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GREENWASH IN THE ELECTRICITY MARKET

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Contents

Section 1. Is this for me?

If you are confused by all these offers of 'Green' energy, Apps to help you reduce you Carbon emissions or simply curious about the term, then do read on.

The term "Greenwash" is widely used to give inaccurate, incomplete or misleading information about products/services to suggest these are more environmentally friendly than they really are.

Here the focus will be on how Greenwash is used in the UK electricity market. The following sections will explain some of the most common myths and misunderstandings in terms of their impact on actual Carbon Emissions. There is also advice on what you can do about this to suit your circumstances.

It is probably useful to have a thorough appreciation of why Carbon Emissions is the only measure considered here. A starting point for the impact of Carbon Emissions can be found here. How electricity is generated/sold may well have other indirect environmental, economic and social impacts, these are not considered here.

Section 2. A quick answer

If your aim is to minimise your Carbon emissions from the electricity you consume, then here are the things you can currently do in descending order of how much reduction you can achieve:

1. **Consume less**. Start by measuring what you use and where. Then consider what is wasteful or what you can do less of. You can get help on how to do this using the TECs Energy Assessment introduction (E-Pack).
2. **Generate your own electricity**. If you have exhausted your ability to reduce your consumption, or you prefer to spend money on reducing your emissions, explore what renewable generation/storage you can install in your building. You can get help on how to work this out from TECs, see also PV Systems and Residential Battery Systems.
3. **Invest directly in renewable generation**. If you have the spare capital, you can use this to fund new renewable generation. There are plenty of effective opportunities to this, some are community owned so deliver additional social/economic benefits locally.
4. **Buy 100% renewable electricity direct from generators**. There are only a few licensed electricity suppliers who buy/own close to 100% renewable generation, the largest of these are Good Energy and Ecotricity. Current regulation only allows you to buy direct from licensed suppliers, unless you can arrange for a private-wire supply from a nearby source.
5. **Buy 100% renewable electricity supplied indirectly from renewable generation**. You can find a list of licensed suppliers with their Carbon emissions here. The most popular being Octopus Energy. These suppliers tend to offer a lower unit price but actually only buy a small % direct from renewable generators. Instead, they purchase certificates to offset emissions. This will still have an impact on emission reduction, but not to the same extent or as quickly.
6. **Anything else you do will at best have no impact and at worst increase Carbon emissions**. This includes changing the time you use electricity from the grid.

If you'd like to understand the reasons behind this, please read on.

Section 3. The detailed explanation, calculations and options

UK electricity supplied through the grid to the consumer is generated from a variety of primary Energy sources. These include low-Carbon sources such as wind, hydro, photo-voltaic (**PV**) and nuclear. There is currently no generation with Carbon Capture and Storage at scale. Other generation includes all types of fossil fuels such as coal, oil and gas in all their different forms/sources.

The grid is divided into two tiers, a Transmission and several distribution networks. Think of the grid as a network of roads where the transmission network is like the motorways and the distribution are progressively smaller roads down to the street you live on. Our Distribution Network Operator (**DNO**) is National Grid Distribution (formerly Western Power Distribution).

The government publishes annual statistics on the performance of the electricity grid. These include the Carbon emissions from the primary Energy sources.

3.1 How does the electricity network work?

Like water, electricity will only flow from the generator if something is switched on to consume it. It will 'flow' along the routes with least resistance, that is the largest cable (widest road in the that analogy) and/or the shortest distance.

If there is more generation than consumption, the voltage on the grid would rise to dangerous levels (a long traffic jam). To prevent this generation, plant is turned off until generation and consumption are matched. This is a complex undertaking as there are several other factors involved (e.g. maintaining the 50Hz frequency).

The size of the cable limits how much Power can be carried along the cable, the bigger it is the more Power it can carry. The unit of Energy (kWh) we consume is simply how much Power we draw through our electricity meter x how long we draw it for. Every time the capacity of the cable changes, there is a junction to transform the voltage (**V**) to the appropriate level, it arrives at ~230V for the residential consumer (~400V for 3-phase). This is referred to as the Low Voltage (**LV**) part of the distribution network.

