

# User Documentation

Tesla Power System

Version 1.1

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# Introduction

## 1.1 Scope/Overview

The purpose of this document is to describe, in detail the usage for 'Tesla Power System'. The document contains all aspects of the project, explaining in detail the overview, practices and usages of the system. Alongside examples of the outcomes.

## 1.2 What is TPS?

TPS or Tesla Power System, is a system which investigates 3 different aspects of power usage. Firstly it investigates Power Usage for a single household, specifically focusing on daily usage allowing the user to input files/ or manually and then creating detailed plots from the information. Next it investigates Power Modelling which goes away from total household usage to for a more detailed usage by looking at individual appliance power usage. Finally it investigates Power Simulation, this looks at a community of households and how they all contribute towards power usage.

## 1.3 Setup/Usage

Usage is very simple, download the file and simply type in the terminal:

```
python3 app.py
```

And the system will open, inside there will be simple to follow prompts which the user can input data and get a response.

## 1.3 External Libraries

**matplotlib** - Library for creating static, animated, and interactive visualisations in Python.

**numpy** - Library which adds support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions.

**bokeh** - Library for interactive visualisation that targets web browsers for representation.

**os** - Module in python which provides functions for interacting with the operating system.

**datetime** - Module which provides a number of function to deal with dates, times and time intervals.

## 1.4 Code Explanation

Code explanation can be found within the source code, line by line there are comments.

## 1.5 References

APA style references can be found in the appendix.

# Bokeh

## 2.1 Overview

Bokeh is an interactive visualisation library for modern web browsers. It provides elegant, concise construction of versatile graphics, and affords high-performance interactivity over large or streaming datasets. Bokeh can help anyone who would like to quickly and easily make interactive plots, dashboards, and data applications.

## 2.2 Why Bokeh?

Bokeh was chosen to present the plots due to how it creates powerful interactive plots which have high visuals. This is important when having rich data to accompany it with rich visualisations and interactivity. Therefore this program uses Bokeh

## 2.3 Documentation

Bokeh has vast documentation on how to create graphs, but due to that being the back end of the program there is no need to worry about it. Though here is a link to the user guide to Bokeh if you are curious.

> [https://docs.bokeh.org/en/latest/docs/user\\_guide.html](https://docs.bokeh.org/en/latest/docs/user_guide.html)

# Power Usage

## 3.1 Overview

When creating a house it is possible to create interactive and rich plots using the '1. Power Usage' option.

## 3.2 Adding Power Usage

In order to create plots data must be added, this can be done by selecting option '2' from the menu, shown below.

```
----- Tesla Power Usage System -----
1. View Power Usage
2. Add Power Usage
3. Go back

What would you like to do? 2
What file are we reading? █
```

Once selected a prompt is shown to input a file, it is important that the file follows the correct format so it is accepted, this is shown below.

```
<D M Y H:M:S>,<Usage>

15 02 2020 22:58:00,143710
16 02 2020 16:13:00,143730
17 02 2020 17:44:00,143732
```

If the format is correct and the correct file is provide the usage data is added to your 'household' and therefore rich interactive plots can be created.

## 3.3 Viewing Power Usage

Once the software has power usage data, plots can be created. The initial version only contains two possible plots, general usage and cumulative usage. The user can create plots by selecting option '1' from the menu, which gives the following shown below.

```
----- Tesla Power Usage System -----
1. General Usage
2. Cumulative Usage
3. Solar Generation (Bonus)

What would you like to do? █
```

### 3.3.1 General Usage

General usage shows daily usage data, within the code it calculates the daily usage through subtracting the previous usage with the current day. Plots can be found at the end of the section. Usage data is collected by me.

### 3.3.2 Cumulative Usage

Cumulative usage shows the total power usage over time. The graph will always be on an upwards slope due to this reason. Plots can be found at the end of the section. Usage data is collected by me.

