



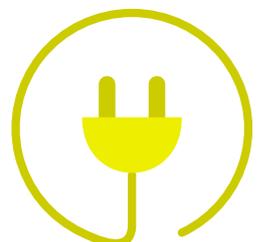
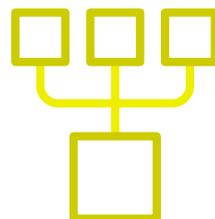
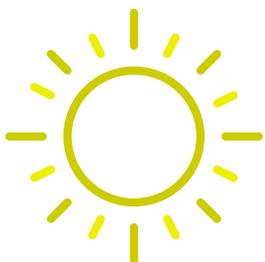
## So Dough

**Project Name:** 14/07/2025 7.36kW PV system and 5.12kWh battery storage

**Address:** 54-56 Huddersfield Road, Holmfirth, HD9 3TU

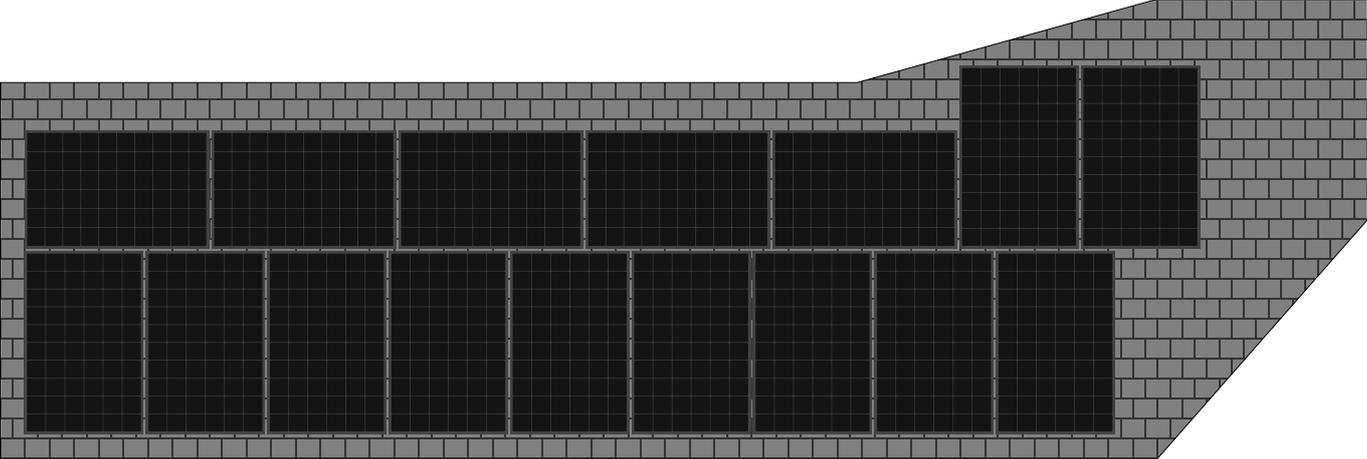
**Date Created:** 14th July 2025

**Designer:** Freddie Maddocks



# Roof Layout

Roof 1 South Facing



# Component list

Item	Quantity
Aiko Neostar 2S 460W All Black ABC N-Type Mono solar panel	16
6kW Hybrid inverter	1
**NET** Emlite Bi-directional Meter ECA2.n*	1
Label sheet	1
Battery Hazard Warning Label Pack	1
AC isolator - IMO - 32A 4-pole	2
Hanchu ESS 5.12kWh Battery	1
IMO 25A DC Isolator 4-pole 2-string	2
MC4 4mm Connector Pair	4
50m reel of 4mm <sup>2</sup> solar cable	1
Fastensol black universal clamp	38
Fastensol black end cap	12
Fastensol portrait flat tile roof hook	44
Genius speedflash	44
Fastensol rail splice	8
Fastensol silver rail 3550mm	14



# Inverter checks

## 6kW Hybrid

### Panels

PV power **7360** Rated AC output **6000**

Input 1: 8 Aiko Neostar 2S 460W All Black ABC N-Type Mono solar panels in 1 strings

### Panels

### Inverter

PV power	<b>3680 W</b>		
Open circuit voltage at $-10^{\circ}\text{C}$	<b>355 V</b>	Max DC voltage	<b>550 V</b>
$V_{\text{mpp}}$ at $40^{\circ}\text{C}$	<b>268 V</b>	$V_{\text{mpp}}$ lower limit	<b>40 V</b>
$V_{\text{mpp}}$ at $-10^{\circ}\text{C}$	<b>299 V</b>	$V_{\text{mpp}}$ upper limit	<b>530 V</b>
$I_{\text{mpp}}$ at $40^{\circ}\text{C}$	<b>13 A</b>	Max DC input current	<b>16 A</b>

#### Max voltage

The open circuit voltage of the solar panels never exceeds the voltage limit of the inverter.



#### Max power point range

The maximum power point voltage of the solar panels is always above the lower limit of the inverter MPPT tracker. The maximum power point voltage of the solar panels is always below the upper limit of the inverter MPPT tracker.



### Max Current

The maximum power point current of the solar panels is always below the maximum current for the inverter MPPT tracker.



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## Input 2: 8 Aiko Neostar 2S 460W All Black ABC N-Type Mono solar panels in 1 strings

Panels		Inverter	
PV power	<b>3680 W</b>		
Open circuit voltage at -10° C	<b>355 V</b>	Max DC voltage	<b>550 V</b>
$V_{mpp}$ at 40° C	<b>268 V</b>	$V_{mpp}$ lower limit	<b>40 V</b>
$V_{mpp}$ at -10° C	<b>299 V</b>	$V_{mpp}$ upper limit	<b>530 V</b>
$I_{mpp}$ at 40° C	<b>13 A</b>	Max DC input current	<b>16 A</b>

### Max voltage

The open circuit voltage of the solar panels never exceeds the voltage limit of the inverter.



### Max power point range

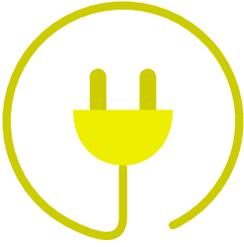
The maximum power point voltage of the solar panels is always above the lower limit of the inverter MPPT tracker. The maximum power point voltage of the solar panels is always below the upper limit of the inverter MPPT tracker.



### Max Current

The maximum power point current of the solar panels is always below the maximum current for the inverter MPPT tracker.





# Electrical

## 6kW Hybrid



### AC Isolator

A AC isolator - IMO - 32A 4-pole has been specified for this input

#### Current

The rated isolator current (32A) is greater than the rated inverter current (27.3A)



#### Phases

The isolator is suitable for use on a single phase inverter.



