Programme Area: Energy Storage and Distribution

Project: Heat Infrastructure Development (HID)

Title: Summary Report (single page format for printing)

Abstract:

This summary report summarises the entire project, in a readily-accessible manner. Readers may find it useful to study this report prior to studying the detailed engineering reports.

Context:

This project seeks to identify the innovative solutions needed to deliver major reductions in the capital cost of heat network infrastructure and accelerate its deployment. Examining the technical, process and system developments needed to deliver a step change reduction in the capital costs, along with cost estimates and time frames for undertaking these developments. District heat networks supply heat to homes and businesses through pipes carrying hot water. They have great potential to deliver CO2 emissions reductions and cost benefits through the use of low carbon heat, waste heat from power stations, industry and other sources, combined heat and power, and large-scale heat pump deployment.

AECOM

energy technologies institute

Reducing the capital cost of district heat network infrastructure

Routes to implement innovative solutions

October 2017

Summary report from the 'Heat Infrastructure Development' project, commissioned and funded by the Energy Technologies Institute

AECOM and ETI in association with:

Total Flow

ENGIE

Loughborough University

COWI

Contents

Executive summary

Heat network capital cost reductions of **30-40%** are possible. Eight route maps summarise the actions required to implement the most impactful solutions with a total funding requirement of **c£10m**.

Project Context

District Heating (DH) is well established in Scandinavia where it dominates the heat market and there are significant city-wide schemes in Germany, France and Eastern Europe. It has not developed to the same extent in the UK, partly because of the availability of indigenous natural gas and partly for cultural reasons. The UK's North Sea gas reserves are now declining rapidly and there is greater recognition that the heat sector needs to de-carbonise for our climate change goals to be met. DH can deliver low carbon heat from a range of heat sources and reduce our reliance on imported gas.

Previous work by the ETI has shown that 56% of the British heat market is concentrated in 4% of the geographical area, and close to half could be economically supplied by DH. Analysis by the BRE for DECC in 2013 identified that the capital cost of DH Networks is the major barrier.

The ETI therefore commissioned AECOM, with Total Flow and ENGIE, to;

"...identify and assess innovative solutions that would deliver a substantial step change reduction in the capital cost of district heat network (DHN) infrastructure deployment and contribute to overall lifecycle cost reduction."

The project team also included COWI (a Danish consultancy with expertise in DH) and Loughborough University.

The project was focussed on assessing the cost reduction potential associated with heat network pipe infrastructure and its installation, in particular in the context of the connection of existing buildings to heat networks.

Key findings from the project

Cost modelling of a notional baseline network (constructed to current good practice in the UK) comprising a mix of types of dwelling from flats to detached houses and a group of non-domestic buildings showed that 77% of the total cost of a typical heat distribution network is associated with three key elements:

a. The civil engineering work to excavate and reinstate trenches (37%).

b. The transmission and distribution pipes and their installation (17%).

c. The supply and installation into the buildings of the heat interface units (HIUs) and associated pipework, which enable the connection of the DH network to the building's heating system (23%).

A technical review of DH experience outside the UK revealed that the technical designs used in countries with established district heating markets are broadly similar to the designs deployed in the UK.

However, in other countries there is a widespread understanding of DH systems and better integration in practice across all delivery stakeholders, including a more standardised methodology for carrying out assessments, design and construction for new schemes.

The technical review also confirmed that the design and installation of pre-insulated pipe systems has reached a level of technical maturity after 40 years of development, and so the areas with the greatest potential for cost reduction are likely to be those concerned with completely new materials and products, new approaches to site work, or more radical system design. Additionally, Heat Interface Units (HIUs) have the potential for cost reduction through optimisation and mass production.

Subsequent technical and stakeholder engagement activity identified a range of innovation opportunities and technical solutions that could deliver substantial reductions in the capital cost (and lifecycle cost) of DHN infrastructure deployment.

These solutions have been prioritised and combined where appropriate to form eight broad groups for which 'route maps' have been developed which describe the mechanisms by which these solutions can be driven through to commercialisation.

Each route map details:

- The particular challenge to be addressed
- The proposed solution
- Development and commercialisation requirements
- A plan of work.

Each activity within the plan of work has been separately defined with a scope, cost and implementation schedule. The funding needed to deliver the activities within the route maps is proposed to come from a combination of central government and the DH industry.

The eight route maps are:

A	Establish a new District Heating Knowledge Centre to co-ordinate: research, training, dissemination and encouragement of innovation across the industry.	**Impact** These highest priority route maps are estimated to deliver a capital cost saving of 32% (range 26% to 39%). If the full set of additional identified solutions is implemented, then the estimated capital cost saving is increased to 38% (range 32% to 45%). **Funding requirements** The funding required to take the route maps through to commercialisation (excluding industry contributions) has been estimated to be c£10 million spread over four years.
B	Design for lower flow rates and reduced pipe diameters by minimising peak demand and reducing return temperatures.	
C	Adopt alternative routes, either on the external wall of buildings, or within loft spaces or cellars, to reduce the amount and cost of trench excavation.	
D	Use trenchless technology to reduce the costs associated with trench excavation, especially for branch connections.	
E	Provide contractors with more accurate survey and design information prior to commencing work on site to achieve increased productivity.	
F	Share the cost of the civils work with other utility companies who may be planning works in the same area.	
G	Adopt a simpler system design using direct connection HIUs and retaining an existing hot water cylinder where present.	
H	Reduce the cost of HIUs through simplification, standardisation, design for manufacture and assembly.	

Next steps — Delivery of the route maps

All stakeholders in DH have a role in delivering the route maps.

Investors in DHNs, whether private or public sector, can act as 'demanding clients' to press for rapid adoption of route map activity across the value chain to achieve lower costs and reduce uncertainty. Investors will need to be willing to provide funding for demonstration projects where they will benefit from involvement in leading edge solutions.

The **Value Chain**, comprising designers, contractors, manufacturers and suppliers needs to actively support the delivery of the route maps with renewed focus on delivering value to investors and end users — not just through design and product development but also through process improvements. The Value Chain will benefit from being part of the innovation process and so gain a greater share of an expanding DHN market.

End users have a key role to play in driving innovation in DHN delivery; by engaging with route map activity they can set demanding requirements for the industry to innovate, especially to deliver higher reliability and a simpler transaction process. Providing suitable sites for demonstration projects will be part of the role.

Central and Devolved Governments are best placed to support the route maps in areas where commercial investment is unlikely due to uncertainty of outcomes and long payback periods. In particular, the support of BEIS for the District Heating Knowledge Centre (route map A) and Innovate UK for match funding of product development will be critical for rapid progress to be made. With c£300m of funding being provided by BEIS through the Heat Networks Investment Project the case for supporting these route maps to help achieve a 40% reduction in cost is very strong.

Local Governments are crucial enablers of DHNs, even if they are not direct investors. Many separate functions of local government are impacted and there is a need for alignment around overarching policies. The large number of local authorities involved mean that there is a risk of duplication of effort, and better knowledge sharing, as envisaged in route map A, will be important. Support for demonstration projects that will build confidence and encourage further investment will be valuable.

The **Energy Systems Catapult** would be well placed to contribute to route map development and delivery.

Professional and trade associations will need to support the work of the District Heating Knowledge Centre in disseminating new approaches and best practice.

Other utilities need to become aware of the potential impact of new DHNs and seek new business models based on collaboration and mutual interest.

Impact of the project

The project has identified eight main groups of innovative solutions which could deliver a step change reduction in the cost of DH networks of the order of 40%. This will be of major benefit to the UK economy as it seeks to decarbonise the heat sector to meet our overall climate change goals at least cost. This cost reduction will result in a greater role for DH within the heat market than that previously estimated. The eight route maps have been developed to enable stakeholders to implement the identified solutions and thus realise these benefits.

Project background

80%

By the year 2050 the UK will need to meet stringent targets requiring an 80% reduction in greenhouse gas emissions compared with 1990 levels.

56%

Currently, 56% of GB building heat demand is concentrated within only 4% of the geographical area, creating good potential for heat networks.

60+%

Dependent on the location, size and type of a heat network, the DH distribution system can account for 60% or more of the overall DHN cost.

By 2050 the UK will need to have delivered an 80% reduction in greenhouse gas levels compared with 1990 levels, while still providing consumers with the services they need. Cost effective ways for providing low carbon heat to buildings need to be developed.

The ETI has identified significant potential for district heating (DH) to reduce CO_2 emissions and offer cost benefits by enabling the use of low carbon heat such as waste heat from power stations and large scale heat pumps utilising waste or environmental sources of heat. District Heating Networks (DHNs) have significant potential to offer a long term solution as they can be served by and enable the use of a wide range of heat sources, supporting the wider transition of the UK's energy system and providing increased security of energy supply.

Currently, 56% of Great British (GB) building heat demand is concentrated within only 4% of the geographic land area, creating good potential for heat networks. Analysis by the ETI indicates that close to half of existing GB heat demand (representing some 12.4 million homes and 2.9 million non-domestic connections) could be connected to heat networks economically.

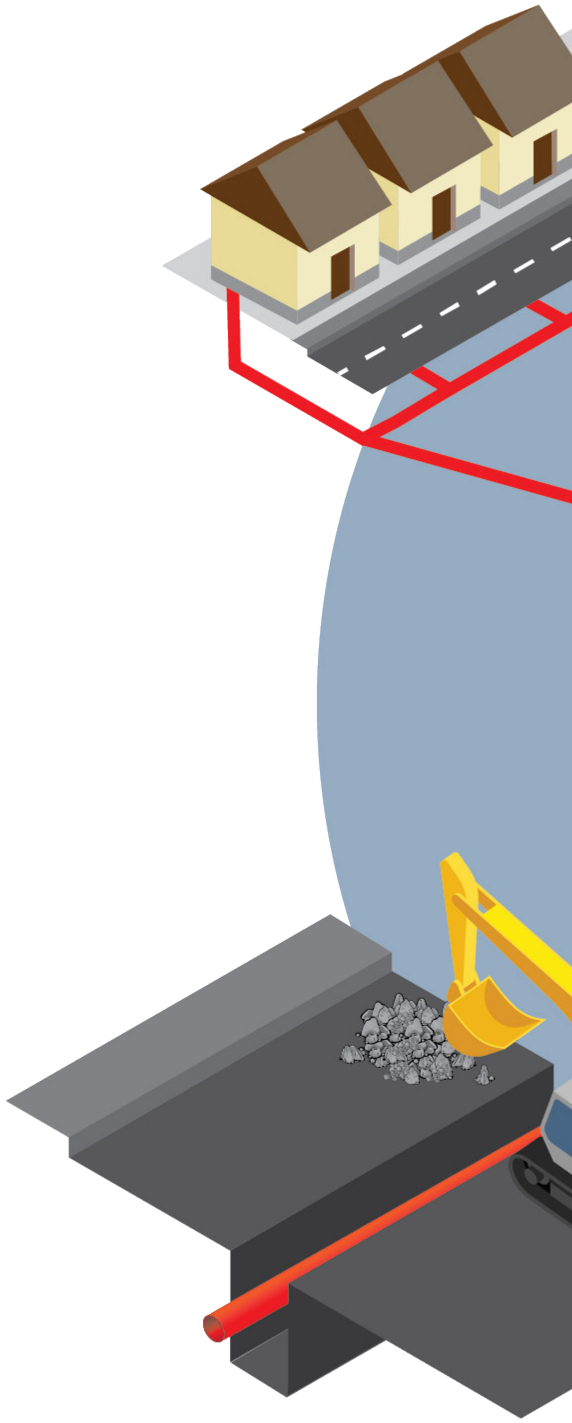
However, only 1-2% of UK buildings are presently connected to district heat networks. In contrast, heat networks are deployed more widely elsewhere in the world and effectively deliver large quantities of heat, particularly to areas of high heat demand; for example, in Denmark and Finland district heating is the most common heating method.

The UK Government has identified that a key barrier to wider uptake of district heating is the high initial capital investment for network installation. A large proportion of this capital cost is for the DH distribution system: between the heat source and the output from the Heat Interface Unit that connects the distribution system to the building's heating system.

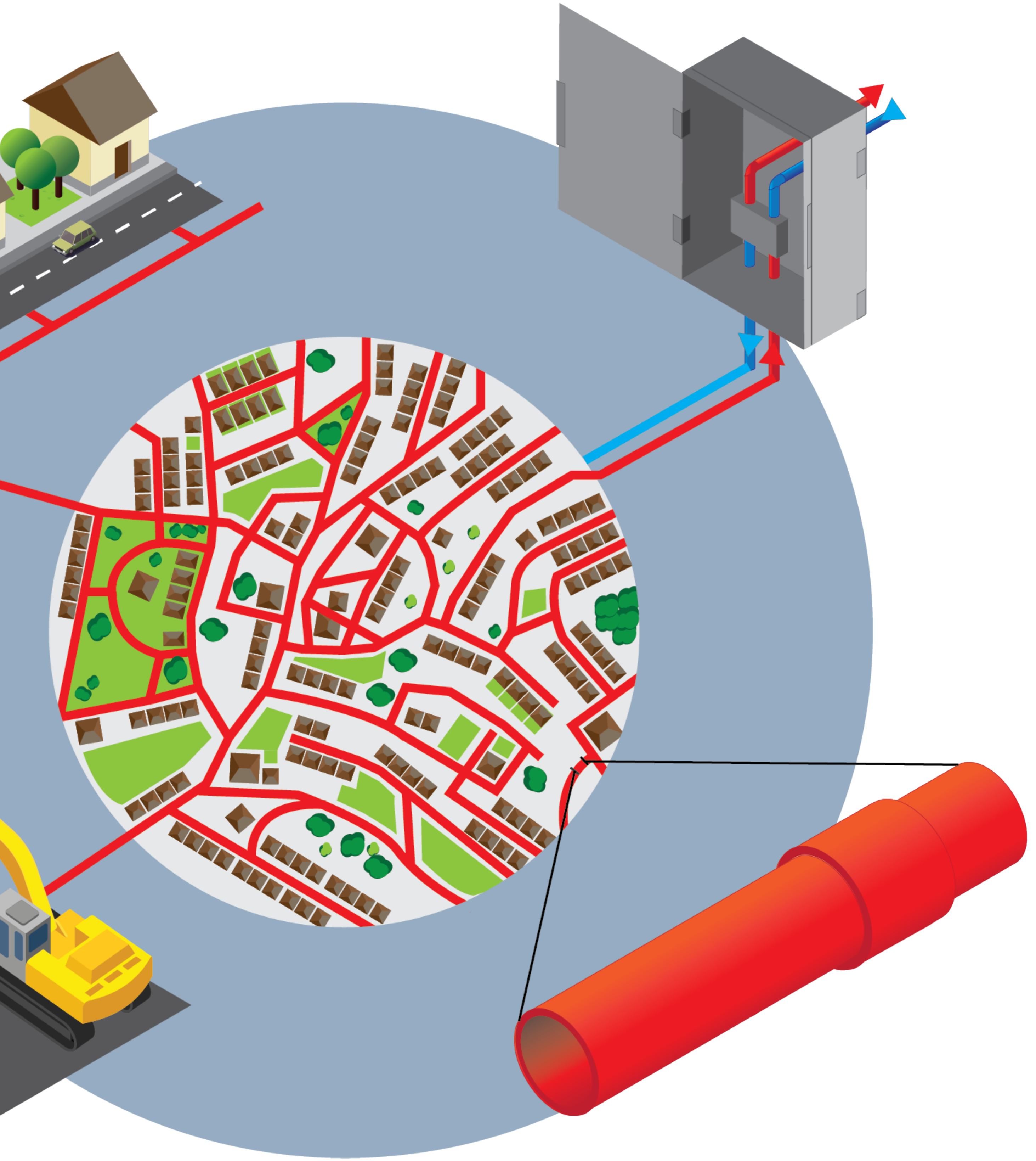
Previous ETI analysis indicated that, dependent on the location, size and type of a heat network, the DH distribution system can account for 60% or more of the overall DHN cost. Reducing this capital cost will enable wider deployment of heat networks.

This report summarises the results from a project commissioned and funded by the Energy Technologies Institute (ETI). The primary objective of this project was to identify and then assess innovative solutions that would deliver a substantial step change reduction in the capital cost and contribute to overall lifecycle cost reduction of DH distribution systems.

