



Department for
Business, Energy
& Industrial Strategy

HEAT NETWORK INVESTMENT PROJECT EVALUATION

Pilot Impact Evaluation Report

BEIS Research Paper Number 2020/040



October 2019

Acknowledgements

The research reported here was led by Risk Solutions and the Tavistock Institute for Human Relations. We are grateful for the help and assistance provided by all the evaluation team, and for the input of the BEIS research manager, Patrick Abbey, and the input and advice offered by the members of the steering group for the research.

Executive Summary

Introduction

Heat networks typically convey hot water from a central heat source (or sources) to meet demand for space and water heating distributed across a number of buildings. Some networks also provide cooling. Heat networks, also known as district heating systems, are important because they can offer significant carbon savings. They can deliver heat from a range of sources, such as waste heat recovery, combined heat and power (CHP), and large heat pumps, which could not otherwise be used to heat domestic properties. Compared with property level heating, the economic case for heat networks can be challenging. This is due to the high initial capital costs (compared with individual gas boilers) which leads to the need for guaranteed demand underpinned by long-term contracts to recoup these, combined with a perception of relatively low returns over long payback periods.

To address this and other challenges, the Department for Business, Energy and Industrial Strategy (BEIS) implemented the Heat Networks Investment Project (HNIP). The main objective of the scheme is to contribute to the development of a heat networks market that is self-sustaining and not reliant on Government subsidy. HNIP is designed to provide capital support for organisations seeking to initiate new heat networks in England or Wales, or expand existing heat networks, which are otherwise unable to do so because the rate of return, while positive, is insufficient to justify the investment.

HNIP has two stages:

1. The pilot: which was launched in October 2016 and announced funding recipients in April 2017; this offered grants and loans to local authorities and the wider public sector; and
2. The main scheme: which will offer grants and loans to local authorities, public bodies, and private and third sector organisations. This will provide funding from April 2019 for up to three years.

The HNIP Pilot attracted 25 applicants of which nine were successful. All the successful projects were local authority sponsored. Of those nine, two did not go ahead as the parties involved decided not to proceed with them.

The remaining seven funded projects are proceeding. BEIS has commissioned a suite of independent process and impact evaluation activities to cover the full HNIP scheme (the pilot scheme and the main scheme).

The evaluation is being delivered in a series of approximately annual iterations. This report follows on from the process evaluation of the pilot¹ and focuses on the initial impact of the HNIP pilot scheme.

It was started just 12 months after announcement of the award of funding. Most of the schemes funded under the scheme are in their early stages – for example at the time the fieldwork was carried out none of the projects had begun construction. The aim of this first cycle of impact evaluation is therefore to look for early indications of emerging effects.

The evaluation approach

The evaluation is to be theory-based and adopts a realist approach². This asks:

What works, for whom, in what respects, to what extent, in what contexts, and how?

This approach has been chosen because the HNIP pilot interacts with a multitude of heat network schemes across very different geographical, technical, political and operational contexts – where such contextual factors are expected to interact with the policy in significantly different ways. These characteristics can make determining causation through comparison with a counterfactual impossible or impractical. Instead realist evaluation attempts to understand an intervention's contribution to observed results through explaining the mechanisms leading to outcomes – specifically, how the programme is affecting the reasoning of the actors which then leads to change.

The high-level research themes for the evaluation are provided in Annex 1 and address:

- HLT1: Scheme technical design
- HLT2: Administrative design and delivery
- HLT3: Delivery of projects
- HLT4: Market sustainability
- HLT5: Delivery of scheme outcomes
- HLT6: Cost benefit of the scheme.

Theories relating to these themes were developed, tested, refined, confirmed or rejected through an iterative process of evidence collection (tailored to the theories under consideration) based, for this initial pilot evaluation, around three case study funded projects selected with BEIS. We also used evidence from earlier data gathering, including

¹ BEIS Research Paper Number 1 (February 2018). Heat Networks Investment Project Evaluation: Process evaluation of pilot
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/699304/HNIP_EVALUATION_-_PILOT_PROCESS_REPORT_-_FINAL.pdf

² Pawson, R. & Tilley, N. *Realistic Evaluation*. London: Sage (1997).

the process evaluation of the pilot and interviews with successful projects to learn more about the delays to construction they have encountered.

Findings

The HNIP pilot is a programme operating in a complex environment. Each of the case study local authorities had already undertaken some work on heat network projects before the HNIP pilot was rolled out.

HNIP pilot support has played a varying role in each of the projects it has funded. In the three case studies we have completed, in one it has been critical in enabling a heat network to be integrated with an existing urban centre development. In another it has operated as an essential part in a complex jigsaw of an urban improvement project begun several years ago and propelled by clean air imperatives. In another, where the buildings to be heated have not yet been built, it has enabled more innovative and sustainable solutions to be adopted.

The additional capital support provided by the HNIP pilot has been critical for each project in enabling it to move forward but its effects have varied from site to site. Throughout we observed the ripple effect of the programme. We find that:

- Analysis of case study interviews and other evidence such as our e-survey have demonstrated the catalytic effect of the HNIP pilot in drawing in and motivating key actors with different motivations, including those who are already engaged in or who favour the development of HNs from a perspective of sustainability and carbon reduction, those interested in addressing fuel poverty and providing reliable heat, and those interested in ensuring that LA investments yield acceptable returns. HNIP pilot support provides scheme validation and has an impact on the confidence of key actors and decision-makers.
- Analysis of case study interview evidence indicated that HNIP support can signal to external stakeholders and potential property developers the benefit and necessity of including heat networks in future planning particularly where there is live evidence of successful heat networks
- Our analysis of evidence from case study interviews suggests that HNIP generates interest among contractors and industry consultants in sustainability focused heat generation technology
- Our analysis of evidence from case study interviews, from earlier interviews on delays and from the e-survey show that the HNIP pilot provides credibility in local authorities, where there can be competition for scarce resources. This is consistent

with evidence from interviews carried out previously for the process evaluation of the HNIP pilot.

- From case study evidence, in one project we have seen learning from the HNIP pilot supported project being taken into neighbouring local authorities for their emerging heat network plans.

At this stage, across the three case studies, the HNIP pilot shows clear signs of influencing and empowering heat network development. We expect ripple effects to be key to ensuring that HNIP achieves its wider objectives of contributing to a self-sustaining market. While we have seen some evidence of effects rippling out beyond the immediate funded scheme, there is no strong evidence available yet of how it contributes directly to a self-sustaining heat network market; this question will be addressed during future evaluation cycles.

Next steps

The work reported here has been used as a major source of evidence to review and refresh the overall theory of change, along with other available evidence and input from the BEIS policy team for the main HNIP scheme. The refreshed theory of change will act as a starting point for the next evaluation cycle. The next focus of evaluation activity will be a process evaluation of the implementation of the HNIP main scheme.

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HNIP Evaluation glossary and definitions

This is a project glossary – not all terms defined here will be used in this report.

Term or acronym	Definition
Actuarial annualization rules	Process set out by HM Treasury relating to calculating and allocating costs and benefits across financial years
Additionality	The extent to which something happens as a result of an intervention that would not have happened in the absence of the intervention.
Anchor load	A long-term, stable and predictable demand source. It provides Heat Network developers with security that the heat produced will have a buyer and helps to optimise technical efficiency by reducing variability in the level of demand
Association for Decentralised Energy	A trade association representing organisations with an interest in decentralised energy.
BEIS	Department for Business, Energy and Industrial Strategy
Borrowing limit	The maximum amount that a financial institution will lend to an organisation. This may be based on a whole range of different factors such as assets that can be used as security for borrowing, past and future expected revenues, and other existing liabilities.
Boundary partners	Individuals, groups, and organisations with whom HNIP interacts directly and who engage with people and organisations on Heat Network development beyond the boundary of HNIP.
CAPEX	Capital Expenditure
Case study	A case study focuses on a particular unit - a person, site, project, or theme, within a larger programme and can be particularly useful for understanding how different elements fit together and how different elements (implementation, context and other factors) have produced the observed impacts. ³

³ Adapted from Better Evaluation: http://www.betterevaluation.org/en/plan/approach/case_study

Term or acronym	Definition
CHP	Combined heat and power – sometimes called co-generation. Combines electricity and heat, because the waste heat from thermal electricity generation is captured and used.
CHPQA	CHP Quality Assurance – the CHPQA is a government initiative providing a means of assessing CHP schemes in the United Kingdom. CHPQA certification demonstrates a level of quality and is necessary for eligibility for a range of benefits.
Confirmation bias	The tendency to search for, interpret, favour, or recall information in a way that confirms one's pre-existing beliefs, hopes or hypotheses.
Customer	A demand aggregator – that is, a building manager or property developer who buys heat for entire buildings, campuses or estates. Customers also include developers – those building or refurbishing commercial or residential property, who can choose how heating will be provided in those properties.
Consumer	End users of the heat provided by the heat network
Context – in realist evaluation	The circumstances that affect whether a policy ‘works’ and for whom. Consideration of ‘context’ forms an important part of realist approaches to evaluation.
Decentralised energy	Energy (for example electricity, or heat) that is produced close to but not at the location where it will be used.
Delivery partner	The ‘delivery partner’ is the organisation commissioned by BEIS to carry out a range of functions associated with administering the Heat Networks Investment Project, including acting as the key point of contact for applicants and processing applications.
District heating	A scheme that provides heat generated at a central location to nearby buildings.
FAQ	Frequently asked questions
Funding gap	The gap between the amount of money available to a project from existing sources and the amount needed to fund development of the project so that it can proceed to operation.

Term or acronym	Definition
Future-proofed	Designed and developed in a manner that considers and takes account of a range of potential future events and changes in relevant drivers (for example commodity prices) to reduce the risk that significant changes will be required in the future to accommodate such changes.
Gearing	Gearing is a financial measure that indicates how much of an organisation's activities are funded by its owner's funds compared with creditor's funds. It is often expressed as a ratio of debt to equity but can also be expressed as the ratio of earnings to interest payments (also known as interest cover), or of debt to assets. Funders may set limits on the values of such ratios that they will allow, to manage credit risk.
Heat network	A Heat Network is a distribution system of insulated pipes that takes heat from a central source and delivers it to a variety of customers in separate buildings. These typically include public sector buildings, shops and offices, sports facilities, university buildings, and homes.
HMT	Her Majesty's Treasury
HMT TAP	Treasury Approvals Point – this is the process by which HMT scrutinises and approves project spending above a certain specified limit for each government department.
HNDU	Heat Networks Delivery Unit – this supplies support and guidance to local authorities in England Wales who wish to explore Heat Network opportunities.
HNIP	Heat Networks Investment Project
Hurdle rate	The minimum value of a rate (such as an internal rate of return) that an investor (internal or external) requires to consider investing.
IRR	Internal rate of return - a measure that is sometimes used in capital budgeting and project appraisal as a measure of profitability. It is calculated as the discount rate that gives a net present value of zero.
LA	Local authority

Term or acronym	Definition
Mechanism – in realist evaluation	Underlying entities, processes, or structures which operate in particular contexts to generate outcomes of interest. ⁴
Mid-range theories	These are theories that can account for similar outcomes in similar contexts across the programme. This knowledge can then be spread across the whole programme to support programme improvement and may also yield lessons that can be <i>transferred</i> to other similar programmes in similar contexts.
NPV	Net present value – a measure used in project appraisal and capital budgeting to assess the financial return from a project.
Outcome – in realist evaluation	A change in the state of the world, brought about as a result of a policy or other influences. Realist approaches to evaluation attempt to identify the ‘contexts’ and ‘mechanisms’ that lead to a particular ‘outcome’.
Project sponsor	The entity that initiates the Heat Network project – they may or may not be the Heat Network operator.
Purposive sample	A sample that is selected based on the characteristics of a population and the objective of the study, using subjective judgement drawing on theory (e.g. the programme theory) and practice (i.e. the experience of the researcher and the evolutionary nature of the research process). The goal is not to attempt to make generalisations (i.e. statistical inferences) from the sample being studied to the wider population of interest but rather, in realist evaluation, to explore some aspect of theory in depth.
Qualitative comparative analysis (QCA)	Qualitative Comparative Analysis ⁵ (QCA) is a means of analysing the causal contribution of different conditions (e.g. aspects of an intervention and the wider context) to an outcome of interest. QCA identifies the simplest set of conditions that can account all the observed outcomes, as well as their absence.
Rapid evidence assessment	Gathers and reviews evidence in a streamlined systematic manner, aiming to produce results on a short timescale.

⁴ Astbury and Leeuw (2010) “Unpacking black boxes: mechanisms and theory building in evaluation. American Journal of Evaluation 31 (3), p 368

⁵ http://www.betterevaluation.org/en/evaluation-options/qualitative_comparative_analysis

Term or acronym	Definition
Realist evaluation	Emphasises the importance of understanding not only whether a policy contributes to outcomes (which may be intended or unintended) but how, for whom and in what circumstances it contributes to these outcomes. ⁶
Ripple effects	Outcomes reaching, or with the potential to reach, beyond HNIP's immediate impact on funded schemes to have a wider impact on the market
Salix	The delivery partner for the HNIP pilot scheme.
Theory-based evaluation	Uses an explicit theory of change to draw conclusions about whether and how an intervention contributed to observed results. An approach to evaluation (i.e., a conceptual analytical model – a way of structuring and undertaking analysis in an evaluation); not a specific method or technique. ⁷
Transition point	Transition points describe the changes expected in project components as a product of HNIP's interventions. These changes are stages on the way to the scheme's intended outcomes (stepping stones). What emerges at one transition point becomes the context for the next stage of change and development. The changes should be clearly identifiable and, where possible, supported by metrics.

⁶ Pawson and Tilley, 1997; a theory-based approach to evaluation. For more information see: http://www.betterevaluation.org/en/approach/realist_evaluation

⁷ For more information see e.g. <https://www.canada.ca/en/treasury-board-secretariat/services/audit-evaluation/centre-excellence-evaluation/theory-based-approaches-evaluation-concepts-practices.html>

Chapter 1: Introduction

The purpose of this evaluation report is to describe the findings relating to the impact of the pilot phase of the Heat Networks Investment Project (HNIP) emerging from the first cycle of realist evaluation. We begin by providing a basic introduction to the policy for those unfamiliar with the scheme, and a summary of the current status of the HNIP pilot and the evaluation, followed by an introduction to the overall approach and the place of the work reported here in the overall evaluation.

The Heat Networks Investment Project

The UK's carbon emissions derive mostly from fossil fuel combustion, with heating accounting for 37% of total energy use. Three quarters of this is consumed as heat in buildings, 60% of which are residential⁸. These emissions must be reduced or eliminated if the UK is to meet its carbon targets.

Heat networks commonly convey hot water from a heat source to meet distributed demand for space and water heating and provide an opportunity for greater energy efficiency and carbon savings. Heat network infrastructure is fuel neutral and can deliver heat from a range of sources, such as waste heat recovery, combined heat and power (CHP) plants, and large heat pumps.

The Heat Networks Investment Project pilot (HNIP pilot) is designed to provide capital support for organisations seeking to initiate new heat networks in England or Wales, or expand existing heat networks, which are otherwise unable to do so because of financial constraints – either internal to their organisation or as required by external funders or investors. Previous research by the Department of Energy and Climate Change into barriers to heat networks identified access to finance as a key barrier to heat network development for local authority commissioners⁹.

⁸ Department for Business, Energy and Industrial Strategy (December 2018) Clean growth: transforming heating – overview of current evidence <https://www.gov.uk/government/publications/heat-decarbonisation-overview-of-current-evidence-base> (Accessed August 2019)

⁹ Department of Energy and Climate Change (2013a). Research into barriers to deployment of district heating networks. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191542/Barriers_to_deployment_of_district_heating_networks_2204.pdf. (Accessed 7 March 2017).

HNIP's objectives¹⁰ set out when the pilot scheme was rolled out are to:

1. Increase the volume of heat networks built, by providing central Government funding which will draw in significant additional investment.
2. Deliver carbon savings for carbon budgets across the lifetime of the infrastructure asset.
3. Build capability among local actors (particularly heat network project sponsors) to develop optimised heat networks that will meet local needs.
4. Support developing heat networks with the technical, contractual and financial characteristics that would not have been developed without Government support. These include: a range of technically and commercially future-proofed innovations; operating with no detriment to the customer when compared with likely alternative heat supplies.
5. Encourage investment in innovation and development within an enabling legislative framework that will contribute to the conditions for a self-sustaining heat network market that no longer requires Government funding once HNIP is completed.

HNIP has two stages:

1. The pilot: which was launched in autumn 2016 and announced funding awards in summer 2017; this offered funding to local authorities and the wider public sector; and
2. The main scheme: which will offer funding to local authorities, public bodies, and private and third sector organisations. This will provide funding from April 2019 for up to three years. It aims to invest up to £281m in up to 200 projects.

The HNIP Pilot attracted 25 applicants of which nine were successful. All the successful projects were local authority sponsored. Of those nine, two did not go ahead¹¹.

The remaining seven funded projects are proceeding.

This initial impact evaluation of the HNIP pilot scheme was started just 12 months after announcement of the award of funding on 7 April 2017. BEIS monitoring at this stage showed that projects were progressing more slowly than originally planned. While the bulk of project funding awarded was to support the construction of projects, at the time the fieldwork was carried out construction had not begun. For most of the projects, commercialisation was at an advanced stage (they had gone through master-planning and

¹⁰ The objectives have since been reviewed and amended for the main scheme; they remain similar to these.

¹¹ Individuals associated with these two projects contributed to our evidence.

feasibility assessment for example, and in several cases, procurement was underway) and they were close to starting construction, but this was later than initially expected.

The evaluation

BEIS commissioned a consortium led by Risk Solutions to deliver an evaluation of the scheme. The evaluation runs in parallel with HNIP pilot and main scheme implementation and is being delivered through a series of annual cycles of activity including process, impact and economic evaluation.

Aims of the evaluation

The aims of the evaluation are:

Process evaluation: to establish how the HNIP application and project initiation stages are working and what improvements can be made, both between the pilot and main schemes and as the scheme progresses.

Impact evaluation: to assess the impact HNIP has had, how it achieved these impacts and the extent to which the policy can be said to have contributed to the observed outputs and outcomes.

Economic evaluation: to quantify the economic benefits and outcomes, compared with the costs of the project, and assess what impact HNIP is having on the heat networks market in practice.

These aims were articulated in a set of high-level themes (see Annex 1).

As well as seeking to explain how and why the project is contributing to observed results and providing learning for the ongoing development of HNIP, the evaluation also aims to provide learning relevant to other similar programmes in the future.

The evaluation is being delivered in a series of approximately annual iterations:

- Cycle 0: Process evaluation of the pilot¹² and initial theory of change (ToC) - This cycle is complete
- **Cycle 1: Initial impact evaluation of the pilot - The focus of this report.**

¹² BEIS Research Paper Number 1 (February 2018). Heat Networks Investment Project Evaluation: Process evaluation of pilot
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/699304/HNIP_EVALUATION_-_PILOT_PROCESS_REPORT_-_FINAL.pdf

- Cycle 2: Further impact evaluation of the pilot and initial process evaluation of the main scheme; depending on the timing of the launch of the main scheme some exploration of early impacts of this may be possible
- Cycle 3: Further process evaluation of the main scheme and impact evaluation of the pilot and main schemes
- Cycle 4: Some final impact evaluation, the economic assessment (Cost Benefit Analysis), final synthesis and reporting.

Context for this evaluation

The HNIP pilot was launched at a point where there is growing interest in sustainability. Ultimately BEIS's expectation is that the HNIP funding will contribute significantly to the emergence of a sustainable market for heat networks, where funding from central government is no longer needed.

Our earlier Process Evaluation¹ found that:

“It is clear that HNIP is sending a positive signal to the heat networks market in terms of government support, for the large-scale public sector market in particular. This is reflected in growing interest from consultants and technologists, greater confidence to invest in skills, expertise and marketing, and potential reductions in costs. It is clear that HNIP has the potential to render previously unviable projects viable and to boost the UK heat networks market.”

It is in this overall context that we began this impact evaluation of the pilot.

Specific aims of this cycle of impact evaluation

This first cycle of impact evaluation has been designed to draw out what has occurred in the early stages of the pilot and how this matches the expectations, set out in the initial ToC. It examines in particular early findings relevant to the following HLTs (more detail can be found in Annex 1):

HLT 1. Technical design of the scheme: What works and what does not, why, and for whom [e.g. BEIS, delivery partner, the different types of applicant and project (incl. technology type)], in terms of the scheme technical design. In particular in this report we explore:

- whether a key eligibility requirement, the existence of a funding gap, is being met and
- how the scheme design may be impacting key matters of scale and progress towards achieving longer term carbon reduction outputs

HLT 2. Administrative design and delivery: What aspects of the scheme administrative design and delivery work, what does not, why, and for whom [e.g. BEIS, the

delivery partner, the different types of applicant and project (incl. technology type)] and for the different stages in the applicant journey. In particular in this report exploration of motivations and mechanisms will be relevant to communications around the scheme.

HLT3. Delivery of project outputs and outcomes: How has the scheme progressed in terms of delivery of project outputs and outcomes? Does this differ in different applicant/project contexts, why, how could this be improved? How confident are we in attributing project outputs and outcomes to HNIP as opposed to other external factors? In particular, in this report we begin to explore issues relevant to:

- scale and management of project risk, and
- developing an understanding of how HNIP is contributing to outcomes alongside other factors.

