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& Industrial Strategy

Heat Network Skills Review

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Glossary of terms

Term	Definition
ADE	The Association for Decentralised Energy
BAME	Black, Asian and Minority Ethnic
BEIS	Department for Business, Energy and Industrial Strategy
BIS	Department for Business, Innovation and Skills
BSE	Building Services Engineering
CAD	Computer Aided Design
CAFM	Computer Aided Facility Management
CCC	Committee on Climate Change
CIBSE	Chartered Institution of Building Services Engineers
CMA	Competition and Markets Authority
CPD	Continuing Professional Development
CP1	CIBSE Heat Networks: Code of Practice for the UK
CSCS Card	Construction Skills Certification Scheme Card
DEL	Department for Employment and Learning (Northern Ireland)
DfE	Department for Education
DHVN	District Heating Vanguards Network
ECITB	Engineering Construction Industry Training Board
EEEG	East of England Energy Group
ESCo	Energy Service Company
ETI	Energy Technologies Institute
EV	Electric Vehicle
GDPR	General Data Protection Regulations
GHNF	Green Heat Network Fund
GSHP	Ground Source Heat Pump Association
HIU	Heat Interface Unit
HNC	Higher National Certificate
HND	Higher National Diploma
HNDU	Heat Networks Delivery Unit

Term	Definition
HNIC	Heat Networks Industry Council
HNIP	Heat Networks Investment Project
HVAC	Heating, Ventilation and Air Conditioning
ILO	International Labour Organization
IPPR	Institute for Public Policy Research
LCITP	Low Carbon Infrastructure Transition Programme
LCREE	Low Carbon and Renewable Energy Economy
LEP	Local Enterprise Partnership
LMI	Labour Market Information
MAC	Migration Advisory Committee
MHCLG	Ministry of Housing, Communities and Local Government
M&E	Mechanical and Electrical Engineering
NSAR	National Skills Academy Rail
NEC	New Engineering Contract (NEC) / NEC Engineering and Construction Contract
NESTA	National Endowment for Science, Technology and the Arts
NOS	National Occupational Standard
NSSG	Nuclear Skills Strategy Group
NVQ	National Vocational Qualifications
OfS	Office for Students
ONS	Office for National Statistics
RHI	Renewable Heat Incentive
SIC	Standard Industrial Classification
SHP	Social Housing Provider
SHNP	Scottish Heat Network Partnership
SOC	Standard Occupational Classification
SOMS	Sales, Operations and Maintenance Set
SSC	Sector Skills Council
STEM	Science, Technology, Engineering and Maths
UK DEA	UK District Energy Association

1. Executive Summary

This chapter provides an overview of the project objectives, key findings, conclusions and recommendations.

1.1 Research aims and objectives

Heat networks were first installed in the United Kingdom (UK) in the 1950s; but while they are a crucial aspect of the path towards decarbonising heat, they currently service only 2% of heat demand in the UK. The Committee on Climate Change (CCC) has estimated that this figure will have to increase to 18% by 2050 if the UK is to meet its carbon targets cost-effectively[1].

While there is a growing heat network market in the UK, supported by government investment, there is a risk that the UK heat network supply chain may not attain capability and capacity needed at a pace that keeps up with market growth. This research was commissioned by the Department for Business, Energy and Industrial Strategy (BEIS) to provide evidence on what supply chain skills are required and what current and future skills gaps exist that might prevent these ambitions from being reached. The Research Questions (RQs) posed by BEIS were:

- **RQ1**: What is the existing skills base in the supply chain and its segments and how can this be increased to meet future demand? (capacity)
- **RQ2**: What is the current capability to deliver the volume of heat networks (e.g. largely using high temperature and generation through fossil fuels) – and with the transition to net zero (e.g. lower temperature with clean heat solutions), how can that skills base be increased to meet future demands? (capability)
- **RQ3**: What are the risks to heat network deployment in the UK presented by a skills gap in the supply chain?
- **RQ4**: In the context of question (1) and (2), how quickly can skills (the labour force) be mobilised through, (a) training, (b) transfer from other sectors, or (c) migration from countries with existing skills base?
- **RQ5**: What is the role of government in supporting growth in the heat network skills base?

1.2 Methodology

A consortium of IFF Research, ACE Research and Dr Tanja Groth conducted this study between January and May 2020. The study had two broad phases: the first included a literature review and a skills mapping exercise; the second involved primary data collection, consisting of 25 interviews and 4 workshops with membership associations, consultancies, energy service companies (ESCos), local authorities and training providers.

[1] Committee on Climate Change (2015). The Fifth Carbon Budget: The next step towards a low-carbon economy.

1.3 Key findings

Literature Review

The findings of the literature review can be categorised into several themes, as below. It is important to note that, with limited literature specific to the heat network sector, much of the review focussed on the wider energy and engineering sectors.

- **The skills gap:** There were frequent references to institutional skills issues across the energy and engineering sectors that contribute to uncertainty of demand and may be a significant barrier to uptake of heat networks. The literature notes how experienced workers are moving out of the sectors, leading to gaps in the high layers of the workforce, whilst a lack of STEM graduates joining the sectors leads to gaps in the middle layers of the workforce. These gaps, if not resolved, will lead to delays in growth.
- **Diversity:** Energy and engineering sectors struggle to attract a diverse workforce, which not only reduces the talent pool available but also reduces the attractiveness of the sectors overall, further limiting the labour pool available.
- **Lack of statistical data:** The decisions that need to be made surrounding skills provisions are made difficult due to a lack of clarity in occupation and sector definitions in the 'green' economy.
- **The role of national government and devolved administrations:** The literature frequently referenced the need for stable and long-term energy policy, as well as the continuation of funding. This would ensure that investors have the confidence to grow the sector and supply chains, and for government to continue programmes to support the growth of the market.
- **The role of local government:** Local government are considered key stakeholders in the successful deployment of heat networks. However, the literature highlights that a lack of skills and resources within local government, along with weak incentives, are important barriers to deployment.
- **Risks to heat network deployment:** Several reports detail the risk to deployment of heat networks of not tackling skills-based barriers. A lack of expertise and immature supply chains may raise the costs of deploying district heating, lead to a lack of flexibility in system extensions and result in poor outcomes for consumers on heat networks.

Sector and Occupational Profile

The heat network sector sits at the interface between a range of other sectors, particularly energy, engineering and construction. As a result, few individuals work on heat networks without also having a wider skills set which might have been applied in another sector. With no defined sector classification such as Office for National Statistics (ONS) Standard Industrial Classification (SIC), population statistics and skills data are not available for the industry, limiting the extent to which these can be used to provide evidence on skills gaps.

In this research, the optimal approach identified for classifying occupations within the heat network sector from a skills perspective was by project stage and skill set required. This classification is particularly useful as organisations may typically specialise in only one or two stages of the heat network development cycle (with the exception of larger companies and public authorities). However, skills required by the sector may not be specific to one part of the

process, and not every occupation can be classified to just one project stage. The research therefore explored key occupations relevant to the heat network sector. A list of these is provided in Table 5.2 in the main body of the report, while the following diagram (Figure 1.1) visually represents the involvement of different sectors in the process over time as the project develops:

Figure 1.1: Heat network project stages: timing of roles of different sectors

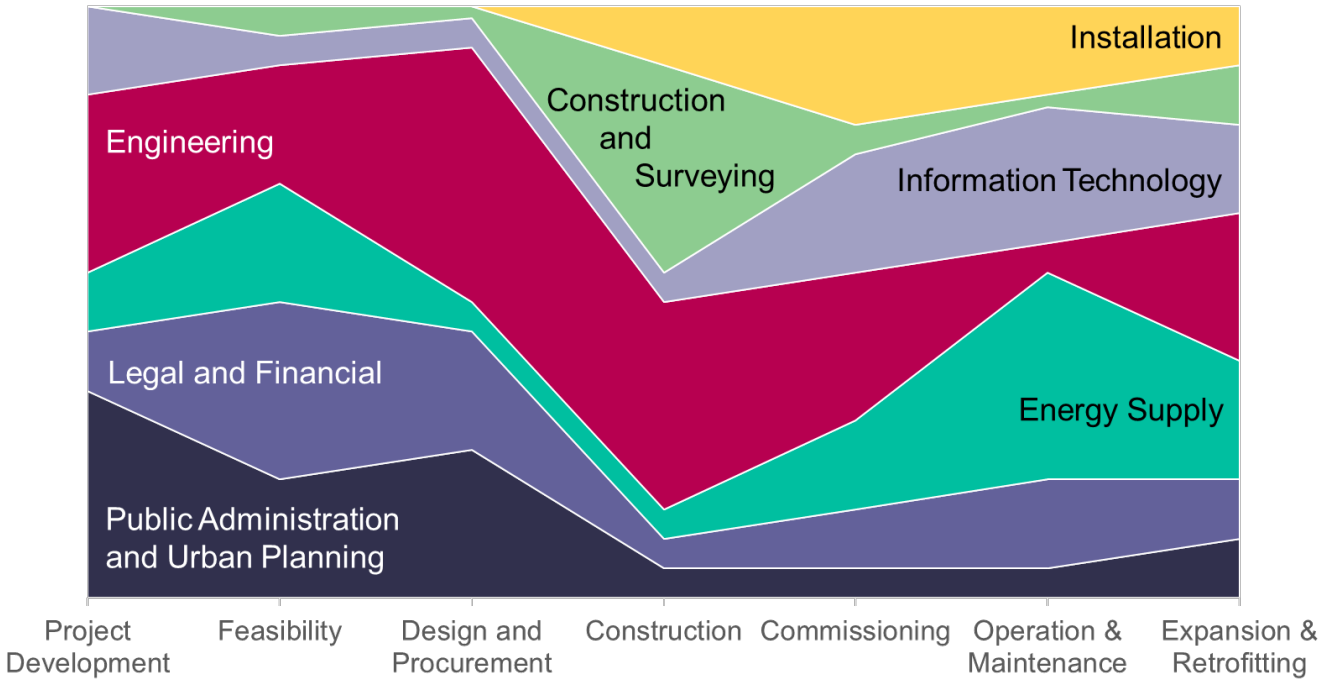


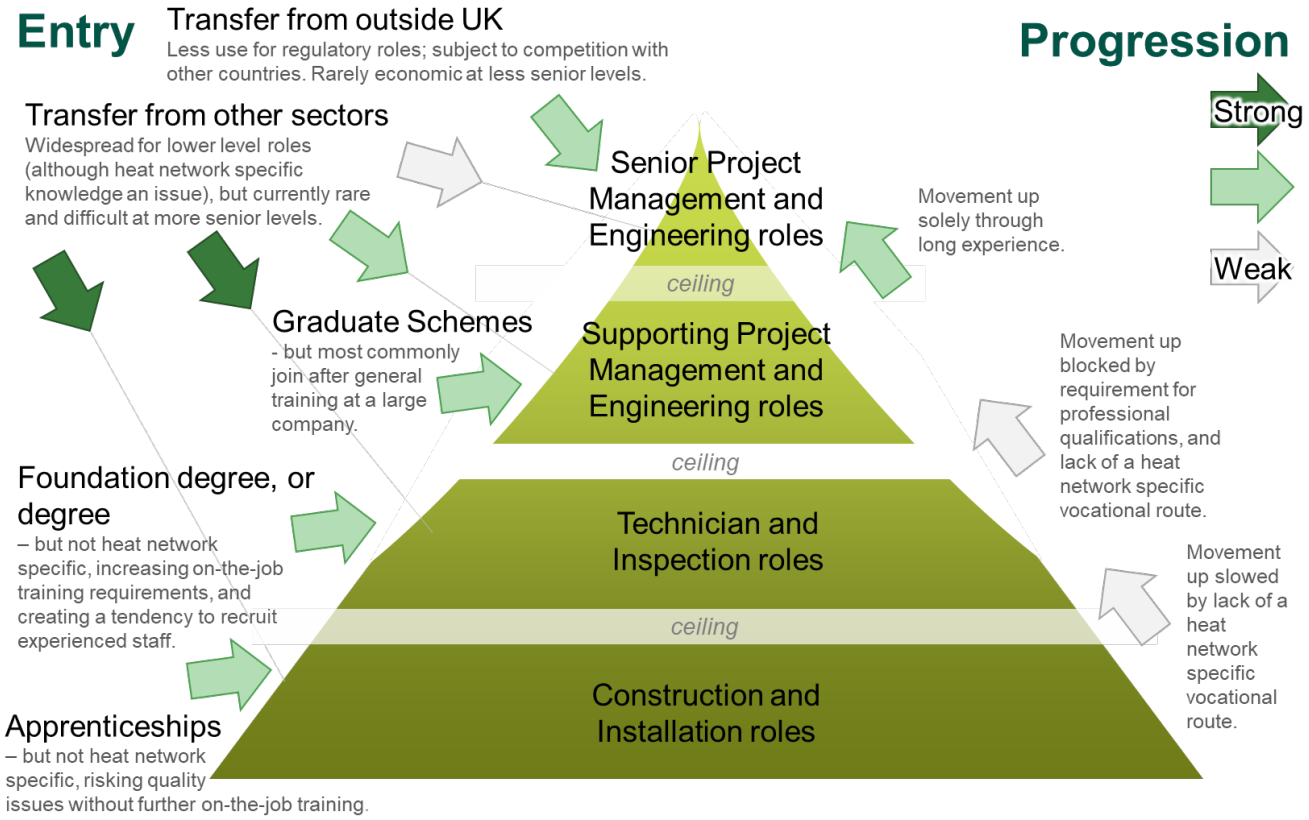
Diagram based on depth interviews and workshop outcomes; project stages taken from CIBSE & ADE (2019). Heat networks: Code of Practice for the UK. 2019. Not a quantitative representation - illustrative of scale of roles of sectors at different stages. Excludes Scientific Research, Heat Generation and Manufacturing, since these are not in the defined scope of the research; Manufacturing is also not specific to a project stage.

The purpose of this research was to determine how the industry might be supported to scale up, but it was noticeable that organisations already struggle to fill a number of vacancies in some key occupations, particularly senior project management and engineering roles. While this shortage occurred across the industry, it was particularly acute in local authorities and, to a lesser extent, housing associations and developers seeking to install a network on a large development. One aspect that is holding back the industry is its lack of diversity: most interviewees considered that the industry was male-dominated.

There are few specialised qualifications for working in the heat network sector, and these are rarely used. Most individuals working in the sector obtain professional or vocational qualifications relevant to their general role, and those installing equipment would generally have a recognised qualification in a related trade. Heat network specific knowledge is generally developed through on-the-job training and supplemented by the short training course run by the Chartered Institution of Building Services Engineers (CIBSE).

Figure 1.2 represents the entry and progression routes in the sector, showing senior roles in the industry at the top, and less senior at the bottom.

Figure 1.2: Representation of entry and progression routes in the sector



Source: Summary of research interviews and workshop participants' input. The arrows represent flows of people, either into the sector at a particular level (on the left) or progressing upward through the sector (on the right). Grey arrows represent weak flows, while green and darker green arrows represent progressively stronger flows. Finally, the horizontal bars represent barriers or 'ceilings' between roles; the paler the colour, the stronger these barriers are.

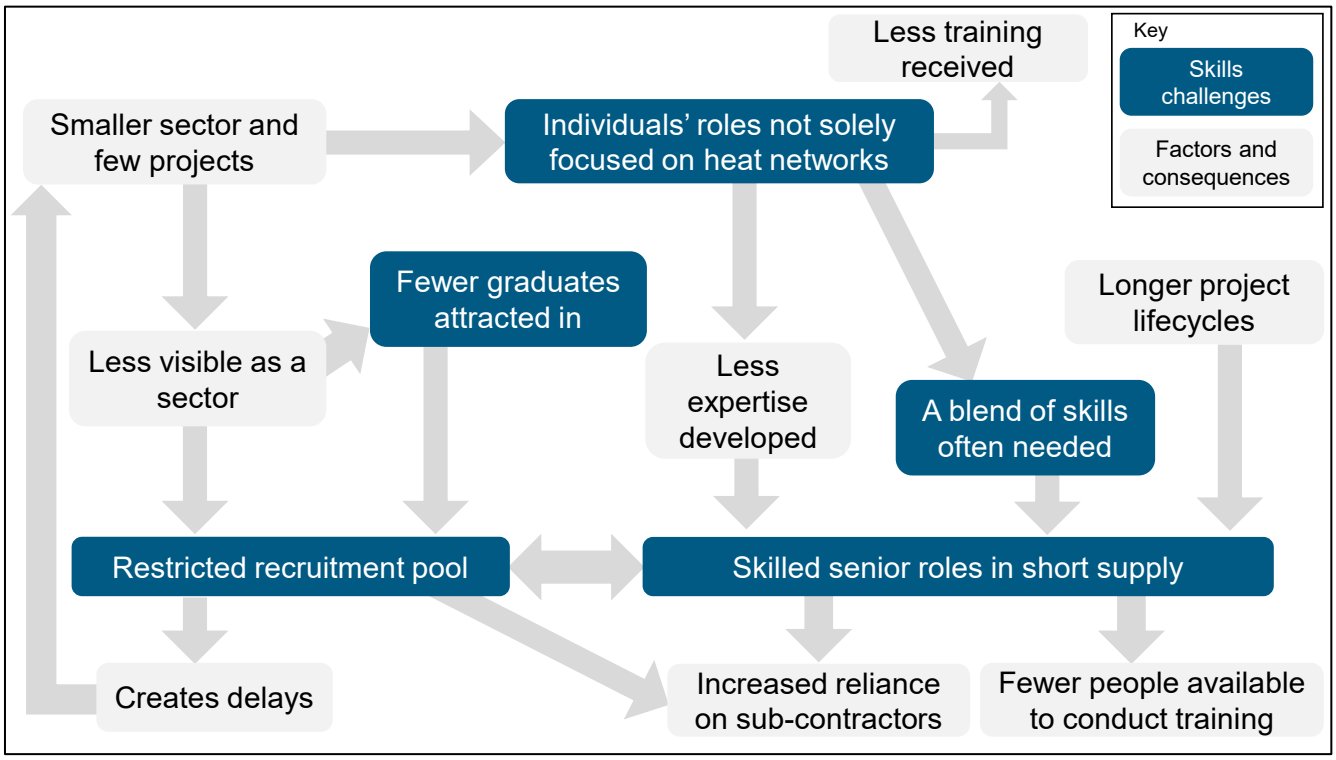
The diagram illustrates a number of weaknesses in the sector's skills and training structures:

- Entry routes are generally through training not specific to the heat network sector, and most often without any heat network-relevant content, leaving individual employers to provide this training (whether formally or informally), and without standardisation or accreditation.
- Although the supply of new entrants to the sector at lower levels has weaknesses, the greater issue in some ways is a shortage of progression opportunities. Movement upward tends to be solely through experience of complete projects.
- Movement up the pyramid is also hampered by the requirement for chartered engineers, including in roles which are predominantly project management oriented, combined with a lack of vocational (e.g. Level 6+ / degree apprenticeship) routes suited to the sector.
- Transfer from other sub-sectors is possible lower down the pyramid, but at the top is hampered by the lack of training to convert high level engineering, project management and other senior level skills from other sectors to a heat network context.

Current and future skills needs

The research identified five important skills challenges, relating to both capacity and capability, that will need to be addressed if the industry is to progress at the pace required. These are illustrated in the chart below, which also demonstrates the factors and consequences of such challenges.

Figure 1.3: Interconnections between current skills gaps



At a specific occupational level, there were noticeable skills gaps in project management and project delivery/development roles, in key technical roles and across legal and financial roles. Typically, individuals in these roles did not have the breadth of skills and experience of heat network projects required to be considered proficient. The table below identifies the skills lacking across each occupation.

Table 1.1: Summary of skills lacking by occupation

Occupation	Skills lacking	Severity of skills gaps
Project Delivery Manager	Challenge finding new recruits with the relevant experience and understanding of the heat network landscape specifically as well as individuals with the commercial skills and experience of procuring large scale projects.	High
Heat Network Development Manager	Typically lack the breadth of roles required in this position, commonly possessing strong project management or engineering skills but rarely both.	High
Energy Master Planner	Acceptance that no-one comes to the role fully proficient Intricate knowledge of heat networks can be lacking among those transferring from other sectors, although most accept that this can be developed. There is also a lack of commercial and legal understanding	High
Control System Specialist	New recruits often do not come equipped with the full range of skills required, and in particular lack direct experience working in the heat network sector.	High
Design Engineer	There is a limited theoretical or practical knowledge and understanding of heat networks, which new recruits will need to learn early on, on the job.	Medium
Commercial / Operations Manager	Suitable business acumen is often the key skill lacking among organisations that struggle to find commercial managers with necessary proficiency.	Medium
Legal Specialist	While there is some relevant knowledge at more junior levels, those at more senior levels typically have limited experience of the heat network sector.	Medium
Financial Specialist	Similar to legal specialists, there is some relevant knowledge at more junior levels; those at more senior levels typically have limited experience of the heat network sector.	Medium
Operations and Maintenance Technician/ Inspector	There is a lack of good problem solvers, i.e. individuals who are able to inspect a system and understand it sufficiently to be able to resolve problems themselves.	Medium
Pipe Layer (including welding)	It is relatively easy for welders to work across different sectors, which means that knowledge of heat network systems themselves is often lacking (although these can be learnt with relative ease).	Low
Installer	It is relatively easy for installers to work across different sectors. The research did not unpick any particular skills lacking in this occupation.	Low

The research explored the transferability of skills from other sectors across to the heat network industry to meet skills needs. There are a range of skills that are transferable from other sectors, including energy, engineering and construction. Most engineers that possess thermodynamic and hydraulic skills are expected to be able to transfer with relative ease. Such transfers are suitable at junior levels, but it can be more difficult to transfer at senior levels where experience of heat networks is expected. It is considered easier to transfer from neighbouring sectors for those in skilled labour roles, e.g. welders, installers and operations and maintenance technicians, as long as they possess the relevant qualifications. Indeed, a number of stakeholders saw a natural movement of skilled labour staff from the non-renewable sector (e.g. gas) to cleaner energy sectors.

While current skills shortages are a focus, there is a range of skills that will take on increasing importance as the sector develops. This includes: ability of welders/installers to work with plastic rather than steel pipes; greater need for surveyors, meter providers and installers as companies respond to new regulations; adaptability and flexibility towards new technologies; familiarisation with a wider range of waste sources of heat; digital skills; and skills relating to maintenance operations and strategic planning on upgrades.

Current training practices

Overall, the supply of heat network training in the UK was characterised as being relatively informal and ad hoc, with minor exceptions for specific technical expertise. Most organisations are reliant on internal training led by senior heat network experts, at times supplemented by international learning or support from other organisations within the UK. This form of training structure has to date required significant pro bono support across the industry with varying degrees of quality and would significantly benefit from national accredited training standards across both technical and non-technical elements.

Training within organisations was typically semi-formal. It was mostly organised as Continuing Professional Development (CPD) courses with a duration of less than half a day and focused on sharing recent developments in the industry rather than best-practice tools and methodology. Availability of internal training differed significantly according to the size of the organisation, with larger organisations more likely to offer tailored training to both graduates and more experienced staff. There is however an increasing focus on cooperation models to provide training across organisations, even where these organisations are competitors, although these have been ad-hoc and limited to date.

External training provision is more limited but there are a handful of organisations currently providing training and/or accreditation in the heat network industry. Training providers include the Chartered Institution of Building Services Engineers (CIBSE), Stoke on Trent College Heat Academy and the Ground Source Heat Pump Association, among others. These training providers tend to focus on technical qualifications aimed at engineers and/or equipment installers. However, the sector considers that there is a lack of technical courses available to train employees to the required standard. There is limited provision within Higher Education, with relevant degrees such as Mechanical Engineering primarily including only one module on heat transfer, which can broadly be applied to the heat network sector.

Learnings from other sectors

The research identified a number of challenges facing similar industries in meeting the supply skill gap. These include the prevalence of certain organisations with very high staff turnover, the loss of senior, highly skilled workers due to retirement and the real or perceived long-term stability of certain industry segments.

Consistency and stability were highlighted as strong drivers for both skill retention and recruitment in industries. The Offshore Wind Sector Deal[2] has significantly contributed to a reduction in uncertainty for the development of the offshore wind sector, attracting dedicated resources and investment in training and capacity-building. Industries which have suffered from cyclical market or policy changes struggle to attract or retain a skilled workforce; for example, changes to the Feed in Tariff in 2015 had particularly adverse effects for the UK solar industry.

A typical learning from other sectors is the importance of continued capacity building particularly with public sector partner organisations. Furthermore, cross stakeholder collaboration is vital to the success of skills development. A current example operates in the offshore wind sector, where the recently formed Offshore Wind Growth Partnership has established an Investment in Talent Group[3] with a remit of developing skills in the industry. In terms of monitoring skills development and workforce data, the heat network sector can learn from the rail industry, where the National Skills Academy for Rail has introduced a 'Skills Intelligence Model' that asks employers to submit regular information about their workforce and skills needs.

With respect to attracting the talent the sector needs, the heat network sector could learn from other low carbon and renewable sectors in terms of appealing to high quality graduates. The electric vehicles sector in particular was identified as one that has been able to capitalise on graduates' desires to work on low carbon projects. Both the rail and offshore wind industries also offer lessons in targeting individuals to transfer across from other sectors (namely, the armed forces, and offshore oil and gas).

1.4 Conclusions

Conclusions can be arranged by relating them to the original research questions posed by BEIS:

"RQ1: What is the existing skills base in the supply chain and its segments and how can this be increased to meet future demand?" (capacity)

Currently the industry is relatively well equipped – from a capacity perspective – to meet demand in the sector for heat network development. The exception to this is in senior project management and engineering roles, where across the sector there are reports of a limited supply of individuals with the necessary experience of the industry to undertake the role required. In line with broader sectors such as construction and engineering, there is also a lack of diversity in what is a male-dominated industry.

However, the sector appears ill-equipped to respond to the surge in demand for skills that will be required to meet expected growth of the sector. In the short-term, there is expected to be a growing need for surveyors, meter providers and installers, as companies respond to the Government's proposed amendments to the heat network (Metering and Billing) Regulations 2014. Longer term there will likely be an increased demand for energy consultants, facilities and estates managers and those in customer service roles as maintenance and upgrades of heat network developments become more common. But across all occupations, demand is likely to increase considerably due to the amount of development anticipated. There is particular concern in construction and technician roles, where the literature suggests generic

[2] Department for Business, Energy & Industrial Strategy (2019) Offshore wind: Sector Deal.
[3] Ibid.

skills across the economy are in short supply, a trend that is worsening. Furthermore, the industry's demand for graduate level engineers may suffer from a general UK shortage in science, technology, engineering and mathematics (STEM) graduates.

To meet the anticipated capacity requirements, evidence suggests that the sector needs to better facilitate the transfer of skills from outside into the industry, be made more visible and attractive to young people, and be given greater prominence in existing Further Education (FE) and Higher Education (HE) provision.

"RQ2: What is the current capability to deliver the volume of heat networks (e.g. largely using high temperature and generation through fossil fuels) – and with the transition to net zero (e.g. lower temperature with clean heat solutions), how can that skills base be increased to meet future demands?" (capability)

The research identified clear pockets of skills gaps in the industry, while also pointing towards skills needs that are likely to become more important as the sector evolves. Organisations struggle to adequately fill **project management and project delivery/development roles**. This was a particular concern among organisations such as local authorities that are responsible for commissioning heat network developments. There was also some difficulty for the sector in locating individuals for **key technical roles**, ranging from master planning of heat networks to the design and implementation of specialist control systems. As the demand for these skills increases individuals are unable to develop the higher levels of expertise quickly enough to meet demand.

Looking forwards, an expansion in the industry's use and range of waste heat sources will pose wider demands for designers and engineers, as well as commercial and legal challenges for lawyers and project delivery managers. Meanwhile, digital skills will also hold greater value as the sector seeks to harness developing technology (drones, augmented reality etc.) to support its work. Finally, a transition to low temperatures will require installers to adapt to working with plastic rather than metal pipework.

The sector would welcome more standardisation of competencies and qualifications in core roles within the sector, particularly among installers, technicians and design engineers. This would reduce the industry's dependence on using experience to determine a person's skills. It would enable career development; and it would also provide employers with greater confidence in the skillsets of applicants when recruiting. Linked to this, there is a need to develop heat network specific training infrastructure at all levels, including in apprenticeships and in university courses. Furthermore, Continuing Professional Development (CPD) should be encouraged. Finally, there is a need to support those suffering more from a lack of appropriate skills, such as small employers and local authorities, to access and/or develop the skills they need.

"RQ3: What are the risks to heat network deployment in the UK presented by a skills gap in the supply chain?"

This research found that the sector already faces skills gaps, which will simply become more acute as the industry grows in size. If not resolved the industry might be unable to meet the expectation of servicing 18% of heat demand in the UK.

There are also more immediate impacts such as low quality outputs and delays in project delivery. If left unresolved there could be a greater reliance on subcontractors to deliver work that in parallel sectors might otherwise be delivered 'in-house'. Some research participants felt that layered sub-contracting made projects more difficult to manage, and was more costly.

There is also a danger that companies themselves reduce their investment in the sector, as they are unable to attract a proficient workforce.

"RQ4: In the context of question (1) and (2), how quickly can skills (the labour force) be mobilised through, (a) training, (b) transfer from other sectors, or (c) migration from countries with existing skills base?"

There will need to be a period of mobilisation to ensure that the sector is able to access the quality and quantity of skills it requires in order to meet its anticipated demand. Currently the levers considered in this research question are being utilised to varying degrees:

- **Training:** Generally, organisations use internal training to develop skills, but this is often inconsistent, while smaller organisations or departments struggle to provide this themselves. Some external provision is available, but this is limited and would struggle to meet the needs of the sector as demand increases.
- **Transfer from other sectors:** There would be value in targeting particular sectors where there is considerable skills overlap, especially among engineers and installers where it is considered relatively easier to transfer. High-carbon sectors (such as oil and gas) that are likely to decline over the next few decades are likely to be good places to start. It is important to acknowledge that the heat network sector will have to compete with other parallel and growing UK sectors for this finite pool of talent. There may be value in adopting a holistic approach across the growing low-carbon sectors, to ensure they work collaboratively to identify and share out skills rather than undermining each other.
- **Migration from countries with existing skills base:** The report highlights that engineering techniques are transferable from Northern Europe. However, the financial, legal and particularly regulatory environment is different in the UK, so it is unlikely that skills gaps in the project management sphere could be filled in the same way. Nevertheless, the Migration Advisory Committee (MAC) should be engaged, to maintain employers' ability to recruit skilled workers from outside the UK and thus fill their most acute skills gaps.

The evidence suggests that to meet skills demands, training and qualifications will need to be developed and contain sufficient heat network specific content. This includes apprenticeships (at Level 4 for construction and construction installation roles and Level 6/7 in engineering and design roles), degree content and more general CPD. There will be also be value in encouraging transfer of workers from other sectors and abroad to plug more immediate gaps.

"RQ5: What is the role of government in supporting growth in the heat network skills base?"

The sector is already displaying leadership and impetus for meeting the skills challenge, through informal knowledge sharing, some evidence of working with training providers (although existing courses do not cover all skills that are in scope) and conferences hosted by trade bodies. However, there is no global or consistent approach to skills development in the sector.

There is therefore a role for government in terms of facilitating skills development in the sector. A policy and sector scoping exercise incorporating close collaboration between industry and local and national governments will be required following this review. As skills policy is devolved across the four nations, relevant departments within each will need to be involved during this process. This scoping exercise should explore the feasibility of suggested interventions that are designed to support the industry to meet its skills needs. These interventions are summarised in the next section.

1.5 Recommendations

The review identified five broad goals for the sector, with a number of more specific levers feeding into these. They are denoted in Figure 1.4 below. In advance of this, a policy scoping exercise should be undertaken, to test the feasibility of the proposed interventions, with an industry-led skills partnership created, to oversee the development of skills in the industry.

