Advanced Infrastructure response:

"Designing a framework for transparency of carbon content in energy products: a call for evidence"

Submission deadline: 6th December 2021

Author:
Noah Miller - Solutions Lead, Carbon Data services

noah.miller@advanced-infrastructure.co.uk

Department for Business, Energy & Industrial Strategy

advanced infrastructure

Advanced Infrastructure

Advanced Infrastructure is a Cambridge based company focussed on emissions from electricity consumption (falling under the GHG protocol Scope 2). We are working to create a greener and fairer energy system in the UK using big data and machine learning to trace energy flows, utilising a digital twin of the energy system. We are able to calculate carbon impact much more accurately than most current methods, and find actionable insights for organisations interested in reducing their carbon emissions by utilising the power of granular energy data.

We work with DNOs, local authorities and sustainability consultancies as well as both large and small corporations covering many industries including technology, energy, communications, retail, industrial, transport and housing.

We are also proud to work with not-for-profits such as EnergyTag and Energy Unlocked to encourage best practices and seek regulatory change to build a more sustainable electricity market.

The views expressed in this document are prepared by the author on behalf of Advanced Infrastructure.

We are happy for these views to be published with attribution, and would like to be contacted when the consultation response is published with the outcome.

Advanced Infrastructure would like to be involved in the continuing process of this consultation and ongoing project to design and regulate a new, fair and transparent framework for carbon content in energy products.

Q1. Does the current approach of retrospective annualised matching (using REGO certificates) provide a sufficient level of consumer transparency?

No. The current approach fails to take into account the time of generation and time of consumption of power, as well as the place of generation and place of consumption. The increasing renewable penetration into the UK electricity grid results in massive variability of the carbon intensity (the amount of CO_2 equivalent produced per kWh of power generated) of the grid across both time and location. This inaccuracy is hidden within the current system of retrospective annualised matching, meaning that consumers are unaware of the full extent of their emissions, and are unable to combat these emissions effectively.

1.1 Variability in Time

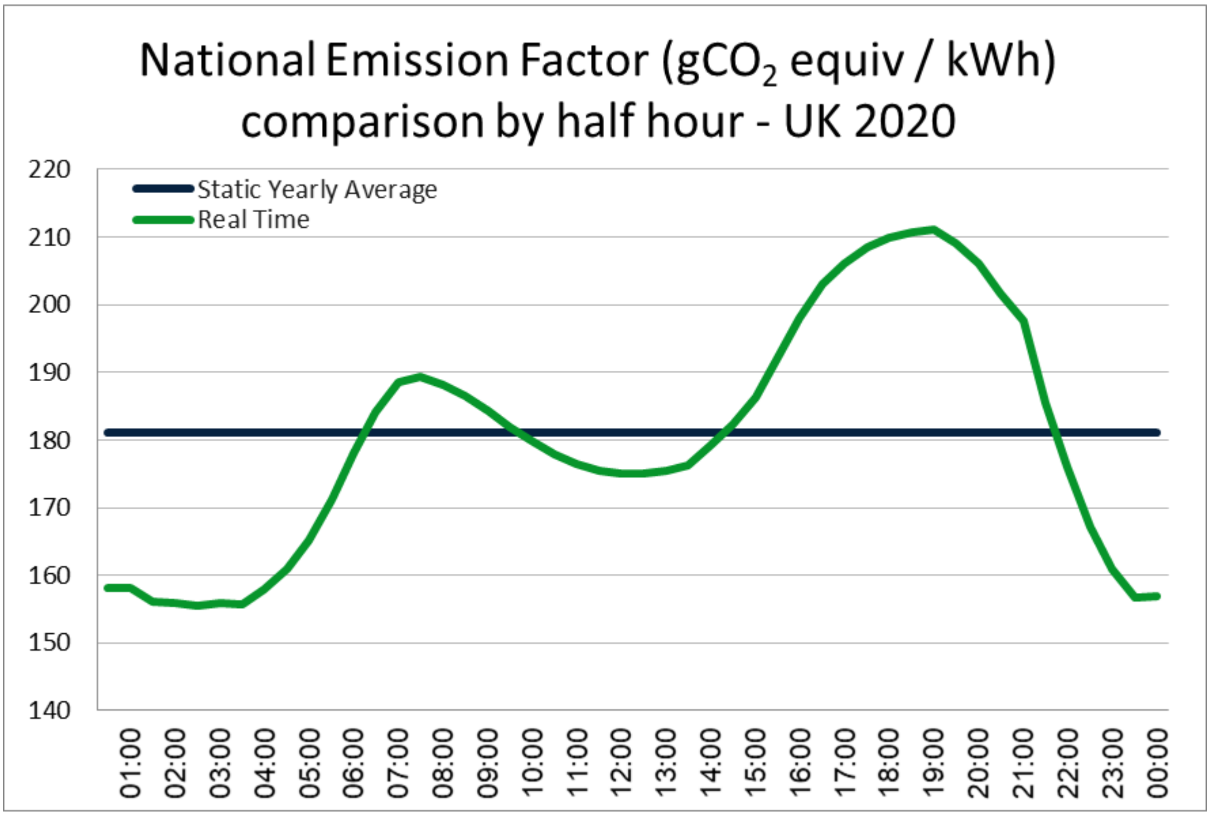

Figure 1 showing the variability in real time national emission factor (gCO_2 equivalent / kWh) averages by half hour time period, when compared to the static yearly average. The static average hides large fluctuations and therefore gives an inaccurate accounting of carbon emitted.[1]

[1] Data from National Grid ESO via Carbon Intensity API https://carbonintensity.org.uk/

