SIF Alpha Round 2 Project Registration

Date of Submission

Project Reference Number

10086459

Initial Project Details

Project Title

Full Circle

Project Contact

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Challenge Area

Accelerating decarbonisation of major energy demands.

Strategy Theme

Net zero and the energy system transition

Lead Sector

Electricity Distribution

Project Start Date

01/10/2023

Project Duration (Months)

6

Lead Funding Licensee

UKPN - London Power Networks Plc

Funding Mechanism

SIF Alpha - Round 2

Collaborating Networks

UK Power Networks

Technology Areas

Asset Management

Heat Pumps

Commercial

Pre-Heat

Transformers

Project Summary

The Full Circle project is changing the way we heat our homes and businesses. Recovering waste heat from distribution network transformers, we can create a more efficient and sustainable heating system that is accessible to everyone.

This innovative project is developing a new industry-leading framework that will make it easier for heat network developers, property developers, and Energy Service Companies (ESCos) to make use of this untapped resource of waste heat from transformers. This new framework will provide the certainty and support that businesses need to invest in waste heat recovery to improve efficiency of heat networks.

Add Preceding Project(s)

10061341 - Full Circle

Add Third Party Collaborator(s)

Ove Arup & Partners Ltd

Atelier Ten Limited

Project Budget

£463,123.00

SIF Funding

£416,811.00

Project Approaches and Desired Outcomes

Problem statement

Heat networks are seen as a cost-effective solution to heat decarbonisation but with the current energy crisis and market conditions, electrifying heat sources is still expensive and increase electrical peak demands on the electricity network. Distribution transformers experience heat losses, which can be used as a supplementary heat source for local heat networks. The project addresses the relationship between the decarbonisation of heat and the electricity network.

During Discovery, we defined the specific opportunity more clearly for the different users.

UK Power Networks, the Distribution Network Operator (DNO) lead partner, has a grid substation in Wandsworth, located 200m away from the heat network energy centre. The power transformers at this site, like many other substations in the UK, have been in operation for 20+ years and have higher losses compared to the latest transformer design. The DNO has operational processes in place to reduce these losses but they contribute to the overall distribution losses and are partially borne by end consumers through their bills. The transformers will continue in operation for the foreseeable future as it is not economically efficient to replace transformers with significant useful life remaining.

SGN is refurbishing a previous gas site at the same location into a residential complex connected to this heat network, with the aim to decarbonise it. This presents a unique opportunity for a demonstrator project to turn the concept into reality by using the power transformers' losses as a heat source for the local district heating network. During the Discovery phase, it was assessed that the transformer's waste heat is comparable to heat network heat demand.

Local authorities want to better understand the scale-up potential of the heat recovery for this transformers solution to their local buildings and how Alpha Phase outputs can feed into their LAEP to help compliance with government planning policy frameworks like Heat Network Zoning.

This project addresses all four themes:

1. Supporting a just energy transition, by avoiding cost burden on all consumers of upgrading networks to support the emerging scale-up of Heat networks in the UK

2. Preparing for a Net Zero power system by using heat flexibility (through thermal storage) to optimise the use of waste heat within heat networks

3. Improving energy system resilience and robustness by harnessing the potential of network assets (transformers) and their respective heat losses to deliver back heat when heat networks need it

4. Accelerating decarbonisation of major energy demands by facilitating the access to decarbonised sources of heat at lower cost, needed to deploy more sustainable heat networks at scale. Full Circle wants to improve the efficiency of heat networks to make heat networks cheaper and more accessible for end consumers while also tackling the challenges of the DNO.

The techno-economic appraisal carried out in Discovery Phase has presented a strong case for the opportunity at UK Power Networks' Wandsworth substation and the neighboring SGN Gasworks development.

This project is focused on solving the needs of all the stakeholders in this value chain: the heat network and property developers, electricity network and finally the end customers. For the heat network developers, ESCos and end customers they will benefit from improved coefficient of performance (COP) for the heating system all year round and reduced electricity and gas costs. For the electricity network, the benefits will come from reduced operating and maintenance (O&M) costs due to recovered waste heat.