Figure 1.4: Summary of interventions

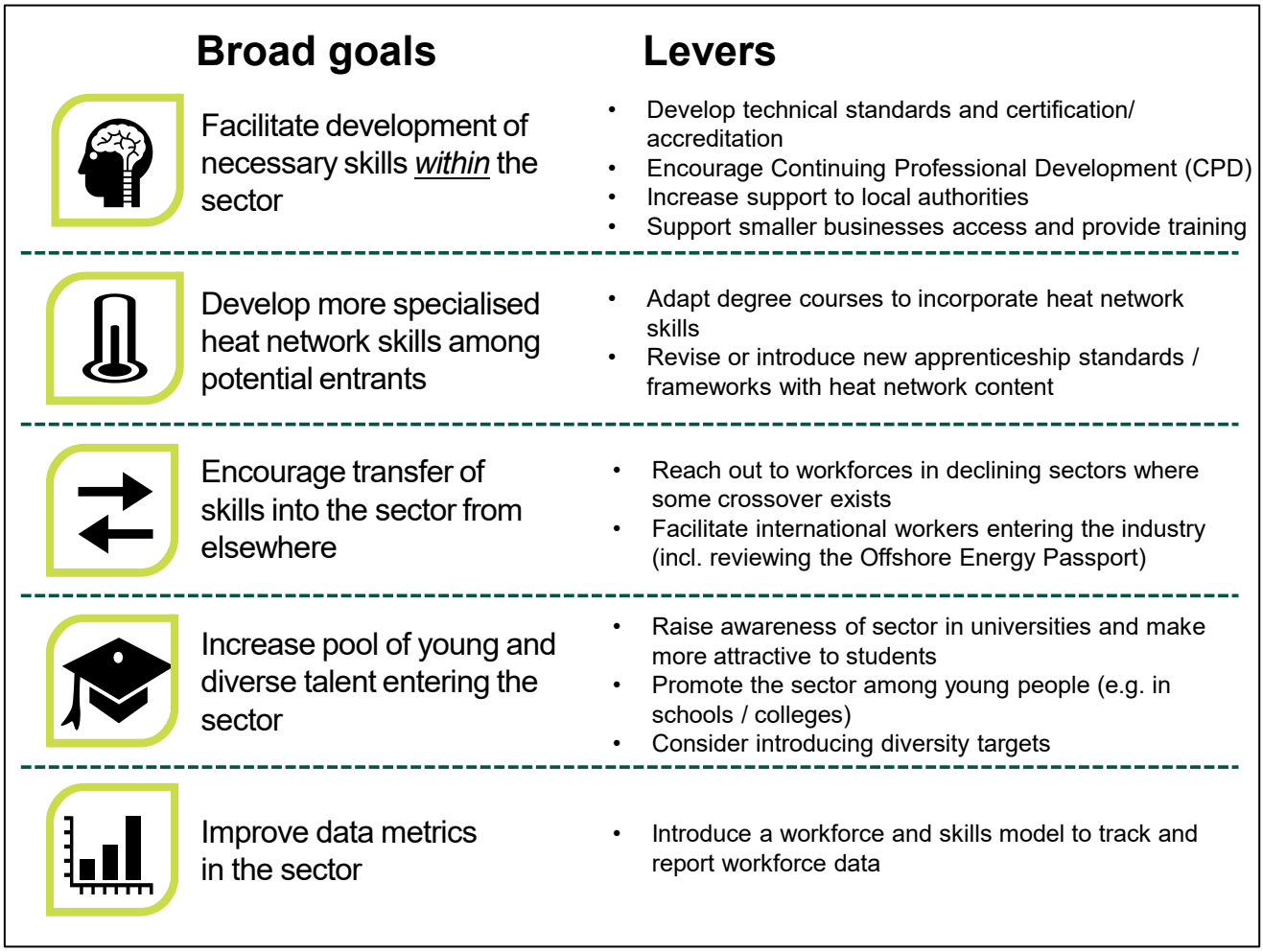
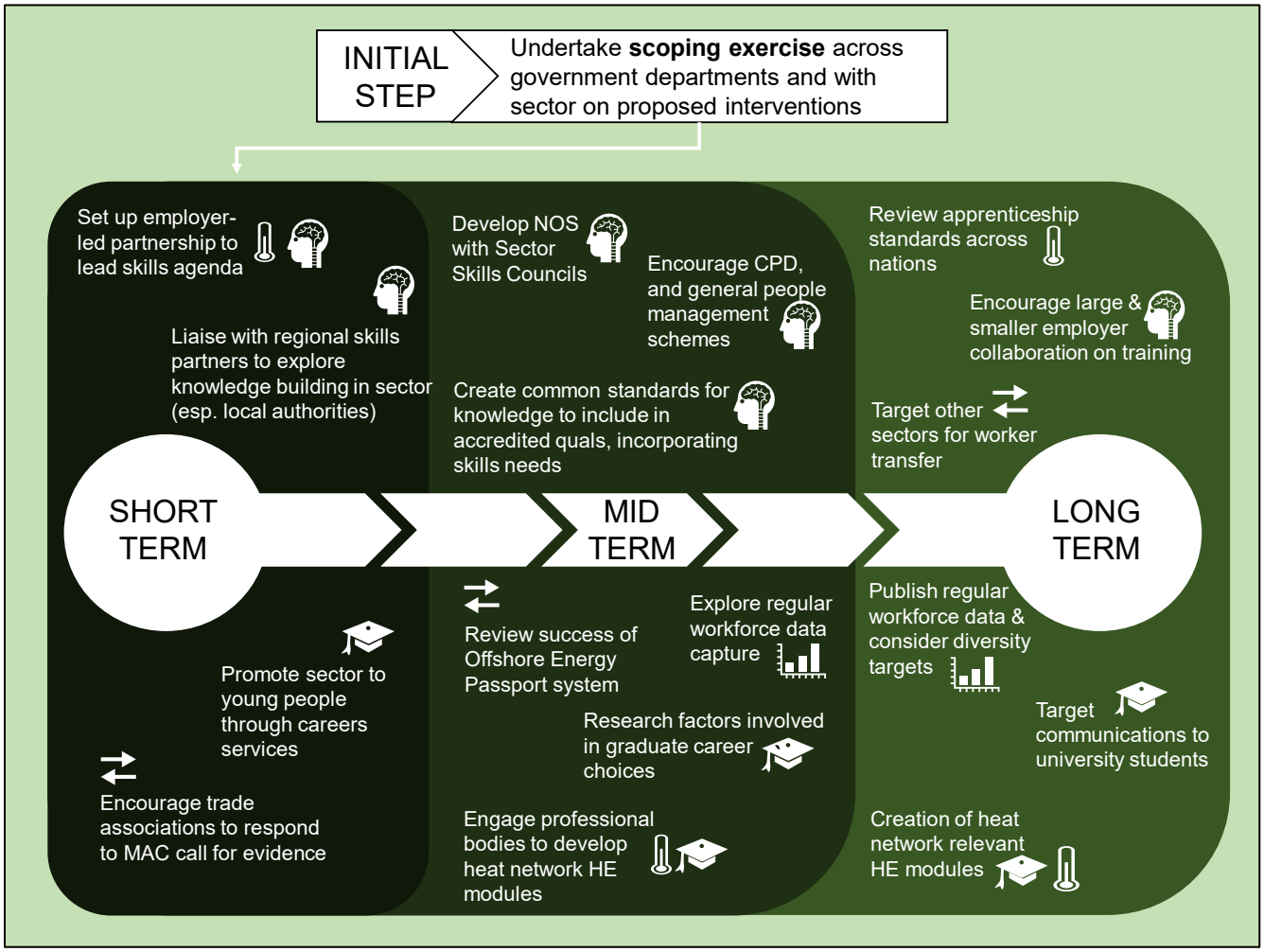


Figure 1.5 overleaf depicts the interventions previously raised and maps them out into an anticipated pathway (the scoping exercise will determine more specific timeframes). Each activity will require different stakeholders' involvement; a list of appropriate stakeholders is contained within the final chapter of the report.

Figure 1.5: Pathway to undertaking interventions



2. Introduction

This chapter outlines the background to the study and subsequent structure of this report.

2.1 Overview of the environment

The UK was one of the first countries to recognise and respond to the societal challenge posed by climate change. The Climate Change Act (2008) committed the UK to reducing greenhouse gas emissions by at least 80% by 2050 when compared to 1990 levels. Then, in 2019, the UK Government set a legally binding target to achieve net-zero greenhouse gas emissions by 2050.

Along with transport, heat in buildings is one of the largest sources of greenhouse gas emissions in the UK, accounting for 23% of total UK's emissions[4]. Heat networks, first installed in the UK in the 1950's, currently provide 2% of UK heat demand. However, it is estimated by the Committee on Climate Change (CCC) that around 18% of UK heat will need to come from heat networks by 2050 if the UK is to meet its carbon targets cost effectively[5]. The technology is viewed in the UK as a means for meeting decarbonisation targets as well as being a vehicle for addressing socioeconomic issues such as fuel poverty, and for increasing the UK's energy supply resilience.

To support decarbonisation of UK heat supply, the Heat Networks Delivery Unit (HNDU) and the Scottish Heat Network Partnership (HNP) were launched to facilitate the identification of technically and financially feasible multi-site networks. This support has been augmented with the launch of grant and loan funding opportunities such as the Heat Network Investment Project (HNIP) in England and Wales and the Low Carbon Infrastructure Transition Programme (LCITP) in Scotland.

In addition, the government has supported the Renewable Heat Incentive (RHI), launched in April 2014, which encourages the adoption of renewable energy technologies by homeowners in Britain. More recently, funding programmes were announced in the government's March 2020 budget including a £270 million Green Heat Network Fund (the scope is intended to be England and Wales, subject to the approval of the Welsh Government on participation), which will encourage new and existing heat networks to adopt low carbon heat sources. These programmes aim to create the environment for a self-sustaining heat network sector, including through building the skills capability of project sponsors and the supply chain[6]. Currently, there are relatively few heat networks in Northern Ireland, however, the potential for heat networks is currently being considered as part of a new Energy Strategy.

Nevertheless, there are numerous barriers and challenges to reaching the CCC's estimate for heat networks. One of the challenges is around skills. There is a risk that the UK heat network supply chain may not attain the capability and capacity required to match the projected market

[4] Department for Business, Energy and Industrial Strategy, 2018, Clean Growth – Transforming Heating: Overview of Current Evidence, December 2018.
[5] Ibid.
[6] Department for Business, Energy and Industrial Strategy, 2020, Heat networks: delivering a market framework.

growth[7]. The UK supply chain will need to expand significantly to meet demand. Whilst there is some evidence on the state of skills in the sector, data is limited and not considered robust.

2.2 Study objectives

This research was set up to support an understanding of the current state of play of skills in the sector, and to set out the practical steps needed to grow the capability and capacity in the UK supply chain. Commissioned by BEIS, it was conducted by a consortium of IFF Research, ACE Research and Dr Tanja Groth.

The overall aims for the project were to:

- Investigate the skills required to design, build (incl. installation), operate and maintain heat networks. The heat generation plant manufacturing and assembling skills are out of scope, however heat distribution and heat interface plant are included. Areas of interaction between manufacturers and heat network developers/installers of hardware, as well as demand and customer management systems will also be considered.
- Identify where skills are currently being developed (e.g. professional education providers, universities, colleges, employers etc.) and sourced (e.g. labour import, related sectors).
- Highlight, if possible, where the heat network supply chain in the UK has particular expertise that could make it internationally competitive, where there are opportunities for growth and which segment could provide highly skilled professions.
- Understand how the UK heat network market can become an attractive and diverse market for new young entrants, those in mid-career related professions (e.g. oil & gas, rail, construction and offshore wind) and conduct a review of barriers to capability and capacity growth in the supply chain.
- Identify potential skills pathways, drawing on successful transformations of other high growth sectors, the available skills today and the necessary heat network market growth by 2050.
- Determine which policy levers and opportunities have the highest likelihood of growing and accelerating the capability and capacity of the UK heat network supply chain, while minimising disruption in the transition to low carbon heating.
- Provide specific, practical and timely recommendations for government interventions and industry leadership.

[7] Department for Business, Energy and Industrial Strategy, 2018, Heat networks: ensuring sustained investments and protecting consumers.

The Research Questions (RQs) posed by BEIS for the project were:

- **RQ1**: What is the existing skills base in the supply chain and its segments and how can this be increased to meet future demand? (capacity)
- **RQ2**: What is the current capability to deliver the volume of heat networks (e.g. largely using high temperature and generation through fossil fuels) – and with the transition to net zero (e.g. lower temperature with clean heat solutions), how can that skills base be increased to meet future demands? (capability)
- **RQ3**: What are the risks to heat network deployment in the UK presented by a skills gap in the supply chain?
- **RQ4**: In the context of question (1) and (2), how quickly can skills (the labour force) be mobilised through, (a) training, (b) transfer from other sectors, or (c) migration from countries with existing skills base?
- **RQ5**: What is the role of government in supporting growth in the heat network skills base?

This research is complemented by a Scottish Government study into skills gaps in heat network supply chains in Scotland and the associated development of training provision. This work is due to be published later in 2020.

This report is intended to provide an overview of the current skills composition, shortages and demands as well as training provision and qualifications. The conclusion section highlights findings and recommendations so that the industry can be better supported to expand, and thus contribute to meeting the UK's target of net-zero greenhouse gas emissions by 2050.

3. Methodology

This chapter outlines the methods used to collect and analyse relevant data.

The study's objectives were broad and ambitious. As this is a very small industry there is little existing data that can provide insight into its skills needs. It was therefore important to consider a range of sources and methods to access the data needed, including literature reviews, interviews, workshops, and assessments of parallel sectors.

The study entailed four stages as listed below:

1. Literature Review
2. Skills mapping exercise
3. Stakeholder Interviews and Workshops
4. Final report

3.1 Literature Review

A comprehensive, desk-based review was undertaken in February 2020 of existing literature (both academic and grey) detailing approaches to delivering skills in the heat network sector, and other relevant sectors. Literature was identified through three routes:

1. ACE Research's networks were used to engage with industry stakeholders to identify sources of literature and data, incorporating international activity of relevance as well.
2. A collection of search terms was entered in search engines to locate suitable online literature.
3. Citations and references within each document reviewed were inspected to source additional literature of relevance.

A total of 76 documents were reviewed: 7 white (peer reviewed academic) documents, 18 government publications and 51 grey (industry) documents. The review explored examples of common, good practice at a local, regional, national or international scale; the success factors which underpin these examples; and their transferability to the UK to develop capability and capacity in the heat network supply chain. The review was continually updated throughout the course of the study as new literature came to light, and in response to BEIS and other stakeholder feedback.

The full literature review can be found in a separate technical document, with a short summary of key findings reported in Chapter 4: Literature Review.

3.2 Skills mapping exercise

A skills mapping exercise identified key occupations in the sector, reviewed skills needs, and determined qualifications currently available and progression opportunities.

This examined both the demand side, i.e. what skills employers in the industry look for, and the supply side, i.e. what training provision and qualifications are available to support individuals in the sector to acquire the skills they need. The work was undertaken alongside the literature review, in February 2020.

The demand side followed a relatively iterative approach:

1. Key occupations in the heat network sector were scoped and defined. This consisted of assessing literature collated as part of the literature review, engaging members of the Association for Decentralised Energy (ADE), one of two industry representatives for the heat network industry (the other being UK DEA), and by searching for job advertisements in the sector by looking at:
    - Advertisements for vacancies on the websites of major employers in the sector. A list of major employers in the sector was provided for this purpose by ADE, drawing on their knowledge of the sector's structure.
    - Advertisements for vacancies on recruitment websites. Search terms were identified via literature submitted and discussions within the research team, drawing on their understanding of the sector.
2. These occupations were mapped across to standard occupational classifications (SOC), to enable exploration of these codes across existing datasets.
3. Organisations' careers and vacancies pages, and recruitment websites, were reviewed to identify the experience, qualifications, and skills required for these identified occupations.
4. A broad review of existing datasets explored typical skills gaps among the SOC codes identified as relevant to heat network occupations. The Employer Skills Survey, a biennial survey conducted by IFF Research on behalf of the Department for Education, was of most value here. Returning the views of c. 90,000 UK employers, it provides a detailed source of skills shortage vacancies to 4-digit SOC level across the whole economy. NESTA's UK Skills Taxonomy, recruitment websites and organisation vacancy webpages were also used to determine the skills needed by workers in the UK.
5. It was important to understand where in the development of a heat network such occupations and accompanying skills were required. Through desk research, approaches undertaken to map out the cycle of a heat network development, e.g. by product or technology or project stage, were explored.

On the supply side, data made available by the Higher Education Statistics Agency (HESA) were used to determine statistical information regarding the number and type of students undertaking degrees of relevance to the heat network sector. Through desk research other provision of training, for example from private providers, was identified and assessed.

3.3 Stakeholder Interviews and workshops

Primary data collection consisted of 25 depth interviews with stakeholders of the heat network industry, alongside four workshops. Primary data collection took place in March and thus coincided with the outbreak of Covid-19. Therefore, all fieldwork was conducted remotely, via telephone or video conference.

The Market Research Code of Conduct and Confidentiality was adhered to during data collection and participants were made aware of this. Participants were asked to sign and return consent forms to confirm what level of anonymity they would like if any of their contributions were referenced within the research. Within this report participants are identified by the type of organisation they represented.

Stakeholder Interviews

A number of approaches were used to recruit interviewees, utilising various sampling techniques. Firstly, an online recruitment form was disseminated to BEIS contacts and ACE Research's networks, outlining the purpose of the research, and checking their eligibility and availability (opportunistic sampling). Those responding to the form were asked to provide details of other organisations or individuals whom they thought could contribute to the research (snowball sampling). Furthermore, where there were considered to be gaps in these networks, a purposive sampling approach was adopted, with relevant organisations identified online and contacted directly. Participants were typically senior individuals within their company with some responsibility for, or oversight of, recruitment and training. Through the literature review and skills mapping exercise it became clear that the sector uses consultancies to perform a range of services and so these formed a large number of the interviewees. The majority are engineering consultancies, involved in design of the network and supporting build; some specialised in law; others in broader sustainability and environmental considerations.

Two distinct topic guides were created for the depth interviews, which lasted an average of 60 minutes. The first was directed at ESCos, consultants, membership associations, and local authorities and the second was designed for training providers. An example topic guide can be found in Appendix A.

Fieldwork was conducted between 18th March and 31st March 2020 and a total of 25 interviews were completed (Table 3.1).

Table 3.1: Interviews undertaken by type of organisation

Organisation type	No. interviews
Association	2
Consultancy	12
ESCo	6
Local Authority	2
Training provider	3

Workshops

Workshops were included in the research to enable stakeholders to come together to hear views from others and consequently encourage discussion and debate. As with the stakeholder interviews, they were used to discuss the information that had been obtained from the literature review and skills mapping exercise.

The workshops were open to a broader group of participants. As these were hosted online a wider audience could be reached, including those from social housing providers (SHPs),

parallel sectors, professional bodies, trade associations and those from overseas networks. Participants were drawn from ACE Research's network.

The discussion guide for the workshops consisted of four broad sections, as below:

- Current skills gaps in the sector
- Impact of skills gaps in the sector
- How the sector is working to reduce skills gaps
- Transferability of skills across sectors

Four workshops were conducted between 16th March and 26th March 2020, with a total of 37 attending (Table 3.2)

Table 3.2: Attendees at workshops by type of organisation

Organisation type	No. of stakeholders
Association	6
Consultancy	8
ESCo	6
Local Authority	7
Social Housing Provider[8]	7
Training provider	2
Other	1

Analysis of data

The stakeholder interviews were written up using an analysis framework (in Excel) which grouped information into key themes and questions. Key quotations from interviewees were also highlighted and these have been used throughout this report. The workshops were transcribed and then analysed by the research team for points of consensus.

Shortly after all interviews and workshops had taken place, the research team conducted an initial analysis session to reflect on the content of both and start summarising the key findings to inform this report. This was then supplemented over the course of report writing with smaller focussed discussions between the research ream and BEIS.

[8] There were a higher number of social housing providers present at the workshops following engagement with individuals at an ADE Heat Network session.

3.4 Data limitations

While every effort has been taken to ensure that the findings presented in this report are as accurate and reliable as possible, it is important to note some limitations of the research.

From a sampling perspective, using a qualitative approach means that the findings may not necessarily be representative of the whole UK heat network sector. The sampling approach was not random, which introduces potential biases into the findings. Further consultation across the sector will be needed when looking to effect the recommendations proposed in this report.

The research was conducted over a short timeframe (less than six months) which impacted on elements such as stakeholder recruitment as well as reducing the amount of time to engage more widely with the sector to inform the research. Furthermore, stakeholder engagement occurred in March 2020, just as the UK entered into lockdown as a result of Covid-19. While this had limited impacts on stakeholder willingness to engage, it does mean that responses do not in likelihood fully reflect the UK heat network market once the UK begins its economic recovery.

Finally, the research was limited by the lack of available secondary data pertaining to the heat network industry and its workforce. This report therefore necessarily places greater emphasis on views, opinions and perspectives.

4. Literature Review

The project team reviewed a total of 76 documents. These included 7 white (peer reviewed academic) documents, 18 government publications and 51 grey (industry) documents. This literature was identified by the BEIS heat network team, as well as literature sourced from within the research team and stakeholders that participated in this research.

A comprehensive overview of these documents can be found in a separate technical document, with a short summary in this section of the report.

It is important to note the limitations with the literature reviewed, however. There were only 18 documents that specifically related to skills provisions in the heat network sector, but these were not in depth studies. A list of all documents reviewed can be found in Appendix B.

While the focus was on literature relating to the heat network sector, the team also reviewed literature from the wider energy and engineering sectors, those sectors with transferable skills and those sectors that have experienced high growth. These sectors included heat pump manufacturing, solar power and solar thermal development, offshore wind development and combined heat and power manufacturing, and literature is referenced in both this section and Chapter 8: Learnings from other sectors.

4.1 Introduction

The literature describes the heat network sector and its supply chain as being relatively immature[9] [10], which could be one reason behind the limited literature specific to skills issues in the sector[11].

The literature also describes the policy and support interventions that have been implemented by the UK government and devolved administrations to support creating a sustainable heat network market and industry[12]. This includes the Renewable Heat Incentive (RHI)[13] and the recent commitment from Treasury surrounding the Green Heat Network Fund (GHNF), both of which have or will continue to support the deployment of low carbon heat networks.

In addition, the literature highlights the encouraging role of programmes such as the Heat Networks Delivery Unit (HNDU)[14], Heat Network Investments Project (HNIP) and the Scottish Government's Low Carbon Infrastructure Transition Programme (LCITP) and the Heat Network Partnership in mitigating skills issues.

[9] Department of Energy and Climate Change (2009) The potential and costs of district heating networks
[10] Energy Technologies Institute (2017) Reducing the capital cost of district heat network infrastructure: Summary report from the 'Heat Infrastructure Development' project.
[11] Causal links between the sector being immature and existing and future skills gaps were not defined.
[12] UK Energy Research Centre (2016) Technology and Policy Assessment Best practice in heat decarbonisation policy: A review of the international experience of policies to promote the uptake of low-carbon heat supply.
[13] The RHI, launched in 2014 operated across England, Wales and Scotland. A separate RHI scheme ran in Northern Ireland between 2012 and 2016.
[14] Carbon Connect (2015) Policy for Heat: Transforming the system.

"*The HNIP pilot is sending a positive signal to the heat network market in terms of government support, particularly for the large-scale public sector market. This is reflected in: growing interest from consultants and technologists and greater confidence to invest in skills, expertise and marketing*"[15].

However, one strong theme from the literature was the need for stable and long-term energy policy, which many reports referenced as having been lacking[16] [17] [18] [19] [20] [21] [22] [23] [24]. This is required to create certainty for investors to expand the heat network supply chain[25] [26] and to help facilitate the development and provision of 'green skills'[27].

"*A stable policy framework and direction of travel will help to provide the long-term policy certainty that is needed to raise awareness and help skills and supply chains develop*"[28].

In addition to policy interventions, the literature calls for the continuation of government innovation funding and support offerings, and for continued support for the communication and coordination between industry and those involved in the training and skills sector[29] [30] [31] [32].

Noting that heat networks can only fulfil their potential if the sector is mobilised quickly to meet the scale of change needed within policy, research from the Energy Technologies Institute (ETI)[33] notes that "*the skills base in the UK needs to be coordinated and supported to increase capacity rapidly, ensuring that best practice is both achieved and incrementally improved through innovation and learning*". Coordination and collaboration between government and industry is crucial. The report therefore calls for the UK and devolved governments to provide frameworks to support demonstration, knowledge transfer and skills development to deliver a low-cost energy system that meets the 2050 emissions targets.

[15] Department for Business, Energy and Industrial Strategy (2018) Heat Networks Investment Project Evaluation, Pilot Process Evaluation Report (BEIS Research Paper Number 1).
[16] Webb, J., Hawkey, D., Tingey, M., Kerr, A., Lovell, H., McCone, D. & Winskel, M. (2014) Heat and the city - Exploring affordable, low carbon community heating in cold climate cities.
[17] UK Energy Research Centre (2018) Incumbency in the UK heat sector: implications for low-carbon heating.
[18] Committee on Climate Change (2018) An independent assessment of the UK's Clean Growth Strategy: From ambition to action.
[19] Committee on Climate Change (2019) Net-Zero: technical report.
[20] Committee on Climate Change (2019) UK housing: Fit for the future?
[21] European Centre for the Development of Vocational Training (2018) Skills for green jobs in the UK.
[22] Zekaria, Y. and Chitchyan, R. (2019) Skills Shortage Assessment Models – Literature Review Summary.
[23] Carbon Connect, 2015, Policy for Heat: Transforming the system.
[24] Off-Gas Grid Industry Group (2020) Skills and training to decarbonise heating.
[25] Carbon Connect (2015) Policy for Heat: Transforming the system.
[26] Energy Technologies Institute (2018) District Heat networks in the UK: Potential, barriers and opportunities.
[27] ECORYS (2011) Research Study to Determine the Skills Required to Support Potential Economic Growth in the Northern Ireland Sustainable Energy Sector, Final Report.
[28] Committee on Climate Change (2019) UK housing: Fit for the future?
[29] ECORYS (2011) Research Study to Determine the Skills Required to Support Potential Economic Growth in the Northern Ireland Sustainable Energy Sector, Final Report.
[30] Energy Technologies Institute (2018) District Heat networks in the UK: Potential, barriers and opportunities.
[31] Hawkey, D. J. C. (2012) District heating in the UK: A Technological Innovation Systems analysis. Environmental Innovation and Societal Transitions, 5, 19-32.
[32] Carbon Connect (2015) Policy for Heat: Transforming the system.
[33] Energy Technologies Institute (2018) District Heat networks in the UK: Potential, barriers and opportunities.

Several documents detail the risk of not tackling skills-based barriers on the deployment of low carbon technologies, including heat networks[34] [35] [36] [37]. A lack of expertise and immature supply chains may raise the costs of deploying heat networks, leading to a lack of flexibility in system extensions and the failure to deliver on intended environmental and social benefits[38] [39] [40] [41] [42] [43] [44] [45].

4.2 Sector Profile

The literature identifies a lack of diversity within the energy and engineering sectors. Whilst there was no literature specifically covering diversity within the heat network sector, it is likely that the sector also suffers from a lack of diversity given its symbiotic relationship with the energy and engineering sectors.

The lack of diversity means that the sectors struggle to attract a diverse workforce, which not only reduces the talent pool available but also reduces the attractiveness of the sector overall, further limiting the labour pool available[46] [47]. While attempts have been made to address the imbalances across gender, ethnicity and disabilities, progress has been disappointingly slow, and a concerted effort is required in the future[48].

"*Reducing both gender and race inequality is key to addressing the damaging shortage of engineering skills in the UK economy*" [49].

Research also details how underrepresentation of women in senior roles - rather than unequal pay - is the single largest cause of the gender pay gap for engineers[50]. This research also highlights that there is a "*serious diversity deficit*" within the engineering profession, with females making up 12% of the workforce and only 9% of the profession categorised within the Black, Asian and Minority Ethnic (BAME) group.

[34] Department of Energy and Climate Change (2009) The potential and costs of district heating networks.
[35] Department of Energy and Climate Change and the Department for Business, Innovation & Skills (2015) Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050: Cross Sector Summary.
[36] Committee on Climate Change (2015) Sectoral scenarios for the Fifth Carbon Budget Technical report.
[37] Element Energy, Frontier Economics and Imperial College London (2015) Research on district heating and local approaches to heat decarbonisation.
[38] Hawkey, D. J. C. (2012). District heating in the UK: A Technological Innovation Systems analysis. Environmental Innovation and Societal Transitions, 5, 19-32.
[39] Department of Energy and Climate Change (2013) Research into barriers to deployment of district heating networks.
[40] Department of Energy and Climate Change (2009) The potential and costs of district heating networks.
[41] UK Energy Research Centre (2016) Technology and Policy Assessment Best practice in heat decarbonisation. policy: A review of the international experience of policies to promote the uptake of low-carbon heat supply.
[42] Competition and Markets Authority (2018) Heat networks Market Study: Final report.
[43] Energy Technologies Institute (2018) District Heat networks in the UK: Potential, barriers and opportunities.
[44] Ramboll (2019) Alternative heat solutions: converting a town to low carbon heating.
[45] Zekaria, Y. and Chitchyan, R. (2019) Skills Shortage Assessment Models – Literature Review Summary.
[46] UK Commission for Employment and Skills (2015) Sector insights: skills and performance challenges in the energy sector.
[47] Department of Energy and Climate Change and the Department for Business, Innovation & Skills (2015) Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050: Cross Sector Summary.
[48] Royal Academy of Engineering (2020) Closing the engineering gender pay gap.
[49] Ibid.
[50] Ibid. It is important to note that the gender pay gap in the engineering profession is smaller than the UK average. The mean (10.8%) and median (11.4%) pay gap for engineers in the sample analysed is around two thirds the national average (13.3% and 11.4% respectively).

However, this lack of diversity is not unique to the energy or the engineering sectors. Diversity is an issue within the construction sector for example. Despite its size, the construction workforce is one of the least diverse in the UK. Mitigating actions to increase gender, ethnicity and disability diversity in the workforce were outlined within the construction sector deal[51]. This is also true in the nuclear sector, where the Industrial Strategy and the Nuclear Sector Deal aims to increase diversity in the workforce, including increasing female representation by 40% by 2030[52].

4.3 Current and future skills needs

There were frequent references within the literature to institutional skills issues, which are prevalent across the energy and engineering sectors[53] [54]. While not all directly linked to the heat network sector, these broad issues can contribute to uncertainty of demand and may be a significant barrier to deployment of low carbon heat networks. There were concerns that constraints around skills could reduce the achievable level of energy system decarbonisation by 2050[55] [56].

There were calls for a greater understanding of the actual skills that are required in jobs across the energy sector, factors that contribute to shortages of these skills, and techniques and models to forecast skills shortages[57]. By improving the forecasting of knowledge and skills in the labour market, the UK can better prepare the sector to provide training and education and facilitate the successful transition to a low carbon economy.

"*Skills-led strategies to support the green transition can serve as a driver of change in their own right: availability of suitably skilled workforce attracts investors in green industries; and environmental awareness encouraged through education and training boosts demand for green products and services. Identifying and anticipating skills needed for the green and low-carbon economy must precede training decisions so that skills acquired are relevant for the labour market.*"[58]

However, it was also recognised that there are difficulties in focussing the efforts of training to meet the skills needs of existing, new and evolving markets. Decisions that need to be made surrounding skills provisions are made difficult due a lack of sufficiently good statistical information[59].

Literature identified an 'ill-equipped skills system' and a lack of adequate training to enable workers to move from high to low-carbon employment[60].

[51] Department for Business, Energy and Industrial Strategy (2018) Construction Sector Deal.
[52] Nuclear Skills Strategy Group (NSSG) (2018) Skills planning to drive sector mobility: Strategic plan update.
[53] UK Commission for Employment and Skills (2015) Sector insights: skills and performance challenges in the energy sector.
[54] Royal Academy of Engineering (2020) Closing the engineering gender pay gap.
[55] Committee on Climate Change (2018) Analysis of Alternative UK Heat Decarbonisation Pathways.
[56] Ramboll, 2019, Alternative heat solutions: converting a town to low carbon heating.
[57] Zekaria, Y. and Chitchyan, R. (2019) Skills Shortage Assessment Models – Literature Review Summary.
[58] International Labour Organization (2011) Anticipating skills needs for the low-carbon economy.
[59] Ibid.
[60] Institute for Public Policy Research (2019) A just transition. Realising the opportunities of decarbonisation in the North of England.

While UK PLC has many of the skills needed to deploy low carbon technologies, the literature highlighted notable gaps, uncertainties in the size of the workforce required and the timeframe for deployment[61].

An estimated 81,000 jobs could be created nationally in the heat network sector by 2030[62], however these opportunities will not be realised if the skills system is not better supported. There were calls for the continuation of funding to enable the development of training courses and continued help in coordinating between industry and those involved in the training and skills sectors.

The literature notes how experienced workers are moving out of the energy industry, due to retirement[63] or to transfer to another sector, and are not being replaced in sufficient numbers or with sufficient speed. This is leaving gaps in the higher layers of the energy sector[64].

Meanwhile a lack of STEM graduates joining the sector has led to gaps in the middle layers of the workforce[65]. This research found that a majority of respondents considered that there were not enough individuals studying STEM subjects at undergraduate or postgraduate level. The reasons given for this imbalance were around a range of perceptions that the costs of studying for a degree (and potentially a masters) are high, that cheaper overseas study options led to students staying overseas once qualified, the entry criteria for STEM degrees being too obstructive and the general perception that STEM subjects are 'difficult'. While research undertaken by UKCES found that there was not an overall shortage of STEM graduates, over 40 per cent of STEM graduates work in non-STEM occupations and that graduates may be attracted into more lucrative sectors such as financial services.

