Accurately Tracking Carbon in Electricity Markets

Energy Systems Catapult and Elexon

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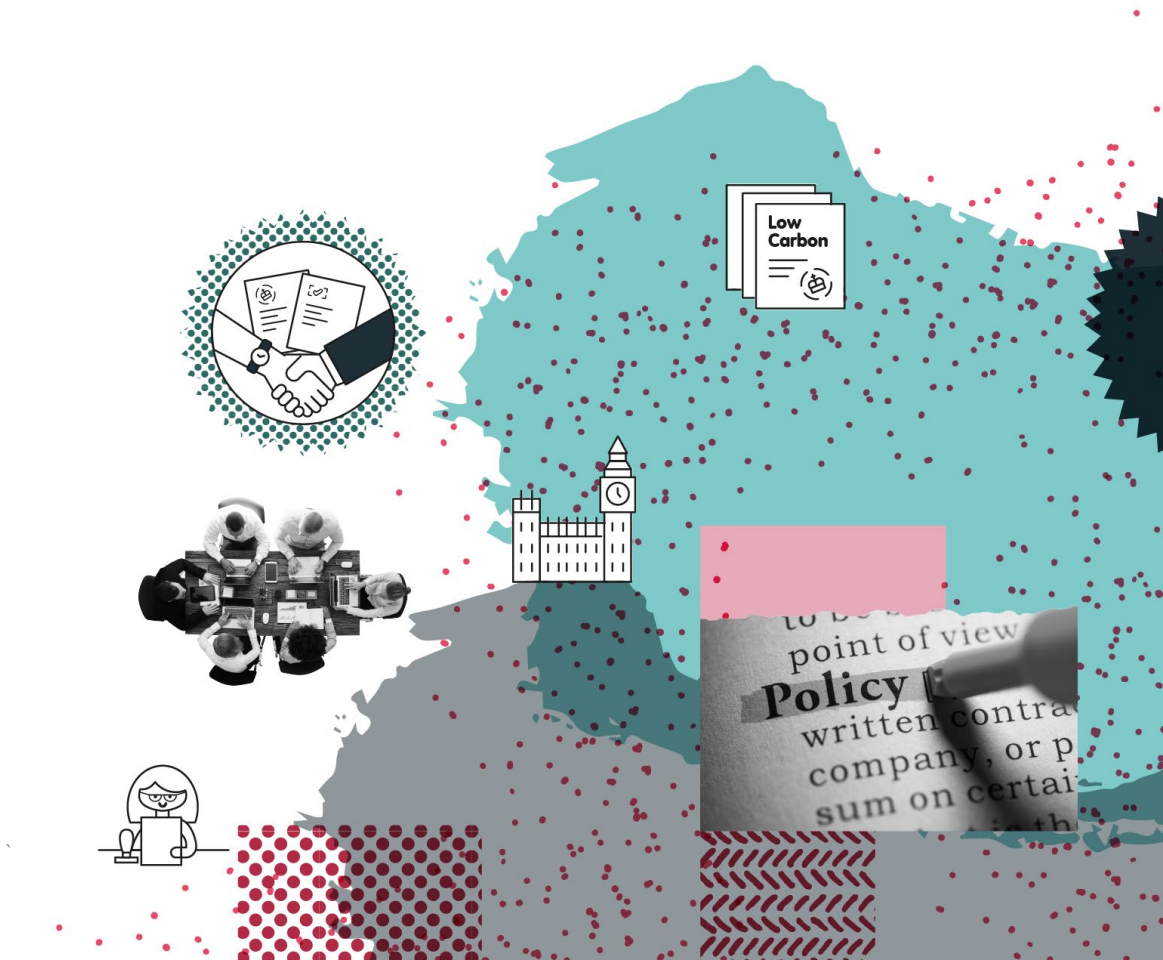

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About Energy Systems Catapult

Energy Systems Catapult was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth. The Catapult is an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia, and research. We take a whole systems view of the energy sector, helping us to identify and address innovation priorities and market barriers, in order to decarbonise the energy system at the lowest cost.

About Elexon

Elexon is the Code Manager for the Balancing and Settlement Code (BSC), which facilitates the effective operation of the electricity market. We are responsible for managing and delivering the end-to-end services set out in the BSC and accompanying systems that support the BSC. This includes responsibility for the delivery of balancing and imbalance settlement and the provision of assurance services to the BSC Panel and BSC Parties (energy Suppliers, generators, and network companies).

1. Introduction

To achieve Net Zero by 2050, the power sector will need to decarbonise more quickly than other sectors, because of its dependence for transport, buildings, and industrial decarbonisation. In their Sixth Carbon Budget advice, the Climate Change Committee (CCC) recommended that the UK fully decarbonise electricity generation by 2035, while meeting a 50% increase in demand.[1] In October this year, the Government formally made a commitment to fulfil this recommendation.[2]

There are a range of policy options for achieving a zero carbon grid, using incentives and/or regulation. Ultimately these interventions need to shape the behaviour and choices of buyers and sellers of electricity so that they, in aggregate, deliver a Net Zero electricity system.

These mechanisms will be much more effective if they are based on accurate data about the actual carbon content (or intensity) of the electricity they buy, sell, and/or use in real time in real locations.

This means that we need to examine options to improve the tracking of carbon content in electricity markets. Judgements will need to be made about how this is done and the balance between strict accuracy and practicality of implementation. In this joint paper between Energy Systems Catapult and Elexon, we aim to:

1. Explain the importance and opportunities that could arise from accurate tracking of carbon in electricity markets,
2. Provide a preliminary exploration of the current state of the art and options for improvement, and
3. Identify recommended next steps.

If the UK can harness the power of digitalisation to accurately track carbon across the system at a granular level in time and space, then it opens up significant opportunities to align power market reform with the implementation of ambitious carbon policy, as well as responding to consumer demand for zero carbon electricity.[3] To enable this, the challenge is to ensure that carbon is fully accounted for across the electricity system, right from generation to its eventual use.