Innovation justification

Although Full Circle spans across all four challenges, the primary challenge addressed is 4: Accelerating decarbonisation of major energy demands.

.If successful, the learning can be used to de-risk similar projects across the UK. The innovation of Full Circle is about bringing a

concept to reality on the network side in collaboration with new stakeholders. Full Circle will also test what potential regulatory and commercial arrangements are required to enable the scheme to be rolled out across DNOs.

Although heat recovery is a well-established concept, many past projects have not progressed further than feasibility study or experiments. This can be attributed to distance between power transformers and heat demand, as well as limited commercial viability.

This project has clear benefits as extracting the heat from the transformers will reduce peak operating temperatures, increasing asset life cycle. If most of the heat required for the end users heating comes from the transformers' waste heat, then less energy needs to be generated from higher cost and carbon sources. This is based on an average annual transformer heat volume and temperature recovery profile meeting 75.9% of the heat demand of 2,752 MWh with recovered heat of the site annual heat demand of 3,626 MWh.

During the Discovery phase, our techno-economic analysis has explored the potential capital and operating costs of the solution at high-level to give an initial estimate for both the DNO and heat network operator. Potential cost savings from selling heat for the DNO and reduction in fuel cost for the heat network operator were also estimated. Carbon reduction has been estimated for the heat network operator against the counterfactual of Wandsworth's heat network operating without heat recovery from transformers. These results are usually accessed separately by the two different stakeholders. No previous project has fully assessed these outputs to this level of detail.

The Full Circle project aims to evaluate a novel cross-vector strategy for implementing waste heat solutions scalable to various communities throughout the UK. To achieve this goal, the project will utilise a phased approach, starting with a technical feasibility study of the proposed design and culminating in a demonstrator as part of the Beta Phase. The project cannot be funded elsewhere within the price control or considered as part of BAUgiven the complexity and risk in approach, integration of technologies and business model. Therefore, the SIF provides the right approach, funding, and ecosystem for the project to develop in an agile way.

From a DNO perspective, transformer losses are typically rejected as heat and paid for by consumers through DUoS charges (counterfactual). Full Circle's heat recovery system provides an opportunity to reduce these losses and improve efficiency, whereas replacing old transformers would only reduce, not eliminate, losses and require significant capital costs. The Wandsworth development's selected hybrid gas boiler and air source heat pump solution was chosen over a full gas boiler or fully electrified heat network (counterfactual options) due to non-compliance with local planning requirements and prohibitive costs, respectively.

With regards to heat recovery options, the oil-water heat exchangers paired with a water-to-water heat pump were selected due to this option's most efficient heat transfer process, lowest costs and least impact on the site. This approach is easiest to upscale to meet potential increases in demand. Other alternative options were disregarded following an Integrated Risks Matrix assessment.

Impact and benefits (not scored)

Financial - future reductions in the cost of operating the network

Financial - cost savings per annum on energy bills for consumers

Financial - cost savings per annum for users of network services

Environmental - carbon reduction – direct CO2 savings per annum

Environmental - carbon reduction – indirect CO2 savings per annum

Revenues - creation of new revenue streams

New to market - services

Impacts and benefits description

Financial - future reductions in the cost of operating the network

The counterfactual baseline for UK Power Networks is the estimated four transformers' losses of circa 4,141MWh per annum and a peak loss of circa 1MW. The cost associated with these losses contributes to the cost of operating the network (DUoS charges). Full Circle will enable reduction of losses in real terms as waste heat is recovered for the heat network. The metric used for reporting this benefit will be the amount of heat supplied to the heat network, which is estimated to be 2,752MWh per annum; assuming a bulk heat offtake rate on a p/kWh basis and UK Power Networks may expect a revenue to cover the capital cost the infrastructure and a modest profit to cover the cost of service.

Active heat removal from transformers enabled by heat recovery might increase transformers rating and assets life cycle, and therefore delay or deferrer assets replacement due to ageing or requiring more network capacity, lowering the cost of operating the network. Both these cost reductions could translate in a reduction of DUoS charges for electricity consumers, subject to policy and regulatory investigations.

