



Towards Decarbonisation: a home living lab - Ely



An Open Eco Homes online tour



Mole



Ecology
Building Society



Towards Decarbonisation: a home living lab - Ely



Peter Bates





My Decarbonisation Roadmap

Normal 3 bed 1975 semi-detached house





“Fabric First” – “Whole House” approach - Insulation

Loft insulation at least 270mm



Cavity Wall insulation



Double-glazed Windows Replaced

Existing 30 year old double-glazed windows replaced with new double-glazed windows in April 2022



“Whole House” - Building Services

Mains gas boiler
– around 30 yrs. old



Radiator – wet system with Thermostatic Radiator Valves (TRVs) + Room Thermostat



Solar Thermal hot water

Added about 19 yrs. ago



With a new hot water cylinder – free hot water for about 5- 6 months/year



Solar Thermal hot water





Questions on Fabric First and Solar Thermal

Solar PV

Added Nov 2011 & March 2012



Two Solar PV arrays 1.2 kWp & 2.6 kWp
– good investment with feed-in-tariff





Smart meter and flexible electricity tariffs



Introducing Agile Octopus
The 100% green electricity tariff with Plunge Pricing

Ovo Energy > Bulb > Octopus Energy

 <p>Intelligent Octopus</p> <p>6 hours of smart charging - Works with Tesla, Ford, VW, Land Rover and Jaguar OR any car with an Ohme charger.</p> <p>Check your rates</p>	 <p>Octopus Go</p> <p>4 hours of smart charging - Works with all other EVs and home chargers.</p> <p>Check your rates</p>
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Battery Storage system

Installed Nov 2019 15kW system



An experiment – cost just under £10K

Required a G99 application to the DNO – UK Power Networks (UKPN) in South East England – import and export at 5kW compared to 3.8 kW



Battery Storage used with Octopus Energy Tariffs

Started 22 November 2019

Current Cost: **8.93p** /kWh
Next half hour: 9.09p /kWh

Time	Cost /kWh
04:00 - 04:30	4.42p /kWh
05:00 - 05:30	4.86p /kWh
05:30 - 06:00	6.22p /kWh
06:00 - 06:30	6.82p /kWh
06:30 - 07:00	7.54p /kWh
07:00 - 07:30	1.76p /kWh
07:30 - 08:00	4.06p /kWh
08:00 - 08:30	4.81p /kWh
08:30 - 09:00	7.46p /kWh
09:00 - 09:30	7.96p /kWh
09:30 - 10:00	9.22p /kWh
10:00 - 10:30	9.39p /kWh
10:30 - 11:00	9.09p /kWh
11:00 - 11:30	8.28p /kWh
11:30 - 12:00	8.36p /kWh
12:00 - 12:30	9.52p /kWh
12:30 - 13:00	10.06p /kWh
13:00 - 13:30	10.58p /kWh
13:30 - 14:00	10.22p /kWh
14:00 - 14:30	10.58p /kWh



Agile Tariff – changes every 30 mins 24/7

But, now using Octopus Go – off-peak – 00:30 hrs till 04:30 hrs



Battery Storage used with Octopus Energy Tariffs





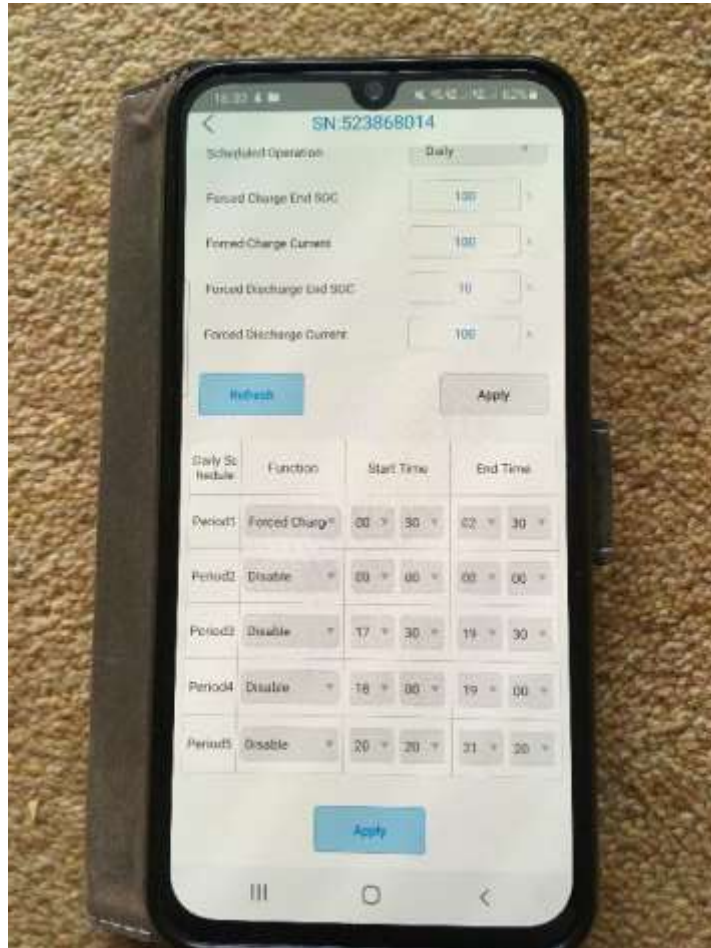
Battery Storage used with Octopus Energy Tariffs





