CONNECTED ENERGY
Advanced Energy Storage Solutions

SMARTHUBS
SMART LOCALISED ENERGY SYSTEMS

MARCH 2020

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west sussex county council · CONNECTED ENERGY Advanced Energy Storage Solutions · icax INTERSEASONAL HEAT TRANSFER · ITM POWER Energy Storage | Clean Fuel · moixa · Newcastle University · passivSYSTEMS

CONNECTED ENERGY Advanced Energy Storage Solutions

Connected Energy is an engineering led innovator in energy storage. Its technologies utilise second-life electric vehicle batteries and are rapidly changing the way intensive energy users can access the benefits of low-cost, on-site solutions. Our E-STOR system is modular and scalable, as well as straight forward to install and operate for energy intensive clients to flexibly control and reduce their energy costs and develop new revenue streams.

The firm's British designed and circular economy focused technology reuses electric vehicle battery packs to create second-life battery energy storage solutions for energy intensive users. Connected Energy maximise the value of already committed natural resources before they are later recycled and its approach to extracting additional value from the finite resources embedded in electric vehicle batteries, essentially doubles their working lives.

Involvement in SmartHubs

As Lead Partner of the SmartHubs Consortium, Connected Energy will be managing the overall programme, coordinating all seven programme partners, as well as delivering a number of their energy storage systems.

Connected Energy has three work packages of its own utilising their second-life battery energy storage systems.

Work Package 6 will see Connected Energy deliver a 12 MW in front of the meter second-life battery energy storage system for West Sussex County Council on a disused refuse site.

Work Package 7 will deliver nine behind the meter second-life battery energy storage systems in various locations across West Sussex for use by energy intensive organisations.

Work Package 9 sees Connected Energy install Solar Carports that will use renewable solar energy in parallel with their second-life battery energy storage system to charge Battery Electric Vehicles at five public sites across West Sussex

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ICAX™ ltd
INTERSEASONAL HEAT TRANSFER

ICAX™ is a cleantech company helping to meet the demand for on-site renewable energy and sustainable development by using heat transfer to achieve low carbon buildings.

ICAX provides turnkey packages for meeting sustainable energy targets on construction projects and retrofit projects aiming for Net Zero before 2050. ICAX undertakes design and installation to ensure that heating and cooling needs are met in a sustainable way by recycling heat energy. ICAX provides a complete range of services from initial feasibility through thermal modelling, design and delivery, to in use maintenance.

ICAX achieves this with Interseasonal Heat Transfer™ - a complementary integration of well-tried technologies and patented innovation.

Involvement in SmartHubs

ICAX is designing and installing a marine source heat pump to transfer heat from the sea water in Shoreham Harbour to heat adjacent buildings of the Shoreham Port Authority using a district heating system.

ICAX heat pumps will be a key component of the Virtual Power Plant being constructed at Shoreham to balance the local supply, storage and use of low carbon energy vectors in the community for power, heating, cooling and transport.

ITM Power Plc designs and manufactures products which generate hydrogen gas, based on water electrolysis.

This technology only uses electricity (renewable) and tap water to generate hydrogen gas on-site and has a product offering capable of being scaled to 100MW+ in size. In establishing the existing customer base, particular importance has been placed on the ability (i) to provide a fully integrated system, (ii) of the system to respond rapidly to varying power profiles, and (iii) to generate hydrogen at a pressure, flow rate and purity appropriate to its application.

ITM Power Plc is a globally recognised expert in hydrogen technologies with the overarching principle to take excess energy from the power network, convert it into hydrogen and use it in one of three broad market areas - Mobility, Power-to-X and Industry. There are multiple application areas within each area, all of which are acknowledged to be growing rapidly and requiring systems of ever larger capacities. This is led by the drive for improved air quality worldwide, the growth of renewable power generators in the energy mix and a need to decarbonise industrial processes to assist with the battle against climate change and enable governments to reach net zero emissions.

Involvement in SmartHubs

ITM Power have been involved in some of the earliest hydrogen mobility projects in the UK, from our first station in Sheffield, which is connected to a wind turbine and has been operational for five years to a network of stations in and around London developed with support from OLEV and the FCH JU.

Within the SmartHubs project ITM Power will be designing, building and deploying a 2MW electrolyser to enable onsite generation of hydrogen for a bus and passenger car refuelling station.

