ENGIE SOLAR PERFORMANCE ON PROJECT

Introduction:

This project aims to analyze over a decade of energy system data from the University of Iowa, focusing on two solar arrays: the Electric Vehicle Charging Station Array and the CAMBUS Array. Utilizing different solar cell technologies, these arrays offer a unique opportunity to study solar energy performance on campus. The ultimate goal is to provide actionable insights for ENGIE North America and the University to optimize future solar installations and enhance sustainability."

Objectives and Scope

Level 1 Objectives:

- Design and implement a program to benchmark the conversion efficiency of the Electric Vehicle Charging Station Array and the CAMBUS Array at the University of Iowa.

Level 2 Objectives:

- Enhance the Level 1 program to provide advanced analytics and predictions.
- Summarize insights for guiding future solar energy decisions at the University of Iowa and ENGIE North America

Technology Stack:

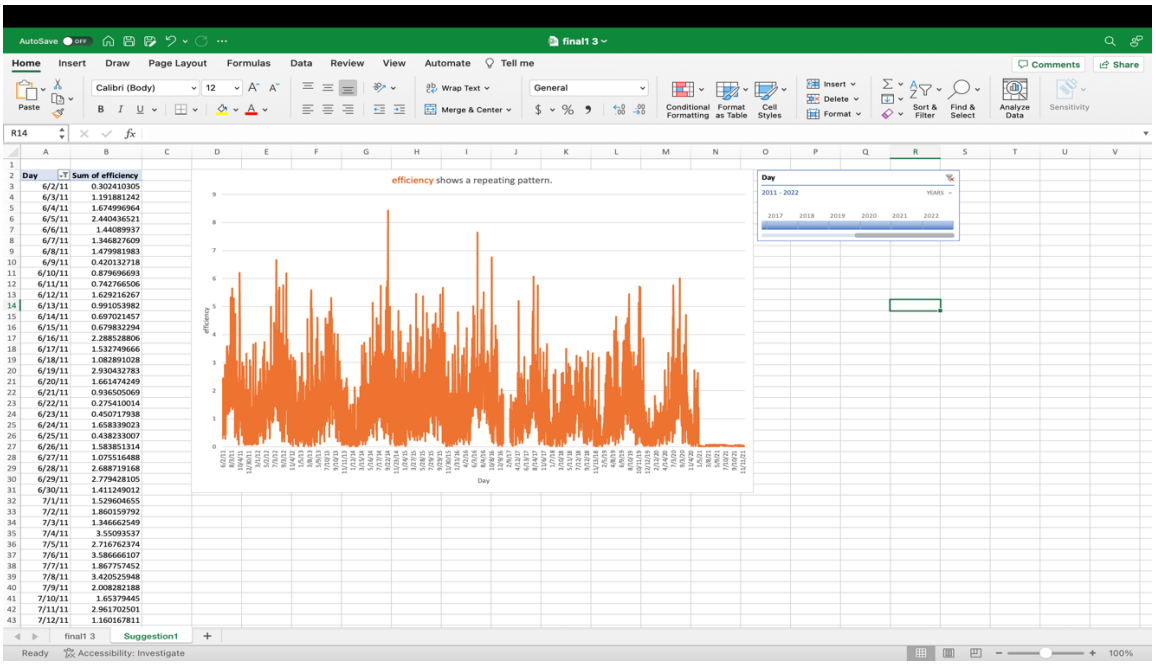
Python, Numpy, Pandas, Matplotlib, SCIKIT-LEARN , Excel , Jupyter Notebook , GitHub , RandomForestRegressor, HistGradientBoostingClassifier

Implementation:

LEVEL - 1

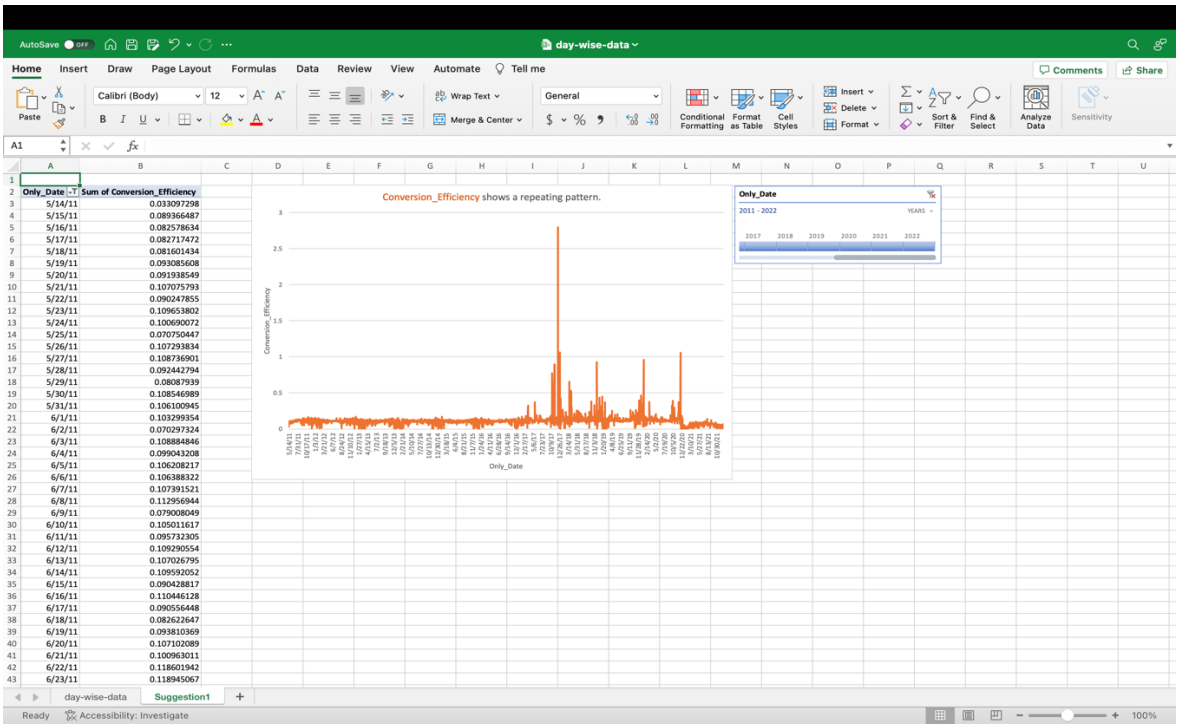
Results for EVCA:

- **Computed Efficiency**: 7.418%
- **Factory-measured Efficiency**: 14.8%
- Detailed breakdown of efficiencies by year, month, day, and hour.



- **Results for CA**:
  - **Computed Efficiency**: 0.9%
  - **Factory-measured Efficiency**: Up to 9%

    Detailed breakdown of efficiencies by year, month, day, and hour.