## Input 01



### DC Isolator

A IMO 25A DC Isolator 4-pole 2-string has been specified for this input

#### Current

The isolator is rated for a current of 20A, which is more than the expected maximum current of 17.81A.



### Voltage

At 20A the isolator is rated for a voltage of 800V, which is more than the expected maximum voltage of 394.18V.



## Cable

10m of 4mm<sup>2</sup> solar cable has been specified

### Voltage drop

Voltage drop at maximum power point at 40°C will be around **1.20 V (0.45 percent)**



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## Input 11



## DC Isolator

A IMO 25A DC Isolator 4-pole 2-string has been specified for this input

### Current

The isolator is rated for a current of 20A, which is more than the expected maximum current of 17.81A.



### Voltage

At 20A the isolator is rated for a voltage of 800V, which is more than the expected maximum voltage of 394.18V.





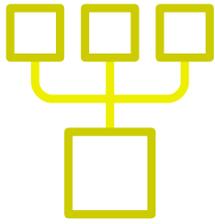
## Cable

10m of 4mm<sup>2</sup> solar cable has been specified

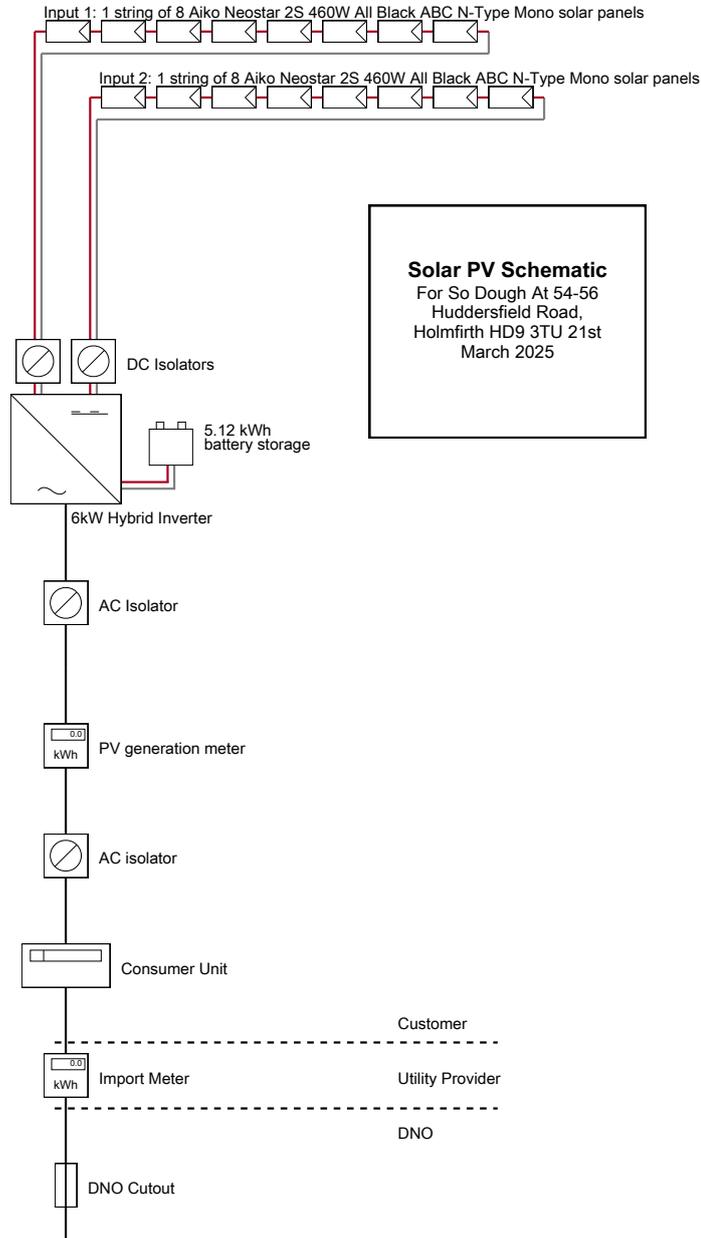
### Voltage drop

Voltage drop at maximum power point at 40°C will be around **1.20 V**  
(0.45 percent)





# Schematic diagram





# Structural calculations

## Weight loading calculations

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### Roof 1 South Facing

Weight of solar panels and mounting	377.7 kg
Area of solar array	27.9 m <sup>2</sup>
Loading imposed by solar array	0.13 kN/m <sup>2</sup>
Dead load from roof covering	0.34 kN/m <sup>2</sup>
<b>Total dead load of solar array, mounting and roof covering</b>	<b>0.47 kN/m<sup>2</sup></b>
<b>Permitted dead load</b>	<b>0.785 kN/m<sup>2</sup></b>

The solar array, mounting system, and roof covering are expected to impose a total dead load on the roof of **0.47kN/m<sup>2</sup>**. This is less than the permitted dead load for the roof of **0.785kN/m<sup>2</sup>**.



# Wind loading calculations

The maximum force acting on a solar array from wind loading is given by the following formula in BRE Digest 489:

$$F = q_p \times C_{p \text{ net}} \times C_a \times C_t \times A_{\text{ref}}$$

## Roof 1 South Facing

$Q_p$		868.8 Pa
From Fig 34 in Guide to the Installation of Photovoltaic Systems for a building 8 m high, in windzone 3, in urban terrain, at a distance of greater than 20km from the sea		
$C_{p \text{ net}}$	Roof Centre	Roof edge
Uplift	-0.5	-0.667
Pressure	0.22	0.396
$C_a$		0.852
At an altitude of 12m		
$C_t$		1
When there is no significant topography		
$A_{\text{ref}}$		27.89m <sup>2</sup>
<b>F</b>	Roof Centre	Roof edge
<b>Uplift</b>	<b>-13937N</b>	<b>-18592N</b>
<b>Pressure</b>	<b>6132N</b>	<b>11038N</b>

With 100 roof hooks we should allow for an uplift force per hook in the central zone of **139N**, rising to **186N** at the edges. If 2 screws are used per roof hook, this equates to **70N** per fixing in the central zone, and **93N** at the edges.

Roof hooks for slate roofs are fixed with screws that pass through the 5mm plate of the roof hook and a 20mm batten (or spacing pad of wood) before being driven home in the rafter. So there is approximately 45 mm of thread in the timber. The pull-out force in C16 timber is given by tables and formulae in BS5268 Part 2:

$$17.3 \times 1.25 \times 45 = \mathbf{973N}$$

The pullout force on the fixings is more than the expected wind loading, even when the fixings are close to the edge of the roof.

