

**WEATHER-ADAPTIVE TIMETABLE GENERATOR**

**FOR RENEWABLE ENERGY UTILIZATION**

**A COURSE LEVEL PROJECT REPORT**

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***in partial fulfillment of the course of***

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## 

# BONAFIDE CERTIFICATE



Certified that this project report **“WEATHER-ADAPTIVE TIMETABLE GENERATORFOR RENEWABLE ENERGY UTILIZATION ”**

is the bonafide work of  **“ D Gangadhar , Priyatharshini, Hruday Achari,** **Dheeraj Karthikeya,** **Seetha mahalakshmi** who carried out the project work under my supervision.

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Submitted for the Project Viva-voce / Review held at Kalasalingam Academy of

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## DECLARATION BY STUDENT

We here by declare that this project titled **“WEATHER-ADAPTITIVE TABLE GENERATOR FOR RENEWABLE ENERGY UTILIZATION**

for the EXSEL-Design Build and operate Course, has been done by us, under the supervision of Department of Electrical and Electronics Engineering, Kalasalingam Academy of Research and Education,, and that no part of this report has been reproduced from anywhere

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# TABLE OF CONTENTS

|  |  |  |
| --- | --- | --- |
| **CHAPTER No.** | **TITLE** | **PAGE No.** |
| 1 | PROBLEM STATEMENT |  |
| 2 | ABSTRACT |  |
| 3 | INTRODUCTION |  |
| 4 | LITERATURE REVIEW |  |
| 5 | BENEFITS |  |
| **6** | WORK PLAN |  |
| **7** | METHODOLOGY |  |
| **8** | REFERENCES |  |

## PROBLEM STATEMENT

Timetable scheduling is an essential component of any academic institution's planning process. However, conventional systems often rely on static schedules that are created without considering dynamic factors like energy availability or weather conditions. This lack of flexibility leads to inefficiencies, especially in energy usage. When energy-intensive tasks such as laboratory sessions are scheduled during periods of low solar radiation or cloudy weather, institutions are forced to depend on non-renewable energy sources, which leads to increased operational costs and a higher carbon footprint.

With the growing emphasis on renewable energy utilization, especially solar power, there is a pressing need for systems that adapt dynamically to weather fluctuations. Unfortunately, most institutions continue to use rigid, rule-based scheduling methods that do not account for environmental variables. This results in missed opportunities to capitalize on clean energy, and ultimately, contributes to energy wastage.

Furthermore, the lack of automation and predictive capabilities in current systems limits their effectiveness. Administrators have no easy way to adjust timetables on short notice based on real-time energy data. Without tools that leverage intelligent forecasting, it becomes impossible to make informed decisions that align scheduling with sustainable practices.

Therefore, the core problem lies in the absence of intelligent, weather-aware, and energy-efficient scheduling systems in academic settings. This project addresses the issue by introducing a smart AI-powered timetable generator that uses weather data to optimize energy usage. By doing so, it paves the way for smarter, greener academic planning.

## INTRODUCTION

The global focus on sustainability has led to a surge in the adoption of renewable energy, especially solar power, in schools, universities, and other institutions. Despite this shift, energy usage in most educational campuses remains inefficient due to outdated scheduling systems. Traditional timetables are static, inflexible, and do not factor in external variables like weather or solar energy potential.

This project was born out of a need to bridge that gap. It introduces a weather-adaptive, AI-based timetable generator that not only responds to energy data but also aligns scheduling practices with peak solar energy periods. By leveraging live weather forecasts, the system identifies optimal days for energy-intensive activities and reorganizes schedules accordingly.

The technology stack behind the system includes Flask (Python), the OpenWeatherMap API, and a web interface built with HTML, CSS, and JavaScript. Together, these components create a seamless and efficient environment for schedule uploads, processing, and downloads.

Incorporating sustainability into day-to-day scheduling has never been more critical. With this project, institutions can reduce their dependence on non-renewable energy and set an example for eco-conscious decision-making. This project serves as a working model of how AI and green technologies can be harmoniously combined to build a smarter, greener future in education.

**Project Objectives**

1. **Develop an AI-powered timetable generator** that aligns with renewable energy production.
2. **Enhance energy efficiency** by reducing reliance on non-renewable sources.
3. **Automate scheduling adjustments** using real-time data and predictive analytics.
4. **Reduce operational costs** through optimized energy consumption.
5. **Promote sustainability** by maximizing renewable energy utilization.

## LITERATURE REVIEW

Research into AI-based scheduling systems has gained momentum in recent years. Early systems focused primarily on static rule-based methods without much consideration for real-time data. However, as energy optimization became a central concern, more dynamic approaches began to emerge. Studies like Li et al. (2020) have highlighted how environmental factors, especially weather, can be used to guide scheduling for better energy utilization.