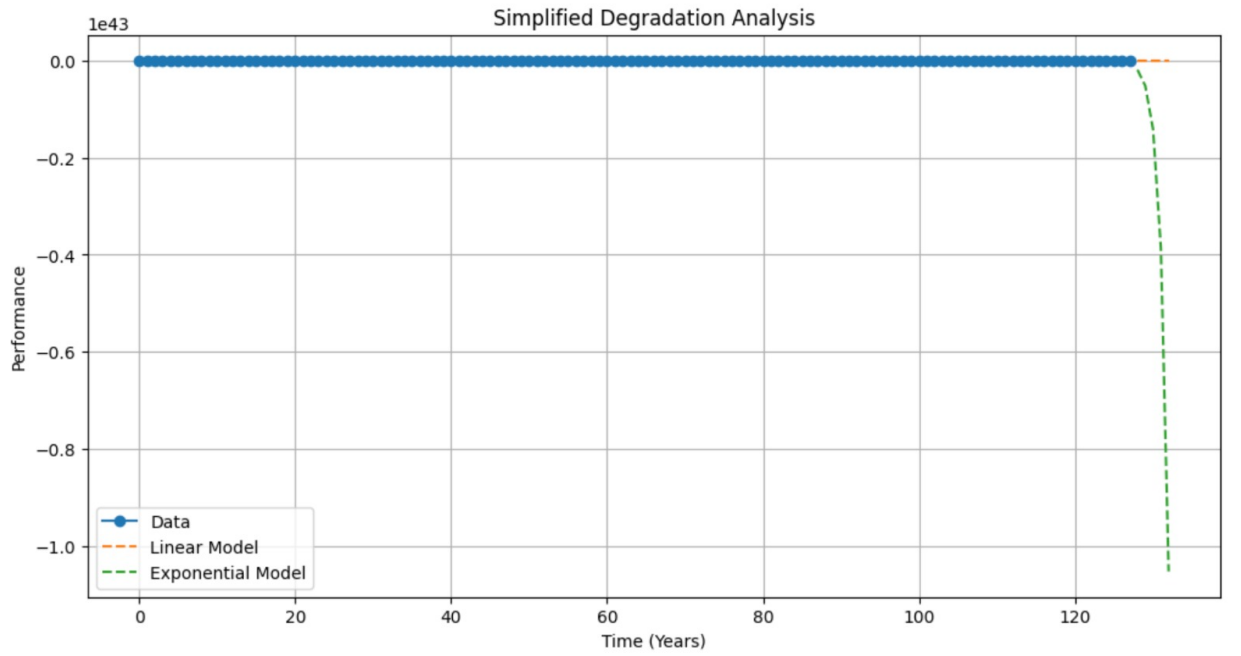


Level – 2:

Degradation Analysis:

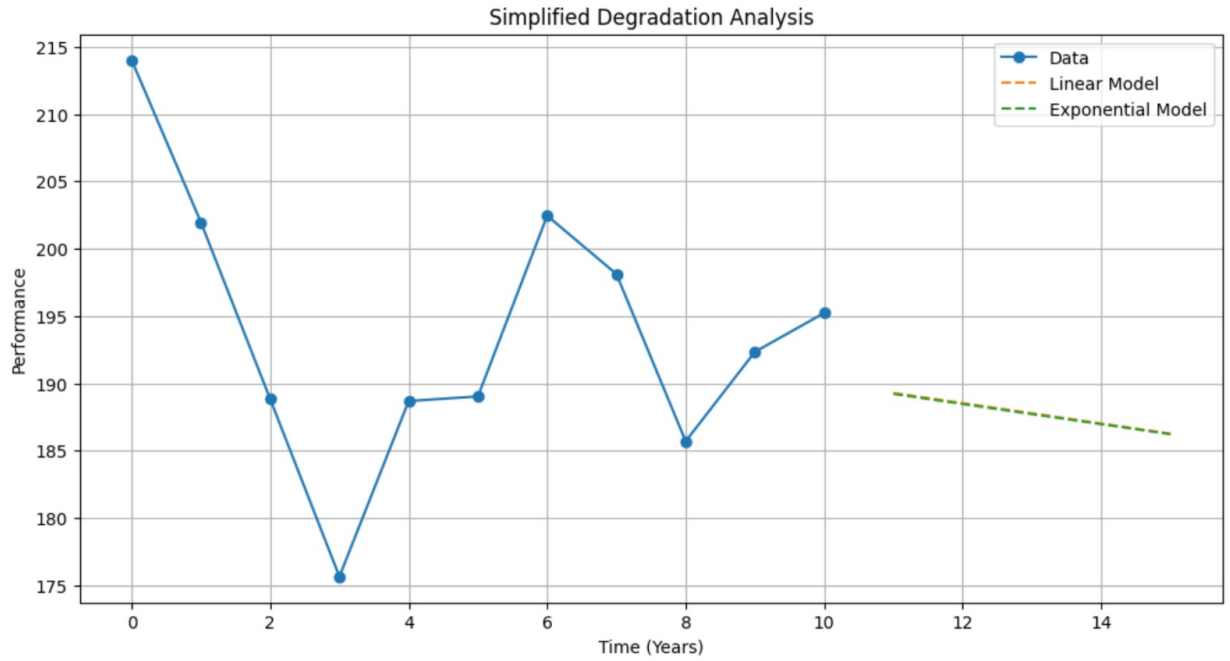
Based on our Degradation Analysis, the Electric Vehicle Charging Station Array (EVCA) exhibits a degradation rate of -0.80, while the CAMBUS Array (CA) has a rate of -0.45. Both technologies show a linear trend in degradation over time. Our findings indicate that EVCA is degrading at a faster pace than CA. It would be prudent for the university and ENGIE North America to closely monitor EVCA's performance for timely maintenance or possible replacement.