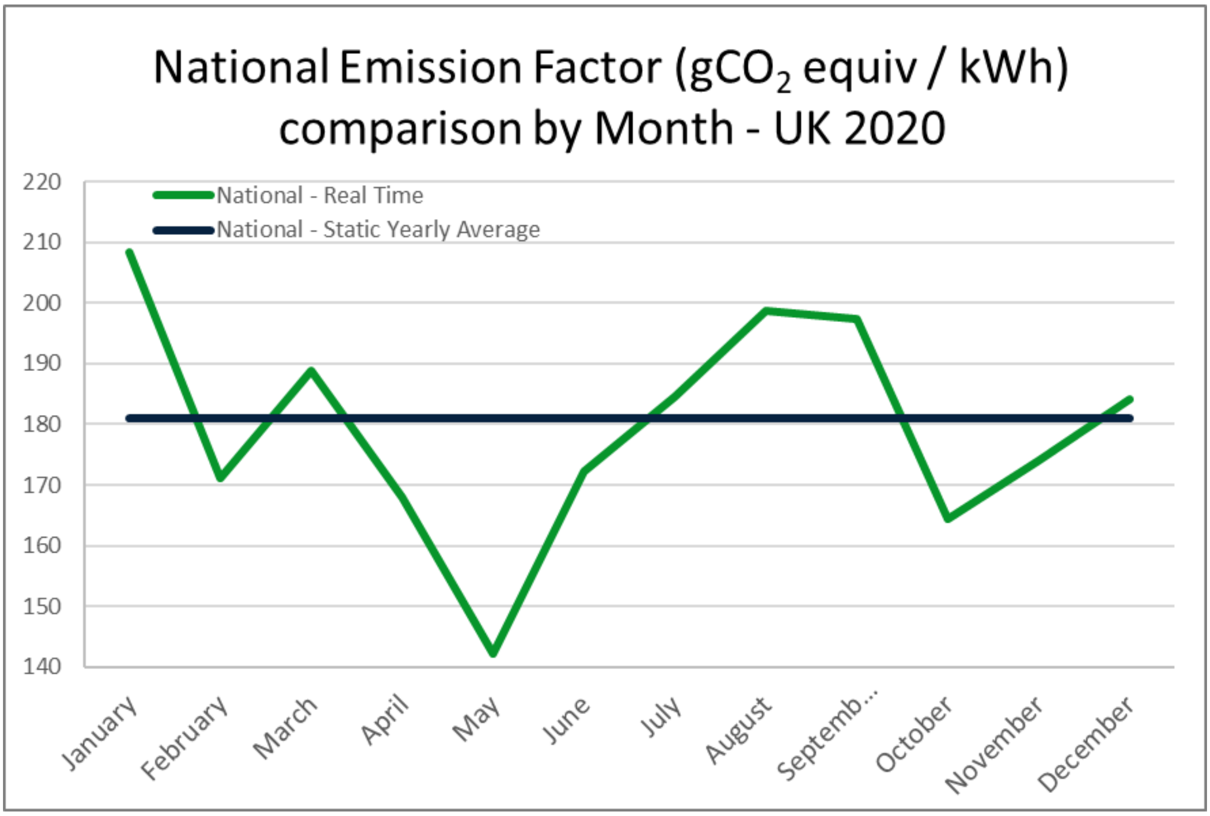

Figure 2 showing the variability in real time national emission factor (gCO_2 equivalent / kWh) averages by month, when compared to the static yearly average. Again the static average hides huge fluctuations in carbon intensity and therefore carbon emitted.[2]

As can be seen from **Figure 1 & 2** there are large fluctuations in carbon intensity over both a 24 hour period, and over a year. This is to be expected due to the variability of renewable energy producing assets and their seasonality, e.g. May 2020 was the "sunniest month on record" which therefore increased solar production and reduced the overall grid emissionality.[3] Similarly offshore wind generation peaks in the spring and Autumn months, driving down the carbon intensity of the grid.[4] The hour by hour carbon intensity figure drops overnight due to a lessening of demand, allowing the nuclear baseload of the UK to play a proportionally larger role.

Under the current system of retrospectively annualised matching, there is no connection between when the power is generated that creates the certificate, and when the power is used that is offset by the certificate. Thus, during times of peak

[2] Data from National Grid ESO via Carbon Intensity API https://carbonintensity.org.uk/

[3] Met Office https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2020/2020-spring-and-may-stats

[4] Potisomporn. P, Vogel. C.**Spatial and temporal variability characteristics of offshore wind energy in the United Kingdom.** 2021. https://doi.org/10.1002/we.2685

renewable energy supply, (e.g. solar PV in May 2020) the majority of the certificates are generated and the price for those certificates is lowest. These certificates are then used to offset power consumed in the peak carbon intensity hours. This miss-match means that using the average grid emissionality, up to one third of the carbon generated by using power during that time is not offset at all. **Figure 3.**

