

Heatropolis Beta

Trial Strategy

Project deliverable D.3.1.1 (a)

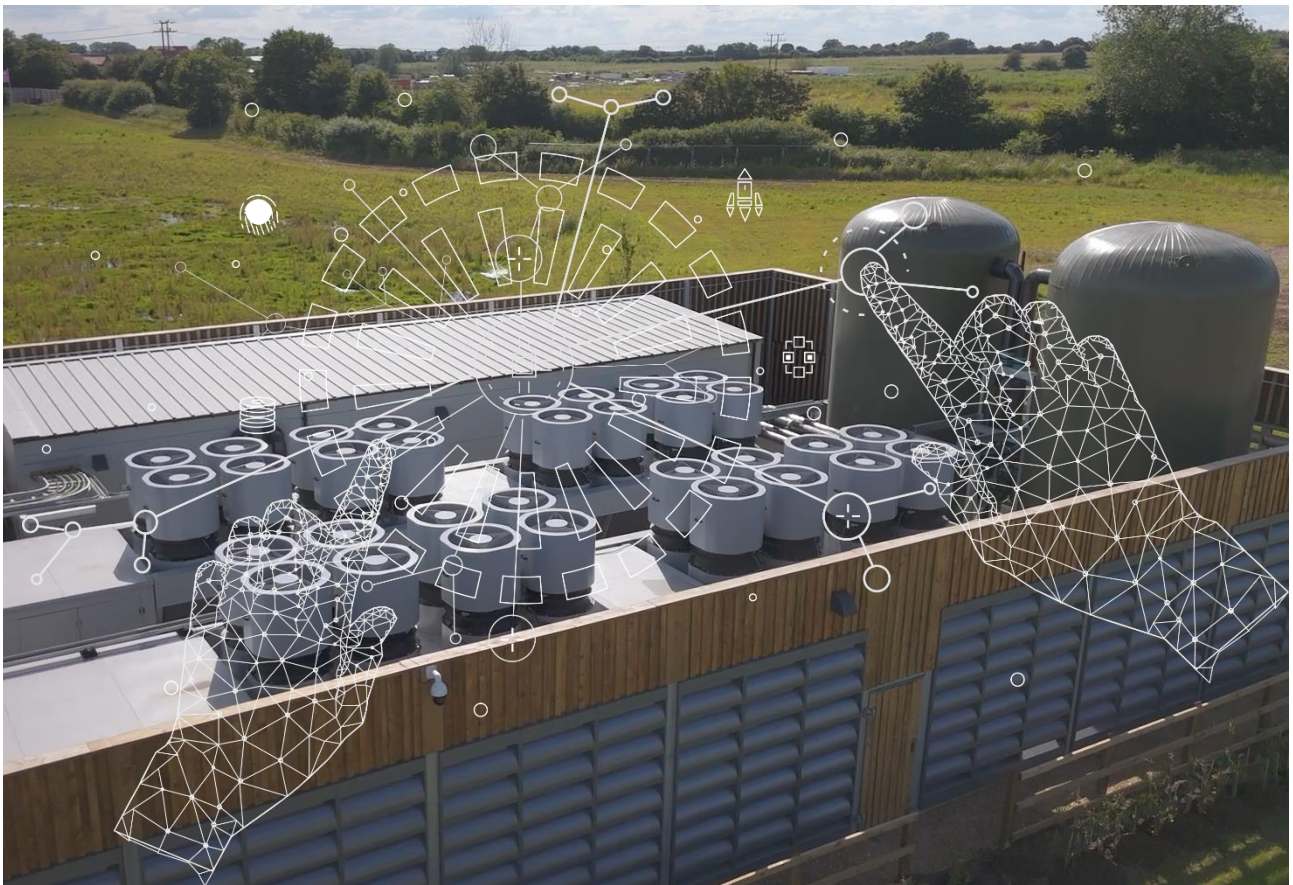


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Executive Summary

Heatropolis is an industry-led innovation and demonstration project focused on low-carbon heat networks. It brings together key partners from across the energy sector: including UK Power Networks, Passiv UK, Metropolitan, and Guidehouse, bringing market leading industry expertise in technology, energy distribution, heat network design, smart controls, and advisory services.

This report, a key deliverable of the Ofgem Strategic Innovation Fund (SIF) Heatropolis Beta project, presents a high-level design of the technical framework that will be used to deliver three field trials.

The Climate Change Committee estimates that by 2050, around 18% of UK heat demand could be met by heat networks, a significant increase from the current 2%¹. While many existing networks still rely on fossil fuels, future systems must become carbon neutral. The Department for Energy Security & Net Zero (DESNZ) anticipates that the electrification of heat will significantly increase the demand on the electricity network², creating important new challenges and opportunities for Distribution Network Operators (DNOs).

Currently, there are limited commercial incentives for heat networks to manage their electrical load in line with network constraints. As a result, unmanaged growth in electrically powered heat networks could lead to reinforcement costs being passed on to end consumers. Heatropolis directly addresses this issue by demonstrating how technical and commercial innovations can unlock flexibility within heat networks.

Building on modelling from previous SIF phases, which showed the technical potential of heat network flexibility, the project will conduct live trials using real assets. These trials will generate evidence to inform future heat network design and operation, and how these systems can be integrated more effectively with electricity distribution networks. Across three winter trial periods, Heatropolis will test novel commercial and technical approaches, with the aim of establishing a replicable model for business-as-usual adoption and benefit realisation.

To ensure scalability and relevance, Heatropolis will trial solutions across three representative heat network archetypes:

1. Large-scale mixed-use commercial and residential developments
2. Low-density residential areas
3. Residential buildings with multiple occupancy

Each archetype requires tailored technical and commercial solutions. For example, larger sites may be able to deploy greater levels of automation and controls, whereas smaller sites may require simpler technical solutions, to provide these end-customers access to heat flexibility.

¹ [Energy Security Bill factsheet: Heat networks regulation and zoning](#)

² [Smart Secure Electricity Systems Programme: Energy Smart Appliances](#)

The Heatropolis approach addresses a critical market failure: today, heat and electricity networks rarely interact beyond their physical point of connection. By leveraging digital controls, communication protocols, and data exchanges, Heatropolis will develop an end-to-end framework that facilitates meaningful integration between these systems. This will create opportunities for greater efficiency and shared value.

The proposed framework links DNO's directly to heat network energy centres, opening an opportunity to explore how flexibility signals can be efficiently communicated. For example, signals can be responded to through centralised heat pumps, electric boilers, and thermal storage. Additional flexibility can also be aggregated from thermal inertia using end-point controls across both residential and commercial premises.

This report is intended as a valuable resource for any Distribution Network Operator planning for the expansion of low-carbon heat networks. While the trial designs reflect the specific context of Heatropolis and its partners, the underlying principles and solutions are relevant to all DNOs and Heat Network Operators (HNOs) preparing for a low-carbon future.

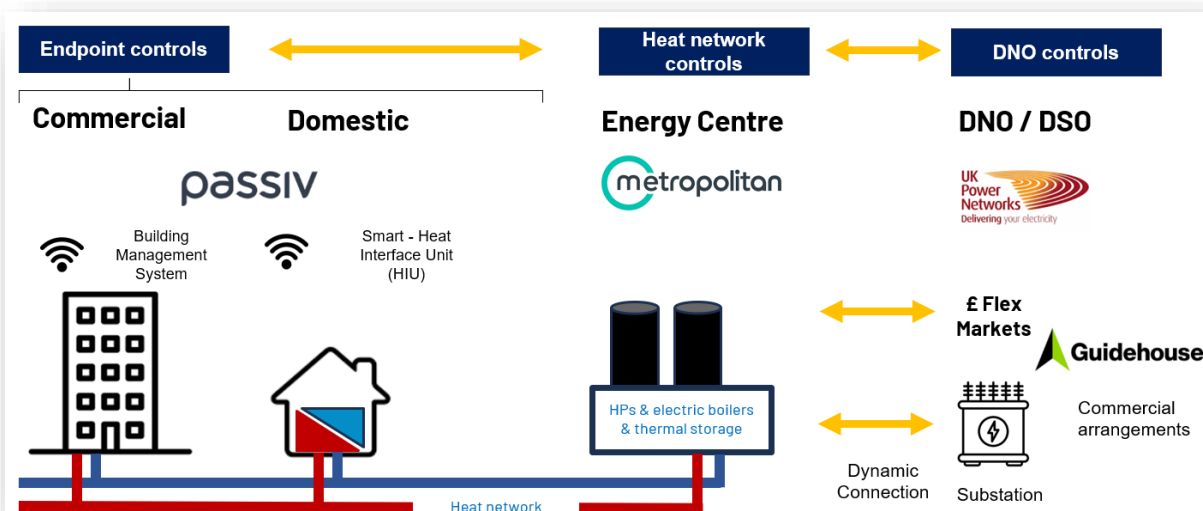


Figure 1. A combination of energy centre and end-point controls can be leveraged to unlock flexibility

1. Background and Purpose

This report is a key deliverable of the Ofgem, Strategic Innovation Fund (SIF) Heatropolis Beta project and provides the output of the work completed in the first months to design the trials and specify the technical framework that will be implemented to conduct each of the field trials.

The aim of the Heatropolis Beta project is to demonstrate the use of novel commercial and technical arrangements to unlock heat network flexibility. Intelligent design and operation is expected to accelerate decarbonisation of heat networks, delivering flexibility and load reduction to drive Distribution Network Operator DNO reinforcement cost savings.

1.1 Introduction to Heatropolis

Heatropolis is an industry led, low carbon heat network innovation and demonstration project that brings together partners from leading technology, energy distribution, heat network design smart control, and advisory services organisations, including UK Power Networks, Passiv UK, Metropolitan and Guidehouse.

Table 1. Heatropolis Project partners

Partner	Description	Role
 UK Power Networks Delivering your electricity	The UK's largest Electricity Distribution Network Operator (DNO) delivering power to 8.5 million homes and businesses across London, the East and South-East of England	Provide networks expertise and will develop new digital customer tools for DNOs and HNOs Ensure a seamless and successful transition to Business as Usual (BaU).
 metropolitan	A leading provider of district heating, with capabilities covering complete utilities infrastructure solutions from initial design through to live network operation of a development including district heat, electricity, water, wastewater and gigabit fibre.	Apply design engineering to optimise network performance and cost-efficiency. Provide commercial and legal input on heat network business plans, leveraging planning and regulatory expertise to support network ownership and operation.
 passiv	Developer of advanced heating control systems, aggregation and flexibility services. Over a decade of experience delivering major network innovation projects.	Lead trial strategy and design for smart controls across heat network archetypes, supporting control system development and overseeing data setup for flexibility testing.
 Guidehouse	Brings global experts supporting utilities, regulators, and governments on energy transition challenges. Guidehouse offers deep expertise in innovation programme design, regulation, market design, and stakeholder engagement to navigate project complexities.	Lead engagement with Project Partners and industry stakeholders to secure buy-in and maximise project learnings through effective knowledge sharing. Support customer engagement by designing and implementing activities and analysing feedback to improve trial processes and outcomes.