Not only does this provide a system which can generate zero carbon fuel for transport, it also provides the local energy system with a 2MW load which can be switched on or off to enable better management and control of the electricity system - the electrolyser will be tested and operated by a demand response aggregator as part of a virtual power plant in conjunction with other components of the wider project.

Moixa, the smart charging specialist, manages and smart charges hundreds of MWh of batteries and EV chargers across homes in the UK, Ireland and Japan. Moixa was recently selected from 13,900 companies as a Global Cleantech 100 company and has raised over £16m in funding in the last two years including investment from leading companies in Japan.

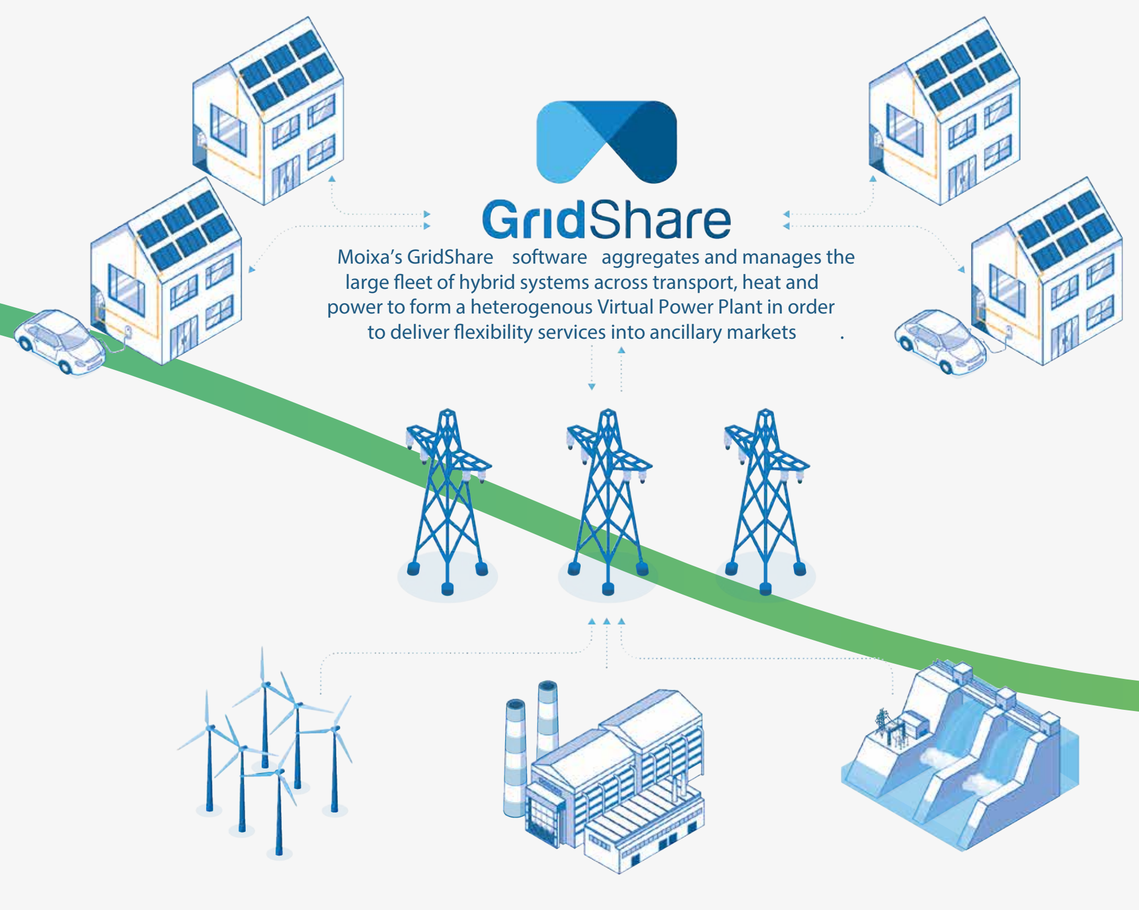
The company has an unrivalled track record in energy storage innovation, gained over 12 years of research and delivery of £6m of grants and pilots, and has over 20 patents on key aggregation, smart storage and electric vehicle optimisation technologies.