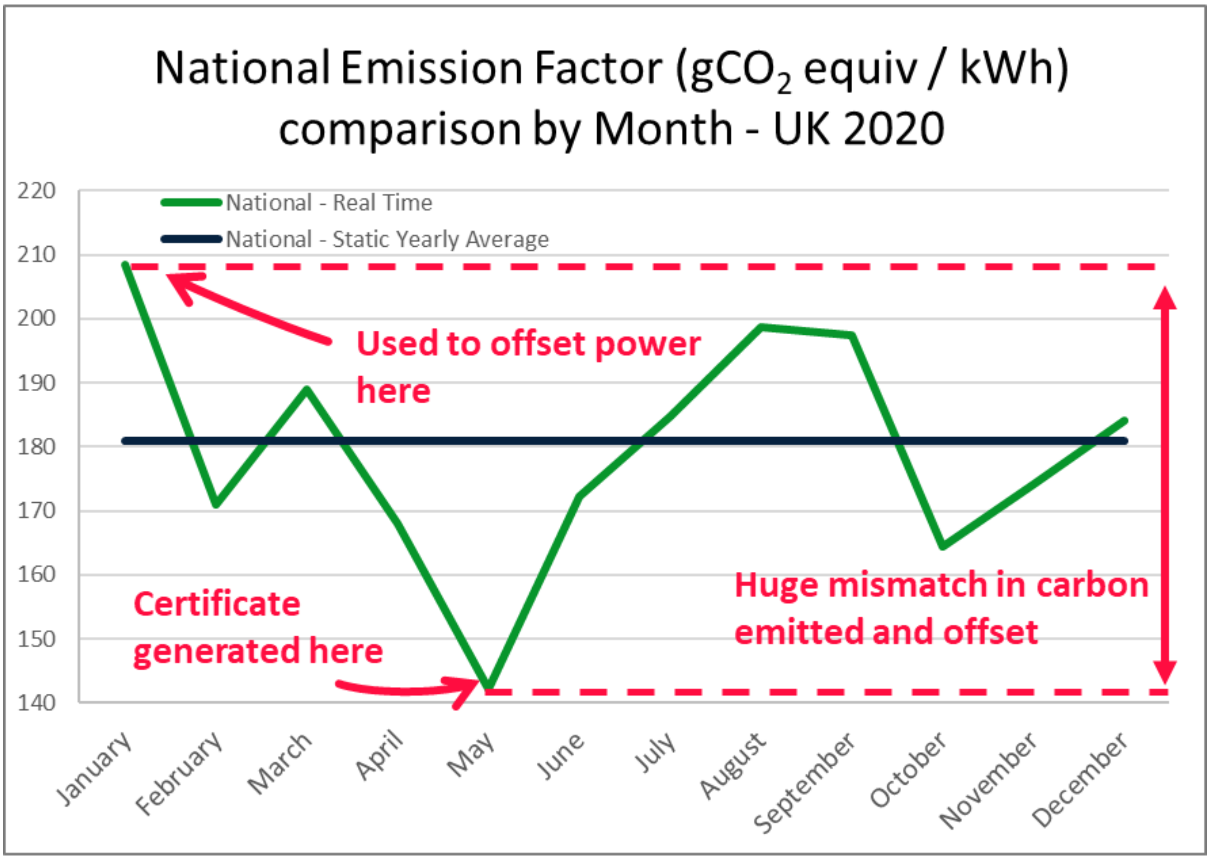

Figure 3. One third of the carbon emitted is not offset by using a certificate that isn't matched by time, which is common practice under the current retrospective annualised carbon accounting system.

1.2 Variability in Space

The same problem exists when comparing the carbon intensity of different areas in the UK. Whilst there is some transfer of power between regions, the grid is often constrained, particularly on certain key boundaries (e.g. South Scotland and Northern England). In general power is consumed within the region or neighbouring regions of its generation.[5] However, there is again huge fluctuation in carbon intensity of the grid in different regions of the UK, over different periods of the day, **Figure 4**, and year, **Figure 5.** This is due to the siting of renewable generation assets, the weather systems that affect these assets, the placement of thermal and nuclear generation.

[5] AI internal calculations and National Grid ESO https://carbonintensity.org.uk/

Again, the current system allows certificates generated in areas of high renewable generation, and therefore low carbon intensity to be used to offset power in areas of high carbon intensity with no consequences, other than a mismatch of carbon emitted and carbon offset.

