

SIF Alpha R2 Close Down Report

Date of Submission

Jun 2024

Project Reference Number

10086459

Initial Project Details

Project Title

Full Circle

Project Contact

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Project Start

01/10/2023

Project Duration (Months)

6

Lead Funding Licensee

UKPN - London Power Networks Plc

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.

Performance and Outcomes

Project phase summary

Full Circle addresses Challenge 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 Distribution Network Operator (DNO).

Problem and evolution

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 this increases electrical peak demand on the electricity network. To reduce the impact on the electricity network by the decarbonisation of heat, supplementary heat sources for local heat networks are being explored, one of which is the heat losses experienced by distribution transformers.

During Discovery, our techno-economic analysis explored the potential capital and operating costs of the solution at high-level to give an initial estimate for both the Distribution Network Operator (DNO) and Heat Network Operator (HNO). Potential cost savings from selling heat for the DNO and reduction in fuel cost for the HNO were also estimated.

Alpha built on these initial findings and conducted a more detailed assessment of the heat recovery system. Through Alpha, the project delivered the initial design of the heat recovery system as well as its integration into the heat network. Further, the project partners engaged with various stakeholders to discuss the required commercial and regulatory framework, such that not only the pilot scheme at Wandsworth will be able to proceed successfully, but also, laying the ground for possible business-as-usual implementation.

Key innovative findings

Modelling and calculations show significant benefits from transformer heat recovery to supplement the heat pumps used for the heat network. However, some stakeholders have raised that a demonstration through installing and operating the real system will be critical, particularly to validate these calculated benefits. This will be delivered through a future implementation of the whole system.

Another innovative aspect was the development of a Geographic Information System (GIS) mapping tool to assess the potential scalability. Although the GIS mapping tool we developed can identify opportunities for replicating this pilot scheme, the stakeholders and the project team also recognise the assumption and gaps behind the mapping tool, of which some can be improved but some may rely on detailed study on a case-by-case basis.

User needs

Full Circle aims to improve the efficiency of heat networks to make them cheaper and more accessible for consumers while also tackling reducing the peak electrical demand for the DNOs. This project is focused on solving the needs of all heat network developers, property developers, DNO's and end customers.

The heat network developers and end customers 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 Operation and Maintenance costs due to recovered waste heat.

The needs of our users were addressed throughout the project by working in close collaboration with UK Power Networks to validate our approach and challenge our assumptions. The project team, maintained close contact with UK Power Networks and tested our findings in an in-depth commercial frameworks workshop and by attending a site visit to the Wandsworth substation.

Vital Energi were subcontracted to SGN Commercial services to offer their heat network expertise to the projects design solution. As a potential future user, we can be confident that this project aligns with their needs. Working closely with a HNO like Vital Energi will be important, should this project be taken forward.

To aide future work, the project team have developed a suite of products to inform decision making for Local authorities (LA), HNO's and other DNO's. This includes a transformer heat recovery brochure and a GIS mapping tool to inform users of the replication potential of this project. Several key assumptions were made to rank and categorise other transformers heat potential across UK Power Networks license area. Interest in the tool from several LAs has been high, however, we are hesitant to share the conclusions due to the lack of empirical evidence.

We believe that a demonstrator for waste heat recovery should be carried out to provide initial validation for the assumptions made in this project. It will also serve to give confidence to other users looking to replicate this work.

Our work has garnered a lot of interest from LAs and HNO's, but the installation work is reliant on acceptance by a DNO. DNO's play a key role in the energy sector, but they are not accustomed to selling heat as it will interrupt their revenue framework. More work needs to be done to develop a commercial structure that works for all parties.

Impacts and benefits

Full Circle has the potential to reduce the cost of operating the network by recovering waste heat from transformers to pre heat the feed to an Air Source Heat Pump in district heat networks, thus reducing demand at peak load times. This could reduce the need for network reinforcement which will avoid an increase in Distribution Use of System (DUoS) charges for electricity consumers

Through Alpha, the project had outlined a new housing development as the intended waste heat receiver. This development is still yet to receive planning permission from the local council due to factors outside the project scope. With no clear site for deploying the solution, the project team have decided that the risk is too high to apply to Beta at this stage. We believe it is most cost efficient to pursue this project with Network Innovation Allowance (NIA) funding to investigate the solution further and identify an alternative waste heat receiver.

