SIF Discovery Round 2 Project Registration

Date of Submission

Apr 2023

Project Reference Number

10061578

Project Registration

Project Title

Calfacto Latent Energy

Project Reference Number

10061578

Project Licensee(s)

SGN

Project Start

Apr 2023

Project Duration

2 Months

Nominated Project Contact(s)

stuart.sherlock@sgn.co.uk

Project Budget

£91,893.00

Funding Mechanism

SIF Discovery - Round 2

SIF Funding

£82,469.00

Strategy Theme

Net zero and the energy system transition

Challenge Area

Accelerating decarbonisation of major energy demands.

Lead Sector

Gas Distribution

Other Related Sectors

Funding Licensees

Lead Funding Licensee

SGN - Southern England (inc South London)

Collaborating Networks

SGN

Technology Areas

Green Gas, Heat Pumps

Equality, Diversity And InclusionSurvey

Yes

Project Summary

Project

This project will support the decarbonisation of heat by increasing the efficiency of hybrid heat pumps ("HHP") when coupled with thermal stores through an innovative heat exchanger design, phase change material ("PCM") based thermal store and intelligent control system.

Aims

This will meet the aims of Innovation Challenge 4 by removing barriers to entry preventing consumers from accessing affordable decarbonised heating.

This is achieved by:

- Increasing the efficiency of heating incorporating thermal storage
- Increasing the energy density of thermal storage
- Reducing the proportion of gas used within hybrid systems

We will demonstrate that increasing energy efficiency and flexibility together can reduce costs decarbonised heating and improve consumer experience.

Innovation

The innovation will incorporate direct coupling of the HHP working fluid (e.g. propane) to a PCM based thermal store and intelligent control systems to optimise the performance.

By direct coupling, the energy efficiency is improved compared to a HHP and a traditional water based thermal store as the heat pump can generate heat at a lower temperature closer to end user requirements. The innovation also allows the HHP and store to be discharged in parallel, providing a boost in capacity during peak heating periods.

PCM store achieves a higher energy density compared to traditional thermal stores. This allows for either increased storage duration or smaller store footprint.

The advanced control system will optimise the operation of the HHP with storage to improve equipment performance and lifespan.

Users

The end users of the innovation will be heat consumers e.g homeowners, heat network operators etc. They require heating and hot water on demand even during extreme grid and weather events. Consumers are also becoming more discerning and want lower carbon heat, for no more cost than fossil fuelled equivalents.

By improving efficiency and optimising the sizing of the heating and storage equipment our project provides decarbonised heat at an affordable cost whilst prioritising consumer heat security.

Partners

SGN are the lead partner, bringing expertise in gas and hydrogen as well as numerous sites in urban areas.

Vital Energi are the heat network provider. They are UK market leader in district heating schemes with 83,000 homes connected.

Imperial College London will be the academic partner, having developed an integrated whole energy systems (IWES) model.

University of Birmingham (UoB) will be an academic partner specialising in phase change material.

Glasgow City Council and West Dunbartonshire Council will be Local Government partners.

Project Description

The project is to increase the efficiency of hybrid heat pumps when coupled with thermal stores through an innovative heat exchanger design, phase change material based thermal store and intelligent control system.

This will by remove barriers to entry preventing consumers from accessing affordable decarbonised heating.

This is achieved by:

- Increasing the efficiency of heating incorporating thermal storage
- Increasing the energy density of thermal storage
- Reducing the proportion of gas used within hybrid systems

We will demonstrate that increasing energy efficiency and flexibility together can reduce costs decarbonised heating and improve consumer experience.

