Solar Panel Energy Prediction Study -- Residential

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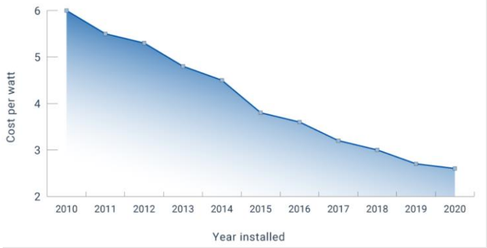
PURPOSE

The research is to study the return on using solar panels to replace traditional electricity in the United States. This research will benefit both solar panel consumers and the local environment.

INTRODUCTION

Solar energy is a clean source of energy. The solar prices fell significantly from 2008 to 2020, and there is still a 4% decline in the last two quarters of 2020. However, solar cells are not widely used and the government is promoting them.



In this session, we mainly focus on the prediction of residential solar energy. Installing residential solar panels could potentially reduce people‘s electric bills by allowing people to source people own energy directly from the sun. Because solar could lower the amount of power people purchase from utility companies and help people save thousands in electrical costs over the lifespan of people’s panel array. When people rent power from the electrical company, you’re at the mercy of a potential outage at any moment. But with a solar panel system, people can store any excess solar energy that doesn’t use.

METHODOLOGY

- Dividing systems into three Types: Residential, Commercial Building, and Farm Solar Energy. We only focus on the solar energy of Residential Building in this session.
- Applying time series analysis model to predict the energy generation with time.
- Developing machine learning algorithms to prediction the energy generation with weather.
- Applying Investment return analysis (ROI) to give this investment a reasonable evaluation.

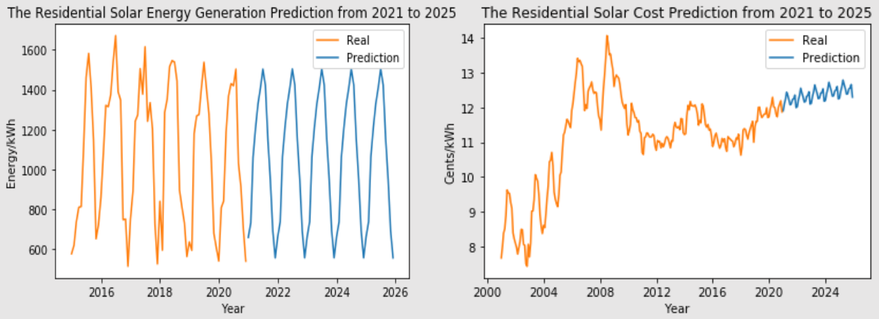
PRODUCT & RESULT

Task 1. Data Collection & Processing

- Weather data and solar energy generation data of a system.
- Cost of solar panel systems.
- Cost of traditional electricity.

Build a data environment, such as data preparation, cleansing, meta data, and ETL (Extract Transform Load). We collected data from Plano, Texas from 2015 to 2020.

Month, Day, ..	HUM	PPT	Power	Pressure	Temp	Wind Speed
January 1, 2015	90.50	0.06	1.40	29.80	35.50	4.50
January 2, 2015	94.10	0.63	1.97	29.60	39.90	6.20
January 3, 2015	83.40	0.96	9.31	29.40	43.40	5.50
January 4, 2015	61.60	0.00	23.74	29.90	35.00	12.80
January 5, 2015	51.80	0.00	23.42	30.00	35.90	6.40
January 6, 2015	60.70	0.00	22.12	29.80	44.70	4.00
January 7, 2015	46.50	0.00	23.15	30.10	33.80	16.40
January 8, 2015	43.00	0.00	23.62	30.00	28.50	8.60
January 9, 2015	43.30	0.00	9.39	30.00	34.60	9.60
January 10, 2015	58.60	0.00	7.31	29.90	33.90	7.40

