Energy Consumption Optimisation

Why and How?

December 2020

A general overview of the United Kingdom energy market, costs and opportunities

Author: Seyedali Khatami (Energy Market Analyst)

BRITS ENERGY

1. Purpose of This Document

Energy optimisation means reducing your company's energy consumption and costs while improving your business energy efficiency and environmental credentials. There are several methods to optimise energy consumption of an asset, including renovating sites' building and replacing old equipment with new energy-efficient ones. Another method beside renovation and replacement is to use energy in smart manner, when the prices are lower, and gain income from providing energy flexibility services.

Brits Energy has been investigating and identifying all opportunities within different energy markets to avoid high energy prices and turn clients' assets into smart energy-efficient sites. This includes forecasting electricity price, avoiding high non-commodity costs and participating in Demand-Side Response services, which will be explained in more details in this document.

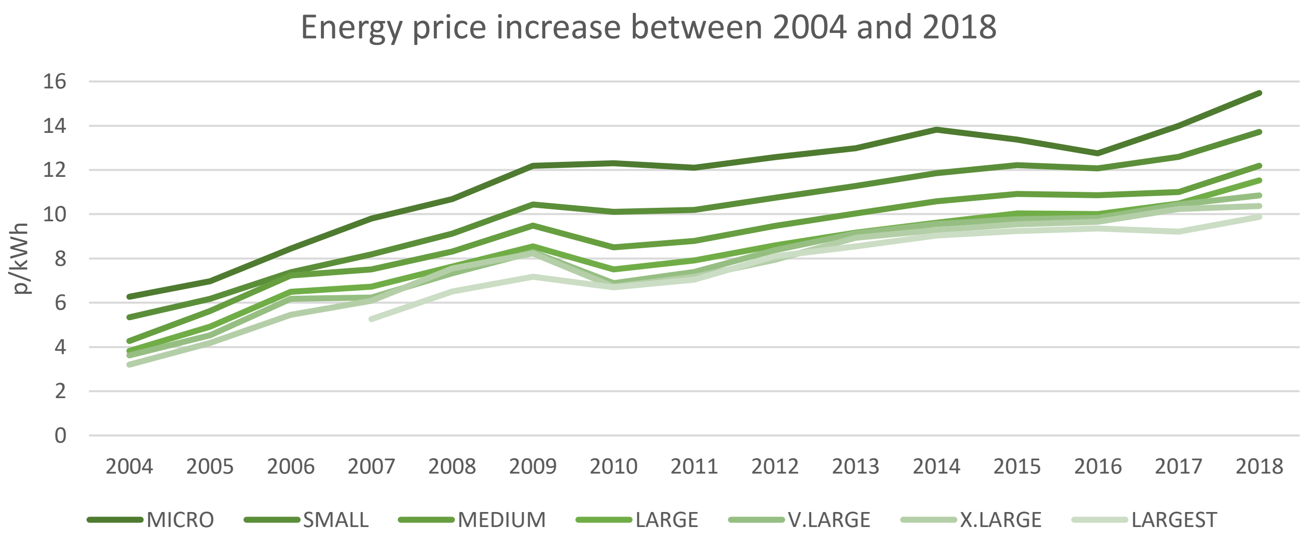
2. Electricity Price Overview

When you get your electricity and gas bills, you may have noticed that you have been charged for your energy consumption in kWh (kilo-watt hour). kWh is a measure of how much energy you're using. It is simply a unit of measurement that equals the amount of energy you would use if you kept a 1,000-watt appliance running for an hour. So, if you switched on a 100-watt light bulb, it would take 10 hours to rack up 1 kWh of energy.

The energy price in the United Kingdom is either pence per kWh or £/MWh (MWh = 1,000 kWh). Over the past fifteen years, the price paid by businesses for their electricity has consistently increased, partly due to wholesale market price rises, but also from government levies and other network costs. This has affected businesses of all size.

