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Reducing the Capital Cost of District Heat Network Infrastructure

Dr. Alex Buckman – Senior Analyst, Energy Systems Catapult

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INTRODUCTION TO THE HEAT INFRASTRUCTURE DEVELOPMENT PROJECT

The Opportunity for District Heating Networks

- Heating buildings accounts for **~20%** of UK CO_2 emissions
- **56%** of building heat demand is located in only 4% of the geographical area of the UK
  - Only 1-2% buildings currently connected
- **Close to half of existing UK heat demand** could be connected to heat networks economically
  - a potential investment of the order of £75bn for heat pipework alone between now and 2050
- **Significant potential savings for consumers**
  - ~£350 /yr annualised cost vs gas boilers
  - ~£950 /yr annualised cost vs air source heat pumps

Courtesy of CPC Civils Ltd

Aim of “Heat Infrastructure Development” Project

- **High initial capital investment** for network installation is a critical barrier to wider uptake of district heating
- The DH **distribution system** can account for **60% or more** of the overall DHN cost
- Project aim: to **identify innovative solutions** that would deliver
  - a step change **reduction in the capital cost** of heat network infrastructure
  - whilst contributing to overall lifecycle cost reduction
- Results would be used to assess:
  - what impact solutions could have
  - where DHNs could be deployed economically
  - what opportunities there are for technology development

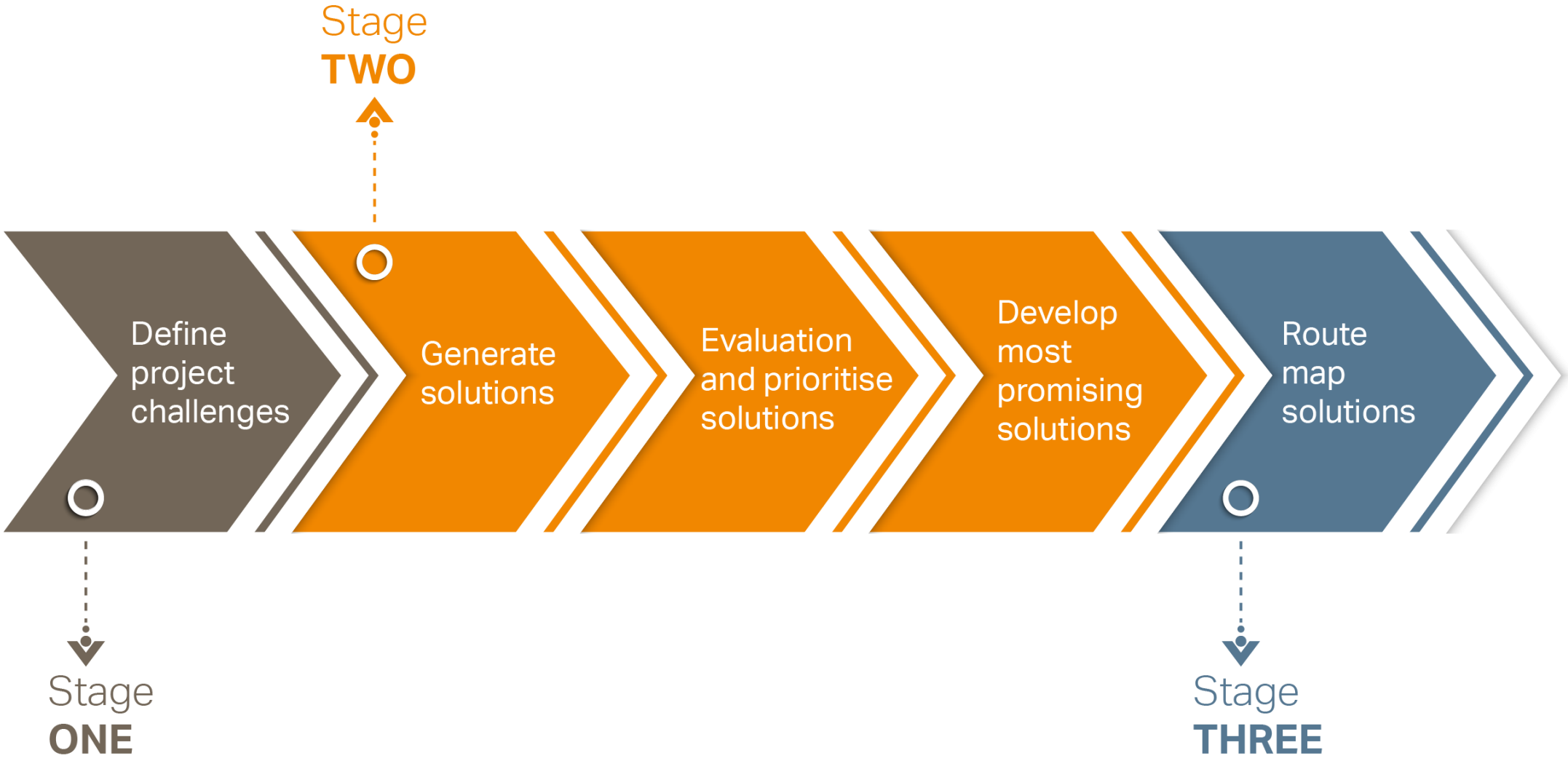
Courtesy of CPC Civils Ltd

Project Team

- AECOM (PM): Experts in district heating design, civil engineering design and cost consultancy
- ENGIE: Market leader for district heating in the UK responsible for design, construction and operation of 7 major schemes including the Olympic Park
- Total Flow: Value proposition design and the industrialisation of processes and products
- COWI A/S: Major Danish consultancy with particular specialism in district heating DH design and operation
- Loughborough University: Range of academic expertise including experts in energy, buildings and civil engineering