The transition to low-carbon heat networks will play a critical role in decarbonising how we heat homes and buildings across the UK. However, there is currently a disconnect between HNOs and DNOs in both planning and operations. Left unaddressed, this misalignment will lead to inefficient investment, operational challenges, and increased costs for consumers.

Heatropolis Beta is a pioneering trial aimed at addressing this gap. It will demonstrate how smarter heat network design and operation can offer greater flexibility and reduce peak electricity demand, helping to avoid expensive reinforcement of the electricity network. The project will explore long-term commercial arrangements that will be needed between heat and electricity infrastructure, recognising their growing interdependence in delivering a net-zero energy system.

To achieve the UK's Net Zero targets, nearly all buildings must shift away from fossil fuel-based heating. While heat networks currently supply around 2% of the UK's heat, the Climate Change Committee and UK government envision this rising to as much as 18% by 2050. This growth will have major implications for both heat infrastructure and electricity networks.

Historically, heat and electricity systems have been planned and operated largely in isolation from each other. Most existing district heating networks are fossil-fuelled and operate at high temperatures, but the future lies in low-carbon, lower-temperature systems, primarily powered by electricity. This transition will increase the coincidence between peak heat and electricity demand, intensifying the constraints on the electricity network, particularly during winter.

To help reduce reinforcement costs and seasonal constraints, new approaches are needed to align the investment strategies of heat network developers with those of DNOs. Although technologies and control systems already exist to manage heat network loads flexibly, cheaper, less responsive alternatives are favoured instead. This is due to the limited amount of long-term commercial incentives that adopt more flexible designs at the outset.

At present, heat network developers typically only need to declare their peak electrical load to the local DNO. Although options such as non-firm connections and flexibility products are available from the DNO, they offer limited practical benefits to heat network operators, primarily related to shorter connection times. As a result, opportunities to deliver mutual benefits through coordinated network operation remain constrained.

Heatropolis Beta aims to trial novel technical and commercial frameworks that will enable heat network operators to design systems that deliver both decarbonisation and grid value. Our core hypothesis is that coordinated planning, and operation will help accelerate the transition to low-carbon heating while reducing DNO reinforcement costs, creating a smarter, more integrated energy system for the future.

The project is set to design, implement, and evaluate a suite of innovative technical and commercial solutions that augment existing energy network practices. These solutions will be tested through a new techno-economic framework to enable integration between heat networks and electricity networks, underpinned by state-of-the-art automation and digitalisation practices.

On the technical side, the project will enhance network design engineering—particularly through increased deployment of dedicated thermal storage—and trial the use of advanced machine learning-based control systems. These digital tools will link electricity networks to heat networks, and further, to end-user systems, enabling more intelligent and responsive operation.

The commercial solution will explore non-firm connections and new flexibility products, alongside the creation of integrated business cases for Distribution Network Operators (DNOs) and Heat Network Operators (HNOs). These business cases will propose new value allocations to support commercial feasibility. Trials will run across three winter heating seasons, enabling iterative testing and evaluation of the framework.

1.2 Heatropolis in the Broader Project Context

While the trials are a central project component, they are not the project's sole activity. Heatropolis Beta comprises eight work packages (WPs):

- WP1: Project Management
- WP2: Commercial Arrangements and Business Case
- WP3: Trials Strategy and Design
- WP4: Trials Build and Evaluation
- WP5: Digital Customer Tools
- WP6: Customer Engagement and Recruitment
- WP7: External Stakeholder Engagement and Knowledge Dissemination
- WP8: BaU Transition and Regulation

The trials are the primary focus of WP3 and WP4. They are designed to:

- Generate data to calibrate commercial and technical models,
- Demonstrate peak electrical load reduction and load shifting in response to flexibility arrangements
- Showcase optimisation and flexible operation through both supply- and demand-side measures, supported by upgraded heat network assets and smart control strategies.

This Trial Strategy guides the execution of WP3 and WP4, while recognising critical interfaces with WP2, WP6, and WP7. Data and insights gathered from the trials will feed into WP2, enabling refinement of the business case and supporting the development of commercially viable arrangements. These arrangements are expected to help unlock system-wide optimisation and flexibility by delivering a financial return on additional investment in technologies that enable flexible operation.

1.3 Purpose of This Document

This Trial Strategy has been developed collaboratively by the Heatropolis Beta Project Partners through a series of workshops and drafting cycles. It is agreed by all Partners and formally approved by the lead Partner, UK Power Networks, and will be updated iteratively ahead of each trial phase.

The strategy outlines the technical and commercial rationale for the trials, defines the framework for their design and delivery, and provides a structure for evaluating outcomes. It will guide the activities delivered through Work Packages 3 (Trial Strategy and Design) and 4 (Trial Build and Evaluation), while aligning with related work in customer engagement, commercial arrangements, and transition to BaU. This section provides a summary of the contents of the document:

Section 2: Governance Framework. Outlines the decision-making, oversight, and approval processes for the Heatropolis Beta trials. It defines partner roles, the need for consensus on strategy changes, and when funder approval is required. Trial plans will be developed for each site and reviewed regularly. Governance ensures coordinated delivery, effective risk management, and alignment with the project scope.

Section 3: Trial Archetypes Overview. The project will test solutions across three representative heat network archetypes to support sector-wide applicability. Each archetype reflects a common UK configuration and presents different technical and commercial challenges, enabling context-specific evaluation and scalable learning.

Section 4: Trial Scope and Methodology. Defines trial aims and delivery methods, focusing on both technical performance and commercial viability. It outlines data collection, the role of modelling, and the evaluation approach used to assess outcomes and support future design and policy.

Section 5: Trial Design Framework. Describes the structure of three seasonal trials—baselining, integration, and business-as-usual readiness. It introduces five key planning documents (engineering, investigational, customer engagement, analysis, and data management) that ensure coordinated, evidence-based delivery across all trial sites.

Section 6: Analysis and counterfactual approach. Explains how counterfactuals will be used to compare trial results to baseline scenarios, isolating the impact of Heatropolis interventions. It details how modelling will supplement findings, address data gaps, and account for variables such as weather and build-out stage.

Section 7: Integration Approach. Covers the increasing integration of technical systems and commercial arrangements across trials. Starting with isolated interventions, trials will evolve into coordinated DNO-HNO interaction and simulated market environments. Two integration themes—technical and commercial—guide this process.

Section 8: Detailed Trial Design Per Archetype. Presents the specific trial approach for each archetype: Kings Cross (large, phased decarbonisation), Chilton Woods (low-density, purpose-

built), and a high-density residential site (TBC). Each plan includes network status, key actions, trial objectives, and analytical focus.

1.4 Overview of Solutions and Archetypes

The Heatropolis Beta trials will test technical and commercial solutions across three representative heat network archetypes. The diagram below outlines the trialled innovations and how they aim to unlock flexibility through smart controls, integrated design, and new commercial models over three winter seasons.

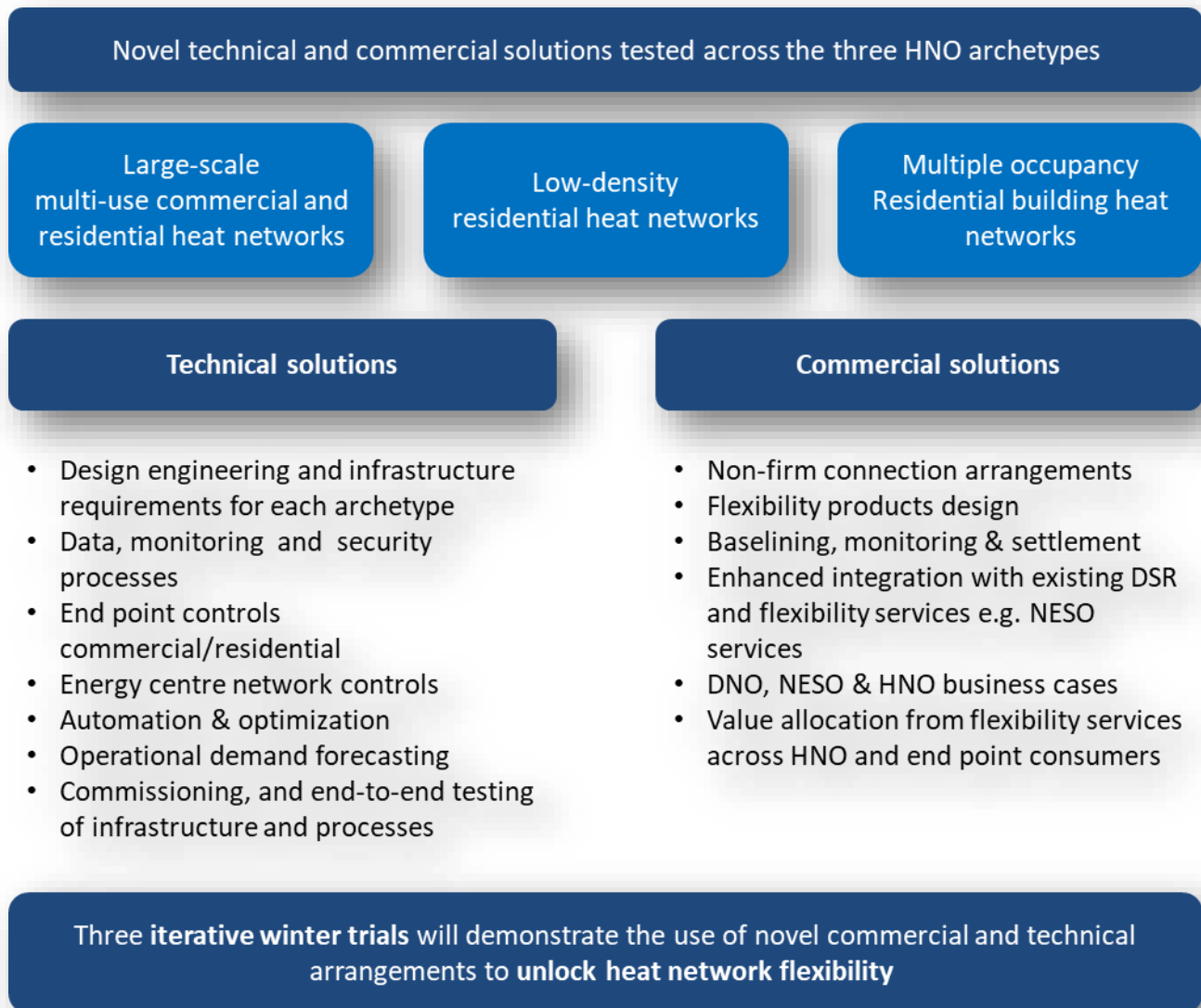


Figure 2. Overview of Solutions and Archetypes

1.5 Planned trial phasing

Heatropolis will demonstrate and commercialise the innovation using different HNO archetypes to prove the technology and commercial arrangements proposed in Alpha, through a series of

defined trials, delivering an iterative approach, transitioning successful components into BaAU solutions progressively.