While some reports concluded that that there has been no concerted support at a national level to resolve decarbonisation skills issues, nor any attempts to facilitate action at a regional or local level[66] [67], the government has recommended a review of skills across building, heat and ventilation supply chains, alongside a nationwide training programme to upskill the existing workforce[68]. This activity will cut across heat and ventilation supply chains to determine the roles of government, industry and the wider supply chain to ensure that supply is able to meet demand. In addition, the government is working with industry to invest £34 million into a national retraining scheme and has committed to improve technical education standards. While not always in the role of heat network sponsors, the essential role of local government (and the wider public sector) as key stakeholders in the successful deployment of heat networks is

[61] Engineering Construction Industry Training Board (2020) Towards Net Zero: The implications of the transition to net zero emissions for the Engineering and Construction Industry.
[62] Institute for Public Policy Research (2017) Piping hot – the opportunity for heat networks in a new industrial strategy.
[63] Department for Energy and Climate Change and the Department for Business, Innovation & Skills (2015) Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050: Cross Sector Summary.
[64] UK Commission for Employment and Skills (2015) Sector insights: skills and performance challenges in the energy sector.
[65] Ibid.
[66] Department for Energy and Climate Change (2009) The potential and costs of district heating networks. While a relatively old document, the issues identified in the research are still valid.
[67] Institute for Public Policy Research (2019) A just transition. Realising the opportunities of decarbonisation in the North of England.
[68] Department for Business, Energy and Industrial Strategy (2019) Leading on clean growth: government response to the Committee on Climate Change 2019 progress report to Parliament - Reducing UK emissions.

frequently described in the literature[69] [70] [71]. However, the literature highlights a lack of skills and resources within local government as important barriers to deployment[72] [73] [74].

There were also calls for an accreditation scheme to develop the skills needed to build and operate new heat networks, ensuring networks deliver intended benefits and an efficient and a good service for customers[75]. While the Chartered Institution of Building Services Engineers' (CIBSE) accreditation is highlighted in the literature, one report notes that "*the course in its current form does not provide, nor does it intend to provide, sufficient training or accreditation for engineers to become qualified experts in this field*".

Another recommendation was to establish a District Heating Knowledge Centre, to co-ordinate research, training and dissemination, boost innovation across the sector and encourage recognised qualifications to build the skills base. It was thought that this activity would lead to heat network schemes being more cost-effective and efficient[76].

There were also calls for the UK Government to use initiatives under the Construction Sector Deal and Buildings Grand Challenge Mission (both of which include commitments to drive up quality) to tackle low-carbon skills gaps[77]. This would include new support mechanisms to train designers, builders and installers in low-carbon heating, energy efficiency, ventilation and thermal comfort. The report recommends "*that a fully-fledged UK strategy for decarbonised heat must be developed in 2020*" and that as part of this strategy, "*a nationwide training programme to upskill the existing workforce is recommended".*

The UK Government have committed to publishing a Heat and Buildings Strategy in the near future. In addition, the Treasury have outlined a commitment in the Spring 2020 budget to spend £270 million on a Green Heat Network Fund (GHNF) from 2022 to support the deployment of low carbon heat networks.

[69] Department for Energy and Climate Change (2009) The potential and costs of district heating networks.
[70] Hawkey, D. J. C. (2012). District heating in the UK: A Technological Innovation Systems analysis. Environmental Innovation and Societal Transitions, 5, 19-32.
[71] Webb, J., Hawkey, D., Tingey, M., Kerr, A., Lovell, H., McCone, D. & Winskel, M. (2014) Heat and the city - Exploring affordable, low carbon community heating in cold climate cities.
[72] Department for Business, Energy and Industrial Strategy (2016) Heat networks Investment Project Consultation Government Response (Capital funding for building heat networks).
[73] UK Energy Research Centre (2016) Technology and Policy Assessment Best practice in heat decarbonisation policy: A review of the international experience of policies to promote the uptake of low-carbon heat supply.
[74] Institute for Public Policy Research (2017) Piping hot – the opportunity for heat networks in a new industrial strategy.
[75] Competition and Markets Authority (2018) Heat networks Market Study: Final report.
[76] Energy Technologies Institute (2017) Reducing the capital cost of district heat network infrastructure: Summary report from the 'Heat Infrastructure Development' project.
[77] Committee on Climate Change (2019) UK housing: Fit for the future?

5. Sector and Occupational Profile

This chapter seeks to provide a conceptual framework for thinking about the heat network sector, both in terms of its extent and its subdivisions, and where it sits in relation to other established sectors in the economy. It also explores the range of job roles identified by the research within the sector, and how these might be classified.

5.1 Identifying the heat network sector

Defining the sector

The heat network sector is ultimately defined by its finished products, rather than by the occupations or activities of its staff. While a business operating a completed heat network, as a supplier of energy to consumers, would usually be considered to sit within the energy sector, a wide range of skills and specialisms are required to plan, design, build, operate and maintain a heat network. In a period of forecast expansion of the sector, these skills come to the fore.

In many ways the heat network sector sits at the interface between other sectors. Energy supply and infrastructure, engineering and construction are central, but with other sectors also playing vital roles. These range from the surveying and urban planning professionals who integrate the network into its environment to manufacturers who produce the specialist machinery required. As such, few individuals work on heat networks without also having a wider skill set which could have been applied or developed in another sector. Most companies and people in the sector, from professionals to installers, would see themselves as primarily members of a wider profession or industry, with heat networks being their specialism, or perhaps only part of their wider skill set.

For the purposes of this research, the sector is defined as including any company or individual that carries out work on heat network projects which requires skill sets or knowledge which are specific to heat networks. This would include legal firms specialising in advice regarding heat networks, but not companies providing services to heat networks which are non-specific to the sector (e.g. HR, accountancy, some generic construction activities).

Together with the recent expansion and formalisation of the sector as a significant source of employment in the UK, this makes it particularly challenging to understand in skills terms.

Identifying the sector in official data

ONS Standard Industrial Classification (SIC2007)

Employers in the UK are classified according to an ONS classification, the Standard Industrial Classification (SIC), most recently revised in 2007. This classification is often used to provide sectoral data regarding employment or employers in a particular industry. There is no specific heat network SIC code within the classification.

The industrial classifications which might apply to the core of the heat network sector were identified based on a list of organisations working in heat networks provided by the Association

for Decentralised Energy (ADE), one of the two trade bodies for the sector[78]. This exercise showed that the organisations relevant to the sector have a wide variety of classifications. The SIC2007 codes identified ranged from the production and distribution of electricity, or the construction of civil engineering projects, to solicitors, buying and selling of real estate, and the manufacture of plastic products.

Heat networks clearly did not make up a majority – or even a significant minority – of the organisations in any SIC2007 code used, and many organisations operate across a range of these codes identified. The SIC2007 sector classification was therefore not deemed useful for classifying the heat network sector or the companies and skills within it. This significantly limits the extent to which the sector can be quantified from existing data, in terms of both number of employers and number of employees. For reference, the full list of the SIC2007 codes identified as covering the heat network industry can be found in Appendix C.

ONS Standard Occupational Classification (SOC2010)

The ONS also provide a standard classification of occupations. There are a wide range of these occupations in the heat network sector. However, all codes again define roles too widely, and those working in the heat network sector would represent only a small minority of employees classified in any SOC2010 code, even at the most detailed level. For reference, a list of the SOC2010 codes covering all heat network occupations identified in the report is included in Appendix C.

Because most government data are gathered using SIC2007 and SOC2010 codes, this makes detailed quantitative analysis of the sector from secondary data difficult at best, and makes it impossible to produce useful results at a sufficiently detailed resolution to provide policy insight. This could be addressed through, for example, a quantitative survey of relevant SIC2007 sectors, analysing the workforce of relevant companies, allowing mapping from official data to take place.

5.2 Subdividing the heat network sector

There is a wide range of ways in which the heat network sector, and companies and skills within it, could be broken down into sub-sectors and classified. The approach taken in this research, after considering alternatives, was to classify the sector in two complementary ways:

- By the project stage at which the company or individual role contributes, ranging from the initial exploration of a project concept, to the ongoing operation of the finished heat network or its further expansion.
- By skill sets associated with sectors which contribute to the construction of a heat network.

These initial classifications do not represent job roles or individual skills, which are outlined later in the report, but ways of thinking about categorising and classifying businesses and individual roles in the sector.

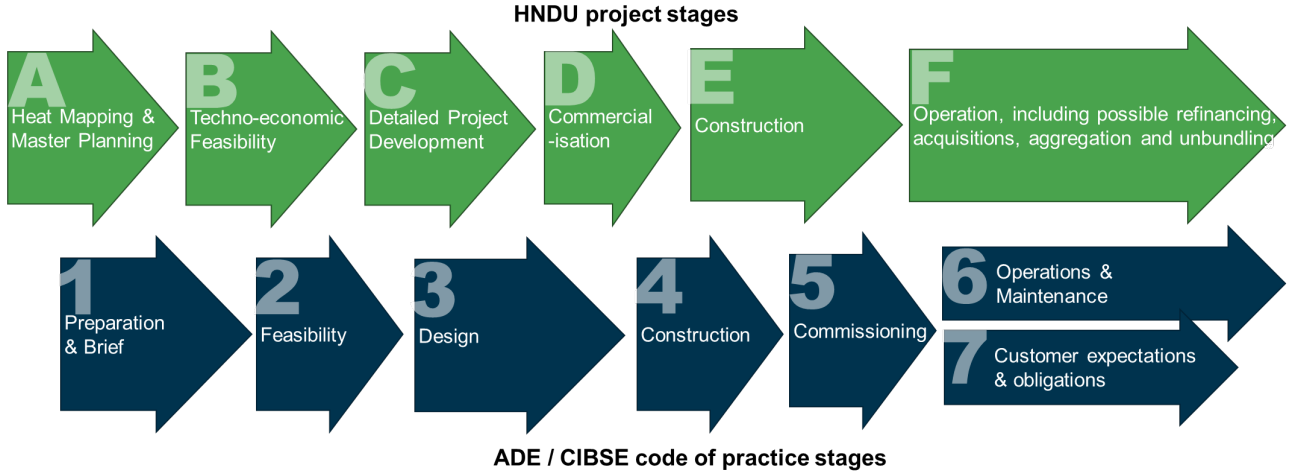
[78] All companies in the UK must classify themselves for the purposes of registration with Companies House, and this information is publicly available.

Classifying by project stage

Employers in the sector may specialise in a specific technology or type of heat network, but they may also specialise in a particular stage of the project process. The project process can be conceptualised in various ways, as shown in Figure 5.1, based on the project stages identified in the *CIBSE & ADE Heat Networks Code of Practice*, and internal stages used at the Heat Networks Delivery Unit (HNDU) within BEIS.

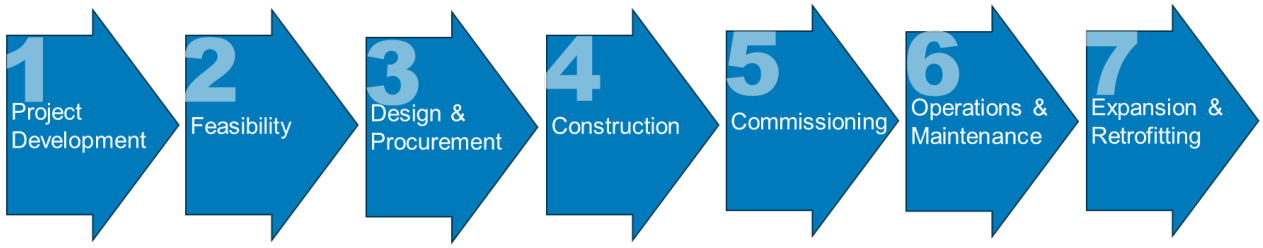
These classifications each have a different emphasis, either on the process of project development within the commissioning organisation, or on the project from a developer and operator point of view. The research developed a general purpose classification which sits between the two, shown in Figure 5.2.

Figure 5.1: Heat network project stages: alternative classifications



Source: CIBSE & ADE (2019). Heat Networks: Code of Practice for the UK. 2019. Communication from Heat Networks Delivery Unit, (HNDU), BEIS (2020).

Figure 5.2: Heat network project stages: classification used in this report



Source: Developed for this report, after CIBSE & ADE (2019). Heat Networks: Code of Practice for the UK. 2019. Communication from Heat Networks Delivery Unit, (HNDU), BEIS (2020).

Fundamentally, the process of constructing a heat network starts with preparation and feasibility assessment (including a period of commercial and planning negotiations), followed by a design and then a build stage. Once this is complete, the network can be commissioned and operations can commence, and then ongoing maintenance will be necessary. In practice, networks may be built in stages, or may be expanded or retrofitted with new heat network technologies as they become available. Table 5.1 below outlines what is typically involved at each project stage.

This classification is particularly useful in considering the roles companies play in the sector. An employer might specialise in the design of heat networks, or may be sub-contractors for one particular element of the process such as in maintenance or provision of operational

software or IT equipment. However, some larger companies – and public authorities - may take a role from beginning to end of the process.

Table 5.1: Classification by project stage

Stage	Description
Project Development	Identify opportunities (heat mapping) Defining appropriate service levels for the heat supply Assess heat demands and heat consumption Identify suitable energy source *Design professionals; but also public administration and urban planning*
Feasibility	Define heat network distribution routes, pipe sizes, and costs Assess operation and maintenance needs and costs Assess environmental impacts and benefits *Compliance, legal and financial professionals are key*
Design and Procurement (detailed design may take place before or after procurement)	Develop contract and procurement strategies Initial design of the network; layout, specification Optimisation of routes and pipe sizing Achieve an efficient heat distribution system Select heat metering and billing systems *Engineering design professionals; but also legal and financial*
Construction and construction installation	Construction of the network and installation of equipment *Construction sector mainly involved at this stage* *Compliance and regulatory professionals key*
Commissioning	Commissioning building heating systems/controls HIU (Heat Interface Unit) and heat metering system commissioning Commissioning the central plant *Peak involvement from control systems engineers* *Commercial and project management professionals key*
Operation and maintenance	Ongoing maintenance of equipment Maintaining reliability and a long life for the heat network Communications with customers *Management and commercial roles are key for operation; specialist technician and inspection roles are key for maintenance* *Peak involvement from IT professionals* *Commercial and customer service roles are key*
Expansion and retrofitting	Expansion of network Retrofitting to use newer heat network technologies Refinancing, acquisitions, aggregation, mergers *Professional roles predominate* *Legal and financial professionals; but also engineering design*

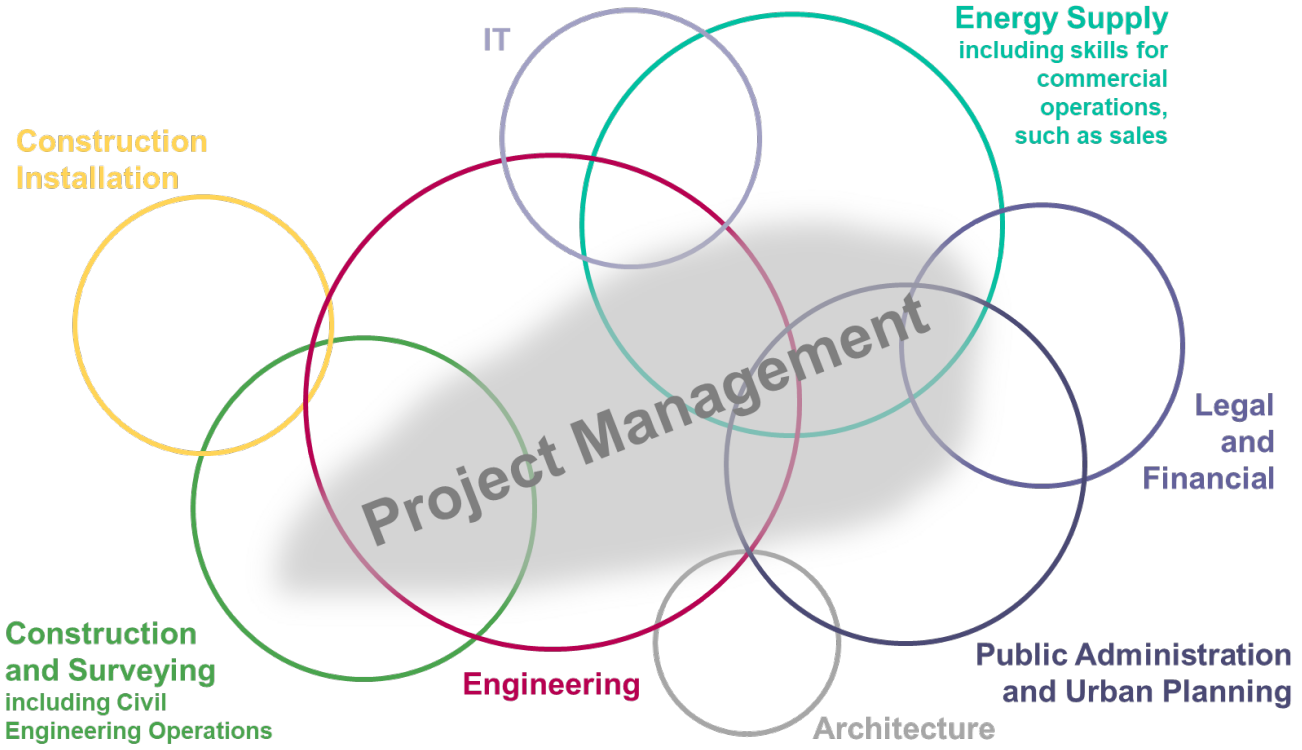
Based on CIBSE & ADE (2019). Heat Networks: Code of Practice for the UK. 2019.

However, while this is one important dimension of skills needs for heat networks, skills required by the sector may not be specific to one part of the process, and not every occupation, role or company can be classified into a project stage. For example, senior managers will be involved throughout, making decisions affecting the project process from beginning to end. Companies specialising in design may also seek some employees with the same or similar skills as companies working on operations or maintenance.

Classifying by skill sets associated with linked sectors

The sector has close relationships with, and shares pools of potential recruits and broad skill sets with, a range of other industrial sectors. The heat network sector could be thought of as sitting at the intersection of these sectors, requiring skills from each. These were most often how the companies interviewed were distinguished, and also in many cases how they distinguished between the skill sets of their own staff. For example, an engineering company with a specialism in heat networks might consider working at any stage of heat network creation, operation or upgrading, dependent on when engineering skills of the type they offered were required. Figure 5.3 shows the various sectors involved in heat network projects, and where skill requirements overlap (i.e. where the sector requires individuals with a combination of these roles). The detailed role of each sector is explained below.

Figure 5.3: Sectors involved, showing areas where roles drawing on skill sets from multiple sectors exist



Source: Developed from depth interviews, workshops and recruitment website search

Engineering

Many core roles in the sector are roles also found in the engineering sector, and skills, qualifications and accreditations may be only weakly specific to the heat network sector. Even those less directly involved in design may require some engineering sector knowledge.

In interviews, the mechanical engineering and electrical engineering sectors were often mentioned as skill areas required for core roles, and to a lesser extent civil engineering. The building services engineering sub-sector is particularly closely linked with heat networks. This sub-sector itself involves elements of mechanical and electrical (M&E) Engineering, although it is typically considered to be specific to services within an individual building. Figure 5.4 below illustrates where engineering relating to core roles in heat networks sits in relation to the various engineering sectors.

There are also skills from other engineering sub-sectors required on a lesser scale in the sector, including chemical engineering for issues regarding water purity in the heat network, which is critical for reliability.

Figure 5.4: Forms of engineering discipline and heat networks

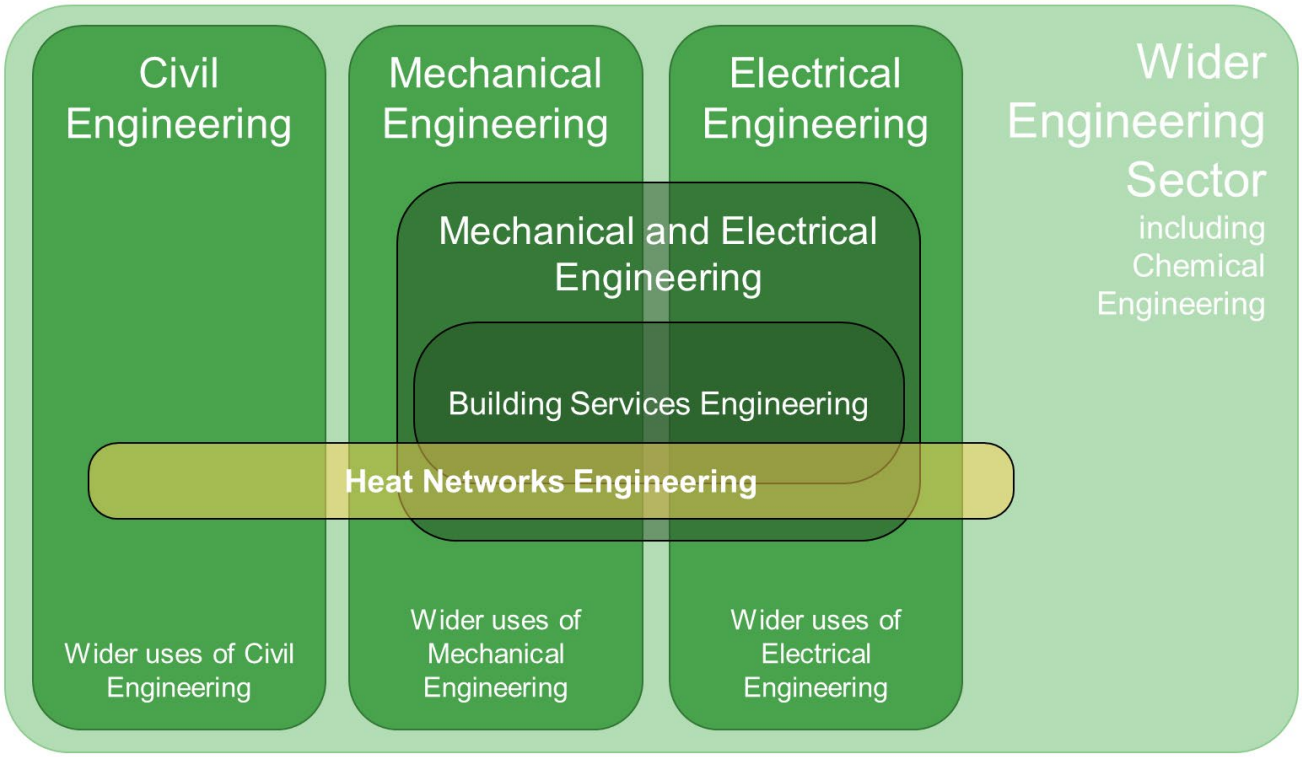


Diagram based on outcomes of depth interviews

Energy supply sector skills

Some skills are similar across multiple forms of energy production and distribution. In particular these skills might be found in the operational stage of reliably delivering energy to a range of end customers, in the project management, commercial and customer services spheres, and in the understanding of regulation and compliance. The management of sales activity is also important in this area, including to individual end consumers of energy, to landowners and developers, and to potential suppliers of energy to the network.

These activities, required for the operation of a heat network, are in principle not greatly different to those which might be required in a traditional electricity or gas supplier. In heat networks, these roles might most typically be contained within an ESCo.

Construction and construction installation sector skills

At the build stage of a project, once the design stage is completed, both generic and specialist construction skills are needed to build the heat network. The specialist skill most often mentioned was pipe welding. Construction installation skills are also required throughout the construction and operational stages of a project to bring heat networks into individual buildings.

In practice, many of these skills are found in the mainstream construction and construction installation sectors, with wider applicability beyond heat networks, and interviews indicated that non-specialist construction and construction installation sector companies are frequently (although not always) involved.

Information Technology sector skills

The IT sector is closely linked because of the need for bespoke hardware and software to operate a modern heat network, including specialist control, monitoring and data management systems, but also other more generic functions common to any complex business. Skills from the software engineering sector are also key in this element of a heat network. Interviews suggest that fewer IT staff are employed than engineers on a typical project, but they remain key in terms of successful operations.

Surveying sector skills

Various elements of the surveying sector – quantity surveying and building surveying – also have a role to play in the creation of a heat network, co-ordinating and providing required technical information for the construction process.

Public administration and urban planning sector skills

District scale heat network projects, by their nature, tend to be led by local authorities. Typically, local authorities take a key regulatory, financial and project management role, especially early in the project, for example driving the formation of an ESCo to shepherd the project from inception to completion. Communal heat network projects may be led by developers or landowners, including housing associations.

Professional urban planning and other regulatory knowledge, often also found within the public sector and particularly in local authorities, is critical at the design stage of a heat network project, albeit generally involving small numbers of people.

Legal and financial sector skills

Interviews showed that heat networks are often legally complex. They may serve multiple developments with diverse ownership, and industrial, commercial or public sector as well as domestic customers. The construction and maintenance of the heat network is a shared cost across a range of public authorities, developers or housing associations, private stakeholders and domestic customers, and each of these have differing interests. Designing these arrangements, understanding their financial implications, and codifying these in legal agreements requires skills typically found in the legal and financial sectors.

Manufacturing sector skills

Manufacturing sector skills are required to provide specialist equipment needed for the heat network. While this is excluded from this specific research due to other research ongoing in this area, it is clearly essential to the sector, including as a key source of training in the use of new products and technologies.

Scientific research sector skills

Scientific research skills are needed for developing new heat network technologies (excluded from this specific research due to their location largely within the Higher Education sector).

Classifying by product or technology

The skill sets required for the heat network sector could also be classified in other ways. Networks can be applied in a variety of contexts; communal heat networks operate within a single building or development, while district heat networks operate over a wider area. However, these require much the same skills (although on a larger scale for district heat networks), and so these have not been used as the basis of classification in this study.

Another alternative way of classifying heat network sector activities is by product or technology, by considering the material supply chain in the sector. One overarching theme is the temperature level used; some networks transmit heat at high temperatures (for example as steam), and others, especially more modern designs, transmit heat at lower temperatures.

Working with different temperatures of heat network requires different technologies, and thus differing skill sets, so this classification does have some value. However, this difference in skill requirements is not as pronounced at some project stages as others; it is in the generation of heat to power the network[79] and the design and manufacturing of equipment[80] where the differences are reportedly the most pronounced.

However, interviewees talking about the construction, operation or administration of heat networks did not generally talk about classifying roles in this way. While knowledge and experience of relevant types of heat network was discussed as desirable, a specific individual would not typically be tasked with working with only one type of network. Typically, although not always, a company in the sector will work across many of these technologies and often multiple heat network types. So, while it is important to bear this classification in mind, to effectively analyse skills in the sector they need to be thought about primarily in other ways.

Skill sets required by project stage

The mix of skill sets required changes throughout the project process. Some skill sets may only be required at one stage, but others may be required throughout the process, including for the network's ongoing operations and maintenance. Figure 5.5 visually represents the involvement of skill sets from different sectors in the process over time as the project develops.

[79] This is not a focus for this specific piece of research, due to the fact that these energy sources have much wider applicability and use beyond the heat network sector.
[80] The manufacturing of heat network equipment is not within the scope defined for this research.

Figure 5.5: Heat network project stages: timing of the requirement for skills associated with different sectors

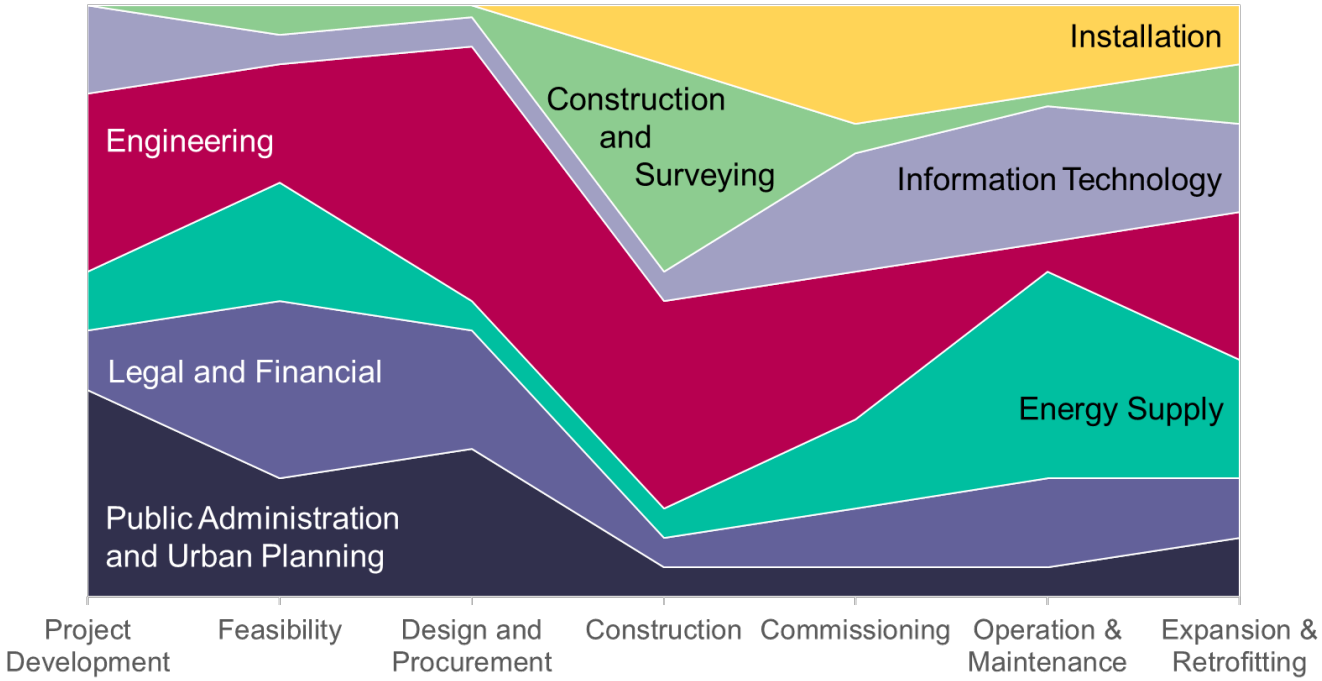


Diagram based on depth interviews and workshop outcomes; project stages taken from CIBSE & ADE (2019). Heat networks: Code of Practice for the UK. 2019. Not a quantitative representation - illustrative of scale of roles of sectors at different stages. Excludes Scientific Research, Heat Generation and Manufacturing, since these are not in the defined scope of the research; Manufacturing is also not specific to a project stage.

5.3 Identifying occupations relevant to the heat network sector

Occupations identified

This section explores the key occupations relevant to the sector. Table 5.2 gives a short description, a summary of typical duties, and the key project phases that each occupation is typically involved in. The table also shows ONS Standard Occupational Codes (SOC2010), but it should be noted that in all cases these are both broader and not specific to heat networks.