2. The importance of tracking carbon in electricity

Under the current market and policy arrangements, the negative externality of carbon is not sufficiently internalised (see ESC's 'Effective carbon prices and emissions in the UK by sector' chart

[1] Climate Change Committee (2020). Policies for the Sixth Carbon Budgets and Net Zero. https://www.theccc.org.uk/wp-content/uploads/2020/12/Policies-for-the-Sixth-Carbon-Budget-and-Net-Zero.pdf

[2] HM Government (2021). Plans unveiled to decarbonise UK power system by 2035. https://www.gov.uk/government/news/plans-unveiled-to-decarbonise-uk-power-system-by-2035

[3] For example, see ESC (2021). EMR2.0: a new phase of innovation-friendly and consumer-focused electricity market design reform. https://es.catapult.org.uk/report/rethinking-electricity-markets-the-case-for-emr-2/

for more details[4]) within the electricity markets nor in ESO[5]/DNO[6] procurement of energy resources. While the UK's Emissions Trading Scheme (ETS) covers the power sector, it also covers other sectors and so the ETS cap – as it stands today in 2021 – will not be sufficient to drive the necessary emissions reduction from the power sector at the required pace. For electricity, renewable support schemes, such as the Contracts for Difference (CfD) scheme, have played a major role in complementing the ETS to drive the reduction in carbon emissions. Other complementary interventions such as the Emissions Performance Standard (EPS) applied to the Capacity Market (CM) and the Carbon Price Support (CPS) scheme have contributed, but to a much lesser extent. For example, emission limits applied to the CM through the EPS and air quality legislation have limited impact on gas resulting from significant gaps for some technologies (e.g. small generators <50 MW).

Recent analysis by BEIS reveals that the resources currently used to balance and optimise the GB power system are predominantly based on fossil fuels (see Table 1).

Table 1 Value, size, and carbon intensity of electricity market, reproduced from BEIS workshop slides.[7]

Market	Value (2019)	Size (2019)	Carbon Intensity
Balancing Mechanism	£590m	Abs: 20,000 GWh Net: 630 GWh	Fossil fuels >99% of turn up
Short Term Operating Reserve (excluding spin generation)	£50m	2,000 GWh	>99% fossil fuel contracts
Fast Reserve	£90m	220 GWh	85% fossil fuel contracts
Firm Frequency Response	£40m	3,250 GWh	20% fossil fuel contracts
Mandatory Frequency Response	£30m	2,500 GWh	Large units only. Will be primarily fossil fuel generation
Capacity Market (2021/22)	£500m (but varies by year)	55 GW (de-rated)	70% fossil fuel contracts
DNO Tenders	£1.5m	c.850 MW (MWh unknown)	>80% fossil fuel contracts
Wholesale Market	£13,000m	219,000 GWh	~40% fossil fuel contracts

Considering the new objective to decarbonise power by 2035, the decarbonisation requirement for the electricity sector is not sufficiently clear nor visible to investors and market participants. To address this and guarantee achievement of the 2035 objective, further regulation will be required to reduce emissions in line with the new carbon reduction trajectory for the sector.

In order to regulate or incentivise the achievement of a target or outcome, however, it must be possible to accurately measure and account for the target. This is recognised by BEIS in its recently

[4] ESC (2019) Current Economic Signals for Decarbonisation in the UK. https://es.catapult.org.uk/news/rethinking-decarbonisation-incentives-current-economic-signals-for-decarbonisation-in-the-uk/

[5] Electricity Transmission System Operator

[6] Distribution Network Operator

[7] Slides presented at the *"Carbon in Flexibility Markets Workshop"* hosted by BEIS on 14th October 2020.

published Smart Systems and Flexibility Plan[8], which expects to establish carbon monitoring and reporting arrangements by 2023. The latter would involve a standardised approach *"implemented across the transmission and distribution levels, allowing full transparency over the carbon intensity of flexibility markets"* [9].

Where carbon is currently tracked and matched with consumption, it is only done on an annual (or occasionally monthly) basis (see Annex 8.1 for examples). Measuring carbon emissions at the point of generation can be relatively straight forward, indeed it is a requirement for many existing carbon policies such as under the UK ETS (see the Annex for more details). The challenge is to accurately track the carbon content of electricity from its point of generation to its contracted end user, including its trading and re-trading. National Grid Electricity System Operator (NGESO) does this to some extent[10], but not at the level of granularity required.

3. Consumers demand greater transparency on carbon

There is also strong demand for low and zero carbon electricity from consumers, both domestic and corporate. Many corporations pursue carbon emissions reductions through their environmental, Social and Corporate Governance (ESG) or Corporate Social Responsibility (CSR) initiatives and objectives. The key means of achieving this for electricity consumption is through the UK's REGO scheme, established in 2003 as an accounting and disclosure mechanism for renewable electricity generation across the European Union[11]. In the UK, REGO certificates are issued per MWh of eligible renewable output to generators of renewable electricity, which can then be sold to electricity suppliers or offtakers to prove that a given share of energy was produced from renewable sources.[12]

The REGO scheme has been relatively successful as there is strong demand for renewable electricity and many green tariffs are available in the retail market. The scheme is attracting criticism, however, as the certificates are not accurately tracking the attributes of a given unit of renewable energy from the generator to the consumer. For example, suppliers and offtakers can claim they are using wind energy on a windless winter's day, because they hold a REGO certificate, but the latter may be for wind energy produced in the summer. In the context of green electricity tariffs, final consumers may consequently be misinformed as to the actual environmental benefit of their energy choices.

Progress has already been made with tracking carbon at more granular timescales through voluntary initiatives such as EnergyTag, which is seeking to establish principles that can be used to complement existing schemes by developing a market for hourly energy certificates[13]. While

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[8] BEIS (2021). Transitioning to a net zero energy system: smart systems and flexibility plan 2021. https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021

[9] It is assumed that this term covers all electricity markets that can or should reward flexibility.

[10] NGESO. What is carbon intensity? https://www.nationalgrideso.com/future-energy/net-zero-explained/what-carbon-intensity

[11] In the EU Member States these certificates are generally referred to as "Guarantees of Origin (GoO) certificates".