Financial - cost savings per annum on energy bills for consumers

The heat network operator will be able to pass on the reduction in the cost of operating the network to its consumers. The pre-innovation baseline is therefore the consumers heating bills based on the hybrid heat generation using electricity and gas, which is circa £300 per annum for each residential unit. Through transformer heat recovery, cost savings per annum on heating bills could be around £90 per annum for each residential unit (about 30%) or a total savings in heating bills of £60,000 per annum for 637 residents. 35% of the end consumers are the future residents of SGN's planned senior housing development (Vulnerable Customers).

Financial - cost savings per annum for users of network services.

The pre-innovation baseline for the heat network operator is a hybrid fuel supply of electricity and gas. The metric used for reporting this benefit will be the overall fuel cost for supplying heat. The initial forecast of reduction in fuel cost is estimated to be circa £60,000 per annum.

Environmental - direct CO2 savings per annum.

The counterfactual is the carbon emissions (i.e. the metric) associated with generating heat by air source heat pumps and gas boilers. The transformer heat recovery could significantly reduce the consumption of electricity and gas, which may lead to an initial forecast of carbon reduction in the order of 50% against the heat network's counterfactual.

Environmental - indirect CO2 savings per annum.

A previous UK Power Networks innovation project (Power TX RTTR) has identified that active heat removal from transformers may lead to transformer rating increases of up to 20%, leading to delayed or avoided new equipment/assets installed in the DNO's network, presenting indirect carbon savings. However, this benefit requires a detailed investigation in the Alpha Phase.

Creation of new revenue streams.

The pre-innovation baseline is no revenue received for waste heat generated from operating the network. Through Full Circle, UK Power Networks would sell waste heat and hence create a new revenue stream for the current business as usual (BAU). As stated before, the initial forecast of this revenue is approximately £70,000 per annum for Wandsworth substation. Potential revenue at UK Power Networks level will need to be investigated during Alpha through the work package for scaling-up and rolling-out opportunities.

New to market – services.

The pilot project through Full Circle at Wandsworth could potentially become the first service of supplying heat provided by a DNO to a heat network in the UK. If successful, this can de-risk similar projects across the DNOs.

Teams and resources

The project partners remain the same as in Discovery Phase as the team worked and collaborated well together:

- UK Power Networks, who have led multiple innovation projects, will provide the project management role throughout Alpha Phase. UK Power Networks has specific technical knowledge and expertise around transformers, operational procedures and regulatory and commercial perspective from DNO side.

- Arup will remain the engineering partner, focusing on developing the detailed design of the Transformer Heat Recovery Solution and the corresponding O&M framework. Arup have a wide experience in developing technical assessments for Heat Networks projects and have been involved with heat recovery feasibility projects in the past. Additionally, Arup also wish to leverage their knowledge of and involvement with the Government's Heat Network Zoning to support the investigation of scaling up and rolling out opportunities.

- SGN Commercial Services (SGNCS) have 80+ years' experience designing, building, operating and maintaining large utility infrastructure which extends to commercial structures, contracts, market revenue energy rates.

- SGNCS' role is facilitator, coordinator, and project manager of the delivery of the heat network technical solution and integration to the developer's site and customer utilisation of the waste heat. This includes easement, wayleave agreements, pipe route and plant location.

- They have experience in commercial solutions which will help to create the legal and commercial framework for BAU template creation. They are skilled at delivering innovative projects such as the first green gas into the UK's gas distribution system and the world's first 100% hydrogen network. They have technical experience approval and appraisal process of asset modification connected to utility networks.

- Delivery of the heat network will be supported by SGNCS JV partner Vital Energi working as subcontractors.

- Vital have 30 years' experience in design, build, operation maintenance metering and billing of DHN heat networks. They will set the design, performance and control specification of the heat exchanger to extract heat from the UK Power Networks transformers. They will also design the DHN infrastructure, thermal storage, heat pump sizing, metering demarcation, energy centre integration, ancillary controls and operating procedure.

- Their staff have key skills and experience in these areas supported by systems and processes to deliver. The success of the Discovery Phase has proven feasibility but the next step is to involve the property developer who will utilise the waste heat.

