SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10025662

Project Registration

Project Title

HEAT BALANCE

Project Reference Number

10025662

Project Licensee(s)

SP Energy Networks Transmission

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

Michael Eves

Project Budget

£141,302.00

Project Summary

HEAT BALANCE (within discovery) will explore the commercial and technical feasibility of network flexibility from large-scale TES to reduce peak demand on the transmission and distribution networks over multiple timescales, reducing the need for network reinforcement. We will also consider benefits to electricity generation by reducing the capacity required to meet peak demand and the gas system by helping to smooth the future demand for hydrogen.

HEAT BALANCE meets the scope of the competition by:

- Using smart approaches to manage large-scale electrified heat deployment in a local area, reducing the need for network reinforcement

- Inclusion of a work package which focuses upon the commercial and investment case for financing heating technologies alongside energy network innovation

- Working with partners on how deployment of low carbon heating solutions can be better coordinated to minimise gas and electricity network constraints at lowest economic cost.

SP Transmission is the lead organisation. We want to help electricity customers transition to low carbon heat at the most efficient cost and enable a quicker transition.

Wales & West Utilities are the gas distribution network operator for Wales and South West England.

Academic Partners

- The University of Edinburgh will lead the Commercial WP, leveraging their experience of transmission system modelling in the INTEGRATE project.

- The University of Glasgow will be a major contributor to the Technical WP bringing their extensive experience in geological thermal energy storage.

Technical & Commercial Expertise

- Ramboll will lead the Technical WP bringing their experience in the rapid development of the thermal pit storage technology in Denmark.

- DELTA-EE will primarily contribute to the Commercial WP building on learnings from their research into large-scale TES undertaken for BEIS and others.

Heat Network Providers

- Vattenfall will contribute to both WPs from their practical experience as one of Europe's largest producers and retailers of electricity and heat.

- Erda Energy will support both WPs bringing expertise from their innovative solutions for low-carbon heating, cooling and geo-exchange technology.

Potential users are those who will deploy heat networks such as; commercial heat service providers, housing developers, local authorities, housing associations, and institutional investors. Research has shown users need a clear pathway to deploy large-scale TES. This includes understanding of: -

- The different technical solutions available – their advantages and disadvantages

- The costs and benefits to the ultimate consumers of the heat being delivered

- New commercial arrangements developed to realise the whole systems value of large-scale TES

Third Party Collaborators

University of Glasgow

Ramboll

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Problem Being Solved

Problem

Credible pathways for decarbonising heat result in a large increase in electricity demand as gas and other fossil fuel fired boilers are replaced by heat pumps. One of the major challenges for the electricity system is the huge seasonal variation in the demand for heat, with gas demand representing heat. In addition, there are extreme intra-day fluctuations in heat demand with rapid ramp rates.

Problem statements:

- Unmitigated increase in peak demand for electrified heat would overload the transmission and distribution networks, requiring major investment.

- Around 30% increase in generation capacity is needed for peak heat electrification, requiring major investment.

- To meet the unmitigated peak demand from low carbon renewable generation implies massive over-capacity in the generation and transmission systems for much of the year which will require to be met by investment.

This would lead to an increase in consumer bills.

Renewable generation is connected predominantly in the north of GB and heat load is predominantly in the south. The interconnectors

in the transmission system are already constrained in their ability to export renewable electricity at times.

Transmission connected renewable generators are being constrained off at a cost of - £450m per year to electricity customers and this is increasing. Renewable generation capacity is expected to quadruple to meet net zero, which could significantly increase constraints.

However, we have an opportunity...

Decarbonisation will profoundly change the way we heat our buildings, commercial and domestic. This proposal forms part of the blueprint required for that transition and supports government objectives. Both inter-seasonal and short-term thermal energy storage (TES) will be essential to balance the demand and supply for the future net zero heating system.

Large-scale TES is one of the lowest cost methods of energy storage and one of the most flexible. Under smart control it can shift demand over timescales between a few hours to inter-seasonally. However, it has not been commercialised in GB to date. There is a huge potential for large-scale TES in conjunction with heat networks.