Third Party Collaborators

Vital Energi

Imperial College London

University of Birmingham

Glasgow City Council

West Bunbartonshire

Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

Project Description And Benefits

Applicants Location (not scored)

Southern Gas Networks St Lawrence House, Station Approach, Horley, England, RH6 9HJ

Vital Energi Solutions Limited Century House, Roman Rd, Blackburn BB1 2LD

Imperial College London Exhibition Rd, South Kensington, London SW7 2BX

Glasgow City Council 82 George Square, Glasgow G2 1DU

West Dunbartonshire Council 16 Church St, Dumbarton G82 1QL

University of Birmingham Edgbaston, Birmingham, B15 2TT

Project Short Description (not scored)

This project is to the efficiency of hybrid heat pumps when coupled with thermal stores through an innovative heat exchanger design.

Video description

https://youtu.be/KPpEtwpwrAw

Innovation justification

Barriers to entry preventing consumers from accessing decarbonised heating are:

- On-going costs are currently higher than gas heating
- Initial investment cost is high
- Incorporating traditional thermal storage reduces efficiency
- Traditional storage has a large space requirement
- Requires complex decision making for the consumer

Innovative integration of a HHP and PCM store with intelligent controls will improve efficiency and reduce the energy requirements which will reduce the cost and timescales of installing and operating decarbonised heating.

The Innovation

The project incorporates three novel elements:

- storage of energy within a phase change material
- heat exchanger design directly transferring energy from the heat pump working fluid to the PCM
- control system to optimise and co-ordinate the operation of the 3 core elements

The project partners are not aware of a similar product which is available. There is the risk that the resulting design will be too expensive or not perform to a sufficient degree to be viable.

Knowledge Gap

The integration of the separate elements has yet to be tested. The preliminary designs and control philosophies have identified the potential benefits however the work to date has only explored limited scenarios using standard modelling. We will use advanced modelling techniques to identify the optimum equipment specification.

There are several options for both PCMs and heat pump working fluid and we have yet to identify the optimum configuration. We will carry out a detailed analysis of the options which will also take into account; upfront and lifecycle costs, sustainability, and suitability for integration with third party equipment.

The control system is yet to be developed, the project modelling will identify the operational parameters of the product. This can

subsequently be used to develop the functional design specification of the product's control system.

Appropriate Counterfactual

Heating provided by modular HHP with separate sensible thermal storage:

Economic Benefits:

- Reduced equipment cost for same functionality
- Increased efficiency reduces operating costs
- Provides more heat from same energy source therefore reduces investment required in generation, transmission, and distribution reinforcement

Sustainability Benefits:

- Increases the proportion of heating from electricity, thus reducing CO2
- Allows for increased penetration of renewables by improving flexibility and efficiency

Price Control

SIF funding is the only option within price control. It wouldn't attract any other type of funding as it is research led and is risky as it requires new models and control systems to be developed and proven.

Benefits Part 1

Environmental - carbon reduction – direct CO2 savings per annum against a business-as-usual counterfactual
Financial - cost savings per annum on energy bills for consumers
Financial - future reductions in the cost of operating the network
New to market – products, processes, and services

Benefits Part 2

Financial - future reductions in the cost of operating the network

The key metric will be installed gas capacity (MWth) of the hybrid system which is required to meet the heating demand (MWth). We expect to achieve a significant reduction in installed capacity of gas versus the counterfactual of gas only heating. This would be achieved at the point of installation with benefits to the network depending on the level of deployment.

Financial - cost savings per annum on energy bills for consumers

A key metric will be the profile of the power (MWe) and gas demands (MWth) which are required to meet the heating demand (MWth). This will form part of the study. The average heating cost of a hybrid system will be lower than gas heating once the price of electric heating becomes cheaper than gas heating. This will occur either through changes to the relative power and natural gas prices which are expected, or as a result of the switch to green hydrogen which is more expensive due to the comparative inefficiency of conversion to heat.

Environmental - carbon reduction -- direct CO2 savings per annum against a business-as-usual counterfactual

The metrics will be the ratio of heat produced from electricity versus gas. The National Grid is forecast to be Net Zero by 2035. As such there will be zero CO2 emissions attached to the heat supplied from electricity. In 2017 the average household generated 2,745 kg of CO2 emissions from heating. The full savings would be apparent after 2035 at the point of installation, subject to the status of the gas grid. Prior to this date a portion of these CO2 savings would be applicable to the power consumption.

