to be carried out within the scope of the Project must adhere to the provisions of the relevant Turkish legislation.

According to the EIA Regulation (Official Gazette dated 29.07.2022 and numbered 31907), the Project is within the scope of Annex-I of EIA Regulation. The EIA Not Required Certificate for the Project is given in Annex-A.

In addition to Environmental Law No: 2872, several associated laws are complementary regarding the protection and sustainability of the environment as well as the protection of health and safety rights of people. Those laws which would be applicable to the proposed Project are listed below:

- Environmental Law No. 2872 (OG No:18132, dated 11.08.1983)
- Expropriation Law No. 2942 (OG No:18215, dated 08.11.1983)
- Forestry Law No. 6831 (OG No:9402, dated 08.09.1956)
- National Parks Law No. 2873 (OG No:18132, dated 11.08.1983)
- Conservation of Cultural and Natural Assets Law No. 2863 (OG No:18113, dated 23.07.1983, and revised through the amendment issued on 27.07.2004)
- Highways Traffic Law No. 2918 (OG No:18195, dated 13.10.1983)
- Soil Conservation and Land Use Law No. 5403 (OG No:25880, dated 19.07.2005)
- Terrestrial Hunting Law No. 4915 (OG No:25165, dated 11.07.2003)
- Animal Protection Law No. 5199 (OG No:25509, dated 01.07.2004)
- Labor Law No. 4857 (OG No:25134, dated 10.06.2003)
- Occupational Health and Safety Law No. 6331 (OG No:28339, dated 30.06.2012)
- Social Insurance and General Health Insurance Law (OG No:26200 dated: 16.06.2006)

The regulations developed under the Environmental Law aim to specify and identify the procedures and principles of the management of environmental aspects. Under the relevant laws, several regulations or communiques are summarized in Annex 1 .

1.6.2. STAKEHOLDER ENGAGEMENT PLAN

A SEP document will be prepared in accordance with the World Bank's ESS10 Stakeholder Engagement and Information Disclosure, according to risk screening to be conducted. The SEP document will provide a framework to support the establishment of a continuous engagement process, and those who potentially would be impacted or have any kind of interest in the Project. The Stakeholder Engagement is a control mechanism that ensures the implementation of key principles during the project. The engagement activities will be scheduled. To maximize stakeholder engagement, it prevents disruption of local stakeholders' daily work and regulates the timing and number of engagement activities. Accordingly, recording the findings and feedback together in accordance with all engagement activities, sharing them with the responsible parties, and following the process are essential. Also, engagement activities need to be culturally appropriate, provided equal access to relevant stakeholders, and enable their feedback.

1.6.3. MONITORING AND REPORTING

According to the ESS1: Assessment and Management of Environmental and Social Risks and Impact, monitoring involves documenting data to monitor performance and implementing appropriate operational measures to ensure compliance and track progress. Monitoring protocols will be adapted based on performance insights, regulatory requirements, and feedback from stakeholders, including community members. Karaman Municipality will maintain regular records of and submit monthly reports detailing monitoring outcomes, as decided, to ILBANK. These reports will provide an accurate account of project progress, including adherence to ESS requirements, as well as stakeholder engagement activities per ESS10. Designated senior officials from Karaman Municipality and project-implementing entities will oversee the review of these reports.

In addition, both the Project Implementation Unit (PIU) of Karaman Municipality and the Contracting Liaison Officer (CLO), representing the contractor, will keep records of all grievances and comments received from corporate entities. such as private sector companies, non-governmental organizations, and other institutions involved in or affected by the project. These entities may include subcontractors, suppliers, service providers, or local businesses, whose feedback will be crucial in monitoring project impacts and ensuring effective stakeholder engagement. The PIU will analyze these records quarterly to understand the number and nature of the grievances/comments and evaluate how effectively they are being addressed. This evaluation will include looking at the percentage of grievances/comments that have been resolved or closed. Further details on this monitoring process can be found in the relevant tables.

Table 4: Monitoring Framework

Parameter	Key Performance Indicator	Phase	Frequency	Responsible Party
Project GM	• Number of grievances/comments received during per consultation • Types of the grievances/comments (community HS, employment, local procurement etc.) • Timeframes for response to each grievance	Construction	Quarterly	To be assigned by Karaman Municipality PIU and Contractor
		Operation	Semi-annually in the first two years; Annually afterwards	To be assigned by Karaman Municipality PIU and Contractor

Parameter	Key Performance Indicator	Phase	Frequency	Responsible Party
	• The number of open or closed grievances • Number of invalid or in progress grievances			
Workers' GM	• Number of grievances/comments received by own workers • Number of grievances/comments received by indirect workers • Types of the grievances/comments regarding worker management and working conditions (e.g. Worker rights, OHS, etc.) • Timeframes for response to each grievance • The number of open or closed grievances • Number of invalid or in progress grievances	Construction	Monthly	To be assigned by Karaman Municipality PIU and Contractor
		Operation	Semi-annually in the first two years; Annually afterwards	To be assigned by Karaman Municipality PIU and Contractor
GM	Effectiveness of the GM	Construction	Quarterly	ILBANK
Reporting	Monthly Progress Report	Construction	Monthly and Quarterly	Contractor

2. PROJECT AREA

2.1. LOCATION AND TOPOGRAPHY

Karaman is located in the Central Anatolia Region of Türkiye, south of Konya. The province is bordered by Mersin to the east, Karaman to the west, and Konya to the northwest. The topography of Karaman is generally mountainous and rugged. In the south, the influence of the Taurus Mountains is evident, these mountains form the natural borders of the province and attract attention with their high altitude. Montenegro of volcanic origin, located east of Karaman, is one of the highest points in the province and rises to an altitude of 2,271 meters. In the northwest, the Ereğli-Karaman Plateau offers wide plains and is suitable for agriculture. Plains such as the Karaman Plain and the Ayrancı Plain are an important part of the province's agricultural production areas. The climate shows typical continental characteristics; Summers are hot and dry, and winters are cold and snowy. Small streams and streams, as well as various dams, constitute critical sources of water for irrigation and agriculture. This geographical structure makes Karaman valuable in terms of both agriculture and tourism.

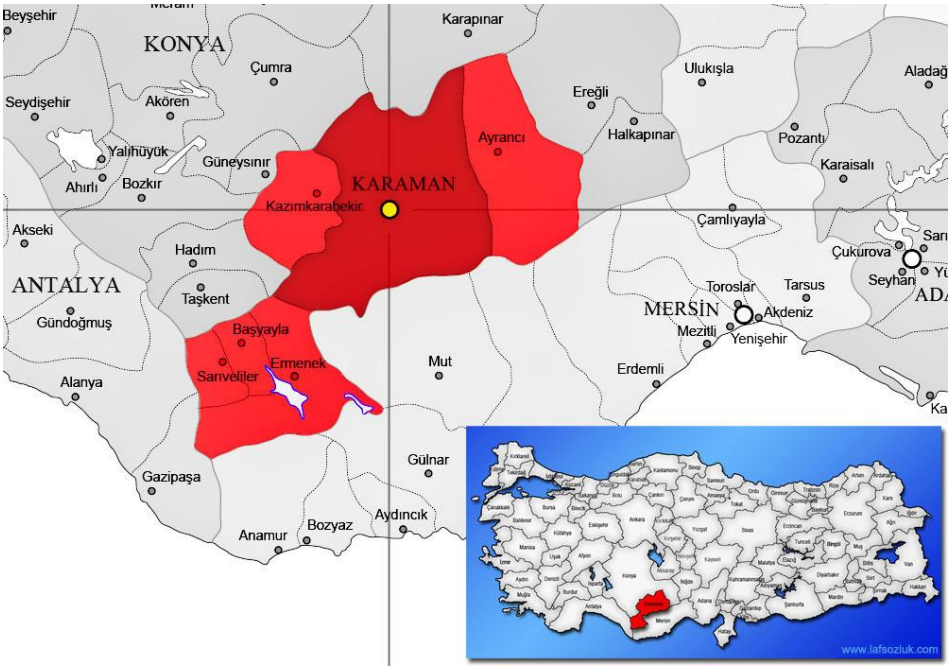

Figure 3. Geographical location of Karaman Province

2.2. EARTHQUAKE ANALYSIS AND RISK

Earthquakes in Karaman are usually of limited magnitude and usually cause limited effects on local people and structures. However, the risk of earthquakes always exists, and local authorities play an important role in taking the necessary measures to ensure that buildings are earthquake resistant.

In the analyzes, AFAD data and data between the years 2020-2023 were used. On the Richter scale, the lowest magnitude was 1 and the largest magnitude was 2.3 The project site has not seen an earthquake around 5 km shooting.

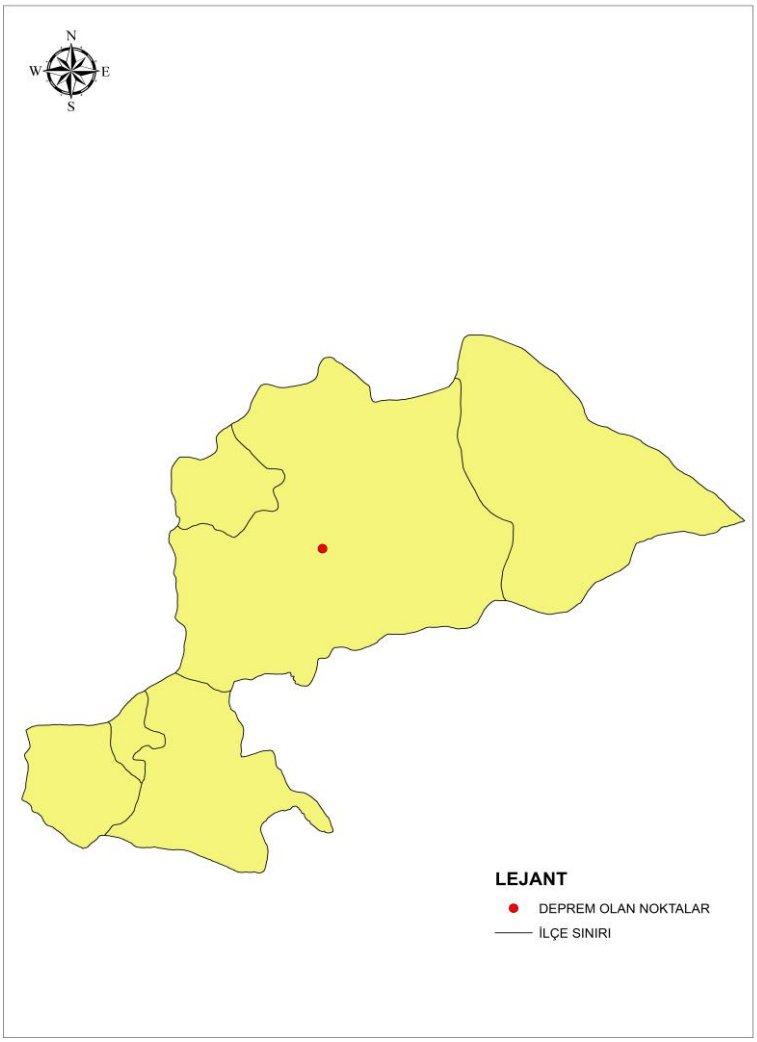

Figure 4: Karaman Earthquake Intensity Map

2.3. FLOOD AND HYDROLOGY

Floodplains are large areas in which water spreads out of the normal beds of rivers, streams and streams due to heavy rainfall or excessive water flow. Floodplains are designated areas to protect residential areas and agricultural areas by preventing water from getting out of control. These areas prevent flooding by allowing floodwaters to spread and help drain water in a controlled manner.

The highest average rainfall in Karaman is 46.5 mm in December. In the analysis, the drainage was taken as 500 m and the direction of the streams in case of precipitation and which channel to connect to them was shown. When rainfall falls, a dry bed passes over the project site, which may pose a flood risk, but it is thought that it will not pose a risk due to Karaman's arid climate and low average rainfall.

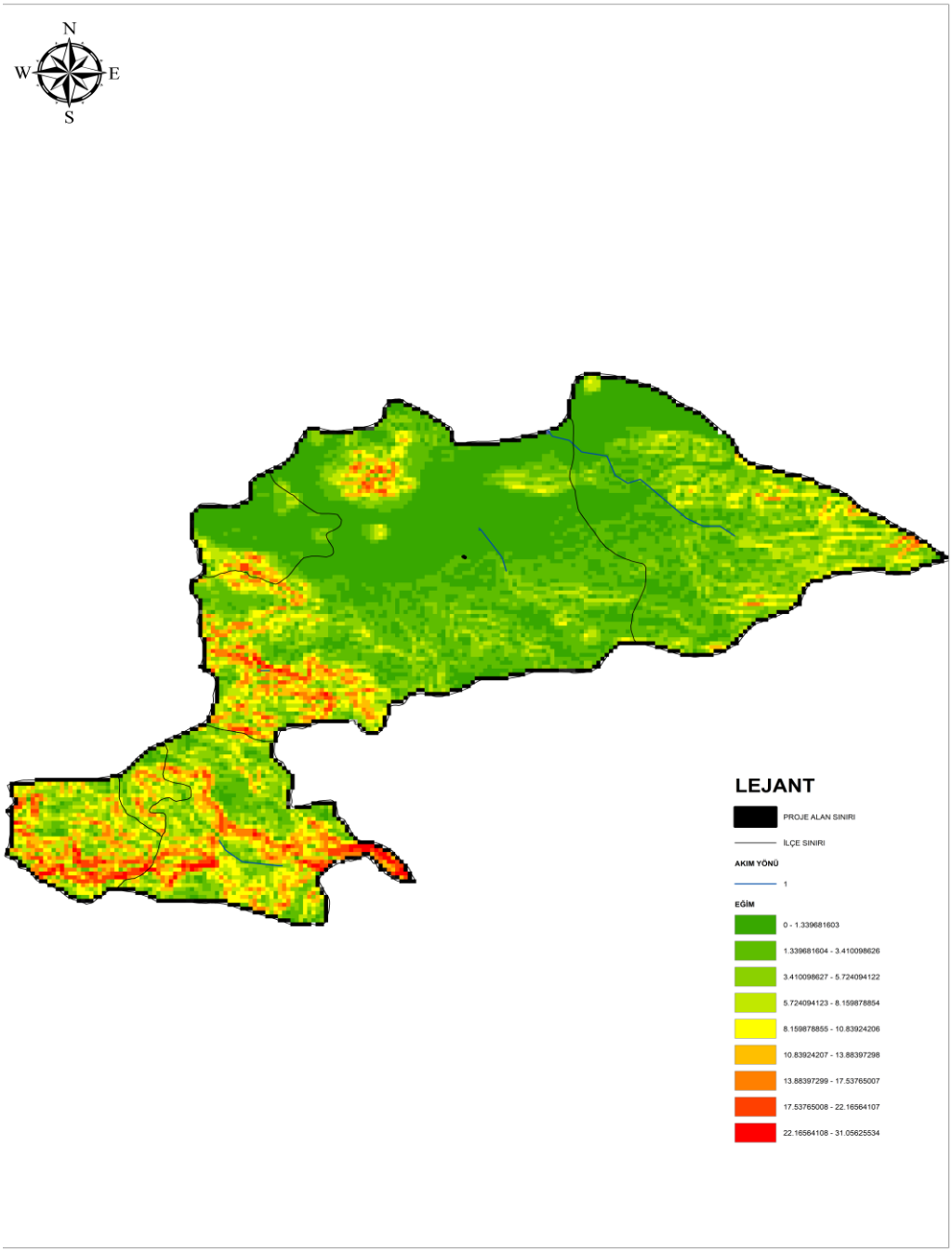

Figure 5: Karaman Flood and Hydrology Analysis

2.4. CLIMATE

Karaman has continental climatic characteristics. Summers are hot and dry, and winters are cold and snowy. The spring and autumn seasons are usually short-lived. In high-altitude regions, winters are harsher and colder, while in low-lying areas, the climate is relatively milder. This climate structure significantly affects agricultural and livestock activities.