With respect to HLT 4. Delivery of a self-sustaining market, HLT 5. Delivery of programme outcomes and HLT 6. Overall cost benefit, we have begun to explore some early effects of the scheme, which will feed into theory development in these areas in later stages of the evaluation.

The evaluation approach

For the impact evaluation we have adopted a realist evaluation approach. Realist evaluation is a theory-based approach¹³ that emphasises the importance of understanding not only whether a policy contributes to outcomes (which may be intended or unintended) but how, for whom and in what circumstances¹⁴. The explanatory strength of realist evaluation in complex situations makes it an attractive choice for the evaluation of the HNIP pilot. The full realist evaluation question is:

What works, for whom, in what respects, to what extent, in what contexts, and how?

Evidence gathering is *purposive* – designed to explore how the programme is working across a breadth of contexts rather than collating views from a representative sample.

More information about the realist approach to evaluation can be found in Annex 2. The methodology we used for this cycle of the evaluation is set out in Chapter 3 and Annex 3.

¹³ That is, it uses an explicit theory of change to draw conclusions about whether and how an intervention contributed to observed results. It is an approach - a way of structuring and undertaking analysis - not a specific method or technique.

¹⁴ Pawson, R. & Tilley, N. *Realistic Evaluation*. London: Sage (1997).

This report

This report covers the initial realist impact evaluation of the pilot project. It reports on the findings emerging from research to date including three case studies where district heat network development has been supported by a grant from the HNIP pilot phase.

The remainder of this report is structured as follows:

- Chapter 2 – Methodology – describes the methodology used for the work reported here
- Chapter 3 – Findings – sets out the findings of the impact evaluation of the HNIP pilot
- Chapter 4 – Conclusions and next steps – presents the key conclusion from the work reported here and describes the next steps.

Chapter 2: Methodology

This section sets out the methodology we used to build, develop and test the initial theory.

Our research process

Process steps

Figure 1 shows an overview of the pilot impact assessment process.

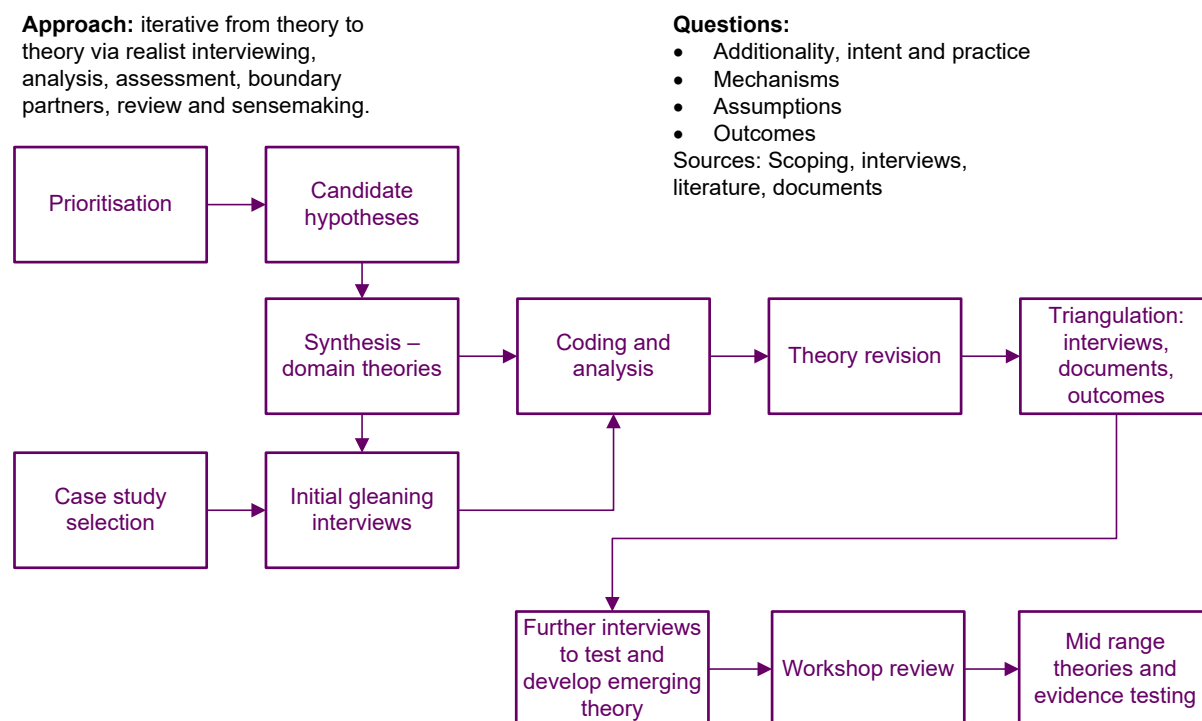


Figure 1: Overview of the methodology

The steps are described below – more details of the process and examples of how theories were identified, tested and refined through this process are provided in Annex 3.

1. **Prioritisation:** An initial review of the ToC determined which areas on the ToC could be examined in the current cycle, these were tested for completeness against the high-level themes established for the evaluation (see Annex 1). Areas for attention in this first iteration of impact evaluation were prioritised with BEIS.
2. **Case study selection:** An initial case study focused on the work of one recipient of HNIP pilot funding was selected with BEIS. This initial case study was selected because it was well advanced compared with other funded schemes, and so more likely to have evidence of outcomes. We used this first case study to pilot the

methodology for identifying, refining and testing hypotheses. We selected two additional case studies to further refine, develop and add to the theories. The three case studies are described below. The case studies were purposively selected; we looked for a variety of contexts, for example characteristics of end users of heat (residential and commercial, public and private sector), and geographical location.

3. *Candidate hypotheses:* We constructed an initial set of hypotheses for testing informed by review of previous interview transcripts (from the pilot process evaluation¹²), the findings of a work carried out on the causes of early delays to HNIP funded pilot projects¹⁵, and existing monitoring reports. The set of draft theories was further developed following examination of relevant literature on additionality. This helped us to develop and refine the theories based on previous research that has explored how state interventions can deliver benefit. This research is summarised in Annex 5. We also sought to identify alternative, non-programme theories, that is alternative explanations for outcomes that did not rely on HNIP.
4. *Refining the hypotheses:* We tested and developed our theories first through a series of gleaning interviews with the heat network sponsor and key stakeholders, and document review. We used a realist approach to interviewing¹⁶ which is primarily concerned with finding out more about the mechanisms at play and how they are influencing outcomes. Evidence collection was purposive (tailored to the exact theories under consideration). (An example interview guide for a gleaning interview is included in Annex 4.) Interviews were recorded and transcribed.
5. *Coding and analysis:* We coded and analysed transcripts, and other documentation, using NVivo¹⁷. We used an evidence grid (see Annex 3 for more detail) to analyse evidence against individual theories and to identify where new theories were emerging.
6. *Theory revision:* We reviewed the evidence in a theory building workshop involving the evaluation team and BEIS evaluation manager. At this workshop we revisited our theories, to revise or add theories, as appropriate. Each workshop was facilitated and was attended by the internal peer reviewer, who with the facilitator provided challenge to ensure the team remained realist focused, considered alternative (non-programme, that is not related to the HNIP pilot) theories to

¹⁵ This was qualitative research involving interviews with project management officers at each of the HNIP funded pilots, exploring the causes of early delays to HNIP funded pilots. (Unpublished)

¹⁶ Manzano, A., 2016. The craft of interviewing in realist evaluation. *Evaluation*, 22(3), pp.342-360.

¹⁷ NVivo is a qualitative data analysis computer software package produced by QSR International. It has been designed for qualitative researchers working with very rich text-based or multimedia information, where deep levels of analysis on small or large volumes of data are required.

explain observed outcomes and were looking for and considering evidence that undermined theories as well as supported them.

7. *Further theory refinement and triangulation interviews*: This continued through additional interviews at Case Study A (An example interview guide for a theory refining interview is included in Annex 4.) These were coded and analysed as for earlier interviews and added to the evidence grid. Evidence from the delays work introduced in Chapter 2 was also considered where relevant. To avoid the possibility of double counting the evidence we used an evidence grid. The grid shows which pieces of unique evidence were used to support the development of which theories. This is described in more detail in Annex 3 under “Coding and analysis”.
8. *Additional triangulation*: In addition to the interviews we triangulated using documentary evidence and the literature to strengthen emerging theories. Examples include: Literature on types of additionality provided by programmes of this nature; background papers provided by interviewees on technical aspects of HN development; materials produced by heat network projects explaining and, publicising the development.
9. *Workshop review*: We held a further workshop to review the additional evidence and revisit the theories.

Case Studies B and C proceeded in the same way as Case Study A. The theories emerging from Case Study A were taken as the starting point. These were reviewed and refined, and added to, in the light of information from HNIP pilot monitoring data for the case study schemes, documentation and gleaning interviews and then tested and further refined through Case Study interviews.

10. *Development of mid-range theories*¹⁸: The iterative process described above allowed us to build successively deeper knowledge of how the HNIP pilot is being enacted and how this is affected by context. Our workshop reviews were used to draw from the evidence to develop mid-range theories. These were then explored initially in the refining interviews and then developed further during subsequent workshop reviews. This enabled us to define and develop several mid-range theories. It is these mid-range theories that are presented in this report.

¹⁸ Mid-range theories are theories that can account for similar outcomes in similar contexts across the programme. This knowledge can then be spread across the whole programme to support programme improvement and may also yield lessons that can be transferred to other similar programmes in similar contexts.

11. *Evidence testing*: To test strength of evidence for or against the revised-form CMOCs¹⁹ and emerging mid-range theories, we used a rubric, derived from principles of good qualitative research.
12. *Validation with steering group*: The final step in this iteration of the impact evaluation was to discuss and validate the findings with the evaluation steering group – which includes BEIS officials responsible for both the pilot and main schemes.

Next steps

The theory of change has been updated with the new theories and areas for further exploration in the next iteration of evaluative activity have been prioritised. This was carried out in a workshop with BEIS and also used information available about the design of the main HNIP. In subsequent waves of impact evaluation, we may choose, in conjunction with BEIS, to revisit one or more of these HNIP pilots to seek evidence of longer term impacts.

Reflections

This first cycle of realist evaluation was used in part to test and develop the methodology, which would then be applied in all subsequent cycles. Throughout the process we therefore kept a log of reflections – particularly on the interviews – this enabled us to refine our approach both within and beyond the first case study. We found the process mostly worked well – one area however where we wish to further refine the approach is how we rate the strength of evidence and confidence in theories. More information on this is provided in Annex 3.

The three case studies

The number of case studies undertaken as part of the research was limited by the resources available for the evaluation of HNIP as a whole, and recognition that this phase of the evaluation addressed only the HNIP pilot (so the resources allocated to evaluating the HNIP main scheme had to be considered).

The three case studies were selected with BEIS to provide a variety of contexts of particular interest to the HNIP pilot, and where we expected there to be evidence of outcomes for the elements of theory we were testing. For context, we looked for a range of geographical locations, a mix of new heat networks and extensions to existing networks and a range of heat generation technologies. We also looked for a mixture of end users of heat including local authority, other public sector and private sector owners, residential and commercial use, and existing building and new build. This was not intended to provide a

¹⁹ Context-Mechanism-Outcome configurations – a means of expressing theories in realist evaluation. See Annex 2 for more details.

representative mix of case studies, but to provide different contexts across which to explore how the theories we were investigating worked. The case study we undertook first was selected as the first case study because it was further advanced than others, and so more likely to have evidence of outcomes of interest.

At each case study we aimed to interview a range of stakeholders, using a realist interviewing approach. Potential interviewees were selected purposively from the key actors and organisations involved in the project, and interviews were conducted by telephone for the convenience of interviewees. Table 1 shows the number interviews completed by type of interviewee:

Table 1: Case study interviews completed

Interviewee type	Number of interviews (number of interviewees)			
	Total	Case A	Case B	Case C
Local authority project leads and deputies	10 (4)	4 (2)	3 (1)	3 (1)
Senior LA officers including project sponsors and those required to approve the project	4 (3)	1 (1)	2(1)	1 (1)
Councillors with knowledge of the project	1 (1)	1 (1)		
Technical advisors or consultants	3 (5)	1 (1)	1 (1)	1 (3)
Commercial advisors or consultants	3 (3)	1 (1)	1 (1)	1 (1)

Interviewee type	Number of interviews (number of interviewees)			
	Total	Case A	Case B	Case C
Consumer ²⁰ representatives	3 (2)		2(1)	1 (1)
Planning officer within the LA	2 (2)	1 (1)		1 (1)
TOTAL	26 (20)	9 (7)	9 (5)	8 (8)

Other evidence sources

While much of the evidence used for the impact evaluation came from the case study interviews described above, we also used other sources of evidence, including evidence from the process evaluation and interviews from work we undertook on early delays to progress. This separate delays research¹⁵ included interviews with project managers at all successful applicants, except for one of the two projects that did not go ahead, and the interview transcripts form part of the body of evidence we have drawn upon in this report. Some of the quotes used to illustrate findings in this report are from those interviews, while some are from interviews carried out for the three case studies we undertook.

We also sent an e-survey to all project managers (that is, to one person at each of nine local authorities) towards the end of the case study phase to gather additional evidence relating to the theories we developed. We received six responses; while some repeat evidence from case studies, some provide additional evidence from other HNIP pilot funded projects.²¹

In addition, we obtained and reviewed the following monitoring data and documents:

- Literature on additionality (previously noted – see Annex 5) – reviewed prior to interviews. This provided additional domain knowledge to inform the research, including interview guides, to allow the evaluators to explore how the HNIP pilot is

²⁰ By consumer we mean end users of the heat provided by the heat network

²¹ As we have few responses, we have not presented a numerical analysis of survey results, but have drawn on them where they provide useful additional evidence, for example where there is evidence that counters interview evidence, or strongly supports it.

contributing to change, including aspects of additionality beyond input and output²² additionality. Wider additionality includes, for example, where the intervention leads to a positive impact on competencies and expertise, which is likely to persist and be applied in the future to other developments.

- BEIS monitoring reports from the HNIP pilot and HNDU – requested by the evaluation team prior to interviews. These were used to provide evaluators with background information on progress at all of the HNIP pilot projects, including the case studies. For the case studies, we found nothing that was inconsistent with the monitoring reports.
- Descriptive documentation provided by interviewees e.g. video and web-based materials on the HNIP pilot funded project, produced for the general public, and offered to the evaluators as background information.
- Technical documentation e.g. a local energy study commissioned by a local authority, research papers on groundwater heating, local authority cabinet paper seeking authorisations for the scheme, paper on technical risks – offered by interviewees in support of their interview responses.
- Newspaper reports relating to the projects of interest – from searches by the evaluation team, at first, in response to comments made by interviewees around, for example, political support for heat networks. Such reports are good evidence of public statements made by actors, and so provide useful triangulation for comments such as those made around political support for projects. For example, where an interviewee describes the level of political and local interest in a HN development this can be illustrated by a newspaper article.
- We searched for published council minutes that might support additionality arguments. In most cases we could not locate such minutes – where we did, they supported what we had been told in interviews.

Limitations

In common with all evaluations, our work is subject to limitations that should be borne in mind when considering our findings. Chiefly, this was an evaluation of a pilot, and so has a relatively narrow scope and scale. We used a range of data sources to help address this. The small number of participants limits our ability to fully illustrate findings, as the need to avoid being disclosive means, for example, that we could not describe context as fully as we would like to. So, here again we have used a wider range of non-disclosive data

²² Input additionality relates to funding for Heat Networks that would not otherwise have been available, while output additionality relates to direct outputs – heat networks in this case – that would not otherwise have been produced.

sources where possible. We have set out the processes we used to develop our findings, to provide assurance that these were fit for purpose.

We expect disclosure issues to decline in future evaluation waves, as the number of case studies in our evidence base will increase. In future waves we will be able to consider combining elements of different case studies into vignettes, to add richness and illustrate findings more fully than disclosure considerations have permitted in this report.

Some types of interviewees were better represented than others, which may affect the views expressed by interviewees and so the balance of analysis.

We carried out interviews by telephone, for the convenience of interviewees. This means the interviewer cannot respond to non-verbal impressions, which would be the case in face to face interviews. Interviews were planned to carefully, (see Annex 4 guides to 'gleaning' and 'theory-refining' interviews) to help mitigate this risk.

A further limitation arises from conducting this work while projects were at a pre-construction stage, which limited the range of impacts we could expect to find evidence of. We mitigated this limitation by identifying areas in our theory of change where we were more likely to see evidence of impacts. Further details on these limitations and their effects is included in Annex 3.

Nevertheless because the evidence has generated findings in the form of mid-range theories these theories are generalizable in the context of HNIP. This means that we expect to see them operating in similar ways across similar contexts within the programme. The testing of these mid-range theories in these settings will extend knowledge of how the programme is working.

To address the limitations on the early phases of research we will continue to explore and refine theories in subsequent evaluation phases, as described in Chapter 4.

Chapter 3: Findings

Introduction

In this chapter we have presented our findings in summary and narrative form. We first provide an overview of the theories and then describe each including the strength of the evidence supporting the theory, the confidence we have in it at this stage of the evaluation and our recommended next steps. A fuller presentation of each theory is provided in Annex 4.

A note on disclosure

To ensure we collected evidence as accurate and unbiased as possible, participants in interviews were promised that their input would not be attributed. This was also necessary to encourage participation. However, with the primary source of evidence used being just three case studies from an original field of nine – there is a high risk of disclosure in reporting, even when including wider evidence (such as from earlier data gathering from the original nine successful applicants and BEIS). For this reason, it has not been possible to illustrate and evidence the findings (in this report) as fully as we would for example, for a more conventional process evaluation. The steps we took to ensure that the findings are robust are set out in Chapter 2 and Annex 3. These include the continual revision of theories against the emerging evidence and their re-testing in subsequent interviews with project leads.

Theories

Overview

The theories listed in Table 2 below summarise the mid-range theories produced by the evaluation. They were produced in four stages. (1) Initial theories were drawn from the ‘gleaning’ interviews with key project actors (2) The evidence from these interviews, in combination with literature derived theories on additionality and supporting documentary interviews led to further refinement of these theories. (3) These theories were then put to key project actors in ‘theory refining’ interviews (4) Reviews following the refining interviews led to the production of the mid-range theories described below.

The evidence obtained from the two stages of interviews combined with the evaluation team’s collaborative sensemaking and testing of the evidence to hand against the emerging theories provides confidence that the theories are viable and plausible explanations of the early signs of HNIP impact. These mid-range theories would account for similar outcomes in similar contexts across the programme.

The process for arriving at the mid-range theories and the level of evidence they represent is described in more detail in Annex 3.

We anticipate further testing the theories in future waves. Applying these theories in new settings could result in refinements or the emergence of alternative theories.

The theories are expressed as simple hypotheses of how the HNIP pilot is affecting outcomes, we have commented on the influence of context where relevant. Later on (in Annex 4) they are presented as the Context, Mechanism and Outcome Configurations that were used to identify and test the mechanisms at play.

Table 2: Theories emerging from the initial realist impact evaluation of the HNIP pilot scheme

Theory
1. HNIP acts as a catalyst to align motivations – drawing people with different motivations together
2.1 HNIP is helping to close a funding gap, to enable the project to proceed
2.2 HNIP funding has helped to manage cost and technology risks, to acceptable levels, to enable the project to proceed
2.3 HNIP funding adds legitimacy to heat network schemes
3. HNIP has a role demonstrating economic benefits to engage potential customers ²³ with HNs
4. HNIP is encouraging heat source replacement planning
5. HNIP milestone requirements are influencing decisions on scale and helping de-risk projects

The theories progress through the following broad types:

²³ By customers we mean those who engage with the heat network to buy heat – e.g. campus managers, facilities managers, and also people like developers, who can choose (within any planning constraints) to connect to heat networks to provide heating (where they exist) or to install property level heating such as gas boilers.

- **Theories responding to clear outcomes, directly influenced by the HNIP pilot, evident in the gleaning interviews:** Theories 1 and 2 relate to motivations and enablers that affected decisions to join the scheme and pursue heat network development.
- **Theories responding to indirect outcomes of the HNIP pilot, reaching, or with the potential to reach, beyond the HNIP pilot's immediate impact on funded schemes - 'ripple' effects:** The idea that the HNIP pilot would lead to effects on the heat network market beyond its impact on funded projects is a longer-term ambition of the scheme – it is these ripple effects that will allow HNIP to achieve its wider objectives. At the outset we did not expect to see much evidence of ripple effects at this stage. However, it was clear from both case study and other interview responses that the HNIP pilot was already having an impact beyond the funded projects. We have highlighted these emerging ripple effects in two ways:
 - **Where the theory was itself about 'ripple' effects we have focussed on these as a central theme for reporting.** For example, in Theory 3, we begin to explore the validity of a key assumption which our Theory of Change suggested was a prerequisite to the emergence of ripple effects (that being able to demonstrate benefits generated by HNIP pilot funded projects would spark interest in, and engagement with, heat networks (in this case from additional heat customers))
 - **Where evidence of ripple effects emerged in the process of exploring a more direct theory – we have noted these findings under the relevant theory**
- **Exploring longer term aspects of the theory of change:** In Theory 4 we continue the process of early exploration of key assumptions underpinning the Theory of Change, looking in this case at early evidence of planning to replace existing heat sources, or the initial heat source funded by the HNIP pilot, with a lower carbon heat source in the future.
- **Exploring underpinning theory:** Theory 5 looks more generally at decision making around the scale of heat network development and the HNIP pilot's role in this. This builds on Theory 2 to understand a little more about how factors such as attitudes to risk might affect decisions around scale and how the HNIP pilot interacts with these.

