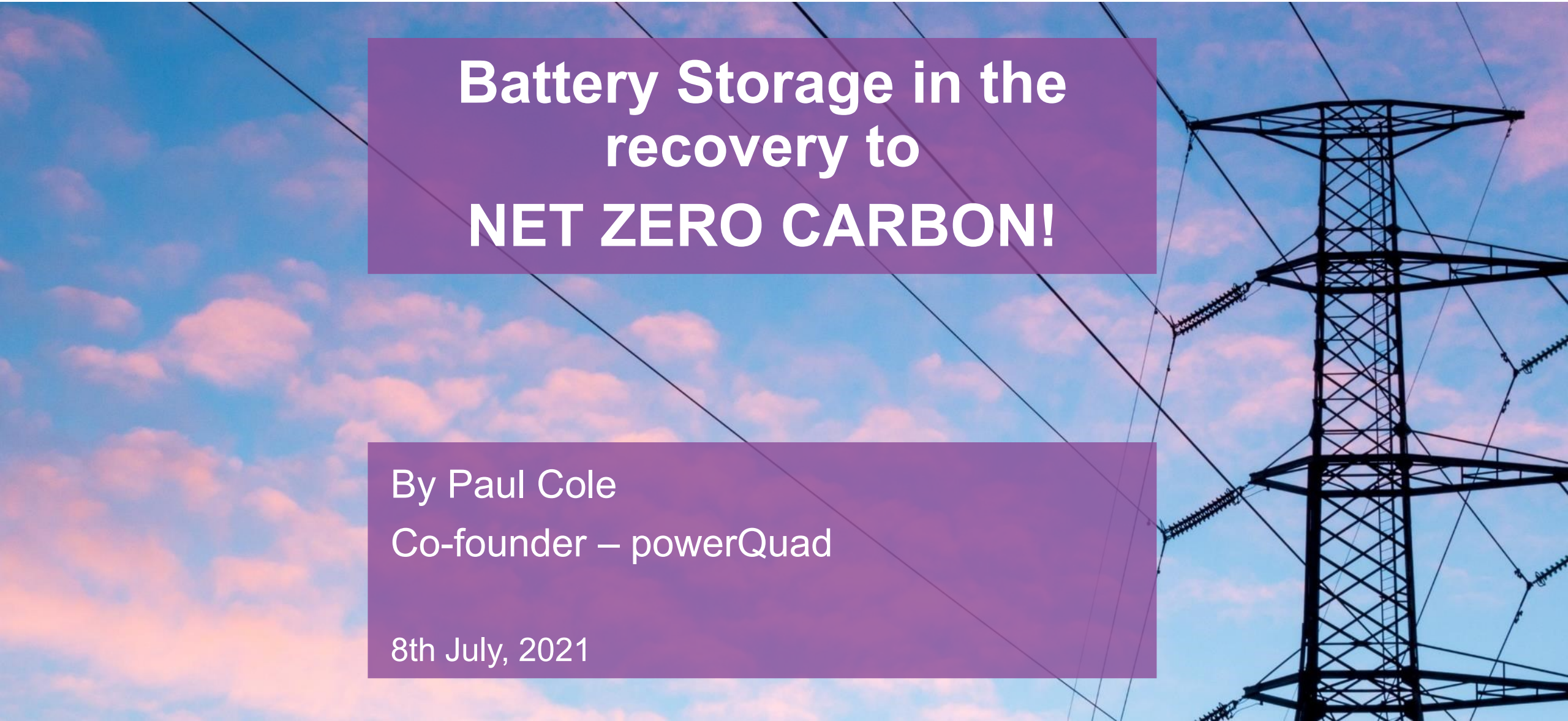
The Institution of Engineering and Technology

IET Berkshire Local Network

https://theiet.org/berkshire



Battery Storage in the recovery to NET ZERO CARBON!

By Paul Cole

Co-founder – powerQuad

8th July, 2021

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Battery Storage in the recover to
NET ZERO CARBON!

Paul Cole
BEng CEng MIET MIoD CMgr MCMI
Co-Founder

15 years in engineering, 14 in power industry.

Directors for 9 years driving businesses, product design, and innovation to international markets.

Who are powerQuad?

Our vision is to bring renewable energy to everyone, helping decarbonise our working world.

We're heavily focused on product sustainability, data, integration and automation. So users can make the most of their energy, maximise cost & carbon savings and get the most of stored energy autonomously.

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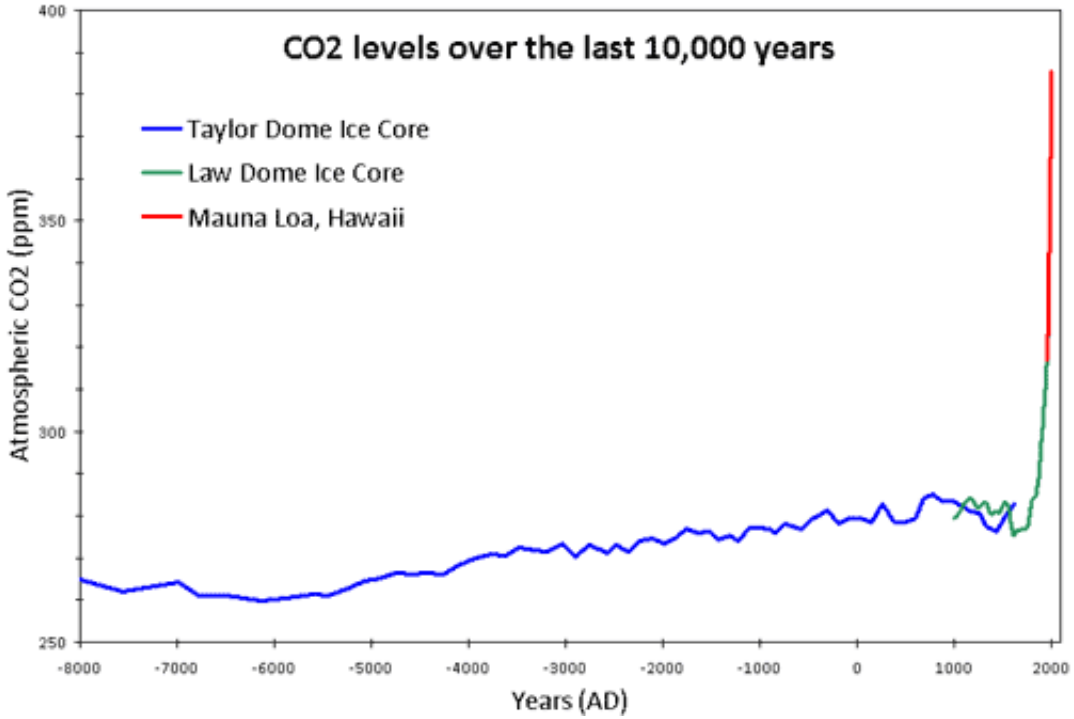
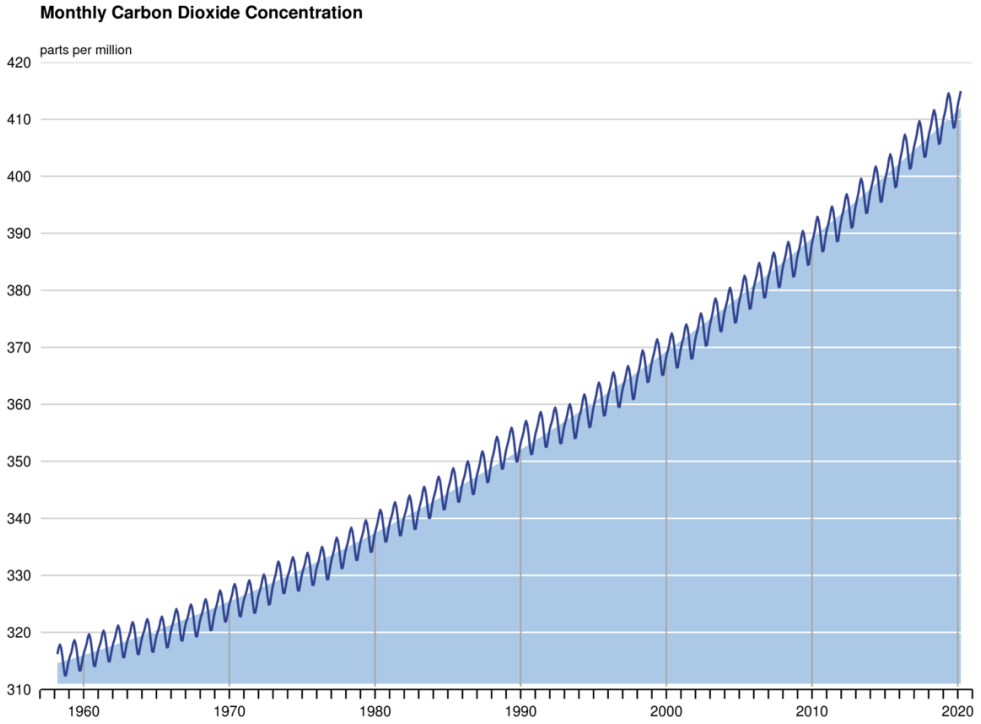
Battery Storage in the recovery to NET ZERO CARBON

