

Final Report: Solar Challenge Week 1

Introduction & Business Objective

MoonLight Energy Solutions aims to enhance operational efficiency and sustainability through targeted solar investments. This report translates solar radiation data into strategic recommendations, focusing on high-potential regions for solar installations that align with the company's long-term sustainability goals.

Methodology

Task 1: Git & Environment Setup

- Initialized GitHub repository `solar-challenge-week1`.
- Created Python virtual environment (`.venv`), added a `.gitignore` and `requirements.txt`.
- Configured GitHub Actions CI to install dependencies and run a smoke test (`python --version`).

Task 2: Data Profiling & EDA

- Developed Jupyter notebooks for Benin, Sierra Leone, and Togo in `src/notebooks/`.
- Computed summary statistics and missing-value reports.
- Detected outliers ($|Z| > 3$) in GHI, DNI, DHI, ModA, ModB, WS, WSgust and imputed or dropped as needed.
- Produced time-series plots (GHI, DNI, DHI, Tamb), cleaning-impact comparisons, correlation heatmaps, scatter and bubble charts.
- Exported cleaned datasets to `data/*_clean.csv`.

Task 3: Cross-Country Comparison

- Merged cleaned data from all three countries.
- Generated boxplots for GHI, DNI, DHI by country.

- Compiled a statistics table (mean, median, standard deviation).
- Conducted one-way ANOVA on GHI ($F = 142.93$, $p < 0.001$) confirming significant differences across countries.

Task 4: Dashboard Development

- Built a Streamlit app (`app/main.py`) with:
 - Country multi-select widget
 - Date-range picker
 - GHI boxplot by country
 - Monthly average GHI time-series
 - Average GHI ranking table
 - Deployed (or prepared for deployment) on Streamlit Community Cloud.
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Key Findings

- **Benin:** Highest mean GHI (240.3 W/m^2) with high variability ($\sigma = 330.9 \text{ W/m}^2$), indicating strong but uneven solar potential.
- **Sierra Leone:** Highest mean DNI (225.8 W/m^2) and lowest mean DHI (85.6 W/m^2), suggesting ideal conditions for concentrated solar power (CSP).
- **Togo:** Highest mean DHI (112.4 W/m^2) despite the lowest mean GHI (229.8 W/m^2), making it well-suited for diffuse-light technologies (e.g., bifacial modules).
- **Statistical Significance:** ANOVA on GHI yields $p < 0.001$, confirming that horizontal irradiance differences across countries are not due to chance.

Reproducibility

Clone & setup

```
git clone git@github.com:Rediet-W/solar-challenge-week1.git
cd solar-challenge-week1
python3 -m venv .venv && source .venv/bin/activate
```

```
pip install -r requirements.txt
```

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- **Run EDA notebooks** in `src/notebooks/`.

Launch Dashboard

```
streamlit run app/main.py
```