[12] Ofgem. Renewable Energy Guarantees of Origin (REGO). https://www.ofgem.gov.uk/environmental-and-social-schemes/renewable-energy-guarantees-origin-rego

[13] EnergyTag. https://www.energytag.org/

demonstrators and voluntary initiatives are needed to demonstrate that it is possible to accurately track the carbon content of electricity across the system, legislation or regulation is likely needed to deliver the UK's commitment to Net Zero power by 2035.

The Government recognises these opportunities and issues, including the 'greenwashing' associated with REGOs. To inform its response, it has published a Call for Evidence, 'Designing a Framework for Transparency of Carbon Content in Energy Products'[14] with the purpose of informing whether a more transparent framework for carbon content of energy services to be communicated to consumers is needed and how such a framework could be designed.

4. Quality carbon data

4.1. How granular by time?

Tracking carbon through the electricity system will make it possible to reveal the actual value of zero carbon energy resources in a rapidly changing energy system with residual demand fluctuating in short timeframes and becoming more difficult to predict.

In the UK, the electricity transmission system operator (ESO) – National Grid Electricity System Operator (NGESO) – is constantly matching electricity generation and consumption in a bid to keep the system in balance. At present, as shown in Table 1 above, ESO is predominantly using high carbon energy resources to achieve this. Whilst NGESO balances the system in real-time, market participants are incentivised to match supply and demand in each of the 48 thirty-minute settlement periods that occur each day. These incentives, however, could be strengthened, enabling greater demand-side flexibility.

Whilst lower wholesale electricity prices often correspond to periods of lower-carbon generation, it is not always the case that the carbon intensity of the electricity system at such points in time is low. When renewable energy generation is plentiful, the current system sometimes has difficulty in absorbing it due to network congestion and lack of flexibility through cross-border trading, demand-side response and storage. The situation is exacerbated by the fact that the price signals emanating from our current market design are not as cost-reflective and granular by space and time as they could be, and CfDs are shielding renewable generators from market signals to some extent. This significantly increases the demand for ancillary services using high-carbon resources.

By increasing the granularity of market signals by space and time, combined with equally granular measurement of the actual carbon intensity, the market would be enabled to identify and reward the types and scale of technology needed to integrate renewable energy generation under all system conditions. Such improvements would simultaneously deliver more efficient dispatch and system operation, as well as investment in the low carbon resources with the right blend of capabilities needed by the system. To reduce carbon emissions and cost effectively integrate weather-dependent generation, heat pumps and electric vehicles, it is necessary to encourage consumers to take up tariffs, incentives, or contracts that reward demand response able to deliver real benefits in terms of carbon emissions reduction as well as power system benefits. By 2025, all

[14] BEIS (2021) Designing a framework for transparency of carbon content in energy products: call for evidence. https://www.gov.uk/government/consultations/designing-a-framework-for-transparency-of-carbon-content-in-energy-products-call-for-evidence

consumers should have access to a smart meter and be settled on a half-hourly basis.[15] Evidence from research and consumer trials shows that residential consumers can be strongly motivated by factors other than price when it comes to providing flexible energy consumption. Parag et al.[16] suggest that bringing attention to the carbon emissions benefits of demand-side flexibility may be more impactful than price signals in generating consumer response. The roll out of smart meters and implementation of half-hourly settlement for all consumers, due to be completed by 2025, opens up the opportunity to measure the carbon intensity of electricity actually consumed in the half-hourly settlement intervals and to provide consumers with accurate information about their carbon consumption along with energy services that can help them minimise their carbon emissions.

4.2. Best practice data development, management and governance

The importance and necessity of quality data for the energy system has recently been emphasised by the Energy Data Taskforce[17], run by Energy Systems Catapult and chaired by Laura Sandys, which published its key findings in 2019. The Taskforce identified a staged approached, with each digitalisation objective building on the previous and informing the next step in the journey, in order to fill the data gaps and maximise data value:

- **Data Visibility** – Understanding where the data exists or is missing, which datasets are important, and making it easier to access and understand data.
- **Infrastructure and Asset Visibility** – Revealing system assets and infrastructure, where they are located and their capabilities, to inform system planning and management.
- **Operational Optimisation** – Enabling operational data to be layered across the assets to support system optimisation and facilitating multiple actors to participate at all levels across the system.
- **Open Markets** – Achieving much better price discovery, through unlocking new markets, informed by time, location, and service value data.
- **Agile Regulation** – Enabling regulators to adopt a much more agile and risk reflective approach to regulation of the sector, by giving them access to more and better data.

The following principles for tracking carbon along with the broader findings for best practice data management in the energy system can ensure that it is carried out in a way that develops investor confidence and spurs innovation:

- **Accuracy** – The data must be accurate within the pre-defined specification. It may not always be possible to precisely measure the carbon content of electricity at the point of

[15] Ofgem. Electricity settlement reform. https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/electricity-settlement-reform

[16] See: Parag, Y. (2021) Which factors influence large households' decision to join a time-of-use program? The interplay between demand flexibility, personal benefits and national benefits, *Renewable and Sustainable Energy Reviews*, 139 *and* Parag, Y., Capstick, S., & Poortinga, W. (2011) Policy attribute framing: a comparison between three policy instruments for personal emissions reduction, *Journal of Policy Analysis and Management*, 30(4)

[17] ESC (2019). Energy Data Taskforce: A Strategy for a Modern Digitalised Energy system. https://es.catapult.org.uk/report/energy-data-taskforce-report/

generation. Where this is not the case, the use of clear proxies backed by scientific evidence should be used (e.g. electricity generated from biomass or abated generation using carbon capture and storage).

- **Accessibility** – Ensuring that data is accessible from the point of generation through to consumption. Without wide accessibility, investor confidence may be dampened.
- **Consistency** – The measurement, reporting, and verification (MRV) approaches used will need to be consistent across the energy system. Consistency across energy data is vital for ensuring it is robust and can be relied upon through various electricity markets, where the value of electricity will be – in part – determined by the carbon, time, and location characteristics in a zero carbon electricity system.
- **Transparency** – At all times the data must be transparent to all those participating in the electricity system, from generators to buyers and the regulator.

