

Introduction

Background

Throughout the course of 2011 SP Energy Networks has been installing **Sub.Net power monitoring devices** in the four secondary substations that feed the village of Ashton Hayes. These devices measure a number of parameters, including power quality and electricity consumption, over 140 times a day, every day before sending data directly to ScottishPower staff. This data, coupled with our knowledge of the Ashton Hayes Low Voltage Network, has allowed us to produce the following graphs and explanations that summarise the electricity usage of the village during the of October.

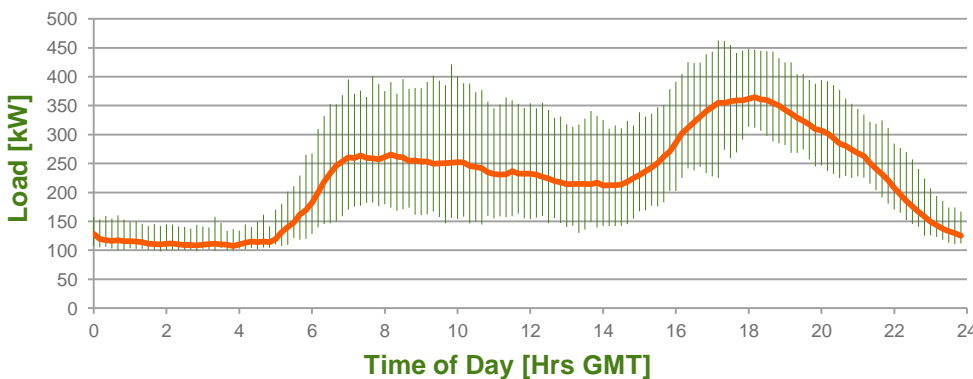
Aims of Research

From our study into the electricity usage of Ashton Hayes we hope to provide the residents of the village with a means of understanding how individual properties contribute to their overall demand. We hope to give an insight into how the community can move their adoption of renewable resources and green technology and help progress the village towards its carbon neutral goal. We also hope that it will give us at ScottishPower how a Low Voltage network performs when innovative technology, such as electric vehicles, heat pumps and solar panels, are connected.



Ashton Hayes electricity demand – October 2011

Average, Maximum and Minimum load



What does the graph tell us?

The orange line on the graph shows Ashton Hayes' demand for electricity throughout a typical day in October. From it we can see that the maximum demand occurs at around 6PM and is 350kW. To give an idea of scale a single kettle requires about 2.2kW of power. The vertical lines illustrate the maximum and minimum demands experienced at that time of day through out the month. The demand profile is closely related to our behaviours, for example the peak at 0700 is due to people waking up and using kettles, toasters and power showers etc. as they get ready for work.

Why is this important?

As more Low Carbon technologies such as electric vehicles and heat pumps are added to the network the peaks in the demand curve will also increase. However there is a limit to what the network can supply and hence it is important that demand does not exceed the capacity of the network. It is therefore important to monitor demand and where possible shift it to quieter parts of the day so that large peaks do not occur.

Interesting Fact

The total Electricity Consumption for October is 163,029kWh. This is equivalent to the electricity required to drive the Nissan leaf to the moon and back!



A Low carbon case study

A possible reduction of around **1 tonne in the daily carbon emissions** could be achieved by the installation of four **100kW wind turbines** and **one 14kW** wind turbine in addition to the solar panels on the pavilion and the school.

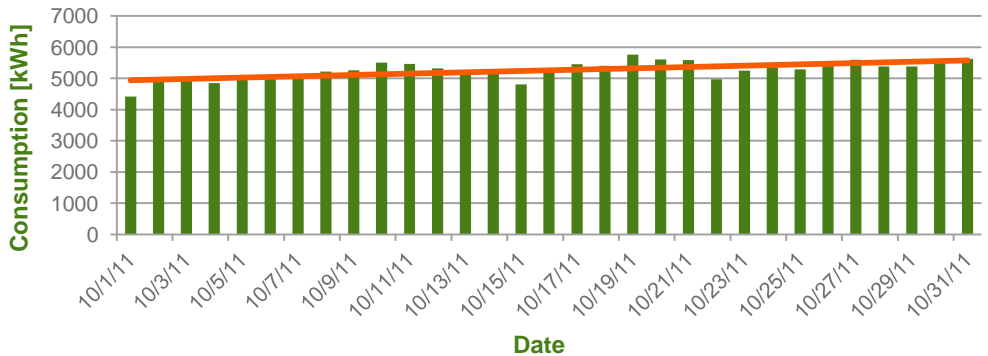
This would result in around **35%** of the village's electricity supply coming from renewables.

The total carbon production for October was **89 tonnes**.

The above proposal could potentially reduce this to about **58 tonnes**.