Todays Presentation

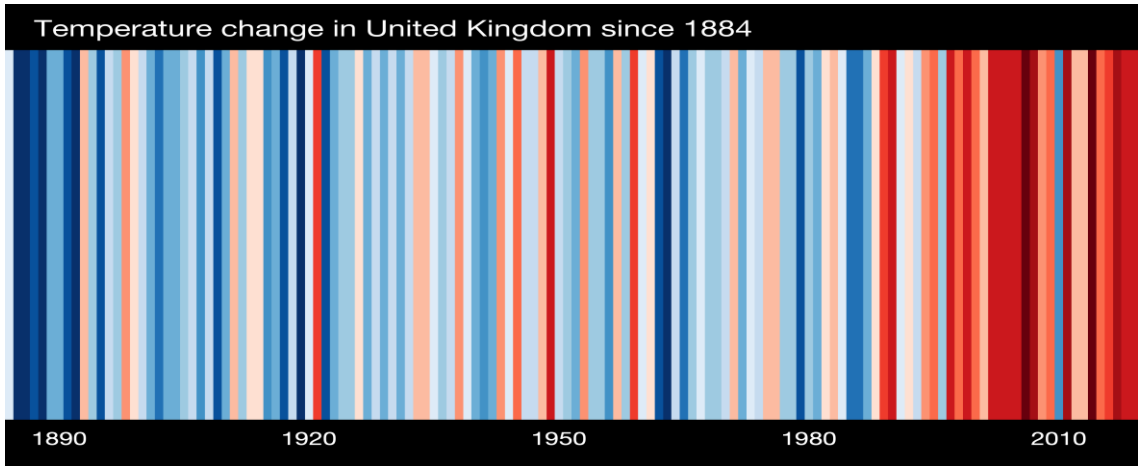
- The need to decarbonise and covid-19 impact.
- The basic and the Battery Energy Storage System
- The Data inputs, $CO_{2,}$ cost, demand & consumption.
- AI & Machine Learning
- Blockchain
- Case Study
- Questions

Why Cut Carbon?

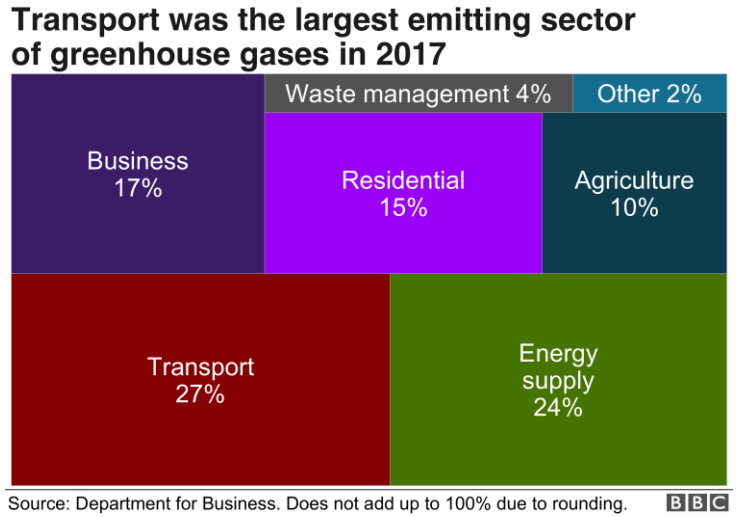




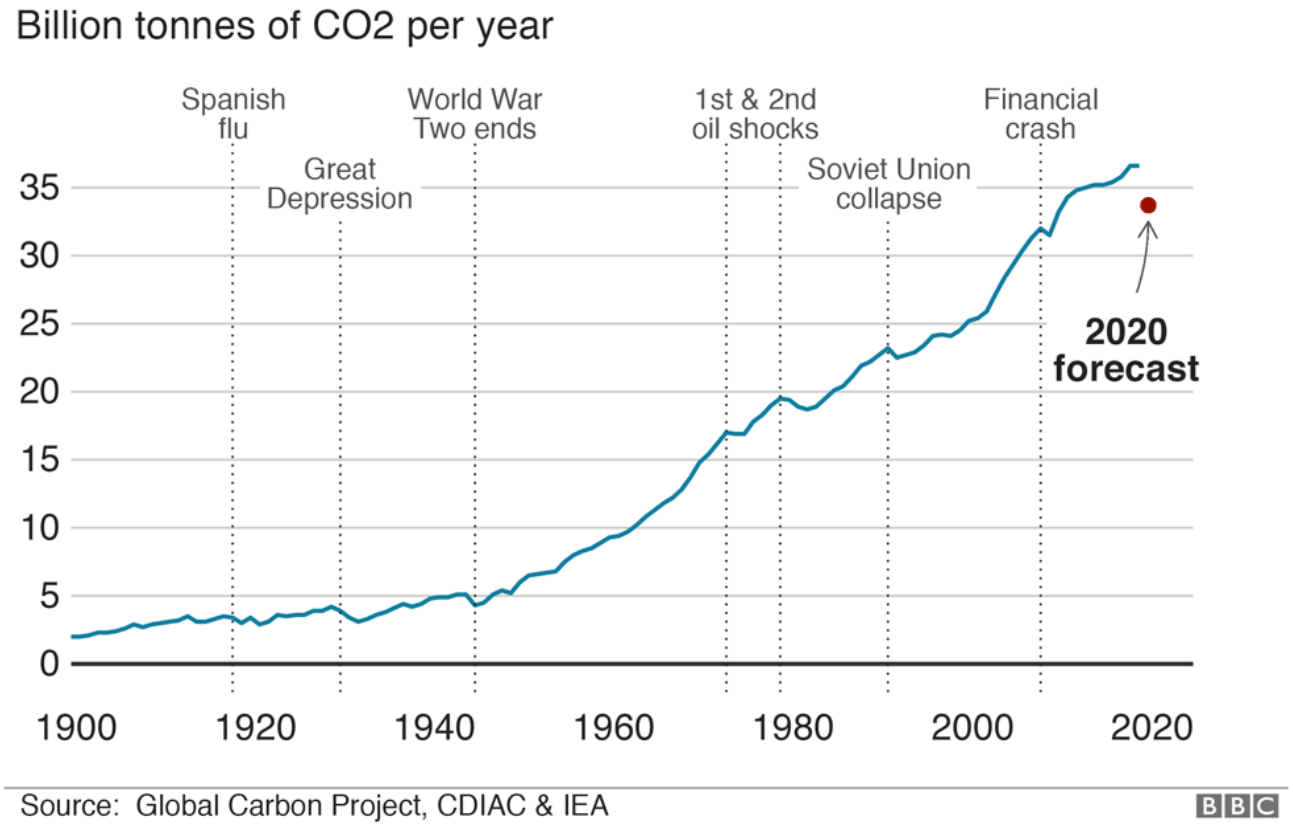
From Mauna Loa Observatory. Data from Scripps CO2 Program

