# Heatropolis – End of Phase Meeting

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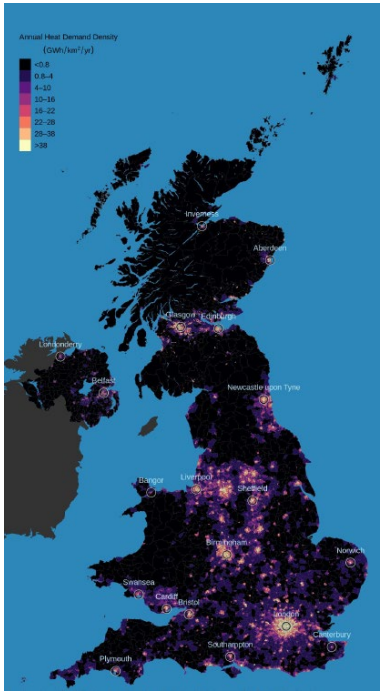
# Problem

- To meet **net zero heating targets**, we will need to move away from fossil fuelled gas boilers
- **Heat networks** will play a critical role in this transition
- Replacing fossil-fuelled systems with heat pumps will have major **implications for the electricity networks**
- **Existing heat networks** wanting to shift away from fossil fuels present a near term challenge
- Understanding and **improving processes** for transition of these sites will provide valuable learning




**UK heat demand density**

# Solution

A **framework** for calculating the **costs and benefits** from **coordinating the investment** decisions between **multiple stakeholders**:

1. **Electricity network operators** – managing power system and planning network reinforcement
2. **Heat network operators** – controlling on site assets to deliver consumer heating needs
3. **Technology providers** – Monitoring and optimising low carbon technologies
4. **Local authorities (LAs)** – understanding how heat networks impact local area energy planning (LAEP)

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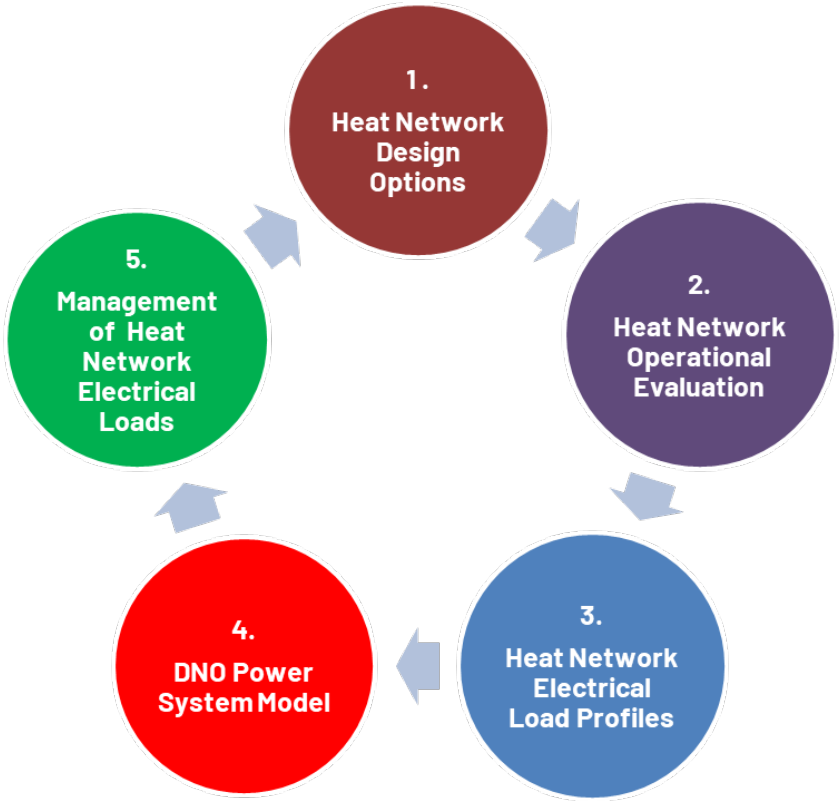
# The site – King’s Cross

**Develop the use case around a specific site:**

- King's Cross development is supported by a large heat network
- The site has is committed to reaching net zero by 2030
- Replacing fossil-fuelled Combined Heat and Power (CHP) systems: **-1.5 MW (CHP)**
- Current plans to increase heat pumps and thermal storage, therefore electrical loads expected to increase significantly: **to +21 MW (low carbon technologies)**

# The Heatropolis framework




- **Heatropolis** proposes a multi-stage decision **framework**
- The aim is to unlock **commercial mechanisms** that link **heat network design** and operation with the **power system**
- **Hypothesis** – Smarter heat network design can deliver significant electrical load reductions for distribution network operators (DNOs)

