Guard Global Centre of Excellence…Powered by Hedera Hashgraph

Hedera 20 Hackathon

Energy Sector Real-time Trading Support and Reporting Platform using DragonGlass API and Real-time Subscription Services

June 2020

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1. Introduction and Executive Summary

The Guard Global Centre of Excellence … Powered by Hedera Hashgraph, is delighted to submit a design and development project to the Hedera 20 Hackathon. We have worked with the DragonGlass team to design and develop an Energy Sector Trading Support and Reporting system based on the Hedera Consensus Services along with the DragonGlass API and Subscription Services.

The design of the Dapps submitted for Hedera 20 are specifically targeted at a live renewable energy project in the heart of London: The London Southbank Energy Project which is backed by the UK Government though Innovate UK.

The intent of the design of the Dapps is to develop iterative looping feeds of information among supply chain participants in the energy sector. Participants will produce feeds of information to the Hedera network using HCS and then retrieve the information using the DragonGlass API and Subscription Services. Once information is received the participants will add value to the information and then republish the enriched information for other participants. The information is linked to energy tokens produced from renewable generation and will track the energy from production through to transmission, storage, trading, and consumption.

The current functionality of the Dapps only supports rudimentary AI and Optimization Algorithms needed to enrich the information during the iterative producer-consumer loops. However, provision has been made for participants to add this in with ease using a library of Energy Sector Dapps customizable to meet user's needs. The principal group contributing to the AI and Optimization Algorithms for information enrichment will be the Energy Sector Academic DLT Working Group which consists of universities, leading research in the field of distributed smart energy supply networks. The current project use case aims to respond to the following customer need:

The Customer's Needs:

The commercial energy customer in our use case currently pays well over half a million pounds per annum in energy bills. They are tied to a fixed rate contract which allows them extraordinarily little flexibility to take advantage of fluctuating market prices. The contract is due for renewal in 6 months.

Our Proposed Solution:

By installing renewable energy generation and storage equipment at their facilities and connecting it to a high-speed DLT Energy Management System they will be able to optimize energy generation and consumption throughout the day and across seasons. The result will be a more balanced and harmonious relationship with the national grid as well as expected reductions in energy bills in the region of 40-50% per annum. The ROI for these types of energy management systems is typically anticipated to be about 3 years. Additionally, by lowering their operational carbon footprint the business stands to gain further benefits.

For Social Good

Each one of the Energy Tokens we create from renewable sources carries a Renewable Energy Guarantees of Origin (REGO) Certificate. The Token has a premium value and incentivizes producers and consumers to migrate to clean energy.

Every REGO Certified Energy Token also carries an Interval Carbon Value. This can be directly traded or eventually auctioned on the Carbon Auction Platform we plan to develop on DragonGlass.

Migrating to the Power Transition Energy Management Platform powered by Hedera Hashgraph will help communities and organization drastically reduce their greenhouse gas emissions.

Realizing the Future of Energy:

The functionality, tools, performance as well as strategic direction of Hedera Hashgraph is ideally suited to develop Mission Critical Applications on an Enterprise Grade DLT Platform across the Energy Sector. The energy sector is rapidly going through a self-redefinition phase, which has been galvanized by the Covid-19 pandemic and subsequent lockdown of people in their homes and the shutdown of many businesses across the world. Society has realized how dependent they are on reliable energy and digital communication. A high-performing, secure, trusted and decentralized energy and communication model is needed for the global economy to function sustainably under normal circumstances and then seamlessly continue when governments are forced to implement a 'Plan-B' during the outbreak of another global pandemic.