METHODOLOGY

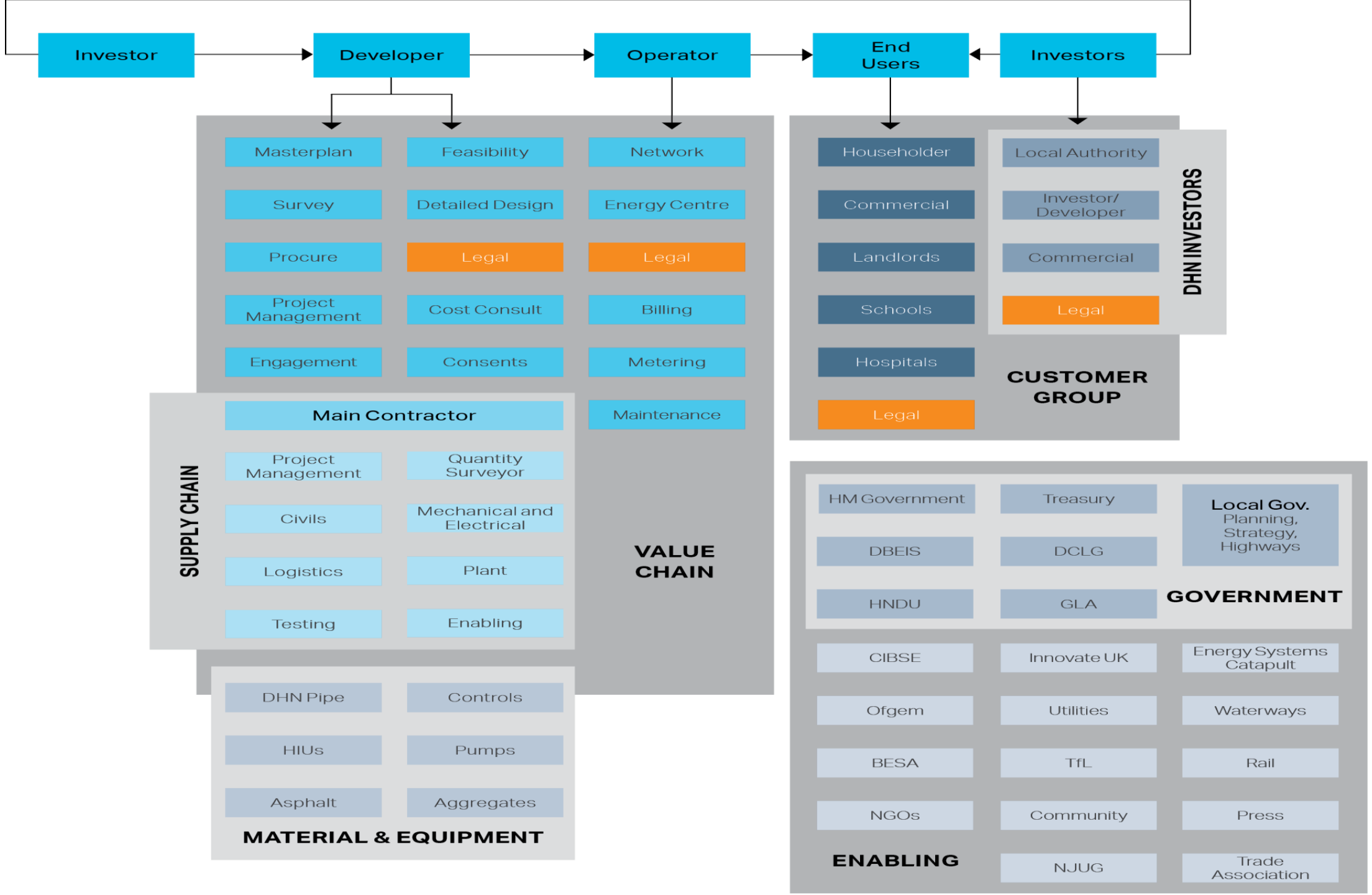
Overview



STAKEHOLDER REQUIREMENTS

Stakeholder Requirements

- High capital costs are a significant barrier to wider DHN deployment. Improvements to other aspects of the proposition will also help increase uptake and should also be considered.
- Stakeholder requirements were identified for heat network deployment based on: a workshop, structured interviews and a mini literature review.
- Three underlying drivers for stakeholders to change from their current heating provision.
  - **Reduced cost** – compared to the current and alternative heat provision
  - **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


Investor
Developer
Operator
End Users
Investors
Masterplan
Feasibility
Network
Survey
Detailed Design
Energy Centre
Procure
Legal
Legal
Project Management
Cost Consult
Billing
Engagement
Consents
Metering
Maintenance
Main Contractor
SUPPLY CHAIN
Project Management
Quantity Surveyor
Civils
Mechanical and Electrical
Logistics
Plant
Testing
Enabling
VALUE CHAIN
DHN Pipe
Controls
HIUs
Pumps
Asphalt
Aggregates
MATERIAL & EQUIPMENT
Householder
Commercial
Landlords
Schools
Hospitals
Legal
CUSTOMER GROUP
Local Authority
Investor/ Developer
Commercial
Legal
DHN INVESTORS
HM Government
Treasury
Local Gov. Planning, Strategy, Highways
DBEIS
DCLG
HNDU
GLA
GOVERNMENT
CIBSE
Innovate UK
Energy Systems Catapult
Ofgem
Utilities
Waterways
BESA
TfL
Rail
NGOs
Community
Press
ENABLING
NJUG
Trade Association

