System Specification Document

S.O.L.A.R. Project

December 17, 2025

Revision History

Version	Date	Author	Description
0.1	2025-12-17	Matteo	Initial draft
1.0	YYYY-MM-DD	Name	Approved release

Contents

1 Introduction

1.1 Purpose

The purpose of the project is to optimize the maintenance and output of solar power plants. Utilizing historical power generation and weather sensor data, the system will provide two critical capabilities: predicting energy production for the upcoming 24 hours and identifying underperforming inverters caused by dirty panels or faulty equipment. The system targets Plant Managers and Maintenance Engineers to facilitate proactive maintenance and grid load planning. .

1.2 Scope

The system should give a website from what is possible to see power production in real time and how much was predicted for the same day and the day after.

1.3 Definitions, Acronyms, and Abbreviations

API Application Programming Interface

1.4 References

List applicable standards, documents, or specifications. NO IDEA

1.5 ML formulation

ML expert need to fill this section.

1.6 KPIs

The performance to be monitored are the power predicted the same day with the actual power produced.

2 Data Specification

The data is gather from a dataset found on Kaggle. For simulating a real system there will be two machine that will generate the unseen data. One will generate the data by the solar pannels and the other will generate the weather condition. The dataset is complete and doesn't contain errors. But we seen a mismatch of dimension in one column so it needed to be adapted to the context.

3 System Overview

3.1 System Description

The system follows a data pipeline architecture comprising Data Ingestion, Machine Learning (ML) Processing, and a Visualization Dashboard. The main modules include: Data Ingestion Module: Handles the loading and cleaning of generation and weather sensor data (based on the provided Kaggle dataset schema). Forecasting Module: Utilizes regression models to predict AC/DC power output based on weather parameters (irradiation, temperature). Anomaly Detection Module: Identifies deviations between expected and actual power output to flag specific source keys (inverters) requiring maintenance. Dashboard Module: A web-based interface for visualizing forecasts and active alerts.

4 Functional Requirements

4.1 Use Cases

See in real time the power produced by the power plant. See how much power will be predicted in the same day and next day

4.2 Functional Requirement List

ID	Description
FR-01	The system shall ingest historical data.
FR-02	The model shall forecast timestamp predictions for the next 24 hours.
FR-03	The system shall forecast total energy yield for the next 24 hours.
FR-04	The system shall detect anomalies in the power production.
FR-05	The system shall identify underperforming inverters.
FR-06	The system shall display the list of underperforming inverters and their efficiency loss.
FR-07	The systems shall display the plot for the total predicted power generation against the actual one.
FR-08	The systems shall display the plot for the predicted power generation for each timestamp against the actual one.

5 Non-Functional Requirements

ID	Description
NFR-01	The forecasting model shall achieve a Mean Absolute Error (MAE) of less than a threshold on the validation set.
NFR-02	The anomaly detection algorithm shall have a low False Positive Rate (FPR) to prevent unnecessary maintenance dispatch.

6 System Architecture

6.1 Architectural Overview

Describe architecture style (e.g., client-server, microservices).

6.2 Component Diagram

Figure 1: System Architecture Diagram

6.3 Component Descriptions

Describe each major component and responsibility.

7 Interfaces

7.1 External Interfaces

APIs, third-party services, protocols.

7.2 Internal Interfaces

Inter-module communication.

7.3 API Specification Example

```
POST /device/register
{
  "otp": "string",
  "deviceFingerprint": "string"
}
```

8 Data Design

8.1 Data Model

High-level entity relationships.

8.2 Database Schema

Field	Type	Required	Description

9 Error Handling and Logging

9.1 Error Codes

Describe error responses and codes.

9.2 Logging Strategy

Log levels, retention, and audit requirements.

10 Security Considerations

Threat model, attack vectors, mitigations, and compliance.

11 Deployment and Environment

11.1 Deployment Architecture

Environments (dev, staging, production).

11.2 Configuration

Environment variables, secrets management.

12 Appendix

12.1 Glossary

Optional glossary.

12.2 Future Enhancements

Planned or potential improvements.