Whilst focussing on this primary objective, the project has also considered the value of the DHN system to relevant stakeholders and the possibility for optimising value and the business case even where this may result in a slightly smaller cost reduction. →



The district heating (DH) distribution system



Methodology

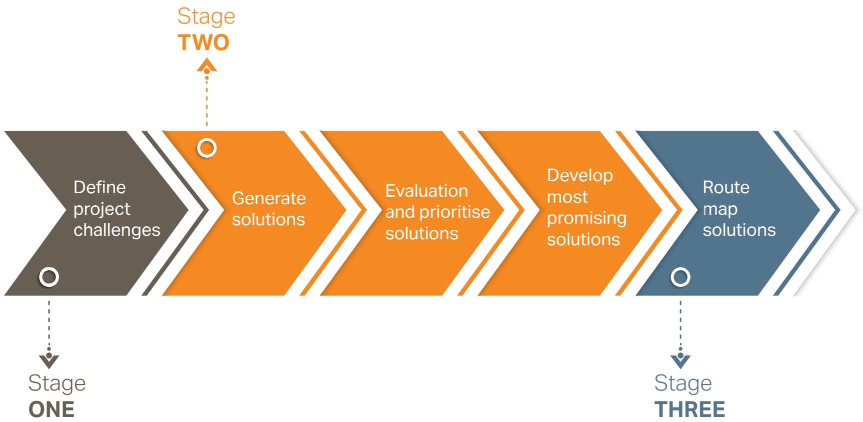
The project comprised three stages: the analysis and definition of the challenges associated with DHN cost reduction; the development of innovative solutions that address these challenges; and the development of route maps to characterise how these solutions might be rolled out.

Stage one – Baselining of current DHN network capital costs and the definition of project challenges

Stage one characterised current DHN practice within the UK and other markets and defined challenges that, if addressed, should significantly increase the attractiveness of district heating within the UK. The analyses:

- Contrasted stakeholders' requirements for district heating with the current DHN offering; highlighting the changes necessary for the DHN system to be more attractive to key stakeholders. This involved project team insight, stakeholder engagement and desk-based review.
- Defined the process of design and construction which currently delivers the CIBSE/ADE Heat Networks Code of Practice for the UK, albeit recognising that there is variation in practice. This specification defined the baseline against which improvements could be judged.
- Developed a cost model of the baseline DHN system (including both capital and on-going lifecycle costs) to assess the cost savings of potential solutions in stage two. The model also highlighted those elements of the DH distribution system that currently make the largest contribution to cost, which helped to define the project challenges.
- Compared current UK practice with that employed in countries with more experience of DH; identifying practices that might be beneficially imported to the UK, for further investigation in stage two. This included a survey of international experts and insight from experience of delivering DHNs in Scandinavia.
- Delivered a literature review and horizon scanning exercise to identify potential future improvements to DHNs, for further investigation in stage two.

↓ The three project stages



Stage two – Development of innovative solutions

Stage two identified and developed solutions to address the challenges set in stage one. This stage:

- Generated potential solutions through identifying: alternative system-level designs, approaches to reduce or eliminate costs in existing designs and ideas to increase network revenue.
- Prioritised solutions to identify the most promising ones for focussed development. Solutions were categorised as:
  - most promising
  - promising but of smaller benefit
  - having little or no benefit.
- Developed and evaluated the most promising solutions. The solution concepts were defined in more detail and evaluated using criteria (see panel, right) based on stakeholder requirements identified in stage one. The process was iterative with the evaluation steering further development to add greater value. The other solutions were regularly reviewed to identify where they could be beneficially integrated into any of the most promising solutions. Selected solutions were chosen for stage three based on the size of the estimated benefits and/or the value that a route map would provide to the solutions.
- Engaged the industry, consulting with a wide range of experts from both within and outside of the DHN industry in generating and developing these solutions. A stakeholder workshop was held at the end of stage two to gain feedback on the findings to date and to confirm that the solutions were likely to be deployed after further development. →

Stage three – Development of route maps

Stage three developed route maps to set out the implementation pathways for each of the selected promising solutions defined in stage two. This process:

- Identified and scoped the activities necessary to take each solution to commercial deployment. These activities were based on an analysis of the barriers and risks to deployment, and technical and commercial development requirements. The scope of each activity was defined and the necessary timescale and investment estimated.
- Produced a high-level route-map to show how the solutions might be taken forward in combination to achieve greater benefit, including identification of dependencies and interactions between individual route maps.

This work drew on the breadth of expertise within the project team, and significant engagement with specialists from Government, academia and industry to help both scope the route map activities and ensure that the delivery requirements were realistic based on their knowledge and experience.

Evaluation criteria

The solutions were evaluated based on their impacts on the following:

- Capital and lifecycle costs
- Attractiveness to investors and users
- Certainty of outcomes for investors (e.g. DH cost and timetable)
- Technical feasibility
- System performance
- Flexibility of heat networks to supply heat at scale
- Transaction complexity and the relative difficulty of implementing DHNs
- Health, safety and environment
- Opportunity to employ across different network types
- Potential for increased revenue from synergies with other utilities
- Wider value to the UK (e.g. increase in jobs, export potential)
- Development requirements (e.g. time, investment to market)

Stakeholder requirements

What do stakeholders want from a district heating scheme?

For more detail see 'Part A of the Requirements, Baseline Analysis and Target Setting Report' on www.eti.co.uk

The UK Government has recognised that high capital costs per connection are a significant barrier to the wider deployment of district heating[1]. However, in addition to reducing capital cost, improvements to other aspects of the proposition will increase uptake and these should be considered in identifying and developing solutions.

Analysis was undertaken to identify the requirements of a wide range of stakeholders for heat network deployment and operation. This included a workshop with client and industry stakeholders, structured interviews with consumers and investors and analysis of relevant research literature.

For stakeholders to consider a DHN, it is crucial to establish a compelling reason to change from the current options for heating buildings. There are three underlying drivers likely to result in such a change:

- Reduced cost — compared to current alternatives.
- Additional benefits — e.g. improved thermal performance and comfort.
- Reduced sacrifices — e.g. easier transactions, reduced risk, fewer quality failures for the system or service delivery.

For the delivery of a DHN there is a very complex and fragmented set of stakeholders undertaking key activities. Many participants operate in a similar space, especially in terms of governance, as shown in the stakeholder map on page 11.

The analysis concluded that there are nine key priorities to address to improve the viability of district heating in the UK, under the three following themes:

DH scheme cost and performance:

- Reducing Capital Cost: Project capital for delivery including planning and design.
- Reducing Operational Cost: Minimising the controllable through-life costs.
- Reducing Time on Site: To reduce disruption and associated additional cost.
- Systems Architecture: Developing a whole systems approach to identify opportunities for a step-change in DHN delivery capacity and operating performance.

Business models and value propositions

- Improving Cost and Revenue Certainty: Capital, operating cost and income.
- Increasing Network Revenues: Increasing income from heat or other revenue streams.
- Improving Customer Value Propositions: Creating a compelling offering for End Users.
- Improving Investor Propositions: Enabling DHNs to become bankable investments.

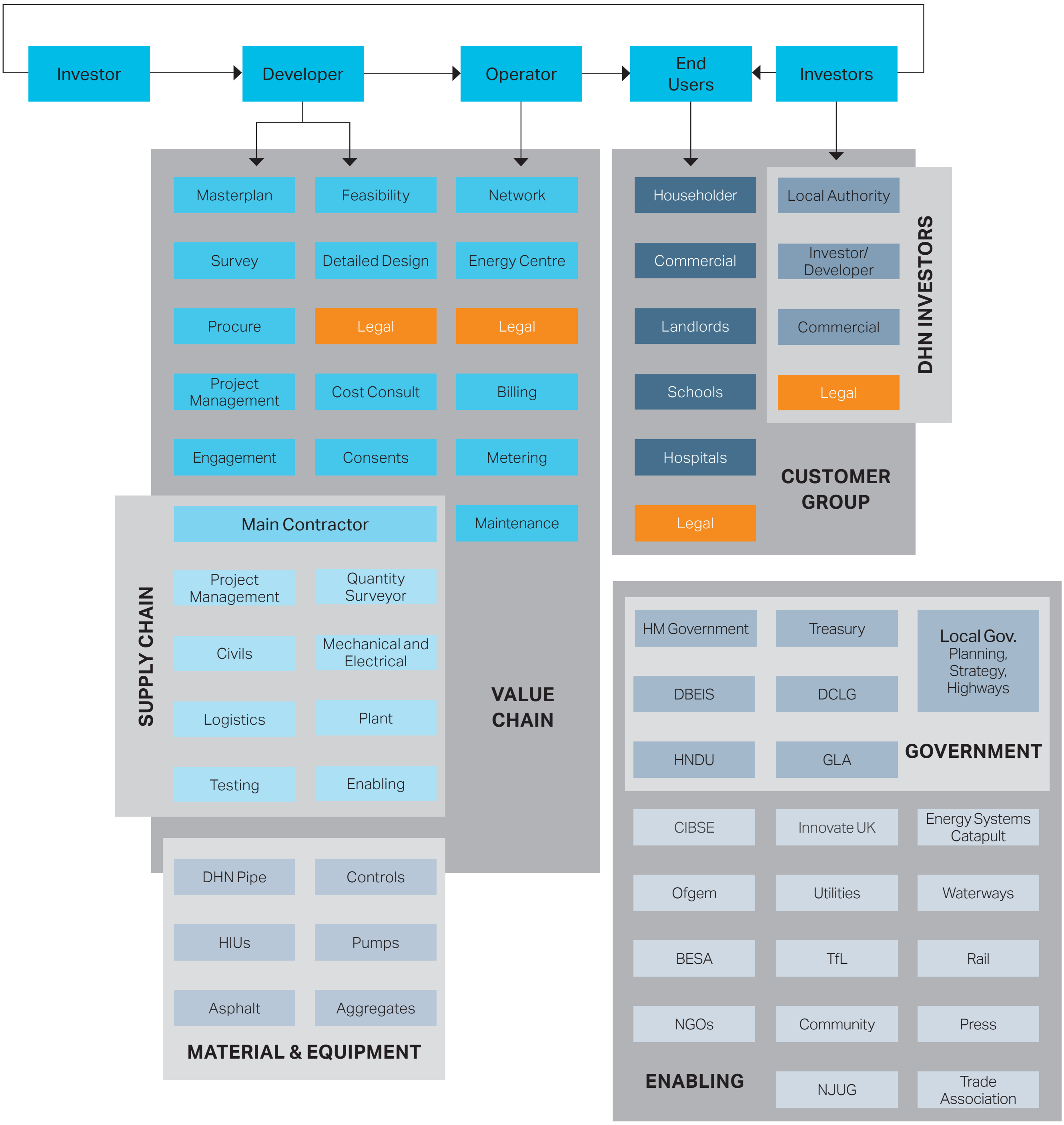
Transactional efficiency

- Reducing Complexity of Transactions Between Stakeholders: Developing solutions to reduce the legal, commercial and transactional burdens of DHN delivery.

For four core stakeholder groups, these priorities can be distilled to a succinct requirements statement which was used to inform the solution development:

- End User Customers require a DHN offering which matches a combination gas boiler in performance, reliability, installation and running cost whilst offering a compelling incentive to change. This proposition needs to recognise most users' unwillingness to invest in their system before it fails.
- DHN Investors require confidence in the DHN's capability to deliver the expected financial returns at low risk of cost and time overruns. The DHN opportunity should be no more complex to broker than similar investments.
- Value Chain organisations require confidence in the future DHN market to justify investment in capability and additional capacity.
- Government and Enabling Stakeholders require a low carbon heat source that is deliverable with minimal policy change and with limited input of resources by these stakeholders. →

[1] *The Future of Heating: Meeting the challenge, Dec 2013*

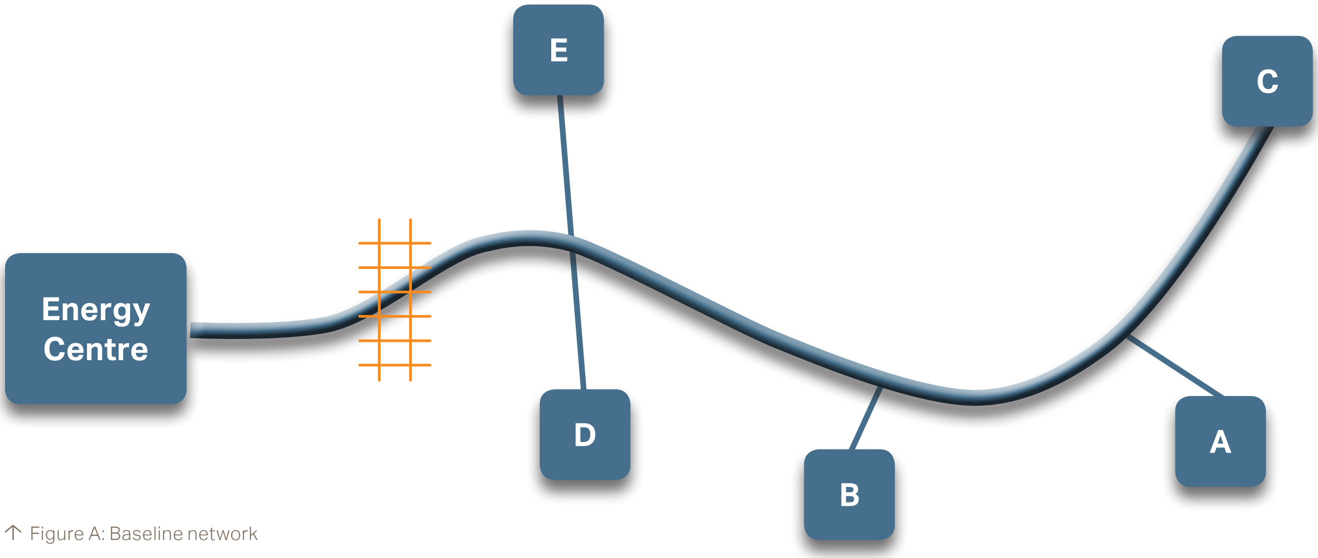


↑ Stakeholder map

Baseline network and costs

Provides a counterfactual to assess the benefits of innovative solutions.

For more detail see 'Part C of the Requirements, Baseline Analysis and Target Setting Report' on www.eti.co.uk



↑ Figure A: Baseline network

Baseline network

A baseline heat network was specified and a cost model constructed of the network. The design and cost data particularly focussed on the components and processes associated with the DH distribution system. This helped identify those elements of the DH distribution system which currently contribute most to the capital cost and on which improvements should focus.

The baseline network also provided a counter-factual against which to assess the benefits of innovative solutions. The network design and installation costs were based on current good practice in the UK.

The baseline network is illustrated in Figure A. It includes five building typologies (A to E) to represent all areas in which district heating could be economically feasible (see Figure B) given lower capital costs.

The baseline network is intended to represent the maximum potential roll-out of district heating in an area of the UK, and hence includes lower density housing which makes up the majority of urban areas.