2.5. OTHER NATURAL AND CULTURAL RESOURCES

Karaman, a province in central Türkiye, is rich in both natural and cultural resources, offering a unique blend of historical significance and natural beauty. The region is home to Karadağ Mountain, an extinct volcano that provides opportunities for hiking and exploring unique geological formations and diverse flora and fauna. Gödet Dam, a significant water resource, doubles as a recreational area for picnics and outdoor activities. Karaman also boasts several notable caves, such as İncesu Cave, known for its impressive stalactites and stalagmites, attracting speleologists and tourists alike. Additionally, the province features various thermal springs, like those in Ermenek, renowned for their therapeutic properties and popular for health tourism. On the cultural side, Karaman is rich in historical monuments, including Karaman Castle, a medieval fortress that offers a glimpse into the region's strategic importance throughout history, and Aktekke Mosque (Mader-i Mevlana Mosque), an important religious site. These natural and cultural resources together make Karaman a region of significant interest and beauty.

2.6. PROJECT LAND USE RIGHTS

The project area for the Karaman Municipality Solar Power Plant is located in the Karaman district, specifically in the Pirireis Neighborhood. It is situated on 4883 Block and 1 Parcel. This land has been owned by the municipality since 2015. The Title Deed, which verifies the municipality's ownership of the land, is provided in the annex. This ensures that the project is situated on municipally owned land, facilitating smooth implementation and management of the solar power plant without any legal or expropriation issues.

For the Karaman Municipality Solar Power Plant Project, there are no expropriation activities required. The project area is located in the Karaman Province, Central District, specifically in the Pirireis Neighborhood on 4883 Block and 1 Parcel, which has been owned by the Karaman Municipality since 2015. The Title Deed confirming the Municipality's ownership is provided in the Annex 2.

Additionally, the energy transmission line, extending 550 meters with an underground 3x150mm² AL XPLE Cable, will follow the existing road. This strategic routing ensures that neither the energy transmission line nor the project site necessitates any expropriation, as the infrastructure is already in place and the land is municipally owned. This streamlined approach facilitates smooth project execution without legal or land acquisition complications. The line will connect the solar power plant directly to the local substation. The substation will be built on the existing road within the sub-project area. Improvement works will be carried out by the municipality on the on-site transportation roads. This road will be easy to access and will provide a significant advantage during substation operation. Moreover, the underground route is planned alongside the existing road, ensuring that no land expropriation is required. The installation will involve precise excavation and cable laying, followed by connection and testing to ensure seamless integration with the substation and efficient energy transmission from the solar plant to the local grid. A detailed visual of ENH, substation and existing road is given in Annex 4 .

Figure 6 Site Photo

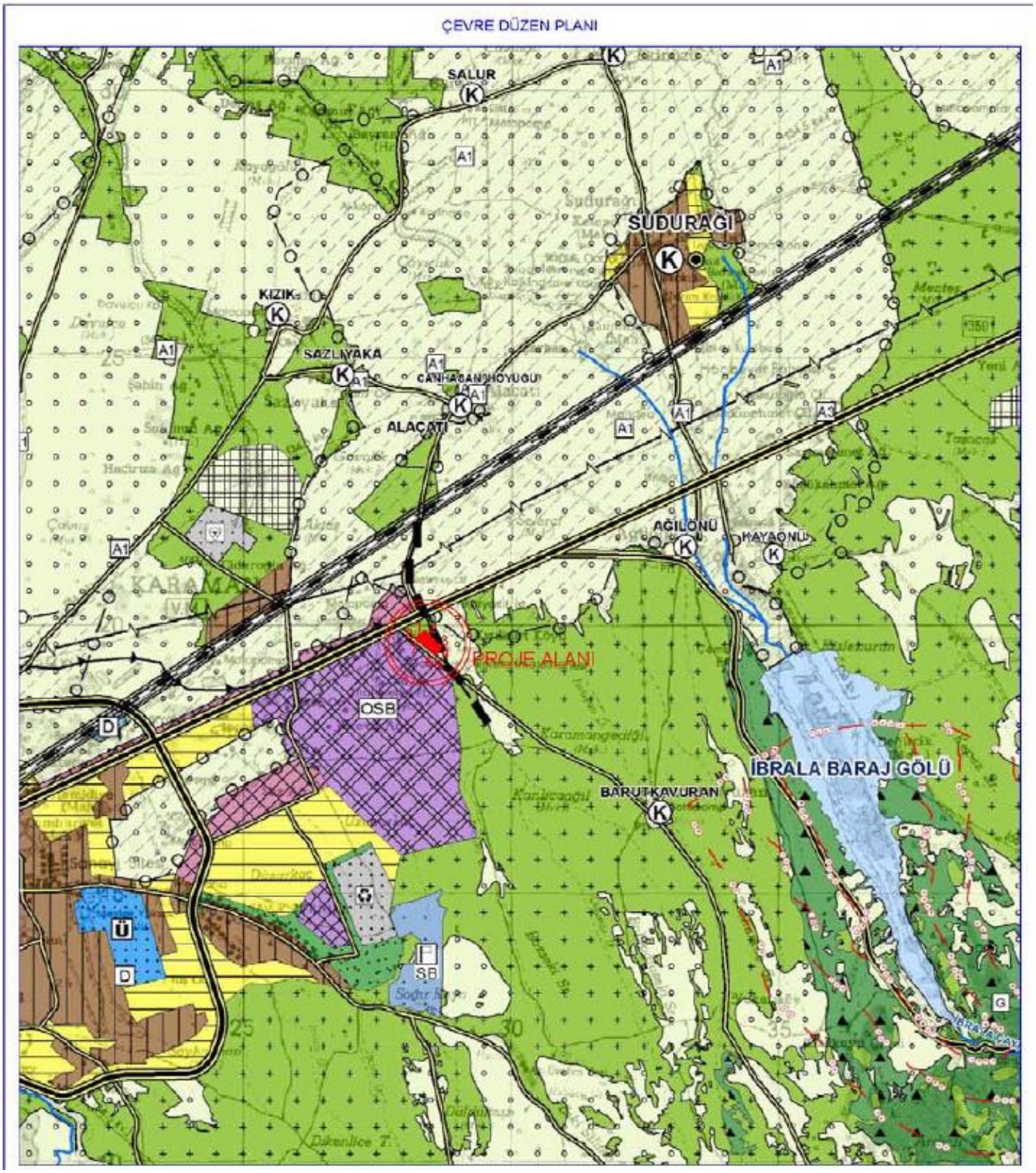

Figure 7 Landscaping Plan

3. PROJECT NEED

3.1. JUSTIFICATION

Due to the rising electricity prices in Türkiye, energy costs, which are already a big burden on municipalities, are increasing day by day. To put it in more detail, the ratio of electricity costs to the total budget in Pirireis municipalities is in the range of 2-5%, in provincial municipalities it is 5-8%, and in district municipalities it is 10-15%. In Water and Sewerage administrations, this value varies between 12-19%.

According to TEİAŞ's December 2023 data, the primary energy source with the highest number of power plants was Solar Power with 9.628 Solar Power Plants. Increased efficiency of photovoltaic panels, widespread production and reduced costs, government incentives, grants and increase in energy unit prices have made Solar Power Plants more attractive. As described in the previous section, Karaman province is very convenient in terms of sunshine time and radiation intensity due to its geographical location. Solar Power Plant with 4787,2 kWp/4000 kWe power, planned to be installed is expected to produce 8.577 MWh/year of energy. For easier understanding, this energy is large enough to meet the electricity needs of approximately 7.147 households.

As well as the amount of energy, how it is produced is an important issue. Power plants that use fossil fuels by traditional methods cause large amounts of greenhouse gas emissions in the atmosphere. Compounds consisting of gases such as carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbon (HFCs) are capable of retaining heat in the atmosphere are called greenhouse gases. As climate change becomes a global problem, renewable energy sources are of great importance for the future of us and our World.

3.2. PROJECT LOCATION PHOTOVOLTAIC POTENTIAL

Solar energy potential map of Karaman province is given in Figure 8. A minimum annual energy production estimate of 1700 kWh/m^2 - year is seen in the Merkez District located in the southern parts of Karaman province. In addition, parts of Pirireis District, which is also located in the center part of the city, constitute the solar-rich parts of the city with an annual energy production estimate of 1550-2000 kWh/m^2 - year.

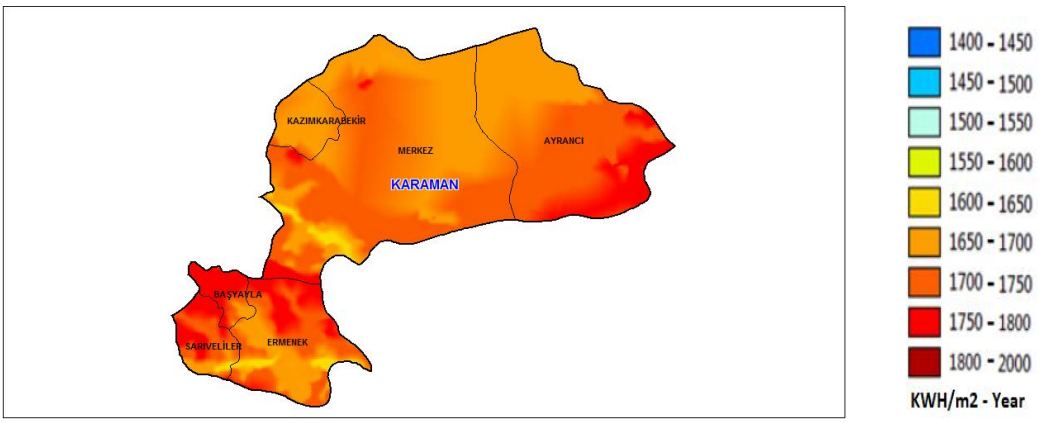

Figure 8. Solar Energy Potential Map of Karaman Province

4. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

PUMREP is subjected to ILBANK ESMS. Thus, WB's environmental and social assessment procedures and Turkish legislation, and key gaps and ways to close these gaps are presented in the ESMS. Under the ESMS, the processes of WB ESS and Turkish EIA Regulation are separately discussed in terms of screening, environmental assessment, public consultation, scoping, review of environmental and social impact assessment, disclosure, monitoring and inspection. The Turkish EIA procedures are, with some exceptions, in line with the WB's ESSs. The primary exceptions are in project categorization, scope of environmental and social assessment, and public consultation. In cases where the Turkish legislation differ from the ESSs, the more stringent one will be applied to the project implementation.

International Agreements and Conventions:

The international agreements and conventions ratified by Türkiye are listed below:

- Paris Agreement (2021)
- UN Framework Convention on Climate Change (UNFCCC) (2004)
- Rio Declaration on Environment and Development and Statement on Forest Principles (1992)
- Convention on Biological Diversity (Rio Convention) (1992)
- Paris Convention on the Protection of the World Cultural and Natural Heritage (1975)
- Barcelona Convention on the Protection of the Mediterranean Sea Against Pollution (1976)
- The Convention for the Protection of Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) (1981)
- Bern Convention on Protection of Europe's Wildlife and Living Environment (1982)
- Vienna Convention for the Protection of the Ozone Layer (1988)
- Montreal Protocol on Substances Depleting the Ozone Layer (1990)
- Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (1994)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (1996)
- UN Convention to Combat Desertification (1998)
- United Nations Europe Economic Commission Convention on Transboundary Effects of Industrial Accidents (2000)
- Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention) (2001)
- Stockholm Convention on Persistent Organic Pollutant (2010)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (1972)
- Mediterranean Sea Protocol Concerning Specially Protected Areas and Biodiversity (1988), including related protocols
- International Labor Organization (ILO) Convention on Forced Labor (1930)
- ILO Convention on Freedom of Association and Protection of the Right to Organize (1948)

- ILO Convention on Right to Organize and Collective Bargaining (1949)
- ILO Convention on Equal Remuneration (1951)
- ILO Convention on Abolition of Forced Labor (1957)
- ILO Convention on Discrimination (Employment and Occupation) (1958)
- ILO Convention on Worst Forms of Child Labor (1999)

The Project will comply with both national legislation and international standards. In case those differ, the most stringent requirement will be met. Moreover, the up-to-date legislation will be followed.

ILBANK has established an Environmental and Social Management System (ESMS) effective on 24th of Dec 2023. The ESMS is aimed at ensuring systematic identification, assessment, management, monitoring, and reporting of the environmental and social (E&S) risks and impacts of the projects and subprojects financed by the International Finance Institutions (IFIs). This process should be implemented on an ongoing basis throughout their loan duration in line with the requirements of the national legislation, international agreements and conventions ratified by Türkiye and E&S standards of lending IFIs (World Bank for the PUMREP). As a critical element of the ESMS, ILBANK has adopted and published3 an E&S Policy applicable to all ILBANK projects and subprojects financed through IFIs.

Within the scope of the ILBANK's ESMS and World Bank Environmental and Social Framework (ESF), projects are classified as either High Risk, Substantial Risk, Moderate Risk or Low Risk taking into account relevant potential risks and impacts, such as the type, location, sensitivity and scale of the project; the nature and magnitude of the potential E&S risks and impacts; the capacity and commitment of the Borrower; and other relevant areas of risks that may result in unintended impacts.

The Project will be in compliance with the World Bank's WB/ESF (2018) and ILBANK ESMS as well as the WB Environment, Health and Safety Guidelines (EHSGs) listed below:

- World Bank Group (WBG) General Guidelines on Environment, Health and Safety,
- WBG Water and Sanitation EHS Guidance,
- WBG Waste Management EHS Guidelines, and
- WBG EHS Guidelines for Electric Power Transmission and Distribution.

Environmental and Social Impacts of the Project

In this section, the status of the proposed Project explained according to the Environmental Impact Assessment (EIA) Regulation and its environmental and social risks and impacts are summarized.

[3] https://www.ilbank.gov.tr/sayfa/ilbank-environmental-and-social-policy

Recent EIA Regulation came into force after being published in the Official Gazette No. 31907 dated 29 July 2022, replaced the EIA Regulation of 2014 (Official Gazette No. 29186 dated 25 November 2014). The EIA process for this project was completed in 2020, January in accordance with the EIA Regulation of 2014, and the project has a valid EIA not required certificate in accordance with the regulation of 2020, given in Annex.

Risk Categorization

This sub-project falls within the scope of PUMREP and is subject to ILBANK ESMS,2023. ILBANK will determine the risk category of the sub-project through risk screening. After the Environmental and Social risk categorization of the Karaman SPP Subproject is determined, the necessary E&S documents such as ESMP (Environmental and Social Management Plan), SEP (Stakeholder Engagement Plan), and etc. will be agreed upon. The required E&S documents and studies will be prepared at the sub-project level by competent and experienced experts appointed by ILBANK and/or the sub-borrower entities (Karaman Municipality) in accordance with the relevant ESS's.

4.1.1. STAKEHOLDER ENGAGEMENT AND DISCLOSURE

During the project development and decision-making processes, no meetings were held to obtain opinions and information from local people and NGOs. However, all the necessary consultation activities will be carried out during the preparation, construction and operational phases of the Project

In addition, according to the ESS10: Stakeholder Engagement and Information Disclosure,Karaman Municipality will continue to engage with, and provide information to project-affected parties and other interested parties throughout the life cycle of the project, in a manner appropriate to their interests and the potential environmental and social risks and impacts of the project. Additional information may need to be disclosed at key stages in the project cycle, for example prior to start-up of operations, and on any specific issues that the disclosure and consultation process or grievance mechanism has identified as of concern to stakeholders. In the case of notable alterations to the project leading to increased risks and impacts, especially those affecting project-affected parties, Karaman Municipality have to inform them about these changes and engage in consultations regarding the mitigation strategies. Continuous input from stakeholders is valuable for monitoring risks and impacts, as well as evaluating the efficiency of the strategies aimed at minimizing environmental and social risks. Consultations serve as a means to evaluate the fulfillment of mitigation measures, identify any emerging issues, and determine appropriate actions.

5. OCCUPATIONAL HEALTH AND SAFETY ACTION PLAN

5.1. LEGAL FRAMEWORK

- A project and site-specific risk assessment document needs to be prepared before works commence on site.
- Regular Site Inspections: Conduct regular inspections of the ground-mounted solar power plant site to identify any potential occupational health and safety hazards. Inspections should encompass the entire installation area and any associated facilities or access points.

