SOLAR ENERGY GENERATION PREDICTION

By: JEFF ALEXANDER

CONTENTS OF THIS PRESENTATION

- Purpose of Investigation
- Data Collection
- Initial Findings
- Modeling
- Conclusions/ Recommendations
- Future Research
- Streamlit App

PURPOSE OF INVESTIGATION

BACKGROUND

Due to the variable nature of renewable energies, as well as the uncertainty and variability inherent in any electrical architecture, predicting the power generation from each site is very challenging.

Consequently, the integration of solar energy generation sites with larger electrical grids can be complicated. One way of easing this burden is accurately reporting and predicting power generation from these variable generation sites.

PROBLEM STATEMENT

Using the solar generation output of a specific solar farm site, along with the corresponding weather data, can a model predict the solar generation output of that specific site within 10% of max output?

Furthermore, can the same model architecture optimized for a specific site be used to predict the generation of another site or even an entire campus?

Data Collection

DATA COLLECTION

Two years of high-granularity solar energy generation data from 42 sites across five campuses at La Trobe University, Victoria, Australia.

Includes:

- Solar Generation Data reported at 15 minute intervals
- Weather data from Australian Bureau of Meteorology (BOM) using longitude and latitude of each campus
  - Includes Apparent Temp, Air Temp, Dew Point Temp, Relative Humidity, Wind Speed, Wind Direction

INITIAL FINDINGS

INITIAL FINDINGS

01

CAMPUS/SITE VARIABILITY

Campuses ranging from 1 to 27 Solar Generation Sites

02

DAILY VARIABILITY

Weather and electrical architecture variability

03

SEASONALITY

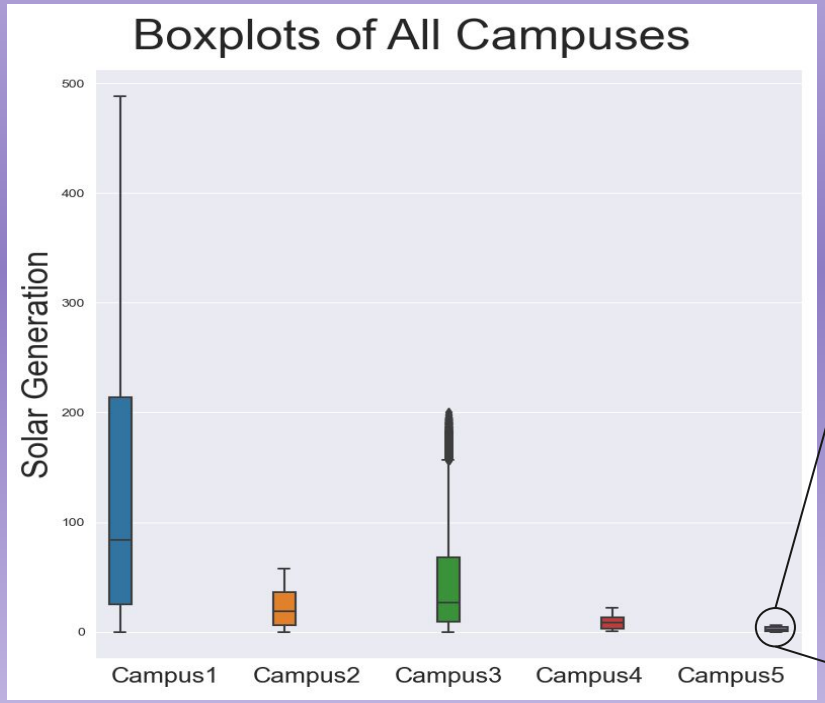
Seasonality present on daily and seasonal scales