Table 5.2: Occupations identified as relevant to the heat network sector (excluding roles which do not require heat network expertise, such as Accountancy, Human Resources and Customer Services)

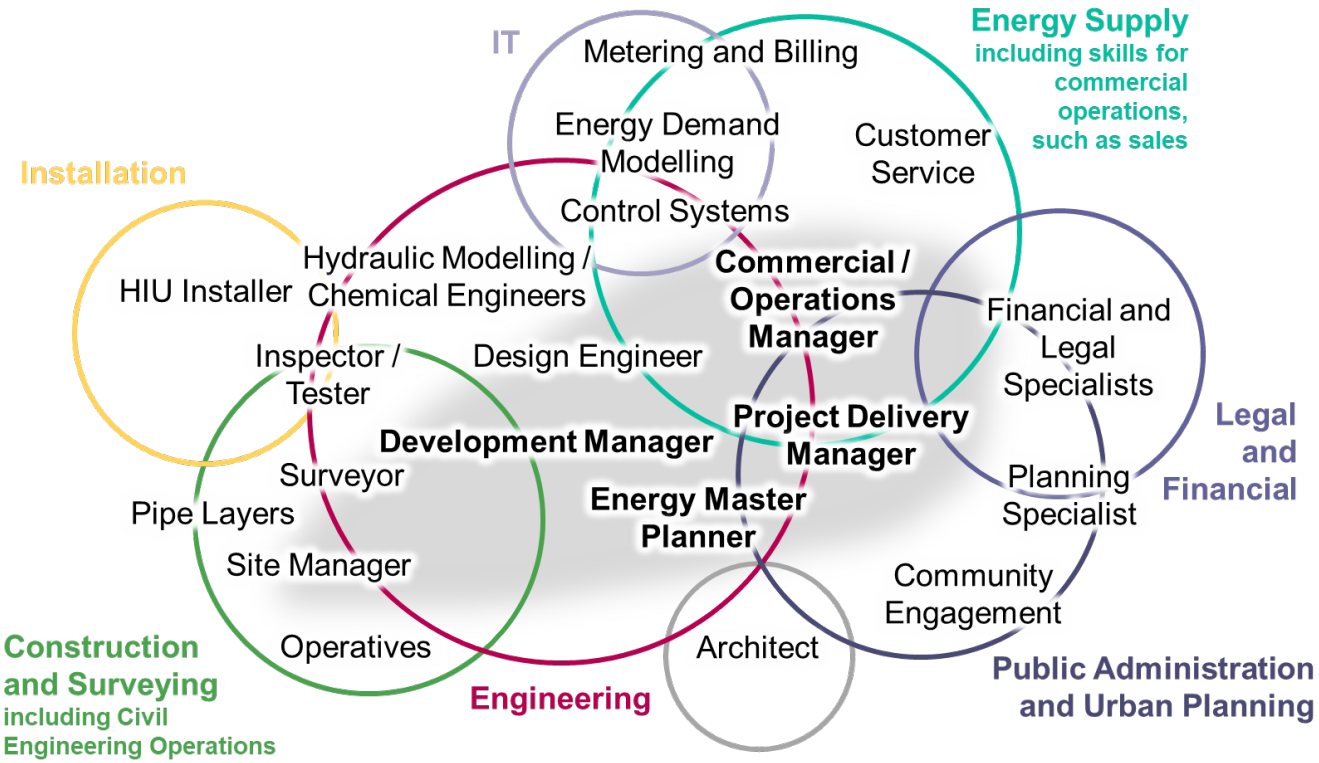
Occupation and SOC code(s)	Description	Broad sub-sector	Professional status
Project Delivery Manager (2424, 3541)	Project manager at a client or local authority level, including procurement of contractors to deliver the heat network	Project management	Optional: Chartered Project Manager (APM)
Development Manager (2121, 2122, 2123, 2436, 2433)	Focus on day-to-day project management of a heat network project's development, expansion, or retro-fitting.	Engineering / Project Management	Chartered Mechanical, Electrical, Building Services or Civil Engineer (IMechE, IET, CIBSE, ICE) Optional: Chartered Project Manager (APM, CIOB), Chartered Quantity Surveyor (RICS)
Commercial / Operations Manager (2424, 2423)	Focus on day-to-day management of the heat network's operations and financial viability, including prior to commissioning.	Engineering / Project Management	Optional: Chartered Project Manager (APM) Chartered Mechanical, Electrical, Building Services or Civil Engineer (IMechE, IET, CIBSE, ICE)
Community Engagement Officer (3561)	Liaison with stakeholders and the wider community during the development stage	Project Management	n/a
Financial Specialist (2421, 2423, 2425, 2433)	Provision of expert advice on financial management of the network, for negotiation with stakeholders	Financial	Chartered Accountant (ICAEW, ICAS) Optional: Chartered Quantity Surveyor (RICS)
Legal Specialist (2413, 2419)	Provision of expert contractual advice, for negotiation with stakeholders	Legal	Legal Professional (Law Society)
Planning Specialist (2432, 2462)	Provision of expert advice on matters relating to planning law and regulations	Urban Planning	Chartered Town Planner (RTPI)
Architect (2431, 2435)	Design of developments and buildings, including access to those developments.	Architecture	Architect (RIBA, RIAS)
Energy Master Planner (2122, 2123, 2126, 2129, 2432)	Assessment of broad requirements for network, energy demand/need, overall layout and structure of the network.	Engineering, Urban Planning, Project Management	Chartered Mechanical, Electrical or Building Services Engineer (IMechE, IET, CIBSE)
Design Engineer (2122, 2123)	Design of elements of the network and detailed specification of equipment required.	Engineering	Chartered Mechanical, Electrical or Building Services Engineer (IMechE, IET, CIBSE)

Occupation and SOC code(s)	Description	Broad sub-sector	Professional status
Hydraulic Modeller (2129)	Expert advice on the flow of liquids within the network.	Engineering	Chartered Mechanical or Building Services Engineer (IMechE, CIBSE)
Chemical Engineer (2129)	Expert advice on maintaining the purity of water / steam.	Engineering	Chartered Chemical Engineer (IChemE)
Energy Demand Modelling (2425, 2123)	Modelling of expected demand levels, for network design.	Engineering	Chartered Electrical Engineer (IET)
Control Systems Specialist (2135, 2136, 2139)	Design and operation of electronic control systems.	IT	Optional: Chartered Electrical Engineer (IET)
Metering and Billing Specialist (2135, 2136, 2139)	Design and/or ongoing operation of metering and billing technologies, and interface with customer services	IT, Project Management	n/a
Surveyor (2434, 3531)	Checking compliance with building and planning regulations and standards, and offering professional advice on physical installation of the network within existing dwellings for retrofit.	Surveying	Chartered Building Surveyor (RICS) Chartered Civil Engineering Surveyor (CICES)
Operation and Maintenance Technician (3112, 3113, 3114)	Connection of new equipment used in the network, maintenance of existing equipment	Construction / Engineering	n/a
Inspector/Tester (3115, 8133)	Checking and/or testing of equipment installed.	Construction / Surveying	n/a
Civil Engineering / Construction Site Manager (5330)	Overseeing trench construction, pipe welding, and installation if fitted with newbuild construction.	Construction	Optional: Chartered Project Manager (APM, CIOB)
Civil Engineering Operative (8149, 9120)	Trench construction and other associated tasks.	Construction	n/a
Pipe Layer (including welding) (8149)	Pipe laying and pipe welding and associated tasks.	Construction	n/a
Installer (including HIU installation) (5241, 5314)	Installation of HIUs and other heat network related equipment in domestic, commercial and industrial premises.	Construction Installation	n/a

It is also possible to represent these roles in graphical form, showing where they sit in terms of skills associated with the sectors contributing to the heat network industry, as shown in Figure 5.6. This combined the information in Table 5.2 with the sectors identified in Figure 5.5.

As can be seen, some roles sit at the interface of multiple sectors; as will be discussed in subsequent chapters, some of these roles can be particularly hard to fill. For example, a control systems expert, designing and managing the heat network's dedicated software and hardware, sits at the interface between engineering, IT and energy supply and requires a rare combination of skills which interviewees reported was difficult to find.

Figure 5.6: Occupations identified as relevant to the heat network sector, located within the sectors contributing to the heat network section



Source: Developed from depth interviews, workshops and recruitment website search

Demand for occupations: overview of shortage areas

Based on insight from interviews and workshops, shortages of suitably skilled staff occur across the board, in all occupations in the heat network sector. However, some trends could be discerned within this. The reasons for these shortages, and the employer reactions to these, are discussed in detail in the next chapter.

From the search of recruitment websites, the key shortage areas were among senior project management and engineering roles. Those engineers that combine mechanical and electrical engineering (including building services engineers) are in highest demand for the sector, as are those with experience of project managing large civil engineering projects.

Employers were often seeking both engineering and project management skills in a single individual. There were a number of reasons for this; as can be seen in Figure 5.6, some key roles require this combination of project management and engineering skills to some extent (in particular energy master planners and project delivery managers). In addition, many

organisations in the sector are small or have small heat network teams, in some cases created to work on a single heat network project. As a result, they may have constraints on the size of their workforce. This makes it necessary to seek out an individual who can fulfil more than one role. The employer experience of this is discussed in the next chapter.

For both project management and engineering roles, employers typically sought long prior experience of heat networks, something which was difficult to find, since the sector is expanding quickly and therefore the demand significantly exceeds the number of people with experience.

Consultant level roles also appeared frequently in recruitment websites, demonstrating the demand for individuals with high levels of heat network knowledge to advise on project design and procurement. This also supported the view that there was a strong demand for individuals in regulated professions such as accountancy, law or urban planning, with specialist knowledge of communal heat network and district heating systems.

Some interviewees also mentioned shortfalls in installers and civil engineering operatives at a construction level. This was relatively infrequently mentioned, but it must be recalled that often these groups are employed by (or working on a self-employment basis for) construction or civil engineering sector contractors, rather than directly by firms designing and managing the creation of a heat network. Typically, these contractors would be businesses operating within the wider construction and civil engineering sectors, working mainly outside the heat network sector. In addition, construction and civil engineering companies often sub-contract work (particularly installation) to companies working specifically in that sphere. Therefore, this problem may seem relatively distant to some businesses working primarily in design and project management of heat network projects.

Operations and maintenance technicians, and building surveyors were not generally mentioned as shortage areas by respondents, although they remain important to the industry.

In terms of organisations where the most significant skills shortages occur, interviewees repeatedly came back to local authorities, and to a lesser extent housing associations and developers seeking to install a network on a large development. These organisations would typically be those initially procuring a heat network, and would ideally take a key overarching project management role. However, many felt that the required skills were unaffordable to local authorities, and local authorities themselves sometimes admitted the difficulty of sourcing the skills they needed at a cost they could afford. Although HNDU offer grant funding to local authorities to hire project managers, this issue seems to persist and was widely reported; why this is the case may require further research.

> *"In terms of Building Control, the skills shortage within local authorities is hugely underestimated."* **Consultancy (Stakeholder Interview)**

5.4 Diversity in the industry

The wider STEM sector is well-documented to perform poorly regarding diversity. Gender and ethnicity are the most frequently mentioned dimensions of this. No figures are available regarding the heat network sector, but the wider engineering sector workforce is 92% male and 94% white[81]. As well as wider concerns around fairness and opportunity for all, as noted by Engineering UK, with a shortage of applicants overall, the sector must not overlook or exclude

[81] Royal Academy of Engineering (2016) Diversity Programme Report 2011-2016.

any potential sources of talent[82]. Diversity has also been identified as a driver for innovation, motivation and retention[83] in the engineering industry.

When asked to consider diversity in the industry in interviews, most stakeholders considered gender, although there were some views on the ethnic diversity of the sector as well. There is a consistent perception that the heat network industry is dominated by white, middle class men, a trend that runs across the broader construction, energy and engineering sectors.

While the lack of diversity was generally accepted across the industry, stakeholders' opinions on the impact of this typically fell into three broad categories.

The first category consisted of those who did not consider a lack of diversity to be an issue for the industry. They agreed it was not a well-balanced sector, but they believed that recruitment processes were fair and that a lack of diversity did not matter so long as those entering the sector possessed the right set of skills.

A second group believed that a lack of diversity in the industry was a problem, but considered it a problem that was much wider than the heat network industry, and therefore one the industry could not resolve itself. A typical comment was that the heat network industry was *"male-dominated…but this is true across the engineering sector"*. These organisations did not consider it their responsibility to change social norms relating to traditional career paths by gender, and felt helpless in terms of influencing student decision-making. Furthermore, companies are restricted by the size of the recruitment pool (see next chapter). Often only a handful of individuals apply for vacancies, so diversity considerations are typically not incorporated into the application process.

> *"It's pale male stale. This derives from traditional gas and engineering. Our education system needs to encourage inclusivity."* ***Consultancy (Stakeholder Interview)***

> *"The country needs to move to change attitudes and encourage more women into the sector as they leave school and look to go to university."* ***ESCo (Stakeholder Interview)***

However, there was a third group of stakeholders who provided evidence of the industry attempting to effect change. For example, one consultancy mentioned that they had set up a networking group aimed at women working in heat networks ("District Heating Divas"[84]), involving monthly breakfasts, conferences and other related activities.

> *"It is massively valuable to have these sorts of networks. It's a good way for new people to meet people and find allies, to learn, to share, to realise they aren't the first person to experience that problem."* ***Consultancy (Stakeholder Interview)***

Others were considering working with schools, colleges and universities to promote engineering and heat networks as a career option to young women and those from BAME backgrounds, although there was only one example given of a company visiting a university to meet students.

[82] EngineeringUK (2018): EngineeringUK briefing: Gender disparity in engineering.
[83] Royal Academy of Engineering (2017) Creating cultures where all engineers thrive.
[84] Heat Exchanger Mentoring Pilot working group (2019); Heat Exchanger Mentor Pilot (2020) District Heating Divas.

5.5 Qualifications

One important finding from the desk research and interviews was that there is very limited availability of specialised qualifications for heat networks, and those that do exist are rarely used. Most of those working in the sector have professional or vocational qualifications specific to their general role. For example, those designing networks would generally be chartered mechanical, electrical or building services engineers, while those installing equipment would generally have a recognised qualification in a related trade.

The lack of heat network specific qualifications may reflect their limited availability and quality, and skills in the sector being viewed by some as transferrable. Heat network specific knowledge would then be built by on-the-job learning, and in some cases by attending the short training course run by CIBSE.

To explore qualifications that professionals in the heat network sector hold, occupations identified above were split into six broader occupational groupings: managerial roles; technical roles; consultants; design roles; legal and financial roles; and commercial roles. Appendix D contains more detail on the qualifications required at each occupational level.

Project management roles

Roles in this group include:

- *Project delivery manager*
- *Development manager*
- *Operational or commercial manager*
- *Supporting roles, such as stakeholder engagement*

Many project managers would come from a technical background and typically possess an engineering degree, often in mechanical, electrical, or building services engineering. This is because they need to be able to understand the designs and systems that they are managing. Project management qualifications on top of an engineering degree were mentioned by some employers as desirable, but not essential.

The level of importance of engineering knowledge varies depending on the role, although it is generally sought; for some roles (particularly commercial manager) general energy sector experience may be more relevant.

Design engineering roles

Key roles in this group include:

- *Energy master planner*
- *Design engineer*
- *Other specialist technical roles*

A recognised engineering qualification is almost always a necessary requirement for a design engineer or energy master planner. Employers typically look for a fully chartered professional,

typically in mechanical or electrical engineering, or for some roles building services engineering, with significant heat network experience.

Many employers interviewed felt that they would prefer heat network specific qualifications, since this would mean it would be easier to identify those with appropriate skills at recruitment, and avoid the process of upskilling within the organisation.

Technician roles

Key roles in this group include:

- *Operations or maintenance technician*
- *Inspector or tester*

For technical roles, a background in the mechanical, electrical, or building services sector, via vocational qualifications, degree or foundation degree is important. The skills from these qualifications seem to be more transferable than most and provide a starting point for a technical career in the sector. However, there are no vocational qualifications specific to the sector at present, meaning that on-the-job training is always necessary for those without experience.

For example, for inspectors and testers, a foundation degree or HNC / HND (Higher National Certificate or Higher National Diploma) in a civil engineering, building services engineering, or building surveying related discipline would typically be needed.

Construction and construction installation roles

Key roles in this group include:

- *Pipe layer (including welder)*
- *HIU installer*

For an HIU Installer, a relevant Apprenticeship or Level 2 or 3 NVQ in a related subject (e.g. building services engineering) would be desirable. Pipe Layers (including welders) would be qualified in construction or civil engineering operations, typically at Level 2 or 3, most often via an Apprenticeship.

These qualifications are generic and not specific to the sector, although that is not to say these roles do not require heat network expertise for a quality result; several interviewees mentioned that lack of knowledge of heat networks in these roles was a problem.

Supporting specialist knowledge

Key roles in this group include:

- *Financial specialist*
- *Legal specialist*
- *Planning specialist*
- *Architect*

- *Other consultants for detailed technical matters*

These roles have in common that they are typically brought in to advise and support on one specific aspect of a heat network project, typically on a consultancy basis. All need to have a strong grasp of the structure of heat networks and their broad design and functioning, but not necessarily a close understanding of engineering issues.

Individuals in these roles will typically hold general qualifications (usually professional) for the sector from which they come (e.g. a planning specialist would be a member of the Royal Town Planning Institute). However, the specialism in the sector would be largely built through personal preference or experience, with no formal heat network training for any of these specific professions encountered during the research. Those spoken to did not feel this was a particular problem for the sector; however, availability of courses might widen the potential pool of consultants of this type.

5.6 Career pathways and the barriers and enablers to progression

Overview

The primary finding from the stakeholder interviews was that for most roles in the heat network sector, there is no typical pathway. Individuals came from a range of backgrounds, although usually in some type of engineering, and often "fell into" the sector without a plan to do so.

> *"I suspect that if you had gone to a graduate recruitment fair for engineering at university a couple of years ago nobody would have known what district heating was... It's not something that comes up in their engineering course. If you speak to some of the young engineers, they will tell you, that it was a bit random how I got into it, didn't know anything about it but they just went with it. It's not an obvious career choice for an engineer."* **Consultancy (Stakeholder Interview)**

The interviews seemed to indicate that in the early stages of a career in the heat network sector, skills are generally more transferable. It is relatively easy to move between lower level or some mid-level roles in heat networks and their associated parallel sectors such as more general building services engineering, construction, and the wider energy supply sector. However, individuals further along in their career need to have specialist knowledge of heat networks.

This expertise is currently in short supply, and numerous interviewees complained about bad experiences with project managers and designers who lacked specialist knowledge, frequently due to a failure to involve a specialist at the appropriate time. This resulted in poor outputs and resources wasted down the line fixing mistakes made as a result.

Transferability at higher levels is therefore more limited. This is partly because there is no in-depth training which would convert an expert in even quite a closely related field to heat networks, nor the time and/or appropriate skills to devise such training at any individual employer. Senior roles are therefore in high demand, and consequently very well paid.

However, there is substantial movement within the sector itself. A few employers mentioned the “revolving door” between ESCos, the public sector[85] and consultancies, and the frequent poaching of highly skilled individuals. One interviewee also mentioned the transfer of individuals to and from equipment manufacturers for the sector, who could pay well. The main reason behind this appears to be the combination of the historically small size of the sector, and the reliance on long heat network specific experience for identifying suitable candidates. This further limits the small pool of skilled recruits for senior project management or senior engineering roles.

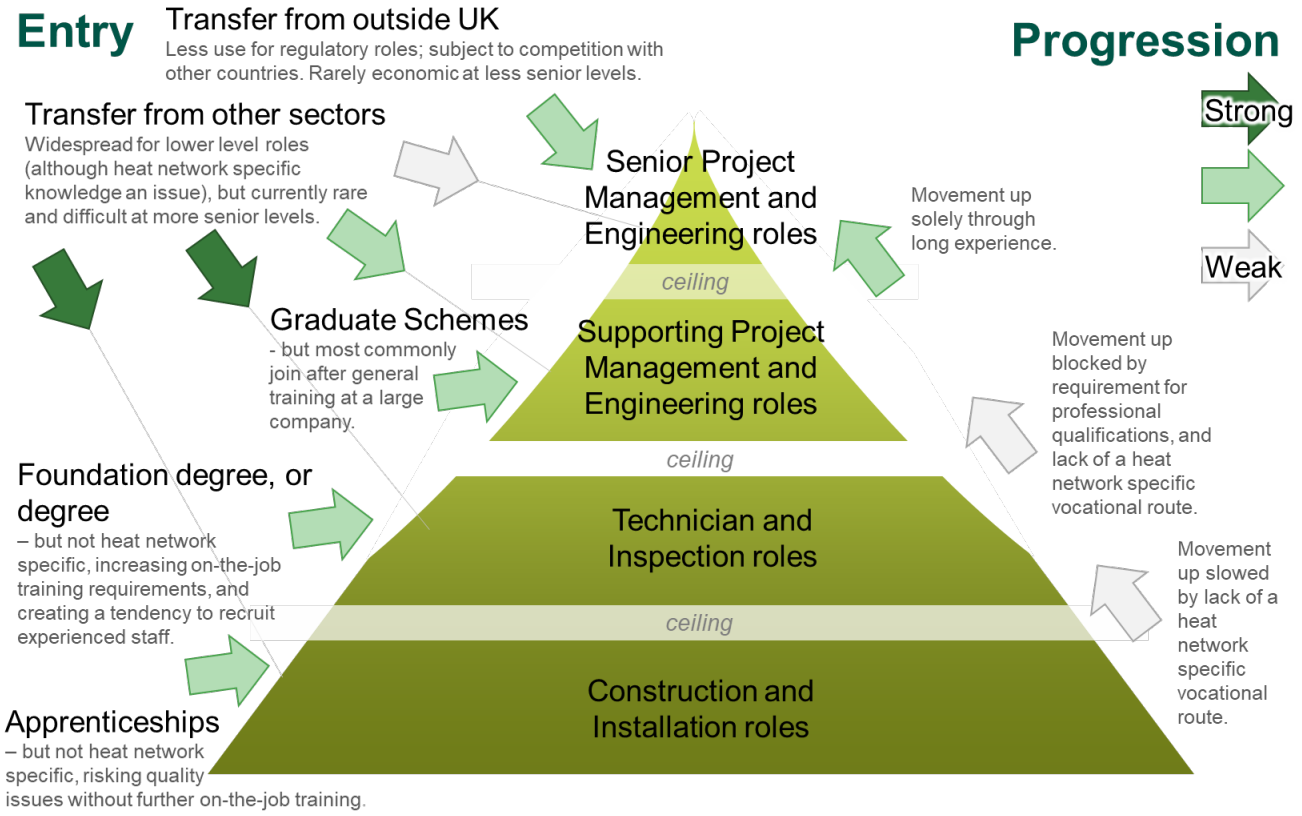
One employer mentioned that he already knows most of the people who would be suitable for highly skilled engineering design (energy master planner) and project development manager roles, and therefore believed that to recruit he would have to poach someone from another organisation in the sector.

Figure 5.7 represents the entry and progression routes in the sector, showing senior roles in the industry at the top, and less senior at the bottom. Clearly this is a simplification; in fact, these roles will be split across organisations, and many more niche roles will have a different structure, without a clear progression. Nevertheless, as a representation it is helpful in conceptualising some of the issues the sector faces.

The arrows represent flows of people, either into the sector at a particular level (on the left) or progressing upward through the sector (on the right). Grey arrows represent weak flows, while green and darker green arrows represent progressively stronger flows. Finally, the horizontal bars represent barriers or ‘ceilings’ between roles; the paler the colour, the stronger these barriers are.

[85] Respondents only specifically mentioned local authorities, but it seems likely that this would occur with any other public sector organisation seeking to employ individuals with heat network expertise.

Figure 5.7: Representation of entry and progression routes in the sector



Source: Summary of research interviews and workshop participants input

The diagram illustrates a number of weaknesses in the sector's skills and training structures:

- Entry routes are generally through training not specific to the heat network sector, and most often without any heat network relevant content, leaving individual employers to provide this training (whether formally or informally), and without standardisation or accreditation. There is some evidence that this results in well-known design problems continuing to occur due to learning not being passed on; for example, one interviewee complained of heat network engineers continuing to make the same design mistakes seen many years previously.
- Although the supply of new entrants to the sector at lower levels has weaknesses, the greater issue in some ways is a shortage of progression opportunities. As documented elsewhere, movement upward tends to be solely through experience of complete projects.
- Movement up the pyramid is also hampered by the requirement for chartered engineers, including in roles which are predominantly project management oriented, combined with a lack of vocational (e.g. Level 6+ / degree apprenticeship) routes suited to the sector.
- Transfer from other sub-sectors is possible lower down the pyramid, but at the top is hampered by the lack of training to convert high level engineering, project management and other senior level skills from other sectors to a heat network context.

Some key roles are also affected by specific issues in addition to those shown above:

Project management roles

The heat network sector is legally and financially complex, and therefore requires complex project management skills. For example, projects often require buy-in from numerous stakeholders. Progression to a project manager role is particularly difficult, since for many, their first involvement in project management will come with seniority and potentially without appropriate training. Because of the importance of engineering knowledge to a heat network project, these roles may be filled by promotion of an engineer without strong project management experience. Finding individuals who combine sufficient heat network knowledge with proven project management expertise is difficult for employers.

For local authorities, the dilemma may be different; here the focus is on procurement and project management skills, which the local authority might be able to source. However, knowledge of the specific challenges of managing a heat network project, and the understanding of the engineering challenges required for effective procurement, is much less widespread. Interviewees mentioned that HNDU provides guidance to local authority officers to assist in the understanding of the processes involved in establishing a heat network. However, many felt that something more engineering-oriented was needed to help local authorities judge the quality of heat network providers' work.

Design engineering

Many similar advanced engineering skills are present in other related sub-sectors. However, the ability to transfer these to the heat network sector, to the level of detail necessary, is currently limited, given the lack of standardised or accredited training in this area. Many interviewees mentioned that they had interviewed candidates working in other sectors who had the requisite skills and knowledge at a theoretical level, but lacked knowledge of how to apply these skills to heat networks. In addition, the ability to operate an effective graduate scheme, which is currently vital for bringing through new talent among this group of employees, depends to an extent on large size. Many companies in the sector are small, or have a small heat network team.

Supporting specialist knowledge

Individuals providing niche expertise to a heat network project, whether legal, financial, urban planning or otherwise, typically enter the heat network sector after a significant career in another profession, and may retain wider interests. They enter a heat network related role solely through experience, since there is no training which would accredit a consultant to work on heat networks. Those spoken to did not feel this was a particular problem for the sector. However, availability of courses might widen the potential pool of consultants of this type.

5.7 Conclusions

- The heat network sector is defined by its products, rather than by the skills involved in producing them. It also has substantial overlap with other sectors, at a company level and even at an individual level.
- Although the core of sector is in mechanical and electrical engineering, it sits at the intersection of engineering, construction, energy supply, and public administration, with contributions from several other sectors. The heat network sector is therefore dependent for

success on skills in a number of sectors, meaning that liaison with a wide range of organisations will be necessary to improve skills provision in the sector.

- Heat network projects are structurally and administratively complex. They therefore require high level project management skills across all core senior roles.
- The differences between traditional higher temperature networks and lower temperature networks do not affect the basic structure of a project nor the types of skills required. The main differences are in the detail of the knowledge required by design engineers, and the reduction in the requirement for welding skills at civil engineering sub-contractors.
- Many companies that are significant in the sector carry out a minority of their work in heat networks, and many individuals whose skills are key to project success spend a portion of their time on non-heat network related employment. For this reason, it is not possible to meaningfully identify the sector in official statistics. Assessing the existing skills base in the heat network sector is therefore particularly difficult. This could be addressed through, for example, a quantitative survey of relevant SIC2007 sectors, analysing the workforce of relevant companies, allowing mapping from official data to take place.
- There are some common themes across the sector in terms of skills challenges. Both basic and advanced skills are often transferable with other sectors outside heat networks. However, within each role there is a core of heat network relevant knowledge which is currently acquired primarily informally, and for which training is not standardised or accredited. Without this standardisation, it is difficult to assess the state of skills in the sector in a way which might be possible in sectors with more established structures.
- The sector is believed by many employers and stakeholders to be weak in diversity terms, with a high proportion of male employees, and relatively limited representation from ethnic minorities.
- Recommendations relating to the sector and occupational profile are addressed in Chapter 9: Recommendations.

6. Current and future skills needs

This chapter has been informed by evidence from the literature review, stakeholder interviews, and workshops as well as complementary desk research. It identifies five current skills challenges, and four associated impacts for the sector as well as summarising anticipated future skills challenges for the industry. It also considers the transferability of skills from other sectors. Detailed information about the skills required at a specific occupational level are documented in Appendix D.

6.1 Current skills challenges

The research shows that skills are a substantial issue for the sector, although that is not to say it is the only challenge. While it is not possible, due to the growing and specialist nature of the sector, to put a number on the shortfall of skilled people in the various occupations, it is clear that shortages are widespread and severe.

As noted by an IPPR report[86], in general the wider low carbon sector already suffers from shortages of skills, even prior to the substantial expansion projected over the coming years. Several studies have identified skills shortages as a potential limiting factor in expansion in the wider low carbon energy sector, and interviews carried out for this research suggest this is also likely to be true of the heat network sector.

Some of the challenges identified are present across a range of occupations, and many have arisen through a combination of factors including the current size of the sector, the maturity of the sector, and the type of roles required.

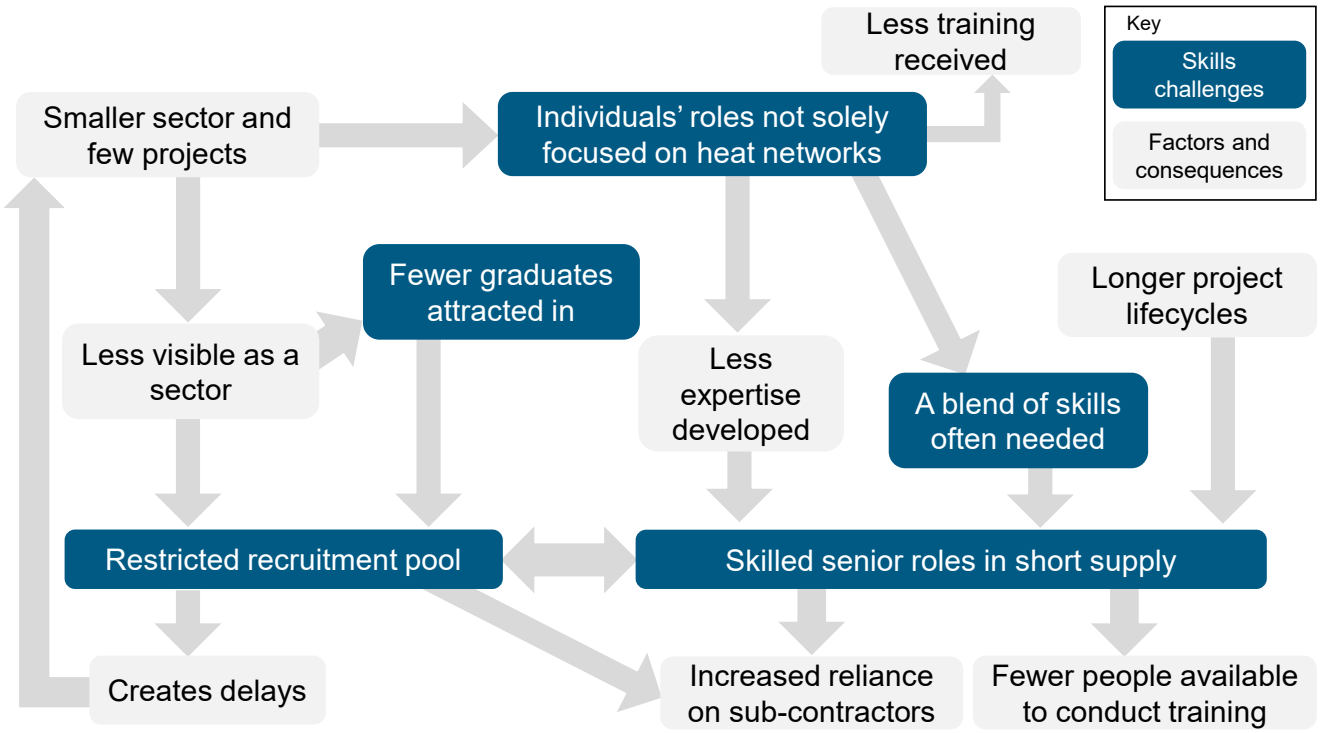
In total, five key skills challenges were identified within the research:

- Recruitment pool is limited
- Finding the right blend of skills in one individual
- People for skilled senior roles in short supply
- Individuals' roles not solely focused on heat networks
- Maximising suitable graduate recruitment pool

Alongside other factors and consequence, these challenges interlink with one another, rather than being in a natural order of importance (Figure 6.1). This might suggest that to be effective in addressing the overarching skills gaps, a number of areas need to be tackled together rather than focusing on a small number of specific areas. Alternatively, it might suggest that by focusing on one area it will naturally have a positive impact on others.

[86] Institute for Public Policy Research (2019) A just transition. Realising the opportunities of decarbonisation in the North of England.

Figure 6.1: Interconnections between current skills gaps



Skills challenge 1: Recruitment pool is limited

A recurring challenge across many organisations working in the heat network sector is that the number of viable candidates to choose from for some roles can be small.

Many acknowledged that it can be a struggle to recruit for certain roles as the experience does not exist amongst candidates, and when it does it is only across a few individuals, restricting recruitment. This resulted in some roles being filled by candidates without all the relevant credentials, but more commonly in roles remaining unfilled for a period, contributing to complaints among interviewees of poor management of projects. Many interviewees also reported that their main source of skilled, experienced employees was from people in similar roles at competitors.

This was particularly problematic among senior and highly technical roles, including project delivery managers, design engineers, senior lawyers, and development managers. For example, one interviewee explained that only four people applied for a heat network development manager role being advertised and none were considered to be strong candidates, resulting in a candidate who was not ideal for the role being recruited.

> *"The amount of people in the market that will be willing to work or have experience working with heat networks is quite limited. It's difficult to find a project manager, for example."* **Local authority (Stakeholder interview)**

Influencing factor: Fewer highly skilled professionals within sector creates a deterrent to produce and deliver training for others which might help to expand the recruitment pool

A key issue is that, as the market is relatively small, there are simply relatively few individuals with experience of working in the heat network sector in the UK, and in the specific

technologies used by employers such as those used to design a heat network. Some stakeholders believed greater levels of standardisation across the industry would help resolve this and reduce the specificity of criteria required in some job roles.