Limitations

The theories presented here are 'mid-range'. These are defined (see the glossary above) as theories that can account for similar outcomes in similar contexts across the programme. This knowledge can then be spread across the whole programme to support programme improvement and may also yield lessons that can be transferred to other

similar programmes in similar contexts. We consequently claim limited generalisability for these theories across the HNIP. What this means is that we would expect to be able to test these theories in similar settings across the project and use the evidence the testing reveals to strengthen and deepen explanations of how the programme is working.

Theory 1: The HNIP pilot acts as a catalyst to align motivations – drawing people with different motivations together

This theory explores the role of the HNIP pilot in providing a catalyst, a focus, that draws key actors, with different motivations, together from across the LA to result in heat network construction, rather than the HNIP pilot establishing a motivation for Heat Network development in its own right. This alignment of different motivations provides the support needed to help heat network plans gain acceptance in the LA, and ultimately to close the funding gap.

For example, within a local authority there may be a sustainability team seeking to meet carbon reduction targets, while a housing team might be aiming to improve the reliability of heating for social housing tenants, and senior management might be seeking to maintain or increase revenues. Finance will have investment criteria to meet (such as an internal rate of return that must be met). HNIP appeals to all of these; a heat network, particularly with a low carbon heat source, will help the sustainability team meet carbon reduction targets, will help provide a reliable source of heat for consumers, and could, particularly with private sector customers such as commercial premises, increase local authority revenues. Along with this, the capital support closes the funding gap so that the finance team's investment criteria are met.

We found that, in the context of local authority sponsored projects, there is good evidence for this theory. At least two interviewees from each of the three case studies confirmed the theory based on their engagement with the project pre the HNIP pilot and during the current phase and were able to describe convincingly why this was the case. Interviewees described their motivations, and the motivations of other key actors; some quotations are included below. Further evidence to support this theory came from the e-survey, where all respondents agreed or strongly agreed²⁴ with the theory. Motivations we observed – from interviews at case studies, and from the e-survey - included:

- Advocacy of sustainability and carbon reduction - carbon reduction was identified as an important or very important factor by all respondents to the e-survey
- The need to see a sound business case, regardless of sustainability benefits
- More reliable heat production

²⁴ Respondents could answer 'strongly agree', 'agree', 'neither agree nor disagree', 'disagree', 'strongly disagree' or 'don't know'. See Annex 5, e-survey questionnaire, Q11.

- Reducing fuel poverty; and
- Interest in generating revenues.

Several interviewees, whose main interest in heat networks was achieving carbon reduction targets, told us that the HNIP pilot had allowed their plans to align with financial motivations of other local authority actors by closing the funding gap. Evidence for the HNIP pilot providing a catalyst for aligning motivations of sustainability, local developments and the economic gain from networked heat was present in interviews from leading actors in all three case studies:

“...[we were] developing a business case before the HNIP pilot came along, [but] we were finding it difficult to justify the return ...when the council could invest a similar amount in buying commercial property, for example and get a safer return, we were falling on deaf ears”

“We were ... excited about the technology, ... the fact that we could make a difference for residents and that [the council] could be seen as innovative and forward looking”

“The HNIP bid was driven by being able to develop district energy networks intended to meet our ...carbon reduction target.”

In our e-survey, we asked respondents to indicate the extent to which they agreed or disagreed that the HNIP pilot had influenced their organisation’s heat network plans by providing a catalyst for people with different motivations to engage with heat networks. All respondents agreed, or strongly agreed with this statement.

We investigated whether any particular motivations dominated. The attractiveness of increasing revenues has emerged as an important motivation in local authorities, however we found no evidence so far that revenue seeking behaviours **dominate** motivation for participation in the HNIP pilot. For respondents to our e-survey, carbon reduction was the dominant influencing factor.

“From a planning point of view, we’re mainly interested in the climate change mitigation aspect of it really.”

“The heat network will reduce energy costs for householders and businesses and improve the town’s low carbon infrastructure.”

“in terms of the viability of the scheme, our leader is particularly in tune to capital investment securing a revenue return.”

Ripple effect: There is some evidence that key actors having engaged with the HNIP pilot have built on the HNIP pilot supported project to stimulate developments elsewhere (within and outside the case study location). This is discussed further under 2.3 below.

Theory 1: next steps

We recommend that we continue to explore this theory going forward because:

- Local authority motivations may change, and
- Private sector motivations may differ and other mechanisms for aligning motivations - possible alternate theories - may be more dominant for this group.

Theory 2.1: The HNIP pilot is helping cover a funding gap

This theory explores whether the scheme condition that HNIP pilot funding bridges a funding gap between capital requirements and capital availability is being met. Here, there are existing plans for a heat network that cannot be pursued because there is a funding gap, and HNIP provides the finance necessary to close that funding gap.

Multiple interviewees at all three case studies said that their project would not have met the required rate of return in their LA, and would not have proceeded without HNIP pilot funding. Interviewees only sometimes referred to this as an investment or funding gap. Instead, they referred to, for example, a need for additional funding or a need to improve rates of return. They reported that investment via the HNIP pilot results in funded projects developing a heat network, or aspects of the heat network by, for example:

- buying in consultancy and expertise
- developing project management skills
- promoting plans for, or installation of, a new technology (see also Theory 2.2).

Respondents clearly have an incentive to report this, however, interviewees were able to give clear examples of how funding had been used in line with HNIP pilot recommendations or requirements (e.g. by demonstrating changed plans) and explain why they could not proceed, or proceed as rapidly, without this support. Project leads could explain why they were unable to obtain funding for this activity from other sources. Interviews with commercial advisors and consultants provided evidence to support this.

“...it’s fundamentally important, the problem is that with networks of this size is that at the start, they were at their least commercially viable, so this kind of grant funding is essential, to actually getting them going.”

“we’d begun developing a business case before HNIP came along [but] we were having difficulty in justifying the return basically because it would have just about backed up, but when [the local authority] could invest a similar amount in buying commercial property, for example and get a safer return, then we were just falling on deaf ears, ‘Why would we do something that’s so risky?’”

In our e-survey we asked respondents about what would have happened to their project without HNIP pilot support; views ranged from abandoning their heat network plans, to

continuing with less ambitious plans. Some referred specifically to the HNIP pilot making their scheme financially viable.

Other theories exploring the additionality provided by the funding (e.g. see Theory 2.2 and 3) also help add support to the assertion by demonstrating credible and persuasive arguments as to how pilot funding has helped move projects forward.

Ripple effects: Many of the activities gained through HNIP pilot funding will deliver benefits beyond the funded scheme. For example, the knowledge obtained through consultancy funded via the HNIP pilot, the partnerships created, and the skills developed e.g. project management skills.

“I think we’ll be able to use a lot of the insight [that we have gained], particularly ... about how we consider risk or unknowns’

“it’s enabled [us] to develop that capability internally, to become a heat network operator.”

“If the scheme works here, I think there will be a lot of interested parties to come and see how it works and perhaps raise it to the next level, at a national level”

“...our learning curve has been steep but our internal capacity has improved significantly and we’ve got two other potential locations ... it looks like there might be a viable heat network, we’d certainly be much better placed to manage those projects with the experience we’ve had of the [HNIP pilot funded] heat network...”

One local authority actor described how their HNIP pilot funded development is giving neighbouring local authorities insight into what could be achieved.

Theory 2.1: next steps

We plan to continue to explore this theory through case studies with the aim of strengthening the evidence, if possible, and exploring whether private sector company responses differ. The case studies should be extended to include some unsuccessful applicants which may provide opportunities to test this and the alternate theory that heat network development could have proceeded at the same scale and pace without HNIP pilot funding.

Theory 2.2: HNIP pilot funding has helped to manage cost and technology risks, to enable the project to proceed

This theory explored the role of the HNIP pilot in managing the short-term risk of revenue shortfall or the risks of introducing a new heat production technology. For example, a local authority might wish to explore using an innovative heat source that might not prove feasible or may suffer cost or time over-runs associated with lack of experience in its use. HNIP funding may reduce the risk to the local authority by providing access to technical expertise that would not otherwise have been affordable.

“...basically, for us it all comes down to reducing risk or perceived risk”

“By default, a grant is a reduction in risk on whoever is receiving the grant [without the HNIP pilot] it would have been much harder for the project to stack up and compete with the other demands on that money”

At least two interviewees at each of two of the case studies identified this aspect of theory by telling us, without probing, about how the HNIP pilot had reduced the risks associated with their project. They explained how HNIP pilot funding had, for example, allowed earlier meaningful engagement with potential customers beyond the base load customer (see also Theory 3) which helped to reduce the risk of the project by increasing the likelihood of increased future revenues. We were told about how the HNIP pilot had funded feasibility studies of novel technology, which was otherwise too risky to proceed with. Respondents to our e-survey also agreed that the HNIP pilot had helped reduce risks relating to technical aspects of the scheme, securing anchor load customers (except of course, where schemes were extending an existing heat network), or engaging with stakeholders.

However, we also identified an alternate theory. Knowledge and advice were provided by HNDU prior to the HNIP pilot application in each case study area and interviewees told us that this also enabled the reduction of risks through the early stages of planning and developing the heat network projects. E-survey respondents agreed that HNDU had been important in influencing their organisation’s decision to consider a heat network.

“I think actually HNDU was probably the catalyst that brought those things [sustainability, economics of heat networks, motivations of stakeholders, needs of householders] together.”

“...dealing with HNDU gave us that confidence because they were the ones that were advising us saying, “This is a viable scheme, it’s got expansion”

We explored whether HNDU expert support alone would have been sufficient to deliver the benefits described. In all cases, we were told that the HNIP pilot was necessary over and above the HNDU support and participants were able to describe why this was the case. HNDU has no remit to fund later stages of commercialisation or any construction, and without the HNIP pilot, we were told, it would have been too difficult to fund these.

Theory 2.2: next steps

We recommend continuing to explore both the programme and alternate theories in the next iteration of evaluation. This should include exploring the theory with unsuccessful applicants for funding and with non-public sector organisations. Non-public sector applicants to the main scheme will not have had the benefit of HNDU support and are likely to have different risk appetites. This theory may therefore play out quite differently for private sector organisations.

Theory 2.3: HNIP pilot funding adds legitimacy to heat network schemes

This theory explores the role of HNIP pilot funding in increasing the confidence of key stakeholders – LA actors, supply chain, and potential heat customers – to invest in heat networks. We found evidence that these actors were responsive to the HNIP pilot's role in signalling government commitment to heat networks and clean energy and the low carbon agenda more widely. Several respondents identified the HNIP pilot unblocking projects at a political or senior official level by creating more positive perceptions of the benefits and risks. This results in stronger support for, and advocacy of, the heat network, enabling the project to compete more effectively for funding in the LA. The fact that government is providing funding, rather than just advocating the technology, is key. At least two interviewees at each of two of the case studies identified with all aspects of this theory.

“...it almost provides a level of confidence to local stakeholders so if you're able to leverage in [government-provided] grant funding, it does also give the project credibility...”

“...it [the HNIP pilot] gives it [the heat network project] a broader legitimacy I guess, across the organisation, across people in the organisation.”

“...[the HNIP pilot] demonstrated to people internally, actually someone outside thinks this is an important project.”

Evidence collected from earlier interviews with other project leads, carried out for the process evaluation of the pilot and for the delays research, also supports this theory. Many of these interviewees stressed the importance for them of the signal provided by the HNIP pilot that government supported the development of heat networks, because it gave their project legitimacy, and helped them get internal buy-in. Responses to our e-survey further suggested that the HNIP pilot helped many project leads get political support for heat network development. Context is important here; local authorities with more experience of heat networks than others were less likely to rate the HNIP pilot as an important influence in this respect.

The strength of the HNIP pilot contribution to a project's legitimacy, does, however, appear dependent on the local context. For example, where the HNIP pilot intervention came at a later stage of the project's development and key stakeholders within the authority were already bought-in to heat networks as a solution.

In one case study, local planning requirements were considered by those involved in the project to be more significant than the HNIP pilot in adding legitimacy to heat network projects. Therefore, while the HNIP pilot clearly contributes to the outcome in some circumstances, local policies and plans may carry more weight in others.

Ripple effects: There is some evidence emerging from the case studies that HNIP pilot funded projects are building the legitimacy of sustainability and heat networks more broadly, for example, that pilot funding has:

- Opened up the discourse around sustainability locally, in neighbours and to a small extent nationally e.g. for one case study, HNIP pilot funding for a renewable scheme opened up discussion of multi-venture renewable schemes (e.g. micro grids and the combining of renewable schemes, such as renewable heating, with photovoltaic charging points). We found newspaper articles about HNIP pilot funded heat networks mentioning ambitions around sustainability, for example:

“The network is a great example of how we are delivering on our ambition to become the green capital of London. This is about investing in the future of Barking and Dagenham and providing energy for generations to come. Our residents deserve cost-effective, cleaner alternatives, and by reducing emissions the Becontree Heat Network is going to do just that.” Barking and Dagenham Post, July 2018

- Made planners and developers more willing to engage with Heat Networks and more innovative heat sources

“...[the HNIP pilot] helped too with our planners ...we could point to it and say, ‘Look, this is big, this is something that the government wants to happen as part of its climate change ambition’...”

- Generated interest among contractors and industry consultants in sustainability focused heat generation technology.

“...the HNIP basically made the business case stack up... so that heat network is now happening and there’s a lot of interest in that in... including local authorities I’ve worked at previously and other projects are now seeing that actually this is a viable thing.”

“A developer who’s looking at converting an existing commercial building into residential, [was] asking if we [could] extend the network. So we’re already getting more interest whereas going back a couple of years, it was more, ‘What’s this about? We just want to put in boilers’, so yes, it’s interesting”.

The e-survey provided a variety of view on this, with most respondents believing that their heat network had increased interest in heat networks among other local authorities and developers and some noting increased interest from supply chain organisations. Interviews with project leads highlighted the important role that a small number of motivated individuals can have. Champions for heat networks or low carbon solutions can, by moving between potential sponsors, or providing services to multiple potential sponsors, support wider engagement with the solutions.

This extends to the role played by leaders within the local authority in supporting and promoting HNIP pilot funded development. Key actors in all three case studies testified to the significance of political and senior level support. This is particularly significant in achieving stakeholder and participant support. For example, in one local authority the chief

executive's instruction to make a building development "heat network ready" avoided the programme being undermined by individual boiler installation.

We also found evidence of one of the case study heat networks being publicised in the local press by a cabinet member, providing evidence of the political support for heat networks in the area.

Theory 2.3: next steps

We recommend continuing to explore this theory, as we expect that it will play out differently in different contexts, e.g. where previous experience of heat networks has been negative, with private, as opposed to public sector sponsors, where there is greater policy support for heat networks already (e.g. where local planning requirements promote heat networks, low carbon or sustainable solutions).

Theory 3: HNIP has a role demonstrating economic benefits to engage potential customers with heat networks

Looking forward, a central feature of the HNIP pilot theory of change is that funded schemes will demonstrate the benefits of heat networks, leading to more widespread adoption (a key ripple effect). Theory 3 begins to explore the evidence that such demonstrations do trigger interest in, and engagement with, heat networks, for one particular key stakeholder group – the customers for the heat (e.g. facilities managers who are responsible for providing heat for a campus, building, or housing estate).

From interviews with project managers at a number of projects that had encountered delays to their construction timetable we found that projects regularly struggle to secure commitment from anchor loads and heat customers in the early development and commercialisation stages. Customers are unwilling to commit or subject their own projects to timetable risks for a heat network that they think may not proceed.

Project leads at all three case studies recognised the necessity of being able to demonstrate benefits, in particular to potential heat customers, and in two case studies, at least two interviewees could point to ways in which heat customers had responded positively to the demonstration of benefits set out in the business case. For example, in one case, local publicity about the heat network supported by the HNIP pilot included information on the benefits. Press reports said these included secure, lower carbon and lower cost energy, and we were told that this publicity had resulted in a previously unknown customer proactively enquiring about the possibility of a future connection to the heat network.

While, this could suggest that the business case development process for a heat network alone may be sufficient to demonstrate benefits, the HNIP pilot has appeared to contribute to unblocking customer commitment in two ways:

- By providing the spark to trigger latent motivations (Theory 1) and overcome barriers such as funding gaps and risk perceptions (Theory 2) it has enabled local authorities to get to the point of fully developed robust business cases, and to begin consultation with potential customers beyond the baseload customers on the basis that there is a firm commitment to build the heat network.
- By providing funding at the development phase it has enabled developers to demonstrate future benefits at an earlier stage of the process and therefore meaningful engagements with customers to begin at an earlier stage than would otherwise have been possible.

Interviewees told us that the potential for aggregate customers to make substantial capital savings by enabling them to treat heat as a utility, somewhat like broadband, electricity or water made the technology particularly attractive to them. A key local authority interviewee told us of an example where a local potential customer is within a heat network and gains the benefit of networked heat without having to meet the capital costs of installing, and renewing, heat generation equipment. Commenting on this an interviewee speculated:

“it will be very interesting to see what happens now, whether when pipes start going in the ground and people learn that [the customer] avoided a [six figure] capital replacement by joining this scheme. People start thinking, ‘mmmm, maybe this is something we need to do instead’”

As further evidence of this, and following the provision of networked heat to a block of flats, one interviewee observed:

“...their plant was older than I am and its efficiency [and reliability] was poor... providing a reliable source of heat for them means that they no longer had to maintain the boilers and they could avoid...expenditure to replace them in the near future.”

Theory 3: next steps

The work to date has gone some way towards showing that demonstrations of benefit are necessary to trigger heat customer interest in, and engagement with, heat networks, and that the HNIP pilot can help deliver these. We plan to continue exploring this theory – gathering evidence about this and the alternate theory that business case planning alone can deliver the assurances needed in different contexts including, if possible, with different heat sources.

Theory 4: HNIP is encouraging heat source replacement planning

An important aspect of the HNIP pilot theory of change is that the HNIP pilot will stimulate heat network development in the short term (e.g. by enabling investment mostly in established technologies such as Combined Heat and Power (CHP)) and that this will

enable the longer-term ambition of HNIP by supporting a gradual move to low carbon heat sources.

We found that CHP is widely recognised by heat network sponsors as a quick and efficient route to cost-effective heat networks with some carbon reduction compared with existing property-level heat sources – such as gas-fired boilers or electric heating. CHP currently produces electricity with lower carbon emissions than the grid as a whole, alongside heating for properties. However, some project leads we interviewed told us that as the grid continues to decarbonise, they expect CHP to become less attractive as a low carbon solution. These interviewees told us that while CHP has a limited life it is easier to put together a financial case with good rates of return using CHP as a heat source rather than other low carbon heat sources, because of the additional revenue from electricity sales.

To test this theory we sought early evidence that the HNIP pilot has encouraged thinking and planning for heat source replacement from the early stages of scheme development. In all case studies we found an awareness of the need for heat source replacement planning at project sponsor levels, stimulated by the HNIP pilot but in projects currently based on CHP we found no evidence of any firm plans, although project leads recognised that this issue will need to be addressed.

“...it’s really key now to decide which energy source you will decide upon because CHP ... it’s not as attractive an option so usually you would try to divert into more of a low carbon option such as heat pumps, but heat pumps are not always feasible”

“That’s the million-dollar question isn’t it? ...the honest answer to this question [about replacement heat sources], nobody knows. I can only imagine it will be some kind of a heat pump or heat cell, who knows?”

This is perhaps not surprising. Once the decision is made to adopt a heat network, then, sponsors are effectively locked into retaining it for up to 50 years. In this context the need to eventually replace a heat source, such as CHP, is clear as these have a lifetime of 15 to 20 years²⁵. Heat source technology will have moved on over the lifetime of a CHP engine, and some interviewees told us that this led them to the view that it made sense for them to defer replacement planning until the CHP engine was closer to the end of its useful life. However, our e-survey, conducted after the case study interviews, provided evidence that while the picture is varied, some participants do have tentative or firm plans for replacement heat sources, including early consideration of options and their constraints, such as where a heat pump might be sited, and the feasibility of using redundant plant rooms to house biomass-fuelled boilers.

²⁵ E.g <https://www.vitalenergi.co.uk/chp/key-considerations/> “CHP engines have a life span of 15-20 years or longer dependant on how they are maintained”

“...we’ve moved on to let’s see if we can do heat pumps and fuel cells and other things, and where we’re going to be in 20-25 years’ time is another question. Already coming up very quickly is with heat pumps but taking it from sewage...”

“I think there’s a future relationship where you balance a heat pump and a CHP engine together, so you’re looking at generating onsite electricity to be used in the heat pump system, I think there’s a potential for that.”

We also have evidence that in a minority of cases the HNIP pilot has enabled immediate exploration of lower carbon heat sources, effectively jumping a stage in the pilot theory of change and potentially accelerating considerably adoption of low carbon solutions. This evidence includes information from HNIP pilot applications and from interviews with project leads.

Ripple effects: There is some evidence that HNIP pilot-funded exploration of low carbon heat sources is causing widespread interest among other potential sponsors and the wider market. It also has stimulated wider sustainability thinking within the LA.