- The developer is a joint venture between SGN Place and Mitheridge who have appointed Atelier Ten as their technical representative and project partner.

- Atelier Ten are an environmental design consultant for sustainable buildings. Their role is to review the output data from the Discovery Phase on heat generation and energy type consumption which has a direct impact on the Dwelling Emission Rate (DER) and the Target Emission Rate (TER). Any changes will have a direct impact on the Standard Assessment Procedure (SAP) planning regulation compliance so they need to access this, change the energy strategy document and make a variation the planning application to stay compliant for approval by the local authority.

- Wandsworth Council has provided feedback on the solution from the council perspective and is happy to continue to be involved, enabling stakeholder engagement with LAEP. They will not be acting as an official partner, for Alpha Phase, but will enable communications between the project development and the local authority planning department to update them on potential changes.

In terms of external support needed, the plan for WP2 and WP3 is to have detailed discussions with both UK Power Networks transformer specialists and external transformer suppliers. The purpose of these discussions is to evaluate the technical feasibility of a solution for future transformers.

Project Plans and Milestones

Project management and delivery

The project is divided into seven WPs:

WP1 - Project Management (UK Power Networks): Managing project delivery, risks, communications, and meetings setup.

WP2 - Transformer Heat Recovery Design (Arup): Detailed design to Royal Institute of British Architects (RIBA) Stage 3 for both heat recovery systems and their integration to the SGN Gasworks Development heat network.

WP3 - Heat Integration Design (SGNCS): Detailed design of heat interface units that are on the heat network boundary with transformers. The transformer heat recovery design is an integral part of the heat exchanger integration to the district heat network. SGN will need to agree heat exchanger performance criteria and four corner temperature design of both the water and oil sections.

WP4 - O&M framework (Arup): Develop a complete and detailed O&M framework agreed by both parties, including requirements, procedures to be updates, plant replacement strategy plan.

WP5 - Commercial & Regulatory framework (UK Power Networks): Develop detailed commercial structure and contractual framework agreement in line with both parties' regulatory constraints. The WP will include two workshops held for UK Power Networks and SGN internal stakeholders: 1) Commercial structure options 2) Regulatory barriers and pathway forward.

WP6 - Scale-up/Replication (Arup): Understand and map-out with detail the replication opportunities for solution in UK Power Networks areas and calculate the respective network impact of and economic benefits.

WP7 – Energy Impact Assessment: Reviewing the reduction in carbon at the SGN site due to the proposed full circle design.

The leads for each deliverable in each WP are defined in the project management book and Gantt Chart.

There are a few interdependencies between WPs:

WP3 will be interdependent with WP2, since all the technical drawings and specifications are needed to proceed. Both WP2 and WP3 will feed into WP4, where the O&M framework is designed in detail. Closer and in-depth collaboration among the partners is expected in for detailed design (WP2) and commercial framework planning (WP5).

The approach taken towards project management is to use UK Power Networks' proven innovation governance framework, which includes stakeholder engagement, risk management, reporting, change control, documentation management. A dedicated project manager is responsible for managing project resources and the project activities on a day-to-day basis and engages with key internal and external stakeholders to advance the project. The project manager will also be responsible for providing accurate project forecasting and to ensure labour, material, contractors, and other costs are allocated to the project continuously.

The risk matrix in the Project Management book outlines detailed mitigation measures for these risks. UK Power Networks has a skilled project management team that will keep the risk log updated and raise any risks/issues during the weekly meetings as the project progresses.

The main risks are:

· The potential benefits on network O&M cost reductions might be lower than initially forecast for this specific site.

o Mitigation: The specific site considerations were identified and considered in techno-economic analysis during Discovery Phase. The techno-economic analysis results were evaluated by network planning but will be reviewed to ensure their accuracy and validity.

· Contractual agreement and operational procedures between UK Power Networks and SGNCS are not agreed in Alpha Phase.

o Mitigation: initial commercial framework and contract between the parties was drafted in Discovery Phase and initial engagements with respective areas have started.