Robust governance of data will be fundamental to its success, this should include:

- **Responsibility** – Organisations that generate, collect, process, and disseminate data have an existing responsibility to manage data effectively.
- **Transparency and Challenge** – Creating transparency enables the regulator and peers to review and challenge decisions of other organisations.
- **Enforcement** – Legislative and regulatory enforcement measures, which can be utilised today and areas where new tools can be created for the future.

With regards to carbon emissions, ESC has previously proposed the introduction of a 'Carbon Monitoring, Reporting, and Verification (MRV) and Accounting Regulator'[18]. Such a body (or set of bodies) would be charged with overseeing accurate and coherent MRV of carbon emissions reduction and removal across the economy. Given the interactions between the electricity sector and other sectors, a Carbon Regulator could assist in the broader data governance of carbon tracking, ensuring it is appropriately accounted for within Carbon Budgets and decision making.

5. Carbon tracking today and in the future

5.1. Carbon tracking in the current electricity settlement systems

The wholesale and retail electricity markets operate within a well-established regulatory framework – legislation, licences, and industry codes. This framework enables a wide range of market participation, but is underpinned by the use of common rules. These rules govern, inter-alia, the provision of ex-ante operational and contractual data by market participants to the Balancing and Settlement Code Company (BSCCo/Elexon) and NGESO, the measurement of electricity production and consumption using standardised metering (across ~30 million metering systems) and the reconciliation of settled positions using actual metered data and where updated/corrected data becomes available. Figure 1 illustrates the basic flows of data that underpin the retail and wholesale electricity markets.

[18] ESC (2021). The Case for an Economy-Wide Carbon Regulator. https://es.catapult.org.uk/report/the-case-for-an-economy-wide-carbon-regulator/

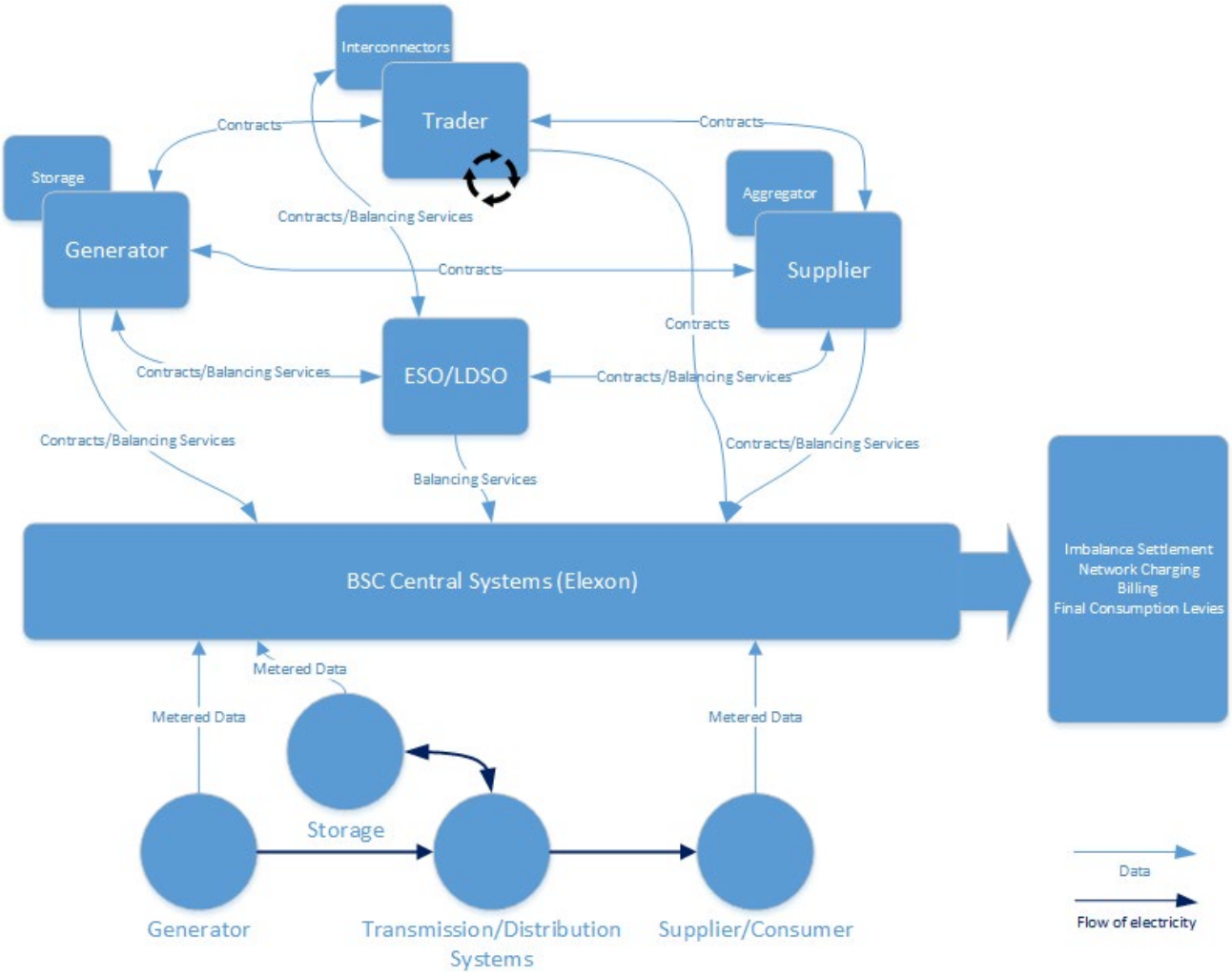

Figure 1 An illustration of the basic flows of data that underpin the retail and wholesale electricity markets.

The systems and processes ensure the accurate and timely processing of large volumes of data on a daily basis at thirty-minute granularity (i.e. by settlement period). Whilst contractual data is currently only attributed to market participants, balancing and metered data is attributed to Balancing Mechanism Units, which may represent individual generator plant.