The average price paid excluding VAT for each size of business is illustrated in graph below, between 2004 and 2018. Reviewing the data below shows that since 2007, all businesses experienced price rises, but these vary depending on the annual consumption of energy.

- Microbusinesses using less than 20 MWh (20,000 kWh) saw an average price rise of 43%.
- Large industrial consumers of electricity saw the highest increases over ten years with a 75% hike.



The price that users pay for electricity is made up of 2 elements; 1) The Commodity cost (via the Wholesale Market) and 2) Non-Commodity Costs which are levied against how much kWh is used at different times of day plus some fixed costs.

The commodity cost is basically the cost of the electrons the non-commodity cost is basically the costs for ensuring the whole system works plus Government levies and taxes for greening the electricity generated.

The value of the commodity cost is circa 1/3 of the total cost paid per kWh by the end user meaning 2/3 of the cost paid per kWh is non commodity costs.

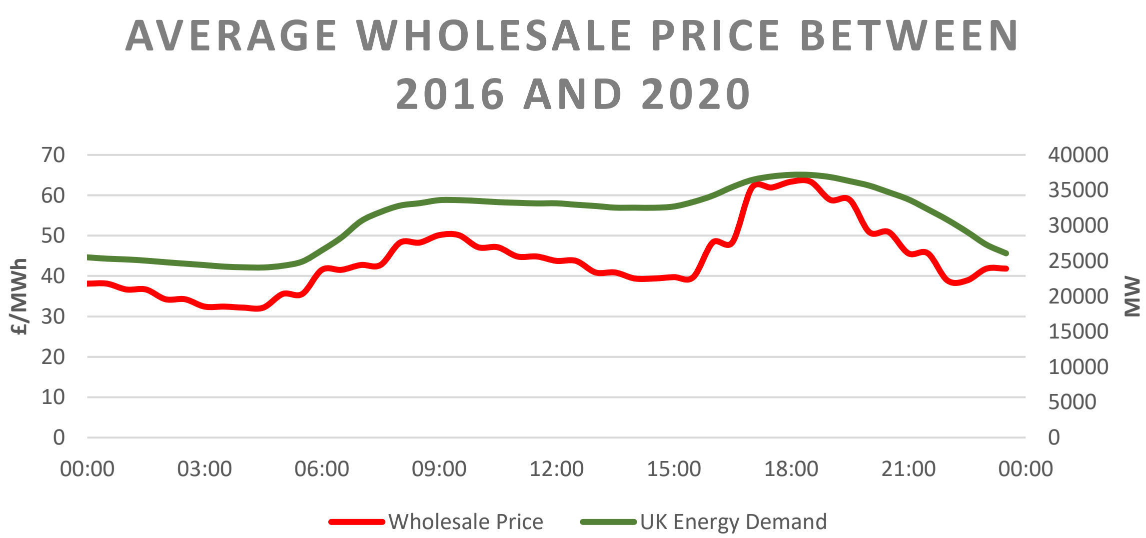
Then some of the Non-Commodity Costs change in value depending on what ½ hour of the day the electricity is used, so some ½ hour times of the day are cheaper than others.

3. Commodity Cost - Electricity Wholesale Market

In the Electricity Wholesale Market for each half hour of the day, those with demand for electricity will estimate in advance what their demand will be and then they will contract with generator(s) for that volume of required electricity. In the half hour itself, generators are expected to generate and deliver their contracted volume of electricity and consumers are expected to use their contracted volume of electricity.

The graph below indicates average Wholesale Market prices between 2016 and 2020 for each half an hour. As the graph shows, the commodity price in early hours of the day is slightly below £40/MWh (4 p/kWh) and reaches above £60/MWh (6 p/kWh) in the afternoon. It is worth mentioning that each day has normally two spikes in the prices; one in the morning and one in the afternoon when demand for energy is at its highest in the country. The spike in the afternoon is usually longer and higher than in the morning.