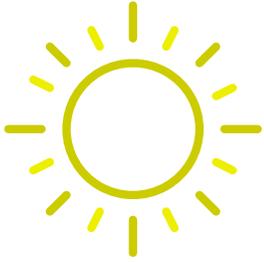


The MCS012 certificate for the selected roof hook states that the maximum design wind uplift is **207N per roof hook**.

For modules 1.76m high, with two rails per panel, the wind loading force per meter of rail will be **439N/m** in the center of the roof ( $500\text{Pa} \times 1.76\text{m} / 2$ ), rising to **585N/m** ( $667\text{Pa} \times 1.76 / 2$ ) at the edge of the roof. In the center of the roof the design uplift should therefore not be exceeded if hooks are spaced no more than **0.47m** apart ( $207\text{N} / 439\text{N/m}$ ). At the edge of the roof hooks should be spaced no more than **0.35m** apart ( $207\text{N} / 585\text{N/m}$ ).

With the specified number of hooks, loading forces are expected to be less than the uplift force per hook derived from the MCS012 certificate both at the center and edge of the roof.





# Performance Estimate

## Site details

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**Client**

So Dough

**Address**

54-56 Huddersfield Road, Holmfirth

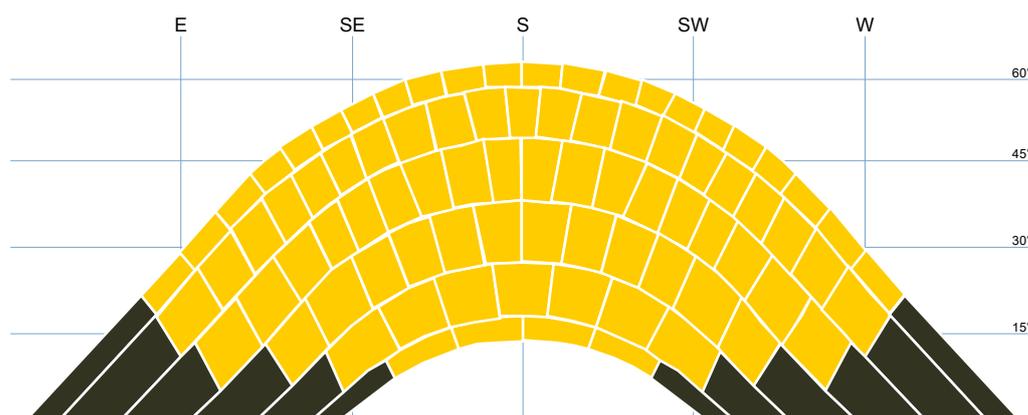
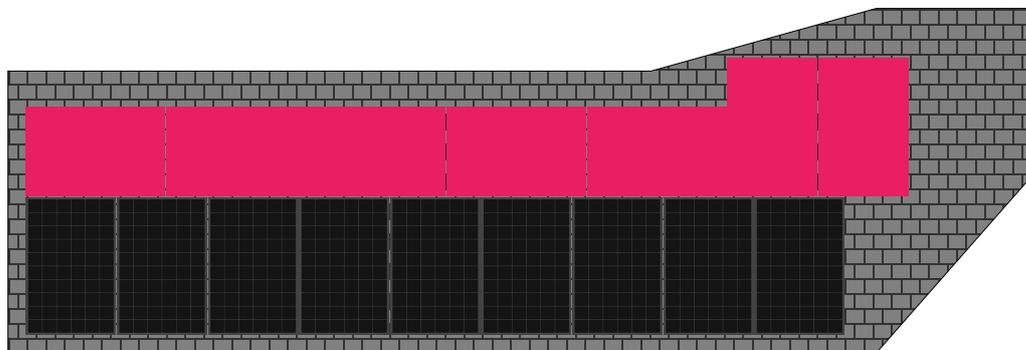
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The sunpath diagram shows the arcs of the sky that the sun passes through at different times of the day and year as yellow blocks. The shaded area indicates the horizon as seen from the location of the solar array. Where objects on the horizon are within 10m of the array, an added semi-circle is drawn to represent the increased shading. Blocks of the sky that are shaded by objects on the horizon are coloured red, and a shading factor is calculated from the number of red blocks. The performance of the solar array is calculated by multiplying the size of the array (kWp) by the shading factor (sf) and a site correction factor (kk), taken from tables which take account of the geographical location, orientation and inclination of the array.

# Inverter 1

6kW Hybrid

## Input 1



### A. Installation data

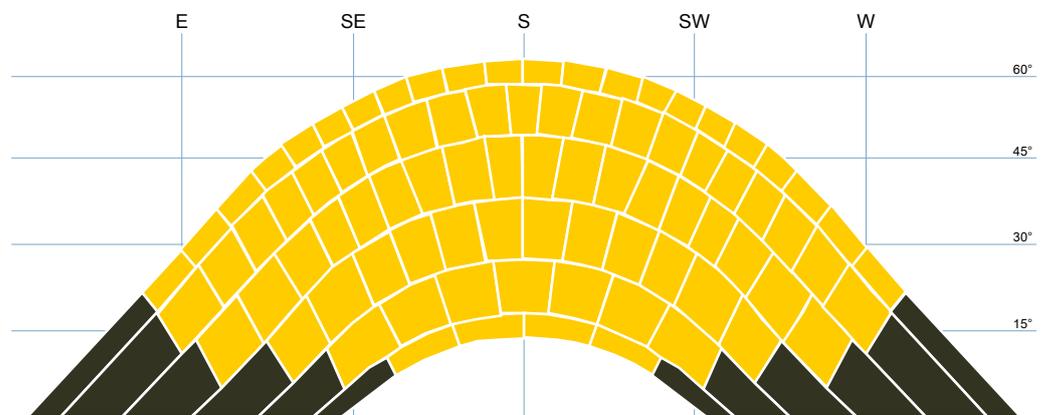
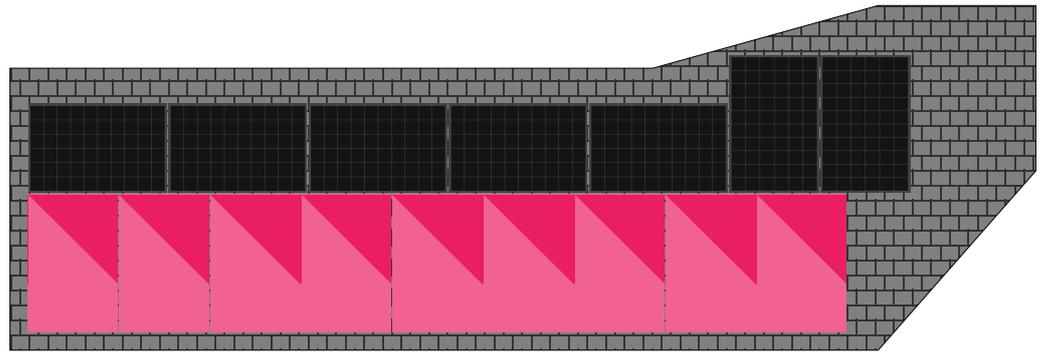
Installed capacity of PV system – kWp (stc)	3.680	kWp
Orientation of the PV system – degrees from South	10	°
Inclination of system – degrees from horizontal	25	°
Postcode region	11	



