Solar Panel Energy Prediction Study

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Purpose

Solar energy and panels have now become a more popular alternative to traditional electricity. This research aimed to find out whether utilizing solar panels are a more cost efficient alternative when all costs are factored in.

Introduction

Two similar components drive the return from a PV system :

- Total amount of electricity produced
- Net value of that production

Methodology

- Find factors that influence the production of a photovoltaic system.
- Collect weather and solar power data.
- Apply MLR, SVM, RBF-NN models to forecast the output of a PV solar system.
- Conduct a financial analysis according to several evaluation methods.

$$\text{Payback (years)} = \frac{\text{Initial Costs (\$)}}{\text{Annual Production (kWh/year) x Value (\$/kWh) - O\&M (\$/year)}}$$

Product and Results

Task 1. Data Collection & Cleansing

- Collect weather and PV output data
- Remove missing values
- Remove outliers

Weather features	Unit	Weather features	Unit
Precipitation	mm	Temperature	℃
Relative Humidity	%	Wind Speed	m/s
Surface Pressure	kPa	Insolation Incident	kWh/m^2

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Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)         22.18425    1.68920  13.133  < 2e-16 ***
Insolation.Incident  4.03236    0.09342  43.165  < 2e-16 ***
Relative.Humidity   -0.20720    0.01960 -10.570  < 2e-16 ***
Precipitation       -0.22311    0.05143  -4.338 1.61e-05 ***
Temperature         -0.08233    0.01903  -4.325 1.70e-05 ***
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Residual standard error: 4.042 on 867 degrees of freedom
Multiple R-squared:  0.8591,    Adjusted R-squared:  0.8584
F-statistic:  1321 on 4 and 867 DF,  p-value: < 2.2e-16
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Task 2. Predict System Output

Predict PV output by using

- MLR (Multiple Linear Regression)
- SVM (Supporting Vector Machine)
- RBF-NN (Radial Basis Function Neural Network)

models and compare their results.

Methods	RMSE	MAD	MAPE
MLR	3.8654	3.0242	0.3773
SVM	4.2256	3.0516	1.4022
NN	6.7583	5.3455	2.3655

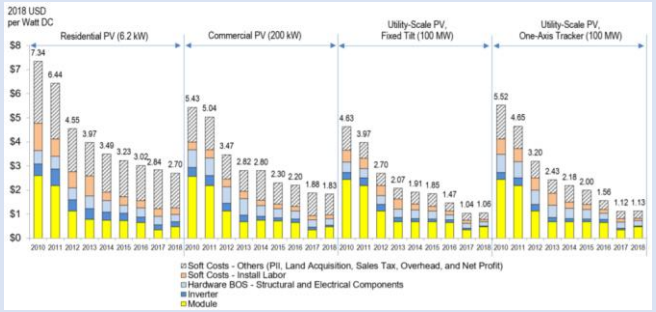
$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n}}$$

$$MAPE = \frac{\sum_{i=1}^{n}|y_i - \hat{y}_i|/y_i}{n}$$

$$MAD = \frac{\sum_{i=1}^{n}|y_i - \hat{y}_i|}{n}$$

Task 3. Conduct a financial analysis

- Assess system cost
- Forecast the Value of Electricity
- Apply various financial analysis tools to evaluate PV solar project (Payback Period, Net Present Value)



Conclusion

- MLR model has the best prediction performance in this case with insolation incident, precipitation, relative humidity and temperature playing a significant impact on the total amount of electricity produced by solar panels.
- Net value of total production is affected by the cost of the solar PV system, the value of electricity, incentives and so on.
- As the costs for PV solar is rapidly declining and a lot of incentives are enacted, it will be a wise choice to invest in solar panels in the future.

Future

- Find a proper model to forecast the value of electricity accurately.
- Take more factors into account.