One method to reduce energy cost without reducing total energy consumption is to avoid peak hours and shift required energy to lower-price times; e.g. early morning (00:00 – 06:00) or midday (11:00 – 15:00).



One of the key factors that affect the price of electricity is renewable generation, particularly wind energy in the UK. When wind generation is high, prices will tend to be lower than normal, and when the wind is low, prices will tend to be higher. On the other hand, the carbon intensity of the grid has a direct relationship with the amount of renewables feed into the grid. Consequently, shifting load to lower-price times not only reduces energy costs, but also diminishes indirect carbon emission by consuming energy when more renewable energy is generating.

4. Non-Commodity costs

Non-commodity costs are the charges added to an energy bill which originate from the government and third parties such as distribution companies. Non-commodity costs accounted for around 23% of a consumer's bill in 2009 and this has risen to at least 61% by 2020. The costs are variable depending on season, day of the week and time of the day.

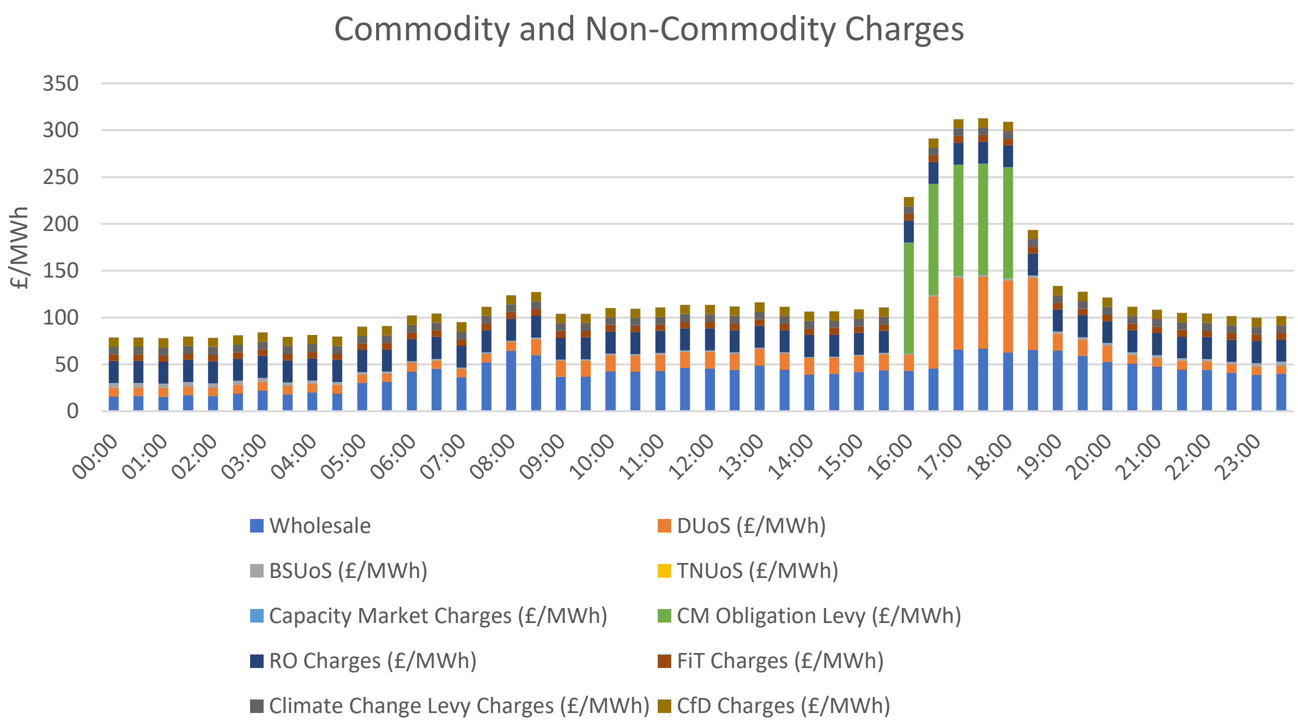
Non-commodity costs can be categorised in two main categories as follows:

- Transportation and distribution charges
  - TNUoS – Transmission Network Use of System
  - DUoS – Distribution Use of System Charges
  - BSUoS – Balancing Services Use of System
- Government Levies and Taxes
  - FiT – Feed in Tariff
  - RO – Renewable Obligation
  - CfD – Contracts for Difference
  - CM – Capacity Mechanism
  - CCL – Climate Change Levy

There are also some other small value Non-Commodity costs which we will not discuss in this paper.

5. The Total Energy Costs (Commodity + Non-Commodity)

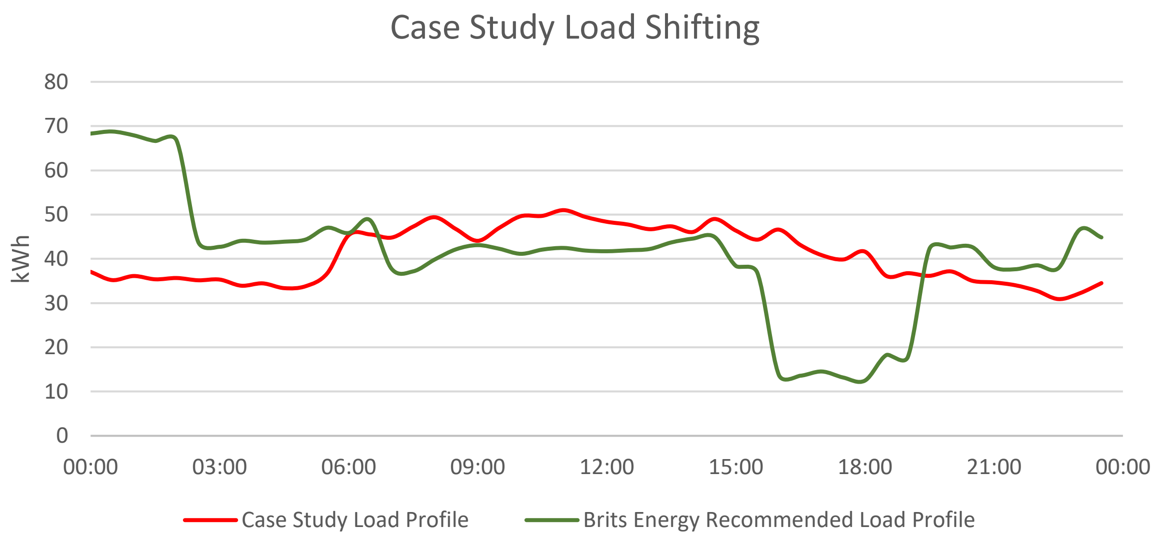
An energy bill is made up of two different groups of charges; commodity and non-commodity costs, as illustrated in graph below, where the peak hours have been shown clearly.