The number of heat networks is set to rapidly increase as part of the government's energy and environmental plans and legislation. There is an opportunity to ensure that appropriate TES is incorporated with heat networks to assist with an efficient transition to low carbon heat and optimal development of the whole energy system.

Project Approaches And Desired Outcomes

The Big Idea

HEAT BALANCE supports the aims of this competition by developing innovative products, processes and services for the planning, operation and delivery of energy networks that support low carbon heating solutions. It will benefit consumers by lowering cost compared to BaU.

Our big idea is to deploy a regulatory and commercial framework for large- scale TES, providing network flexibility to mitigate the impact of the electrification of heat. Integrated with the rollout of heat networks, the framework will provide a robust mechanism to ensure that consumers benefit from its use.

Through technical and commercial innovation, the project will build the industry knowledge base on TES and will facilitate changes to regulation and commercial arrangements that incentivise the provision of TES.

Brief overview of technology

- ATES (aquifer thermal energy storage). Composed of two or more wells into a deep aquifer that is contained between impermeable geological layers above and below.

- BTES (borehole thermal energy storage). Composed of one to hundreds of vertical boreholes, typically 150 mm in diameter.

- CTES (cavern or mine thermal energy storage). Possible in flooded mines, purpose-built chambers, or abandoned underground oil stores.

- Pit Storage. Lined, shallow dug pits that are filled with gravel and water are used in many Danish district heating systems.

Current state of development

These technologies have not been deployed to any significant extent in the UK and learning is needed through HEAT BALANCE to understand how these will perform in the context of both; physical considerations, such as the geology in the UK and network technical characteristics; together with the regulatory and commercial framework.

A study into a pit storage solution for Burntisland as part of the Fife Energy Masterplan found that: - 'The proposed installation would have a significant beneficial impact on the Scottish energy market in terms of adding flexibility and power system balancing capabilities.' 'Further investigation on revenues from providing such electricity services is required.'

A case study by Erda Energy for a care home in north-west England found that an innovative solution incorporating energy storage could reduce the network maximum demand from 720kW to 270kW. However, revenue from providing electricity services is required to make this solution economically viable.

HEAT BALANCE will determine how the revenues can be extracted for these services and propose new commercial arrangements.

The relevant foreground IP concerning the developed framework will be freely shared to provide stakeholders with information that they need to make informed decisions.

Innovation Justification

TES solutions are not part of transmission network business as usual considerations. Network innovation is required to enable their integration into flexibility services.

There are very few documented examples of TES at the required scale in the United Kingdom.

BEIS (Evidence Gathering: Thermal Energy Storage (TES) Technologies, 2016) commented 'For interseasonal heat storage, developments in the UK are far behind those advancements made in other northern and central European countries.'

The study identified areas where additional research could be undertaken to enhance understanding and support the integration of TES into the wider strategy for meeting the UK's decarbonisation targets and ensuring security of energy supply, including:

- Carrying out real world field trials for interseasonal TES, PCM and thermochemical heat storage to fully understand and evaluate

technological performance.

- Fully evaluating how different TES technologies, besides hot water tanks, can be integrated into the existing UK heating infrastructure.

- Better understanding how electric heating and CHP can be used with TES to provide benefits to the wider electricity system.

HEAT BALANCE will address these innovation needs, implementing a roadmap through the Discovery, Alpha, and Beta phases to develop business as usual solutions.

All of our project partners have significant experience in leading the way in thermal storage developments both in the UK and internationally. HEAT BALANCE will benefit from our partners expertise in this field and take learnings from a number of previous projects.

An important academic research project in which a number of our partners are involved is the EPSRC INTEGRATE (Integrating seasoNal Thermal storagE with multiple enerGy souRces to decArbonise Thermal Energy, EP/T023112/1) project. HEAT BALANCE will leverage valuable learning from this research.