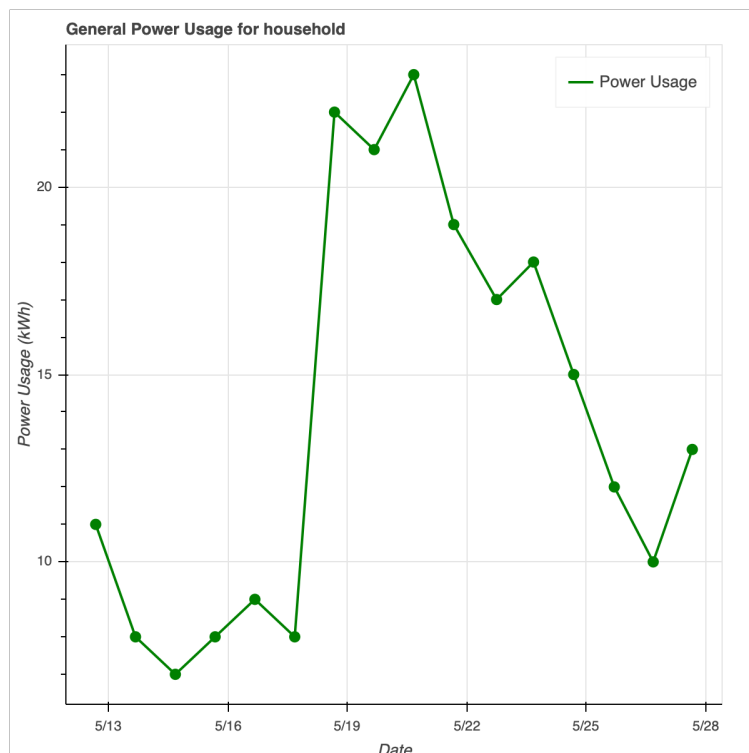
### 3.3.3 Solar Generation

When selecting option '3' it gets you to input a solar file, format shown below. If you haven't already, then it automatically creates a graph using the information and compares the power usage to solar generation. Solar data is collected by me.

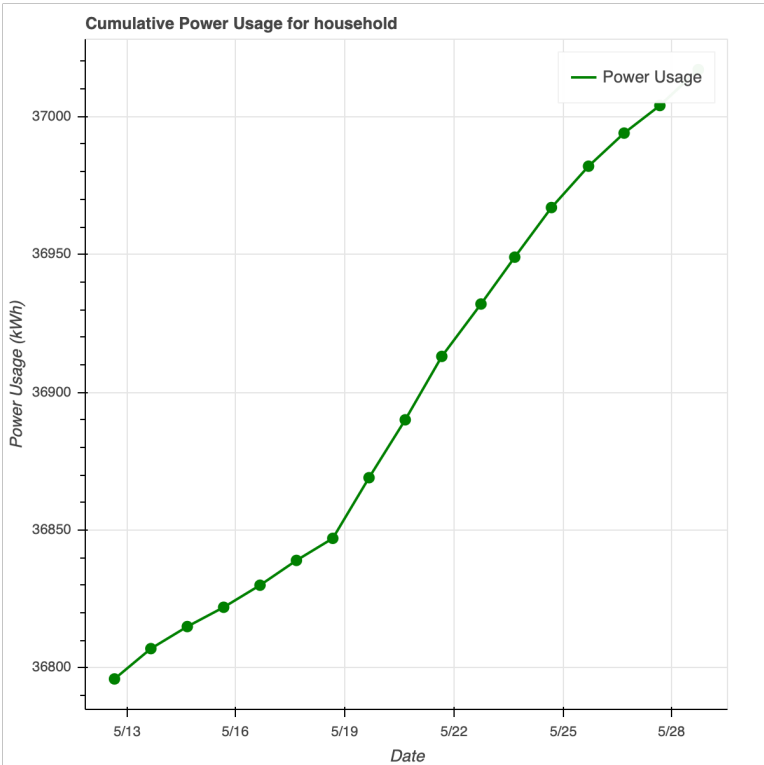
```
<D M Y H:M:S>,<Usage>
15 02 2020 22:58:00,13.10
16 02 2020 16:13:00,10.42
17 02 2020 17:44:00,3.81
```