2. Project Consortium in the London Southbank Energy Project

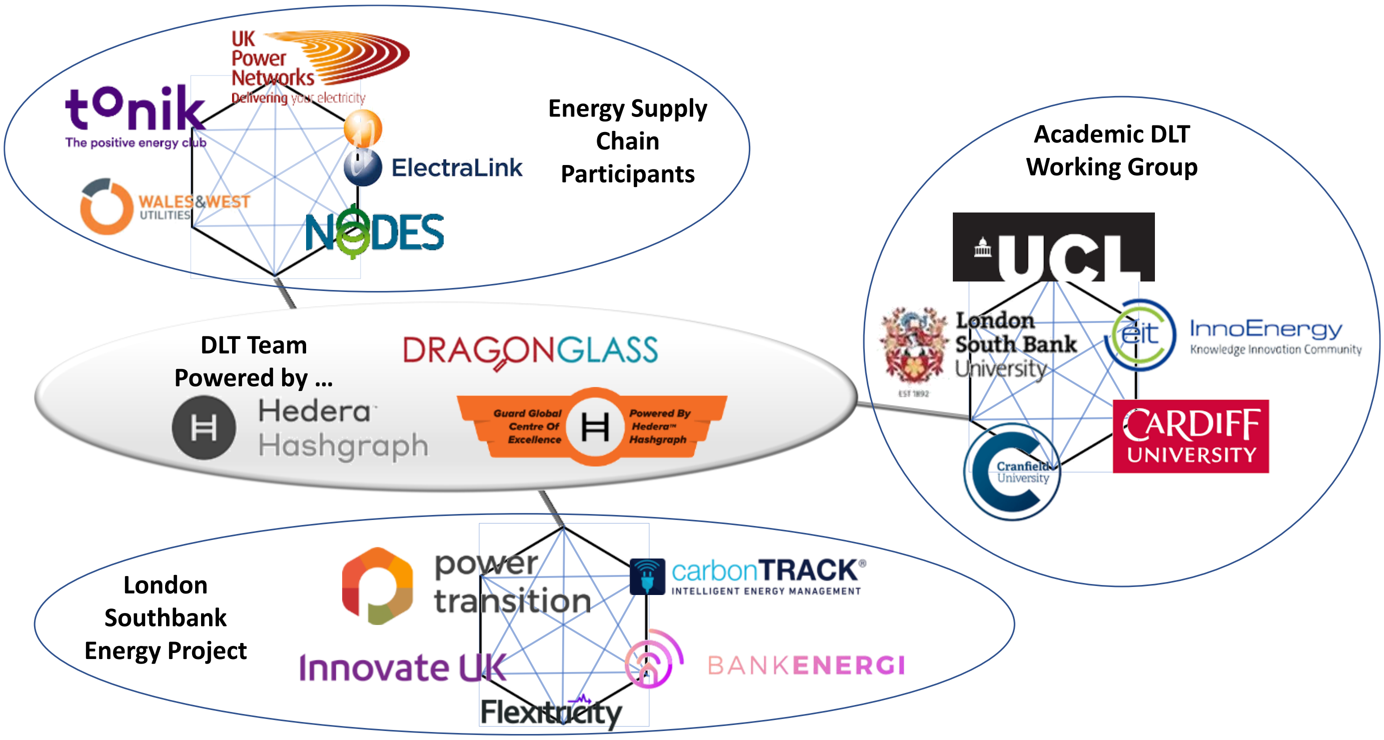

Figure 1: London Southbank Energy Project

2.1. Energy Supply Chain Participants

- **UK Power Networks:** Principal District Network Operator for London area
- **Wales & West Utilities :** Utilities Infrastructure providers
- **Tonik Energy:** Energy wholesalers/suppliers
- **Nodes Markets:** Decentralized energy flex-market trading
- **ElectraLink:** Energy Market and Data Services

2.2. London Southbank Energy Project

- **Power Transition:** Lead integrators and Energy Sector DLT consultants
- **BankEnergi:** London Southbank Energy Project Management

- **Innovate UK:** UK Government project backers
- **CarbonTrack:** Smart Energy Management System hardware suppliers
- **Flexitricity**: GDPR data privacy and regulatory compliance

2.3. DLT Team … Powered by Hedera

- **Guard Global Center of Excellence …Powered by Hedera:** Project Dapp designers, developers, and contributors to Hedera 20 and Energy Sector Academic DLT Working Group
- **DragonGlass**: DragonGlass API and Subscription Services providers and collaborators with Guard Global Center of Excellence
- **Hedera Hashgraph**: Hedera SDK with HCS extensions, portable Solidity Smart Contracts and MirrorNets

2.4. Academic DLT Working Group

- **UCL, University College London:** Hedera Governing Council Member and leaders of Global Observatory on Peer-to-Peer
- **Cardiff University:** Microgrid and Multi-Vector Energy Systems leader
- **Cranfield University:** Modelling, analysis, and optimization of integrated smart energy supply networks research lead
- **EIT InnoEnergy:** Hedera and smart energy infrastructure consortium with Vattenfall
- **London South Bank University:** London Southbank Energy Project host

3. Plans with the Energy Sector Academic DLT Working Group

Power Transition (Guard Global Centre of Excellence) along with the Hedera Team have organized an Energy Sector DLT Working Group. This is a growing academic working group consisting of key universities researching energy and technology.