Managing the Battery Storage System

Forced Charge and Forced Discharge

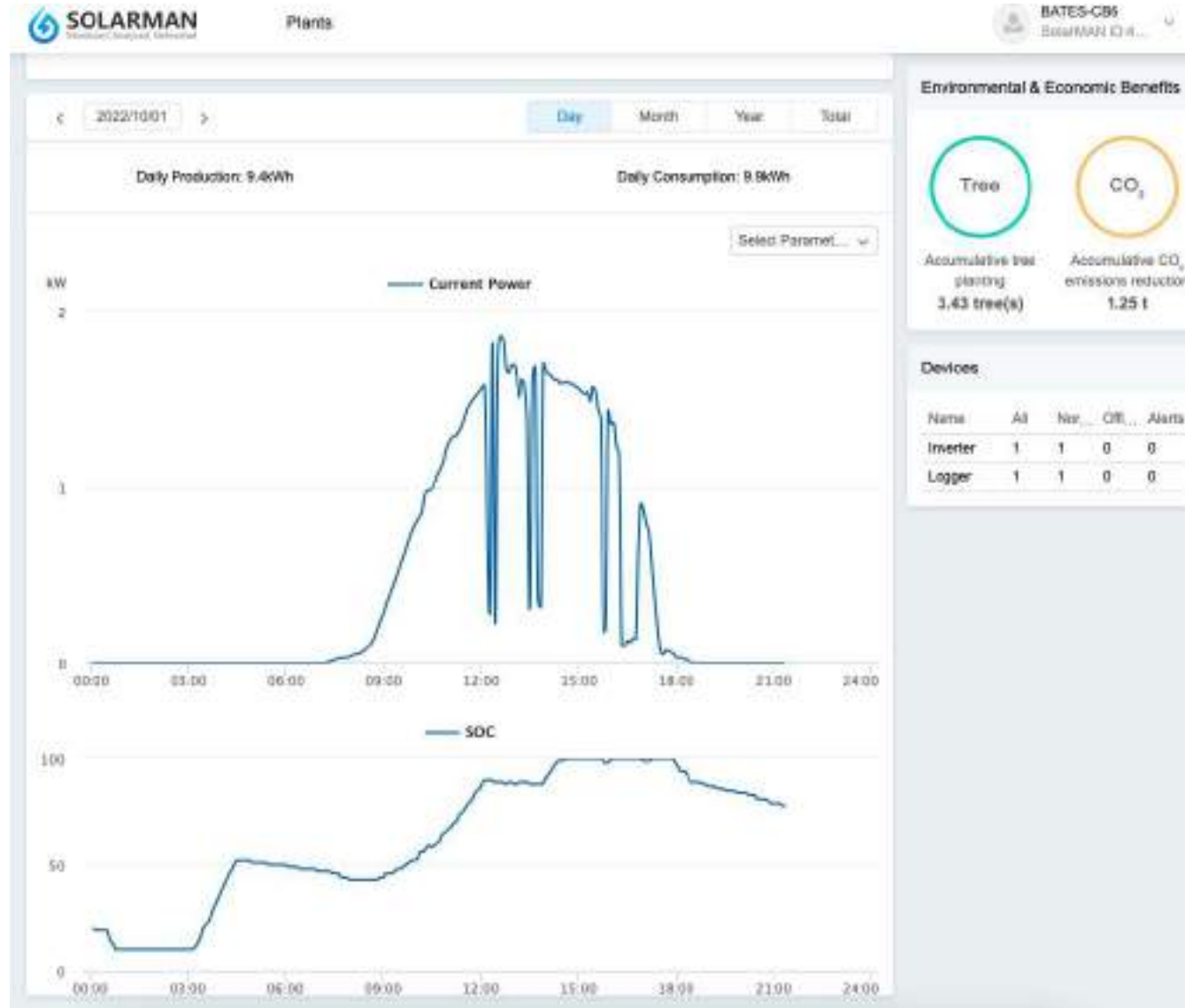


Forced Charge





Managing the Battery Storage System





Questions on Solar PV and Battery Storage

Experimentation

Intelligent Electric Heating

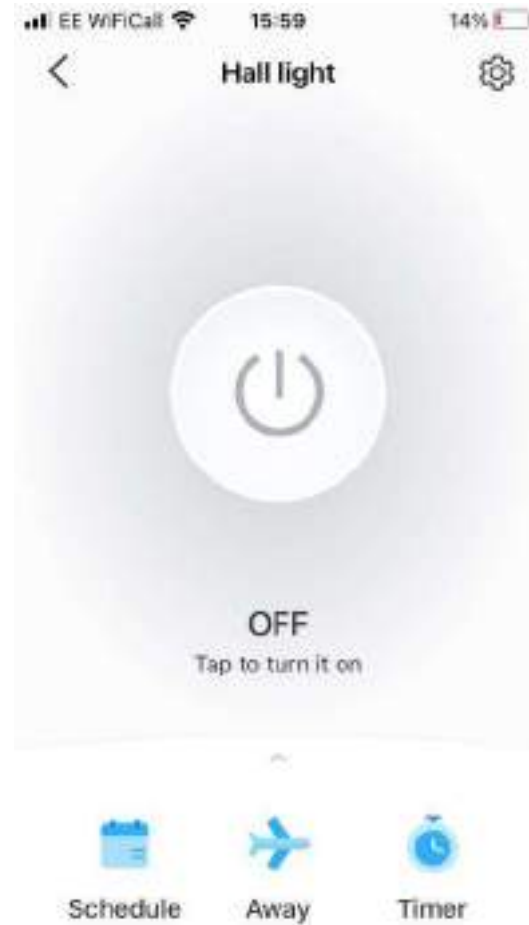
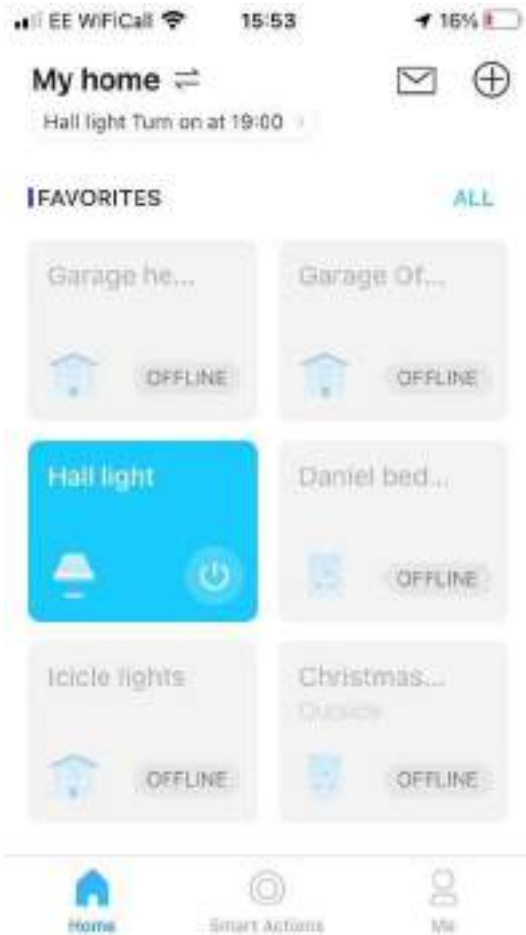


Tapo Smart plug connected to a 500w heater under my desk





Managing the Tapo Smart plugs



Smart Plug
Smart partner for small appliances



Smart Camera
See what matters most



Smart Light Bulb
Ideal brightness at your fingers



Smart Sensor
Worry-free home automation



Smart Switch
More than just on and off



“Electric Wallpaper” - NexGen

Described “as an ultra thin, ultra-safe, laminate infrared heating, which can turn your walls or ceilings into a low carbon heating system. Rather than warming the air, Nexgen gently heats objects in your home (including you), which is more efficient.”

Uses graphite and graphene based nano-technology





Questions on Intelligent Heaters, Smart Plugs and Electric Wallpaper



Electric Car – PowerShaper Project

Nov 2020 - bought Nissan Electric Car
62kW battery to replace my 13 yr old ICE
car and to use for battery storage. Range
235+ miles cost less than £5



Joined Carbon
Co-op
Powershaper
Project and
received the
EmonEVSE
charger





PowerShaper - Home Assistant

Home Assistant is open-source software for Home automation using a home energy management system (HEMS) that connects various devices