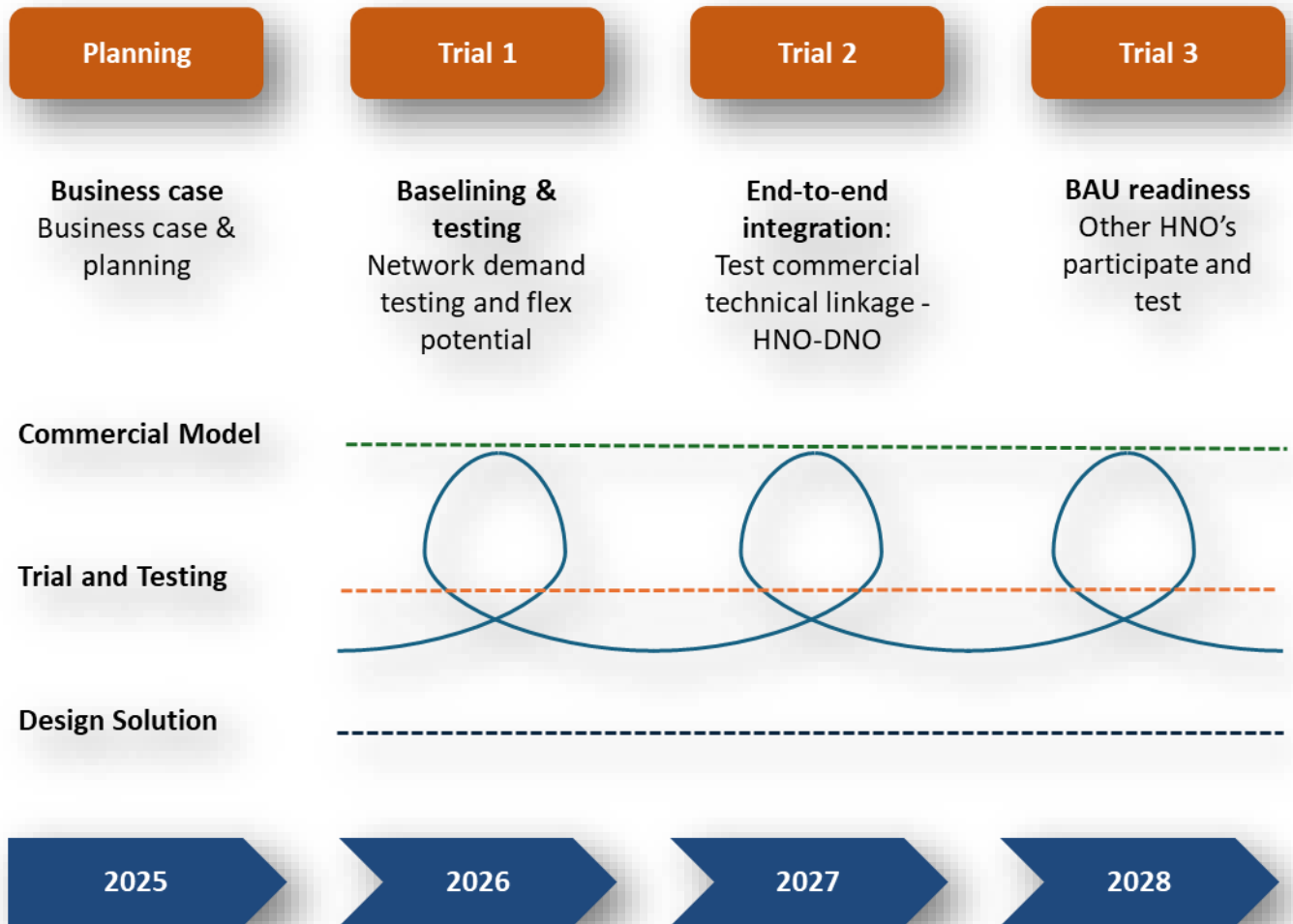


Figure 3. Trial delivery iterative approach

2. Governance Framework

This governance framework briefly describes the measures that underpin the organisation and control of the trials: trial strategy, trial plans, and guiding principles. It complements the broader project management tools, including project planning, monitoring and reporting measures that are not documented here.

2.1 Review and revision of strategy

This strategy and any iteration of it is to be agreed by all Partners and approved by the lead Partner. The Funder's approval may be also necessary if a revision of strategy represents a material change to the project scope.

The strategy is to be reviewed before the 2nd and 3rd trials commence. It may be reviewed and refined at other times, if appropriate.

2.2 Development of trial plans

The project is founded on the following hypotheses:

To unlock flexibility from heat networks, new commercial arrangements and technical integrations are required:

- Live trials with real assets are required to build the evidence base.
- New commercial arrangements, tools, and the evidence base will together inform the future design and operation of heat networks, and the associated connections to the electricity networks.
- Improved system level efficiencies, and better integration of heat networks in the energy system, will reduce the costs of connecting and operating decarbonised heat networks and in turn electricity networks.
- The trials will demonstrate technical solutions and inform the development of new commercial arrangements.

The hypotheses are to provide a point of reference when developing detailed trial plans, and when interpreting results.

A trial plan will be prepared prior to each trial for each trial site. The outline content of a trial plan is described in Section 5: Trial Design Framework. Each trial plan will detail the series of investigations to be undertaken in each heat network archetype. Trial plans are to be agreed by the Partners.

When the trials are live, the Partners will review progress at least monthly. Revisions to the plans are to be agreed by all Partners.

Technical and commercial trial objectives are presented in Section 4: 'Trial Scope and Methodology'.

2.3 Guiding principles

The trials should adopt the following guiding principles to ensure their impact is positive and any potential negative impacts are mitigated.

- **Service level:** Throughout the trials the HNO will deliver heat to consumers in compliance with Service Level Agreements. To mitigate the risk the vulnerable may be adversely impacted, the HNO will not offer interruptible heat supply contracts. Some trials will reschedule heating profiles but will not curtail the occupant's access to heat on demand.
- **Consent:** Consumers are to be asked to consent to their participation in trials of demand side optimisation solutions, such as smart controls and HNO-consumer commercial arrangements
- **Transparency:** Provide honest information throughout the trials, without over-promising on benefits or under-representing potential drawbacks to allow stakeholders to make informed decisions about trial participation. Clearly communicating the project purpose and scope, so participants understand the "why".
- **Fairness:** Align customer experience across trials where possible to avoid unintended variation across suppliers and service providers. Consider the different vulnerabilities, preferences, and experiences of customers. Avoid potential benefits being skewed towards a certain group/category of stakeholders.
- **Customer Protection:** Comply with GDPR regulation and publish data agreements. Ensure trialists aren't exposed to untoward risk and are not worse-off due to participation in the trials. Assess potential external risks, and plan for responses and points of contact / escalations for different challenges that may arise. Ensure customers can access support easily through a channel of their preference.
- **Knowledge Sharing:** Learnings and best practices gained through the trials should be shared internally across project partners and externally with the wider public and stakeholders to further collective learnings and advancements
- **Data best practice:** We will comply with Ofgem's Data Best Practice Guidance. UK Power Networks have prepared a written statement on how the project aims to comply with Ofgem's guidance.



Figure 4. Guiding principles

3. Trial Archetypes Overview

Heat networks in the UK vary widely in scale, configuration, and consumer profile. To ensure that the Heatropolis solution is replicable, scalable, and applicable across the sector, the project will test its approach across three representative archetypes. These archetypes capture the diversity of heat network design and operation, helping to identify technical challenges and commercial opportunities unique to each context. This segmentation supports the development of flexible models that can be adopted as standard BaU practice.

Designing and trialling the solutions across a range of heat network archetypes will ensure the scalability of the technical and commercial arrangements. Trials will be conducted at three sites, each representative of a heat network Archetype.

The three heat network archetypes used in Heatropolis are:

Large-Scale 1	Mid-Scale 2	Small-Scale 3
		
Multi-use commercial and residential heat networks	Low-density residential housing estate	Residential multiple occupancy building
Peak heat load: 25 MW+	Peak heat load: 1-5 MW	Peak heat load: 1-5 MW

Figure 5. Heatropolis Heat Network Archetypes

The proposed technical and commercial arrangements need to be tailored to the requirements of these archetypes. For example, larger sites may be able to deploy greater levels of automation and controls, whereas smaller sites may require simpler technical solutions, to provide these end-customers access to heat flexibility.

3.1 Archetype 1: Large-scale multi-use commercial and residential heat networks

Large-scale, multi-use heat networks, commonly known as district heating systems, serve both commercial and residential buildings across wide areas, including entire city districts. These systems typically rely on multiple energy centres that centrally generate high-temperature hot water (around 90°C), which is then distributed through pressurised, insulated underground pipework. Heat is delivered to individual buildings via heat interface units that transfer energy from the network to the building's internal heating systems. Most existing district-scale networks operate at high temperatures (typically 60°C to 100°C, and sometimes even higher) and depend on heat sources such as energy-from-waste plants or large combined heat and power (CHP) systems. However, to enable the transition to net-zero, these networks will need to be reconfigured to operate at lower flow temperatures, typically between 40°C and 60°C, to maximise efficiency and compatibility with modern low-carbon technologies such as large-scale heat pumps.

3.1.1 Key Characteristics for Archetype 1

- Peak heat load: 25 MW+
- Configuration: Multiple energy centres serving multiple buildings
- Expected roll-out: Tens across London, fewer than 100 across the UK, with 1–5 developments expected per year to 2050

3.1.2 Trial Site: Kings Cross

Located in the heart of London, The Kings Cross Site is one of the most celebrated and sustainable major urban redevelopments in the world and is home to the UK headquarters of household names such as Google, Meta, AstraZeneca, Universal Music and Nike along with a thriving community of small to medium-sized businesses. The site has a well-established commitment to decarbonisation and is recognised as a leading example of sustainable development by the UK building industry.

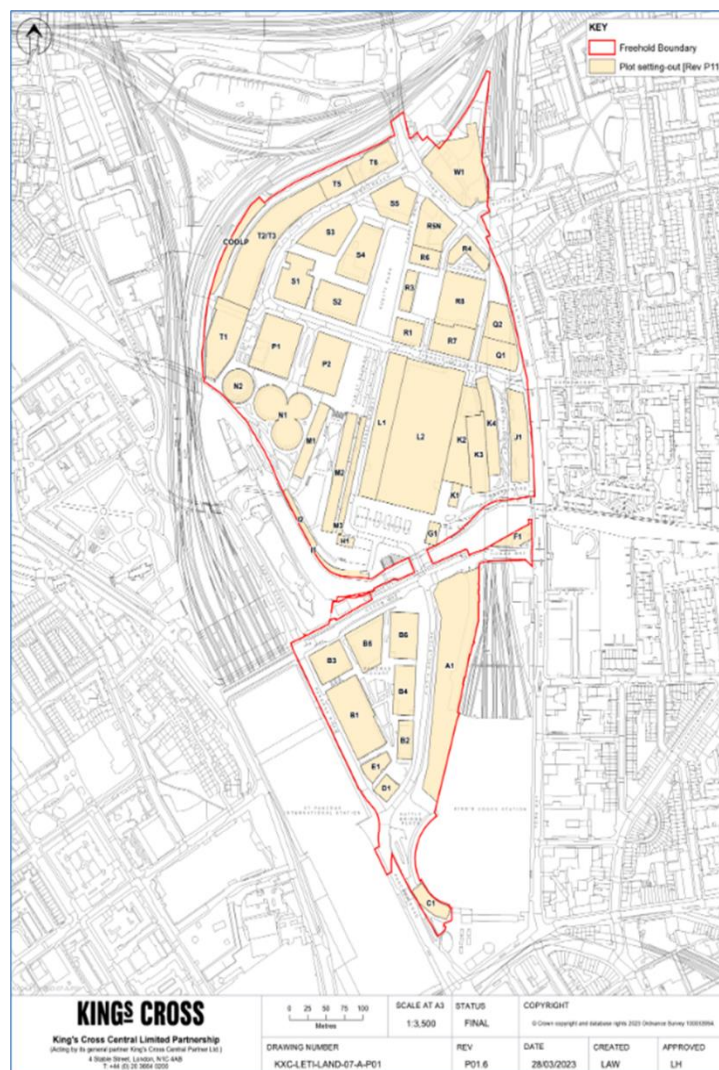


Figure 6. Kings Cross site

Currently the Site is served by district heating and cooling networks along with a 'private wire' electricity network, owned and operated by Metropolitan King's Cross Limited (MKC), a fully managed Energy Supply Company (ESCo) Special Purpose Vehicle (SPV) between Argent, Metropolitan and Kings Cross Central Limited Partnership (KCCLP) as majority shareholder.