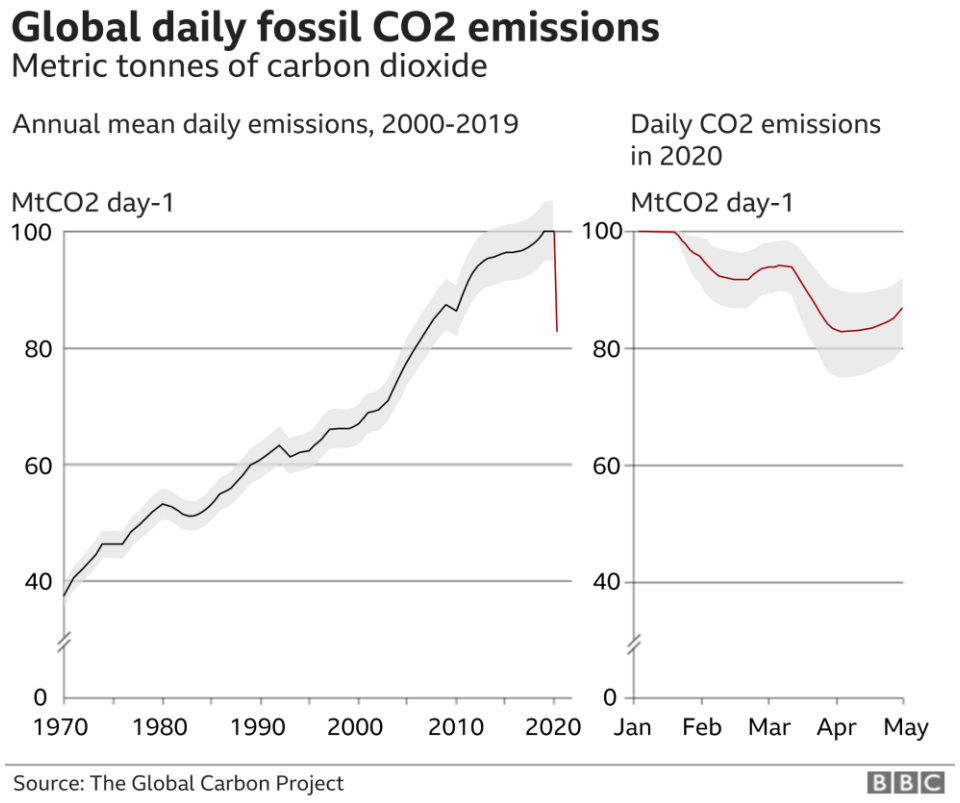


Credit: Ed Hawkins University of Reading



Covid-19 Impact





In the UK first half of 2020 ~25% drop (predicted) in CO2 emissions occurred with a ~20% drop in GDP.
[2020 UK greenhouse gas emissions, provisional figures (publishing.service.gov.uk)]

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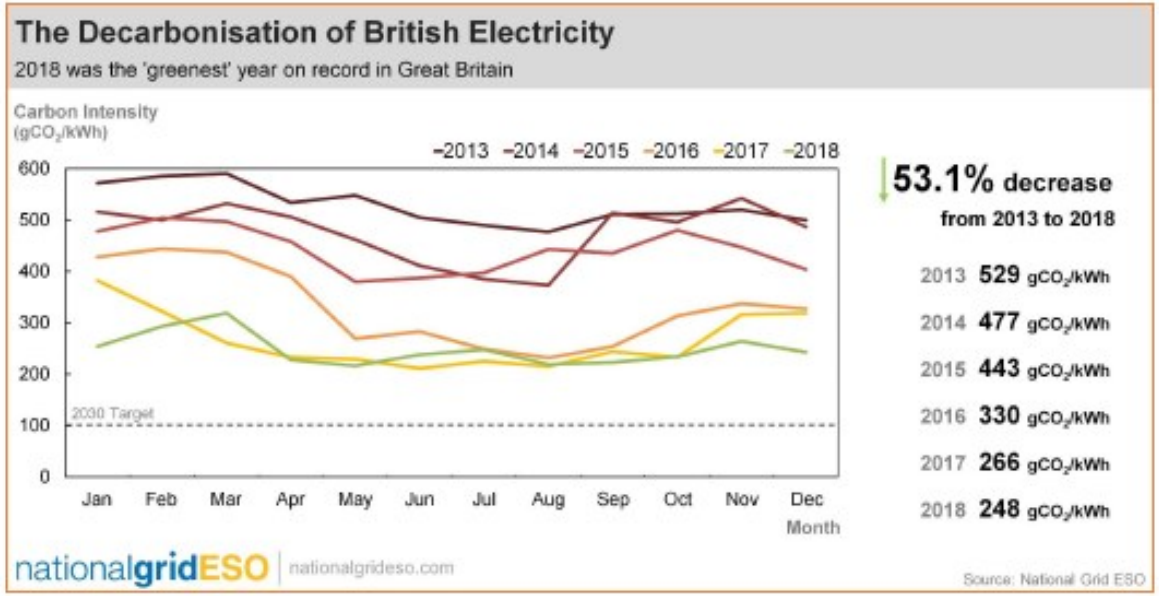
The Drive to Zero Carbon

- **Decarbonisation**
- **Decentralisation**
- **Digitalisation**



-Decarbonisation: Removal of carbon-based fuels for electricity generation

-Decentralisation: large centralised power stations --> localised power production connected to Distribution network

-Digitalisation: Provide energy insight and to effective management & monitoring of the generation, transmission and distribution of the electricity

Basic Battery System

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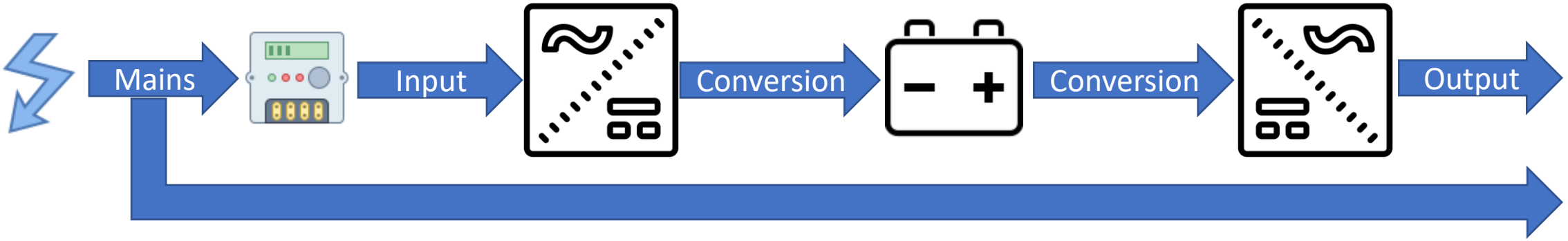
A basic system consists of:

- Input power.
- Conversion for charging.
- Storage device, the ‘battery’
- Conversion for outputs.
- Switches to outputs.

‘Battery’

- Lead Acid/Li-ion
- Fly wheel (Kinetic)
- Hydrogen
- Chemical – Redox
- Thermal
- Pressure

“The UPS”



Complex Battery System

More sustainable, more efficient, and more resilient.

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Import and export

Solar Input

Wind Input

Grid Carbon &
Local Carbon

Time of Use tariffs

Consumption times:
Demand prediction
Price offset
CO2 offset

Generation prediction:
Solar
Wind
Grid carbon
Grid / local excess

Battery Cell life

Temperature variances

Powercuts

Mobility

Multi storage systems
on site

Behind the meter
In-Front of the meter

kWh
kW
kWpk
Charge
Capacity
DoD
Degradation
Rate of power flow

Community Energy

Complex ‘Battery’ System

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Cloud Data
Grid CO_2
Weather data
Grid demand
Grid price

Battery Control
Temperature
Charge Rate
Discharge Rate
Cell balance

Battery type?

User Control
CO_2
Price
Resilience
NOW!