Theory 4: next steps

We recommend that this theory is refined going forward, especially in the context of the main scheme. Here changes to the scheme design will make BEIS’s low carbon ambitions clearer to applicants and therefore may stimulate greater interest in moving directly to low carbon solutions.

Theory 5: HNIP milestone requirements are influencing decisions on scale and helping de-risk projects

Our case studies revealed an emerging theory around the drivers of decisions on the scale of heat network development and the influence of risk attitudes in sponsor LAs and the risk reward balance.

There is some early evidence that LAs may be keeping schemes to what they consider is a manageable scale, sometimes keeping the boundaries of the scheme as far as possible in-house, and avoiding combining with other local schemes, to reduce the number of interfaces to manage and hence delivery risks. For example, one project lead told us:

“...it’s about putting a boundary around it so you can deliver the core scheme and then once [the core scheme has been delivered], then it becomes ok to expand into those areas that were once perceived to be risky ...because you’ve proven the business case for the core scheme, so you know you can expand in a more controlled way.”

The HNIP pilot requirement to meet strict milestones to qualify for payments, could be contributing to limit the scale, to reduce project complexity and hence the risk of missing milestones. This in turn, could be ensuring more reliable delivery of demonstrable projects.

Some of the respondents to our e-survey said that the HNIP pilot had influenced their plans by encouraging them to adjust the scale of their plans to improve deliverability. However, some respondents disagreed, and this appears to be linked to context – those disagreeing have more experience of heat networks or have other constraints on scale.

The fact that milestones may limit ambition could be an advantage – helping ensure projects are deliverable – but may be restricting the scale of ambition and leading to e.g. sub-optimal procurement, for example, if project elements are re-phased to allow spending to align with strict HNIP pilot funding milestones. In one case study the project manager told us – and monitoring reports supported this – that work had been rephased to help meet the required spend profile. This had resulted in a change to the procurement strategy.

This theory may play out quite differently for private sector participants in the main scheme, where risk appetites and risk management mechanisms are expected to be different.

Theory 5: next steps

This theory emerged at a relatively late stage of the process; we have some limited evidence to support it, but it requires further work to test and refine. We did not explicitly explore the role of milestones in helping project sponsors push through decisions and make progress – we can add a theory next time to explore this.

Chapter 4: Conclusions and next steps

Conclusions

The HNIP pilot is a programme operating in a complex environment. All of the local authorities who were awarded HNIP pilot funding had already undertaken some work on heat network projects before the HNIP pilot was rolled out, although the degree of experience varied across respondents to this research. Some, for example, had already constructed at least one heat network in their area. The additional capital support provided by the HNIP pilot appears to have been critical for projects in enabling them to move forward, but its effects have varied from site to site depending on context (Chapter 3, Theory 2.1). For example, from our case studies:

- In one case study it has enabled a heat network to be integrated with an existing urban centre development.
- In another it has operated as an essential part in a complex jigsaw of an urban improvement project begun several years ago and propelled by clean air imperatives.
- In the third, on a new build site, it has enabled more innovative and sustainable solutions to be considered.

In the course of this research, respondents reported that the HNIP pilot scheme support has provided credibility for heat networks (Chapter 3, Theory 2.3) and helped financially and technically de-risk projects (Chapter 3, Theory 2.2), resulting in stronger support for, and advocacy of, the heat network from council members and senior officials. This has enabled projects to compete effectively for funding in the LA against other more conventional projects. This ‘credibility’ effect appears strongest where there is less existing experience of heat networks.

There is some early evidence to suggest that by providing funding at the commercialisation phase, the HNIP pilot has enabled developers to demonstrate future benefits at an earlier stage of the process and therefore begin meaningful engagements with customers at an earlier stage than would otherwise have been possible (Chapter 3, Theory 3).

It is difficult to judge whether the HNIP pilot has provided the right level of funding – but the fact that the funding has enabled LAs to carry out well-defined activities with valuable outcomes (see for examples Theory 2.1 and 2.2), and that it appears to have enabled

development of heat networks at a desired and manageable scale (see below) suggests that the funding provided was sufficient to close funding gaps, and so was at a useful level.

The evaluation has highlighted a number of ways in which stakeholders have responded to the HNIP pilot that could have implications for the ongoing delivery of the pilot and main schemes, specifically:

- Its action as a catalyst stimulating interest in and construction and expansion of heat networks, drawing key actors together and aligning their different motivations, rather than establishing a motivation for Heat Network development in its own right (Chapter 3, Theory 1).
- The attractiveness of increasing revenues has emerged as an important, but not dominant motivation in local authorities (see Chapter 3, Theory 1). Carbon reduction appears to be a more important motivation.
- The potential for heat network customers to make substantial capital savings (as upfront capital costs can be transferred to the heat network developer) enables them to treat heat as a utility, somewhat like broadband, electricity or water, has emerged as an important motivation for customers (see Chapter 3, Theory 3).

In some projects, we either observed or respondents reported that the design of the scheme, specifically the requirements to meet strict timed milestones to qualify for funding, could have limited the initial scale of projects to minimise the risk of missing those milestones (Chapter 3, Theory 5). This may be an advantage in some cases, as it might help de-risk projects. However, it may also restrict the scale of ambition of networks. It might also lead to sub-optimal procurement, for example, where procurement strategy is driven by rephasing the project so that spend profiles match strict HNIP pilot funding milestones.

Throughout we observed potential ripple effects of the programme. Ripple effects are the key to delivering market transformation as opposed to just localised, direct impacts from the HNIP pilot. For example:

- It has generated champions for heat networks (see Chapter 3, Theory 2.3) and built relationships and a body of expertise and skills among applicants (such as project management skills) (see Chapter 3, Theory 2.1) that will continue to deliver benefits after the funded project has finished.
- It signals to external stakeholders and potential property developers the benefits of including heat networks in future planning (see Chapter 3, Theory 2.3 and 3); this was particularly the case where there is live evidence of successful heat networks

- In some locations, respondents identified that it has opened up local discourse on wider sustainability initiatives, such as micro grids and photovoltaic charging points (see Chapter 3, Theory 2.3)
- It has begun to generate interest among LAs, contractors and industry consultants in sustainability-focused heat generation technology (see Chapter 3, Theory 2.3)
- We have evidence of learning from an HNIP pilot supported project being taken into neighbouring local authorities and fed into their emerging heat network plans (Chapter 3, Theory 1 and 2.3).

At this stage we conclude, on the basis of the data and evidence collected to date (i.e. across the case studies, e-survey, deep dive interviews into delays) that the HNIP pilot shows clear signs of influencing and empowering heat network development. However, no evidence is available yet of how it contributes directly to a self-sustaining heat network market. We will be able to use the techniques applied here to identify early effects for the HNIP pilot in future evaluation cycles, to explore and explain impact on market development.

Perhaps not surprisingly, at this stage there is only limited evidence that the longer-term ambition that heat network development now will support a gradual move to low carbon heat sources later is realisable. However, in a minority of cases, the HNIP pilot has enabled more innovative low carbon solutions to be considered from the outset. The main scheme design makes BEIS's low carbon ambitions clearer and should incentivise lower carbon heat sources from the outset. We can explore if this is leading to more widespread, early consideration of low carbon heat sources in later stages of the evaluation.

Next steps

The work reported here has been used as one input to review and refresh the overall theory of change, along with input from the BEIS policy team for the main HNIP scheme. The refreshed theory of change will act as a starting point for the next evaluation cycles: the process evaluation of the implementation of the main HNIP scheme and the continuing realist evaluation of the pilot and main schemes.

The sources of evidence used in the current cycle of realist evaluation are necessarily restricted to a narrow range of contexts. Most particularly, all the projects funded in the pilot scheme are local authority sponsored. The main scheme is likely to include other public sector and private sector led schemes. Private sector schemes will have different decision-making processes, attitudes to risk, and availability to funding. A key aim of the next round of realist impact evaluation will be to expand the exploration of theory to cover a broader range of these contextual factors.

The next steps for developing the current theories for the next cycle of realist impact evaluation are summarised in Table 3. Additional theories for testing will be derived from the updated Theory of Change, using the process described in Chapter 2. During the next phase of impact evaluation, we will also continue to develop the strength of evidence testing rubric described in Annex 3.

Table 3: Summary of next steps for theory development

Theory and current status	Next steps
<p>1. HNIP acts as a catalyst to align motivations – drawing people with different motivations together.</p> <p>In the context of local authority sponsored projects there is good evidence supporting this theory.</p>	<p>Continue to explore this theory going forward as LA motivations may change over time; private sector motivations may differ, and other mechanisms be more dominant for this group.</p>
<p>2.1 HNIP is helping cover a funding gap, to enable the project to proceed.</p> <p>This theory is difficult to test reliably, but is supported by other theories, particularly 2.2, 2.3 and 3.</p>	<p>Continue to explore this theory with the aim of strengthening the evidence, if possible, and exploring whether private sector company responses differ.</p> <p>Extend case studies to include unsuccessful applicants, which may provide opportunities to test the alternate theory that heat network development could have proceeded at the same scale and pace without HNIP funding.</p>
<p>2.2 HNIP funding has helped to manage cost and technology risks, to enable the project to proceed.</p> <p>In the context of local authority sponsored projects there is some evidence supporting this theory.</p> <p>The alternate theory that HNDU funding alone would have been sufficient to deliver the benefits described requires more testing.</p>	<p>Continue to explore this theory and the alternate theory, as we expect that they will play out differently in different contexts, e.g. where previous experience of heat networks has been negative, with private, as opposed to public sector sponsors.</p>

Theory and current status	Next steps
<p>2.3 HNIP funding adds legitimacy to heat network schemes.</p> <p>This theory is partially confirmed for the pilot.</p> <p>An alternate theory is that in some areas, local policies and plans may carry more weight.</p>	<p>Continue to explore evidence for the theory and for the alternate theory as we expect that they will play out differently in different contexts, e.g. where previous experience of heat networks has been negative, with private, as opposed to public sector sponsors, where local planning requirements promote heat networks, low carbon or sustainable solutions.</p>
<p>3. HNIP has a role demonstrating economic benefits to engage potential customers with heat networks at a sufficiently early stage to help de-risk the project.</p> <p>It is early days for testing this theory and the evidence at this stage is weak. An alternate theory suggests that the business case planning process alone can deliver the assurances needed.</p>	<p>Continue to explore this theory – gathering evidence about this and the alternate theory in different contexts.</p>
<p>4. HNIP is encouraging heat source replacement planning.</p>	<p>Not proved in its current form, refine to reflect changes to the main scheme.</p>
<p>5. HNIP milestone requirements are influencing decisions on scale and helping de-risk projects.</p> <p>This theory emerged at a relatively late stage of the process and requires further work to test and refine.</p> <p>A related theory that we did not explore - the role of milestones in helping project sponsors push through decisions, make progress and improve deliverability.</p>	<p>Continue exploring this theory and add the related theory.</p>

Theory and current status	Next steps
<p>Ripple effects</p> <p>There is early evidence of HNIP effects rippling out beyond the funded projects. These can include: wider and stronger interest in HN development among HN sponsors; HNs viewed as valued and attractive building development components; Strengthening interests in area-wide sustainability and innovative heating, cooling and energy solutions (e.g. micro grids) of which HNs form a key part.</p>	<p>Define and test theories around ripple effects.</p>

We believe that this impact evaluation report of the HNIP pilot has added substantially to the evidence base and aim to build on this understanding in future waves.

The refreshed theory of change will act as a starting point for the next evaluation cycle. The next focus of evaluation activity will be a process evaluation of the implementation of the HNIP main scheme, focused primarily on the application, assessment, and funding processes for applicants to the HNIP main scheme.

Annex 1: The high-level themes

During project inception, a framework of high-level themes has been agreed. These provide a checklist we can use to ensure that realist and other elements of the evaluation are providing adequate coverage of the key themes of interest to BEIS. Table 4 summarises the high-level themes and which theories in this work relate to which HLTs.

Table 4: The high-level themes

High-level theme	Description	Exploration in this impact analysis
1. Technical design of the scheme	<p>Scheme technical design: What works and what does not, why, and for whom [e.g. BEIS, delivery partner, the different types of applicant and project (incl. technology type)], in terms of the scheme technical design, including:</p> <ol style="list-style-type: none"> 1. eligibility and scoring criteria (including their effectiveness in mitigating gaming) 2. funding mechanisms provided by the scheme? 	<p>Theory 2.1 explores whether a key eligibility requirement, funding gap, is being met – and the nature of that gap</p> <p>Theories 3, 4 and 5 explore how the scheme design is impacting key matters of scale</p> <p>Theory 4 is relevant to achieving longer term carbon reduction outputs where changes to the scheme design are planned to encourage improved performance</p>
2. Administrative design and delivery	<p>Administrative design and delivery: What aspects of the scheme administrative design and delivery work, what does not, why, and for whom [e.g. BEIS, the delivery partner, the different types of applicant and project (incl. technology type)] and for the different stages in the applicant journey?</p>	<p>In exploring motivations and mechanisms, the theories are providing learning relevant to designing improvements to communications around the scheme</p>

High-level theme	Description	Exploration in this impact analysis
3. Delivery of <u>project</u> outputs and outcomes	Delivery of projects: How has the scheme progressed in terms of delivery of project outputs and outcomes? Does this differ in different applicant/project contexts, why, how could this be improved? How confident are we in attributing project outputs and outcomes to HNIP as opposed to other external factors?	<p>Theory 5 is beginning to explore issues relevant to scale and management of project risk</p> <p>All the theories are exploring early steps in the causal chain that will help us understand how HNIP is contributing to outcomes alongside other factors</p>
4. Delivery of a self-sustaining market	Market sustainability: To what extent has HNIP contributed to the development of a self-sustaining market, how? How confident are we in attributing changes to HNIP as opposed to other external factors?	The early identification of ripple effects will enable us to design theories to explore development of the market
5. Delivery of <u>programme</u> outcomes	Delivery of scheme outcomes: What contribution is HNIP making to the desired outcomes, how? Were outcomes as intended? How confident are we in attributing scheme outcomes to HNIP as opposed to other external factors?	Theory development in this area will progress in later stages of the evaluation
6. Overall cost benefit	What is the cost-benefit analysis position of the scheme likely to be ex-post?	The exploration of ripple effects is relevant to estimating the wider cost benefit of the scheme (beyond the funded projects). Information collected in this stage of the evaluation will enable us to define theories for testing here

Annex 2: Theory based and realist evaluation

This Annex explains the theory and philosophy of theory based and realist evaluation. Annex 3 details the specific methodology and actions taken (within this framework) for this report.

Theory-based evaluation

Theory-based approaches to evaluation attempt to understand an intervention's contribution to observed results through a mechanistic or process interpretation of causation, rather than determining causation through comparison with a counterfactual. Theory-based evaluation approaches offer insight into **why** a programme works, and **how** it can be successfully adapted for different contexts. This yields valuable learning in complex environments.

The use of theory-based evaluation is supported by the Magenta Book²⁶: "Theory-based evaluation approaches involve understanding, systematically testing and refining the assumed connection (i.e. the theory) between an intervention and the anticipated impacts. These connections can be explored using a wide range of research methods (both qualitative and quantitative), including those used in empirical impact evaluation" (p. 45).

Realist evaluation

Realist evaluation is a theory-based approach that emphasises the importance of understanding not only whether a policy contributes to outcomes (which may be intended or unintended) but how, for whom and in what circumstances²⁷. The full realist evaluation question is:

What works, for whom, in what respects, to what extent, in what contexts, and how?

The purpose of realist evaluation is to test the programme theory and as a result explain how the programme is performing against expectations as it unfolds. It is method neutral and a variety of quantitative and qualitative methods can be deployed depending on the scale and circumstances.

Realist evaluation focuses on building depth of understanding. Evidence gathering is *purposive* – that is it is designed to explore in-depth how the programme is working across a range of contexts, rather than collating a breadth of views from a representative sample.

²⁶ *The Magenta Book Guidance for Evaluation*, HM Treasury (2011).

²⁷ Pawson, R. & Tilley, N. *Realistic Evaluation*. London: Sage (1997).

The explanatory strength of realist evaluation in complex situations makes it an attractive choice for the evaluation of HNIP.

What does realist evaluation involve?

Realist evaluation starts by using programme theory to describe how the programme or intervention will work. The theory is built from a synthesis of knowledge of how programmes have worked in similar settings combined with the assumptions, experiences, knowledge and perspectives of programme designers and actors.

The units of analysis in realist evaluation are testable hypotheses about how specific mechanisms lead to outcomes and how these are affected by context. These are referred to as Context-Mechanism-Outcome configurations (CMOCs) and are derived from the programme theory and observed outcomes (see Box 1 overleaf).

Understanding how mechanisms are triggered to produce outcomes provides explanations of how the programme is working. CMOCs are tested, refined, confirmed or rejected through an iterative and purposive process of evidence collection (tailored to the exact CMOCs under consideration). Key to realist evaluation is realist interviewing (see Box 2 below). It is used to elicit data from programme actors on the mechanisms that deliver the outcomes mainly by asking why they responded to the intervention in the way that they did.

Once a theory has been tested in one context, we can test its relevance to other contexts. This can be done by additional case study work, or a survey, to explore whether the knowledge obtained in one part of a programme also is relevant to another. This process leads to the development and testing of mid-range theories. These are theories that can account for similar outcomes in similar contexts across the programme. This knowledge can then be spread across the whole programme to support programme improvement and may also yield lessons that can be *transferred* to other similar programmes in similar contexts.

The potential for transferability of learning to other similar schemes also makes realist evaluation an attractive choice for the HNIP evaluation.

More information about the realist approach to evaluation can be found in Annex 2. The methodology we used for this cycle of the evaluation is set out in Chapter 3 and Annex 3.

Box 1: Context Mechanism Outcome configurations (CMOCs)

Context: This is the backdrop against which the programme is operating. It can include cultural norms, a community's history, social networks, infrastructure, resources, geography, types of funding, opportunities and constraints. In relation to HNIP context can include: the state of heat network development; the level of investment; the supporting infrastructure; de-carbonisation policies; customer attitudes; and the availability of relevant skills and knowledge.

Mechanism: In realist evaluation 'mechanism' can be a slippery concept in that it covers the internal mechanism that results in people responding to the combination of context and intervention. Mechanisms are about why people choose, or decline, to respond to an intervention. The mechanisms activated will vary from person to person in the same circumstances hence the realist quest of finding out “what works for whom, in what context, how and why?”. They can best be understood by firstly identifying outcomes and then understanding from programme actors the mechanisms that delivered them.

Intervention: The intervention introduces resources to the context in a way that produces a change in reasoning or perception. This in turn can trigger the mechanism, altering behaviour, which then leads to an outcome.

Outcome: Outcomes are wide ranging and could broadly be considered as anything that changes following the intervention²⁸. They can be expressed qualitatively or quantitatively and can occupy a range between small effects to life changing outcomes and be intended, unintended, planned or unexpected. The unexpected are of particular interest in the knowledge that they provide and the opportunity to develop the scheme's ToC. Outcomes can have ripple effects and start to appear across a range of CMOCs.

²⁸ Outcomes here refer to the immediate outcomes of the mechanism, rather than the ultimate outcomes of the scheme.

Box 2: Realist interviewing²⁹

Interviews using realist principles are:

- Focused on testing and refining hypotheses: The interviewer does not need to adopt a neutral or ignorant stance but can share the programme theories, theories suggested by others, the experiences related by others (anonymously) etc in order to prompt deliberative responses. Interviewees become partners in sense making, not just sources of information that will be post processed by the evaluation team.
- Relevant: designed around stakeholders' awareness and experiences of the scheme, including their reasoning about specific theories
- Directed: In that the interviewer will guide the direction of the interview to retain focus on the theories rather than allowing the interviewee to guide the direction of the conversation within broad topics, and
- Emergent: The interviewer may choose to direct the interview in new directions to respond to emerging information.

²⁹ Manzano, A., 2016. The craft of interviewing in realist evaluation. *Evaluation*, 22(3), pp.342-360.

Annex 3: Methodology description

In this annex we provide more detail of the methodology described in Chapter 3. For each of the process steps described in Chapter 3 we provide examples to illustrate the process of theory building and testing. We also describe the measures taken to ensure the work was robust and fit for purpose.

Prioritisation of key research areas

The first question we asked was ‘where would we expect to see early evidence of the HNIP pilot’s effect?’ To answer it we turned to the Theory of Change (ToC) constructed at the start of the programme, with BEIS, to identify areas where impacts should or could have begun to arise at the point of fieldwork. The areas identified were expressed as theories and then prioritised for development in Context-Mechanism-Outcome (CMO) form and testing against the evidence.

The evaluation team and the BEIS evaluation manager worked through the four meso ToCs (Heat network development; Third Party Investors; Consumers and Customers; Carbon Savings) to identify areas where change was expected at this early point in the programme.

Promising areas for investigation were marked on each ToC. An example is shown in Figure 2.