Involvement in SmartHubs

Moixa will be using their GridShare software to learn and optimise daily charging of the assets in this project, such as 250 domestic solar and battery systems, 100 3phase solar and battery systems and electric vehicle chargers including vehicle to grid, leveraging low carbon resources and time-of-day tariffs.

The AI software will also aggregate and manage the large fleet of hybrid systems across transport, heat and power to form a heterogenous Virtual Power Plant in order to deliver flexibility services into ancillary markets deliver superior customer propositions and monetary as well as carbon savings.

- Use innovation to support local authorities in achieving their decarbonisation targets
- Support the evolution of flexibility markets
- Build smarter, sustainable business models that can be replicated and scaled across the UK
- Maximise the use and uptake of renewable energy in the UK
- Reduce the need for grid upgrades in the UK, passing savings on to energy customers



Newcastle University is a public research university in Newcastle upon Tyne in the North East of England.

Newcastle University is a member of the Russell Group, an association of prestigious research-intensive UK universities, and it is one of only eight Russell Group universities to achieve a Gold Teaching Excellence Framework (TEF) rating. Newcastle's vision is to advance education and research and to help society tackle the many challenges it faces.

The academics at Newcastle who are working on the Smarthubs project are based in the Electrical Power Research Group, within the University's School of Engineering. The Electrical Power group is the UK's largest academic research group in Electrical Power, with specialisms in power systems and energy storage research. The group has access to state-of-the-art research laboratory facilities at the Newcastle Helix site, a newly-built sustainable urban development combining commercial space with research and education.

Involvement in SmartHubs

In the Electrical Power Research Group, our socio-technical research uses mathematical methods in order to evaluate a series of network management techniques, in the presence of emerging low carbon technologies such as electric vehicles, heat pumps and solar photovoltaic generation.

In our research, we work with domestic and commercial consumers at multiple levels of the distribution network.

The researchers at Newcastle University will bring modelling expertise to the Smarthubs project, providing a detailed technical understanding of the performance parameters of each technology to be deployed in the smart local energy systems (SLES). Our research will incorporate the requirements of the energy consumer alongside the technology parameters.

Our team will assess state-of-the-art open source modelling and simulation tools suitable for SLES, within and outside Newcastle University. We will assess how the flexibility in system operation can be harnessed, across energy vectors and end user requirements, to get as close as possible to the preferred performance objectives.

We will ensure that the project is aligned with ongoing related national and international research initiatives, as well as managing relationships with other research organisations who may wish to work with the project.

PassivSystems has developed a range of home energy services which are changing the landscape of the energy industry.

We are a pioneering company at the forefront of making energy use more efficient and more affordable for millions of households. Our motivation is to help consumers, asset owners and businesses get better value for money and to make a significant difference to global emissions.

In 2010 we were the first company to launch a smart thermostat that allowed consumers to remotely control their heating. In 2015 we became the UK's No 1 residential Solar PV asset management services business and in 2016 we launched the world's first predictive load management service for optimising CHP equipment on residential district heating networks. Most recently, we became the first company to market with a hybrid heat pump solution that uses smart predictive controls, - a solution that is ready to deploy at scale today.

Involvement in SmartHubs

PassivSystems led the £5m FREEDOM Project which proved how multi-fuel, hybrid home heating systems can play a pivotal role in reducing carbon emissions to the mandated 2050 levels and at the same, significantly lower running costs for consumers - both on and off the gas grid - while improving comfort levels.

Passiv will deploy the learnings from FREEDOM in West Sussex and target 250 ASHP installations in domestic social and private residences both on and off gas grid. Households will have access to Passiv's smart controls; learning algorithms analyse multiple data points within the home to learn its thermal properties. Weather information and user behaviour is then overlaid allowing us to predict user demand. The data is used to optimise the efficiency of the individual's system and can also be aggregated to respond to DSR opportunities.

Throughout the life of SmartHubs Passiv will further develop its smart controls and operating platform to enhance and improve social landlord and tenant interfaces with the aim of improving adoption rates in this sector. Working with Social Housing Providers, Passiv will identify the core areas of focus. . Development will also focus on improvements to demand forecasting to support VPP outcomes.

ITM POWER

ITM Power supplies on-site hydrogen generation systems, which use electricity and water to make green hydrogen for refuelling Fuel Cell Electric Vehicles (FCEVs). When hydrogen is generated on-site via water electrolysis, it is a very clean fuel to use in your car.