Solar

Wind

Mains

Input

Conversion

Conversion

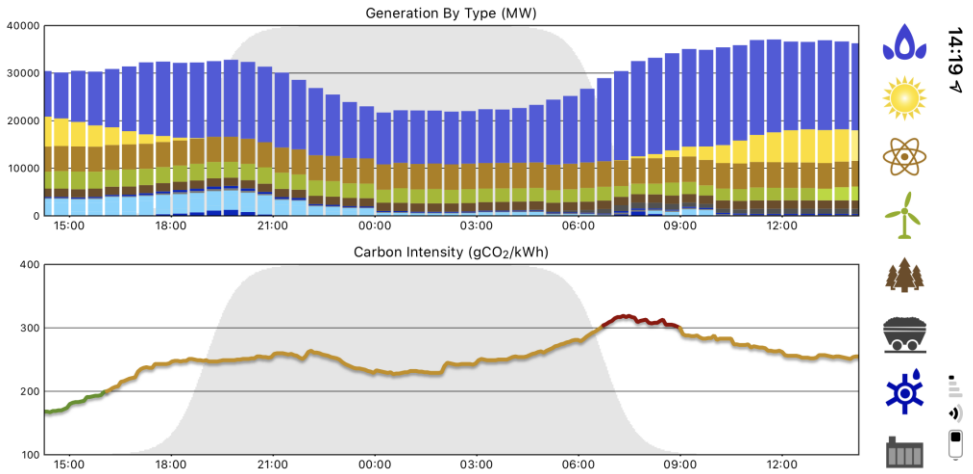
Output

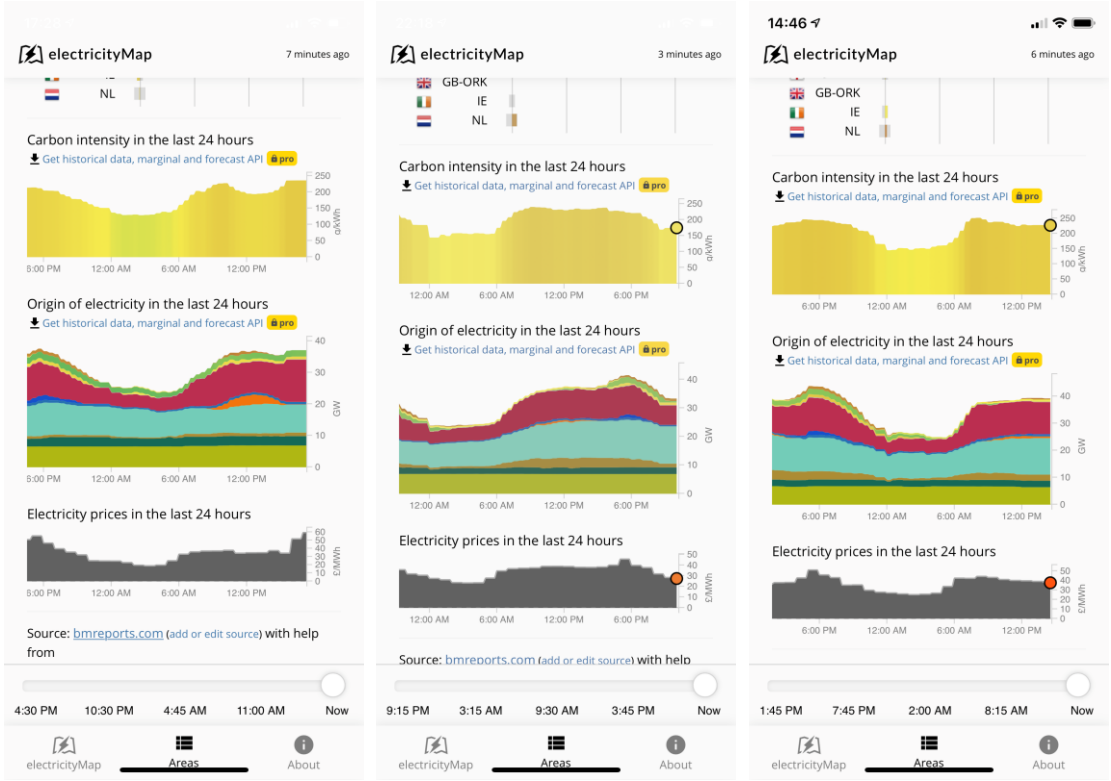
Export/Bypass

Site Data
Type
Size
Usage

Demand Profile Data
EV’s
Heating

Data: Energy CO_2 vs Price





Strong correlation between energy price and low carbon Energy.

Low Carbon = Low Price

Date	29/12/2019	02/01/2020	07/01/2020	Average
Lowest CO_2	3AM 129g/kWh 19.03 £/MWh	2AM 149g/kWh 23.83 £/MWh	2AM 147g/kWh 25.37 £/MWh	141g/kWh for about 4 hours
Highest CO_2	6PM 240g/kWh 59.65 £/MWh	6PM 237g/kWh 48.12 £/MWh	5PM 244g/kWh 51.28 £/MWh	240g/kWh

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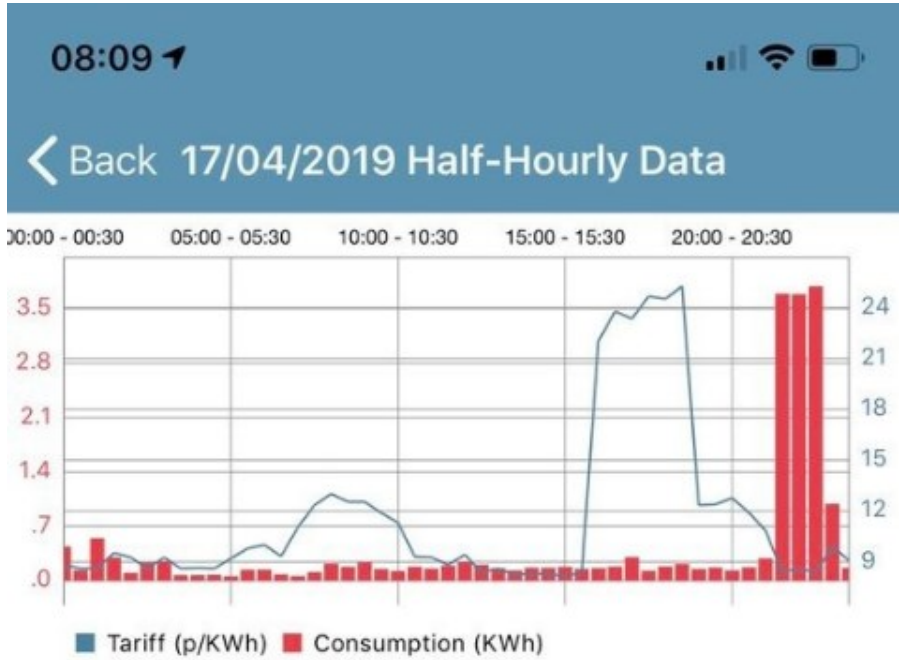
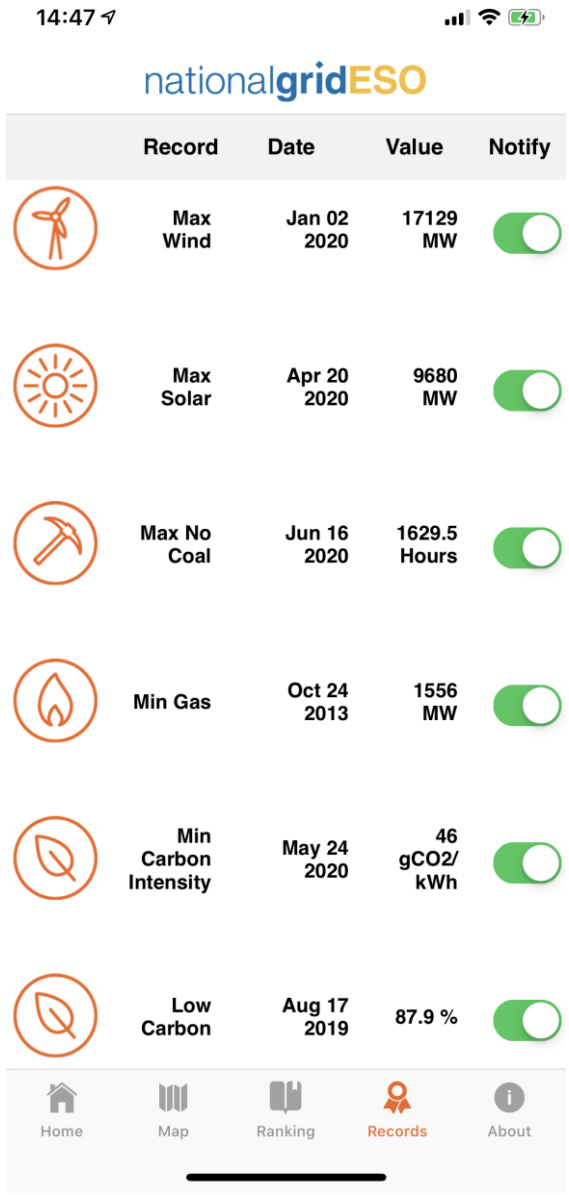
Data: Demand vs Price