## 3.4 Output Examples

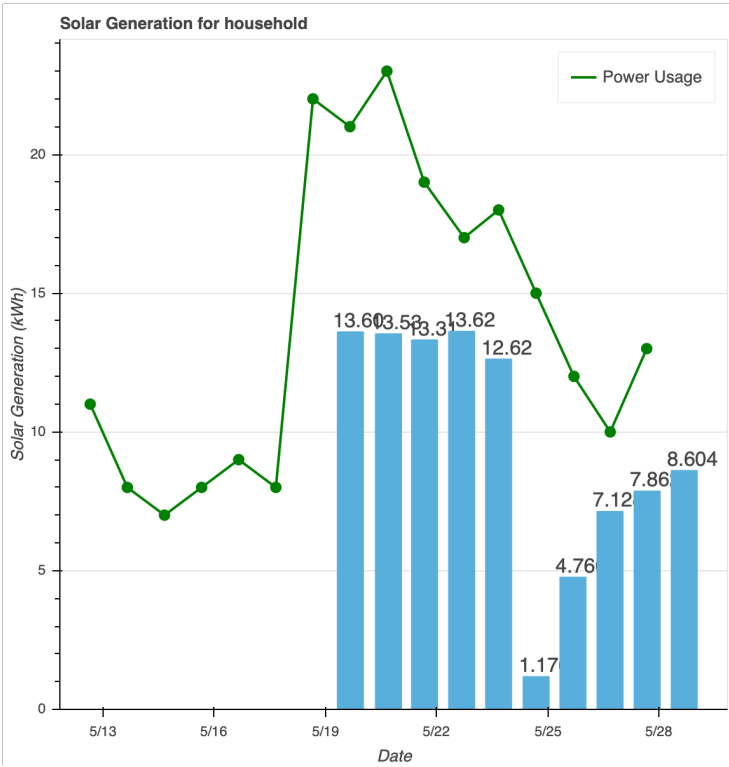
### 3.4.1 General Usage



### 3.4.2 Cumulative Usage



### 3.4.3 Solar Generation





# Power Modelling

## 4.1 Overview

More in-depth statistics within the household are required to get a bigger picture of where the usage occurs from, using the '2. Power Modelling' option.

## 4.2 Adding Appliances

In order to create plots data must be added, this can be done by selecting option '3' from the section main menu. The data can either be inputted via a file or manually inputted. These options are shown below.

### 4.2.1 File Input

```
----- Tesla Power Modelling System -----  
  
How would you like to input data?  
1. File Input  
2. Input Appliance  
3. Go back  
  
What would you like to do? 1  
What file are we reading? █
```

Once selected a prompt is shown to input a file, it is important that the file follows the correct format so it is accepted, this is shown below.

```
Residents:<number>  
  
<name>:<watts>:<activity, 0 = not being used, 1 = being used>,x24  
  
Fridge:200:1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1  
Washer:500:0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,1,1,0,0,0,0  
TV:1000:0,0,0,0,0,0,0,0,0,0,0.5,0,0,0,0,0,0,0,0,0.5,0,0,0.5,0,0,0
```

If the format is correct and the correct file is provide the appliances are added to your 'household' and therefore rich interactive plots can be created.

### 4.2.1 Manual Input

Once selected it prompts you in stages which gives descriptive details of what it expected, if given data which isn't the correct the system just asks for the data again until provided with the correct format. Though with manual entry only one appliance can be entered at once.

```
----- Tesla Power Modelling System -----  
1. Input the name of the Appliance...  
> iPhone X  
2. Input the usage (W) of the Appliance  
> 200  
3. Input activity of appliance (0-1) seperated by commas x 24(hrs)  
eg) 0,0,0,0,0.25,0,0,1,0,0,0.15,0,0,0,0.5,0,0,0,1,1,0,0,0,0  
> 0,0,0,0,0,0,0,0,0,0,1,1,0,0,0,0,0,0,0,0,1,1,0  
Success! Added a iPhone X  
  
Press enter to continue... █
```

## 4.3 Search for Appliance

This doesn't add much functionality to the system as a whole, it ensures you can see what appliances you have in the system current by searching them up. This can be done by selecting option '2' from the section main menu. An example is shown below of the functionality.

```
----- Tesla Power Modelling System -----
Input the name of the Appliance... washer
Found: Washer | 500W | 0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,0,0,0,0
Press enter to continue... █
```

You are prompted to give the name of the Appliance and the system shows all the data it holds about it, if it exists.