- Hazard Identification and Risk Assessment: Perform comprehensive hazard identification and risk assessments to evaluate potential risks to workers' health and safety. This includes assessing risks related to electrical hazards, manual handling, machinery operation, and other relevant factors specific to ground-mounted solar installations.
- Training and Education: Provide adequate training and education to all personnel involved in the ground-mounted solar project regarding occupational health and safety protocols and procedures. This includes training on safe work practices, emergency procedures, and the proper use of personal protective equipment (PPE).
- Emergency Response Planning: Develop and implement emergency response plans specific to ground-mounted solar installations, including procedures for responding to incidents such as electrical shocks, equipment failures, or other emergencies. Ensure all workers are familiar with these procedures and conduct regular drills to test their effectiveness.
- Incident Reporting and Investigation: Establish clear procedures for reporting and investigating occupational health and safety incidents or near misses. Encourage workers to report any incidents promptly, and conduct thorough investigations to determine root causes and implement corrective actions to prevent recurrence.
- Ongoing Monitoring and Evaluation: Continuously monitor and evaluate the effectiveness of occupational health and safety measures implemented at the ground-mounted solar power plant. This includes tracking key performance indicators, such as incident rates, near misses, and compliance with safety procedures, to identify areas for improvement.
- Documentation and Reporting: Maintain detailed records of all occupational health and safety activities, including inspections, risk assessments, training sessions, incident reports, and corrective actions taken. Prepare regular reports summarizing OHS performance and trends for management review and regulatory compliance.
- Worker Consultation and Participation: Foster a culture of worker consultation and participation in OHS matters by actively involving workers in decision-making processes, hazard identification, and safety initiatives. Encourage open communication channels for workers to raise concerns or suggestions regarding health and safety issues.
- By implementing robust OHS monitoring and reporting practices, ground-mounted solar power plant projects can effectively manage occupational health and safety risks, ensure compliance with regulations, and protect the well-being of workers involved in the installation and operation of solar energy systems.

6. IMPLEMENTATION OF THE PROJECT

6.1. TIME SCHEDULE

The schedule for the execution of the period covering the contract and construction phase of the project is presented in the Table 5 : Expected Duration of Karaman Renewable Energy Project

below. According to site visit studies, no drilling is required and ramming method will be used to install steel structure supports.

The expected duration of the project including the tendering period is 12 months.

Table 5 : Expected Duration of Karaman Renewable Energy Project

No.	Impelementation	Project Management	1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month	7th Month	8th Month	9th Month	10th Mont	11th Mont	12th Mont
1	Contract Sign	Selection Of EPC												
2	Contract Sign	Contract Process												
3	Contract Sign	Procurement Process												
4	Contract Sign	Installation												
5	Contract Sign	Commissioning												
6	Contract Sign	Provisional Acceptance Certificate												
7	Contract Sign	System in Operation												

6.2. PURCHASE AND PROCUREMENT PLAN

The procurement plan for the Karaman Municipality Solar Power Plant project, which boasts a capacity of 4787,2 kWp and 4000 kWe, intricately outlines the acquisition strategy for pivotal components essential to both the construction and operational phases of this ambitious renewable energy venture. This comprehensive plan navigates through a meticulous process aimed at acquiring top-tier PV modules, inverters, steel structures, cables, electricity distribution boards, transmission lines, and substations. Rigorous steps include initiating a competitive tendering process to source high-efficiency PV modules tailored specifically to harness Karaman's abundant solar irradiance levels. Simultaneously, the selection of inverters aligns with the modules and grid requirements, prioritizing compatibility, reliability, and efficiency. Additionally, meticulous attention is directed towards identifying suppliers capable of delivering durable and weather-resistant steel structures compliant with project design specifications. The procurement strategy for cables and distribution boards emphasizes safety standards, robust insulation properties, and sufficient load-bearing capacity to withstand the plant's operational demands.

Moreover, the procurement approach extends to collaborating with specialized contractors or suppliers proficient in grid infrastructure. This selection process prioritizes expertise, technical compliance, reliability, and adherence to established standards. These selected entities are crucial for the procurement and installation of transmission lines and substations, critical elements for enabling seamless grid connectivity. Their ability to execute within the project's specified timeline is paramount to ensure timely completion and integration of the solar power plant into the regional grid network. This meticulous and comprehensive procurement strategy underscores the commitment to acquiring high-quality materials and infrastructure, essential prerequisites for the successful implementation, efficient operation, and long-term sustainability of the solar power plant in Karaman. In addition, if partial progress is to be made when starting work in the field, it should be ensured that the equipment are in the field.

6.3. PROJECT MANAGEMENT AND AUDIT

The project execution will be managed by the Contractor awarded after the tendering stage and the Municipality will supervise the contractor's entitlements and compliance with the specifications and projects of its activities.

The management and execution of the project will be entrusted to the contractor selected through a meticulous tendering process, while the Karaman Municipality assumes the crucial role of supervising the contractor's adherence to specified project requirements and activities. To ensure stringent quality control measures throughout the project's lifecycle, the Municipality will engage a third-party consulting firm during both pre- and post-manufacturing phases. This firm will conduct comprehensive checks encompassing factory manufacturing processes of materials and on-site inspections, providing invaluable support to the Municipality in formulating technical specifications, overseeing the tendering stage, and offering ongoing assistance during the Operations and Maintenance (O&M) period.

In order to maintain impartiality and eliminate potential conflicts of interest, the selection of this consulting firm will be overseen by the International Financial Institution (IFI) financing the project. The objective is to guarantee an unbiased selection process that aligns with international standards. The overall coordination and supervision of the project will be conducted by the Project Management Unit (PMU) established jointly by ILBANK International Relations Department and the Karaman Municipality. Additionally, the IFI or the designated bank retains the authority to conduct audits at any juncture during the project's execution, reinforcing the commitment to transparency and adherence to established guidelines and standards. This multi-tiered approach ensures robust oversight, quality assurance, and compliance with project specifications, thereby fostering accountability and optimal project outcomes.

Overall process will be managed and controlled by Project Management Unit (PMU) established by ILBANK International Relations Department and Karaman Municipality. The IFI or the Bank reserves right to perform audit activities in any time during the execution of the Project.

6.4. INVESTMENT PLAN

In the current situation in Türkiye, solar panel prices are on average at the level of 0.20 €/Wp. The reason why these values have fallen so much is that the supply of panels and inverters exceeds the demand. Total estimated cost of the plant is given in **Hata! Başvuru kaynağı bulunamadı.**9, and the exact investment cost will be determined as a result of EPC tender.

By including survey, project, engineering, license, land correction, construction and auxiliary structures, insurance, transportation and commissioning, these items were calculated as expense items and fixed capital investment (CAPEX) for solar plant was calculated. The estimated cost breakdown would typically follow a similar structure to smaller projects, but scaled up accordingly. Project preparation and design costs could account for 5-10% of the total, covering permits, licenses, and consultancy fees. Equipment and materials costs, including solar panels, inverters, and electrical components, would make up 45-50% of the total cost, benefiting from economies of scale. Construction and installation costs, such as site preparation, labor, and transportation, would be around 30-35%. Operation and maintenance costs, including repairs, cleaning, and monitoring, would take up 5-10%. Grid connection costs would generally be 5-10% depending on the infrastructure requirements, and other costs like taxes, legal fees, and training would be about 5%.

Table 6:Power Plant Details (inc. Supervision, Contingency and VAT)

Institution	Installed Power (kWp)	Connection Power (kWe)	Fixed Investment Cost (EUR)
Karaman Municipality	4787,2	4000	4.404.224,00

6.5. LOGISTIC PLAN

The Karaman Solar Power Plant Project is a solar energy initiative located in Karaman City, designed to generate sustainable electricity. The project site is easily accessible, and the logistic plan is structured to facilitate the efficient delivery of materials and equipment required for the construction of the solar power plant.

Material Delivery:

- The project site is suitable for all types of material delivery, and there is no need for oversize material transportation or specific vehicles.
- Regular trailers will be used for the transportation of PV panels, steel structures, cables, inverters, transformers, and other project materials.
- There will be vertical and horizontal loading and unloading facilities with bobcat forklifts.
- Excavators, JCBs, and ramming machines will be utilized for civil works, including concrete pouring vehicles and concrete mixers.
- The road infrastructure to the project site can accommodate all required machinery.

Material Quantity and Delivery:

Table 7: Logistic Item and Shipment Amount

Logistic Item	Shipment Amount
PV Panels	• Approximately 16 trailers will be required for PV panels
Steel Structure	• 8 trailers will be needed for the steel structure.
Goods, Materials and Equipments	• Around 10 trailers will be utilized for cables, inverters, transformers, and other project materials.

- The delivery schedule will be coordinated to ensure a smooth flow of materials throughout the construction process.

Safety and Compliance:

- Strict adherence to safety regulations and guidelines will be maintained throughout the project.

- All transportation vehicles and machinery will undergo regular maintenance and inspections to ensure safe operation.
- Compliance with local traffic and environmental regulations will be a priority.

Communication and Coordination:

- A dedicated logistics team will be responsible for coordinating material deliveries, managing on-site transportation, and ensuring timely execution of the construction plan.
- The logistic plan for the Karaman Solar Power Plant Project aims to streamline the material delivery process, optimize on-site operations, and ensure the efficient construction of the solar power plant.

With a focus on safety, compliance, and effective communication, the project is set to achieve its goals within the specified timeline.

7. RECYCLING PLAN

7.1. DISPOSAL OF WASTE CRYSTAL SILICONE PHOTOVOLTAIC MODULES

The crystalline silicon (c-Si) panels used today are composed of 76% glass, 10% polymer, 8% aluminium, 5% silicon, 1% copper, and less than 0.1% silver and other materials. Two-thirds of the panels used worldwide are crystalline silicon, with over 90% of their composition being glass, polymer, and aluminium, making them generally classified as harmless. However, materials like silver, lead, and tin, which pose challenges in recycling, make up 4% of the total weight and require specialized recycling methods.

Waste management approaches are divided into three main categories:

1. **Voluntary Approach**: Manufacturers can voluntarily take back panels for recycling upon request. This can be direct (using their own recycling systems) or indirect (utilizing other agreed-upon recycling methods).
2. **Public and Private Approach**: Organizations like PV CYCLE operate in Europe to support manufacturers and facilitate panel recycling.
3. **Regulatory Approach**: The lifecycle management of PV panels is governed by regulations developed by governments. For example, the Waste Electrical and Electronic Equipment (WEEE) directive in Europe falls under this category.

These approaches aim to facilitate recycling and reduce the environmental impact of harmful materials.

7.2. RECYCLING OF PROJECT EQUIPMENT/MATERIALS

Recycling of Crystal Silicon Solar Panel

Experimentally, pyrolysis methods in a conveyor belt furnace and fluidized bed reactor have achieved 100% recovery of glass and 80% of silicon. By using trichloroethylene at 80°C for 10 days and applying mechanical pressure, 100% silicon recovery was achieved while preventing EVA intrusion into the cell. The PET-based backing layers used in the panels can decompose at 80°C

within 1-2 hours, while PVF-based back layers take 5-8 hours. In some cases, separating the EVA layer from PET or PVF back layers can be done using multiple layers. In a 2011 study by Wang et al., recycling was explored through chemical and thermal processes, resulting in direct reuse of glass and recovery of 62% silicon and 85% copper. This study utilized combustion at two temperatures: 330°C for 30 minutes and 400°C for 120 minutes. Chemicals like HCl, H2O2, H2O, hydrofluoric acid, and NaOH were used to recover silicon, silver, and aluminum. H2SO4 is effective for recovering aluminum, requiring 90°C for 4 hours, while HNO3 recovers silver. Granata et al. (2014) observed that approximately 85% of mass recovery could be achieved with polycrystalline and amorphous silicon panels, and their methods were also used for CdTe panels. Another widely used recycling method is the Deutsche Solar process, where plastic parts are burned at 600°C to release silicon, which is then recovered with acid treatment. This process is particularly efficient, achieving 98% silicon and 100% glass recovery.

Due to its high recycling efficiency, the Deutsche Solar process has been specifically chosen for this project's recycling efforts. This process involves burning plastic parts at 600°C to release silicon, followed by recovering the silicon wafer using acid treatment. The method is known for its effectiveness, allowing for the recovery of 98% of silicon and 100% of glass, making it a preferred method for solar panel recycling. Although it is widely used in certain regions, its implementation in Turkey may vary. However, it has been successfully adopted globally, especially in countries focused on renewable energy and sustainability. The Deutsche Solar process is valued for its efficient and environmentally responsible approach to minimizing waste and maximizing resource recovery, and it is likely to be adopted in Turkey or other countries with similar environmental regulations and sustainable development goals.

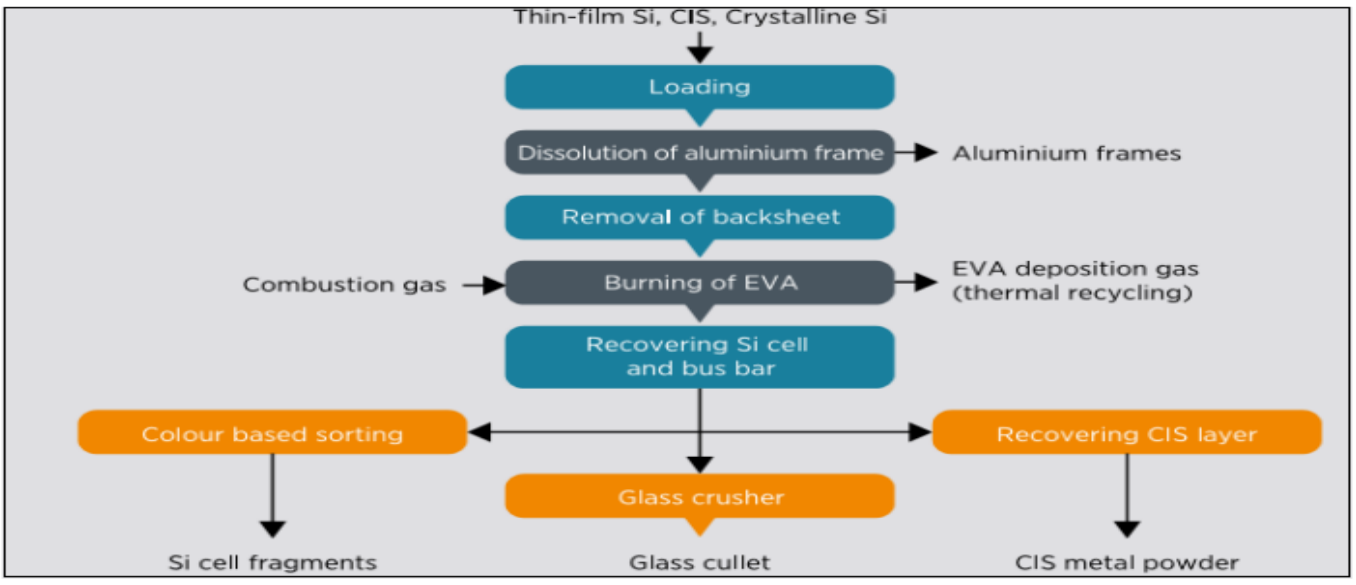

Figure 9. The process used by the Japanese company (Weckend et al. 2016)

Some international companies specializing in solar panel recycling include:

- First Solar: First Solar is a leading company in solar panel manufacturing and recycling. The company operates a comprehensive program to manage the recycling process of solar panels.
- Veolia: Veolia is a global company providing environmental services. The company specializes in solar panel recycling and promotes sustainable practices in the renewable energy sector.
- Recycle PV: Recycle PV is a company specialized in solar panel recycling. They offer various services for the waste management and recycling of solar panels.
- Reclaim PV Recycling: Reclaim PV Recycling is an Australia-based company offering solar panel recycling services worldwide. The company utilizes various technologies to safely and environmentally recycle solar panels.
- SolarCycle: SolarCycle is a company focused on solar panel recycling and operates in the United States. They provide solutions for the collection, transportation, disassembly, and recycling of solar panels.

These companies specialize in the safe and environmentally friendly recycling of solar panels and play a significant role in the global solar energy industry.

7.3. HAZARDOUS WASTES

Solar panels, while environmentally beneficial, can generate hazardous waste throughout their lifecycle, particularly during installation, operation, and decommissioning. The primary hazardous materials include cadmium, lead, and other toxic metals found in some photovoltaic cells, as well as the potential for chemical spills from maintenance activities. In the scope of this project, a comprehensive waste management plan will be implemented to mitigate these risks.

Hazardous wastes produced during the project will be stored in secure, designated areas that comply with environmental regulations. These storage areas will be designed to prevent leaks, spills, or contamination, featuring impermeable surfaces, proper labeling, and restricted access to ensure safety.

For disposal, all hazardous wastes will be transported to certified facilities equipped to handle and process such materials responsibly. This includes using licensed hazardous waste disposal services that adhere to strict guidelines for the safe treatment, recycling, or disposal of toxic substances. Regular audits and inspections will be conducted to ensure compliance with all relevant regulations, minimizing any potential environmental or public health impacts

8. FINANCIAL ANALYSIS

8.1. Financial Sources and Finance Plan

All project investments will be financed by the World Bank loan. The distribution of loan utilization over the years in parallel with the project investments is given in the table below.