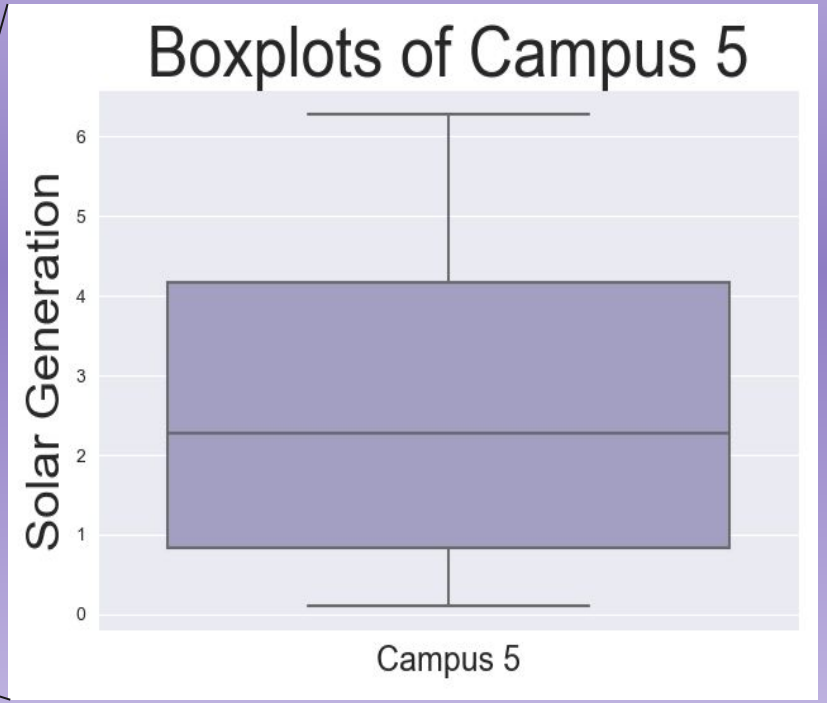
04

CORRELATION

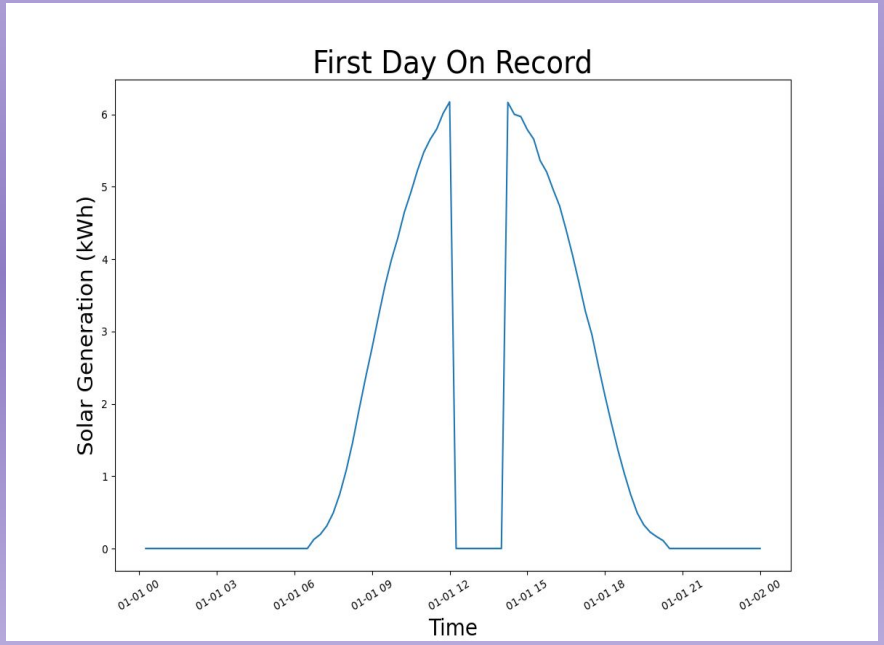
Auto- and partial autocorrelation reflects seasonality and variability