CA:




```
Annual degradation rate (Linear Model): -0.45%
```

EVCA :

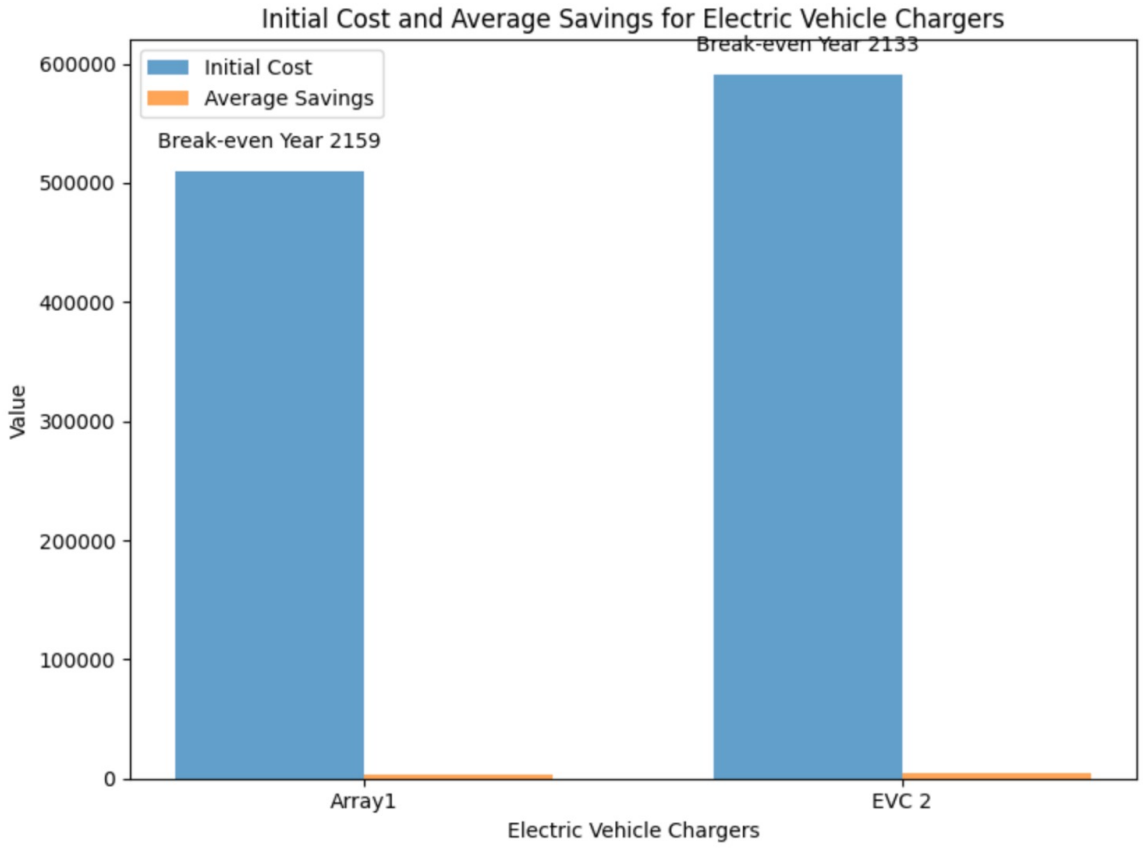



```
Annual degradation rate (Linear Model): -0.80%
```

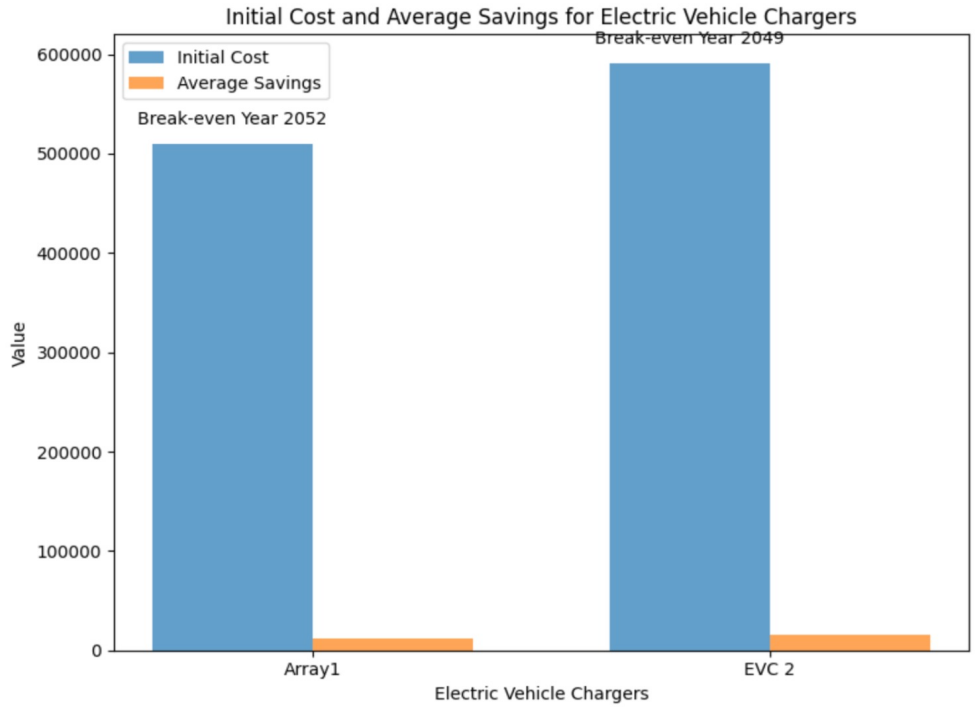
PlaybackAnalysis:

In the Payback Analysis, two scenarios were considered: varying costs and a flat rate of 30 cents per kWh. For the varying costs, the projected payback period for EVCA, including a $300,000 grant, is 122 years, whereas for CA it's 148 years. When considering a flat rate of 30 cents per kWh, EVCA has a shorter payback period of 38 years compared to CA's 41 years, making EVCA more financially successful in both scenarios.

WithDifferentcosts:



With30cents :



PerformanceAnalysis:

We conducted a Performance Analysis to verify the initial predictions about the Electric Vehicle Charging Station Array (EVCA) and the CAMBUS Array (CA). We employed the RandomForestRegressor model due to the imbalanced nature of the data, a scenario in which this model is known to excel.

For EVCA, the model yielded an R^2 score of 65.9% and an adjusted R^2 of 65.8%. The closeness of these values suggests that the model is not overfitting and captures the data well. For CA, multiple configurations of RandomForestRegressor were tested, yielding the highest R^2 and adjusted R^2 values of 76.9%. Again, the proximity of the R^2 and adjusted R^2 confirms that the model is effectively describing the data without overfitting.

These results provide a data-driven foundation to understand the performance characteristics of both solar technologies under different weather conditions and times of the day.

Results:

```
R-squared (R2): 0.6590983105141641
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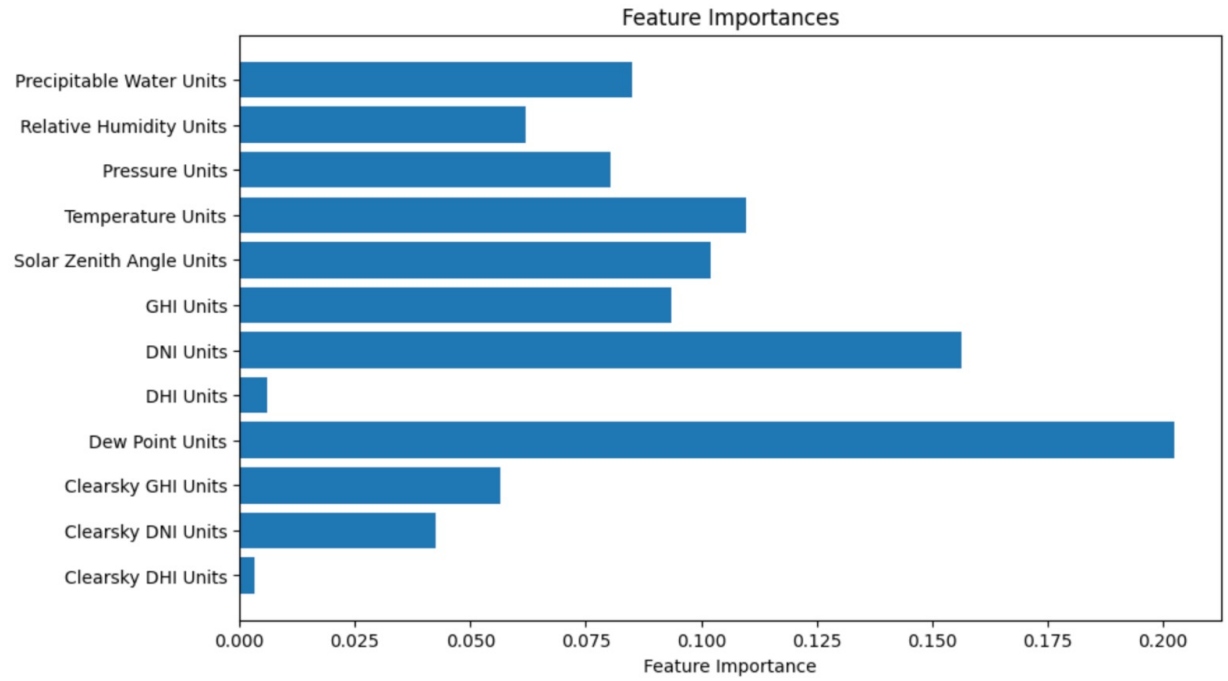


