



Full Circle End of Phase Meeting

Sofia Goncalves, UK Power Networks

Yutian Zhou, Arup

Robert Smyth, SGN Commercial Services

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Final update on project plan

Work package (WP)	Tasks	Lead	Dependencies/Engagement	Deadline	Status
WP1 – Transformer impact assessment and implementation	Transformer data input and reviewed engineering requirements and risk assessment completed Business as Usual (BAU) implementation developed	UK Power Networks	Network Planning team Technical Sourcing & Standards Team	30/04/23	Delivered
WP2 – Development site heat demand profiles	Provide heat demand data for evaluation against waste heat data from the electrical transformers	SGN Commercial Services (SGNCS)	Vital Energi (subcontractor)	30/04/23	Delivered
WP3 – Heat and transformer data analysis and Cost Benefit Analysis (CBA) development	Arup will model, evaluate and analyse the data sets, identify heat interface and offtake options, identify the costs, benefits and risks of the options and recommend a solution	Arup	Network Planning team	30/05/23	D1-D4 Delivered
WP4 – Customer benefits and dissemination	Understand the benefits of the proposed heating design on customer bills; Local Authority input into Local Authority Energy Planning (LAEP) and implications and input on scalability of the project to other sites	SGNCS	Wandsworth Council	30/05/23	Delivered
WP5 – Project management	Project progress management against objectives, risk register monitoring. Management and interaction between the Project Partners and UK Power Networks business units and external stakeholders	UK Power Networks	Legal & Procurement/ PM support	30/05/23	Delivered

Discovery Deliverables

Deliverable	Format	Lead
WP2- D4,D5 Heat Load Report + System and thermal store capacity	PDF	SGNCS
WP3- D4- Techno-Economic Analysis report (Public issue)	PPT	Arup
WP3 D2- Proposed pipe routes	PDF	SGNCS
WP3 Deliverables - Heat losses calculations	excel	Arup
WP3 Deliverables –IRM -Integrated Risk Matrix	excel	Arup
WP3 Deliverables -Options Schematics (3x)	PDF	Arup
WP4- D2- report Customer benefits	PDF	SGNCS
End of phase meeting slides	PPT	UKPN
Show n'Tell Slides	PPT	UKPN

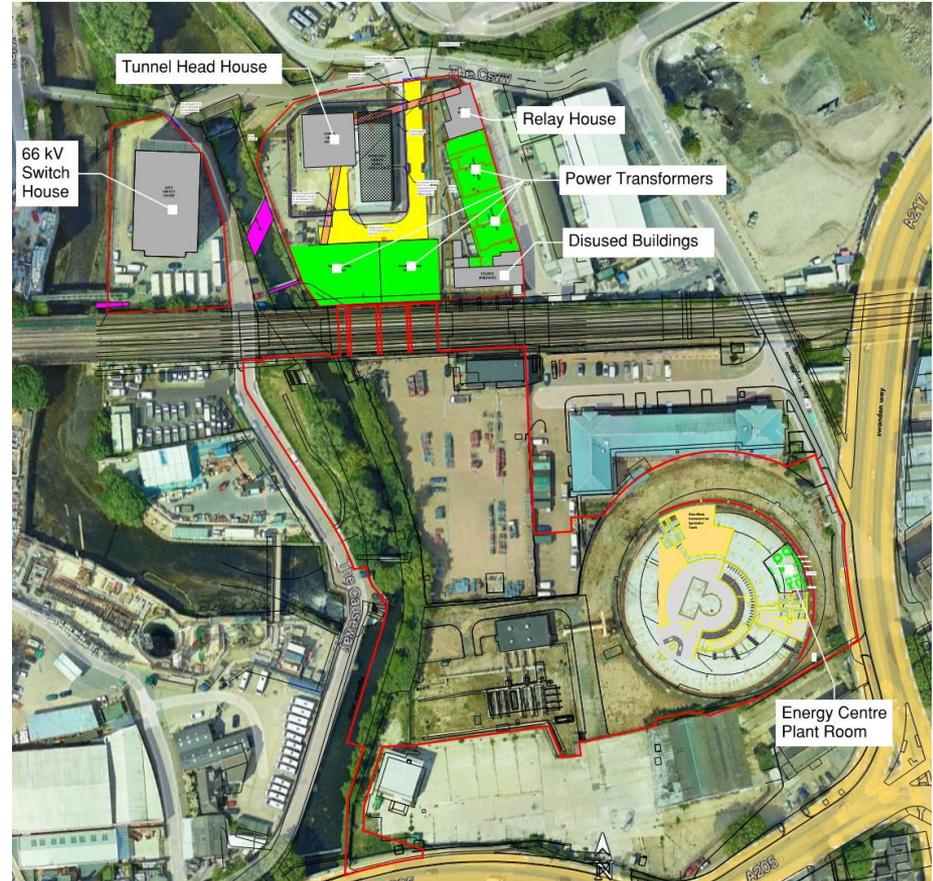
Project outputs - Opportunity

The overlaid satellite image on the right-hand side demonstrates the layouts of the SGN development and the UK Power Networks substation.