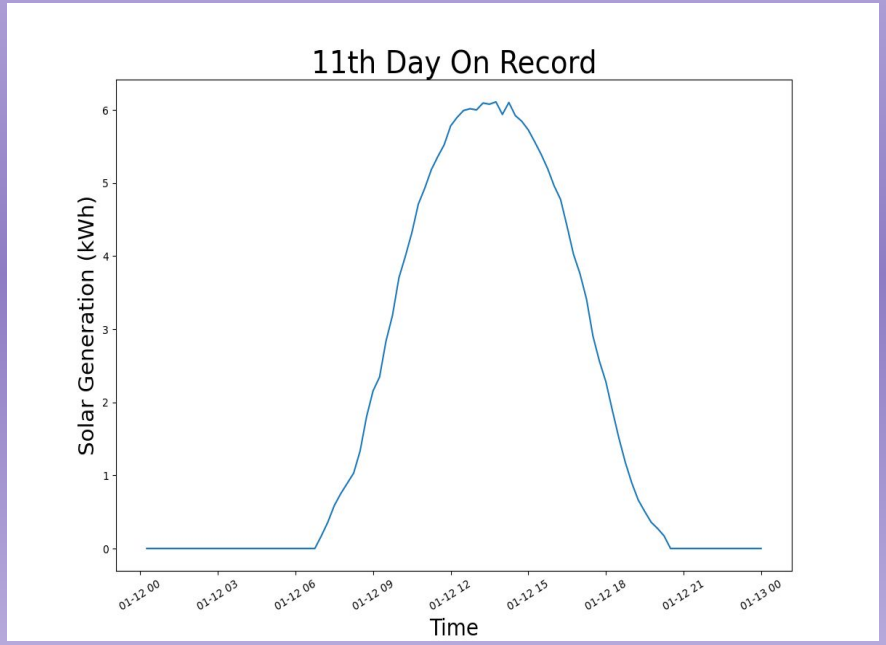
CAMPUS / SITE VARIABILITY



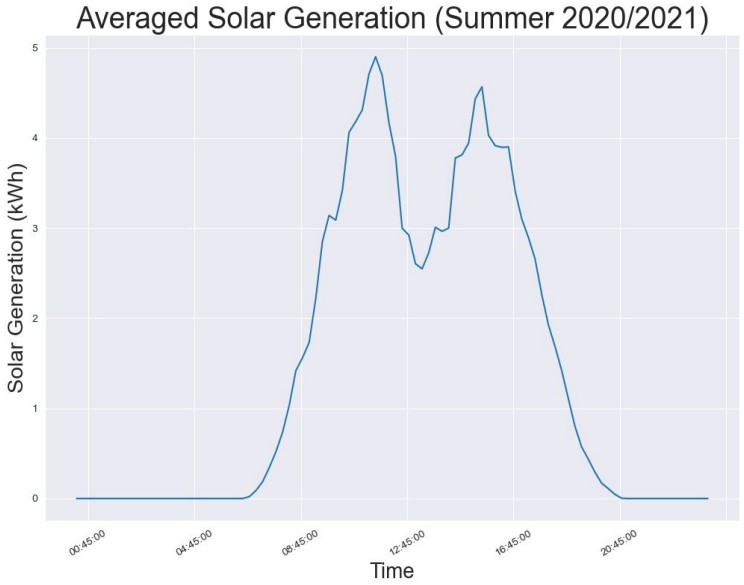


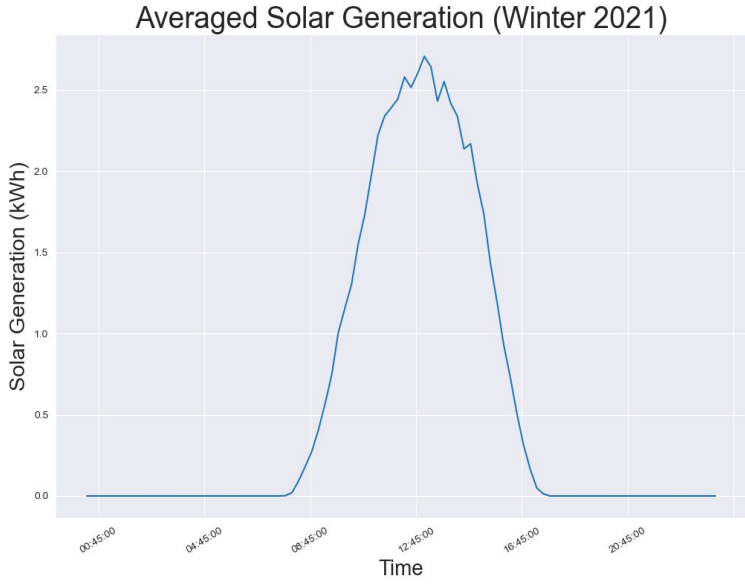
DAILY VARIABILITY



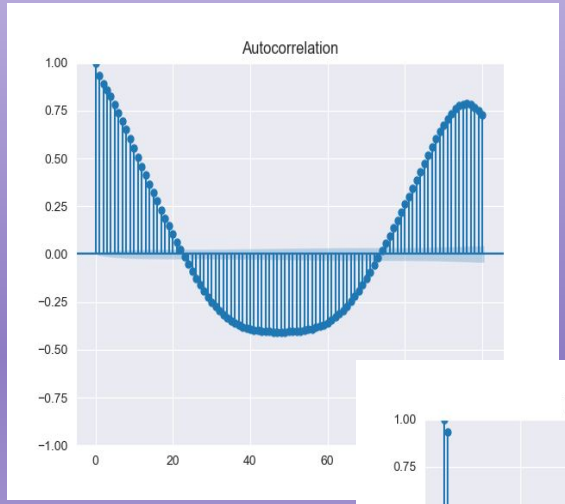