The refuelling process is very simple and similar to refuelling a car with petrol or diesel today.

Hydrogen is also a perfect fuel for Fuel Cell Electric Buses (FCEBs) as it offers a ten minute refuel time, enabling the bus to be back in operation as quickly as a conventional bus Unlike battery-electric buses which add substantial weight to the vehicle, a FCEB stores energy compactly enabling it to cover a similar distance to a conventional bus, yet the only tailpipe emission is water vapour.

- Hydrogen refuelling station
- Hydrogen is generated on site
- Eliminate fuel deliveries
- Green hydrogen from electricity and water
- 3 to 5 minutes refuelling time
- Improves air quality
- Decarbonizing transport fuels
- Working towards government target of net zero emissions

Hydrogen is also a perfect fuel for Fuel Cell Electric Buses (FCEBs) as it offers a ten minute refuel time, enabling the bus to be back in operation as quickly as a conventional bus

MOIXA

VIRTUAL POWER PLANT

The Smarthubs VPP powered by GridShare will aggregate and manage the large fleet of hybrid systems across transport, heat and power to deliver flexibility services into ancillary markets ensuring system reliability and delivering a stronger, cheaper, cleaner network.

This technology aims to use the VPP of local assets to maintain a stable frequency of the grid or relieve stress, by absorbing excess generation from renewable energy, in order to avoid blackouts and ensure maximum usage of clean energy.

Analytical tools are used to help of asset owners to understand the behaviour of their fleet and its interaction with the grid. It provides a platform for grouping storage systems and offers a live view of device data.

This is our way of supporting a low-carbon, renewable energy powered future.

MOIXA

SMART PV-BATTERY SYSTEMS AND EV CHARGING

The Moixa smart PV-Battery systems will deliver sustainable, low-carbon energy to social homes, schools, businesses and the local public sector.

Adding intelligence to energy storage

Each system comes with GridShare, our customisable cloud-based software platform that identifies a home's energy generation, consumption patterns and available flexible tariffs. Based on all the data points, GridShare generates a personalised charging and energy plan which is optimised to save money for each customer. Users with batteries managed by GridShare benefit from personalised dashboards, showing real-time performance data to drive more efficient energy usage.

For landlords, schools and local authorities, GridShare can maximise renewable energy investments.

With ambitious targets to reduce fuel poverty and carbon emissions, the housing sector needs ways to unlock the potential of renewable energy. GridShare, coupled with the solar storage, offers solutions to a number of these challenges. GridShare allows local authorities and landlords to manage energy use across groups of properties. Localised groups of batteries can provide income streams from grid services.

GridShare technology will also support the electrification of local council public fleets to maximise the potential of electric vehicles for drivers and reducing stress on the grid.

Moixa is pioneering Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H) technology - key for the future of EVs. GridShare enables drivers to stay in control by ensuring their vehicles are charged at the optimum time for their energy bills. It allows charging-device companies to create an enhanced user experience, access analytics about charge-point usage, and drive intelligent decision-making.

As part of this project, GridShare will allow powerful EV batteries to function as energy storage points for the grid, so vehicles can be charged when there is excess solar or wind, and give power back to the grid when it's not needed – opening up further revenue streams

ICAX

An ICAX marine source heat pump will be installed to Maritime House at the east end of Shoreham Harbour to provide heating to the building in place of the oil boilers which are currently being used. The oil boilers will be retained to provide failsafe back up and additional resilience.

ICAX has designed an abstraction and rejection system to cope with the corrosive potential of salt water and biological growth and potential fouling from molluscs and other maritime debris.

The ICAX heat pump is designed to provide a high temperature flow to the building so that the existing heat distribution system within Maritime House will not need to be refurbished. This will save time and avoid disruption so that the retrofit can proceed with minimum interruption to the work that goes on in the building.