· Regulatory barriers for DNO selling heat and approval for modification to transformers.

o Mitigation: Workshop with UK Power Networks regulation team planned for WP4;

There are no supply interruptions planned as part of this project.

The project will have a positive impact on existing and future energy consumers and their premises by providing them with reliable and efficient heating while reducing their energy bills and carbon emissions. The project will also engage with energy consumers by raising awareness of the benefits of waste heat recovery through continuous engagement with the LA, Wandsworth Council, where we will share the technical outputs of this project (WP6) and any commercial framework developed.

Key outputs and dissemination

The key achievements for the Alpha Phase are as follows:

1. Detailed design for transformer heat recovery – Arup is responsible, UK Power Networks accountable.

2. Heat integration design – SGN is responsible, Vital Energi (support and accountable).

3. Stakeholder engagement with transformer specialists to explore how active heat removal may increase asset rating and lifespan – Arup is responsible, UK Power Networks accountable.

4. Development of an O&M framework, including procedures between UK Power Networks and SGN – Arup is responsible, UK Power Networks accountable.

5. Development of a commercial framework, including a supply agreement between UK Power Networks and SGN – Arup is responsible, UK Power Networks accountable/support, SGN supports.

6. Mapping of scale-up and roll-out opportunities in UK Power Networks' areas and across the UK – Arup is responsible, UK Power Networks accountable/support.

7. Addressing regulatory barriers related to security of supply and selling heat as a DNO product – UK Power Networks and SGN, in collaboration with regulatory bodies and relevant stakeholders.

UK Power Networks, as the lead partner, will undertake the following communication and dissemination activities:

· Project Publication: All our Alpha Phase projects will be uploaded to the Smarter Networks Portal and feature on the UK Power Networks's innovation website with specific project learnings being disseminated at the IUK Show & Tell events.

· Social media: UK Power Networks will look to share project successes and discoveries via its social media channels with the possibility of publishing external media where appropriate.

· Dissemination Webinar: UK Power Networks will host an in-person event in London to disseminate the learnings and key outputs of all SIF projects to a wider audience. The webinar will provide an opportunity for stakeholders to learn about the project's progress and findings, as well as to ask questions and provide feedback.

Joint Press Release Development: UK Power Networks will explore the potential for developing joint press release with SGN and Arup. The aim of this activity is to increase the visibility of the project and its findings, as well as to promote collaboration between the project partners.

Commercials

Intellectual property rights, procurement and contracting (not scored)

The project will be using the default IPR arrangement between UK Power Networks and partners.

More specifically, Arup intends to develop a GIS mapping tool for scaling up and rolling out opportunities, which Arup will be the owner of the Foreground and Background IPR. For the Full Circle project's use, Arup would grant a royalty free licence to the project partners. This is aligned with the SIF IPR arrangement included in contracts with the Lead Partner.

Commercialisation, route to market and business as usual

To ensure new solutions and services can be quickly adopted into BAU, Full Circle will work with stakeholders throughout the project lifecycle through design and testing to ensure solutions are based on real BAU situations, particularly in the stage of detailed design during Alpha Phase.

Alpha Phase will also see the development of an O&M framework as well as a commercial and regulatory framework, to ensure this new service can be adopted into BAU practices.

The commercial and operational framework will be developed with BAU in mind to enable it to be scaled across the country with other DNOs, heat network operators and property developers. There are several real examples of Energy-from-waste (EfW) plants that typically have heat supply agreements with heat network operators, which can be used as a basis for these discussions. Part of the commercial options assessment includes brief engagement with such actors (EfW operators and heat network operators, such as Vital Energi, to understand the commercial structures in place. BEIS (now DESNZ) have previously issued template contracts for bulk heat supply which can be utilised and adapted as a BAU contract agreement.

Any market frameworks and incentives developed through this project will be made available to all market participants as part of BAU. The framework and findings can be used by any relevant party to undertake a similar project.

More specifically, an initial commercial framework and contract between the parties has been drafted in Discovery Phase, including:

· Commercial Structure

· Commercial Supply Agreement (draft based on the Government's heat supply agreement template)

Exploration of the wider economic benefits through increasing operating capacity of existing power transformers will be carried out in collaboration with UK Power Networks' transformer specialists.