In an all-hydrogen scenario, we estimate significant levels of hydrogen would be blue hydrogen (there is 1kg of CO2 emissions for every 1kg of blue hydrogen). The associated savings from our zero-carbon solution would be apparent after 2035 at the point of installation subject to the status of the gas grid.

New to market -- products, processes, and services

Success will be once the product is available to supply heat to customers' homes. We expect this to be in a 4-5 year time period. Initially we expect the product to be incorporated into heat networks (500+ homes connected) before being made available at scale suitable for individual domestic properties.

Project Plans And Milestones

Project Plan and Milestones

The attached Project Plant will be updated throughout the project, our team is flexible, agile, and responsive to change.

We consider the key work packages to be:

WP1 Project Support (SGN lead)

Liaising with BEIS regarding deliverables, administration of claims and supporting documentation.

WP2 Project Management (SGNCS)

The project will require a dedicated project manager (PM) to disseminate the deliverables between parties and assemble the final report.

WP3 Heating & Storage Sizing (Vital Energi lead)

VE will use Plexos simulation software to optimise sizing of the heat delivery equipment (heat pump, gas boiler and heat storage). This will seek to identify the relative capacity of each of the elements to provide the optimum solution based on a 50MW grid connection and a representative heating profile. This will take into account both upfront and ongoing costs of the equipment.

WP4 Review distribution infrastructure (SGN lead)

Considering the required gas profile (in MWh) from WP2, SGN will review the impact on the gas network when using either natural gas or hydrogen for the gas portion of heating in addition to the requirements for other gas fired equipment in the homes. SGN will seek to identify the maximum level of gas for heating which would allow the transition to hydrogen within the existing infrastructure in an example heating zone.

WP5 Review heat pump options (Vital Energi lead)

There is a variety of heat pumps on the market with different working fluids (e.g propane). These have different characteristics which would influence the heat exchanger and store design whilst considering cost, safety and sustainability. VE have experience installing heat pumps and will assess options, an important factor will be the ability to integrate with multiple manufacturers so focus will be on the main working fluids.

WP6 Review of PCM Options (University of Birmingham to lead)

UoB have experience in developing a range of composite PCMs and understand the properties of different PCMs which would support the heat exchanger design. The focus will be on cost, safety and sustainability whilst ensuring it is integrated with the selected heat pump working fluid.

WP7 Review of impact (Imperial College lead)

Imperial College team will enhance and apply advanced Integrated Whole-Energy System modelling concepts to estimate the role and value of rolling out the proposed concept.

Regulatory Barriers (not scored)

At present SGN and the project team, are confident the proposed concept would not provoke any regulatory barriers that could affect or hinder delivery of either the Alpha or Beta phases.

Heat Network contractors are not yet eligible for 'statutory undertaker' status, although this has been proposed. Lack of this status limits the obligations of contractors to respond in the instance of a fault with the heat network, which can negatively impact on quality of service, system KPIs, and acts as a regulatory barrier. There have been proposals for this status to be extended to the heat network sector in order to encourage development but details are not currently available.

As the utility industry aims to build a shared net-zero future by accelerating decarbonised energy solutions and minimising our environmental impact.

The project team will also be working closely with internal stakeholders including Operations, Network Planning and Policy, to help consider any policy and procedural impact. As the project develops through the different phases, we will also be making use of a suitable accredited Technical Consultant to help add further industry understanding.

Commercials

Route To Market

Business-As-Usual

SGN is already considering how heat network infrastructure can be included in the on-going infrastructure works, both to accommodate hydrogen and the distribution of heat. SGN have secured 50MWe grid connections on 5 former gas holder sites to develop heat networks. This is expected to become business as usual across SGN's networks by the end of the decade.