## 4.4 Viewing Appliance Usage

Once the software has appliance data, plots can be created. The initial version only contains four possible plots. The user can create plots by selecting option '1' from the menu, which gives the following shown below.

```
----- Tesla Power Modelling System -----

1. Appliance Ratings
2. All Appliance Usage plot
3. Appliance Usage Plot
4. Day General Usage vs Appliance Usage

What would you like to do? █
```

### 4.4.1 Appliance Ratings

The user can view appliance power usage by selected '1' option. This option doesn't produce a plot, rather lists the current appliances and gives them a kWh power rating, in no order. An example is shown below of the functionality.

```
----- Tesla Power Modelling System -----

1. Appliance Ratings
2. All Appliance Usage plot
3. Appliance Usage Plot
4. Day General Usage vs Appliance Usage

What would you like to do? 1

Found: Fridge | 200W | 1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Rating: 1752kWh per year

Found: Washer | 500W | 0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,1,1,0,0,0,0
Rating: 547kWh per year
```

Firstly the total amounts of Watts used is created and then that is converted to kWh using the formula below.

$$E(\text{kWh}) = P(\text{W}) \times t(\text{hr}) / 1000$$

#### 4.4.2 All Appliance Usage Plot

When selecting option '2' it automatically creates a plot which compiles all the usage data for each appliance within a 24hr window. The usage amount is decided by multiplying usage x activityPerHr (e.g. 200 x 1 = 200W). Plots can be found at the end of the section.

### 4.4.3 Single Appliance Usage Plot

When selecting option '3' it allows you to view the usage for a select appliance which you input. An example is shown below of the functionality.

```

===== Tesla Power Modelling System =====
Input the name of the Appliance... iphone x
Found: iPhone X | 200W | 0,0,0,0,0,0,0,0,0,0,1,1,1,0,0,0,0,0,0,0,1,1,1,0
Press enter to continue...

```

Once selected you are promoted to input the name of the appliance. If the appliance is found the data is presented and compiled and a plot is automatically prepared. Plots can be found at the end of the section.

#### 4.4.4 Day General Usage vs All Appliance Usage Plot

When selecting option '4' it allows you to view the daily usage for daily usage vs appliance usage, letting you compare both. An example is shown below of the functionality.

```

===== Tesla Power Modelling System =====

1. Appliance Ratings
2. All Appliance Usage plot
3. Appliance Usage Plot
4. Day General Usage vs Appliance Usage

What would you like to do? 4
Add single day usage data...
What file are we reading? █

```

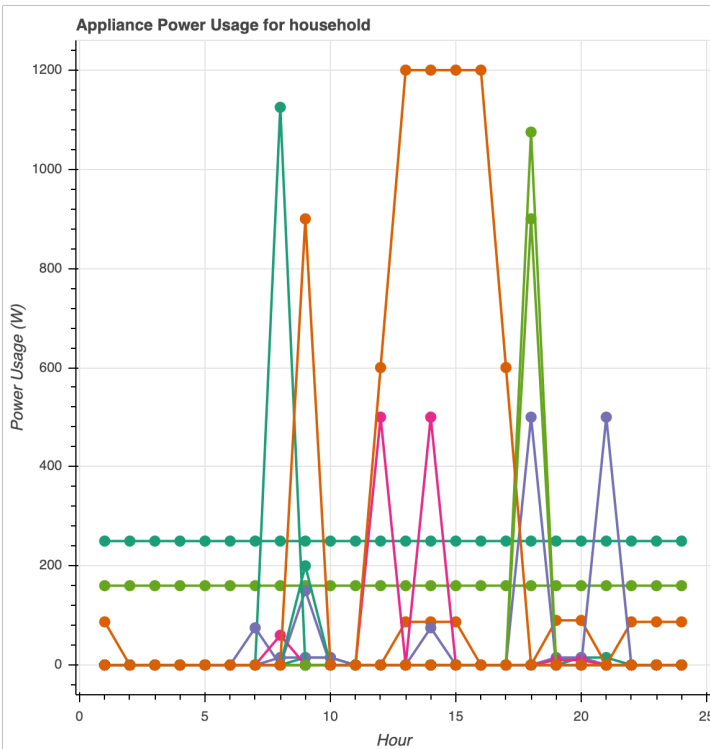
Once selected a prompt is shown to input a file, it is important that the file follows the correct format so it is accepted, this is shown below.

```
<D M Y H:M:S>,<Usage>
27 05 2020 01:59:00,327009
27 05 2020 03:19:00,327010
... x 22 more
```