### B. Performance calculations

kWh/kWp (Kk)	871	kWh/kWp
Shade factor (SF)	1.00	
Estimated output (kWp × Kk × SF)	3205	kWh

## Input 2



### A. Installation data

Installed capacity of PV system – kWp (stc)	3.680	kWp
Orientation of the PV system – degrees from South	10	°
Inclination of system – degrees from horizontal	25	°
Postcode region	11	



### B. Performance calculations

kWh/kWp (Kk)	871	kWh/kWp
Shade factor (SF)	1.00	
Estimated output (kWp × Kk × SF)	3205	kWh

# Performance Summary

<b>A. Installation data</b>		
Installed capacity of PV system – kWp (stc)	7.36	kWp
Orientation of the PV system – degrees from South	See individual inputs	
Inclination of system – degrees from horizontal	See individual inputs	
Postcode region	11	
<b>B. Performance calculations</b>		
kWh/kWp (Kk)	See individual inputs	
Shade factor (SF)	See individual inputs	
Estimated output (kWp × Kk × SF)	6410	kWh
<b>C. Estimated PV self-consumption – PV Only</b>		
Assumed occupancy archetype	Home half the day	
Assumed annual electricity consumption, kWh	20000	kWh
Assumed annual electricity generation from solar PV system, kWh	6410	kWh
Expected solar PV self-consumption (PV Only)	4041	kWh
Grid electricity independence / Self-sufficiency (PV Only)	20	%
<b>D. Estimated PV self-consumption – with EESS</b>		
Assumed usable capacity of electrical energy storage device, which is used for self-consumption, kWh	4.61	kWh
Expected solar PV self-consumption (with EESS)	5052	kWh
Grid electricity independence / Self-sufficiency (with EESS)	25	%

**Important Note:** The performance of solar PV systems is impossible to predict with certainty due to the variability in the amount of solar radiation (sunlight) from location to location and from year to year. This estimate is based upon the standard MCS procedure is given as guidance only for the first year of generation. It should not be considered as a guarantee of performance.

The solar PV self-consumption has been calculated in accordance with the most relevant methodology for your system. There are a number of external factors that can have a significant effect on the amount of energy that is self-consumed so this figure should not be considered as a guarantee of the amount of energy that will be self-consumed



# Self consumption

We model here the performance of a solar PV system with battery storage over the course of a year, using high resolution minute-by-minute generation data for a typical PV system and consumption data for a typical house, and calculating the flow of energy from the solar panels to the house and the battery during the day, and from the storage battery back to the house at night – or from the grid to the house when the battery is empty or loads exceed the discharge capacity of the system.

We provide yearly profiles of generation, consumption, import / export and battery utilisation, along with detailed profiles for a typical spring day.

## Battery system specification

### 6kW Hybrid Inverter with a Hanchu ESS 5.12kWh Battery

Charge rate is directly taken from the inverter specification; this value can be less depending on the type of battery connected.

Charge rate	6000 W
Inverter charge efficiency	95 %
Inverter discharge efficiency	95 %
Battery efficiency	95 %
Round trip efficiency	86 %
Battery bank capacity	5.1 kWh
Max discharge depth	90 %
Usable capacity	4.6 kWh



#### Consumption

20000 kWh

Electricity consumed in the property each year



#### Self consumption

80 %

Proportion of PV generation used in the property



#### Import / Export

14948 kWh /  
1205 kWh

Electricity import / export each year from the property



#### Generation

6410 kWh

Electricity generated by the PV array each year



#### Independence

25 %

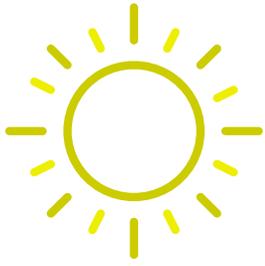
Proportion of electricity consumption provided by PV



#### Utilisation

64 %

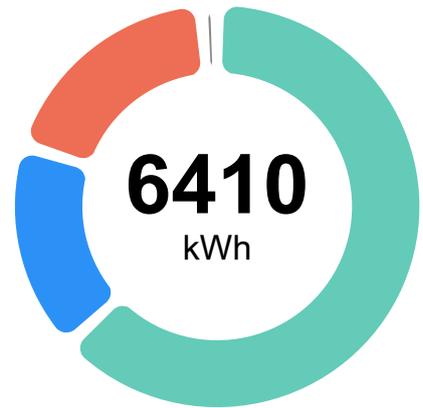
Average daily utilisation of the storage battery