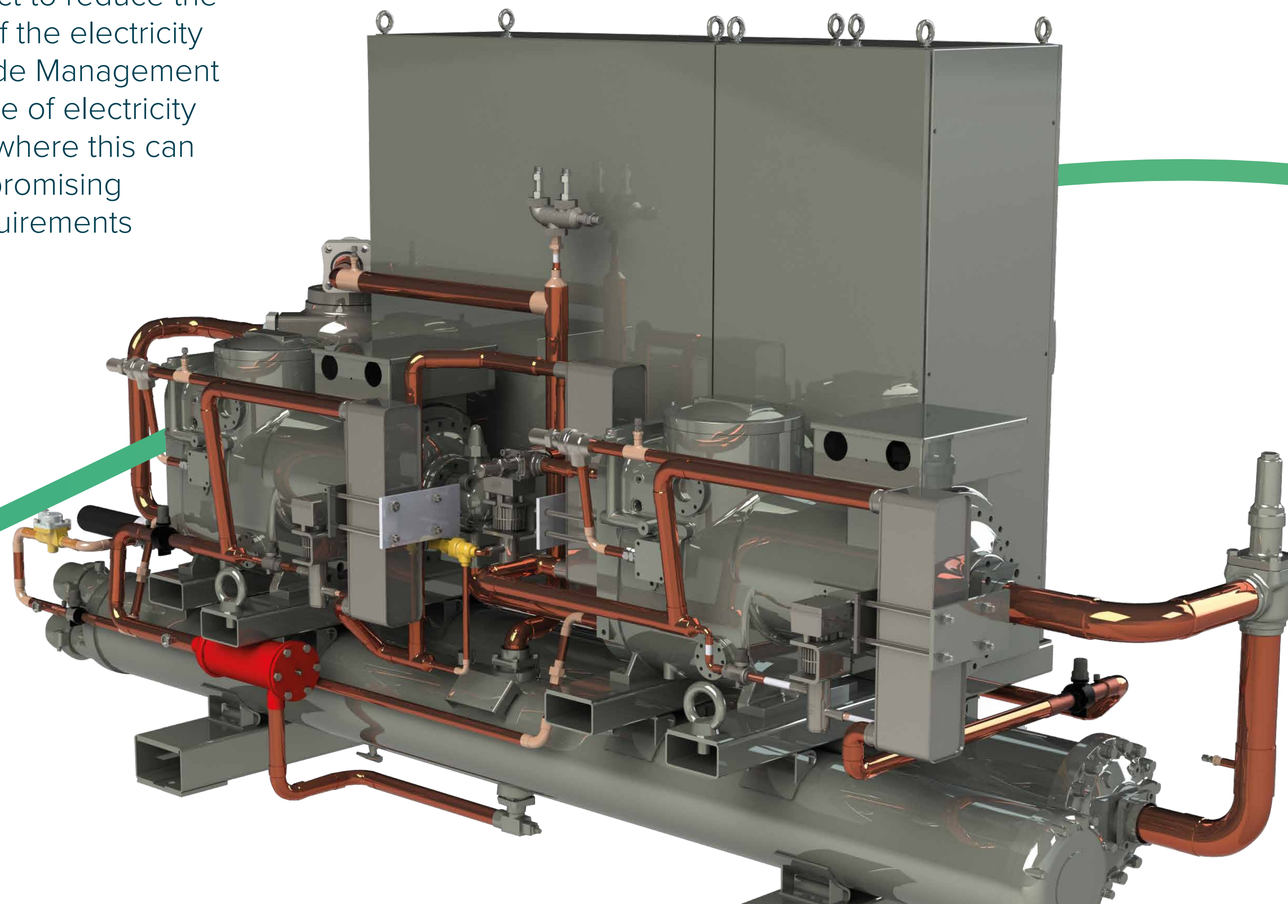
This 240 kW heat pump, like all other heat pumps, will emit no carbon dioxide on site. Because heat pumps avoid the need for combustion it will also issue no nitrogen dioxide, nor sulphur dioxide or any other gas or particulate matter in Shoreham.

Heat pumps use electricity which may be generated from renewable electricity or from fossil fuel sources. The CO2 released at power stations is sometimes attributed to use of electricity for heating to imply that use of heat pumps is not entirely low carbon heating.

However, the electricity generated for the National Grid has a dramatically reduced carbon factor now that coal fired generation is largely phased out and wind generated electricity is making an increased contribution.

The electricity supplied to the heat pump in Shoreham Harbour will take advantage of the Virtual Power Plant being established in the Smarthubs SLES project to reduce the cost and carbon content of the electricity used by using Demand Side Management algorithms to match the use of electricity to times of excess supply where this can be achieved without compromising the heating or cooling requirements in the building.