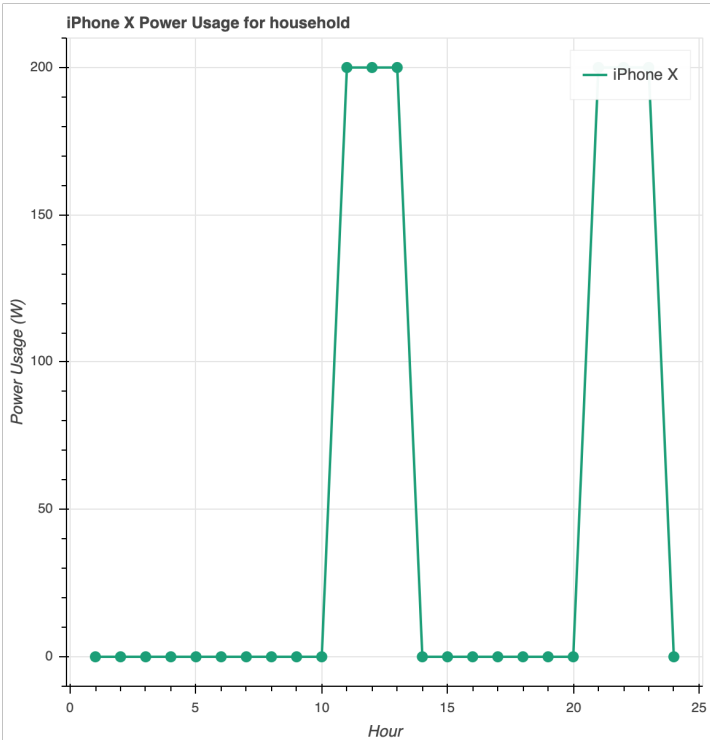
It then automatically creates a graph using the information given, if correct and compares the daily power usage to appliance power usage.

# 4.5 Output Examples

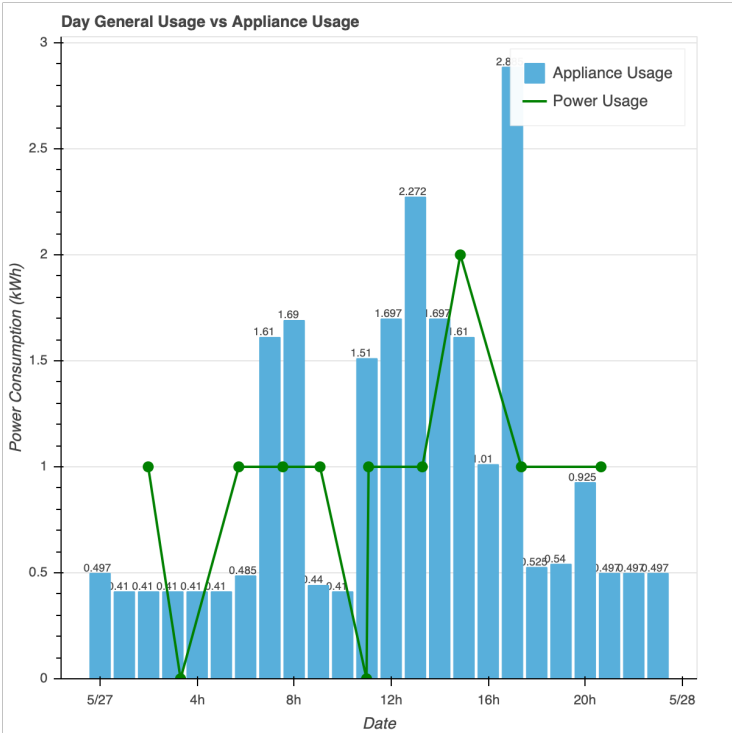
## 4.5.1 All Appliance Usage Plot



## 4.5.2 Single Appliance Usage Plot



4.5.3 Day General Usage vs All Appliance Usage Plot



# Power Simulation

## 5.1 Overview

Power Simulation, looks at a community of households and how they all contribute towards power usage, using the '3. Power Simulation' option. Each simulation only uses an 8 day range to create a simulation.

## 5.2 Creating Simulation

### 5.2.1 File Input

```
----- Tesla Power Simulation System -----  
Would you like to read a file in? y/n...  
Read documentation for required format  
> y  
What file are we reading? █
```

Once selected a prompt is shown to input a file, it is important that the file follows the correct format so it is accepted, this is shown below.

```
House=<number>,<suburb>  
  
<D M Y H:M:S>,<Usage>  
  
15 02 2020 22:58:00,143710  
  
16 02 2020 16:13:00,143730  
  
... x 6 more
```

Date must be unique, each line is a new day. And more houses can be added underneath. If the format is correct and the correct file is provided the usages are added to your 'suburb' and therefore rich interactive plots can be created. Plots can be found at the end of the section.