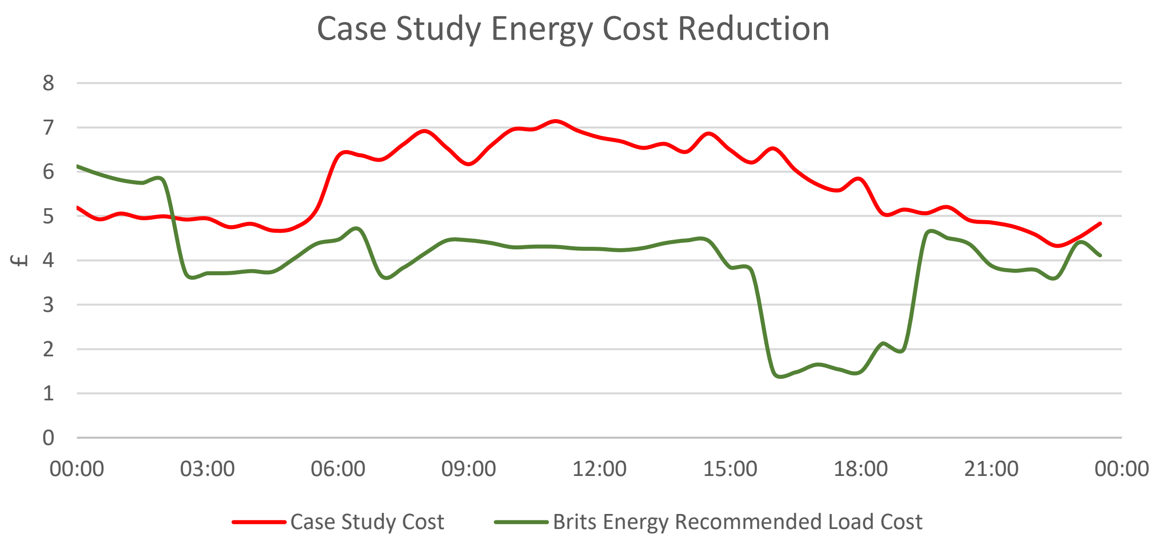
6. The Opportunity – Case Study

We monitored and analysed energy consumption pattern of a case study farm for the duration of October 2020. We noticed that the site is consuming more energy during the morning and afternoon peak cost hours, which incurs higher electricity costs to the operator. Our optimisation model reduced the energy consumption of this site to "0" between 16:30 – 19:00 and increased energy consumption in early hours of the day (00:00 – 03:30), as shown in graph below, where the green line is Brits Energy's suggested load profile. By making this change we could potentially save approximately 30% of energy costs by using less at peak cost time and using more at lowest cost time.

The graph below shows how much electricity is being used every half hour by the equipment that is connected to the "Case Study" as shown by the red line, whilst Brits Energy optimisation model suggests the Green line. Load shifting from peak hours (Red-band) to off-peak hours (Green-band) could reduce energy cost by 30%.

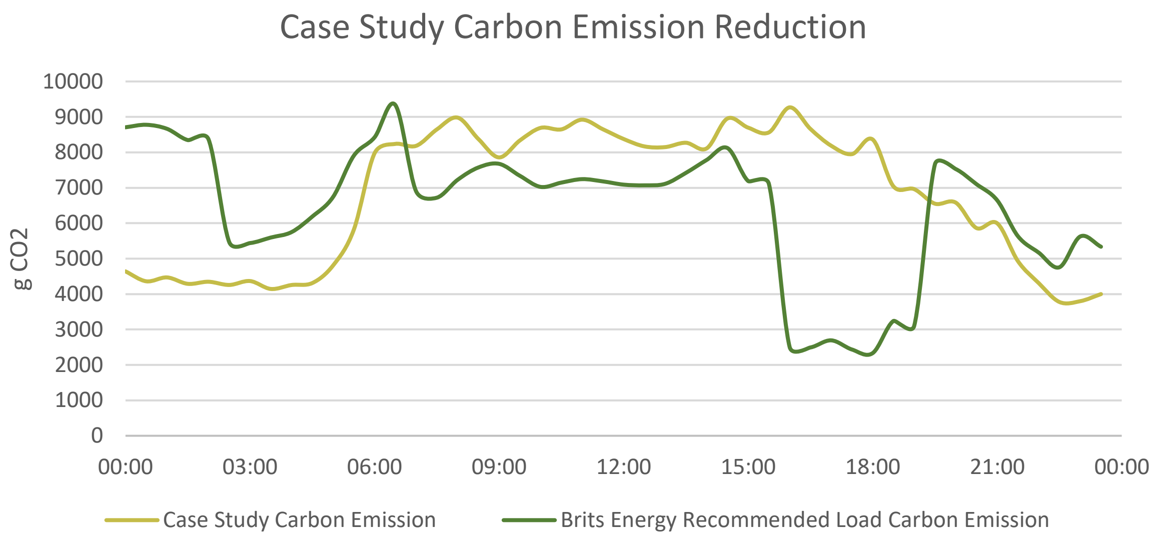


Accordingly, the energy cost per each half an hour has been illustrated in table below. It can be concluded that a significant amount could have been saved by shifting load to the consumption pattern suggested by Brits Energy optimisation model.