Table 8: Utilization of Ilbank-WB Loan by years (inc. VAT)

Loan Utilization EUR	TOTAL	2025
Solar Power Plant Project	4.404.224,00	4.404.224,00

The conditions of the World Bank loan are as follows:

Conditions	Value
Name of the Loan	WB Pumrep
World Bank Interest Rate (annual)	Euribor 6M (3.06%) + 0,61%
ILBANK Interest Rate (annual)	0,50%
Front-end Fee (over credit amount)	0,25%
Guarantee Fee (over credit amount)	0.10%
Commitment Fee (over undisbursed amount)	0,25
Maturity	16 Years (13 Years + 3 Years Grace Period)

Figure 9 WB Loan Conditions

The credit repayment period is 13, loan grace period is 3 years total loan repayment period is 16 years. Interest rate is EURIBOR 6M+ 0.61% (0,61% + 3,06 % + 0,50 = 4.17%) Ilbank's interest rate is 0.5%.

The loan onetime payment costs can be found in the table below.

Table 9: Loan Onetime Payment Costs

One Time Payments	Amount
One Time Payments	Amount
Front-end Fee (over credit amount) (%0,25)	EUR 11.010,56
Guarantee Fee(over credit amount) (%0,10)	EUR 4.404,22
Total Payment	EUR 15.414,78

Equity Scenario:

This scenario assumes the project is fully financed through equity, meaning the required funds come directly from the stakeholders or owners without any borrowing. In this case:

- The project's cost includes only the direct investment required for construction and operation.
- The payback period and financial return are typically higher because there are no loan interest or repayment obligations.
- It provides a clear picture of the project's potential profitability if external financing is avoided.

Credit Scenario:

This scenario assumes the project is financed through loans or credit facilities. Key points include:

- The project cost includes both the fixed investment and the cost of the loan (interest and fees).
- Loan repayment terms, including interest rates, maturity periods, and grace periods, significantly impact the cash flow.
- The financial return is lower than in the equity scenario due to the added burden of loan payments, but it allows the stakeholders to leverage external financing and retain liquidity.

8.2. Financial Analysis

It is estimated that 8,577 MWh of energy will be produced at the Solar Power Plant and the plant save the Municipality from the energy expense burden of EUR 708.606,21 in the first year.

According to feedback received from B.L. Electricity Markets & Policy global OPEX prices of solar power plants excluding insurance fee, but including personnel, and maintenance average cost, OPEX price is between 5-8 $-USD/kWh (4.65-7.48 €-Euro/kWh). So, the in the cash flow analysis the median price is used which is €6,06/kWh.

Within the scope of the project, an annual insurance fee of €1.000,00/MWp is added in the total cash outflow.

This facility, which is planned to be established with a 16-year loan, has an economic life of 30 years.

8.3. Reduced Cash Flow Statement

A Nominal Cash flow statement has been prepared for 30 years. Cash flow statements and details are presented in the appendix section.

Calculated values for total cash inflow, total cash outflow including OPEX and credit cost the return of investment, net flow between 2026 and 2055 are presented in tables.

Nominal cash flow values in the table incorporate an estimated annual inflation rate of 2.5% as an approximation, beginning on 2027 and onword. This adjustment accounts for projected price increases over time, ensuring that the figures reflect anticipated economic conditions. The applied inflation rate is consistently factored into each year to provide a more accurate representation of expected cash flows in nominal terms.

8.4. Equity Scenario

The approximate cost of the planned Solar Power Plant project to be EUR 4.404.224,00.

Project return on investment time is approximately 6 years (Six Years) according to the criteria in Cash Flow Analysis.

The total revenue of the power plant will be EUR 27.273.330,18 after 30 years.

The project financial return rate is calculated as %17.05.

A precise calculation requires detailed financial data; however, an estimation of discount rate has been made based on the project's nature. Given that solar power investments typically provide stable cash flows and have low financing costs, a conservative discount rate is suitable. Additionally, renewable energy projects often benefit from favorable market conditions and long-term viability, justifying a moderate discount rate.

In this context, considering the specific financial dynamics and industry trends, the estimated discount rate is around 5.6%. This rate offers a realistic approach to assessing the investment's economic sustainability.

8.5. Credit Scenario

%0,61 + Euribor + %3,06 + %0,5 İlbank Interest = %4.17 annually, 3+13 Years Maturity, Foreign Exchange Credit

The approximate cost of the SPP project planned with foreign Exchange credit with no grace period, the estimated overall cost of the power plant including fixed investment cost and credit cost will be EUR 7.342.722,25

The project return on investment time is approximately 17 years (Seventeen Years) according to the Cash Flow Analysis.

However, during overall there is a cost sharing between World Bank (for Credit Payment) and Karaman Municipality. Around %75 of the income every year will be paid for Credit Payment to World Bank and around %25 of the income will be received by Karaman Municipality.

The project financial return rate is calculated as %10.29.

9. ECONOMICAL ANALYSIS

PVsyst The objective of the CBA is to analyse a project's impact on society's well-being in the project area. A financial analysis, by contrast, only takes into account the costs and (direct/immediate) benefits that accrue to the investor as a result of the measure. A CBA should include the total costs and benefits from the perspective of the society that benefits from the project. The purpose of the Economic analysis carried out within the scope of the project is to measure and evaluate the contribution of the project to the project area, the industry of Karaman, Merkez and to the welfare of Türkiye in a broader sense. Although the values used in Economic analysis are not financial indicators, measuring the contribution to economic welfare which is the main purpose of economic analysis makes an important contribution especially for making the right investment decisions.

9.1. Methodology

The benefits of the proposed project have been estimated following European Commission Guide on Cost-Benefit Analysis (2014). The benefits comprise environmental, social, health and economic development benefits.

Following general steps are undertaken in this economic analysis:

- Converting financial costs to economic costs by removing distortions due to tax and other factors; and
- Estimating external costs and benefits.

The following indicators are used to in a CBA to describe the economic effectiveness of the project:

- ENPV (economic net present value) – this indicator should be greater than zero (0). If it is less than zero, the project represents a net loss to society and should be rejected.
- ERR (economic rate of return) – this indicator should be higher than the social discount rate (this is assumed at 8%)
- Benefit-cost ratio – the project should have a benefit-cost ratio greater than one (1). If it is less than one, the project represents a net loss to society and should be rejected.

9.2. STANDARD CONVERSION FACTOR AND ESTIMATION OF ECONOMIC COSTS

For the economic analysis, taxes and subsidies should be subtracted from estimated costs to convert project costs from market-priced financial costs to social opportunity cost-based economic costs. Since local market prices do not generally reflect the true value of the product, depending on the tax policies applied, prices in international trade provide a better basis for estimating economic costs.

9.3. SOCIAL CONVERSION FACTOR

The Social Conversion Factor (SCF) is calculated according to the following formula based on the imports and exports realized in the country:

M : total imports to Türkiye (with CIF value)

X : Total exports from Türkiye to abroad performed (the FOB value)

TM: Taxes and pictures taken from imports

TX : taxes on exports

whereas,

SCF = (M + X) / [(M + Tm) + (X -Tx)]

Social Conversion Factor (SCF)	%98,2
M = Total imports	271,425,553.03
X = Total exports	225,214,458.04
Tm = Taxes taken from imports	9,055,224.00
Tx = Taxes on exports	0

9.4. Conversion Factor For Imported Goods And Services

Conversion Factor for Imported Goods and Services (CFI) is used to convert imported goods and services into economic prices among the expenses included in the financial analysis. According to the formula shown in the table below, CFI is calculated as 93.5%.

A : Total imports,

B : Taxes on imports,

while,

CFI = 100%- (B/A)

Table 10:Conversion Factor for Imported Goods and Services

Conversion Factor for Imported Goods and Services		96.7%
Imports	A	271,425,553.03
Taxes on imports,	B	9,055,224.00
	B/A	3.3%

9.5. Shadow Personnel Costs

It is essential to adopt the shadow price approach in economic analysis in accordance with the Strategy Budget Department's Investment Program Preparation Guide and relevant international best practices. Accordingly, in countries with high unemployment, the opportunity cost of labor employed in the project may be lower than the actual personnel costs, depending on the legislation regulating employee wages.

Therefore, to reflect the social value of the labor and time spent within the scope of the project; shadow personnel cost should be calculated by applying an adjustment procedure to paid personnel expenses.

The following formula was used to calculate the shadow personnel wage rate conversion factor:

SWR = W(1-u)(1-t)

Here;

W is the market salary;

U is the regional unemployment rate and the proportion of social insurance and related taxes in salary payments.

It is assumed that the skilled labor force is a limited resource and therefore it is reasonable to be remunerated in the market to cover the opportunity cost, so no adjustments have been made to the skilled labor costs.

On the other hand, shadow price conversion is applied, considering that the remuneration applied in the market for unskilled labor might not be economically reasonable. In other words, the opportunity cost of unskilled labor may be lower than actual wages.

Taking into account the above, the following assumptions are made:

- It is assumed that the unemployment rate in the project area is 7,9 %, which is the rate for TR52 Region (Karaman, Konya) average;
- The ratio of social insurance and taxes in salaries is 21%.

In line with the above assumptions, the shadow personnel wage rate was calculated as SWR=67,69%.

It is foreseen that almost all the personnel expenses included in the operating and maintenance expenses consist of qualified labor force. However, it has been foreseen that 30% of maintenance and repair costs are composed of unqualified labor, and 70% of goods, materials and qualified personnel.

9.6. Conversion Factors Applied In The Project

A summary of the assumptions and calculation methodology applied for the Economic evaluation of Karaman SPP Project and the conversion factors used are presented in the table below:

Table 11: Conversion Factors used for the Project

Parameters		Factor	Details
Main Conversion Factors	SCF	0.9821	Applies to administrative cost item and other O&M costs
	CF for imported goods and services	0.9666	Calculated on the basis of Türkiye's total import and customs duties for 2021. Energy and fuel oil, oil and mineral oil items are subject to this conversion factor.
	Personnel cost (Shadow wage)	0.6809	Calculated based on regional unemployment rate and income tax rate.
	Maintenance Costs	0.8917	Calculated based on the assumption that 30% of the maintenance cost is personnel cost of unskilled personnel and 70% is skilled personnel including material, therefore sum product is taken for shadow wage and SCF respectively.
Conversion Factors Used in the Analysis	Investment Costs	0.9666	Conversion factor for imported goods and services is also applied for investment costs.
	Residual Value	0.9666	Taken same as the conversion factor for investment costs.
	Operation and Maintenance Costs	0.9451	Calculated based on average weights of individual cost items over the project

Parameters		Factor	Details
			lifetime multiplied by corresponding conversion factor.

9.7. Benefits Related To Reduction Of GHG Emissions

In the Without Project Scenario, all the electricity consumption is covered by the electric supplied from grid, so first the GHG emissions caused by the consumption from the grid is calculated. In the with Project scenario the energy generated from the SPP does not cause any GHG. In the calculation of the GHG produced in the with project scenario, the amount of electricity produced by the SPP is thus deducted from the total energy consumption of the Municipality. In other words, the with project scenario uses less electricity from the grid and the GHG is less compared to without project scenario. In monetarizing the amount of reduction in the GHG in two scenarios, the methodology suggested in the EC CBA Guideline and EIB Carbon Footprint Methodology is used.

According to the European Environment Agency, 319.95 grams of CO2 emissions per kwh are realized in Türkiye. Using this conversion factor, annual net tonnes of CO2 emissions were calculated from the project-related net energy consumption. The monetary equivalents of tonnes of net carbon reduction emissions is assumed to 50 EUR/tonnes for the initial year of analysis and calculated as recommended in the EC CBA Guideline.

The net present value of the emissions savings caused by the incremental electricity consumption is calculated as EUR 107.020,38.

9.8. Benefits Related To Employment

The socio-economic benefits of large-scale solar and wind: an econ Value report' proposes a methodology for assessments of the employment effects of the renewable energy industry (IRENA and CEM ,2014).With this approach employment for different segments of the renewable value chain can be estimated for permanent activities like O&M described as full-time equivalents (FTE) or jobs per MW of installed capacity. Also, temporary or one-time activities, such as manufacturing or construction, are expressed as FTE-years or person-years per MW of installed capacity in this study. This methodology is applied to assess the increase in employment for Karaman SPP Project. The report suggests that for the PV systems, min 7.1 Jobs/MW are created for manufacturing and installation works while for the operation and maintenance min of 0.1 jobs/MW will be created for the project. The report also suggests maximum values for these temporary and permanent jobs created in the employment market. To be on the safe side, min values are used in the calculations. The annual wage rate for indirect employment suggested herein is assumed to be 6,748.60 EUR/year (15,8K TL/month).

Besides the employment created during the installation and construction and maintenance works. It is also estimated with the technical assessments that 1 permanent worker in the Municipality will be assigned to the operation of the SPP. The annual wage rate for direct employment suggested herein is assumed to be 8,219.79 EUR/year (19K TL/month) on the initial year of the operation and real increase in the wages during the analysis period are also considered.

The net present value of the above-mentioned increase in employment is estimated to have a NPV of EUR 92,483.

9.9. Non-Financial Benefits

Solar power plants contribute to reducing greenhouse gas emissions and other harmful pollutants associated with conventional electricity generation. The societal benefits of cleaner air and reduced environmental impact can lead to cost savings in terms of public health, climate mitigation efforts, and avoiding the consequences of climate change.

The cost of electricity from the grid can be subject to fluctuations due to changes in fuel prices, regulatory policies, or supply and demand dynamics. By relying on solar power, which has a predictable and stable cost (once the solar plant is installed), energy consumers can hedge against potential future increases in grid electricity prices.

Generating electricity locally through solar power increases energy independence and resilience. By reducing reliance on imported or distant sources of energy, regions and countries can enhance their energy supply security and stability.

National Economic Advantage
This signifies its contribution to reducing reliance on imported energy sources and decreasing carbon emissions, aligning with the country's goals for cleaner energy solutions. The calculation is made by below formulas:

1 m^3 of natural gas (A)	10,55 kWh
Combine Cycle Natural Gas Power Plant Efficiency (B)	%60
Türkiye's Natural Gas Procurement Price (Y)	0.18 $ / m^3
Annual Production of Solar Power Plant (kWh) / (A x B)	Annual Natural Gas Amount Needed to Produce The Electricity (X)
National Economic Advantage	(X) x (Y)

Calculations: Annual Natural Gas Amount Needed to Produce The Electricity (X) =Annual Production of Solar Power Plant (kWh) (8.576.691 MWh) / (A x B) (10,55 * %60) = 1.354.927,49 m^3

National Economic Advantage = 1.281.861,78 x 0,18 = 243.886,95 EUR

Regional Economic Advantage
The project's regional economic advantage includes factors like increased employment opportunities, infrastructure development, and enhanced energy efficiency. This would positively impact the local economy by attracting investments and fostering growth in businesses. The calculation is made by below formulas:

Regional Economic Advantage	Produced Electricity(kWh) * Netting Benefit (€cents)

Calculations: Produced Electricity (8.576.691 kWh) * Netting Benefit (6,885 €cents)*VAT = 708.606,21 EUR

9.10. Economic Performance Indicators (ENPV/Err)

As a result of the analysis stated above, the economic rate of return of 38,35% is above the discount rate, indicating that the project is economically viable. So, the project will significantly contribute to prosperity in Karaman and Türkiye's economy.

In addition, the realization of the project has benefits that cannot be quantified for the economy of the region, such as increasing the need for temporary labor.

Economical Analysis	
National Economical Advantage (Natural Gas)	243.886,95
GHG Advantage	107.020,38
Employment Advantage	92.483,00
Regional Economical Advantage	708.606,21
Overall Economic Advantage	1.151.996,54
Economical Return Rate (ERR)	**41,23%**

9.11. Sensivity and Risk Analysis

Sensitivity and Risk analysis allows the determination of the critical variables or parameters of the financial model. Such variables are those whose variations, positive or negative, have the greatest impact on the project's financial and economic performance. The analysis is carried out by varying one element at a time while keeping other parameters constant and determining the effect of that change on rate of Return and Net Present Value.