Ashton Hayes electricity consumption - October

Ashton Hayes total electricity consumption



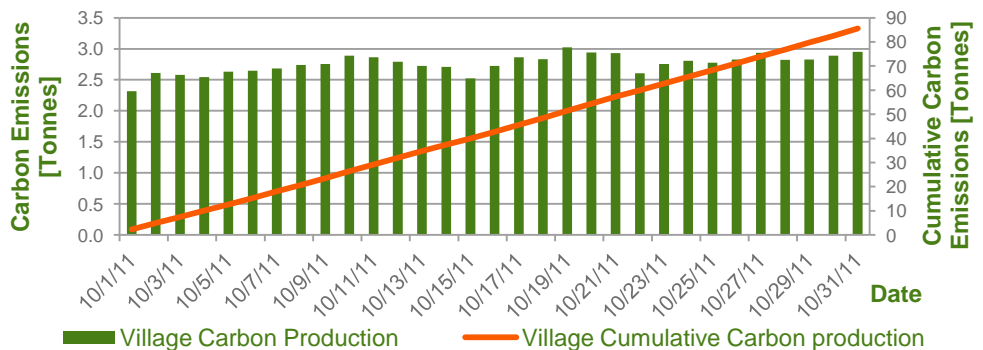
What does this graph tell us?

The graph shows the total electricity used for each day in October 2011 in Ashton Hayes. We can see that the average quantity for each day is around 5,000kWh. This is equivalent to running around 3,145 very hot wash 90°C washing machine cycles. The orange line indicates the overall trend in electricity usage throughout the month. From the graph we see that consumption is increasing through the month. This is due to the approach of winter as well as the switch to Daylight Saving Time that means more electricity is being used for lighting and people are spending more time indoors and hence using appliances more.

Why is this important?

Electricity consumption is linked directly to the quantity of carbon produced as the majority of British power stations combust carbon based fuels to produce electricity. In order to reduce the amount of carbon produced it is important to understand firstly how much electricity is being consumed, then with the addition of renewable generation to the network we will also be able to monitor the percentage of the electricity demand that is supplied by these sources and hence the associated carbon reduction.

Ashton Hayes total and cumulative carbon emissions



What does this graph tell us?

The graph shows the carbon dioxide production for each day of the month. From this we can see the average is around 2.5 - 3 tonnes of Carbon Dioxide per day. The orange line is the cumulative total quantity of carbon emissions released through the month.

Note: carbon conversion factor used is 0.52462 from '2011 Defra/DECC 's GHG Conversion Factors for Company Reporting' Version 1.2

Carbon facts

A web search
0.0075kg
carbon emissions

100W light bulb
on for 4 hours
0.17kg
carbon emissions

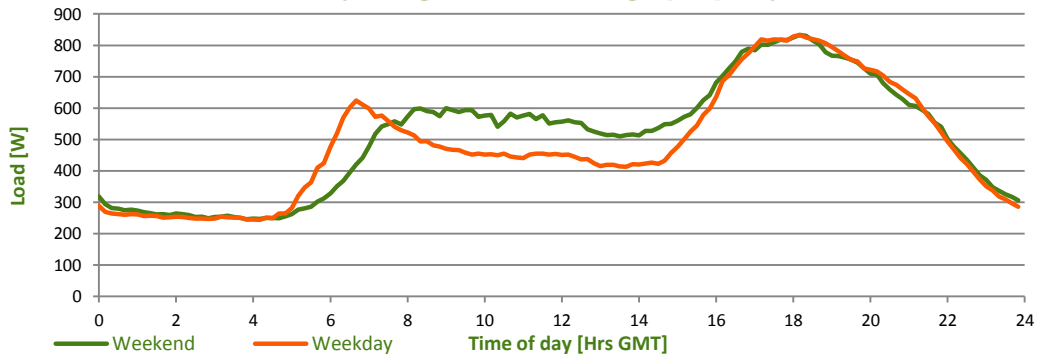
An 'A'-rated fridge
on continuously
for one day
0.48kg
carbon emissions

A bus
for a
100 mile journey
4.8kg
carbon emissions

A car
for a
100 mile journey
20.5kg
carbon emissions

Average Property contribution for October

Weekend and weekday usage for an average property



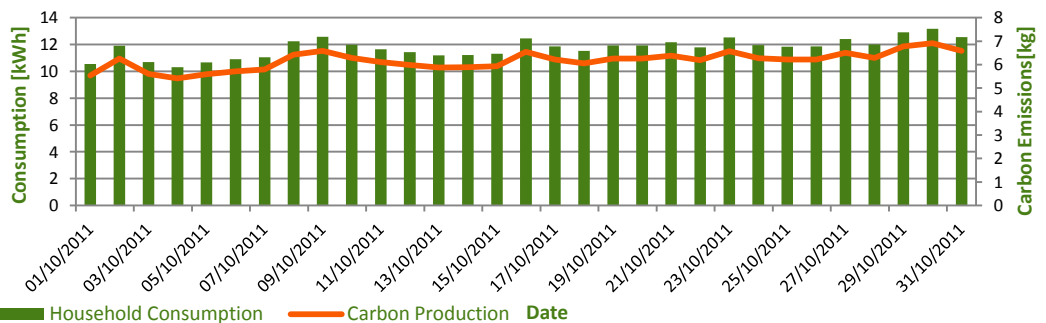
What does this graph tell us?