Our approach to reduce cost by following the market price points, inherently reduces the operations CO_{2e} emission as it tends to source electricity when grid renewable generation has higher stake and consequently grid has lower CO_{2e} intensity.

Graph below shows how Brits Energy optimisation model would save 0.5 tonnes carbon emission per month compared to conventional load pattern by just shifting demand.



NOTE: Grid carbon intensity for each settlement period in g/kWh used, and based on actual and suggested consumption, indirect carbon emission of the operation calculated.

7. Balancing Services or Demand Side Response services (DSR)

Since electricity cannot currently be stored in large amounts, supply and demand for electricity must be matched, or balanced, at all times. National Grid (NG) procure trading and balancing services to balance demand and supply and to ensure the security and quality of electricity supply across Britain's transmission system. National Grid, now called the Electricity System Operator (ESO), procure Balancing Services in real time to balance demand and supply, whenever there is a discrepancy between forecasts and actual generation/consumption. In other words, if a consumer buys 100kWh energy from Wholesale market, but only consumes 50kWh, there will be 50kWh extra energy in system so an imbalance.

Similarly, if there is a large amount of wind turbine generated or solar panel generated electricity on the network when the weather changes, i.e less wind or less sun, then there is potentially imbalance in the system again that needs to be managed. This also works in reverse so if there is too little energy in the system to meet demand then the system is in imbalance.

Alongside this the local network operator, Called Distribution System Operator (DSO), also procures similar balancing services (DSR) that are needed if the network is forecast to come under strain where the physical network won't be able to cope with the amount of electricity being distributed across the network.

In the past the DSO would spend £billions in "reinforcement works" to basically increase the amount of electrical network capability by adding more or bigger cables. By procuring DSR the DSO can reduce the cost of ensuring the network is fit for purpose and therefore slow down the increase in cost that is passed through to the electricity user in the form of the DUOS charge.

DSR services enable the ESO and DSO to manage this extra or lack of energy and the network strain by asking other parties to use more or use less energy at an agreed price to avoid the energy system crashing.

There are various DSR services available to participate in such as Frequency Response, STOR and Demand Turn-Down, Demand Turn-Up (predominantly Winter 01:00 – 04:00 due to wind turbines over producing vs demand and summer 11:30-13:30 due to solar panels over producing verses demand).

Any site can make itself available for these services and act upon receiving the signal from the ESO or DSO. By participating in these DSR services the participants can get income from flexing their energy usage and thus offsetting the overall energy bill.

So, in effect buy moving your energy usage from the red line to the green line as shown in the previous graph you can potentially;

1) Save the price of buying energy during the peak cost times and shift the energy usage to the lower cost times;
2) Gain income from participating in DSR services at the same peak times to reduce consumption.
3) Gain income by using more energy at certain times of day as part of the Demand Turn Up DSR service.
4) Reduce CO_{2e} by shifting your demand away from high grid CO_2 intensity times.

8. How can your organisation benefit from this?

Brits Energy has active engagements with operation owners who are looking to reduce their energy cost and CO_2. Through our partnership, we study energy demanding processes and help operators to identify the flexibilities within their operation and mechanisms to utilise the flexibilities in order to avoid peak times when commodity and non-commodity costs are high, as well as participating in demand side respond programmes to generate revenue.

If you think your operation can offer some level of demand flexibility, please get in touch with us and we will take you through the process.

Info@britsenergy.co.uk
Tel:01908 915234
www.britsenergy.co.uk