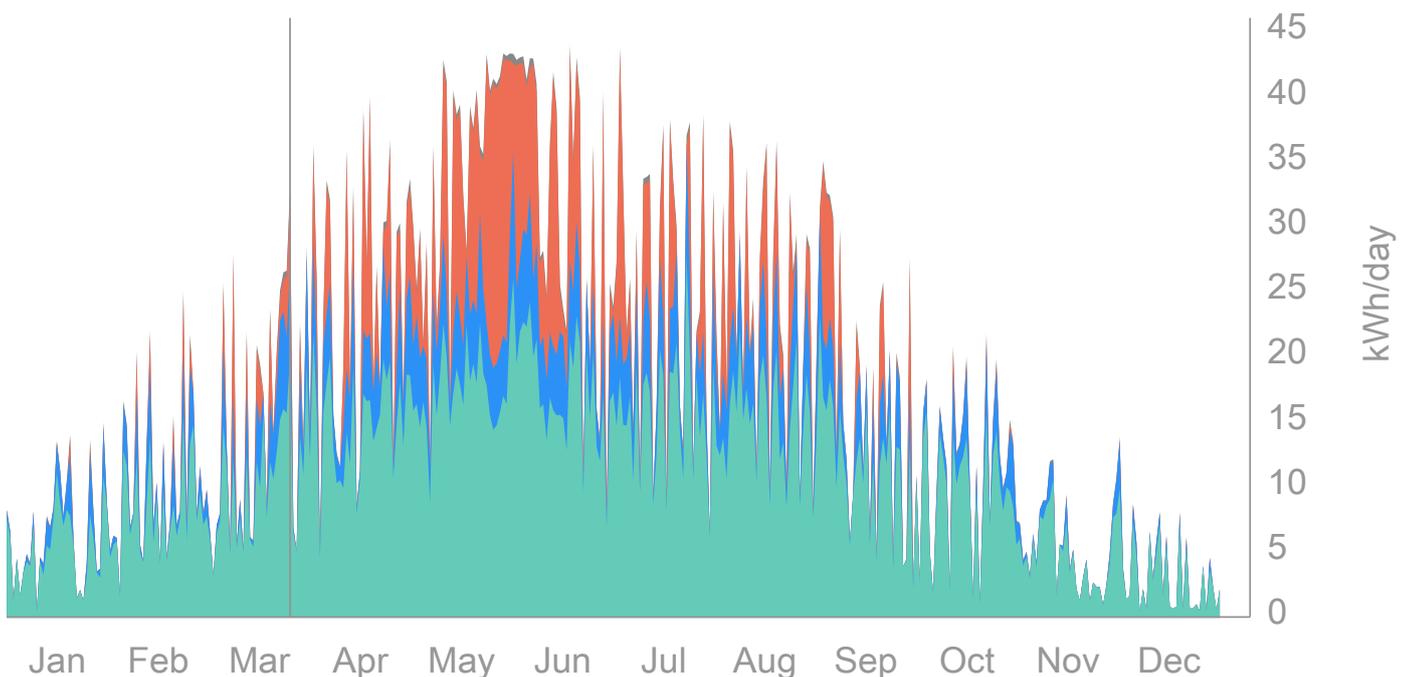
# Yearly generation

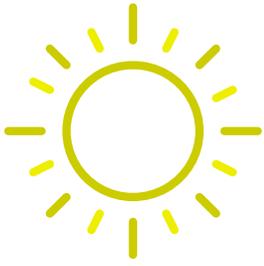
The solar PV array is expected to generate a maximum of 6410 kWh over a typical year. The graph shows whether the generated energy is used directly in the house, used to charge the storage battery, or exported to the grid.

63% (4041 kWh) of the electricity generated is expected to be used directly in the property. 18% (1164 kWh) is directed to the battery for later use, although 83 kWh of this is lost during battery charging, leaving 1081 kWh for use in the property. The remaining generation (1205 kWh, or 19% of the total) is exported to the grid.



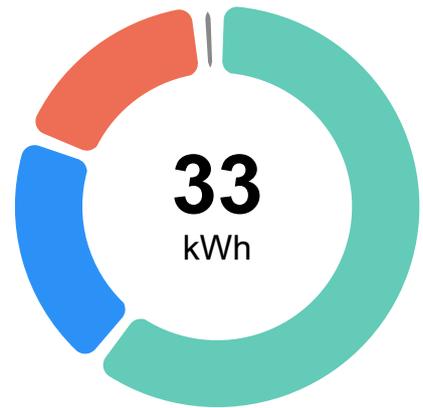
Direct use	Via battery	To grid	Losses
<b>4041</b> kWh	<b>1081</b> kWh	<b>1205</b> kWh	<b>83</b> kWh





# Daily generation

This graph shows the modelled profile of electricity generated by the PV array on a selected day (March 27th). On this day the PV system is expected to generate 33.1 kWh. Of this, 20.1 kWh (61%) is used directly in the property, 6.7 kWh (20%) is stored in the battery for later re-use, and 5.8 kWh (18%) is exported to the grid.

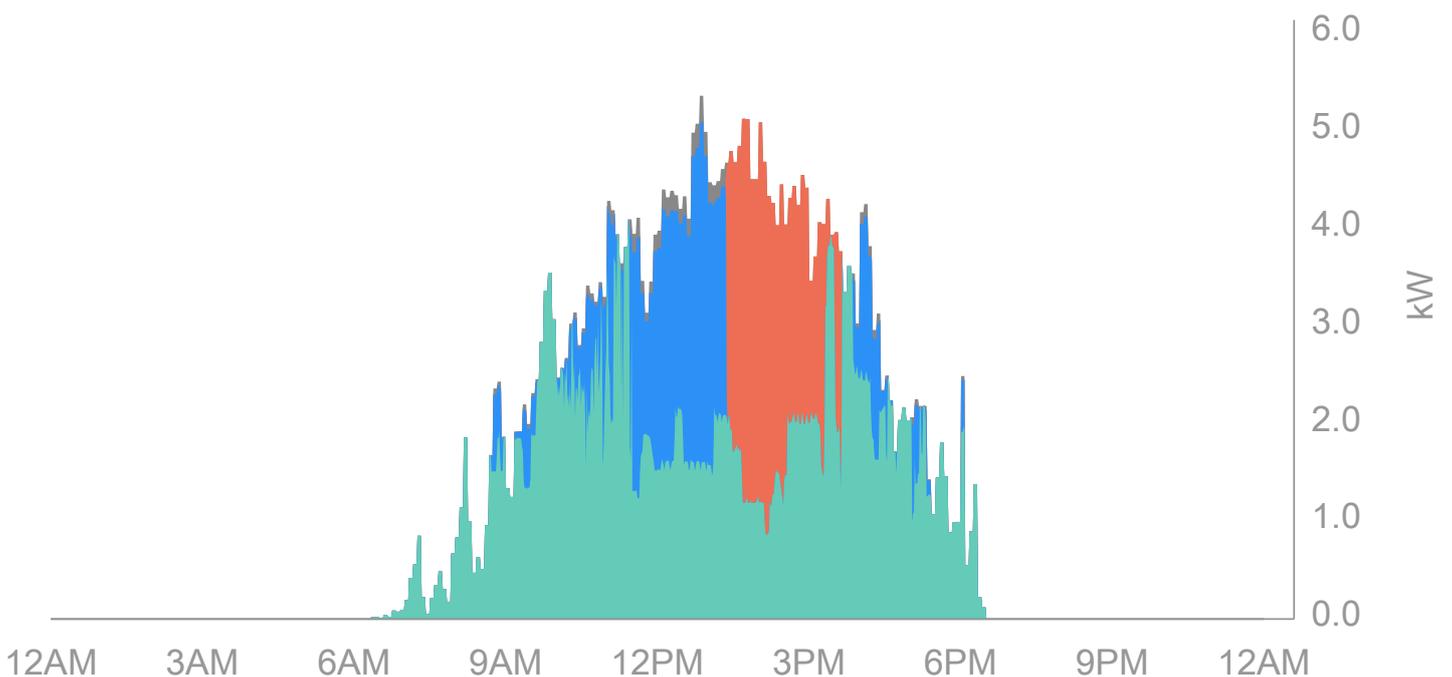


Direct use  
**20 kWh**

Via battery  
**6.7 kWh**

To grid  
**5.8 kWh**

Losses  
**0.51 kWh**

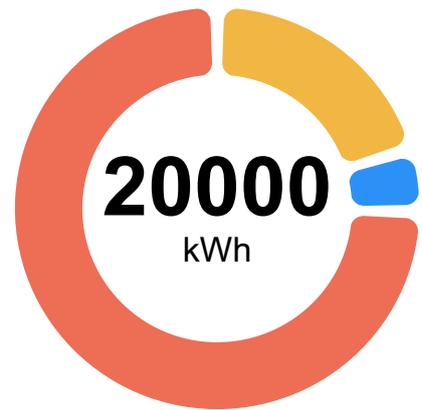




# Yearly consumption

The property is expected to consume 20000 kWh of electricity each year. Around 20% of this (4041 kWh) is expected to be supplied directly by the solar array. Another 5% (1011 kWh) is supplied from the storage battery. The remaining 75% (14948 kWh) is supplied from the grid.