The locations of transformers, plant room, and buildings are labelled.

The **success of Full Circle** relies on:

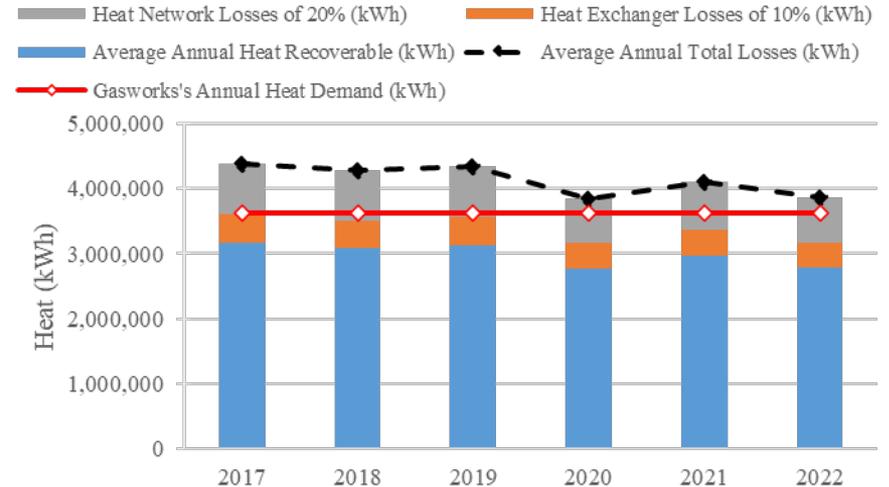
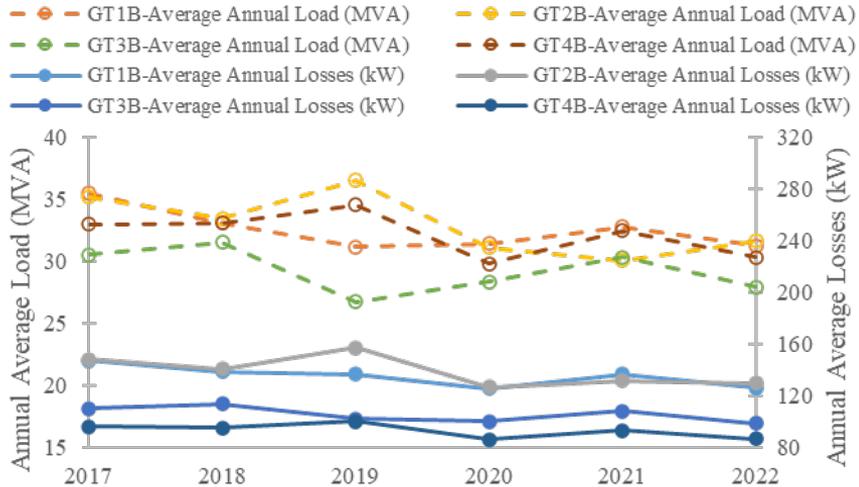
- Continued service of the power transformers
- Heat recovery and integration design
- SGN development
- Supply agreement and procedures between UK Power Networks and SGNCS
- Implementation and operation of the designed systems



Project outputs – Counterfactual

The “do nothing” scenario, i.e. no heat recovery, the average losses of the four transformers per annum is **4,141,346 kWh**.

The annual heat demand of the SGNCS Gasworks development is estimated to be **3,626,350 kWh**.



Project outputs – Option Appraisal

Four options for heat recovery have been assessed through an Integrated Risk Matrix, in order to evaluate their merit for application in the Full Circle project. The option of oil-to-water heat exchanger with the lowest weighted average score of 1.45, is considered the most appropriate technology for this specific application, whereas Organic Rankine Cycle is the least suitable option.

	Efficiency	Site Impact	Operational Impact	CAPEX	OPEX	Carbon Reduction	HX Scalability	Weighted Average Score
<i>Weighting Factor</i>	30%	5%	15%	10%	10%	25%	5%	100%
Oil-to-water HX	1.0	2.0	1.0	1.0	2.0	2.0	2.0	1.45
Air-to-water HX	3.0	4.0	4.0	3.0	4.0	4.0	4.0	3.60
Direct Contact w/ Air Cooler	2.0	3.0	3.0	2.0	3.0	3.0	3.0	2.60
Organic Rankine Cycle	5.0	5.0	4.0	5.0	5.0	5.0	4.0	4.80

Project outputs – Initial Economic Appraisal

The costs for installing and operating the heat recovery systems expected at **UK Power Networks' Wandsworth** substation are summarised as follows:

- CAPEX: £263,780 for heat recovery four transformers
- REPEX: £249,780 every 15 years
- OPEX: £10,104 per annum

Assuming a non-disclosed bulk heat offtake rate, UK Power Networks may expect a revenue of £68,810 per annum.

