nationalgrid

# Our energy insights

## Off Grid? Can I run my house without using electricity from the grid?

This is the first of a series of Thought Pieces which aims to stimulate discussion on how we generate electricity and whether self-sufficiency is an achievable ambition. We'll discuss what that means for my home and in future pieces what it means for my community and finally virtual communities. We would welcome your thoughts and views

**If I am an average person, in an average home and I want to run my house without buying electricity from the grid, so that I am self-sufficient, what challenges will I face? Being able to generate enough electricity for my annual demand is quite easy. However, managing that energy over the year, especially with the British weather, is where the challenge lies…**

### Let's get to know you.

Many of my circumstances are average – which is no bad thing. My home is a house which has a roof and a garden. It is set in an urban or suburban street somewhere in the middle of Britain. Being an average semi-detached house means it has a roof area of about 40 $m^2$.

I use an average amount of electricity a year which is 3,100 kWh[1] (1 kWh is about the energy that an electric oven would use in half an hour, or a 50 watt light bulb would use in a day). This much electricity does not include electric heating, which means I probably heat my home with gas, and I do not own an electric vehicle. My annual electricity bill is around £562 a year[2].

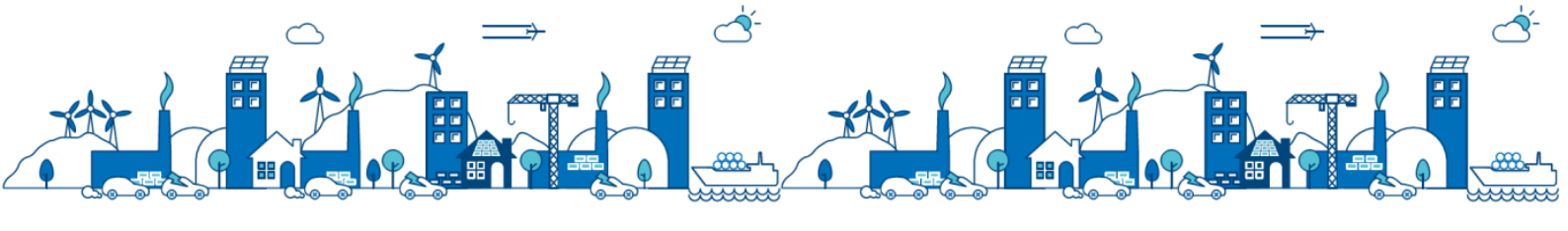
[1] https://www.ofgem.gov.uk/gas/retail-market/monitoring-data-and-statistics/typical-domestic-consumption-values
[2] https://www.ofgem.gov.uk/publications-and-updates/infographic-bills-prices-and-profits

**Figure 1: My self-sufficient house**

### Can you generate enough solar electricity to meet your demand?

With the amount of roof space available I would find about half of it was facing in the right direction to fit solar panels. About 20 $m^2$, or 12 panels at 2.6 kW, could be installed and would cost around £5000[3], although costs continue to fall. On average these 12 panels would generate about 2,500 kWh[4] each year. I am just short of my needs.

[3] http://www.theecoexperts.co.uk/how-much-do-solar-panels-cost-uk
[4] Based on http://www.pvfitcalculator.energysavingtrust.org.uk/Documents/150224_SolarEnergy_Calculator_Sizing_Guide_v1.pdf and an 11% PV load factor.



If I were careful with my use of electricity, replaced my light bulbs with LED ones, and bought efficient electrical appliances available then I could get my usage down to 2,500 kWh.

Either way my own solar generated electricity now meets the electricity I would have taken off the grid over a year. So I can produce enough electricity for my own use; but in practice it's not quite that simple…

## Not everything is average and some things are less average than others.

Unfortunately the amount of sunshine that is available varies throughout the day. Obviously there is no sunshine at night-time, so I will need to cater for this; each and every day. I will need a battery to store the excess electricity generated during the day.

Sunlight levels also vary throughout the year. The amount of daylight available reaches its peak at the summer solstice, which is around the 21st June. It is least available on the winter solstice, which is around the 21st December.

The amount of electricity I use varies throughout the day, the week, and the year. Generally more electricity is used in the early mornings and evenings, fitting with peoples working and school habits. I invariably use more electricity during a weekend than during a weekday. I will also use more electricity in the winter than in the summer. That is because in winter I will want more lighting, I will tend to stay indoors and use electronic devices more, have more hot meals, and so on. Unhelpfully this is the opposite of when the most solar generation will be available.

The difference between demand and generation on a mid-winter's and a mid-summer's weekend day is illustrated in Figure 2 and Figure 3.