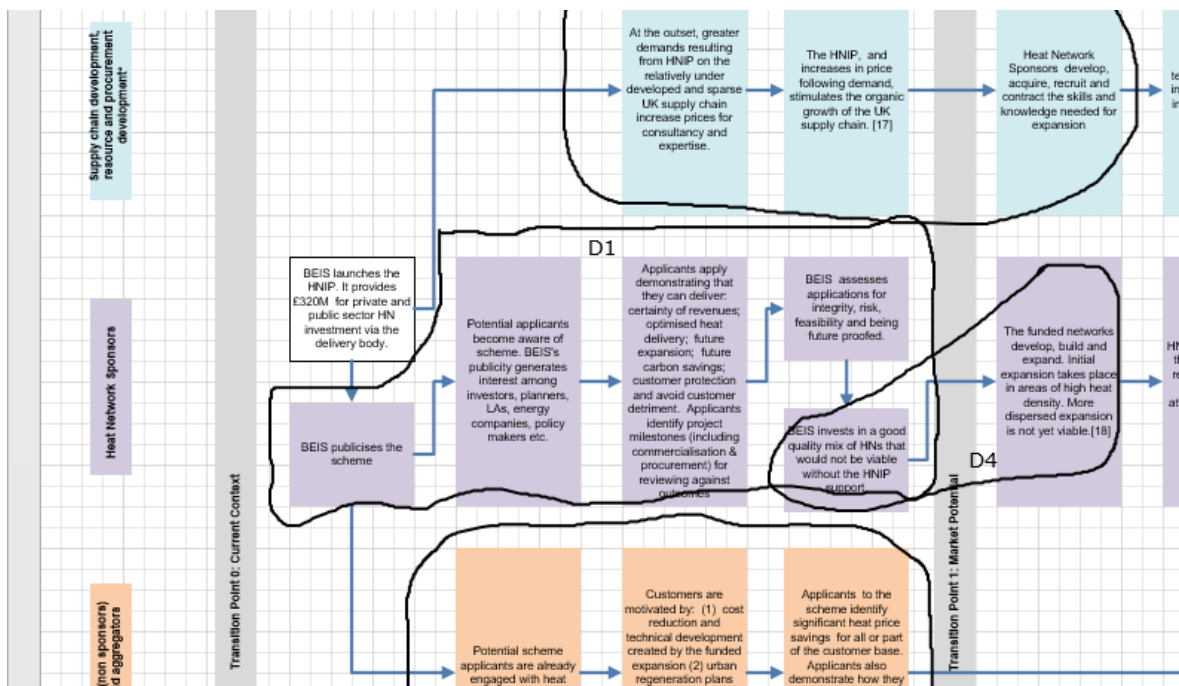


Figure 2: Mapping areas for theory exploration on to the Meso ToCs - example extract of the heat network development Meso ToC

Each area was a short sub-chain in a meso ToC leading from the HNIP pilot intervention to an effect or outcome. Figure 3 shows an example sub-chain (designated D1, identified in the Heat Network development meso ToC describing the expected impact of the HNIP pilot launch on applicants.

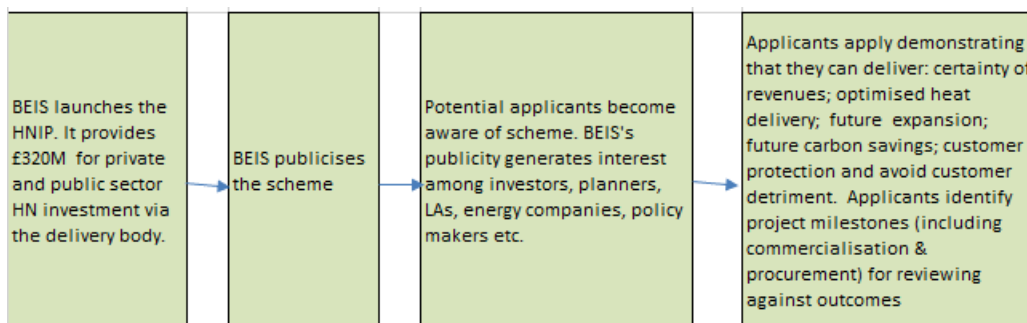


Figure 3: Example extract showing a sub-chain from the heat network development Meso ToC

This chain (D1) was developed into and expressed as a theory and prioritised using the following criteria:

- Feasibility: Would we expect to see evidence of outcomes at this stage
- Utility: How useful would findings be at this stage – could they be used to inform activities around the main scheme for example

- Suitability: Is a scheme-based case study the most appropriate way to explore this theory or would e.g. a case study focused on a particular type of stakeholder, such as investors, be more appropriate.

Each area was mapped to the HLTs. Where there was no or partial coverage of an HLT, we looked to see if we could identify additional areas for theory development related to the gaps. This, for example, prompted us to explore how the HNIP pilot selection criteria aligned with local motivations for adopting heat networks.

An example of the HLT mapping and prioritisation information is shown on Figure 4 for area D1 which explores how the HNIP pilot works with synergies with the ambitions of sponsors – and the implications of this for scaling (rippling beyond the HNIP pilot and for carbon reductions)

Narrative of candidate theory	HLT mapping	Prioritisation
<p>Meso ToC HN development</p> <p>D1 – HNIP pilot creates, and publicity generates, a synergy with the development ambitions (business plans) of HN sponsors</p> <p>The prospects of commercialisation and carbon reduction operate as attractors to sponsors who might not otherwise have been seeking this scale of development at this point.</p> <p>Central govt support and commitment gives applicants confidence in the scheme</p>	<p>HLT1. Link to how the technical design of the scheme surfaces motivations of applicants.</p> <p>HLT2. Link to awareness raising and motivation</p> <p>HLT5, 6. If development decisions linked to carbon reduction targets or ethos, then potential for greater shift to lower carbon solutions in future - if applicants are typical of wider HN sponsors - then may also scale beyond the scheme funded projects</p>	<p>Feasibility: This is about motivations to join the scheme and can be investigated now</p> <p>Utility: It may deliver useful information for promoting the main scheme</p> <p>Suitability: Yes, can explore motivations to join scheme and decision to adopt HNs</p>

Figure 4: Example of mapping on to HLTs and recording of prioritisation information

To ensure that the work was tractable (that we were not trying to address too many theories) and was focused on policy need, a final set of priorities was agreed with the BEIS evaluation steering group for the evaluation.

Table 5 shows the initial long list of theory areas we identified, and the areas prioritised by the evaluation steering group for research in this report are highlighted.

Table 5: List of theory areas (areas prioritised with the Evaluation Steering Group highlighted in green)

Theory area (D = market development, CM = consumers, I = investors, C = carbon savings)
D1: Explores how the HNIP pilot works with synergies with the ambitions of sponsors – and the implications of this for scaling (rippling beyond the HNIP pilot and for carbon reductions)
D2: Explores changes in perceptions of customers to information about HN emerging from the HNIP pilot
D3: Explores the market response
D4: Explores management and governance
CM1: Explores end-user detriment in funded projects
CM2: Explores impact of the HNIP pilot on end-user detriment in the wider HN market
I1: Explores the impact of standardised reporting practices on Investors
I2: Explores the role of projects in raising skills and experiences and introducing innovation
I3: Explores the impact of BEIS communications around the HNIP pilot with investors
I4: Explores the impact of the growing body of information on HNs stimulated by HNIP
C1: Explores the HNIP pilot impact on motivations and drivers of carbon reduction

Case study selection and recruitment

The theories were developed, tested and refined primarily through case studies. Each case study in this cycle of the evaluation centred on a scheme being funded by the HNIP pilot.

We used interviews conducted as part of our work on delays to ensure that local authorities were happy to take part in case studies. All of those we spoke to expressed their willingness to participate

Case study selection was agreed with BEIS, though the use of a case study selection matrix, and aimed to select cases where we could find evidence of impacts of interest for the theories being tested, and to achieve a range of contexts, specifically:

- geographical locations
- a mix of new heat networks and extensions to existing networks
- a range of heat generation technologies
- a mixture of end users of heat including local authority other public sector and private sector owners, residential and commercial use, and
- existing building and new build.

The requirements evolved as our understanding of the HNIP pilot and its emerging impact developed.

Over the course of the whole evaluation we will aim to achieve a mix of case studies across the range of contextual characteristics along with case studies based on themes (e.g. investment, the supply chain and/or focussing on unsuccessful projects) rather than individual projects.

Initial candidate hypotheses construction

For the prioritised areas, the theories were developed into an initial set of hypotheses for testing using information from: discussions with the steering group, the HNIP pilot monitoring data³⁰, the process evaluation of the pilot³¹, interview transcripts from that work, the literature review carried out as part of the scoping stage and feedback from the steering group. These provided information about context, likely mechanisms and early

³⁰ HNIP monitoring data (unpublished)

³¹ BEIS Research Paper Number 1 (February 2018). Heat Networks Investment Project Evaluation: Process evaluation of pilot
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/699304/HNIP_EVALUATION_-_PILOT_PROCESS_REPORT_-_FINAL.pdf

outcomes. During these discussions D1 was split into two theories with D1b as a theory on the additionality enabled by the HNIP pilot. In other words, the funded projects were able to accomplish aspects of HN development that they could not otherwise have undertaken at this stage. It was judged, by BEIS's HNIP Steering Group and the Evaluation Team, to be too early to address area I3. This decision was confirmed in the subsequent case study interviews.

The initial hypotheses we tested were therefore:

- **D1a Motivation** - The HNIP pilot fits with the development ambitions (business plans) of heat network (HN) sponsors and the developing HNs. The prospects of commercialisation and carbon reduction attract sponsors who might not otherwise have been seeking this scale of development at this point. Central government support and commitment gives HN applicants confidence in the scheme. (Also covers C1 motivations regarding Carbon reduction.)
- **D1b Additionality** - Investment via the HNIP pilot results in funded projects developing an HN, or aspects of the HN, they would not have been able to achieve without the funding (additionality). These aspects will contribute to the sustainability and scaling up of the HNs supported by the HNIP pilot. At this stage of the project additionality could be: buying in consultancy and expertise; new or changed roles; new partnerships; plans for, or installation of, a new technology; getting management competency right for the expanded, and more complex project.
- **D2 Demonstrating the benefits of HNs** – Focuses on demand risk. If HN sponsors can demonstrate the cost benefits of HNs to customers (non-sponsors) and demand aggregators, produced by a growing market, then customers will respond positively to the HN offer. Customers can include building management and developers who sell heat on to end users.

These hypotheses were then refined, tested and developed through a combination of case study work (interview and document review) and examination of evidence drawn from other sources: the delays research, documentary evidence and an e-survey.

Refining the initial hypotheses: document review and gleaning interviews

We tested and developed the initial hypotheses first through the case studies using document review and a series of gleaning interviews with the heat network sponsor and key stakeholders.

Documents reviewed typically included published information on the case studies, sometimes provided to us by the project leads, and newspaper reports we found on

several of the HNIP pilot funded heat networks. We also reviewed the monitoring reports submitted to BEIS. Looking at and, where possible, triangulating across a range of materials provides confidence that the content of interviews is consistent with public statements about individual heat networks, and information reported to BEIS in monitoring reports.

The gleaning interviews articulated the three initial theories behind the programme and identified how the contextual circumstances of the programme could be impacting on actor behaviour and subsequent outcomes. (An example interview guide for a gleaning interview is included in Annex 4.) We used the gleaning interviews to explore alternate, new and amended theories, in addition to the three initial theories.

An important aspect of realist evaluation is that alternate theories (non-programme theories that could also explain observed outcomes) should be identified and tested alongside programme theory. This helps explore whether outcomes could have happened in the absence of the intervention and counters confirmation bias. To help identify and formulate alternate theories in this research, during the gleaning interviews (and subsequent interviews) we challenged interviewees to identify other explanations for the outcomes so that these could also be explored.

Typically, five gleaning interviews of approximately 45 minutes in length were carried out for each case study. We used a realist approach to interviewing³² which is primarily concerned with finding out more about the mechanisms at play and how they are influencing outcomes. Evidence collection was purposive (tailored to the exact theories under consideration – for example, interview guides were tailored and key respondents targeted for each theory). (An example interview guide for a gleaning interview is included in Annex 4.)

At every stage we used experienced interviewers, who had received training in realist interviewing techniques and could probe and challenge interviewees and adapt their questioning in response to participants answers.

Interviews were recorded and transcribed and the lead realist evaluator reviewed early transcripts to check interview quality.

³² Manzano, A., 2016. The craft of interviewing in realist evaluation. *Evaluation*, 22(3), pp.342-360.

Coding and analysis

We coded and analysed transcripts, and other documentation, following a grounded theory approach, using NVivo³³.

We used an evidence grid to analyse evidence against individual theories and to identify where new theories were emerging. The evidence grid provided a single location where different types and sources of evidence could be collated against each theory. At each stage of theory development, testing and refining, data was captured in the grid allowing us to trace theory developments and their supporting evidence.

An illustration of the grid is shown in Table 6. The populated grids contained considerable information – with quotes from interviewees, extracts from papers etc – relevant snippets of evidence were placed in the grid where appropriate (sometimes in more than one place), along with evaluator judgments e.g. in emergent theory. Populated grids were used in theory revision as noted below.

Theory revision

We reviewed the evidence in a theory building workshop involving the evaluation team and BEIS evaluation manager. At this workshop we revisited our theories, to revise or add theories, as appropriate. Each workshop was facilitated and was attended by the internal peer reviewer, who with the facilitator provided challenge to ensure the team remained realist focused, considered alternative (non-programme, that is not related to the HNIP pilot) theories to explain observed outcomes and were looking for and considering evidence that undermined theories as well as supported them.

The workshop triangulated information emerging from both the different interviews and documentation captured in the evidence grid and separately checks were made that assertions were not inconsistent with assertions made in progress report submissions to BEIS.

In parallel to the first gleaning interviews, we carried out a literature review on the topic of programme additionality. This is briefly reported in Annex 5. This information helped us further refine the theories. For example, for Theory D1b three aspects of additionality were identified and described for subsequent testing:

1. **Behavioural Additionality** - the HNIP pilot brings legitimacy to the HN's carbon reduction and sustainability dimensions legitimacy

³³ NVivo is a qualitative data analysis computer software package produced by QSR International. It has been designed for qualitative researchers working with very rich text-based or multimedia information, where deep levels of analysis on small or large volumes of data are required.

2. **Behavioural Additionality** - the HNIP pilot validates the development ambitions of key actors already committed to it
3. **Outcome Additionality** - the HNIP pilot covers the funding gap between capital expenditure and expected rate of return on an expanded heat network.

The output of this step was a set of theories expressed as CMOs. Figure 5 shows an example: Theory D1a expressed as a CMO as formulated at the end of the first set of gleaning interviews.

Context: The HN development so far represents a good alignment between the motivation of politicians, planners and heat customers. They are not motivated by the same things, but their combined motivations led to HN development. (Context)

The motivations that could create the pre-conditions for this are:

1. Growing governmental and public support for sustainability as demonstrated by the HNIP pilot.
2. Demonstrable economic benefits of having a 'plug and play' HN
3. The need to replace or modernise heat production technology (Context)

Mechanism: Recognition of this alignment is the mechanism that sparked interest in the HNIP pilot. The HNIP pilot acted as a catalyst on the mechanism of recognising the alignment of motivations in place rather than providing the motivation for HN development.

Outcome: The current state of development.

Figure 5: Example CMOC for Theory D1a

Table 6: Illustration of evidence grid

ENRICHED CONTEXT	CMOCs (theory – set of rows for each area of theory)	Enhanced theory from literature	Outcomes/outputs/evidence captured	Emergent theory	Theory development	Reasoning, comment follow-up (retain, ex amend, combine, dis explore)
<i>Relevant additional context</i>	e.g. D1 A MOTIVATION The HNIP pilot fits with the development ambitions (business plans) of Heat Network (HN) sponsors and the developing HNs. The prospects of commercialisation and carbon reduction attract sponsors who might not otherwise have been seeking this scale of development at this point. Central government support and commitment gives HN applicants' confidence in the scheme.	<i>e.g on behavioural additionality</i>	<i>relevant quotes, or other evidence e.g. Heat customer motivation may be higher where plant is old, inefficient and incurring high maintenance costs "...in the case of X, their plant was older than I am and its efficiency was poor' (Source of item - Initials of interviewee, or author of paper etc)</i>		As more building services are outsourced, acceptance of heat as a service may become more mainstream. (Evaluator)	

Annex 3: Methodology description

ENRICHED CONTEXT	CMOCs (theory – set of rows for each area of theory)	Enhanced theory from literature	Outcomes/outputs/evidence captured	Emergent theory	Theory development	Reasoning, comment follow-up (retain, extend, amend, combine, discard, explore)
	<p>D2 Demonstrating the benefits of HNs - If HN sponsors can demonstrate the cost benefits of HNs to customers (non-sponsors) and demand aggregators, produced by a growing market, then customers will respond positively to the HN offer.</p> <p>'Customers' can include building management and development who sell heat on to end users</p>		<p>Benefits are not uniform - e.g. in supplying a block of flats, consumers could be tenants or leaseholders. Tenants benefit from cheaper heating but private landlords - owners - see no benefit as heating costs passed on to tenants or paid by tenants.</p>	<p>'no consumer detriment' is being used as a means of gaining consumer support. Disruption and heating costs are the main issues here. We can explore HNIP's contribution to this (Evaluator)</p>		

Further theory refinement and triangulation: CMOC testing and development

Following review and assessment by the Evaluation Team we used our body of evidence - from case studies, interview transcripts from work on delays, monitoring reports, and other documentation - to test, refine, add to or dismiss the CMOCs.

Evidence mainly comprised realist interviews with stakeholders to test and refine the theories against the reality experienced by, and the expertise of, the stakeholder being interviewed. At this stage this was identified as the best way to capture data on the mechanisms at play in this early stage of HNIP's development. Interviewees were selected purposively to achieve good coverage of a range of stakeholders involved in the project. We then sought recommendations from this initial set of stakeholders for further interviewees.

The key objective of these interviews was to capture and understand the mechanisms at play, and captured in the CMOC, as this would provide explanations of how the programme is working. We also drew out data on the developing project and how the contextual drivers responded to the HNIP pilot to affect outcomes. (An example interview guide for a theory-refining interview is included in Annex 4.)

The total number of interviews (of all types) carried out over the three case studies are shown in Table 7.

Table 7: Case study interviews by interviewee type

Interviewee type	Number of interviews (number of interviewees)			
	Total	Case A	Case B	Case C
Local authority project leads and deputies	10 (4)	4 (2)	3 (1)	3 (1)
Senior LA officers including project sponsors and those required to approve the project	4 (3)	1 (1)	2(1)	1 (1)
Councillors with knowledge of the project	1 (1)	1 (1)		
Technical advisors or consultants	3 (5)	1 (1)	1 (1)	1 (3)

Interviewee type	Number of interviews (number of interviewees)			
	Total	Case A	Case B	Case C
Commercial advisors or consultants	3 (3)	1 (1)	1 (1)	1 (1)
Consumer ³⁴ representatives	3 (2)		2(1)	1 (1)
Planning officer within the LA	2 (2)	1 (1)		1 (1)
TOTAL	26 (20)	9 (7)	9 (5)	8 (8)

We also drew on other information available on the project including project documentation and other information as described in Chapter 3, where we could identify this from interviews, or information provided by BEIS. We did not carry out a systematic search for documentary evidence, but rather sought documents from respondents where possible, and where a second confirmatory source of evidence would add to our confidence in the interview evidence for the theory under examination. An example of the sort of evidence we obtained was a newspaper article provided evidence of a local authority publicising its low carbon objectives and the heat network and seeking interest from business. It demonstrated political commitment as a councillor was quoted speaking to motivation, leadership and political support.

Once a useful body of evidence had been collected and collated in the evidence grid, it was reviewed in an evidence review and synthesis workshop involving the evaluation team and a knowledgeable representative from BEIS (from their evaluation function). The workshops were facilitated, and attended by the internal peer reviewer, who with the facilitator provided challenge to ensure the team:

- Remained realist focused
- Considered alternate (non-programme) theories to explain observed outcomes, and
- Looked for and considered evidence that undermined theories as well as supported them.

The outputs of the workshops were typically diagrammatic representations of each theory (including new emerging theories) marked up to show areas requiring refinement (and

³⁴ By consumer we mean end users of the heat provided by the heat network

how), additional evidence gathering required to test the theory, alternate theories etc. These were then used by the lead realist evaluator to refine and develop the theory, and with the evaluation manager, to identify additional evidence sources, refine interview guides etc. In total we carried out three theory building and refining workshops.

Through this process we continued to test and refine theories, and to identify new theories. For example, towards the end of field work, one of the case studies revealed an emerging theory around what drives decisions on the scale of heat network development and its relation to risk attitudes in sponsor LAs (Theory 5 in this report). Had this theory emerged at an earlier stage, we would have tested it in other case studies.

Definition and testing of mid-range theories

The iterative process described above allowed us to build successively deeper knowledge of how the HNIP pilot is being enacted. This enabled us to begin to develop the theories as mid-range theories – that is theories that can apply across more than one context – although this was necessarily limited by the small number of case studies examined at this stage. It is these emerging mid-range theories that are presented in this report.

Table 8 lists these theories and shows how they relate to the initial set of theory areas identified from the ToC at the start of this cycle of evaluation.