The electricity network evolved over many decades, it was designed like our road network with large generators along the 'motorways' with small streets eventually leading to consumers at the periphery. Renewable plant, apart from large off-shore wind farms, tend to be small generators mostly connected to the distribution network. Behind the electricity meter, PV systems are mostly connected to the smallest pipes, the LV pipes.

Although theoretically a typical single-phase residential consumer could draw 10-30 kW of Power through their meter (~ 240 – 720 kWh of Energy in a day), this is not possible in practice. The distribution network, cable and transformer capacities, are designed on the basis that not all consumer turn lots of appliances on at the same time, within certain exceptions referred to as Peak Periods. The total electricity generation currently supplying all consumers has some 'spare' generation, and more can be built over time. In section 1.3 of WPD's Electric Vehicle Strategy have suggested that they could distribute an additional ~35kWh per week per household under current plans. This is a fraction of the theoretical maximum.

The task of balancing supply/demand, dealing with sudden/gradual changes to this while maintaining voltage/frequency constraints and a high level of availability, is challenging. This is made even more difficult with renewable generation which is 'unpredictable' as the wind and the sun can change by the minute. One of the main tools available to network operators is to turn power generation on/off as demand fluctuates. While renewables can be turned off, the current economics make it difficult to have sufficient 'spare' renewable energy waiting to be turned on when needed. In contrast, gas powered electricity plant is relatively easy and cost effective to turn on/off.

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Unfortunately, today there is no regulation that requires network operators to prioritise low-carbon generation over other sources, the decision is based primarily on cost and convenience (i.e. maintaining existing practices).

3.2 How much Carbon is emitted by electricity?

That depends on where the electricity comes from. Strictly we should calculate the ongoing annual emissions from operating the network (i.e. primary fuel emissions, operations and maintenance and inefficiencies in generation/transmission). We should also include the amortised embodied emissions, that is the Carbon emissions resulting from the mining/manufacture/construction of the generating plant/network divided by the number of years it is expected to operate.

It is too complex to do this here, partly because not all the information is available. However, it is reasonable to focus on the ongoing emissions as these tend to be much higher than amortised embodied emissions. It is also reasonable to assume that whatever the primary energy source, renewable or otherwise, they will all use the same electricity network.

The amortised embodied emissions of the generation plant will vary. As a rule of thumb, the following values can be used over the expected life. This is expressed as a Carbon Intensity (**CI**), the amount of Carbon emissions per delivered unit of energy (in kg or gm per KWh).:

- Wind and nuclear : 20-50 g CO2e/kWh
- PV : 50-300 g CO2e/kWh

Own generation (also referred to as behind the meter) does not use the grid if we consume it on-site. Ignoring the amortised embodied emissions, PV systems, even with batteries, can be considered to have zero operational CI, provided their embodied emissions have been accounted for elsewhere.

The most recent operational CI of the grid published for 2019 was ~316 g CO2e/kWh. This only covers operational emissions from primary fuels and generation/transmission inefficiencies (losses). This CI includes renewable generation, so includes excess generation from PV systems that get exported to the grid, deemed or metered. These can therefore not be included as a personal offset because they have already been included in the grid's CI.

The total emissions in 2019, however allocated, were 316 g CO2e/kWh * 294TWh = ~92.9 Mt of ghg emissions.

How we choose to allocate these can be debated, but the actual emissions remain the same. So, if those who pay a 100% green tariff, from any supplier, calculate their emissions from grid electricity as zero, the rest of the consumers would need to be allocated a higher CI. This is of course not the case.

The only official and accurate method of allocating ghg emissions to electricity consumption is the annual CI published by the government. It would be impractical and unequitable to calculate anything other than the average UK electricity CI when working out what our emissions from grid electricity are. It may be possible to develop systems that calculate and allocate grid electricity CI on a more granular level, eventually on a half hourly (**HH**) basis, but these do not currently exist.

3.3 So why bother buying 'green'?

Licensed electricity suppliers are required to publish the mix of fuels used in the electricity they sell. What is actually delivered to our meter is the same for everyone in terms of its Carbon Intensity.