- Increasing Low Carbon generation
- Smart Meters and the introduction of ‘time of use’ tariffs.
- Increasing EV charge demand, and electrical heating
- Grid Supporting Services.
- Homes & business wanting to go off grid

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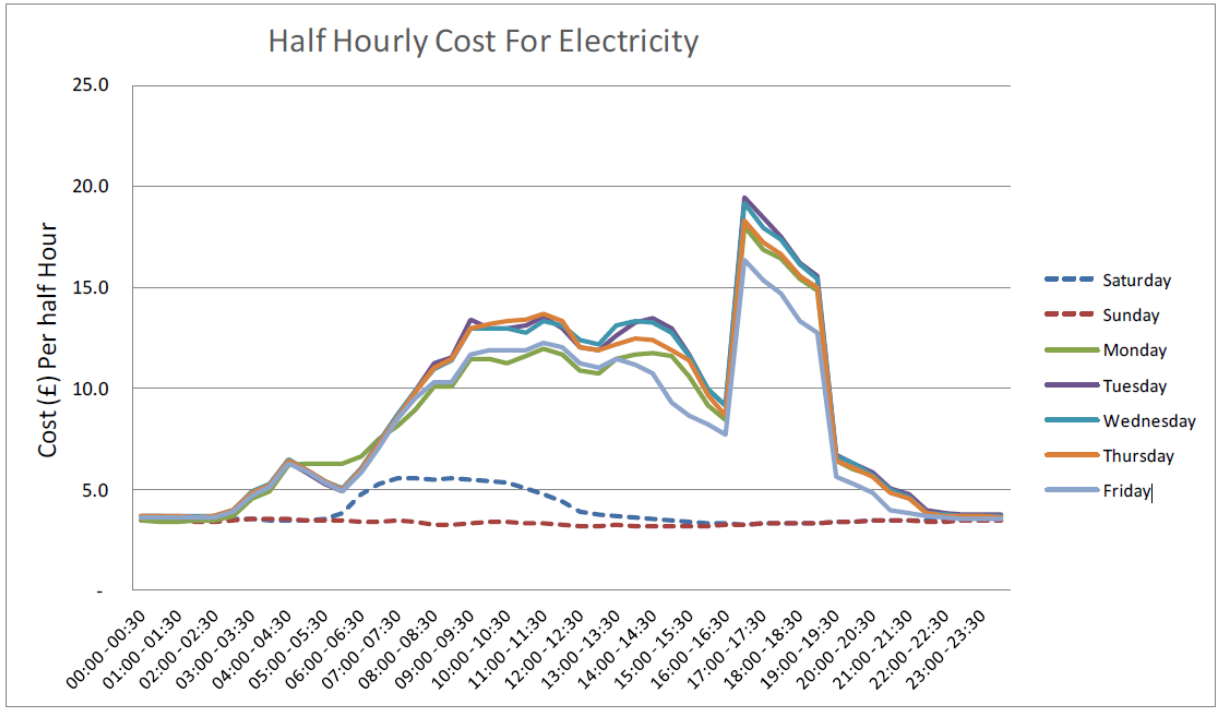
Business Energy DUoS and TUoS

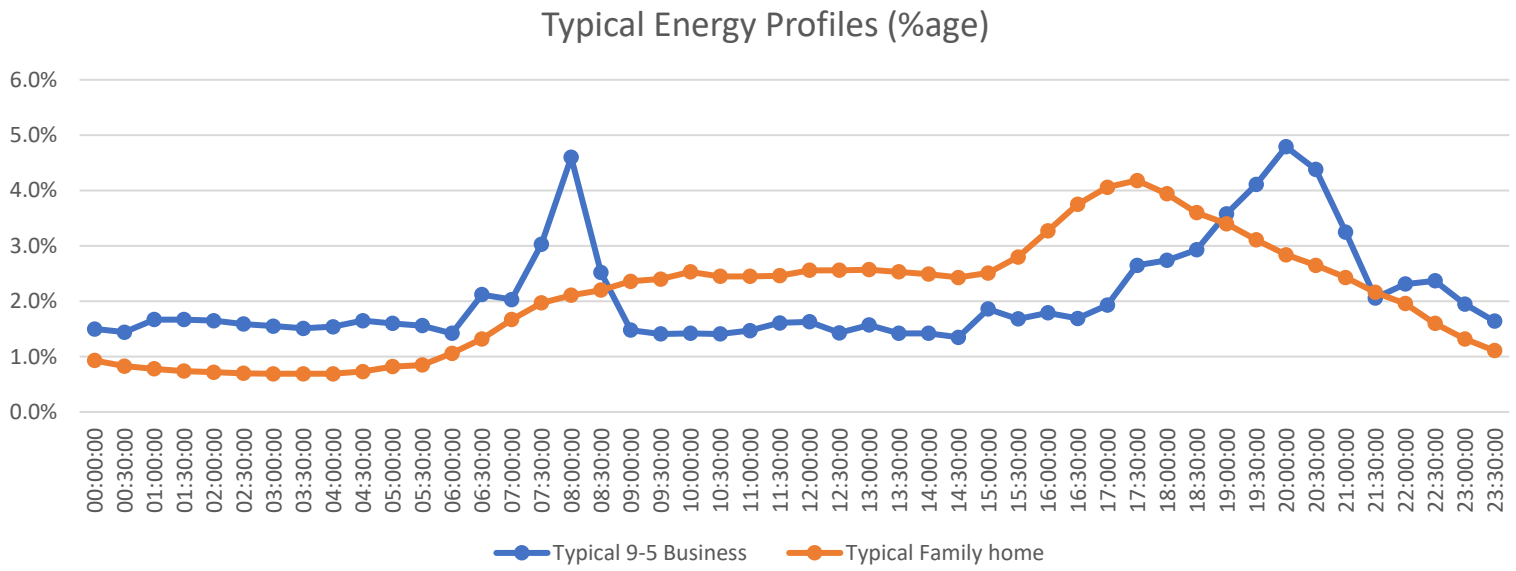
DUoS – Distribution Use of System charges are charges for used of the electrical system imposed by the District Network Operator.

TUoS – Transmission Network Use of System charges are charges imposed by the Transmission operator (National Grid) for the use of their system.

Time Bands for Half Hourly Metered Properties			
Time periods	**Red Time Band**	**Amber Time Band**	**Green Time Band**
Monday to Friday (Including Bank Holidays) All Year	16.30 - 19.30	08.00 - 16.30 19.30 - 22.30	00.00 - 08.00 22.30 - 00.00
Saturday and Sunday All Year		16.00 - 20.00	00.00 - 16.00 20.00 - 00.00
Notes	All the above times are in UK Clock time		



Data – Demand Consumption



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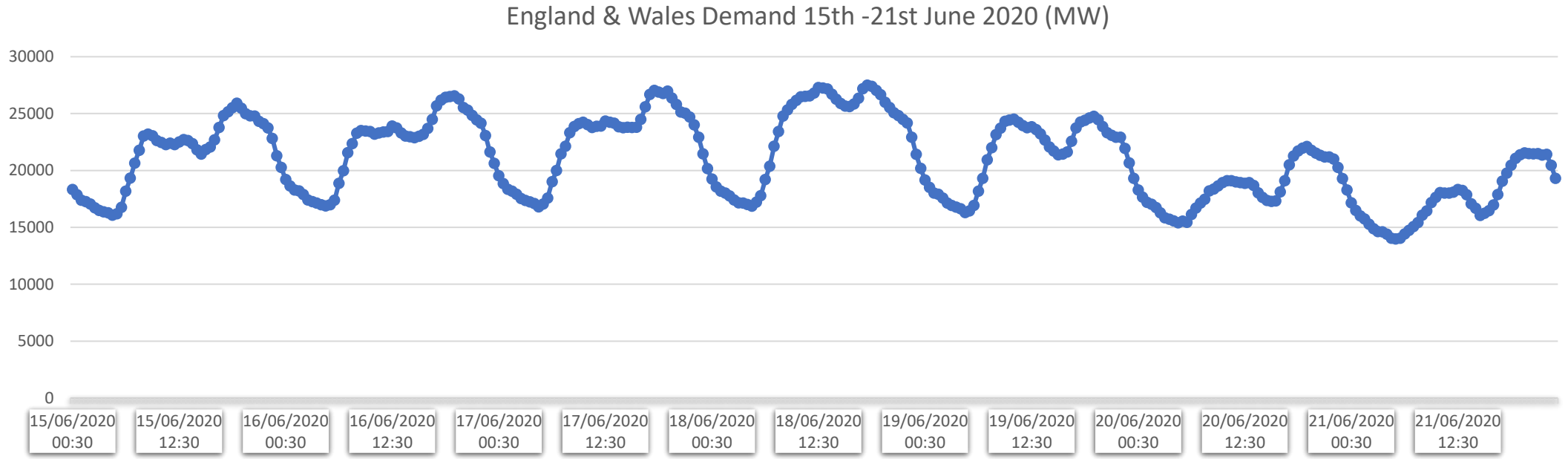

336 data points for 6 days.
Source: National Grid
30 minute intervals

Making Sense of all the data

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- There could be upwards of 80,000 datapoints for a single month.