The network serves a range of commercial and mixed residential/commercial use buildings of different types and ages, the oldest being the University of Arts London, built in in 2012; the newest will be Google UK HQ, which is due to complete by the end of 2024, as will the W zone and the Cubitt Park residential complexes. In total there are 44 plots on the site of which 13 are domestic or mixed domestic/commercial developments with a total of 2,429 residential units. Over half of the site is used for commercial offices and a quarter is used for residential and general accommodation

Site Details:

- Location: [///loft.menu.ankle](#)
- Operator: Metropolitan Infrastructure Ltd (Heatropolis project partner)
- Year of first operation: 2011
- Network completion: 2024
- Net internal floor area served: 556,113 m³

Usage breakdown:

- Office space: ~56%
- Residential: ~21% (~2,430 dwellings)
- Educational: ~10%
- Retail/Other: ~13%

Technical Configuration:

- Heating: 65.6 GWh across 44 plots
- Cooling: 11.5 GWh across 12 plots
- Current Heating Configuration (as of March 2025)
 - 2× 2 MWe (~1.16 MWth) CHP engines
 - 3× 10 MW gas boilers
 - 2× 2.9 MW gas boilers
 - 2× 74 m³ (~5 MWth) water-based thermal stores
- Current operating temperature (primary feed): 90°C
- Decarbonisation Retrofit Plan (New Plant) (Counterfactual)
 - 10 MW electric boilers

- 3 MW ground source heat pump³
- 2 MW heat recovery heat pump
- 1× 1.5 MW air source heat pump
- Phased reduction operating temperature to 75°C
- Planned Flexibility Enhancements (Heatropolis Solution)
 - Up to 12 MWth phase change thermal store
 - Additional air source heat pump capacity (up to 1.4 MW, either as an additional unit or uprated capacity of planned decarbonisation retrofit plant).

Note that capacities of new retrofit assets and enhancements indicated above are subject to site investigations and engineering considerations, e.g. the productivity of ground sources at King's Cross will be evaluated through test bore holes and will influence the specification of both GSHP and ASHP plant.

3.1.3 Justification for Site Selection

Kings Cross is representative of many urban, large-scale heat networks operating on gas. Located within UK Power Networks' catchment area and operated by a project partner, the site offers:

- Advanced decarbonisation plans already in progress
- Sufficient electrical supply for fully decarbonised operation, eliminating infrastructure risk
- Urban spatial constraints typical of large-scale DHNs, providing real-world insight into practical flexibility options (e.g. phase change thermal stores are preferable in dense environments)
- Independently controllable heat substations per building, enabling discrete monitoring and testing across varied profiles

3.1.4 Trial Implementation

Trial 1 (Winter 2025/26):

Trial 1 will establish a baseline demand profile for this primarily gas-fuelled network. Key activities include integration of smart control systems within the energy centre and commercial buildings, initial stakeholder engagement, and limited commissioning of decarbonisation plant such as the Heat Recovery Heat Pump (HRHP). The focus will be on testing discrete technical interventions and calibrating commercial models.

Trial 2 (Winter 2026/27):

By Trial 2, significant additional decarbonisation assets such as thermal stores and Air Source Heat Pumps (ASHP) will begin to be operational. The trial will focus on integrated DNO-HNO control,

³ Ground Source heat productivity is yet to be confirmed through test boreholes. If productivity is lower than anticipated, ground source heat pump capacity will be reduced and air source heat pump increased.

validation of flexible operation, and evaluation of refined commercial propositions. Lessons learned will inform wider rollout feasibility and in BaU scaling testing in Trial 3.

3.2 Archetype 2: Low density residential heat network

Low-density residential heat networks are designed to serve new housing estates, often from a single, centralised energy centre. Unlike traditional large-scale high-temperature networks, these systems are designed from the outset to operate at lower distribution temperatures, around 65°C, to reduce heat losses to the ground and lower installation costs. This temperature range is particularly well-suited for renewable energy sources like large-scale heat pumps, which operate more efficiently at lower temperatures. These networks often use highly insulated plastic pipework and incorporate central thermal storage to balance energy demand and enhance plant performance.

Homes across new housing developments low-density residential heat networks on are fitted with a compact Heat Interface Unit (HIU), which transfers heat to radiators, underfloor heating, and hot water systems, functioning much like a conventional boiler. The move toward lower temperature operation also aligns with the UK's Future Homes Standard, which mandates low-carbon heating and higher energy efficiency in all new homes from 2025. As such, these networks offer a cost-effective, scalable solution to meet future planning and decarbonisation targets in the residential sector and are expected to become a primary growth area for low-carbon, electric heat networks in the UK.

3.2.1 Key Characteristics for Archetype 2

- Peak heat load: 1–5 MW
- Configuration: Single energy centre serving multiple houses and small non-residential units
- Expected roll-out: >1,000 networks nationally, with up to 100 new deployments annually to 2050

3.2.2 Trial Site: Chilton Woods

Located in Suffolk, Chilton Woods is a major new residential development that will ultimately comprise of 950 homes, 3,000 m² of commercial space, and a 2,000 m² primary school. The site is being delivered in phases across ten development parcels.

The low-carbon heat network at Chilton Woods is operated by Metropolitan Infrastructure Ltd, a Heatropolis project partner. It is served by a central Community Energy Hub, a fully prefabricated energy centre constructed off-site and installed to reduce construction disruption and speed up deployment.

The energy centre is powered by two 700 kW air source heat pumps and supplemented by three 700 kW electric boilers, one 500 kW electric boiler with heat stored in two 65 m³ thermal tanks. Heat is delivered to homes through a network of insulated plastic pipes designed to retain water temperatures of 60°C, minimising distribution losses. Each home is fitted with a HIU, enabling

space-efficient delivery of heating and hot water without the need for domestic hot water cylinders.

The system has been designed from the outset for fully electric, decarbonised operation, and all central plant has already been installed to meet full build-out capacity. During the trial period, this overcapacity in generation and storage will support the testing of demand flexibility strategies and calibration of commercial modelling.



Figure 7. Chilton Woods Community Heat Hub

Site Details

- Name: Chilton Woods
- Location (what3words): ///sounds.presides.activism
- Operator: Metropolitan Infrastructure Ltd (Heatropolis project partner)
- Year of first operation: 2025
- Network completion: Ongoing phased estate build-out

Technical Configuration:

- Design peak heat load 3,397 kWth
- Design peak electrical load 1,378 kVA
- Configuration: 2x 700 kW air source heat pumps
- 3x 700 kWth, 1 x 500 kWth electric boilers
- 2x 65 m³ Thermal Stores (water)

3.2.3 Justification for Chilton Woods as a trial site:

Chilton Woods represents a typical archetype for new low-density, all-electric residential developments that align with the Future Homes Standard. This suburban site is located within UK Power Networks' electricity network area. The site provides:

- A fully decarbonised energy centre with no reliance on fossil fuels
- A fully built energy centre connected to a partially built housing estate, with capacity that significantly exceeds the forecast load during trials 1 and 2. The excess capacity of electrical connection and heat supply will significantly exceed need, allowing the headroom to demonstrate flexible network operation strategies.
- A realistic development layout and housing typology typical of thousands of UK new builds

The operator of the Chilton Woods heat network is one of the Heatropolis Project Partners. This facilitates trials at this site. Protocols to be agreed with Metropolitan's network operators will safeguard heat delivery to customers during trials.

An alternative Metropolitan operated heat network at Upper Worsham Farm was considered. Chilton Woods is the preferred network as the Upper Worsham housing estate and energy centre are smaller, and the estate will be fully built sooner than Chilton Woods. There will be less scope to demonstrate flexible operation strategies once heat demand from the estate approaches the network's supply capacity.

3.2.4 Trial Implementation

Trial 1 (Winter 2025/26):

At Chilton Woods, the heat network has been designed from the outset for full decarbonisation and includes of a purpose build energy centre with ASHP, thermal storage and electric back up boilers. During Trial 1, the energy centre will operate with significant spare capacity, as the estate will be only partially built out. This creates an ideal environment to test flexibility strategies using smart residential controls. A small cohort of residents will be recruited to trial prototype Passiv Smart Thermostat (PST) systems integrated with household HIUs, providing property level smart control capabilities. The trial will also evaluate energy centre control software enhancements and provide early validation of load-shaping potential using the thermal storage tanks and thermal inertia within the network itself. Baseline network performance data will be captured and used to inform system calibration and commercial modelling.

Trial 2 (Winter 2026/27):

With a larger number of dwellings expected to be connected by Trial 2, the PST-HIU prototypes will be upgraded to a commercial-ready version that can be deployed to a wider group of households. The trial will test end-to-end integration between the HNO and DNO, using predefined flexibility signals to assess response behaviour. Analysis will focus on quantifying additional peak reduction achievable via residential controls and evaluating the commercial viability of incentives designed to encourage customer participation in flexibility events.

3.3 Archetype 3: Single building high density residential heat network

Single-building high-density residential heat networks, often referred to as communal heating systems, supply heating and hot water to multiple dwellings within a single building, such as blocks of flats or other multi-occupancy developments. A significant majority of all heat networks in the UK are communal heating systems. As in other heat network archetypes, heat is generated in a central plant room and distributed to individual homes via insulated pipework and each dwelling is equipped with a Heat Interface Unit (HIU), which transfers heat to space heating and hot water systems.

Communal heating systems differ from larger networks primarily in scale. They typically serve a single building and are simpler to install and manage. However, both share the principle of centralised heat generation and distribution. To meet the UK's net-zero targets, existing communal heating systems will need to shift away from high-temperature, fossil fuel-based boilers and CHP systems to lower temperature systems that are compatible with low-carbon technologies, such as communal heat pumps. New developments are increasingly being designed with low-temperature communal systems from the outset, in line with the Future Homes Standard and other emerging building regulations. There is also significant potential to retrofit existing multi-occupancy buildings that currently rely on individual gas boilers, offering opportunities to improve system efficiency, reduce carbon emissions, and lower energy bills for residents.