In Alpha we modelled and calculated the expected impact, however, this requires further validation in a trial:

- The transformer heat recovery from all transformers on-site (through the water-to water heat pump) can meet 92% of the total heat network load, and could eliminate the use of gas boilers, which will solely be for backup and emergency purposes. This results in savings in the order of 62% for the heat consumers, even with the consideration of the initial capital expenditure, operational and maintenance expenses.
- The heat network operator could save up to £60,000 per year on fuel costs due to a reduction in the use of electricity and

gas. The heat network operator could pass on the cost savings to consumers, potentially saving each residential unit up to £90 per year on heating bills.

- Transformer heat recovery could significantly reduce electricity and gas consumption, leading to a forecasted carbon reduction of 27% for the whole development. Active heat removal from transformers could also lead to delayed or avoided new equipment/assets installation, presenting indirect carbon savings.

- The total estimated cost of installation of the heat recovery system would be £470,318. With an estimated replacement cost of £271,000 every 20 years. The payback period would be approximately 10 years, using the assumed revenue from the heat tariff (£70,028 per annum)

Risks, issues and constraints

One key risk of the project from the start has been getting buy in from senior members of UK Power Networks. In 2015, a similar project was carried out by UK Power Networks in partnership with the Tate Modern. In this project, excess heat was extracted from nearby transformers to directly heat the central heating system of the Tate Modern. Due to the direct reliance on the transformers' waste heat, there was not enough heat supply to the building which significantly limited the project success.

Another key risk is the planning approval for the SGN development. Due to the planning process, this development is still yet to be signed off by Wandsworth council, which will lead to a delay in when construction will start. There is a risk that the eventual timelines do not align with the fixed duration of a Beta project. Considering this impact, the project partners have explored alternative heat off takers, within a reasonable distance of the Wandsworth Substation. Two feasible options are a nearby housing development currently being constructed and an existing fossil fuelled development that already uses a heat network could be converted to take the transformer waste heat.

Both these alternatives will not have the same benefits as set out in the Alpha modelling and calculations. There is also no guarantee that they would want to be a part of this project. Proceeding with this project as NIA will allow the parties greater flexibility in how they engage with the heat offtake customer.

The transformer replacement strategy of UK Power Networks will also pose a risk to the long-term benefits of this project. Newer transformers are more energy efficient than older ones, which will mean that less heat is dissipated, thus rendering the heat recovery system inefficient.

Key regulatory requirements

It was recognised that the sale of waste heat recovered from power transformers is outside the DNO's day-to-day operation of distributing electricity to consumers. Therefore, we reviewed 'Electricity Distribution Licence Special Condition: Directly Remunerated Services 15 Miscellaneous'. Which we believe to permit a DNO to sell the waste heat from its transformers.

We would like to consult with Ofgem on the appropriate approach or licence condition such that the sale of waste heat from transformer can be considered as part of the DNO's Distribution Business Activities. This will need to be agreed prior to commencing work.

Working in the open

Dissemination of Full Circle learnings

- Presented at the Net Zero Networks event (21/02/2024) to Innovate UK representatives, members of Ofgem, partners of other SIF projects and other industry stakeholders. Full Circle was well received by the audience and saw good engagement in the Q&A.
- An overall project summary will be published on UK Power Networks' Innovation microsite.
- Findings, outcomes, and learnings from the project were presented with questions answered as part of the Show and Tell presentation in the "Unlocking flexibility for heat decarbonisation" session (24/04/2024).

Inviting engagement and challenge

- Held a customer journey workshop with key representatives from Regulation, Planning, Communications, Connections, Design and Innovation in UK Power Networks, as well as relevant SMEs from project partners. The session allowed the project party to be challenged on all aspects of the project and how it could be rolled out as Business as Usual (BAU).
- All technical drawings were reviewed by UK Power Networks' Asset Management team, feedback was acted on by the project team to ensure all deliverables were completed to UK Power Networks' standards.
- Upon completion of the GIS-based mapping tool, a workshop was held with the project party and different teams within UK Power Networks. This session allowed the project to take on board valuable feedback and understand how different teams might use the tool in the future.