- An average of 55 data inputs to a 30 minute decision.

Data points are growing all the time.

All data is processed to provide answers to set primary questions:

1) When to charge or discharge.
2) How long to charge and discharge for.

But, the data provides the opportunity to answer many more questions,

1) Which energy tariff is most suitable to saving money?
2) How 'noisy' is the mains electricity (in real time or historical)?
3) How do grid faults, (spikes and surges) ripple through the network?
4) What will the grid demand be at time 'x'
5) How much charge capacity if there for geographical area 'y'
6) If there is a powercut for maintenance, how long will backup power last for?
7) .....

Making Sense of all the data for businesses

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Businesses are beginning their drive to cut carbon from their operations.

Business needs differ. – Streamlined Energy and Carbon Reporting.

Regular review, and re-processing of data is used to determine a set criteria

What type of carbon saving technology to buy?

Heat Pumps?, Solar?, Battery Storage?, EV's and EV chargers?, Electrical heating?

How big does it need to be?

Just to cover the peaks? Just to provide a base load?

How long will the investment be of maximum use based on growth plans?

Will the business need to move site?

Will I need to completely change the tech soon?

AI (Artificial Intelligence) & Neural Networks

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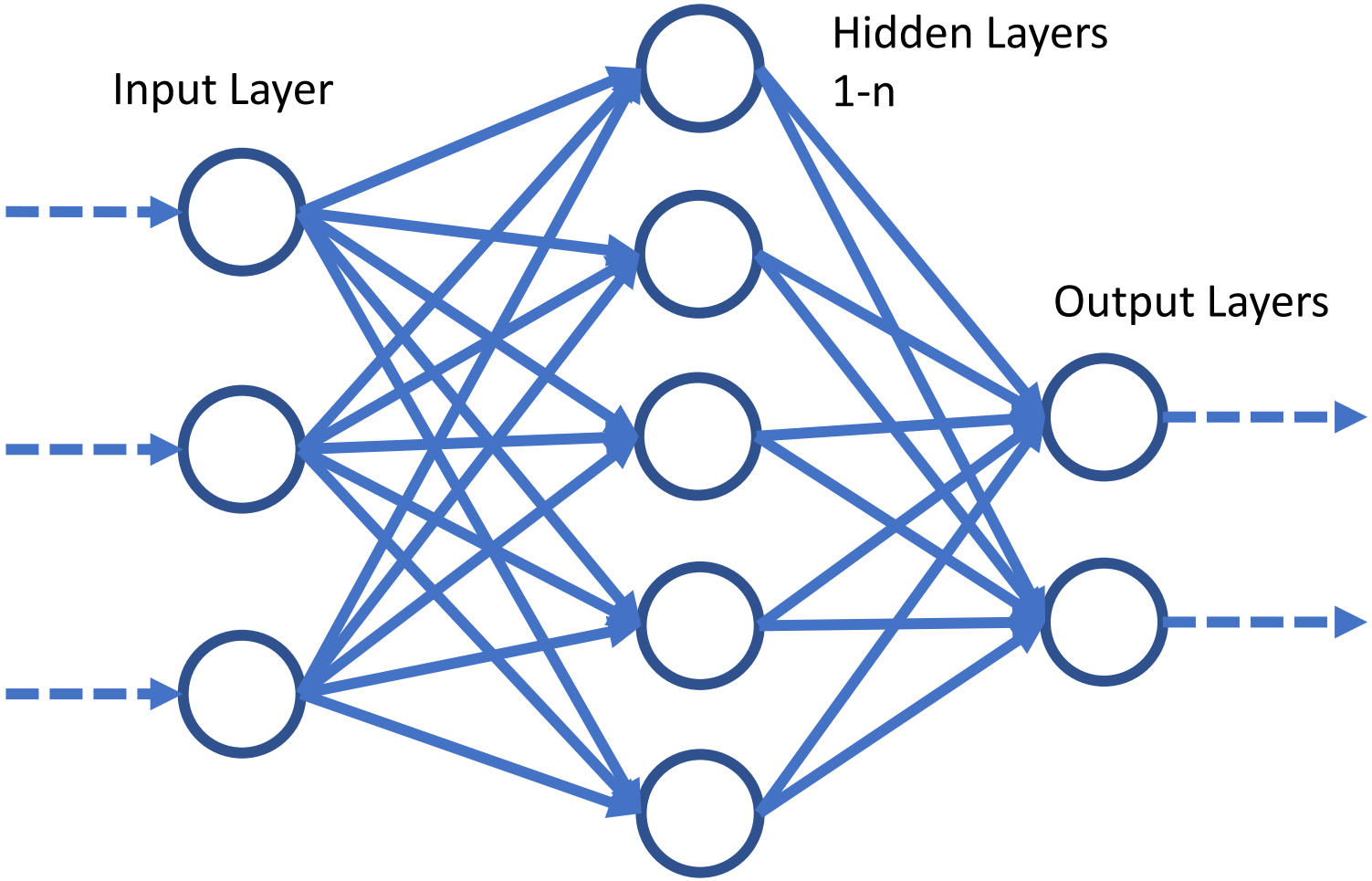
What is AI? What is machine learning?

AI is a computer that is able to think or act in a more human way by taking in data from its surroundings, and decides its response on what it learns and senses.



Machine learning is a form of AI that allows a computer to learn and re-learn from previous decisions and experiences.

Machine learning requires use of neural networks.

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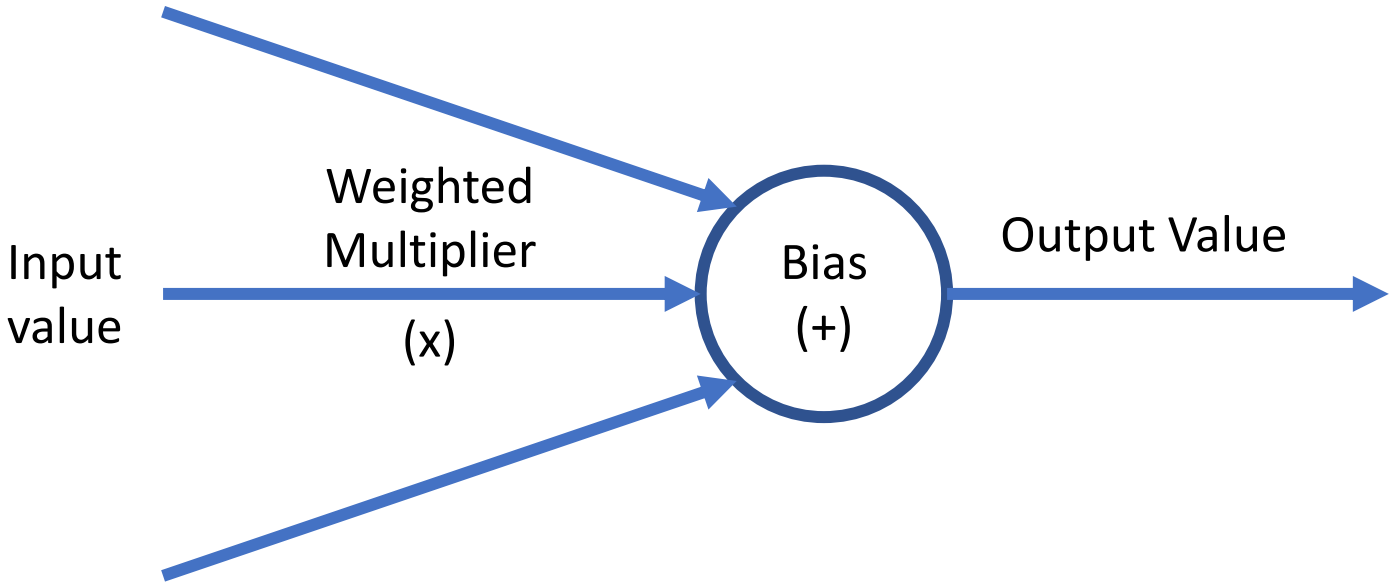