In addition to supporting the calculation of imbalance settlement, settlement data (including metered data) is shared with market participants to support a number of other industry processes and calculations, for example, wholesale market monitoring, the calculation of network charges and final consumption levies, and for use in supplier billing.

However, the rules that govern the operation of the wholesale and retail electricity markets do not require the collection and sharing of any data on the carbon intensity of the electricity produced or consumed.

5.2. Future requirements to track carbon in the GB power system

Whilst the current industry rules that govern the wholesale and retail electricity markets do not track carbon, the principles and processes for measuring electricity production and consumption may provide a useful starting point that can be extended for tracking carbon produced by

electricity generators, traded and re-traded and ultimately consumed. Re-using existing, established systems, processes and governance may be a cost-effective approach, rather than building entirely new processes and systems for tracking carbon.

In order to effectively track carbon and encourage better outcomes, we expect to need to establish the following elements for the tracking of carbon:

- **Registration of participants and assets** – Participating parties will need to register themselves and their assets with a central body. Details about the participant are likely to be straightforward. Details about the participant's assets are likely to be more detailed – e.g. technology types, size/capacity, location, emission factors (in different operating states).
- **Ex-ante reporting and forecasting** – In order to enable more targeted and efficient decisions by generators, consumers, and investors, participating parties must report agreed/expected emissions to a central body. In addition to details of agreed emissions by participants (i.e. as agreed in conjunction with wholesale market trading), any actions taken by or agreed with the Transmission System Operator (and/or Distribution System Operator(s)) must also be notified to the same central body. The central body must then publish details of the expected emissions.
- **Timely ex-post reporting** – Soon after the emission of carbon, estimates/actual measurements of carbon emissions must be determined/collected and provided to the central body. The central body will publish details of asset emissions as soon as possible after determining/receiving them.
- **Reconciliation** – Over a set period of time, following the production of energy and corresponding emission of carbon, market participants and the central body will be responsible for identifying errors, providing updated data to central body and for central body to updated published data.
- **Audit/Assurance** – A central body should be responsible for checking the veracity/accuracy of participants submissions and the overall accuracy of any centrally calculated data.

5.3. Opportunities to align with existing settlement arrangements

Existing retail and wholesale market arrangements already operate to collect, share and use granular details about electricity production and consumption on a thirty-minute basis. Whilst existing electricity market rules do not require the collection and sharing of carbon intensity data, they could, in principle, be easily extended to require the provision of carbon intensity data alongside other ex-ante operational, contract and balancing service data. Existing arrangements are also in a strong position to derive and share carbon intensity from actual metered electricity production/consumption.

Existing retail and wholesale electricity market arrangements have well-established participant and metering system billing and registration systems. Existing registration details already maintain details about all metering systems measuring electricity imported and exported to the public electricity networks, and enable metered data to be matched with individual plant, sites and customers. Whilst there may be benefits to designing dedicated arrangements for carbon tracking, there may be considerable cost and process efficiencies to extending existing arrangements rather than building new registration details, possibly covering millions of metering systems and sites.

In order to perform Imbalance Settlement of wholesale electricity, market participants must provide details of the contracts they agree (or the Balancing Services requested) which are then compared with metered data that shows what has actually been produced or consumed. These existing requirements could be extended so that in addition to providing information about electricity expected to be consumed/produced, counterparties to these contracts also indicate the expected carbon intensity of the electricity.

For every settlement period, the carbon emissions produced by each participating generator could be determined (according to a pre-determined method for estimating and/or by collecting data from meters for actual CO_2 emissions measured). The existing electricity market arrangements can support both options. On the one hand, established electricity metering arrangements may provide a basis for establishing and maintaining similar for carbon metering. Alternatively, widely used metered electricity production data can be used to determine carbon emissions. Volumes by party and by asset could then be aggregated and published.

Looking ahead, Elexon is working with Ofgem and the industry to implement systems and processes that will ensure all electricity is settled on a half-hourly (HH) basis.[19] This programme will mean that HH metered data from domestic and small non-domestic metering systems (i.e. smart and advanced meters) will begin to be collected and shared with central settlement. This will mean that central settlement systems will have visibility of metered data for almost all consumers and producers connected to public electricity networks.

Alongside the implementation of market-wide HH settlement, Elexon is upgrading the BSC central systems. This large-scale digital development is in order to enable us to accommodate market participants' future needs and supports our commitment to helping the industry achieve its Net Zero goals.

6. Challenges of tracking carbon

Metering carbon – The existing electricity industry rules have well established standards for metering electricity production and consumption. The rules provide assurance to market participants that metered electricity used in a number of industry processes is accurate and reliable. As it stands, we are unaware of agreed international or British standards for carbon metering equipment. Such standards and rules for installing, operating carbon metering equipment and for collecting and using carbon metered data would need to be developed. It is possible that carbon standards and rules could mirror those for electricity metering, and that the existing electricity rules could be expanded to incorporate any new carbon metering standards and rules.

Secondary Trading – A defining feature of GB's retail and wholesale electricity markets is a high level of competition. Suppliers and Generators may agree deals to buy and sell electricity from close to real-time up to several years ahead of delivery/consumption. Trading years ahead of delivery/consumption means that market participants can hedge their positions and potentially trade and re-trade their portfolios many times before the point of delivery/consumption. This secondary trading may also involve non-physical traders who ultimately do not produce or supply the energy being traded. Wholesale market trading and secondary trading can take place bilaterally, through brokers and on power exchanges. Electricity trading is not subject to detailed

[19] For an overview of the Market-wide Half Hourly Settlement programme, please see https://www.elexon.co.uk/about/industry-wide-changes/mhhs-programme/

regulation and so there is limited visibility of the trades except where counterparties publish details or are required to share details, e.g. to facilitate the calculation of Imbalance Settlement. Furthermore, secondary trading of electricity may result in 'clips' of electricity with different carbon values being combined meaning there is a challenge to determining/setting the final carbon intensity of the electricity finally consumed.

