Energy Usage Analysis

An Analysis of Solar Generation Effectiveness

Stuart Gow

19 October 2024

Introduction

(20 Marks)

- Origin
- Why is it important to me
- Show first 5 or 6 lines of data to help understanding

Scope of The Data

This analysis looks at the generation and domestic use of solar energy during September 2024 in the southern highlands of Scotland. The objectives of this analysis are to see how well solar generation covers the demands of a domestic residence at the tail end of the summer and to determine if additional solar generation and battery storage is needed. Being able to ensure solar generated power covers all household needs is important as this reduces the financial cost of having to import electricity from the national power grid. It is also a small contribution to the reduction of non-green energy energy generation.

- ?? Solar linked to sunshine/irradiance?
- ?? How well does solar generation cover house consumption? How much is the grid still used?
- ?? How much is house consumption impacted by absence?
- ?? What impact does temperature have? On house consumption? On solar generation?

The data comprises three main parts:

- Weather: Daily temperature and solar irradiance readings
- Power Generation & Use: Daily solar energy generated and consumed
- House Occupation: A simple flag to indicate if the house is occupied or not

All data and also supporting files can be found online at Github[1]

[1] https://github.com/StuartG24/Home-Solar-Usage-Analysis

Weather

Weather data is sourced from a local weather station[2]. Temperature is the mean daily temperature in °C and is derived from 6 readings taken at 4 hourly intervals during a 24 hour period. Solar irradiance[3] is a measure of the solar energy experienced over a specified area and is measure in W/m^2; typically this is used to actually calculate the power generated from an array of solar panels, but here it is used here as a proxy for daily sunshine hours because this data was not available.

ACTION: Recalculate the irradiance figues to give a better average approximation for the day .. but continue analysis approach meanwhile

Power Generation & Use

Power data is downloaded from an iPhone App that controls the distribution of power to the domestic house being analysed, see Figure 1. This is a Tesla Powerwall and controller that takes electricity from: i) an array of 36 solar panels; ii) battery storage; iii) the national power grid and then intelligently routes this for: i) consumption by the house; ii) battery storage; iii) export to the national power grid. Electricity is measured here in kWh.

It should be noted that there are some limitations in the data that could be obtained. Only solar generation and house consumption was used and energy flow both to and from the battery was not readily available.

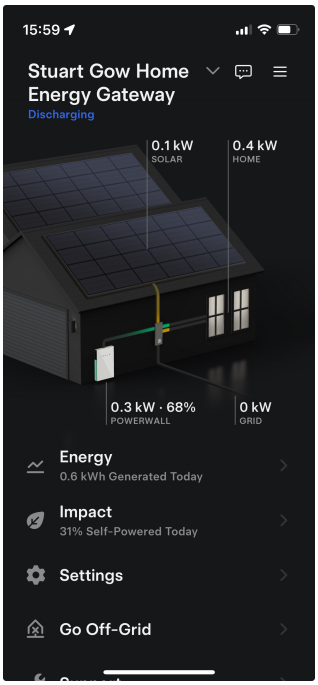

Figure 1: Tesla Powerwall App

Data Analysed

ACTION: Tidy up table columns display

Once the three sources of data have been collated the dataset for analysis consists of the below:

[2]Balqhuidder Village Hall: https://www.blscc.org/weather
[3]Wikipedia: https://en.wikipedia.org/wiki/Solar_irradiance[4]

Table 1: First 6 Rows of the source dataset

Date	Home	From_Solar	From_Grid	To_Grid	From_Battery	To_Battery	Temp_Avg	Irradiance	Occupied
2024-09-01	19.0	2.4	11.4	0.0	11.7	0	12.9	365.9	1
2024-09-02	11.3	1.2	17.3	0.0	5.2	0	13.4	335.4	0
2024-09-03	13.9	6.4	10.5	0.0	7.1	0	9.9	1346.8	0
2024-09-04	16.2	6.8	7.4	0.0	9.3	0	9.5	1722.5	0
2024-09-05	18.0	11.0	11.5	0.1	9.1	0	14.5	1681.8	1
2024-09-06	16.0	14.7	0.4	1.0	11.0	0	16.6	1489.4	1

The dataset consists of:

- 30 observations, for each day in September 2024
- Home: The total electricity, kWh, used by the home all day
- From_ Solar, Grid, Battery: The total electricity provided by the solar panels, power grid and battery respectively. All kWh.
- To_ Grid, Battery: The total electricity exported to the power grid or stored by battery. All kWh.