Power Transition plans to release and support the Energy Sector Trading Support and Reporting Code for the universities on GitHub. Specifically, we plan to work with UCL and DragonGlass to create a Hedera based business modelling platform. One of the project Use Cases will be the London Southbank project, part funded by the UK government to develop business cases for Energy Trading and Grid-Renewable Energy Balancing. We eventually plan to extend this into a carbon trading and auctioning platform.

The universities will build optimization models for buying, selling, storing, and trading energy, taking into consideration the complex regulations that are currently in place, but are rapidly evolving. The London Southbank project hopes to use these models and test them for commercial viability.

4. Approach to Design

To develop the Hedera 20 Dapps we took sample historical data from a DER (Distributed Energy Resource – large commercial scale Prosumers) site that Power Transition is working with and created a working model of the site with respect to how it interacts with other supply chain stakeholders: DNO (District Network Operator), Boundary Point Supplier, the Energy wholesaler and the Route to Market Provider.

The original energy pricing data is generated by the DNO (District Network Operator), Boundary Point Supplier, the Energy wholesaler, and the Route to Market Provider. They will publish the data as Topics to HCS as Energy Data Feeds (Topics). The DER will tap into all this feed data using the DragonGlass Subscription Services in real-time. The DER will then decide the best course of action to take according to built-in algorithms for the subsequent 30-minutes e.g. buy from grid, sell to grid, use or charge battery storage etc. The action taken will produce a transaction with calculations performed from the data feed information. The result will then be published as a Topic via HCS. All participating stakeholders can then monitor these reports to further optimize grid performance and balancing.

Currently the large commercial site simply pays a standard flat rate for electricity to keep payments simple. As a result, they are paying in the region of £650,000 p.a. in energy bills. By adding solar panels and wind-wall technology as well as battery storage and then optimizing use via the DLT Energy Management system powered by Hedera Hashgraph, the site could cut energy bill by 40-50%, presenting an ROI of 2-3 years. We will work with the Academic Energy Sector Working Group to produce optimization algorithms and predictive models.

4.1. Tokenization

All the energy produced by the DER via solar and wind power is tokenized by the kWh and tracked throughout their life cycles from production, storage, transmission, and storage. The status of each can be tracked on DragonGlass.

Additionally, for large quantities traded, smart contracts can be used. All buy/sell smart contracts are tracked on DragonGlass. All qualifying energy tokens contain a REGO (Renewable Energy) Certification per OFGEM specification, which adds more tradable value.

4.2. Data for the System (Simulation data for Hedera 20 Hackathon)

Historical Energy data for the project was taken from the test site and the public domain. The data is provided in 30-minute intervals from 2019. For the purposes of the hackathon demonstration the dates were altered to their 2020-year counterparts. The data is then produced to Hedera network via HCS to coincide with each 30-minute interval. We have constructed simulators for the data that each stakeholder produces. The simulator data resides in local databases. When the final production system is implemented at the Southbank London and other projects, the simulators will be replaced by Power Transition's Open Integration Bus, which includes Dapp-to-hardware APIs

4.3. Information Producer/Consumer Architecture

- The Data Producers transfer information to the Hedera DLT as feeds (Topics) using Consensus Services (HCS)
- The information is then retrieved as reports using the DragonGlass API and Subscription Services. Subscriptions are controlled on a stakeholder role basis
- Once subscription information is retrieved this data can be used for analytics, optimization, billing and system control and command
- DragonGlass API is used to specify and view date and times ranges of historical information for reporting purposes
- DragonGlass Subscription Services is used to view information in real-time and will be used for trading and energy/carbon auction purposes
- Definition of Participants in the Figure 2 below:
  - **DER**: Distributed Energy Resources: the principal stakeholder/commercial energy prosumer for the London Southbank Energy Project

- **DSO:** District Service Operator or District Network Operator, UK Power Networks (UKPN) and Wales & West Utilities
- **Boundary Point Supplier / Route to Market Provider**: Supplier/Energy Wholesaler: Tonik Energy, Flex-market trader: Nodes Markets and Market Data Services: ElectraLink