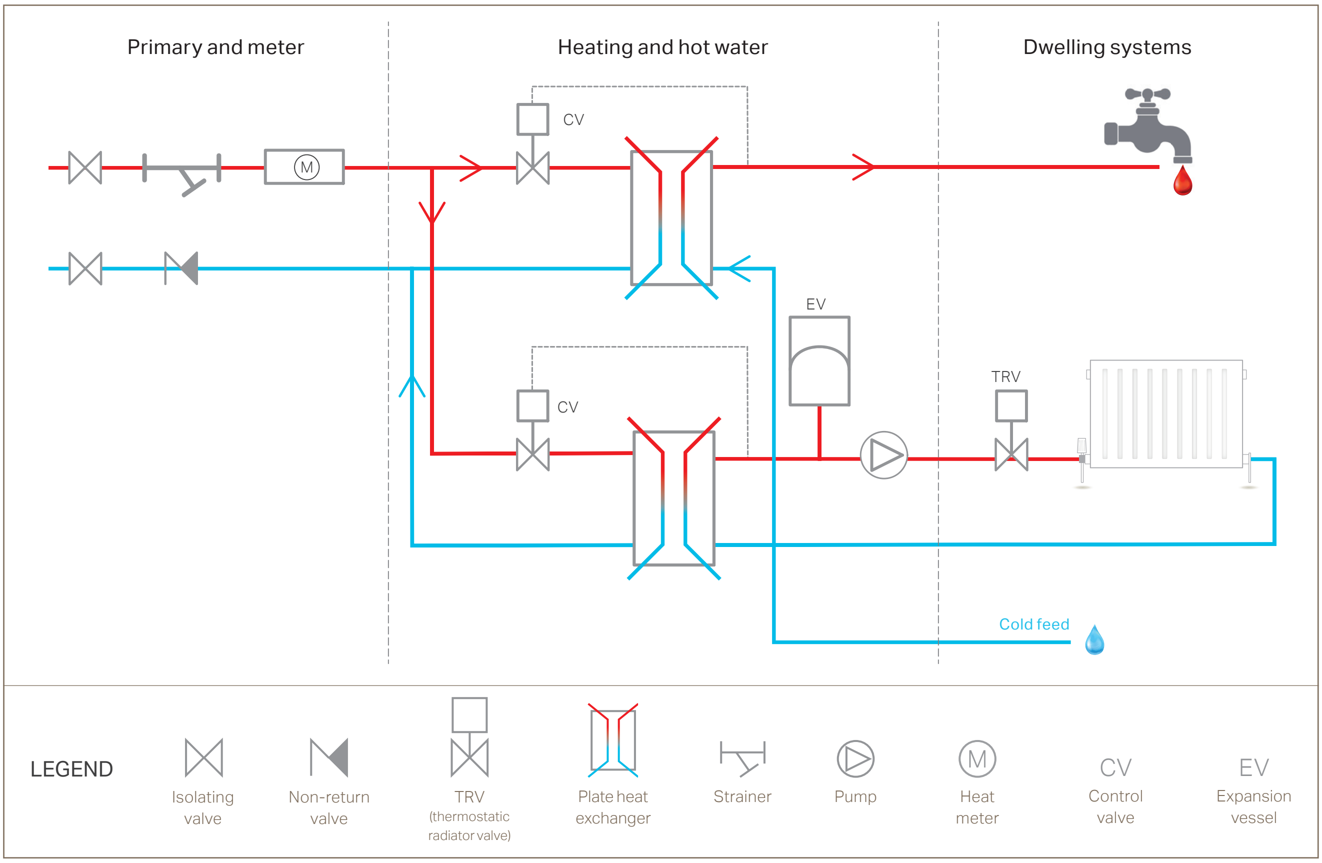
A transmission main of 2,500m connects the typologies to the Energy Centre.

The network also includes three major crossings (two railways and one canal).

In addition, a dense village was separately evaluated, as a 400 home cluster of terraced and semi-detached housing (50:50 mix).

Typology	Details	Number of properties in typology
A	City centre - commercial/ institutional non-domestic buildings	Nine buildings with combined peak demand of 21 MW
B	High density flats	512
C	High density terraced housing	400
D	Medium density semi-detached housing	1,600
E	Low density semi-detached/ detached housing	800

↑ Figure B: Building typologies



↑ Figure C: Indirect HIU/instantaneous hot water

The cost model enables assessment of the impact that solutions make within the whole network and within individual typologies. It includes a database of capital costs for the different components and processes of a district heat network drawn from industry input.

The model allows the user to flexibly build together these components and processes into the network design, both to evaluate in detail the cost breakdown of the baseline network and to quickly compare the impact of different design options.

The cost model also includes lifecycle cost data to evaluate the impact of alternative designs on total costs.

The baseline design assumed the following key characteristics. These design assumptions are varied within some of the solutions.

- The flow temperature peak is at 90°C, reducing to 70°C in the summer, with a return temperature at peak demand of 60°C.
- Radiators are retained in all buildings.
- Plastic twin pipes are used for diameters of 50mm and less. Steel pre-insulated pipes are used for 80mm diameter or more.
- Indirect HIUs are used with instantaneous hot water for all dwellings, as illustrated in Figure C. Blocks of flats also have an indirect (heat exchanger) connection at ground level.
- All pipes are buried in the ground using conventional trench excavation and backfilling. →

Network costs

The total capital cost for the baseline study scheme was £63 million of which 72% was from the network and 28% was from the energy centre. This shows the relative importance of the heat network to the overall cost.

The split of capital costs for the heat network itself is summarised in Figure D. Civil engineering dominates the cost of the network (36%). Heat Interface Units (HIUs) and connections within the buildings (23%), and heat network pipes and their installation (17%) also have significant costs.

Sensitivity analysis was undertaken to identify how the costs vary by typology. In particular, HIUs and internal connections dominate the cost of high rise flats (around 75% of the cost of the DH distribution system) as there is relatively little trenching needed to reach each home.

Conversely, for the more suburban areas with longer pipe runs per home, pipes and civils elements contribute a higher share of cost (around 50-60% of the cost of the DH distribution system).

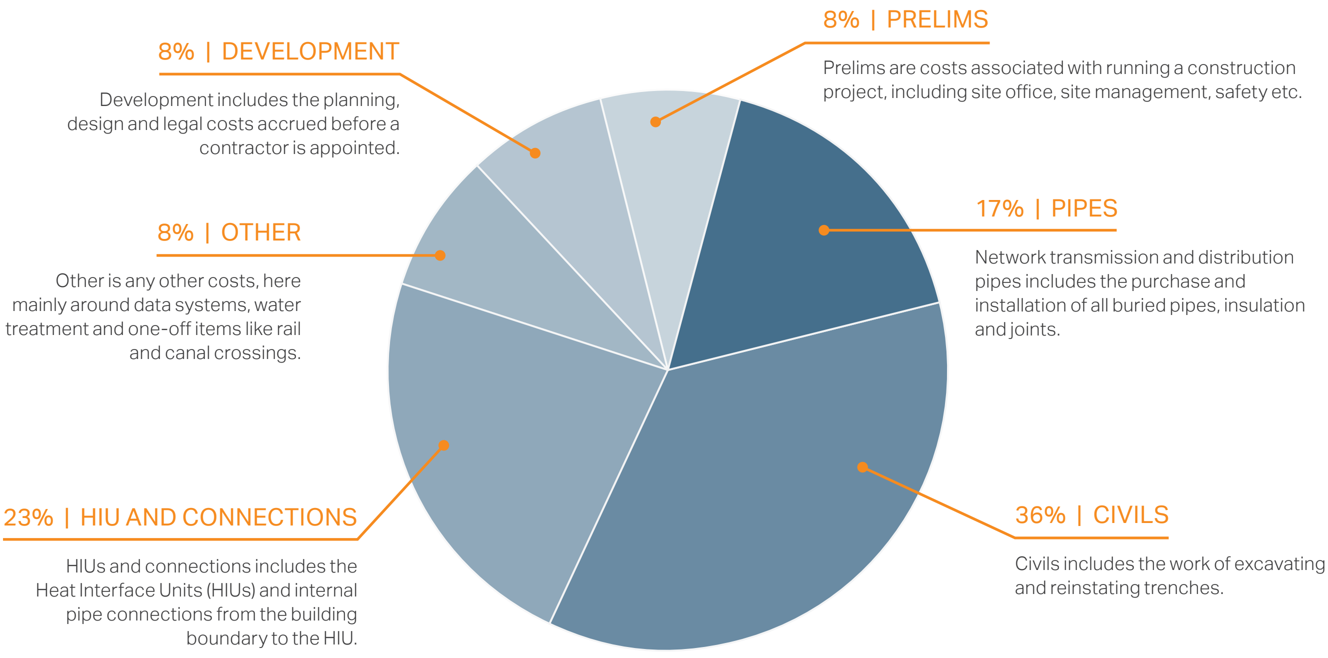
Key drivers and variability for the principal cost elements were analysed. In particular, the civil engineering costs are driven by:

- Rate of progress (labour and plant together representing the majority of the cost).
- Ground conditions (soft dig in verges or similar is much cheaper than hard dig in the road).
- Ground uncertainty (e.g. unplanned identification of other services can cause delays and consequent costs).
- Trench depth (additional depth is often needed to install the pipes to avoid other services).

The variability in HIU costs is dependent on the type of HIU installed (direct or indirect) and whether every property has its own HIU or whether they are shared between multiple homes.

The operational cost of the baseline network (for pumping, heat loss and maintenance of pipes and connections) was calculated as £960k per year. When capitalised, this was the equivalent of around 26% of the capital cost of the heat network based on a net present value calculation over 25 years with a 6% discount rate.

↓ Figure D: Baseline heat network capital costs



International comparison and technology review

Findings from the international comparison, literature review and horizon scanning work.

For more detail see 'Part B of the Requirements, Baseline Analysis and Target Setting Report' on www.eti.co.uk

This section summarises the findings from the international comparison, literature review and horizon scanning work carried out in stage one which highlighted areas of potential interest where cost savings might be possible.

International comparison

- The technical solutions used in countries with established district heating markets are broadly similar to those in the UK. This includes both the products used and installation practices. Differences identified include a greater use of twin pipes and an approach to network design which results in lower operating temperatures and fewer heat exchangers.
- There is much greater experience of the delivery of DH systems in countries where the technology is established. There is a widespread understanding of the DH systems, and a better integration in practice across all delivery stakeholders, including a more standardised methodology for carrying out assessments, design and construction. A more bespoke approach is typical within the UK and the workforce is less experienced.
- In other countries, heat demand data is readily available which enables optimised designs, more confident use of diversity factors, and less likelihood of pipes and other equipment being over-sized, leading to lower capital costs and higher efficiency.
- The business model and policy framework is very different in many Scandinavian countries to the UK. DH companies are typically owned by local municipalities on a not-for profit basis, which enables access to low cost financing, keeps the cost of heat down and provides confidence to customers. A history of long-term energy planning has resulted in policies which deliver a high market share for DH in defined zones either through regulation or market mechanisms.

Technology review

- The design and installation of pre-insulated pipe systems has reached a level of technical maturity after 40 years of development and is supported by a number of European standards.
- The areas with the greatest potential for cost reduction are likely to be those concerned with:
  - Completely new materials and products.
  - New approaches to site work (e.g. trenchless approaches to pipe installation, opportunities to make trenches narrower or shallower, reusing excavated soil as backfill, greater use of 3D non-invasive technologies to map underground obstacles).
  - A more radical system design.
  - Heat Interface Units (HIUs) which are established products but with potential for cost reduction through optimisation and mass production.
- A key area of technical development in the last few years is the reduction in the cost of monitoring equipment, with more operational data now available that could both improve operational efficiency and reduce peak demands thus lowering capital costs.

Low temperature DH

- There is significant research being undertaken in Scandinavia and by the International Energy Agency into the use of low temperature DH (50-60^{0}C flow and 20-30^{0}C return), often termed '4th Generation DH' (4GDH). The main benefits are operating cost savings from lower network heat losses and more efficient use of heat pumps and other low temperature heat sources.
- For the UK, a 4GDH system would be incompatible with existing heating systems that typically require higher temperatures, and upgrading these would lead to higher capital costs. However, some aspects of 4GDH — such as achieving low return temperatures and flexible operation of multiple heat sources — can be adopted in the UK.

"The areas with the **greatest potential** are likely to be new materials and products, new approaches to site work, a more radical system design, and optimisation and mass production of Heat Interface Units."

Overview of solutions

The full set of solutions is estimated to deliver a capital cost reduction of 38% across the DH distribution system.

For more detail see 'Solution Development, Analysis and Selection Report' on www.eti.co.uk

The following pages present the eight most promising solutions and the route maps for their commercial deployment.

Solutions

91 separate solutions were identified in this project. The number of solutions relating to each aspect of the DH distribution system is summarised in Figure E. There was a good spread of solutions with improvements to the system design architecture, civil engineering practices and HIUs having the largest number and judged to achieve the most significant impact.

The 35 most promising solutions were clustered together to form 13 broader solutions which were developed and evaluated in more detail. If the solutions are applied together in the most optimal way across the baseline heat network, it is estimated that a capital cost reduction of 32% across the DH distribution system could be achieved (range from 26% to 39%).

Operating costs should also reduce slightly, by around 10%. This mainly arises from 'Solution A: Knowledge management, research and training' delivering improved network design and better control of operational performance, and 'Solution H: HIU optimisation' leading to simplification of the HIU design with the use of fewer and easier to change components which should result in lower maintenance costs.

Overall, the network performance for all of the solutions will be comparable to the baseline.

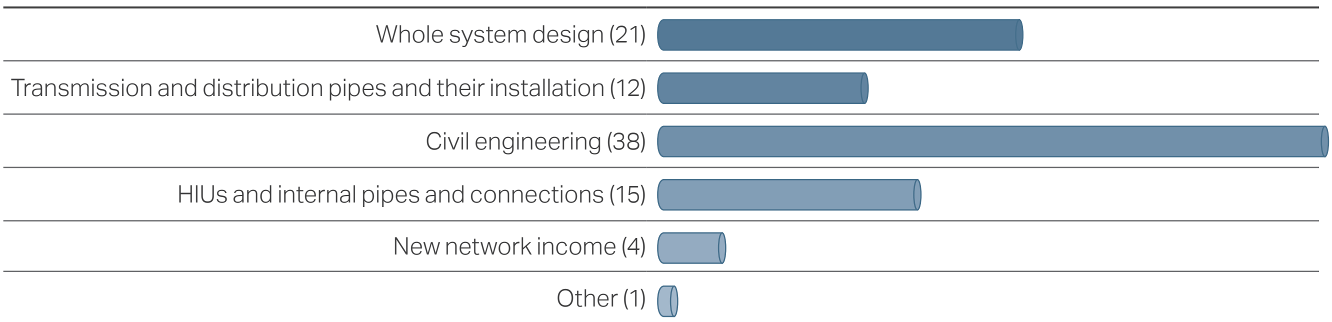
In addition to these 13 solutions, the other solutions reflect further opportunities to reduce costs. It is estimated that a further 6% cost reduction could be achieved. **Hence, the full set of solutions is estimated to deliver a capital cost reduction of 38% (range from 32% to 45%) across the DH distribution system.**

There was significant consultation with a wide range of experts from both within and outside of the DHN industry in generating and developing the solutions and then scoping the route map activities and ensuring that the delivery requirements were realistic.

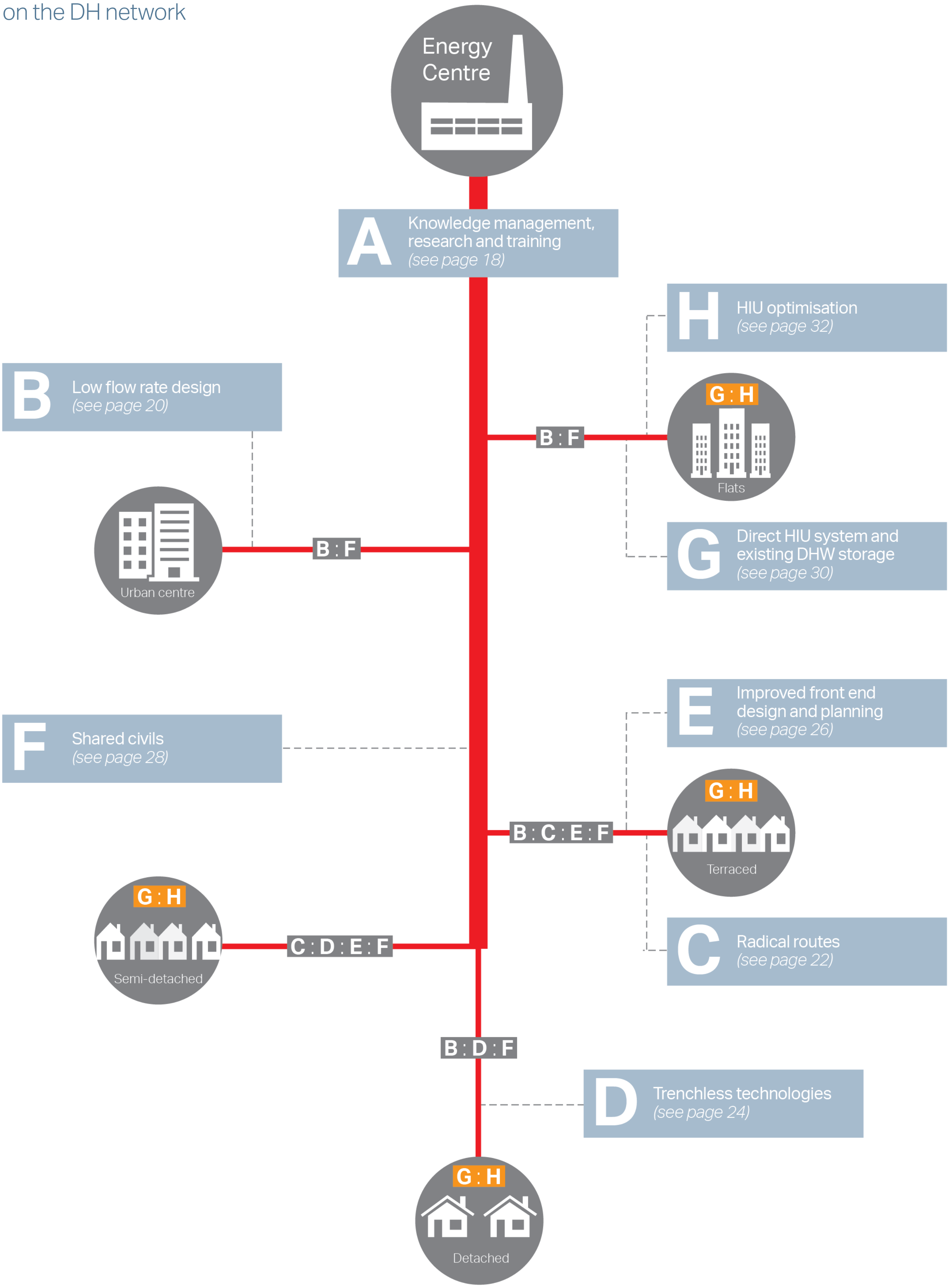
These concept solutions were presented at a stakeholder workshop with experts from both within and outside of the DHN industry at the end of stage two. The feedback was overall very positive; in general the most promising solutions were judged likely to be deployed following further development work.