Used to control the EmonEVSE charger



HEMS connects to home router

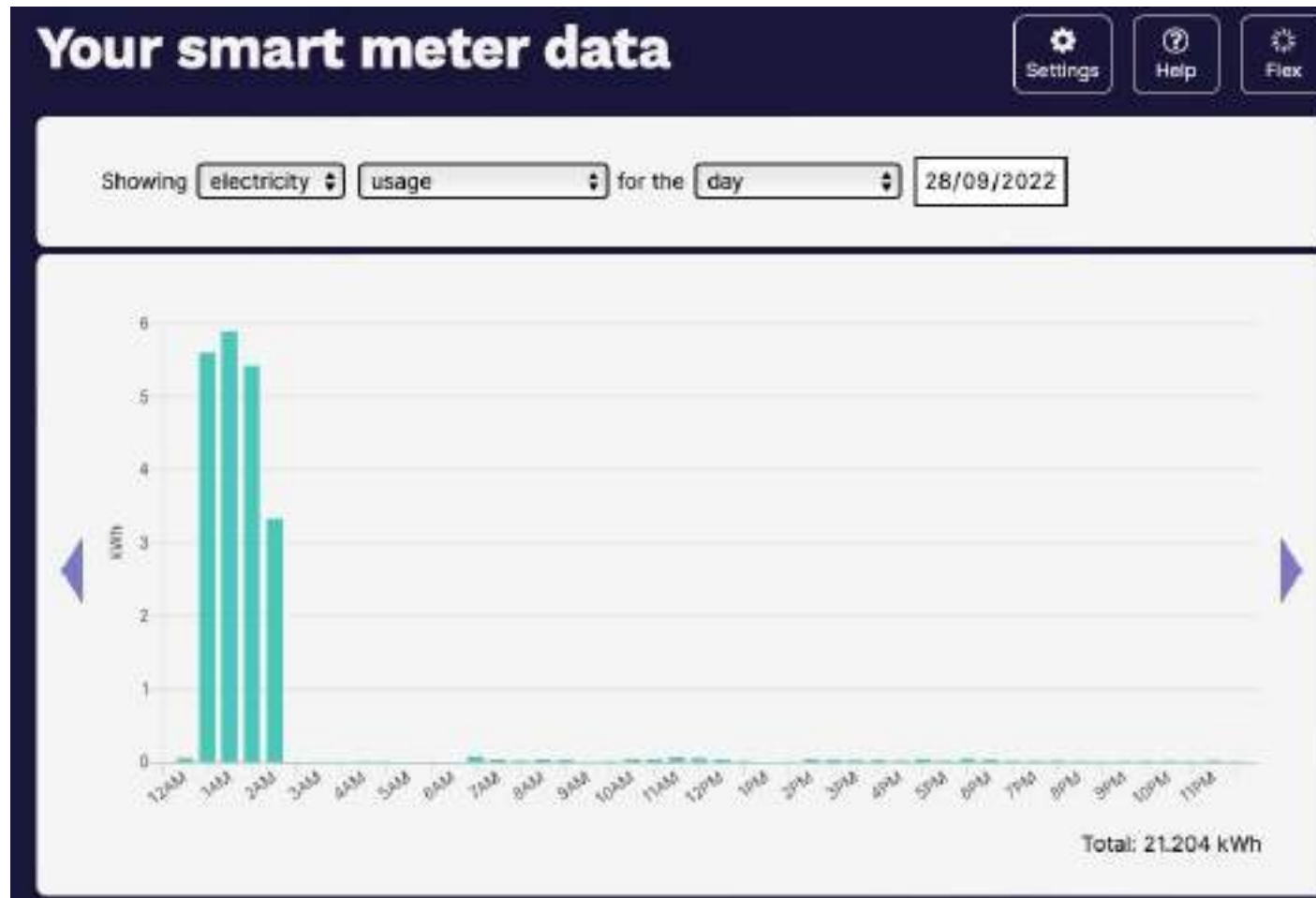


Used to control the switching on and off of an immersion heater with a relay switch



PowerShaper - Monitor

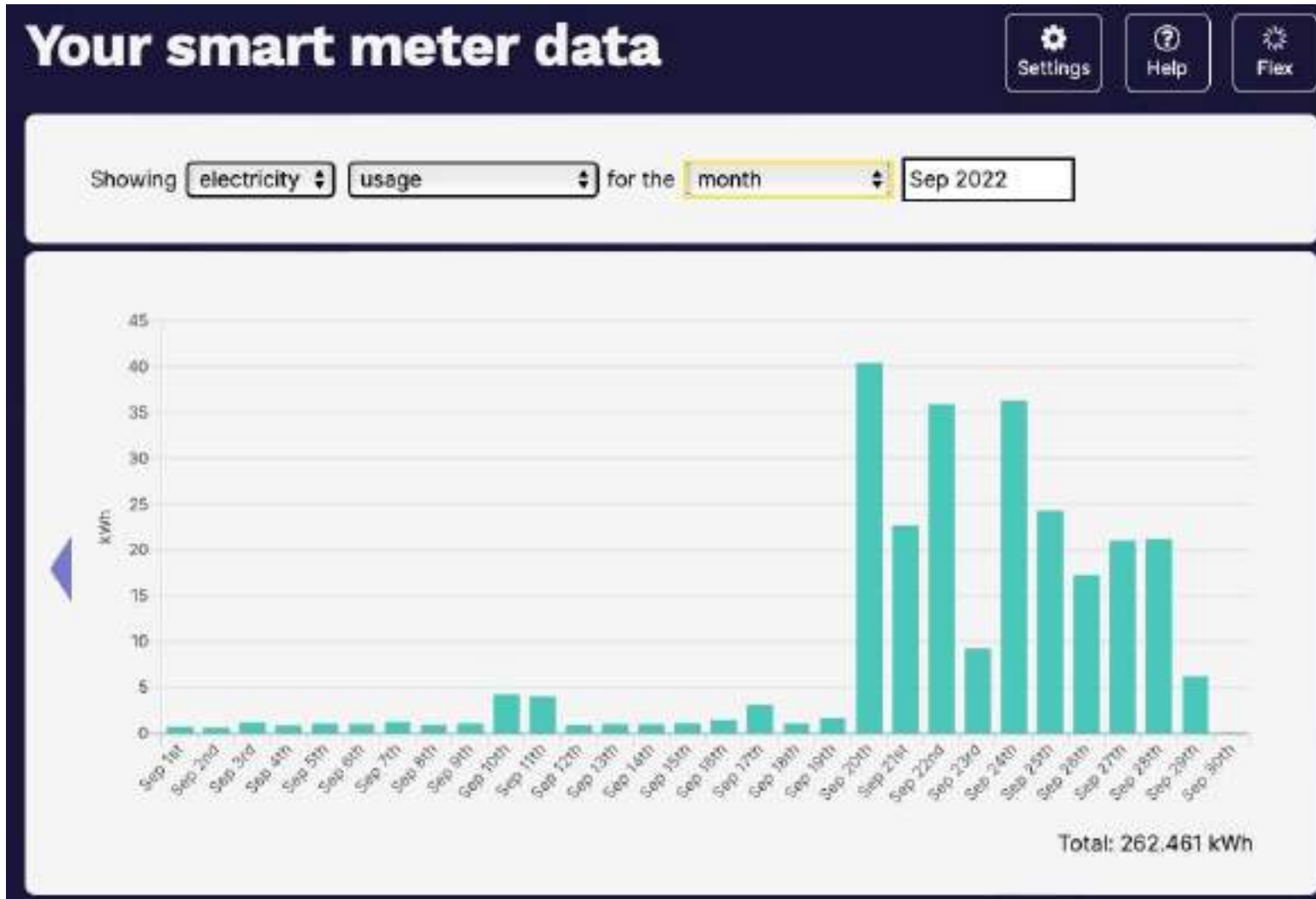
As service free to Carbon Co-op members or £12 per year for non-members - <https://powershaper.io>