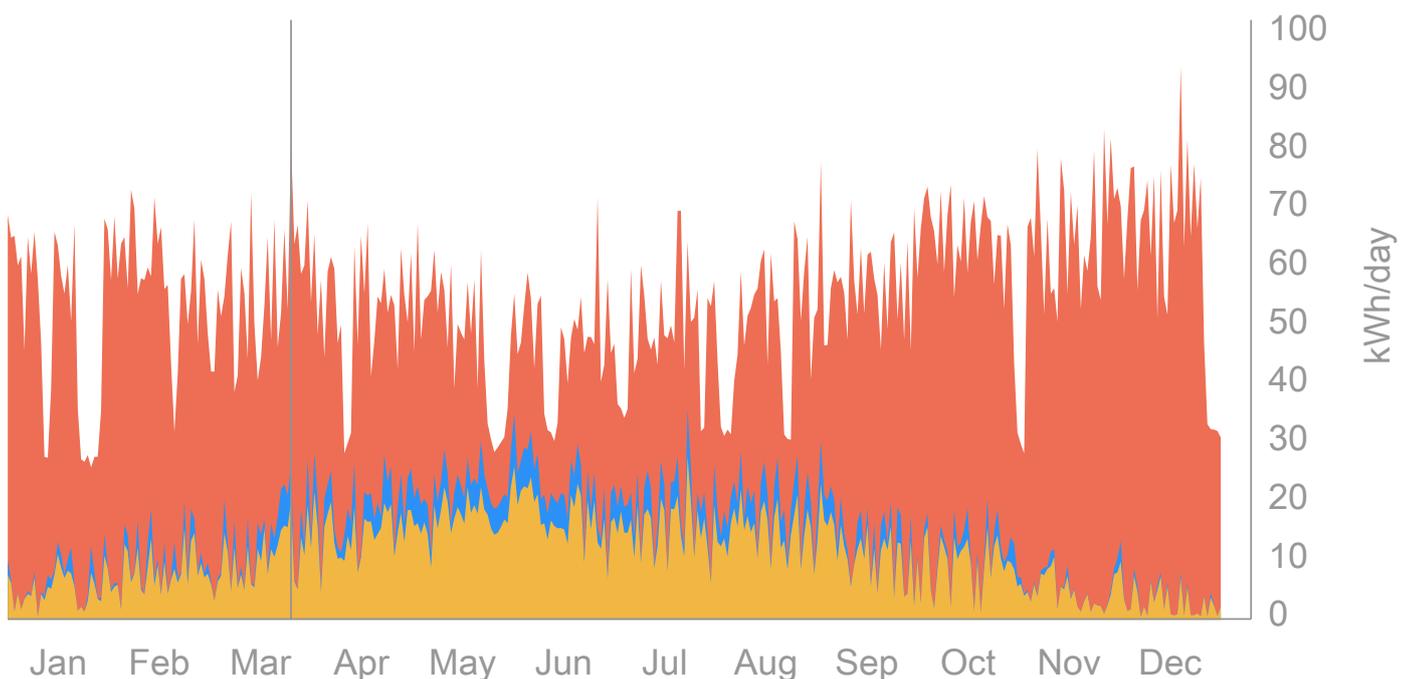
Overall, 25% (5052 kWh) of the electricity used in the property is expected to be supplied by the solar array and battery storage system. Without battery storage it would be 20% (4041 kWh).