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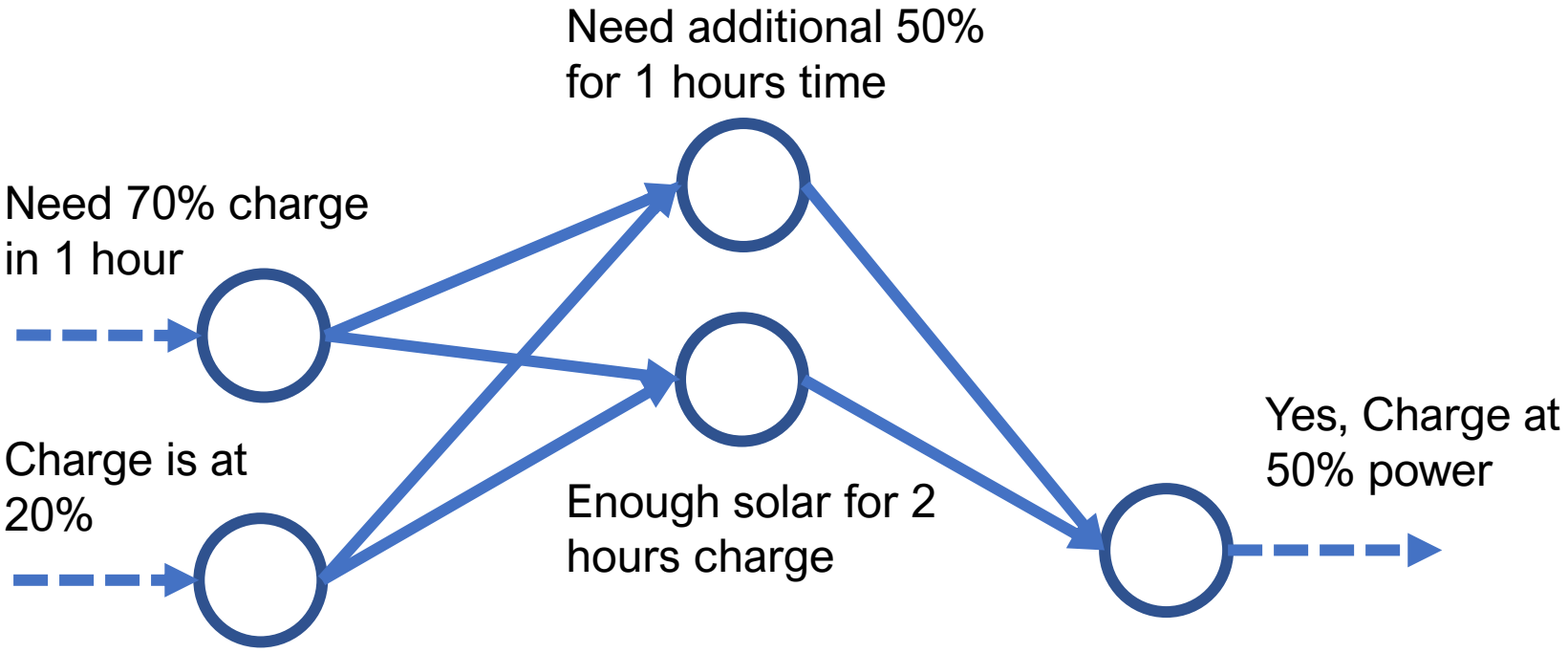
Application of AI to energy

Let us keep it simple for the time being.

Consider the question “When shall I charge from the solar”

What are the inputs? Let’s think?

Consider the question **“When to Charge?”**



Blockchain in Energy

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What is Blockchain?

Blockchain is a way of making and tracking transactions.
These transactions can be assessed, modified and verified very easily without specialist tools. Blockchain is secure and **trustworthy**.

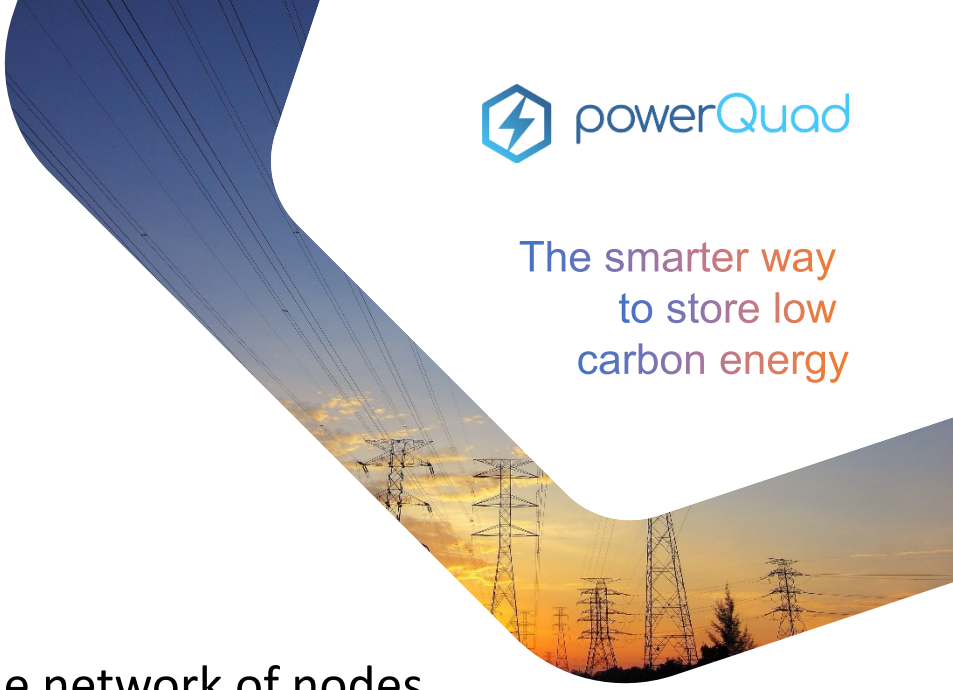
Blockchain is processed in a decentralised way with multiple computers validating the transaction that has occurred in **real time**.

All blockchain transactions are processed in a **decentralised ledger**, which is available to all and is constantly tracked, verified and updated.

Blockchain in Energy

1) Storage unit needs more charge

2) Unit sends transaction request to cloud ‘network of nodes’



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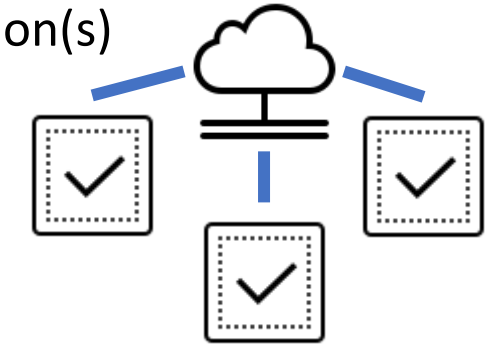
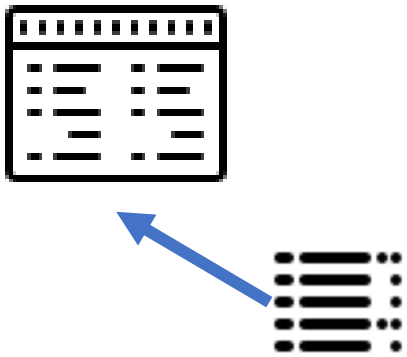
3) The network of nodes validates the transaction(s)