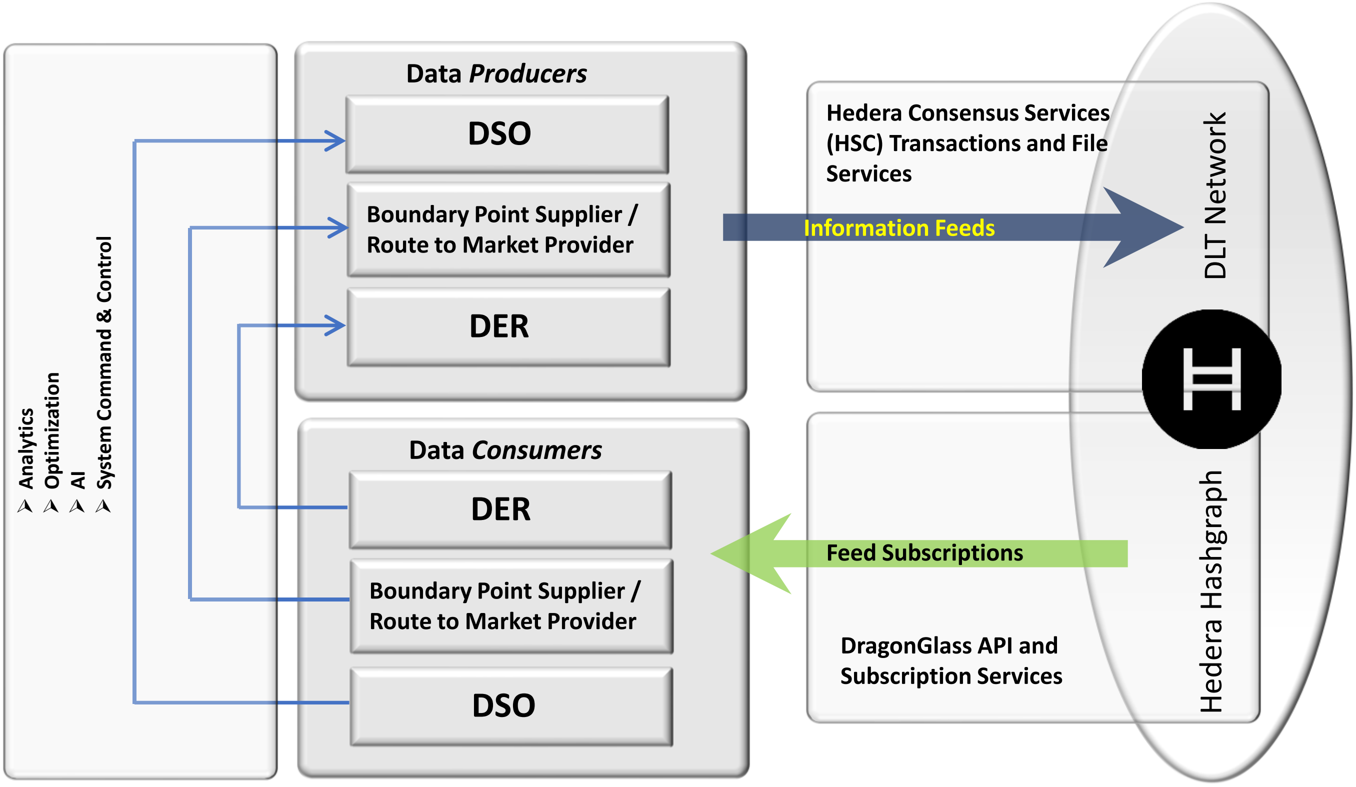

Figure 2. Information Producer/Consumer Architecture

5. High-level Data Model and Information Flow

The initial data model is for a single DER connecting to single DSO and Supplier, exchanging information, reporting and with the possibility of building in command and control of hardware behavior. This model has vertical and horizontal scalability with respect to the quantity of transaction processes and number of customers/supply chain participants involved.

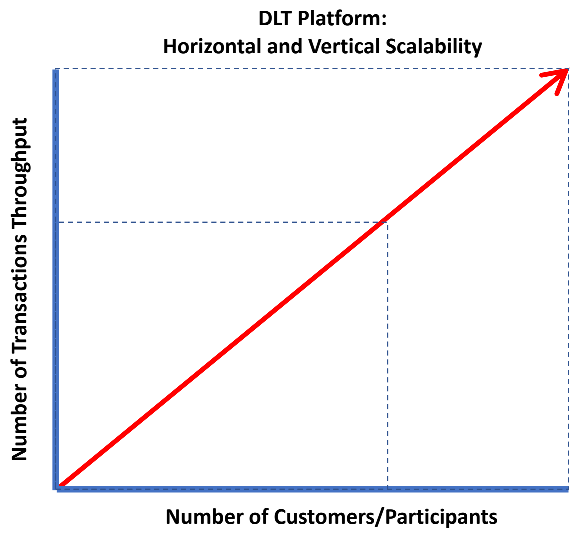

Figure 3 Vertical and Horizontal Scalability

The user community consisting of DERs, DSOs and Boundary Point Suppliers and/or Route to market Providers are able to 'Subscribe' to the various feeds of data provided on the Hedera DLT network. Users are able access the various feeds of data according to their profiles, having role-based access to the information. The feeds operate in real-time and thus levels of granularity of the data can be varied over time as market demand evolves.