Stakeholder Requirements

Nine priorities identified to improve the viability of district heating in the UK

- Reduce Capital Cost
- Reduce Operational Cost
- Reduce Time on Site – reduce disruption and associated additional cost
- System Architecture – develop improved whole system solutions

DH Scheme Cost & Performance

- Improve Cost and Revenue Certainty
- Increase Network Revenues – from heat or other revenue streams
- Improve Customer Value Propositions – create a compelling offer for users
- Improve Investor Propositions – enable DHNs to become bankable investments

Business Models and Value Propositions

- Reduce Complexity of Transactions between Stakeholders

Transactional Efficiency

Stakeholder Requirements

These priorities can be distilled for three core stakeholder groups

- **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 existing system before it fails.
- **DHN Investors** require confidence in 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.

BASELINE NETWORK AND COSTS

Baseline Network Overview

- A baseline heat network was specified
  - 5 building typologies represent areas where district heating could be economic given lower capital costs
  - Transmission main of 2500m to connect typologies to Energy Centre
  - 3 major crossings (2 railways, 1 canal)

- **Network represents the maximum potential roll-out of DH in the UK and includes lower density housing which makes up the majority of urban areas**

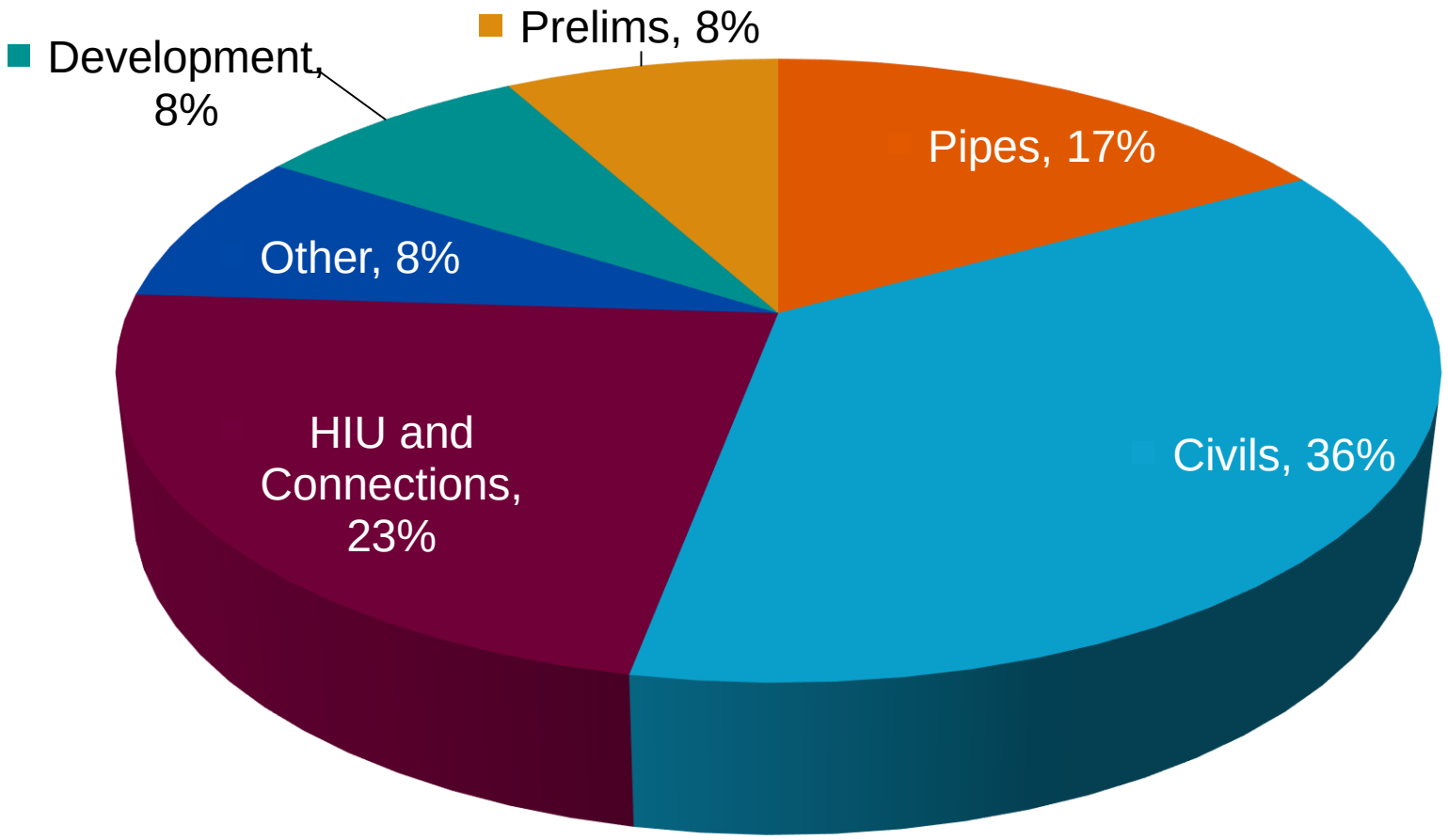
Typology	Details	Number of Properties
A	City centre - commercial / institutional non-domestic buildings	9 buildings with combined peak demand of 21 MW
B	High density flats	512
C	High density terraced housing	400
D	Medium density semi-detached housing	1600
E	Low density semi-detached / detached housing	800