# Key activities during Discovery Phase

**Compare different smarter low carbon heat network designs to understand DNO benefits:**

1. Review and **validate the current plan (counterfactual)** to decarbonise the King's Cross heat network
2. Investigate and **shortlist alternative options** (technological, operational, storage) for the heat network to better manage the electrical load on the DNO than in counterfactual plan
3. Evaluate the technical engineering requirements and increased costs for the heat network to realise a smarter, managed electrical load
4. Assess benefits of a smarter heat network type of solution in DNO **reinforcement planning**
5. Set out approach for **Alpha Phase**

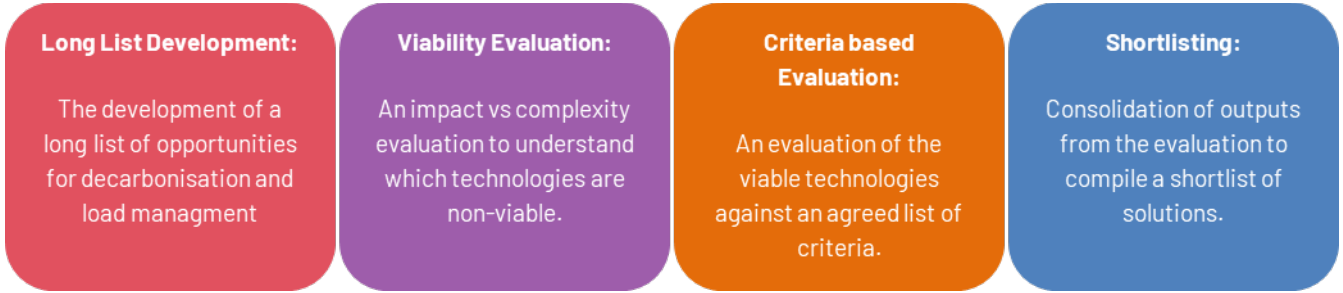
# Project Output 1 - Review existing low carbon heat network design

**Review and validate processes and baseline assumptions used in counterfactual design to decarbonise the Kings Cross heat network**

Stage 1

# Output 2 - Review smart system design options

**Process used to shortlist heat network designs to better manage the electrical load on the DNO**




## Results of heat network design scenarios to model in comparison with counterfactual

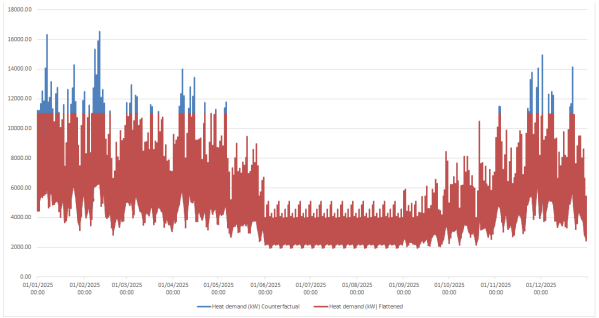
- **Counterfactual (current plan)** – (HRHP+ASHP+GSHP+EB+TS)
- **Scenario 1a** – (HRHP+ASHP+GSHP+EB+TS+**DF**)
- **Scenario 1b** – (HRHP+ASHP+GSHP+EB+TS+**DF+Additional ASHP Capacity**)
- **Scenario 2** – (HRHP+ASHP+GSHP+EB+ **Additional PCM TS**)
- **Scenario 3** – (HRHP+ASHP+GSHP+TS+**HB**)

**HRHP** – Heat recovery heat pump
**ASHP** – Air source heat pump
**GSHP** – Ground source heat pump
**EB** – Electric boiler top-up
**HB** – Hydrogen boiler top-up
**TS** – Thermal storage
**DF** – Demand flattening
**PCM** – Phase change material

# Output 3 - Tecno-economic modelling of a smarter heat networks

**Modelling to evaluate the technical engineering requirements and increased costs for the heat network to realise a smarter, managed connection to the DNO**