Half hourly readings



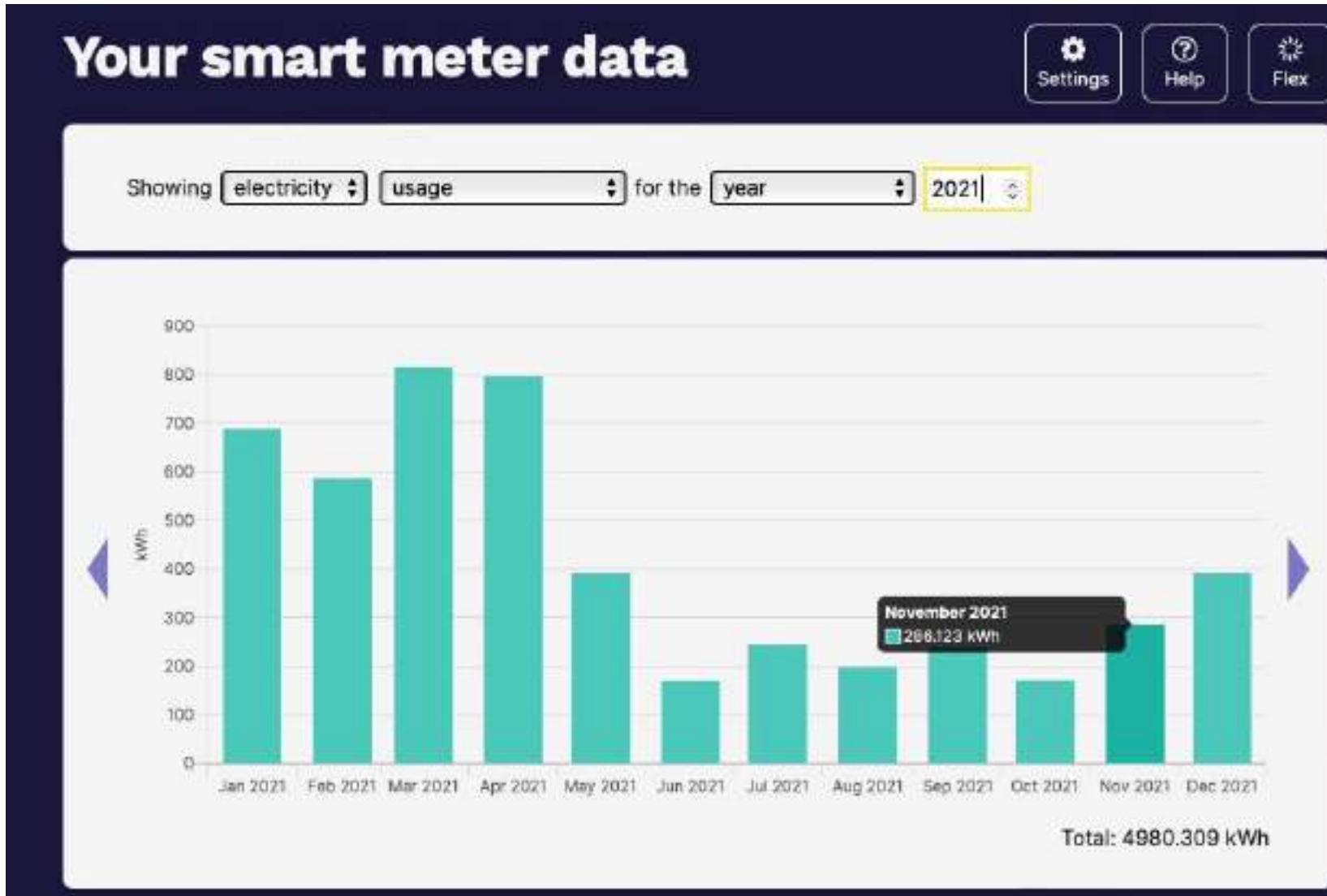
PowerShaper - Monitor



Monthly readings



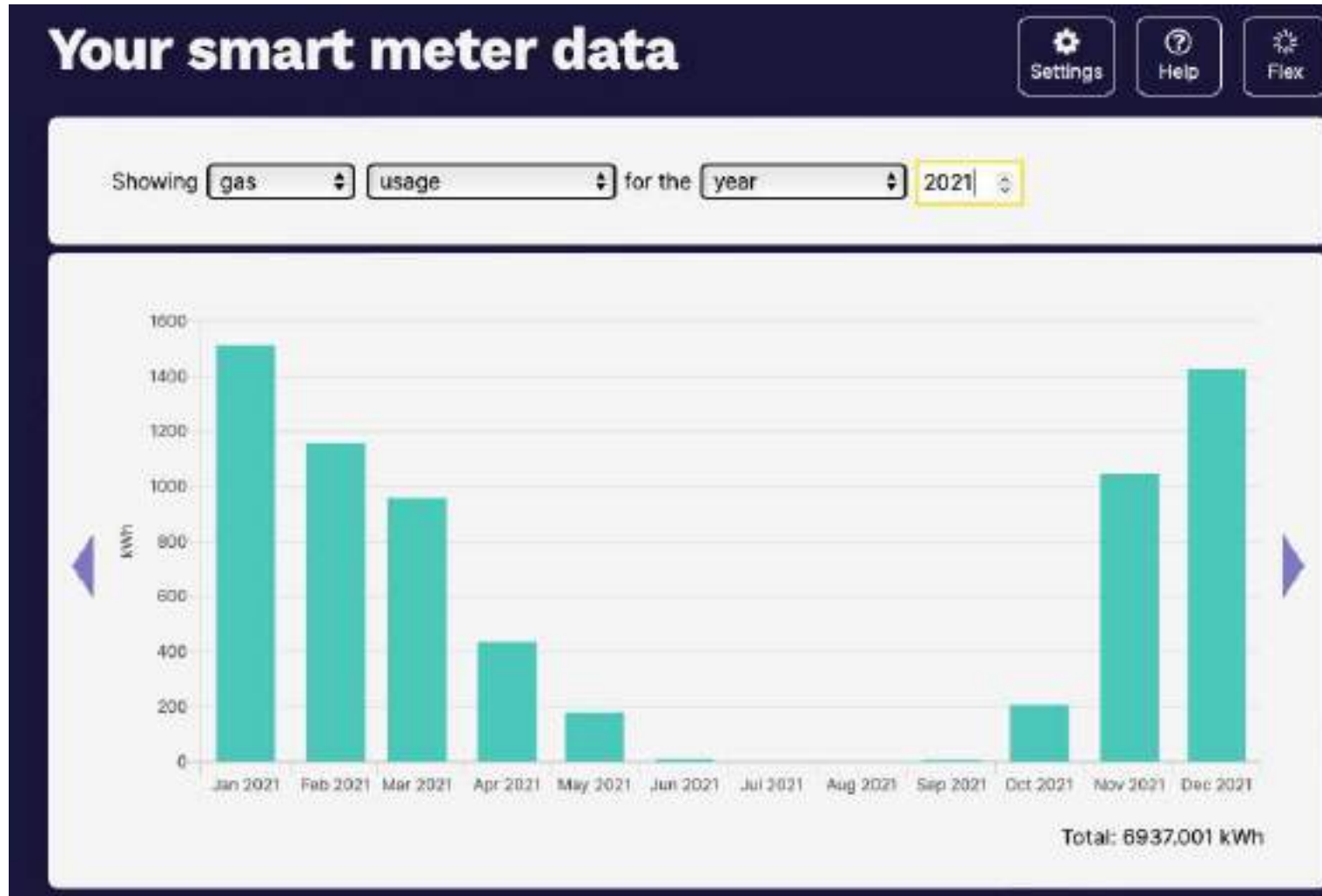
PowerShaper - Monitor



Yearly
electricity
readings



PowerShaper - Monitor



Yearly gas readings



PowerShaper – Demand Side Response

A screenshot of the PowerShaper Flex user interface. The header includes the "PowerShaper Flex" logo and navigation buttons for Monitor, Flex, Settings, HEMS, and Help. The main content area is titled "Past events" and contains a table of event history. The table has columns for Event ID, Date, Start Time, End Time, and a status column with a checkmark and the word "Completed", followed by a "View" link.

Event ID	Date	Start Time	End Time	✓ Completed	View
31	16 Mar 2021	1 a.m.	5 a.m.	✓ Completed	View
30	14 Mar 2021	5 a.m.	7 a.m.	✓ Completed	View
29	11 Mar 2021	12:55 p.m.	1:55 p.m.	✓ Completed	View
28	5 Mar 2021	5 p.m.	7 p.m.	✓ Completed	View
27	2 Mar 2021	4 p.m.	5 p.m.	✓ Completed	View
26	28 Feb 2021	2 p.m.	3 p.m.	✓ Completed	View
25	27 Feb 2021	2 p.m.	3 p.m.	✓ Completed	View
24	24 Feb 2021	noon	2 p.m.	✓ Completed	View
23	20 Feb 2021	9 a.m.	10 a.m.	✓ Completed	View
21	29 Jan 2021	1 a.m.	3 a.m.	✓ Completed	View
20	28 Jan 2021	1 a.m.	3 a.m.	✓ Completed	View



Delivering Smart and Flexible Demand Services



“A smart and flexible electricity system is critical to decarbonise our economy, help manage electricity demand and reduce consumer bills. Energy smart appliances like electric vehicle charge points and smart heat pumps, as well as organisations who provide services to consumers to manage their electricity usage, will play an important role in this future energy system by providing “flexible demand” services.”