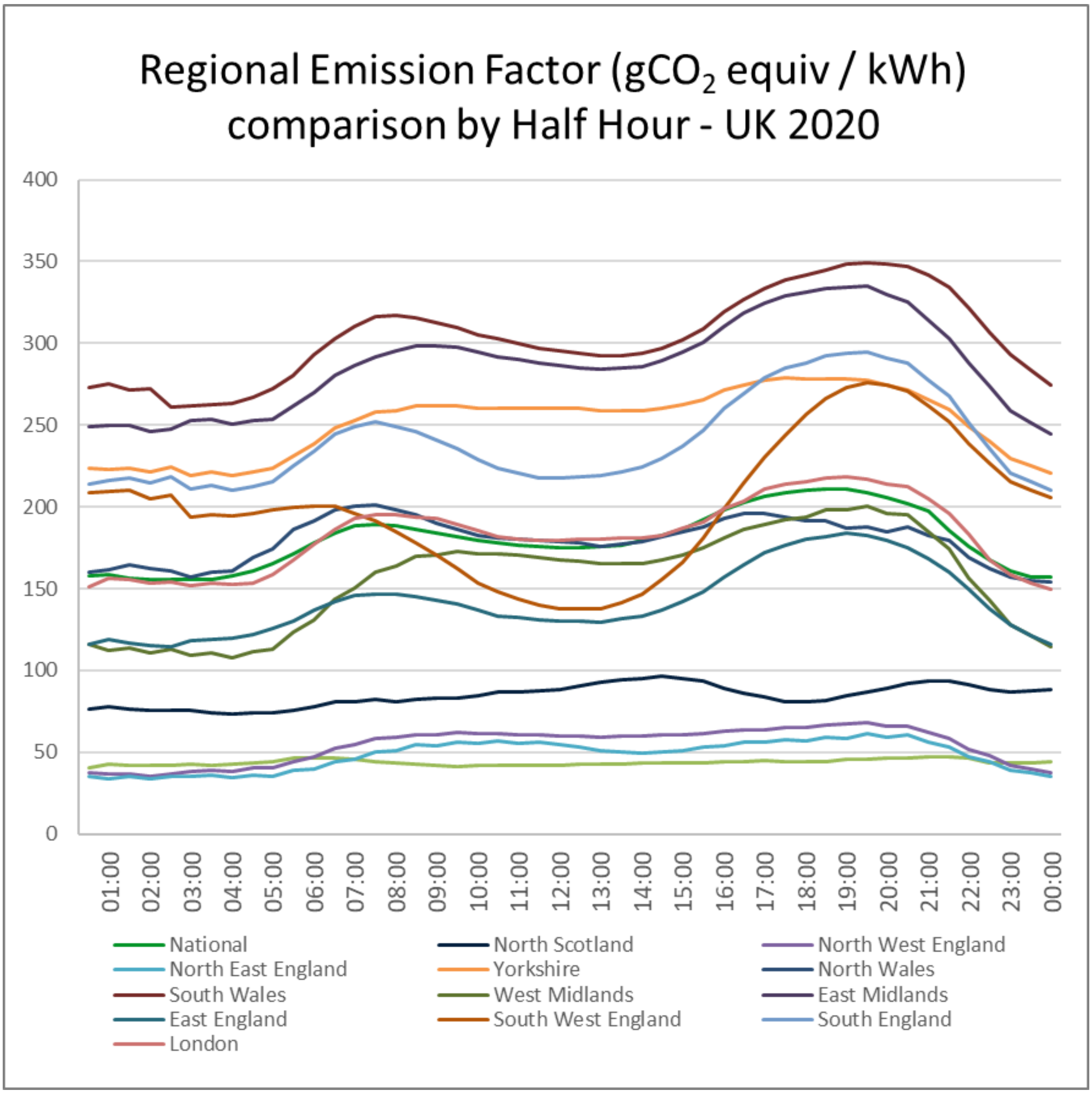

Figure 4. A comparison of carbon intensity across regions in the UK by half hour, showing up to a seven fold difference between regions during peak periods.[6]

[6] Data from National Grid ESO via Carbon Intensity API https://carbonintensity.org.uk/

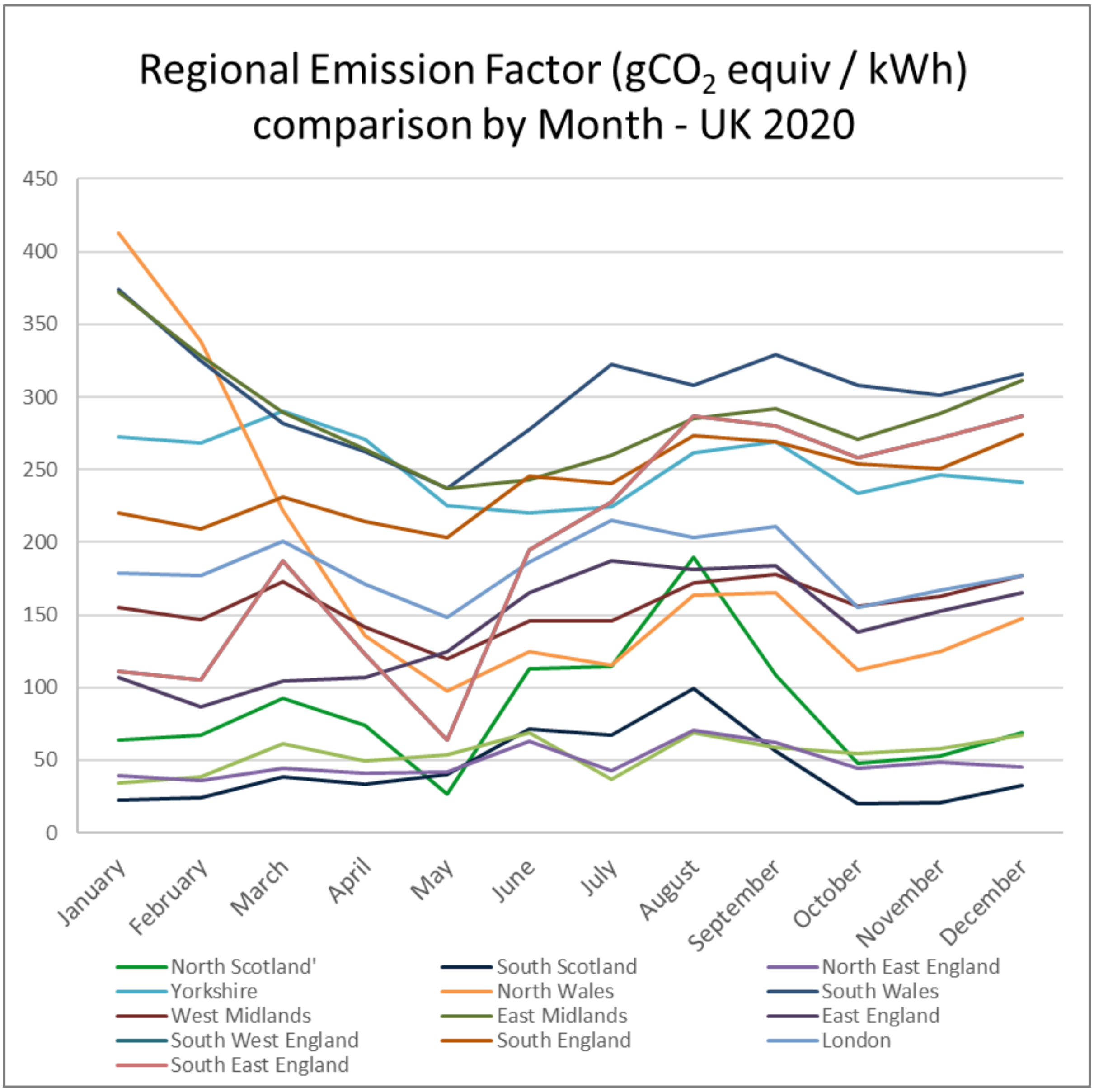

Figure 5. A comparison of carbon intensity across regions in the UK by month, showing up to a eight fold difference between regions during peak periods.[7]

Similarly to the example shown in **Figure 3** the lack of connection between location of generation and location of consumption makes the carbon offsetting potential of certificates much weaker and harms the consumer in several ways.