Modelled impact of **Demand Flattening** on heat load



Yearly Heat demand Counterfactual vs Heat demand flattened

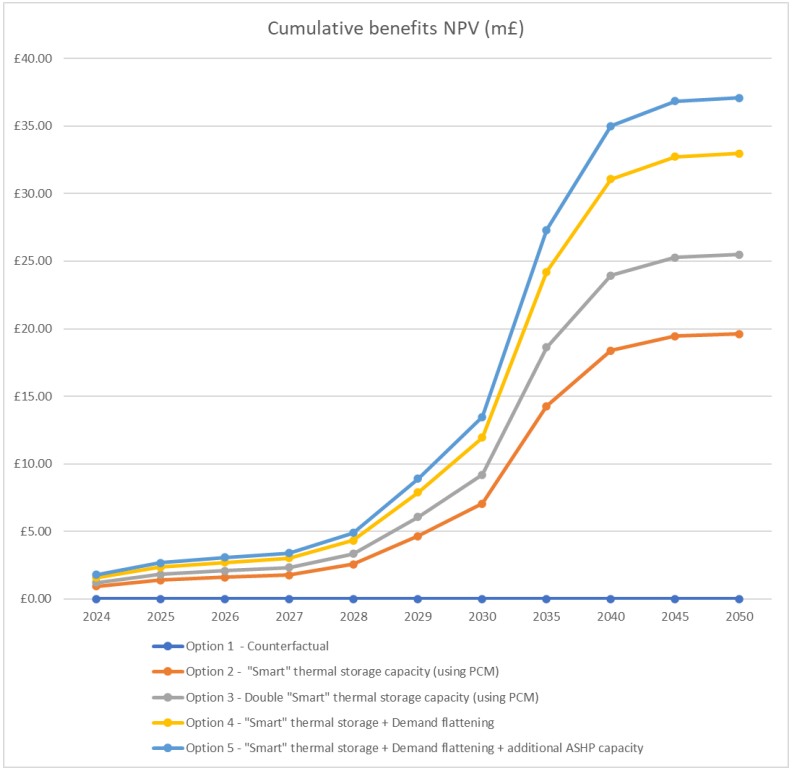
- Multiple design scenarios modelled using different equipment variations
- Key metrics reported to allow comparison
  - Impact on peak electrical demand
  - Impact on overall energy balance (level of energy supplied from each technology)

**Outputs from smart heat network design** options identified

| Heat network Design Options | Scenario | Reduction in Electrical Demand (%) |
|---|---|---|
| **Option 1** - Counterfactual | 0 | 0% |
| **Option 2** - "Smart" thermal storage capacity (using PCM) | 2 | 23% |
| **Option 3** - Double "Smart" thermal storage capacity (using PCM) | 2 | 30% |
| **Option 4** - "Smart" thermal storage + Demand flattening | 1a | 39% |
| **Option 5** - "Smart" thermal storage + Demand flattening + additional ASHP capacity | 1b | 44% |

# Output 4 - Network impacts of smarter heat network designs

## Modelling to evaluate the impact of smarter heat network designs on network reinforcement




- Modelling the impact of future heat demand on the power system is complex
- Network impact projections based on UK Power Networks' Distribution Future Energy Scenarios (DFES) and Strategic Forecasting System (SFS)
- Modelling identified savings of over £37m by 2050 in avoided network reinforcement by using smarter heat network designs
- Option 5 - Demand flattening + additional ASHP capacity is optimal
- Doubling thermal storage for Option 3 only provides 2% saving, and therefore has limited value

# Lessons learnt

**Low carbon heat networks are set to have an increasing impact on the electricity distribution system, but there is a disconnect between DNO planning and heat network design and operation.**

## Technical requirements

**a) Smarter HN design**

- Counterfactual low carbon HN design is only optimised for heat network operation
- No incentive for HN design to reduce or manage peak electrical load
- 44% peak electrical load reduction is achievable

**b) Power system modelling**

- Early analysis suggest limitations to existing HN load impact projections
- Risk of higher levels of reinforcement than anticipated
- Urgent need to understand and foster smarter HN design and operation


**Dominant heating technologies in central London - System Transformation 2050**

Source: Distribution Future Energy Scenarios Network-Level Outlook December 2020

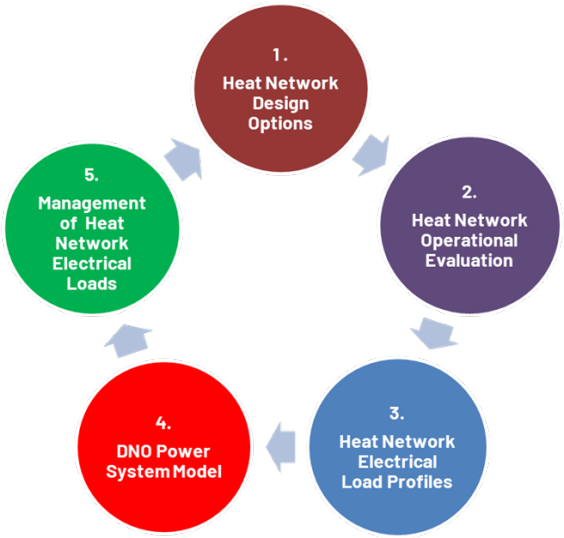
## Commercial mechanisms

- Limited incentives with existing flexibility and connection products
- Heat network and DNO interaction only considers peak load for a site
- Timing of peak load calculated with a diversity factor not designed
- Considerations for Alpha:
  - Pre-agreed energy performance-based contracting
  - Long term contract mechanisms