<https://www.gov.uk/government/consultations/delivering-a-smart-and-secure-electricity-system-the-interoperability-and-cyber-security-of-energy-smart-appliances-and-remote-load-control>



Vehicle to Home (V2H) & Vehicle to Grid (V2G)

Nov 2021 – was given Wallbox Quasar to take part in Beta/Field Testing using the Nissan Leaf



The “gun” fits into the Chadamo socket on the car and can charge and discharge up to 7kW



Upgrading the Tails and main Fuse

Needs to upgrade the tails (wires) and main fuse to 100 Amps

<https://www.ukpowernetworks.co.uk/electricity/fuse-upgrade>





Questions on Electric Vehicle charging and Powershaper Project

Tado - Smart TRVs

As a member of the Energy Systems Catapult – Living Lab - installed Tado smart TRVs to radiators in Jan 2022



Can control the timing and temperature for each room

3rd Solar PV

Added a 3rd Solar PV array 2 kWp in April 2022



Took advantage of the inverter in the hybrid battery storage system (direct DC)

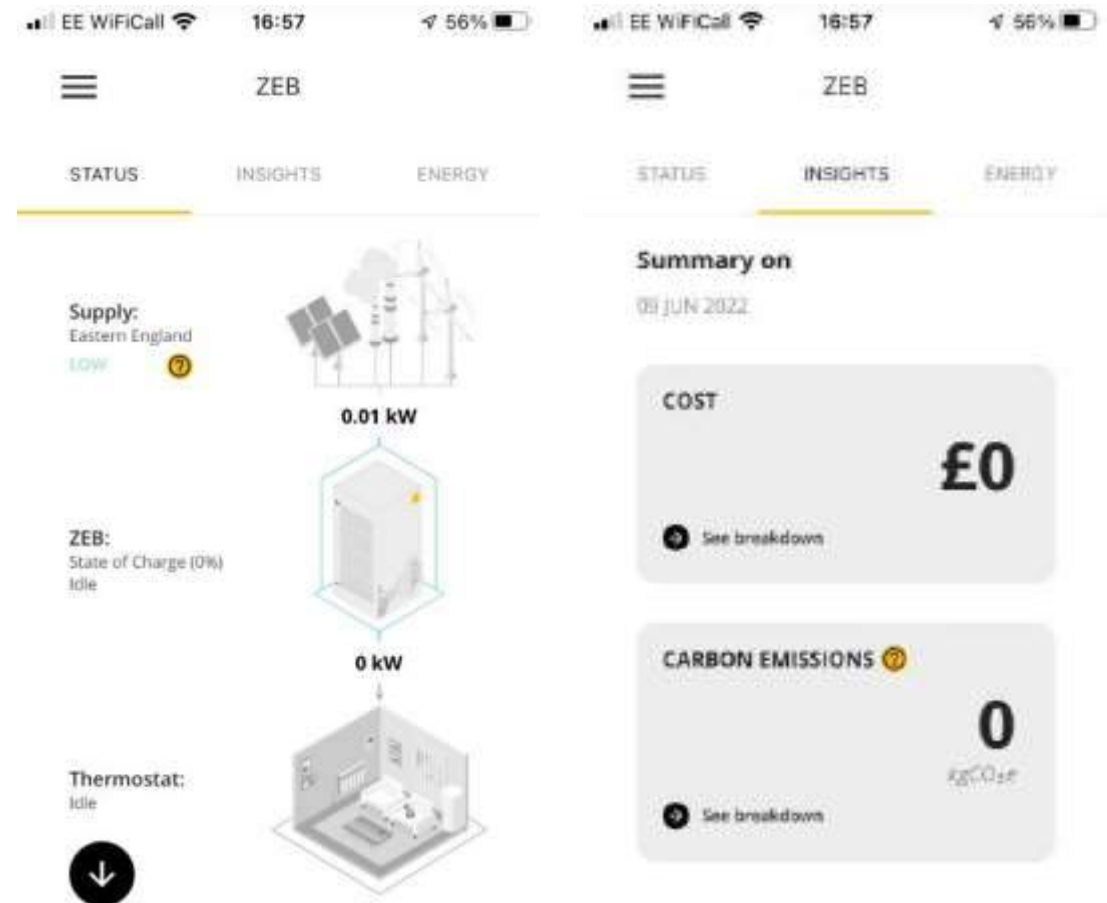


Questions on Smart Thermostatic Radiator Values (TRV)



Tepeo – Electric Thermal Storage Boiler

Connected to the existing wet radiator system – Installed in April 2022



Gas boiler and gas meter removed and Capped. Uses off-peak electricity

Tepeo – ZEB Boiler installation

30 yrs old gas boiler with cupboard on left



cupboard removed



Wall insulated after gas boiler removed



Tepeo – ZEB Boiler installation

Arrival of the ZEB



Carried on a
special trolley



Getting up the steps



Tepeo – ZEB Boiler installation

Just got through the back door



Completely installed



Nearly there



Insulation on ceiling and pipes to left





Zero Emissions Boiler (ZEB) How does it work?