UK Power Networks may have over 2,000 power transformers similar to those at its Wandsworth substation currently in service across its distribution network.

Note: assuming a bulk heat supply/offtake of 2,752,399 kWh

The costs for installing the pipes and plants at the **SGNCS Gasworks development** end are expected to be as follows:

- CAPEX: £250,000
- REPEX: £187,500 every 20 years
- OPEX: £5,000 per annum

The development can expect savings of £57,164 per annum in its fuel costs (including electricity, gas, and heat).

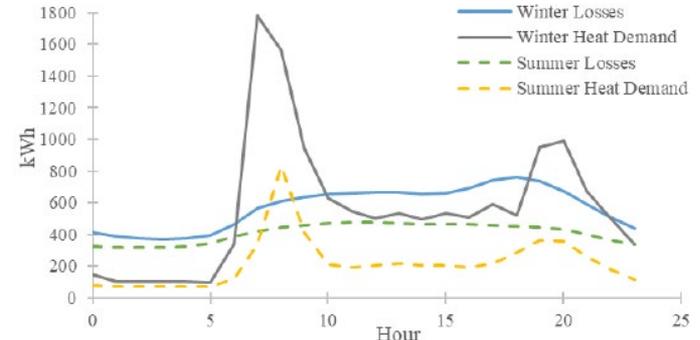


Figure 2.5.1 – Comparison of seasonal demand against seasonal transformer heat losses

Benefits analysis for end customers

The transformer heat could deliver 75.9% of the site heat demand and could reduce customers' bills.

Heat Demand Total/home	kWh	3,500	100%	
Heat Demand Waste	kWh	2,657	75.9%	
Heat Demand Generated	kWh	844	24.1%	
Waste Charge	£	£ 133		
Generated Charge	£	£ 72	Previous charge	Savings
Cost	£	£ 205	£ 298	31%

This is a 31.2% saving on energy bill (£92.91). The total savings that can be delivered by heat recovery to the 637 homes will be £59,184 per annum.

CO2 Savings

Generation fuel source	Gas boiler Co2 tones	Hybrid Co2 t tonnes	Transformer Co2 tonnes
Gas	807.23	80.23	0.26
Electricity	0.000	178.55	122.32
Total carbon tonnes	807	259	123

Carbon saving of 53% when compared to the current hybrid and 85% based on a gas counterfactual.

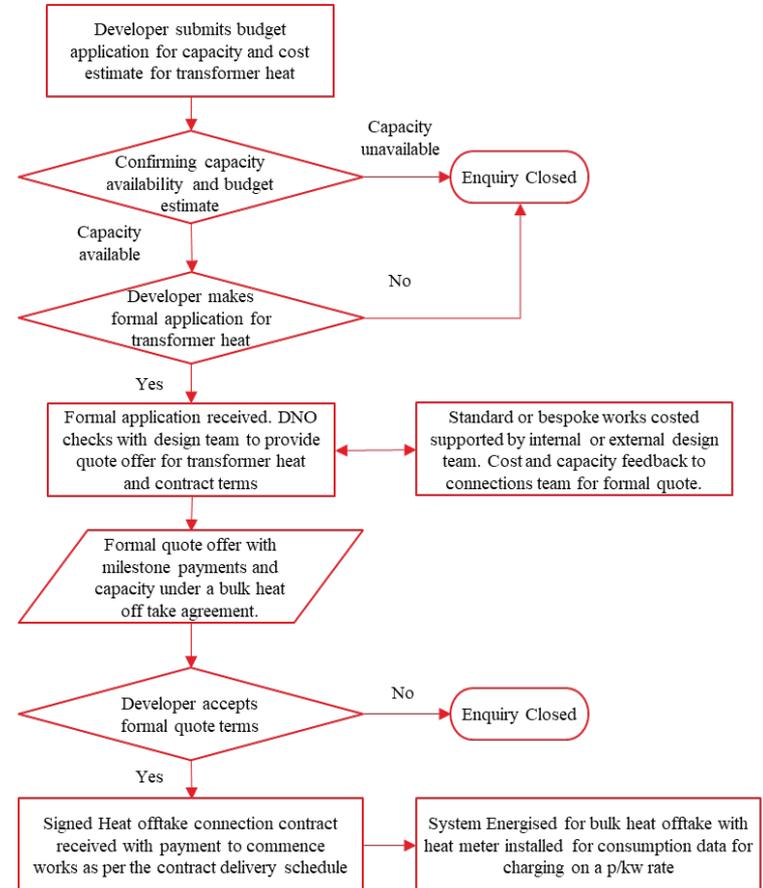
Project outputs – Route to Market

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.