Baseline Network Specifications

- The baseline design assumes the following key characteristics to represent common and good practice
  - Flow temperature peak of 90°C, reducing to 70°C in the summer, with a return temperature at peak demand of 60°C
  - Radiators retained in all buildings
  - Plastic twin pipes for diameters ≤50mm. Steel pre-insulated pipes for ≥80mm diameter
  - Indirect HIUs with instantaneous hot water for all dwellings. Blocks of flats also have an indirect (heat exchanger) connection at ground level
  - All pipes buried in the ground using conventional trench excavation
- These design assumptions vary within some of the solutions

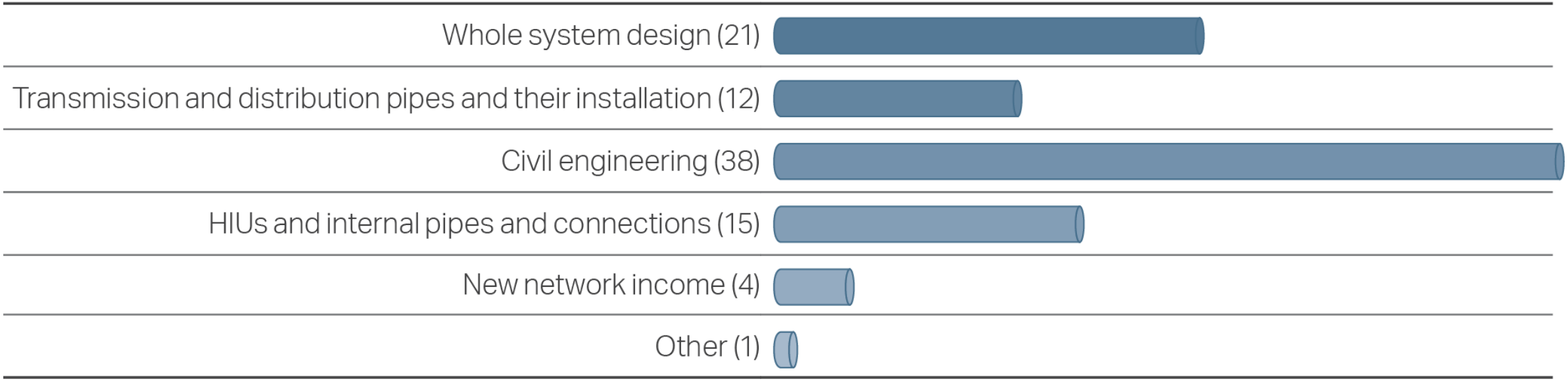
Baseline Network Costs

- Total CAPEX is £63M; 72% from the network and 28% from the energy centre
- Installation costs based on delivery of good practice in the UK (CIBSE/ADE Heat Networks Code of Practice)
- Operational cost of the network itself is ~26% of the capital cost of the heat network based on a NPV calculation over 25 years with a 6% discount rate