From solar  
**4041 kWh**

From battery  
**1011 kWh**

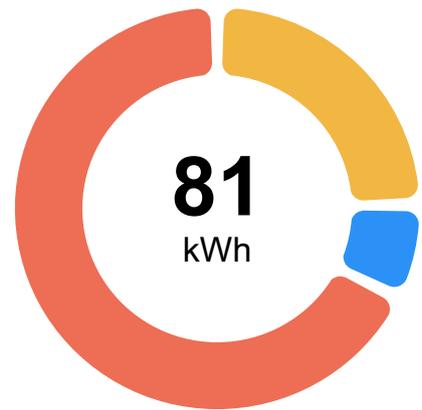
From grid  
**14948 kWh**





# Daily consumption

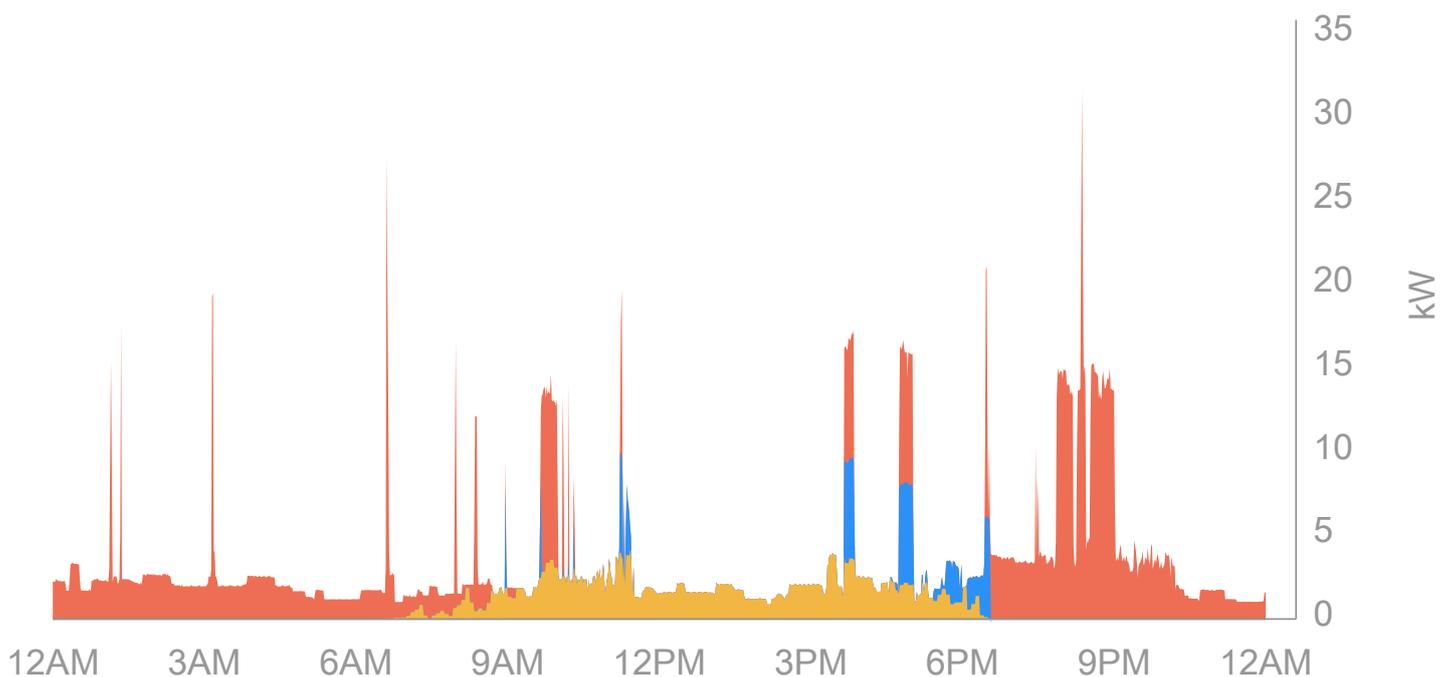
This graph shows modelled consumption data over the course of the selected day (March 27th). Total electricity consumption on this day was 81.5 kWh, of which 20.1 kWh (25%) is expected to be supplied directly by the solar array, and a further 6.2 kWh (8%) drawn from the battery storage system. The remaining 55.1 kWh (68%) is imported from the grid.

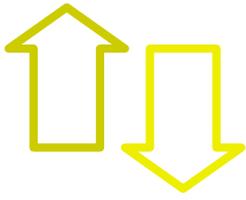


From solar  
**20 kWh**

From battery  
**6.2 kWh**

From grid  
**55 kWh**





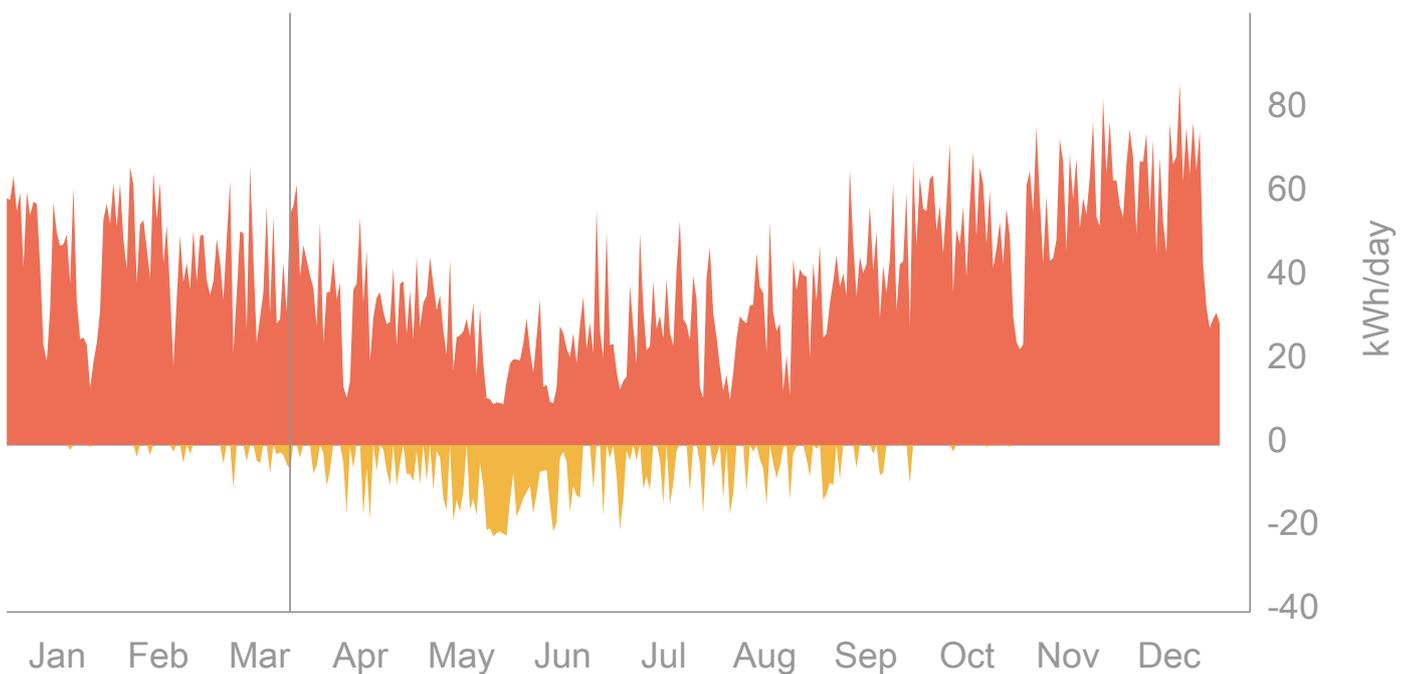
# Yearly import and export

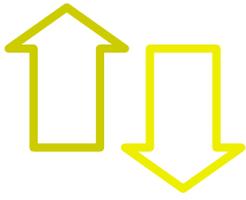
This graph shows modelled profiles of electricity imported and exported to and from the grid over the course of a year. The red area above the horizontal axis represents imported electricity, and the yellow area beneath the axis exported electricity.

Over the course of the year, a total of 14948 kWh is expected to be imported by the property, and 1205 kWh exported back to the grid.