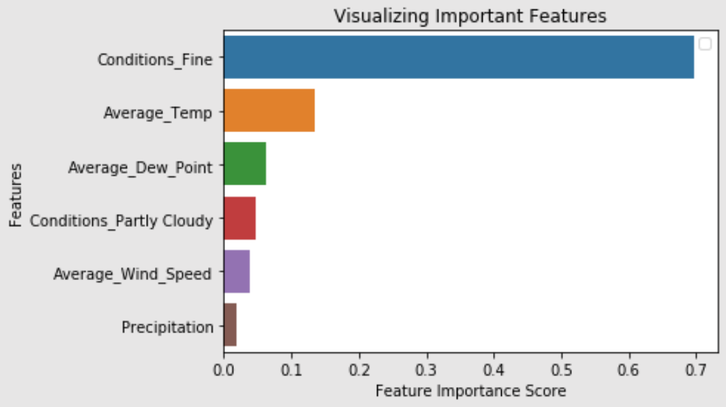


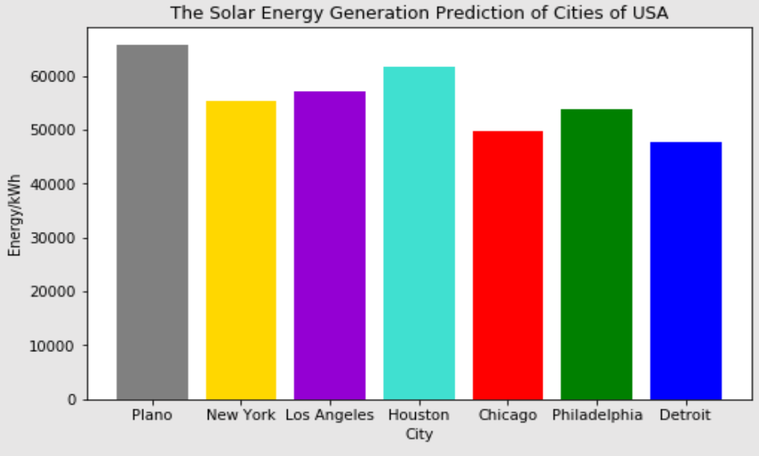
Task 2. Time Series Analysis Model

According to the figure of the solar energy generation of a single solar system with time, solar energy production has changed periodically in recent years. We consider using the SARIMA model to fit the data to get the trend of solar energy production.
By using this model, we can give seasonal suggestions for solar usage and predict the future generation of a single solar system.

Task 3. Energy Prediction Model

We hope to use weather data and energy production data to train a model to predict solar energy generation in other regions. We used multiple linear regression (MLR), random forest (RF), support vector machine (SVM), neural network algorithms to do the prediction.
These models can help us compare solar energy generation in each cities. Further more, we can perform investment return analysis (ROI).





Task 4. Investment Return Analysis

The address of the solar panels that generated the data we use is Plano, Texas. The solar panel is 10.5kW. We assume that the price of the solar panel is 25,000 US dollars and the installation cost is 2,000 US dollars. By predicting the electricity generation and traditional electricity in the next 20 years Expenses, the payback period is calculated to be 16 years. We did not take into account other costs such as equipment damage and repairs.

INTERPRETATION

The photovoltaic power potential (PVOUT) is closely related to weather. Among all the features, the indicator weather condition falling into fine is the most important factor

CONCLUSION

1. Weather conditions have greatly affected the generation of solar energy. In addition, the average temperature, average dew point, wind speed and precipitation also have some influence on the amount of solar energy produced. Therefore, we believe that installing solar systems in places with better weather conditions, higher temperatures, and higher wind speeds can get more rewards.
2. The payback period for an investment of installing an 10.5kW commercial solar system in Plano, Texas in 2021 is 16 years. In contrast, the payback period of 11.76kW commercial solar panels in Texas is 25 years, which is much longer than that of residential solar panels
3. This shows that taking into account the ROI rate and other uncertainties during the payback period, the current residential solar panels are more likely to be accepted.

FUTURE

1. Collect more precise and regionally segmented weather data.
2. Predict solar generation in different types of buildings with advanced models.
3. Conversion efficiency, service life and cost changes.

REFENERCE

1. Figure in Introduction. Source: Solar panel cost: Market update winter 2021/2022. Retrieved from https://www.solarreviews.com/solar-panel-cost
2. Weather Dataset get from https://www.wunderground.com/Solar
3. Generation Dataset get from https://pvoutput.org/