Figure 4 shows the high-level data model of the data-feeds produced by the participants.

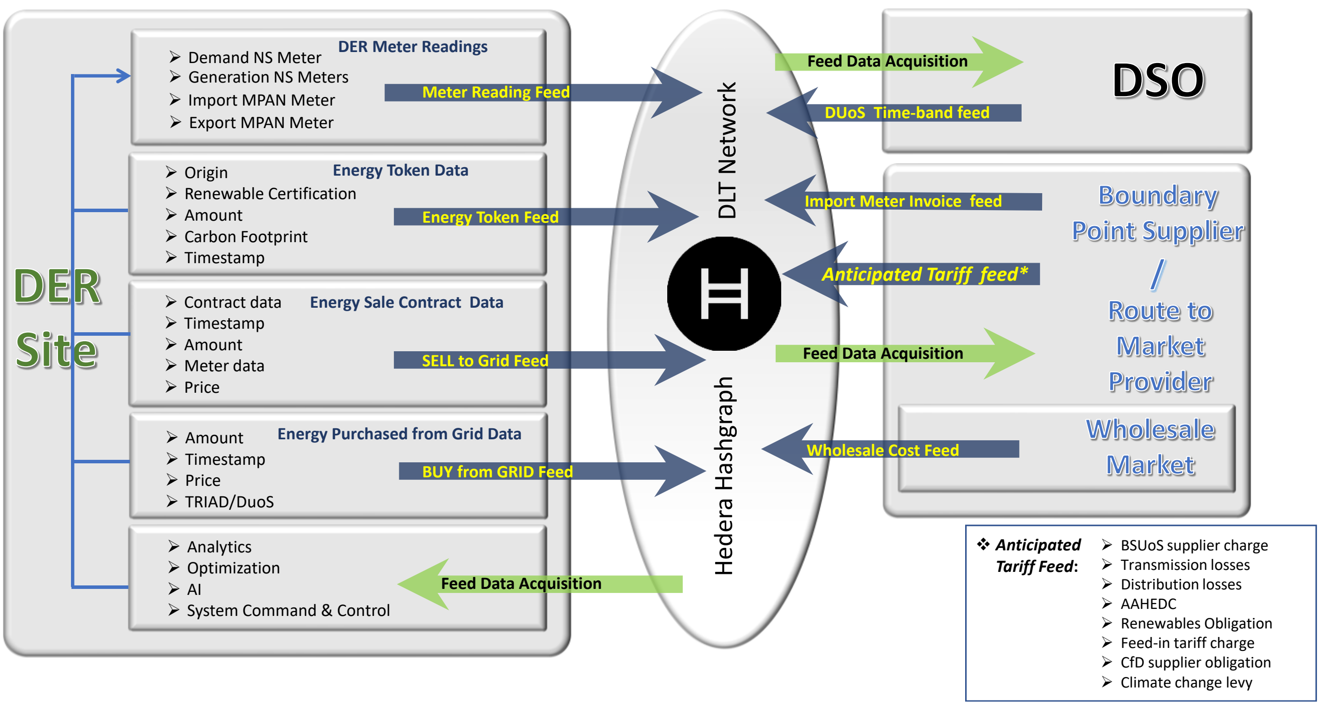

Figure 4

Figure 5 shows a list of the data fields for each feed:

DSO (Feed)
Date / Timestamp
DUoS
TUoS

Boundary Point Supplier / Route to market provider/Wholesale (Feed)
Date / Timestamp
Capacity market supplier charge
BSUoS - supplier charge
Transmission losses
Distribution losses
AAHEDC
Renewables Obligation
Feed-in tariff charge
CfD supplier obligation
Climate change levy
Wholesale Cost

- Summary of Data Producer Feeds: Upload every 30 mins onto Hedera Network vis HCS
- The feed data can also be read from Hedera network via Dragonglass API (Date Range) or Subscription Services (Real-time update window)