Storage – There is a temporal challenge to manage when determining the fuel mix/carbon mix of the energy stored by a storage facility. Should the energy exported reflect the average mix of the energy imported/stored over time or when a specific amount of stored energy is exported should it reflect the carbon intensity of the electricity originally imported? For example, if 10 units of high carbon electricity and 15 units of low/zero carbon electricity are imported and stored, should 5 units of electricity exported at a later time reflect a mix of the energy originally imported and stored or should the storage operator be able to pick whether to export 5 units of high or low/zero carbon (or possibly be able to choose to export a mixed value)?

Interconnectors – The UK is typically a net importer of electricity. In Q2 2021, the UK experienced net imports of 6.1TWh or 8.2% of electricity supplied[20]. Tracking the carbon intensity of imported electricity faces a similar challenge to that of secondary traded electricity. That is, electricity produced outside the UK is open to being traded and re-traded in secondary markets and visibility of these trades is limited. Furthermore, the opportunity to influence rules on trading outside the UK is likely to be limited, particularly post-Brexit.

Tying wholesale market activity to individual consumers – Typically end consumers do not have a direct relationship with the party producing the electricity they consume. Instead, most consumers use a supplier who purchases electricity directly from generators or from other traders. Because suppliers typically purchase electricity to cover a portfolio of customers, there is often not a direct link between who or where electricity is produced and who or where the electricity is consumed. Some suppliers are developing the ability to more accurately demonstrate how the electricity they purchase matches their customers demand or even tariff requirements. However, the need to match specific electricity (and carbon) purchased with consumption does not exist because it is not centrally required through regulation.

7. Conclusions and recommended next steps

In this paper we have established the importance and opportunties that can arise from granular tracking of carbon, highlighting the potential requirements and how it could be possible to build on existing arrangements.

While efforts are underway or already in place to measure, track, and report the carbon content of electricity within the electricity system, both within existing mechanisms and increasingly in voluntary iniatives, there still remains no whole system coordinated effort in Great Britain to do so at a more granular level. This will likely require the development of common rules and standards, to ensure coherent and consistent verification processes across the entire electricity system. In addtion, it may be necessary to improve regulatory practices to ensure this is carried out, which will require further exploration.

[20] ONS (2021). Energy Trends: UK electricity https://www.gov.uk/government/statistics/electricity-section-5-energy-trends

We believe that the existing rules for electricity markets provide a basis, removing the requirement to develop entirely new systems, and therefore a substantive effort to address carbon tracking should begin in the near-term.

Recommendations for policymakers

1. Carry out a study to assess the feasibility for measuring and reporting carbon emissions across the electricity system, exploring options for measurement (e.g. direct emissions measurement, proxy via carbon content of fuel, etc.) and approaches for reporting between actors and associated parties.
2. Carry out a detailed assessment of the current electricty system to understand pathways to granular carbon data measurement and reporting that build on existing rules and processes for electricity markets as well as options for implementing new approaches. This could involve learning from international best practice within a UK context.
3. Seek to establish a coordinated approach to granular carbon data tracking, working with innovative initiatives that are already developing options on a voluntary basis.
4. Ensure data development, management, and governance follows best practice, building on the principles recommended by the Energy Data Task Force.

8. Annex

8.1. Carbon reporting by electricity market participants

Policy	How the Policy Considers Carbon	Reporting Requirements	Other
Renewable Energy Guarantees of Origin (REGO) **[Ongoing]**	REGO certificates are used to track low carbon electricity generation and consumption. All eligible generators are zero carbon generators other than those which use biomass. As such the only reporting requirements which are explicitly linked to carbon are on assets which use biomass.	Amount of renewable electricity generated on an annual basis to Ofgem, on a scale between monthly to annual. The data year for REGOS runs from April-March, all data for the year must be submitted by the end of June as suppliers use the certificates for their Fuel Mix Disclosure on 1 July.[21] Biomass users must report certain characteristics of the biomass used every month.[22]	There are arrangements to ensure a unit of renewable electricity cannot be sold/counted twice in two jurisdictions. All EU Member States are required to have such a scheme and there are requirements to enable trading of UK REGOs with European Guarantees of Origin (GoOs). Ofgem is currently reviewing these arrangements.[23]
Renewables Obligation (RO) **[Closed to new applications]**	This was/is a policy to support low carbon generators. All eligible technology types were/are zero carbon generators other than those which use biomass. As such the only reporting requirements which are explicitly linked to carbon are on assets which use biomass.	Amount of renewable electricity generated. Reported on a monthly basis to Ofgem (or annual for generators smaller than 50 kW). Biomass users must report certain characteristics of the biomass used every month.[24]	Under some circumstances (i.e. meter failure) estimated data is used, created from a pre-agreed method. There are biodiversity and sustainability requirements for biomass.
Feed-in-Tariff (FiT) **[Closed to new applications]**		Once registered the asset owners receive FiT payments quarterly (at least). Payments are made based on the meter reading submitted to the energy supplier. Suppliers send the data on the	There are biodiversity and sustainability requirements for biomass.

[21] https://www.ofgem.gov.uk/sites/default/files/docs/2018/11/rego_guidance_note_0.pdf

[22] https://www.ofgem.gov.uk/publications/renewables-obligation-sustainability-criteria

[23] https://www.ofgem.gov.uk/environmental-and-social-schemes/renewable-energy-guarantees-origin-rego