[7] Data from National Grid ESO via Carbon Intensity API https://carbonintensity.org.uk/

1.3 Why does this matter?

These mismatches create several problems, all of which hurt the consumer and the environment:

1. Carbon emissions are hidden from view, meaning their environmental impact is not offset.

2. There is no incentive for consumers to change their behaviour to consume during lower carbon times as every hour costs the same to offset.

3. There is no way to differentiate between suppliers who are providing genuine low carbon energy over long periods vs those who are using cheap offsets that don't align with demand.

4. There is no incentive for suppliers to improve the renewable energy production capability of areas with high carbon emissions or to cater for time periods of high carbon emissions.

When considering the requirements for future energy products, both the time of generation and the location of generation must be connected to the time and location of the energy consumed and offset. There has to be an incentive for providers, suppliers and consumers all to reduce carbon emissions at peak times, not just when the average emissionality of the grid is already very low, in order to reduce carbon emitted into the atmosphere. The current system does not do this.

Q2. Can you provide any evidence on your commercial experiences with PPAs for renewable energy? For example – availability, commercial competitiveness etc.

Physical PPAs are a well documented way for developers to secure funding for renewable asset deployment, guaranteeing a certain level of income for enough years to make finance the project viable. However, beyond these physical PPAs there are a large number of different types of PPA agreements, including synthetic or virtual PPAs and into even less connected agreements. Due to the highly varied nature and huge complexity of these agreements not all of them can be shown to have a high level of additionality (i.e. how much they have made extra renewable energy generation possible) and those that become less connected between the power generation and the power delivery can start to loose their sustainability shine, much like unbundled RECs.

Q3. Can you provide any evidence on operational issues or other challenges that may materially limit a supplier's ability to offer PPA backed green electricity tariffs? For example, how do you balance forecasting of consumers usage vs the need to settle on a half hourly basis?

There are several obstacles that will limit a suppliers ability to offer sustainable PPA backed green electricity tariffs;

1. The availability of high quality PPAs and amount of renewable energy generation is not high enough in the UK.

2. The variability of renewable energy generation assets, based on uncontrollable variables such as weather, means that without hugely increased flexibility provisions within the grid, fully PPA backed green electricity will be impossible.

3. Consumer behaviour is often apathetic to the needs of the supplier, regardless of sustainability outcomes.

Based on this it seems highly unlikely that 24/7 green energy could be achieved in the UK using only PPAs, due to the lack of availability of renewable energy as well as the detrimental effect this would have on grid stability.

Q4. Can you provide any insights or evidence as to the role REGO certificates play in financing and commercial decision making?

On the side of renewable asset financing, currently REGO certificates play little role in financing and commercial decision making, as they are too cheap to impact future planning. There is significant evidence that in their current state they have little to no additionality.[8] This hurts both the consumers that believe through using REGO backed green energy they are having a measurable green impact and does little to increase the availability of renewable energy.

This does not have to be the case. EnergyTag, the global not for profit organisation dedicated to building a better certificate system which links the certificates to the time and location of production, makes a compelling argument that by doing this the scarcity of certificates, particularly those most attractive to the consumer (created during times of peak demand, rather than times of peak supply) will be far greater and therefore these premium certificates will be more expensive. In this scenario the

[8] https://www.bccas.business-school.ed.ac.uk/impact-and-collaboration/renewable-energy-purchasing/

price of REGO certificates would then be high enough, and the risk associated with them low enough that they could start to play a role in project financing.

It is undoubtedly true that in a market where REGO certificates are linked to their production time/location and have to be cancelled in a similar scenario, the scarcity of these certificates would be greater and this should lead to a higher price of certificates and a greater overall offsetting of carbon. However, it is unclear the extent to which this price increase will be enough to play a role in project financing, and it is highly likely that it will take many years for the market of this new certificates market to mature to the extent that they can be used in this manner.

Q5. How can green tariffs be regulated to enable consumer choice to drive additional investment in low carbon electricity generation?

The language around renewable energy is complex to the point that many industry professionals regularly mix up terminology, and many companies make up their own terms in order to market their sustainability credentials. The average consumer has neither the time nor inclination to fully immerse themselves in this world, in order to then find the best provider.

Our suggestion would be a sustainability score, provided by an external body (either BEIS or a regulatory body such as Ofgem) which allows for quick comparisons between energy providers. Exactly how the scoring system would work will be a subject of intense debate, but to begin with, 0 would be 100% of power coming from gas or coal turbines, and 100 being 24/7 renewable energy matching backed by physical PPAs. **Figure 6**.

Figure 6. An illustration of a sustainability score, where 0 is power from 100% thermal generation, and 100 is 24/7 renewable energy production matched to demand via physical PPAs.