11 of these 13 solutions were taken forward for route mapping. In total eight route maps were developed; two of the route maps comprise multiple solutions as they are closely linked. →

↓ Figure E: Analysis of solutions generated



An overview showing where each solution is best deployed on the DH network



A

Knowledge management, research and training

For more detail see the following on www.eti.co.uk
- Section 3 of the Solution Development, Analysis and Selection Report.
- Section 4 of the Solution Route Maps Report.

Challenge

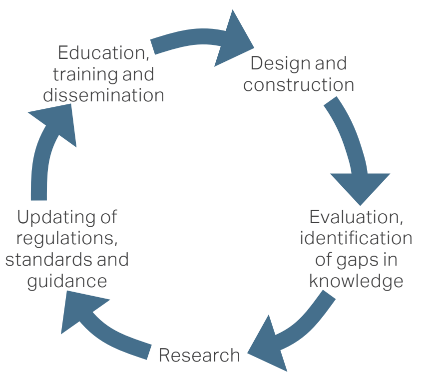
There is a lack of embedded knowledge within the UK on how to design and construct heat networks cost-effectively. There are three key aspects to this:

- Knowledge management: There is a lack of co-ordination of expert knowledge. Many guidance documents exist but it is unclear what represents the most authoritative guidance on each issue. There can be a reluctance to share knowledge as it may be perceived as commercially valuable or the process too time-consuming.
- Research: Applied research is required to move the industry forwards. There is no central co-ordination of DH research work in the UK to focus research on the priority issues.
- Training: There is the need for skilled people across the industry to make DH schemes cost-effective and efficient. This will be difficult to achieve for a rapidly expanding industry without a co-ordinated training programme and established qualifications which are not currently in place.

Solution

A District Heating Knowledge Centre (DHKC) would be formed to provide co-ordination and funding for knowledge management, research and training at a national level. This should deliver continuous quality improvement (see Figure F). Specific objectives of this body would include:

- Identify gaps in knowledge and commission targeted research.
- Monitor research work being carried out in other countries and disseminate in the UK.
- Prepare case studies on innovative projects to disseminate good practice.
- Ensure standards and guidance documents are current, authoritative and consistent with each other; commission additional guidance to fill gaps.
- Set-up a comprehensive training programme to up-skill the expanding workforce at all levels with recognised qualifications specific to DH.
- Liaise with the Government to establish how this work can inform regulations to provide higher quality DH schemes.



↑ Figure F: Continuous improvement process

It is proposed that the DHKC would be structured and funded as follows. This requires further evaluation as identified in the route map.

- The Heat Networks Delivery Unit (HNDU) within BEIS would provide the initial funding and the overall leadership, at least for the first year.
- The DHKC would be governed by a Board which sets its direction and priorities. The Board would be chaired by HNDU and include industry organisations most actively involved in district heating who have an interest in increasing DHN deployment and enhancing the reputation of the industry.
- The Board would commission a Delivery Partner that would be responsible for delivering the work of the DHKC, procuring individual packages of work as required. The Delivery Partner would receive funding from HNDU but also obtain separate funding for specific activities such as training courses, events and publications.

  In the longer-term, as the industry grows, an industry-wide levy could be collected from DH heat suppliers so that a predictable annual fund could be relied upon for future activities.

Although it is difficult to predict the overall cost saving of this solution alone, it is estimated to deliver a 3% saving through improved design and practice. This may be a conservative figure but it is assumed to be additive to the significant savings within the other solutions; this solution acts as an important enabler e.g. disseminating learning and up-skilling the workforce to deliver the other solutions. Additionally, the project's baseline position is one of good practice, but many in the industry may not currently be achieving this. →

Capital cost savings

A	B	C	D	E	Total
3%	3%	3%	3%	3%	3%

Typology

A: Urban centre; **B:** Flats; **C:** Terraced; **D:** Semi-detatched; **E:** Detatched.

Route Map A

Overall cost for development: £2.1 million

Industry Consultation
3 months duration

Discussions with the various DH industry bodies with the aim of achieving a consensus for the structure, scope and funding of the DHKC. In parallel, identify the status of various initiatives in progress so that the DHKC can support these and incorporate them rather than undermine them or cause delay. Any emerging ideas on regulations that might be introduced for heat supply from DH would also be captured, as this may influence the proposed organisational structure e.g. a need for a compliance or accreditation body.

Task lead: Expert consultant

Define initial work plan
3 months duration

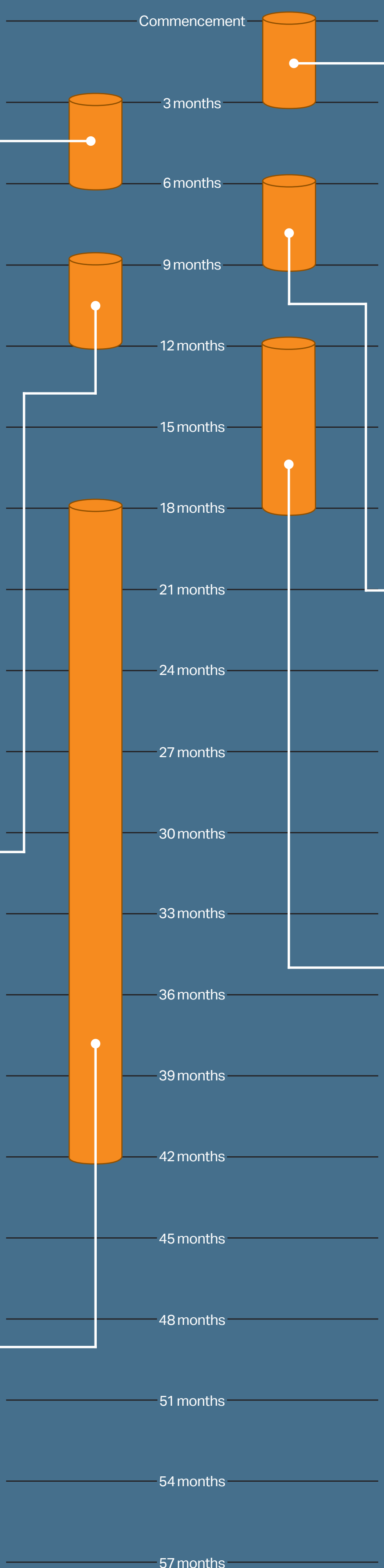
Draw up a schedule of planned activities that the DHKC would seek to deliver in the first few years. This needs to be set out in sufficient detail to inform the Delivery Partner and the wider industry of the likely scale and diversity of the work.

Task lead: DHKC

Procure and deliver work
24 months duration (ongoing)

The Delivery Partner would deliver the work packages whether for publication, training or research within a clear definition of scope, budget and timescale, either in-house or through competitive procurement from sub-contractors.

Task lead: Delivery partner



Knowledge management in other industries
3 months duration

To learn from other industries how the issue of knowledge management, research and training has been approached. Based on this, it is expected that a suitable structure would emerge which can be presented as a firm proposal to the industry in the next step.

Task lead: Expert consultant

Set-up DHKC governance structure
3 months duration

The new District Heating Knowledge Centre would be set up with the fundamental documentation in place, structure and accountabilities defined and funding agreed.

Task lead: HNDU

Selection of delivery partner
6 months duration

Competitively tender for and select a Delivery Partner with the right skills and experience to deliver the work plan over a period of up to five years.

Task lead: HNDU/specialist procurement

B

Low flow rate design

For more detail see the following on www.eti.co.uk
- Section 3 of the Solution Development, Analysis and Selection Report.
- Section 5 of the Solution Route Maps Report.

Challenge

The cost of the DH network is in part a function of the diameter of the pipes. The diameter is dependent on the peak flow rate estimated by the designer, which is based on two parameters:

1. The peak heat demand of the property (i.e. on the design day at a specified external air temperature).
2. The temperature difference between the flow and return pipes (the 'delta T').

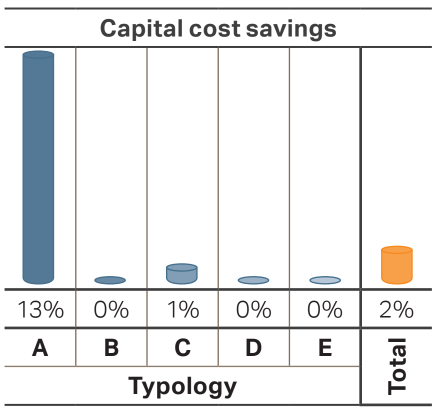
Often the peak heat demand is over-estimated and the delta T is not maximised which can significantly increase the pipe diameter and the cost of both the pipes and the associated civil engineering works to install them. If a lower peak demand can be justified and if the delta T is maximised, the cost of the network can be reduced. There needs to be a significant reduction in flow rate to have an impact on costs; to reduce the pipe diameter by one standard size requires about a 50% reduction in flow rate. The main impact on cost is seen with reducing pipes of larger diameters (see Figure G).

Solution

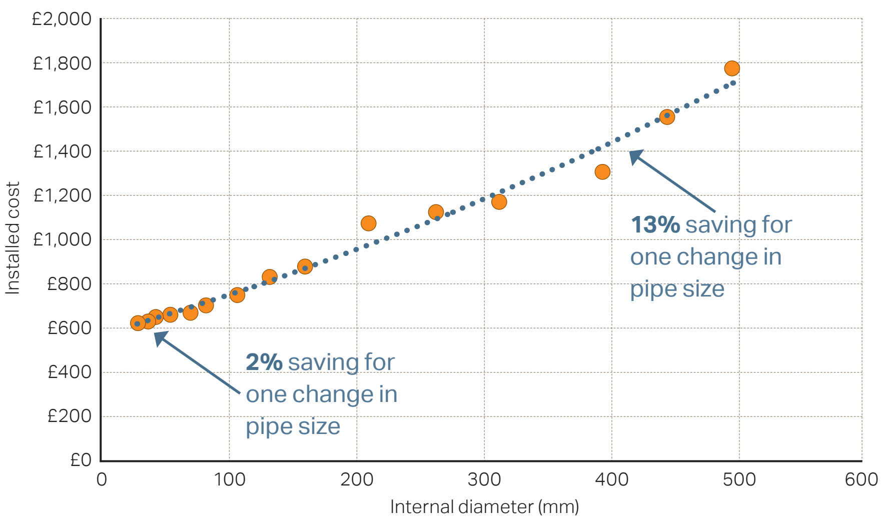
The solution addresses both aspects of the challenge — i.e. reducing peak demand and maximising delta T.

- Reducing peak demand: Data from smart meters will be used to improve the accuracy of the peak demand estimate. In cold weather the user will need to turn the heating on earlier to maintain the desired room temperature and this can be done manually or automatically using an optimum start controller. Finally, a hot water priority system will be used so that the space heating circuit is shut off whenever hot water is drawn off; this facility is already available with some HIU designs.
- Maximising Delta T: The solution concentrates on reducing return temperatures using existing radiators, as it will be most economic to retain these. To achieve lower return temperatures, the radiator will need to be balanced to restrict the flow rate. To do this accurately and speedily, a new thermostatic radiator valve (TRV) with a calibrated pre-setting device will be installed on all radiators. Once the TRV is set up with the correct flow rate, the end user can adjust the TRV to give the required room temperature in the usual way and would not need to change the flow rate setting. A software tool will be developed to help rapidly determine the TRV setting for each radiator to deliver the lowest return temperature for the required heat output for the room.

This solution could be applied across all types of heat networks. The core solution is technically viable now but would benefit from some development work to maximise its potential, particularly on software to speed up the design process. A cost saving of 2% is predicted allowing for the additional cost of the TRVs. Whilst there is little direct saving for Typologies B to E, it delivers a reduction in the larger pipe diameters in the Primary Network (allowed for in the total cost savings) which form the main component of the total cost saving. →



A: Urban centre; **B:** Flats; **C:** Terraced;
D: Semi-detatched; **E:** Detatched.



← Figure G: Impact on installed cost (pipes + civils) from reducing pipe diameters by one pipe size (costs based on baseline network)

Route Map B

Overall cost for development: £330k

Review of existing products and services
3 months duration

Review whether there are existing competitive offerings relating to surveys, radiator outputs, smart meter energy data analysis, control valves and advanced controls for domestic systems.

Task lead: Expert consultant

Radiator performance software tool
6 months duration

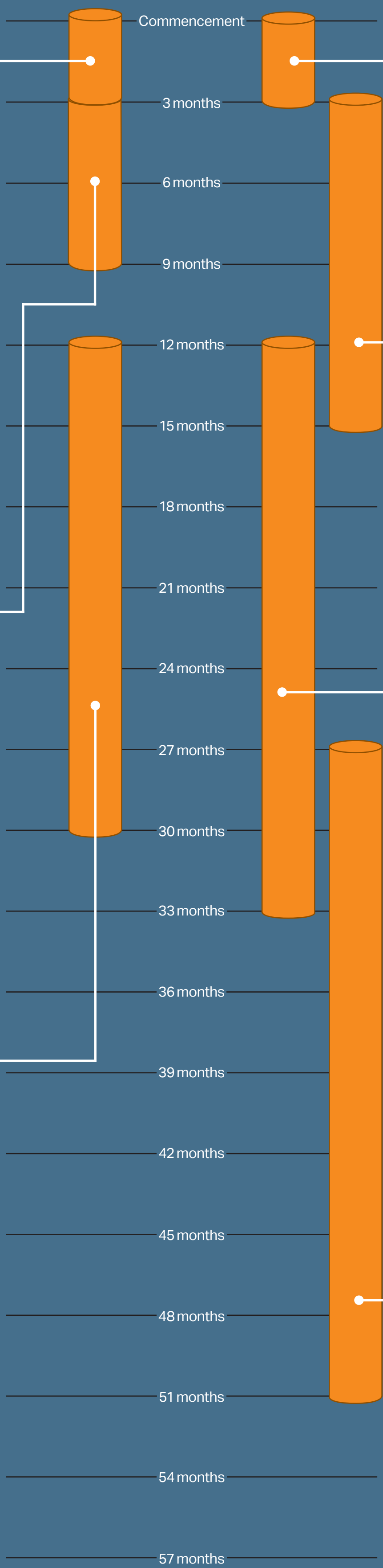
Develop software to assist the designer to determine the setting of the TRVs to minimise the return temperature for a given heat output. The tool will require data on radiator and TRV characteristics from manufacturers and/or performance testing.

Task lead: Building services consultant

Demonstration project
18 months duration

Demonstrate how this solution delivers cost reductions whilst meeting customer requirements. This would involve 50-100 houses to allow for a range of house types.

Task lead: DH developer



Market research of DH developers and designers
3 months duration

Interviews with DH developers and their designers to: understand their attitudes to the solution, identify any drawbacks, and generate ways to overcome them.

Task lead: Market research specialist

Use of smart meter data to establish peak demands
12 months duration

More detailed evaluation of the viability and increased accuracy of using smart meter data. Develop algorithms to determine peak load demand from smart meter data, and implement in software tools.