3.3.1 Key Characteristics for Archetype 3

- Peak heat load: 150 – 450 kW
- Configuration: Single energy centre servicing multiple apartments in a single building
- Likely roll out: >10,000 across the UK by 2050

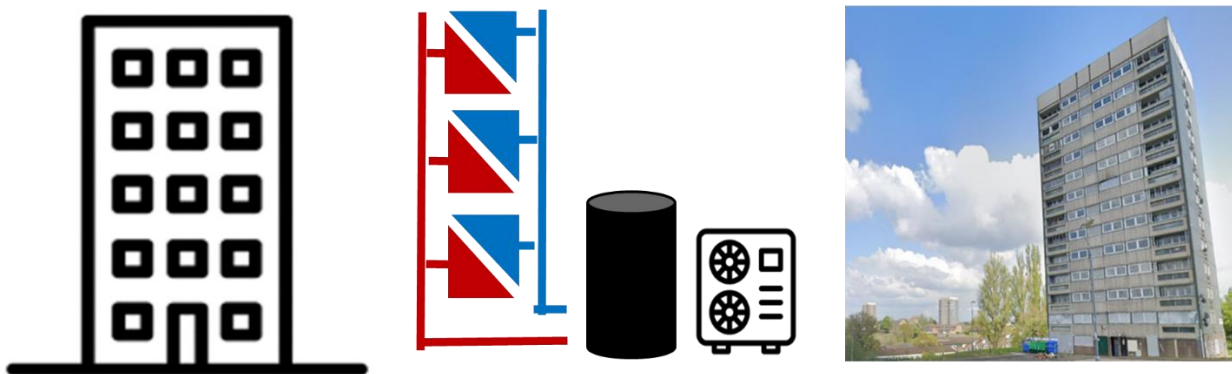


Figure 8. Archetype 3- Single Building High Residential Heat Network

3.3.2 Trial Site: To Be Confirmed

At the time of writing, the trial site for this archetype is yet to be confirmed.

Site Selection Criteria:

The selection of a suitable site will follow these guiding principles:

- **Location:** Within the UK Power Networks licence area
- **Operational Readiness:** Capable of fully or largely decarbonised operation by Winter 2026/27 (Trial 2), with potential for baseline data collection in Winter 2025/26 (Trial 1)
- **Technical Feasibility:** Clear and achievable decarbonisation plan including the integration of low-carbon technologies such as air source heat pumps or thermal storage
- **Stakeholder Commitment:** Site owner/operator must commit resources, including modest funding and personnel, and take primary responsibility for system operation and resident communications
- **Project Support:** Metropolitan can provide advisory and technical support for engineering design, procurement, commissioning, and resident engagement, subject to agreement

Candidate sites will be evaluated based on:

- Willingness of the building owner/operator
- Realism and deliverability of the proposed decarbonisation measures
- Flexibility potential and compatibility with trial objectives
- Lead times for design, planning, approvals, and procurement
- Required support level from the Heatropolis project
- Ability to facilitate and resource the flexibility trials

3.3.3 Trial Implementation

Trial 1 (Winter 2025/26):

At the time of writing, a Trial 1 site for Archetype 3 heat network has not yet been confirmed. A targeted search is underway to identify a high-density residential building capable of supporting partial decarbonisation by Winter 2025/26. The selected site must be within the UK Power Networks service area, with a committed operator willing to support site preparation, resident engagement, and operational upgrades. Trial 1 may be used to establish a baseline profile and conduct enabling works, provided the site can deliver meaningful trial activity within the timeframe.

Trial 2 (Winter 2026/27):

Pending successful site identification and commissioning, Trial 2 will aim to test flexible operation using residential smart controls and enhanced thermal storage. The project team anticipates that retrofitting or extending communal systems with additional low-carbon technologies or thermal storage will create opportunities to evaluate integrated control strategies. Where feasible, consumer-focused commercial models will also be piloted.

4. Trial Scope and Methodology

The Heatropolis Beta trials are designed to evaluate the technical and commercial potential of flexible heat network operation to support the wider electricity system. By conducting coordinated trials across three representative archetype sites over three heating seasons, the project will generate robust evidence on how different optimisation strategies and commercial models can reduce peak electricity demand, improve integration with DNO systems, and accelerate decarbonisation of heat networks.

This section outlines the objectives, data strategy modelling methodology that underpin the trial programme.

4.1 Aims

The trials have been structured around two core objectives:

1. To test and validate technical solutions that reduce peak electrical demand from heat networks.
2. To inform the development of new commercial models that incentivise flexible operation.

Together, these aims will provide a foundation for scalable, replicable frameworks that align the interests of HNOs, DNOs, and end-users.

4.1.1 Technical Objectives

The aims of the trials are to:

- Calibrate the heat network engineering models that predict network performance
- Validate the actual reduction in peak electrical demand from heat network technical flexibility solutions.
- Demonstrate demand shaping,
 - the shifting of network peak electrical demand away from the periods of peak electrical demand across DNO network, and
 - actual reduction in peak electrical demand
- Evaluate the relative value of each technical solution in each Archetype.
- Provide an evidence base for the technical efficacy of the trialled optimisation and flexibility solutions.
- Demonstrate enhanced integration and automation between HNOs and DNOs.

4.1.2 Commercial Objectives

The aims of the trials are to:

- Calibrate DNO-HNO commercial models by.

- demonstrating the extent of HNO electrical load shaping that can be achieved through technical solutions whilst being advantageous to the HNO.
- validating cost estimates for implemented upgrades.
- Demonstrate the HNO can comply with a flexibility commitment.
- Assess the appetite for HNO-consumer commercial arrangements that assist HNO's network optimisation^{4 5}

Trials will be conducted over three heating seasons. Each trial will have specific aims for each of the three Archetype sites, which will be elaborated in detailed trial plans

4.2 Data sets

Robust data collection and transparency is central to the trial strategy. The trials will generate datasets that not only support the technical heat network performance models but also underpin the validation of the commercial arrangements being tested.

Data sets from the trials will be used to:

- Calibrate models of dynamic heat network electrical demand.
- Evaluate the cost effectiveness of the commercial models developed under WP2 Commercial Arrangements and Business Case.
- Provide appropriate open metadata, for interested 3rd parties to use including independent evaluation of trial conclusions.

A detailed Data Management Plan will define the scope of the data to be collected, publication standards, and access protocols.

4.3 Modelling

To complement real-world data, modelling will be used where necessary to extend insights from the trials. Modelling or extrapolated data from partially decarbonised sites will be used to predict electrical demand profiles at fully decarbonised sites, to fill data gaps and support scenario-based analysis.

Purpose of Modelling

- To predict heat network response to operating strategies.
- To support refinement of heat network control strategies before or during trials.
- To predict heat network loads and performance during extreme weather conditions

⁴ Such as a profiled heat tariff

⁵ Subject to technical feasibility and affordability

- To extrapolate trial data from limited deployment of smart demand-side controls to predict network-wide electrical demand profiles under full deployment.
- Address data gaps arising from unplanned events (e.g. loss of signal, loss of calibration, malfunction, data corruption, etc)
- To support or enhance interpretation of generalised results.

4.4 Technical Solutions

The trials will evaluate a range of technologies including thermal storage, additional low-carbon heat sources, and intelligent control systems designed to enable optimised and flexible operation of decarbonised heat network. The technical solutions to be evaluated, singly or in combination, include:

- Augmented thermal storage capacity⁶
- Combined solutions: Augmented thermal storage capacity alongside augmented electrical heat source capacity² (e.g. additional ASHP)
- Smart controls:
 - Supply side: supply temperature and flow optimisation within energy centres
 - Commercial demand-side: building level heat transfer and return temperature optimisation
 - Residential demand side – dynamic demand shaping, informed by building fabric thermal inertia, system performance and weather forecasts

To maximise the potential value of these assets will control strategies will be required that realise their optimisation and flexibility potential, including:

- preheating schedules that exploit the capacity of augmented thermal stores and heat sources
- taking account of weather and heat demand forecasts
- exploiting novel commercial solutions that reward flexible operation

All trials will be conducted in line with Service Level Agreements (SLA's) between the HNO and site owner, or HNO and consumer, to ensure service quality is maintained.

If assessed to be commercially and technically viable, the trials will also explore commercial models that might encourage consumers to modify their behaviours. Modified behaviours might require consumers to deviate from their accustomed habits. The trials will not directly ask participants to compromise comfort, e.g. by turning down thermostat setpoints and will follow the guiding principles outlined in 2.3.

⁶ Above that typical for a heat network not optimised for flexibility.

4.5 Commercial Solutions

Successfully scaling flexibility in heat networks requires not only technical capability but also effective commercial models that align incentives across all stakeholders. This section outlines how the Heatropolis trials will test new commercial frameworks, including non-firm connection terms, flexibility contracts, and consumer-facing incentives. By simulating real-world interactions between HNOs, DNOs, and consumers, the project aims to validate the business case for flexible, low-carbon heat networks.

Commercial models and business cases are to be developed under WP2. The commercial solutions will consider:

- Non-firm connection parameters
- Flexibility product design
- Baseline, monitoring & settlement
- Integration with existing Demand Side Response (DSR) and flexibility services e.g. NESO services
- DNO, NESO & HNO business cases
- Value allocation from flexibility services across HNO and end point consumers

In respect of commercial arrangements to reward flexibility, the comparison of results between each flexed and unflexed day can be used to interpret the total amount of flexibility the heat network could provide. Compliance with a non-firm connection instruction can then also be simulated enabling assessment and evaluation of associated business cases.

4.6 Commercial Evaluation Objectives

The trials will support commercial model development by addressing the following key tasks:

- Validate peak reduction assumptions, by live trials, for each Archetype at the heat network energy centre.
 - These peak reduction values will inform lifetime earnings calculations from the HNOs' flexibility market participation.
- Trial peak reduction at the heat network energy center under simulated/real commercial arrangements
 - Simulated signal from DNO/NESO, resulting in flex provided at energy centre,
 - Trial outcomes will assess the fulfilment of flex contracts.
- Validate assumptions regarding additional peak reduction using customer end point controls.
 - Inform lifetime earnings calculations from the HNOs' flexibility market participation.

- Evaluate and inform different commercial offerings for customer end point controls.
- Test different commercial offerings for customer end point controls.
 - Explore what type of incentives are required to motivate end consumers' response.
 - Results will inform assumptions on earnings from flex market participation.

5. Trial Design Framework

This section sets out the trial design framework for the Heatropolis Beta project, which will deliver a structured programme of field trials over three consecutive heating seasons. The trials will be carried out across three distinct heat network archetypes and are designed to test both technical innovations and commercial frameworks that aim to unlock system flexibility and accelerate the decarbonisation of heat networks.

The trial programme is structured into three phases, each building on the results of the last. These include initial testing and baselining, end-to-end system integration, and a final demonstration of BaU readiness.

Progression between each phase will be subject to a stage gate review, allowing for evidence-based decisions on whether to advance based on results, system readiness, and alignment with project goals.