There are two ways a supplier can claim a % of their sold electricity is low-Carbon (i.e. "green").

- The first is they generate it themselves or buy it direct from a low-Carbon generator via a Power Purchase Agreement (**PPA**).

- The second is to buy Renewable Energy Guarantee of Origin (**REGO**) certificates that represent renewable generation in the year these were generated. REGOs are traded in the market and have a value set by market forces (i.e. supply/demand).

Because there is currently an oversupply of renewables compared to those buying 'green' electricity, there is a glut of REGOs in the market. In 2019, the wholesale price of a REGO (1 MWh) is ~£5, compared to the wholesale price of electricity (any source) of ~£50/MWh and a retail price of ~£150/MWh. This makes it easy for any supplier to simply buy these cheap REGOs and claim they are supplying 'green' electricity without any additional renewable plant being built/installed. They can keep their retail price low as the additional cost of the REGO is insignificant.

Some 100% 'green' energy providers, buy their REGOs from outside the UK (known as GoOs), these may not be as well regulated as in the UK and therefore potentially open to double accounting.

To stimulate the growth of renewables in the current market, the demand must exceed supply. That is, we should encourage everyone to buy 100% 'green' energy from any supplier. The only other stimulus would be if regulations prioritised renewables over fossil fuels. Unfortunately, the opposite is often the case.

A good measure of a supplier's contribution to the amount of renewable energy available is the proportion of energy generated either directly from renewables or via a UK PPA with a renewable generator. Some suppliers are now publishing the % contribution of PPA/REGO/GoO. Anything close to or over 100% of PPA is good.

Good Energy and Ecotricity have a long-standing commitment to buy their electricity direct from renewable sources through a PPA. Octopus Energy, on the other hand, supplies the vast majority of its 'green' electricity by purchasing REGOs, half of these from outside the UK (see latest Ofgem published list of Guarantee of Origine, note list of electricity suppliers that use this). Although purchasing electricity through a PPA is not a guarantee to immediately build new renewable plant as the plant may already be in operation, it will result in additional renewable generation happening more quickly. Only when there is more demand than supply, and therefore more expensive REGOs, will other green suppliers be encouraged to source additional renewable generation.

3.4 What about the Apps that tell me when the grid in my area is low-Carbon?

There are now quite a few of these Apps as there is a website to monitor UK real-time generation mix and resulting emissions. These are interesting tools to help you understand what is happening on the grid, in some cases down to a main transformer point nearby.

The message is to consume your electricity when the grid has low-Carbon emissions. This is also greenwash as the annual Carbon emissions for the total network will not decrease, see sections 3.2 and 3.3. In fact, they may even increase if a lot of people respond to this message by increasing their consumption at these times.

Generally, the instantaneous Carbon Intensity at night tends to be low because the predominant supply comes from Nuclear and Wind. Similarly, there are periods during the day, mainly in the summer months, where the instantaneous Carbon Intensity is also relatively low because of PV generation.

As discussed earlier, the complex structures/flows in the electricity network require operators to turn generation on/off. If there were a significant increase in consumption over a short period, the most likely response would be to turn on flexible Gas-powered generation nearby. Since it is unlikely that an operator can reliably turn on renewable generation during those periods, the most likely outcome is an increase in overall GHG emissions.

There is already over 860MW of battery storage on the network, fulfilling specific functions such as frequency response. Only 0.1% of balancing services (to match supply and demand) are currently provided by batteries, this is because technical and regulatory barriers still need to be overcome for this to be viable.

In any case the only official/correct way to measure actual emissions is to use the annual Carbon Intensity for every unit of Energy we consume from the grid. Nevertheless, responding to these apps or prompts from suppliers to encourage demand shifting to off-peak times has its benefits. These are mainly financial (certainly for the supplier and sometimes for the consumer) but also help the electricity grid operators balance the network more easily. There may or may not be a ghg reduction benefit, but this is impossible to verify and often uncertain to predict.

The ghg emission argument is very different if you have your own renewable/battery technology. Here, balancing electricity generation/consumption is well worth doing, either manually or automatically. This is because the more on-site renewable energy consumed, the less you need to import from the grid. So, every kWh generated and used on-site reduces your emissions by ~277gm.