Task lead: IT expert/specialist consultant/software developer

Monitoring and report on demonstration project
21 months duration

Monitor scheme both at a technical level and by customer research to establish whether comfort levels are met, peak demands are as expected and the design return temperatures are achieved. The results to be widely disseminated. The demonstration project will also include the use of optimum start control, and hot water priority control, so that peak demands are reduced. Advice will be given to users on the operation of the system and comfort levels monitored.

Task lead: Research specialist

Further demonstration projects and software commercialisation
24 months duration

Further demonstration projects will be encouraged to gain wider industry buy-in. Further software development to learn from the first demonstration project and to commercialise the product.

Task lead: DH developer/ software developers

C

Radical routes

For more detail see the following on www.eti.co.uk
- Section 3 of the Solution Development, Analysis and Selection Report.
- Section 6 of the Solution Route Maps Report.

Challenge

Civil engineering forms 36% of the capital cost of the baseline heat network. Trench excavation is a time consuming process; it is often necessary to place the pipes below other utilities and care is necessary during excavation to avoid damaging them. The cost of burying the pipework below ground per home can be very high in lower density housing as longer pipe runs are needed.

Solution

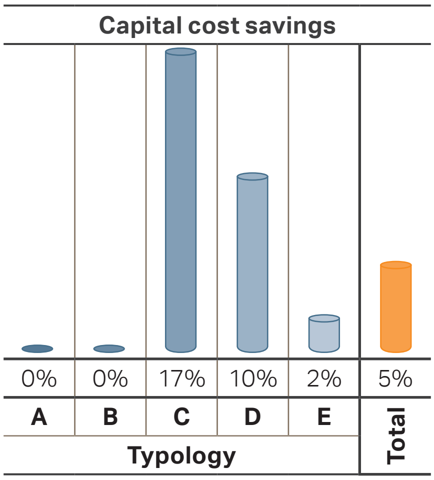
Much of the street and branch mains pipework would be installed above ground to avoid civil engineering works. Two options are presented for routing the flow and return pipes.

1. External wall: The pipes would run along the external wall of the houses and are insulated and covered in a suitable cladding to provide an aesthetic finish. The route could be on either the front or rear elevation depending on visual impact and available space. A further variant would be to incorporate the pipes within external wall insulation which avoids the need for pipe insulation and cladding of the pipework.
2. Loft space/cellar: The pipes would be installed either within the loft space or within cellars where these exist, passing between properties through the party walls. This has the benefit of less visual impact and very short branches within the property. For the loft space the pipes would be routed at low level at one side of the attic to minimise impact on storage space.

Both solutions could be applied to terraced, semi-detached and detached houses, with pipe bridges spanning between semi and detached properties. Pipe bridges would add to the cost and be more visually intrusive, and would be most suitable for houses built close together.

The estimated cost saving is 5% with greater savings for Typology C which requires no pipe bridges. The main barrier to this solution is customer acceptance, given the more direct impact on the property and the need for most customers in a street agreeing to have pipework installed.

Market development would be required to develop attractive value propositions. Some product development is needed to provide designs to suit different house types and deliver acceptable aesthetics. →



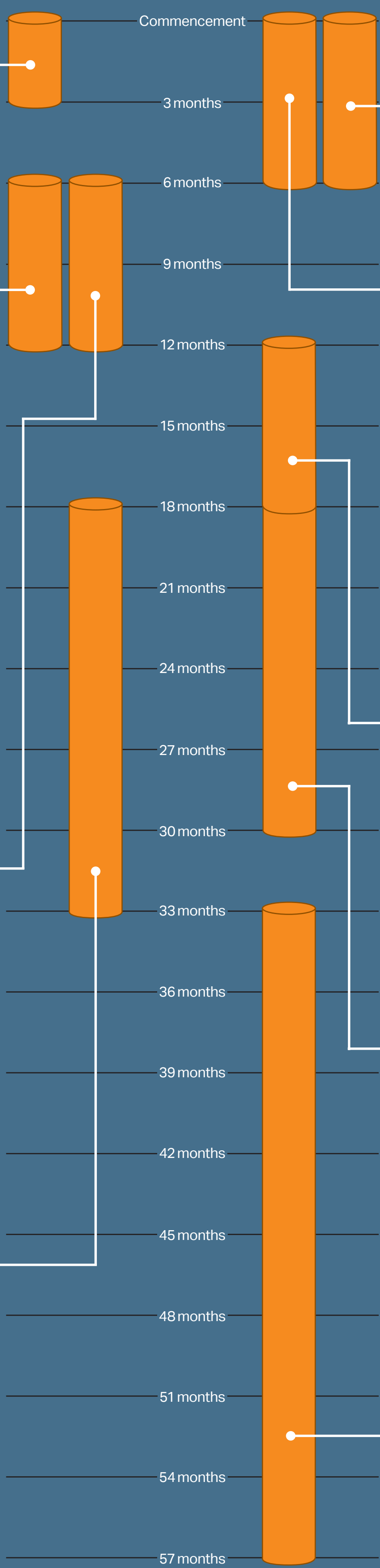
A: Urban centre; B: Flats; C: Terraced; D: Semi-detatched; E: Detatched.

↑ Figure H: Typical arrangement of loft space route for detached houses

↑ Figure J: Typical arrangement of external wall pipe on front elevation about doorways with entry at ground floor level

Route Map C

Overall cost for development: £440k



Market research into customer attitudes
3 months duration

Understand customer concerns and attitudes to installing this solution. Include owner-occupiers, landlords and tenants across a range of socio-economic groups and locations.

Task lead: Market research specialist

Research of housing designs
6 months duration

Survey characteristics of existing housing which are relevant for designing above ground routes. Complement existing information available in national databases.

Task lead: Market research specialist

Planning study
6 months duration

Engage 10 planning departments across the country to establish the most appropriate approvals process (e.g. single planning application across scheme) and any planning concerns (e.g. visual impact) and how these can be overcome.

Task lead: Specialist planning consultancy

Produce concept designs
6 months duration

Solution designs developed based on prior activities. The number of designs to be limited and mainly comprising customising existing components rather than developing completely new components.

Task lead: Pipe manufacturer

Prototype designs
6 months duration

Once the designs are sufficiently developed, they would be tested on an actual group of buildings. An alternative could be a full-scale mock-up in a factory.

Task lead: Pipe manufacturer

Legal requirements
6 months duration

Develop a standard form of agreement for a wayleave or easement to provide both for the route for the pipe work and access for maintenance. This should provide the necessary rights to the DH developer and protect customer interests.

Task lead: Legal specialist

Demonstration project
12 months duration

Demonstrate benefits through installing the solution in one or more streets of occupied houses; to comprise a mix of house types and enable both the external wall and loft space concepts to be trialled.

Task lead: Pipe manufacturer

Monitoring and report on demonstration project
15 months duration

Establish the costs and benefits of design and construction compared to the conventional approach. Interview residents to capture customer experience. The results to be widely disseminated.

Task lead: Research specialist

Further demonstration projects
24 months duration

Further demonstration projects and dissemination would be encouraged to gain wider industry buy-in.

Task lead: DH developer

D

Trenchless technologies

For more detail see the following on www.eti.co.uk
- Section 3 of the Solution Development, Analysis and Selection Report.
- Section 7 of the Solution Route Maps Report.

Challenge

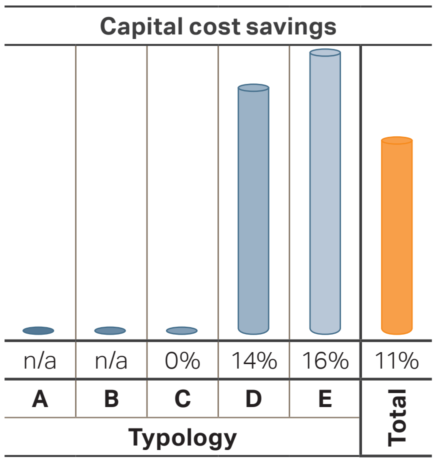
Civil engineering forms 36% of the capital cost of the baseline heat network. Trench excavation is a time consuming process; it is often necessary to place the pipes below other utilities and care is necessary during excavation to avoid damaging them. Trench excavation is also disruptive to road users and other stakeholders.

Solution

Adopt a trenchless approach comprising two key components which together have the potential to deliver considerable cost savings.

- Horizontal directional drilling (HDD): This is a guided trenchless method to drill along a pre-determined drill path. It could be used both within the street and for the branches between the street and the property. It has the potential to be faster and less disruptive than trench excavation.
- Core and vac excavation: In comparison to conventional methods, this approach allows faster and less disruptive access to the mains pipe along its length to form branch connections to buildings. An initial 'keyhole' is created above the DH pipeline running down the street. This is achieved by drilling through bound or concrete surface layers removing the resulting core. Vacuum excavation then removes any unbound material to gain access to the mains pipe. A mini-HDD rig is inserted in the hole to drill the branch line to the nearby properties and the branch and main pipes connected. The unbound material is returned to the excavation and compacted in layers. The core is then grouted back into place to match the original surface level.

The solution is expected to be most applicable for lower heat density typologies. These typologies have a reduced risk of underground objects and less need to fund excavation to confirm the safe passage of drilling. Applying the solution across Typologies C to E only, as they have lowest heat density, resulted in an 11% cost saving for the baseline network, albeit Typology C showed no cost saving.



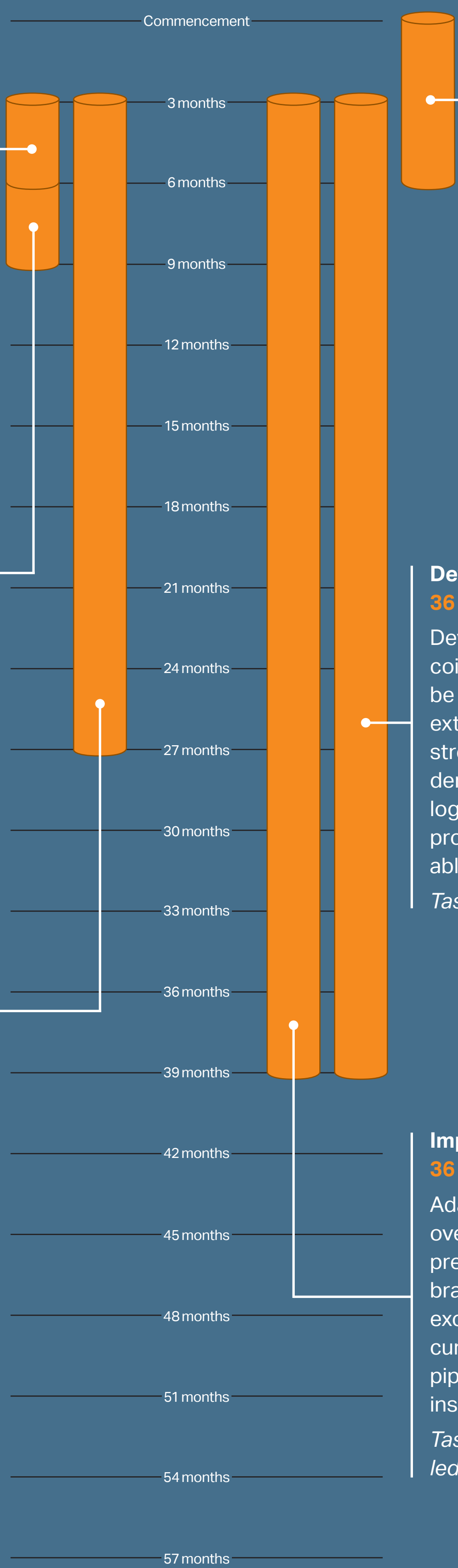
A: Urban centre; **B:** Flats; **C:** Terraced;
D: Semi-detatched; **E:** Detatched.

↑ Figure K: HDD equipment
(Source: Tracto Technik)

↑ Figure L: Removal of the core
(Source: Tracto Technik)

Route Map D

Overall cost for development: £3.3 million



Demonstrate current capability

3 months duration

A demonstration project both to show that trenchless solutions can be viable with current technology and to increase industry confidence. A group of around 20 properties should be sufficient.

Task lead: Local Authority or DH developer

Develop value propositions

6 months duration

Market research to determine DH developers' understanding of the current capability of trenchless technologies and their attitudes to the solutions. This enables commercial requirements to be defined and value propositions developed.

Task lead: Specialist in value proposition design

Disseminate findings

3 months duration

Disseminate findings from the demonstration project through both written material and presentations.

Task lead: Local Authority or DH developer

Develop more flexible pipe

36 months duration

Develop more flexible pipe to allow coiled pipe of larger diameter to be used with HDD rigs. This would extend the use of the solution in street mains to those of greater heat demand. Also need to address the logistics and handling to get the pipe product from factory to site and to be able to safely use the pipe on site.

Task lead: Pipe manufacturer

Develop remote access

24 months duration

Currently to weld every DH branch connection to the main pipe requires a welder to work in the hole. Develop a solution to remotely live connect mains to branch pipes; improves safety risk and reduces time of an operator welding down the hole, saving cost and avoiding the need for temporary works permits.

Task lead: Pipe manufacturer

Improve branch pipe installation

36 months duration

Adapt existing capability to overcome physical barriers preventing installation of property branch pipes from a core and vac excavation. Two potential solutions currently proposed are: improve the pipe flexibility and/or modify the pipe installation process.

Task lead: DH Developer led Consortium

E

Improved front end design and planning

For more detail see the following on www.eti.co.uk
- Section 3 of the Solution Development, Analysis and Selection Report.
- Section 8 of the Solution Route Maps Report.

Challenge

There is commonly inadequate upfront survey, design and planning prior to the civils works commencing which results in sub-optimal pipe routes and causes on-site delays and reduces productivity throughout the excavation process. This arises from the developer wishing to minimise expense during uncertain contract negotiations with typically the Local Authority. Once the contract is signed, there is immediate pressure on delivery.

An associated issue is how risk is allowed for in the contract price. The DH developer commonly uses a fixed-sum design and build contract to commission the civils work so as to be confident of the investment needed for the scheme's development and its viability. The contractor needs to price risk into the contract based on limited survey information — for example, related to additional works to navigate around any underground services and other buried features that may only be identified during excavation, when in fact these costs may never be realised.

Solution

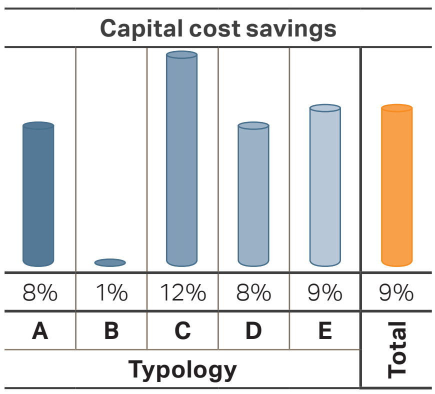
There are three principal components of this solution.

- **Undertake detailed survey and design work early in the process:** This should significantly improve the productivity of the civils work and lead to reduced contract prices. The main barrier is that a sponsoring organisation needs to invest more money at risk for this work during a period when there is still significant uncertainty whether the DH scheme will happen. In the short-term, HNDU funding can be used for such works. In the longer term, the intention is that industry views the reward from undertaking the upfront work as outweighing the risk that the DH scheme will not progress. Stronger local or national district heating policy will also improve confidence in investing upfront.
- **Achieve greater standardisation of the survey and design works:** The intention is to focus resources on those survey and design activities that realise the greatest cost savings in practice. This should build from existing work such as PAS 128:2014 "Specification for underground utility detection, verification and location".
- **Adopt alternative contract frameworks:** It should be possible to adopt alternative contract frameworks to minimise the pricing of remaining risk into the contractor's fee. For example, a Target Cost approach to contracting can include a provisional sum in the contractor's fee for anticipated risks which can be adjusted at a later date to take account of the contractor's actual costs. The contract can also include a pain/gain share mechanism to incentivise the contractor to find ways to reduce costs.