The project aims to prove that heat networks will benefit from hybrid heat pumps coupled with thermal stores. Subject to it being demonstrated that these units provide commercial and technical benefits, we expect these units to become business as usual on all heat networks within 8 to 10 years.

Competitive Market

The market required for decarbonised heating is significant. To accomplish the ambitious requirements of Net Zero, many companies will be required to implement solutions with all requiring gas and/or power infrastructure. Through efficiency improvements the innovation will maximise the usage of existing infrastructure for all decarbonised heat solutions.

Implementation

SGN is in a Joint Venture with Vital Energi to deliver heat networks across the UK. The JV will be responsible for the implementation of the innovation. We consider this initially to be incorporating the product into the delivery of the JV's own heat networks but in time will be made available to third party heat network providers and domestic properties. Vital is experienced in developing proprietary products for inclusion in heat networks such as the vTherm range of Heat Interface Units.

Customers

The tangible innovation delivered will be an innovative hybrid heat pump and PCM store which will increase the efficiency of conversion of power to heat. The primary customer for this product would be heat network providers and ultimately homeowners. The business model is to be established during the Discovery Phase, but one option would be to licence the base products. This would be equally suitable internationally.

Customer Value

The innovation will reduce the cost of owning and operating a network, allowing customers costs to be lowered. For direct sale to consumers the product will lower CAPEX and reduced operating costs compared to equivalent solutions.

Funding

Adoption of the primary innovation should reduce the cost and timescales of installing heat networks. The intention to introduce heat network zones has increased investor interest and SGN have already had discussions with investors who would be interested in investing in further development and implementation of the product once it has been proven.

Intellectual property rights (not scored)

For SIF projects, each Project Partner shall own all Foreground IPR that it independently creates as part of the Project, or where it is created jointly then it shall be owned in shares that are in proportion to the work done in its creation. The exact allocation of Foreground IPR ownership will be determined during the contractual negotiations with the Project Partners on the agreement for the project.

We intend to ensure each Project Partner will comply with Chapter 9 SIF Governance Document through the contractual terms governing the project. However, precisely how this is done will be subject to contractual negotiations with the Project Partners on the agreement for the project.

Costs and value for money

How much will the project cost for this Discovery Phase and how does it represent value for money for the consumer?
Total Project Cost: £91,241

Private Funding: Our partners will fund ineligible costs and the none supported eligible costs of this project via retained earnings, these

will be in excess of 10% of the project cost.

SIF Funding:

The SIF funding will be split between the partners as follows:

SGN -- £1

SGN Commercial Services - £15,277

Vital Energi -- £30,450

University of Birmingham - £15,880

Imperial College -- £19,360

Glasgow City Council - £1,500

West Dunbartonshire Council - £1

Subcontractors:

Turnbull and Scott will be a subcontractor working under Vital Energi

Value for Money:

The innovation will incorporate direct coupling of the HHP working fluid (e.g. propane) to a PCM based thermal store and intelligent control systems to optimise the performance. The energy efficiency is improved compared to a HHP and a traditional water based thermal store as the heat pump can generate heat at a lower temperature closer to end user requirements. The innovation also allows the HHP and store to be discharged in parallel, providing a boost in capacity during peak heating periods. This should lead to a reduction in charges on customers' bills and make savings far beyond to costs of the SIF investment.

In addition, the results of this discovery phase will feed back into our business as usual, allowing us to focus on other areas if the project results in alternatives that deliver more value at lower cost. There is overlap between the Work Packages of this application and those within application 10061578. Should both applications be successful in obtaining funding, there would be a saving of £7,500 against this application as a result of efficiencies gained.

Document Upload

Documents Uploaded Where Applicable

Yes

Documents:

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Discovery R2 End of Phase Report (Calfacto) Final.pdf

Calfacto Latent Heat - Show and Tell.pptx

This project has been approved by a senior member of staff

☑ Yes