Replication

- Held several meetings with different LAs across London and the South East to inform them of the work we were doing and the chances for replication in their regions.
- Spoke with leading transformer manufacturers about the potential replication of this work and how retrofitting new builds could alleviate the effort and cost of future projects.
- Proactively connected with the team conducting the North-East Square Mile Heat Network Feasibility Study to identify how learnings can be shared. This shows that the project could have far reaching benefits and that there is interest across industry.
- The GIS based mapping tool will be used by the UK Power Networks' Distribution System Operator (DSO) team to inform their conversations with LAs. The mapping tool is only suitable for providing an initial high-level scan of the potential for waste heat recovery from power transformers. This can serve as a starting point to identify areas of interest, which need to be followed by specific studies on a case-by-case basis.

Costs and value for money

The project was awarded £416,811 of SIF funding. The costs and funding were split between UK Power Networks, SGN Commercial Services, Arup and Atelier 10.

After taking into account the contributions from Project Partners, the total project costs for the Alpha Phase amount to £447,785, with a total SIF funding request of £401,563. The Project Partners contributed 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. All work packages

were completed within the allocated project budget.

The project has represented value for money for the consumer because:

- The project partners brought previous experience, industry knowledge and stakeholder contacts to the project. SGN Commercial Services subcontracted work to Vital Energi throughout the project which allowed them to utilise specialist knowledge in relation to the project.
- The project has been well managed financially. All cost were agreed contractually prior to starting any work.
- The project objectives were achieved by a focused project team which defined project tasks concisely and collaborated in delivery. The Alpha Phase was carried forward with the same partner organisation's and individuals who have already led the Discovery Phase, which reduced the time required to initiate the project.
- The project partners and subcontractors are highly experienced in the subject matter, which enabled them to deploy their knowledge efficiently in the project. Additionally, the project partners contributed resources at competitive market rates.

Special conditions

Condition 4: Summary of how any learnings from similar schemes and projects in Europe and Scandinavia are being incorporated into the Project.

We have fulfilled this condition and a summary of learnings was presented as part of work package 6 before the project finished. The similar schemes are:

- A research project completed in conjunction with the Technical University of Denmark analysed voltages in power transformers across the grid in Denmark and evaluated the excess heat available using thermodynamic processes.
- The Swedish Transmission System Operator, Svenska kraftnat is working with energy provider Stockholm Exergi to implement heat recovery at a new power substation being constructed in Stockholm – Substation Skanstull. This was constructed with an integrated cooling and heat recovery system.
- REWARDheat – Renewable and Waste Heat Recovery for Competitive District Heating and Cooling networks – is a project working on the development and installation of 8 different district heating networks in different European cities which are being used as demonstration networks to prove the systems work commercially.

Condition 5: Explanation as to whether the Project plans to broaden its focus beyond the Wandsworth substation to more broadly examine the risks associated with network upgrades and asset replacement. Outline how its proposed solution could be applied

more widely than the Wandsworth substation.

We have fulfilled this condition and a case for expansion was presented at the mid-point meeting of the project with representative for Innovate UK in attendance. Work package 6 has expanded upon the initial findings to develop a GIS based mapping tool. The GIS based mapping tool is capable of identifying the replication opportunities not only on a substation-by-substation basis but also on a LA by LA basis. The lists of opportunities have been produced based on the current information available have been produced respectively. The GIS based mapping tool is also capable of ingesting new datasets regularly to enable regular updates to the lists of opportunities.

This tool will be used to demonstrate the replication potential of this project to other LAs who have shown interest throughout the project. Additionally, SGN Commercial Services are also actively evaluating opportunities that may be linked to their development sites both inside and outside of UK Power Networks's license area.

In summary, although we are not applying for Beta Phase due the planning permission delays, the project partners will closely investigate both the Wandsworth opportunity and other opportunities to implement the solution developed through Full Circle.

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File Upload

No documents uploaded

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