DER (Registration Feed)	DER Buy Report	DER (Energy Token Feed)	DER (Carbon Value Feed)	Sell Contract History (Smart Contract)
Date / Timestamp	Date	Contract ID	Date	Contract ID
Company Name	Time (half-hour starting)	Producer ID Token	Time (half-hour starting)	Contract Type
Company Registered No.	Wholesale cost	Buyer ID Token	Generation Meter Reading	SELL Energy Amount kWh
Postal Address	Capacity market supplier charge	Energy Token ID	kWh Generation	Contract Start Time/Date
Postal Code	TNUoS	Contract Type	Demand Meter Reading	Contract Fulfilment Time/Date
Contact Name	DUoS	Amount	kWh Demand	SELL Price £
Email Address	BSUoS - supplier charge	Transmission Adjustment	Supply Meter Reading	Service Charge £
Telephone No.	Transmission losses	Sale Price	kWh Supply	Final Price £
MPAN Meter model (Export)	Distribution losses	Service Charge	Carbon Factor	Export Meter Reading (Start)
MPAN Meter Serial Number (Import)	AAHEDC	Revenue	Interval kgCO2e	Export Meter Reading (Fulfilment)
MPAN Meter (Export) installation date	Renewables Obligation	Contract Start Time/Date	Interval Carbon Value (£/T)	Token Details
MPAN Meter model (Import)	Feed-in tariff charge	Contract Fulfilment Time/Date	Accumulated Carbon Value (£/T)	
MPAN Meter Serial Number (Import)	CfD supplier obligation	Meter Reading (Outgoing) at Start		
MPAN Meter (Import) installation date	Climate change levy	Meter Reading (Outgoing) at Fulfilment		
	Total cost			

Figure 5

Figure 6 shows the flow of information among the energy supply chain participants with the feed producers using HCS (Topics) to publish data to Hedera and DragonGlass API and Subscription Services to consume it:

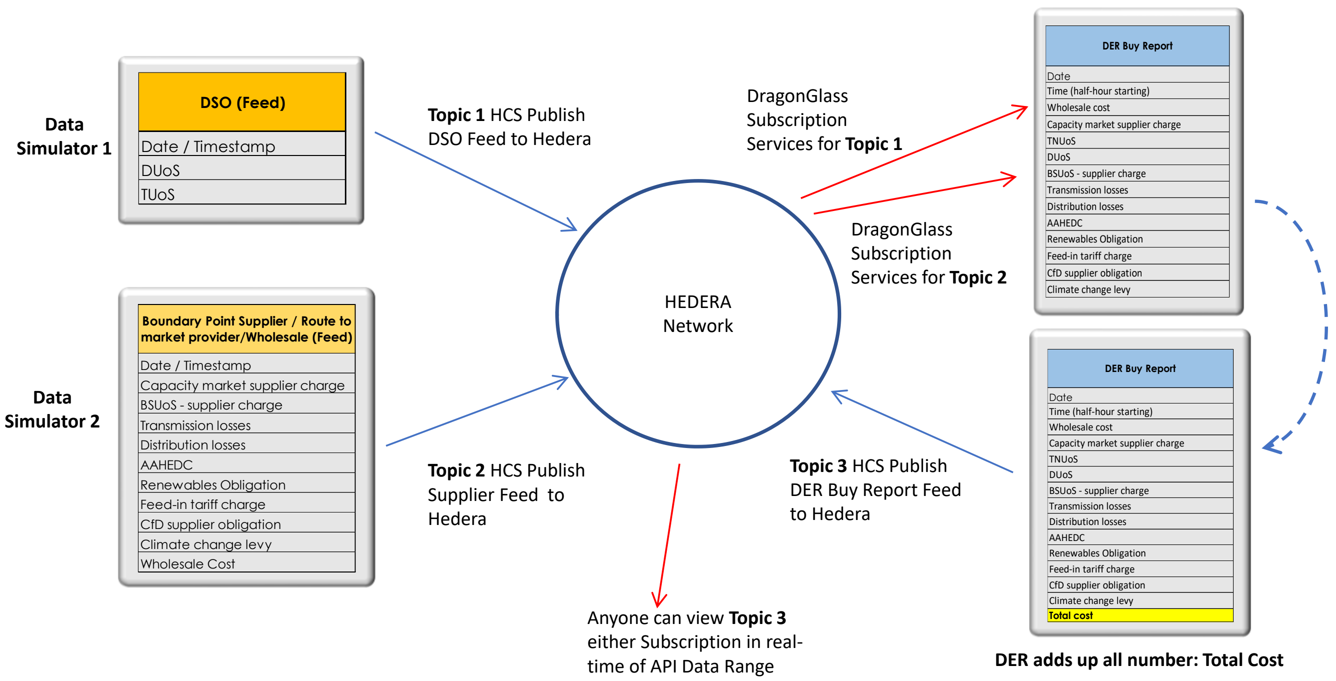

Figure 6

6. Carbon Reporting

Interval carbon values are calculated and tagged to each energy token. These energy tokens will carry a REGO Green Energy Certification along with meter readings, provenance information, quality specifications etc. All of these quantifiable measures of an energy token add value during its life cycle. Currently we are the only platform that can provide trusted REGO Certifications at the kWh unit. This is a premium product and can be sold directly to customers and traded as carbon offsets.