Each trial season will include tests of standalone interventions (e.g. smart supply-side controls, thermal storage optimisation, and smart demand-side controls in residential and commercial settings). Later trials will demonstrate integrated system optimisation, combining these interventions into full-system flexible operation. Comparative testing will occur under both baseline and optimised conditions, ideally on consecutive days with stable weather, to provide valid like-for-like analysis.

5.1 Trial Phases Overview

Initial testing of technical potential will aim to evaluate the potential of discrete interventions such as:

- Control strategies that exploit additional thermal storage,
- Smart supply side controls at energy centres
- Smart controls for commercial buildings and multiple dwelling
- Smart demand-side controls within individual dwellings

Trial 1: Baselining & testing (winter 2025/26)

- The first trial season will focus on establishing baseline demand profiles, validating early-stage technical interventions, and developing assessments of initial responses to commercial signals. This phase will be used to calibrate technical engineering requirements and validate the suitability of different commercial models across all archetype sites.
- A Stage Gate Review will occur after trial 1.

Later trials will demonstrate integrated control strategies, combining supply-side and demand-side optimisation within realistic weather and load conditions. Comparative analysis of optimisation and flexibility will be conducted by operating the networks under baseline conditions

and then under optimised or flexible scenarios on consecutive days, during periods of stable and suitable weather.

Trial 2: End to end integration (winter 2026/27)

- The second trial will aim to test full, end-to-end integration between DNO & HNO systems. It will evaluate and refine the technical and commercial arrangements needed across system components and stakeholders, generating practical, applied learning on the requirements for real-world implementation.
- A Stage Gate Review will occur after trial 2.

Subject to the outcomes of Trials 1 and 2, it is anticipated that trials of optimisation and flexibility testing will continue during Trial 3 at each of the three heat network Archetype sites involved.

Participation of other HNO's and DNO's in trial 3 will be subject to negotiation and be dependent on of the availability of project resources and alignment with trial objectives. A strategy for outreach with potential HNOs and DNOs is being led through WP7: External Stakeholder Engagement and Knowledge Dissemination.

Trial 3: BaU readiness (winter 2027/28)

- A potential third trial will demonstrate full-scale BaU deployment. This trial may involve additional HNOs and DNOs and will showcase operational maturity and replicability of the Heatropolis approach. Progression to Trial 3 will be subject to a stage-gate review informed by outcomes from Trials 1 and 2.

Trial 3 is expected to continue optimisation and flexibility testing at the original three archetype sites. The potential inclusion of additional HNOs or DNOs will depend on project resources, site readiness, and strategic fit.

5.2 Trial Plans

There are five core types of trial plan that will be used to develop and deliver the Heatropolis Beta trials in each of the heat network archetypes. These have been set out in the table below:

Table 2. Five types of trial plan

Engineering Plans	Investigational Plans	Customer Engagement and Recruitment Plans	Analysis Plan	Data Management Plan
Processes for procuring and upgrading hardware and	Documentation of the tests to be undertaken	Detailing how customer stakeholders will be	Detailing the methodologies to be used to evaluate and	Governance on how data is collected

associated infrastructure upgrades.	during each trial.	involved and supported.	assess trial outcomes	managed, stored and shared
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5.2.1 Engineering plans

Engineering plans will be prepared prior to the trials and will specify the scope of detailed engineering design work and services to be undertaken by subcontracted 3rd parties. The detailed engineering designs will in turn be used to procure assets such as thermal stores and heat pumps and the contracting of services like civil works for the installation and connection of assets.

The engineering plans will focus on augmentation of existing network assets: enhancement or addition of facilities (e.g. thermal storage, heat pumps) and/or control capabilities, to enable more flexible operation that results in load shaping (peak shifting and/or peak reduction) of the heat network's electrical demand.

Each engineering plan will address the site-specific augmentation of technical infrastructure and control systems at the heat network.

At the Archetype 1 site (Kings Cross), Heatropolis-funded enhancements, will supplement the broader heat network decarbonisation programme led by the network owner. Engineering plans developed under the project are those associated with the augmentation measures. The Heatropolis project plans will be informed by the broader engineering design studies for decarbonisation of the network.

5.2.2 Investigational Plans

A detailed Investigational Trials Plan will be prepared for each Archetypes site before the start of each trial period (winter 25/26; 26/27 and 27/28). These Plans will define the specific investigations to be undertaken during each trial period.

Each investigation will include:

- A clearly stated purpose
- The proposed adjustment(s) to operational parameters (e.g. control strategies) to support that investigation.
- Alignment with overarching objective for that phase, baselining, integration, or BaU readiness and the operational status of each heat network during the trial period

The plans will reflect the current technical status of each heat network at the time of the trial and will prioritise investigations based on their importance to the overall objectives. Priorities may evolve in response to earlier trial results or external factors such as weather conditions. Any investigations not completed within the scheduled period may be carried forward into subsequent trials.

5.2.3 Trial Purposes and Model Calibration

The Investigational Plans will support a range of technical and commercial objectives, including:

- **Calibration of Technical Models:** Trials will be used to calibrate engineering models used for the sizing of plant and network, for achieving low heat network losses, consistently low return temperatures and optimising flow temperatures. Trials will be used to calibrate the EnergyPro models of the heat networks to improve the predictions of performance when fully decarbonised and/or under maximum load.
- **Calibration of Commercial Models:** Trial data will be used to inform the commercial models developed under WP2, validating the real world the magnitude of load shaping that can be achieved in real life conditions and supporting assumptions on the financial value of flexibility
- **Validating Load Shifting Potential:** It is expected that combining thermal storage, with energy centre control strategies and smart end point controls can deliver significant electrical load shifting and peak load reduction, beyond that of each measure in isolation. Trials will validate these assumptions and provide evidence to justify investment in the most cost-effective combination of measures.

Testing Commercial Arrangements: Trials 2 and 3 will deploy a combination of technical augmentations and commercial arrangements. The aim is to demonstrate what is feasible in a future BaU scenario in which new commercial arrangements encourage investment in technical solutions that enable flexible heat network operation.

5.2.4 Structure and Content of Investigational Plans

For each trial at each archetype site, the investigational plan will include:

- **Site Configuration:** A description of the site's expected setup at the time of the trial, including all decarbonisation upgrades and control enhancements in place.
- **Trial Goals:** A summary of the specific objectives for that trial phase at the given site.
- **Intervention Schedule:** A list of planned interventions, each accompanied by a purpose statement. Interventions may be discrete (e.g. implementing a smart supply-side control) or integrated (e.g. combining supply-side optimisation with residential demand-side controls).
- **Communication Protocols:** Clear procedures and lines of authority for implementing interventions will be outlined, recognising that sites are typically operated by engineers outside the Heatropolis project team.
- **Risk Statement:** Identification of known and potential risks, along with the flexibility to adapt the trial plan based on results, unexpected events, or environmental conditions that may affect implementation.

This structured and iterative approach ensures that trials are evidence-driven, responsive to real-time findings, and aligned with the overall goals of developing scalable, flexible, and commercially viable heat networks.

5.2.5 Customer engagement and recruitment plans.

The customer engagement plans, developed under Work Package 6 (WP6), will be guided by both the overarching customer engagement strategy and the Investigational Plan for each trial site.

These plans will outline how the project will communicate with heat network customers who are directly or indirectly impacted by trial activities. The core objective is to ensure a positive customer experience through clear, proactive, and transparent communication. This will include providing timely updates, establishing effective feedback channels, and ensuring participants feel informed and supported throughout the trial process.

Customer engagement plans will outline how the project communicates with heat network customers who are directly or indirectly impacted by trial activities. The primary objective is to ensure a positive customer experience through:

- Clear, proactive, and transparent communication,
- Timely updates,
- Effective feedback channels,
- Ongoing support for participants.

Each site's engagement plan will be tailored to:

- The specific technical interventions being trialled,
- The timing and scope of associated engineering works.

The Site's Investigational Plan will be informed to customers to:

- Ensure alignment with technical activities,
- Translate technical information into accessible, meaningful customer messages.

Example – Archetype 2 (Chilton Woods):

- A small group of residents will be recruited to trial prototype smart endpoint controls integrated with their HIUs.
- The Investigational Plan will define the technical scope.
- The customer engagement plan will detail how participants are selected, recruited, and supported throughout the process.

This coordinated approach ensures that customers remain engaged and that their experiences contribute meaningfully to trial outcomes and future scalability.

The Investigational Plan will document the technical scope of tests. The customer engagement plan will document how the trialists are to be recruited and supported.

5.2.6 Analysis plan

For further detail on the analytical methodology, see Section 6.

The Analysis Plan will define the approach for each trial phase, including:

- Operational parameters to be monitored and analysed.
- Data required and how it will be normalised (e.g. for daily temperature fluctuations).
- Methods to extrapolate results from unusual conditions (e.g. extreme or mild weather).
- Analytical methodologies to be used, based on recognised energy sector standards. These could include P376 'Utilising a Baselining Methodology to set Physical Notifications', subject to decision on suitability.
- Modelling approaches for:
 - Predicting performance at fully decarbonised sites using data from partially upgraded networks (e.g. Kings Cross).
 - Extrapolating from partially built estates to full build-out scenarios (e.g. Chilton Woods).

The Analysis Plan will inform the structure of each trial's implementation and will be updated between trial phases to reflect lessons learned and improve analytical certainty.

5.2.7 Data Management Plan

The Data Management Plan will define how data generated during the Heatropolis Beta trials is collected, handled, validated, and shared. It will ensure data integrity and consistency across all trial sites, while supporting robust analysis and regulatory compliance.

The Data Management Plan will define:

- Data logging: detailed protocols for data logging at each site.
- Data analysis: Identification of the specific data subsets required to support trial evaluation, modelling and reporting.

Data assurance planning including:

- Data cleansing and validation processes to identify and address missing values, outliers, and inconsistencies.
- Data profiling processes to analyse incoming data to identify potential issues like format errors or unexpected patterns
- Data ownership and responsibilities for each Archetype/trial site
- Communication protocols for resolving data quality issues that may arise during a trial
- A data dictionary outlining data formats and units for standardisation of terminology

The Data Management Plan will ensure full compliance and alignment with industry standards, including their information security policy, and Ofgem's Data Best Practice Guidance, and Digitalisation Strategy and Action Plan Guidance.

The Data Management Plan will be developed in parallel with the Analysis Plan, with both documents informing and reinforcing one another throughout the project lifecycle.

6. Analytical Methodology

This section outlines the analytical framework that will be used to assess the effectiveness of the Heatropolis solution. The aim is to quantify both the technical and commercial added value of deploying flexibility-enabling interventions in decarbonised heat networks.

To do this effectively, each trial site will implement a range of interventions designed to optimise heat network performance. These will include the use of advanced machine learning smart control techniques, enhanced thermal storage, and additional low-carbon generation capacity.

These outcomes from these interventions will be benchmarked against a baseline scenario that represents how the same network would perform without any of the enhancements in place. This counterfactual comparison will form the foundation for assessing both the engineering performance and commercial viability of the Heatropolis solution.