### 5.2.1 Manual Input

```
----- Tesla Power Simulation System -----  
Would you like to read a file in? y/n...  
Read documentation for required format  
> n  
Lets create a houses for carramar suburb  
1. What is the house number?...  
> 14  
Creating house ...  
  
Now lets add a 8 day power usage  
2. Add day 1 usage | format: <Date>,<totalUsage>  
eg) 16 02 2020 00:00:00,143732  
> █
```

Once selected it prompts you in stages which gives descriptive details of what it expects, if the given data which isn't the correct the system just asks for the data again until provided with the correct format.

```

2. Add day 7 usage | format: <Date>,<totalUsage>
eg) 16 02 2020 00:00:00,143732
> 16 02 2020 00:00:00,143732
2. Add day 8 usage | format: <Date>,<totalUsage>
eg) 16 02 2020 00:00:00,143732
> 16 02 2020 00:00:00,143732

Would you like to add another house? y/n...
> n

Press enter to continue... █

```

Once at the end the system asks if you would like to add another household to the suburb (shown above), if not then a rich interactive plots is automatically created. Plots can be found at the end of the section.

## 5.3 Pre-set Simulation Plot

When selecting option '2' it automatically creates a preset plot and presents you with it. The data set used is from a government study into the power usage of households. (Link below). This study compiles households from 2012-2014 and tracks their electricity consumption. The usage which the plot includes is from 09/02/14 - 16/02/14.

> <https://data.gov.au/data/dataset/0f3d60db-bd63-419e-9cd9-0a663f3abbc9/resource/9267e15e-1292-40fa-b6ef-3b41c9b95bd8/download/electricityconsumptionbenchmarkssurveydataaergovhack.csv>

## 5.4 Average Simulation Plot

When selecting option '3' it automatically creates an average plot which can be changed using a slider which controls the amount of households (**Parameter Sweeping**). This is shown below.

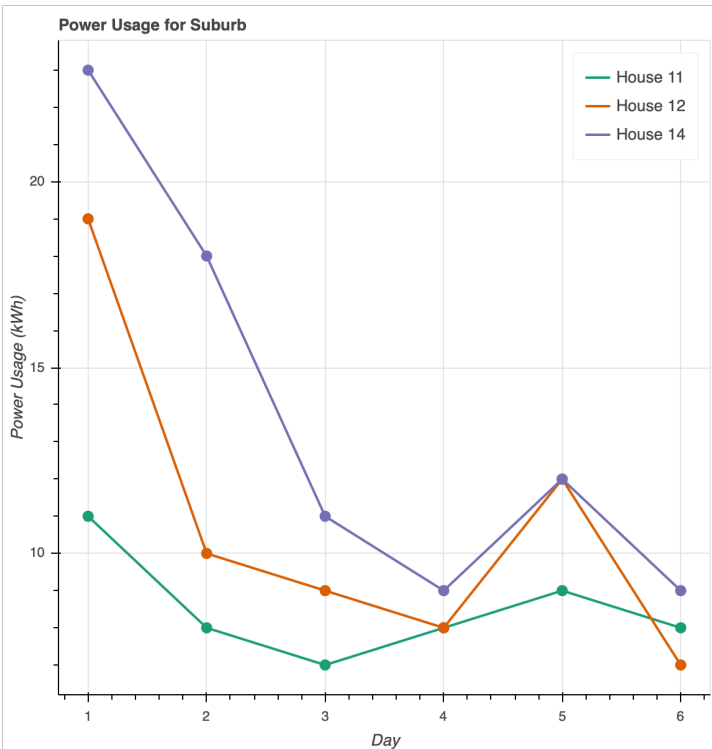


The hourly average is compiled from a CSIRO study (Link below) which looked into the average power consumption into Victorian homes during the year. This plot only presents the average during the month of May. Alongside it adds randomness to the value as not all households will follow the set average.