This 240 kW heat pump, like all other heat pumps, will emit no carbon dioxide on site.



NEWCASTLE UNIVERSITY

The data analysis for Smarthubs will be undertaken by academics from Newcastle University's Electrical Power Research Group. This group is UK's largest academic research group in Electrical Power, with specialisms in power systems and energy storage.

Our socio-technical research uses mathematical methods in order to evaluate a series of network management techniques, in the presence of emerging low carbon technologies such as: electric vehicles, heat pumps, solar photovoltaic generation In our research, we work with domestic and commercial consumers at multiple levels of the distribution network.

Newcastle University will contribute to the Smarthubs project through the following work packages:

Flexibility and Constraint Data

Newcastle University's initial role in the Smarthubs project will be to attain a detailed technical understanding of the performance parameters of each technology to be deployed in the smart local energy system (SLES), allowing flexibility and constraints to be compared between technologies across heat, power and transport sectors. We will assess what data is required to supply our later work packages of modelling and simulation and monitoring and evaluation. Through this data collection stage, we will account for energy consumers' requirements alongside the technology parameters.

Modelling and Simulation

We will determine the modelling methods and tools to be used in the project, assessing state of the art open source modelling and simulation tools suitable for SLES. We will identify gaps in available tools and specify the resulting requirements of additional or new components, and develop and integrate missing modelling and simulation components.

External Research Environment Interaction

Throughout the project, we will develop relationships with relevant energy system researchers through the University's research centres and the new opportunities provided by Smarthubs. We will build partnerships with local educational institutions and national research networks that wish to engage with the project. We will facilitate interactions with professional bodies including the Chartered Institute of Building Services Engineers (CIBSE), the Royal Town Planning Institute (RTPI) and the Royal Institute of British Architects (RIBA). We will present the conference to new audiences through conference papers and publications.

Systems Interactions and Optimisation

Using the tools determined in earlier work packages, we will assess how the flexibility in system operation can be harnessed, across energy vectors and end user requirements, to get as close as possible to the preferred performance objectives. We will define alternative operating modes that optimise against performance criteria, including cost, environmental performance and resilience. We aim to demonstrate a range of operating modes, within and beyond the existing system's operating conditions.

Monitoring and Evaluation

We will record the performance of SLES technologies in sufficient detail to report conclusively on outcomes, as well as creating a database of operational data for analysis. We will develop a periodic reporting process that determines insights and outcomes from the operation of the SLES that can be shared effectively with project partners and feed into external dissemination.

PASSIVSYSTEMS

PassivSystems is leading the work package that will see as many as 250 ASHP installations in domestic social and private residences both on and off gas grid.

SmartHubs households and social landlords will have access to PassivSystems award-winning energy management platform consisting of:

PassivLiving: consumer data presentation, in-home asset optimisation and control

PassivPro: life cycle asset monitoring and performance management platform

PassivEnergy: demand aggregation and a flexible trading platform

PassivLiving provides an online smart heating service that uses learning algorithms and an external weather feed provided via the internet to develop a physics model of how to deliver comfort at least cost. The system consists of a hub with data collection, computing and control capabilities which maintains a connection to cloud storage and data processing via the internet.

The hub feeds to the PassivPro portal, a secure, scalable, cloud-based IoT home energy services platform which offers complete performance control over a portfolio of energy assets – a key attribute for integrating with the VPP work package.

Throughout the life of SmartHubs Passiv will further develop its smart controls and operating platform to enhance and improve social landlord and tenant interfaces and outcomes with the aim of improving adoption rates in this sector.

Areas of development will focus how best to manage tenant lifecycle within social housing as well as creating collateral to improve understanding of how heat pumps and hybrid heat pumps work to improve user experiences and outcomes. Passiv will also consider the enhancements necessary to enable integration with the VPP including flexibility forecasting and dispatch.

CONNECTED ENERGY

FRONT OF METER BATTERY ENERGY STORAGE SYSTEM

A front of the meter system connected directly to the grid. It will charge and discharge quickly, and can respond with full power within two seconds, to provide a grid balancing service to keep the National Grid running efficiently.