[24] https://www.ofgem.gov.uk/publications/renewables-obligation-sustainability-criteria

		volume of electricity generated to Ofgem.[25, 26] Biomass users must report certain characteristics of the biomass used every quarter.[27]	
Contracts for Difference (CfD) **[Ongoing]**		The greenhouse gas emissions from the Generator's biofuel must be reported each month and annually.[28]	There are biodiversity and sustainability requirements for biomass.
Capacity Market (CM) **[Ongoing]**	As of 2020 there are carbon emission limits for assets to receive Capacity Market contracts. All prequalification applicants must submit a Fossil Fuel Emissions Declaration, which includes the carbon intensity of generation and potentially evidence of previous annual carbon emissions. Asset operators commit, as part of the application process, to comply with the carbon emissions limits.	If assets are called on to meet their CM obligations, assets must submit meter readings to the CM Settlement Body.	-
Emissions Performance Standard (EPS) **[Ongoing]**	The EPS is an emissions limit for electricity generators, stating they must not emit more emissions than a plant operating at 450 gCO_2/kWh at baseload (85% load factor for the year). Only fossil fuel generators (and those using gasified fuels) are	Operators of fossil fuel plants are required to report their annual carbon emissions to the Regulator no later than 3 months after the end of the relevant reporting year.	Operators are required to monitor their plants carbon emissions in accordance with the methodology in the Monitoring and Reporting Regulation for the EU ETS

[25] https://www.ofgem.gov.uk/environmental-and-social-schemes/feed-tariffs-fit

[26] https://www.ofgem.gov.uk/publications/feed-tariffs-guidance-licensed-electricity-suppliers

[27] https://www.ofgem.gov.uk/sites/default/files/docs/2018/06/sustainability_and_feedstock_guidance_version_2.pdf

[28] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/486212/Blackline_-_CfD_Standard_Terms_and_Conditions_-_comparison_against_versi....pdf

	obligated to prove compliance.[29]		
UK (or EU) ETS **[Ongoing]**	The UK ETS is a cap-and-trade carbon pricing mechanism. It requires data on the carbon emissions of eligible assets to function.		-

8.2. Example Approaches

8.2.1. EnergyTag

EnergyTag is a voluntary initiative established in 2020 by industry and NGOs to define and build a framework for hourly or sub-hourly energy certificates. The initiative intends to harness consumer demand through Energy Attribute Certificates (EAC) to accelerate the transition to zero carbon energy. The initiative asserts that to achieve this, EACs need to be updated as they do not currently reflect the varying value of low carbon electricity being provided in different time periods.

EnergyTag looks to create a set of principles for these new EACs so that they will work within the current arrangements. To do this, the initiative is looking at the minimum changes needed within the current arrangements to enable a voluntary market.

In *EnergyTag and Granular Energy Certificates*[30], EnergyTag laid out initial principles for trading more time granular EACs. Figure 2 is a pictorial representation of some of these initial principles.

[29] https://www.legislation.gov.uk/uksi/2015/933/regulation/3/made

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

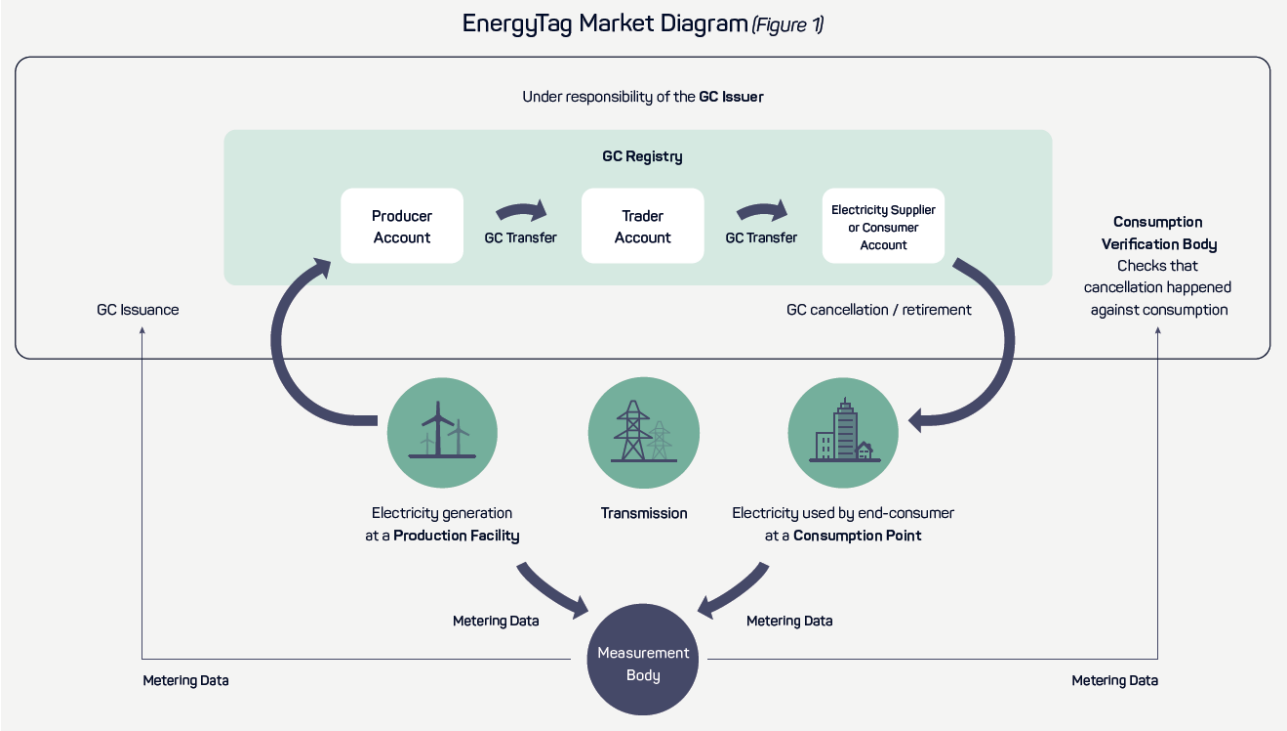

Figure 2 EnergyTag Market Diagram.[31]

The initiative is working through two methods:

Working Groups

These are an opportunity for experts to come together and deliver the projects aims. There are four workgroups:

1. Workgroup 1 – Making hourly certificates available as a robust instrument
2. Workgroup 2 – Use cases for hourly certificates (e.g. carbon accounting)
3. Workgroup 3 – Discussion forum for demonstrator project participants
4. Workgroup 4 – Raising awareness and policy

Demonstrator Projects

There are a number of projects globally that will trial the different approaches outlined by the initiative and feedback key learnings. There are at least six demonstrator projects that commenced in 2021 and will run until 2022.