Table 8: List of initial and final theories developed through this initial evaluation stage

Initial theory area	Theory definition at this stage
C1: Explores the HNIP pilot impact on motivations and drivers of carbon reduction	Theory 4: HNIP is encouraging heat source replacement planning (project level outcome / acceleration additionality)
D1: Explores how the HNIP pilot works with synergies with the ambitions of sponsors – and the implications of this for scaling (rippling beyond the HNIP pilot and for carbon reductions)	Theory 1: HNIP acts as a catalyst to align motivations – drawing people with different motivations together (a project level behavioural additionality) Theory 2.1: HNIP is helping cover a funding gap (project level outcome additionality) Theory 2.2: HNIP funding has helped to manage cost and technology risks, to enable the project to proceed (project level outcome additionality)

Initial theory area	Theory definition at this stage
	Theory 2.3: HNIP funding adds legitimacy to HN schemes (a project level and strategic level behavioural additionality)
D2: Explores changes in perceptions of customers to information about HN emerging from the HNIP pilot	Theory 3: HNIP has a role demonstrating economic benefits to engage potential customers with HNs (a project level and strategic level behavioural additionality)
D3: Explores the market response	Not explored explicitly as considered too early to see outcomes
D4: Explores management and governance	Theory 5: HNIP milestone requirements are influencing decisions on scale and helping de-risk projects (project level behavioural and outcome additionality)
I1: Explores the impact of standardised reporting on Investors	Not explored as too early to see outcomes
I2: Explores the role of projects in raising skills and experiences and introducing innovation	During the case studies the interviews suggested that projects are some way off from being able to attract the depth of interest that could engage investors. But there is early evidence of the HNIP pilot effects rippling out beyond the funded projects (strategic level additionality) (note: not with investors at this stage)
I3: Explores the impact of BEIS communications around HNIP with investors	
I4: Explores the impact of the growing body of information on HNs stimulated by the HNIP pilot	
CM1: Explores end-user detriment in funded projects	Not explored as too early to see outcomes

Initial theory area	Theory definition at this stage
CM2: Explores impact of the HNIP pilot on end-user detriment in the wider HN market	Not explored as too early to see outcomes

Validation with steering group:

The final step in this iteration of the impact evaluation was to discuss and validate the findings with the evaluation steering group. We presented each theory, and discussed the strength of evidence and next steps including e.g. whether we should continue testing the theory, whether the theory required refining etc. For example, at this meeting we agreed that Theory 3 required refining to reflect the practicalities of the timescales involved in heat source replacement planning and Theory 5 should be extended to explore whether HNIP milestone requirements helped project sponsors ‘push-through’ decisions in local authorities.

Additional exploration via e-survey

The e-survey aimed to see if there was sufficient regularity and similarity to conclude that knowledge obtained in the first three case studies is also relevant to the other funded schemes. It was therefore designed as a census of all funded projects.

We were not sure if an effective e-survey could be designed to do this – so this initial attempt was very much a pilot to test its feasibility and usability.

The survey consisted of 15 questions (see Annex 4) derived from the theories and discussed and agreed with the BEIS evaluation manager. In deciding whether to include questions we were guided by:

- The need to keep the questionnaire short to prompt high returns
- The ability of the project sponsor to answer the questions from their knowledge
- The likelihood of receiving a meaningful, unbiased response.

We received six responses to our survey, having successfully delivered it to eight people. The results added to the body of evidence and we consider it a useful additional research tool. We expect future waves of research to involve more participants, so the e-survey should be more useful still going forwards. We recognised that some respondents had already participated in our impact evaluation and had previously answered very similar questions. In those cases, we were careful not to assign additional weight to their e-survey responses in our synthesis exercise.

Testing the strength of evidence

A key factor in ensuring that the collection and synthesis of data was robust was the purposive design of fieldwork tailored to the specific hypotheses for testing, and the use of highly experienced interviewers. This is particularly important for realist interviewing, where the interviewer may direct the interview towards the specific evidence required to prove or disprove a hypothesis, in addition to steering respondents in response to emerging information.

However, because elements of the process are emergent, a way of more objectively testing the strength of evidence is needed. We considered the use of formal process tracing³⁵ as an alternative method of evidence testing, but rejected it because of the time and resources required, and because it is not always easy to explicitly account for factors that are important in determining the quality of interview evidence. We therefore developed a rubric to test the strength of evidence for or against the emerging mid-range theories, derived from principles of good qualitative research.

We identified the measures of quality listed below. For practical and testing reasons – we were developing and trialling the approach, and while we used all of the elements, we have not formally recorded all of them. For this first round of impact evaluation the rubric was applied by the lead realist evaluator – drawing on discussions at our internal workshops and review sessions - who recorded performance for each of the final theories presented in this report against the four metrics highlighted in **bold** below. The project manager sense-checked the first two applications of the rubric and agreed with the ratings.








- About interview evidence:
 - **Interviewees have relevant knowledge**
 - **Interviewees are not strongly biased**
 - Interviewees 'evidenced' assertions – for example they could provide examples or illustrations to support their assertions
 - **Multiple interviewees across multiple sources support the theory – where this would be expected** - The interviewees were selected on the basis of their direct involvement in HN development. This involvement could be one or more of: setting up, project managing, strategic oversight, technical consultancy, or obtaining political approval of the scheme. The interview evidence therefore came from respondent's direct knowledge, experience of and participation in HNIP.

³⁵ See e.g. <https://www.betterevaluation.org/en/evaluation-options/processtracing>

- About other evidence:
 - The literature, grey literature, or other documentation supports the theory
 - Project monitoring, survey or other data supports the theory
- About the body of evidence as a whole:
 - Multiple independent sources of evidence support the theory
 - **No evidence undermines the theory**
 - Alternate theories have been explored and results considered when formulating the findings.

We did not propose a formula for adding together performance against each of these metrics to arrive at an overall assessment of quality as the nature of the evidence required to provide confidence will vary from theory to theory. Rather, a judgement is made based on performance against the rubric, but the overall judgement must be justified. In reaching a decision about our overall confidence in the theory other metrics were also considered – along with the extent to which it was possible to test the theory at this stage.

We have colour coded our confidence as follows:

Theory confirmed as described	
Theory partially confirmed but requires some further work to refine or confirm or to test in different contexts	 
Theory requires significant further work to refine or confirm in the current context – theory may be rejected	 
Theory rejected	
Theory is emerging and requires significant further work to refine and test	

We are continuing to develop the rubric and how it is applied.

Limitations

In common with all evaluation, our choice of methodology, the environment within which we conducted it, and resource constraints result in limitations which should be borne in mind. Key limitations are identified below:

- **Scope and scale:** This is a small scale pilot project aimed at capturing the early effects of HNIP. A realist approach was used to provide explanations for the effects observed. Interviews were arranged using a purposive sample selected on the basis of subjects' role, knowledge and experience of HNIP. These factors limit the extent to which the research findings can be applied across the breadth of the programme going forward in their current form. We mitigated the impact of this limitation by generalising to mid-range theory incorporating documentary and e-survey evidence to support this process. Going forward, we will continue to test the explanations arrived at for the phenomena observed and thereby revise and strengthen the theories. At this point the findings provide a moderately reliable expectation, subject to contextual influences, of what we would expect to see in

similar settings going forward.

- **Ability to illustrate findings:** We offered respondents to our fieldwork an assurance that their responses would not be attributed to them because this is evaluation ethical best practice and is more likely to elicit accurate information. Avoiding disclosure can limit our ability to fully illustrate all findings. We mitigated the impact of this limitation by illustrating findings using less disclosive sources such as documentation, e-survey or census telephone interviews (carried out to explore the reasons behind early delays). We also describe the systematic processes followed in synthesising and interpreting the evidence to provide confidence that they are fit for purpose. Consequently, we believe that this issue has a low impact on the quality of the report.
- **Interview methods:** Interviews were conducted by telephone; this may have influenced findings by reducing the ability of the interviewer to respond to non-verbal impressions given off in face to face interaction. More nuanced aspects of responses may have been lost, because of the inability of interviewer to follow up on such impressions with probe questions. We planned interviews (as illustrated in Annex 4 guides to ‘gleaning’ and ‘theory-refining’ interviews) to help mitigate this risk
- **Timing of the research and evidence available:** We conducted this research while projects were at a pre-construction stage because the findings were needed to inform decisions on the HNIP main scheme design. This limited the extent of observable impacts of the HNIP pilot, the focus of the research questions we could address, and the balance of numbers of different types of interviewees with knowledge of the programme who were available for interview. The focus was entirely on evidence of early impact and the section of the Theory of Change covering HNIP’s first steps. The report is therefore limited by its relatively narrow reach into the programme. We mitigated the impact of this limitation by adjusting our approach to reflect what was possible – for example, testing areas of theory where we were more likely to find evidence of impact. The report provides valuable evidence on steps towards getting networks in place but cannot offer evidence on the impact of the networks being developed.

Annex 4: Description of final theories

The tables below summarise the findings for each of the seven mid-range theories (or hypotheses) we have formulated and refined through the process described in Section 3 and Annex 3. The tables set out the theory in context, mechanism and outcomes format used to define and test each theory. In addition, they identify: the nature of the additionality being tested, any related alternate theories and wider impacts (ripple effects, see below), our assessment of the strength of the evidence and proposals for next steps. The findings section in the main report sets out the evidence for each theory in depth.

The exploration of additionality and causation is at the core of the findings. This means investigating how the HNIP pilot intervention enabled developments, resources and activities that were otherwise unlikely to have occurred at this point in the developing heat networks. To assist the construction of theory we also explored academic and practitioner literature on additionality – see Annex 5 for a summary of the review and definition of the types of additionality identified.

Note that the rubric we used to assess strength of evidence is under development; for more information please see Annex 3. Note also, that where we refer to interviewees in the rubric, this is interviewees across a number of sources, not just the case study interviews.

Theory 1 – HNIP acts as a catalyst aligning motivations – drawing people with different motivations together

<p>Description: HNIP aligns with the development ambitions (business plans) of heat network (HN) sponsors. The prospects of commercialisation and carbon reduction attract sponsors who might not otherwise have been seeking this scale of development at this point. Recognition of this alignment is the mechanism that sparked interest in the HNIP. The HNIP pilot acted as a catalyst, sparking these latent motivations, rather than establishing a motivation for HN development. (This is a type of behavioural additionality – see Annex 4.)</p>
<p>Nature of additionality: A project level behavioural additionality</p>
<p>Context: In one case study an existing heat network is in place. Prior to HNIP in one case study there was some developer scepticism about the financial and practical viability of a heat network, balanced against the LA’s commitment to sustainability, community improvement and affordable heat for residents. In one case study new regeneration projects have to comply with carbon reduction and clean air policies.</p>

Generalised across all three case studies, motivation for HN development appears finely divided between commitments to carbon reduction and ensuring that the heat network is financially viable – in terms of rates of return - and makes no additional demands on the developer's resources.

Mechanism: HNIP pilot in all three case studies has acted as a catalyst for schemes in place or in the pipeline through its alignment and coherence with LA ambitions around sustainability for all case studies, and for clean air in one, all of which are well established political commitments in the respective LAs. The HNIP pilot acts as a catalyst, a focus, that draws key actors, with different motivations, together from across the LA to result in heat network construction, rather than the HNIP pilot establishing a motivation for Heat Network development in its own right. This alignment of different motivations provides the support needed to help heat network plans gain acceptance in the LA, and ultimately to close the funding gap.

For example, within a local authority there may be a sustainability team seeking to meet carbon reduction targets, while a housing team might be aiming to improve the reliability of heating for social housing tenants, and senior management might be seeking to maintain or increase revenues. Finance will have investment criteria to meet (such as an internal rate of return that must be met). HNIP appeals to all of these; a heat network, particularly with a low carbon heat source, will help the sustainability team meet carbon reduction targets, will help provide a reliable source of heat for consumers, and could, particularly with private sector customers such as commercial premises, increase local authority revenues. Along with this, the capital support closes the funding gap so that the finance team's investment criteria are met.

It was made clear in two of the case studies that whatever the sustainability benefits, the project had to pay its way and be delivered with no financial detriment and the HNIP pilot also was material in enabling this. The opportunity to increase revenues is also an important motivation. However, despite extensive probing we found no evidence so far that revenue seeking behaviours **dominate** motivation for participation in the HNIP pilot.

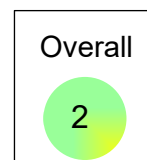
Contribution to outcomes: In two of the case studies the HNIP pilot is enabling the replacement of older heat sources and so reducing carbon emissions. In the other it is enabling the project sponsors to fulfil an ambition to move towards carbon neutral heat delivery. One case study is already experiencing reduced heat costs from their project. Beyond the case studies, HNIP pilot funded projects are replacing older heat sources with lower carbon sources, in some cases by extending existing heat networks, and in some by constructing new heat networks,

Ripple effect: There is some evidence that key actors having engaged with the HNIP pilot have built on the HNIP pilot supported project to stimulate developments elsewhere (within and outside the case study location). This is discussed further under 2.3 below.

Alternate theories: None tested

Strength of evidence and next steps:

Multiple interviewees support the theory	Y
Interviewees have relevant knowledge	Y
Interviewees are not strongly biased	Y
No evidence undermined the theory	Y



At least two interviewees with good knowledge of their project from all three case studies confirmed the theory on the basis of their engagement with the project pre the HNIP pilot and during the current phase. Beyond the case studies, a further three project leads confirmed the theory via the e-survey (and none undermined it).

This theory is confirmed for the pilot. It will be further explored for different contexts (e.g. private sector sponsors) for the main scheme.

Theory 2.1 – HNIP is helping cover a funding gap, to enable the project to proceed

Description: Investment via the HNIP pilot results in funded projects developing an HN, or aspects of the HN, they would not have been able to achieve without the funding by for example: buying in consultancy and expertise; enabling new or changed roles; enabling new partnerships; promoting plans for, or installation of, a new technology; developing project management.

The HNIP pilot **covers the funding gap** between capital requirements and capital availability enabling the HN project to meet the relevant hurdle rate for internal rate of return.

Nature of additionality: Project level input additionality

Context: As a requirement of the HNIP pilot, applicants submitted evidence that the returns on investment of their projects – though positive – were insufficient to secure investment at market rates. All three case studies are committed to HNs as a carbon use reduction programme, but not at the expense of additional costs in the longer term. In one case study there is strong local authority interest in adopting new alternative heat production technologies.

<p>Mechanism: The HNIP pilot reduces the short-term risk of revenue shortfall and enables the HN project to meet risk-return requirements (for example, required internal rate of return) so that the organisation can make the decision to proceed.</p>										
<p>Contribution to outcomes: Multiple interviewees at all three case studies said that their project would not have proceeded without HNIP pilot funding. Two case studies have been able to use HNIP pilot capital support for an essential component of network building for refurbishing or developing heat networks. They say that this could not have happened without that support. The other case study confirms that it would not have pursued its project without HNIP pilot support and other external funding. Via the e-survey a further three project managers said that the HNIP pilot was important or very important to making their plans financially viable; two said that without the HNIP pilot funding, their project would not have gone ahead, while a third said that their plans would have been less ambitious and achieved more slowly.</p>										
<p>Ripple effects: Two of the case studies refer to the benefits of consultancy funded via the HNIP pilot as providing knowledge that would otherwise have been difficult to acquire – and which will be retained beyond the end of the specific scheme.</p>										
<p>Alternate theory: None tested</p>										
<p>Strength of evidence and next steps:</p> <table border="1" data-bbox="167 1205 842 1368"> <tr> <td>Multiple interviewees support the theory</td> <td>y</td> </tr> <tr> <td>Interviewees have relevant knowledge</td> <td>y</td> </tr> <tr> <td>Interviewees are not strongly biased</td> <td>n</td> </tr> <tr> <td>No evidence undermined the theory</td> <td>y</td> </tr> </table> <table border="1" data-bbox="1094 1205 1240 1368" style="margin-left: 200px;"> <tr> <td style="text-align: center;">Overall 3</td> </tr> </table> <p>Multiple interviewees at all three case studies said that their project would not have proceeded without the HNIP pilot funding. From the e-survey, a further two project managers said their projects would not have continued, while a third said that it would have been scaled down and completed more slowly. Overall, we consider this theory as partially confirmed for the pilot, despite potential bias of respondents to support the theory. We judged that the interviewees were sincere and fairly reliable as they were able to describe clearly how they used the funding for credible activities. In addition, other theories e.g. 2.2 help add supporting evidence for this theory. We will continue to explore evidence for the theory for the pilot and main scheme.</p>		Multiple interviewees support the theory	y	Interviewees have relevant knowledge	y	Interviewees are not strongly biased	n	No evidence undermined the theory	y	Overall 3
Multiple interviewees support the theory	y									
Interviewees have relevant knowledge	y									
Interviewees are not strongly biased	n									
No evidence undermined the theory	y									
Overall 3										

Theory 2.2 – HNIP funding has helped to manage cost and technology risks, to enable the project to proceed

<p>Description: Investment via the HNIP pilot results in funded projects being able to manage managing cost and technology risk</p> <p>The HNIP pilot provides a way of managing the short-term risk of revenue shortfall or the risks of introducing a new heat production technology, for example by funding feasibility studies or the acquisition of knowledge and expertise.</p>										
<p>Nature of additionality: Project level output additionality</p>										
<p>Context: All three case studies are committed to HNs as a carbon use reduction programme, but not at the expense of additional costs in the longer term. In one case study there is strong local authority interest in adopting new alternative heat production technologies.</p>										
<p>Mechanism: By reducing the economic risks or by funding additional feasibility work, the HNIP pilot has significantly reduced the risks associated with the heat network enabling the LA to approve and implement the scheme.</p>										
<p>Contribution to outcomes: One case study told us that by removing the risk of having to compete with other demands for funding locally the HNIP pilot was a significant risk reduction factor. One is using the funding to carry out additional feasibility testing in an area where the technical risks we considered too high to proceed.</p>										
<p>Alternate theory: Knowledge and advice was provided by HNDU prior to the HNIP pilot application in each case study area and this enabled the reduction of risks through the early stages of planning and developing the HN projects we looked at. We explored whether this alone would have been sufficient to deliver the benefits described. In all cases, we were told that the HNIP pilot was necessary over and above the HNDU support.</p>										
<p>Strength of evidence and next steps</p> <table border="1" style="width: 100%;"> <tr> <td style="width: 80%;">Multiple interviewees support the theory</td> <td style="width: 20%;">y</td> <td rowspan="4" style="border: 1px solid black; text-align: center; vertical-align: middle;">Overall 2</td> </tr> <tr> <td>Interviewees have relevant knowledge</td> <td>y</td> </tr> <tr> <td>Interviewees are not strongly biased</td> <td>y</td> </tr> <tr> <td>No evidence undermined the theory</td> <td>y</td> </tr> </table> <p>At least two interviewees for two of the case studies identified the theory. A further two respondents to the e-survey told us that the HNIP pilot had reduced risk relating to the technical aspects of their projects ‘quite a lot’. This theory is partially confirmed for the</p>		Multiple interviewees support the theory	y	Overall 2	Interviewees have relevant knowledge	y	Interviewees are not strongly biased	y	No evidence undermined the theory	y
Multiple interviewees support the theory	y	Overall 2								
Interviewees have relevant knowledge	y									
Interviewees are not strongly biased	y									
No evidence undermined the theory	y									

pilot. We will continue to explore evidence for the theory and for the alternate theories for the pilot and main scheme.

Theory 2.3 – HNIP funding adds legitimacy to HN schemes

<p>Description: The HNIP pilot has increased the confidence of key LA actors in scaling up and developing projects by signalling government commitment to heat networks and carbon savings.</p> <p>That government is providing funding, adds legitimacy to heat networks and to their specific scheme, managing perceived risks and producing a shift of perception in the organisational (for the pilot, LA) leadership that results in stronger support for, and advocacy of, the HN.</p>
<p>Nature of additionality: Strategic level behavioural additionality</p>
<p>Context: All three case studies are committed to HNs as a carbon use reduction programme, but not at the expense of additional costs in the longer term. In one case study there is strong local authority interest in adopting new alternative heat production technologies.</p>
<p>Mechanism: By signalling government commitment to heat networks and carbon savings, the HNIP pilot has added legitimacy to heat networks and has stimulated and increased the confidence of key LA actors. It has helped them visualise the possibilities and opportunities for scaling and development. It has provided additional credibility for their heat network projects, and enabled them to more convincingly demonstrate the benefits, and achieve the buy-in needed to compete with the variety of other projects from which local authority finance officials face demands. (Note – we have not spoken to local authority finance officials and will need to explore this aspect further in future evaluation cycles.)</p>
<p>Contribution to outcomes: One case study describes the HNIP pilot’s intervention, by providing central government support, as significant in being able to validate and add weight to existing plans for HN development. The HNIP pilot is described as having a catalytic effect in strengthening awareness of HN development and the possibilities it creates. Another case study describes how recognition of scheme viability produced a shift of perception in the LA leadership that resulted in stronger support for, and advocacy of, the HN. A further two project managers responding to the e-survey agreed or strongly agreed that the HNIP pilot had increased the legitimacy of heat networks with key decision makers in the LA by signalling Government support. Context was important here – unsurprisingly, this was more important where the LA had less experience of heat networks.</p>

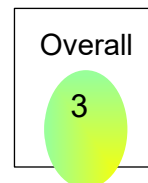
Alternate theory: In one case study the Greater London Authority (GLA) is considered as more significant than the HNIP pilot in adding legitimacy to HN projects. While the HNIP pilot contributes to the outcome, in some areas, local policies and plans may carry more weight.