The above graph shows the electricity demand for an average property at the weekend and on a weekday. It highlights the difference in these load trends, for example there is a prominent peak at 0700 on the weekday curve as the majority of people get up for work/school at the same time and use high power appliances such as kettles and power showers. In contrast at the same time on the weekend curve there is a much gentler rise at this time as people get up at varying times.

Why is this important?

Understanding when we use the most electricity is a key part to reduce our overall demand and being able to shift load to another part of the day. From this information you can relate your peak demand to the appliances you have on at the time and this allows you to understand which use the most electricity and hence produce the most carbon emissions. You can then make educated decisions on how you use your appliances and perhaps consider upgrading to a more energy efficient model.

Electricity consumption / carbon production per domestic property



What does this graph tell us?

The graph shows the daily electricity consumption for an average property in Ashton Hayes. It also shows the daily carbon dioxide production for an average property in the village. From this we can see that the average household uses around 13kWh of electricity a day, producing around 6kg of carbon*. This energy consumption is equivalent to playing an Xbox 360 through a 58" plasma television for 18 hours continuously.

Why is this important?

As more renewable generation is added to the Ashton Hayes network, we will be able to calculate how much carbon is offset per property i.e. how big the reduction in carbon emissions is for each household.

Note: carbon conversion factor used is 0.52462 from '2011 Defra/DECC 's GHG Conversion Factors for Company Reporting' Version 1.2)

The predicted annual electricity consumption for Ashton Hayes equivalent in energy to:

Running a **1191MW Nuclear Power Station** for **1 hour and 46 minutes** at max output

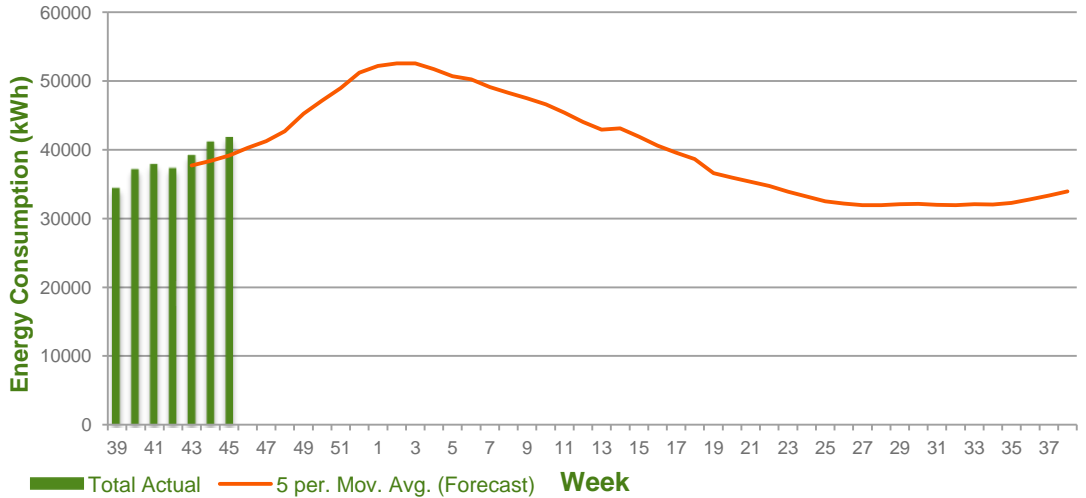
Boiling a **kettle** continuously for **37, 690 days** (103.3 years)

Driving the Nissan Leaf to the **moon** and back **12 times** (a distance of 5,816, 034 miles)

The energy Required to fly a **Boeing 747** for **14.2 hours**

Future electricity consumption prediction

Electricity consumption: Actual v. Forecast



What does this graph tell us?

The graph above shows the electricity consumption for each week in Ashton Hayes mapped against the forecasted consumption for each week in the coming year. This is calculated from the weekly consumption data collected from monitors in the village and from data collected from other parts of the network. The graph illustrates how overall consumption will fluctuate due to the changing conditions around us, for example the increase from weeks 43 to 3 can be related to the coming of winter. From the graph we can also predict a value for the village's consumption for one year. The current prediction is 1.99GWh (1,990,000kWh).

Generating this quantity of electricity would produce 1,086 Tonnes of carbon which is equivalent:

- In emissions to those released by a bus travelling 518,606 miles (nearly 21 times round the equator)
- In emissions to those released by powering an 100W light bulb for 20,700,698 hours continuously

Why is this important?

In order for the village of Ashton Hayes to go carbon neutral one of its challenges will be to reduce carbon emissions due to electricity consumption to 0. This will therefore require the village to generate 1.99GWh of electricity from carbon neutral resources. Understanding how the village consumption is closely linked to the prevailing climatic conditions is key to gaining a clear picture of the different variables that affect our electricity usage. By understanding these variables we can then act to reduce our overall consumption and hence reduce the quantity of renewable generation required to progress Ashton Hayes towards carbon neutrality.