6.1 Use of counterfactuals

The core purpose of the counterfactual approach is to clearly separate out the impact of Heatropolis interventions. The analysis will aim to contrast the electrical load profile of each trial site with and without the interventions. The counterfactual represents a decarbonised heat network operating without additional:

- Heat storage capacity (to more aggressively exploit profiled and flexible electrical connection contracts),
- Heat generation capacity (to increase the volume of heat produced during low electricity demand periods).
- Smart control strategies to shift or shape electrical demand (within the constraints of the storage and generation capacity)

In reality, the Heatropolis trial sites will either be undergoing a program of decarbonisation or already include technology upgrades to support flexible operation. To model the counterfactual scenario:

- Storage and generation capacity may be restricted during testing to simulate the constraints of a conventional decarbonised heat network.
- Smart controls may be temporarily disabled to represent a static system without optimisation.
- For partially decarbonised networks (e.g. in Trial 1), gas consumption data will be used to estimate what electrical loads would be required if the network were fully electrified using heat pumps.

This approach allows for a comparative analysis of system performance under both flexible and constrained operation ensuring that any benefits from Heatropolis intervention can be clearly measured and quantified.

6.2 Technical augmentations introduced through Heatropolis

The Heatropolis solution includes a range of technical interventions designed to increased flexibility and optimisation of heat network operation. These enhancements may be implemented individually or in combination at each trial site, depending on the network archetype and trial phase. Key technical interventions include:

- **Enhanced thermal storage:** Enables shifting of heat production in line with flexible or profiled electricity agreements.
- **Additional heat pump(s):** To increase the volume of heat that can be produced during low electricity network demand periods whilst staying within defined electrical capacity limits.
- **Electric boilers** (where appropriate): To provide cost effective resilience and absolute peaking capacity.
- **Smart supply and end-point controls:** For dynamic optimisation of network performance and load-shifting based on demand forecasts and system constraints.
- **Upgrade to monitoring and control systems:** To enable near real-time control strategies that exploit profiled and flexible electrical connection contracts

In the counterfactual scenario, the above interventions will be excluded or simulated at reduced capacity to mimic traditional, non-flexible operation. For instance, the thermal store will be operated at its original baseline capacity, and controls will be set to static parameters.

In combination, the technical interventions and commercial arrangements, which are explored in Work Package 2: Commercial Arrangements and Business Case, can be considered as the 'Heatropolis solution'.

6.3 Counterfactual derivation

A specific counterfactual "baseline" will be developed for each trial site to provide a credible benchmark for performance comparison. These baselines will represent the expected electrical load of the heat network operating at:

- Design feed temperatures
- Conventional levels of thermal storage and heat supply capacity
- Standard operating parameters under a profiled electricity connection agreement

For sites not yet fully decarbonised, the counterfactual electrical load will be extrapolated by assuming gas-fired equipment is replaced with industrial-scale heat pumps of equivalent output.

Archetype 1: Large-scale multi-use commercial and residential heat networks (Kings Cross) – Counterfactual Configuration

- The counterfactual is the planned decarbonised configuration, excluding Heatropolis upgrades

- The decarbonisation plan is being implemented but the site is not expected to be fully decarbonised in the timescale of the project. The demand will be satisfied through a combination on electrical heat sources as they come online, and existing gas fuelled assets. EnergyPro will be used to determine the electrical demand were the heat load to be satisfied by the counterfactual configuration.
- Gas supply adjustment: The current gas supply contract lacks daily profiling. CHP operation will be adjusted to simulate heat supplied via a profiled electrical supply contract.

Archetype 2: Low density residential heat network (Chilton Woods) – Counterfactual Configuration

- The site is already decarbonised. The energy centre heat source and thermal store will be operating with excess capacity during trials 1 and 2 due to incomplete estate build-out.
- The baseline for each trial will be adjusted to reflect the electrical load of the energy centre when the heat source and thermal store are scaled to match the peak demand for the estate build-out stage during each trial period.
- 2021 CIBSE design guidelines will be used to inform sizing of the operational capacity of heat source and thermal store for the load.
- Different baselines will be derived for Trials 1, 2, and 3.

Archetype 3: High-Density Residential (Site TBC)

- As the site has not yet been identified, a baseline scenario will be developed once the technical and operational characteristics are confirmed.

Across all archetypes, the counterfactual scenario will assume operation within the boundaries of a contemporary profiled electrical connection agreement, using only the baseline thermal and generation capacity. This will ensure comparability across systems and trial conditions.

By establishing robust counterfactual baselines for each site, the Heatropolis project aims to generate meaningful evidence on the performance and commercial value, ensuring that any measurable benefits can be clearly attributed to the interventions under investigation.

7. Integration Approach

This section outlines the strategy for integrating technical and commercial components across the Heatropolis trials. Integration is an essential component for demonstrating how improved coordination and interactions between both DNO's and HNO's can be applied to accelerate the decarbonisation of heat networks. The approach is structured around key themes and trial phases, designed to explore increasing levels of integration and complexity as the trials progress.

7.1 Solution integration themes

Two primary integration themes have been identified to guide the development and evaluation of the Heatropolis solution:

1. Optimisation of the DNO and HNO interface. This includes:
 - commercial arrangements, connection monitoring enhancements, and mechanisms for data exchange & communication.
2. Combinations of Heat Network Technical solutions. This involves integrating multiple technical upgrades to enable optimised and flexible heat network operation, such as:
 - Coordinated use of supply-side thermal storage,
 - Demand-side optimisation using smart end point controls across both commercial and residential buildings.

7.2 Solution integration sequence

The level of integration will increase through each successive trial phase:

Trial 1: Baselining & Testing (Winter 2025/26)

Focus on foundational 'building blocks':

- Evaluation of discrete heat network technical solutions in isolation
- Stakeholder and customer engagement to assess the appeal of nascent commercial models.

Trial 2: End to end integration (Winter 2026/27)

Aims to demonstrate end-to-end integration through:

- Integration of both the DNO-HNO solutions (technical and commercial)
- Inclusion of feedback from stakeholders and consumers into draft commercial proposals

Trial 3: Business-as-Usual (BaU) Readiness (Winter 2027/28)

Subject to progression, Trial 3 will aim to:

- Transfer lessons from integration practices to other DNOs and HNOs

- Test addition, refined integration arrangements at existing trial sites.
- Simulate a DNO-HNO flexibility market scenarios, such as a mock trading site.
- Pilot commercial arrangements to incentivise consumer behaviours that support peak load reduction.
- Demonstrate the use of the DNO digital connection tools for HNOs developed under WP5.

7.3 Other integration considerations

In addition to trial-specific integration:

- **Platform Alignment:** The project will leverage existing tools and infrastructure where possible, including established electricity trading models, such as flexible electricity contracts to minimise duplication and accelerate learning.
- **Test Systems and Simulations:** While seamless integration is the goal for Trials 2 and 3, the use of test systems and simulated data may be employed where full integration is not essential for achieving key project outcomes.

7.4 Schematic Phased Trial Plan

The table of the phased trial plan below summarises the key goals and focuses for each Winter trial, illustrating its progress, beginning with baselining and testing, advancing to integrated operation, and culminating in scaling as a BaU proposition.

Table 3. Phased Trial Plans

Trial Period	Trial 1 Winter 2025/26	Trial 2 Winter 2026/27	Trial 3 Winter 2027/28
Goal	• Baseline heat network demand. • Assess initial flexibility technical potential and initial commercial signals	• Demonstrate end to end integration between DNO & HNO systems. • Test commercial and technical arrangements	• Full BaU commercial and technical arrangements demonstration • Open to other HNOs and DNOs to participate based on integration criteria.
Technical Focus	• Evaluate discrete heat network technical solutions implemented singly	• Demonstrate DNO-HNO interface • Demonstrate heat network technical solutions in combination	• Trial evolved integration arrangements
Commercial Focus	• Calibrate commercial models • Test the appeal of nascent commercial arrangements	• Feedback on draft commercial arrangements	• Simulate a DNO-HNO flexibility market, such as a dummy trading site • Simulate commercial arrangements that reward desired consumer behaviours

7.5 Work Package Linkages

The interdependencies between the Heatropolis work packages are summarised to show how the trial phases are coordinated across technical, commercial, engagement, and regulatory aspects. Effective integration and timing of activities across WPs will be critical to ensure the success of the overall project.

WP3: Trials Strategy and Design and WP4: Trials Build and Evaluation

- WP3 delivers the detailed planning and strategy for the trials implemented through WP4.
- Although WP3 and WP4 are sequential, some activities will be delivered in parallel, particularly where long lead in times for procuring assets are involved.
- WP3 trial strategies and plans will be reviewed and refined prior to each new trial phase (Trials 2 and 3).
- WP4 trial build out will continue through to December 2026, some items with long lead times or subject to regulatory approvals may not be installed before trial 2 begins, in late 2026.
- WP3 planning will be informed by continuous information on WP 4 commissioning forecasts.

WP2: Commercial Arrangements and Business Case and WP4: Trials Build and Evaluation

- WP4 will validate and refine the commercial assumptions for electrical peak reduction developed within WP2.
- WP4 to simulate flex requests from DNO/NESO to trial how these interact with flexibility contracts formulated through of WP2.
- WP4 will support identification of potential technical feasibility / viability of providing additional consumer incentives to enable participation in flexibility events.

WP6: Customer Engagement and Recruitment and WP4: Trials Build and Evaluation

- WP6 supports WP4 Trials by providing customers with a mechanism for providing clear feedback and communications throughout the project process.
- WP6 will capture qualitative information to supplement the quantitative data collected in WP4, for example assessing customer awareness of flexibility interventions and satisfaction with domestic endpoint smart controls.
- WP6 will help identify potential consumer appetite for commercial incentives to encourage active participation in flexibility events.

WP7: External Stakeholder Engagement and Knowledge Dissemination and WP4: Trials Build and Evaluation

- WP7 will disseminate trial conclusions to external stakeholders, including other DNOs and HNOs who may be interested in participating in Trial 3 or future BaU scaling.

- WP7 horizon scanning for potential changes to regulation and legislation might impact the design, delivery, or scalability of other work packages.

All Work Packages and WP8: Business-as-Usual (BaU) Transition and Regulation

- Each work package contributes evidence, tools, or insights to WP8, which focuses on defining pathways for scaling the Heatropolis solution into BaU operations and informing future regulatory frameworks.

Appendix 1: Detailed Trial Design Per Archetype

In this section, the trial design for each of the three Heatropolis archetypes is presented in outline. The detailed trial design remains subject to consideration of operating constraints and opportunities, and consent of stakeholders.

Each archetype represents a distinct heat network typology, allowing the project to test the Heatropolis solution across a distinct context in terms of scale, system complexity, and technical configuration. For each site, the section outlines the network status, enabling actions, trial objectives, and analysis focus for both Trial 1 (Baselining and Testing) and Trial 2 (End-to-End Integration). Trial 3 will be scoped at a later stage, based on outcomes from the first two phases.