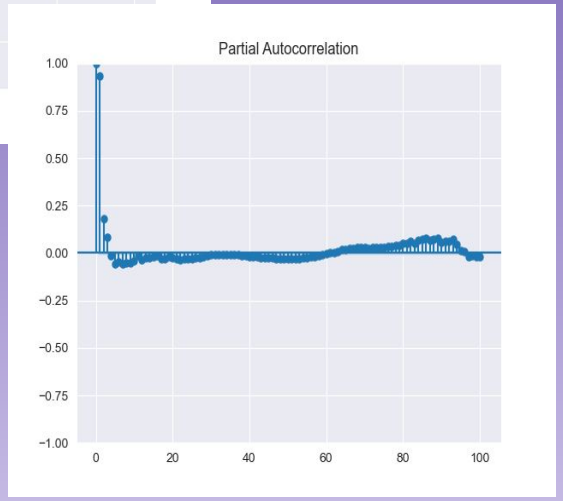
SEASONALITY



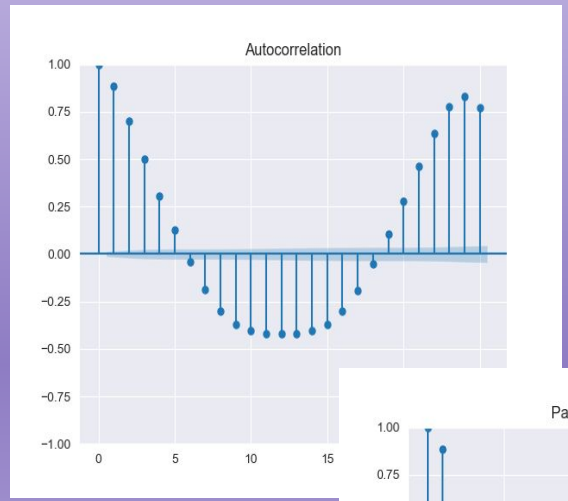


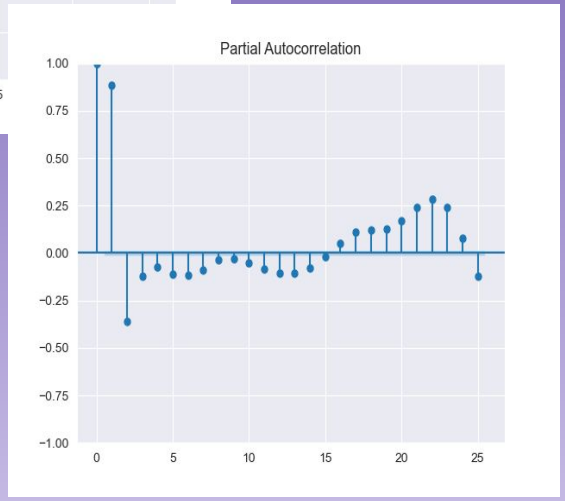
CORRELATION





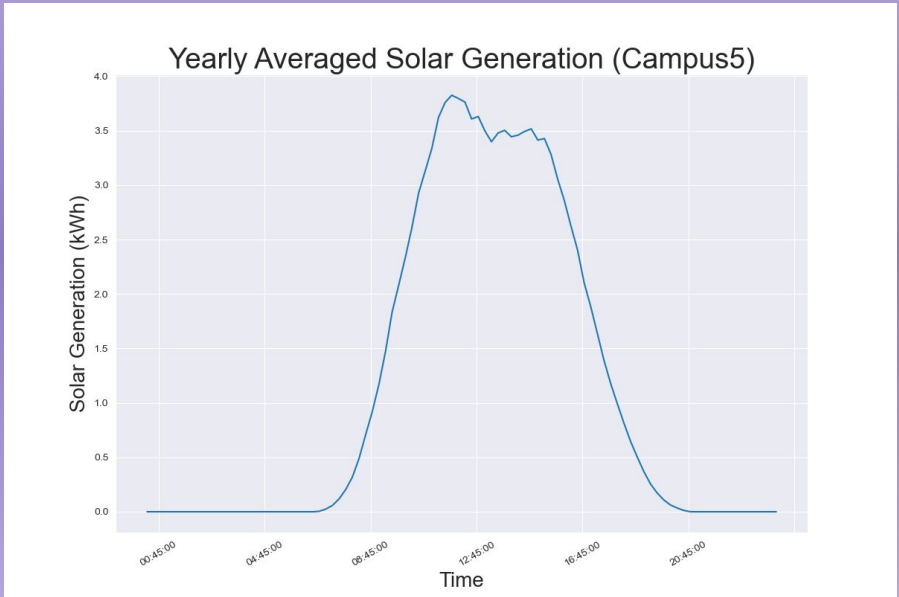
15 - Min Interval