An initial commercial framework and contract between the parties has been proposed in Discovery Phase, including:

- Commercial Structure
- Commercial Supply Agreement (based on the Government’s heat supply agreement template)- commercial arrangement that regulates supplies between generators and network operators of the heat network.

As part of the Alpha Phase, we will identify all substations that are suitable for heat recovery, expected to include over 2,000 power transformers.



Lessons Learnt in Discovery

- The technical and commercial viability of the heat recovery scheme at Wandsworth was demonstrated
- Engagements with transformer specialists, heat network operator, and suppliers went well, and contributed to the success of the project
- Site visit helped bridge the gap in information
- Regularly progress meetings and effective communications across the partner teams
- Closer and in-depth collaboration among the partners are expected in Alpha Phase for detailed design
- The team understood the new resources and expertise needed in Alpha Phase, which will require more coordination and management between partners
- The project partners for Discovery Phase performed well and are expected to form the same partnership for Alpha Phase. Additional partners will be invited for Beta Phase as appropriate depending on the scope development
- Key risk mitigation activities to include in next phase: site visits, investigations, contractors' engagement.

Barriers, risks, issues that we identified and overcame

Risks:

1. Discovery Phase/Alpha Phase: The potential benefits on network operation and maintenance cost reductions might be lower than initially forecasted for this specific site.

Mitigation: The specific site considerations were identified and were considered in techno-economic analysis.

2.Alpha Phase: Supply agreement and procedures between UK Power Networks and SGNCS are not agreed in Alpha Phase

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

3. Beta Phase: Significant technical and operational challenges to implement solution on existing transformers in UK Power Networks' substation in Wandsworth

Mitigation: Early engagements with asset engineers and site visit taking place before Alpha Phase.

Meeting project specific conditions

Discussions with project lead for 'Carnot Gas Plant' (SIF project from SGN) took place. These discussions covered heat generation, heat utilisation and storage. Systems based on different generation models, so not a common process. Comparison analysis of the two different projects in the following table:

Heat	Full Circle	Carnot	Comments
Heat Generation	Continuous baseload heat generated as a waste buy-product of base and peak load electrical distribution from transformers.	Intermittent heat generation and storage system only utilised during low ½ hourly electrical wholesale prices.	Carnot battery is intermittent generation as cost where transformer heat is baseline waste heat at no additional cost.
Heat utilisation	Direct heat utilisation at time of generation with small storage for delayed release.	Heat is thermally stored with delayed release.	System have different heat storage approach. Full circle uses energy at time of generation and storage is secondary. Carnot is a primary function.
Storage	Storage capacity is quite small	Larger storage system required.	Different thermodynamic models.

Full circle is base load heat generation with secondary thermal storage and Carnot is intermittent generation with primary heat storage so different operating models. There may be common approaches on thermodynamics when sizing thermal storage.

Comms and engagement plans going forward

- UK Power Networks, as the lead partner, will publicise key learnings from Discovery Phase
- Organise a “Show and Tell” for Local Authorities that are interesting in using waste heat for Heat Networks, depending on interest and successful bid
- Alpha Phase: Organise a dissemination webinar for Heat Network projects stakeholders
- Explore the potential for developing joint press release between UK Power Networks, SGN Commercial Services and Arup

Plans for Alpha / what is next

- High level plan for Alpha Phase; Milestones will be defined in the application to Alpha Phase.

Ref	Work Package Title	Partner Responsible	Duration	Key Tasks
WP1	Project management	UK Power Networks	6 months	Project Governance – financial, roles, risk matrix, setup communications and meetings
WP2	Transformer heat recovery design	Arup	5 months	RIBA* Stage 3 design package (drawings, scope of work, requirements, etc.), tender package, specs, techno-economic model to assist commercial package WP5;
WP3	Heat integration design	SGNSC (Vital Energy support)	2.5 months	Detailed design of heat interface unit with transformers, pipe design and distribution, lease and easement pipe route, new water to water ancillary controls, capital cost modelling, energy consumption and operation modelling, thermal store and thermodynamics
WP4	Operation and maintenance framework	Arup	2.5 months	Development of framework, functional description specification; RACI Matrix; operational and plant replacement strategy; Policies and Operational procedures to be modified
WP5	Commercial and regulatory framework	UK Power Networks (SGNSC support)	3 months	Detailed proposal of the bulk heat supply off-take agreement between parties. SGNSC to build commercial structure and feed into contractual framework template
WP6	Scale-up/Replication	Arup	3 months	Focus on UK Power Networks area - GIS maps for asset and opportunities. Engagement with transformer manufacturers (limited to 3). Provide technical details to assist communication with wider local authorities

*Royal Institute of British Architects (RIBA)



THANK YOU