8.2.2. Carbon Trust

Carbon Trust often work with organisations to verify the carbon footprint of their products and services. This can result in being awarded a 'Carbon Neutral' label or 'Lower CO_2' label (meaning it has a reduced carbon footprint than the market standard) to place on their product. This increased visibility of emissions enables companies to work more intelligently to reduce their emissions. They have conducted this process for a number of organisations including Quorn, Evian, and Bentley.

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

They also work with organisations to set science-based targets, create strategies for reducing emissions, and monitor ongoing progress.

Carbon Trust applies their 'Product Carbon Footprint Protocol', which delivers clear requirements and guidance for organisations seeking to measure and reduce their product's emissions, and is provided in two parts:

1. Sets the minimum requirements for footprint certification.
2. Establishes requirements for communication and labelling.

For this example, we will focus on Part 1 of the protocol, which is organised by Carbon Trust into three sections:

1. **Defining products** - The data gathered and the meaning of footprint results critically depend upon defining the product. Existing standards in this area are vague, either using a simple definition such as "any goods or service" or not directly addressing the question at all.
2. **Data requirements** - A critical element of a footprint calculation, management and communication programme is defining necessary and sufficient data. Too much detail may be expensive and difficult to manage, too little may limit the usefulness of the process.
3. **Calculating reductions** - A central aim of this Protocol is to define how to achieve measurable footprint reduction.

For data requirements, setting the boundary of the footprint is key:

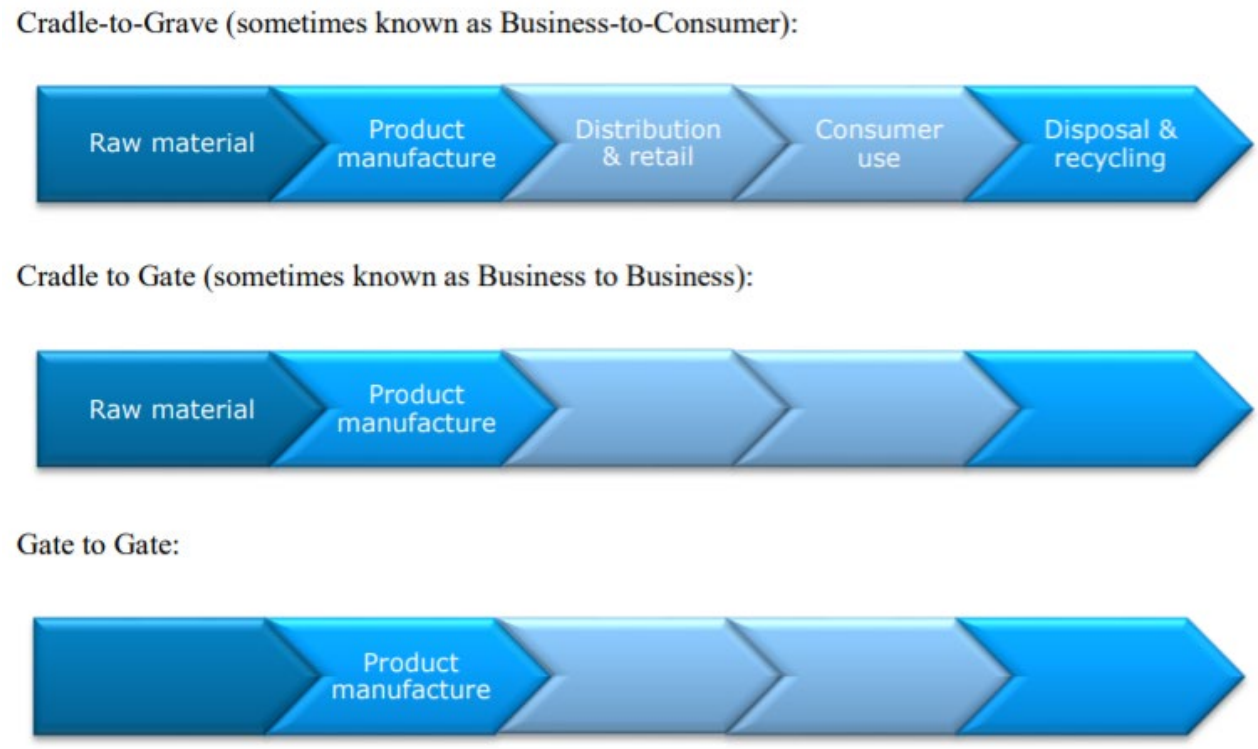

Figure 3 Summary of footprint boundary options.[32]

[32] https://prod-drupal-files.storage.googleapis.com/documents/resource/public/product-carbon-footprint-certification-part-1.pdf

Carbon Trust assess the emissions data using the international standards, including the GHG Protocol Product Standards PAS 2050 and ISO 14067. A key part of this process is gathering data on the activities within the agreed boundary (as discussed above). Where data is not available the operation can be modelled to estimate emissions. This process is undertaken in line with key guiding principles and processes. Through this, Carbon Trust is able to track, as well as estimate, carbon resulting from the manufacturing of a product or delivery of a service.

Glossary of Terms

Carbon Policy
Carbon policy is a shorthand term for all policies that require or incentivise action to reduce or remove greenhouse gas emissions, including pricing, regulation, subsidies, and standards. These can be combined with complementary policies, such as innovation support and access to finance, to form policy packages.

Carbon Standard
The term 'carbon standard' is used to encompass any regulation, standard, or policy mandate on an economic actor (e.g. a business or a household) to meet a decarbonisation requirement or metric. Examples include product or performance standards, regulatory targets, regulated obligations, or market rules.

Net Zero
Net zero requires elimination of all greenhouse gas emissions wherever feasible, with any remaining sources offset by the removal of carbon dioxide from the atmosphere.

Residual Demand
Residual demand is the remaining demand to be served in the scheduling interval that cannot be met by available renewable generation, also commonly referred to as 'net demand'.

Energy Systems Catapult supports innovators in unleashing opportunities from the transition to a clean, intelligent energy system.

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