The following plots etc etc

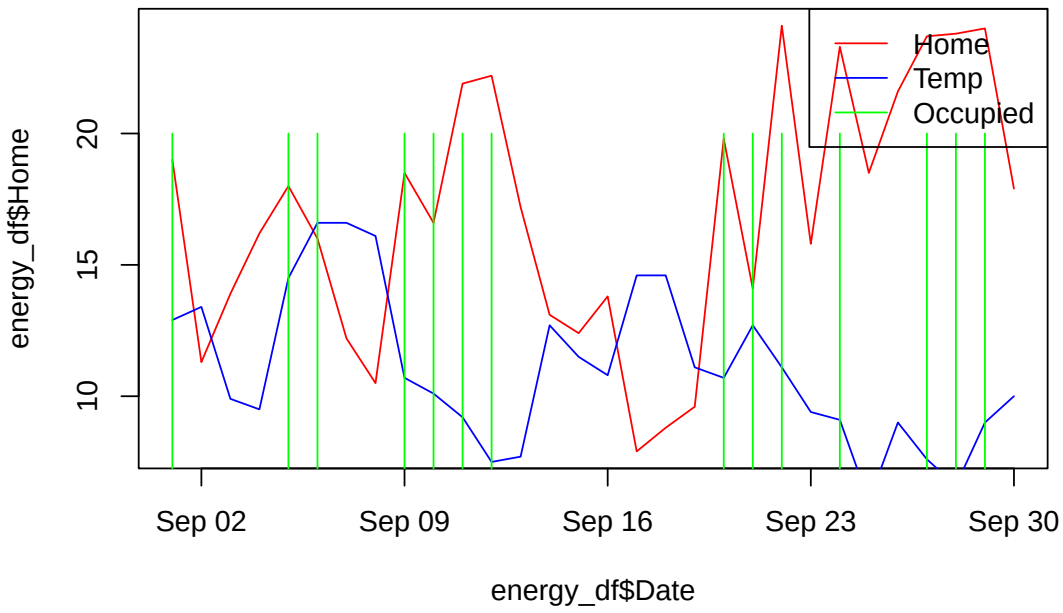

Figure 2: First plot

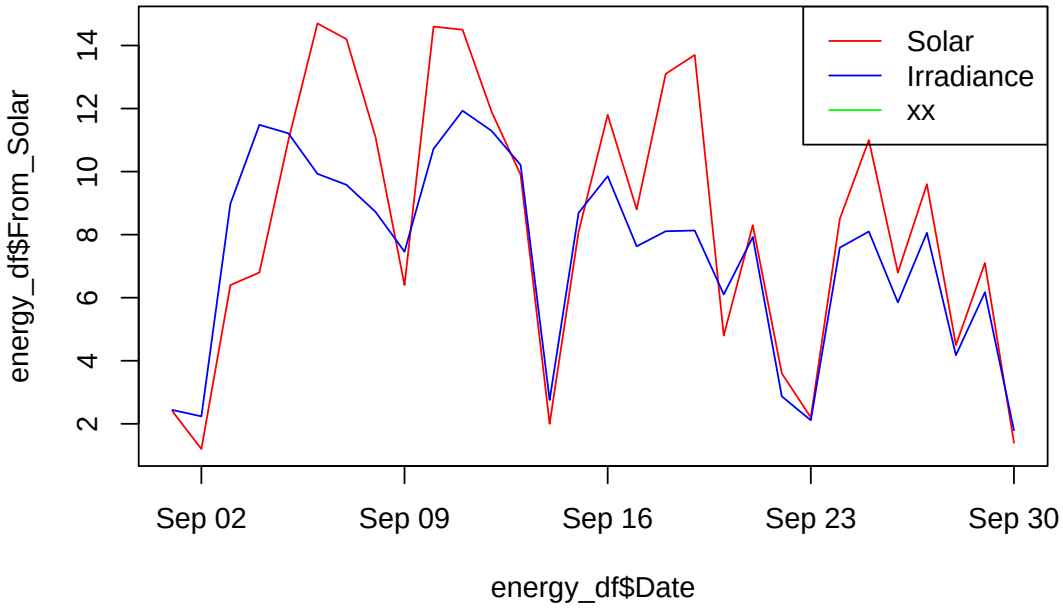

Figure 3: Second plot

Methods and Results

(40 marks)

Test link[5]

Conclusions

(20 marks)

Test citations (Crawley, 2014) and as Fraix-Burnet (2016)

Spiegel and Schiller (2012)

[5]https://bookdown.org/yihui/rmarkdown-cookbook/latex-variables.html

References

Crawley, M.J. (2014) *Statistics: An introduction using R.* 2nd Edition. John Wiley & Sons.

Fraix-Burnet, D. (2016) 'Introduction to R', *Statistics for Astrophysics: Clustering and Classification*, Volume 77(2016), pp. 3–12. Available at: https://doi.org/10.1051/eas/1677002.

Spiegel, M.R. and Schiller, J. (2012) *Schaum's outline probability and statistics.* 4th edn. McGraw Hill.