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R-squared (R2): 0.7687841977597624
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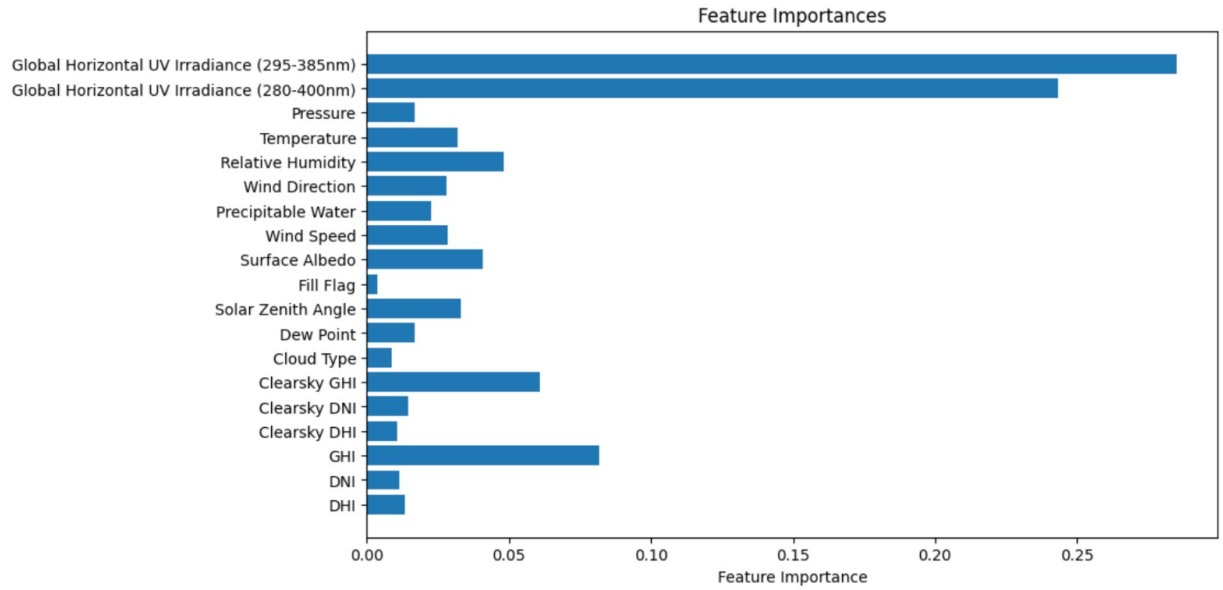

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R-squared (R2): 0.7698493536477379
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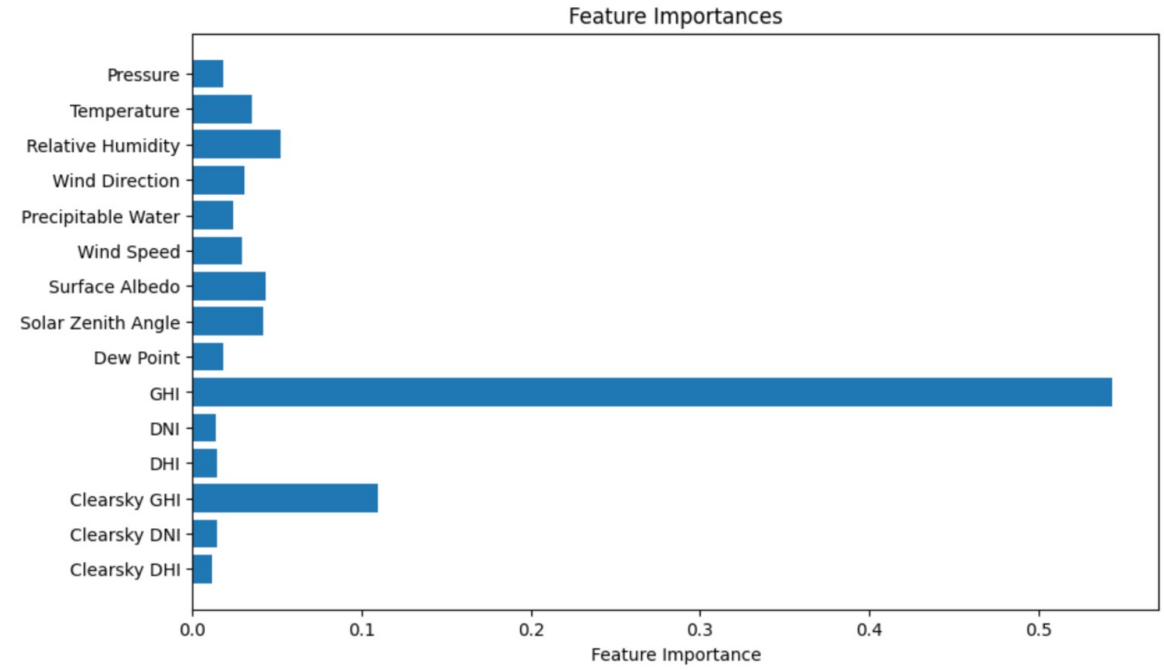

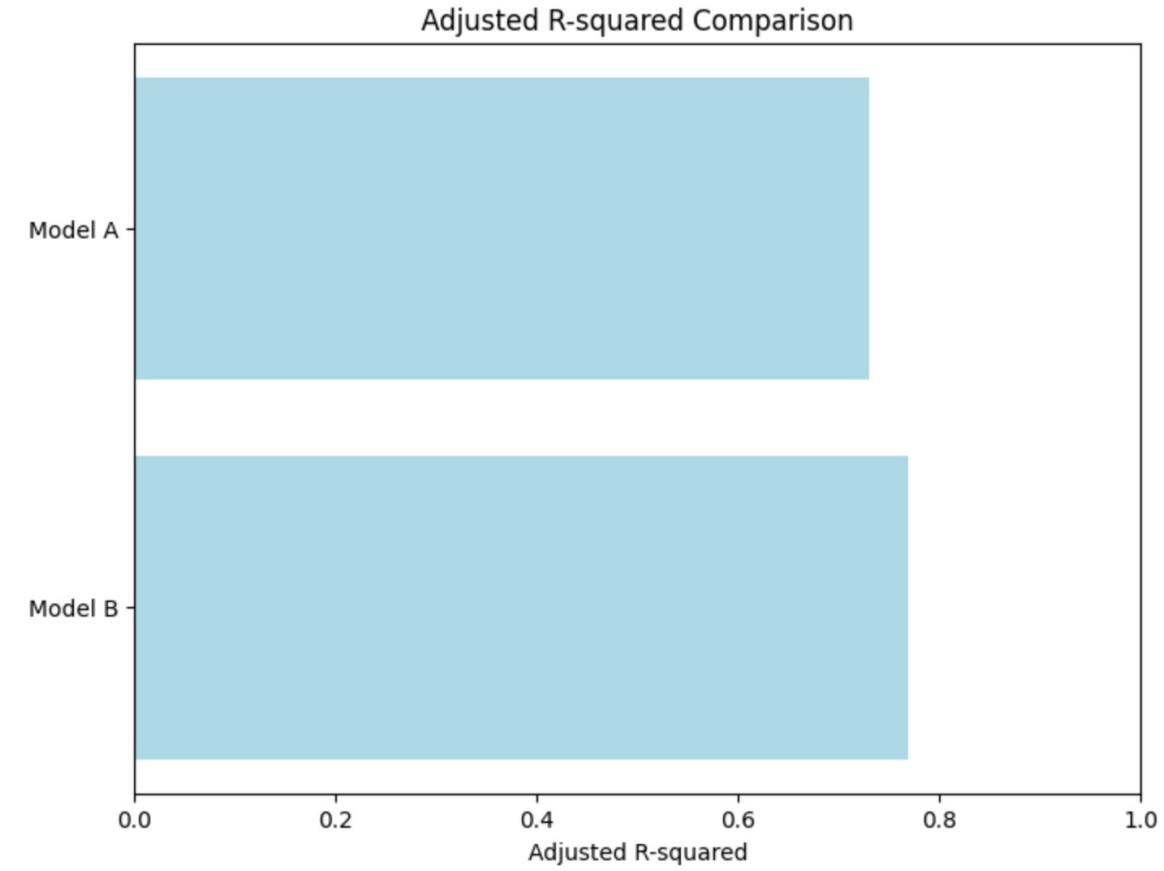

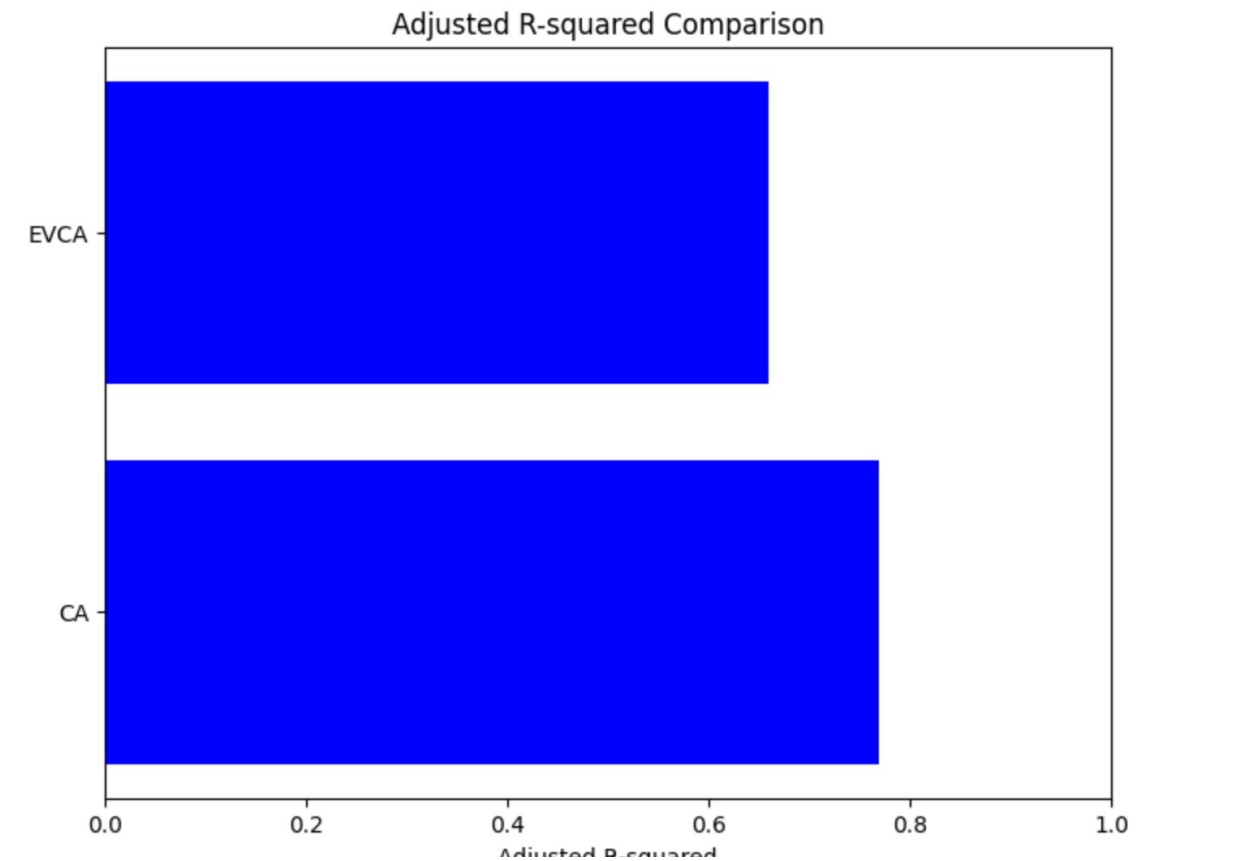
Adjusted R-squared Comparison
EVCA
CA
0.0
0.2
0.4
0.6
0.8
1.0