In a subsequent phase we plan to customize the DragonGlass Auction Platform Dapps and use it to model a Carbon Trading Platform. With it we hope to eventually create a purely market-driven carbon pricing and trading mechanism to disrupt current approaches such as government dictated emissions trading systems and carbon taxes.

The Guard Global Centre of Excellence has developed hardware drivers which are able to communicate with metering instrumentation then enables us to calculate energy token carbon emissions in a simple but effective way.

Figure 7 shows the meter set-up for Carbon Value Generation/Grid Purchase. The carbon emissions are simply calculated by subtracting the purchased energy from the overall site demand and factoring in the Carbon Factor provided by the energy regulator, OFGEM.

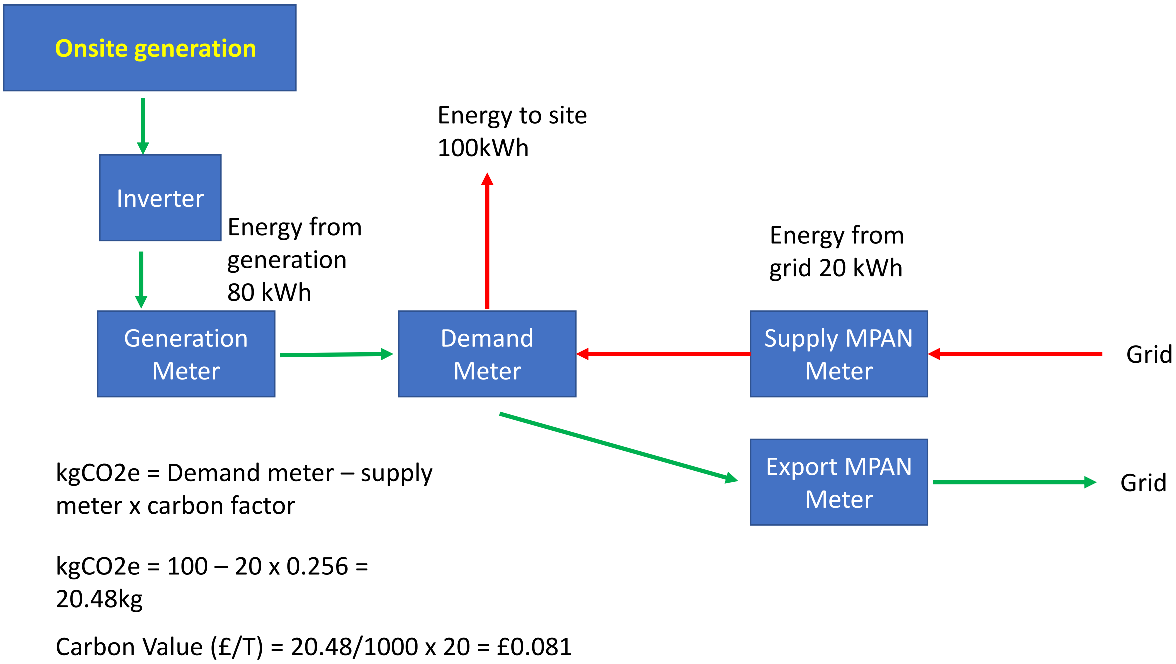

Figure 7 Carbon Value Measurements and Calculations

Carbon Value Generation/Grid Purchase

Date	Time (half-hour starting)	Generation Meter Reading	kWh Generation	Demand Meter Reading	kWh Demand	Supply Meter Reading	kWh Supply	Carbon Factor	Interval kgCO2e	Interval Carbon Value (£/T)	Accumulated Carbon Value (£/T)
20/05/2020	00:30:00	123606	150	827751	257	883999	250	0.256	193.000	3.860	3.860
20/05/2020	01:00:00	123756	150	828008	257	884249	250	0.256	193.000	3.860	7.720
20/05/2020	01:30:00	123906	150	828265	257	884499	250	0.256	193.000	3.860	11.580
20/05/2020	02:00:00	124056	150	828522	257	884749	250	0.256	193.000	3.860	15.440
20/05/2020	02:30:00	124206	150	828779	257	884999	250	0.256	193.000	3.860	19.300
20/05/2020	03:00:00	124356	150	829036	257	885249	250	0.256	193.000	3.860	23.160