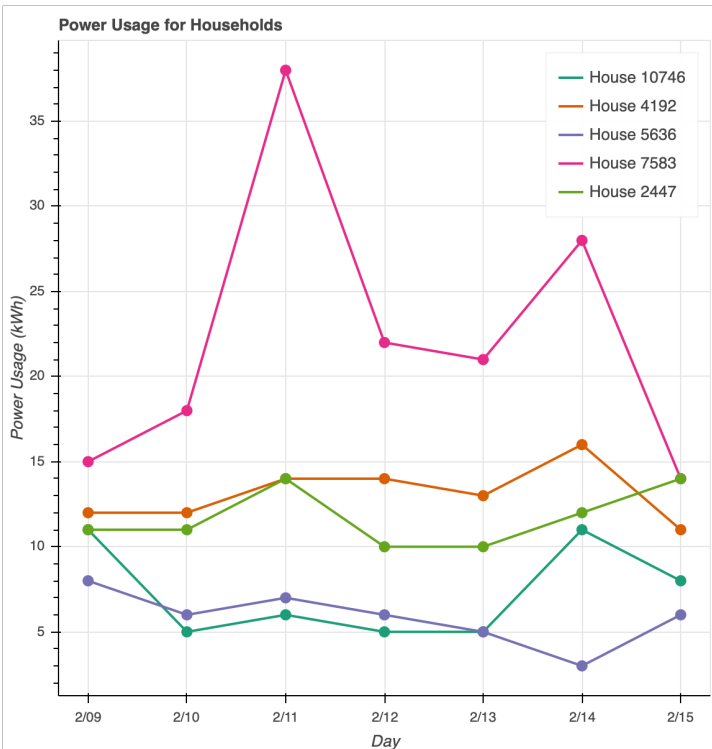
> <https://ahd.csiro.au/other-data/typical-house-energy-use/>

# 5.5 Output Examples

## 5.5.1 Creating Simulation



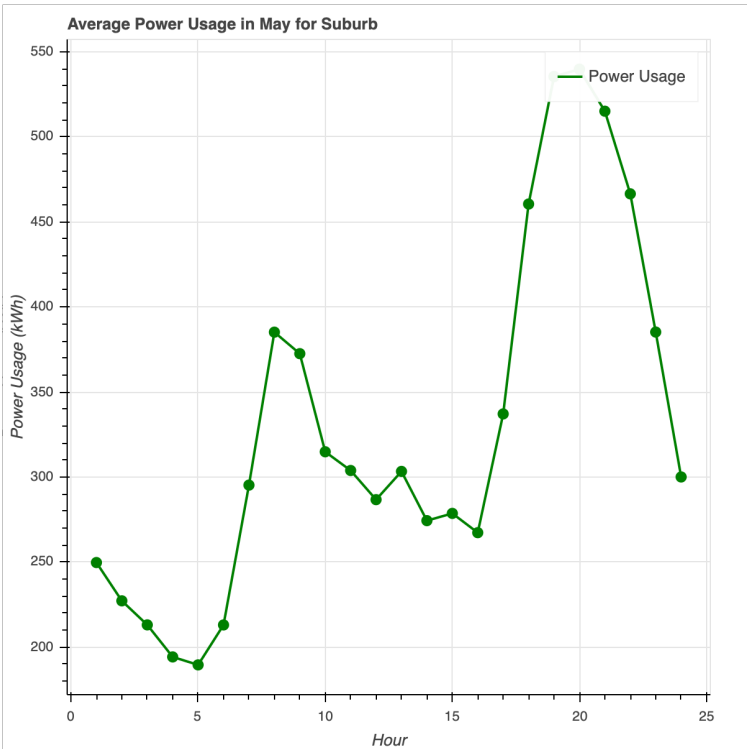
## 5.5.2 Pre-set Simulation





# 5.5.3 Average Simulation

Below shows 500 households



# Appendix

## Glossary

TPS	Tesla Power System
CSV	Comma-separated values. A file which is formatted by values being separated by commas.
Me	Rares Popa

## References

User Guide — Bokeh 2.0.2 Documentation. Docs.bokeh.org. Retrieved 31 May 2020, from [https://docs.bokeh.org/en/latest/docs/user\\_guide.html](https://docs.bokeh.org/en/latest/docs/user_guide.html).

Typical House Energy Use - Australian Housing Data. Australian Housing Data. (2013). Retrieved 31 May 2020, from <https://ahd.csiro.au/other-data/typical-house-energy-use/>.

Electricity consumption benchmarks. Data.gov.au. (2014). Retrieved 31 May 2020, from <https://data.gov.au/dataset/ds-dga-0f3d60db-bd63-419e-9cd9-0a663f3abbc9/details>.

## Licenses

MIT License

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