> *"[With standardisation] we can take non specialist engineers and give them the tools they can use in an individual way to drive the work forward. We can facilitate engineers to make decisions that are broadly correct that are then confirmed by a skill specialist. This is driven [by] observations [of] the Danish … sector['s work] on upskilling. For example, they have an online planning portal where engineers can enter certain information and the tool tells you if heat networks are the right way to go. Centralised leadership on communal data sets will provide the inputs for rapid upskilling."* **ESCo (Workshop)**

> *"We can bring the bar down by standardising a bit more. It is currently time consuming as everyone is trying to reinvent the wheel, but we need a more consistent approach, the market is so fragmented we end up with lots of different variations. HNIP launched the template contracts. These templates should be expanded into procurement strategy and specifications for specific types of heat networks which could be shared broadly".* **Local authority (Workshop)**

Local authorities in particular suffer from small recruitment pools as they are bound by procurement rules, which often require them to use pre-checked agencies when recruiting.

The size of the recruitment pool is also dependent on location. For example, London, Leeds and Manchester were considered to have a more competitive market for recruiting consultants compared to other areas of the UK.

Influencing factor: A geographically dispersed workforce as well as a lack of geographical focus can limit on-the-job training opportunities

Skills challenge 2: Finding the right blend of skills in one individual

With the sector still maturing in the UK, organisations typically have relatively small departments focussing on heat networks. One consequence of this is that organisations tend to look for individuals who are capable of performing a wide range of tasks in their role. Finding an individual who possesses the right combination of the required skills can be challenging.

> *"The combination of both sets of skills [technical and project management] is difficult to find. It's not impossible but it's difficult. If you add the extra layer of experience with heat networks, that's when it becomes really, really tricky."* **Local authority (Stakeholder interview)**

For example, occupations such as project managers would primarily require skills which are not specific to the heat network sector e.g. organisational and communication skills. However, project managers with limited or no technical understanding of what a heat network does and how it operates are unlikely to be as successful in the role as someone who does. A lack of technical knowledge may result in a poor-quality heat network being procured. Meanwhile a lack of stakeholder engagement skills may result in a network which is less financially successful, may make it difficult to attract developer or other stakeholder buy-in, and could lead to issues identifying and connecting to local anchor loads.

The same can be true for those in senior engineering roles, where technical skills are vital, but they need to be complemented by strong project management skills.

> *"We often get really good engineers who struggle with managing projects, or project managers who know little about engineering."* **ESCo (Stakeholder interview)**

A few stakeholders also highlighted the need for commercial expertise amongst the blend of skills needed within some heat network roles such as project managers. For instance, one local authority explained that a good project manager would have to have an understanding of the technical concepts of a heat network, but also an understanding of the financial and regulatory issues relating to constructing a heat network.

> *"You'll find project managers with expertise in construction, or complex engineering projects, but someone with the right mix of skills for heat networks and understands the local and political context is really difficult. I'm not saying there's nobody there, but we struggle."* **Local authority (Stakeholder interview)**

This challenge can also be seen across legal roles, such as solicitors, where there are many lawyers in the market who have the relevant 'generic' skills in construction, commercial or public procurement for example, but little experience of heat networks themselves. They would struggle to identify the specific requirements and risks involved in these kinds of projects.

Skills challenge 3: Skilled senior roles in short supply

Linked to both challenges already discussed, there was consensus across the industry that it was most difficult to fill senior technical and professional roles. While retention is not considered a critical issue for the sector, there was a lack of individuals with 10+ years' experience working on heat networks who were available to move into senior managerial roles.

Influencing factor: Long project life cycles can result in it taking years for an individual to gain experience in all stages of a heat networks project.

Throughout the industry, supply of people for all types of senior role is principally via individuals gaining long experience within the sector. In some sectors, this situation might persist without causing major difficulties, as people are promoted by employers as their experience grows with time. However, in a rapidly growing sector such as the heat network sector this presents substantial difficulties since the supply of people with experience is limited by the small historic size of the sector.

> *"When it comes to detailed design and doing the client-side role and overseeing construction operation, you have to have a lot of experience under your belt."* **ESCo (Stakeholder interview)**

When recruiting for more senior technical roles such as energy master planners and design engineers, it becomes harder to transfer staff in from other sectors as the roles require them to have more specific knowledge and experience of heat networks.

This challenge appears more difficult for smaller businesses and public bodies to resolve because they are less able to train up their existing employees and are less likely to have the budgets to buy in or retain the expertise.

It was acknowledged by many that for some of the more technical or senior roles, on the job experience was invaluable and hard to teach or train. This is a challenge for the sector because the number of projects that come to fruition are still small and the timescales mean it can be years before individuals fully gain experience. This does however imply that as more projects are completed and the sector grows, there will be more opportunity for individuals to acquire this, on the job, experience and consequently reduce this challenge.

> *"There is a degree of learning curve in this market because it's not been done before."* **ESCo (Stakeholder interview)**

Skills challenge 4: Individuals' roles not solely focused on heat networks

One skills challenge identified through interviews with the sector was that for many who work on heat network projects, these projects may comprise only a small part of their overarching role within their organisation.

Consequently, those individuals are at a natural disadvantage in gaining experience and understanding of heat networks (experience and understanding that would improve their ability to work on these projects). It is also an explanation, in part, for why some individuals may not receive adequate training for working on heat networks.

This issue affected local authorities and housing associations mostly, and especially staff operating at managerial levels. This is important as heat network development largely focuses on local authority owned and led heat networks, so it could be resulting in slower development.

> *"[A key challenge is] Under-resourced clients [e.g. local authorities]. Often the scheme is not the main focus – they're doing a housing development but want district heating adding to it. They have no dedicated staff, no resource for it."* **Consultancy (Stakeholder interview)**

A linked issue for organisations such as local authorities is that the heat network related knowledge is often confined to a particular individual, or small team. If they were to leave, this knowledge would depart with them, reducing the institutional knowledge held within the organisation.

Influencing factor: Local authorities have started to enter the energy supply business and therefore may not always consider this to be core and continuous part of their remit. However, the private sector does rely on their internal skills to oversee heat network developments.

Skills challenge 5: Maximising suitable graduate recruitment pool

While the sector struggles due to the size of the recruitment pool of managerial/senior staff with relevant experience, the issue for new entrants is slightly different. Here there is, in theory, a greater pool of talent, especially those recently graduating through UK universities with relevant qualifications (e.g. Bachelors or Masters degrees in mechanical, chemical or electrical engineering). And this is a pool that offer employers the ability to train up individuals immediately on the skills required to work on heat networks.

> *"I can take a new graduate with an engineering/science degree with no work experience and develop them into a very competent design engineer."* **ESCo (Stakeholder interview)**

However, many interviewees stated that, whilst recruiting graduates was easier than some more senior roles, it did not offer quick returns, and retaining graduates after training could be difficult. Degree courses do not always contain substantial heat network related content and some employers interviewed found they needed to train engineering graduates in heat networks. This poses an issue for smaller companies who lack formal training or knowledge management systems, due to capacity or resource availability. Indeed, many interviewees, including at some larger organisations, acknowledged that their recruitment practices were not constructive for the sector as a whole, but felt they had little choice.

Some considered that the sector provided an attractive opportunity to graduates, especially those with interest in joining growing industries utilising cleaner energy technologies, although it might not be as appealing as some others such as electric vehicles.

> *"We're bringing people from chemical engineering. It's been an attractive target group. The main reason is that graduates see oil and gas as a less appealing option. We received over 200 applicants for 4 graduate positions."* **Consultancy (Workshop)**

However, the heat network industry is competing with other energy and related sectors. Graduates are sought by many other engineering employers in other sub-sectors which are also experiencing a shortage of skilled employees. Such career opportunities and may feature more prominently in degree/course content or might be more strongly promoted, for example at careers fairs.

Stakeholders believe the heat network industry is not as visible to students as other competitor sectors, which means students are simply less aware of the career opportunities available to them. The lack of industry presence in the UK is an inevitable consequence of its market size, but it is also caused by the courses available to students, whereby a focus on heat networks is commonly one minor aspect of far broader content.

> *"I can see within the membership that the growth of electric vehicles is the exciting sector which attracts a lot of graduates. Not the same story on the heat side of things."* **Association (Workshop)**

6.2 Skills challenges by occupation

Another important aspect of understanding current skills challenges is to address specific occupation needs. Table 6.1 provides a summary of the current skills challenges identified across occupations. More information about skills needed and lacking for specific occupations can be found in Appendix D.

Table 6.1: Summary of skills lacking by occupation

Occupation	Skills lacking	Severity of skills gaps
Project Delivery Manager	Challenge finding new recruits with the relevant experience and understanding of the heat network landscape specifically as well as individuals with the relevant commercial skills and experience of procuring large scale projects.	High
Heat Network Development Manager	Typically lack the breadth of roles required in this position, commonly possessing strong project management or engineering skills but rarely both.	High
Energy Master Planner	Acceptance that no-one comes to the role fully proficient Intricate knowledge of heat networks can be lacking among those transferring from other sectors, although most accept that this can be developed. There is also a lack of commercial and legal understanding	High
Control System Specialist	New recruits often do not come equipped with the full range of skills required, and in particular lack direct experience working in the heat network sector.	High
Design Engineer	There is a limited theoretical or practical knowledge and understanding of heat networks, which new recruits will need to learn early on, on the job.	Medium
Commercial / Operations Manager	Suitable business acumen is often the key skill lacking among organisations that struggle to find commercial managers with necessary proficiency.	Medium
Legal Specialist	While there is some relevant knowledge at more junior levels, those at more senior levels typically have limited experience of the heat network sector.	Medium
Financial Specialist	Similar to legal specialists, there is some relevant knowledge at more junior levels. Those at more senior levels typically have limited experience of the heat network sector.	Medium
Operations and Maintenance Technician/ Inspector	There is a lack of good problem solvers, i.e. individuals who are able to inspect a system and understand it sufficiently to be able to resolve problems themselves.	Medium
Pipe Layer (including welding)	It is relatively easy for welders to work across different sectors, which means that knowledge of heat network systems themselves is often lacking (although these can be learnt with relative ease).	Low
Installer	It is relatively easy for installers to work across different sectors. The research did not unpick any particular skills lacking in this occupation.	Low

6.3 The impacts of skills gaps

As might be expected, the skills challenge facing the heat network industry threatens growth ambitions in the sector, with four identified impacts:

- Delays to development
- Lower quality projects
- Higher costs
- Greater reliance on subcontractors

All of these impacts were referenced as happening now within the sector and until challenges are addressed are likely to continue into the future.

Delays to the development of heat networks

Without enough people with sufficient skills within the sector, projects are likely to take longer to be delivered. This can be because it takes longer to recruit the right person for a particular role: some reported roles taking up to 6 months to fill. Additionally, there is more chance that someone with the required skills was not available at a particular time needed, or that poor quality work required time to amend or adjust.

Lower quality projects

A more concerning risk of an on-going skills gap is that projects continue to occur, but are delivered at a lower quality. There were already examples provided from stakeholders where roles were filled by candidates with fewer skills and experience than would have been ideal, with some organisations relaxing their recruitment criteria in order to avoid delays.

> *"They employed project managers who didn't particularly know what they were doing. People designing and building the scheme were not from district heating either: they were standard M&E contractors, who then further subcontracted the design to standard building services consultancy. [The contractor] brought in more specialist engineers to try and fix the poor product, which has worked to an extent."* **Local authority (Stakeholder interview)**

> *"When it comes to the detail and reviewing detailed designs control logics, about 70% has mistakes in it."* **ESCo (Stakeholder interview)**

Others however were not so concerned about relaxing their recruitment criteria.

> *"With the growth plans that we have got I don't see any immediate shortages. At the moment we have 7 individuals in the project development manager role. We might need 10 to 15 in the next 3 to 4 years (2 or 3 a year) to meet our growth plans. If we are a little bit creative about the people we bring in I don't see that as being a showstopper."* **ESCo (Stakeholder interview)**

Lower quality projects are more likely to need updating, fixing or replacing. This will involve additional costs and the networks will therefore become more expensive to run and more expensive to consumers - resulting in sub-optimal outcomes. Moreover, lower quality projects may contribute to a negative perception of what heat networks can achieve and reflect badly

on the sector as a whole. This may negatively impact public opinion of heat networks more broadly.

> *"There was a rush to get technology installed that wasn't necessarily well designed for the site which they were going into and because of that we're seeing issues later down the line where things are not working efficiently enough to actually heat the property"*
> **Housing association (Stakeholder interview)**

Heat networks cost more to deliver/operate

If there continues to be higher demand than supply for certain roles, such as heat network designers, lawyers and consultants, then the cost to hire such individuals is likely to be high, which restricts how cost-effective projects can be.

> *"People are jumping from one organisation to another… it's about who can attract the best talent and in the current climate it's about who has got big pockets for that."*
> **Consultancy, finance and commercial (Stakeholder interview)**

Additionally, errors in the network can result in substantial costs. One housing association recalled a poor performing heat network where the bulk heat meter had been incorrectly located, and it cost £10,000 to fix the issue. There was a lack of internal skills to notice the error in the first place as those in charge of the project did not have the technical engineering skills.

Reliance on subcontractors

While this is not considered unusual for a maturing sector, there is much reliance on specialist subcontractors as organisations do not have the skilled resource in-house to deliver their required activities, or the ability to scale up quickly enough to deliver new projects internally. This is particularly common where there is a lack of in-house experience of working on heat network systems.

Having a large number of subcontractors working within the sector is not necessarily a bad thing and, in some respects, subcontractors are helping to increase capacity within the sector. However, an over-reliance on subcontractors could lead to other negative consequences. For example, some workshop participants felt that sub-contracting could become an expensive way of meeting skills needs, due to the higher day rates charged. Some other workshop participants felt that it could introduce additional complexity and therefore difficulty into the process of managing a heat network project, which might already have an array of contracting and sub-contracting arrangements.

6.4 Transferability of skills

As part of a growing, maturing market, organisations in the heat network industry are familiar with the need to access skills from outside of the core UK sector in order to fill vacancies. These skills may originate from neighbouring energy sectors, or from the international (typically Northern European) markets.

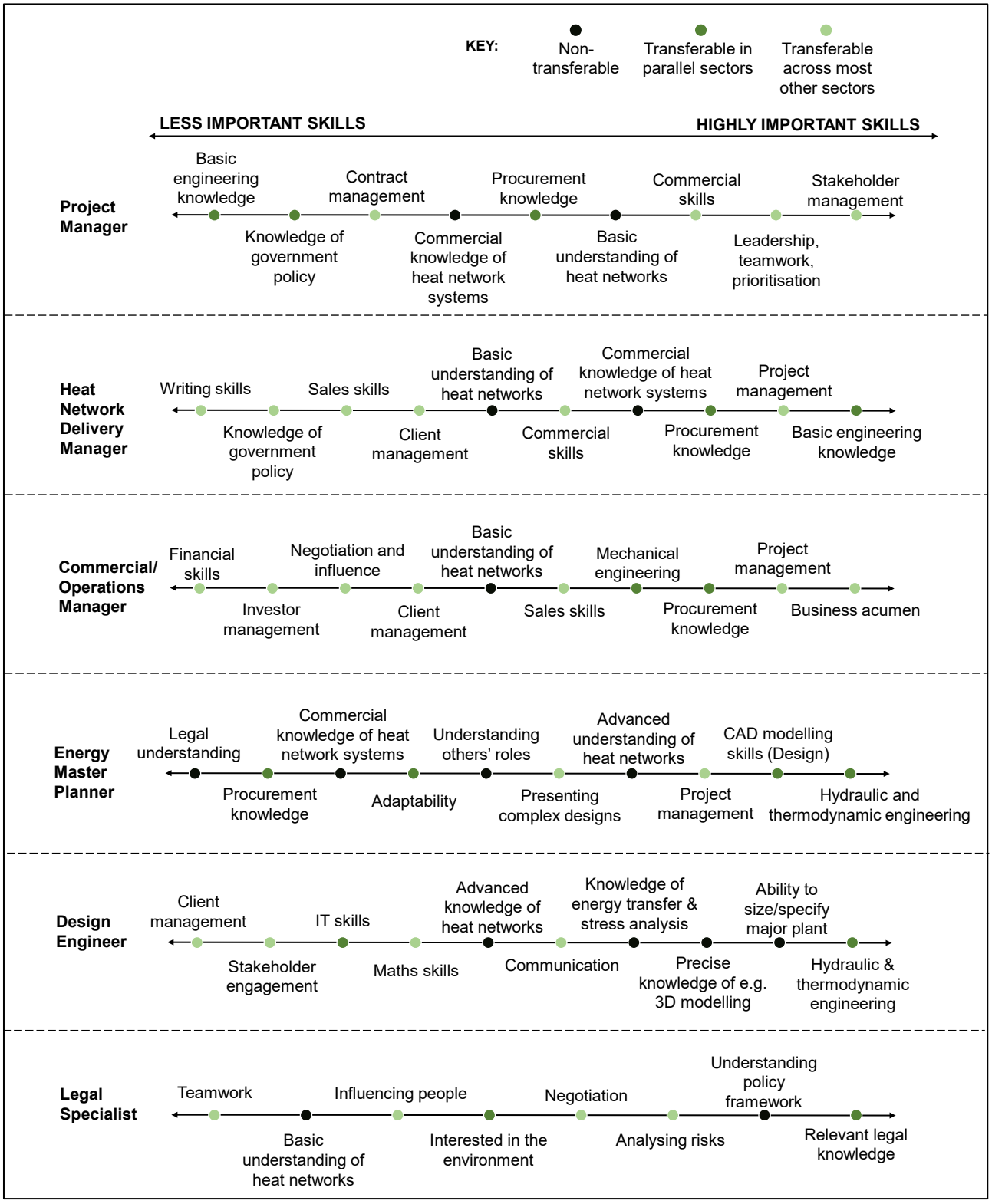
The international market is an attractive option: there are a number of countries with more mature heat network industries than the UK, meaning a greater number of staff have developed more in-depth skills tailored specifically to the heat network industry.

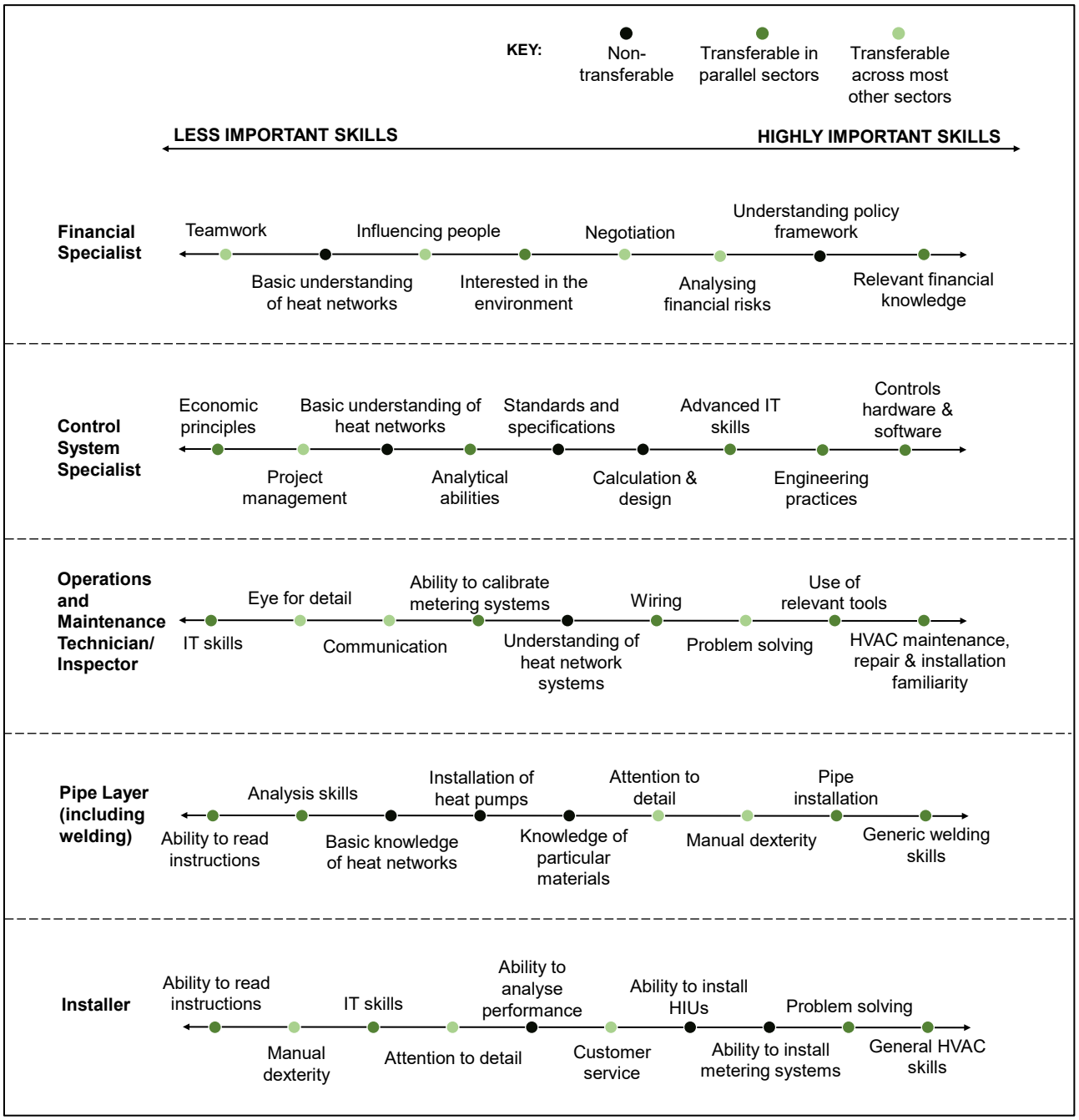
> *"We advertise far and wide. Engineering has a European focus. Lots of European countries have more heat network projects e.g. Denmark, Scandinavia, Germany, Holland. They have more extensive networks so by definition you have more people who are trained in heat network systems."* **ESCo (Stakeholder interview)**

But there are risks attached to accessing this talent. One currently affecting all sectors, including the heat network sector, relates to the impact of the UK's exit from the EU. Some organisations are concerned that potential applicants might be less likely to apply for vacancies or that there will be restrictions on the number of foreign staff who are able to work in the sector. A second risk relates to the types of skills they have developed. While these might have been learnt through more formal mechanisms, on industry-tailored courses, UK conditions are quite different to those overseas and this affects skills required. This can affect a range of occupations, in different ways. There are complications for example for those seeking legal skills, as there are often quite niche differences in laws across different countries. Meanwhile, in the UK heat networks are still growing in their maturity and therefore ESCos are building new networks from scratch. In Europe, a lot of work is constrained by existing structures; the skills and requirements for engineers are different as a result and not always directly transferable to the UK market without additional upskilling or retraining.

Domestically, there are a range of skills that are transferable across sectors, although the extent to which this is possible differs by occupation, seniority and sectors from which individuals are transferring. Figure 6.2 illustrates the key skills for eleven selected occupations and organises them by importance and transferability. Skills that are less transferable but required across roles, such as 'basic understanding of heat networks', might warrant more focus when addressing skills gaps as they are wider reaching. More information about the skills required for these roles can be found in Appendix D.

Figure 6.2: Summary of skills per occupation (importance vs transferability)





Transferability within occupations

Designers who already work in heat are considered to possess most of the skills required to work in the heat network industry, with some internal training and on-the-job learning expected to improve their proficiency, alongside developing familiarity with the CIBSE Code of Practice. Meanwhile engineers who have experience of utilities and building services are also expected to hold relevant skills that can be further developed on the job.

> *"The basics are similar; the design process is not too difficult or different to other utilities – they understand what a trench design looks like; separation distances etc."*
> **Consultancy (Stakeholder interview)**

Engineers need to possess thermodynamic and hydraulic skills, so staff working in energy sectors where these are less relevant (e.g. wind) are considered less likely to be able to transfer across to the heat network industry. However, to apply for a role as a design engineer

or heat network development manager, applicants are expected to have proven experience in heat networks as the technologies employed can be very particular to the industry; thus, it is difficult to transfer at this more senior level.

There are a number of occupations in the heat network industry, especially project managers, where a range of skills are required, from specific knowledge of the technical aspects of heat networks, to commercial and legal skills. Figure 6.2 shows the range of skills required for a project delivery manager, but also how transferable these skills are.

Organisations in the industry appreciate that there are few individuals whose skillset covers these needs, and thus roles are open to potentially a broader range of individuals than might otherwise be expected. There is also some disagreement as to which skills are of most importance. Some prefer staff starting these roles to have a strong technical background and believe project management skills can be developed on the job; but others prefer new recruits to arrive with stronger project management skills than technical expertise.

> *"Technical and project management skills are both essential for a project manager, but to be honest it's a bit easier to develop project management skills than the technical skills."* **Local authority (Stakeholder interview)**

Among legal professionals, core skills in for example negotiation, seeking to influence others etc. were felt to be more important than precise knowledge of the heat network industry, which again could be learnt (Figure 6.2) Those joining at a more senior level however would again be expected to have some knowledge of heat networks.

For manual labourers working in the heat network sector, it was not considered too difficult to transfer skills from a wide range of sectors (including ship building, steel works and car manufacturing, alongside energy sectors), so long as they had the necessary qualifications/certificates to work on the relevant materials.

There was some support for exploring synergies between skills required in the heat network industry and those in similar sectors which are in, or at risk of, decline. One such industry identified was the gas industry, which is experiencing a long-term decline that may accelerate in light of the need to reach the UK's net zero carbon emissions target. Indeed, there was a consideration that longer-term it would be only natural for workers to shift from the non-renewable energy sectors to renewable sectors. This was considered more appropriate in skilled labour roles as opposed to professional level roles.

> *"There might be an opportunity where there is a sector which is in decline and staff working in this sector can be shifted across to meet the lack of capacity in the district heat sector. Tying up the end of gas engineers and the start of heat network…would be the most obvious fit as they have the skills with the controls, water and how to connect electricity to this which are the same skills that someone who is implementing a district heating system would need. The pipes are similar but there is a difference when it comes to welding which is always identified as a skills gap. This is where a real focus is needed."* **ESCo (Workshop)**

> *"Anyone who is trained to install gas networks is a natural fit for our sector, similarly with gas and oil boiler technicians and providing funding and training to deal with heat pumps."* **Association (Workshop)**

6.5 Future skills needs

If the heat network sector continues to grow, then many occupations and therefore skills will be required at a greater volume than they are currently. In addition, there are also likely to be new skills that become important, as technologies update, as the transition towards lower temperatures in heat networks gathers pace, and as different heat sources are used. Whilst the skills challenges discussed above have the potential to persist in the future, the research identified the following additional skills challenges that could also need addressing in the years ahead. These are organised within short-, medium- and long-term timeframes.

Short-term (~2022)

- In the short-term, it is expected that there will be an acute need for surveyors, meter providers and installers, as companies respond to the Government's proposed amendments to the Heat Network (Metering and Billing) Regulations 2014.
- There may also be a greater need for those in customer roles to communicate with customers about their heat meter.
- The literature strongly suggests that the generic skills which heat network specific training would build upon are in short supply in the wider economy, a situation which has worsened in recent years. This would include domestic and commercial plumbing, which is important for construction installation roles in the sector, and construction workers with the skills required to lay and weld pipework. If shortages continue in these skill areas, this could become a major obstacle and cost to the installation of heat networks. Importantly this not seem to be 'on the radar' of those working on design and project management in the sector, perhaps due to the sub-contracting relationship.

Medium-term (~2030)

- With the transition to lower temperature systems, welders/installers will be required to work with plastic rather than steel pipes, entailing a different type of welding or joining of pipe material. One stakeholder however disputed this, noting that steel pipes still had a role to play, particularly in bigger networks.
- It is likely that the heat network industry will continue to expand its use of waste heat sources, through the use of heat pumps. The type and breadth of waste heat sources is likely to continue to evolve over time, to include rivers, mines, and sewers as well as incineration. Adaptability and flexibility therefore become even more important assets, as staff need to be prepared to work with new sources. While there are technical considerations that designers and engineers must familiarise themselves with, there is concern in the sector that it is at commercial levels where the skills are unlikely to keep pace. Lawyers will have greater involvement, as responsibilities for the waste heat management may become less clear or more complex, and there are likely to be a number of actors involved in the planning. That said, one stakeholder considered that skills such as negotiation could become less important, should the industry be able to standardise.
- As with most sectors, digital skills are increasing in importance in the heat network industry. advanced IT, complex data analytics, cyber security, and augmented reality are all areas that those involved in the planning and design of heat networks will have to develop, in order to harness more advanced software and develop higher quality heat networks at a quicker pace. Digital skills, although referenced within the stakeholder interviews and

workshops, were not covered at great depth by the sector which may reflect a lack of importance, or more likely, lack of immediate concern compared to other challenges.

Longer-term (~2050)

- As the sector matures, and existing heat networks age, maintenance operations, strategic planning of upgrades to existing networks, and strategic planning of next generations of heat networks all become more important. This would likely mean an increased demand for energy consultants, and facilities and estates managers as well as occupations across the heat network project lifecycle.

6.6 Conclusions

- The research identified clear pockets of skills gaps in the industry, while also pointing towards skills needs that are likely to become more important as the sector evolves.
- Multiple factors are contributing to the current skills challenges including lack of training provision, the nature of heat network projects (e.g. their timescales and complexity), the visibility of the sector and its current size.
- There are issues of limited recruitment pools across multiple occupations, which are often exacerbated by the need for many roles to have a particular blend of non-specific and specific heat network experience and expertise.
- The limited supply of individuals with the necessary experience to carry out senior project management and engineering roles is a particular skills concern. As the sector grows there are likely to be more people available to fill such roles, however in order for this growth to occur, more needs to be done to address this issue upfront.
- There is more potential to increase the number of graduates entering the sector but there will be competition from other sectors, so it is crucial that the heat network sector maximises its visibility and attractiveness amongst this cohort in the coming years.
- The impacts of these skills challenges are already being felt by the sector, with projects taking longer to occur or being delivered at a lower quality helping to limit how cost-effective projects can be.
- As part of a growing, maturing market, organisations in the heat network industry are familiar with the need to access skills from outside of the core UK sector in order to fill vacancies. However, this was accepted with caveats, including the fact that the UK market does differ in some respects to its closest neighbouring markets in Northern Europe and so different skills are often required. Domestically, there are a range of skills that are transferable across sectors, although the extent this is possible differs by occupation, seniority and sectors from which individuals are transferring.
- The research identified several additional skills challenges which are likely to become more important in the short- medium- and long-term future.
- Recommendations on how to address the current and future skills gaps are addressed in Chapter 9: Recommendations.

7. Current training practices

This chapter summarises current training provision and employer attitudes towards training, including challenges faced and the role of qualifications and standards. Insights from the workshops and interviews have been used to identify the current status of available training in the heat network industry alongside challenges and concerns felt by industry stakeholders. This includes an overview of existing training as well as identifying gaps in current training provision that should be addressed in the near term. This chapter is split into two sections covering existing training provision and requests for future training provision.

A recent report by the Institute for Public Policy Research (IPPR)[87] highlights challenges faced by the UK low-carbon sector, which also specifically apply to the UK heat network sector. Vacancies across the low-carbon sector are partly a result of a lack of applicants with high-level skills such as engineering, and partly due to the length of time required to train people, typically at least 3-4 years. The report also echoes concerns raised by respondents that trained personnel are very likely to move across companies or industries, reducing the value-add from investing in training of existing employees, particularly any specialisms needed for the heat network industry.

Within the heat network industry, there is also a lack of experienced applicants with specialised high-level skills, although this is more strongly evident at senior levels rather than graduate levels. Trained personnel are more likely to move within the industry with the notable exception of the public sector, which respondents agreed was more susceptible to shifts across industries, potentially due to the prevalence of more transferable skills within the job specification.

7.1 Overview of existing training

Internal training provided for staff

Responses from both the interviews and workshops indicated clear differences between the availability of internal training for larger and smaller organisations. Smaller organisations[88] are less likely to have any formal training or knowledge management systems in place to support internal capacity building for new entrants to the sector and continued professional development for existing staff. This is mostly due to capacity and/or resource availability, as higher skilled members of the team do not have time to provide formal training or develop training materials. Internal training in smaller organisations is therefore more focused on “on-the-job” training in delivery of projects.

Larger organisations have a more varied approach to internal training. Some large organisations provide formal training for new market entrants with accompanying bespoke training materials. This approach does not differ significantly across the value chain (e.g.

[87] Institute for Public Policy Research (2019) A just transition. Realising the opportunities of decarbonisation in the North of England.
[88] Typically those with fewer than five employees, including teams within public sector organisations responsible for the delivery of heat networks and small consultancies.

consultancies, ESCos, equipment manufacturers and public sector organisations), but is primarily aimed at young (graduate and/or apprentice) recruits to the company.

The provision of ad-hoc internal training with or without bespoke training materials is provided across all large organisations. This training is usually provided by a more senior team member and is considered an intrinsic part of the duties of senior staff members. This form of ad-hoc internal training is complemented by “on-the-job” training but provided on a more structured basis than in smaller organisations.