**Figure 2: Demand and generation on a winter solstice weekend (kWh per half hour)**

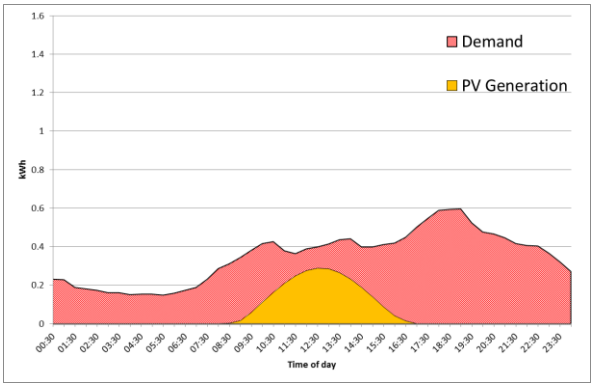
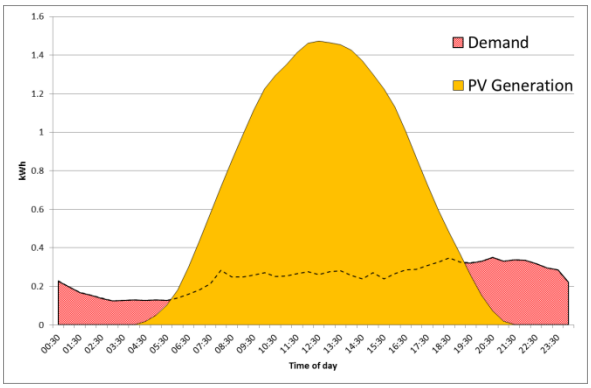
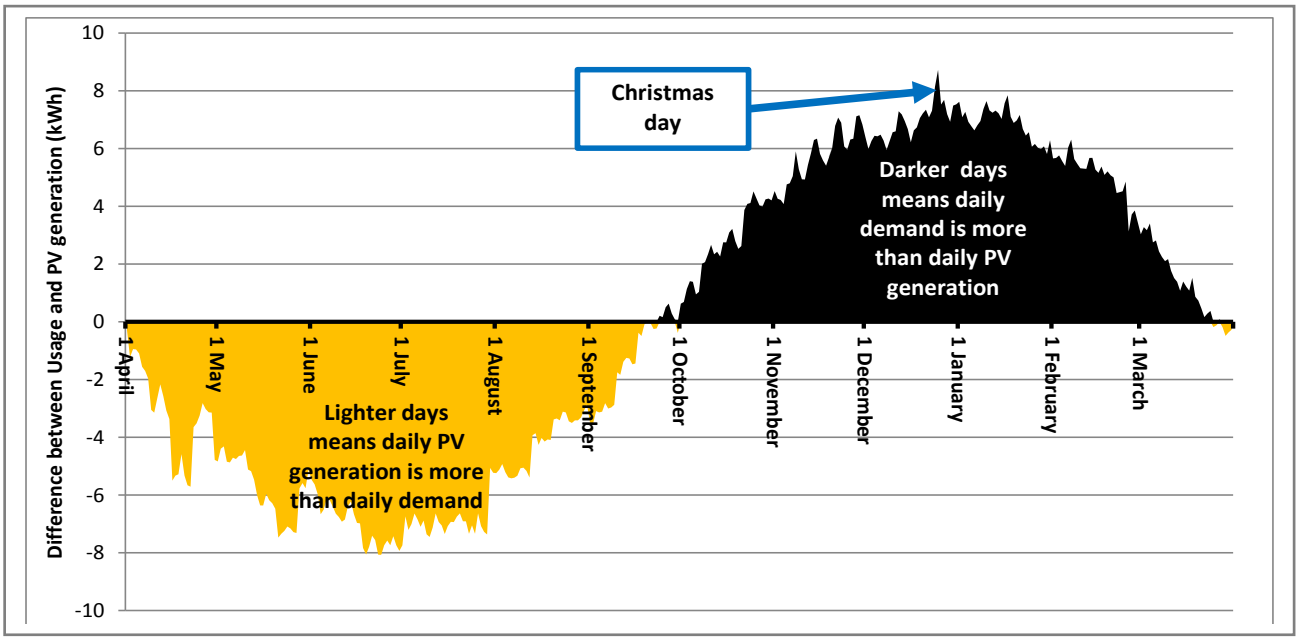



**Figure 3: Demand and generation on a summer solstice weekend (kWh per half hour)**




These graphs show the two solar generation extremes during a year. There are gradations of these two throughout the year. Figure 4 illustrates the variation throughout a typical year.