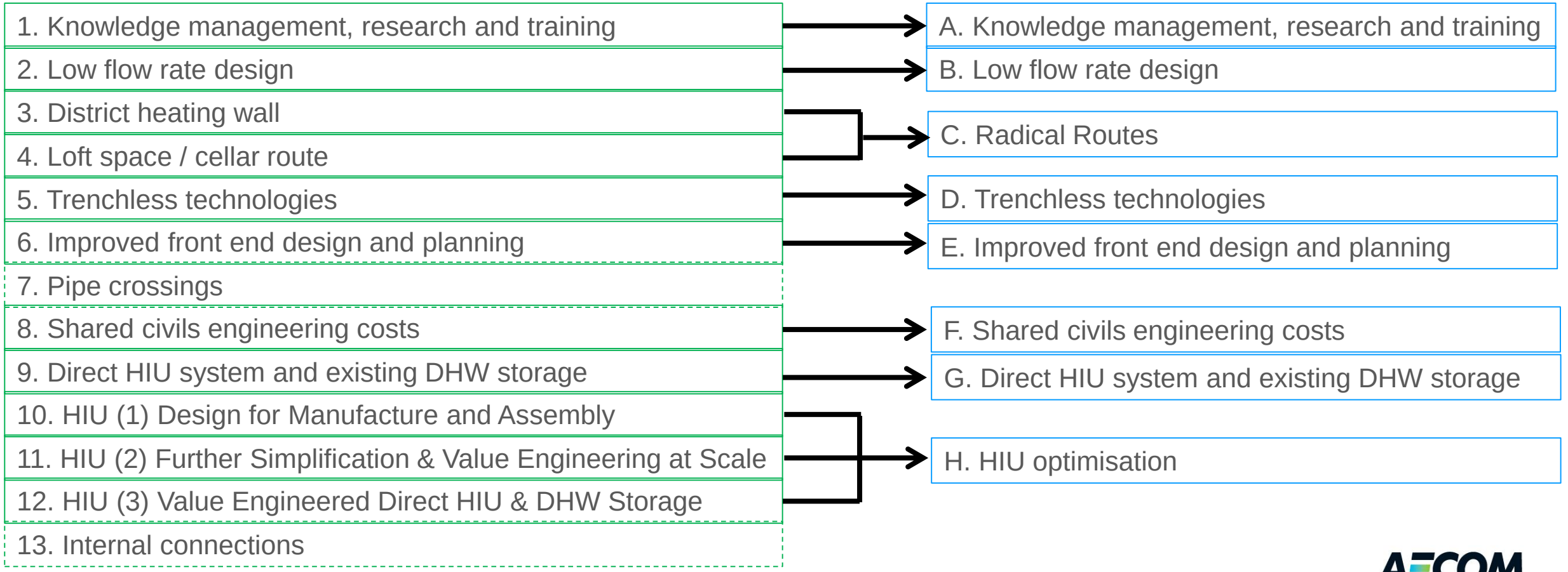
SOLUTIONS AND ROUTE MAPS

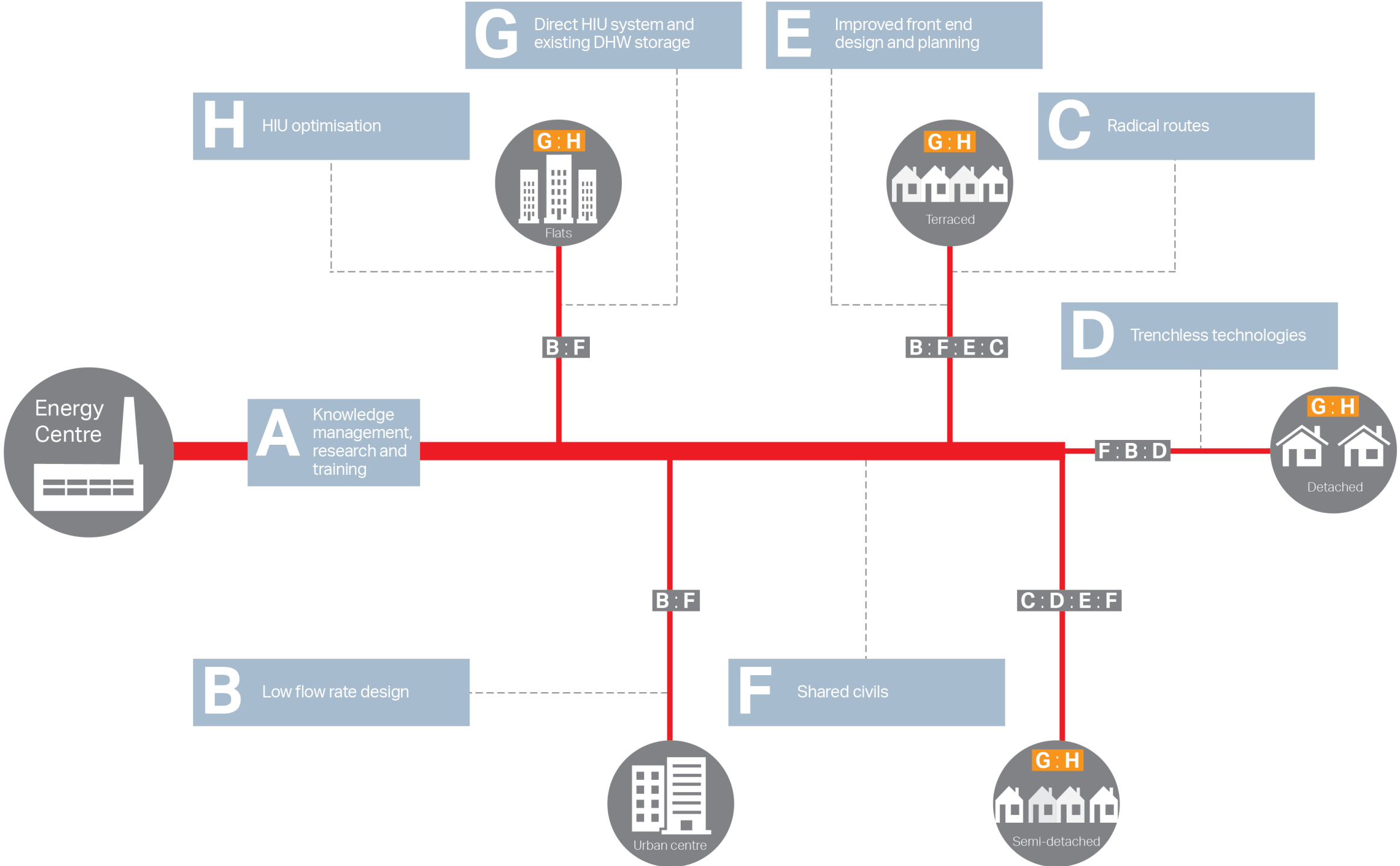
Overview of solutions



Overview of solutions

- 11 of the 13 green solutions were taken forward for route mapping
- Total 8 route maps were developed; 2 route maps comprise multiple linking solutions