The type of training provided in-house depends on the organisation needs and capacities. For instance, the legal consultancies interviewed provide significant guidance and capacity-building for individuals choosing to specialise in the heat network sector. Public sector organisations were more focussed on sharing heat network-specific project management and stakeholder engagement expertise, while ESCo providers provide a broader range of training depending on the role and responsibilities for the graduate/apprentice.

Training across organisations

There is an increasing focus on cooperation models to provide training across organisations, even where these organisations are competitors, potentially due in part to the UK’s heat network sector being characterised as an immature, albeit growing, industry. Several respondents indicated that there were ongoing discussions with other organisations on sharing learnings, although these were currently ad-hoc, informal discussions. This was particularly the case up or down the supply chain, with e.g. manufacturers and ESCos particularly keen to share best practice and new developments with other actors in the supply chain.

This type of training is typically provided as Continuing Professional Development (CPD) seminars with relatively short durations ranging from a couple of hours to a couple of days or through workshops held as part of a larger conference. Conference organisers highlighted as particularly relevant for the industry include the Association for Decentralised Energy, Nordic Heat, the UK District Energy Association and the District Heating Vanguards Network.

These seminars are ad hoc in nature, held at irregular intervals and rarely cover the same topic or are provided by the same provider twice. Information and access to these courses is shared through industry networks and on social media, but there is no comprehensive list maintained by any industry association.

Due to its relatively informal nature the level of detail or quality of this type of training is variable but it benefits from being able to incorporate the latest developments in industry. On its own it is insufficient to support wider capacity-building across the sector but is a useful supplement to more formalised internal and external training provision.

External training provision

There are a handful of training providers currently providing training and/or accreditation in the heat network industry. Training providers include the Chartered Institution of Building Services Engineers (CIBSE), Stoke on Trent College Heat Academy and the Ground Source Heat Pump Association, among others. These training providers tend to focus on technical qualifications aimed at engineers and/or equipment installers.

Illustration of external training

A specific example of useful external training highlighted by respondents is Logstor Academy, aimed at installers/fitters. This was rated highly as it is an internationally recognised certification given Logstor's global market presence, with applications in other utility sectors and due to the importance of pipe-laying to the efficient operation of heat network in general.

Another example of external training highlighted is the CIBSE Code of Practice training (currently aligned to CP1), an accredited two-day training course which has been running for the past four years and provides an overview of voluntary minimum standards for heat network design.

Much like the collaborative training identified in the previous section, external training is typically provided as CPD eligible coursework but also available as tailored modules in vocational training programmes. A UK Commission for Employment and Skills (UKCES) report[89], which considers skills and performance challenges in the wider energy sector, found that 20% of employers said there are not enough technical courses available to train employees to the required standard. Respondents in the workshops agreed that the lack of specialised heat network training, particularly for the buildings industry on e.g. installation of radiators and internal building heating systems to optimise heat network maintenance and operation, remains a significant barrier to skill development in the industry. These courses would strongly benefit from additional teaching material linked directly to development and operation of heat network systems. Even where these courses currently exist, the quality of instruction varies and is likely to remain so in the absence of nationally recognised standards.

> *"We can tend to find applicable training courses, but those are designed for building services, not district heating. Very similar but not the same. So, I end up doing my own."*
> **ESCo (Stakeholder interview)**

Respondents broadly agreed there was more progress in providing training for technical aspects of heat network delivery, although this training was still patchy and of varying quality or level of detail. They also agreed there was a substantial gap in the provision of training covering other elements in heat network delivery, including project management, procurement, governance, legal and financial elements, among others. The work undertaken by the Scottish Heat Network Partnership, the Heat Networks Delivery Unit and the Heat Networks Investment Project to provide standardised templates and guidance materials is considered a valuable starting point across the industry but needs to be supported by formalised, accredited training[90].

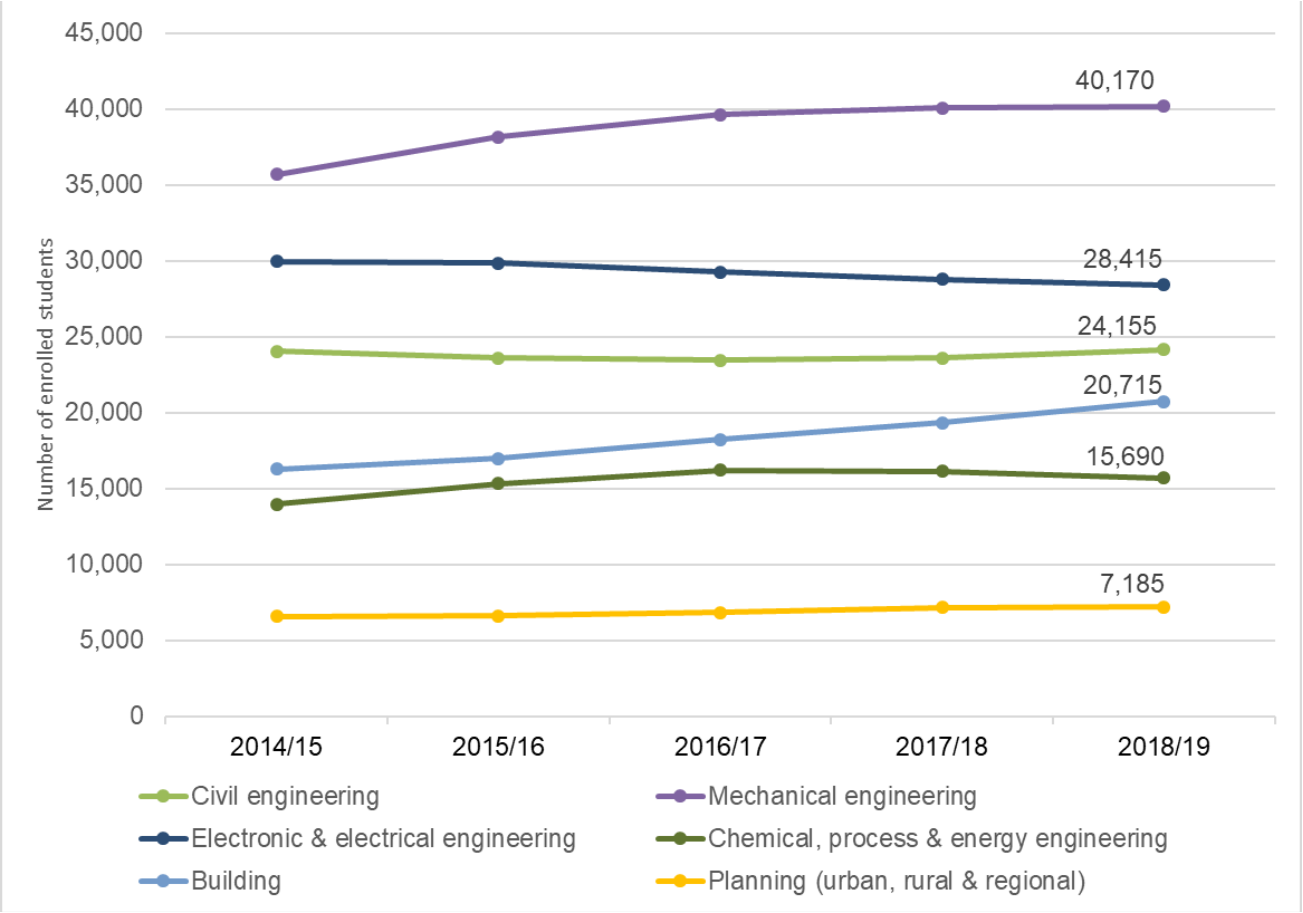
Higher Education

There is a range of degrees delivered in the UK that are of broad relevance to the heat network industry. In the chart below are highlighted four engineering degrees and two building services

[89] UK Commission for Employment and Skills (2015) Sector insights: skills and performance challenges in the energy sector.
[90] Documents from each organisation available at the following links:
https://www.gov.uk/guidance/heat-networks-overview#heat-network-guidance-documents
https://districtheatingscotland.com/resources/
https://tp-heatnetworks.org/heat-contract-templates/
https://www.gov.uk/government/publications/standardised-due-diligence-set-sdds-for-heat-networks

degrees of most relevance, and the number of enrolments in these degrees (at both undergraduate and postgraduate level) over the last five years.

Figure 7.1: Number of student enrolments in UK Higher Education in relevant degrees



Source: IFF Research analysis of Higher Education Statistics Data – What do HE students study? Data extracted from site in May 2020.[91]

Positively, it illustrates that Mechanical Engineering has experienced a growth in numbers in this period, increasing to c.40,000 student enrolments in the most recent academic year, although this growth trend has slowed down recently. However, there has been a decline in other degrees of relevance including Electronic and Electrical Engineering, and Chemical, Process & Energy Engineering.

Around two-thirds of UK universities (114 out of 169) provide some form of Engineering degree, with provision across the devolved administrations and English regions. The course content of the most popular Engineering courses in the UK was reviewed to ascertain the extent of provision that covered heat networks specifically.

Undergraduate degrees primarily have at least one module on heat transfer which is also broadly applicable to heat networks. While some courses offer optional modules on renewable energy, these appear to be primarily aimed at solar and wind power, rather than renewable heat options. Other course modules of wider relevance include energy systems modelling, covering performance of buildings and suitable renewable energy technologies. Research from the Scottish Government details a small number of colleges and universities that offer modules

[91] Higher Education Statistics Data website, Accessed April-May 2020. www.hesa.ac.uk/data-and-analysis/students/what-study

linked to heat networks, and notes that there are more options available at a postgraduate level.[92]

7.2 Challenges in training provision

Lack of expertise

Relevant heat network expertise is multidimensional, covering the breadth and length of the supply chain and factoring in local, regional and national characteristics. One example from heat network operation is metering and billing. An illustration is provided below.

Illustration of expertise gaps applied to heat metering and billing

Heat metering and billing units include physical components, data processing components, data storage and analysis, administration to issue bills and monitor complaints, and accountants to monitor and allocate costs of operating the network.

Each component of heat metering needs to meet industry standards and applicable regulation. In the UK, this includes compliance with the Heat Network (Metering and Billing) Regulations 2014, Heat Trust guidance on minimum information provided on bills (for members of the Heat Trust), an understanding of tenant rights and obligations, compliance with General Data Protection Regulations (GDPR), among many others.

Different standards and regulation will be applicable at different levels of the supply chain, from the equipment manufacturer to the heat network owner and operator. For example, decisions need to be made on the choice of physical components (e.g. the meter itself) as well as the underlying data collection software, both of which have implications for the operation of the network. Metering and billing delivery for operation of the network requires expertise on data collection, interface to accountancy software and (ideally) expertise on how to use demand data to optimise network operation.

This means that delivery of metering and billing requires technical expertise, financial expertise, procurement expertise, regulatory compliance expertise and operational expertise (for optimising network delivery) as a minimum. Some of this expertise could be offset by the existence of qualifications and standards, particularly on the technical side, but the rest should be met ideally through standardised training. At the moment, there is no formal training to cover metering and billing, with pockets of expertise across multiple organisations and some organisations providing informal CPD sessions on best practice on one or more of the needed skills, e.g. the Winckworth Sherwood and Switch2 breakfast briefings in London on updates on the Heat Network (Metering and Billing) Regulations 2014.

This lack of comprehensive pooled expertise to address specific elements of heat network delivery and operation is consistent across the industry. Respondents identified that there are pockets of expertise available in the UK and other pockets available internationally, which have successfully supported heat network delivery. Lack of coherent and multi-disciplinary training undermines understanding the holistic system and improving system performance.

[92] Scottish Government (2020) Heat Network skills in Scotland: skills gaps and training needs. Retrieved from the Scottish Government June 2020.

What is lacking is a more coordinated effort to develop tailored training bringing together these pockets of expertise to address delivery and operation challenges (previously a role typically undertaken by Sector Skills Councils). Development of a more coordinated effort within the heat network industry could learn from efforts in the construction sector e.g. the establishment of Trailblazer groups working with the Institute for Apprenticeships to develop higher-quality, more relevant apprenticeship programmes in England. In the other nations, responsibility for apprenticeship programme development lies with the relevant government body: Skills Development Scotland, Skills, Higher Education and Lifelong Learning (SHELL), Welsh Government, and Department for the Economy in Northern Ireland.

Multiple respondents indicated that there were both government and industry-led collaborations to develop external training programmes for target market participants, e.g. consulting engineers, installers or ESCo providers. Following from the stakeholder engagement activities conducted during this research, feedback from one training provider highlighted an increase in momentum in the industry, with a more concerted effort to develop regional hubs developing joint industry-led external training.

Lack of access and availability

Multiple public sector organisations and smaller organisations active in the industry highlighted that they struggle to access external training due to a combination of time and cost constraints. This is particularly the case for multi-day training located a distance away from their base of operation, as the additional time and cost needed for travel and accommodation is often prohibitive.

Additionally, public sector respondents identified a lack of tailored training relevant for their role as project sponsors. In particular they highlighted a lack of training covering commercial and contractual issues and support, although the guidance documents and templates released over the past couple of years through the Scottish Heat Network Partnership and via HNDU/BEIS was a useful starting point.

Role of qualifications and standards in training provision

There was broad agreement across all respondents that there is a standards and certification gap in the UK heat network industry, and this is driving sub-standard installation and performance of networks.

There was less consensus on which standards and certifications are particularly needed in the industry. The workshop discussions distinguished between standards for components/equipment, which were viewed as more widely available, and standards for operation which were identified as a significant gap in the industry (albeit understandably so given the relative maturity of the market).

The impending shift from an unregulated to a regulated market will need to address the lack of standards and certification. This was flagged as particularly relevant for vocational training aimed at heat network installers, as many issues with heat network delivery and operation are hampered by the lack of tailored training standards directed to installers. This is compounded by many installers identifying themselves as part of the building services industry rather than the heat network industry. Frequent examples provided by respondents include substandard installation of radiators impacting operation of networks and issues with pipe-laying, which have significant impacts on balancing and operation of heat networks.

7.3 Conclusions

- There is no clear overview of available training for the UK heat network industry. Currently, there is a variety of internal and external training available from industry partners and training providers, with varying degrees of formalisation and accreditation.
- Availability of internal training differed significantly according to the size of the organisation, with larger organisations more likely to offer tailored training to both graduates and more experienced staff. Training within organisations was characterised by its relatively informal structure. It was mostly organised as Continuing Professional Development (CPD) courses.
- External training provision was more limited, but some colleges appear to offer core modules tailored to the heat network industry and some manufacturers provide international company accreditation for certain types of installation. These types of more formal external training appear to be strictly limited to technical qualifications.
- Overall, the supply of heat network training in the UK is characterised as being relatively informal and ad hoc, with minor exceptions for specific technical expertise. Most organisations are reliant on internal training led by senior heat network experts, at times supplemented by international learning or support from other organisations within the UK.
- Support for smaller organisations, particularly public sector organisations, is required to ensure access to sufficiently trained personnel to deliver the volume of heat networks expected in the near and medium-term. This will be even more crucial to support existing and new high-temperature, fossil-fuelled networks to transition to lower temperature, lower carbon networks in the medium to long-term.
- Recommendations on how to support training practices are addressed in Chapter 9: Recommendations.

8. Learnings from other sectors

This chapter summarises the learnings from other sectors gathered through the workshops and literature reviews. These sectors include heat pump manufacturing, solar power and solar thermal development, nuclear, offshore wind development and combined heat and power manufacturing. Common to most of these other sectors is that they have or are experiencing comparable increases in expected growth of their markets. This chapter is divided into three sub-sections covering challenges faced in other sectors regarding supply of skills, the way in which these challenges were addressed, and the transferability of the lessons learnt from other (non-heat network) sectors.

8.1 Challenges in the supply of skills faced in other sectors

Organisations with high turnover

A number of organisations within the industry were identified as having unusually high staff turnovers. Local authorities and other public sector organisations were identified as being particularly vulnerable to this phenomenon. Public sector organisations struggle to retain institutional knowledge or sufficiently disseminate knowledge to new or existing staff. With the departure of a key individual the expertise can also be lost within the organisation. This affects all public sector organisations irrespective of which market segment they work with.

One model that public sector could apply learnings from is the 'Investment in Talent Group' operationalised by the offshore wind sector[93]. This includes developing an 'Offshore Wind Passport' to facilitate mobility between offshore renewable and oil & gas sectors. This could work to attract the necessary expertise from more established heat network markets in continental Europe.

Another model is the Nuclear Gateway platform that matches talent surplus to nuclear jobs across the sector[94].

Small or public sector organisations that depend on external experts have a limited scope for leveraging learning for internal development. Hence, the small size of an organisation can become a disadvantage in the long-term. Tailored structured training, coaching and mentoring schemes can alleviate this disadvantage. A pilot mentoring scheme open to the whole sector was launched in January 2020 (District Heating Divas Heat Exchanger Pilot) but it is too early to share any findings from this industry-led support.

Generation gap

There is a distinction between retaining skills within an organisation, where skilled workers may be recruited by other organisations within the same sector; retaining skills within the industry, where skilled workers may be recruited by organisations in other industries; and the loss of skilled workers to retirement, a permanent reduction in the level of skilled workers for the industry. Each industry suffers their own skills shortages from manual labourers to design

[93] HM Government (2019) Industrial Strategy, Offshore Wind Sector Deal
[94] Nuclear Skills Strategy Group (NSSG) (2018) Skills planning to drive sector mobility: Strategic plan update

engineers. Sectors with significant overlap which partially recruit people from each other are also experiencing skills shortages and trying to retain their workforce.

A key reason for the skills shortage across multiple UK industries, e.g. the construction industry, is the loss of highly skilled workers due to retirement, introducing a generational gap. This differs from the skills gap where skilled workers switch industry. As a consequence, efforts to meet the skills gap in these sectors target the younger generation looking for apprenticeships and/or vocational training. However, respondents agreed that a generational gap is not the cause of the skills shortage in the UK heat network industry, but instead that the market for heat networks is not developed enough to retain key workers.

One approach to protecting skills within the heat network industry is to mirror the collaboration example provided by the Nuclear Technology Education Consortium in 2005. This collaboration example provided a Masters level education in Nuclear Science and Technology, spanning 20 modules designed in collaboration with employers, tailored to meet the needs of the UK nuclear energy sector. The Consortium was initially funded through the Engineering and Physical Sciences Research Council but eventually was able to fully fund itself through fee income. By providing a committed education pathway for the heat network industry, the industry may be able to demonstrate a powerful signal to potential and existing employees that it is committed to further development. There may be additional learnings and opportunities from the newer Institutes of Technology[95], government-sponsored collaboration programmes to advance development of technical skills, with the first wave launched in 2019 and the second wave opening later in 2020.

Impact of industry stability

The heat network industry is a nascent industry, where growth is strongly supported through government schemes such as the Heat Networks Delivery Unit, the Scottish Heat Network Partnership, the Heat Networks Investment Project and the Low Carbon Infrastructure Transition Programme, among others. There is wide agreement that the support from these schemes, some of which have been running since 2013, has ensured growth and development of the industry.

One respondent flagged that the change to the Feed in Tariff scheme announced in 2015 strongly impacted the UK solar industry, and that a change to heat network support schemes could similarly affect the UK heat network industry. The solar industry has partially recovered and is not yet finding it difficult to find appropriate entry-level candidates. However, there is a challenge in retaining skilled employees due to the instability (boom-bust cycle) of the market. For instance, the solar industry lost many people to the heat pump industry with the introduction of the Renewable Heat Incentive (RHI).

Another respondent referenced the offshore wind development roadmap as a contrast to the heat network sector. The Offshore Wind Sector Deal[96] has significantly contributed to a reduction in uncertainty for the development of the offshore wind sector, attracting dedicated resources and investment in training and capacity-building. In particular, programmes such as the Offshore Wind Accelerator[97] and the Offshore Renewable Energy Catapult[98], both industry collaboration programmes aimed at developing a new expertise and supporting a robust supply

[95] Information available on the Institutes of Technology site (last accessed June 2020) https://www.gov.uk/government/publications/institutes-of-technology--2
[96] Department for Business, Energy & Industrial Strategy (BEIS) (2019) Offshore wind: Sector Deal.
[97] https://www.carbontrust.com/our-projects/offshore-wind-accelerator-owa
[98] https://ore.catapult.org.uk/

chain, demonstrate the amount of private sector investment attracted by a secure, long-term policy environment.

8.2 Tackling the challenges in other sectors

Organisations with high turnover

Industry stakeholders outlined that continued capacity-building, particularly with public sector partner organisations, is the first step to overcoming challenges of dealing with high turnover in public sector organisations. Before offering training, they focus on public education and imparting information about what technology is available and the benefits of embracing it. This is provided through Continuing Professional Development (CPD) sessions, networking and talking to people, press releases and social media channels and engaging with organisations like the Engineering Construction Industry Training Board (ECITB) and the East of England Energy Group (EEEGR).

Respondents believe that to bring real change in the skills challenge in the heat network industry, continued intervention from government is needed to support industry capacity-building in existing government and public sector organisations. As a priority, senior public sector stakeholders should be instructed about the importance of decarbonisation of heat and their role in this challenge. This is even more important in the wake of climate emergency declarations.

Addressing the generation gap

Some companies in the construction industry have started to link up with schools and colleges to address their issues with an ageing workforce, supported by or channelled through the CITB. One respondent, representing a relatively new technology and service, highlighted that they exhibit at vocational skills colleges to raise awareness with the younger generation about the use of drones in sustainability.

One respondent raised the example of East Coast College, which has a focus in the oil & gas sector with an emphasis on transferable skills, partially also covering skills needed in the wind industry. The location of the college was seen as important, situated near significant offshore industry activity. Also, within the same region, the East of England Energy Group (EEEGR) looks at the skills in the region and focuses on oil & gas. They provide multiple training courses aimed at young or skilled workers in the region, including apprenticeship training courses and health, safety and environment certification for construction site managers.

Although the generation gap was not flagged as being of particular relevance to the skills gap experienced in the heat network industry, the approach taken to overcome this gap in other sectors has learnings which can be applied to address other sources of skills gaps. Similar regional training collaborations are being seen in the UK heat network industry, with the Heat Academy in Stoke-on-Trent and Heat Academy Masterclasses set up with Bridgend College in Bridgend. Both of these initiatives are located near ongoing heat network developments.

A representative from the ground source heat pump industry outlined that many members of Ground Source Heat Pump Association (GSHPA) recruit skilled engineers from Eastern Europe where well rounded engineering apprenticeships are already in place.

Impact of industry stability

Within the solar industry training is widespread, but not standardised as the industry is quite small. Lack of funding for industry-wide standards and certification seems to be the main challenge here, which is parallel to the heat network industry. Some standards are available for products rather than installation of the system. Therefore, training directed at operations (rather than specific equipment components) is not aligned with standards and certification.

To ensure that the heat network industry is self-sustaining once government subsidy support programmes come to their end, the development of nationally-recognised standards and certifications for operation was recommended by interviewed stakeholders. This would hopefully minimise impacts from a potential boom-and-bust impact on the sector, avoiding issues experienced within the solar industry following changes to the Feed in Tariff support scheme announced in 2015.

8.3 Transferring lessons to the heat network industry

In the East of England, East Coast College covers renewable industries, such as wind and solar, and is actively engaging with local colleges to highlight job opportunities and the required skills. Similar steps should be taken to provide information to young people on the opportunities of transitioning into heat network sector, as this sector is less well-known particularly among the younger generation.

Introducing standardisation, particularly for the non-technical elements of heat network delivery, is seen to be an important step in establishing more stability in the market. It is believed that this would bring efficiency to the sector, avoiding repetitive approaches and attempts to reinvent the wheel. One respondent highlighted the value of the template contracts[99] launched by BEIS and HNIP and suggested that they should be expanded into procurement strategy and specifications for specific types of heat networks which could be shared broadly.

One respondent articulated that technology solutions will be driving the skills requirements. For example, when moving to lower temperature systems plastic pipes might become more appealing than steel pipes. More welders might be needed in the industry today, but this may not be the case in five years' time. Hence, the training (and/or retraining) will need to be synchronised with the pace of development in technology and the requirements from the market.

An example of how new technology solutions can drive skills requirements in the sector is illustrated by the growth of district cooling, which significantly overlaps the skills requirement needed for district heating. Skills development for the heat network industry in the UK will also support cooling network development over time.

While there is still limited information on the skills requirements for district cooling, similarities to district heating can be inferred from the development of the Copenhagen district cooling network, which is owned and operated by the Copenhagen district heat operator (HOFOR). More information on this scheme is illustrated in the box below.

[99] https://tp-heatnetworks.org/heat-contract-templates/, https://www.gov.uk/government/publications/standardised-due-diligence-set-sdds-for-heat-networks

Description of the Copenhagen district cooling sector

The municipally owned HOFOR in Copenhagen owns and operates the largest district cooling network in Denmark. The first cooling plant was opened in 2010, the second plant in 2013, and the system is still under expansion.

Parallels to the development of heat networks for the start-up phase include engaging with finance, stakeholder engagement with potential connections and general capacity-building to spread awareness of the technology relative to more conventional cooling solutions. For stakeholder engagement, HOFOR identified that district cooling requires more engagement with commercial and industrial properties relative to residential properties, which are more common for district heating.

Also similar are the technical skills required in the build and extension phases of networks, including both conversion of cooling systems in existing buildings and development of pipework extensions to new-build. District cooling networks can be connected to existing or potential district heating networks, as they allow for better utilisation of waste heat – conversion to cooling in the summer months and conversion to additional heating in the winter.

As the UK district heating industry matures to incorporate more sources of waste heat (relative to the current dominance of natural gas based combined heat and power systems), there will be more opportunities to develop district cooling networks alongside existing or proposed district heating networks. As most skills are transferable between these two sectors, investment in skills for district heating will also support development of this second industry.

Many workshop attendees reported that high quality graduates have been joining due to the increasing appeal of working with low carbon impact rather than the name or size of the companies. Hence, this aspect of the sector should be pushed further as an advertisement opportunity. The electric vehicle (EV) industry was given as an example that has been able to capitalise on this aspect.

A respondent from the solar industry suggested that the skills required for the heat network sector lies between civil engineering and mechanical engineering. Chemical engineering graduates can be targeted to widen the skills base. Another respondent brought up that professional institutions should be given the opportunity and the responsibility to promote the heat network industry since they will benefit from growth by increasing their membership.

The ground source heat pump sector has been targeting petrol technicians. Someone who is trained to install gas networks is seen as a natural fit for the ground source heat pump sector. Similarly, gas and oil boiler technicians would be able to handle heat pumps if funding and re-training is provided.

One respondent shared their experience of forming teams consisting of members from the UK and Scandinavia, where the skillset is available. This approach is found to encourage knowledge sharing between countries and contribute to the growth of skillset in the UK.

Elsewhere this review highlights the importance of acquiring more quantitative data on the workforce of the heat network industry. One model that could be used to support this aim is the

'Skills Intelligence Model'[100], originally developed by the National Skills Academy for Rail, which tracks and reports on workforce data with the aim to encourage diversity, inclusion, and equitable access to opportunity.

8.4 Conclusions

- A challenge other industries also experienced is the high level of staff turnover in public sector organisations, which are additionally characterised by relatively small teams and their frequent role as project champions. These elements mean that the loss of key staff members is felt more strongly and is considered a significant barrier to project development across the buildings and energy infrastructure industries.
- There were no best practice approaches identified across other industries on how to address this high turnover in public sector organisations or the constraints to project development. An initial request was for central government subsidy support to facilitate access to training and workshops for public sector organisations, as they struggle to find the budget to access externally hosted training.
- The heat network sector is less susceptible to loss of expertise from retirement relative to other sectors. This is partially due to the lack of sufficiently skilled senior workers due to the immaturity of the market, which means less knowledge is lost as the workforce reaches retirement age. It also reflects the industry seeing significant innovation, with newer recruits more active in learning the new skills required for the market, e.g. use of drones for troubleshooting network performance and in reducing operating temperatures in the network.
- Policy consistency and industry stability were highlighted as strong drivers for both skill retention and recruitment across multiple industries. Industries which have suffered from cyclical market or policy changes struggle to attract or retain a skilled workforce and the heat network industry as a nascent industry was considered especially vulnerable for sustainable recruitment and retention within the sector.
- Key learnings from other sectors are incorporated into Chapter 9: Recommendations.

[100] National Skills Academy for Rail (2018) Skills Intelligence Model (SIM) https://www.nsar.co.uk/sim/ (last accessed June 2020).

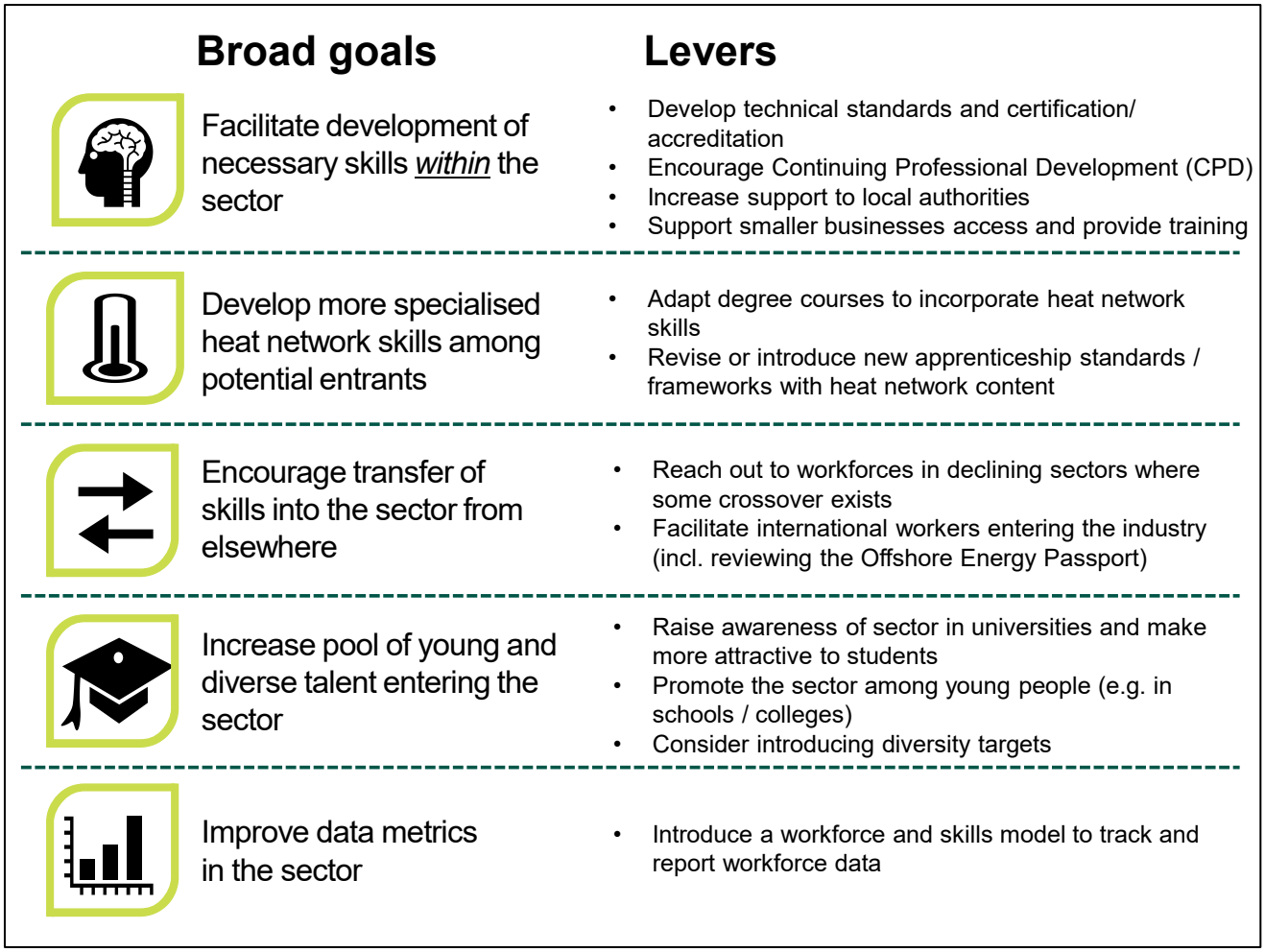
9. Recommendations

The report has demonstrated that the sector is suffering from a lack of proficiency in skills, particularly in certain occupations, and is ill-equipped to respond to the anticipated industry growth. This chapter considers suitable opportunities and policy levers to address current and future skills issues.

9.1 Opportunities for intervention

Through the research, five broad goals have been identified, that can help the industry meet its skills challenge. These sit above a subset of specific levers that can be actioned to help achieve these goals, as summarised below.

Figure 9.1: Summary of interventions



The rest of this section discusses these goals and levers in more detail. Subsequent sections then consider timeframes, impacts and stakeholders involved in these interventions.