Ripple effects: There is anecdotal evidence of the case studies generating ripple effects by building confidence in heat networks in neighbouring LAs and also in renewable and low carbon schemes elsewhere in the LA and more broadly:

- For one case study, the HNIP pilot funding for a renewable scheme has opened up the discourse on such schemes locally and to a small extent nationally. The effect is one of recognising, and potentially acting on, multi-venture renewable schemes (e.g. micro grids and the combining of renewable schemes, such as renewable heating, with photovoltaic charging points).
- One is acting as an example to neighbouring boroughs that are beginning to engage with heat networks – there is evidence of planners and developers being more willing to consider alternatives to installing property-level boilers in new schemes. In particular, we were told that an HN scheme would not have started in a neighbouring town without the example of the HNIP pilot case study
- One is attracting industry interest because its plans for its innovative heat source technology, enabled by the HNIP pilot, are on a larger scale than elsewhere
- One is seen as providing a learning opportunity for others planning regeneration
- It has been suggested that projects have generated strong interest among contractors and industry consultants in sustainability focused heat generation technology
- The role of key actors was highlighted. One individual's commitment to sustainability has been engaged by the scheme. In moving to another LA, the individual continues to lobby for a similar scheme especially with the expected implementation of the main phase of HNIP.

Strength of evidence and next steps

Multiple interviewees support the theory	y
Interviewees have relevant knowledge	y
Interviewees are not strongly biased	y
No evidence undermined the theory	y



At least two interviewees for two of the case studies covered all components of this theory in their response. At one case study interviewees were unable to identify behavioural additionality because the HNIP pilot intervention came at a later stage of the project's development than in the other two case studies. In e-survey responses, one response was neutral, while others all agreed or strongly agreed that the HNIP pilot had increased the legitimacy of heat networks within the LA by signalling Government support for heat networks.


This theory is partially confirmed for the pilot. We will continue to explore evidence for the theory and for the alternate theories for the pilot and main scheme as we expect that they will play out differently in different contexts, e.g. where previous experience of heat networks has been negative, with private, as opposed to public sector sponsors, where local planning requirements promote heat networks.

Theory 3 – Demonstrating the benefits of heat networks

Description: If HN sponsors can demonstrate the benefits of HNs to customers (non-sponsors), then they will respond positively to the HN offer, helping to ensure the scheme is viable. ‘Customers’ can include developers, who choose how to provide heating in the properties they develop, demand aggregators (who sell heat onto consumers), and in some cases individual consumers.

Looking forward, a central feature of the HNIP pilot theory of change is that funded schemes will demonstrate the benefits of heat networks, leading to more widespread adoption (a key ripple effect). This theory helps explore the evidence that such demonstrations do trigger interest in, and engagement with, heat networks.

Context: For two schemes, the heat network scheme is being progressed at the same time as at least some of the developments that will use the heat, meaning that the customers will not have to install heating units (e.g. boilers) in their developments. In one of the case studies the heat network is being expanded, including to buildings that have existing (but ageing) communal boilers. In one the feasibility of a carbon neutral network is being explored for buildings not yet developed. One case study recognises an inbuilt capacity to demonstrate early benefit in that the scheme is commercially viable at the outset and grant supported.

<p>Mechanisms: Both heat demand aggregators and domestic customers currently express far more interest in cost than in sustainability. The HNIP pilot, by funding heat network development, enables sponsors to demonstrate to customers, and particularly demand aggregators, that if the timing is right, they can make substantial capital investment savings by enabling them to treat heat as a utility, somewhat like broadband, electricity or water. Although the context described is relatively specific we expect the dominant interest in cost and commercial viability described here to operate as a mechanism across similar contexts, i.e. where reduced cost is achievable it will outweigh sustainability as a motivation.</p>									
<p>Contribution to outcomes: All three case studies recognise the necessity of being able to demonstrate the benefits to engage future interest.</p> <p>In one case study the LA persuaded an independent housing provider, who is within the networked area, to join the network. This was on the basis of the forecast economic savings from the reduced capital and revenue costs of residential heat supply. In another case study, the HNIP pilot will allow the installation of a CHP engine which will reduce costs to end use consumers (by reducing overall costs through electricity sales).</p> <p>The realisation that HNs reduce the capital costs of heating for demand aggregators is expected to influence their perception of, and their subsequent behaviour towards, HNs.</p>									
<p>Alternate theory: The evidence could suggest that funding from the HNIP pilot was not necessary to demonstrate the benefits of heat networks – that this could have been achieved as part of the process of building a business case, in the absence of the HNIP pilot; however, overall the evidence suggests that the HNIP pilot has contributed in two ways:</p> <ul style="list-style-type: none"> • By providing the spark to trigger latent motivations (Theory 1) and overcome barriers (Theory 2) it resulted in local authorities being able to begin committed consultation with potential customers • By providing funding at the development phase – it has enabled these consultations to begin when it was possible to demonstrate clear savings for potential customers 									
<p>Strength of evidence and next steps</p> <table border="1" data-bbox="320 1805 997 1966"> <tr> <td>Multiple interviewees support the theory</td> <td>y</td> </tr> <tr> <td>Interviewees have relevant knowledge</td> <td>y</td> </tr> <tr> <td>Interviewees are not strongly biased</td> <td>y</td> </tr> <tr> <td>No evidence undermined the theory</td> <td>y</td> </tr> </table> <div data-bbox="1102 1809 1249 1971" style="display: inline-block; text-align: center; vertical-align: middle;"> <p>Overall</p>  <p>4</p> </div>		Multiple interviewees support the theory	y	Interviewees have relevant knowledge	y	Interviewees are not strongly biased	y	No evidence undermined the theory	y
Multiple interviewees support the theory	y								
Interviewees have relevant knowledge	y								
Interviewees are not strongly biased	y								
No evidence undermined the theory	y								

In two case studies at least two interviewees could point to ways in which heat customers have responded positively to the benefits of the heat network.

Evidence at this stage is weak – as would be expected. The work to date has gone some way to showing that demonstrations of benefit are necessary to trigger heat customer interest in, and engagement with, heat networks, and that HNIP can help deliver these. We expect context to be important here – potential customers will be at different points in their heating asset replacement cycles – where their heat generating assets are at the end of their economic life, they are more likely to see benefits. The challenge for the project is to know when the case for heat networks is sufficiently well made and embedded, for HNIP funding to be no longer necessary. Also, this is just one audience.

We should continue to explore this theory and its extension to other audiences.

Theory 4 – Replacement Heat Sources Planning

Description: In the short term the HNIP pilot is concerned with stimulating heat network development (e.g. by enabling investment in Combined Heat and Power (CHP) as a heat source so that networks can get up and running quickly and efficiently). The longer-term ambition of HNIP however is that this should enable a gradual move to low carbon heat sources. This creates the need for replacement heat source planning.

This theory seeks early evidence that the HNIP pilot has contributed to the development of replacement heat source planning.

Context: CHP is recognised by all three case study projects as a quick and efficient route to carbon reduction. CHP produced electricity with lower carbon emissions than the grid as a whole, although the grid continues to decarbonise. LAs appreciate that CHP has a limited life but find that HN installation without CHP is currently challenging particularly if cost savings are to be made. Also, some lower carbon technologies, such as heat pumps, do not suit every location, because of their space requirements, and because the heat generated is lower temperature than from conventional boilers, which makes it unsuitable for older buildings.

Mechanism: The HNIP pilot can contribute to the development of replacement heat source planning by creating opportunities to introduce carbon neutral technology at an earlier stage than might otherwise have been the case by encouraging this thinking from the early stages of scheme development and perhaps contributing to the de-risking for sponsors of innovative technologies.

Contribution to outcomes: In all case studies we found an awareness of the need for planning at project sponsor levels, stimulated by the HNIP pilot, but in two case studies

no clear response other than recognition that this issue will need to be addressed. HNIP pilot funding has been used to improve their technology and the speed of HN development on the assumption that in the future emerging low carbon technology can be plugged into the established network.

In one case study, the combination of a new build site, the location and political support for sustainable solutions has resulted in a response to the HNIP pilot that is effectively jumping a stage in the technology by planning a ground source heat pump. Government funding from more than one source has enabled not just a feasibility study to be conducted on a more innovative heat source (to de-risk the technology – see Theory 2) but has also encouraged wider thinking around sustainability.

The e-survey revealed thinking had progressed at the case studies, with more thought given to potential replacement sources, and that one further HNIP pilot had plans in place relating to replacing their hear source in the future.

Alternate theories: None tested

Ripple effects: As noted under Theory 2 above, work at one case study to explore innovative, low carbon technology is causing widespread interest with other potential sponsors and the wider market. It also has stimulated wider sustainability thinking within the LA.

Strength of evidence and next steps

Multiple interviewees support the theory	y
Interviewees have relevant knowledge	y
Interviewees are not strongly biased	y
No evidence undermined the theory	n

Overall
4

Evidence at this stage is weak, as expected.

Discussions at the Steering Group meeting to validate the findings, suggested that this was perhaps not surprising. Once the decision is made to adopt a heat network, then, in the absence of disruptive advances in heating technologies, sponsors are effectively locked into retaining it for up to 50 years. In this context the need to replace a heat source, such as CHP with a lifetime of around 15-20 years, is clear. There is some limited evidence that a few HNIP funded pilots are already developing plans for lower carbon replacement heat sources, but others have no plans in place.

We will refine this theory to reflect both these considerations, and changes to the main scheme designed to make BEIS’s ambitions to move to low carbon heat sources more evident.

Theory 5 – Theory of Scale

Description: Our case studies revealed an emerging theory around what drives decisions on the scale of heat network development and its relation to risk attitudes in sponsor LAs.

HN schemes are complex – requiring management of a number of interfaces with complex timing requirements. The HNIP pilot requirement to meet strict milestones could be contributing to this control of scale, which in turn, could be helping address programme complexity and leading to a relatively early build of demonstrable projects, or aspects of projects.

Context: A combination of contextual factors affect scale including:

- ensuring economic viability (meeting IRR hurdle rates)
- presence of a secure market of heat customers – and the nature of that market – does the LA for example have buildings with ageing communal heating systems?
- space constraints (which may rule out some technologies in some places)
- strict milestones to be reached to allow HNIP pilot funding to be drawn down.

Mechanisms: Risk aversion in LAs is a central factor affecting the scale of heat network schemes. In part this is driven by HNIP pilot requirements to meet strict milestones combined with a risk averse culture in some LAs. Limiting the scale of schemes and keeping tight control is enabling LAs to take advantage of the HNIP pilot.

A willingness to change the shape and balance of project elements as the scheme develops, and capability in agile project management can help manage risks.

Outcomes: So far in the case studies there is some limited evidence from interviews that sponsors are keeping schemes to what they consider to be a manageable scale, sometimes keeping the boundaries of the scheme largely in-house, and avoiding combining with other local, private sector schemes, to reduce delivery risks in this complex environment. One case study, close to delivering heat through use of HNIP pilot funding, is currently developing similarly scaled schemes in the same urban area, based on this experience.

Alternate theories: None tested		
Strength of evidence and next steps		
Interviewees have relevant knowledge	y	Overall 7
Interviewees are not strongly biased	y	
No evidence undermined the theory	y	
Theory partly confirmed	y	
<p>In two case studies the theory was reviewed but neither confirmed nor denied.</p> <p>This is an emerging theory, we anticipate continuing to develop its use in future theory building.</p> <p>The steering group validation meeting asked that we also explore the role of milestones in helping project sponsors push through key decisions and make progress.</p>		

Annex 5: Example research tools

This annex presents examples of the research tools we used for the case studies. These were developed from case study to case study and tailored to the specific theories under considerations and the interviewee. The interviewer also tailored the interview as it progressed in response to the information emerging in line with the principles of realist interviewing described in Annex 2.

Participant Information Sheet and Consent Form

PARTICIPANT INFORMATION SHEET: HNIP EVALUATION

Aim of interview

The aim of the interview is to collect data on the development so far of the _____ heat network since it received funding from the Heat Networks Investment Project (HNIP). Through the interview we would like to gain insight into the early steps of the project and the initial impact of the funding. This interview will be part of a case study conducted under the umbrella of the independent evaluation of the Heat Networks Investment Project (HNIP) pilot scheme. The evaluation is funded by the Department for Business, Energy and Industrial Strategy (BEIS), and is being undertaken by an independent consortium led by Risk Solutions.

This interview will be conducted by a member of the evaluation team from either Risk Solutions or the Tavistock Institute for Human Relations.

Aim of the evaluation [E] [SEP]

This is not an audit; it is part of an independent evaluation designed to improve understanding of the functioning of HNIP. This case study aims to identify learnings on the early effects and impact of the HNIP.

About the interview

The interview will be conducted by telephone or face-to-face, at a time that is convenient for you, and will last approximately 40 minutes. It will take the form of an informal conversation. Importantly, there are no right or wrong answers, we are interested in your impressions, knowledge and experiences of the project processes. With your consent (see details below), we will record the interview to facilitate our analysis. With your permission we might want to return to you for a second interview to help us to test and confirm our findings after collecting and analysing other data.

Queries and concerns

If you have any queries about the interview, please contact _____ at the Tavistock Institute for Human Relations, at _____ or _____. You can also contact the evaluation manager for BEIS, _____ at _____ or _____.

If you have any concerns about the way in which the interview is conducted, you may contact _____ at _____ or _____.

Confidentiality and consent

We would be very grateful if you could confirm – by email – that you have read, understood and give your consent to the following:

- Your participation in the evaluation is voluntary and – even after granting consent – you may withdraw from the interview at any time. Subsequent to the interview, you may withdraw from the evaluation at any time and request that the evaluators delete your response data, or a specific response, up until the end of August 2018.
- The interviewer will record the interview, and have it transcribed for analysis. You may choose to not answer questions or to ask the interviewer to turn off the recorder when you answer certain questions;
- This transcript will not be shared in full beyond the independent evaluation team and their transcribers – some parts may be shared with selected officers from BEIS for activities necessary for the evaluation, in which case these will be anonymised;
- The transcript will be used for the BEIS-funded evaluation of HNIP, and for no other purpose;
- Should the research team wish to use any direct quotes in any evaluation presentation or evaluation report, this will be anonymised.

Use of data collected, benefits and risks of taking part^{SEP}

The results of the study will be kept confidential and will be used to inform evaluation reports to BEIS, which may be published. Your input and any quotations used or published will be anonymised and we will not identify you unless you request otherwise.

Anonymised input and quotations may also be used in academic and other publications, but only with the permission of BEIS. No personal or commercial data (e.g. names or contact information) will be shared or made public.

While we will not use your name or attribute any quotes to you, it is possible that given the limited number of projects in the pilot and information on the context of your participation that some readers may be able to identify you.

We will analyse notes and transcripts from the interview for the purpose of this research and they will inform reports and other publications. We will treat all data collected confidentially.

The main benefit of taking part in this study is that your insight will help to inform our evaluation of HNIP, and thus shape and improve its future operation and implementation.

Recordings, transcripts and notes from the interview will be kept securely and stored on the Tavistock Institute for Human Relations' encrypted and password-protected system. We will keep these until the end of the evaluation project, and then we will delete them.

If you have any questions about the interview, please contact ____ at _____ or _____.

Consent form

I agree to participate in an approx. 30-40 minute interview as part of the evaluation for the Heat Networks Investment Project (HNIP). This interview is being led by the Tavistock Institute for Human Relations under the direction of Risk Solutions (Risksol Consulting Ltd) and on behalf of the Department for Business, Energy and Industrial Strategy (BEIS)

I have read the participant information sheet provided, and understand the aim of the study, and how my input will be recorded and used.

- I give permission for the interview to be recorded and transcribed**
(please check the box)

Details below can be filled in electronically and returned via email

Name.....

Signature.....

Date.....

Email.....

Phone number.....

Example Interview guide for Gleaning Interview

This is the interview guide for the first interviews to be undertaken.

Gleaning Interview – notes for the interviewer

The focus of realist interviewing is the programme. The interest in the actors is the part they play in the programme, what it is achieving, how, why and for whom. There is no need to share any of these details with the interviewee as they provide background for the interviewer.

The 'gleaning' interviews articulate the basic initial theories behind the programme and identify how the contextual circumstances of the programme could be impacting on actor behaviour and subsequent outcomes. Some of the initial theories (e.g. Additionality) have already been articulated in the HNIP ToC. Others will emerge as we work through the interviews.

These are the theories that we want to work with in these interviews:

D1a Motivation - The HNIP fits with the development ambitions (business plans) of heat network (HN) sponsors and the developing HNs. The prospects of commercialisation and carbon reduction attract sponsors who might not otherwise have been seeking this scale of development at this point. Central government support and commitment gives HN applicants confidence in the scheme.

D1b Additionality - Investment via HNIP results in funded projects developing an HN, or aspects of the HN, they would not have been able to achieve without the funding (additionality). These aspects will contribute to the sustainability and scaling up of the HNs supported by HNIP. At this stage of the project additionality could be: buying in consultancy and expertise; new or changed roles; new partnerships; plans for, or installation of, a new technology; getting management competency right for the expanded, and more complex project. Please keep 'additionality' in mind throughout the interview to pick up on anything that could be from the ripple effect of HNIP. This can include: new customers and connections; changes to the heat source; buying in consultancy and expertise; new or changed roles; new partnerships; plans for, or installation of, a new technology; getting management competency right for the expanded, and more complex project.

D2 Demonstrating the benefits of HNs - If HN sponsors can demonstrate the cost benefits of HNs to customers (non-sponsors) and demand aggregators, produced by a growing market, then customers will respond positively to the HN offer. 'Customers' can include building management and development who sell heat on to end users.

The interview guide should be treated as a guide to the topics to be covered, but the aim is to keep the interview conversational and exploratory. For example, as you become more familiar with the nuances of the project and its Context, Mechanism, Outcome

configurations (CMOCs) other questions may emerge. Alternatively, as you work through the questions you may find some have already been addressed by earlier questions.

The data drawn from the interviews, our reflections on it in combination with data we already have, will be used to refine the programme theories. These theories will provide the structure for a second set of interviews. These could be with the same actors and/or with other people depending on what we learn from the gleaning interviews.

If time is running out, please make sure you have covered the CMOC questions at 7,8 and 9.

Once you have completed the interview please complete the interviewer review below. The information you provide will be used to refine and develop the interview guide as the interviews progress.

There are specific questions for the three theories but throughout the interviews please look out for and follow up:

- Anything that sounds like motivation for HN development,
- Anything additional that has happened since the start of HNIP
- Anything that captures heat customers' interest in HN development
- Any evidence that points to ways in which the programme is failing or being disrupted

Interviewer introductions

- Introduce self, and check that it is convenient to do the interview.
- Introduce the evaluation; we are independent researchers who have been contracted by BEIS to evaluate the Heat Networks Investment Project (HNIP) as it is rolled out. This interview is simply about exploring the early effects of HNIP and how, and why, key actors and stakeholders have responded to it. During the interview we will be putting some ideas to you about how we think HNIP could be working and we are really keen to get your views on these.
- Comment that – although we will try to cover only issues that are appropriate to the interviewee – we may raise issues that the interviewee does not feel qualified to comment on. This is fine, just confirm when this is the case.
- Double check the interviewee has received participant information sheet, and is happy to reconfirm verbal consent to proceed, record the interview and transcribe. Ask for written consent form to be returned after the interview (if it hasn't already been sent to us).
- Begin recording
- State date, interviewer name and interviewee name, thanks for participation, any questions before we begin?