European Commission's Guide to Cost Benefit Analysis of Investment Projects, (European Commission, Directorate General Regional Policy, 2014) establishes as a general rule that if a change of 1 percent in a variable (parameter) leads to over 1 percent change in the financial and economic performance, then this factor is a critical variable. The criteria to be adopted for the choice of the critical variables vary according to the specific project and must be accurately established on a case-by-case basis.

In this section a number of parameters are changed by intervals +/- 1 per cent and the impact on FNPV and ENPV is tested. The parameters (risk factors) considered are:

- Project investment costs
- Project revenues
- Operating and maintenance costs
- Economic benefits
- Economic costs (investments)
- Economic costs (operating and maintenance costs).

The parameters given above are the sources of uncertainties in obtaining the expected benefits from the project. The purpose of the sensitivity analysis carried out is to determine the sources of uncertainty that can have a more impact on the outcome of the

study. In cases where the above parameters are increased / decreased by 1%, the change in FNPV and ENPV has been tested. The effect of the change in parameters on performance indicators is given in the table aşağıda:

Table 12:Critical Variables

Variable	Change in FNPV due to change by ± 1%	Assessment
Project investment costs - %1 increase	0.0489	(Critical)
Revenues - %1 decrease	0.0000	(Not Critical)
O&M Costs - %1 increase	0.0000	(Not Critical)
Variable	Change in FNPV due to change by ± 1%	Assessment
Economic benefits- %1 decrease	-0.00521	(Not Critical)
Economic costs (investments) - %1 increase	0.01721	(Critical)
Economic costs (O&M costs) - %1 increase	-0.00224	(Not Critical)

9.12. RISK ANALYSIS

A probabilistic risk analysis was conducted using the standard Monte Carlo simulation model of JASPERS4. It uses Monte Carlo simulations to build a distribution of the model output variables. The results presented here are computed using 25,000 iterations of the model.

Table below lists the main results of the risk analysis for the economic and financial net present value. A histogram and cumulative distribution of the results are shown figures below.

Table 13: Main Results of the Risk Analysis

	Variable	FNPV/K (EUR)	ENPV (EUR)
1	Expected value	-1.094.008	2.729.875

4 JASPERS, 2013, Monte Carlo Simulation of Cost-Benefit Analysis Results, Staff Working Papers

2	Standard deviation	365.390	808.009
3	Probability FNPV/K>0	99.90%	
4	Probability ENPV>0		99.90%

In line with the assumptions made in this study, the economic net present value is positive with a probability of 99,9%. In other words, it indicates that the project contributes to national welfare with a probability 99,9 of %. FNPV/K will reach a positive value with 99.9% probability.

Payment Term	Payment No.	WB Interest Rate (%)	İlbank Interest Rate (%)	Euribor Rate(%)	Total Interest Rate (%)	Capital (€)	Commitment Fee (€)	Principal Payment (€)	Total Interest Payment (€)	Interest Payment (€)	Total Loan Payment(€)
2023-2	1	0,61	0,5	3,060	4,170	4.404.224	11.011	0	2.938.498	102.839	102.839
2024-1	2	0,61	0,5	3,060	4,170	4.404.224	11.011	0	2.938.498	102.839	102.839
2024-2	3	0,61	0,5	3,060	4,170	4.404.224	11.011	0	2.938.498	102.839	102.839
2025-1	4	0,61	0,5	3,060	4,170	4.404.224	11.011	0	2.938.498	102.839	102.839
2025-2	5	0,61	0,5	3,060	4,170	4.404.224	11.011	0	2.938.498	102.839	102.839
2026-1	6	0,61	0,5	3,060	4,170	4.404.224	11.011	0	2.938.498	102.839	102.839
2026-2	7	0,61	0,5	3,060	4,170	4.404.224	11.011	169.393	2.938.498	102.839	272.232
2027-1	8	0,61	0,5	3,060	4,170	4.234.831	10.587	169.393	2.825.479	98.883	268.277
2027-2	9	0,61	0,5	3,060	4,170	4.065.438	10.164	169.393	2.712.460	94.928	264.321
2028-1	10	0,61	0,5	3,060	4,170	3.896.044	9.740	169.393	2.599.441	90.973	260.366
2028-2	11	0,61	0,5	3,060	4,170	3.726.651	9.317	169.393	2.486.422	87.017	256.411
2029-1	12	0,61	0,5	3,060	4,170	3.557.258	8.893	169.393	2.373.402	83.062	252.455
2029-2	13	0,61	0,5	3,060	4,170	3.387.865	8.470	169.393	2.260.383	79.107	248.500
2030-1	14	0,61	0,5	3,060	4,170	3.218.471	8.046	169.393	2.147.364	75.151	244.545
2030-2	15	0,61	0,5	3,060	4,170	3.049.078	7.623	169.393	2.034.345	71.196	240.589
2031-1	16	0,61	0,5	3,060	4,170	2.879.685	7.199	169.393	1.921.326	67.241	236.634
2031-2	17	0,61	0,5	3,060	4,170	2.710.292	6.776	169.393	1.808.307	63.285	232.679
2032-1	18	0,61	0,5	3,060	4,170	2.540.898	6.352	169.393	1.695.287	59.330	228.723
2032-2	19	0,61	0,5	3,060	4,170	2.371.505	5.929	169.393	1.582.268	55.375	224.768
2033-1	20	0,61	0,5	3,060	4,170	2.202.112	5.505	169.393	1.469.249	51.419	220.813
2033-2	21	0,61	0,5	3,060	4,170	2.032.719	5.082	169.393	1.356.230	47.464	216.857
2034-1	22	0,61	0,5	3,060	4,170	1.863.326	4.658	169.393	1.243.211	43.509	212.902
2034-2	23	0,61	0,5	3,060	4,170	1.693.932	4.235	169.393	1.130.192	39.553	208.947
2035-1	24	0,61	0,5	3,060	4,170	1.524.539	3.811	169.393	1.017.172	35.598	204.991
2035-2	25	0,61	0,5	3,060	4,170	1.355.146	3.388	169.393	904.153	31.643	201.036
2036-1	26	0,61	0,5	3,060	4,170	1.185.753	2.964	169.393	791.134	27.687	197.081
2036-2	27	0,61	0,5	3,060	4,170	1.016.359	2.541	169.393	678.115	23.732	193.125
2037-1	28	0,61	0,5	3,060	4,170	846.966	2.117	169.393	565.096	19.777	189.170
2037-2	29	0,61	0,5	3,060	4,170	677.573	1.694	169.393	452.077	15.821	185.215
2038-1	30	0,61	0,5	3,060	4,170	508.180	1.270	169.393	339.057	11.866	181.259
2038-2	31	0,61	0,5	3,060	4,170	338.786	847	169.393	226.038	7.911	177.304
2039-1	32	0,61	0,5	3,060	4,170	169.393	423	169.393	113.019	3.955	173.349

Figure 10 World Bank Payment Plan

Years	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
KARAMAN	Grace Period	Grace Period	Grace Period	1	2	3	4	5	6	7	8	9	10
Total Cash Inflow (€)				708.606,21	722.689,76	737.053,22	751.702,15	766.642,23	781.879,25	797.419,10	813.267,80	829.431,50	845.916,45
Total Energy Production (kWh)				8.576.691,00	8.533.807,55	8.491.138,51	8.448.682,81	8.406.439,40	8.364.407,20	8.322.585,17	8.280.972,24	8.239.567,38	8.198.369,54
Total Energy Consumption (kWh)				8.576.691,00	8.533.807,55	8.491.138,51	8.448.682,81	8.406.439,40	8.364.407,20	8.322.585,17	8.280.972,24	8.239.567,38	8.198.369,54
Total Energy Consumption (kWh) - Other Locations				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Energy Netting Benefit (€/kWh)				0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689
Energy Netting VAT (€/kWh)				0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138
Energy Selling Benefit (€/kWh) - Other Locations				0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583
Total Cash Outflow (€)				33.797,63	34.522,89	35.266,29	36.028,26	36.809,29	37.609,84	38.430,41	39.271,49	40.133,59	41.017,25
OPEX €4,65-€7,48/kWdc - (B.L. Electricity Markets&Policy) Range: €6.06				29.010,43	29.735,69	30.479,09	31.241,06	32.022,09	32.822,64	33.643,21	34.484,29	35.346,39	36.230,05
Insuarance Fee (€)				4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20
Fixed Capital Investment (€)				4.404.224,00									
Solar Power Plant (inc. VAT)				4.404.224,00									
Cumulative Income(€)				674.808,58	688.166,87	701.786,93	715.673,89	729.832,94	744.269,40	758.988,69	773.996,31	789.297,90	804.899,19
Reduced Cash Flow (€)				674.808,58	1.362.975,44	2.064.762,38	2.780.436,27	3.510.269,21	4.254.538,61	5.013.527,30	5.787.523,61	6.576.821,51	7.381.720,71
Financial Return Rate (FRR)				**17,05%**									
Return of Investment									**6 YEARS**				
World Bank Credit Scenario (%0,61 + Euribor + %3,06 + %0,50 İlbank Interest = %4,17 annually, 3+13 Years Maturity, Foreign Exchange Credit)				7.342.722,25									
Annual Credit Payment (€)	102.839,00	205.677,00	205.677,00	532.598,00	516.776,00	500.955,00	485.134,00	469.312,00	453.491,00	437.670,00	421.848,00	406.027,00	390.206,00
Net Annual Income (€)				-371.982,42	171.390,87	200.831,93	230.539,89	260.520,94	290.778,40	321.318,69	352.148,31	383.270,90	414.693,19
Cumulative Income(€)				-371.982,42	-200.591,56	240,38	230.780,27	491.301,21	782.079,61	1.103.398,30	1.455.546,61	1.838.817,51	2.253.510,71
Financial Return Rate (FRR)				**10,29%**									
Financial Payback Period													
Economical Analysis													
National Economical Advantage (Natural Gas)				243.886,95	248.734,20	253.677,79	258.719,64	263.861,69	269.105,94	274.454,42	279.909,21	285.472,40	291.146,17
GHG Advantage				107.020,38	109.147,41	111.316,71	113.529,13	115.785,53	118.086,76	120.433,74	122.827,36	125.268,55	127.758,26
Employment Advantage				92.483,00	94.795,08	97.164,95	99.594,08	102.083,93	104.636,03	107.251,93	109.933,22	112.681,56	115.498,59
Regional Economical Advantage				708.606,21	722.689,76	737.053,22	751.702,15	766.642,23	781.879,25	797.419,10	813.267,80	829.431,50	845.916,45
Overall Economic Advantage				1.151.996,54	1.175.366,44	1.199.212,68	1.223.545,00	1.248.373,38	1.273.707,98	1.299.559,18	1.325.937,59	1.352.854,00	1.380.319,47
Cumulative Economical Income				1.151.996,54	2.327.362,98	3.526.575,66	4.750.120,66	5.998.494,03	7.272.202,01	8.571.761,19	9.897.698,78	11.250.552,78	12.630.872,25
Economical Return Rate (ERR)				**41,23%**									
Economical Payback Period									**6 YEARS**				

Years	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
KARAMAN	11	12	13	14	15	16	17	18	19	20
Total Cash Inflow (€)	862.729,04	879.875,78	897.363,31	915.198,40	933.387,97	951.939,06	970.858,85	990.154,67	1.009.833,99	1.029.904,44
Total Energy Production (kWh)	8.157.377,70	8.116.590,81	8.076.007,85	8.035.627,81	7.995.449,68	7.955.472,43	7.915.695,06	7.876.116,59	7.836.736,01	7.797.552,33
Total Energy Consumption (kWh)	8.157.377,70	8.116.590,81	8.076.007,85	8.035.627,81	7.995.449,68	7.955.472,43	7.915.695,06	7.876.116,59	7.836.736,01	7.797.552,33
Total Energy Consumption (kWh) - Other Locations	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Energy Netting Benefit (€/kWh)	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689
Energy Netting VAT (€/kWh)	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138
Energy Selling Benefit (€/kWh) - Other Locations	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583
Total Cash Outflow (€)	41.923,01	42.851,40	43.803,01	44.778,40	45.778,18	46.802,96	47.853,35	48.930,00	50.033,57	51.164,73
OPEX €4,65-€7,48/kWdc - (B.L. Electricity Markets&Policy) Range: €6.06	37.135,81	38.064,20	39.015,81	39.991,20	40.990,98	42.015,76	43.066,15	44.142,80	45.246,37	46.377,53
Insuarance Fee (€)	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20
Fixed Capital Investment (€)										
Solar Power Plant (inc. VAT)										
Cumulative Income(€)	820.806,03	837.024,38	853.560,30	870.420,00	887.609,79	905.136,10	923.005,50	941.224,66	959.800,42	978.739,71
Reduced Cash Flow (€)	8.202.526,74	9.039.551,12	9.893.111,42	10.763.531,42	11.651.141,21	12.556.277,32	13.479.282,81	14.420.507,48	15.380.307,89	16.359.047,60
Financial Return Rate (FRR)	**17,05%**									
Return of Investment										
World Bank Credit Scenario (%0,61 + Euribor + %3,06 + %0,50 İlbank Interest = %4,17 annually, 3+13 Years Maturity, Foreign Exchange Credit)										
Annual Credit Payment (€)	374.384,00	358.563,00	173.349,00							
Net Annual Income (€)	446.422,03	478.461,38	680.211,30	870.420,00	887.609,79	905.136,10	923.005,50	941.224,66	959.800,42	978.739,71
Cumulative Income(€)	2.699.932,74	3.178.394,12	3.858.605,42	4.729.025,42	5.616.635,21	6.521.771,32	7.444.776,81	8.386.001,48	9.345.801,89	10.324.541,60
Financial Return Rate (FRR)	**10,29%**									
Financial Payback Period							**17 YEARS**			
Economical Analysis										
National Economical Advantage (Natural Gas)	296.932,70	302.834,23	308.853,06	314.991,52	321.251,97	327.636,86	334.148,64	340.789,84	347.563,04	354.470,86
GHG Advantage	130.297,46	132.887,12	135.528,25	138.221,88	140.969,04	143.770,80	146.628,24	149.542,48	152.514,63	155.545,86
Employment Advantage	118.386,06	121.345,71	124.379,35	127.488,84	130.676,06	133.942,96	137.291,53	140.723,82	144.241,92	147.847,97
Regional Economical Advantage	862.729,04	879.875,78	897.363,31	915.198,40	933.387,97	951.939,06	970.858,85	990.154,67	1.009.833,99	1.029.904,44
Overall Economic Advantage	1.408.345,25	1.436.942,84	1.466.123,98	1.495.900,63	1.526.285,04	1.557.289,67	1.588.927,26	1.621.210,81	1.654.153,58	1.687.769,13
Cumulative Economical Income	14.039.217,50	15.476.160,35	16.942.284,32	18.438.184,96	19.964.470,00	21.521.759,67	23.110.686,93	24.731.897,74	26.386.051,32	28.073.820,44
Economical Return Rate (ERR)	**41,23%**									