Electricity powers electric heating elements which heat the storage medium which then stores the heat until needed to heat the home/hot water

Storage medium is a proprietary mix of high density inert non toxic and low impact materials up to 900 degrees C

It stores 40kWh of usable thermal energy taking 4 hours to fully charge from empty.

It can output 15kW max with water temperature up to 80 degrees C





ZEB – beta testing Solar matching feature

Just started beta testing the solar matching feature, using data from a consumer access device (CAD) to divert surplus solar PV generation to the ZEB



Gas – cancelled, removed meter and capped

Octopus Energy arranged to remove gas meter and cap the pipe – for free

From 1 October 2022 may gas rate would have been 10.31p/kWh compared to off-peak electricity of 7.5p kWh



Octopus Go rates

Period	Price (inc. VAT)
00:30 - 04:30	7.50
04:30 - 00:30	40.13



Questions on the ZEB

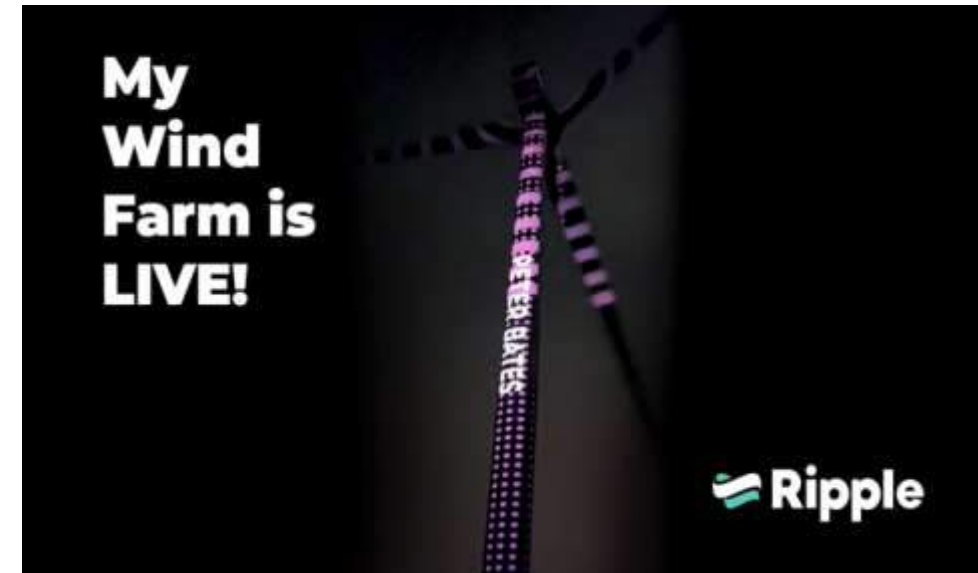


Part-owner of wind turbine

Since April 2022 receive income through Ripple Energy from generation of wind turbine in South Wales

My wind farm summary

Capacity owned total	4.870 kW
Graig Fatha	2.096 kW
Kirk Hill	2.774 kW
Expected annual generation	14,400 kWh
Graig Fatha	5,601 kWh
Kirk Hill	8,799 kWh
Investment total	£8,774.67
Graig Fatha	£3,631.03
Kirk Hill	£5,143.64
Electricity consumption	12,000 kWh
% of energy consumption met by wind farms	120%



Income

April = £27.68
May = £37.57
June = £34.08
July = £15.65
August = £24.72
September = £20.65



Part-owner of wind turbine

Graig Fatha location



Graig Fatha ownership

2,096 watts
which will meet...



Kirk Hill location



Kirk Hill ownership

2,774 watts
which will meet...





Decarbonisation in the Home – next Challenge

Optimisation, integration and interoperability of building services

- Making them talk to each other
- In order to optimise electricity generation
- Reduce over-heating loses
- Minimise carbon emissions



What do I need?

Optimisation, integration and interoperability of building services

- Knowing when and what I export to Grid
- Being able to divert surplus to my EV battery, Home battery storage and immersion heater when demand for hot water is high
- Ensuring that batteries are not charged up too much when next day is likely to be a sunny day
- Reduce over-heating losses
- Ensuring that my immersion heater has hot water at least 48C by 20:00 hrs
- Balancing each storage electric and hot water system, so that each only uses solar PV generation as first priority, then off-peak electricity and peak electricity as the last resort.



Any other Questions?



Can you help us?

- Make a donation to help us run more Open Eco Homes tours: cambridgecarbonfootprint.org/donate
- Share your experiences on social media: [#OEH2022](https://twitter.com/OEH2022)

Thank you for your support!



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Your next steps

- Find out how you can get started with your retrofit
- Book another tour or talk
- Research our past case studies
- Book a training session and borrow a thermal imaging camera
- Use Transition Cambridge's personalised home energy advice tool



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