 Importing  
**14948** kWh

 Exporting  
**1205** kWh



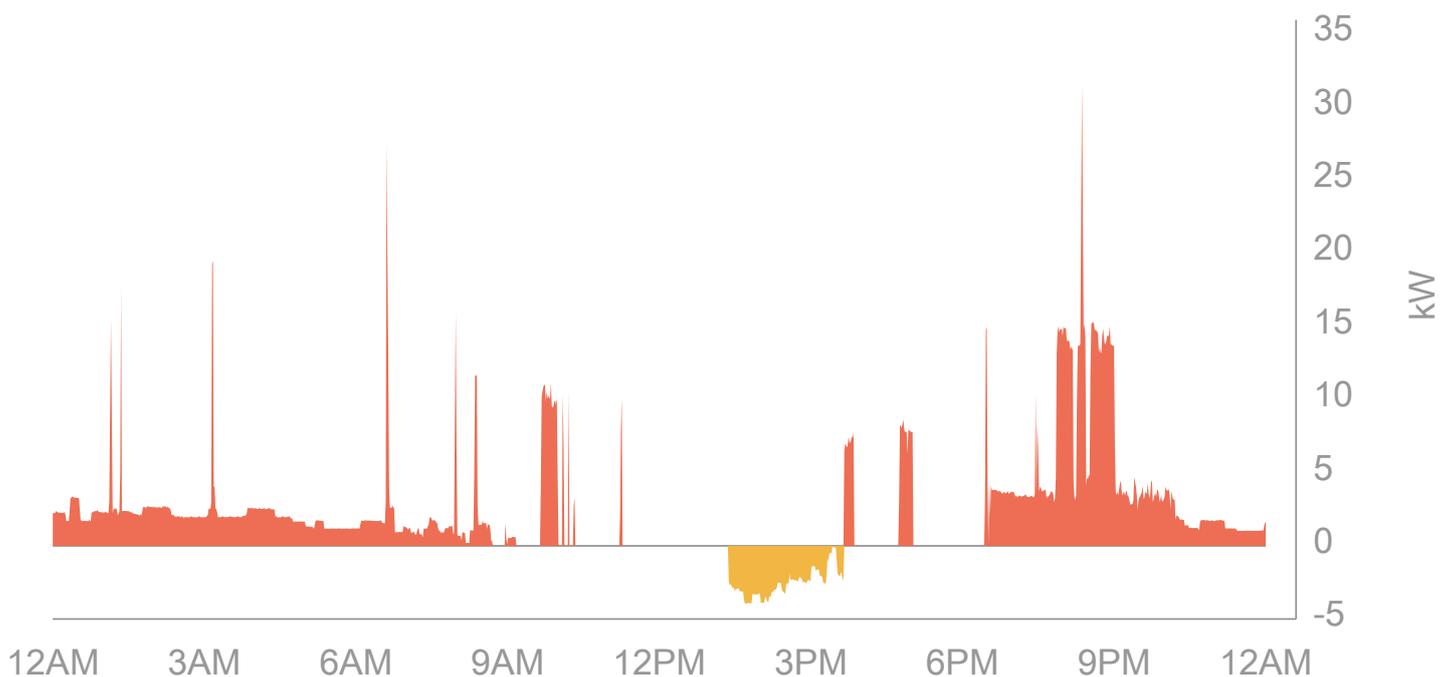


# Daily import and export

This graph shows the modelled import and export of electricity over a selected day (March 27th). On this day 55.1 kWh is expected to be imported from the grid, and 5.8 kWh exported. At times when no import or export is shown the battery storage system is charging or discharging.

 Importing  
**55 kWh**

 Exporting  
**5.8 kWh**





# Yearly battery utilisation

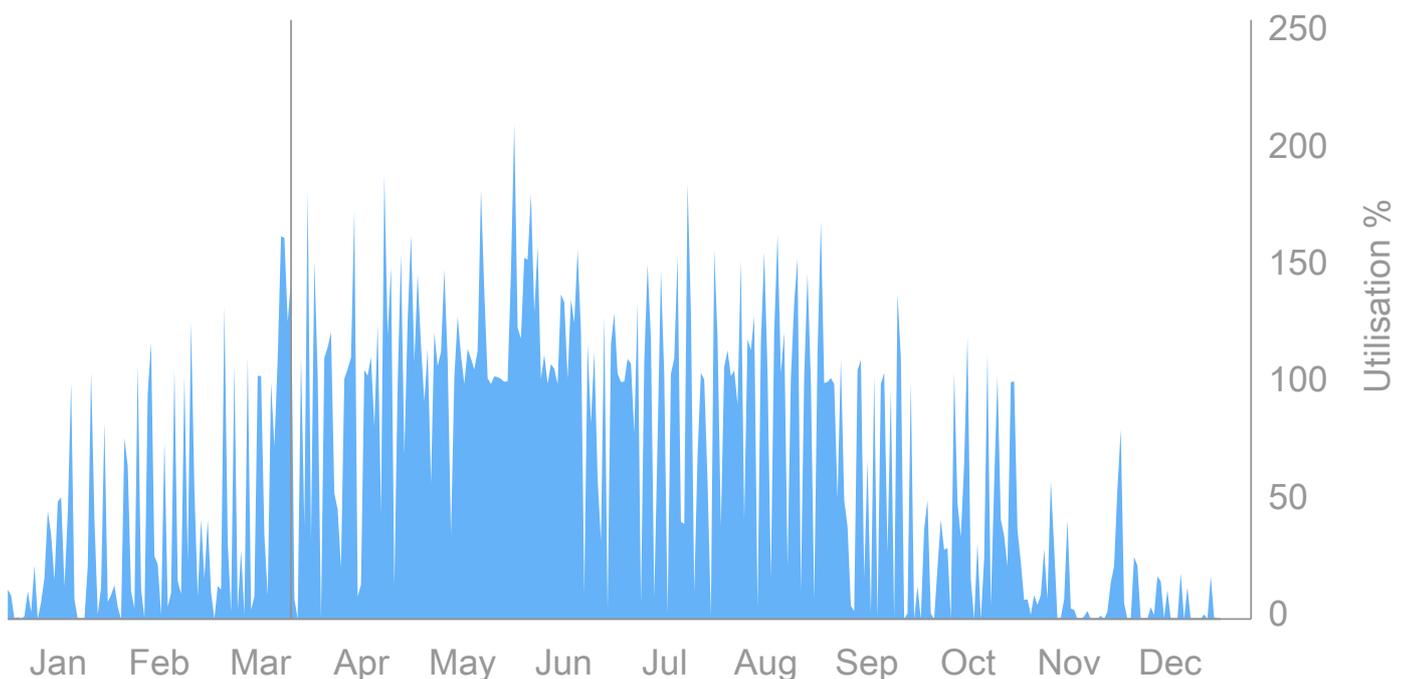
The graph shows the modelled utilisation of the battery over the course of the year – the fraction of the available battery capacity that is actually charged and discharged each day. Utilisation of over 100% is possible at times where a battery is charged and discharged more than once during a day.

Low battery utilisation can be due to either insufficient spare PV generation to charge the battery (often the case in winter, or on cloudy days), or because loads are small overnight and the battery does not fully discharge.



## 64%

Avg Battery Utilisation





# Daily battery utilisation



**145%**

Avg Battery Utilisation

The state of charge of the battery over a selected day (March 27th) is shown in the graph below. The battery discharges overnight or when there is heavy demand during the day, and charges when there is excess solar PV generation during the day. On this day, 145.0% of the battery capacity was utilised.