Overview of Trial Design

The table below provides an overview of the proposed approach to trial design for each of the three Heatropolis archetypes

Table 4. Overview of Trial Design

Archetype	Trial 1 – Baselining & Testing	Trial 2 – End-to-End Integration	Trial 3 – BaU Readiness (TBC)
Archetype 1: Kings Cross <i>Large-scale mixed-use urban network</i>	- CHP and gas boilers with HRHP (~10%) commissioned - Baseline thermal store - Smart control setup - Early commercial calibration	- ASHP, electric boiler, and thermal store installed - Integrated DNO-HNO coordination - Demonstration of smart control optimisation - Consumer incentive evaluation	- Potential flex market simulation - Refined commercial models - Multi-party coordination for BaU readiness - Evidence for broader rollout
Archetype 2: Chilton Woods <i>Low-density residential estate</i>	- Fully electric energy centre - Prototype PST-HIU testing in homes - Load shaping trials - Small resident cohort recruited	Commercial version PST-HIUs deployed – Larger resident sample – Integrated control testing – Consumer incentive evaluation	- Full smart control deployment - Demonstration of consumer-driven flexibility - Evidence for broader rollout
Archetype 3: TBC <i>High-density residential building</i>	- Site engagement and selection - Baseline profiling if secured	- Dependent on-site readiness - Likely retrofit controls and resident smart control trials - Consumer incentive evaluation	- To be defined based on selected site - Informed by earlier trial outcomes and local decarbonisation strategies - Evidence for broader rollout

Archetype 1 - Kings Cross

A large-scale, mixed-use, urban heat network with a phased decarbonisation plan.

Trial 1 – Baseline & Testing (Winter 2025/26)

Table 5. Trial 1 – Archetype 1

Category	Details:
Anticipated Network Status:	- Energy centre primarily carbon-fuelled (CHP and gas boilers). - HRHP (providing ~10% of supply capacity) expected to be commissioned during the trial. - Thermal stores remain at baseline capacity. - Over 40 connected buildings, including commercial, educational, and residential.
Enabling Actions:	- Engagement with owner and building management teams to define intervention scope (12 buildings). - Review and, if needed, upgrade Supervisory Control and Data Acquisition (SCADA) and monitoring systems to enable integration with smart control integration and control platforms. - Configure and test data flow between smart control integration and control platforms. - Develop and implement the data management, analysis, and customer engagement plans. - Identify commercial solutions for calibration through trial data.
Trial Objectives	- Establish a heat network demand baseline. - Test technical solutions in isolation and assess their optimisation potential. - Assess initial flexibility technical potential - Calibrate DNO-HNO commercial models (validate electrical load reduction assumptions) - Evaluate nascent commercial offers with participating stakeholders.
Analysis Focus	- Evaluate energy centre strategies for flexibility and optimisation. - Extrapolate gas use to electrical loads under full decarbonisation. - Assess commercial smart control and optimisation systems across supply and demand. - Simulate extreme weather responses, if necessary - Consumer response to draft commercial terms

Trial 2: End-to-End Integration (Winter 2026/27)

Table 6. Trial 2- Archetype 1

Category	Details:
Anticipated Network Status:	- New assets installed: thermal store, electric boiler, and one ASHP. - Possible inclusion of additional ASHPs and GSHPs. - Reduced dependency on carbon-fuelled heating.

	Numbers of network connected buildings remains unchanged
Enabling Actions	- Complete engineering design, modelling, and procurement for new assets. - Define DNO-HNO flexibility scenarios and establish communication protocols. - Agree trial electrical baseline supply profile. - Commercial models identified for demonstration and evaluation during trial. - Update supporting plans (Data analysis, Customer engagement, interventions schedule and baseline electrical supply profile)
Trial Objectives	- Demonstrate end to end integration between DNO & HNO systems. - Demonstrate and evaluate individual technical arrangements in isolation - Validate initial DNO-HNO commercial models with real world data - Optimised heat network operation (within profiled electrical supply profile parameters) - Flexible heat network operation (response to DNO supply limitation signals) - Test the appeal of commercial arrangements for consumers
Analysis Focus	- Quantify optimal sizing of new thermal and generation capacity. - Model commercial value needed from profiled and flexibility contracts for investment beyond the minimum for decarbonised operation. - Evaluation and modelling of heat supply and demand to extreme weather scenarios. - Capture stakeholder input on commercial engagement.

Archetype 2 – Chilton Woods

A low-density residential development with a fully decarbonised, purpose-built energy centre.

Trial 1: Baseline and Testing (Winter 2025/26)

Table 7. Trial 1- Archetype 2

Category	Details:
Anticipated Network Status:	- Energy centre decarbonised as built. ASHPs, electric boilers, and thermal storage installed for full estate build-out. - Connected homes represent a small proportion of eventual capacity.

Enabling Actions:	• Design build and test prototype PST-HIU residential end point smart controls. • Recruit properties for the prototype trial. • Install prototype controls and commission. • Implement additional network control features through software upgrades. • Update supporting plans (data analysis, customer engagement and interventions schedule). • Commercial solutions identified for calibration and evaluation through trial data
Trial Objectives	• Establish baseline heat network demand • Evaluate performance of individual technical measures in isolation and assess potential for optimisation • Assess technical load-shifting potential using existing thermal capacity. • Calibrate DNO-HNO commercial models (validate electrical load reduction assumptions). • Evaluate appeal of nascent commercial arrangements for domestic consumers.
Analysis Focus	• Evaluate energy centre operational strategies for optimisation (compliance with a profiled electricity contract) and flexibility (response to a signal from the DNO). • Assess the contribution of domestic smart controls to flexibility strategies. • Simulate extreme weather responses, if necessary • Extrapolate PST results to full build out scenario. • Gauge resident responses to draft commercial terms • Gauge resident engagement with smart controls and draft commercial offers.

Trial 2: End-to-End Integration (Winter 2026/27)

Table 8. Trial 2- Archetype 2

Category	Details:
Anticipated Network Status:	• As built energy centre operational with upgraded control software. • A larger number of homes connected to heat network.
Enabling Actions:	• Refine PST-HIU prototype into commercial-ready product. • Recruit ~24 residents for smart control deployment. • Upgrade prototypes, instal new controls and commission. • Define DNO-HNO flexibility scenarios and establish communication protocols.

	• Update supporting plans (Data analysis, Customer engagement, interventions schedule and baseline electrical supply profile) • Commercial solutions identified for calibration and evaluation through trial data
Trial Objectives	• Demonstrate end to end integration between DNO & HNO systems. • Demonstrate and evaluate technical arrangements • Optimised heat network operation (within profiled electrical supply profile parameters) • Flexible heat network operation (response to DNO supply limitation signals) • Validate DNO-HNO commercial models with real world data • Test the appeal of commercial arrangements for consumers
Analysis Focus	• Effectiveness of end-point controls to deliver flexibility benefit. • Model commercial value needed from profiled and flexibility contracts for investment. • Evaluation and modelling of heat supply and demand to extreme weather scenarios. • Capture stakeholder input on commercial engagement. • Revisit the contribution of domestic smart controls to flexibility strategies. • Greater load on the network leads to a revaluation of and modelling of heat supply and demand to extreme weather scenarios.

Archetype 3 – To Be Confirmed (High-Density Residential Building)

A single-building, high-density residential network (site not yet confirmed).

Trial 1: Site Identification and Baselining (2025/26)

Table 9. Trial 1- Archetype 3

Category	Details:
Current Status	• No confirmed site. Engagement with stakeholders is ongoing.
Enabling Actions	Continue outreach via: • London Boroughs (via UK Power Networks), • Heat Network Operators via Association for Decentralised Energy (ADE) • Conferences and targeted engagement events. • Evaluate and shortlist candidate sites for: Maturity and timing of decarbonisation plans, Technical relevance, design barriers and limitations Site readiness and stakeholder commitment. • Establish agreements with selected partner and scope interventions.

Trial Objectives & Analysis	• To be defined following site selection. • Trial 1 may focus on enabling works and baseline assessment depending on site maturity
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The Trial 2 Plan for Archetype 3 will be updated once the site has been identified.

Appendix 2: Glossary

Word	Definition
Analysis	The process of evaluating trial data to assess the performance, effectiveness, and replicability of technical and commercial solutions, including comparison against counterfactuals.
Augmentation	The enhancement or addition of technical assets (e.g., thermal storage, heat pumps) or control capabilities to existing heat network infrastructure to enable flexible operation.
Baseline operating profile⁷	The HNO's electrical load profile that conforms within the maximum electrical load profile of the connection agreement.
BaU	Business as usual
Consumer (h)	User of heat. e.g. dwelling occupier, or commercial unit tenant.
Customer (e)	User of electricity. e.g. HNO
Counterfactual	A reference scenario representing how a heat network would operate without the Heatropolis interventions, used to compare actual trial performance and quantify added value.
Decarbonisation	The transition of heat networks from fossil fuel-based energy sources to low- or zero-carbon alternatives, such as electric heat pumps and renewable electricity.
DNO	Distribution Network Operator
DSR	Demand Side Response
Flexibility⁸	The ability of someone connected to the electricity network to change when they generate or consume power ⁹ . In the context of this project, 'Flexibility' involves a shift from the baseline in response to a signal from the DNO.

⁷ In which peak electrical load will not exceed the agreed profile whilst the aggregate energy consumed in a day will vary because of weather driven fluctuations of heat demand.

⁸ Such as an instruction to reduce electrical load for a limited period below the agreed load profile.

⁹ See [Local Flexibility Markets](#) and [Flexibility Services- UK Power Networks DS0](#)

when they generate or consume power.

Funder¹⁰	Ofgem, through the mechanism of the Strategic Innovation Fund.
Governance	The framework of oversight and decision-making structures applied to the trials, including review cycles, approval processes, partner roles, and alignment with project scope.
HN	Heat network
HNO	Heat Network Operator
Intervention	A discrete change or deployment (e.g., installation of smart controls or operational adjustments) made during a trial to test its impact on network performance or flexibility.
Optimisation^{11, 12}	HNO's utilisation of thermal stores, thermal building mass and smart control algorithms: • to manage HNO electricity consumption by shifting load to conform to a profiled electricity contract, • with the aim of supporting a flattening the DNOs wider network electrical load profile.
Partners	The project partners, who are UK Power Networks (Operations) Ltd (UK Power Networks), Metropolitan Infrastructure Ltd (Metropolitan), Passiv UK Ltd (Passiv), Guidehouse Europe Ltd (Guidehouse). UK Power Networks is the lead Partner and the project DNO. Metropolitan is the project HNO.
SCADA	Supervisory Control and Data Acquisition is a system used to monitor and control industrial processes.
Service Level Agreement (SLA)	A documented commitment that ensures minimum service standards (e.g., uninterrupted heat delivery) are maintained throughout the trial, regardless of interventions.
Smart Controls	Digital systems that automatically adjust heating system parameters (e.g., temperature, flow rate) based on demand forecasts, thermal inertia, or control signals from DNOs.
Trial Archetype	A representative model of a heat network type (e.g., large mixed-use, low-density residential, high-density communal) used to ensure findings are scalable and applicable.

¹⁰ Additionally, the Partners each contribute funding to the project (in kind or as a funding contribution toward materials and subcontracts)

¹¹ For HNs yet to be decarbonised, optimisation can be demonstrated through managing energy consumption with electrical load of the decarbonised heat network being inferred through a conversion calculation.

¹² Heat network optimisation might require upstream measures at the substation or transformer.