Facilitate development of necessary skills within the heat network sector

This broad goal addresses the need to support skills development within the sector, particularly at certain occupation levels where there are evident deficiencies, and within certain types of organisations as well. Within this broad goal, there are four interventions for consideration, to help develop skills within the sector: developing technical standards; encouraging Continuing Professional Development (CPD); supporting local authorities; and supporting smaller businesses with training needs.

Develop technical standards and certification/accreditation

The sector clearly welcomes the development of heat network specific technical standards. These would need to incorporate the skills needs identified in this research. Standardisation would bring several benefits linked to the issues identified by this research:

- It would reduce the dependence in the industry on long experience for determining a person's skills.
- It would enable career development, particularly for those working in small organisations in the sector where movement between companies is likely to be necessary for progression.
- For those at school or in university considering their career options, it would create clearer pathways into the heat network industry.
- If those procuring heat network projects were to use the standardised qualifications in the contractor's team to assess their suitability, this approach could drive up quality of networks.
- The Competition and Markets Authority (CMA) has previously called for a voluntary accreditation scheme to ensure that heat networks are built to sufficiently high standards and make clear that setting standards for skills would be a key route toward this.

Standardisation also aligns to existing direction of travel for the sector: the 2020 heat network market framework government consultation[101] explored proposals for developing technical standards, certification and accreditation processes, to improve the quality, cost and reliability of heat networks, and to provide certainty to the market.

A mapping exercise can identify both generic and sector specific competencies across key occupations that are consistent across the sector. This would build on the findings detailed in this Review (as detailed in Appendix D in particular). One mechanism to then progress standardisation further, especially for roles that require qualifications at Level 3 or below, is the creation of new National Occupational Standards (NOS), which describe the competencies and knowledge required for jobs in the sector. This is commonly the domain of Sector Skills Councils (SSCs), so the Construction Industry Training Board (CITB), the Engineering Construction Industry Training Board (ECITB) and Energy & Utility Skills will likely need to be involved. This will need to be in partnership with employers in the industry and relevant government departments across the UK (Department for Education in England, Skills Development Scotland, Skills, Higher Education and Lifelong Learning (SHELL), Welsh Government, and Department for the Economy and Department of Education in Northern Ireland). For professional levels, broader standards will already exist, but these may need

[101] Department for Business, Energy and Industrial Strategy (2020) Heat Networks: Building a Market Framework.

reviewing against heat network specific competencies. Professional bodies such as CIBSE should be engaged in this process.

Encourage Continuing Professional Development (CPD)

Based on the responses to this research, there is scope for additional CPD courses aimed at several key gaps in the heat network sector, to address the shortfall in high level staff. The foundation for the CPD courses should be the standards discussed in the previous section.

To increase the supply of skilled individuals for project management and commercial management roles, this could most usefully include (although should not be limited to):

- Provision aimed at bringing those with engineering but not project management experience in heat network projects into management roles. It should focus in particular on the legal, administrative and financial structures involved, and improving project management skills.
- Provision to equip staff working in other relevant sectors (e.g. civil engineering, construction, energy) with the knowledge of heat networks required to bring their wider skills to the heat network sector.
- Provision aimed at upskilling local authority staff and professional urban planners in the skills required to procure and oversee a heat network contract.

To improve supply of individuals for senior engineering roles, this could most usefully include:

- Provision aimed at bringing those with broadly relevant high level engineering or control systems skills in other industries into heat network roles. This provision would need to be much more detailed and technical than the existing short course provided by CIBSE in relation to the Heat Networks Code of Practice. Provision would need to be targeted at those currently working in sectors where either demand for engineering skills is projected to decrease in the UK, or where the heat network sector can be competitive in terms of pay and conditions.
- Provision aimed at bringing those with design skills relating to earlier heat network technologies into design of modern networks, including retrofitting. This should primarily focus on whole network issues, to avoid duplicating training in the use of individual technologies which may be provided by manufacturers.

To improve the quality of installation and construction, this could most usefully include:

- Provision aimed at installers, typically plumbers and gas fitters, who might be engaged to install HIUs or other equipment in domestic, commercial or industrial premises to connect them to the heat network.
- Provision aimed at currently non-specialist civil engineering technicians, operatives, and site supervisors who work on other utilities projects, including pipe layers, to upskill them on construction and installation of the components of heat networks outside individual premises.

Design of CPD for different professions and roles would need to be co-ordinated, to avoid conflicting messages being sent to different groups. This co-ordination could be achieved partly through the standardisation and accreditation mentioned above; but it would also require organisational co-ordination.

In terms of delivery, for professional roles, CPD could be delivered through professional bodies for related sectors, which usually have well-established CPD programmes already for members which heat networks could be added into. For other roles, trade associations may be better placed to deliver these, particularly for installers. For civil engineering technicians, operatives and site supervisors, CITB might be well placed to lead on the delivery of this provision via their levy system. Provision via these routes, if the cost were partly or wholly met through fees paid by all members, should reduce the issue of individual employers being unwilling to fund training for staff due to the risk of poaching by competitors.

It should, however, be borne in mind that sector-specific organisations will typically only provide CPD to members (whether individuals or employers). As such it may be necessary to involve multiple professional bodies or trade associations to achieve reasonably easy access to all those working in the sector or considering doing so.

More broadly there are schemes that could be promoted to employers to encourage them to develop their staff. People management standards such as Investors in People place great emphasis on workforce development[102].

Increase support to local authorities

Currently, responsibility for procurement and project management of heat network projects often sits at a local authority or large developer level. This has clear advantages, but also significant disadvantages in that local authorities (and to a lesser extent housing associations) may not be involved in heat networks in sufficient volumes or at a sufficient funding levels to attract staff with the skills required for this task, or to offer them long-term opportunities.

There are existing mechanisms in place, designed to support local authorities in their heat network planning and delivery. For example, authorities can use existing planning powers to ensure that new buildings in a particular zone connect to a heat network, while the HNDU provides grant funding and guidance to local authorities (in England and Wales) for heat network project development.

Local authorities interviewed for this research welcomed the central government support provided so far to develop skills, knowledge and resources to plan and implement heat networks. However, they recognised that their skills capabilities still had further room for improvement.

In addition, creating a resource hub that local authorities can access as and when needed during the heat network development process would alleviate the pressures of attempting to recruit staff with in-depth knowledge of the industry. Such a hub could be an extension to the role of the current BEIS Energy Hubs (in England), although there are no equivalent examples in the other nations. It could provide practical and interactive training materials that individuals can access via a dedicated website, which might also contain common pitfalls to avoid, types of stakeholders to engage, bespoke tools that they can utilise, and links to other relevant information. Energy Hubs would need to work with relevant individuals within local authorities to fully understand needs and demand before developing this further.

There is an argument for encouraging local authorities and/or combined authorities to work in partnership at a much wider geographical level to deliver heat networks, thus creating regional or sub-regional organisations with a volume of ongoing heat network projects work which

[102] This was originally a government project founded in 1991, designed to help organisations improve their performance through investment in staff and help to address market failures in staff development. Since 2017 it has been run by a community interest company. Details can be found here: www.investorsinpeople.com.

enables economies of scale to be achieved. This would also enable heat network procurement and management skills to be retained and developed in-house rather than needing to be sourced on a project-by-project basis, and potentially allow larger teams. The expansion of the industry may also bring larger dedicated heat network teams in the private sector, as individual companies spend more of their time on these projects.

Considering this together with the findings on difficult-to-fill roles, it may be that the creation of larger teams may reduce the need for multi-skilled senior staff who have both advanced heat network engineering and advanced project management skills. A larger team could instead split these currently widespread multi-skilled roles into two or more specialised roles (e.g. one focussed on project management, the other on engineering). Even without this expansion of teams, some organisations may be able to adjust their structures such that less specialised project managers can successfully perform their role, perhaps supported by external technical support or resource. Further research with employers in the heat network sector may be needed into the extent to which this type of change could address skills issues in the industry.

If carried out on a sufficient scale, a co-partnership model could also enable career paths and training routes to be developed within and in partnership with these organisations, reducing the current reliance on the existing relatively small number of people who have gained end-to-end knowledge of managing heat networks through ad hoc experience.

Ownership or responsibility for such activities would differ across the four UK nations. In England, it may be a responsibility for Local Enterprise Partnerships (LEPs) to co-ordinate. In Scotland this would lay in the domain of Regional Economic Partnerships and the Scottish Heat Network Partnership. In Wales the responsibility might be taken on by regional partnership organisations such as City Deals and Growth Deals, or Regional Skills Partnerships. In Northern Ireland it would likely require collaboration with Northern Ireland Local Government Association to reach regional and City Councils (although heat network demand in the region is currently low).

Support small businesses access and provide training

Similar to local authorities, small businesses struggle to develop the skills of their employees due to a lack of resource, time and in-house expertise. It is important that as standardisation occurs across the industry, and as accreditation and certification evolves, due consideration is given to the needs of these businesses. Among small businesses in particular, flexibility of delivery, the ability to tailor content, and cost are all key factors in businesses' decisions to cater for skills development.

These businesses will also need support from elsewhere to access training, be this through collaboration with larger employers, or financial support from government. This could potentially be accessed through LEPs or Energy Hubs in England, or Regional Skills Partnerships in Scotland and Wales, as well as national grants operated by the Education and Skills Funding Agency (ESFA) in England, Skills Development Scotland, SHELL, Welsh Government, and Invest Northern Ireland. There may also be a role for industry representatives (ADE and UK DEA) to support access to training.

Develop more specialised heat network skills among potential entrants

The research determined that those joining the sector typically possessed skills that were of relevance to the industry, but did not possess the precise knowledge that enabled them to work in heat networks immediately. There is therefore value in reviewing two key areas that support entry into the sector: higher education and apprenticeships. As an initial step, existing

degree courses and apprenticeship frameworks/standards should be reviewed to explore where heat network content best 'sits'. Following these, those courses or frameworks/standards can either be adapted to better incorporate heat network content, or new courses etc. may need to be developed should this not be feasible. Of course, adaptation to provision would not just support new entrants to the sector, but also those currently operating in the sector looking to upskill.

Adapt degree courses to incorporate heat network skills

Opportunities to influence Higher Education in terms of expanding course content to include heat networks are limited, since the sector determines degree course content without much external input. However, universities may be influenced through grant funding, which is channelled through the Office for Students (OfS) in England, an agency of the Department for Education (DfE), the Scottish Funding Council (SFC), the Higher Education Funding Council for Wales (HEFCW), and the Department for the Economy in Northern Ireland.

Previously grant competition schemes have included funding for providers to develop postgraduate conversion courses in artificial intelligence and data science, resulting in the development of relevant courses at 18 universities in 2019[103]. A similar approach could be taken by government to encouraging the creation of courses relevant to the heat network sector, at any level.

Chartered professional bodies also have an influence in this area, in that they already specify detailed requirements for becoming a chartered professional, in terms of knowledge and skills. If heat networks are to become a mainstream technology, they will need to be included in the knowledge required of professionals joining those sectors as a matter of course. Although there is no direct mechanism for government to specify these standards, they may be able to work constructively with relevant chartered institutes to move toward this.[104]

This is relevant to key subject areas such as mechanical engineering and electrical engineering, but it also applies to less directly involved sectors. Urban planners and architects were mentioned by respondents as contributing to the design of heat networks via layout of new developments, without always having the necessary knowledge to do so effectively.

Revise or introduce new apprenticeship standards / frameworks with heat network content

Most individuals working in construction and construction installation come to work in these sectors via vocational training routes. Currently these routes do include some low carbon content, but it is mostly general, and generally covers heat networks in a limited way, or as an option for people thinking of specialising in low carbon techniques.

If heat networks are to become a mainstream practice, they will need to be included in course content for mainstream apprenticeships aimed at those entering civil engineering and installation roles.

There may also be scope for a specific heat network apprenticeship, but it should be borne in mind that those joining the sector may not want to specialise in heat networks at an early stage

[103] More detail on this initiative can be found here: https://www.officeforstudents.org.uk/advice-and-guidance/skills-and-employment/postgraduate-conversion-courses-in-data-science-and-artificial-intelligence/

[104] e.g. Institute of Mechanical Engineers; Institution of Engineering and Technology; CIBSE; Chartered Institute of Plumbing and Heating Engineering; Energy Institute; Royal Town Planning Institute; Royal Institution of Chartered Surveyors

to the exclusion of other potential work. This is more likely to be a Level 4 apprenticeship, aimed at individuals working in construction or construction installation wanting to develop a specialism in the field.

There might, however, be more scope to introduce more specialist Degree and/or Level 6+ apprenticeships, given the complex tasks and advanced skills involved in the sector. The standardisation and accreditation of skills and qualifications mentioned earlier in this chapter would be required to create an apprenticeship of this type.

The introduction of the Apprenticeships Levy also makes this a route likely to have significant appeal for larger companies working in the field. It could provide a bridge between operation and maintenance technician level roles and the professional roles which dominate in senior roles in the heat network sector.

The introduction of apprenticeships of this type would require more detailed feasibility studies and further consultation with employers and training providers. This will help determine what shape these apprenticeships could take, and whether employers would recruit sufficient volumes of apprentices to make the courses viable for training providers to supply.

The approach to reviewing and creating apprenticeships is different across the UK. In England, there is an emphasis on employer-led standards (“Trailblazers”), while in the remaining devolved administrations this responsibility lies with the relevant government body. The sector will need to work with the Institute for Apprenticeships in England, Skills Development Scotland, Skills, Higher Education and Lifelong Learning (SHELL), Welsh Government and Department for the Economy in Northern Ireland. Sector Skills Councils (CITB, ECITB and Energy & Utility Skills). Industry representatives (Heat Networks Industry Council [HNIC], ADE, UK DEA), awarding bodies and relevant training providers will also need to be engaged during this process.

Encourage transfer of skills into the sector from elsewhere

While the aforementioned goals will support the capability of staff working in or joining the industry, they will not by themselves meet capacity challenges. The sector is projected to experience rapid expansion, and the most acute shortages are at senior technical and project management levels. Therefore, the sector cannot exclusively rely on initiatives focused on bringing through young people and graduates, and must consider other sources including transfer from other sectors and potentially other countries. Such transitions, which are especially complex in higher level roles, are contingent on the industry developing consistent technical standards as discussed earlier in this chapter.

Reach out to other workforces

There is the potential for the heat network sector to reach out to workforces in other sectors where there are clearly transferrable skills. This has been attempted in other industries such as rail, which explored the transferability of armed forces into the industry, and offshore wind, which targeted those working in other offshore sectors such as renewables, oil and gas.

Certainly, there would be some logic to targeting high carbon sectors that would be expected to decline (such as oil and gas) as decarbonising industries such as the heat network sector grow. Once the industry has created occupational standards, these standards can be reviewed against those of other industries to explore which in particular may be targeted. Any gaps in competencies can be built into accredited programmes to plug the “specialist” skills gaps and/or up-skill the existing workforce.

There would be benefit in reviewing the Offshore Energy Passport, which is currently being developed for the offshore wind sector, and exploring whether a similar function could be adapted for the heat network industry. The Passport allows greater (international) mobility of skills across similar (i.e. offshore) industries. This activity is likely to be best undertaken by an industry-led skills partnership, as discussed later in this chapter.

Facilitate international workers entering the industry

The report has highlighted that heat network engineering techniques are transferable from Northern Europe, where the market for new build networks is reducing due to their existing widespread use. Also, in some Eastern European countries, heat network techniques are reportedly already widely included in vocational qualifications for construction installation.

However, the financial, legal and particularly regulatory environment is different in the UK, so it is unlikely that senior skills gaps in the project management sphere (especially urban planning and regulatory compliance; i.e. those higher up in the entry and progression route pyramid) could be filled in the same way, without specific re-training or upskilling. Once more, the success of the Offshore Energy Passport, which is recognised outside of the UK, will be important to review and consider in terms of how a similar initiative might support the transfer of skills into the UK, as well as export opportunities in future. In addition, given that expansion in the use of heat network technology is expected in many countries, competition for this source of skilled employees is likely to be fierce.

Nevertheless, there is a strong argument for engaging with the Migration Advisory Committee (MAC) to ensure that those skills most in demand are included in their skills shortage list[105]. The list already includes most forms of chartered engineering but not include project management skills. It also does not include technician or operative level construction skills which are already in short supply. MAC submit regular calls for evidence, which the industry can respond to, to highlight their most severe skills shortages. This activity should be led by industry representatives (ADE and UK DEA), who are well placed to channel industry concerns over skills challenges to the MAC.

Increase pool of young and diverse talent entering the sector

In order to ensure future growth of the industry, it is important that it is made more visible to younger generations. Promotion of the sector in many ways aligns with existing government efforts to promote STEM subjects in schools, colleges and universities, so there is an opportunity for the industry to harness this.

Raise awareness of sector in universities and make more attractive to students

There is evidence that the heat network industry suffers from a lack of recognition among university students, and thus needs better promotion.

More research is needed with relevant (and in particular engineering) students to understand the factors behind career decisions; this can then be used to inform future communications and promotions towards this audience. Consideration should also be given to how the sector can stand out from other attractive career choices, such as electric vehicles. As a sector that suffers from low visibility, the heat network sector may benefit from being promoted alongside other more prominent sectors such as electric vehicles. This could be achieved for example through the promotion of ‘low carbon’ career pathways that combine a range of sectors

[105] MAC publish a shortage occupation list, with those applying for jobs on the list given greater advantage in accessing Tier 2 (General) visas, enabling them to work in the UK.

including the heat network sector. Additionally, employers could do more to advertise graduate roles in their heat network teams, by attending careers days or running events.

So far, CIBSE has taken a leading role in the promotion of heat network skills in the UK. However, as a body which represents engineers, they represent only part of the skill set required by the sector. It is important that other sectors contributing to heat network projects become involved in similar ways. Heat networks should be promoted more directly to those seeking to move into sectors with less widely influential professional bodies, in particular IT because of its central importance in heat network commissioning and ongoing operations. This could also extend to working with professional and sector bodies (as previously named) and trade associations in public administration, urban planning, and energy generation sub-sectors.

Promote the sector among young people (e.g. in schools / colleges)

While the impacts would take time to be felt, there is also value in promoting the industry among school children. As a small sector, it would be best for the industry to harness existing programmes to reach a broad audience.

For example, industry occupations could be embedded within the National Careers Service list of occupations, as well as other available careers services (Skills Development Scotland's Careers Services, Careers Wales, and Northern Ireland Careers Service). Certain professional bodies could also be leveraged to support the promotion of the sector[106].

Consider introducing diversity targets

It has been highlighted in this research that the heat network sector does not reflect the make-up of society as a whole. Although figures are not available, most interviewees believed that the sector workforce was predominantly male, and that ethnic minorities remain under-represented. This suggests that a very significant proportion of potential talent is being missed, and makes promotion of the sector particularly important among those demographic groups currently under-represented.

While it is worth noting that this is a wider trend that affects many organisations in the engineering, energy and construction sectors, there are still organisational measures that could be put in place to increase diversity in the sector. These include: reviewing and adapting recruitment strategies (such as blind interviews or CVs to reduce bias; reviewing selection criteria), adapting workforce policies and activities to appeal to a more diverse audience and actively supporting under-represented groups through work experience placements and targeted advertisements. There could be a role for trade associations to advise the industry accordingly.

There may also be value in setting diversity targets for the industry; currently the industry typically feel that this is not an issue for them to solve, but targets would generate a sense of responsibility that would bring not just societal but business benefits as well. These could also be promoted, if not mandated, through trade associations, or the Heat Networks Industry Council (HNIC)[107], which is looking to support the development of a diverse, fairly-paid skills base across the heat network industry. This is an approach taken elsewhere such as in the

[106] For example, EngineeringUK run an annual 'Big Bang' fair, where STEM-based careers are promoted to thousands of school pupils. CITB run the 'Go Construct' website which provides information about careers in construction alongside educational resources. BuildUK provide work experience opportunities to build awareness and skills among individuals looking to enter the construction industry.
[107] https://www.hnic.uk/

nuclear sector, where the Industrial Strategy and the Nuclear Sector Deal aims to increase diversity in the workforce[108].

Improve data metrics in the sector

The research has been limited by a lack of workforce data. This is in part because, as referenced previously, the sector does not map across to any established classifications. But as the sector seeks to grow it will be important to be able to provide a more quantitative assessment of workforce size and needs, so that government are able to review and adapt priorities and interventions accordingly. This data could also be used to capture diversity statistics.

One model that could be harnessed is the skills gap analysis model created by the National Skills Academy for Rail, which is also being operationalised by the offshore wind sector. This 'Skills Intelligence Model' asks employers to submit regular information about their workforce and skills needs, which enables the industry to forecast skills issues and adapt their apprenticeship strategy to futureproof accordingly. An added advantage of this model is encouraging employers themselves to reflect on and react to their skills needs.

Another model that could be considered is the ONS Low Carbon and Renewable Energy Economy (LCREE) Survey[109]. Categorising the low carbon and renewables into 17 subsectors (including 'renewable heat', which most closely aligns to the heat network sector) provides a more detailed level of analysis potential for heat networks than any survey currently utilising SIC codes. As things stand, the survey suffers from a lack of information gathered on the workforce itself, while even the renewable heat subsector is not specific enough. Nevertheless, with some refinement it may possible to acquire regular workforce data using this model.

9.2 Pathway to achieving goals

The previous section contains possible interventions that could support the industry meet its skills challenge. There are a number of steps that need to be taken however in order to meet these broad goals.

As a first step, it is crucial that a policy scoping exercise is undertaken, both within government and with industry representatives. The research has assessed what the industry considers its skills challenges; but resulting suggestions for intervention have not been examined or tested with the organisations and institutions that would be responsible for engaging with and supporting these interventions. A period of time is needed subsequent to this review therefore to explore what is feasible, and who should have responsibility for undertaking the work.

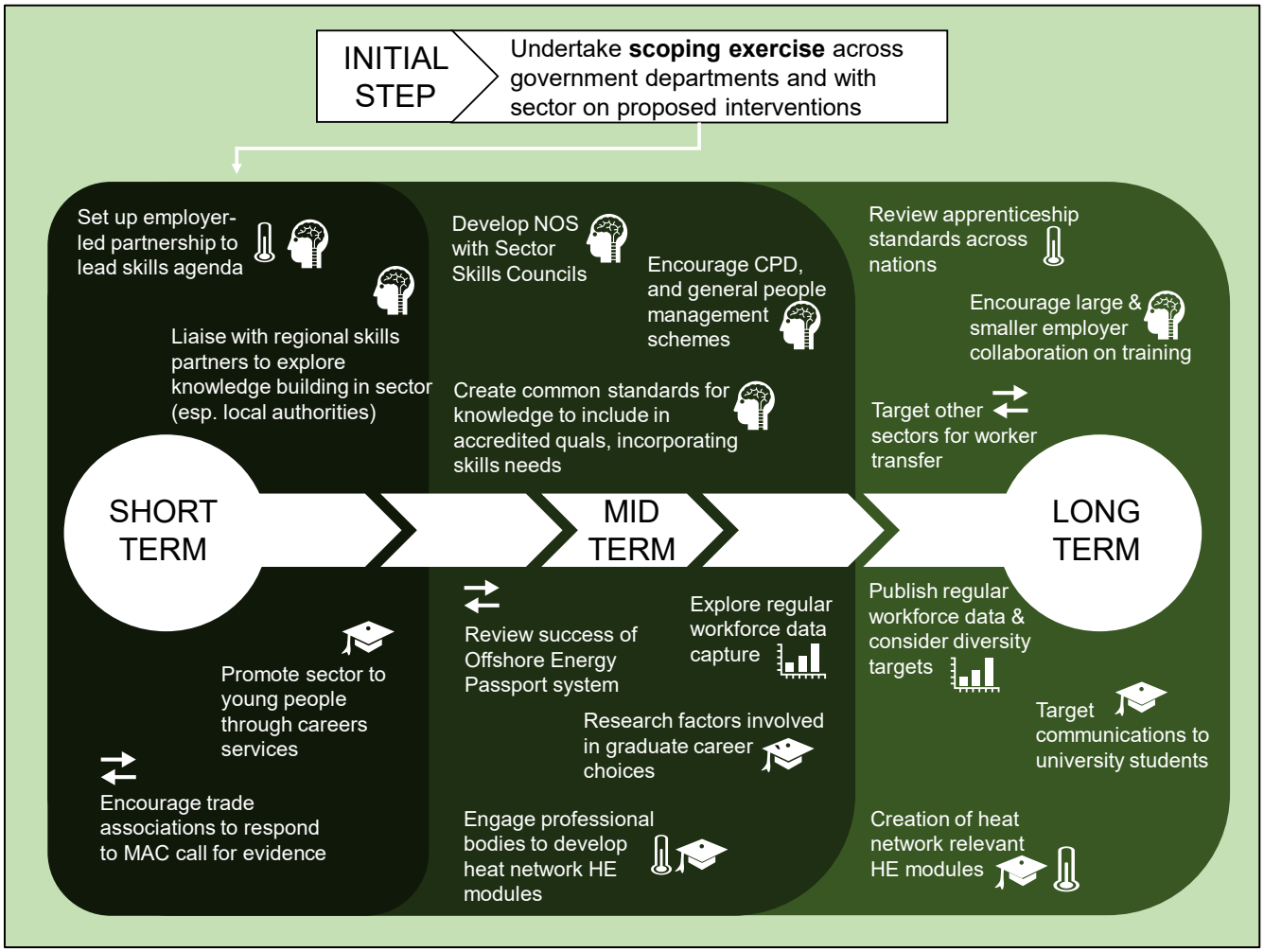
Secondly, there is merit in creating an employer-led skills partnership that takes ownership of a number of the interventions proposed, and ensures they fully meet industry needs. The Heat Networks Industry Council (HNIC) was established to bring employers together to support the sector. However, a separate body that focusses solely on skills will be best placed to oversee the changes required. Such bodies or task groups have successfully supported growth in other sectors, such as the Investment in Talent Group for Offshore Wind, and the Nuclear Technology Education Consortium (although this was led by universities alongside employer

[108] Nuclear Skills Strategy Group (NSSG) (2018) Skills planning to drive sector mobility: Strategic plan update.
[109] Office for National Statistics (2020) Low Carbon and Renewable Energy Economy (LCREE) Survey QMI.

involvement). This body would be UK-wide but with sub-teams responsible for the four UK nations.

Figure 9.2 depicts the interventions previously raised and maps them out into an anticipated pathway. The scoping exercise would be used to identify specific timeframes for this work.

Figure 9.2: Pathway to undertaking interventions



9.3 Stakeholder engagement

Having determined what levers can be used, it is important to explore which stakeholders should be engaged in order to support the delivery of these. They may be tasked with leading such initiatives, or act in a more consultative fashion. Each lever is set out below and is mapped against stakeholders that should be engaged. It is important to note that skills policy in the UK is devolved across the four nations, hence different bodies will need to be engaged in each nation.

This should be considered an indicative list that will be refined during the scoping exercise referenced previously. Much of this engagement will need to be channelled through the industry-led partnership body, as previously mentioned. Throughout there is also likely to be some form of input from BEIS and the devolved administrations.

Table 9.1: Stakeholders to engage

Lever	Broad Goal	Stakeholders involved
Develop technical standards and certification / accreditation	Skills development in sector	Sector Skills Councils (CITB, ECITB and Energy & Utility Skills) Government departments (Department for Education in England, Skills Development Scotland, SHELL, Welsh Government, and Department for the Economy and Department of Education in Northern Ireland) Professional bodies (e.g. Institute of Mechanical Engineers; Institution of Engineering and Technology; CIBSE; Chartered Institute of Plumbing and Heating Engineering; Energy Institute; Royal Town Planning Institute; Royal Institution of Chartered Surveyors) Industry representatives (ADE, UK DEA)
Encourage Continuing Professional Development (CPD)		
Increase support to local authorities		Energy Hubs, Local Enterprise Partnerships (LEPs) in England, Regional Skills Partnerships and the Scottish Heat Network Partnership in Scotland, regional partnership organisations such as growth and city deals or regional skills partnerships in Wales, and the Northern Ireland Local Government Association
Support smaller businesses access and provide training		LEPs or Energy Hubs in England, Regional Skills Partnerships in Scotland and Wales; ESFA in England, Skills Development Scotland, SHELL, Welsh Government, and Invest Northern Ireland; industry representatives (ADE, UK DEA)
Adapt degree courses to incorporate heat network skills	Heat network skills among new entrants	Professional bodies (e.g. Institute of Mechanical Engineers; Institution of Engineering and Technology; CIBSE; Chartered Institute of Plumbing and Heating Engineering; Energy Institute; Royal Town Planning Institute; Royal Institution of Chartered Surveyors) alongside selection of HE institutions. Office for Students (OfS) in England, the Scottish Funding Council (SFC), the Higher Education Funding Council for Wales (HEFCW), and the Department for the Economy in Northern Ireland have responsibility for funding.
Revise or introduce new apprenticeship standards / frameworks with heat network content		Government bodies with responsibility for apprenticeships: Institute for Apprenticeships; Skills Development Scotland; SHELL, Welsh Government; Department for the Economy in Northern Ireland. Sector Skills Councils (CITB, ECITB and Energy & Utility Skills), awarding bodies, industry representatives (ADE, UK DEA) and selection of training providers (both HE and FE)
Reach out to other workforces where some crossover exists	Encourage transfer of skills into the	Industry-led skills partnership

Lever	Broad Goal	Stakeholders involved
Facilitate international workers entering the industry ((incl. reviewing the Offshore Energy Passport)	sector from elsewhere	Industry representatives (ADE, UK DEA) and Migration Advisory Committee (MAC). Industry-led partnership to explore Wind Energy Passport
Raise awareness of sector in universities and make more attractive to students	Increase pool of young and diverse talent entering the sector	Professional bodies (e.g. Institute of Mechanical Engineers; Institution of Engineering and Technology; CIBSE; Chartered Institute of Plumbing and Heating Engineering; Energy Institute; Royal Town Planning Institute; Royal Institution of Chartered Surveyors) and industry representatives (ADE, UK DEA)
Promote the sector among young people (e.g. in schools / colleges)		Careers services such as National Careers Service in England, Skills Development Scotland's Careers Services, Careers Wales, and Northern Ireland Careers Service. Also, sector representatives such as EngineeringUK, CITB, BuildUK
Consider introducing diversity targets		BEIS, industry representatives (ADE, UK DEA) and HNIC
Introduce a workforce and skills model to track and report workforce data	Improve data metrics in the sector	Explore models used by National Skills Academy for Rail and Offshore Wind sector. Liaise with ONS over sector classifications.

Appendix A: Topic and Discussion Guide Coverage

Two distinct topic guides were created for the stakeholder interviews, which lasted an average of 60 minutes, and a discussion guide was used for the workshops. These are detailed below.

Topic guide: ESCos, consultants, membership associations, and local authorities

- Background to the organisation and involvement in heat network industry.
- Broad challenges present in the industry.
- Approach to recruitment including challenges faced.
- Views on, and experiences of, retaining staff.
- Focussing on one specific role/occupation, identified by the participant as important to their business:
    - Skills, experience and qualifications required for this role, and the transferability of these skills.
    - The skills that are commonly lacking in new starters for this role
    - Training offered or provided for individuals in this role
    - Typical career pathway for such individuals.
- Views on diversity in the industry.
- Approach to using subcontractors, and views on proficiency.
- Role of national and local government in supporting the industry.
- Future skills needs.

Topic guide: Training providers

- Background to the organisation and involvement with heat network modules/courses.
- The process by which courses are created.
- Content of the modules covering heat networks.
- Student volumes/demand.
- Challenges faced in delivery.
- Diversity in the industry.

- Plans for the future.
- The role of government.

Workshop discussion guide

- Impact of skills gaps on performance and efficiency in participant's sector and supply chain.
- Current skills challenges and how these are being reduced or exacerbated.
- How participant's organisation / sector currently resolve skills gaps.
- Transferability with the sector and supply chain, and with other sectors.
- Which institutions can help resolve skills issues.

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Appendix C: SIC and SOC mapping

The SIC2007 classification, devised by ONS (Office for National Statistics), is the standard classification used in the UK to classify businesses. The most relevant code to the heat network sector is 35.30, “Steam and Air Conditioning Supply”. However, for most organisations working on heat networks, this is not their main activity, so they would be classified in another code. Based on a list of organisations provided by ADE, the research identified the following most common codes:

SIC Section D: Electricity, Gas, Steam and Air Conditioning Supply

- 35.11 - Production of electricity
- 35.13 - Distribution of electricity
- 35.30 - Steam and air conditioning supply
- 35.22 - Distribution of gaseous fuels through mains

SIC Section F: Construction

- 42.99 - Construction of other civil engineering projects not elsewhere classified
- 43.22 - Plumbing, heat and air-conditioning installation
- 43.29 - Other construction installation

SIC Section J: Information and Communication

- 62.09 - Other information technology service activities

SIC Section L: Real Estate Activities

- 68.32 - Management of real estate on a fee or contract basis

SIC Section M: Professional, Scientific and Technical Activities

- 70.22/9 - Management consultancy activities other than financial management
- 71.12/2 - Engineering related scientific and technical consulting activities
- 71.12/9 - Other engineering activities
- 74.90/1 - Environmental consulting activities
- 74.90/9 - Other professional, scientific and technical activities not elsewhere classified

SIC Section N: Administrative and Support Service Activities

- 82.99 - Other business support service activities not elsewhere classified

SIC Section O: Public Administration and Defence; Compulsory Social Security

- 84.11 - General public administration activities

The SOC2010 classification, also devised by ONS, is the standard classification used in the UK to classify the employment of individuals. There are no codes specific to the heat network sector. Based on the list of occupations produced for the research, the SOC2010 codes listed in Table E.1 have been identified as important to the sector, although people working on heat networks will not make up a majority of any code.