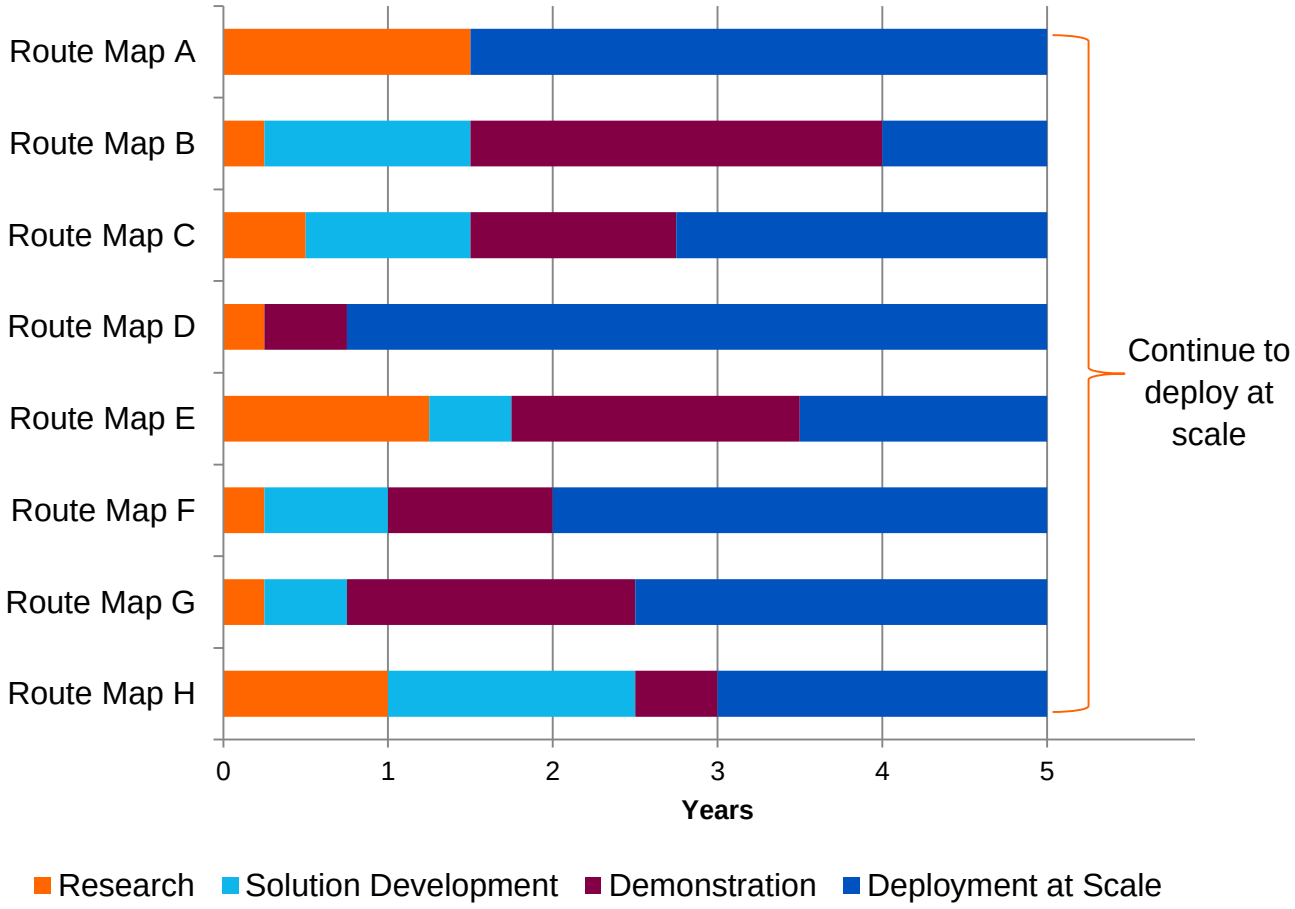

G Direct HIU system and existing DHW storage
E Improved front end design and planning
H HIU optimisation
C Radical routes
G : H
Flats
G : H
Terraced
D Trenchless technologies
B : F
B : F : E : C
Energy Centre
A Knowledge management, research and training
G : H
Detached
F : B : D
B : F
C : D : E : F
B Low flow rate design
F Shared civils
Urban centre
G : H
Semi-detached

CAPEX reduction from solutions within the optimum mix

	A: Centre	B: Flats	C: Terraces	D: Semis	E: Detached	Primary	Prelims	Total
Knowledge Management	3%	3%	3%	3%	3%	3%	3%	3%
Low Flow Rate Design	13%	0%	1%	0%	0%	10%	0%	2%
Radical routes	0%	0%	9%	0%	0%	0%	0%	1%
Trenchless Solutions	0%	0%	0%	14%	16%	0%	32%	11%
Improved Front End Design	8%	1%	6%	0%	0%	3%	5%	2%
Pipe Crossings	0%	0%	0%	0%	0%	13%	0%	2%
Shared Civils	2%	1%	1%	2%	2%	1%	0%	1%
HIU Optimisation	0%	24%	11%	10%	9%	0%	0%	8%
Internal connections	0%	5%	6%	2%	2%	0%	0%	2%
								32%

Overview of Route Maps

- Short time period to deliver significant benefits
- Opportunities to reduce investment
  - Combine market research
  - Combine demonstration projects
- May be challenging to implement all together
  - If so progress individually
  - No solution dependent on another



Funding of Route Maps

- The funding of the route maps is assumed to be obtained from four sources. Other alternative forms of funding may be available.
  - BEIS-HNDU funding is proposed for fundamental research work and dissemination
  - Innovate UK funding is proposed to support manufacturers developing a product
  - Strategic Energy funding is proposed to support demonstration projects
  - Industry funding especially manufacturers who would be developing new products

Funding of Route Maps

Route Map	BEIS-HNDU (£k)	Innovate UK (£k)	Industry Match Funded (£k)	Strategic Energy Funding (£k)	Total (£k)
A	2,135	-	-	-	**2,135**
B	172	-	20	141	**333**
C	187	120	120	15	**442**
D	40	1,600	1,600	70	**3,310**
E	194	-	-	55	**249**
F	271	-	-	95	**366**
G	£97	90	90	139	**416**
H	158	3,700	3,700	-	**7,558**
TOTAL	**£3,255k**	**£5,510k**	**£5,530k**	**£515k**	**£14,809k**

WHAT ABOUT YOU?