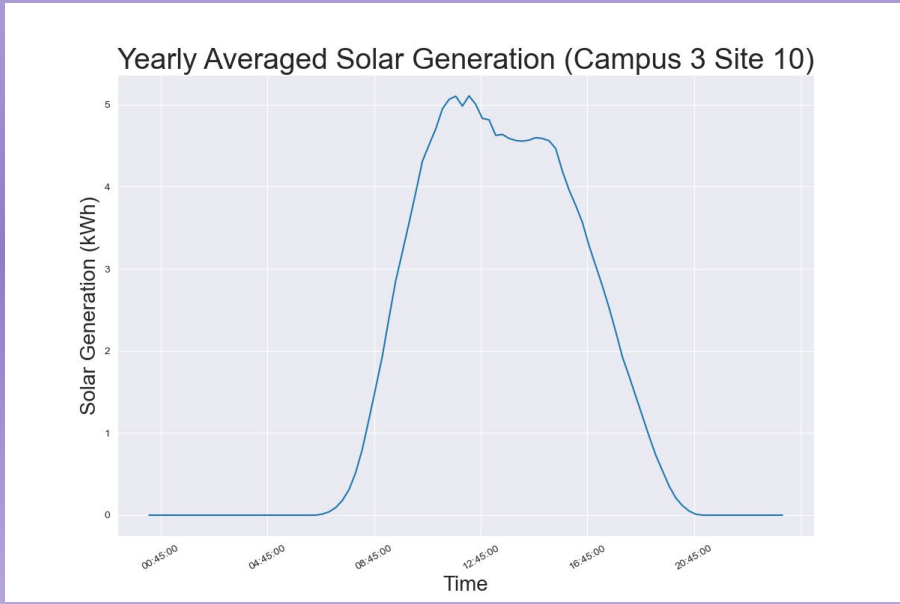


Resampled Hourly

CAMPUS 5



CAMPUS 3 – SITE 10

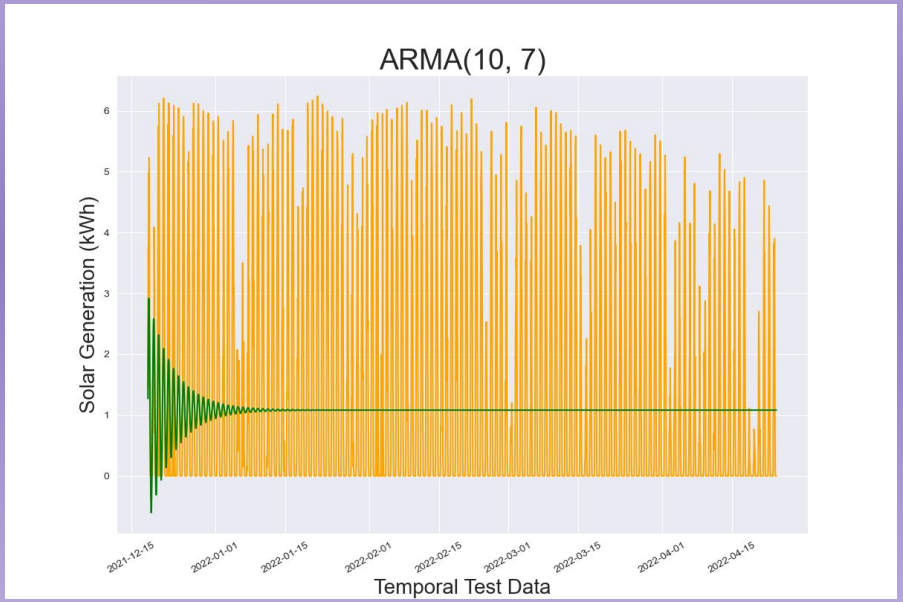


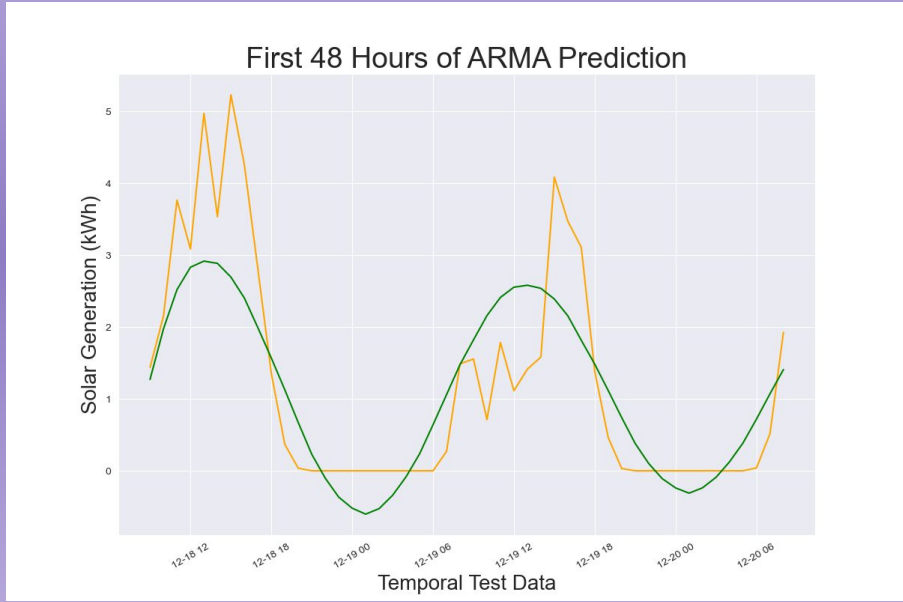
MODELING

MODELING

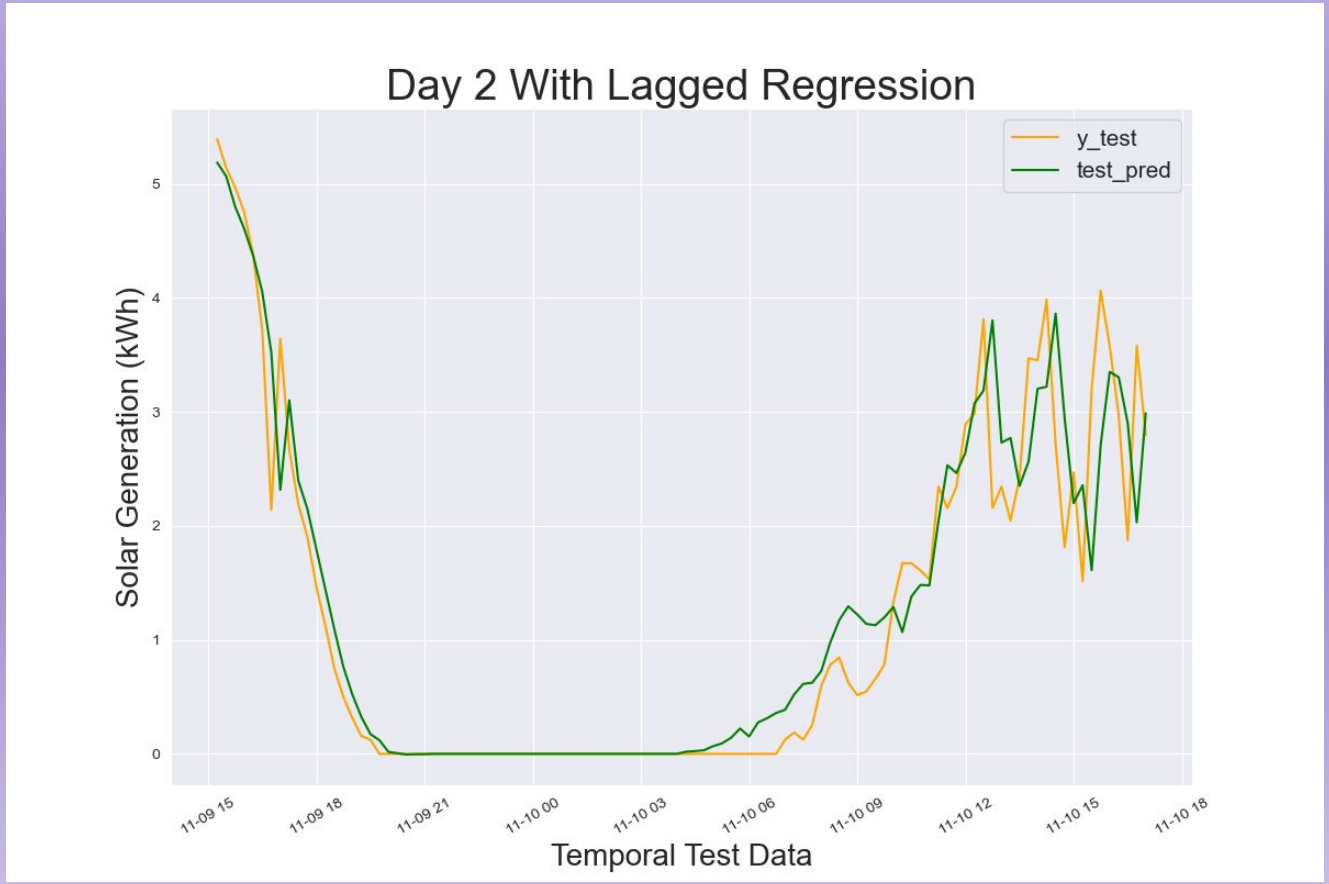
01	02	03	04	05
BASELINE	**ARIMA**	**LAGGED LINEAR**	**UNIVARIATE**	**MULTIVARIATE**
MAE: 1.141 RMSE: 2.447	MAE: 1.524 RMSE: 1.934	MAE: 0.260 RMSE: 0.629	MAE: 0.1871 RMSE: 0.5765	MAE: 0.4346 RMSE: 0.8450