Table E.1: SOC2010 codes identified as associated with heat network occupations identified in this report

SOC2010 Code	Heat network occupations
2121 Civil Engineers	Development Manager
2122 Mechanical Engineers	Development Manager Energy Master Planner Design Engineer
2123 Electrical Engineers	Development Manager Energy Master Planner Design Engineer
2126 Design and Development Engineers	Design Engineer
2129 Engineering Professionals not elsewhere classified[110]	Energy Master Planner Hydraulic Modeller Chemical Engineer
2135 IT Business Analysts, Architects and Systems Designers	Control Systems Specialist Metering and Billing Specialist
2136 Programmers and Software Development Professionals	Control Systems Specialist Metering and Billing Specialist
2139 IT and Telecommunications Professionals not elsewhere classified	Control Systems Specialist Metering and Billing Specialist
2413 Solicitors	Legal Consultant
2419 Legal professionals not elsewhere classified	Legal Consultant
2421 Chartered and Certified Accountants	Financial Consultant
2423 Management Consultants and Business Analysts	Commercial or Operations Manager
2424 Business and Financial Project Management Professionals	Commercial or Operations Manager Project Delivery Manager
2425 Actuaries, Economists and Statisticians	Financial Consultant Energy Demand Modeller

[110] The term 'not elsewhere classified' is used throughout the SOC2010 classification to describe activities which fit into the headline description of a part of the classification but not any of the other specific detailed codes within it.

SOC2010 Code	Heat network occupations
2431 Architects	Architects
2432 Town Planning Officers	Planning Consultant
2433 Quantity Surveyors	Development Manager Financial Consultant
2434 Chartered Surveyors (excludes Quantity Surveyors)	Surveyor
2435 Chartered Architectural Technologists	Architects
2436 Construction Project Managers and Related Professionals	Development Manager
2462 Quality Assurance and Regulatory Professionals	Planning Consultant
3112 Electrical and Electronics Technicians	Operation and Maintenance Technician
3113 Engineering Technicians	Operation and Maintenance Technician
3114 Building and Civil Engineering Technicians	Operation and Maintenance Technician
3116 Quality Assurance Technicians	Inspector and Tester
3531 Estimators, Valuers and Assessors	Surveyor
3541 Buyers and Procurement Officers	Project Delivery Manager
3561 Public Services Associate Professionals	Community Engagement Officer Project Delivery Manager
5241 Electricians and Electrical Fitters	Installer (including HIU installation)
5314 Plumbers and Heating and Ventilating Engineers	Installer (including HIU installation)
5330 Construction and Building Trades Supervisors	Civil Engineering / Construction Site Manager
8133 Routine Inspectors and Testers	Inspector and Tester
8149 Construction Operatives not elsewhere classified	Civil Engineering Operative Pipe Layer (including Welder)
9120 Elementary Construction Occupations	Civil Engineering Operative

Appendix D: Occupation skills mapping

This appendix reviews 11 key occupations of relevance to the heat network industry, and considers the skills needed, preferred qualifications, and career pathway for each. It also presents a diagram showing a rating of skills by their transferability from other sectors against their importance to the role.

The 11 occupations illustrated in this section are:

- Project Delivery Manager
- Heat Network Development Manager
- Commercial / Operations Manager
- Energy Master Planner
- Design Engineer
- Legal Specialist
- Financial Specialist
- Control System Specialist
- Operations and Maintenance Technician / Inspector
- Pipe Layer (including welding)
- Installer

These have been fashioned using online job descriptions and interviews with stakeholders. However, it is important to note that this should be taken as an indicative reflection of the industry, as opposed to a comprehensive assessment of each occupation. Organisations in the sector will have their own structure for which they require a unique set of skills. As such these illustrations serve only as a guide to each occupation.

Each slide shows, from top to bottom:

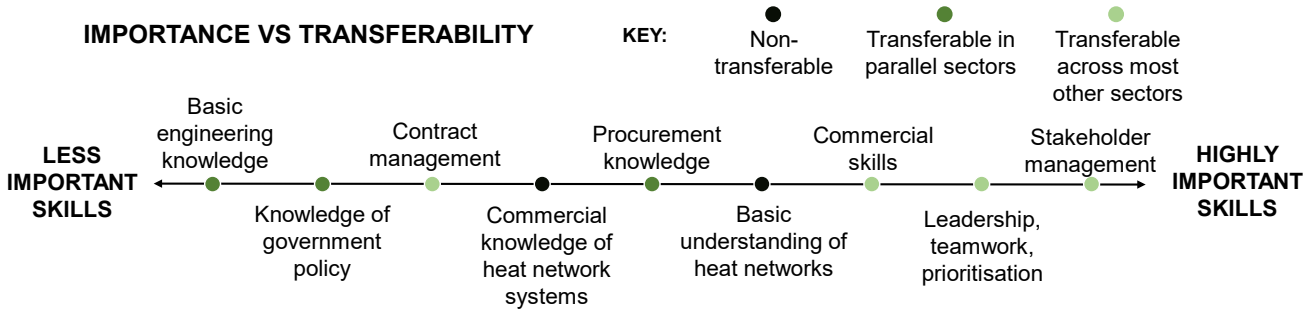
- The stages of a heat network project in which this role might be most involved, indicated by darker shades of green. Stages in grey are where this role might not be involved at all.
- A summary of key tasks within a project, shown in a green box.
- A table of information gathered regarding skills needed, qualifications and experience desired, and career pathways.
- A summary of skills most frequently lacking in this role, according to respondents, shown in a red box
- A diagram to summarise transferability of skills, with the most important skills shown on the right of the diagram, and darker coloured dots denoting the less transferable skills.

Project Delivery Manager

Key tasks of a Project Delivery Manager: The main role of the project delivery manager is to oversee the whole process of the creation of a heat network. They facilitate the communication and the conditions so all contractors working on a heat network project can interact with each other to deliver a successful project. They must communicate with and report progress to stakeholders - council senior management, councillors, and community. They typically work at local authorities or housing associations.

Skills needed	Qualifications and experience desired	Career pathway
• Commercial knowledge of heat network systems (cost to buy and run, how much carbon they save) • Basic understanding of heat network systems (how equipment functions, relative merits and disadvantages are of different pieces of equipment etc.) • Commercial skills incl. risk management • Procurement knowledge • Contract management • Stakeholder management • Knowledge of government policy • Soft skills incl. communication, negotiation, being inquisitive, balancing priorities, leadership, teamwork, problem solving & managing others with greater understanding of technical detail • Basic engineering knowledge	No one particular qualification is required, and there is no requirement to have worked on heat networks previously. The following are all considered to be of some use: • Experience in project management within building services • Experience of procurement in the public sector • Contract management (NEC 3/4 or equivalent) • Level 3 qualifications in Building / Environment / Engineering / Quantity Surveying • CIBSE Code of Practice (CP1) • Prince 2 PM or equivalent training	Individuals will typically start out as junior project managers, supporting a lead project manager on any given project. If not recent graduates, then likely to join from elsewhere in the public sector or from building services Promotion likely to occur after 3+ years, once the individual has gained more relevant experience, although there is no one pathway that all take. Common for project managers to move across to other energy sectors.

Skills lacking: It's rare to find new recruits that have experience or understanding of the heat network landscape specifically. They also struggle to find individuals with the relevant commercial skills and experience of procuring large scale projects.

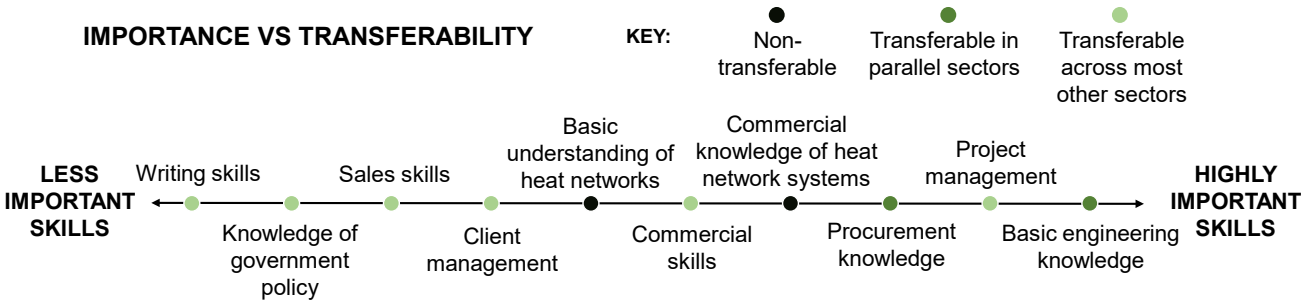


Heat Network Development Manager

Key tasks of a Heat Network Development Manager: This individual is responsible for overseeing the feasibility and design phases of a heat network development. They identify and secure new contracts, oversee the strategic direction of their heat network portfolio, manage internal resources and subcontractors, explore innovations, and report to clients (normally local authorities or housing associations).

Skills needed	Qualifications and experience desired	Career pathway
• Basic engineering knowledge • Commercial knowledge of heat network systems (cost to buy and run, how much carbon they save) • Basic understanding of heat network systems (how equipment functions, relative merits and disadvantages are of different pieces of equipment etc.) • Writing skills • Sales skills • Commercial skills • Client management and understanding client needs • Knowledge of government policy • Soft skills incl. communication, negotiation, being inquisitive, balancing priorities, leadership, teamwork, problem solving & managing others with greater understanding of technical detail • Procurement knowledge	• Mechanical or Chemical Engineering Degree • Experience of sales and developing proposals • Business Administration qualification • Prince 2 PM training or similar • CIBSE Code of Practice (CP1)	Typically start out as engineers before progressing to development managers after minimum 5 years working on district heating projects

Skills lacking: Similar to Project Delivery Managers, Heat Network Development Managers typically lack the breadth or roles required in this position, commonly possessing strong project management or engineering skills but rarely both.

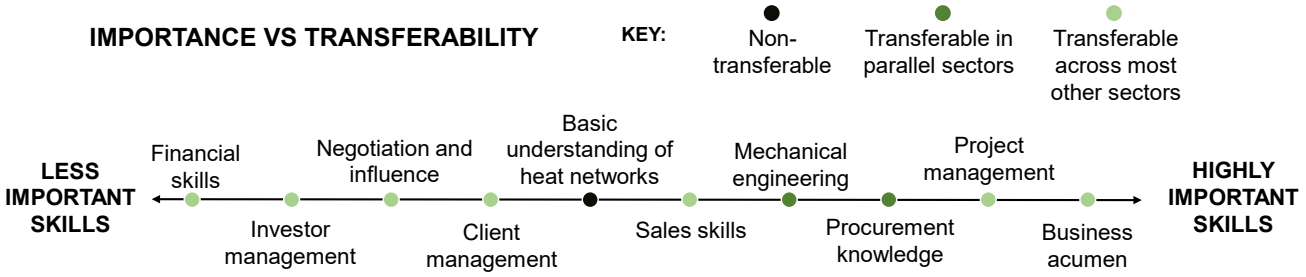


Commercial / Operations Manager

Key tasks of a Commercial / Operations Manager: They are in charge of business development and bid management, including: seeking / negotiating for sources of heat / cooling for the network; seeking and negotiating with new customers for the heat / cooling supplied, developing proposals and preparing quotations; pricing; dealing with the full project process; management of customers, partners and supply chain; advising clients and investors.

Skills needed	Qualifications and experience desired	Career pathway
• Basic knowledge of heat network systems • Business acumen and developing proposals • Client management and understanding client needs, for both heat users and suppliers. • Investor management and understanding investor needs • Project management incl. communication skills • Negotiation and influence • Sales skills, for both heat users and suppliers • General knowledge of mechanical engineering • Procurement knowledge • Financial skills	• Mechanical or Chemical Engineering Degree • Level 3 Qualifications in Building / Environment or appropriate subjects • Experience of sales and developing proposals • Prince 2 PM training or similar • CIBSE Code of Practice (CP1)	Typically two progression routes to this level (5+ years experience): 1. Starting as sales assistant executive or co-ordinator roles and progressing accordingly 2. Starting as a technical engineer before taking on responsibility for running own projects before starting overseeing, and bidding for, contracts

Skills lacking: Suitable business acumen is often the key skill lacking among organisations that struggle to find commercial managers with necessary proficiency.

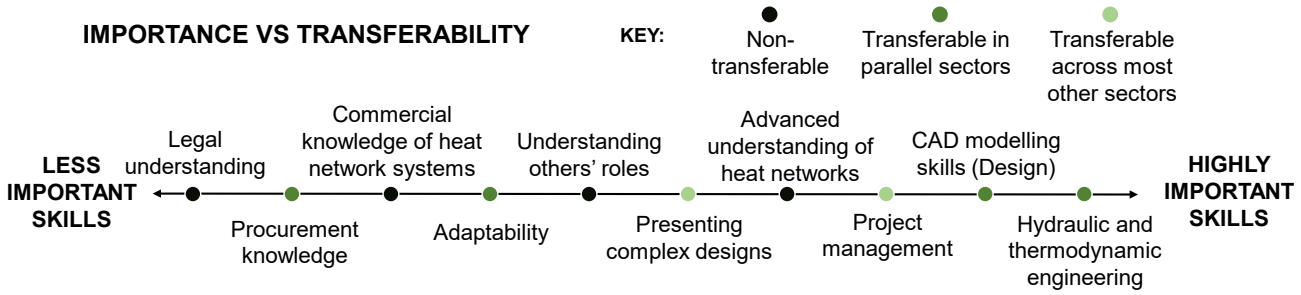


Energy Master Planner

Key tasks of an Energy Master Planner: They are responsible for the management and development of heat network design. They study, research and develop ideas for systems (including sizing the network, considering distribution and transmission), and modify existing products or processes to improve efficiency and performance. They design and implement energy systems, and develop projects from an outline brief and specification. They regularly consult with clients to understand their requirements.

Skills needed	Qualifications and experience desired	Career pathway
• Hydraulic and thermodynamic engineering skills • CAD modelling skills (Design) • Advanced understanding of heat network system • Understanding the day-to-day activities of contractors and other staff • Project management incl. teamwork, communication, client interaction • Ability to present complex designs to lay audience • Commercial knowledge of heat network systems • Procurement knowledge • Legal understanding • Adaptability to new technologies	• Experience working with Design and Build contractors • Experience working with district heating network operators • Engineering degree (typically in Mechanical or Electrical Engineering) • CIBSE CP1 training	There is no standard pathway. Entrants to the occupation might be recent graduates, or transfer from neighbouring engineering or building sectors, although the former is more cost effective for organisations. They often start as design engineers working on a component of the heat network, before progressing to being principal planners/designers. There is a lot of movement both within the sector and outside the sector in this occupation.

Skills lacking: There is acceptance that no-one comes to the role fully proficient. Few are able to fully understand individual operators' roles. Intricate knowledge of heat networks can be lacking among those transferring from other sectors, although most accept that this can be developed. There is also a lack of commercial and legal understanding

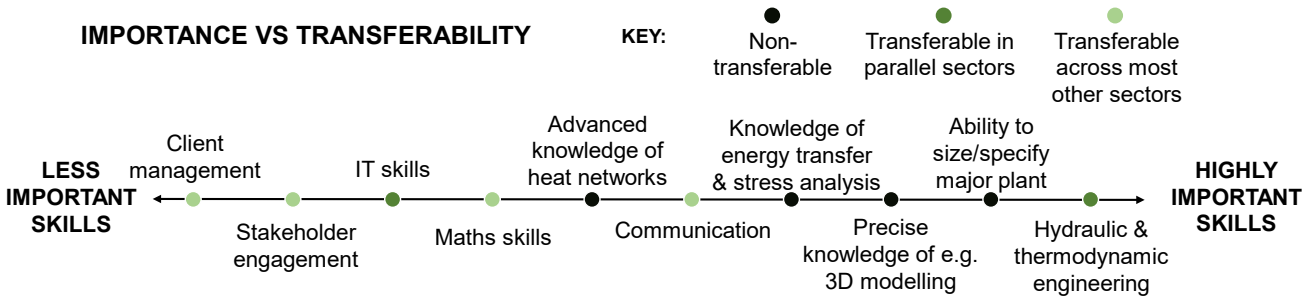


Design Engineer

Key tasks of a Design Engineer: They design mechanical and electrical systems for buildings. They take designs from concept through to production, building and testing prototypes. They produce reports and presentations, including design feasibility studies

Skills needed	Qualifications and experience desired	Career pathway
• Hydraulic and thermodynamic engineering • Ability to size / specify major plant such as boilers, CHP engines, pumps, heat exchangers and chillers • Precise knowledge of e.g. 3D modelling, P&IDs and Engineering Schematics in 2D AutoCAD Experience; energy pro sizing software to size plant; pipe positioning • Knowledge of energy transfer and stress analysis • Advanced knowledge of heat network systems • IT skills (Excel used for calculations/financial modelling); • Ability to present the results to the clients; being able to sell the idea to clients • Stakeholder engagement • Communication skills • Maths skills	• Degree qualified in Mechanical, Building Services or Energy Engineering • Some experience of process engineering or building services	Most will come from roles in building services or design engineering and have at least 4-5 years experience before moving into more managerial level roles. Garnering experience of working on heat networks themselves opens up opportunities to progress, although the market is very small

Skills lacking: There is a limited theoretical or practical knowledge and understanding of heat networks, which new recruits will need to learn early on, on the job.

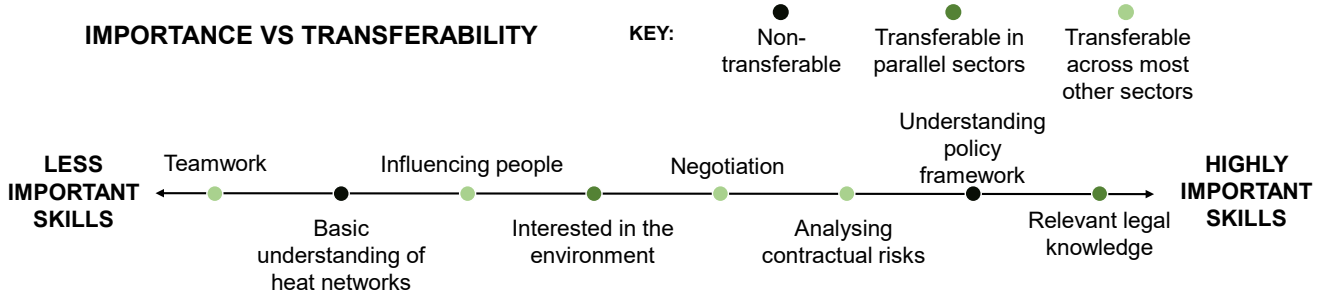


Legal Specialist

Key tasks of a Legal Specialist: Legal expertise is typically subcontracted to specialists operating in law firms. They are responsible for advising and resolving issues of a contractual, procurement, and planning nature, often acting as intermediary across a range of stakeholders.

Skills needed	Qualifications and experience desired	Career pathway
• Analysing risks in contractual agreements • Motivation / commitment to the environment • Basic understanding of heat networks • Understand policy framework • Negotiation • Teamwork • Influencing others • Relevant legal knowledge (incl. corporate, commercial, construction, public procurement and state aid)	• UK-based law degree, preferably specialising in one of corporate, commercial, construction, public procurement and state aid.	Individuals need to specialise fairly early in their law career. So while sideways movement is possible, typically 'new' legal advisors will be recent graduates. They would take the usual route through law firms, starting as a trainee before progressing through to associate solicitor, senior associate solicitor, and partner.

Skills lacking: While there is some relevant knowledge at more junior levels, those at more senior levels typically have limited experience of the heat network sector.

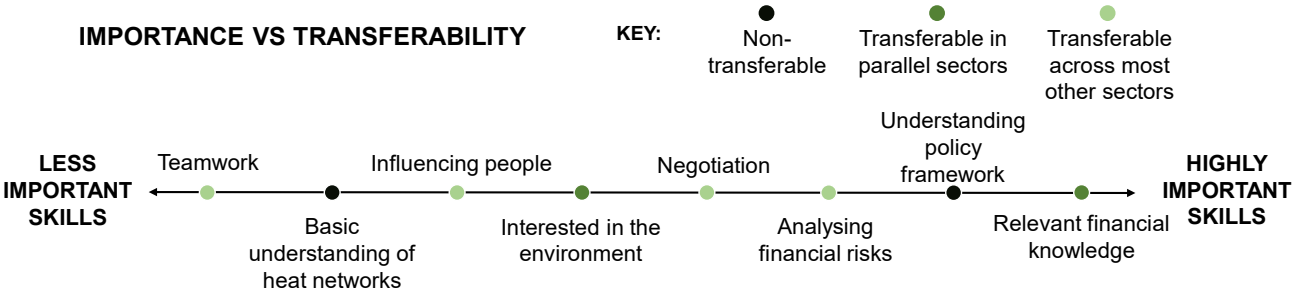


Financial Specialist

Key tasks of a Financial Specialist: Financial expertise is typically subcontracted to specialists operating in financial consultancies. They are responsible for advising and resolving issues of a financial nature, often acting as intermediary across a range of stakeholders.

Skills needed	Qualifications and experience desired	Career pathway
• Analysing financial risks • Strong understanding of the financial considerations and targets surrounding heat network delivery • Motivation / commitment to the environment • Basic understanding of heat networks • Understand policy framework • Negotiation • Teamwork • Influencing others	• Chartered accountancy qualification	Similar pathway as among legal advisors. Individuals need to specialise fairly early in their finance career. So while sideways movement is possible, typically 'new' finance advisors will be recent graduates. They would take the usual route through consultancies.

Skills lacking: While there is some relevant knowledge at more junior levels, those at more senior levels typically have limited experience of the heat network sector.

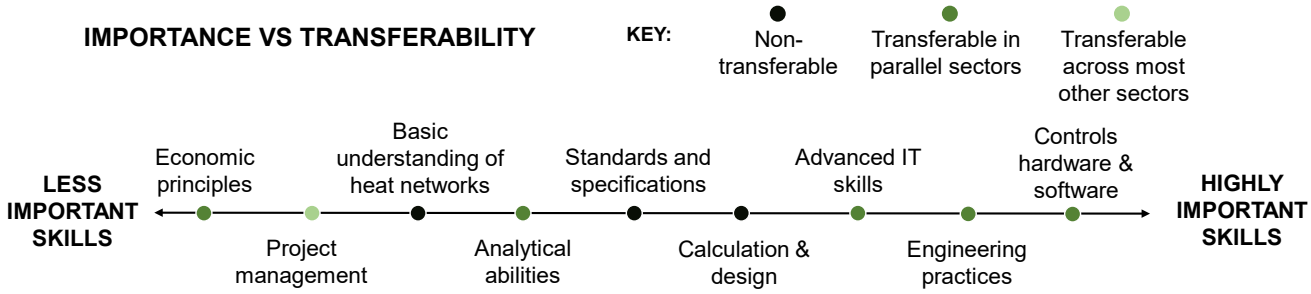


Control System Specialist

Key tasks of a Control System Specialist: They are involved in designing, developing, installing, managing and maintaining equipment which is used to monitor and control engineering systems, machinery and processes. They make sure that these systems and processes operate effectively, efficiently and safely. The role is multidisciplinary, working closely with colleagues across a number of functions, including operations, purchasing and design.

Skills needed	Qualifications and experience desired	Career pathway
• Knowledge of controls hardware and software • Knowledge of engineering practices • Associated IT skills to be able to develop / install systems and make hardware and customised software work together. • Knowledge of economic principles • Knowledge of calculation methods, design details • Knowledge of international codes, standards and specifications • Analytical abilities • Project management • Basic understanding of heat networks	• Mechanical Engineering Degree • Operational experience of heat networks • Experience of integrating bespoke or customised software with industrial hardware.	This is a fluid occupation: a number transfer from the buildings services sector into this role, but the reverse is also true with specialists leaving the sector to work elsewhere. There are no defined career pathways since the joint software / hardware development skills are highly specialist and generally learned through experience which may be gained in a range of ways.

Skills lacking: There is a general lack of skills in new recruits, and in particular direct experience working in the heat network sector. However, organisations that have the capacity to train new recruits find this is a straightforward task if people have the right baseline degree and some experience in the energy sector.

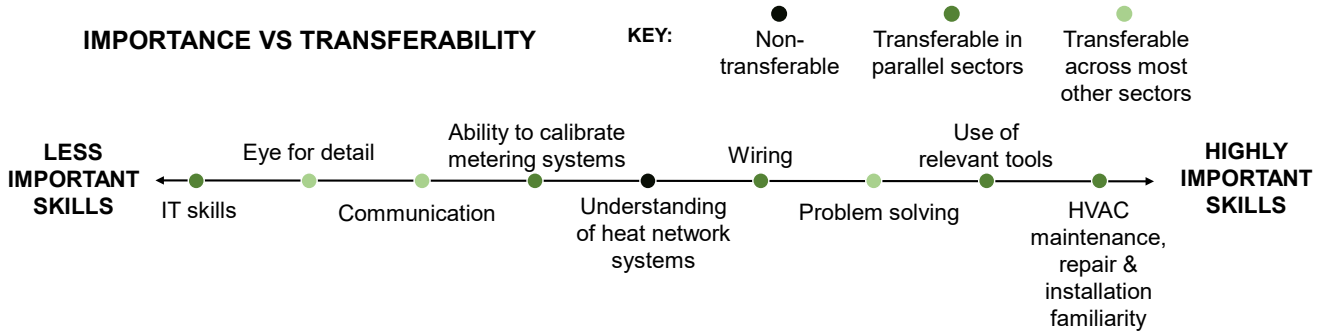


Operations & Maintenance Technician / Inspector

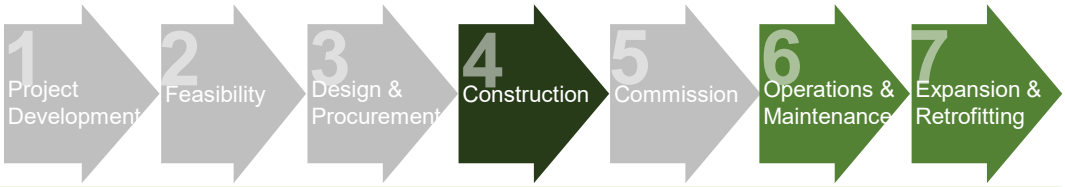
Key tasks of an Operations and Maintenance Technician/Inspector: They provider full operational and maintenance support to the heat network system, responsible for systems procedures, inspect and/or test parts and products; controls and reporting; compliance and standards, conducting risk assessments; assisting with maintenance budgets; dealing with stakeholders which could include suppliers, contractors, tenants, service providers, commercial building owners and private domestic customers

Skills needed	Qualifications and experience desired	Career pathway
• Familiarity with HVAC maintenance, repair and installation • Good understanding of heat network systems • Use of relevant tools and components associated with repairs and installation (e.g. HIU, heat pumps, pipes) • Ability to calibrate and maintain bespoke metering systems • IT skills and familiarity with relevant software • Problem solving • Wiring • Eye for detail • Communication	• Experience in breakdown/repair / maintenance on heat interface units or more general experience of HVAC maintenance, repair and installation. • Plumbing qualification is important; a Level 2 in Mechanical / Electrical NVQ and hot water certification also desirable	New starters are often recent apprentices who have undertaken a relevant qualification. There is a lot of movement across the energy sector however for these technicians, with limited opportunity for progression.

Skills lacking: There is a lack of good problem solvers, i.e. individuals who are able to inspect a system and understand it sufficiently to be able to resolve it themselves.



Pipe Layer (including welding)

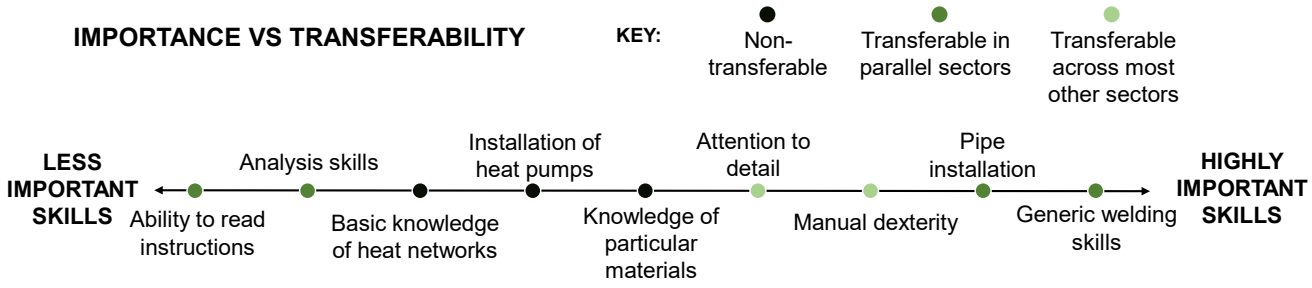


Key tasks of a Pipe Layer: Typically working on a construction site, these individuals need to follow engineering drawings/instructions, prepare relevant materials, calibrate tools and machinery, operate equipment, and inspect work, as they lay and fit the pipes used to distribute heat in the heat network

Skills needed	Qualifications and experience desired	Career pathway
• Generic welding skills • Pipe installation • Knowledge of particular materials and how to install them correctly • Installation of heat pump technologies • Manual dexterity • Attention to detail • Ability to analyse quality and performance • Basic knowledge of heat networks • Ability to read and interpret instructions	• Level 2 or 3 NVQ in Welding Skills or Welding Engineering Technology • Appropriate welding certification according to international coding standard • Safety certificate e.g. CSCS Card	New starters are often recent apprentices who have undertaken a relevant qualification. There is a lot of movement across the energy sector however for these techicians, with limited opportunity for progression.

Skills lacking: It is relatively easy for welders to work across different sectors, which means that knowledge of heat network systems themselves is often lacking (although these can be learnt with relative ease).

IMPORTANCE VS TRANSFERABILITY

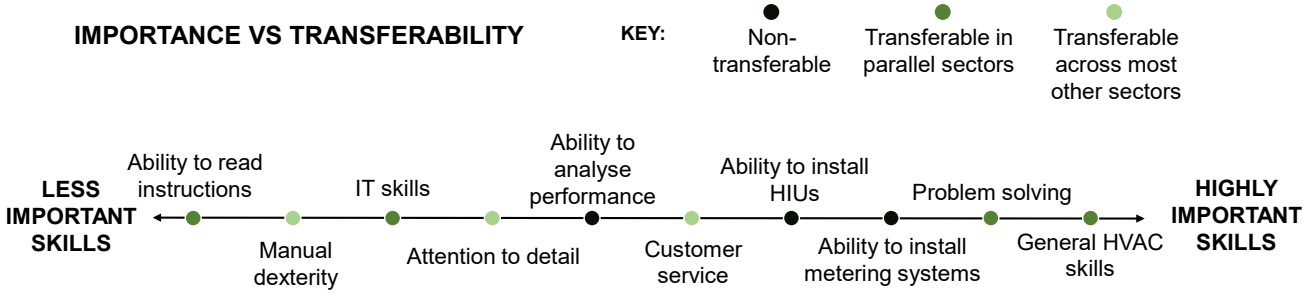


Installer

Key tasks of an Installer: Their primary function is to connect homes and businesses to the heat network. They work on low/high pressure and temperature installations in district heating system properties, servicing and repairing Hydraulic Interface Units (HIUs), installing meters, diagnosing faults, carrying out minor electrical repairs and attending callouts as necessary.

Skills needed	Qualifications and experience desired	Career pathway
• Ability to install hydraulic interface units (HIUs) • Manual dexterity • Attention to detail • Ability to analyse quality and performance • Ability to install and calibrate bespoke metering systems • Maintenance, repair and installation: HVAC • IT literate and be comfortable working with an electronic works management systems (CAFM) • Problem solving • Customer service skills • Ability to read and interpret instructions	• Level 2 or 3 NVQ in gas, plumbing and/or mechanica/engineering • Those starting in more senior positions will be expected to have experience of installing and repairing HIUs	New starters are often recent apprentices who have undertaken a relevant qualification. They will identify as working in the broader building sector as opposed to the heat network sector, hence much movement occurs into and out of the industry. Promotions to senior positions normally likely after five years' experience specifically in domestic heating systems.

Skills lacking: It is relatively easy for installers to work across different sectors. The research did not unpick any particular skills lacking in this occupation.



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