# Lessons learnt

**Commercial mechanisms** – Needed to realise value from smarter heat network design and operation

- Distribution system operator (DSO) flexibility products have limited spatial application and limited scope to improve return on investment for smarter heat network designs
- DNO connection products available don't provide financial incentives for the smarter heat network, only faster connections
- Heat network - DNO interaction only considers "***Peak Load"*** *for a site*
- Timing of "***Peak Load"*** is calculated within **"Diversity"** calculations carried out independently by a DNO rather than contractually agreed between networks
- Commercial mechanisms under consideration include:
  - **Pre-agreed energy performance-based contracting** - deliver load reduction using metering and monitoring using data to validate contract delivery
  - **Long term contractual mechanisms** – metering and monitoring ongoing peak electrical loads with appropriate incentives and or penalties for achieving targeted profiles.




**Heatropolis Framework**

# Deliverables

| Work package (WP) | Deliverables | Lead |
|---|---|---|
| WP1 Project Management | Project initiation document (PID)<br>Maintain risk matrix updated | Passiv |
| WP2 Counterfactual system design | Counterfactual system design (energy modelling of current and future build phases on site) | Metropolitan |
| WP3 Smart system design | Detailed shortlist of smart system design options for review (operational improvements, technology switching, thermal storage) | Metropolitan |
| WP4 Techno-economic assessment | Assessment outlining the value of the smart systems solution for development in Alpha phase. Analysis of equipment sizing and configurations for shortlisted design options, modelling demand reduction options, impacts on the network. Discovery Phase conclusions. | Passiv |
| WP5 Dissemination | Dissemination materials for Ofgem Show & Tell workshop | UK Power Networks |
| | End of Discovery Phase report<br>Dissemination Public Report (Short format) | Passiv |

# Meeting project specific conditions

**Project specific condition:** Prior to the end of the Discovery Phase, the Funding Party must engage with the team behind the SIF Project 'Carnot Gas Plant' to examine areas of commonality and potential overlap, and how the two Projects could inform each other on their findings and potentially work together in future Project Phases.

Initial discussions were held with the project leads for 'Carnot Gas Plant' (SGN) and the project leads for 'Full Circle' (UKPN/SGN). The project discussion covered heat generation, heat utilisation and storage comparison between the two projects.

- **Carnot Gas** – Intermittent heat generation and storage system will only be utilised during low half hourly electrical wholesale prices
- **Full Circle** – Exploring direct heat utilisation at times of high generation with small storage for delayed release
- **Heatropolis** – Purpose of storage is to flatten load against generation instead of demand. Smart controls to optimise storage will be able to pre-charge storage based on market pricing signals.

In-depth discussions are planned to share final learnings before Alpha Phase commencement.

# Comms and engagement plans going forward

**Communications:**

- UK Power Networks, as the lead partner, will publish the top **three key learnings** from the Discovery Phase on its website for all SIF projects.
- A case study has been published on the Passiv UK website and the timing of a **joint press release** is being considered between partners.

**Engagement:**

- A **project snap-shot** has been prepared for Camden Council to disseminate
- A **Show & Tell** for local authorities that are interesting in using smart solutions for heat networks, will be held subject to interest and successful Alpha Phase bid
- A **dissemination workshop** for heat network project developers and stakeholders at Alpha Phase commencement if successful.

# Plan for Alpha Phase

**Alpha will continue to focus on the two main functions of the Heatropolis framework**

- **Technical requirements** – to design a smarter heat network
- **Commercial mechanisms** – to realise value from avoided reinforcement using smarter heat networks

| Workstream | Detail | Months | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| **Technical Design** | Development of engineering designs for solutions outlined in Discovery to RIBA Stage 3 for procurement of D&B Contractor in Beta | | | | | | |
| **Smart control testing** | Proof-of-concept control systems on a single building to validate modelling | | | | | | |
| **Commercial and operational framework for DNO and Heat Networks** | business case to validate contractual mechanisms for unlocking value from managed vs unmanaged electrical load profile | | | | | | |
| **Dissemination and planning for Beta Trial** | Detailed planning for Beta trial to test the two main functions of the Heatropolis framework: Technical requirements and Commercial | | | | | | |

**Existing Parners:** UK Power Networks, Passiv UK, Metropolitan, Camden Council

**New Partners / Sub-contractors:** Buro Happold, Crossbreed, Noda

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# THANK YOU