Whilst 100 on this score would be almost impossible at present, as discussed in Q.3, the closer to that number, the more the consumer could have confidence in the supplier having a positive impact on sustainability. The weighting of this score should be set up to reward two key metrics;

1. Additionality - how much does the supplier, through the actions of this tariff, contribute to increasing the amount of renewable energy available.

2. Carbon Avoided - how much does the supplier, through the actions of this tariff, contribute to avoiding carbon emissions that would otherwise have been produced.

Through this the buyer knows that their actions contribute to increasing the amount of renewable energy available, and to reducing the amount of carbon emitted. This achieves the ultimate goal of buying a clean energy tariff.

Q6. Should the ability to report emissions using both market-based and location-based emission factors be maintained, and if so, should there be a requirement to report both side by side in corporate reporting?

Whilst neither market based or location based methodologies are perfect, location based emissions factors must be used to report emissions, whilst there is a place for both market based and location based reporting for carbon offsetting.

It is important to retain some level of market based carbon offsetting, as a deeper and more liquid market allows for more innovation and the ability of consumer choice to drive down emissions. However, the reporting of emissions should be done using a location based approach, as this gives a far more accurate picture of an organisation's emissions. Without this, our analysis shows many corporations vastly underreport, and therefore under offset, their carbon emissions. **Figure 7**.

This shows the emissions of the same factory calculated by, static annualised emissions (the current scenario), National - Static Average, real time emissions calculations at a national level, National - Real Time, and then the real time emissions of that factory, located in each region of the UK. As can be seen from the results, both the location, and the time, are incredibly important to an accurate calculation of emissions. The national static average underestimates the emissions of the factory compared to the national real time average, and the national average is incredibly inaccurate when compared to the emissions calculated by location within the UK. The red bars are all the areas that a national, static calculation would underestimate, and the green are those that it would overestimate.

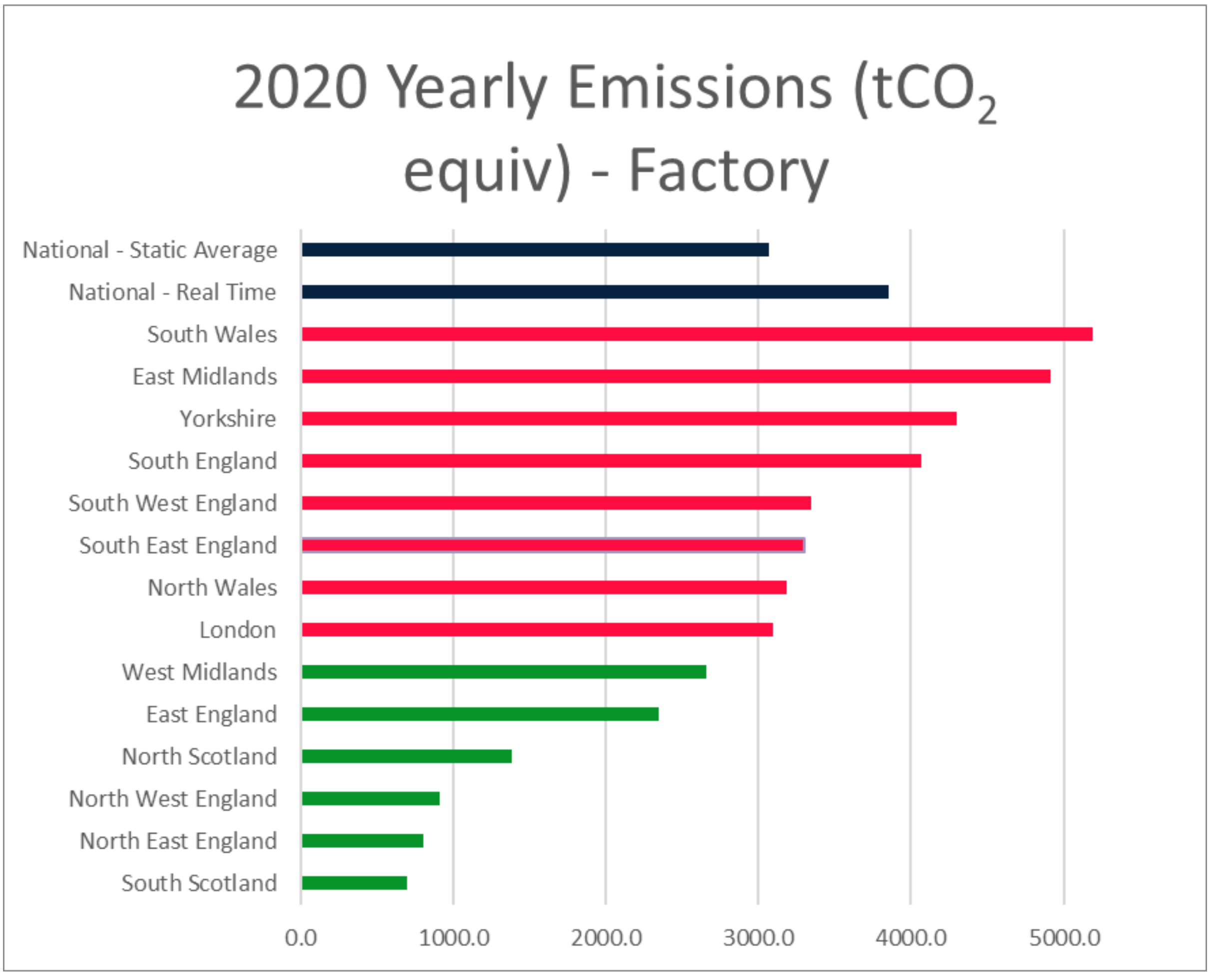

Figure 7. A comparison of the emissions of a factory in 2020, when calculated nationwide with an annualised average (National - Static Average), when calculated with a nationwide real time approach (National - Real Time), or by using a localised and real time emission factor in every area of the UK. The red bars show which areas a national static calculation would underestimate the emissions of the factory when compared to a location based and real time approach, whilst the green lines show areas where the emissions would be overestimated.