	Question	Logic
1.	<p>What part do you play (have you played, will you play) in the ___ HN development? (Draw out whether an initiator or responder or both.)</p> <p>What appeals to you about the ___ HN project?</p>	<p>Introductory scoping to get them talking and to identify their place in the ___ HN system</p>
	<p>What appeals to you about the ___ HN project?</p> <p>Prompts: commercialisation, profitability, carbon reduction, effectiveness, future proofing, consumer benefits</p>	<p>Looking for outcomes/early effects/changes - Testing CMO C D1a (Motivation) Attraction, motivation,</p>
	<p>Could you say a bit more about your role in the ___ HN development (Activities, who, what, when, where, how?)</p> <p>Why are you doing that? (What is your reasoning behind what you've described yourself doing?)</p>	<p>Introductory scoping to get them talking and to identify their place them in the ___ HN system</p>
	<p>What relationships with other people or organisations have been important for your role in the HN development?</p> <p>Could you say more about these relationships, why they were important, and what resulted from this connection?</p> <p>How did the HN network fit in with your interests?</p> <p>Prompt: How are decisions made in the ___HN context? Who are the key decision makers? What do you think it is about HNIP that motivates them?</p>	<p>Introductory scoping to get them talking and to identify their place in the ___ HN system.</p> <p>Also looking for information on how decisions are made and the possible mechanisms at play</p>
	<p>What has happened, or changed, since the current ___ HN project started? Prompt: 'started' means from the point when they first became aware of HNIP and its offer.</p>	<p>Searching for the early effect of HNIP support and funding. These could be relevant to project development and influencing, publicising, and promoting HN development. Please note the separate effects and ask how the programme caused them (mechanisms)</p>
	<p>We are interested in how the programme has caused these outcomes. How do you think the programme has caused, or helped to cause, the outcomes you have identified?</p>	<p>Searching for mechanisms</p>

	<p>What would you like to see the ___ project achieving (Prompt: at the level of (a) local infrastructure development (b) influencing, publicising, promoting HN development)</p>	<p>Reflecting the HNIP macro ToC</p>
	<p>As far as we can see, one of the ways HNIP works is to stimulate interest in the purpose and value of Heat Networks e.g. among developers, heat providers, policy makers and ideally investors? Has this happened? What's the evidence?</p> <p>How has the programme caused this to happen?</p> <p>Did you/ Do you/ Will you have a role in this? Please describe</p>	<p>Looking for outcomes/early effects/changes - Testing CMOC D1a (Motivation) – This may have already been covered, or partly covered, in the questions above</p> <p>Looking for mechanisms</p>
	<p>Another way the HNIP works is by providing funding to Heat Networks to do things they might not otherwise have been able to do? Can you identify any activities and changes so far that reflect this (e.g. consultancy support for commercialisation, legal advice, technical support, pursuing low carbon options, approaches to, or from? developers and aggregate customers)</p> <p>How has the programme caused this to happen? Prompt: Did BEIS's application process/scoring criteria have any impact here?</p>	<p>Testing CMOC D1b (Additionality) Looking for outcomes/early effects/changes – At this stage additionality could be: buying in consultancy and expertise; new or changed roles; new partnerships; plans for, or installation of, a new technology; getting management competency right for the expanded, and more complex project.</p> <p>Looking for mechanisms</p>
	<p>It is possible that if the local HN can demonstrate the cost benefits of HNs to heat customers (demand aggregators), produced by the technical and efficiency gains from a growing market, then they will respond positively to the HN offer.</p>	<p>Testing CMOC D2 (Demonstrating the benefits of HNIP) Looking for outcomes/early effects/changes in how current</p>

	<p>Has this happened? What’s the evidence? How has the programme caused this to happen? Are there any ways in which HNIP made this less likely or more difficult?</p>	<p>and potential customers see HNs</p> <p>Looking for mechanisms</p>
	<p>In ___ we’ve heard that high level support from the Council has been significant in enabling the HN to get to this stage. Can you comment on that? Did you/do you have a role that? If so, what was it and how did you carry it out? Why did you do it in the way you described?</p>	<p>This is a possible theory</p>
	<p>What local factors (policies, other developments) have been, or will be, important to the HN development? These might be inside or outside the local authority – e.g. private developments, public attitudes, local investment)</p>	<p>Looking for new theories. If possible, identify boundary partners. They are people, groups, and organizations who the programme interacts with to produce change (e.g. heat customers, planners, developers, investors)</p>
	<p>Can you see anything that is likely to get in the way of or disrupt the development of the ___ HN (locally or nationally, politically, technically, internally/externally). Which of these possibilities, if any, affects your role/falls within your remit?</p> <p>Do you know of steps being taken to avoid foreseeable disruption? If so what? Do you have a role in it?</p>	<p>Capturing external/environmental/contextual factors.</p> <p>This for establishing Theories of no change</p>
	<p>What would make the HN sustainable beyond the support of HNIP?</p> <p>What does ‘sustainable’ look like?</p> <p>Prompt: Building sustainability is a condition of HNIP funding. BEIS’ objective is a sustainable HN market</p>	<p>Reflecting the HNIP macro ToC</p> <p>Looking for new theories relevant to sustainability. This will draw out the sustainability ToC</p>
	<p>What would it take for the ___ HN to scale up and out (go to scale)?</p>	<p>Reflecting the HNIP macro ToC</p> <p>Looking for new theories</p>
	<p>If you could change something about this programme to make it more effective what would you change and why?</p>	<p>Comments on programme effectiveness</p>

<p>What else do you think we need to know, to really understand how HNIP has worked here? (E.g. what interest has it motivated, where and why?)</p> <p>Who else should we interview?</p>	<p>Probing for issues not already covered by the interview</p> <p>This point should be covered throughout the interview but in case no-one has yet emerged this question is needed.</p>
<p>Please ask the interviewee if we could come back for a second interview if necessary, to get his/her responses to our findings so far (i.e. Theory refining)</p>	<p>Theory refinement</p>

Example Theory refining interview

Interviewer introductions

- Introduce self, and check that it is convenient to do the interview.
- Introduce the evaluation; we are independent researchers who have been contracted by BEIS to evaluate the Heat Networks Investment Project (HNIP) as it is rolled out. In this interview, we are keen to understand how the project is progressing and to pick up early signs of its effect. In particular we would like to learn from you how the programme is producing these outcomes.
- Comment that – although we will try to cover only issues that are appropriate to the interviewee – we may raise issues that the interviewee does not feel qualified to comment on. This is fine, just confirm when this is the case.
- Double check the interviewee has received participant information sheet, and is happy to reconfirm verbal consent to proceed, record the interview and transcribe. Ask for written consent form to be returned after the interview (if it hasn't already been sent to us).
- Begin recording
- State date, interviewer name and interviewee name, thanks for participation, any questions before we begin?

Questions – Theory presentation

The process is simply one of putting the theories to the respondents and asking for their responses. There are three theories below relevant to how and why the project engaged with HNIP and what resulted.

Key Actors: The first question is to ensure that we have captured who the key actors are as all the subsequent CMOCs are concerned with their interrelationships and interdependencies. A key actor is someone who has primary influence on, or is an essential partner, in the Project. We want to make sure that our theory building includes all of them.

We see the key players here as: Local Authority Politicians; Officers responsible for the Town Centre Plan; Senior Council officers with strategic responsibilities e.g. Deputy Chief Executive Officers responsible for energy and sustainability; Heat customers (College, Police, Library, Town Hall); Residential scheme owners/developers; development consultants; supply chain. Do you agree? Anyone missing?

Motivation and recognition of alignment for getting started on heat network commercialisation/construction process (Note: This brings motivation and demonstrating benefits the into a single CMOC)

Context: The HN development so far represents a good alignment between the motivation of politicians, planners and heat customers. They are not motivated by the same things, but their combined motivations led to HN development. (Context)

The motivations that could create the pre-conditions for this are:

Growing governmental and public support for sustainability as demonstrated by the HNIP.

Demonstrable economic benefits of having a 'plug and play' HN

The need to replace/modernise heat production technology (Context)

Mechanism: Recognition of this alignment is the mechanism that sparked interest in the HNIP. The HNIP acted as a catalyst on the mechanism of recognising the] alignment of motivations in place rather than providing the motivation for HN development.

The **outcome** is the current state of development.

In addition, we can ask:

1. What crystallised your decision to go for HNIP?
2. Are there other ways in which HNIP has acted as catalyst?
3. Are there any other core motivations? If so for whom are they motivations?
4. How significant is the HNIP in delivering this outcome?
5. Are there other explanations for this outcome?

Behavioural Additionality - HNIP brings legitimacy to the HN's carbon reduction and sustainability dimensions.

Context: The pre-HNIP combination of motivations, interests, opportunities and physical environment for HN development. Also, the presence of one or two HN champions in the right place.

The HNIP amplifies the legitimacy of the LA's approach to HN development.

Mechanism: The HNIP has stimulated and increased the confidence of key LA actors in scaling up and developing the programme (mechanism = increased confidence). They can visualise the possibilities and opportunities for scaling and development.

Outcomes: This results in: (1) LA actors being able to take a more robust and confident approach in keeping key stakeholders engaged (local College) and (2) delivering a more assertive approach to developers and potential partners in getting them on board with the heat network (3) Legitimacy is one possible weapon in overcoming longer than planned timescales.

In addition, we can ask:

6. Are there other factors that have affected confidence (positively or negatively) in pursuing HN development?
7. How significant is HNIP in delivering this outcome?

8. Are there other explanations for this outcome?

Behavioural Additionality -The HNIP validates the development ambitions of key actors already committed to it.

Context: Bringing the development together and aligning motivations was made possible by having one or two champions who are keen to work on overcoming barriers. These champions are more likely to be motivated by sustainability. They need political support, which could be motivated mainly by economic benefits.

Mechanism: The HNIP sparks collaborative activity of the champions who see it as an opportunity to validate HN development, especially from a sustainability perspective (mechanism).

Outcomes: This produces a shift towards greater understanding of why and how an HN can be developed and what the benefits are. In effect the HNIP serves to legitimise HN development as a worthwhile activity and provides support to the champions in overcoming barriers in implementing their plans to demonstrate these benefits.

This in turn results in goals for expansion and scaling up and the drawing of interest from current and potential HN stakeholders, partners and beneficiaries?

In addition, we can ask:

9. How important is validation to the development and scaling up of HN development? What does it let you do that you couldn't otherwise do – has it facilitated any aspects of the project?
10. How significant is the HNIP in delivering this outcome?
11. Are there other explanations for this outcome?
12. How did you view the prospect of political/wider support for HN development before HNIP was available?

Outcome Additionality - HNIP covers the funding gap between capital expenditure and expected rate of return on an expanded heat network.

Context: The LA is committed to HNs as a carbon use reduction programme but not at the expense of additional costs in the longer term.

Mechanism: HNIP reduces the short-term risk of revenue shortfall and enables the HN project to meet the hurdle Internal Rate of Return (Mechanism)

Outcomes: This in turn reduces the barriers to establishing a viable (reasonably scaled) HN. thus, enabling the HN to move to the next phase. (Outcome)

In addition, we can ask:

13. Are there other ways in which the HNIP is seen as reducing HN development risks, and/or for evidence of how it has reduced risk? Ask which risks.
14. How significant is the HNIP in delivering this outcome?
15. Are there other explanations for this outcome?
16. Is reaching the 'hurdle' rate the driver or is it simply the possibility that HNIP enables a better rate of return than other competing projects/enterprises in this space within the LA? Is an IRR hurdle rate the usual LA decision criterion, or are other measures used such as payback period, NPV, something else? (Be aware that there might be an ever-present mechanism concerned with improving the rate of return that could override, or conflict with, other mechanisms).

End the interview by thanking the interviewee for participating. After the interview load the recording to the vault, check it has uploaded successfully, and delete any local copies.

The e-survey questionnaire

This is a hard copy version of an electronic survey and so inevitably does not completely mimic the survey as experienced by those completing it. For example, in the actual e-survey where there is text saying 'other, please specify' there is space to allow this to be entered.

The following text was included in the email sent to participants:

The Heat Networks Investment Project (HNIP) is a government capital funding initiative to help accelerate HN market growth towards a larger self-sustaining market. We are independent researchers who have been contracted by BEIS to evaluate the HNIP project as it is rolled out. In this survey, we want to explore why you decided to apply for HNIP pilot funding, how you are implementing your project, and what difference the HNIP pilot has made to your project. We are aware that not all projects are proceeding; please answer whichever questions are relevant to your situation.

Q1 The results of the study will be kept confidential and will be used to inform evaluation reports to BEIS, which may be published. Your input and any quotations used or published will be anonymised and we will not identify you unless you request otherwise. Anonymised input and quotations may also be used in academic and other publications, but only with the permission of BEIS. No personal or commercial data (e.g. names or contact information) will be shared or made public. While we will not use your name or attribute any quotes to you, it is possible that given the limited number of projects in the pilot and information on the context of your participation that some readers may be able to identify you. We will treat all data collected confidentially. The main benefit of taking part in this study is that your insight will help to inform our evaluation of HNIP, and thus shape and improve its future operation and implementation. Survey results will be kept securely and stored on encrypted and password-protected systems. We will keep these until the end of the evaluation project, and then we will delete them. Please indicate that you acknowledge the notification above.

Yes

No

Q2 Please indicate the importance of the following factors in influencing your organisation's decision to develop a Heat Network **before** you heard about HNIP, on a scale from 'Very important' to 'Not important'?

	Very important	Important	Moderately important	Not important
Carbon reduction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Generate revenue for the Local Authority)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reducing fuel poverty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More efficient heat production	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More reliable heat production	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Availability of HNDU support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q3 To what extent, do you currently have a plan for replacing the heat source with a low carbon source?

- No plan in place
- Tentative plan
- Firm plan in place

Page Break

Display This Question:

If To what extent, do you currently have a plan for replacing the heat source with a low carbon source? = Tentative plan

Or To what extent, do you currently have a plan for replacing the heat source with a low carbon source? = Firm plan in place

Q4 Please outline your plan below:

Page Break

Q5 Please indicate the importance of the following factors on your organisation's decision to apply for financial support from the HNIP pilot, on a scale from 'Very important' to 'Not important'?

	Very important	Important	Moderately important	Not important
Enabling an increased project scope	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Making plans for a heat network financially viable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pursuing carbon (or carbon equivalent) reduction plans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Addressing fuel poverty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

Q22 Please rank these factors in order of importance?

- _____ Enabling an increased project scope
- _____ Making plans for a heat network financially viable
- _____ Pursuing carbon reduction plans
- _____ Addressing fuel poverty
- _____ (This is items entered as 'other')

Page Break

Q6 Please indicate to what extent you agree or disagree that your participation in HNIP has led to:

	Strongly agree	Agree	Disagree	Strongly disagree
Increased involvement of consultants in your project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased technical knowledge for HN development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved Project Management capacity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved engagement with stakeholders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q7 Please tell us how HNIP led to the outcomes you have indicated in the question above:

Page Break _____

Q8 Please indicate the extent to which HNIP has reduced risks relating to:

	Very much	Quite a lot	Slightly	Not at all
Technical aspects of the scheme	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Securing anchor load customers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stakeholder engagement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Achieving CO2 reduction targets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gaining political support for HN development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q9 Please indicate to what extent you agree or disagree that your heat network has generated **increased interest in heat networks** among:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Key actors in the local authority	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Developers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Potential heat customers (heat aggregators)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other local authorities / public bodies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supply chain organisations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q10 Please indicate to what extent you agree or disagree that HNIP funding of your heat network helped generated **increased interest in sustainable or low carbon solutions more generally** among:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Key actors in the local authority	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Developers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Potential heat customers (heat aggregators)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other local authorities / public bodies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supply chain organisations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q11 Please indicate to what extent you agree or disagree that the HNIP pilot has influenced your organisation's heat network plans by:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Providing a catalyst for people with different motivations to engage with heat networks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helping manage technology risks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increasing the legitimacy of heat networks with key decision makers in the LA by signalling Government support for heat networks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engaging potential customers for heat, through enabling earlier and clearer demonstration of economic benefits	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
plans by: encouraging planning to replace the current heat source with a lower carbon source in the future:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Encouraging adjustments to scale (downwards) to ensure deliverability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other please specify	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q12 Please indicate to what extent you agree or disagree that the following would have happened **without** HNIP support:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Abandoned HN plans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Slowed development of the HN	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Implemented less ambitious plans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sought other sources of funding	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Proceeded using internal funds	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Annex 6: Additionality

We are interested in whether HNIP has resulted in *additional* outcomes that would not have happened in the absence of the project. There are a range of ways in which additionality can manifest itself. The simplest concept is that impacts happened that would not have happened at all in the absence of the project, but additional impact is also delivered if beneficial outcomes happen earlier, or the intervention helps a team take more risks. We therefore carried out a rapid review of some papers we have found useful in our work, in order to provide a checklist of different types of additionality we could use to help develop theory. The papers reviewed were:

1. Behavioural additionality of R&D subsidies: A learning perspective: Bart Clarysse, Mike Wright and Philippe Mustare *Research Policy* 38 (2009) 1517–1533 Elsevier.
2. *Does Europe change R&D-behaviour? Assessing the behavioural additionality of the Sixth Framework Programme* Final report Prepared for: European Commission, Research Directorate-General Directorate A – Inter institutional and legal matters –Framework Programme IDEA Consult in collaboration with: Rahel Falk (The Austrian Institute of Economic Research - WIFO) Brussels, April 14th, 2009
3. *Input, output and behavioural additionality: concepts and relationships*: Paper presented at the 25th Celebration Conference 2008 on Entrepreneurship and Innovation - Organisations, Institutions, Institutions, systems and Regions, CBS, Denmark, June 17 - 20, 2008. Einar Lier Madsen Nordland Research Institute, Tommy H. Clausen Nordland Research Institute, Elisabet Ljunggren, Nordland Research Institute, Einar Lier Madsen Nordland Research Institute
4. Georghiou, L., 2002. Impact and additionality of innovation policy. *IWT Studies*, 40, pp.57-64.

From these references we constructed the list of additionalities shown in Table 9 – note that many of these additionalities overlap with one another – this does not concern us here, as we have used the list to prompt thinking about outcomes and mechanisms.

Table 9: Different types of additionality

Additionality	Description
Input additionality	Focuses on issues such as ‘crowding-out’ and ‘deadweight’ i.e. whether government funding substitutes private investment. The aim therefore is to finance promising projects that would not have taken place without the public support.
Output additionality	Focuses on the proportion of outputs which would not have been achieved without public support. Output is either defined in terms of marketable output (e.g. patents or successful innovations) or commercial output (e.g. sales or profits that are directly attributable to public assistance).
Impact additionality	A type of output additionality which is defined in terms of enhanced productivity or a better competitive position. For obvious reasons, the case of impact additionality is hard to verify.
Behavioural additionality.	<p>Refers to the effects on the funded organisations’ behaviour and strategy resulting from a government intervention, looking inside the “black box”. <i>It therefore potentially provides the basis for theories about the mechanisms of change taking place in organisations as a result of the government-support measures.</i></p> <p>Note that behavioural effects may not always be positive. An example of negative and unintentional would be to lead an organization into an alliance which turns out to be unproductive and costly. An example of negative and intentional would be to persuade an SME to perform high risk R&D when it cannot really afford to do so and should be devoting resources to consolidation</p> <p>The following are all types of behavioural additionality.</p>
Strategic level vs project level behavioural additionalities	Project level additionalities relate to a specific project, strategic level additionalities work at the level of the organisation affecting strategies and capabilities of organisations and can be persistent (may be expected to endure beyond the period of the funded project and to be integrated into the general capabilities of the organisation) and modified behaviour is likely to strengthen a policy’s latent ability to influence the creation of output additionality. Hence, many

Additionality	Description
	<p>authors argue that policy makers should be more interested in strategic level behavioural additionality compared to input- and output additionality. effects”.</p> <p>Note that project level additionalities can result in strategic level additionalities, helping organisations adopt behaviours in other projects and undertakings</p>
<p>Project additionalities</p>	<p>Project additionalities are in place if the research project would be cancelled, unless it is supported by public funds.</p> <p><i>For HNIP e.g.: if a heat network scheme would not go ahead without HNIP funding – this is full project additionality</i></p>
<p>Partial project additionality</p>	<p>In many cases firms do not follow a rigorous approach when deciding on implementation or non-implementation of a project when government funding is denied. Instead, they tend to adapt the size or other characteristics like the scope or the timing of their projects or investments when public support is denied or granted. Partial project additionality is when the project is continued but changed in one or more of these dimensions</p> <p><i>For HNIP e.g.: If a scheme would be smaller in scope or ambition without HNIP funding</i></p>
<p>Acceleration additionality</p>	<p>A project level additionality, present if participation in a scheme speeds up the course of the project. Observable outcomes could be, for example, an earlier starting date, a shorter implementation phase, or the earlier completion of the project. Firms could also anticipate acceleration additionalities (shorter time to market) and therefore be less reluctant to e.g. engage in long-term projects or carry on research in areas beyond short-term business needs (scope additionalities)</p> <p><i>For HNIP e.g.: If HNIP funding allows a low carbon heat source to be adopted earlier than otherwise</i></p>
<p>Scale additionalities</p>	<p>A project level additionality, said to be on hand if public funding allows the project to be conducted on a larger scale. In a way, scale</p>

Additionality	Description
	<p>additionalities describe the gradual variant of binary defined project additionalities.</p>
<p>Scope additionalities</p>	<p>A project level additionality, refers to cases where the coverage of an activity is expanded to a wider range of markets, applications or players than would have been possible without public assistance.</p> <p>These may also extend to other products and services in the firm's portfolio (strategic level additionality).</p>
<p>Challenge additionality.</p>	<p>A project level additionality, when government support helps to take more risks in a project. Note this is related to scope additionality because the case of assisted firms advancing into new research areas could be reflected in a greater risk profile of innovation projects, since activities in areas beyond the organisation's key competencies involve greater technical difficulty (hence an increase in technical risk) and bring about less predictable business success (hence an increase in commercial risk).</p>
<p>Network or cooperation additionality</p>	<p>A strategic level additionality, pays explicit attention to the impact of government support on the persistent cooperative behaviour of the actors i.e. when government support helps to create networks and enlargement of the original group of participants that would not occur otherwise, for example, new partnerships between the business and academic spheres, interaction with collaboration networks (within or between sectors), sustained technology alliances. This kind of additionality can be further split up into two dimensions:</p> <ul style="list-style-type: none"> • Is public funding suitable for fostering a change of firms' cooperative behaviour towards a more diversified set of partners? (diversification of cooperation) • Are business or science collaborations newly initiated within a publicly funded project lasting, even when public funding ends? (continuation of new partnerships)

Additionality	Description
Cognitive capacity additionality	A strategic level additionality, refers to a positive impact on competencies and expertise such as technological and market routines and capabilities that can subsequently be applied in other developments. Can also encompass innovation and commercialisation capabilities (for example securing intellectual property or raising venture capital investment). Corporate R&D is sometimes only sustained through ongoing public funding.
Management additionality	A strategic level additionality, refers to when government support improves company management routines e.g. SMEs learning about control procedures through compliance with planning and monitoring requirements demanded by a funding agency, or large firms using international collaborative projects as a means of training managers in internationalisation skills. Manufacturing strategy or strategy for service provision may also evolve in as a result of a process-oriented project or arise indirectly because the advance in a firm's knowledge enables it to change its production or service delivery methods. An example could be increasing use of e-commerce to reduce inventories.
Follow-up additionality	A strategic level additionality, refers to the situation when government support helps to establish follow-up projects