20/05/2020	03:30:00	124456	100	829286	250	885449	200	0.256	198.800	3.976	27.136
20/05/2020	04:00:00	124556	100	829536	250	885649	200	0.256	198.800	3.976	31.112
20/05/2020	04:30:00	124656	100	829786	250	885849	200	0.256	198.800	3.976	35.088
20/05/2020	05:00:00	124756	100	830036	250	886049	200	0.256	198.800	3.976	39.064
20/05/2020	05:30:00	124856	100	830286	250	886249	200	0.256	198.800	3.976	43.040
20/05/2020	06:00:00	124956	100	830536	250	886449	200	0.256	198.800	3.976	47.016
20/05/2020	06:30:00	125056	100	830636	100	886450	1	0.256	99.744	1.995	49.011
20/05/2020	07:00:00	125156	100	830736	100	886451	1	0.256	99.744	1.995	51.006
20/05/2020	07:30:00	125256	100	830836	100	886452	1	0.256	99.744	1.995	53.001
20/05/2020	08:00:00	125356	100	830936	100	886453	1	0.256	99.744	1.995	54.996
20/05/2020	08:30:00	125456	100	831036	100	886454	1	0.256	99.744	1.995	56.990
20/05/2020	09:00:00	125556	100	831136	100	886455	1	0.256	99.744	1.995	58.985
20/05/2020	09:30:00	125756	200	831236	100	886605	150	0.256	61.600	1.232	60.217
20/05/2020	10:00:00	125956	200	831336	100	886755	150	0.256	61.600	1.232	61.449
20/05/2020	10:30:00	126156	200	831436	100	886905	150	0.256	61.600	1.232	62.681

View Cumulative Graph | Close

Figure 8 Carbon Value Generation/Grid Purchase

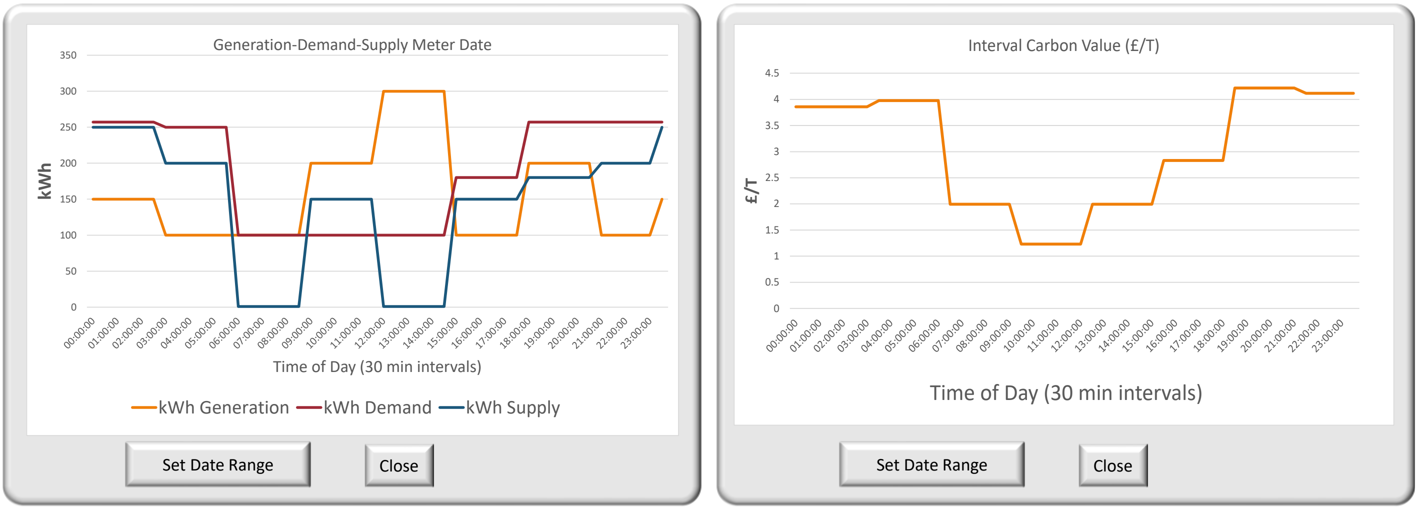

Figure 9 Graphical representations of Energy Usage and Carbon Value Generation

Appendix

Code repository

GitHub:

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Guard Global Centre of Excellence, Hedera 20 Hackathon Team

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- **Senior developer: Prabhu Anbalagan**
- **QA, Test, Configuration, Documentation : Ponsu Lingam**