These calculations are similarly varied by location for many different electricity consumption profiles, from individual consumers through to large corporations. Whatever the energy consumption, the location matters hugely. If corporations are reporting emissions based on a purely market based approach, there will be huge inaccuracies in their reported emissions. This is detrimental for both consumers and the environment. If corporations are under-reporting their emissions then they are going to do less to offset those emissions, meaning more carbon is emitted than offset. There will also be less incentive for companies to provide the best carbon offsetting strategies that they can, if they can hide their emissions under a national average.

Furthermore, purely market based reporting disincentives the implementation of targeted, local sustainability strategies that can be hugely effective in reducing carbon emissions and increasing carbon offsets. Strategies such as;

- Load management to remove high consumption from local grid carbon emission peaks
- Optimal renewable asset siting to maximise carbon offset from the asset
- Local carbon planning and management

A lot of these actions represent fairly easy to implement sustainability strategies, however, there is no incentive to do this under the current retrospective annualised carbon reporting, using market based reporting. Under the current system, a kWh of power used has the same carbon intensity associated with it whenever it was used, and wherever it was used, as discussed in Question 1. Using location based reporting in real time, the emissions associated with that kWh are much more accurately calculated, which incentivises the reduction in carbon emissions associated with every unit of power at every point in the day. This overall leads to a far greater reduction in carbon emissions.

To truly optimise carbon reporting, the offsetting ability of any project should be measured against a localised Marginal Emission Factor. This measurement takes into account for every kWh of energy produced by a renewable asset, for example, where would that kWh of energy have come from if that asset did not exist, and what would be the carbon emissions associated with that alternative path. If the marginal power being turned down by the renewable asset is a gas turbine, this represents a very high amount of carbon offset. If the marginal power is instead another renewable asset (e.g. a wind turbine who's output has to be constrained for grid stability) this is a negligible amount of carbon offset. Whilst this topic falls beyond the remit of this call for evidence, again, locationality of actions is key to their sustainability outcomes.

Whilst it is true that electrons cannot be traced through the grid exactly, we can model power flows and measure interconnectors and constraint boundaries across the network. From this we have a good understanding of where the power is flowing from, and to, and so disconnecting the location entirely represents another gross oversimplification and inaccuracy in carbon accounting and carbon offsetting.

Q7. Can you provide any evidence regarding the types of messages associated with green electricity tariffs that you believe to be misleading to consumers?

Much of the advertising jargon and publicity around green tariffs is an oversimplification and, whether intentional or not, is misleading to consumers. "100 % renewable" tariffs are expected by most of the public to mean your electricity comes all of the time from renewable energy sources. This is obviously not the case, and so this type of language should be heavily regulated. To our knowledge, the supplier 'Good Energy' are one of the only, if not the only suppliers that make the claim of "100 % renewable energy" and back this up with sourcing their power from only renewable energy assets. This should be a hugely unique selling point, but given the ability of other suppliers to use unbundled REGOs to also sell "100% renewable energy" this is not the case.

Q8. Can you provide any evidence as to the type of interventions or remedies (including international best practice approaches) which may help achieve greater transparency in green electricity tariffs?

The EnergyTag Initiative are running pilot programs with many partners in Europe, Australia and the US, with more planned in the future, showcasing the possibility and benefits of using granular energy certificates matched by time and by location.[9]

Q9. How best do you think the carbon content of energy supplied to a home or business consumer could be made more transparent to consumers?

The carbon content of energy supplied to consumers could be easily made more transparent by more widely publicising the local grid emission factor. This could be done via an app, the screen on a smart meter, or through connected internet devices. It is easy to understand that a higher number means more carbon emitted, and a lower number means less, per unit of energy consumed.

Emission calculations of both suppliers and consumers of electricity should be made as granular as possible, either half hourly or hourly in real time. They should also be as granular in terms of location as is possible for a reasonable calculation model. This granularity should be extended to offset by REGO certificates as well.

[9] https://www.energytag.org/wp-content/uploads/2021/05/EnergyTag-and-granular-energy-certificates.pdf

The ultimate aim is a system where every kWh of electricity is measured in terms of carbon emitted at production, by hour and location, and is matched against its use, by hour and location.

Q10. Should there be any avenues to accommodate flexibility technologies within a future green tariff framework? If so, how could this be achieved?

Yes. In order to increase the penetration of renewable energy into the grid, the level of energy storage must increase dramatically, and so creating market based incentives for this is imperative.

Advanced Infrastructure works with a housing development to optimise their flexibility asset for sustainability. The 1.3 MWh battery is optimised to charge when the local grid marginal emission factor is lowest, and discharge when the local grid marginal emission factor is highest, using both forecast and historic data to find the most carbon saved. **Figure 8**.