3.5 Should I invest in PV, Heat pumps and Electric Vehicle?

It is certainly worth considering but the easiest and cheapest way to cut Carbon emissions is to reduce energy consumption. Whether you decide to invest in technology or change behaviour, it always makes sense to measure your actual consumption first.

Only when you know how much Energy you are using, where and when, can you make an informed decision on how to reduce your emissions. You can start with the quick Carbon Footprint Calculator and move to the E-Pack to help you do this.

It is easy to make the mistake of opting for a technology solution because it feels like the right thing to do. This can often be quite expensive for minimal or no reduction in emissions. Remember Energy has to come from somewhere. Knowing how much you need and what its Carbon Intensity is, will be essential to make sure there is enough of the right type.

Section 4. Further information and references

As this is a complex subject, not everyone has the background/experience/time to delve into the various details and nuances. The following additional material is included for those with further questions. Please contact TECs' Dr Watt or Professor Joules for any other questions.

4.1 Embodied Carbon emissions

The simplified assumption to largely ignore embodied Carbon emissions is appropriate for comparative reasons. It is, however, misleading in terms of actual emissions which are of course the one thing that directly impacts Climate Change.

To avoid perpetuating greenwash here, we should account for these emissions. TECs has published a Carbon Footprint Calculator to help include all our Carbon emissions, embodied and on-going. It is important to establish both because embodied emissions typically make up well over half the total.

Although it is difficult to apportion all embodied emissions accurately, it is possible to assign these on the basis of or capital expenditure. The TECs Carbon Calculator does this on an individual basis for goods we buy (e.g. insulation, a PV system or an EV) and on a pro-rata basis for services (e.g. supply of electricity including new embodied emissions and operational emissions for the grid).

4.2 Criteria other than Carbon emissions

Throughout, the focus has been on Carbon emissions, real or greenwashed. As stated in the introduction, there are other criteria when making a choice on how we use and where we get our electricity. Cost is certainly relevant to those on a tight budget but so is the service we receive and wider social implications.

Some suppliers are running trials where things like charging electric cars are managed by the network. This could provide a means of the network signalling to the consumer. Taking part in suitably set up trials could lead to knowledge that improves the use of renewables in the grid.

It is therefore worth highlighting that there are several local/regional electricity service providers who may not offer 100% direct generation (via PPA or ownership) but offer other social and longer-term emission reduction benefits.

Community-owned Energy organisations are a case in point. As these are relatively new to the electricity market, we have not listed them in the earlier sections. We believe the mission of many of these organisations should be supported as they provide wider benefits to their communities than Carbon reduction alone. Today, in Teignbridge, TECs is the only organisation that meets these criteria. Others, operating in Devon, can be found here.

The Local Electricity Supply Bill currently going through Parliament may make it easier for these Electricity suppliers to expand and improve their offer of truly 'Green' electricity. Unfortunately the bill has been watered down as it now sets a high Carbon Intensity threshold for generation so that gas would qualify as low-carbon!

4.3 The impact of regulation and industry practices

The lack of consistent regulation to meet the UK's commitment to stay below 1.5^{O}C needs to be highlighted at every opportunity. In 2016 TECs published its views on government policy in this area, unfortunately little has changed since.

The practices employed by major players, including Ofgem, in how electricity costs/payments are settled is complex. Regen, the industry representative for Low Carbon Energy, has representatives involved with the bodies that discuss/regulate these matters. Please contact TECs if you'd like more information on this.

4.4 Future developments

Many of the constraints slowing the progress to decarbonising Energy can be solved with technology. However, there is a lack of political, institutional, and personal will to make the transition to a low Carbon economy at the pace necessary to avoid runaway Climate Change. This results in a lack of confidence by operators to invest in low-Carbon storage, or to implement greater Local Balancing.

As TECs members, we can all do our best to overcome the reluctance to change. We can start by understanding our own behaviour (TECs E-Pack) on Energy use. We can also support and lobby for this change through organisations such as ACT.