ARIMA (10, 0, 7)


ARMA(10, 7)
Solar Generation (kWh)
0
1
2
3
4
5
6
2021-12-15
2022-01-01
2022-01-15
2022-02-01
2022-02-15
2022-03-01
2022-03-15
2022-04-01
2022-04-15
Temporal Test Data


First 48 Hours of ARMA Prediction
Solar Generation (kWh)
0
1
2
3
4
5
12-18 12
12-18 18
12-19 00
12-19 06
12-19 12
12-19 18
12-20 00
12-20 06
Temporal Test Data

LAGGED LINEAR

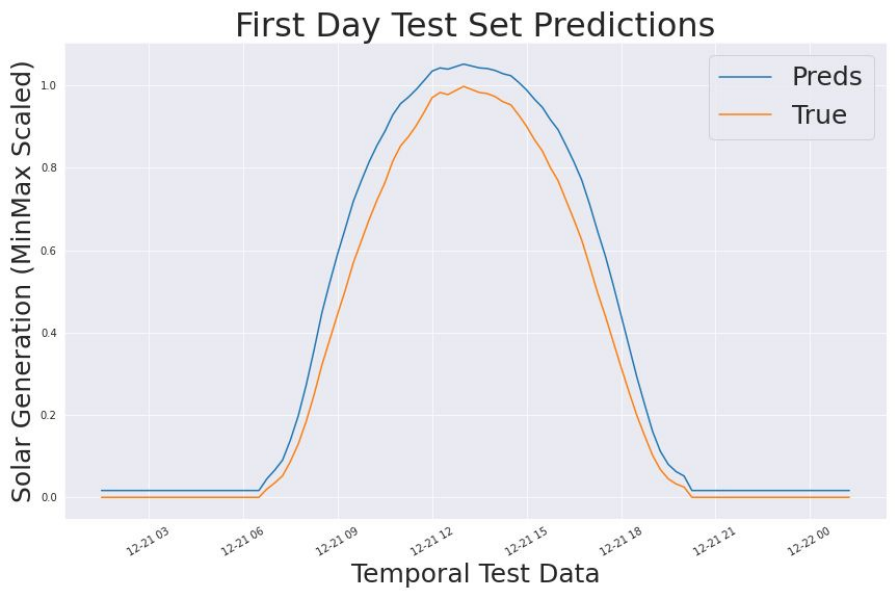


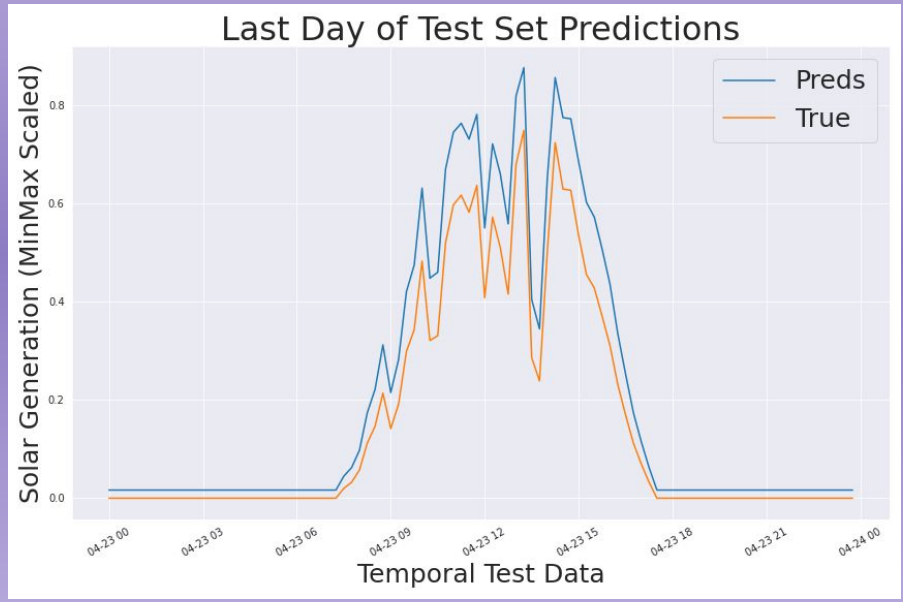
BEST MODEL APPLIED TO ALL (MIN/MAX SCALED)

Campus/Site	MAE Testing	RMSE Testing	Max Production
Campus 5	0.02992	0.09386	6.281
Campus 1	0.03372	0.08035	488.088
Campus 2	0.03548	0.09301	57.363
Campus 3	0.03617	0.09281	200.215
Campus 4	0.03916	0.12786	21.938
Site 6	0.028186	0.07417	28.734
Site 8	0.03348	0.0897	26.969
Site 10	0.03832	0.11368	7.75
Site 12	0.05323	0.15264	17.594