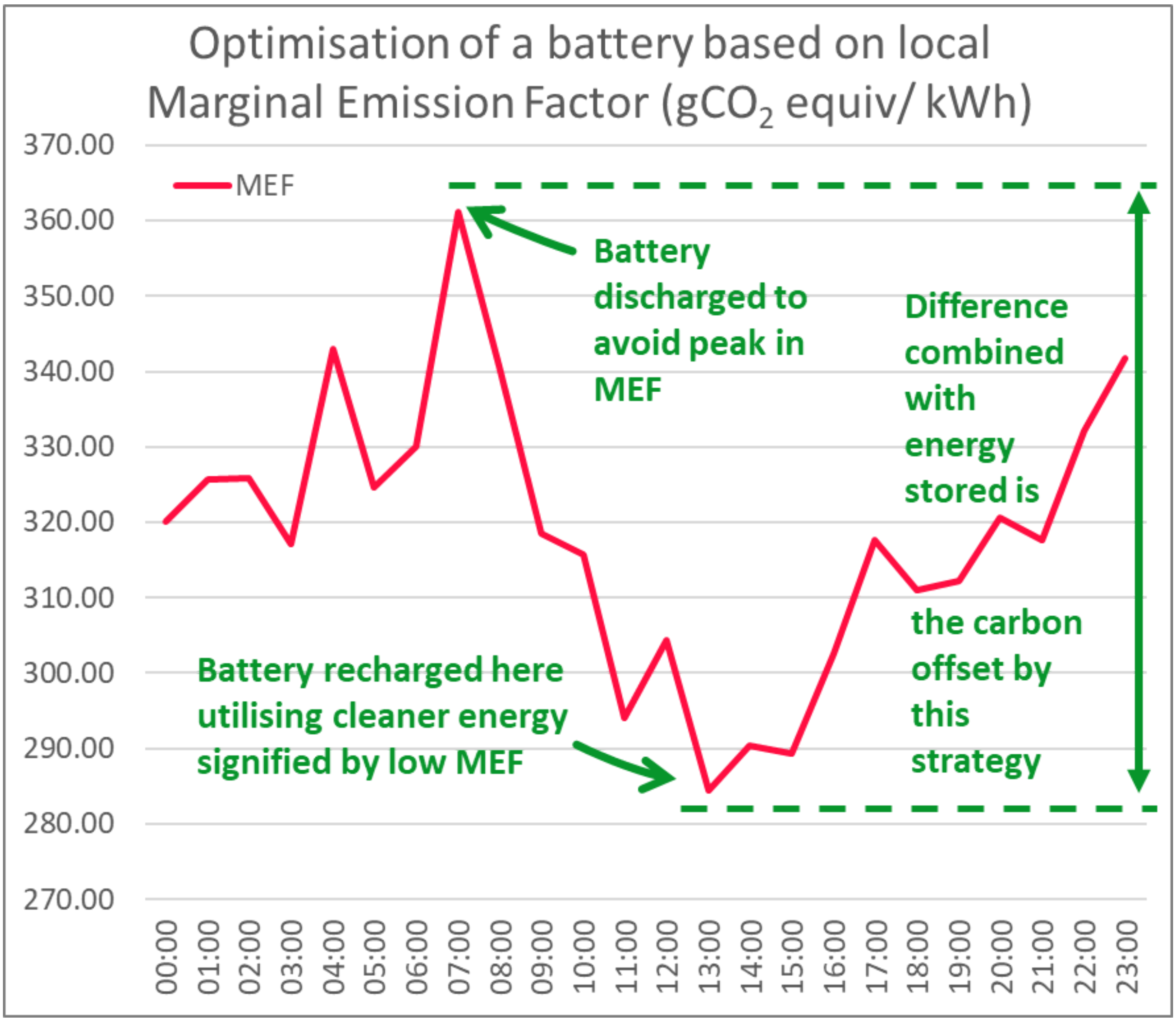

Figure 8. The optimisation of a flexibility asset based on local Marginal Emission Factor. The carbon offset is the difference between the marginal emission factor of the charging and discharging multiplied by the energy discharged and accounting for efficiency.

This action should be accountable as a carbon offset as it clearly reduces the amount of carbon emitted in the atmosphere, when compared to not running the battery system. The carbon offset is the difference between the marginal emission factor (MEF) at the time of usage and the time of storage, combined with the energy discharged into the grid, accounting for efficiency;

$$Carbon\, Offset \;=\; [MEF_{(t\, =\, use)} - MEF_{(t\, =\, storage)}] \;\times\; kWh$$

Similar projects such as the CarbonFlex pilot have demonstrated the benefits of using flexibility assets optimised for reducing carbon emissions.[10] The key to how this is accounted for is for the energy stored in the system to be associated with the carbon emissions of its production, rather than its usage, accounting for the efficiency of the system.

Q11. Can you provide any evidence on areas where the current REGO system works well or creates barriers to the market offering more innovative ToU tariffs?

The current REGO system creates barriers to market offering more innovative ToU tariffs, as they allow suppliers using only unbundled REGOs to undercut those with more sustainable or innovative offerings in price, whilst using the same language in marketing, as discussed in Question 7.

They also do not provide any measure of benefit for consumer or supplier behavioral choices which could lead to a reduction in emissions as discussed in Question 6.

Q12. Are there any other emerging needs you believe a future green or low carbon tariff framework should accommodate?

No. The addition of time and location to the accounting of carbon emissions in power generated and used is the main requirement for this framework and should be the focus.

[10] https://www.energyunlocked.org/carbonflex

Q13. Should other forms of low carbon power, such as nuclear, hydrogen, CCUS and CHP be considered as part of any future green or low carbon tariff regulatory developments?

Yes, any technology that can demonstrate a reduction in carbon emissions and contribute to a low carbon grid should be considered and implemented.

Q14. There is an emerging market for 'green gas' tariffs. Should our work consider any interventions to include these within the regulatory framework?

The regulation of this emerging market is very important, as the terminology associated with it is becoming increasingly muddled and misleading, as it has become in the electricity market. E.g. Green, brown, blue hydrogen, their various production methods and associated emissions. However, this should be done separately as it is another large area of policy that requires its own attention.