A 9% saving is estimated across the network with significant savings across all typologies with the exception of Typology B where the civils costs are a relatively low proportion for the blocks of flats. →

↑ Figure M: Congested DH route

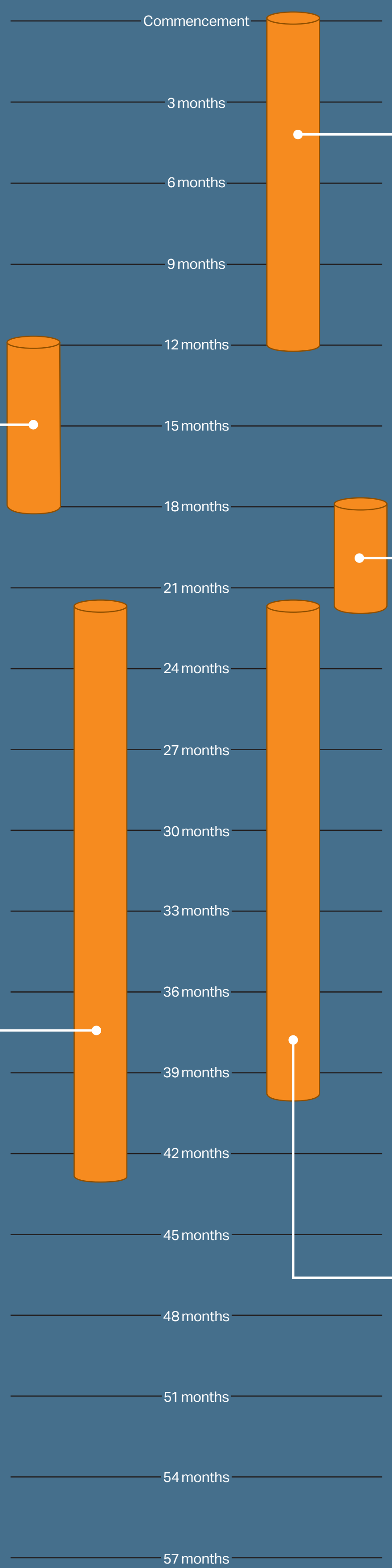
↑ Figure N: Undertaking ground penetrating radar survey



A: Urban centre; **B:** Flats; **C:** Terraced; **D:** Semi-detatched; **E:** Detatched.

Route Map E

Overall cost for development: £250k



Project activity analysis
12 months duration

Detailed project activity analysis of works on three - five live DH project sites. This is to determine and disseminate the whole-project time and cost saving opportunities that could be realised from upfront survey and detailed design. It would benefit from broad industry involvement to gain buy-in to the results.

Task lead: Specialist consultant

Guidance for comprehensive survey and design
6 months duration

Guidance and training would be produced to optimise survey and design works. This would build from the Project Activity Analysis to target those elements which should deliver the greatest cost savings. This would be led by an industry expert and supported by a broad industry group to provide input and encourage buy-in. It is important that this guidance and training is regularly reviewed and refreshed to account for further learning in practice.

Task lead: DH expert

Improved contract framework
4 months duration

Review alternative contract frameworks for commissioning the civils work to identify an alternative approach which both reduces the cost of district heating and continues to provide the investor with confidence as to their costs and the viability of the project. The civil engineering contractor also needs to be able to contractually rely upon any upfront survey and design work if undertaken separately. It should particularly build from successful approaches in other utility sectors and district heating in other countries.

Task lead: Procurement expert

Monitoring and report on demonstration project
21 months duration

Monitor process to establish whether improvements have been successfully applied and the final results to confirm that the predicted cost savings have been achieved. The results to be widely disseminated.

Task lead: Research specialist

Demonstration project
18 months duration

Demonstrate how this solution delivers cost reductions through more detailed upfront survey and design, and alternative contract framework.

Task lead: DH developer

F

Shared civils

For more detail see the following on www.eti.co.uk
- Section 3 of the Solution Development, Analysis and Selection Report.
- Section 9 of the Solution Route Maps Report.

Challenge

Civil engineering forms 36% of the capital cost of the baseline heat network. If the civil engineering costs can be shared with other utility providers there is potential for a significant impact on capital cost and hence the viability of district heating at scale.

There are several challenges that will need to be overcome including:

- Maximising the overlap of viable utility renewal with district heating roll-out in terms of location and timetable.
- Delivering services simultaneously, ideally in the same trench, without detrimental impact on performance, accessibility or lifespan of any service.
- Agreeing a contract with acceptable allocation of responsibility and risk.

Solution

The proposed solution is to research and develop mechanisms by which DH developers can collaborate with other utility providers and Local Authorities to share the cost of street works. The range of potential mechanisms includes:

1. Case by case shared civils: Utility companies share their plans for network renewals and look for any opportune overlaps.
2. Aligned planning cycles: Central planning for utilities and strategic DHN development across a local area, likely led by the Local Authority.
3. Streetworks partnership: A top-down ambition to minimise duplication of road works and the reduction of disruption, likely led by the Local Authority.
4. Joint venture between DH and utility companies: Develop a mutually beneficial joint venture company to combine works.
5. A utility led heat network development: Utility company delivers both utility and district heating infrastructure.

Research thus far has identified greatest interest and potential synergy with water supply. In particular, smaller water companies recognise the potential for links with DHN deployment and their need to upgrade existing water supply pipe.

Initial analysis suggests that 4% to 20% of potential DH pipe routes might align with water main renewal based on a 1% annual replacement rate required by the regulator. The overlap is dependent on geography, housing density, age of existing utilities and the ability to align DHN and utility programmes of work.

This solution's value is in reduced excavation cost, with a net benefit of £200/m, shared between the two parties.

The net £100/m saving to the DH company, applied across the expected 6.5km (13.3%) of DHN piping, delivers a potential capital cost reduction of 1.4%.

This water company synergy forms the focus of the route map but potential exists with electricity, gas and data/telecoms. The route map proposes approaches that provide straightforward mechanisms to assess the potential for, and deliver the benefits of, shared civils solutions.

In a city or metropolitan area it is likely that the Local Authority will play an important leadership role, but as new commercial models develop there is potential for new combined utility companies to drive the solution.

Capital cost savings

A	B	C	D	E	Total
2%	1%	2%	2%	2%	1%

Typology

A: Urban centre; **B:** Flats; **C:** Terraced; **D:** Semi-detatched; **E:** Detatched.

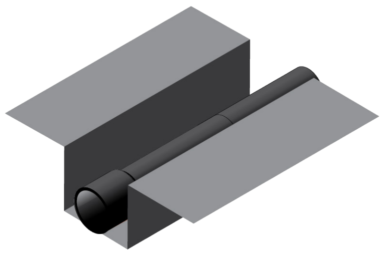


Figure O: This shows an old cast-iron water main in need of replacement, which may be hand excavated or may use a 'pipe bursting' approach.

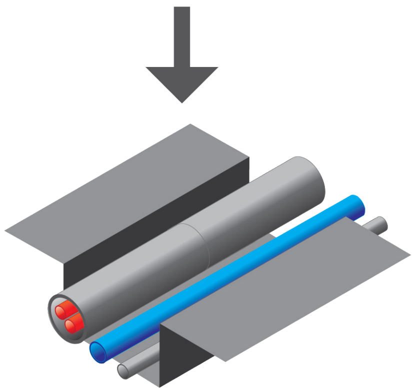


Figure P: As an alternative, the blue water pipe can be laid (optimising the route) in a combined trench with a twin DHN pipe and a duct for fibre-optic data.

Route Map F

Overall cost for development: £370k

Example business case
3 months duration

Test this concept solution by exploring opportunities in detail, as a worked example for a UK city and develop a business case for commercial deployment. Analyse water network renewal/repair priorities and align with a hypothetical district heating scheme.

Task lead: City council

Market Research to test the Solution and Commercial Models
3 months duration

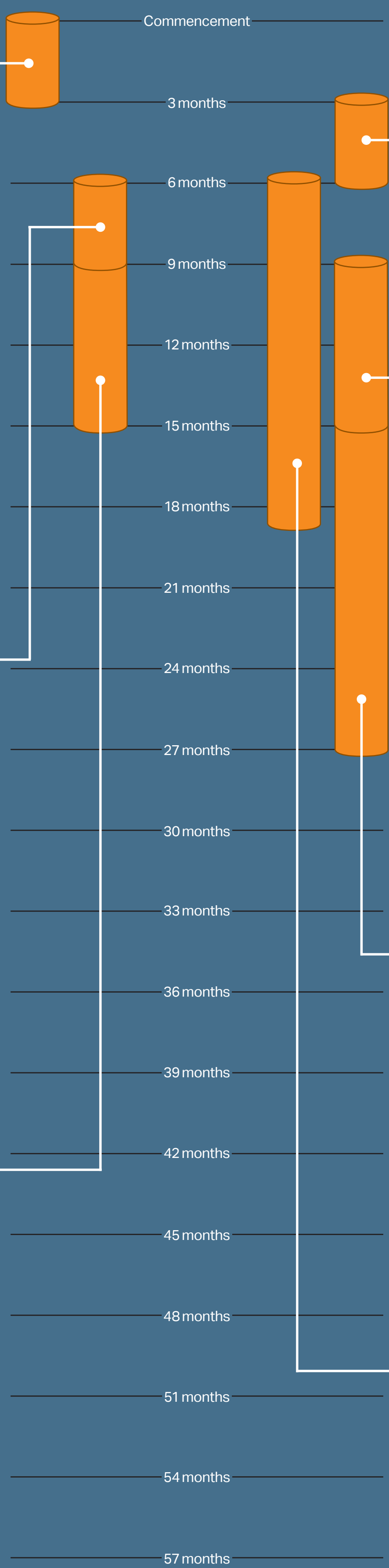
Market research to clarify the specific requirements of DHN Developers, local authorities, other utilities and contractors in order to maximise the benefits of a shared civils solution and reduce the challenges and sacrifices of combining the activity between multiple organisations.

Task lead: Market research specialist

Demonstration project proposal and deployment
6 months duration

Demonstrate the technical and cost viability of a shared civils solution. The testing of a shared civils solution is likely to require the joint commissioning of the work between the DHN developer, another utility company and the local authority. It would be sufficient to demonstrate with 10-50 homes.

Task lead: City council



Technical Solution Development
3 months duration

Detailed review of the potential technical challenges for combining district heating pipes with potable water supply in close proximity, and consideration of other utilities. Develop a matrix of compatibility and requirements for future deployment.

Task lead: Water company

Develop commercial/contractual/legal models
6 months duration

Develop a single commercial model and contractual documentation for the shared civils approach to save the significant cost of developing bespoke models each time. More than one standard model may be needed in practice but effort should be made to limit the number of variants.

Task lead: Specialist consultant in alternative delivery models

Programme deployment model
12 months duration

Develop a standard approach to enable DH developers to simply assess the likelihood that a shared civils solution will have a positive impact on project financial viability. It would utilise the Scope Assessment Tool and the Commercial/Contractual/Legal Models for routine use in DHN planning.

Task lead: Specialist consultant in alternative delivery models

Scope assessment tool
13 months duration

Create a tool which enables Local Authorities and utility companies to rapidly assess the potential viability of shared civils between district heating and one or more utilities. This would need to align utility asset maps with Local Authority housing plans and existing cost data.

Task lead: Specialist consultant in alternative delivery models

G

Direct HIU system and existing DHW storage

For more detail see the following on www.eti.co.uk

- Section 3 of the Solution Development, Analysis and Selection Report.
- Section 10 of the Solution Route Maps Report.

Challenge

The supply and installation of the HIU accounts for 17% of the total cost of the district heat network in the baseline model. The baseline design assumes an indirect connection to the space heating system with a heat exchanger separating the DH circuit from the dwelling radiator circuit, and for domestic hot water an instantaneous hot water heat exchanger to replace an existing hot water cylinder if installed. Alternatives which involve a simpler design should lead to a significant cost reduction.

Solution

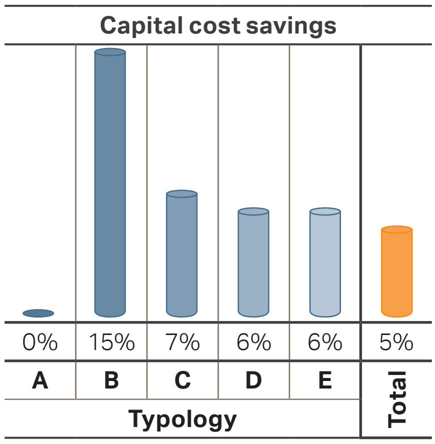
There are two ways to simplify the design and reduce the cost:

- Direct Connection HIU: A direct connection HIU would be used for dwellings and smaller non-domestic buildings where the DH network water is circulated directly through the building's radiators. This saves on the cost of a heat exchanger and associated equipment. There would also be operating cost savings as return temperatures would be lower and there is less equipment to maintain.
  Direct connection is not feasible where pressures in the DH network exceed radiator pressure ratings, such as very high blocks of flats.
- Reuse of existing hot water cylinder: Existing cylinders would be retained where available, subject to being in satisfactory condition. This avoids the cost of the hot water heat exchanger and associated control valve within the HIU. It is further assumed that the existing temperature control for the cylinder would be retained. Published surveys suggest that about 50% of existing dwellings have a hot water cylinder.

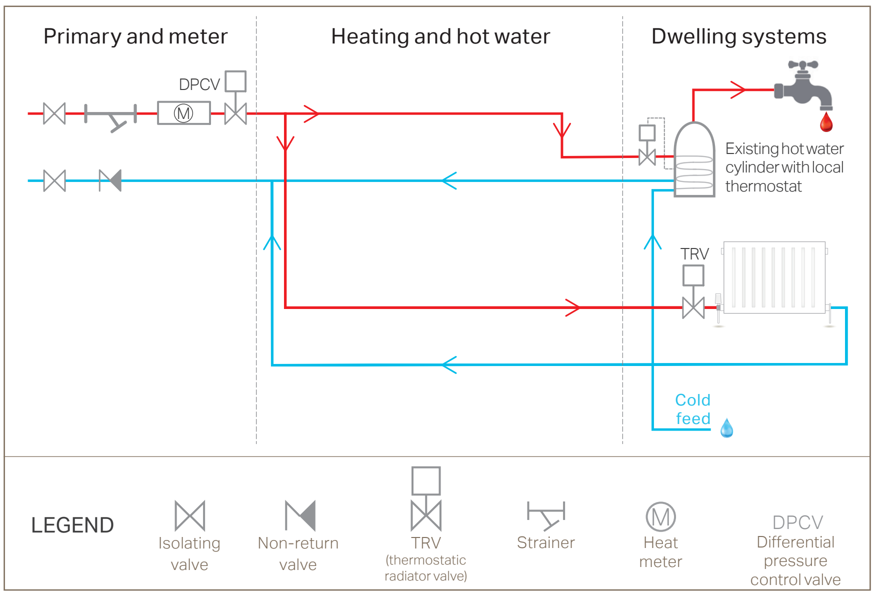
The diagram below shows that the section of the HIU titled 'heating and hot water' requires no heat exchanger equipment for either space heating or hot water production. This solution is technically feasible and has been used in many applications. It is estimated that it should reduce network costs by around 5%. However, the optimum option for a given dwelling would depend on a number of factors including the dwelling itself, the condition of the existing equipment and customer preference (e.g. occupants may wish to release space by removing their hot water cylinder).

Some product development would make the solution more attractive, especially to ensure that operational risks and costs do not increase. For example, the main barrier to direct connection would be customer perception of greater risk of damage to the property if there is a leak and, whilst products exist to detect leaks and automatically shut off the DH supply, further development should provide greater confidence and lower cost.

In addition, to overcome the reluctance of designers to specify this solution, a design methodology would be produced so that the optimum solution in any application can be easily identified together with supporting technical studies that will provide evidence of cost savings and operational benefits. →



A: Urban centre; **B:** Flats; **C:** Terraced; **D:** Semi-detatched; **E:** Detatched.



↑ Figure Q: Direct/hot water cylinder retained

Route Map G

Overall cost for development: £420k

Market research of customers

3 months duration

Market research to understand better the customer preferences with respect to the type of hot water system they have and how a DH system would provide benefits. A set of user requirements can then be defined and new value propositions developed to satisfy these requirements.

Task lead: Market research specialist

Process methodology for designers

3 months duration

To develop a clear process that will enable designers to rapidly assess an individual dwelling and taking account of the customer's preferences to determine the optimum strategy.

Task lead: Specialist engineering consultant

Product design and development

6 months duration

To produce product enhancements that address market concerns to reduce cost and improve performance. For example, an automatic leak detection and shut-off system, the use of a non-return valve, and more sophisticated controls for hot water cylinders.