**Figure 4: The imbalance between generation and demand throughout the year**




## Can you put in more solar panels to cover the winter period?

In theory, yes I can; but in practice this may not be possible. There are two obstacles that need to be overcome. One is about how many solar panels are going to be required and the second is how to store the energy overnight.

I need to have sufficient solar panels to be able to generate enough electricity for;

- my needs on a day to day basis
- throughout the course of an average winter
- when the sun shines an average amount each day.

To cover all these requirements I estimate that I am going to require the ability to generate about 9 kWh per day – to cover my day to day needs in the height of winter. My panels will only be generating 1.3 kWh so I would need 6 times as many panels to reach 9 kWh - 72 panels.

I only have one roof though – unless five of my neighbours can help or set up an array somewhere. We'll investigate this further in our next Thought Piece on the topic…

For our purpose's let us assume I have found the extra space for my panels. I still have to get through the night. To this end I will need some batteries. It is worth noting that batteries are not 100% efficient; under normal operation they are between 85-90% efficient. I will need two to get comfortably through a winter's day and night – and that would include Christmas too, the day I use the most electricity!

Similar to solar panels, battery costs are falling rapidly and the number of battery providers increasing every day. A battery for my needs would cost me in the region of £6,000[5] today. In total the hardware will cost around £36,000 for all my solar panels and batteries.

Now I no longer have an electricity bill to pay and I'll receive a financial incentive for my renewable generation, the Feed in Tariff, this is currently around £640 a year for my number of panels. With these costs it would take around 30 years for me to break even. However, my solar panels and batteries will need replacing before 30 years. Of course there is a lot of uncertainty as costs are falling rapidly, a 10% cost reduction takes three years off my break even date.

[5] https://www.tesla.com/en_GB/powerwall

This also assumes an average sunny day, and we know this does not happen all the time. I would need more batteries to cover every below-average sunny day we have. With the vagaries of the British weather this could run into weeks.

### If you do not have space for the additional solar panels do you have room for extra batteries? Could that be a solution?

Theoretically yes; but there is a snag here too and that is the cost.

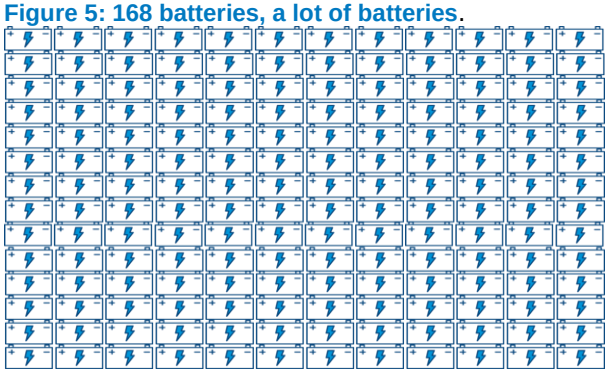
In effect I am trying to make hay (electricity) while the sun shines and consume it in the duller periods of winter -as illustrated in Figure 4. The amount of energy that I will need to transfer from summer to winter is around 870 kWh.

We know that batteries are about 90% efficient. They also leak energy (self-discharge) over time – I could lose up to 25% of charge over 6 months[6]. Therefore I will need to store not 870 kWh but around 1,090 kWh.

This additional 220 kWh will take my demand above the electricity I generate. For the sake of argument let's assume I can make this difference up probably by lowering my demand slightly.

To store 1,090 kWh, using say 6.5 kWh batteries, I require around 168 batteries and need a 4m by 4m average height room just for storing the batteries, say a typical garage. This may be the least of my problems. At current costs this would be hundreds of thousands of pounds.

**Figure 5: 168 batteries, a lot of batteries.**



[6] http://batteryuniversity.com/learn/article/elevating_self_discharge

However, battery costs are decreasing year on year but they will need to drop substantially to make this option economically viable for me.

### What are my other options for generating my own electricity?

It is challenging for me to go it alone, certainty at the moment. Both of my options involve either having lots of solar panels or lots of batteries. Today, practicality and economically, I could not make either of these options work. Also I have not even considered an electric vehicle or what my heating system will be in the future. Of course there are other means of generating my electricity:

- wind turbines
- biomass generators
- micro combined heat and power units
- diesel generators.

All of these have their own challenges, especially for my urban setting, either using carbon intensive fuels or potentially being a disturbance to my neighbours.

It is clear that for at least some of the year I will need help; could that help come from my local community? Could we all pull together and be a self-sufficient community? I already know I can generate all the electricity I need to meet my annual demand, can my local community solve the problem I have in winter? What about those who can't install solar panels?

We will investigate these further in our next pieces, to be published this summer

If you have any questions or comments we would like to hear from you.

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