Years	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
KARAMAN	21	22	23	24	25	26	27	28	29	30
Total Cash Inflow (€)	1.050.373,79	1.071.249,97	1.092.541,06	1.114.255,32	1.136.401,14	1.158.987,11	1.182.021,98	1.205.514,67	1.229.474,27	1.253.910,08
Total Energy Production (kWh)	7.758.564,56	7.719.771,74	7.681.172,88	7.642.767,02	7.604.553,18	7.566.530,42	7.528.697,77	7.491.054,28	7.453.599,01	7.416.331,01
Total Energy Consumption (kWh)	7.758.564,56	7.719.771,74	7.681.172,88	7.642.767,02	7.604.553,18	7.566.530,42	7.528.697,77	7.491.054,28	7.453.599,01	7.416.331,01
Total Energy Consumption (kWh) - Other Locations	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Energy Netting Benefit (€/kWh)	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689	0,0689
Energy Netting VAT (€/kWh)	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138	0,0138
Energy Selling Benefit (€/kWh) - Other Locations	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583	0,0583
Total Cash Outflow (€)	52.324,17	53.512,60	54.730,73	55.979,32	57.259,12	58.570,92	59.915,51	61.293,72	62.706,38	64.154,36
OPEX €4,65-€7,48/kWdc - (B.L. Electricity Markets&Policy) Range: €6.06	47.536,97	48.725,40	49.943,53	51.192,12	52.471,92	53.783,72	55.128,31	56.506,52	57.919,18	59.367,16
Insuarance Fee (€)	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20	4.787,20
Fixed Capital Investment (€)										
Solar Power Plant (inc. VAT)										
Cumulative Income(€)	998.049,62	1.017.737,38	1.037.810,33	1.058.276,00	1.079.142,02	1.100.416,20	1.122.106,47	1.144.220,95	1.166.767,89	1.189.755,71
Reduced Cash Flow (€)	17.357.097,22	18.374.834,60	19.412.644,93	20.470.920,93	21.550.062,96	22.650.479,15	23.772.585,62	24.916.806,57	26.083.574,47	27.273.330,18
Financial Return Rate (FRR)	**17,05%**									
Return of Investment										
World Bank Credit Scenario (%0,61 + Euribor + %3,06 + %0,50 İlbank Interest = %4,17 annually, 3+13 Years Maturity, Foreign Exchange Credit)										
Annual Credit Payment (€)										
Net Annual Income (€)	998.049,62	1.017.737,38	1.037.810,33	1.058.276,00	1.079.142,02	1.100.416,20	1.122.106,47	1.144.220,95	1.166.767,89	1.189.755,71
Cumulative Income(€)	11.322.591,22	12.340.328,60	13.378.138,93	14.436.414,93	15.515.556,96	16.615.973,15	17.738.079,62	18.882.300,57	20.049.068,47	21.238.824,18
Financial Return Rate (FRR)	**10,29%**									
Financial Payback Period										
Economical Analysis										
National Economical Advantage (Natural Gas)	361.515,97	368.701,10	376.029,03	383.502,61	391.124,72	398.898,32	406.826,43	414.912,10	423.158,48	431.568,76
GHG Advantage	158.637,34	161.790,25	165.005,83	168.285,33	171.630,00	175.041,14	178.520,08	182.068,17	185.686,78	189.377,30
Employment Advantage	151.544,16	155.332,77	159.216,09	163.196,49	167.276,40	171.458,31	175.744,77	180.138,39	184.641,85	189.257,90
Regional Economical Advantage	1.050.373,79	1.071.249,97	1.092.541,06	1.114.255,32	1.136.401,14	1.158.987,11	1.182.021,98	1.205.514,67	1.229.474,27	1.253.910,08
Overall Economic Advantage	1.722.071,26	1.757.074,09	1.792.792,02	1.829.239,74	1.866.432,26	1.904.384,89	1.943.113,27	1.982.633,34	2.022.961,38	2.064.114,03
Cumulative Economical Income	29.795.891,70	31.552.965,79	33.345.757,81	35.174.997,54	37.041.429,81	38.945.814,70	40.888.927,97	42.871.561,30	44.894.522,68	46.958.636,71
Economical Return Rate (ERR)	**41,23%**									

10. PROJECT INDICATORS

10.1. KEY PERFORMANCE INDICATORS (KPI)

PVsyst simulation results of the plant, which has 4787,2 kWp DC Power and 4000 kWe AC power, are as follows. The simulation report is included in the attachments.

According to the simulation, the plant will produce 8,576,691 kWh of energy annually. However, the actual performance indication will be established by installing a pyranometer and meteorology station on the project site. The measurements will be performed by the pyranometer and meteorology station will be compared with the actual energy generation of the power plant and the performance ratio will be calculated.

PUMREP Eligibility Criteria of the renewable energy investment financed under the PUMREP Project Finance are listed aşağıda:

Table 14: PUMREP Eligibility Criteria of the Renewable Energy Investment

Eligibility Criteria	Project Compliance
• The Property Is Legally Allocated To The Municipality	• Municipality-Owned Property By National Real Estate Agency.
• There Are No Plans For Move, Closure, Demolition, Or	• No Plans For Facility Changes Or Privatization Of The Facility.
• The Project Land Is Not Exposed To High Flood Risk.	• Project Site Not At High Flood Risk
• The Proposed Renewable Energy Investment Qualifies For	• Solar PV Technology Utilized
• "Unlicensed" Electricity Production Pursuant To The	• Explain In Compliance To Legal Framework Section
• "Unlicensed Electricity In The Electricity Market	• Explain In Compliance To Legal Framework Section
• Production Regulation" No: 3772.	• Explain In Compliance To Legal Framework Section
• The Feasibility Study Confirms The Financial Viability	• Feasibility Study Confirms Viability With A
• With A Maximum Simple Payback Period Of 15 Years.	• Explained in Financial and Economical Analysis
• Project Facility Is Not Associated With Military Or	• No Military Or Security-Related Purposes
• Security-Related Purposes.	• Associated With The Project.

10.1.1. OHS INDICATORS

Employers and supervisors are obliged to implement all reasonable precautions to protect the health and safety of workers. In this regard, under the scope of this project World Bank General EHS Guide 2.0 taken as reference while designing the principle Environmental, Health and Safety Guard of this project.[56]

EHS topics of World Bank's EHS Guideline handled the categories given below

- General Facility Design and Operation
- Communication and Training
- Physical Hazards
- Chemical Hazards
- Biological Hazards
- Radiological Hazards
- Personal Protective Equipment (PPE)
- Special Hazard Environments
- Monitoring

In this context, the contractor is obliged to do the followings:

- The Contractor will provide occupational health and safety orientation training to all employees consisting of basic hazard awareness, site-specific hazards, safe working practices, and emergency procedures,
- The Contractor will be committed to ensure all H&S measures are in place to prevent accidents and reduce the consequences of non-conformance events during construction and operation phases,
- The EPC will provide training, awareness and supervision to ensure all of its construction workers comply with the OHS procedures;

[5] https://www.ifc.org/wps/wcm/connect/1d19c1ab-3ef8-42d4-bd6b-cb79648af3fe/2%2BOccupational%2BHealth%2Band%2BSafety.pdf?MOD=AJPERES&CVID=ls62x8l
[6] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines

- The EPC will provide all appropriate resources i.e. personal protective equipment (PPE) to all workers onsite; and an emergency response procedure and infrastructure will be available on site to ensure provision of first aid for personnel in case of an emergency.

11. OPERATION AND MAINTENANCE

High-quality and timely servicing increases the productivity of solar power plants and reduces maintenance and repair costs. Compared to other power generating equipment, PV-stations are simple and unpretentious in maintenance, however, their effectiveness and return on investment depend on how professionally the construction is carried out, subsequent maintenance, and monitoring of the functioning of individual elements of the system. Therefore, operation and maintenance (O&M) are one of the main ways to ensure the most highly efficient operation of a solar power plant.

The operation and maintenance of the Karaman Municipality Solar Power Plant are critical components ensuring its efficient and sustainable functioning. This section outlines the organizational structure, staffing requirements, and monitoring procedures for the operation and maintenance of the solar power plant.

Organizational Structure

The operation and maintenance team of the Karaman Municipality Solar Power Plant will be structured as follows:

Plant Manager: Responsible for overseeing all aspects of the operation and maintenance activities, ensuring compliance with safety regulations, and managing personnel.

Operation Technicians: Two technicians will be assigned to the operation phase. They will be responsible for monitoring equipment performance, troubleshooting operational issues, and ensuring smooth operation.

Security Personnel: Security personnel will be assigned to ensure the security and safety of the solar power plant 24 hours a day, 7 days a week.

Staffing Requirements

The operation and maintenance team will consist of a total of 3 technical personnel, as follows:

Plant Manager: 1

Operation Technicians: 2

In addition to the technical personnel, there will be security personnel assigned to ensure the security and safety of the solar power plant 24/7.

Qualifications of Personnel

Plant Manager: Bachelor's degree in Electrical Engineering or a related field, with extensive experience in solar power plant operation and management.

Operation Technicians: Diploma or technical certification in Electrical or Mechanical Engineering, with experience in operating and maintaining solar power plants.

Security Personnel: Trained in security protocols and emergency response procedures, with a focus on ensuring the safety of personnel and facilities.

Monitoring Procedures

The operation of the solar power plant will be monitored continuously through a Supervisory Control and Data Acquisition (SCADA) system installed in the operation room of the substation. The SCADA system will provide real-time data on the performance of the solar panels, inverters, transformers, and other critical components, allowing the operation team to identify and address any issues promptly.

Regular inspections and maintenance checks will also be conducted as part of the monitoring procedures to ensure the reliability and efficiency of the solar power plant.Regular inspections and maintenance checks will also be conducted as part of the monitoring procedures to ensure the reliability and efficiency of the solar power plant.

By implementing an effective operation and maintenance strategy and staffing the solar power plant with qualified personnel, we aim to maximize the plant's energy production, minimize downtime, and ensure the long-term sustainability of the project.

A competent set of solar power plant operation and maintenance (O&M) services guarantees that the photovoltaic system maintains a high level of technical and, hence, economic performance throughout its life cycle. Stakeholders should understand the importance of high-quality operations and maintenance services decrease possible hazards and improve return on investment.

Measured indicators are the key parameters to notice and eliminate possible failure or malfunctions in time. These indicators are listed below[7].

- General indicators (voltage, current, performance);
- Amount of electricity generated;
- Amount of electricity consumed;
- Status of connections and switches;
- Damage and emergency status of individual system elements;
- Solar energy conversion efficiency;

[7] https://avenston.com/en/articles/operation-and-maintenance-services/

- Charge-discharge batteries.

The typical malfunctions for a SPP can be listed as

- Fasteners Lack or Weakening and Corrosion
- Inverters Overheating or Damage
- Photovoltaic Modules Faulty or Ineffective
- Poor Grounding
- Clogged Ventilation
- Shading by Tree Branches and Modules Pollution
- Production Defect
- Damage from Pests

For a regular inspection and unscheduled support, which involves the departure of the emergency team, diagnostics and repair work, several equipment is required as listed below.[8]

- Checking the condition of cables and equipment
- Thermal inspection of connection boxes and power circuits
- Measurement of insulation resistance of cables and equipment
- Conducting an audit of contact compounds
- Grounding resistance measurement
- Temperature measurement of PV modules and inverter power section
- Internal cleaning of the inverter from dust and dirt
- Check bolt connections
- Inspection of all equipment and insulation for mechanical damage
- Carrying out maintenance
- Processing of indicators and electronic layout transfer
- Indicators reconciliation acts drawing up

[8] https://avenston.com/en/articles/operation-and-maintenance-services/

In recent years, many different methods for testing PV modules developed and a significant part of them applied in practice (see Figure 27). O&M companies are very interested in these methods, but often face the problem of choosing the most effective method.

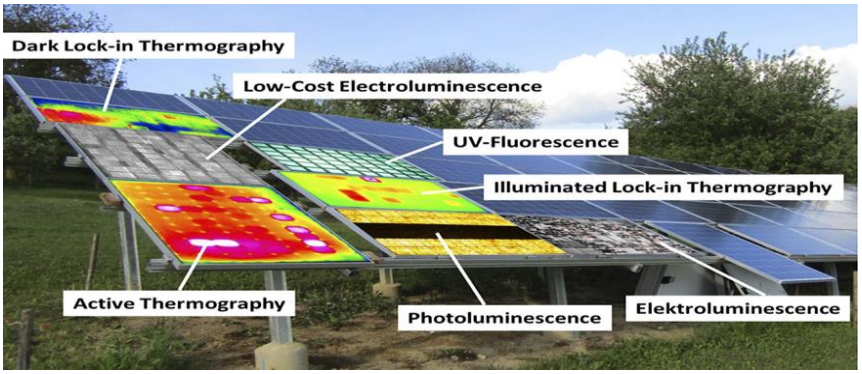

Figure 11. Schematic representation of various PV-modules testing methods

However, visual inspection is the most trivial and quite effective method. Specially trained personnel can detect module malfunctions with a simple external examination. Although many changes in performance are invisible and require more sophisticated detection methods, nevertheless, an external inspection allows identifying defects such as: Hot Spot, Shadowing effects, Yellowing, Glass Breakage, Delamination, Ruptured Back sheet.

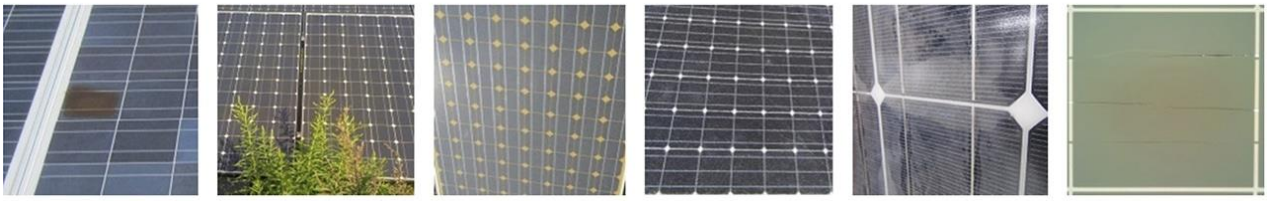

Figure 12. Visual modules inspection (from left to right): Hot Spot, Shadowing effects, Yellowing, Glass Breakage, Delamination, Ruptured Back sheet

Besides all these, Personnel for Maintenance and Operation of solar power plants require training, skills, and abilities. With market growth and the solar investment portfolios globalization, expectations for service quality are growing rapidly. Consequently, maintenance services providers should deal with

- Real-time interpretation and data collection;
- Ongoing energy production monitoring;
- Critical as well as non-critical repairs;
- Trend and KPI analysis to continuous performance improvement ensure;
- Minimize costs and the best system performance ensure;
- Inventory and spare parts management;

- Remote or local sensing of environmental conditions affecting solar power plant;
- Security issues identifying.

In addition, although the maintenance costs of solar power plants are negligible compared to other power generating devices, maintaining, and operating costs depend on several factors such as location, solar system type, PV components and environmental conditions.

A typical maintenance needs for a solar power plant illustrated in figure below.

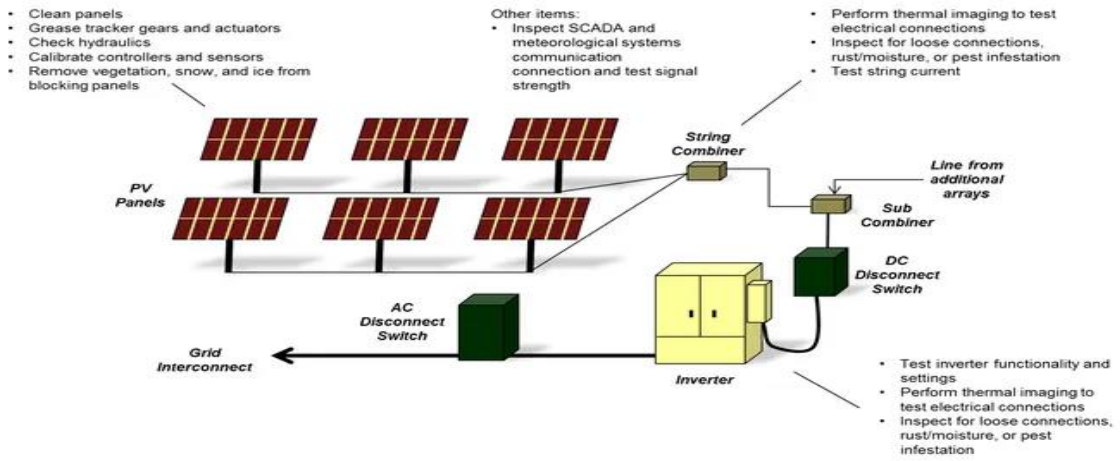

Figure 13. Some of the maintenance need for solar power plant that needs to be considered.[9]

- cables should be selected by the consultant/EPC contractor.