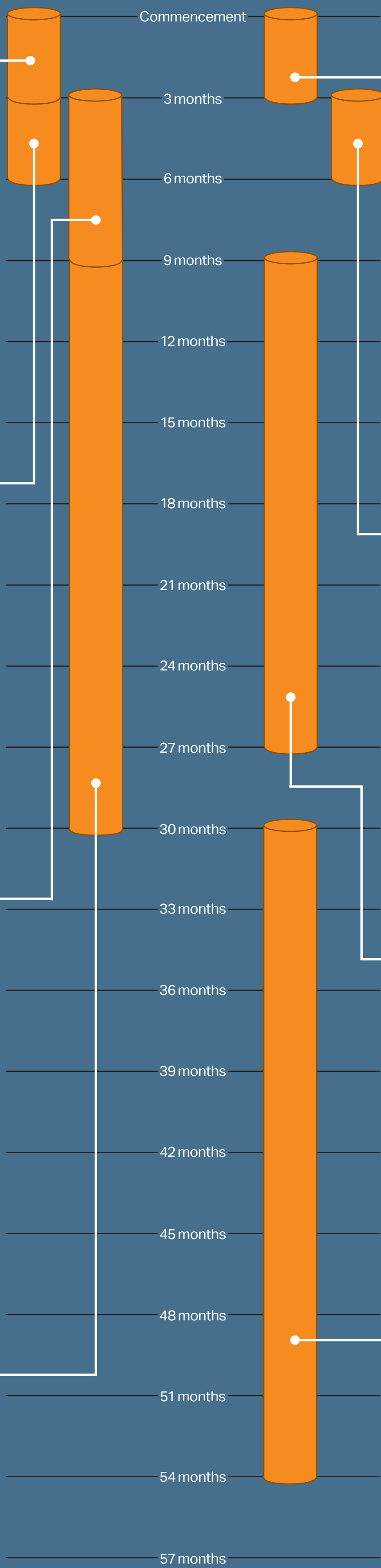
Task lead: HIU manufacturers

Monitoring and report on demonstration project

21 months duration

The demonstration scheme would be monitored both at a technical level and by customer research to establish the impact of the installation work in terms of disruption, how comfort levels have been met, and any technical issues that have arisen. The results of the project would be written up and widely disseminated.

Task lead: Research specialist



Market research of DH developers and their designers

3 months duration

Market research to understand the attitudes of DH developers and their designers to the proposed solution. Identify any perceived drawbacks and suggestions for product development to overcome them.

Task lead: Market research specialist

Technical supporting studies

3 months duration

Technical studies to help designers select the optimum option for a range of building types and heat system configurations. This includes better understanding the operating costs and the financial benefit of hot water cylinders in terms of demand management for different heat sources.

Task lead: Specialist engineering consultancy

Demonstration project

18 months duration

A demonstration project to provide confidence to the design community in the direct connection/use of existing cylinders design concept. It would comprise a group of around 20-50 houses with a range of HIU options being installed for comparison purposes.

Task lead: DH developer and design team

Further demonstration projects

24 months duration

A single demonstration project would not have the necessary impact for the whole of the industry so further projects would be encouraged. These projects would be subject to further monitoring and feedback to the industry.

Task lead: DH developer

H

HIU optimisation

For more detail see the following on www.eti.co.uk

- Section 3 of the Solution Development, Analysis and Selection Report.
- Section 11 of the Solution Route Maps Report.

Challenge

The supply and installation of the HIU accounts for 17% of the total cost of the district heat network in the baseline model. There are three challenges to cost reduction of domestic HIUs:

- Cost challenges — reducing component and overall system capital and operating costs.
- Technical challenges — engineering and manufacturing changes which still ensure system performance and reliability.
- Commercial challenges — encouraging HIU manufacturers to standardise, reduce costs and pass on savings to the network developer.

Solution

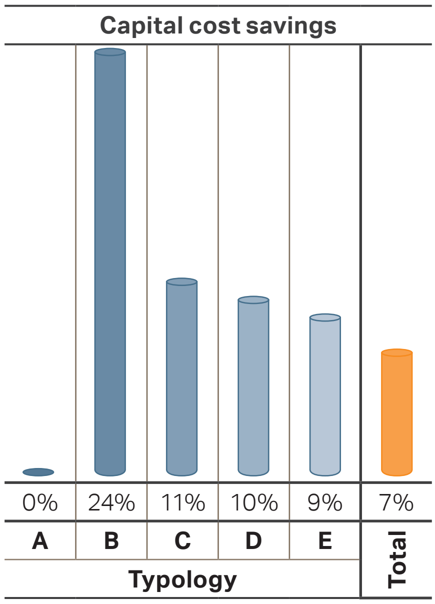
This solution takes a three tier approach to reduce the capital cost of the HIU whilst ensuring that the operational performance and cost are not compromised.

- Simplification and Design for Manufacture and Assembly: Potential cost savings from: (i) simplification and standardisation of components, (ii) reduction in parts count through common sub-assemblies and reduced duplication/ redundancy, and (iii) components which are quick and easy to install correctly.
- Value Engineering at scale: Components have been identified with potential for elimination or substitution due to: (i) duplication of functionality within the HIU or elsewhere in the system, (ii) over-engineering above the basic requirement, and (iii) optional items which could be designed as chargeable upgrades.
- Optimisation of system solution: Integration of benefits from Direct HIU System and Existing DHW Storage solution.

There would need to be technical developments of both components and the assembled HIU products. These include: (i) the reduced cost of key components which currently attract disproportionate cost, (ii) a new Primary Metering Module (PMM) to support standardisation for the DHN developer whilst allowing consumer choice in the home, and (iii) a fully industrialised design and manufacturing process for the most commonly specified HIUs. The developments must be delivered without detrimentally impacting on HIU performance and reliability.

Although there is HIU development activity, alternative technical solutions are vying for position in a relatively small market (compared to combi boilers). If the UK were to take a lead on the drive for standardisation of components and platform, the benefits of reduced costs and improved performance would be achieved earlier.

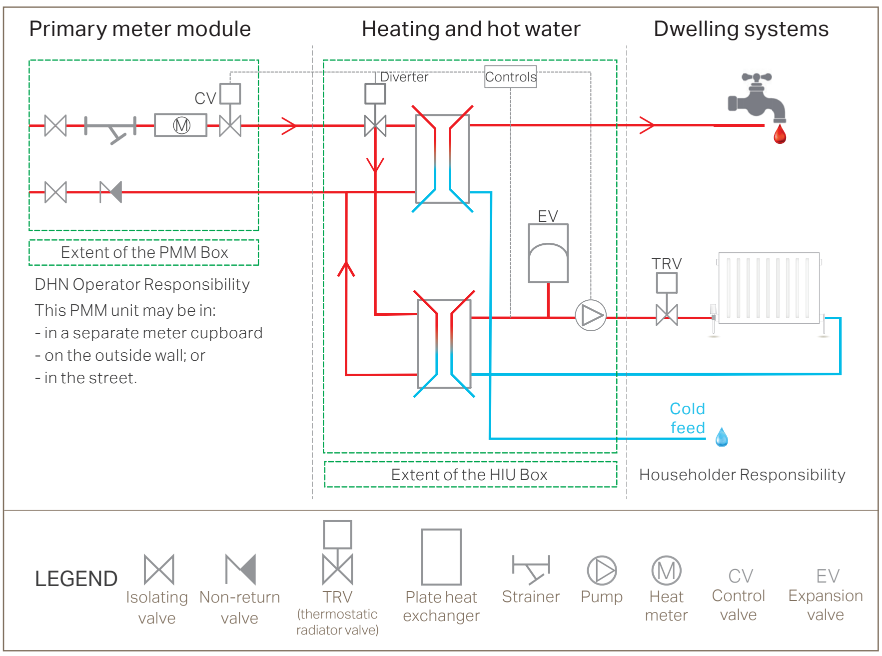
It is estimated that HIU optimisation should reduce network costs by around 7%. The greatest reduction is for Typology B blocks of flats where HIUs form the dominant cost component. →



A: Urban centre; **B:** Flats; **C:** Terraced; **D:** Semi-detatched; **E:** Detatched.

→

Figure R: Primary Metering Module (PMM) – separate unit



Route Map H

Overall cost for development: £7.6 million

Market alignment
6 months duration

DHN developers, HIU manufacturers and the UK government to declare their joint intent to achieve a viable mass market HIU product at a target cost below £400. To be achieved through wide engagement across the DHN value chain to: (i) confirm the range of standard specifications and costs needed to serve the UK market in HIUs, and (ii) develop future demand scenarios sufficient to attract investment in capacity at the target cost. Central government leadership will be needed to support the development of mechanisms/ stimulus proposals which generate demand.

Task lead: Specialist consultant in alternative delivery models

Development of a low-cost and low-maintenance IND/INS HIU
24 months duration

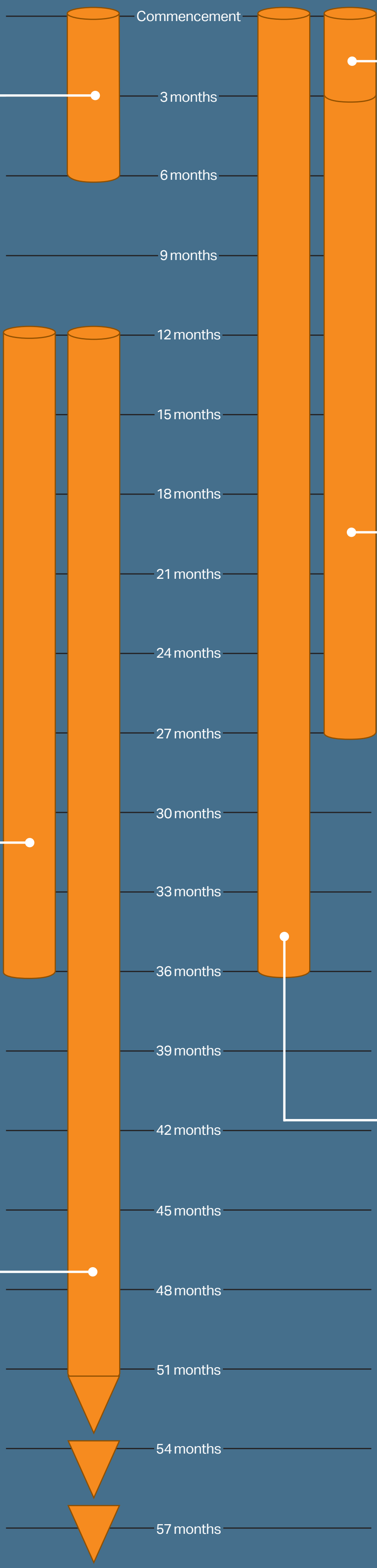
Develop a technically sound and commercially viable Indirect HIU with Instantaneous DHW heating that achieves a target cost below £400 through working collaboratively across the value chain and building on the outputs of the previous activities.

Task lead: HIU Manufacturers

Development of a low-cost plastic Primary Metering Module
24 to 48 months duration

Develop a very low-cost stand-alone metering and control unit.

Task lead: HIU Manufacturers



Market research of HIU requirements
3 months duration

Market research directed predominantly at network designers and developers to understand the underpinning requirements of individual HIU units. The aim is to establish a common baseline performance specification requirement for the core HIU variants, and so reduce the likelihood of over-specification and increased costs.

Task lead: Market research specialist

Development of a combined control valve for the PMM
24 months duration

The control valve components for the Primary Metering Module (PMM) currently account for a significant proportion of HIU cost and are produced in comparatively low volumes. Product development to combine the key components to create an electronically controlled valve at a significantly lower target cost.

Task lead: HIU and valve manufacturers

Development of low-cost and low-maintenance heat meter
36 months duration

Develop a low cost heat meter within the PMM through simplification of the approach to metering and the engineering.

Task lead: Academic research and heat meter suppliers

Overview of route maps

Synergies, timescales, cost savings and potential funding sources.

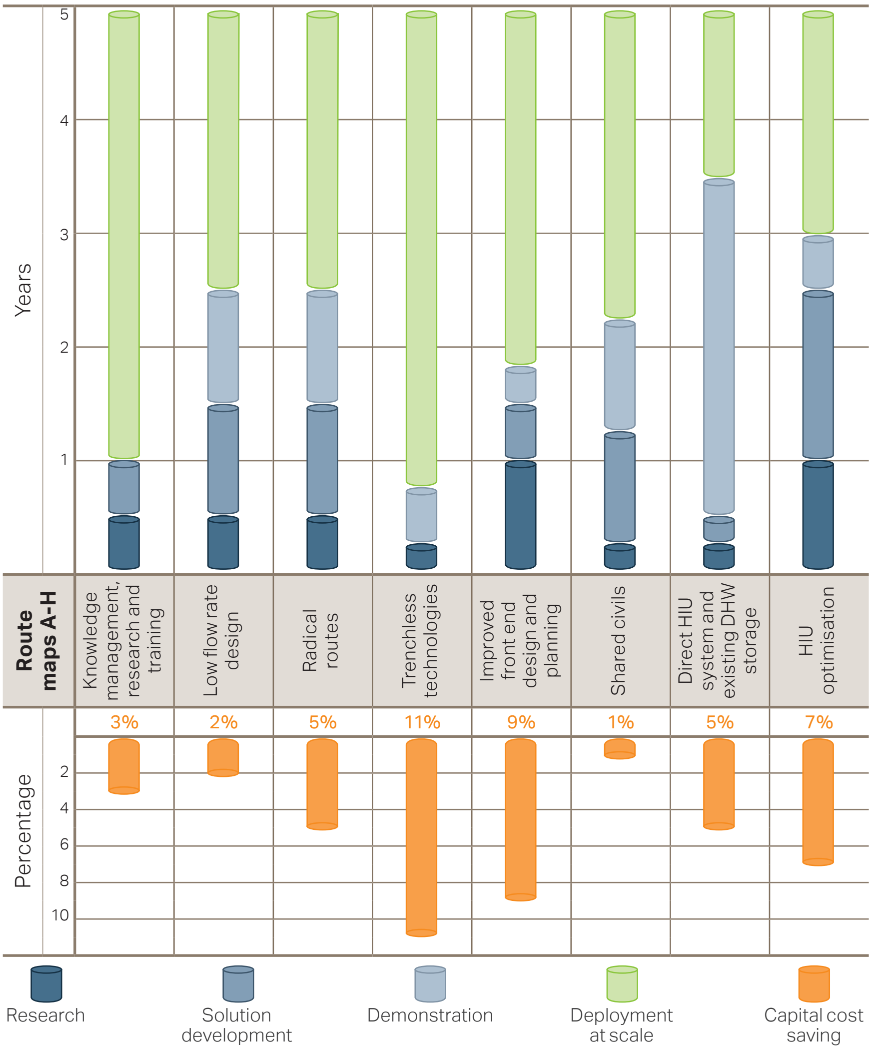
For more detail see 'Solution Route Maps Report' on www.eti.co.uk

Route Maps

Typically, the route map activities encompass four stages: research, product or market development, demonstration projects and deployment. The overall programme for the route maps is shown in Figure S. This particularly highlights that the solutions could be implemented and deliver significant benefits within a relatively short time period.

There are benefits in implementing some of the route maps simultaneously; most route maps include market research and/or demonstration projects and where combined could reduce route map investment and demonstrate beneficial synergies between solutions.

Public sector funding will be particularly required for fundamental research and to support the development of new products and services. The expectation is that industry will support the development of new products and services, and their demonstration and deployment, with investment based on confidence in future demand and profitability.



↑ Figure S: Overview of programmes and capital cost savings for route maps A - H

↓ Figure T: Summary of costs for the route maps

Route map	Government funding (£/000)	Industry funding (£/000)	Total (£/000)
A	2,135	-	2,135
B	333	-	333
C	322	120	442
D	1,710	1,600	3,310
E	249	-	249
F	366	-	366
G	326	90	416
H	3,858	3,700	7,558
Total	9,299	5,510	14,809

Figure T summarises the cost estimates made for the first three elements (research, solution development and demonstration).

The cost of construction of the demonstration projects (which is not included in Figure T) will be fully funded by DH developer companies, as the lower costs will mean the project can be financed through future heat sales to customers; in addition the company will benefit from learning a new approach and showing leadership.

Other solutions

Many other ideas are promising and could be adopted in the future.