- The flexibility the battery provides allows the grid to source more energy from renewable sources which can fluctuate regularly due to weather conditions.
- When the sun is shining and the wind is blowing the battery captures surplus energy from the grid.
- When renewable energy production is reduced the battery provides clean power back to the grid.
- The battery is a 12 MW system which is capable of powering 4,000 kettles simultaneously.
- The battery has a total capacity of 14.4 MWh.
- The system will use around 960 second-life batteries.

The battery has a total capacity of 14.4 MWh: the energy equivalent of powering 1,695 average homes for a whole day*

*Based on a UK household using 3,100 kWh per year.

CONNECTED ENERGY

BATTERY ELECTRIC VEHICLE SOLAR CARPORTS

Five sites with integrated solar car ports, electric vehicle charging points and battery energy storage.

- Total electric vehicle charging power of 243 kW and an estimated 865 kW of solar PV.
- The batteries are 300/360 kWh E-STOR systems which will each use 24 second-life batteries.
- Battery energy storage reduces peak power periods with the battery providing an alternative to costly grid upgrades.
- To reduce demand from the chargers solar canopy's will be installed and the battery will capture excess solar generation.

The sites will have a total electrical vehicle charging power of 243 kW and an estimated 865 kW of solar PV

CONNECTED ENERGY

BEHIND THE METER BATTERY ENERGY STORAGE SYSTEMS

Nine behind the meter systems connected to high energy user sites.

- In addition to providing some of the grid balancing services from the front of the meter system these batteries will be controlled to avoid costly energy bill charges.
- Each battery will be 300 kW in size.
- Each battery system has a total capacity of 360 kWh.
- Each system will use around 24 second-life batteries.
- Embedding a battery on a site provides black out resilience, removing the need for carbon intensive diesel generators.

Each system will use around 24 second-life batteries

DEALING WITH GLOBAL ISSUES

CONNECTED ENERGY
Advanced Energy Storage Solutions

REDUCED TRAFFIC

AIR QUALITY

THE TRANSPORT TRILEMMA

CARBON EMISSIONS

DECARBONISATION

BATTERIES ARE REMOVED FROM VEHICLES

COST MANAGEMENT

THE ENERGY TRILEMMA

SECURITY OF SUPPLY

BATTERIES DEGRADE

THE EV BATTERY CHALLENGE

RANGE REDUCES

WHAT THE ENERGY TRILEMMA MEANS FOR WSCC

West Sussex County Council (WSCC) is a pioneering local authority in the energy sector.

With the energy trilemma at the heart of its strategy, WSCC has built a track record of successful delivery and extensive experience that will be key to the success of Project SmartHubs.

The authority currently generates more renewable energy than it consumes through its core activities, excluding street lighting and schools, and has an ambitious pipeline of new projects.

WORK TO DATE HAS INCLUDED:

- Two large solar farms on surplus council land generating clean electricity and revenue to invest in services for West Sussex residents;
- Largescale battery storage providing grid services and additional income;
- An 80-strong solar schools programme with the combined generation capacity of a 5MW solar farm providing average, annual bill savings per school of £2,000;
- An ongoing programme of self-funding energy and water efficiency retrofits in council buildings, including schools;
- A local, not-for-profit energy supplier (Your Energy Sussex) offering competitively priced energy and 100% renewable electricity to residents;
- Work with businesses to establish a local energy community on one of the largest business parks in the south east (through the EU-funded BISEPS project).

Project SmartHubs will draw on the authority's commitment, experience and local networks to demonstrate how different approaches to generating, sharing and using renewable energy, heat and energy for transport can be seamlessly integrated.

Adur and Worthing Councils are also key project partners as many of the domestic and commercial energy solutions deployed through Project SmartHubs will be located in this area.

The West Sussex solar for schools programme

Westhampnett solar farm, Chichester

WSCC'S COMMITMENT TO SUPPORTING BUSINESS GROWTH IN THEIR REGION

West Sussex County Council has an explicit focus on supporting new and existing businesses to grow and thrive.

Fostering innovation and a new economic identity for West Sussex as a 'green energy county' is central to that vision and one of the drivers behind the county council's commitment to Project SmartHubs.