[9] https://avenston.com/en/articles/operation-and-maintenance-services/

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Annexes

Annex 1:Environmental , Social , Labor , Health and Safety Legislation

Regulations / Communiques	OG Number	OG Date	Relevance/Implication for the Project
Environmental Permit and Licenses			
Regulation on Environmental Impact Assessment	31907	29.07.2022	Scoping of the Project and evaluation of impacts for the pre-construction, construction and operation stages of the Project.
Regulation on Environmental Permits and Licensing	29115	10.09.2014	Requirements for environmental permits and licenses at all stages of the Project.
Regulation on Environmental Auditing	27061	21.11.2008	Requirements for environmental audits to be performed by either Project Owner or governmental authorities during construction and operation stages.
Regulation on the Implementation of the Law Concerning Private Security Services	25606	07.10.2004	During the construction phase for camp site security and during the operation phase for safety purposes.
Air Quality Control and Greenhouse Gas (GHG) Emissions			
Industrial Air Pollution Control Regulation	27277	03.07.2009	During the construction phase, dust emissions.
Exhaust Gas Emission Control Regulation	30004	11.03.2017	Operation of Project vehicles, machinery, and equipment at all phases of the Project.
Biodiversity Conservation and Protection of Nature			
Regulation on Protection of Wildlife and Wildlife Development Area	259637	08.11.2004	Measures to be taken for wildlife protection near to the Project area during the planning phase of the Project.
Chemicals and Other Dangerous Substances			
Regulation on Classification, Labelling, and Package of the Materials and Mixtures	28848	11.12.2013	Taking measures for chemicals and mixtures to be used during construction and operation phases.
Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals	30105	23.06.2017	Determination of chemicals to be used during the operation phase.
Regulation on the Control of Polychlorinated Biphenyls (PCBs) and Polychlorinated	26739	27.12.2007	Usage of transformers, capacitors, electrical equipment including voltage regulators,

Regulations / Communiques	OG Number	OG Date	Relevance/Implication for the Project
Terphenyls (PCTs)			switches, oil used in motors, old electrical devices or appliances containing PCB capacitors, fluorescent light ballasts during the operational phase.
Noise			
Environmental Noise Control Regulation	32029	30.11.2022	Determination of noise emissions and measures to be taken at construction and operation phases.
Regulation on the Environmental Noise Emissions Caused by Equipment Used Outdoors	26392	30.12.2006	Regulating the noise levels caused by noise sources within the Project site at the construction and operation phases.
Soil and Land Use			
Regulation on the Control of Soil Pollution and Lands Contaminated by Point Sources	27605	08.06.2010	Determination of risks of soil contamination at construction and operation phases.
Regulation on Control of Excavated Soil, Construction and Demolition Wastes	25406	18.03.2004	Management of excavated soil and construction and demolition wastes at the source.
Regulation on Protection, Use, and Planning of Agricultural Lands	30265	09.12.2017	Management of change in the land use during the planning phase of the Project.
Waste			
Regulation on Waste Management	29314	02.04.2015	Management of waste from generation to disposal without harming the environment and human health during construction and operation phases.
Zero Waste Regulation	30829	12.07.2019	General principles regarding the establishment, development, monitoring, financing, recording and certification of the zero waste management system in line with sustainable development goals during construction and operation phases.
Regulation on Packaging Waste Control	30283	27.12.2017	Preventing the formation of packaging waste, reducing the amount of unavoidable

Regulations / Communiques	OG Number	OG Date	Relevance/Implication for the Project
			packaging waste to be disposed of using reuse, recycling and recovery methods in construction and operation phases.
Regulation on Waste Oil Management	30985	21.12.2019	Waste oils included in the definition of waste oil and the management, recovery, disposal of these wastes, precautions to be taken and notifications to be made
Regulation on Medical Waste Control	29959	25.01.2017	Collection of medical waste in the places where it is produced, temporary storage, transportation to the medical waste processing facilities and disposal
Regulation on Control of Waste Electrical and Electronic Equipment	28300	22.05.2012	Management of electrical and electronic equipment wastes during construction and operation phases.
Regulation on Control of Waste Batteries and Accumulators	25569	31.08.2004	Establishment of a collection system and management for the recovery or final disposal of waste batteries and accumulators.
Regulation on Control of End-of-life Tires	26357	25.11.2006	Establishing a collection and management system for ensuring the necessary regulations and standards in the management of end-of-life tires during the construction and operation phases.
Water and Wastewater			
Regulation on the Protection of Ground Waters against Pollution and Deterioration	28257	07.04.2012	Protection of groundwater sources against pollution during construction and operation phases.
Regulation on the Control of Pollution Caused by Hazardous Substances in and around Water Environment	26005	26.11.2005	Management of hazardous substances during construction and operation phases.
Regulation on Wastewater Collection and Removal Systems	29940	06.01.2017	Procedures and principles regarding the planning, design and project design, construction and operation of wastewater

Regulations / Communiques	OG Number	OG Date	Relevance/Implication for the Project
			collection and removal systems.
Structural Safety			
Regulation on Structures to be Built in Natural Disaster Areas	26582	14.07.2007	Management of construction works within the scope of the Project.
Regulation on Building Constructions in Earthquake Zones	26454	06.03.2007	Management of construction works within the scope of the Project.
Regulation on Building Earthquake of Turkiye	30364	18.03.2018	Measures to be taken for the design and construction works under the impact of earthquakes and the evaluation of the performance of existing buildings under the impact of earthquakes.
Regulation on the Protection of Buildings from Fire	26735	19.12.2007	Measures to be taken for fire protection during construction and operation phases.
Traffic			
Regulation on the Road Transportation of Hazardous Goods	28801	24.10.2013	Hazardous goods to be transported during construction and operation phase.
Regulation on Highway Traffic	23053	18.07.1997	Regulating speed limits of vehicles and machinery used during construction and operation phases.
Regulation on Traffic Signs	18789	19.06.1985	Regulating the traffic signs to be used during the construction and operation phases
Health and Safety and Labor			
Regulation on Emergency Situations in Workplaces	28681	18.06.2013	Preparation of emergency plans, prevention, protection, evacuation, firefighting, first aid and similar studies in workplaces.
Regulation on duties and responsibilities of OHS Specialists	28512	29.12.2012	Defines roles and responsibilities of OHS specialists
Regulation on duties and responsibilities of Occupational Physicians and other medical personnel	28713	20.07.2013	Defines roles and responsibilities of Occupational physicians and the medial personnel
Regulation on Health and Safety at Construction	28786	05.10.2013	Measures to be taken during construction

Regulations / Communiques	OG Number	OG Date	Relevance/Implication for the Project
Works			phase.
Regulation on Health and Safety Conditions Regarding Use of Work Equipment	28628	25.04.2013	Measures to be taken during construction phase related to use of equipment.
Regulation on Health and Safety Precautions Regarding Working with Chemicals	28733	12.08.2013	Measures to be taken during construction and operation phase related to use of chemicals.
Regulation on Protection of Employees from the Hazards of Explosive Environments	28633	30.04.2013	It regulates the procedures and principles regarding the precautions to be taken in order to protect the employees from the dangers of explosive atmospheres that may occur in the workplaces in terms of health and safety.
Regulation on Health and Safety Regarding Temporary and Time-Limited Works	28744	23.08.2013	Protection of employees with a temporary or fixed-term employment contract at the same level as other employees in the workplace in terms of health and safety.
Regulation on Health and Safety Signs	28762	11.09.2013	Measures to be taken during construction and operation phases.
Regulation on Management of Dust	289812	05.11.2013	Measures to be taken to combat dust in terms of occupational health and safety to prevent the risks that may arise from dust in the workplaces and to ensure that the workers are protected from the effects of dust.
Regulation on Material Safety Data Sheets on Hazardous Materials and Mixtures	29204	13.12.2014	Preparation of safety data sheets to ensure effective control and surveillance against the negative effects of harmful substances and mixtures on human health and the environment during construction and operation phases.
Law on Occupational Health and Safety (6331)	28339	20.06.2012	Health and safety measures to be taken during construction and operation stages.
Regulation on Personal Protective Equipment	30761	01.05.2019	Measures to be taken during construction and operation phases to ensure the health and safety of employees.

Regulations / Communiques	OG Number	OG Date	Relevance/Implication for the Project
Regulation on Protection of Workers from Risks Created by Noise	28721	28.07.2013	Measures to be taken during construction and operation phases to ensure the health and safety of employees.
Regulation on Risk Assessment for Occupational Health and Safety	28512	29.12.2012	Determination of occupational health and safety risks occurring during construction and operation phases.
Regulation on Sub-contractors	27010	27.09.2008	Management of contactors/sub-contractors during construction and operation phases.
Regulation on Use of Personal Protective Equipment in Workplaces	28695	02.07.2013	Measures to be taken during construction and operation phases to ensure the health and safety of employees.
Regulation on Vocational Training of the Employees Working in Dangerous and Highly Dangerous Workplaces	28706	13.07.2013	Measures to be taken during construction and operation phases to ensure the health and safety of employees.
Regulation on the Procedures and Principles of Employee Health and Safety Training	28648	15.05.2013	Measures to be taken during construction and operation phases to ensure the health and safety of employees.
Regulation on High Current Electrical Facilities	24246	30.11.2000	Covers measures regarding the safe installation, construction, operation and maintenance of high current electrical facilities.
Regulation on Manual Handling	28717	24.07.2013/	Defines the safe procedures for safe handling of goods and equipment using manual manpower.
Cultural Heritage			
Law on Protection of Cultural and Natural Assets	18113	23.07.1983	During chance finds at the construction phase, determination of measures to be taken.
Regulation on Researches, Drillings and Excavations in relation to the Cultural and Natural Assets	18485	10.08.1984	Defining the procedures and obligations concerning the cultural and natural assets found out during construction.

Annex 2: Title Deed

İli	KARAMAN
İlçesi	MERKEZ
Mahallesi	PİRİREİS
Köyü	
Sokağı	
Mevkii	Tatlıkuyu Sırtları

Türkiye Cumhuriyeti

TAPU SENEDİ

Fotoğraf

Satış Bedeli	Pafta No.	Ada No.	Parsel No.	Yüzölçümü ha	Yüzölçümü m²	Yüzölçümü dm²
0,00		4883	1		94.079,03	m2

GAYRİMENKULÜN

Niteliği	ARSA
Sınırı	Planındadır Zemin Sistem No : 88967756
Edinme Sebebi	PİRİREİS Mah. 1201 Ada 1 Parsel taşınmazının İfraz İşlemi (TSM) işleminden.
Sahibi	KARAMAN BELEDİYESİ - (KARAMAN) Tam

Geldisi		Yevmiye No.	Cilt No.	Sahife No.	Sıra No.	Tarihi	Gittisi	
Cilt No.		7371	42	4157		29/04/2015		Cilt No.
Sahife No.		Siciline Uygundur. İsmail UYSAL Yetkili Müdür Yardımcısı						Sahife No.
Sıra No.								Sıra No.
Tarih								Tarih

NOT : * Mülkiyetin gayri ayni haklar ile şerhler için tapu kütüğünü müracaat edilmelidir.
** Tebligat Kanunu Hükümleri gereğince adres değişikliği ilgili Tapu Sicil Müdürlüğüne bildirilecektir.

Annex 3: EIA Decision

T.C.
ÇEVRE ve ŞEHİRCİLİK BAKANLIĞI
Çevresel Etki Değerlendirmesi, İzin ve Denetim Genel Müdürlüğü

T.C.
KARAMAN VALİLİĞİ
ÇEVRE ve ŞEHİRCİLİK İL MÜDÜRLÜĞÜ

Karar Tarihi : 07-01-2020
Karar No : 69306553 220-02 E-20203

ÇEVRESEL ETKİ DEĞERLENDİRME BELGESİ

25.11.2014 tarih ve 29186 sayılı Resmi Gazete'de yayımlanarak yürürlüğe giren Çevresel Etki Değerlendirmesi Yönetmeliği'nin Ek-II listesinde yer alan **'4MWe GÜNEŞ ENERJİ SANTRALİ KAPASİTE ARTIRIMI'** projesi ile ilgili olarak inceleme-değerlendirme yapılmış ve Proje Tanıtım Dosyasında çevresel etkilere karşı alınması öngörülen önlemler yeterli görülmüştür. Ayrıca ÇED Raporu hazırlanmasına gerek bulunmadığı tespit edilmiş olup, söz konusu projeye ÇED Yönetmeliğinin 17. Maddesi gereğince Valiliğimizce **"Çevresel Etki Değerlendirmesi Gerekli Değildir"** kararı verilmiştir.

Hacı İbrahim TÜRKOĞLU
Vali a.
Vali Yardımcısı

Proje Sahibi : KARAMAN BELEDİYE BAŞKANLIĞI
Proje Yeri : Karaman İli, Merkez İlçesi, Pirireis MAh. - N30c1 pafta - 4883 Ada - 1 Parsel (94079,03m2)
Kapasite : 4.999 kWe

Annex 3: Agricultural Permit

T.C.
KARAMAN VALİLİĞİ
İl Tarım ve Orman Müdürlüğü

Sayı : 70261189-230.99-E.2850362 — 19.09.2019
Konu : Arazi Sınıfı (Pirireis 4883/1 Parsel)

KARAMAN BELEDİYE BAŞKANLIĞINA
(Plan Ve Proje Müdürlüğü)

İlgi : 17.09.2019 tarihli ve 62614786-E.118855-36-5396 sayılı yazınız.

İlgi dilekçenizde, Pirireis Mahallesi Tatlıkuyu Sırtları Mevkii sınırları içerisinde bulunan ve arsa vasfı ile Karaman Belediyesi adına kayıtlı tapunun 4883 ada 1 nolu parselde güneş enerjisinden elektrik üretmek amacıyla lisanssız güneş enerjisi santrali (GES) kurulmasının planlandığı belirtilmekte ve ilgili elektrik dağıtım şirketine verilmek üzere Kurum görüşümüzün bildirilmesi istenmektedir

GES yatırımı yapılmak istenen ve mülkiyeti Karaman Belediyesine kayıtlı Pirireis mahallesi sınırları içerisinde bulunan arsa niteliğindeki 4883 ada 1 nolu parsel (94079 m^2) taşınmaz, 5403 sayılı Toprak Koruma ve Arazi Kullanımı Kanunu ile bu Kanuna bağlı olarak 9.12.2017 tarihli ve 30265 sayılı Resmi Gazete' de yayımlanan Tarım Arazilerinin Korunması Kullanılması ve Planlanmasına Dair Yönetmelik hükümlerinin uygulanması kapsamına girmemektedir

Karaman Belediyesine kayıtlı Pirireis mahallesi sınırları içerisinde bulunan, tapunun 4883 ada 1 nolu parsel taşınmazın vasfının ***arsa*** olması nedeniyle arazi sınıf tespiti yapılmamıştır.

Bilgilerinizi arz ederim.

Abdullah KAYA
İl Müdürü V.

Not: 5070 sayılı Elektronik İmza Kanunu gereği bu belge elektronik imza ile imzalanmıştır.

Cumhuriyet Mahallesi 703 Sokak No:11 70100 KARAMAN
Tel: 0 (338) 213 16 53 Faks: 0 (338) 213 49 80
E-Posta: karaman@tarim.gov.tr Kep: karaman@gthb.hs01.kep.tr

Bilgi için:Ayhan İNAN
Tekniker
Telefon No:(338) 213 16 53-307

Annex 4:Map of ETL Route

Karaman ETL Kmz

Karaman ETL.kmz

Annex 5:Yield Analysis

Sürüm 7.3.1

PVsyst - Simülasyon raporu

Şebekeye bağlı sistem

Proje: KARAMAN PİRİREİS

Varyant: Yeni simülasyon varyantı
3B sahne tanımlanmadı, gölgelemesiz
Sistem gücü : 4787 kWp
Karaman - Turkey

Hazırlayan

REPUBLIC OF TURKEY
MINISTRY OF ENVIRONMENT
AND URBANISATION

İLBANK
CONSTRUCTIVE POWER OF TURKEY

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

Proje: KARAMAN PİRİREİS

Varyant: Yeni simülasyon varyantı

Proje özeti

Coğrafi konum
Karaman
Turkey

Konum
Enlem 37.18 °N
Boylam 33.22 °E
Rakım 1033 m
Saat dilimi UTC+3

Proje ayarları
Albedo 0.20

Hava durumu verileri
Karaman
Meteonorm 8.1 (2003-2010), Sat=% 100 - Sentetik

Sistem özeti

Şebekeye bağlı sistem

3B sahne tanımlanmadı, gölgelemesiz

Kolektör düzleminin yönlendirmesi
Sabit düzlem
Eğim/Azimut 30 / 25 °

Yakın gölgelemeler
Gölgelemesiz

Kullanıcı ihtiyaçları
Sınırsız yükleme (şebeke)

Sistem bilgisi

PV alanı
Panel sayısı 8704 adet
Toplam nom. güç 4787 kWp

Invertör
Öğe sayısı 40 adet
Toplam nom. güç 4000 kWac
Nom. güç oranı 1.197

Sonuçların özeti

Üretilen enerji	8576691 kWh/yıl	Üretilebilir	1792 kWh/kWp/yıl	Perf. oranı PR	86.34 %

İçindekiler

Genel parametreler

Şebekeye bağlı sistem — **3B sahne tanımlanmadı, gölgelemesiz**

Kolektör düzleminin yönlendirmesi

Yönlendirme		Dizi ayarları	Kullanılan modeller	
Sabit düzlem		3B sahne tanımlanmadı	Transpozisyon	Perez
Eğim/Azimut	30 / 25 °		Difüz	Perez, Meteonorm
			Circumsolar	ayrı