The use of external APIs, particularly the OpenWeatherMap API, has been a game-changer in this context. Real-time weather prediction enables smarter decisions and reduces reliance on manual planning. However, dependency on external APIs introduces risks related to uptime and changes in API structure, which must be accounted for during system design.

File handling and data management also play a crucial role in such automated systems. Studies by Patel et al. (2019) emphasize the importance of secure, scalable file processing. Improper validation can lead to data corruption and security breaches.

Machine learning has also been explored for predictive scheduling. Techniques like K-Nearest Neighbors (KNN), Decision Trees, and Neural Networks have shown promise in predicting renewable energy availability. However, their effectiveness depends heavily on data quality and preprocessing.

Overall, while the foundation for AI-based scheduling exists in the literature, this project stands out by combining weather forecasts, smart file handling, and a web-based interface for dynamic, green scheduling—making it practical for real-world academic use.

**BENEFITS**

1. The AI-powered timetable generator delivers multiple benefits, both from an energy management perspective and a user experience standpoint. At the forefront is **energy efficiency**. By automatically aligning lab sessions with sunny days, the system ensures that electricity usage is optimized and maximum benefit is drawn from solar power.
2. Second, the system leads to **cost savings**. Institutions can significantly reduce their power bills by minimizing energy wastage, especially during periods of low renewable energy availability. This also contributes to more efficient budget utilization.
3. Third, the project supports **environmental sustainability**. By reducing reliance on fossil fuels, it directly helps lower the carbon footprint of educational institutions, aligning them with broader global sustainability goals.
4. Another major benefit is **real-time adaptability**. Unlike traditional scheduling methods, the AI system can adjust lab timings on the fly based on updated weather data. This dynamic nature ensures that users always have the most efficient timetable possible.
5. Additionally, the system is **scalable** and can be extended beyond educational institutions. Industries, offices, and smart cities can all benefit from the underlying principles of intelligent, weather-responsive scheduling.

## Improved Energy Efficiency – The AI system ensures that energy-intensive activities are scheduled during peak renewable energy generation times.

## WORK PLAN

The execution of the AI-Timetable Generator was structured into five key phases. Each phase was designed to ensure systematic progress and integration of both technical and operational components.

In **Phase 1**, the focus was on **data collection**. Historical and live weather data was gathered using OpenWeatherMap, while class schedules were collected in CSV format from users.

**Phase 2** involved the **development of the scheduling algorithm**. Python, with libraries like Pandas and Requests, was used to implement logic for optimizing lab sessions based on sunny days.

**Phase 3** tackled **system integration**. A web interface was built using HTML, CSS, and Flask to allow users to upload and download schedules effortlessly. API integration was added at this stage for real-time weather retrieval.

**Phase 4** emphasized **testing and optimization**. The system was tested with real data, and bugs were fixed. Feedback from faculty and students was collected to improve usability and performance.

**Phase 5** involved **evaluation and documentation**. Reports were prepared, and the system's effectiveness in reducing energy consumption was documented. Plans for future upgrades, such as IoT integration and machine learning, were outlined for extended utility

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| **Phase** | **Description** |
| **1. Data Collection** | Gather user schedules and real-time weather data. |
| **2. Model Development** | Design logic to modify schedules based on forecast data. |
| **3. System Integration** | Develop Flask-based web interface for user interaction. |
| **4. Testing & Optimization** | Validate output schedules; collect user feedback. |

## METHODOLOGY

The methodology of this project is structured into five key steps, from data input to intelligent timetable generation. Each step was designed to ensure accuracy, adaptability, and ease of use.

The first step is **data collection and preprocessing**. Users upload CSV files containing their class schedules. At the same time, real-time weather data is fetched from OpenWeatherMap. This includes temperature, humidity, cloud cover, and forecasted conditions.

Next is **data cleaning**. The uploaded schedule is cleaned using Pandas in Python. Date formats are standardized, missing values are filled, and weather parameters are categorized into sunny, cloudy, or rainy labels.

The **third step** involves **schedule analysis and logic application**. The algorithm reviews each lab session's date and checks the weather forecast. If a session falls on a rainy day, it is moved to the next sunny or cloudy day without disrupting other sessions.

The **fourth step** is **file processing and output**. The adjusted schedule is written back to a new CSV file. The system also zips the output for easier download and storage.

Finally, the **frontend interface** built with Flask and Jinja2 allows users to interact with the tool easily. They can upload schedules, view results, and download the updated timetable. The system is also built with modularity in mind for future upgrades like IoT integration and ML-based forecasting.

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