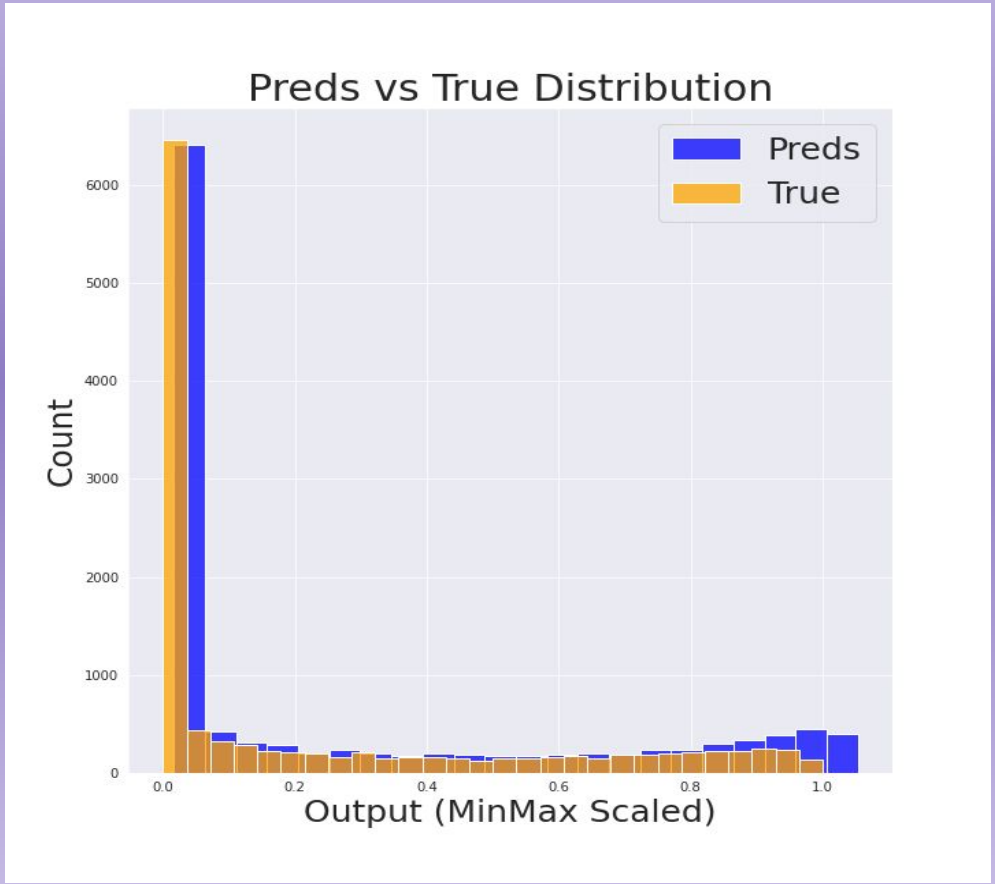
POST MODEL ANALYSIS

POST MODEL ANALYSIS



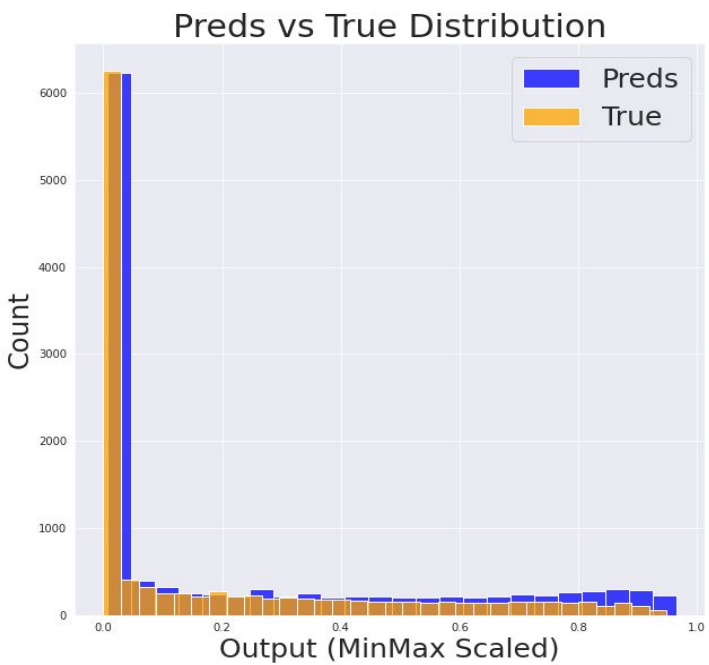


POST MODEL ANALYSIS

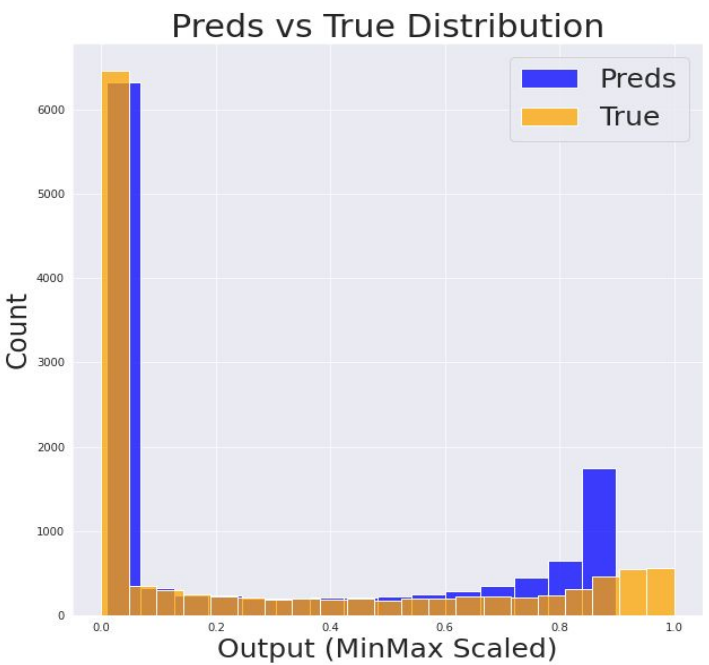


POST MODEL ANALYSIS

Campus I



Site I0



POST MODEL ANALYSIS

Campus/Site	Preds MAE	Preds RMSE
Campus 5	0.0571	0.0757
Campus 5 Subracted	0.0406	0.0601
Campus 1	0.0458	0.0651
Campus 1 Subtracted	0.0383	0.0601
Site 10	0.0468	0.0692
Site 10 Subtracted	0.0399	0.0653

CONCLUSIONS/ RECOMMENDATIONS

CONCLUSIONS

Based on the wide variety of analyses and modeling conducted, the best model could predict solar generation within 10% of max output.

Moreover, the same model architecture can be used to predict the generation of other sites and even entire campuses?

FUTURE RESEARCH

FUTURE RESEARCH

01

SUNLIGHT

Accurate Sunrise and Sunset Feature

02

CLOUD COVER

Weather Data Specific to Cloud Cover

03

ALL SITES/CAMPUSES

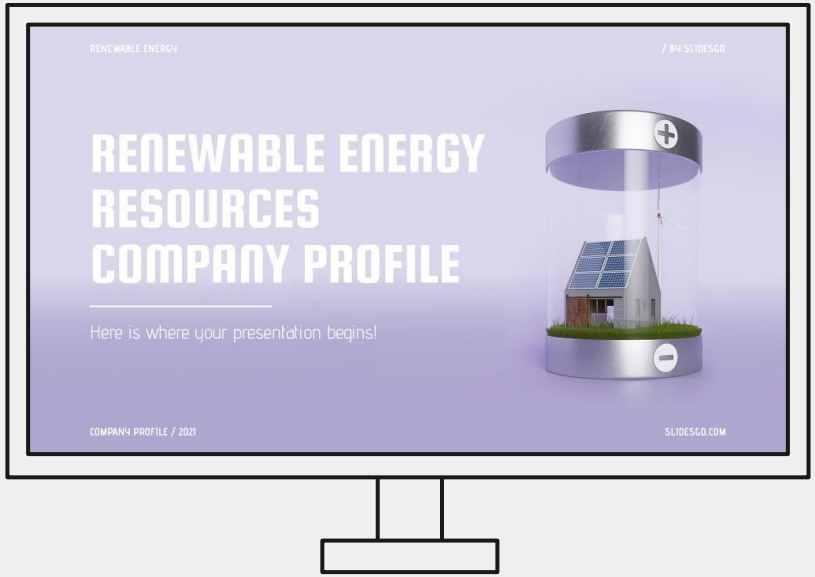
Employ different models to each site/campus and levels

04

ARCHITECTURE VARIABILITY

Maintenance schedules or electrical malfunction reports feature

FUNCTIONING APP



You can replace the image on the screen with your own work.
Just right-click on it and select "Replace image"

THANKS

Do you have any questions?