

Forecast of Renewable Energy Consumption

Insight into Solar



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Summary of Goals

WHAT:

The world of solar has advanced dramatically, solar clean energy is becoming more accessible every day. High residential electricity costs prompt homeowners to turn to solar for financial savings and environmental benefits.

WHY:

These trends motivated us to take a closer look at residential solar energy consumption in the United States.

HOW:

Exploration into Monthly Solar Energy using four distinct techniques:

Autoregression

Linear Regression,

Multi-layer Perceptron Regressor

Random Forest Regressor

Solar Energy Trends:

Residential Solar Energy is exponentially increasing since 2012. The residential electricity price is highly correlated to the residential solar energy consumption.

More info about data

Solar Energy Consumption by the residential sector from [U.S. Energy Information Administration](#)

Residential Energy Demand Temperature Index (REDTI) from [NOAA National Oceanic and Atmospheric Administration](#)

Average Retail Price of Residential Electricity from [U.S. Energy Information Administration](#)

“In descriptive modeling, or time series analysis, a time series is modeled to determine its components in terms of *seasonal* patterns, *trends* and relation to *external factors*. In contrast, time series forecasting uses the information in a time series (perhaps with additional information) to forecast future values of that series.”

“

[Jason Brownlee: What is Time Serie Forecasting?](#)



Data Exploration

Defining Features

Features on a time series

- Seasonality:
 - months
- Serial dependency:
 - Lag
 - Peek

Other features:

- Price
- Total Energy consumption
- Temperature Index

“The main features of many time series are **trends** and **seasonal variations** ... another important feature of most time series is that observations close together in time tend to be correlated (***serially dependent***)”

“

[Jason Brownlee: What is Time Serie Forecasting?](#)



Data Cleanup

- Time series analysis
 - Decompose
 - Auto correlation
 - Lag plot
- Feature Normalization
 - Using Log1
- Feature Correlation
 - Heatmap with and without normalized features
 - Filtered most correlated





A photograph showing a series of blue solar panels installed on a grassy hillside. The panels are angled towards the sun. In the background, a vibrant sunset or sunrise creates a horizontal gradient of orange, yellow, and red across the sky.

**UNDERSTANDING THE
TREND**





Monthly Trend

Dataset analysis: understand trend

Model to describe our times series

- Time series analysis
 - Persistence model
 - Autoregression
 - Autoregression with history
- These models help describe the time series dataset
- To identify the predictive model that best fits our time series, we leveraged a range of approaches, from the most simplistic to robust machine learning models.

Machine Learning: forecasting



- *Linear Regression,*
- *Multi-layer Perceptron Regressor*
- *Random Forest Regressor*



Applications & Tools

For exploration, dataset and model creation:

- Jupyter Notebooks
- Python: Pandas, Numpy, Matplotlib, Seaborn, Scikilearn, Statsmodels

For production, Interactive web page:

- Flask app
 - Html/css/bootstrap/bootswatch
 - Javascript
 - Jsonify (Get)

“Time series forecasting is an important area of machine learning that is often neglected. It is important because there are so many prediction problems that involve a time component. These problems are neglected because it is this time component that makes time series problems more difficult to handle.”

“

[Jason Brownlee](#): [What is Time Serie Forecasting?](#)



References

- Solar Energy Consumption by the residential sector from [U.S. Energy Information Administration](#)
- Residential Energy Demand Temperature Index (REDTI) from [NOAA National Oceanic and Atmospheric Administration](#)
- Average Retail Price of Residential Electricity from [U.S. Energy Information Administration](#)
- Time Series concept: <https://machinelearningmastery.com/time-series-forecasting/>
- Data analysis study: [https://github.com/Arronno/House-Prices--Advanced-Regression-Techniques-/blob/master/AI-0009-Report.ipynb](https://github.com/Arronno/House-Prices--Advanced-Regression-Techniques/blob/master/AI-0009-Report.ipynb)
- Use of Autoregression: <https://machinelearningmastery.com/autoregression-models-time-series-forecasting-python/>
- Reference study: <https://github.com/Azure/cortana-intelligence-energy-demand-forecasting>
- Use of Multi Layer Perceptron Regressor:
https://www.programcreek.com/python/example/93778/sklearn.neural_network.MLPRegressor
- Lag and Peek data manipulation credit Matthew Young from Cryptocurrency forecasting



Thanks!

Any *questions* ?

You can find our full analysis at

- ◉ <https://github.com/gvo34/energy-solar>