Additional projects that are likely to deliver valuable learning to inform HEAT BALANCE include: -

- The HotScot project which has been awarded early stage funding by UKRI to develop plans to harness the geothermal energy contained within an abandoned, flooded coal mines in Scotland

- The European HeatStore project which aims to lower the cost, reduce risks, improve the performance of high temperature underground thermal energy storage (HT-UTES) technologies and to optimise heat network demand side management (DSM). This is primarily achieved by 6 new demonstration pilots and 8 case studies of existing systems with distinct configurations of heat sources, heat storage and heat utilisation.

Project Plans And Milestones

Project Plan And Milestones

HEAT BALANCE Discovery Phase will build towards a Beta phase demonstration of large-scale TES that benefits the electricity networks and the whole energy system.

The technical work package will be led by Ramboll and primarily supported by University of Glasgow and Delta-EE.

- We will investigate the different options for large-scale TES and assess their compatibility with GB – geology, geography and demographics.

- In addition, this work package will estimate the real-world costs for the different solutions to inform the CBA undertaken as part of the commercial work package.

- It will also be important to benchmark TES against other energy storage technologies in terms of technical feasibility and costs. Informed by the learning from these activities we will develop outline design for a pilot demonstration of the solution for further development in alpha phase.

Our deliverable for this work package will be a report assessing the different large-scale TES technologies comparing their suitability for application under key UK use cases, with a recommendation for technology(s) to trial and the appropriate scale of a pilot demonstration to be developed in future project phases.

The commercial work package will be led by University of Edinburgh and supported by Delta-EE and other partners.

- This will determine the benefits of large-scale TES to the wider energy system including generation, and electricity transmission and distribution networks. An overall system cost benefit analysis will be developed.

- It will describe existing market and regulatory arrangements for large-scale TES, in addition, develop understanding of where value from large-scale storage arises in the system. This will inform the composition of a Commercial Working Group. In later phases of the project the working group will develop proposals for investment solutions that reflect the value TES provides to the overall energy system including changes to policy and regulation.

The deliverables from this work package will be: -

- An overall cost benefit analysis for large-scale thermal storage deployed in the UK, using the costs developed in the technical work package.

- The governance and remit of a Commercial Working Group that will develop commercial arrangements and regulatory changes in the alpha phase

Project management and coordination will be led by SP Energy Networks.

Route To Market

HEAT BALANCE will demonstrate large-scale TES as a lower cost alternative to conventional reinforcement. It will de-risk and accelerate the provision of large-scale TES in the UK.

Large-scale TES is a demand-side solution requiring significant investment from commercial customers in behind-the-meter assets. Recent learning from the grid- scale battery energy storage sector shows the enablers needed to facilitate this. Customers and institutional investors need to understand the technology, its benefits and risks. They need confidence in the return that they will receive on their investment. HEAT BALANCE will support both of these enablers, implementing a roadmap through the SIF project phases and subsequently business as usual (BaU).

The learning from our technical workstream, including a Beta phase demonstration project, will build the UK industry knowledge base. This will be reinforced by a comprehensive dissemination programme among stakeholders. Through our commercial workstream we will demonstrate the value of large-scale TES to different parts of the energy system and propose how this can be released and the value 'stacked' to provide a return for investors.

The details of the BaU commercial arrangements will be developed through the project phases. Network operators are already able to

pay for demand side flexibility through Totex as an alternative to conventional reinforcement. However, in this case the network benefits arise in both the transmission and distribution networks including reduced constraint payments by the Electricity System Operator (ESO). We will develop a regulatory mechanism for payments from these different sources to customers. One option is for the distribution system operator (DSO) to make the overall payment and recover the relevant contribution from the other parties. The Beta phase project will emulate and evaluate the financial model developed in preparation for BaU adoption.

Building from our experience in developing flexibility markets in BaU and in our innovation project FUSION we will develop the market by helping commercial customers and institutional investors to understand and have confidence in the technical solutions and the commercial/market arrangements.

Project partners Ramboll and Vattenfall are international leaders in the design and construction of heat networks and TES. Their in-depth understanding of the project solution will assist clients in BaU develop large scale TES solutions.

Costs

Total Project Costs

141302

SIF Funding

127172

This project has been approved by a senior member of staff

☑ Yes