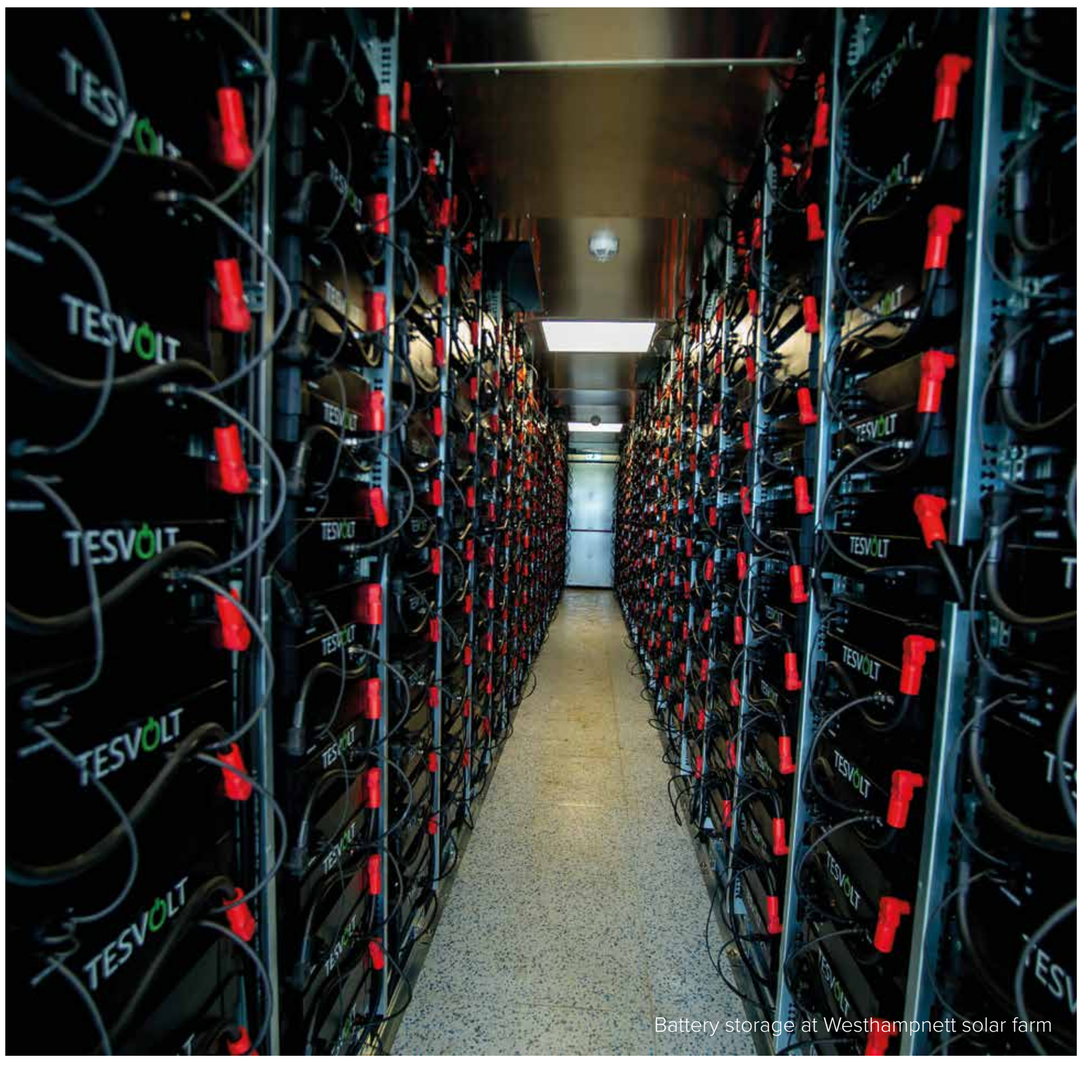
In its Economic Growth Strategy, the authority sees local investment in the clean energy sector and smart energy systems as being a direct benefit to its 42,000 existing businesses - and a major factor in encouraging others to invest in the county.

Investing in the clean energy sector has the potential to provide a greater security of energy supply, significant environmental benefits for the county, low-cost energy to businesses and residents and high-value and productive employment opportunities for the future.

That is why WSCC is committed to identifying clean growth opportunities, working with partners to secure funding, acting as a hub for innovation and testing solutions for businesses investing in the sector.

By committing to research and innovation through projects such as SmartHubs, WSCC is also supporting the development of new energy solutions that will have a positive impact on the energy landscape and economic growth at a regional and national level.

Tangmere solar farm, Chichester



Battery storage at Westhampnett solar farm