For more detail see 'Appendix E of the Solution Development, Analysis and Selection Report' on www.eti.co.uk

The route maps captured the most promising solutions. However, many of the other ideas are still promising and could be adopted in the future to realise further cost savings. Some of those considered to have the greatest potential for cost savings are summarised below:

- Shallow burial: Conventional design requires DH pipes to be buried at a minimum depth of around 600mm to avoid excessive force from traffic. In practice, this typically means installing at greater depth to avoid existing services. Costs could potentially be reduced if the pipes could be buried within the thickness of the road sub-base, i.e. in the range 200mm - 400mm cover. For structural support, the pipe could be located in a concrete duct or trough with a lid, or alternatively the pipes themselves could be designed to withstand traffic loading. The critical issue is proving that the long-term performance of the road surfacing will not be impacted.
- Kerb route: Use the space typically taken up by the kerb and its concrete support. The concept is to excavate and remove the existing kerb and replace with a specially cast kerb containing ducts where DH pipes can be pulled through. There could potentially be a problem with kerb-dropping at various places and circuits for traffic lights located within existing kerbs. The new kerb would need to be larger than existing kerbs to install the pipes. A further alternative could be to place another utility in the kerb (e.g. media cables which have smaller dimensions) and re-use their space for district heating pipes.
- Recycling excavated material for backfill: Commonly, excavated material is removed from site and new aggregate purchased for use as backfill. Alternatives were identified that should cost less in some circumstances: (i) re-use of excavated material, (ii) use of recycled aggregate, (iii) use of hydraulically bound materials, and (iv) use of foamed concrete. Issues that need considering depending on approach include: suitability of material for re-use, storage requirements, any increased risk of structural failure and ease of access for future maintenance.
- Front garden or rear garden route with trenchless technology: A route close to the house will mean very short branches, reducing costs especially for houses set back from the road. Trenchless technology could be used to limit impact on gardens or surfacing. Shallow burial also has a greater potential with this solution. Legal agreements will be needed as the pipes will serve other properties in the street. Routes in rear gardens may be close to the location of existing gas boilers, so may also reduce connecting pipework within the property. There would be twice the length of the street main as one route each side of the street would be needed. However, the lower civils costs and the shorter house connections are expected to result in a net reduction in cost. Access pits to install the pipe and make the branch connections could be disruptive even if trenchless technology is used for the main runs.
- Higher temperature plastic pipes: This could save cost through improving both the flexibility of the pipe and the avoidance of expansion loops. This is most beneficial at smaller pipe diameters (e.g. up to 150mm), which would benefit from the flexibility, and where conventional plastic pipe cannot be used as the temperatures are too high. Products are coming onto the market but the benefits need to be weighed against the currently significantly higher costs than that of conventional steel pipe.
- Pipe crossings: Delivering or extending district heat networks commonly requires major crossings of existing infrastructure, e.g. railways or canals. The cheapest solution is often to utilise existing bridge structures to support the district heating pipes. However, often the bridge owner imposes onerous liability conditions on the DH company, resulting in the adoption of more expensive tunnelling. As the risks are in practice low, an alternative approach would be for the bridge owners to accept a lower limit of liability from the DH company as standard practice. The related infrastructure (bridges, railway, etc.) are commonly in public ownership, and if national policy is to promote cost-effective district heating, it may be reasonable for a lower limit of liability to be agreed.
- Pipework and connections within the property: The project identified opportunities to eliminate excessive material waste and outlined a programme of work to substantially reduce labour requirements.

Findings and implications for stakeholders

The requirements of a complex and diverse range of DHN stakeholders are summarised on pages 10-11.

For each key group, this section now addresses their motivations to invest in the DHN solution developments in specific route maps.

DHN INVESTORS

Private development

Private sector energy companies are taking the lead in DHN development, but these are almost entirely for new-build networks, without the challenge of persuading existing consumers to switch. The retrofit of existing buildings will become an attractive market once developers are able to offer consumers and landlords a compelling reason to switch to DH based on cost or convenience.

The solution route maps in this project have identified activities that reduce the barriers of cost, disruption and uncertainty of programme to make retrofit (and new build) DHNs a more attractive investment. The District Heating Knowledge Centre DHKC (route map A) will play a crucial role in building confidence for private investors and other route maps will reduce the technical uncertainty of projects. In the meantime private investors and developers have an opportunity to engage early and participate in solution development and deployment to gain a first mover advantage.

Public sector development

Local authorities are the key instigators of public DHN development; this may be driven by political or sustainability priorities, or as a result of community engagement in low carbon energy.

The duration and cost of the commissioning and procurement processes are crucial barriers and these are particularly addressed by route maps A (Knowledge Management, Research and Training) and E (Improved Front-End Design and Planning).

The project route maps reduce uncertainty of DHN timescales, outcomes and hence financial returns. This creates a compelling case for further investment from private and public sectors.

In addition, both private and public sector developers will benefit greatly from activities that reduce HIU cost and improve reliability to give long, maintenance free asset life (route maps G & H). Improved operational performance from reduced peak flow (route map B) has potential to increase DHN viability and accelerate investment.

By acting as 'demanding clients' DH developers can press for rapid adoption of route map activity across the value chain. Developers will also benefit directly from incorporating demonstration projects in their programmes to prove the potential for project solutions to deliver cheaper, more robust networks.

The project route maps reduce uncertainty of DHN timescales, hence improving outcomes and financial returns. This creates a compelling case for further investment from public and private sectors. Purely financial investors have not been a focus of the research, but the increasingly reliable financial returns delivered by the route maps are expected to bring such capital to the DHN sector.

VALUE CHAIN

The value chain encompasses the design, delivery and supply chain organisations enabling DHN delivery; none of which are currently mature in the UK and so have not achieved industrial levels of performance and cost. The opportunities arising are considered here.

Design and development

Network design engineers, surveyors, planners and cost consultants are cautious with their design and costings for DHNs. This tends to lead to over-specification and hence inflated cost of DHN delivery. The District Heat Knowledge Centre (DHKC - route map A) would be the custodian and champion of best practice and would enable a step-change in capability for UK DHN delivery, reducing costs in parallel. The DHN design community needs to engage, collaborate and develop common solutions; overcoming the concern that standard solutions will reduce fees for bespoke design. The resulting capital cost reduction will enable the market to grow rapidly and profitably for those that choose to develop common solutions.

Capturing best practice from demonstration projects and wider deployment will improve the knowledge base further and support additional cost reduction. Designers and consultants that embrace a standardised approach, which reduces development costs, are likely to be the most successful as the DHN market shifts and grows.

DH main contractors

Most main contractors co-ordinate project activity as sub-contracted packages to multiple specialists; as opposed to multi-disciplinary teams that cover excavation, pipe-laying, commissioning and reinstatement. The potential for simplification and increased productivity is considerable and aligns with route maps D (Trenchless Solutions), E (Improved Front-End Design and Planning) and F (Shared Civils) as well as with the DHKC development of best practice.

Contracting organisations which develop new propositions, that simplify contracts and reduce cost and disruption, will be most likely to succeed as the market grows.

Supply chain

Specialist multi-disciplinary contractors operate successfully in other utility sectors and, during this project, have shown an ambition to broaden their capability to cover the range of DHN delivery requirements.

A single organisation to lay DHN mains (trenchless or open-cut), make connections, commission pipework and reinstate the landscape would support simplicity of contracting and faster programmes, in line with route maps D (Trenchless Solutions), E (Improved Front-End Design and Planning) and F (Shared Civils).

A multi-disciplinary DHN delivery offering will enable the sector to scale rapidly and the currently smaller contractors to grow with it. An alternative is for larger installers to evolve and become turnkey providers in a single organisation or by forging very close collaborative partnerships.

> Collaborative, multi-disciplinary design and installation teams are a key enabler of improved DHN delivery at scale.

Equipment suppliers

Steel pipe manufacturers have dominated the market. New entrants are interested in the DHN market despite limited growth in sales to date.

The route-mapping process demonstrated the potential for demand at scale for enhanced **plastic pipe** products that address installation and durability challenges. As a result, manufacturers are working on products linked to trenchless solutions (Route Map D) and shared civils (Route Map F).

The **HIU** manufacturing base appears to be at a point of transition. Multiple, small, competing businesses have been vying for market share with a diverse range of products.

The market may now be at a point where larger heat system providers use their scale to acquire smaller technology businesses to rapidly grow their market share.

Route maps G and H (HIU Direct Connections and HIU Optimisation) propose UK industry wide standardisation to accelerate cost reduction and enable a step-change in the market volumes as a result. However, some current manufacturers may wish to continue with bespoke custom solutions with high costs and margins.

Experience from more industrialised sectors demonstrates that a standardised approach will accelerate market growth and support improvement in HIU quality and reliability. Successful HIU manufacturers in the growing DHN market will be those that develop a compelling proposition, as opposed to adopting a purely technical focus.

> Successful HIU manufacturers in the growing DHN market will be those that develop a compelling proposition, as opposed to adopting a purely technical focus.

Plant manufacturers are important enablers of Trenchless solutions with a need for adaptations to existing directional drilling tooling and innovation in 'Down-the-Hole' connections (route map D). Manufacturers have confirmed that medium/low-density housing could be a very successful application of trenchless technology for DHN's at scale.

Civil engineering plant manufacturers have already declared an interest in investing time to demonstrate the applicability of innovations to the DH market and then develop tailored solutions to meet specific requirements.

DHN delivery has been a niche market, particularly in the UK, but plant manufacturers that are able to adapt their products rapidly to suit this emerging sector will gain advantage in DHN and wider infrastructure delivery.

END USER CUSTOMERS

Consumers and Landlords will be drawn to DHN solutions once both reduced disruption and improved reliability are proven, provided that operating costs can be shown to be equal to, or lower than, alternatives.

Consumers

The research has shown that two key consumer requirements are performance-in-use (including cost to run and reliability) and the speed and disruption of installation. The route maps explore how cheaper, reliable, high-performing DH can be demonstrated as an attractive proposition to consumers, supporting its expansion to households in more areas.

For consumers to get involved in demonstration projects there is likely to be a need to incentivise their switch to a new heating solution.

This will be easier to achieve through Housing Associations and other social landlords where a single point of contact can link with multiple households. Additional effort will be needed to engage owner-occupiers and persuade them to adopt DHNs.

Landlords

Social landlords have a valuable link to consumers as described above. In London there is a requirement to consider the use of communal or district heating when refurbishing properties. Landlords find this problematic due to the complexity of specification, variable performance in use and high operating costs for maintenance.

Other cities are also encouraging more widespread use of low-carbon heat (e.g. Aberdeen, Sheffield, Bristol), but this is not a universal priority. A DHN system which is highly reliable, and easy to specify and procure, reduces the landlords' operating costs and staffing, so a well-designed value proposition from a DHN developer is likely to be very attractive to social landlords.

Private Rented Sector (PRS) landlords are a more disparate group; there are a growing number of professional institutional investors, whose requirements are similar to social landlords. However, these institutional landlords are currently focused on new properties, which are a relatively small proportion of the potential future market.

A large majority of the existing private rented stock is owned and let by private individuals with one or two properties. As a result their requirements are more closely aligned to owner-occupier consumers.

Non domestic

The bulk of heat requirements for the project's notional baseline network are for domestic properties. Schools, public and commercial buildings have different demand profiles and equipment requirements, but will benefit from the route maps of this project.

ENABLING STAKEHOLDERS

UK central and devolved governments

Government is the ultimate enabling stakeholder with both the remit and resources to invest in the UK's long term energy and industrial strategies through the Department of Business, Energy & Industrial Strategy (BEIS).

The Department's priority for energy is the leadership of initiatives to address the trilemma of sustainability, security and affordability to meet the UK's climate change commitments. This will need both strategic policy interventions and industry engagement. The devolved administrations for Scotland, Wales and Northern Ireland have aligned ambition, but there will be a need to adapt to their specific objectives.

Central government funding of the route maps is proposed only for stimulating or accelerating the market to deliver the cost and performance improvements. Such funding is proposed only where local or commercial investment is unlikely to be forthcoming (typically as a result of uncertain outcomes or lengthy development periods before a return on investment is expected).

The Heat Networks Delivery Unit (HNDU) within BEIS has an important role to play in stimulating innovation at the strategic industry and network design levels: particularly linked to the creation of the District Heat Knowledge Centre (DHKC - route map A) and in market research (route maps B,C,D,G,H). Such activities are unlikely to be funded commercially until the market potential is clear.

The total HNDU funding proposed for the route map solutions (£3.3 million) is equivalent to only 1.1% of the £300 million Heat Networks Investment Project.

Also funded by BEIS, **Innovate UK** is positioned to provide match-funding for industrial research and development. This funding is designed to accelerate product and process development ahead of a confirmed commercial opportunity.

The Innovate UK model of competition bids and match-funding (30%-60%) of investment generates interest in collaborative research and development between industry, academia and not for profit organisations.

Activities within route maps C, D, G and H are linked to product innovation in pipes, connection technology, metering and HIUs which have the potential to stimulate UK DHN supply chain capability. This could have significant export potential as well as forming an integral part of the UK's Energy and Industrial Strategies.

Heat does not currently come under the remit of the Cabinet Office, Infrastructure and Projects Authority (IPA) as the centre for expertise in infrastructure and major projects.

Elevating DHNs to infrastructure would give impetus to innovate and reduce the ETI's estimate of the £75 billion pipework cost to connect up to 50% of UK properties; accelerating this project's identified potential to reduce the investment needed by 38%, saving nearly £30 billion.

The route maps could reduce the UK's required network investment by 38%, **saving nearly £30 billion**.

Local government

Local Government has a number of roles which are crucial to the development of DH — as heat customer, as the highways & planning authority, and as direct investor in heat networks.

A significant proportion of UK DHN projects are led or advocated by Local Authorities, in line with council energy strategy. Local Government could also sponsor demonstration schemes proposed in the route maps.

The Local Government Association represents almost all principal councils, providing an important vehicle for the engagement of individual councils and the dissemination of results.

It is clear that Local Government stakeholder commitment is a crucial enabler of DHN delivery at scale.

This project has identified solutions which align well with Local Authority requirements for improved certainty of outcomes, reduced cost and minimal disruption. This will, in turn, increase Local Authorities' confidence to promote or mandate the development of DHNs for the provision of low carbon heat.

The District Heating Knowledge Centre (route map A) will be a crucial solution to minimise the duplication of development effort at the local level. Demonstration projects will also build confidence amongst Local Authorities and encourage further investment.

By seeking non-partisan central expertise to accelerate DHN delivery, Local Authorities will add weight to the case for creating the DHKC and generate a virtuous cycle of investment in DHNs.

Local Government commitment is a crucial enabler of DHN delivery at scale, and can generate a virtuous cycle of investment in DHNs.

Other energy and heat related bodies

The mission of the Energy Systems Catapult (ESC) includes acceleration of the development of new technology-based products and services, and the development of world-leading capabilities, to meet the future needs of the energy system.

Delivery of the route maps, generating a central body of knowledge and enhancing DH products and services, are therefore closely aligned with its mission, and the ESC could be a key partner in the delivery of this work.

Professional & trade bodies

There are many heat and energy related bodies with varying levels of overlap with DHN remits and priorities. Most are interested in sharing best practice with their membership and provide useful vehicles for the dissemination of both project and route map results in support of the DHKC.

A priority for these organisations will be to align with common standards and give a clear message to their members and markets that DHNs have an important role to play for the UK Energy System.

Other utilities

The delivery of DHNs has significant overlaps with other utilities; in both civil engineering (route map F - shared civils) and future business models where DHN supply will reduce or replace gas and electricity demand.

These have positive potential for new business models, but risk defensive actions from water, electricity, gas or telecoms businesses if DHNs are seen as a threat to their organisations.

Other key stakeholders in the utility sector include the regulators and trade bodies for utility supply companies.

Other utilities may see DHNs as potential investment opportunities to generate new revenue streams. Some also see both a disruption risk to their underground assets as DHNs are installed and a threat of reduced demand for their energy supply. Regulators and trade bodies can play a key role in encouraging integrated utility models that include the provision of heat.

As new business models are developed, other utilities may see DHNs as potential investment opportunities to generate new revenue streams.

About AECOM
AECOM is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organisations in more than 150 countries. As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A *Fortune 500* firm, AECOM had revenue of approximately $17.4 billion during fiscal year 2016. See how we deliver what others can only imagine at aecom.com and @AECOM.

About The Energy Technologies Institute
The Energy Technologies Institute (ETI) is a £400 million industry and Government funded research institute into low carbon energy system planning and technology development to address UK energy and climate change targets.

For further information please contact:

David Ross
AECOM
Regional Director, Sustainable Development
+44 (0)7921 646 257
david.ross@aecom.com

The Energy Technologies Institute
Holywell Building, Holywell Way, Loughborough LE11 3UZ
+44 (0)1509 20 20 20
info@eti.co.uk

www.aecom.com | www.eti.co.uk

LM00148 | 1017 | v8e.0