Mapping of scaling up and rolling out opportunities will be conducted in Alpha Phase, as part of the route to market study.

The route to market could be for UK Power Networks to publicise these mapping for developers to view and make competitive connection applications for heat. A service contract will then be signed for the supply of bulk heat.

The success of Full Circle relies on:

- Continued service of the power transformers
- Heat recovery and integration design
- Appraisal and approval of transformer new design by UK Power Networks
- Agreed Transformer and heat exchanger system control and operating procedures
- Commercial viability

- SGN Gasworks Development
- Lease and easement agreements with UK Power Networks, SGN Place and Mitheridge
- Compliance with Part L SAP regulation and planning approval by WCC
- Supply agreement and procedures between UK Power Networks and SGN
- Implementation and operation of the designed systems

Policy, standards and regulations (not scored)

During the Alpha Phase, the project will gather requirements that include DNO regulations and policies, specifically in WP4 and WP5. The findings will be collated in reports, which will identify areas where existing or new policies could be developed to increase the success of the project and accelerate the route to market and scale. We do not anticipate that the demonstration will require derogation or exemption.

While local planning policies and building regulations could potentially hinder the delivery of the Beta Phase, the proposed energy solution is compliant with Part L SAP regulations and the London Betterment condition. The success of the Discovery Phase has improved the project's ability to exceed planning requirements. Therefore, we do not foresee this as an issue. Regulatory barriers will be mitigated through discussions with UK Power Networks' regulation teams and SGN as part of WP5. There are no barriers to the District Heat Network development. There are no legislative regulations within DHN technical standards just a suggested guidance standard to be adopted in the form of Chartered Institution of Building Services Engineers (CIBSE) Code of practice (CP1).

Value for money

After taking into account the contributions from Project Partners, the total project costs for the Alpha Phase amount to £463,123, with a total SIF funding request of £416,811. The Project Partners are contributing 10% of the total project costs through the provision of uncharged time, demonstrating their commitment to the project and providing value for money to customers.

Breakdown of costs and SIF funding:

UK Power Networks:

· Total £73,350

· Contribution £9,597 (13.08%) in labour costs

· SIF funding request £63,753

SGN Commercial Services:

· Total £99,772

· Total Contribution £17,550 (17.59%) including benefit in kind £4,877 in site visits and travel subsistence cost

· SIF funding request £82,222

Arup:

· Total £259,897

· Contribution £16,156 (6.22%) in site visits and labour cost

· SIF funding request £243,741

Atelier 10:

· Total £30,104

· Contribution £3,009 (10%) in labour costs

· SIF funding request £27,095

The project has the potential to provide value for money to consumers due to the following reasons:

· it can unlock a total consumer savings in heating bills of £60,000 per annum for the 637 units targeted by this heat network.

· As UK Power Networks could find an opportunity, from selling bulk heat, to cover part of the electricity network losses cost (Depending on regulatory decisions external to the project), which currently are borne by electricity consumers via their electricity bills (i.e. DUoS charges).

· There might be a potential opportunity to delay or avoid new equipment/assets installed in the DNO's network due to increase life cycle of assets.

The project objectives are aimed to be achieved through lean teams by defining project tasks concisely. The Alpha phase will be carried forward with the same partner organisations and individuals who have already led the project, which will reduce the time required to initiate the project. The project partners and subcontractors are highly experienced in the subject matter, which enables them to deploy their knowledge efficiently in the project. Additionally, the project partners are contributing resources at competitive market rates. It is expected that the project findings will offset the opportunity costs of the project participants who would otherwise use resources on other core business opportunities that enhance value.

Associated Innovation Projects

- ○ Yes (Please remember to upload all required documentation)
- ◉ No

Supporting documents

File Upload

Full Circle Show and Tell ENA.pdf - 1.8 MB
Full Circle End of Phase ENA.pdf - 2.8 MB
Full Circle_UKRI Mid Point Meeting_Jan 15.pdf - 1.0 MB
SIF Alpha Round 2 Project Registration 2024-01-25 9_37 - 73.3 KB

Documents uploaded where applicable?

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