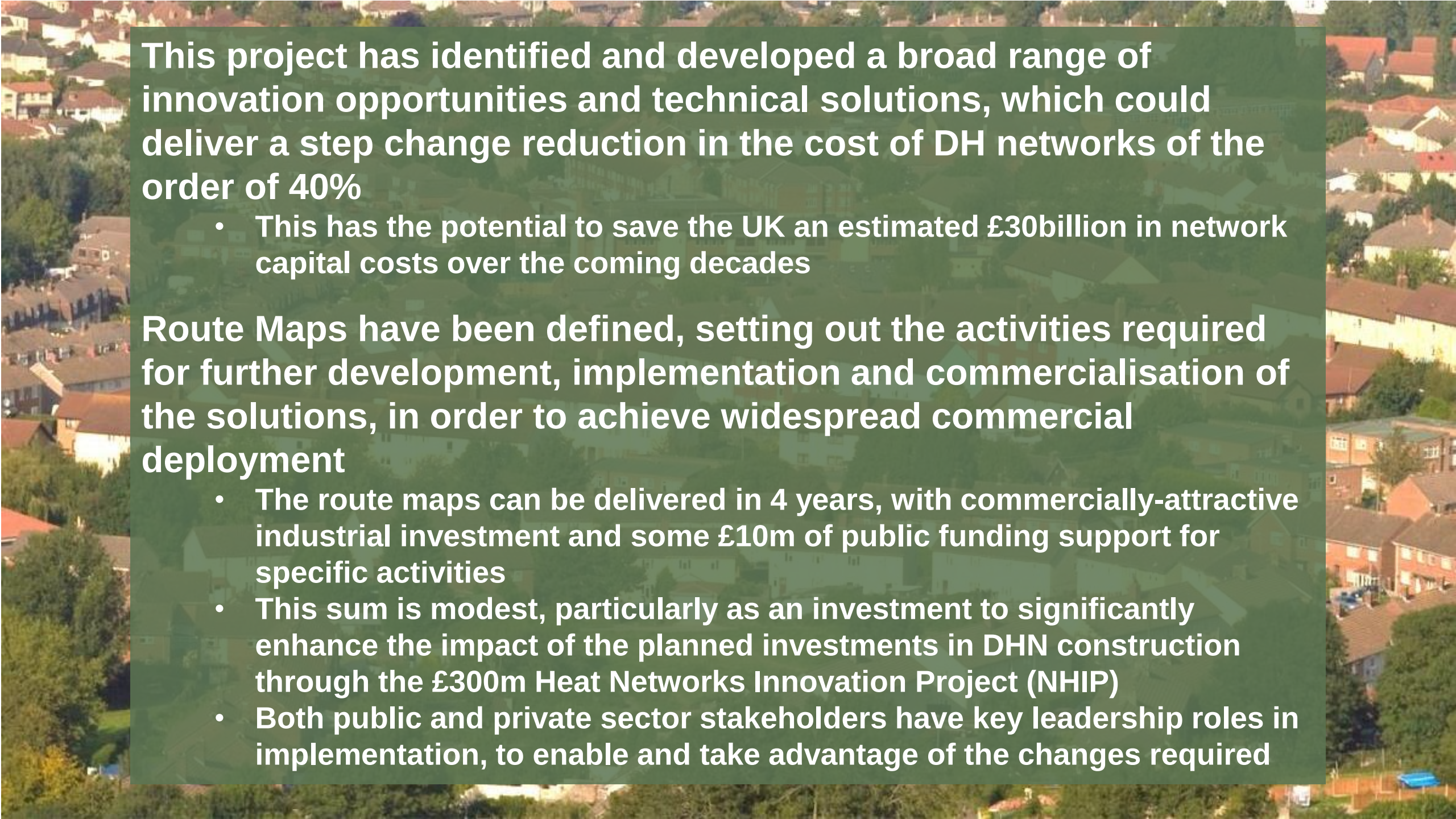
Summary

What needs to be done?

- Align policy across multiple impacted teams
- Support demonstration projects, including owned housing
- Encourage FEED

Why?

- Reduce cost
- Improve certainty of outcomes
- Reduce disruption
- Gain confidence to mandate DH for low carbon development



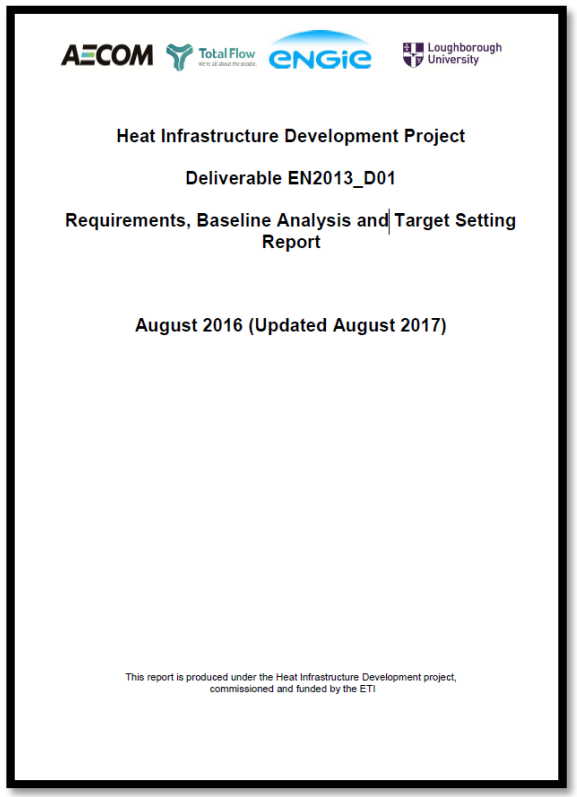
This project has identified and developed a broad range of innovation opportunities and technical solutions, which could deliver a step change reduction in the cost of DH networks of the order of 40%