Ufuk		Yakın gölgelemeler	Kullanıcı ihtiyaçları
Ortalama yükseklik	1.4 °	Gölgelemesiz	Sınırsız yükleme (şebeke)

Kolektör alanının özellikleri

PV modül

Üretici	CW Enerji
Model	CWT550 - 108PM12
(Kullanıcı tarafından belirlenen parametreler)	
Birim gücü	550 Wp
PV modül sayısı	8704 adet
Nominal (STC)	4787 kWp
Modül	544 Zincir x 16 Seri
İşletme şartlarında (50°C)	
Pmpp	4366 kWp
U mpp	456 V
I mpp	9574 A

Total PV gücü

Nominal (STC)	4787 kWp
Toplam	8704 modül
Panel yüzeyi	22286 m²
Hücre yüzeyi	20728 m²

İnvertör

Üretici	Huawei Technologies
Model	SUN2000-100KTL-INM0-415Vac
(Kullanıcı tarafından belirlenen parametreler)	
Birim gücü	100 kWac
İnvertör sayısı	40 adet
Toplam güç	4000 kWac
Çalışma gerilimi	300-1000 V
Maks güç (=>35°C)	110 kWac
Nom. güç oranı (DC:AC)	1.20
Power sharing within this inverter	

İnvertör toplam gücü

Toplam güç	4000 kWac
İnvertör sayısı	40 adet
Nom. güç oranı	1.20

Dizi kayıpları

Termal kayıp faktörü

Işınıma göre modül sıcaklığı	
Uc (sabit)	20.0 W/m²K
Uv (rüzgar)	0.0 W/m²K/m/s

DC kablolama kaybı

Global alan direnci	0.79 mΩ
Kayıp oranı	1.5 STC'de%

Modül kalite kaybı

Kayıp oranı	-0.8 %

Modül uyumsuzluk kaybı

Kayıp oranı	2.0 MPP'de%

Dizi uyumsuzluk kaybı

Kayıp oranı	0.1 %

IAM kayıp faktörü

Yansıma etkisi (IAM): Fresnel, yansıma önleyici, n(cam)=1.526, n(AR)=1.290

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

Ufuk tanımlaması

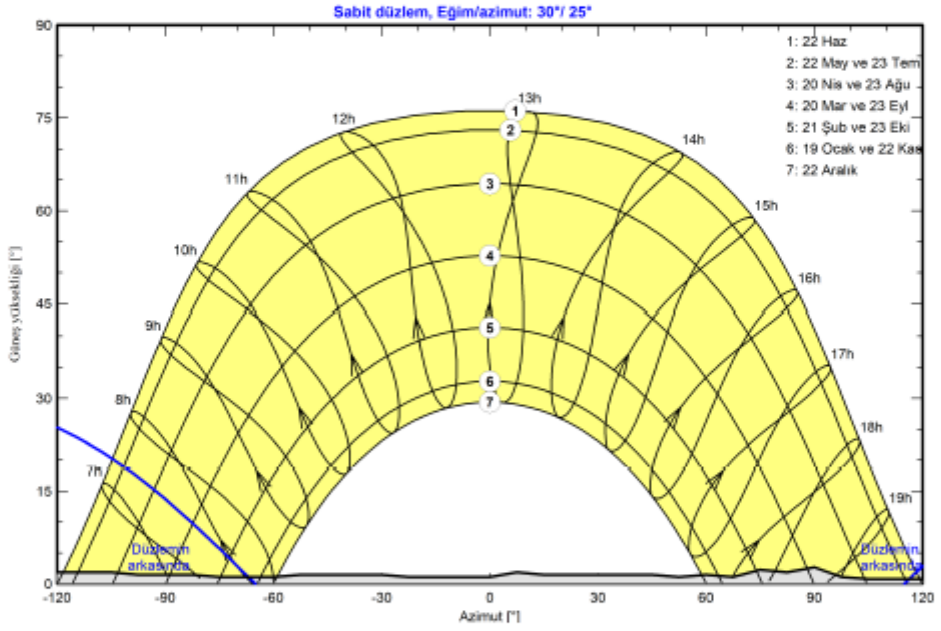
Horizon from PVGIS website API, Lat=37°10'51", Long=33°12'54", Alt=1033m

Ortalama yükseklik	1.4 °	Albedo faktörü	0.93
Difüz faktörü	0.99	Albedo oranı	100 %

Ufuk profili

Azimut [°]	-180	-165	-158	-105	-98	-83	-75	-60	-53	-30	-23	0	8	15
Yükseklik [°]	0.8	0.8	1.9	1.9	1.5	1.5	1.1	1.1	1.5	1.5	1.1	1.1	1.9	1.5
Azimut [°]	45	53	60	68	75	83	90	98	105	150	158	165	173	180
Yükseklik [°]	1.5	1.1	1.5	1.1	2.3	1.9	2.7	1.1	0.8	0.8	1.9	2.7	1.5	0.8

Güneş yörüngesi (yükseklik/azimut diyagramı)



Proje: KARAMAN PİRİREİS

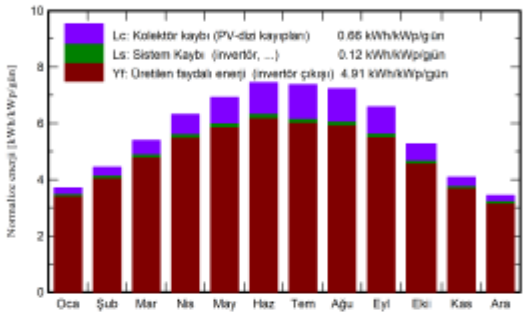
Varyant: Yeni simülasyon varyantı

Genel sonuçlar

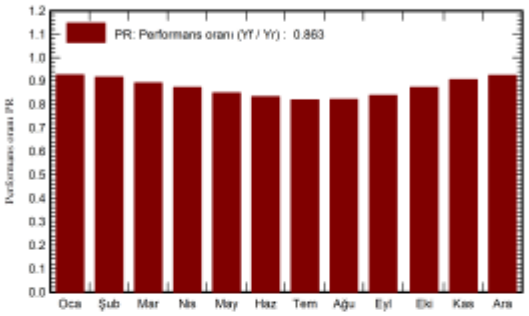
Sistem üretimi

Üretilen enerji	8576691 kWh/yıl	Üretilebilir	1792 kWh/kWp/yıl
		Performans oranı PR	86.34 %

Normalize üretim (kWp başı)



Performans oranı PR



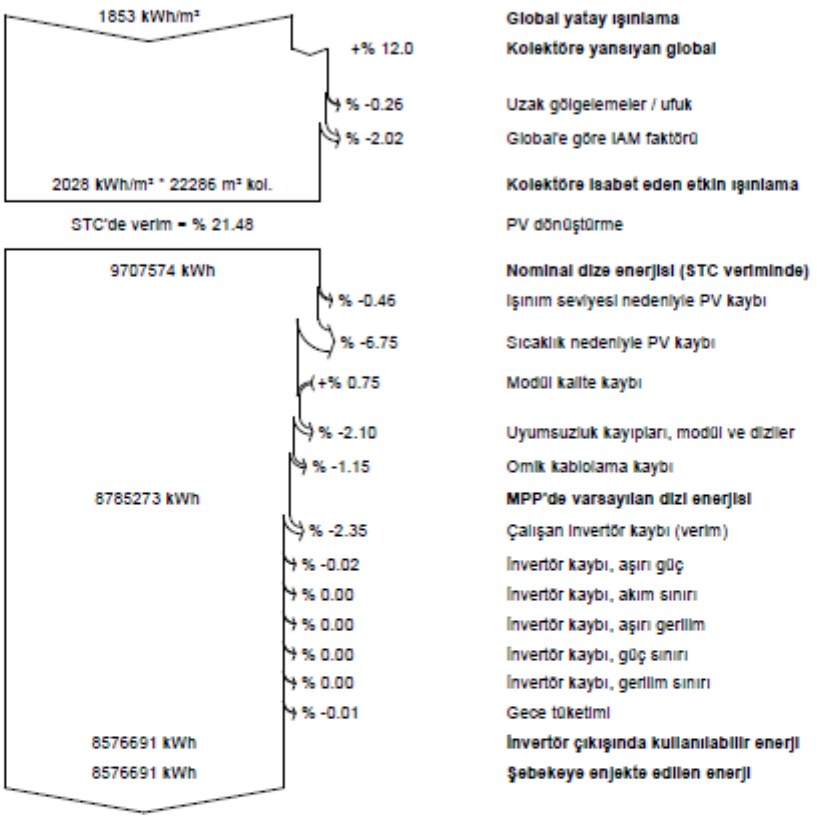
Bilanço ve genel sonuçlar

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR oran
Ocak	74.4	25.98	0.05	114.6	112.4	520341	507993	0.926
Şubat	91.4	34.78	2.04	124.2	121.3	558164	545108	0.917
Mart	139.8	52.55	7.18	167.1	163.4	730782	713505	0.892
Nisan	176.0	61.28	11.53	189.4	185.1	810195	791048	0.872
Mayıs	222.6	62.74	16.42	214.6	209.3	894491	873225	0.850
Haziran	240.6	57.08	20.94	223.2	217.4	912177	890549	0.833
Temmuz	241.3	57.89	24.73	228.4	222.7	918241	896553	0.820
Ağustos	217.2	53.12	24.61	224.1	219.4	903407	881994	0.822
Eylül	172.8	48.39	19.63	197.3	193.2	812021	792830	0.839
Ekim	125.3	42.44	13.74	163.0	159.7	696977	680736	0.872
Kasım	83.5	32.67	6.90	122.7	120.0	544617	532164	0.906
Aralık	67.7	27.03	1.85	106.4	104.0	482070	470987	0.924
Yıl	1852.6	555.96	12.53	2075.0	2027.9	8783485	8576691	0.863

Açıklama

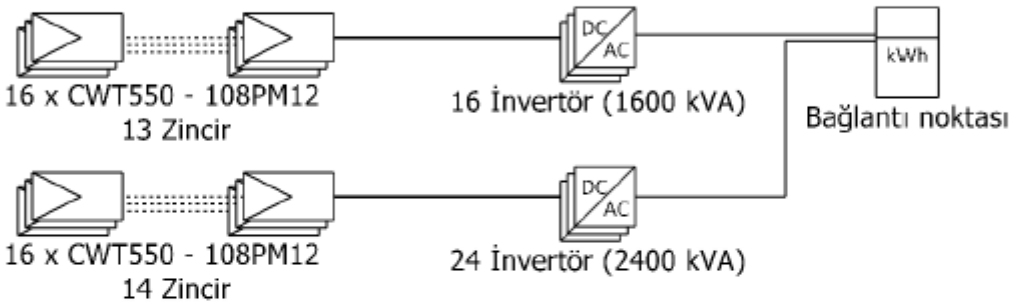
GlobHor	Global yatay ışınlama	EArray	Dizinin çıkışında etkin enerji
DiffHor	Yatay difüz ışınlama	E_Grid	Şebekeye enjekte edilen enerji
T_Amb	Çevre sıcaklığı	PR	Performans oranı
GlobInc	Kolektöre yansıyan global		
GlobEff	IAM ve gölgeleme için düzeltilmiş etkin Global		

Kayıplar diyagramı



Tek hat şeması

PVsyst V7.3.1
VC0, Simülasyon tarihi:
03/05/24 16:28
v7.3.1 lle

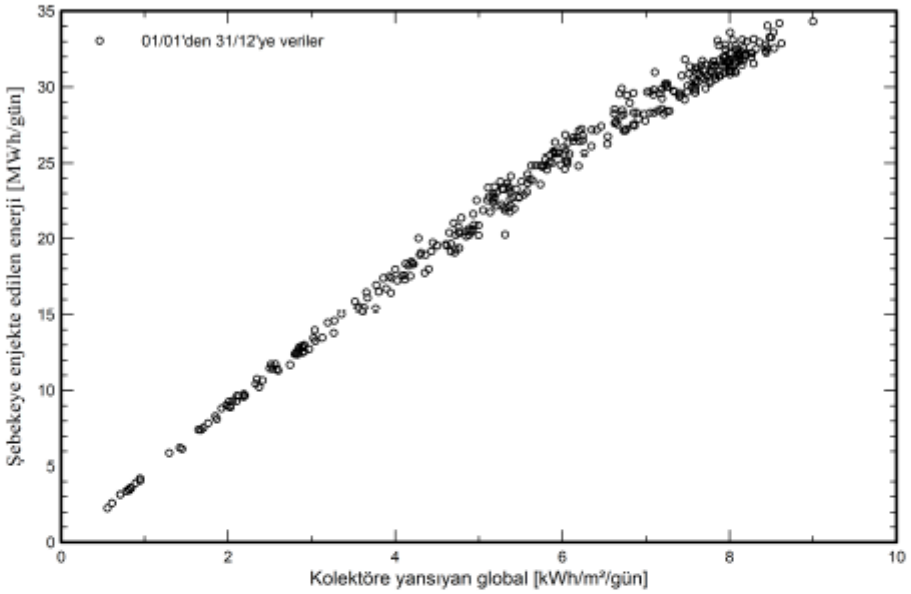


PV modül	CWT550 - 108PM12
İnvertör	SUN2000-100KTL-INM0-415Vac
Zincir	16 x CWT550 - 108PM12

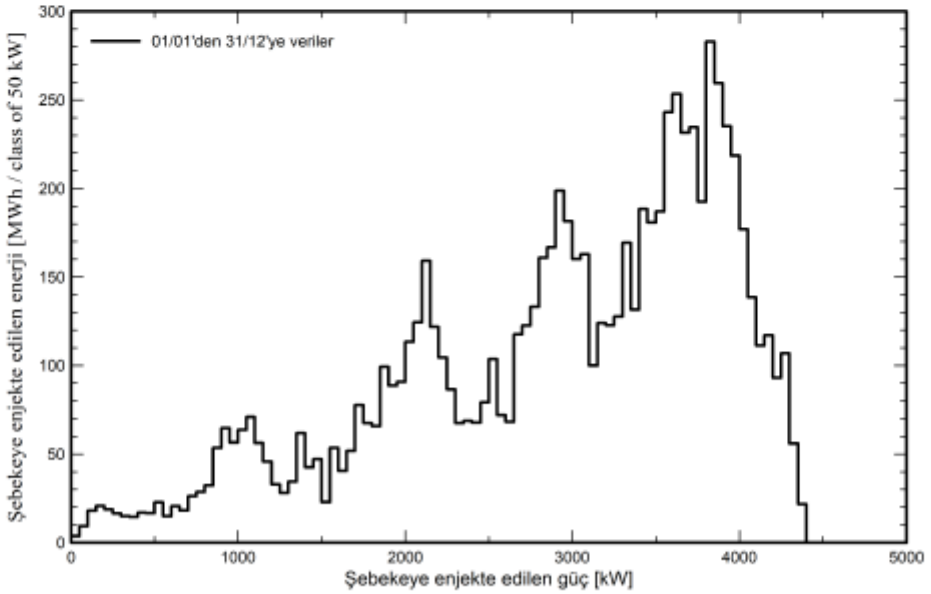
	KARAMAN PİRİREİS	
	VC0 : Yeni simülasyon varyantı	03/05/24

Ön tanımlı grafikler

Günlük giriş / çıkış diyagramı



Sistem çıkış gücü dağılımı



Annex 6:RCIAP Table

• Pollutant	• Limit Values (Typical Guidelines)	• Regulation/Standard
• Carbon Monoxide (CO)	• 50 µg/m³ (ambient air quality standard for short-term exposure)	• WHO Air Quality Guidelines, EU Ambient Air Quality Standards
• Nitrogen Oxides (NOx)	• 200 µg/m³ (hourly average for NO2)	• WHO Air Quality Guidelines, EU Ambient Air Quality Standards
• Particulate Matter (PM10)	• 50 µg/m³ (24-hour average for PM10)	• WHO, EU, or national standards depending on the region
• Particulate Matter (PM2.5)	• 25 µg/m³ (24-hour average for PM2.5)	• WHO, EU Ambient Air Quality Standards
• Sulfur Dioxide (SO2)	• 500 µg/m³ (hourly average)	• WHO, EU Ambient Air Quality Standards
• Volatile Organic Compounds (VOCs)	• 150 µg/m³ (ambient air quality standard for benzene, as a representative VOC)	• National air quality standards (e.g., U.S. EPA, EU)