4) The validated transaction is added to the ledger – the **Blockchain**



5) The transfer of energy is completed and the process repeats

Controller can review the ledger to confirm initial source of power

Case Study

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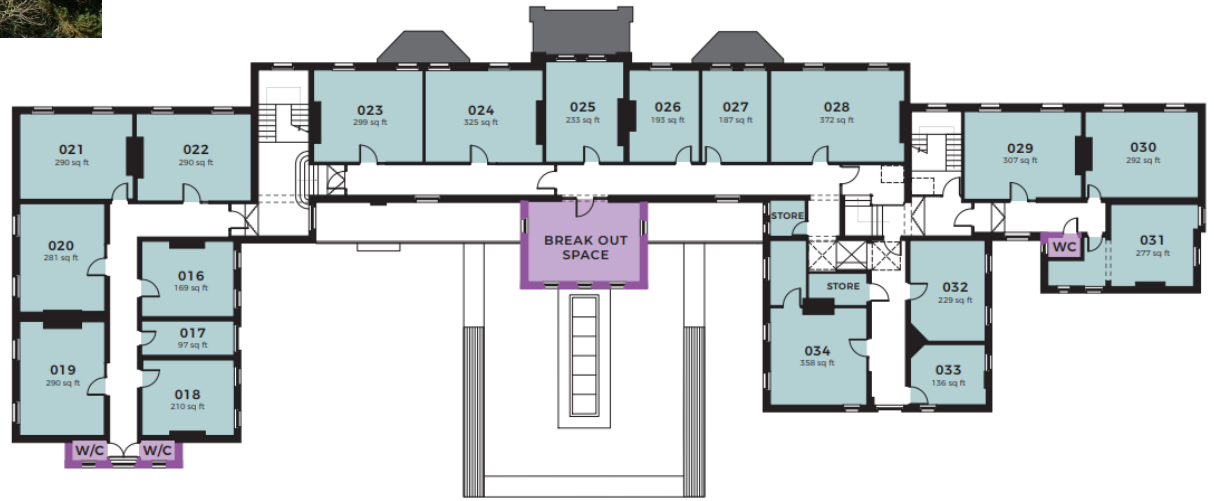
Shared office space in Bordon, Hampshire.
Multiple Offices, multiple businesses, various sectors.



Case Study

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Energy Problems

- Power cuts
- Businesses want to cut carbon. Decarbonise supply chains.
- Looking to save on energy bill

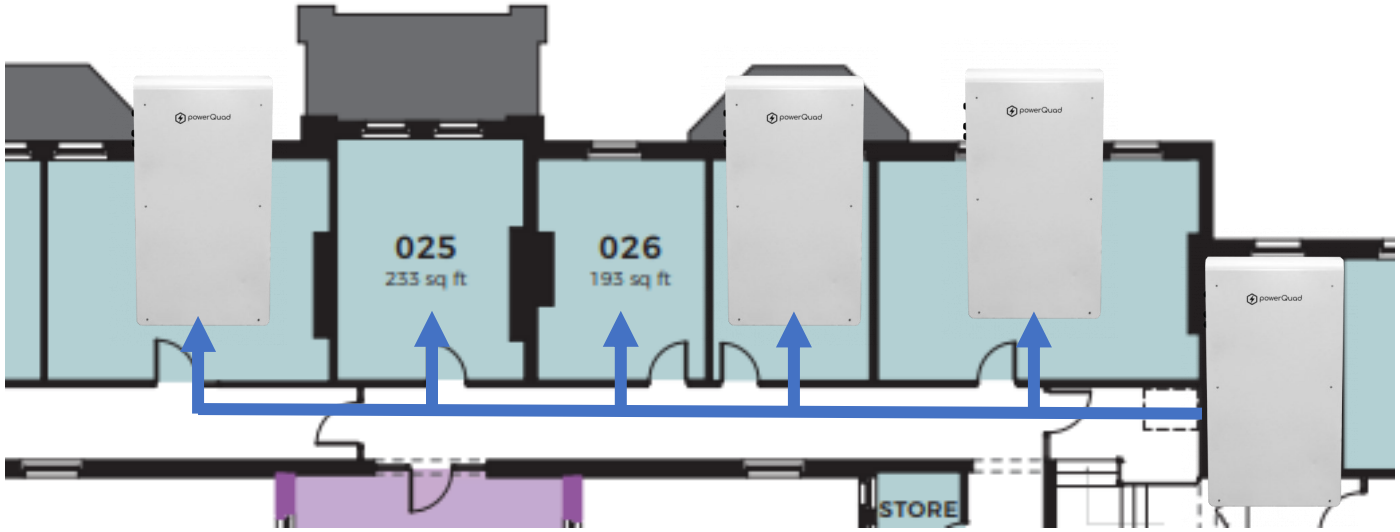
Other Problems

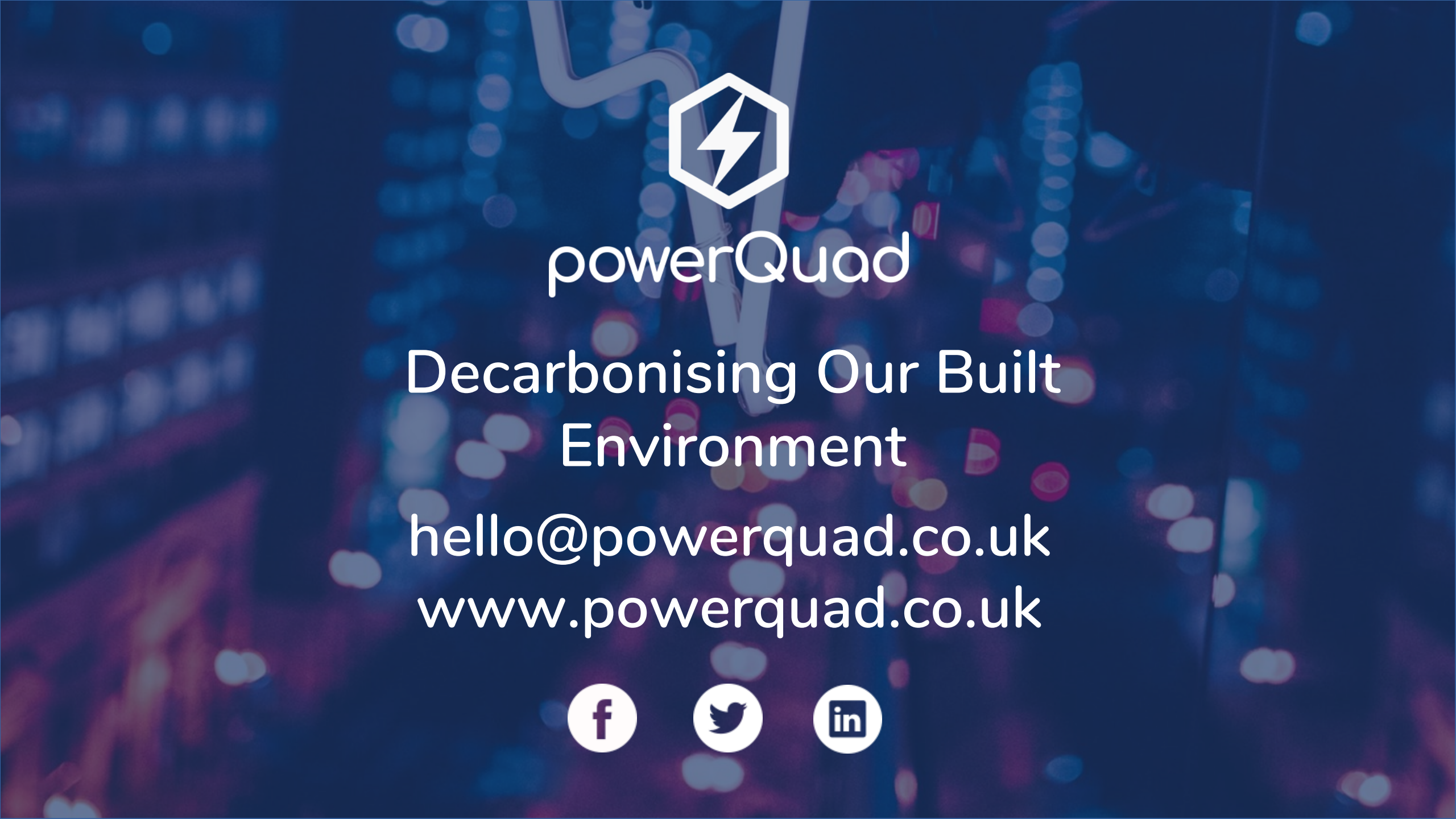
- Multiple businesses in different markets (shared internet).
- Building shared, has multiple uses
- Solar investment is not possible.
- Built 1903 – British Army officers block.

50% of CO2 savings ~ 150kg.
40% of electricity costs.

Solution

- Multiple smaller units supported by larger shared units.
- Cut costs from red band tariff
- Track low grid carbon

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