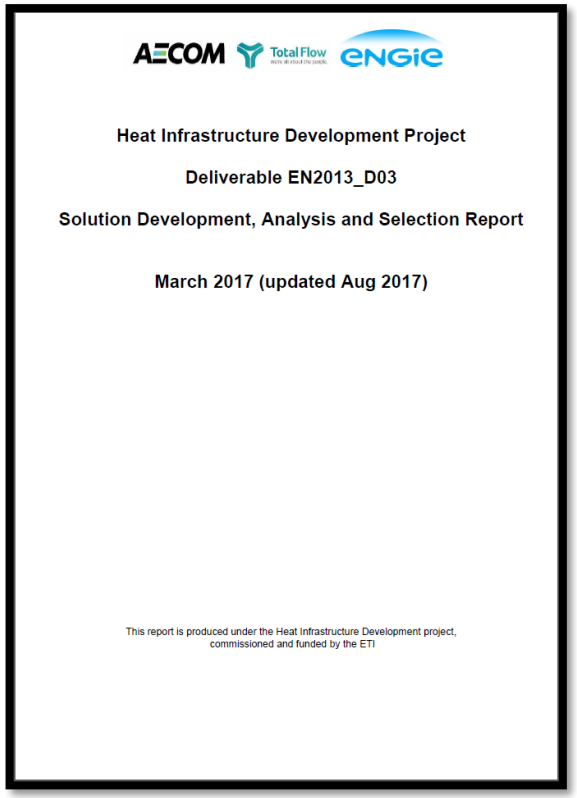
- **This has the potential to save the UK an estimated £30billion in network capital costs over the coming decades**

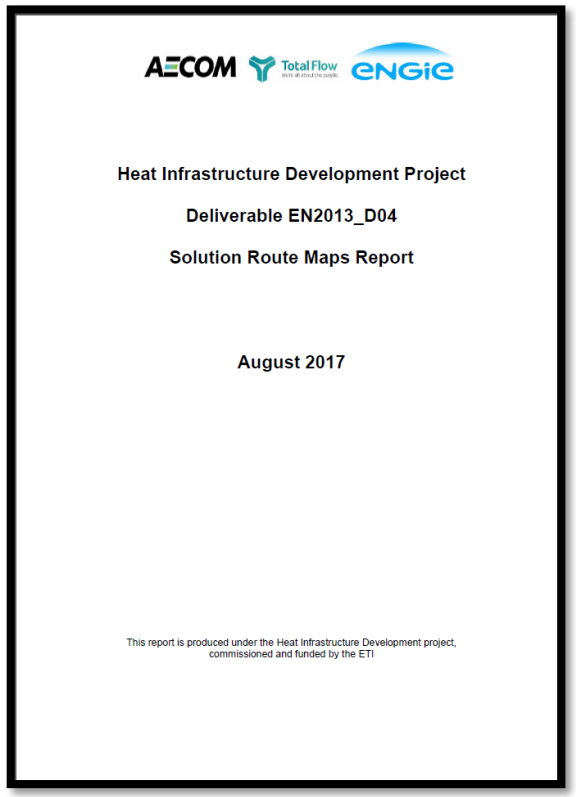
Route Maps have been defined, setting out the activities required for further development, implementation and commercialisation of the solutions, in order to achieve widespread commercial deployment

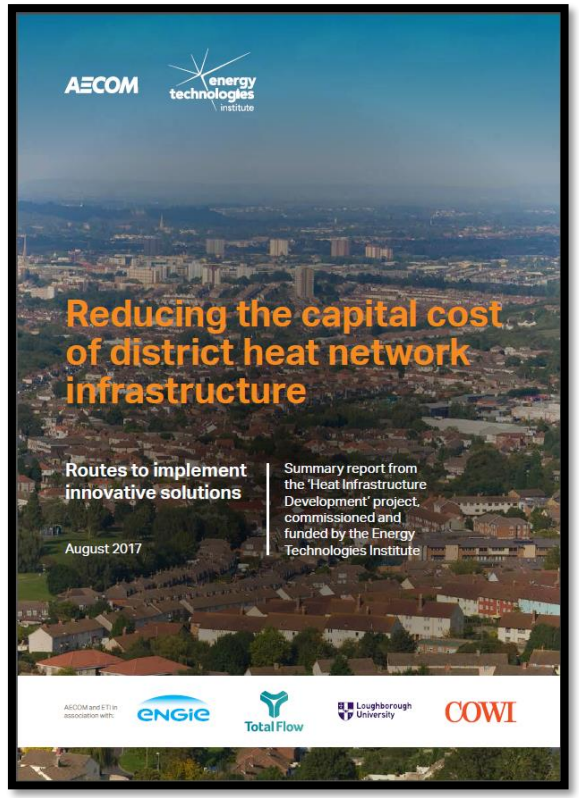
- **The route maps can be delivered in 4 years, with commercially-attractive industrial investment and some £10m of public funding support for specific activities**
- **This sum is modest, particularly as an investment to significantly enhance the impact of the planned investments in DHN construction through the £300m Heat Networks Innovation Project (NHIP)**
- **Both public and private sector stakeholders have key leadership roles in implementation, to enable and take advantage of the changes required**

Publications









Contact

If you have any questions about this project, please get in touch with me:

Alex.Buckman@es.catapult.org.uk

Also, the ESC is planning a Local Area Energy Planning conference on June 19th. For more information on this please contact:

suzanne.coles@es.catapult.org.uk

Registered Office
Energy Technologies Institute
Charnwood Building
Holywell Park
Loughborough
LE11 3AQ

For all general enquiries telephone the ETI on 01509 202020.

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